Canada North Environmental Services Limited Partnership

A First Nation Environmental Services Company

NUCLEAR WASTE MANAGEMENT ORGANIZATION
ADAPTIVE PHASED MANAGEMENT PROJECT – NORTHWESTERN ONTARIO REGION

ENVIRONMENTAL MEDIA BASELINE PROGRAM DESIGN

Final Report

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LIST OF ACRONYMS

Term	Description
AACE	Association for the Advancement of Cost Engineering
AAQC	Ambient Air Quality Criteria
AMIS	Abandoned Mines Information System
AOI	Area of Interest
APM	Adaptive Phased Management
ATV	Acoustic Televiewer
BACI	Before-After-Control-Impact
BCMOE	British Columbia Ministry of the Environment
BEAHR	Building Environmental Aboriginal Human Resources
BIS	Biodiversity Impact Studies
BOLD	Barcode of Life Database
C-14	Carbon-14
CAAQS	Canadian Ambient Air Quality Standards
CABIN	Canadian Aquatic Biomonitoring Network
CALA	Canadian Association for Laboratory Accreditation Inc.
CCME	Canadian Council of Ministers of the Environment
CES	Critical Effect Size
CIE	Commission Internationale de L'Eclairage/International Commission on Illumination
CIHR	Canadian Institute of Health Research
CNSC	Canadian Nuclear Safety Commission
CO	Carbon Monoxide
COC	Chain of Custody
COPC	Contaminant(s) of Potential Concern
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
COSSARO	Committee on the Status of Species at Risk in Ontario
Cs-137	Cesium-137
CSA	Canadian Standards Association
CSM	Conceptual Site Model

DGR	Deep Geological Repository
DMP	Data Management Plan
DOC	Dissolved Organic Carbon
DQO	Data Quality Objective
DRL	Derived Release Limit
ECCC	Environment and Climate Change Canada
ELC	Ecological Land Classification
EMBP	Environmental Media Baseline Program
eDNA	environmental DNA
FNIGC	First Nations Information Governance Centre
H-3	Tritium
HVAS	High-Volume Air Sampler
I-129	Iodine-129
IA	Impact Assessment
IAIA	International Association for Impact Assessment
ICP-MS	Inductively Coupled Plasma Mass Spectrometry
ICRP	International Commission on Radiological Protection
IISD	International Institute for Sustainable Development
IMS	Information Management System
IK	Indigenous Knowledge
ISO	International Standards Organization
IWA	Ignace Withdrawal Area
IWA-A	Ignace Withdrawal Area A (Revell Batholith)
Kr-85	Krypton-85
LSA/LSA_x	Local Study Area/Local Study Area for 'x' component
m bgs	metres below ground surface
MECP	Ontario Ministry of the Environment, Conservation and Parks
MEND	Mine Environment Neutral Drainage Program
MGBHP	Migratory Game Bird Hunting Permit
MNRF	Ontario Ministry of Natural Resources and Forestry
MOE	Ontario Ministry of the Environment (now MECP)

MOEE	Ontario Ministry of the Environment and Energy (now MECP)
MOECC	Ontario Ministry of the Environment and Climate Change (now MECP)
MOU	Memorandum of Understanding
MTO	Ontario Ministry of Transportation
NH_3	Ammonia
NHIC	Natural Heritage Information Centre
NIST	National Institute of Standards and Technology
NO_2	Nitrogen Dioxide
NO_x	Nitrogen oxides
NWMO	Nuclear Waste Management Organization
O_3	Ozone
OBBN	Ontario Benthos Biomonitoring Network
OPG	Ontario Power Generation
OSAP	Ontario Stream Assessment Protocol
PAH	Polycyclic Aromatic Hydrocarbon
PHC	Petroleum Hydrocarbon
$PM_{2.5}$	Particulate Matter less than 2.5 µm in diameter
PM_{10}	Particulate Matter less than 10 µm in diameter
PMP	Probable Maximum Precipitation
PSP	Permanent Sampling Plot
PUF	Polyurethane Foam
QA/QC	Quality Assurance/Quality Control
Ra-226	Radium-226
RDL	Reportable Detection Limit
Rn-222	Radon-222
RSA/RSA_x	Regional Study Area/Regional Study Area for 'x' component
Sr-90	Strontium-90
SAR	Species at Risk
SC	Study Component

SEP	Selective Extraction Procedure
SO_2	Sulphur Dioxide
SOP	Standard Operating Procedure
SSA	Site Study Area
SVOC	Semivolatile Organic Compound
SWH	Significant Wildlife Habitat
TSP	Total Suspended Particulate
U.S. EPA	United States Environmental Protection Agency
UTM	Universal Transverse Mercator
VOC	Volatile Organic Compound
WLON	Wabigoon Lake Ojibway Nation

EXECUTIVE SUMMARY

INTRODUCTION

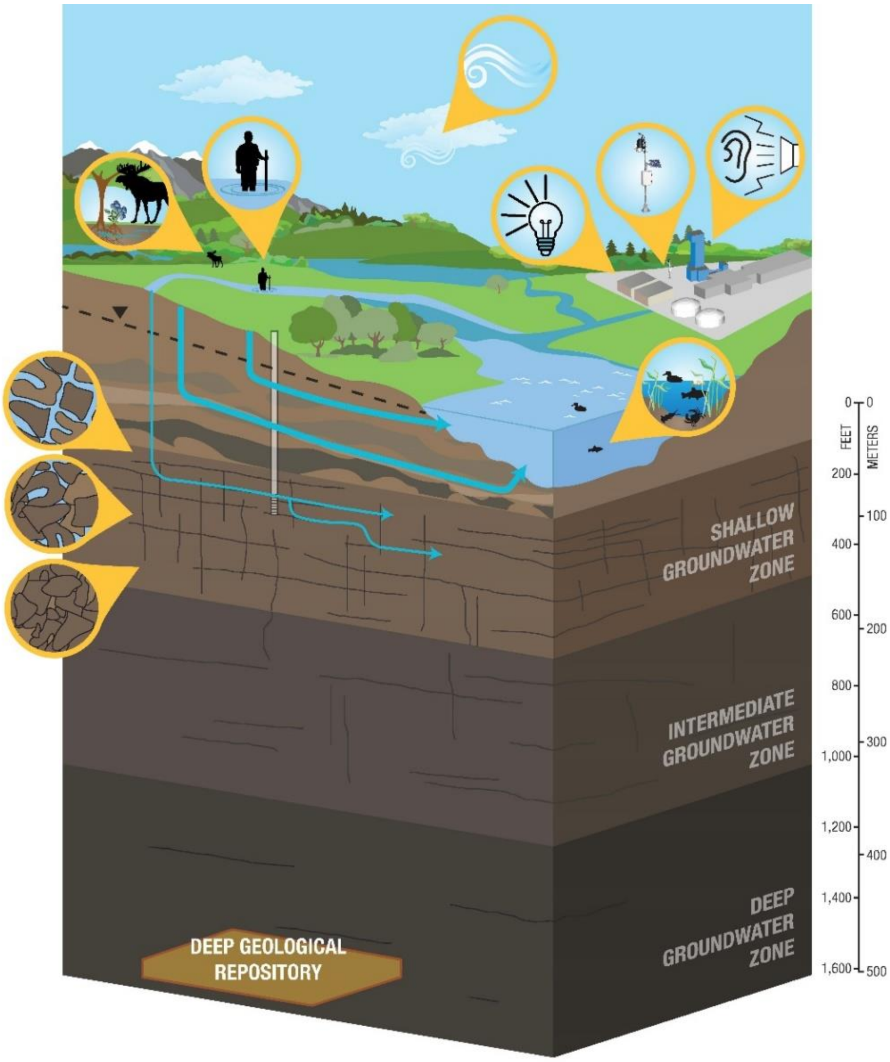
The objective of this report is to present the sample design for the Environmental Media Baseline Program (EMBP) to be completed in the Northwestern Ontario region, which is one of the Nuclear Waste Management Organization's (NWMO) proposed locations for the Deep Geological Repository (the Project). The NWMO is conducting its activities related to the Project in a manner that protects the public and the environment, promotes community understanding, and addresses and incorporates community, First Nations, Métis and stakeholder concerns, interests, and well-being. As the NWMO has yet to identify a preferred site, it is acknowledged that the Impact Assessment process has not been initiated and the Duty to Consult has not been delegated. Throughout this document, the term stakeholder has been used to identify community members, agencies, private entities, etc., while rights-holder has been used to identify Indigenous peoples and communities (i.e., First Nations and Métis). These groups would be consulted in the event of an Impact Assessment.

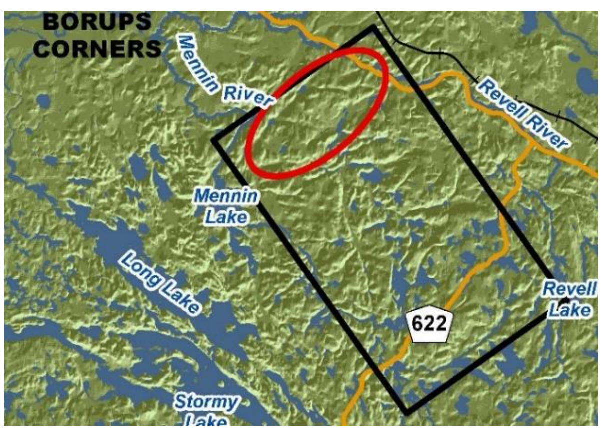
The EMBP will characterize parts of the environment before development of the Project. As shown in the Conceptual Site Model below for the biophysical environment, the focus of the EMBP is on select environmental components that have potential to interact with the Project and includes 1) tissues, 2) hydrology, 3) surface water parameters, 4) air quality, noise, and light, and 5) soil (soil quality and gamma radiation). Shallow groundwater and shallow bedrock also have the potential to interact with the Project, particularly with the surface environment, and are therefore important to monitor as well. Although these components were considered in the preliminary design process, they are being implemented under separate contract by the NWMO Geosciences group and detailed sample designs for them are therefore not included in this report.

The EMBP sample design has several objectives:

1. **To collect data of high importance to stakeholders and rights-holders, maximimizing the use of local and Indigenous Knowledge to ensure the data are appropriate and representative.**
2. **To collect data that are of high quality and are statistically rigorous.**
3. **To collect data that will provide adequate information for future modelling and preparation of an Impact Assessment.**
4. **To maximize opportunities for community involvement in completing the sampling, if desired.**
5. **To provide an understanding of potential cumulative effects.**

Figure ES.1 Conceptual Site Model for the biophysical environment



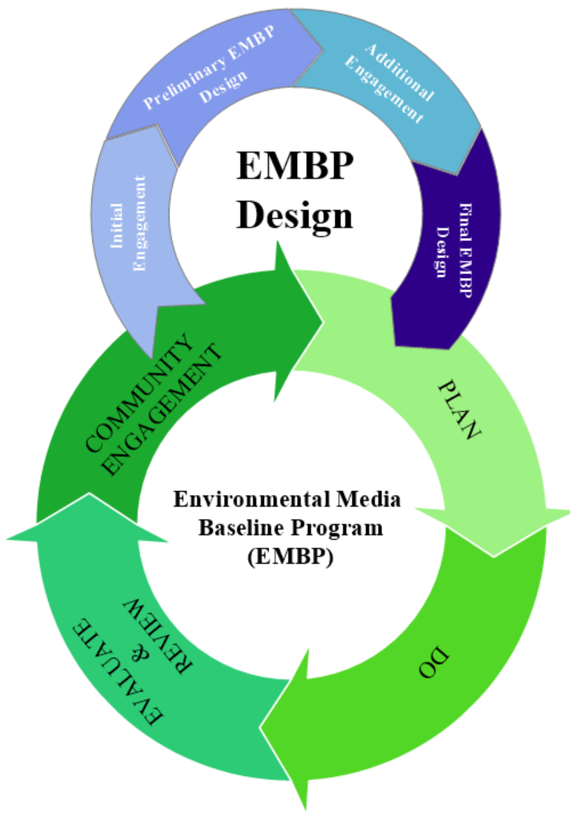


Revell Batholith Temporary Withdrawal Area (black rectangle) and Area of Interest (red elipse)

The NWMO has selected an Area of Interest as a future site for the Project (see red ellipse in picture). Some studies have already started in this area, such as preliminary water, soil, and sediment sampling. The EMBP sample design will build on those studies. Other types of studies, such as looking at animal use of the area, are not a part of this program but will be studied before Project development as part of the Biodiversity Impact Studies.

Input from stakeholders and rights-holders has been considered in the design presented herein, but it must be emphasized that the EMBP is not static. After every year of the three-year field sampling program, the data and assumptions will be reviewed and the EMBP will be modified as needed. A thorough evauation of the EMBP will be completed after Year 3. Additional input received from stakeholders and rights-holders will be considered during the reviews and three-year evaluation. The following diagram illustrates the process.

Figure ES.2 Adaptive management process for Environmental Media Baseline Program



SAMPLE DESIGN OPTIONS

Initial input provided through stakeholder and rights-holder workshops led by the NWMO, alongside evaluations of standard best practices and emerging technologies, was used to develop preliminary sample design options. There are many factors that can be modified in the sample design, including the following:

- **Sample type**
- **Sample size**
- **Sampling method**
- **Sample location**
- **Laboratory method**
- **What is measured in the sample**

Several sample design options were previously developed for each component that varied some of the factors listed above. Input on these various design options was sought from stakeholders and rights-holders through a second set of workshops. The preferred options, along with other recommended changes, were incorporated into the design and are presented in this final sample design report.

The list of Contaminants of Potential Concern measured in each component (i.e., water, soil) needs to be extensive to characterize the environment before the Project starts. This list was developed alongside the NWMO and with consideration of stakeholder and rights-holder concerns and includes numerous metals, radionuclides, and other parameters used to characterize the environment. The focus was on identifying contaminants of highest relevance to the Project (e.g., copper) and/or the community (e.g., glyphosate).

Provided below is summary information for the final sampling programs for each media type. Table ES.1 at the end summarizes the questions the EMBP is trying to answer for each component, the data types that are needed to answer each question, the selected methods that will be used to collect the data, as well as the strengths and limitations of each method.

TISSUES

Tissue chemistry includes testing baseline levels of metals and radionuclides in various parts of plants (e.g., berries, leaves, etc.) and animals (e.g., muscle, organs, etc.). This component is of particular interest to stakeholders and rights-holders, as demonstrated by the input provided during the community engagement workshops.

A preliminary list of tissue types to test was put together from

1. **Stakeholder and rights-holder input;**
2. **Plants and wildlife species commonly identified during Indigenous traditional foods programs;**
3. **Plants and wildlife species commonly identified in the uranium mining industry and nuclear power generation in Canada; and**
4. **Plants and wildlife species recommended in guidance documents.**

Since there are many potential tissue types to sample, they were grouped into primary (higher priority) and secondary (lower priority) categories, as well as into a category for those tissues not required. Measuring radionuclides requires a large amount of material be submitted to the laboratory; therefore, the ability to collect enough material for meaningful results without causing too much mortality was also considered when selecting primary tissue types.

Figure ES.3 Prioritizing tissue types for the Environmental Media Baseline Program

It is proposed that traditionally harvested plants and wildlife be collected by community members, if willing, during hunting, trapping, fishing, and harvesting activities. A dietary survey is recommended to collect information on the quantity, type, and general harvest locations of traditional foods consumed by stakeholders and rights-holders local to the Project.

The sample design for tissues involves lethally sampling primary tissue types for metals and radionuclides and non-lethally sampling secondary tissue types for metals. For the non-lethal program, samples of hair, feathers, or scales would be collected and analyzed. Measuring radionuclides is not an option using this laboratory method and, thus, only metals would be measured. This new innovative technique involves doing metal analyses using laser ablation, while maintaining industry-standard laboratory techniques and detection limits. The sampling program has been designed to involve stakeholders and rights-holders in decision making (i.e., what and where to sample) and sampling, if desired.

HYDROLOGY

Water flowing in Mennin Lake

Hydrology is the movement of water in the environment through precipitation (snow, rainfall), surface water (rivers, streams, lakes, wetlands), and groundwater. It is important to understand changes in flow throughout the year to prevent negative impacts to the local environment and to understand risks for flooding or drought. Hydrological studies provide information used to protect the local water supply, fish and wildlife habitat, and recreational activities.

The sample design consists of understanding current hydrological conditions by collecting data and information on flow in small streams and large rivers, on water levels and bathymetry (water depth) in lakes, by completing an aerial photo survey in winter, and by studying local weather patterns in order to assist in Project planning and design decisions to avoid, minimize, and monitor Project-related environmental impacts.

Flow and Water Levels

Flow monitoring in small streams consists of manually monitoring for seasonal flow measurements. The plan includes monitoring during the spring melt and the late summer dry period in the three years of the EMBP.

Staff gauge measuring water levels

Taking flow measurements

For larger rivers near the Project (Mennin and Revell rivers), manual flow measurements will be collected in the first year while a continuous water level measurement pressure transducer gauge will be installed to monitor hourly water levels. A relationship will be developed between flow and water level so that flow in subsequent years can be estimated directly from this relationship using water level measurements. This approach will provide a comprehensive dataset of the water level and estimated flow variability over the three years of the EMBP. It is anticipated that community members can assist in the field when taking flow measurements and maintaining these water level gauges.

Aerial Survey

An aerial photography survey will be conducted to assess the amount of snow and ice cover in the area during the winter. The aerial photography survey will involve collecting aerial imagery from flying drones over the area during the first year.

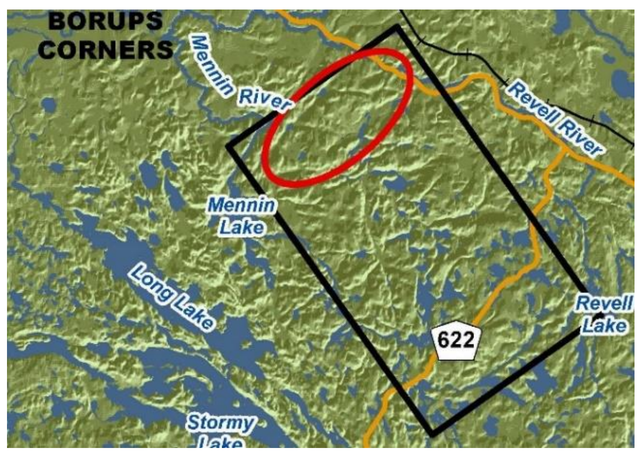
Meteorology

To monitor local weather patterns such as temperature, wind, rain, and snowfall, an automatic meteorological station will be installed. The meteorology data can also be used to derive a localized hydrology model of the area, which can support future climate change analyses.

SURFACE WATER PARAMETERS

The surface water parameters component measures baseline surface water and sediment quality (i.e., sand, soil, and debris at the bottom of a waterbody), which includes communities of phytoplankton (algae) and zooplankton (bugs) in the water column and benthic invertebrates (bugs) in the sediment. This component is an essential part of the EMBP because of potential Project interactions mainly related to effluent discharge and water withdrawal.

The Local Study Area is proposed to include waterbodies in the Area of Interest (red ellipse in the figure), Mennin Lake and downstream waterbodies, the Revell River north of the Area of Interest, parts of the Wabigoon River, and reference areas. It is not known if the Mennin River or Revell River would be impacted by the Project since the Project design hasn't been finalized, but an assumption was made that one of these rivers would be the discharge site for treated effluent.



Locations of the Mennin and Revell rivers relative to the Area of Interest (red elipse)

A Regional Study Area is included for surface water quality only and includes waterbodies identified as being significant to stakeholders and rights-holders.

Surface Water Quality

A surface water quality sampling program will occur in the Local Study Area to fill multiple data objectives. An extensive list of Contaminants of Potential Concern will be measured, including general water chemistry parameters, nutrients, ions, total and dissolved metals, parameters related to treated sewage effluent, and radionuclides. At waterbodies in the Area of Interest, glyphosate is being measured because of community concerns from forestry practices, even though there is no interaction with the Project. In each study area, quarterly sampling (four times a year; once per season) will be completed to capture seasonal differences.

In the Local Study Area, 6 ponds in the Area of Interest, 3 reference ponds, 11 sampling areas in the Mennin Lake drainage, Revell River, and Wabigoon River, and 2 reference lake sampling areas are included in the sample design. In addition to using standard field methods, an autonomous remote monitoring station will be installed to collect continuous water quality data for certain Contaminants of Potential Concern over the long-term. This component is planned for Year 3 when Project plans are further along.

Example of a community member taking a water sample

The regional program was designed to collect water quality data from lakes identified as important to local stakeholders and rights-holders and from lakes close to Ignace and Wabigoon Lake Ojibway Nation. The intent is for the sampling locations to be largely selected by community members and for the sampling to be completed by community members, once properly trained.

Sediment Quality

Sediment quality will be sampled in the Local Study Area and reference areas from the same study areas described above for the water quality monitoring program. Three or five replicate stations will be sampled depending on the study area. The Contaminants of Potential Concern to be measured in sediment include metals, moisture, total organic carbon, particle size, nutrients (e.g., ammonia, nitrate, phosphorus), and a comprehensive list of radionuclides. Sediment sampling will occur in the Fall of Year 2 only, as concentrations of contaminants in sediment change slowly over time. Sediment sampling will be paired with the benthic invertebrate monitoring program. The recommended sampling method for the EMBP is a gravity coring device, as this method does not disturb the top layer of the sediment as much as grab samplers and it enables the sampling of a set horizon (e.g., 0 cm to 2 cm sediment depth). Since sediment sampling requires experience with sampling

Sediment core

equipment and protocols, it is recommended that community members be involved as field assistants, which will provide a training opportunity, capacity building, and employment.

Plankton

Plankton is paired with the surface water quality program, as plankton provide an assessment of water quality and an indication of nutrient levels. Plankton sampling to document baseline community composition and biomass estimations will be completed at three sampling areas in Mennin Lake and two sampling areas in the reference lake, with three stations per sampling area. Quarterly sampling will be completed to capture seasonal data. In addition, chlorophyll a, which relates to phytoplankton, will be measured in the Local Study Area and at reference areas at all locations in which water samples are being taken. Chlorophyll a and blue green algae will be among the parameters measured by the autonomous remote monitoring station being installed during Year 3 of the EMBP.

In addition to standard field and laboratory sampling methods, zooplankton community composition will also be assessed using environmental DNA (eDNA) analyses, which is a novel and emerging method for identifying species presence/absence in the environment from a water sample. This sampling will be completed in the Fall of Year 2 and Year 3 of the EMBP, alongside the benthic invertebrate monitoring program. This will begin the process of building an eDNA barcode reference sequence library to enable future biomonitoring of eDNA.

Benthic Invertebrates

The benthic invertebrate sampling program is paired with the sediment program as benthic invertebrates provide information on sediment quality and the ecology of the area. However, unlike sediment, benthic invertebrate samples will be collected in the Fall of Year 2 and Year 3 to provide multiple years of data.

Benthic invertebrate samples will be collected to document baseline community composition and biomass estimations at the same study areas as the water and sediment monitoring programs, with the exception of the Area of Interest ponds and reference ponds. Five replicate stations will be sampled in each study area, and the habitat types to be sampled will be determined during Year 1 of the program. Standard field and laboratory sampling methods will be used alongside eDNA analyses to enable a comparison of the data collected and to build an eDNA barcode sequence library.

Benthic invertebrate sample

AIR QUALITY, NOISE, AND LIGHT

The existing air quality, noise, and light conditions in the Project area will be characterized for comparison to future modelled or measured levels. Feedback from stakeholders and rights-holders indicated that there was a concern regarding potential cumulative effects of the Project, particularly with regard to air quality. Furthermore, air quality is an indicator of change in human and environmental health, while noise and light changes may impact members of the community and wildlife.

Air Quality

Air quality monitoring station

The contaminants that have been considered for inclusion in the air quality program have been sorted into two tiers: Tier 1 and Tier 2. Tier 1 includes conventional air quality contaminants that are tracked by provincial and national monitoring programs and are expected to be readily measurable in the area, as well as key radiological contaminants that may be of concern to the community, such as radon. The Tier 2 contaminants are those that may be present in low amounts, such as trace metals and radionuclides.

The air quality program consists of using approved air quality monitoring methods in the immediate vicinity of the potential Project location (i.e., the Site Study Area). A secondary network of offsite passive air monitoring stations in the Local Study Area will expand the spatial coverage of the program to within approximately 10 km of the potential Project location. The program involves training a community member to assist with the implementation of the program, with the intent of passing responsibility for it to the community.

Noise

The EMBP will include measurement programs to characterize the existing noise levels in the Site Study Area and the Local Study Area. Noise from the Project is expected to be confined to the Local Study Area. The proposed program will occur in Year 1 only and will account for seasonal variability. The recommended option for baseline noise monitoring involves training a community member to assist in the implementation of the program.

Noise meter

Light

The EMBP will include a measurement program to characterize the existing light conditions in the Site Study Area in Year 1. The measurements will consist of illuminance (i.e., the amount of light being received at a sensitive location) and sky glow (the extent to which the sky is illuminated by artificial sources). The recommended option involves training a community member to assist in the implementation of the program.

SOIL QUALITY

Soil

The soil quality component of the EMBP includes assessing soil at the ground surface. Soil and rock at a depth down to 100 m are being covered under different contract, and the details of the design and monitoring are not included in this report. Surficial soil quality and the protection of soil is listed by the stakeholders and rights-holders as important. Soil and near-surface bedrock quality supports the health of plant tissues, including edible plants, roots, flowering bushes, traditional medicines, and rock, and can also impact animal tissues, surface water quality, and sediment quality.

Soil quality is to be sampled primarily in Year 1 using standard field methods, with confirmation sampling occurring in Year 2 at a subset of the Year 1 locations. Soil eDNA will also be conducted to complement the terrestrial environment eDNA program being planned separately as part of the Biodiversity Impact Study that will focus on larger vertebrate species. The soil eDNA sampling will largely be completed in Year 1 alongside the benthic invertebrate monitoring program. This will begin the process of building an eDNA barcode reference sequence library to enable future biomonitoring of eDNA.

An additional component of the soil program is to characterize the gamma radiation levels of the surficial soils in the area to support future impact and risk assessments. The gamma radiation survey, completed in Year 3 only, will characterize the background levels of gamma radiation in the area of the proposed Project at one metre above ground surface.

Table ES.1 Rationale for selected EMBP design

Question we are trying to answer	Data types needed to answer question	Method(s)	Strengths	Limitations
Tissues				
What are the baseline chemistry conditions of traditionally harvested animals, plants, and medicines that are of importance to stakeholders/rights-holders prior to Project development?	Chemical analyses of a number of different primary tissue types identified by stakeholdes/rights-holders that are of the most importance.	Lethal sampling methods (radionuclide and metals data will be collected for the baseline).	Gathering samples with the input and aid of stakeholders and right-holders on species they feel are important to culture, lifestyle, and food security will help to build trust and build a strong tissue baseline dataset that will be valuable for any future human health and ecological risk assesments.	The program will be challenging and will require further community engagement and a well coordinated team to carry out the number of samples proposed. The sample sizes for the certain SCs required for radionuclides may be difficult to obtain and the species will need to be lethally sampled. The costs of chemical analyses, particularly for radionuclides, is very high.
What are the baseline chemistry conditions of non-harvested species that are of importance to the ecological risk assessment prior to Project development?	Chemical analyses of a number of secondary tissue types identified by stakeholdes/rights-holders and the Project.	Non-lethal sampling methods (metals data will be collected for the baseline).	Species do not need to be lethally sampled in order to collect baseline information.	Radionuclides cannot be analyzed using these new methods. However, the new innovative technique (Metals - ICP-MS) using laser ablation will maintain industry-standard laboratory techniques and detection limits.
What are the baseline chemistry conditions of soils that are co-located with lichen and edible vegetation samples (e.g., berries etc.) prior to Project development?	Chemical analyses of a number of soil samples co-located with vegetation species (e.g., berries and lichen) identified by stakeholdes/rights-holders and monitoring air dispersion in proximity to the proposed site.	Assess soil chemistry (radionuclide and metals data will be collected for the baseline).	Provides data that can be used to evaluate relationships between soil and vegetation chemistry for numerous contaminants, including Tier 1 and 2 radionuclides; allows for stakeholder and rights-holder involvement.	The cost of chemical analyses is high.
Hydrology				
What is the hydrology like surrounding the Project prior to Project development?	Measures of stream flow in large and small streams and lake levels in the study areas local to the Project and at study areas that can act as reference areas in the future.	Assess local hydrology and possible flood or drought conditions.	Provides a comprehensive overview of the hydrology by assessing numerous endpoints, establishes baseline hydrological conditions, and identifies areas potentially impacted by cumulative effects.	Access to study areas local to the Project will be challenging, and maintaining field equipment may be challenging.
What is the hydrology like in the region prior to Project development?	Measures of water levels in regional lakes surrounding the Project, Ignace, and at lakes of interest to stakeholders and rights-holders.	Assess regional hydrology.	Provides preliminary hydrology data; ensures a high level of involvement from stakeholders and rights-holders in deciding sampling locations and conducting the sampling.	Provides a limited dataset per lake per year at select lakes.
Which waterbodies may serve as water supplies or receiving waters for Project discharge?	Measures of stream flow in the two largest rivers closest to the Project.	Assess the hydrological conditions over time in the two large rivers.	Provides preliminary hydrology data to assess which rivers or lakes may serve as a water supply or discharge receiving water.	Access to study areas local to the Project will be challenging, and maintaining field equipment may be challenging.

Table ES.1 Rationale for selected EMBP design

Question we are trying to answer	Data types needed to answer question	Method(s)	Strengths	Limitations
Surface Water Parameters				
What is surface water quality like surrounding the Project prior to Project development?	Measures of water quality in numerous study areas local to the Project and at study areas that can act as reference areas in the future.	Assess limnological parameters, water chemistry, chlorophyll a concentrations, and phytoplankton and zooplankton community composition and abundance.	Provides a comprehensive overview of water quality assessing numerous contaminants as well as biological measures; establishes baseline concentrations and identifies areas potentially impacted by cumulative effects.	Access to study areas local to the Project will be challenging, and the cost of chemical analyses, particularly for radionuclides, is very high.
What is surface water quality like in the region prior to Project development?	Measures of water quality in regional lakes surrounding the Project, Ignace, Wabigoon Lake Ojibway Nation, and at lakes of interest to stakeholders and rights-holders.	Assess water chemistry.	Provides preliminary water quality data; ensures a high level of involvement from stakeholders and rights-holders in deciding sampling locations and conducting the sampling.	Provides a limited dataset per lake per year and will only sample select lakes, unless the program is extensively expanded.
What is sediment quality like surrounding the Project prior to Project development?	Measures of sediment quality in numerous study areas local to the Project and at study areas that can act as reference areas in the future.	Assess sediment chemistry and characteristics as well as benthic invertebrate community composition and abundance	Provides a comprehensive overview of sediment quality assessing numerous contaminants as well as biological measures; establishes baseline concentrations and identifies areas potentially impacted by cumulative effects.	Access to study areas local to the Project will be challenging, and the cost of chemical analyses, particularly for radionuclides, is very high.
Air Quality, Noise and Light				
What are the air quality, noise, and light levels in the Project area prior to Project development?	Active and passive ambient air quality data for extensive list of contaminants; campaign- and seasonally-based noise and light monitoring data.	Direct measurement using established and approved regulatory methods and techniques.	Follows accepted regulatory methods; provides coverage for complete list of Contaminants of Potential Concern.	Initial setup and ongoing operating/maintenance costs are high.
What is the spatial and temporal variability of the air quality, noise, and light?	Data collected within the local, regional, and site study areas over a sufficient duration to establish seasonal and annual trends/changes (over three years).	Direct measurement using established and approved regulatory methods and techniques.	Follows accepted statistical and regulatory practices and provides suitable coverage to assess spatial and temporal variability and trends.	Initial setup and ongoing operating/maintenance costs are high, and three-year period may not capture all potential local influences on air quality data variability (i.e., forest fires).

Table ES.1 Rationale for selected EMBP design

Question we are trying to answer	Data types needed to answer question	Method(s)	Strengths	Limitations
Soils				
What is the soil quality like surrounding the Project prior to Project development?	Measures of background soil quality in numerous study areas local to the Project.	Assess soil chemistry and quality.	Provides a comprehensive understanding of soil chemistry and quality by assessing numerous contaminants, including Tier 1 and 2 radionuclides; allows for community and stakeholder involvement.	The cost of chemical analyses is high.
What aspects of soil chemistry and quality will affect air quality or water transport during excavation and construction activities?	Measures of background soil quality in numerous study areas local to the Project and at study areas that are downwind.	Assess soil chemistry and quality.	Provides a comprehensive understanding of soil chemistry and quality by assessing numerous contaminants, including Tier 1 and 2 radionuclides; allows for community and stakeholder involvement.	The cost of chemical analyses is high.
What is the natural environmental radioactivity of surficial soils in the region prior to Project development?	Measures of background gamma radiation levels in areas surrounding the Project.	Handheld radiation survey.	Provides knowledge of specific levels and distributions of gamma in soil as a reference for documenting potenital changes to environmental radioactivity as a result of Project development.	Does not provide data for other naturally occuring radionuclides in soil.

1.0 INTRODUCTION

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. Since that time, considerable resources have been spent on engagement, decision making, and studies. This process has included the adoption of Adaptive Phased Management (APM) as the plan, undertaking a siting process for the Deep Geological Repository (DGR) and other project infrastructure (called the Project) and conducting preliminary studies. From an initial list of 22 communities, 2 remain in the siting process as a potential host community for the Project, including Ignace, Ontario (the Northwestern Ontario region). The NWMO’s aim is to select a single preferred site by 2023.

On behalf of the NWMO, Canada North Environmental Services (CanNorth), in collaboration with its subconsultants (Geosyntec Consultants International Inc. [Geosyntec], Independent Environmental Consultants [IEC], and Zajdlik & Associates Inc.), technical advisors, and academic experts, is designing an Environmental Media Baseline Program (EMBP) for the Northwestern Ontario region. The EMBP will collect baseline environmental data to be used to support an Impact Assessment (IA) should the community remain in the process and become the single preferred site for the Project. A Preliminary Sample Design Feasibility Assessment report (CanNorth et al. 2019) was prepared previously to develop and evaluate various design options. The information presented herein represents the final design of the EMBP based on input received from stakeholders and rights-holders on the preliminary report.

The NWMO is conducting its activities related to the Project in a manner that protects the public and the environment, promotes community understanding, and addresses and incorporates community, First Nations, Métis, and stakeholder concerns, interests and well-being. 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 delegated. Throughout this document, the term stakeholder has been used to identify community members, agencies, private entities, etc., while rights-holder has been used to identify Indigenous peoples and communities (i.e., First Nations and Métis). These groups would be consulted in the event of an IA.

Throughout the report, the term consultant refers to the sampling team that is ultimately contracted to carry out the EMBP field studies.

1.1 Study Area Overview

Previous siting studies conducted by the NWMO in collaboration with local communities and rights-holders in the Northwestern Ontario region established an Area of Interest (AOI) for the Project that is located approximately 40 km west of Ignace, Ontario, within the northern portion of the Revell Batholith Temporary Withdrawal Area (see Figure 1.1). The AOI is defined by an oval that is approximately 4.4 km by 8.7 km and extends from immediately north of Highway 17 in a southwest direction (Figure 1.2). Within the AOI, there are two primary roads, a network of operations roads, and temporary access roads constructed to support borehole drilling and logging, and several small watercourses and wetlands.

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 offsite excavated rock management area (Figure 1.3). There is also likely to be a buffer that will be cleared beyond the fence boundary to serve as a fire break in the event of a forest fire in the future. Since the area is heavily forested, it is assumed there will be a 100-m fire break buffer for the DGR surface facilities and a 30-m buffer for the excavated rock management area. Additional land will be required for access roads, water management infrastructure, and potentially a construction camp site. The location of the Project infrastructure within the AOI is currently unknown.

Figure 1.1 Site location

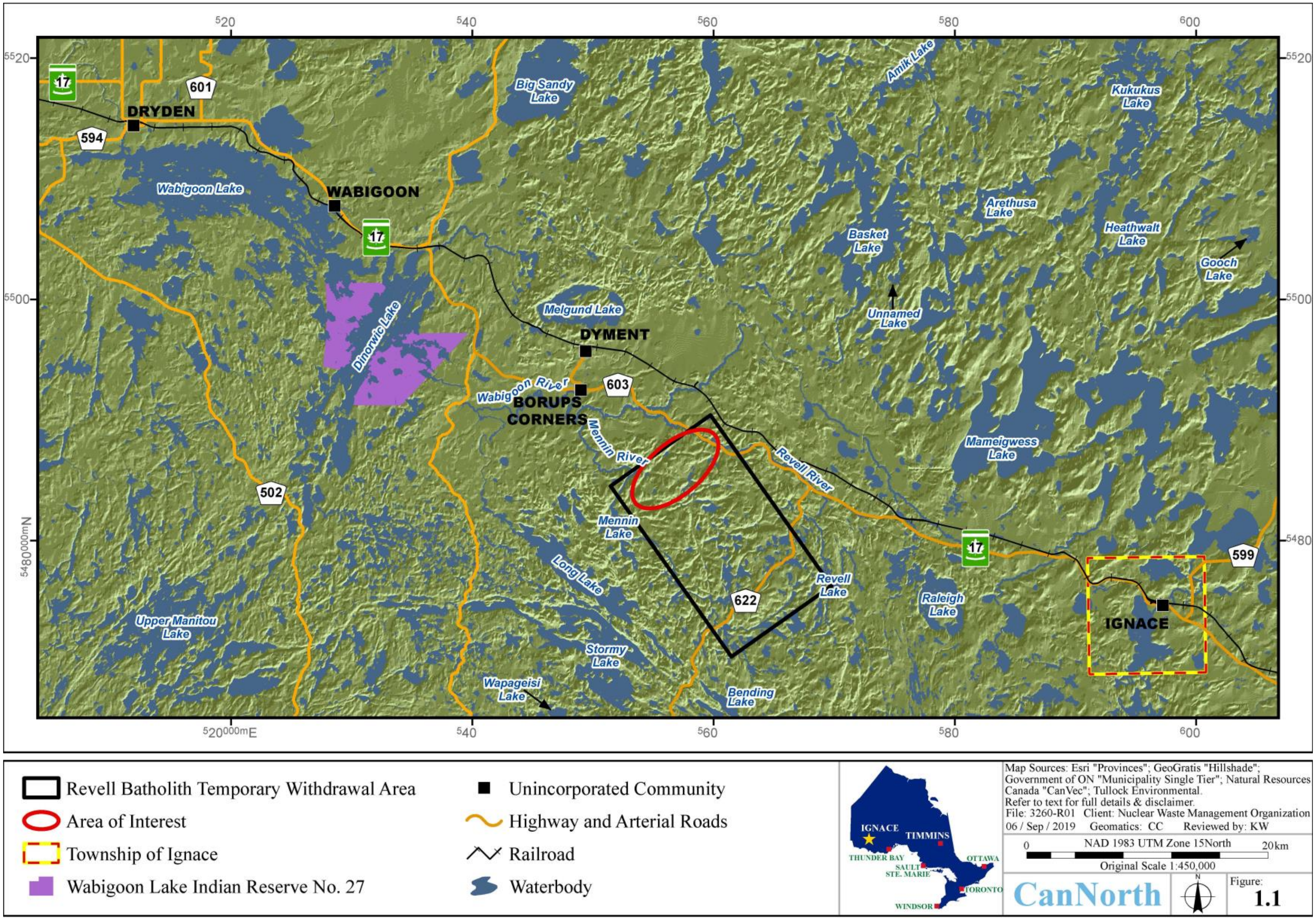


Figure 1.2 Location of Area of Interest that may contain the Project footprint along with current and future boreholes

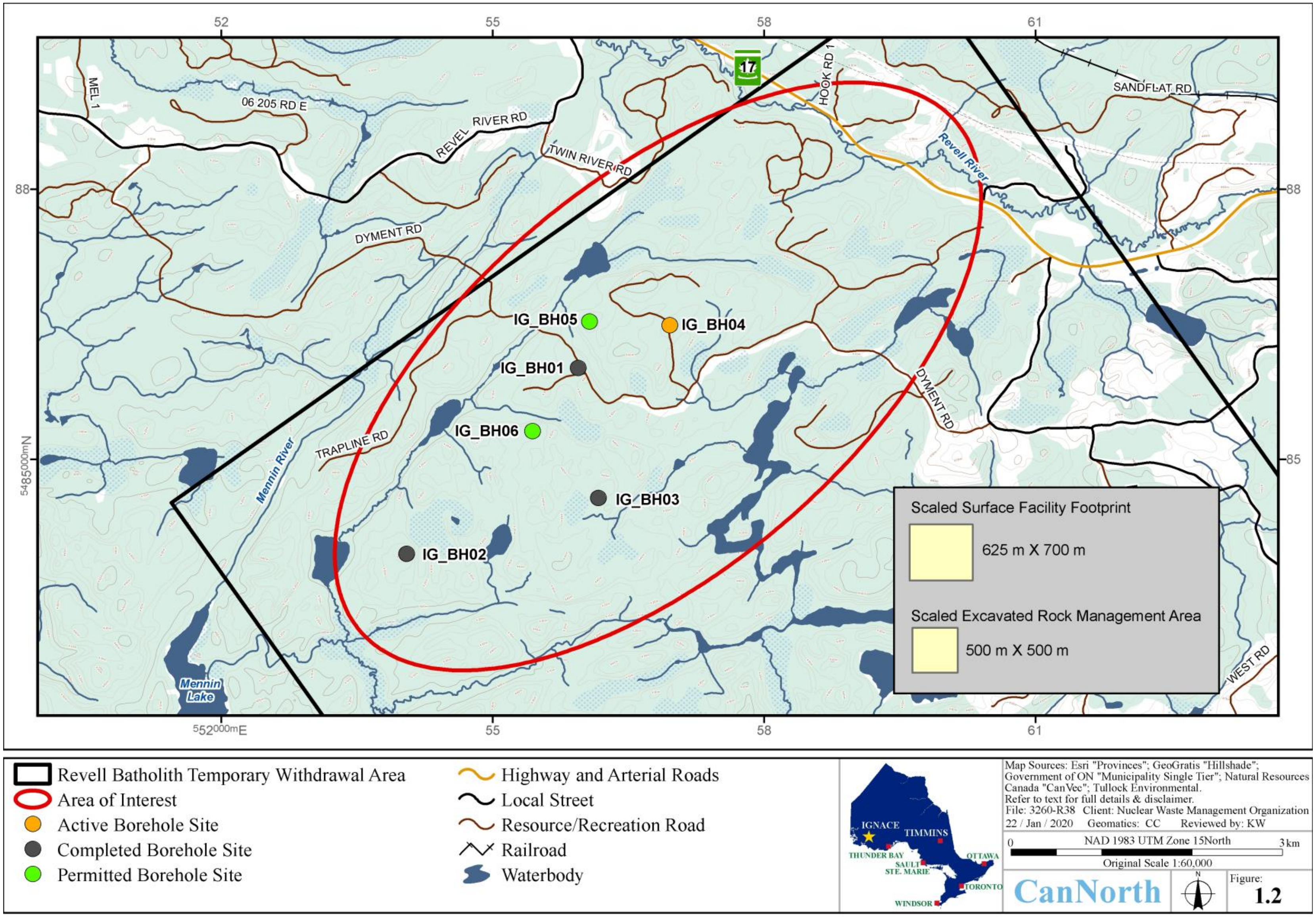
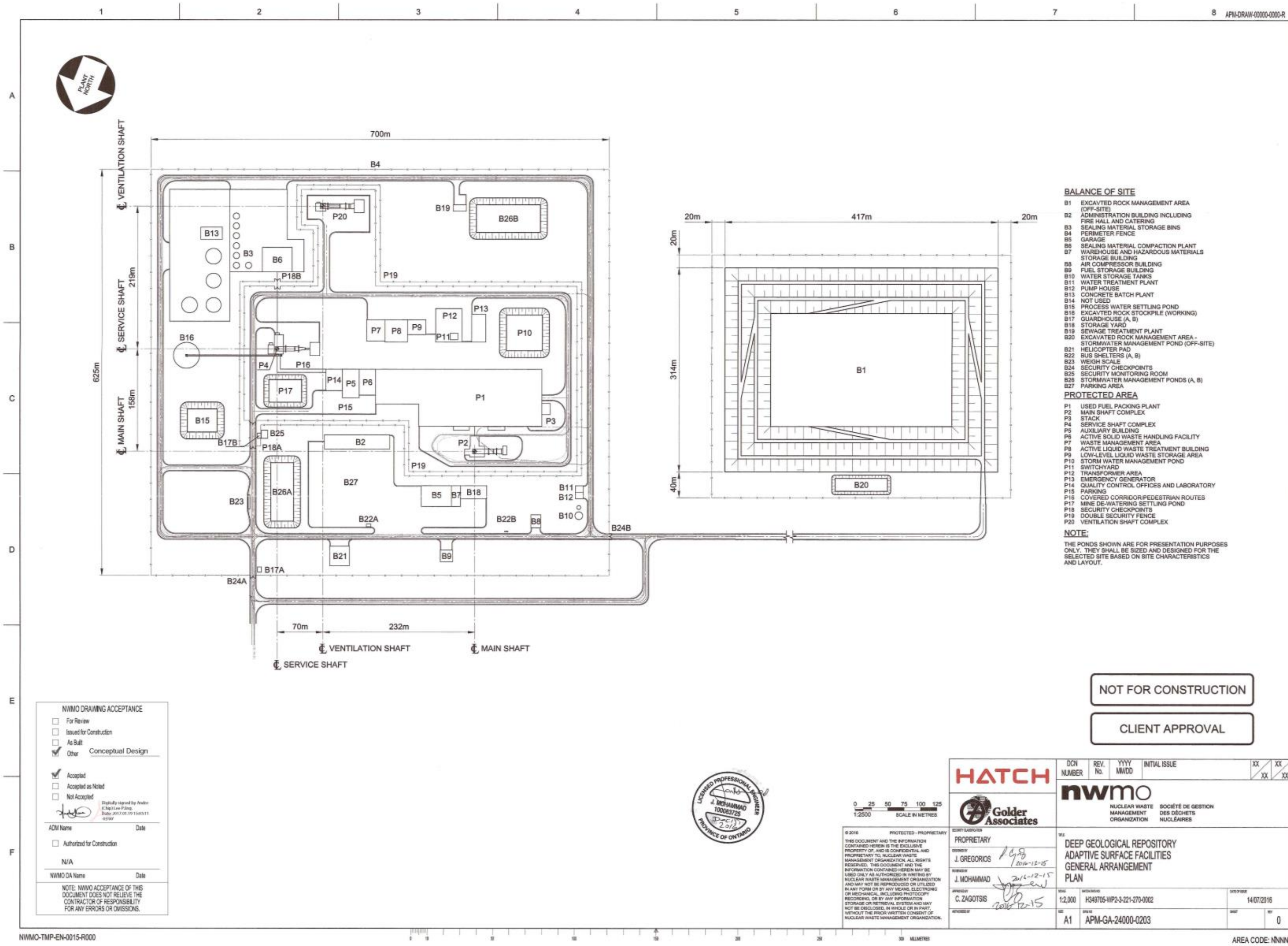


Figure 1.3 Surface facilities layout



1.2 Program Objectives

The purpose of a baseline environmental monitoring program needs to be clearly defined to ensure that appropriate data are collected. The purpose of this EMBP is to characterize environmental baseline conditions prior to development of the Project so that potential effects of the major stages (construction, operation, extended monitoring, decommissioning, and postclosure) can be measured in the future or that a lack of detectable effects is defensible. Information from the EMBP can also provide insight to existing pressures (i.e., industry) or sensitivities (i.e., rare and endangered species) in the environment and inform Project design elements so as to avoid or minimize potential cumulative effects.

The focus of this EMBP is on selected environmental components that have the potential to be impacted by the Project. Sampling focuses on those specific environmental effects that are “important”, “likely,” and “negative/positive”. A sampling program that obtains data that are necessary for making defensible decisions for carefully selected environmental components is ultimately more useful than a program that samples many environmental components but provides insufficient information to inform defensible decisions. A key objective in the design of the EMBP is to ensure information of high importance to the interests of the surrounding communities, stakeholders, and rights-holders is collected so that the potential for Project-related effects on the environment can be effectively monitored over the long-term and to support an adaptive management program. Furthermore, the data collected as part of the EMBP may be used to help assess cumulative effects and inform the Biodiversity Impact Studies (BIS) that are being undertaken separately. Field studies for the EMBP and BIS are being conducted simultaneously; thus, these programs are being coordinated so that the study areas and information obtained will meet multiple data objectives.

Design of this EMBP is specifically focused on the following five components, which include those of interest to stakeholders and rights-holders in the area:

1. Tissue samples (e.g., blueberry chemistry, wildlife and fish tissue chemistry, etc.)
2. Hydrology
3. Surface water parameters (e.g., water quality, sediment quality, etc.)
4. Air quality, noise, and light
5. Soil (soil quality and gamma radiation)

Shallow groundwater (from 0 to 100 metres below ground surface [m bgs]) and subsurface soil and bedrock (between 0.3 m bgs to 100 m bgs) are also essential components when conducting site characterization of a DGR facility (CNSC 2018), as the Project has the potential to affect both the quantity and quality of the groundwater resource and the aquatic environments through multiple pathways (detailed in the Conceptual Site Model [CSM] provided in Appendix C). Although these components were included in the Preliminary Sample Design Feasibility Assessment report (CanNorth et al. 2019) and discussed with stakeholders and rights-holders at community engagement workshops, they are being implemented under separate contract by the Geosciences group within the NWMO as part of the deep drilling program. Detailed designs are, therefore, not included in this report. The NWMO will remain accountable for addressing concerns raised at engagement workshops related to groundwater (see Appendix B). Shallow groundwater will also be included in the safety case, which will include identifying three groundwater systems (shallow, intermediate, and deep). The shallow groundwater system will be typified by higher groundwater velocities and oxygenated.

The EMBP will establish the expected concentrations of Contaminants of Potential Concern (COPC) in the above-listed media to provide part of the information needed to assess potential changes in the environment resulting from or associated with the Project. It is acknowledged that this is only part of the assessment, and that there are other components, such as those being monitored under the BIS, that will require evaluation prior to the construction of the Project in order to be able to address the larger questions.

The overall objective of the EMBP is to ensure that high quality scientific data and other invaluable knowledge contribute to a trusted process with credible outcomes. The design of this program acknowledges that evidence comes in many forms and incorporates Indigenous Knowledge (IK) and community engagement. This program seeks to integrate Western science with IK to collect evidence and build the Environmental Pillar in the four pillar sustainability-based IA framework[1]. While the data collected from this program will also contribute to the other pillars (health, social, and economic), separate baseline data collection programs will be implemented to fill the baseline data needs of these other pillars. The BIS will also provide essential information to the environment pillar.

[1] Under the Impact Assessment Act, sustainability means “the ability to protect the environment, contribute to the social and economic well-being of the people of Canada, and preserve their health in a manner that benefits present and future generations” (CEAA 2019). Thus, the four pillars of sustainability are human, social, economic, and environmental.

1.3 Report Objectives

This report provides details on the selected sampling designs for each of the environmental components of the EMBP. A Preliminary Sample Design Feasibility Assessment report (CanNorth et al. 2019) was prepared previously which evaluated the strengths and limitations of several sampling design options for each component. Stakeholder and rights-holder input from a series of engagement workshops in early 2019 was a consideration when identifying possible options. The recommended options were then presented to stakeholders, rights-holders, and technical experts in order to ensure that the options were technically sound and that they addressed the interests and concerns of local community members. The additional input gained from these workshops, detailed in a separate report that is in progress (see Section 3.1), was used to inform the final sample designs prsented herein. This report presents the final design options and includes the following information:

- A review of environmental work done to date.
- An overview of considerations that were integral in designing the EMBP, for example the input from stakeholders and rights-holders; potential Project-environment interactions; physical, biological, and geochemical nature of the area; statistical considerations; and guidelines and benchmarks.
- Detailed final sample designs for each of the components included in the EMBP that maximize the use of IK and community engagement and enables coordination with the BIS.
- High level Standard Operating Procedures (SOPs) and draft datasheets that provide information on selected methods, Quality Assurance/Quality Control (QA/QC) measures, and data recording[2].

Data collections and reporting for the EMBP will take place over three years. Annual reviews and a thorough three-year program update will be completed to modify the EMBP as needed, based on analysis of data collected each year and on continued feedback from stakeholders, rights-holders, and technical experts. Furthermore, the data collections will be modified as needed, based on the results and data needs of other studies occurring simultaneously, such as the BIS. Ultimately, the data from the various studies will be used in an IA should the Northwestern Ontario region be selected as the preferred site.

[2] The production of detailed SOPs and finalized datasheets is reliant on the instrumentation chosen by the consultant and further alignment of study areas and data collections needs with the BIS.

2.0 REVIEW OF WORK COMPLETED TO DATE

Through collaboration with Canadians and Indigenous peoples from 2008 to 2010, the NWMO developed a nine-step site selection process in order to ensure that the site that is ultimately selected for the DGR is safe and secure and meets the highest scientific, professional, and ethical standards. The multi-year, community-driven site selection process was initiated in 2010 (Step 1: NWMO Initiates the Process), while interested communities were subjected to an initial screening between 2010 and 2012 (Step 2: Initial Screening). The next step (Step 3: Preliminary Assessments of Suitability) was initiated in 2015 for the 22 interested communities that progressed through Step 2. The first phase of Step 3 (Phase 1 – Desktop Studies and Engagement) has been completed, while the second phase (Phase 2 – Field Studies and Engagement) is ongoing. As of June 2020, two potentially suitable siting areas remain in the site selection process, including the Northwestern Ontario region.

A summary of the studies completed for the Northwestern Ontario region as part of Step 3 (Phases 1 and 2) is provided below. A list of the reports consulted in designing the EMBP is provided in Appendix A.

2.1 Step 3: Phase 1 – Desktop Studies and Engagement

Phase 1 studies were completed in order to advance understanding of the environment of the potentially suitable siting areas, including the Northwestern Ontario region, and to assess whether it was possible to identify potentially suitable repository areas within each siting area. Key activities completed in Step 3: Phase 1 include:

- Working with the community to agree on how the work will proceed, including plans for involvement of citizens and surrounding communities, First Nations, and Métis;
- Conducting scientific and technical studies to further explore the potential suitability of the geology in the area and to collect preliminary information on the local environment;
- Exploring the potential effects of the Project on the long-term well-being of the community through desktop studies and community engagement;
- Involving community members in the assessments and in learning about the Project; and

- Summarizing the information learned from the Phase 1 studies to identify and screen out communities with low potential to be suitable for the Project.

The desktop studies for the Northwestern Ontario region that were reviewed in designing the EMBP relate to the community profile of Ignace and nearby communities, land use and protected areas, geology, terrain, topography, watershed boundaries, previously documented species of concern, commercial and recreational fisheries, and available regional information on meteorology, air quality, groundwater quality, and sediment quality. Regional information was obtained from regulatory sources such as the Ontario Ministry of the Environment, Conservation and Parks (MECP; formerly Ontario Ministry of the Environment and Climate Change [MOECC], formerly Ontario Ministry of the Environment and Energy [MOEE]), the Natural Heritage Information Centre (NHIC), and Ontario Ministry of Natural Resources and Forestry (MNRF). A list of the reports produced and a summary of the information provided in each as it relates to the components included in this EMBP is presented in Appendix A.

The NWMO produced a detailed summary report to document the process and results of Phase 1 and summarize the learning (NWMO 2013). Overall, the Phase 1 studies completed suggested that the Township of Ignace would be suitable for the Project from the perspectives of engineering logistics, geoscientific suitability, environmental health and safety, transportation safety, and social, economic, and cultural effects within the community and surrounding areas.

2.2 Step 3: Phase 2 – Field Studies and Engagement

Step 3: Phase 2 studies were initiated in 2016 as a series of field and engagement activities of the potentially suitable repository areas that were identified within each of the potentially suitable siting areas. For the Northwestern Ontario region, five potentially suitable repository areas were identified, termed the Ignace Withdrawal Areas [IWAs]. Information from the Phase 2 studies and others were used to select the socially and technically preferred IWA as the Revell Batholith (IWA-A) and to narrow down the AOI within IWA-A where the Project could be located (see Figure 1.2). The Phase 2 studies completed thus far are summarized below.

The BIS, which is currently under design for the Revell Batholith (IWA-A) as part of the continuing Phase 2 studies, will include biodiversity model(s) and impact studies. It will be important to ensure proper integration occurs between the BIS and the EMBP in study design, community involvement, data quality objectives (DQO), and impact assessment methods. Data collected as part of the EMBP will support the BIS and vice versa.

2.2.1 Mapping and Natural Heritage Features

2.2.1.1 2017 Studies

In 2017, Tulloch Engineering (Tulloch) completed desktop studies in combination with field verifications to narrow down potential siting areas within the five potential IWAs. Only the information applicable to the socially and technically preferred IWA-A (the Revell Batholith) is reviewed herein.

As part of the desktop studies, data from various secondary sources were compiled to produce environmental sensitivity maps of the proposed IWAs, including Ecological Land Classification (ELC), candidate Significant Wildlife Habitat (SWH), stream reach classification, and potential presence of Species at Risk (SAR). Select areas were identified for field verification assessments in order to confirm and further describe identified environmental sensitivities, confirm the relative absence of sensitivities in those areas indicated as minimally sensitive, and investigate areas that presented knowledge gaps (Tulloch 2018a).

The scope of further environmental studies was narrowed down to three borehole sites (BH-1, BH-2, and BH-3, which have since been renamed to IG_BH01, IG_BH02, and IG_BH03) and four potential borehole access roads within IWA-A. This refined study area is presented in Figure 2.1, along with the results of the sensitivity mapping for this area. Detailed environmental characterization is presented in Tulloch (2018b) based on field investigations from May to November 2017. The key results are summarized below.

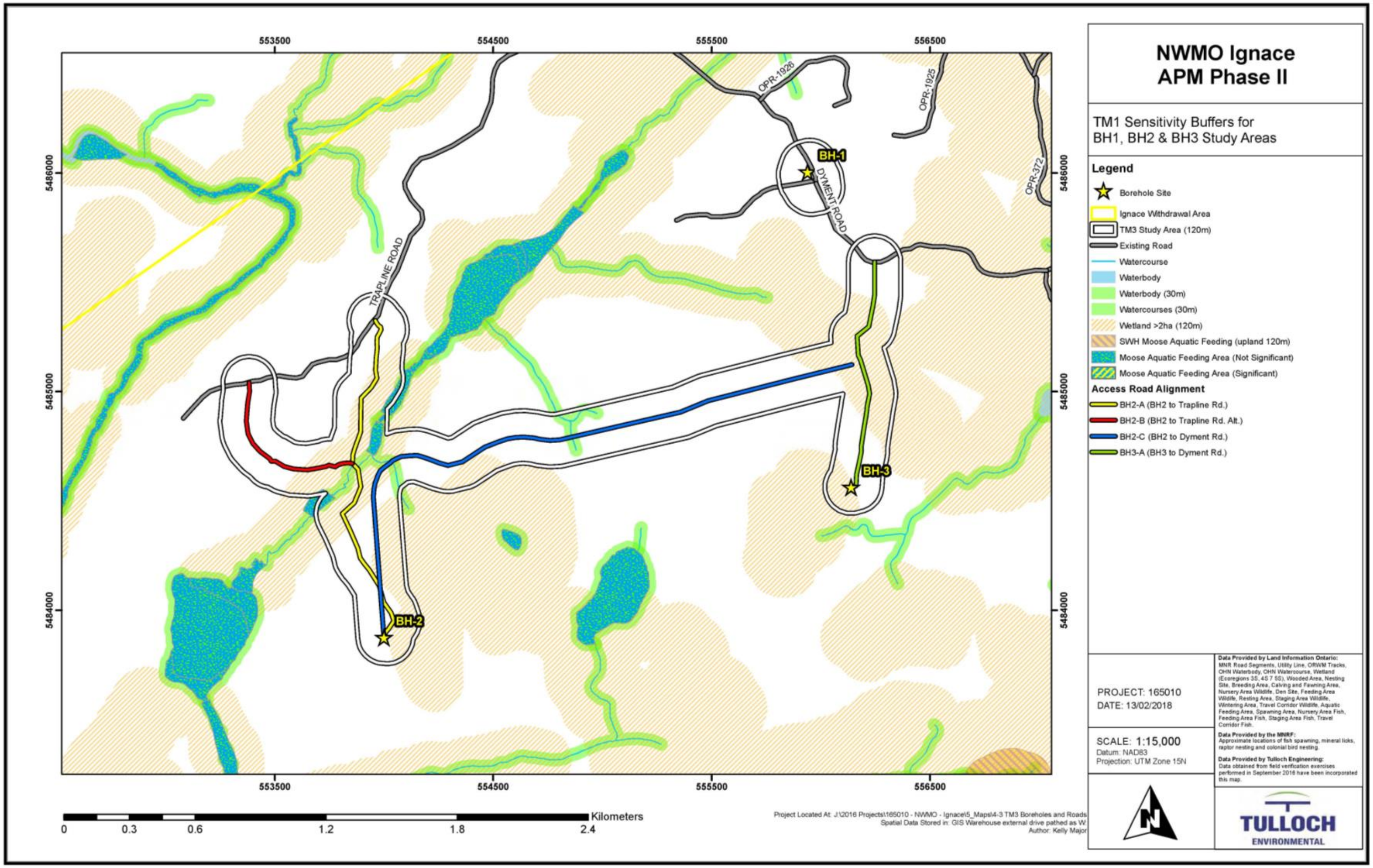
According to the ELC, most of the study area consists of undeveloped upland habitat dominated by jack pine (*Pinus banksiana*) and black spruce (*Picea mariana*), and 11% of the area is classified as wetlands. Soil types range from silty clay/silty loams (fine-textured) to silty sands/medium sands (coarse-textured), with moisture levels varying from fresh to moist. Searches were conducted for two rare plant species (Vasey's rush [*Juncus vaseyi*] and brook cinquefoil [*Potentilla rivalis*]) that were identified by the desktop study as being possibly present in the area (Tulloch 2018a), but the species were not found (Tulloch 2018b).

The 2017 field studies found 33 migratory bird species in the study area shown in Figure 2.1, which may also breed in the area. Suitable habitat was found for several SAR, including common nighthawk (*Chordeiles minor*) and eastern whip-poor-will (*Caprimulgus vociferus*), but only common nighthawk was observed during the field studies. One distant eastern whip-poor-will call was heard during the survey, but it was estimated to be approximately 600 m from the study area. An olive-sided flycatcher (*Contopus cooperi*) was also observed near a watercourse approximately 100 m from the study area. The estimated and observed locations of the eastern whip-poor-will and olive-sided flycatcher are within the AOI that is being studied as part of the EMBP. No sign of woodland raptor nesting was found (Tulloch 2018b).

Suitable habitat was found for mountain lion (*Puma concolor*) in the study area, but targeted surveys could not be performed due to the large home range of the species. Studies also found potential foraging and day-roosting habitat for little brown myotis (*Myotis lucifugus*) and northern myotis (*Myotis septentrionalis*) within the area; however, the presence of these two endangered bat species could not be confirmed.

One permanent watercourse connected to Mennin Lake was considered direct fish habitat, while three intermittent streams contributing to the main watercourse were considered indirect fish habitat. Although fish collection was not conducted during the 2017 field investigation, gill netting, minnow traps, and backpack electrofishing were used to examine fish species assemblage in the 2016 field sampling (Tulloch 2018a). Finescale dace (*Chrosomus neogaeus*), white sucker (*Catostomus commersonii*), yellow perch (*Perca flavescens*), blacknose shiner (*Notropis heterolepis*), and Iowa darter (*Etheostoma exile*) were observed during the preliminary field studies in the Revell Batholith (Tulloch 2018a).

Figure 2.1 Borehole sites and sensitivity mapping



Note: Figure 3 from Tulloch (2018b); BH-1, BH-2, and BH-3 have since been renamed to IG_BH01, IG_BH02, and IG_BH03.

2.2.1.2 2018 Studies

During the 2018 environmental field study conducted in the Northwestern Ontario region (Tulloch 2019a), natural heritage field assessments were carried out at five locations within IWA-A: boreholes 4, 5, and 6 (since renamed to IG_BH04, IG_BH05, and IG_BH06), as well as two possible future borehole locations (Area of Interest 1 and 2). The locations are shown in Figure 2.2. Local flora/fauna, SAR, and SWH were identified and assessed in the field studies, which investigated plants, amphibians, mammals, migratory birds, and fish species in the study area (Tulloch 2019a). Locations of the biodiversity observations and study equipment are presented in Figure 2.2.

General methods of investigation for animal species included site reconnaissance, motion activated wildlife cameras (Trailcams), automated wildlife recordings (Songmeters), and night acoustic surveys. General site reconnaissance was conducted twice in May and June 2018 at each location. One Trailcam and one Songmeter per site were set up throughout June 2018. In May and June 2018, three night acoustic surveys were performed. The Ontario ELC system was employed to describe the local soil substrates and plant communities. Areas with suitable habitat for Vasey's rush and brook cinquefoil were visited to search for these rare plant species (Tulloch 2019a).

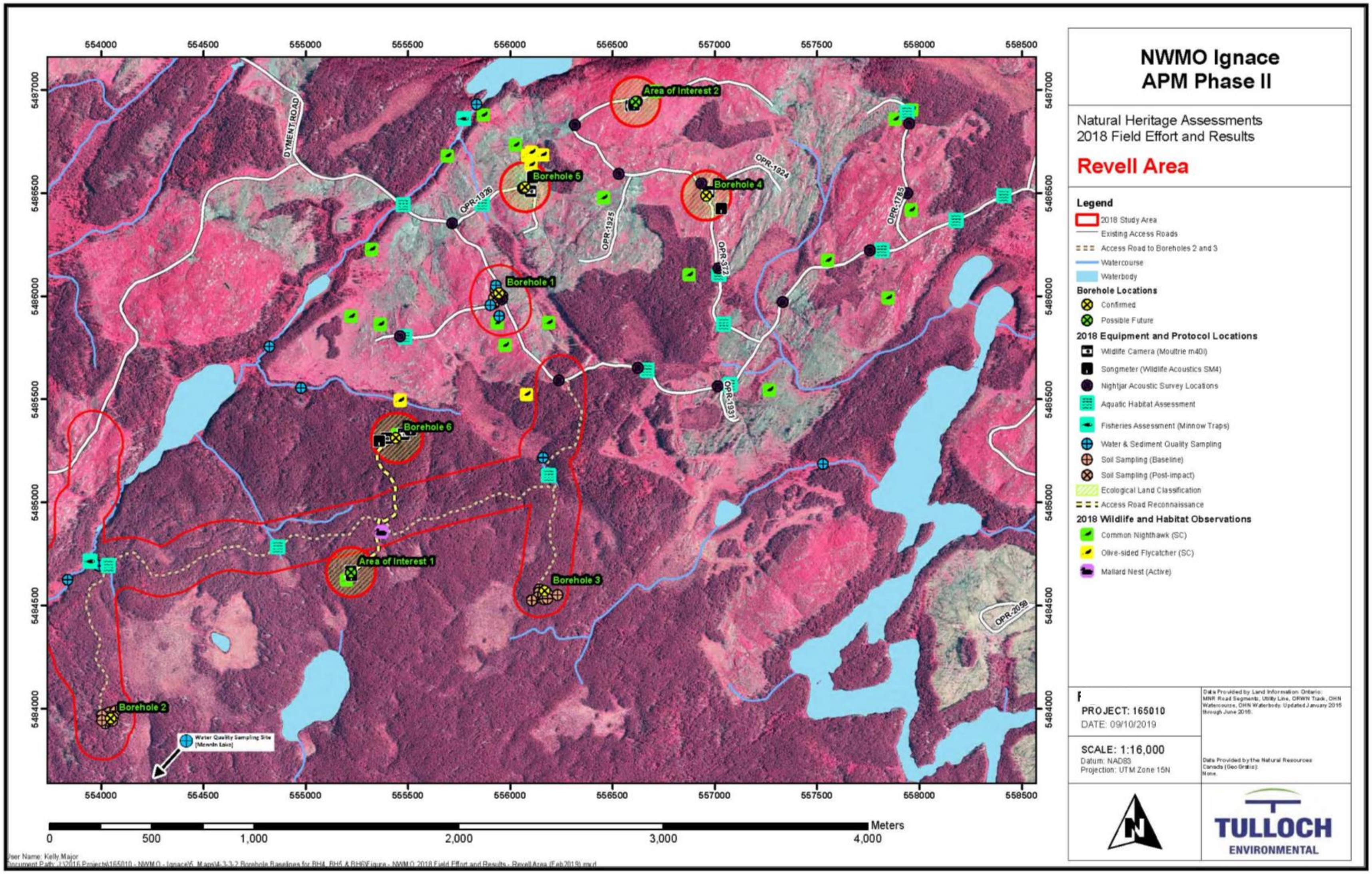
As in 2017, common nighthawk was observed in and around the study area in 2018. Olive-sided flycatcher was the only other SAR bird species observed (calling) in the study area (Borehole 5/IG_BH05). Although several of the locations studied had suitable habitat for eastern whip-poor-will, it was not located in the area during the acoustic nightjar surveys in 2018 (Tulloch 2019a).

For amphibians, five species were identified in the study area, including American toad (*Bufo americanus*), grey treefrog (*Hyla versicolor*), green frog (*Rana clamitans*), spring peeper (*Pseudacris crucifer*), and wood frog (*Lithobates sylvaticus*). Mammals observed by Trailcams on site include black bear (*Ursus americanus*), Canada lynx (*Lynx canadensis*), grey wolf (*Canis lupus*), moose (*Alces alces*), and snowshoe hare (*Lepus americanus*) (Tulloch 2019a). None of the amphibians and mammals observed in 2018 is a SAR.

The majority of the study area is covered by jack pine and black spruce (Tulloch 2019a). Other plant species growing in the area includes speckled alder (*Alnus incana*), trembling aspen (*Populus tremuloides*), and white birch (*Betula papyrifera*). No rare plant species were found at any of the locations (Tulloch 2019a).

Although no fish habitat was found at the future borehole locations, water crossings along the access roads for boreholes 2 and 3 (IG_BH02 and IG_BH03) were assessed for fish using minnow traps. Fish captured during the assessment included white sucker, yellow perch, and northern pike (*Esox lucius*), none of which has an endangered status (Tulloch 2019a).

Figure 2.2 Locations of observations and equipment in the 2018 natural heritage assessments



Note: Figure 5 from Tulloch (2019a); boreholes 1 through 6 have since been renamed to IG_BH01 through to IG_BH06.

2.2.2 Surface Water, Sediment, and Soil Monitoring

A baseline sampling program of surface water, sediment, and soil around the proposed borehole sites was initiated in 2018. The purpose of this sampling program is to understand the background environmental conditions in the area surrounding the borehole locations to enable monitoring of changes associated with siting activities (Tulloch 2019b). Surface water, sediment, and soil sampling locations are shown in Figure 2.3.

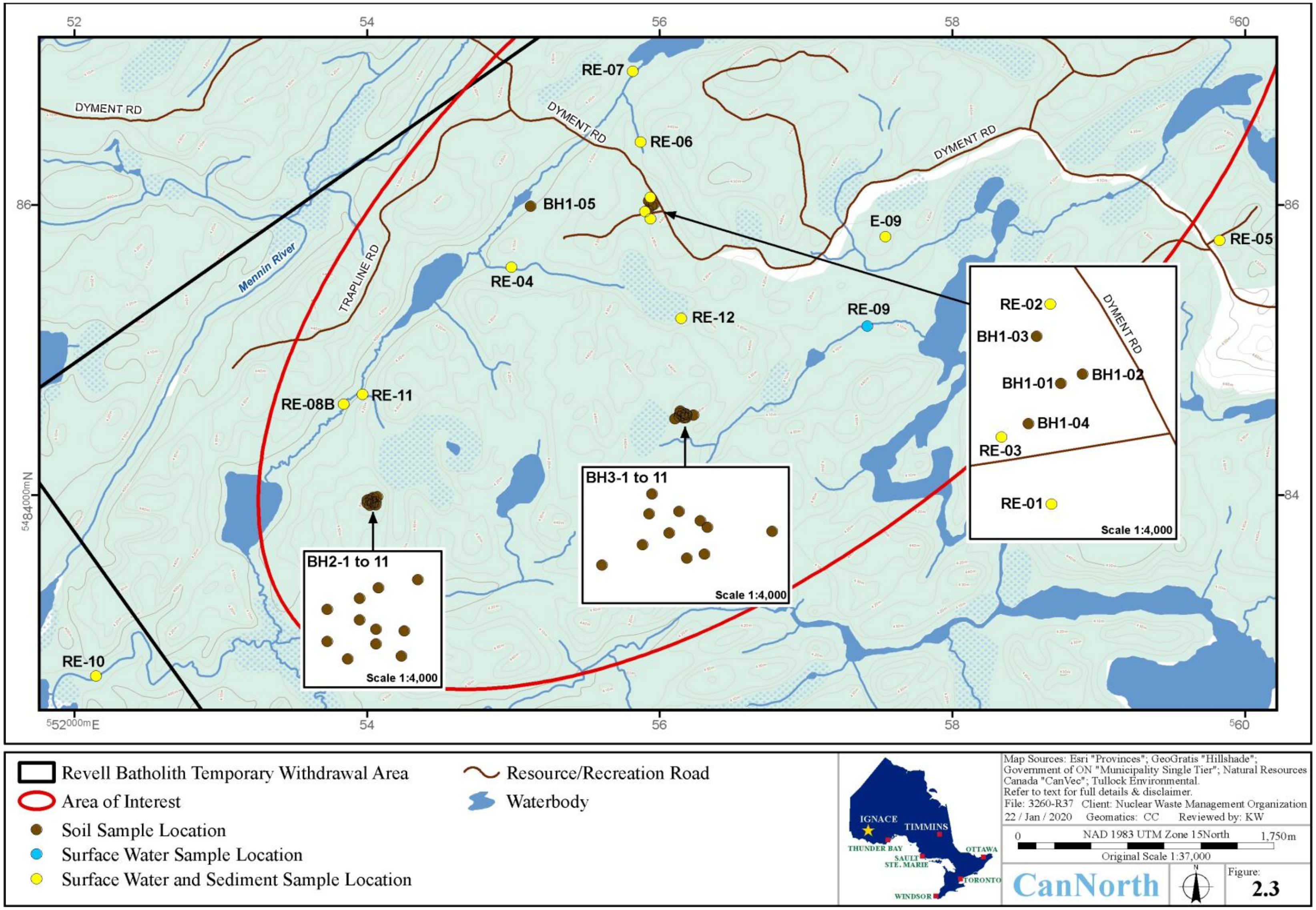
Surface water was sampled from the 12 locations (see Figure 2.3) in June and October 2018. Samples were taken from only five locations in August because of the lack of water at the other seven locations. *In-situ* limnology parameters (pH, temperature, conductivity, dissolved oxygen, and oxidation-reduction potential) were measured at each location in August and October 2018 (Tulloch 2019b). Sediment samples were collected using a Petite Ponar at all 12 locations following the water sampling in October 2018. Soil sampling occurred at boreholes 1, 2, and 3 (i.e., IG_BH01, IG_BH02, and IG_BH03) in August 2018. Five samples were taken at Borehole 1 (IG_BH01), nine samples from each of boreholes 2 and 3 (IG_BH02 and IG_BH03), and four samples downgradient of boreholes 2 and 3 (Tulloch 2019b).

All samples collected in the field (water, sediment, and soil) were submitted to AGAT Laboratories for analysis (Tulloch 2019b). Polycyclic Aromatic Hydrocarbons (PAHs), Volatile Organic Compounds (VOCs), Petroleum Hydrocarbons (PHCs) and general water quality parameters (including metals) were analyzed for the surface water samples, while PAHs, VOCs, PHCs, and general inorganic parameters (including metals) were analyzed in the sediment and soil samples (Tulloch 2019b).

Tulloch found seven parameters in surface water with one or more exceedances of the provincial water quality guidelines (MOEE 1994), including pH, aluminum (dissolved), iron, cadmium, cobalt, total phosphorus, and toluene. However, toluene exceedances were also detected in the field blank, suggesting potential sample cross-contamination (Tulloch 2019b). All 12 of the sampling locations had at least one exceedance or deviation from guidelines for pH, aluminum (dissolved), and iron; most sites did not meet the guidelines for pH values, aluminum, and iron concentrations during any of the sampling events. The reason for these exceedances is not known; it could be naturally elevated background or anthropogenic sources. Further sampling conducted as part of the EMBP will aid in determining the extent and likely source. This type of information will be important for the evaluation of cumulative effects.

Cyanide concentrations in sediment were found to exceed the applicable regulatory guideline at four locations (Tulloch 2019b). In soil, cyanide was also found to be the only exceeding parameter at Borehole 2 and Borehole 3 (IG_BH02 and IG_BH03) locations. Most concentrations of PAHs, PHCs, and VOCs in water, sediment, and soil were below laboratory detection limits, which were also below applicable regulatory guidelines (Tulloch 2019b).

Figure 2.3 Locations of existing water, sediment, and soil sampling stations in the Area of Interest



Note: Figure adapted from Tulloch (2019b).

2.2.3 Engagement

The NWMO is conducting its activities related to the Project in a manner that protects the public and the environment, promotes community understanding, and incorporates community, First Nations, Métis, and stakeholder needs. Throughout Phase 2 of Step 3 (ongoing), NWMO staff and contractors have continued to meet with stakeholders and rights-holders, including municipal representatives, First Nation and Métis leaders, organizations and communities, key opinion leaders, community liaison committees, and citizens to better understand the thoughts and concerns of people who wish to be engaged. Figure 2.4 shows the locations of the First Nation and Métis communities with whom the NWMO has entered into Learn More[3] agreements. The nearest First Nation community to the AOI is that of Wabigoon Lake Ojibway Nation (WLON).

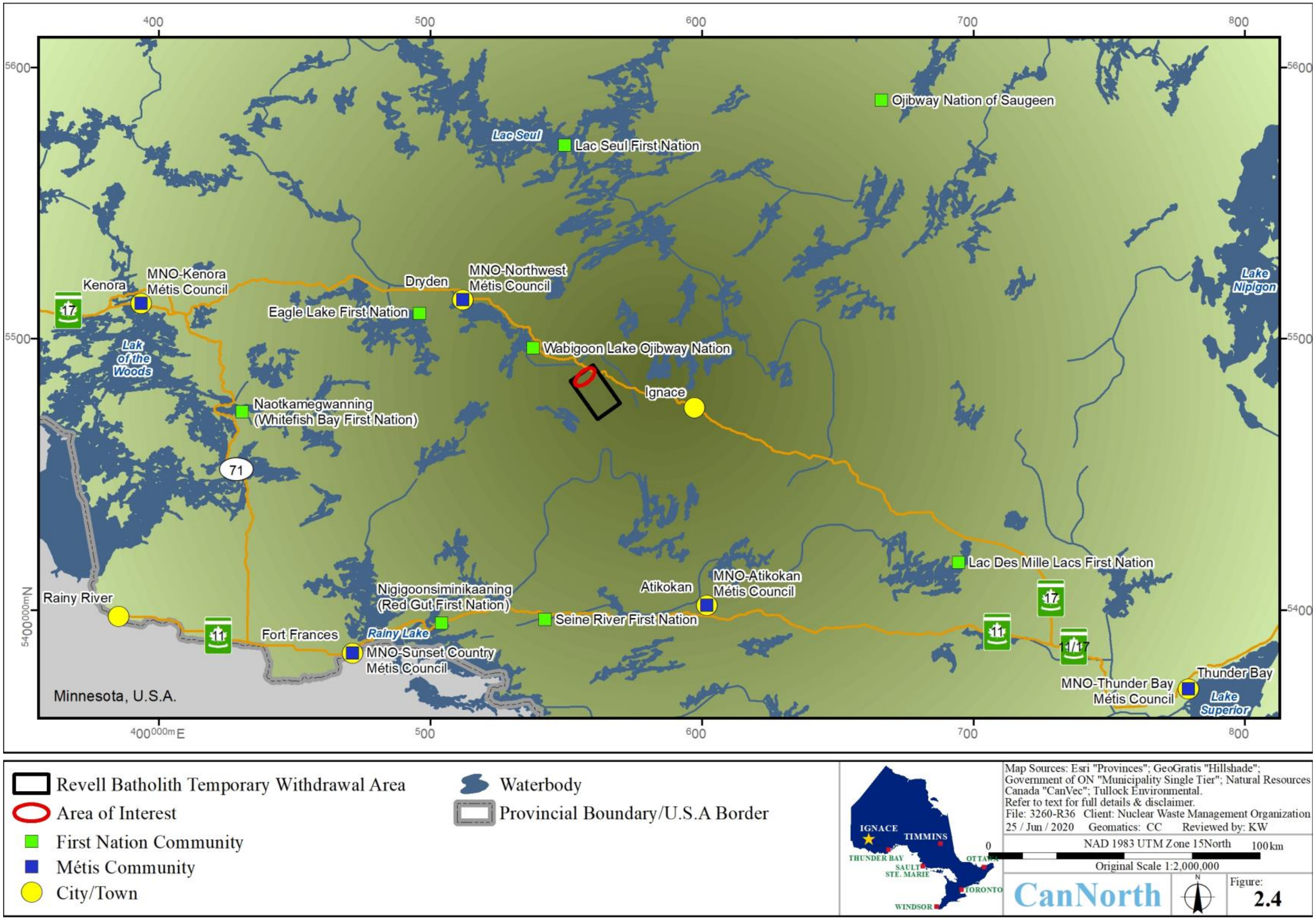
The engagement activities as part of the Phase 2 studies are being carried out to contribute to a more detailed understanding of potential Project benefits, identify opportunities to work together, and determine how potential negative effects of the Project can be managed. Discussions are ongoing on various topics such as the basis for confidence in the safety of the Project, local land uses that need to be taken into account in planning field studies in the area, consideration of Spirit and ceremony, potential economic effects of the Project, and the long-term vision for the area held by local residents (NWMO 2017a).

Numerous open houses have been held in the area to support ongoing learning and engagement of people related to each major assessment and field activity (NWMO 2017a). Representatives from the NWMO have also participated in many community and area events, and several opportunities have been provided for youth engagement to facilitate youth in learning more about the Project and to gain youth perspectives.

Specific to the design of the EMBP, the NWMO held a series of workshops in 2018 and 2019 with stakeholders and rights-holders to provide direction to the EMBP design. These are discussed in more detail below.

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

Figure 2.4 Locations of communities in the region



2.2.3.1 Targeted Community Engagement Workshops

Several community engagement workshops have been held with various Indigenous and local community groups in the Northwestern Ontario region to provide direction to the EMBP design[4]. The workshops were designed to be very informal and collaborative in nature, with opportunities for people to answer pointed questions and ask their own questions. The knowledge gained from these workshops is summarized below, while Section 3.1 provides further details on how the input was considered when designing the EMBP.

2.2.3.1.1 Round 1

Approximately 105 people participated in a total of 10 community engagement workshops led by the NWMO that were held between November 2018 and April 2019. The goal of each workshop was to answer three questions to help inform the design of the EMBP:

1. What are the questions/concerns you have about your environment?
2. What are the current stressors on your environment?
3. What are the key elements of an open and trustworthy monitoring program?

Participants were provided with sticky notes on which to write their responses, and these notes were then organized and grouped together by the participants as a whole in order to identify recurring themes. This first round of workshops revealed that the EMBP should be designed to address the following recurring themes:

- Be honest and transparent, with publicly accessible data.
- Engage with and involve local communities, especially regarding training and employment opportunities for residents (especially youth) and explicitly incorporate local input and Indigenous Knowledge (especially from Elders).
- Monitor for potential impacts on air, water and soil quality, fish, vegetation (berries, mushrooms, wild rice, medicinal plants), and wildlife.
- Respect the land and Spirit.

Appendix B provides a log of the input received from the first round of workshops and shows how these concerns were taken into consideration in the design of the EMBP. There were some aspects that could not be directly addressed by the program, and Appendix B

[4] As per regulatory requirements, the input was collected in a disaggregated manner. However, for confidentiality reasons, the input from the workshops is not shown in a disaggregated form in this document.

provides rationale and suggestions for how they could be addressed in other studies. Some concerns also could not be incorporated without additional clarification or input from stakeholders and rights-holders, such as the respectful incorporation of Spirit and ceremony.

2.2.3.1.2 Round 2

The NWMO led an additional round of community engagement workshops in September and October 2019, with members of the Study Team representing each of the components of the EMBP design also attending. The goal of these workshops was to present the design options developed and presented in the feasibility report (CanNorth et al. 2019) and seek further input and clarification on how some of the issues and concerns raised during the Round 1 workshops could be addressed in the EMBP (see Section 3.1.1). As discussed previously, implementation of the shallow groundwater and bedrock monitoring programs has become the responsibility of the Geosciences group at the NWMO. However, options for monitoring these components were evaluated as part of the Preliminary Sample Design Feasibility Assessment (CanNorth et al. 2019) and were presented to and discussed with stakeholders and rights-holders at the community engagement workshops. The NWMO will remain accountable for addressing concerns raised at engagement workshops related to these components (see Appendix B).

The workshops aimed to answer three questions before completing the final design:

1. Do community members feel that their input from the first round of workshops is reflected in the preliminary design options?
2. Are the proposed Study Components (SCs) and sampling locations reflective of local use of the area?
3. Do community members feel that there are any gaps in the design that need to be addressed?

Overall, the participants felt that their input from the Round 1 workshops was reflected in the design. A summary of the input received during these workshops is provided in Appendix B, while more detailed information is provided in a separate report that is in progress.

2.3 Path Forward

The EMBP is expected to be dynamic and will need to reflect other studies that are planned, or being considered, by the NWMO, including the BIS and additional IK that may be gathered (including a country foods dietary study). The EMBP may also need to adjust to reflect changes as the project design progresses.

It is important to have open and ongoing dialogue with stakeholders and rights-holders on the EMBP regarding the approach taken, the information obtained, the need for possible adjustments, and addressing additional questions and input. This ongoing dialogue is part of having an honest and transparent program and requires a respectful relationship with stakeholders and rights-holders.

3.0 SAMPLE DESIGN CONSIDERATIONS

There are many factors to consider in the design of the EMBP, including community input and involvement, objectives, potential Project-environment interactions (i.e., the Conceptual Site Model, or CSM), potential cumulative effects, end uses of the data and statistical analyses, and regulatory requirements and guidance documents such as N288.4-10 (CSA 2010) and REGDOC-1.2.1 (CNSC 2018). The sections below provide an overview of the factors considered in the design of the EMBP for the five components.

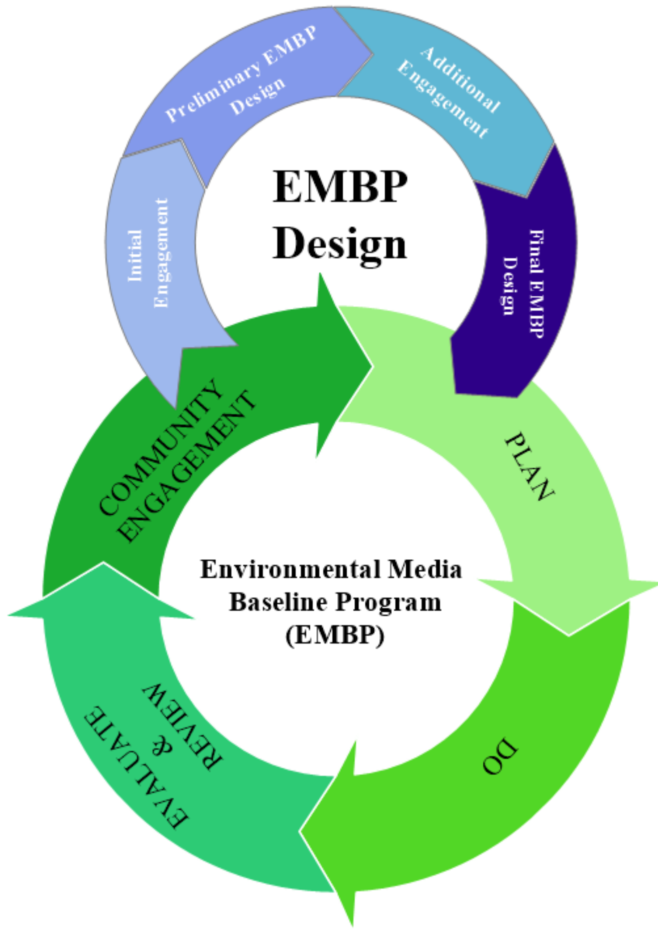
3.1 Community Input and Involvement

The EMBP has been designed to incorporate community input and IK and also to involve community members as much as possible in its execution.

3.1.1 Input and Indigenous Knowledge

Consideration of stakeholder input and IK from local First Nation and Métis communities is imperative in the design of a successful baseline program that is accepted by local communities. As discussed previously (see Section 2.2.3), the NWMO has been actively engaged with stakeholders and rights-holders throughout the site selection process, and input obtained from these engagement sessions has been considered in the design of the EMBP. It must be emphasized that the EMBP presented is not static and will be reviewed annually and modified every three years as needed, based on data collected in previous years, on coordination with other study components, and also on continued feedback from stakeholders and rights-holders. Furthermore, due to difficulties experienced as a result of COVID-19, this document as it stands has not undergone final review by Indigenous groups; NWMO is committed to the participatory process and comments received in the future will be considered when revising the document during the review. This process is illustrated in Figure 3.1.

Figure 3.1 Adaptive management process for Environmental Media Baseline Program



As discussed in Section 2.2.3, a series of community engagement workshops were held in 2018 and 2019 in an effort to obtain input to inform the study design. Appendix B provides a log of the input received from the first round of workshops, which illustrates how these concerns were taken into consideration in the design of the EMBP. The key feedback from the second round of workshops that was considered in the final design is summarized in Table 3.1. During both rounds of workshops, participants repeatedly expressed concerns over cumulative effects of the Project and the importance of Spirit and ceremony. Appendix B provides a log of the input received from the first round of workshops that shows how these concerns were taken into consideration in the design of the EMBP. The key feedback from the second round of workshops that was considered in the final design is summarized in Table 3.1.

3.1.1.1 Cumulative Effects

One concern raised repeatedly in the workshops pertained to cumulative effects and a desire to understand how the Project may interact with existing levels of COPC in the environment. In other words, it was important to the stakeholders and rights-holders that the Project not be assessed in isolation, but rather in combination with the existing environment. As baseline monitoring will occur prior to the occurrence of any Project-related activities and account for spatial and temporal variability, the results will provide a comprehensive representation of the current environmental conditions in the area. This will form the basis upon which the effects of the Project are evaluated. The potential effects of the Project would be assessed in the effects assessment stage of an IA (see Figure 3.2), with models providing estimates of the levels of COPC due solely to the Project. These would then be added to the levels established during the EMBP plus those occurring from other potenital future activities to arrive at cumulative levels that can be either compared to fixed limits (e.g., regulatory criteria, discussed in Section 3.5) or compared to the baseline levels to evaluate the degree of change expected. The data collected as part of the EMBP is only part of the story and the data from other studies, such as the BIS, will also contribute to overall understanding of cumulative effects.

3.1.1.2 Spirit and Ceremony

During both Round 1 and Round 2 workshops, the importance of Spirit and ceremony was a recurring theme. The EMBP has been designed with this in mind; however, it is not prescriptive and identifies possible opportunities for the inclusion of Spirit and ceremony, such as:

- Participation of all field staff in cultural awareness training;
- Following cultural field protocols prepared by WLON;
- Holding ceremonies for the killing of fish or animals as part of the sampling programs; and
- Making offerings of tobacco as a show of respect for the land, its inhabitants, and its history.

The Study Team is not in a position to determine what is important from a spiritual or ceremonial standpoint. The NWMO is committed to working with WLON to ensure that they can lead this aspect of the program as desired.

Table 3.1 Summary of key feedback from Round 2 workshops and impact on design

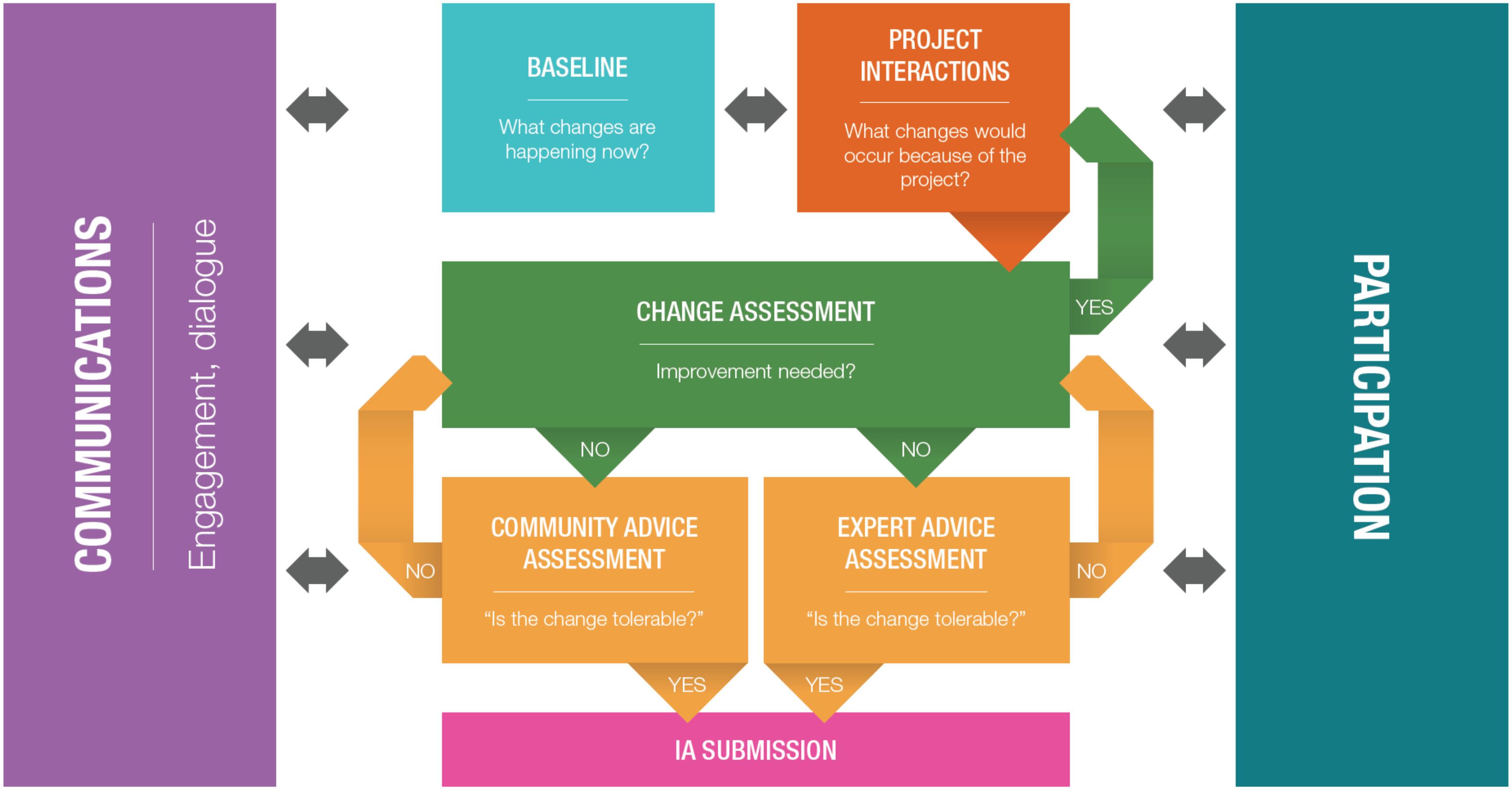
Component	Category	Preliminary Design	Feedback	Final Design
Tissues	Black bear	Originally not included since it was assumed that local people do not eat black bear.	Many community members from Ignace eat black bear; it should be included.	Black bear is identified as a primary Study Component for the tissue component.
Tissues	Deer/moose	Include deer and moose as Study Components.	Around the AOI, deer are more prevalent than moose (moose are more common further east towards Dryden).	No change to program; moose and deer were originally identified as primary Study Components.
Tissues	Moose	Include moose liver as a Study Component.	People avoid liver due to flukes and spots.	No change to program; moose/deer organs was originally identified as a primary Study Component for the tissues component.
Tissues	Aquatic birds - herbivores	Appendix F listed snow goose as a potential primary Study Component.	People eat Canada goose but not snow goose.	Snow goose no longer identified as a primary Study Component.
Tissues	Upland game birds	Select ruffed grouse to be representative Study Component.	Consider selecting ptarmigan as representative Study Component.	Keep ruffed (or spruce) grouse; ptarmigan only migrate to the area during the winter months and are, therefore, not representative of year-round exposure.
Tissues	Honey	Ranked as ‘Not Required’ (i.e., not included in design), largely due to difficulty in obtaining samples.	There is an apiary at the community garden in Ignace (no other apiaries or farmed hives closer to the AOI).	No change to program; Ignace is too far from the AOI to represent local exposure to honey bees (foraging range of 10 km maximum from hive).
Tissues	Sampling method (minimize lethal hunting)	The program is designed to obtain as many samples as possible as donations from kills by community members.	Consider roadkill, tissues from controlled bear hunts from MNRF, local grocery store in Ignace that butchers moose.	Communication with MNRF has confirmed they do not lead controlled bear hunts. If possible, samples of roadkill can be collected and sent for analysis with other community samples, but an agreement would need to be set up by NWMO.
Surface Water Parameters	Invasion of toxic algal blooms from the west	Monitoring of algal species is included in the phytoplankton component of the program.	Toxic algal blooms are currently occurring in Manitoba and there is concern they may move east and invade the study area.	No change to program; monitoring of algal species is part of the program, which will establish a baseline to which temporal changes can be assessed.
Air Quality, Noise, and Light	Noise	No inclusion of wildlife bioacoustics.	Interest in understanding and tracking animal calls, which may also be of particular cultural and spiritual relevance.	Recording of wildlife bioacoustics has been added to the Biodiversity Impact Studies (BIS) to allow for the measurement of diurnal patterns, seasonal fluctuation, and behaviour characteristics.

Table 3.1 Summary of key feedback from Round 2 workshops and impact on design (continued)

Component	Category	Preliminary Design	Feedback	Final Design
Air Quality, Noise, and Light	Air Quality	Radiation monitoring is included.	Important to understand the potential pathways for radiation-related effects.	Monitors are planned for the three nearest communities (WLON, Dyment, Ignace) to ensure radiation is measured at relevant locations; these communities have available a source of power for active monitoring equipment, which will increase the probability of collecting quantifiable data.
COPC	Glyphosate	Not included as a COPC, as glyphosate will not be released to the environment as a result of the Project.	Cumulative effect; there is a lot of concern from every community group related to glyphosate use by the forestry industry.	Glyphosate has been added as a COPC for select media at select sample locations (surface water in the AOI, berries, wild mushrooms, groundwater, soil).
Spirit/ Ceremony	Incorporation of Spirit and ceremony	Acknowledged that it is important and can be incorporated, but further input required from community.	Some general feedback was obtained: - Pray to give you the best knowledge for how to look after it. - Always give thanks. - Keep in mind that everything is alive. - Use water ceremony prior to water sampling campaign. - Moon ceremony (which is held during full moons) could be completed prior to starting the light monitoring campaign (which must be completed with no moon). - Use ceremony to ask how ceremony should be incorporated. - The only way to appreciate water and the power it holds is to go without water (fast).	There are many considerations around the incorporation of Spirit, prayer, and ceremony. What is important from a spiritual or ceremonial standpoint must be led by WLON. We suggest that it be considered to ask WLON how they wish to conduct the ceremonies, prayers, and spritual elements that would be required and who they would want to lead it. If appropriate, the consultant(s) could be included in this discussion, but it may be that WLON prefer to keep these practices to themselves.
General	Visual tools		To engage youth and visual learners, the program needs to be designed to be visual (pictures, videos) and accessible via social media.	The design of the Data Management System is part of a separate contract, but considerations are discussed in Section 9.2.

Note: A log of comments and input received during the workshops can be found in Appendix B.

Figure 3.2 Impact Assessment process



3.1.2 Involvement

The NWMO is committed to investing in building skills and capacity of youth and community members in the municipal, First Nation, and Métis communities engaged in the site selection process to position them to secure jobs related to future phases of the Project or other large projects in the area. Thus, in designing the EMBP, it was imperative to determine the community's level of interest in implementing the program and outlining steps to be taken to ensure that level of interest is achieved.

The WLON, which is the closest First Nation community to the Project, has a vision of forming an environmental services provider. Some of the community members are already participating in environmental sampling being conducted as part of the Phase 2 studies in the Northwestern Ontario region. To further this vision, the EMBP has been designed to provide numerous opportunities for community member involvement in its execution to enable capacity building. As discussed throughout sections 4.0 to 8.0, this could include one or more of the following actions:

- Acting as field assistants and/or guides for studies that require trained consultants to lead the work.
- Providing cultural training or protocols to field staff involved in the sample collection.
- Being trained to conduct sampling independently (e.g., collecting surface water samples in the region as part of the regional community-based surface water quality monitoring program [see Section 6.2.1.4 for further details]).
- Conducting a traditional foods dietary survey where community members are hired and trained to conduct interviews (see Section 4.2.1 for more information).
- Collecting tissue samples to submit for chemical analyses during routine hunting and gathering activities (see Section 4.2.1.5 for more information).
- Hiring a community liaison and/or elder to assist in the coordination of the tissue sampling program and to aid in the dissemination of information back to leadership and the broader community.
- Having a representative from the local First Nations and Métis communities to lead the Spiritual and Ceremonial aspects of the EMBP as desired.

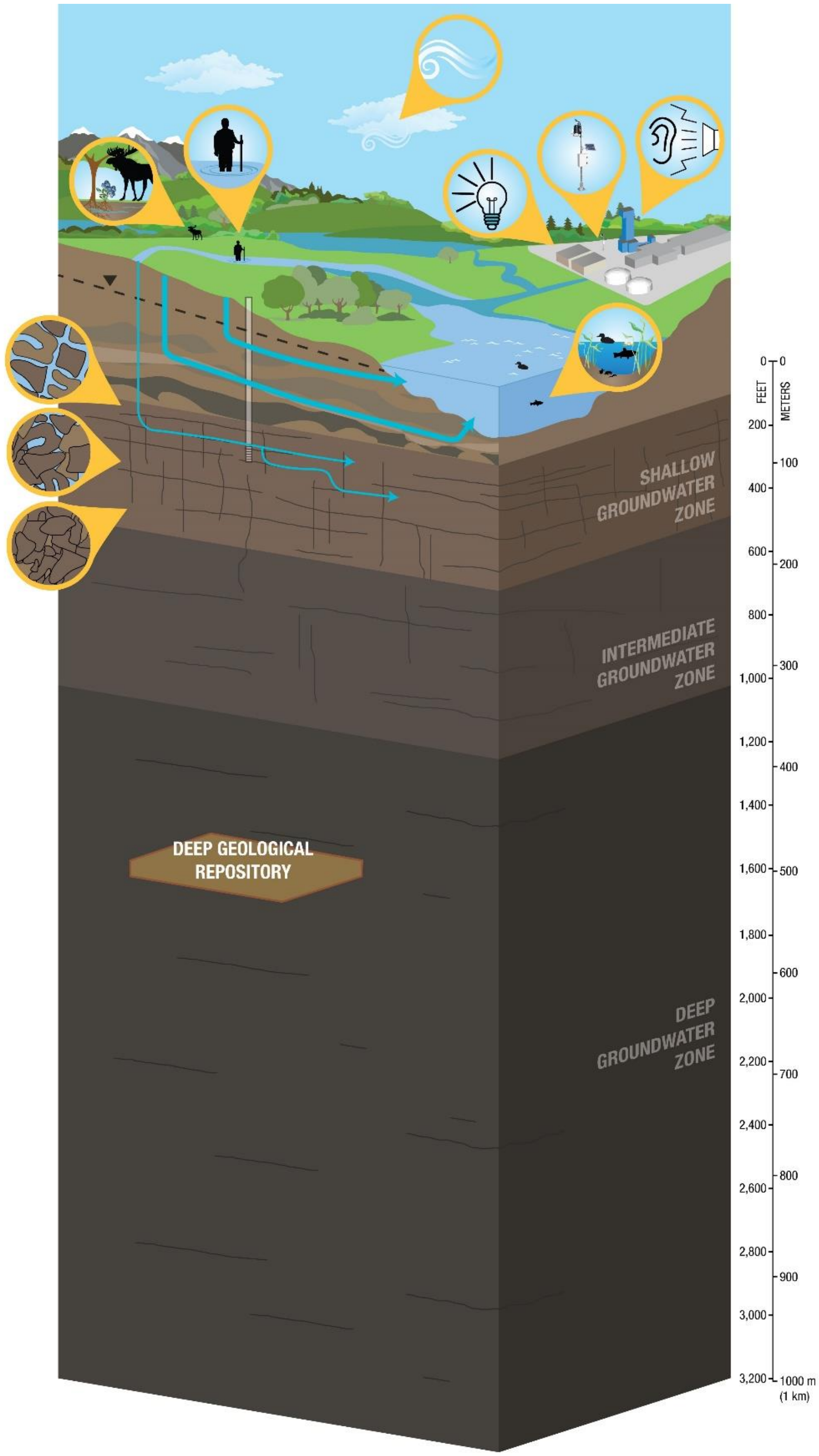
There are a number of other training opportunities that could be provided to local communities prior to and during the EMBP that are in addition to the hands-on training gained through working with a consultant to conduct field sampling. These could include training videos, conducting school visits, or having students collect samples as part of school projects or having a school field trip. In 2019, members of local Indigenous communities participated in environmental monitoring training provided through ECO Canada's BEAHR (Building Environmental Aboriginal Human Resources) Indigenous training and employment program(s).

3.2 Conceptual Site Model

The NWMO developed a preliminary description of the Project that provides a proposed site layout and describes the works and activities likely to be associated with the construction, operation, extended monitoring, decommissioning, and postclosure phases (NWMO 2016). Our Study Team used this preliminary description to develop a CSM for the biophysical environment for the Project, which is presented pictorially in Figure 3.3. Further details are presented in Appendix C. The CSM integrates information to identify how the various Project components and stages interact with one another and the environment. This is important to the design of the EMBP in helping to identify the following for each component:

- Study areas;
- Study Components (SCs);
- Contaminants of Potential Concern (COPC);
- Potential pathways of effects; and
- Assumptions.

Figure 3.3 Conceptual Site Model for the biophysical environment



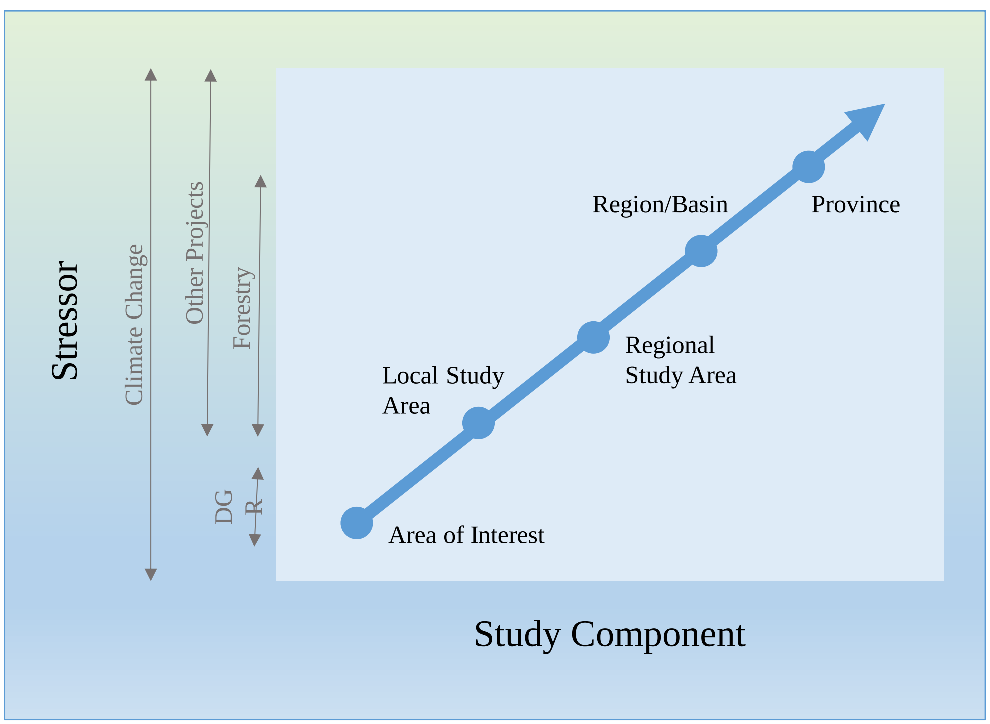
Note: 1000 m reflects the extent of deep drilling being completed by NWMO.

3.2.1 Study Area

The EMBP will include monitoring the boundary of the facility that may be located somewhere within the AOI (called the Site Study Area [SSA]), in environments surrounding the facility (called the Local Study Area [LSA]), and in some cases, in a larger area (called the Regional Study Area [RSA]). The proposed LSA and RSA for each of the components of the EMBP differ and are discussed within respective sections of this report (i.e., sections 4.0 to 8.0). The setting of study areas is illustrated in Figure 3.4.

In addition to examining areas in the SSA and LSA that could be subject to future Project impacts, study areas are being established that can act as reference areas in the future. Sampling reference areas will aid in determining whether temporal changes can be attributed to the Project or are due to other factors such as climate change, natural variability, or other anthropogenic sources. As described in various sections throughout this report, assessment of cumulative effects is a key component of the study design and will be an important factor in baseline study area characterization and selection of sampling locations.

Figure 3.4 Illustration of setting of study areas



Adapted from Ministry of Natural Resources and Forestry (MNRF 2015a).

3.2.2 Study Components

Study Components (SCs) can encompass aspects of biological (e.g., moose, algae, etc.), physical (e.g., change in aquatic habitat, change in topography, etc.), and social (e.g., increased population, increased traffic, jobs, road access to wilderness, impacts on natural resource use, etc.) environments and are selected with consideration of potential residual environmental effects to be included within a future IA. The SCs for the EMBP are very specific to each of components (i.e., tissue, surface water, etc.) and are discussed within respective sections of this report (i.e., sections 4.0 to 8.0).

3.2.3 Contaminants of Potential Concern

A comprehensive list of COPC is required for a baseline sampling program to provide a complete picture of the natural constituents in the environment; however, it is also important that the COPC list meets project objectives, is relevant to potential project interactions with the SCs, and is not cost prohibitive.

In general, only those contaminants with the highest potential for having interactions with the Project have been identified as COPC. There are some exceptions where a contaminant was included due to a high level of community concern, and the potential for cumulative effects. For example, the herbicide glyphosate is not expected to have any Project-environment interactions, but it may be present in environmental media being sampled as part of the EMBP due to its use by the forestry industry or in invasive vegetation management. Glyphosate was not included as a COPC in the Preliminary Sample Design Feasibility Assessment report (CanNorth et al. 2019); however, the Round 2 community engagement workshops revealed that there is a high level of concern around the use of glyphosate and its environmental fate and, thus, it has been included as a COPC for those media identified as being of highest concern by community members (e.g., surface water, berries, etc.). The collection of information on levels of glyphosate in various environmental media may also provide valuable insight into aspects of the BIS.

The COPC list for Year 1 of the EMBP was developed in collaboration with the NWMO, with consideration of stakeholder and rights-holder concerns, and with consultation of numerous reports (Amiro 1992; Ontario Hydro Nuclear 1993; SENES 2012; NWMO 2017b; Liberda and Leung 2018). The Preliminary Sample Design Feasibility Assessment report (CanNorth et al. 2019) provided the rationale for the selection of COPC. Appendix D summarizes the COPC list by media. The 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 list will be re-evaluated as part of the annual reviews to ensure it is remains comprehensive and relevant.

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, operation, or postclosure). This includes tritium (H-3), carbon-14 (C-14), strontium-90 (Sr-90), iodine-129 (I-129), cesium-137 (Cs-137), and radium-226 (Ra-226), as well as radon (Rn-222) and krypton-85 (Kr-85) for air only. In addition, gross-α and gross-β levels are being measured to characterize the background values. There are two classes of Tier 2 radionuclides: the first are artificial radionuclides and the second are the natural radionuclides. For the artificial radionuclides, there is no reason that these isotopes would be present under background conditions; thus, a limited number of samples will be collected. For the natural uranium and thorium series radionuclides and potassium-40 (K-40), information on background levels will be important to understand the natural levels and to understand measured gross-α and gross-β. In addition, the uranium isotope and K-40 data may also be used as a quality control indicator on the spectral gamma borehole logging data.

3.2.4 Potential Pathways of Effects

In order to focus design of the EMBP on the Project, it is important to understand the multiple pathways through which the Project could affect the various environmental components during each Project phase. Examples of potential Project-related interactions include blasting residuals, combustion by-product emissions, suspended particulates, treated effluent(s) releases, accidental surface releases, noise and light during construction and operation, and run-off or leaching from disturbed soils and the excavated rock pile. Further information on potential pathways of effects is provided in the CSM in Appendix C.

3.2.5 Climate Change Impacts

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

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

3.2.6 Historic and Current Land Use in the Area

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

3.2.6.1 Historic Activities

Using the Abandoned Mines Information System (AMIS; MNDM 2019), no abandoned mines were found within the AOI or Revell Batholith Temporary Withdrawal Area, as shown in Figure 3.5; however, there are several abandoned mines in the region, including several that are in close proximity to the Mennin Lake drainage downstream of the AOI. According to AMIS, the abandoned mines contain a variety of hazardous features such as water-filled shafts, rotten tramway and mill foundations, leaching and tailing areas, and open cuts.

3.2.6.2 Current Activities

Land use in the area is shown in Figure 3.6. The land features consist mostly of forest, pasture, wetlands, and open land with man-made or recreational looking paths and trails. There are limited transportation corridors and no discernable development in the immediate area.

There are no active mines within 25 km of the AOI; the nearest mines are Rainy River Gold Mine 165 km to the southwest and North American Palladium Ltd (Platinum Group Metal Mine), located approximately 190 km to east (Ontario Prospectors Association 2019). The Goliath Gold Project is a proposed open-pit and underground gold mine located approximately 35 km to the northwest of the AOI (see Figure 3.5). It recently completed its federal Environmental Assessment, receiving government approval in August 2019 to proceed with obtaining additional authorizations and permits. The Bending Lake Iron Project, located approximately 20 km south of the AOI, is a proposed iron ore mine and on-site metal mill that is currently in the IA stage (see Figure 3.5).

The most active industry in the region is forestry. The AOI and surrounding LSA is predominantly located within the Wabigoon Forest Management Unit (MU #130), within the Dryden District and the Northwest Region of the MNRF. The northern quarter of the LSA is within MU #535 (Dryden Forest). As per the Forest Management Plans for MU #130, the total planned harvest area was 70,946 hectares (ha) from 2008 to 2018, and 57,051 ha from 2019 to 2029 (MNRF 2019). Between 2008 and 2018, only 67% of the planned harvest area was in fact harvested because of the down turn in the forest economy (Domtar 2018). Current and planned forestry land uses for the region and AOI are described in the Forest Management Plans for MU #130 and MU # 535. The plans can be accessed at https://nrip.mnr.gov.on.ca/s/fmp-online?language=en_US. The spatial data underlying the maps in the plans were not available from the MNRF at the time of writing and, thus, forest land uses have not been included on Figure 3.6. Pesticide (VisionMAX™ Silviculture Herbicide # 27736 at a concentration of 356 grams of glyphosate per litre) is applied annually in MU #130 by aerial spraying over a two-month period, generally from August 1 through to September 30, for site preparation or vegetation management of regenerating areas.

Other active operations in the area include hydro dams, with the nearest dam approximately 100 km northwest at Lac Seul. Additionally, Ontario Power Generation (OPG) operates the Atikokan Generating Station, which was converted to operate on biomass in 2014, approximately 50 km southeast of the AOI is constructing a thermal development approximately 90 km southeast at Atikokan. The International Institute For Sustainable Development (IISD) also has their Experimental Lakes Area, with 58 small lakes and their watersheds set aside for scientific research around the impacts of climate change, agricultural runoff, water management, contaminants such as mercury and organic pollutants, and a growing list of chemical substances. However, the nearest lake is over 100 km to the west of the AOI.

Figure 3.5 Abandoned and potential future mines in the region

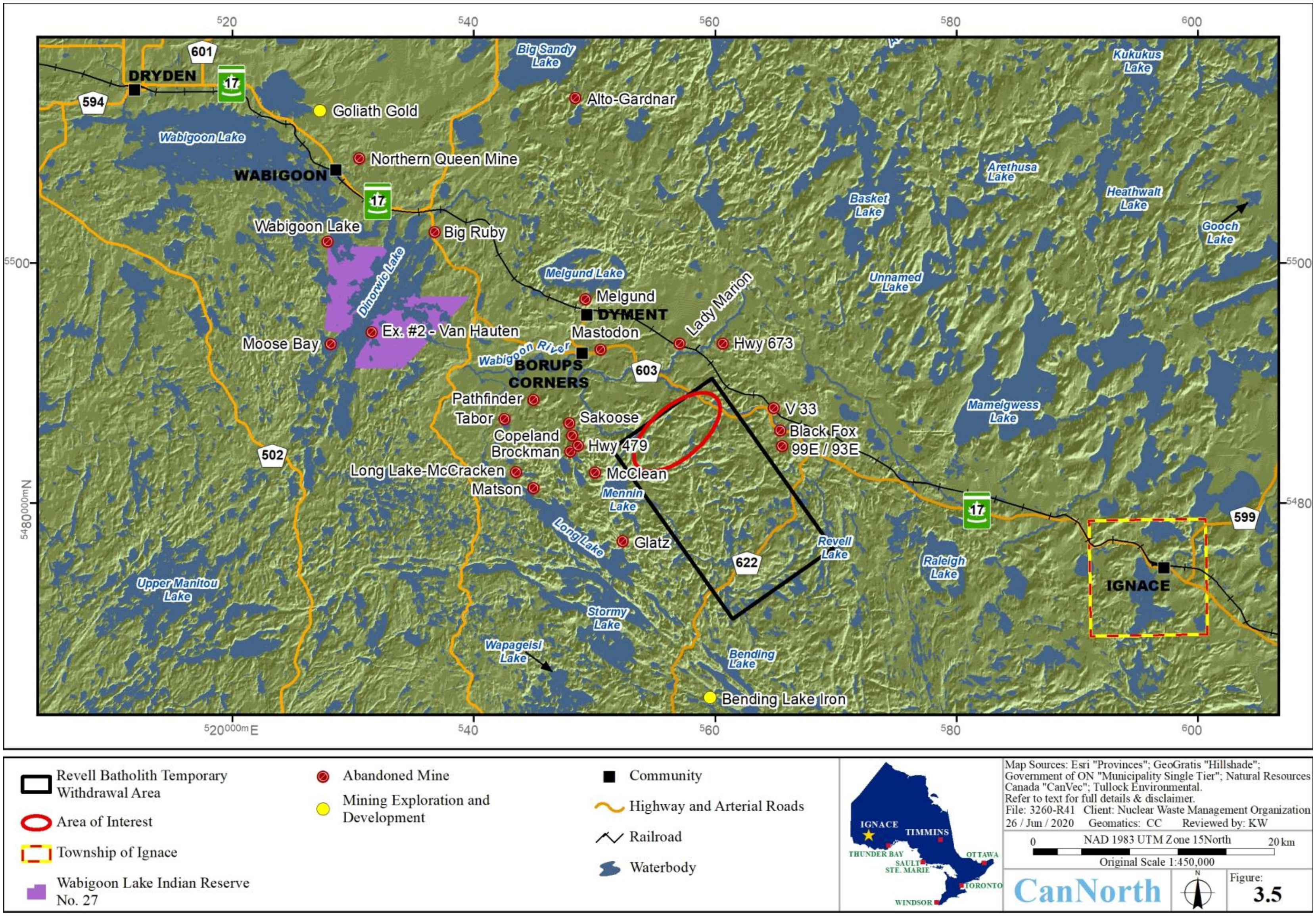
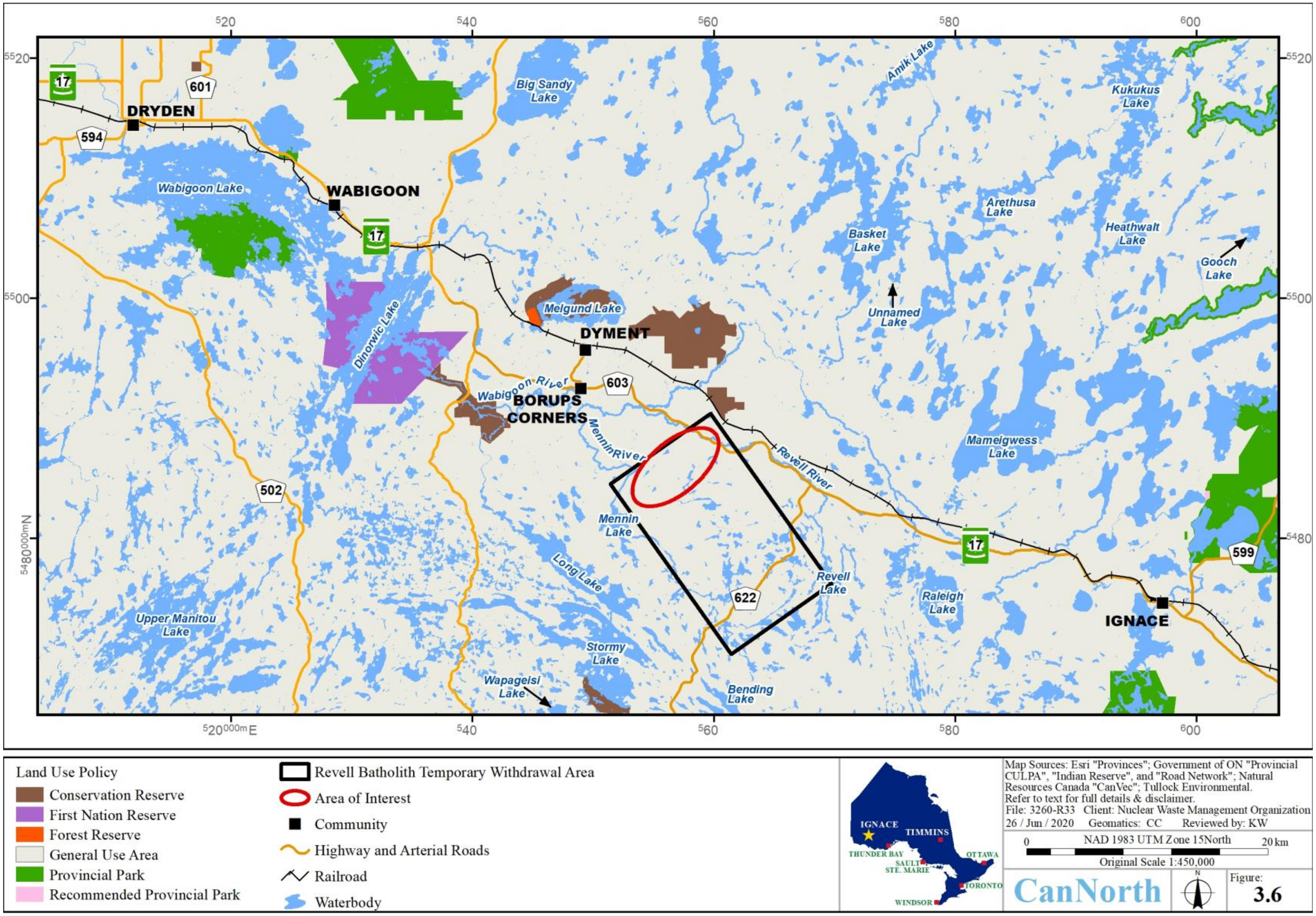


Figure 3.6 Land use map of the of the region



3.2.7 Assumptions

A number of assumptions had to be made about the Project when designing the EMBP because the Project design and location have not been finalized. Detailed assumptions are provided in the CSM (Appendix C).

3.3 Potential Cumulative Effects

The assessment of cumulative effects is an important part of the IA process, and the data collected as part of the EMBP will contribute to this component of a future IA should the community remain in the process and become the single preferred site for the Project. As discussed in Section 3.1.1.1, it was important to the stakeholders and rights-holders that the Project not be assessed in isolation, but rather in combination with the existing environment. Potential cumulative effects can arise from historic, current, or future anthropogenic activities in the area (see Section 3.2.6), and these can be identified through the following means:

- Conducting database searches and investigating other information sources;
- Gathering local community knowledge and IK;
- Collecting detailed site characterization data during the field studies; and
- Evaluating field observations and lab results during the annual and three-year reviews of the EMBP.

There is also the potential for cumulative effects that are not directly related to Project-environment interactions but that could arise as a result of the Project such as a population increase in Ignace or alterations to tourism. All these factors were considered in the study design for the EMBP, including selection of COPC, SCs, study areas (i.e., inclusion of reference areas, see Section 3.2.1), and information recorded during data collections. For example, and as discussed in Section 3.2.3, the herbicide glyphosate is not expected to have any Project-environment interactions, but it has been included as a COPC because of the potential for cumulative effects based on its high use in the area by the forestry industry.

An important component of site characterization during Year 1 of the EMBP field studies will be recording land use and other relevant information at sampling locations. This will enable an assessment of potential cumulative effects and help determine if there are historical or current anthropogenic activities in the area that may deem a study area not representative of baseline or reference conditions (for example, see Section 6.2.1.3). Data categories to document these components (e.g., land use, nearby industry or agriculture, indications of soil run-off or contaminants entering or in the water) are included on the field forms included in Appendix J. This information only needs to be recorded at sampling locations when first visited, or if land use or one of the other data categories changes. Local knowledge and IK may also be able to indicate areas impacted by historical activities that are not identified through desktop research and environmental records. The EMBP will be continually adapted to modify study areas and other study components as needed.

3.4 Statistical Considerations for Sample Design

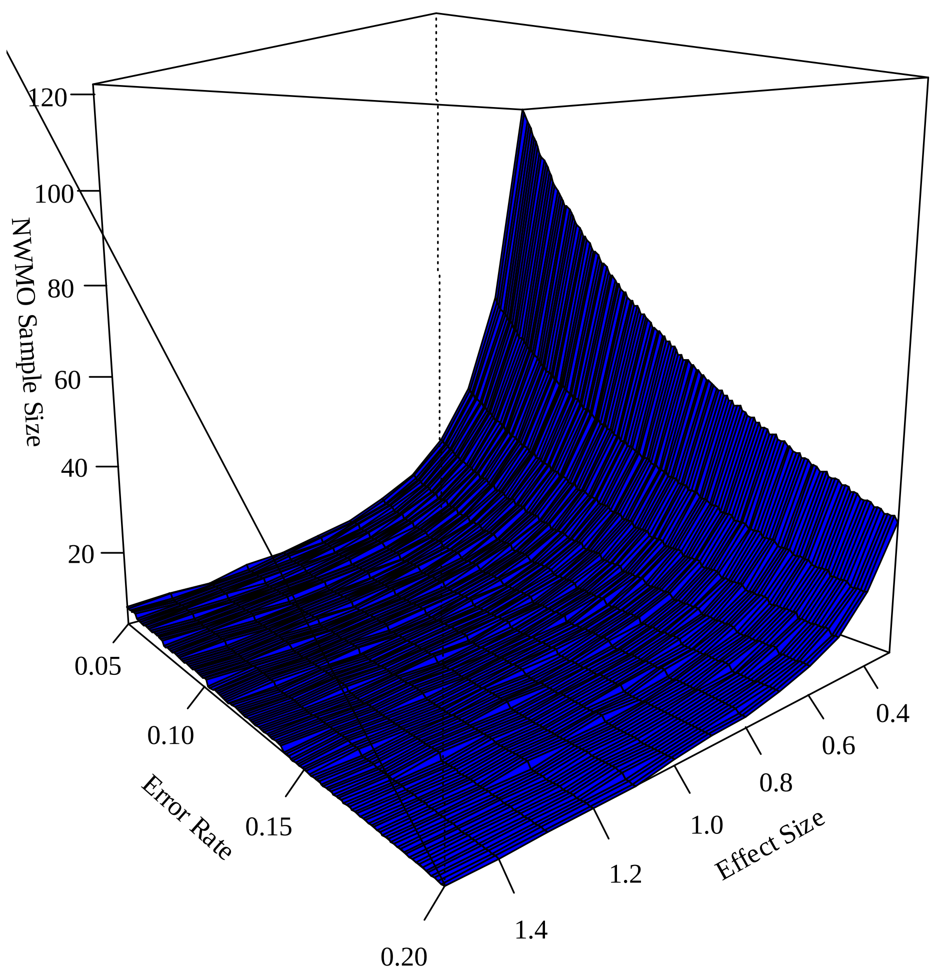
As discussed previously, the purpose of the EMBP is to sufficiently characterize environmental baseline conditions prior to development of the Project such that potential effects can be measured with a pre-specified degree of uncertainty or that an absence of detectable effects is not due to insufficient samling effort. In order to develop a sampling program that is sufficiently powerful to defensibly demonstrate that an effect has or has not occurred, the statistical design of the program must be carefully considered.

When designing a sampling program to collect data that will be used to make decisions about the effect of a project using data collected from the natural environment, sample size is a key component. The required sample size is influenced by the following three factors:

- The amount of natural variability, as natural sources of variation affect the ability to make conclusions about the effect of a project. If there is a large amount of variability, more samples need to be collected to understand that variability and to make good decisions.
- The Critical Effect Size (CES), which is a measure of how much change is to be detected/acceptable. The CES for a given measurement endpoint may be different for different Project phases. For example, in Years 1 to 10 of the Operation phase, a CES might consider the change in a measurement endpoint between the "before" and "after" phases. Subsequent to Year 10, a CES might be the magnitude of change in the temporal trend of Project-affected areas relative to control or reference areas. The number of samples required is inversely related to the degree of change to be detected (i.e., fewer samples are required for detecting larger changes).
- The amount of certainty required for any conclusions drawn from the data regarding whether or not the Project is having an adverse effect. The more certainty required, the more samples are required.

When making decisions about a Project-associated effect, two types of errors can be made: a Type I error, whereby it is concluded that the Project is having an effect when it actually is not; and a Type II error, whereby it is concluded that the Project is not having an effect when it actually is. Both of these errors can be reduced by collecting more samples, but there is a threshold at which point collecting more samples does not significantly lower the rates for these errors. Figure 3.7 shows that the more errors in conclusions we are willing to accept, the fewer samples are required. It also shows that as the size of the effect we would like to detect gets smaller, the number of samples increases.

Figure 3.7 Sample size estimation for a hypothetical biological measurement endpoint



Statisticians have developed methods to estimate sample sizes for a specific statistical test once the CES and Type I and II error rates have been selected. Inputs to these methods should be sought from regulators, rights-holders, and stakeholders. Initial sampling is necessary to understand and estimate local variability in order to obtain preliminary sample size estimates. Since the necessary input on the CES and acceptable levels of uncertainty have not occurred yet, and only limited (if any) sampling of the environmental components has been conducted, preliminary sample sizes have been estimated by the Study Team. This was completed using their knowledge of similar systems, such as environmental monitoring programs for mining operations or power generating stations, to estimate the following: expected variability for those variables that will be measured; the degree of change that has been typically considered as unacceptable by subject experts; and conventionally accepted degrees of uncertainty (i.e., the three critical statistical design elements listed above) when making decisions using information that is naturally variable. In addition, best practices, literature, and widely used guidance documents helped guide the decisions made for the Year 1 field program, which is scheduled to run from Fall 2020 through to the end of Summer 2021. As discussed below, the sample sizes employed during Year 1 of the program will be updated during annual reviews as additional information becomes available.

The focus of Year 1 of the EMBP is to understand variability for each SC primarily within the LSA and, to a lesser extent, in the RSA. Understanding variability allows for more effective apportionment of sampling effort in later years to generate a baseline dataset that will meet data quality objectives. In the absence of knowledge regarding variability, statistical designs should, in general, be balanced to the extent possible. That is, the same number of samples should be collected for each of the factors being considered. Consequently, the initial sampling design collects more samples from areas that are expected to not be affected by the Project than is typical of environmental sampling programs.

Since variability for a given SC is known to vary by “levels” of a “treatment” or category, samples are collected within each level of a treatment. For this design, “treatments” for water samples are reference and exposure areas, while “levels” are ponds, lakes, streams, and rivers. The program has been designed with the goal that sufficient samples are collected within each treatment level to make statistical comparisons that satisfy data quality objectives. The number of samples may be modified in subsequent years in consideration of variability, the likelihood of a Project-environment interaction, and the importance of the particular SC or sampling location to stakeholders and rights-holders.

Repeated samples of the same sampling unit are sub-samples. Sub-samples can be used in statistical models to estimate the within-sample variance, which increases the ability to reliably detect change. However, when the expectation is that there is little within-sample variance or that the within-sample variance is small relative to the among-sample variance for a fixed total number of samples, a more effective design is to reduce the number of sub-samples and to increase the number of samples. The relative magnitudes of within and among sample variances are currently not known, and the experience of the Study Team was used to determine the number of sub-samples to collect in the first year of the EMBP. The within, and among, sample variances will be estimated following Year 1 to refine the program and revise the number of sub-samples as necessary.

3.5 Guidelines and Benchmarks

When developing the sample design, applicable guidelines and benchmarks must be considered to ensure the data ultimately collected as part of the EMBP is of high enough quality to meet these guidelines. Some potential sources of these guidelines are summarized in Table 3.2.

The NWMO developed interim acceptance criteria for the protection of persons and the environment from non-radiological impacts for surface water, groundwater, soil, sediment, and air (NWMO 2015, 2019). The interim acceptance criteria are primarily based on the applicable guidelines, supplemented as needed by internationally developed guidelines and literature. These acceptance criteria are being used in the NWMO postclosure safety assessment (see Table 7-1 of NWMO 2017b) and are, therefore, also highly relevant as an evaluation tool.

Table 3.2 Sources of applicable regulatory guidelines

Medium	Agency	Standard
Tissues	Canadian Council of Ministers of the Environment (CCME)	Canadian Tissue Residue Guidelines for the Protection of Wildlife Consumers of Aquatic Biota.
Surface Water Quality	CCME	Canadian Water Quality Guidelines for the Protection of (Freshwater) Aquatic Life, and for the Protection of Agriculture (Irrigation and Livestock) .
	Government of Canada	Federal Environmental Quality Guidelines for surface water quality.
	Ontario Ministry of Environment, Conservation and Parks (MECP)	Provincial Water Quality Guidelines.
	Health Canada	Guidelines for Canadian Drinking Water Quality and Recreational Water quality.
	British Columbia Ministry of Environment (BCMOE) [(a)]	Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture; Drinking Water Sources; and Recreation.
Sediment Quality	CCME	Canadian Sediment Quality Guidelines.
	MECP	Soil, Groundwater and Sediment Site Condition Standards and Provincial Sediment Quality Guidelines.
Air Quality	MECP	Ambient Air Quality Criteria (AAQC) for a wide array of contaminants (5,100) that include short-term (10 minute, 1 hour and 24 hour) and long-term (annual) standards.
	CCME	Canadian Ambient Air Quality Standards (CAAQS) for nitrogen dioxide, sulphur dioxide, fine particulate matter ($PM_{2.5}$) and ozone.
Groundwater Quality	MECP	Soil, Groundwater and Sediment Site Condition Standards.
	Government of Canada	Federal Interim Groundwater Quality Guidelines for Federal Contaminated Sites.
Noise	Health Canada	Guidance for Evaluating Human Health Impacts in Environmental Assessment: Noise (uses a change in highly annoyed persons as in indicator of effects, which is calculated based on equations developed by the International Standards Organization (ISO) and United States Environmental Protection Agency (U.S. EPA).
	MECP	Environmental Noise Guideline Stationary and Transportation Sources – Approval and Planning Publication NPC-300.
Soil Quality	MECP	Soil, Groundwater and Sediment Site Condition Standards.
	CCME	Canadian Soil Quality Guidelines for the Protection of Environment and Human Health.
	Government of Canada	Federal Environmental Quality Guidelines.

Note: Table 7-1 of NWMO (2017b) also provides interim acceptance criteria for non-radionuclides for surface water, groundwater, soil, sediment, and air.

[a]Secondary source; to be used if federal or provincial value is unavailable.

4.0 TISSUES

This section contains the design details for the recommended option for the tissues component of the EMBP. This component of the program relates only to tissue chemistry and not to species presence/absence and health of SCs in the region. Community diversity, population health, habitat studies, Species at Risk (SAR), and other studies of ecological SCs will be included as part of the BIS that is currently being designed. Detailed study design information is provided below and summarized in Appendix E and Appendix F.

4.1 Data Objectives and End Use

4.1.1 Data Objectives

Baseline tissue concentrations are necessary for the future assessment of risk to SCs through the human health and ecological risk assessment components of an IA as well as for establishing pre-operation values for potential future monitoring programs. Tissue baseline concentrations are also essential to NWMO to develop site specific concentration ratios used in safety assessment modelling and in the development of Derived Release Limits (DRLs) during operations. Tissue chemistry of SCs is of particular interest to stakeholders and rights-holders in the region as demonstrated by the input provided during workshops held by the NWMO (see sections 2.2.3 and 3.1). During the workshops, concern for plants, wildlife, traditional foods, and traditional medicines was a common theme expressed by stakeholders and rights-holders in the region (Appendix B). To adequately meet data objectives related to both community assurance and scientific rigour, it is necessary that the tissue chemistry monitoring be inclusive of a wide network of both local and regional sampling locations, COPC, and SCs, and that a high level of stakeholder and rights-holder involvement, engagement, and sample coordination be maintained throughout the program.

The primary data objectives of the tissue component of the EMBP are to 1) characterize the variability of a wide range of tissue-based SCs in the local and regional study areas for tissues (LSA_{TIS} and RSA_{TIS}) under current conditions for incorporation into human health and ecological risk assessments, 2) provide the necessary baseline data for the development of a potential future long-term monitoring program to address environmental, human health, and stakeholder and rights-holder concerns relevant to the Project, and 3) establish Permanent Sampling Plots (PSPs) to assess the potential transfer of contaminants from air dispersion to soils and biological tissues within the LSA_{TIS}.

The data objectives for the LSA_{TIS} are primarily driven by potential Project interactions and the potential for localized cumulative effects in the AOI and the Mennin Lake drainage. Project components that have the potential to impact the local environment during each project phase (Project interactions) are detailed in the CSM provided in Appendix C. Data objectives are also driven by potential Project interactions with stakeholders and rights-holders in the region, including possible effects of the Project on human and ecological health and the ability of rights-holders to maintain their traditional way of life.

The data objectives for the RSA_{TIS} are primarily driven by stakeholder and rights-holder engagement activities and include providing community assurance and addressing perceptions, building relationships, and addressing the potential for cumulative effects. They are also driven by the need to include reference sampling locations for the LSA_{TIS} samples. To meet these data objectives, the sample design extends beyond the LSA_{TIS} to include regional study areas to capture natural variability in select SCs in the RSA_{TIS}.

In order to meet the data objectives, primary and secondary SCs were selected for sampling based on the potential for Project interactions, on the importance to the stakeholders and rights-holders in the region, and whether they would be important for future risk assessment work in support of an IA. The selection of certain SCs was based on those that the communities feel are most important, even if there is a low probability of the SC having a Project interaction (see Section 4.2.1.2).

4.1.2 Data End Use

The tissues baseline data will be used to:

- Establish variability in SCs of concern to stakeholders and rights-holders identified during the community engagement meetings prior to Project development;
- Establish variability in SCs that could be utilized for a future monitoring program to assess potential effects of the Project temporally;
- Provide the necessary data to be utilized in both the human and ecological modelling components, in Project planning, and to predict and assess Project impacts and cumulative effects in the IA;
- Support the pre and postclosure modelling needed for the safety assessments; and
- Assess the potential transfer of contaminants from air dispersion, water, and uptake from soils and sediments on biological tissues within the AOI.

4.1.2.1 Evaluation Criteria

The tissues study design includes sampling a wide variety of SCs over a broad study area and in targeted locations to enable data to be analyzed both spatially and temporally. For some SCs, reference areas are being sampled so that a Before-After-Control-Impact (BACI) study design can be used in the future once the site is operational. The program was designed to be adaptive, and data will be continually evaluated to ensure data quality objectives and end-use needs are being met.

The evaluation criteria will also include using applicable federal and provincial guidelines and comparing the data temporally and to regional data sets (if available) to assess if COPC baseline concentrations are naturally elevated within the LSA_{TIS} and RSA_{TIS}.

4.2 Data Collection

4.2.1 Sampling Details

The tissue sampling program proposes gathering 26% of the identified SCs in Year 1, 57% of SCs in Year 2, and 17% in Year 3. Since the EMBP is being completed over multiple years, the data from each study year, together with the evolution of Project plans, will be used to optimize the program. The sample design will also be modified as needed based on information that is collected from the Traditional Foods Dietary Survey (see Section 4.2.2) and the BIS.

The tissue sampling program and timing will depend entirely on the species being collected, and it is anticipated that sampling campaigns will occur in each of the four seasons. All sampling will be completed in partnership with or by local stakeholders or rights-holders. The tissue sampling program has been developed with the knowledge that the BIS and EMBP field studies will occur simultaneously. Where possible, tissue chemistry samples will be retained during surveys being conducted to meet the BIS data objectives, which will provide efficiency in sampling programs and reduce incidental mortality.

4.2.1.1 Study Areas and Sampling Locations

The proposed study areas for the tissues component of the EMBP will include the following:

- LSA_{TIS} – Portions of the AOI and the Mennin Lake drainage that are most relevant to the Project interactions and contain habitat types where target SCs can be obtained.
- RSA_{TIS} – Lands and waterbodies beyond the LSA_{TIS} that stakeholders and rights-holders consider being of high importance and express concern over the potential for Project interactions.

Sampling areas will be species-specific and will include multiple locations within the LSA_{TIS} and RSA_{TIS} depending on the distribution and home range of the target species. For instance, the study area for moose will be the whole RSA_{TIS} due to their large home range, whereas fish will be targeted from multiple locations progressively downstream of the Project, as well as multiple locations within the RSA_{TIS} that are of significance to the local communities. Reference locations within the RSA_{TIS} up-gradient of any potential exposure location were also selected for relevant SCs, such as berries and fish. It is important to sample reference locations to evaluate if changes observed during future monitoring are potentially Project related or are due to other causes such as natural variation, climate change, or other human activities in the area (CSA 2010; CCME 2015, 2016a; CNSC 2017). In addition to providing valuable information to the stakeholders and rights-holders, sampling completed in the RSA_{TIS} will serve as regional data for comparison to data collected within the LSA_{TIS}.

Sampling locations, particularly within the RSA_{TIS}, but also in the LSA_{TIS} as relevant, may be informed in future years based on the results of a local Traditional Foods Dietary Survey as of yet to be scheduled (see Section 4.2.2). Target species associated with the BIS will also overlap with target species for tissue analysis. Important site characterization information will be collected from the LSA_{TIS} as part of the BIS (e.g., fish community, habitat, and wildlife surveys), which will be used to ensure the dominant species are being sampled as part of the EMBP. The BIS will also help to provide further information related to the distribution and home range of target species in the RSA_{TIS} that will be necessary for determining the associated sampling locations for the SCs.

4.2.1.1.1 Local Study Area

Since it is not currently known where in the AOI the Project may be located, it is also not known which areas are most likely to be subject to potential impacts. Therefore, the EMBP is focused on characterizing spatial variability throughout the AOI and downstream environment in the LSA_{TIS}. The LSA_{TIS} has been sub-divided into three smaller areas (LSA_{TIS-1}, LSA_{TIS-2}, and LSA_{TIS-3}) that have the potential of being impacted by the Project (Figure 4.1 and Figure 4.2). The detailed sampling plan for the LSA_{TIS} for each SC is presented in Appendix E and summarized in Table 4.1 and Table 4.2.

- LSA_{TIS-1} is planned for the AOI and the small creeks entering the north end of Mennin Lake. The small ponds, creeks, and waterbodies located in this area may be subject to impacts from construction activities, water drawdown caused by dewatering, accidental releases, or aerial dispersion. Depending on Project plans, this study area should capture any potential COPC impacts from the Project on SCs within LSA_{TIS-1} prior to the Mennin Lake drainage.
- LSA_{TIS-2} encompasses Mennin Lake, and potential Project impacts could include water withdrawal, treated effluent release (more likely into the Mennin River north of Mennin Lake)[5], and/or COPC contributions from the AOI in the north end of the lake where the inflow is located.
- LSA_{TIS-3} extends north from the outlet of Mennin Lake for approximately 14 km along the Mennin River until it discharges into the Wabigoon River. The exact sampling locations along the Mennin River will be dependent on species availability and access, to be determined in Year 1 of the EMBP and from the BIS.

Sampling of some tissues will be dependent on simple species presence/absence in the LSA_{TIS}; however, other types will be matched between the exposure and reference areas and be more selective based on similar habitat types (e.g., aquatic macrophytes). The need to alter the size of the LSA_{TIS} and proposed locations will be re-evaluated as the Project plans progress and additional information is collected and made available from the local stakeholders and rights-holders, the BIS, and the proposed Project plans.

[5] The hydrology and surface water programs are collecting select data from the Revell River north of the AOI as it is also a potential site for treated effluent release/water withdrawal. The inclusion of this study area in the tissue chemistry program will be evaluated following Year 1 of the EMBP once preliminary data are collected and Project plans are further determined.

4.2.1.1.2 Regional Study Area

Tissue sampling will also take place in the RSA_{TIS} in order to establish a monitoring program that can be conducted by or with the assistance of stakeholders and rights-holders, that meets community needs, and that provides regional information and acts as reference locations for the LSA_{TIS}.

The broad RSA_{TIS} boundary (orange line shown in Figure 4.3 and Figure 4.4) extends along Highway #17 from 10 km west of Dryden to 10 km east of Ignace and encompasses lakes that have been identified as important to local stakeholders and rights-holders. Samples of larger game (i.e., moose, deer, bear, etc.) may be obtained by stakeholders and rights-holders from this broad RSA_{TIS}. Within the RSA_{TIS}, four distinct sampling areas have been defined that, based on input from the community engagement workshops, are believed to be of significance to the communities in the region (RSA_{TIS-1} through to RSA_{TIS-4}, as shown in Figure 4.3 and Figure 4.4). These four general areas were selected with consideration of accessibility, known fish species, and distance from the Project:

- RSA_{TIS-1} was selected to include Revell Lake and the surrounding area. It is proposed to sample Revell Lake as the reference lake for Mennin Lake since it is also classified as a cool water thermal regime, and according to Aquatic Resources Area, these two lakes also have quite similar large-bodied and small-bodied fish species, surface areas, depths, and Secchi depths (MNRF 2015b).
- RSA_{TIS-2} was selected to include Dinorwic Lake and the surrounding area. Dinorwic Lake is home to the WLON whose reserves lands are along the eastern shoreline. The lake is an important lake in the region for both recreational fishing as well as traditional harvesting and gathering. Dinorwic Lake contains a number of the fish species (e.g., walleye, lake trout, northern pike, lake whitefish, cisco, and white sucker) selected for tissue sampling (see Section 4.2.1.2).
- RSA_{TIS-3} was selected to include Long Lake and the surrounding area. Long Lake was identified as an important lake in the region for recreational fishing. It is a deep, well oxygenated lake and includes several of the fish species (e.g., walleye, lake trout, northern pike, lake whitefish, cisco, and white sucker) that were selected for tissue sampling (see Section 4.2.1.2).
- RSA_{TIS-4} was selected to include one of the three lakes (e.g., Mameigwess, Indian, and Paguchi lakes) and their surrounding areas. All three lakes north of Ignace are close, accessible, and important recreational sport fishing lakes in the region.

The need to alter the locations of the proposed sampling areas within the RSA_{TIS} may arise as additional information is collected and made available on current resource and land-use activities during studies completed in 2020, such as the Traditional Foods Dietary Survey (see Section 4.2.2). In addition, certain study areas may need to be relocated due to current anthropogenic influences. Consideration of cumulative effects will be important when selecting study areas to represent baseline or reference conditions. Land use and the potential for cumulative effects will be documented during the field surveys.

Figure 4.1 Proposed sampling locations within the tissues Local Study Area for the primary Study Components

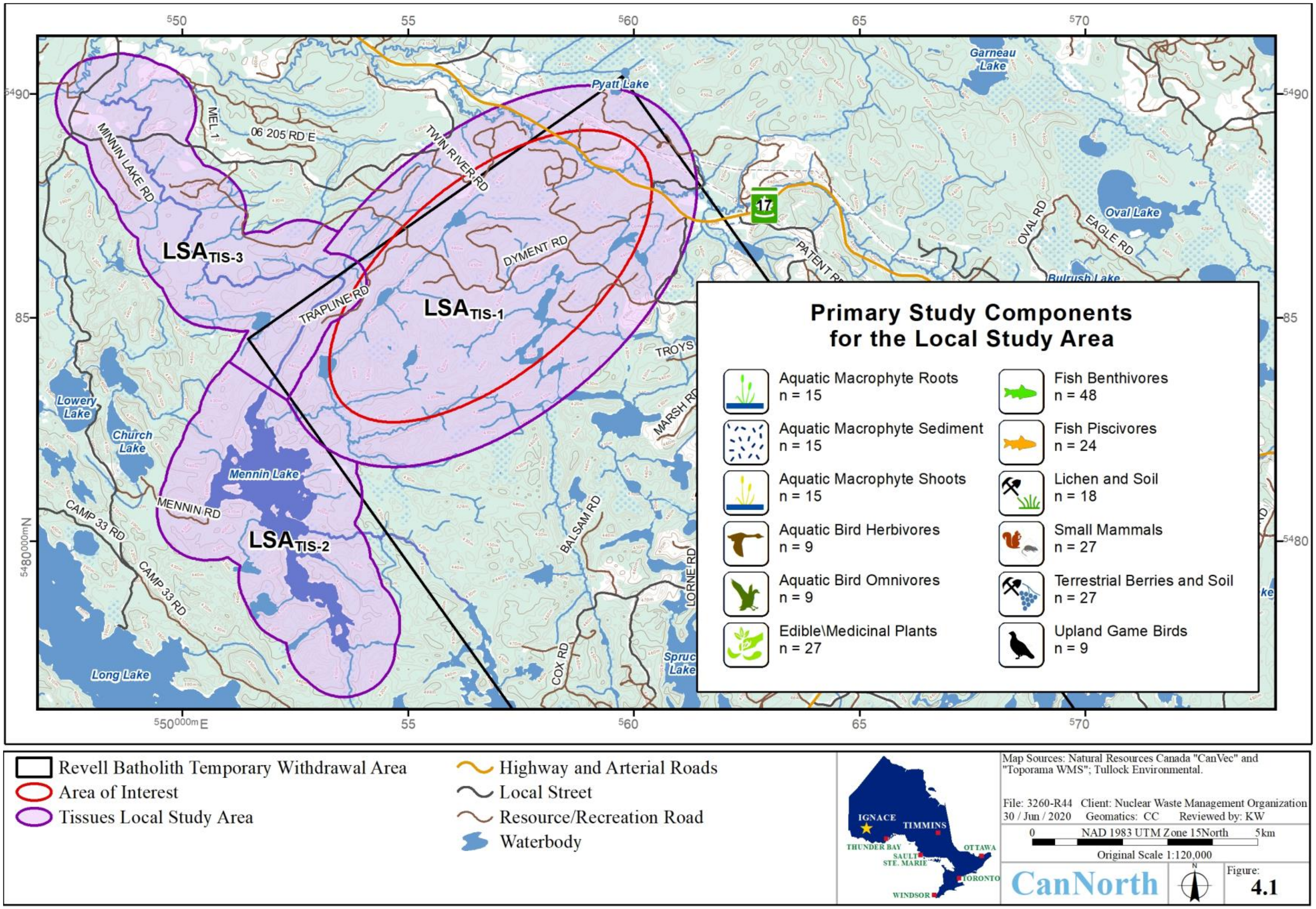


Figure 4.2 Proposed sampling locations within the tissues Local Study Area for the secondary Study Components

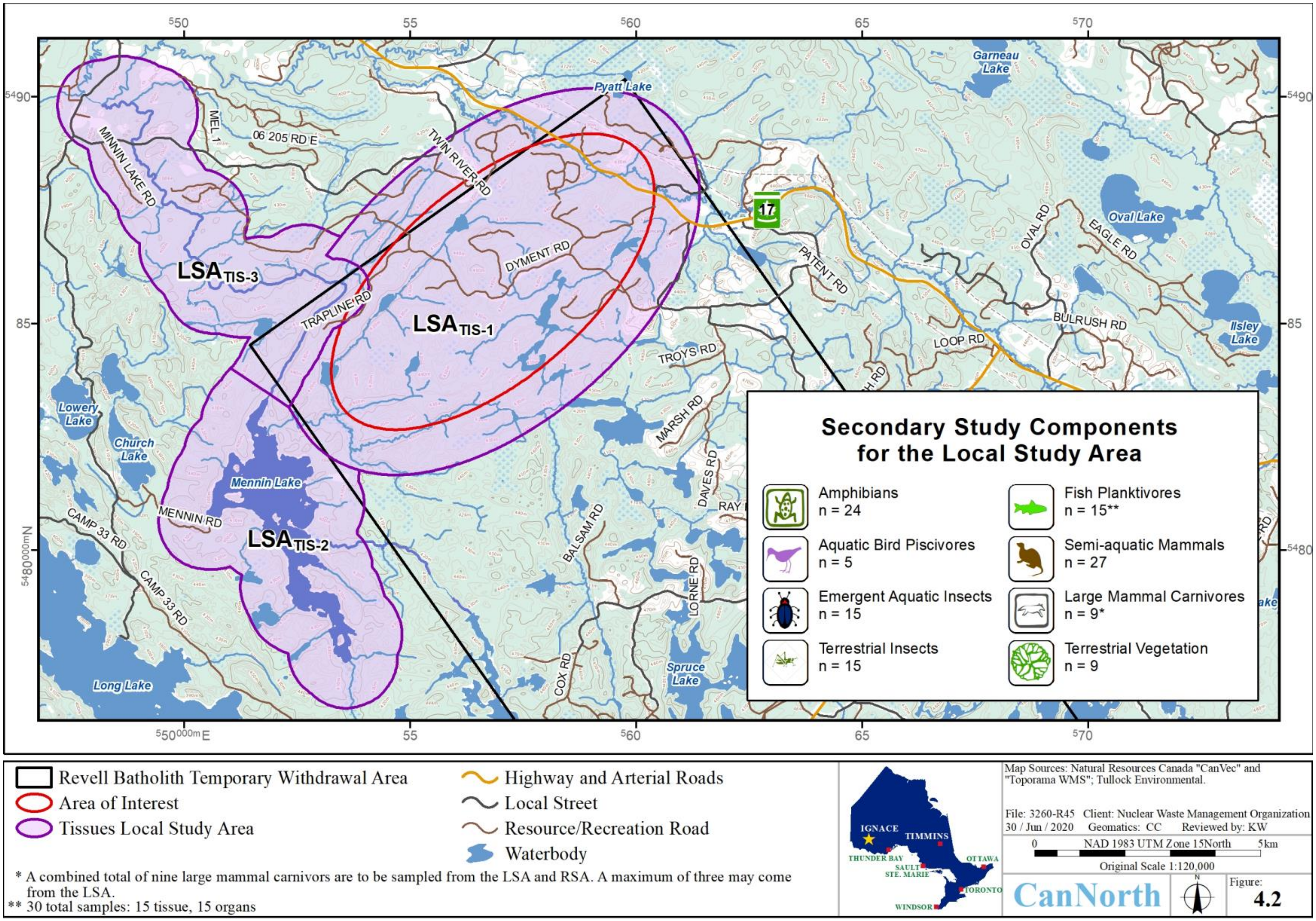
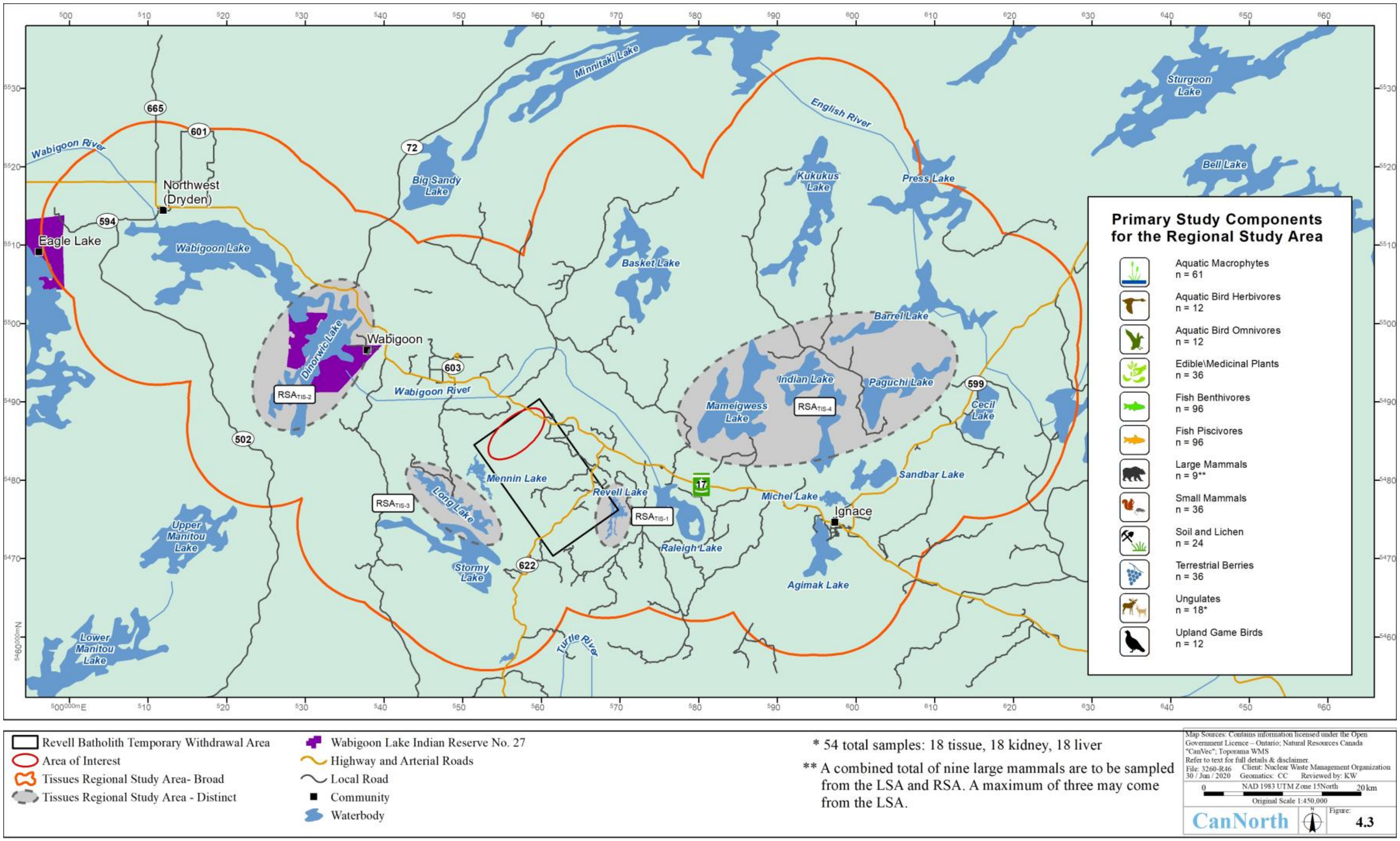


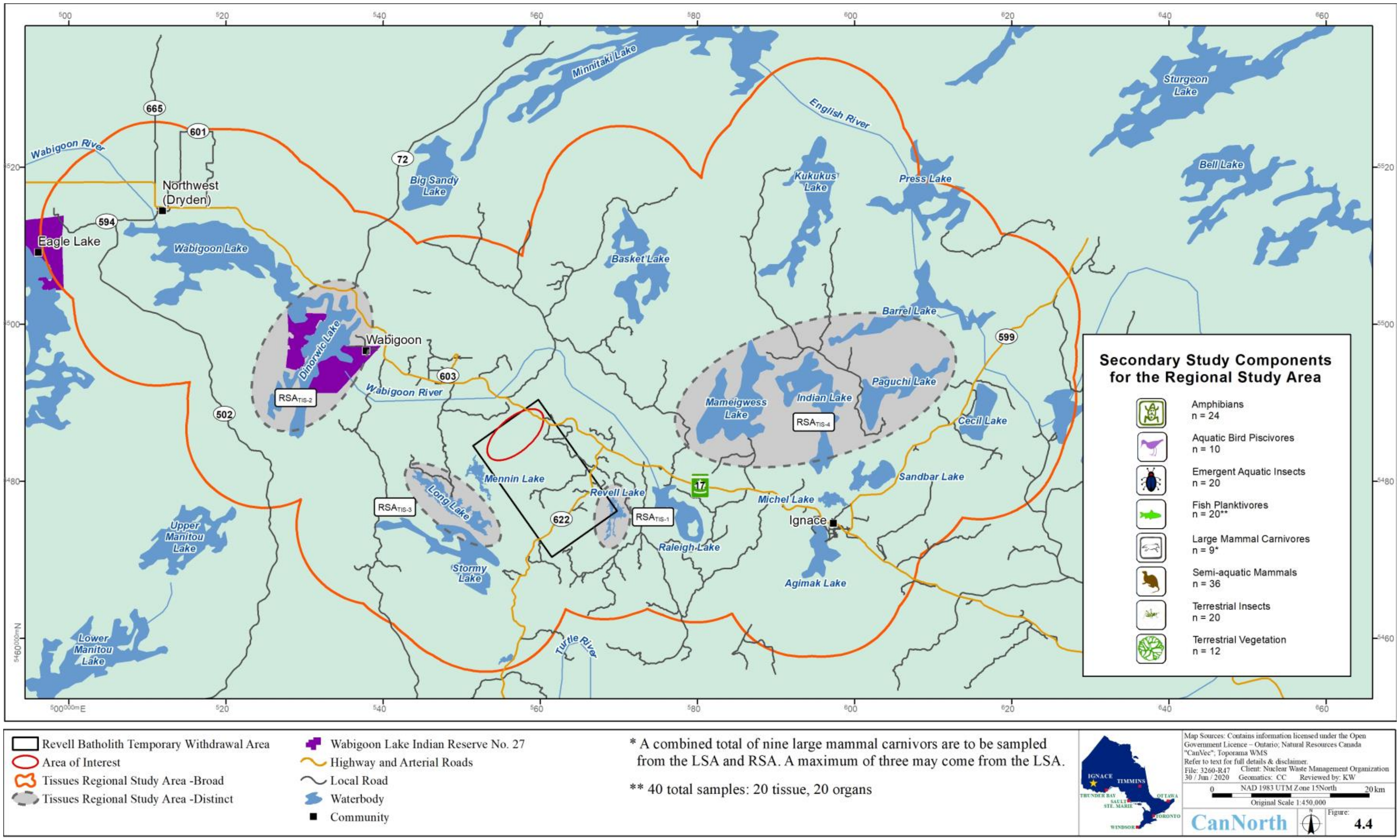
Figure 4.3 Proposed sampling locations within the tissues Regional Study Area for the primary Study Components



* 54 total samples: 18 tissue, 18 kidney, 18 liver

** A combined total of nine large mammals are to be sampled from the LSA and RSA. A maximum of three may come from the LSA.

Figure 4.4 Proposed sampling locations within the tissues Regional Study Area for the secondary Study Components



4.2.1.2 Study Components

A comprehensive list of potential SC categories for tissues was assessed to determine which SC categories should be considered as tissue monitoring endpoints during the EMBP. The list was derived from available stakeholder and rights-holder input (Appendix B), SCs commonly identified for First Nation traditional foods programs (Chan et al. 2014; CanNorth 2011, 2014, 2017a, 2018a, 2018b), SCs commonly identified in the uranium mining and nuclear power generation industries (Pröhl et al. 2003; ICRP 2008; NWMO 2014; AREVA 2016; EcoMetrix 2016; CanNorth 2017b), and those recommended in guidance documents (CSA 2012; Environment Canada 2012a; BCMOE 2016; CCME 2016a; CNSC 2018). Each potential SC category was evaluated in a matrix based on the following criteria:

- Community/Indigenous Knowledge
  - Cultural significance to rights-holders in the broader LSA_{TIS} /RSA_{TIS}.
  - Traditional food sources known to occur in the LSA_{TIS} /RSA_{TIS}.
  - Hunting/trapping/fishing sources known to occur in the LSA_{TIS} /RSA_{TIS}.
  - Tourism/economic importance in the RSA_{TIS}.
- Ecological Risk
  - Likelihood of receiving the greatest exposure to COPC due to habitat, behavioural trait, or home range.
  - Representation of various levels in the trophic web (e.g., carnivore, herbivore, insectivore).
  - Represents an important food source for a culturally important species (i.e., moose)
  - SAR that may occur within the LSA_{TIS}.
- Human Health Risk
  - Likelihood of exposure pathway relevant to human health.
- Practical Implementation
  - Known to occur in the LSA_{TIS} and would be potentially exposed to COPC from the Project.
  - Possible to achieve sample number and weight requirements for meaningful chemical analysis (i.e., able to achieve adequate laboratory detection limits for the COPC).

Each SC category was given a rank of 1 (low), 2 (medium), or 3 (high) based on its importance to either stakeholders and rights-holders, human health risk, or ecological risk.

Additionally, consideration was given to whether a SC could provide insight into potential effects within the AOI related to air dispersion on a long-term basis. Furthermore, the practical implementation of collecting sufficient material weight and sample sizes for meaningful results was also ranked. SC categories that received total scores between 10 and 12 were selected as primary SCs to include in the tissue component of the EMBP, while those that scored between 7 and 9 were selected as secondary SCs. It is recognized that these secondary SCs may still be of importance to stakeholders rights-holders; the need to collect tissue samples for COPC content was further evaluated during community engagement workshops. SC categories that scored less than 7 will be considered in future risk assessment work; however, baseline tissue monitoring is not needed for these categories. The full matrix is provided in Appendix F.

High level fish, wildlife, plant, and land use information in the Northwestern Ontario region is available from the MNRF (2015b), from the Phase 2 studies that have been completed to date (see Section 2.2), and from community engagement workshops (Appendix B). This information was used to identify species of concern for inclusion within each SC category. The inclusion of certain species was refined during these workshops, such as the inclusion of black bear as a primary SC (see Section 3.1.1). The SCs may also be further refined as part of the Traditional Foods Dietary Survey that is being planned (see Section 4.2.2), and as more detailed inventory data becomes available through the BIS.

4.2.1.2.1 Aquatic Study Components

The following primary aquatic SC categories are considered essential components for evaluation in the aquatic baseline tissues assessment of the LSA_{TIS} and RSA_{TIS}:

- Muscle tissue of key large-bodied piscivorous (e.g., walleye, lake trout, northern pike) and benthivorous (e.g., lake whitefish, cisco, white sucker) fish species in both the LSA_{TIS} and RSA_{TIS}, based on species availability.
- Representative aquatic macrophytes (e.g., roots, shoots, sediment of sedge species from LSA_{TIS}, wild rice from RSA_{TIS}, rat root/sweet flag from the LSA_{TIS} and RSA_{TIS}). Inclusion of roots, shoots, and sediment for sedge species will aid for contaminant modeling in risk assessment work. Wild rice and rat root/sweet flag are being targeted due to the use as a traditional food source in the region.
- Muscle tissue of key herbivorous (e.g., Canada goose) and omnivorous (e.g., mallard duck) aquatic birds from both the LSA_{TIS} and RSA_{TIS}.

The secondary aquatic SC categories include the following:

- Hair and/or muscle tissue of representative semi-aquatic mammals (e.g., beaver, muskrat, mink) from the LSA_{TIS} and RSA_{TIS}.
- Representative amphibians (e.g., green frog, wood frog tadpoles) from the LSA_{TIS} and RSA_{TIS}.
- Feathers of key piscivorous aquatic birds (e.g., merganser, grebe) from the LSA_{TIS} and RSA_{TIS}.
- Whole body (organs removed) from representative planktivorous fish species (e.g., spottail shiner, longnose dace) from the LSA_{TIS} and RSA_{TIS}.
- Organs (liver) from representative planktivorous fish species (e.g., spottail shiner, longnose dace) from the LSA_{TIS} and RSA_{TIS}.
- Whole aquatic emergent insect chemistry (e.g., dragonflies/damselfly).

4.2.1.2.2 Terrestrial Study Components

The following primary terrestrial SC categories are considered essential components for evaluation in the terrestrial baseline tissues assessment of the LSA_{TIS} and RSA_{TIS}:

- Muscle and organ tissue of key ungulates (e.g., moose, whitetail deer) from the RSA_{TIS}.
- Muscle tissue of representative large mammal (e.g., black bear) from the RSA_{TIS}.
- Tissue of representative small mammals (e.g., mouse [whole], shrew [whole], snowshoe hare [muscle]) from the LSA_{TIS} and RSA_{TIS}.
- Muscle tissue of key upland game bird (e.g., ruffed grouse) from the LSA_{TIS} and RSA_{TIS}.
- Berry chemistry of key edible berry species (e.g., blueberry, cranberry, raspberry) in the RSA_{TIS} and co-located with soil samples in the LSA_{TIS}.
- Vegetation chemistry of key edible or medicinal use plants (e.g., wild mushroom, Labrador tea, Chaga) from the LSA_{TIS} and RSA_{TIS}.
- Soil and lichen co-located PSPs for assessment of air dispersion in the LSA_{TIS} and reference PSP plot in the RSA_{TIS}.

The secondary SC categories include the following.

- Hair and/or muscle tissue of representative large carnivores (e.g., lynx, wolf) from the RSA_{TIS}.

- Vegetation chemistry of representative browse species (e.g., willow) from the LSA_{TIS} and RSA_{TIS}.
- Whole terrestrial insect chemistry from the LSA_{TIS} and RSA_{TIS} (e.g., caterpillars/beetle).

4.2.1.3 Contaminants of Potential Concern

A comprehensive COPC list was developed in collaboration with the NWMO as discussed in Section 3.2.3 and detailed in Appendix D. For the tissues component, COPC include percent moisture, cyanide, and a full suite of metals, including total mercury. Based on concerns raised by stakeholders and rights-holders on the use of the herbicide glyphosate in the area and its potential transfer to water and food, glyphosate has also been included for yearly analysis in select SCs (berries and some edible or medicinal use plants).

As discussed in Appendix D, metals and Tier 1 radionuclides will be analyzed in tissues of primary SCs (where adequate sample volume/weight can be achieved). For secondary SCs, radionuclides will not be tested as sample volumes will be challenging to obtain and the associated costs to complete the analysis outweigh the value of the data. The secondary SCs will largely be collected non-lethally and tested using laser ablation and Inductively Coupled Plasma Mass Spectrometry (ICP-MS) (see Section 4.2.1.5). The final list of COPC selected for each SC is presented in Appendix E.

4.2.1.4 Sample Size and Frequency

A number of factors were considered in terms of sampling size and frequency, including the availability of SCs within the study area, the ability to collect sufficient volume/weight of the sampling material to achieve meaningful radionuclide results, lethal versus non-lethal sampling, and the ability to collect a sufficient number of replicates to obtain statistically sound estimates (see Section 3.4). For the purpose of obtaining initial estimates of local variability, the sample size of each SC is between three and nine samples, depending on the number of areas being sampled.

In cases where multiple species of concern have been identified within a SC category (e.g., berries), the collected species may alternate by year to ensure data are collected for the species identified as significant to stakeholders and rights-holders and for risk assessment. There is also the opportunity to sample the same species in multiple years to obtain estimates of temporal variability and to increase sample sizes if variability in COPC concentrations is higher than anticipated. Consideration was given to the balance between obtaining data for the range of species of interest locally and the ability to provide sufficient data for statistical analysis to gather a better understanding of the spatial variability within the data from the region.

The number of sampling areas and replicate samples per SC category are summarized in Table 4.1 for primary SCs and in Table 4.2 for secondary SCs. They are also indicated in Figure 4.1 through to Figure 4.4, with details provided in Appendix E. Following Year 1 of the EMBP (scheduled for Fall 2020 to end of Summer 2021), the SCs and associated sample sizes will be further refined based on the variability of the dataset and the local abundance of each SC. If sample sizes are not achieved for one SC during the first year as a result of natural conditions (i.e., no berries can be harvested due to inclement weather), additional sampling can be completed during Year 2 or Year 3 to achieve the total sample size for the SC.

Table 4.1 Tissue sampling requirements for Primary Study Components

SC Category	Example VC[a]	Radio-nuclides Included?	Number of Areas		Number of Samples per Area[b]			Total
			RSA$_{TIS}$	LSA$_{TIS}$	Year 1	Year 2	Year 3	
Aquatic								
Large-bodied Fish – Piscivores	Walleye	✓	4	3	8 (RSA)	8 (LSA)	-	56
	Northern Pike	✓	4	3	8 (RSA)	8 (LSA)	-	56
	Lake Trout	✓	4	NE	8	-	-	32
Large-bodied Fish – Benthivores	White Sucker	✓	4	3	8 (RSA)	8 (LSA)	-	56
	Lake Whitefish	✓	4	NE	8	-	-	32
	Cisco	✓	4	NE	8	-	-	32
Aquatic Macrophytes	Sedge Species (Roots, Shoots, and Sediment)	✓	4	3	-	5	-	105
	Manoomin/Wild Rice	✓	4	NE	-	3	-	12
	Rat Root/Sweet Flag (Root Only)	✓	3[e]	3	-	-	3	18
Aquatic Birds – Herbivores	Canada Goose	✓	4	3	-	3	-	21
Aquatic Birds – Omnivores	Mallard	✓	4	3	-	-	3	21
Terrestrial								
Berries	Blueberry (Berry)	✓	4	3	3	-	-	21
	Raspberry (Berry)	✓	4	3	-	3	-	21
	Cranberry (Berry)	✓	4	3	-	-	3	21
Soil	Soil (co-located with berries)	✓	NE	3	3	3	3	21
Terrestrial Vegetation – Edible or Medicinal Use	Wild Mushroom	✓	4	3	3	-	-	21
	Chaga	✓	4	3	-	3	-	21
	Labrador Tea	✓	4	3	-	-	3	21
Terrestrial Soil Vegetation – Air	Soil[c]	✓	4[d]	3[d]	-	3	-	21
	Lichen[c]	✓	4[d]	3[d]	-	3	-	21
Upland Game Birds	Ruffed/Spruce Grouse	✓	4	3	3 (RSA)	3 (LSA)	-	21
Large Mammals	Black Bear	✓	1[f]	NE	3	3	3	9
Small Mammals	Snowshoe Hare	✓	4	3	-	3	-	21
	Mouse or Vole (Whole)	✓	4	3	-	3	-	21
	Shrew (Whole)	✓	4	3	-	-	3	21
Ungulates	Moose	✓	1[d]	NE	3	3	3	9
	Moose (Kidney)	✓	1[d]	NE	3	3	3	9
	Moose (Liver)	✓	1[d]	NE	3	3	3	9
	Whitetail Deer	✓	1[d]	NE	3	3	3	9
	Whitetail Deer (Kidney)	✓	1[d]	NE	3	3	3	9
	Whitetail Deer (Liver)	✓	1[d]	NE	3	3	3	9

Note: NE: Not Evaluated (species not identified within LSA$_{TIS}$ or species has larger home range than LSA$_{TIS}$).
[a] Unless otherwise noted, bird and mammal samples are muscle tissue.
[b] Where multiple species of concern have been identified within a Study Component (SC) category, species sampled can alternate year by year to ensure data are collected for all species.
[c] Sampling objective specific to localized effects in the AOI and also included regional reference locations.
[d] Ideally, three Permanent Sampling Plots (PSPs) will be established within the LSA$_{TIS-1}$ and four reference PSPs within the RSA$_{TIS}$.
[e] Rat root is small and difficult to find and, thus, the number of sampling areas within the RSA$_{TIS}$ has been reduced.
[f] VCs with larger home ranges will be collected from the RSA$_{TIS}$ as a whole and not explicitly from RSA$_{TIS-1}$ through to RSA$_{TIS-4}$.

Table 4.2 Tissue sampling requirements for Secondary Study Components

SC Category	Example VCs[a]	Radio-nuclides Included?	Number of Areas		Number of Samples per Area[b]			Total
			RSA_{TIS}	LSA_{TIS}	Year 1	Year 2	Year 3	
Aquatic								
Small-bodied Fish – Planktivores	Spottail Shiner and/or Longnose Dace (organs removed	-	4	3	-	5	-	35
	Spottail Shiner and/or Longnose Dace (organ - liver)	-	4	3	-	5	-	35
Amphibians	Green Frog/Wood Frog Tadpole	-	3	3	-	8	-	48
Semi-aquatic Mammals	Beaver (Hair and/or Muscle)	-	4	3	-	3	-	21
	Muskrat (Hair and/or Muscle)	-	4	3	-	3	-	21
	Mink (Hair and/or Muscle)	-	4	3	-	-	3	21
Aquatic Birds – Piscivores	Grebe or Merganser (Feather)	-	2	1	5 (RSA)	5 (LSA)	5 (RSA)	15
Emergent Aquatic Insects	Dragonflies or Damselfly (Whole)	-	4	3	-	5	-	35
Terrestrial								
Large Mammals – Carnivores	Wolf or Lynx (Hair and/or Muscle)	-	1[c]	NE	3	3	3	9
Terrestrial Vegetation – Browse	Willow	-	4	3	-	-	3	21
Terrestrial Insects	Caterpillars or Beetles (Whole)	-	4	3	-	5	-	35

Note: NE: Not Evaluated (species not identified within LSA_{TIS}/species has larger home range than LSA_{TIS}).
[a] Sampling could be via lethal (e.g., muscle) or non-lethal (e.g., scale, feather, hair) methods, depending on options.
[b] Where multiple species of concern have been identified within a Study Component (SC) category, species sampled can alternate year by year to ensure data are collected for all species.
[c] VCs with larger home ranges would be collected from the RSA_{TIS} as a whole and not explicitly from each of RSA_{TIS-1} through to RSA_{TIS-4}.

4.2.1.5 Sampling Methods

A standard sampling program is proposed to obtain samples of SCs that are not commonly eaten by people and/or are targeted from areas where people do not spend a lot of time hunting and fishing (i.e., the LSA_{TIS}). Samples of these primary SCs will be submitted for analysis of metals and radionuclides.

Hunting, fishing, and gathering of local food is common in the area, and many stakeholders and rights-holders have indicated a willingness to donate samples of these foods to the EMBP. A community harvesting program is proposed that will decrease the overall impact of the sampling program on the local population of target species, will further engage the communities in the sampling program, and will ultimately ensure sampling is focused on the SCs of most concern to the stakeholders and rights-holders. Based on input received from the workshops describing where hunting and fishing occurs, it is expected that samples from community harvesting efforts will largely be from the RSA_{TIS} with limited samples, if any, from the LSA_{TIS}.

For SCs where lethal sampling is not possible or desirable, or for SCs where sufficient sample cannot be obtained for analysis of radionuclides, samples will be obtained and submitted for laser ablation analysis of metals.

All samples will be submitted to certified laboratories selected by the NWMO. Information on minimum sample weights required for each media type, particularly for radionuclide analyses, will need to be acquired from the laboratory prior to the sample collection. It is expected that a minimum of 500 g per sample be collected for primary SCs to ensure sufficient sample for radionuclide analysis. Smaller sample sizes would be required for secondary SCs (metals only).

4.2.1.5.1 Standard Sampling Methods

Standard sampling and analysis of primary SCs will be completed by consultants working with local stakeholders and rights-holders; Standard Operating Procedures (SOPs) and data sheets are provided in Appendix J. These efforts will be largely focused on SCs from the LSA_{TIS} and/or that people do not regularly eat, which include:

- Primary SCs (metals and radionuclides):
  - Muscle tissue of large-bodied fish (e.g., walleye, northern pike, white sucker,) in the LSA_{TIS};
  - Roots and shoots of sedge species (and co-located sediment);
  - Muscle tissue of aquatic birds (e.g., Canada goose and dabbling duck) in the LSA_{TIS};
  - Muscle tissue of upland game birds (e.g., ruffed grouse/spruce grouse) in the LSA_{TIS};
  - Small mammals (mice and shrew [whole body]; snowshoe hare [muscle tissue]);
  - Berries (e.g., blueberry, cranberry, raspberry) and co-located soils in the $LSA_{TIS;}$

- Wild mushroom, chaga, Labrador tea (vegetation) in the LSA$_{TIS}$; and
- Soil and lichen from co-located PSPs in LSA$_{TIS-1}$.

If adequate samples are not obtained through the community sampling program in the RSA$_{TIS}$, then standard sampling methods will be used to fill identified gaps.

4.2.1.5.1.1 Large-bodied fish

Large-bodied fish samples will be collected using standard methods such as gill netting, angling, or electrofishing within selected waterbodies from the LSA$_{TIS}$ and four waterbodies selected from the RSA$_{TIS}$. Whenever possible, large-bodied fish for chemical analyses will be retained during the community inventory surveys being completed as part of the BIS or will be donated by community members. Target fish retained for chemistry will be measured to the nearest mm (fork or total, depending on species), weighed (± 1%), and assessed for condition (health). Ageing structures removed from target fish will be cleithra from northern pike, fin rays from white sucker, and otoliths from all other species as well as secondary ageing structures (scales). Additional internal health measures will be recorded, including gonad weight (±1%), liver weight (±1%), stomach fullness and contents, presence of parasites, and any abnormalities. Gutted, large-bodied fish will be placed into labelled bags and frozen. Tissue and ageing structures will be submitted to a laboratory selected by the NWMO.

4.2.1.5.1.2 Aquatic Macrophytes

Aquatic macrophyte chemistry samples will include sedge, wild rice, and rat root/sweet flag. Sedge samples will be separated into two components for chemical analysis: shoots (above the sediment/water interface) and roots (below the sediment/water interface). Wild rice and rat root/sweet flag will only be sampled as one component (i.e., shoots of wild rice, roots of rat root/sweet flag). Samples will be collected using Teflon-coated scissors and/or a stainless steel shovel. Macrophyte samples will be rinsed with lake water (i.e., the sediment washed off the roots), bagged, labelled, and frozen prior to submission to a laboratory for chemical analysis.

At each sedge sampling station, sediment will be collected from around and beneath the macrophyte samples using a stainless steel shovel. Three sediment samples will be composited at each sampling station by shovelling the area around macrophyte roots up to a depth of 5 cm. Sediment samples will be bagged, labelled, and frozen prior to submission to a laboratory for chemical analysis.

4.2.1.5.1.3 Aquatic and Upland Game Birds

Canada goose, dabbling duck, and grouse (spruce/ruffed) tissues will be sampled lethally from within the LSA_{TIS} by a consultant and stakeholder/rights-holder where they are present to ensure samples from the LSA_{TIS} are collected. It is assumed a number of samples from the RSA_{TIS} will be submitted by local hunters during the spring or fall months during routine hunting activities (See Section 4.2.1.5.2); should additional samples be required, they will be collected by the consultant and local stakeholders and rights-holders.

Care will be taken to ensure the birds are hunted without the use of lead shot, and this will be communicated to local hunters that are submitting samples from the RSA_{TIS}. A federal Migratory Game Bird Hunting Permit (MGBHP), Wildlife Habitat Conservation Stamp, and an Ontario licence to hunt small game will need to be obtained in order to hunt migratory game birds. All regulations on open hunting seasons, bag, and possession limits will be followed. The birds will be bagged, labelled, processed, for chemical analysis.

4.2.1.5.1.4 Small Mammals

Small mammal trapping techniques will vary depending on the species targeted. Mice and shrew sampling will be completed in August or early September in the LSA_{TIS} and RSA_{TIS} by a consultant, after the breeding season but before juvenile dispersal. Trapping methods may include a combination of snap traps and dry pitfall traps. Whole-body specimens of mice and shrew will be retained and will need to be composited (to increase sample weight) in order to obtain the minimum sample size required for the tissue analyses. Each specimen will be identified to species, and morphometric measurements, weight, and sex will be recorded. Specimens will be bagged, labelled, and frozen prior to submission to a laboratory for chemical analysis.

Snowshoe hare sampling will be completed in the fall or early winter months by a consultant and stakeholder/rights-holder within the LSA_{TIS}. It is assumed a number of samples from the RSA_{TIS} will be submitted by local hunters during routine hunting activities (See Section 4.2.1.5.2); should additional samples be required, they will be collected by the consultant and two local stakeholders/rights-holders. An Ontario licence to hunt small game will be obtained and regulations on open hunting seasons, bag, and possession limits will be followed. The hare will be bagged, labelled, processed for chemical analysis.

4.2.1.5.1.5 Terrestrial Vegetation

Terrestrial vegetation sampling, including berries, wild mushrooms, and edible and medicinal vegetation (e.g., chaga, Labrador tea, other), will be collected in collaboration with stakeholders and rights-holders and will be handpicked. Multiple samples that are to be collected from each of the sub-areas should be spaced more than 20 m apart. For terrestrial vegetation, the current year's growth should be collected and will be cleaned of debris (but not rinsed with water). Soil samples will also be collected and co-located with the LSA_{TIS} berry samples collected yearly from LSA_{TIS-1} to LSA_{TIS-3}. Additional details on soil sample collection procedures are outlined below. Vegetation and soil samples will be bagged, labelled, and frozen prior to submission to a laboratory for chemical analysis.

4.2.1.5.1.6 Soil and Lichen

Permanent Sampling Plots (PSPs) will be established for sampling soil and lichen within LSA_{TIS-1} (i.e., the AOI) as well as at reference locations within the RSA_{TIS}. Additional soil samples are proposed for the soil component of the EMBP and are discussed further in Section 8.0.

Before sampling of PSPs takes places in Year 2 of EMBP, the ecosite habitat classification should be known within the AOI and LSA_{TIS}. The PSPs will pre-selected based on habitat, known wind direction, and abundance of lichen to occur. The sampling will be completed by a consultant working with two local stakeholders/rights-holders within the LSA_{TIS-1} and RSA_{TIS}. Once a PSP is located, a 10 m by 10 m area will be outlined to avoid trampling the lichen before it is sampled, and each PSP will be spaced a minimum of 20 m from the nearest PSP sampling plot.

Soil samples will be collected at a depth of 5 cm to 10 cm using a soil corer. The surficial loose organic debris from the top of the core samples will be carefully removed and the top horizon of the underlying mineral soil will be collected and composited to form a single soil sample. Soil samples will be bagged, labelled, and frozen prior to submission to a laboratory for chemical analysis.

Lichen chemistry is used as an indicator of atmospheric fallout, as nutrients are obtained primarily through the atmosphere and precipitation. Lichen samples will be collected at each PSP station using Teflon-coated scissors. Only the heads (top 2 cm to 3 cm) of the plant will be sampled. The samples will be cleaned in the field (e.g., all non-lichen material removed, such as pine needles), bagged, labelled, and frozen prior to submission to a laboratory for chemical analysis.

4.2.1.5.2 Community Harvesting

The following SCs are species known to be harvested in the RSA_{TIS} and, thus, may be submitted by local stakeholders and rights-holders for chemical analyses:

- Muscle tissue of large-bodied fish (e.g., walleye, northern pike, lake trout, lake whitefish, white sucker, cisco);
- Aquatic macrophytes - Manoomin, rat root/sweet flag (vegetation);
- Muscle tissue of aquatic birds (e.g., Canada goose and dabbling duck);
- Muscle tissue, liver, and kidney of ungulates (e.g., moose and deer);
- Muscle tissue of small mammals (e.g., snowshoe hare);
- Muscle tissue of upland game birds (e.g., ruffed grouse/spruce grouse);
- Black bear (e.g., muscle or hair);
- Berries (e.g., blueberry, cranberry, raspberry);
- Wild mushroom, chaga, Labrador tea (e.g., vegetation);
- Hair and small muscle tissue plug of lynx, wolf; and
- Hair and small mucle tissue plug of semi-aquatic mammals (e.g., beaver, muskrat, and mink).

The proposed RSA_{TIS} locations will need to consider accepting samples submitted for chemistry based on the species and the locations that local stakeholders and rights-holders currently use for harvesting of these traditional foods and medicines. The SOPs and field data sheets developed to guide sample submission by stakeholders and rights-holders are provided in Appendix J.

A local sample coordinator(s) will be required who will be responsible for engaging with and educating the local hunters/trappers/rights-holders on sample collection submission and handling procedures. It is also recommended that the local sampling coordinator(s) engage with the MNRF district (Dryden) and field (Ignace) offices in the region to potentially source samples from large mammals (e.g., bear, moose, deer), if acceptable, that are killed on roads in the local and regional areas.

Those stakeholders and rights-holders interested in submitting samples will be educated on using clean techniques to collect any tissue samples needed from the targeted list of species, including using nitrile gloves, clean tools, and steel shot to avoid lead contamination. They will be provided with written instructions by the community coordinator(s) to ensure Quality Assurance/Quality Control (QA/QC) methodology is being followed during sample collections. The following information will be collected and recorded by the community sampling coordinator(s) when the samples are submitted by stakeholders or rights-holders:

- SC type/species (i.e., moose, walleye, blueberry, etc.);
- Location (UTM coordinate if possible or marked on a map) when the sample is received;
- Date and approximate time the tissue sample was collected;
- Name and details of the sample collector;
- Description of how the sample was collected (i.e., equipment, hand-picked, trapped);
- A note as to whether steel shot or lead shot was used if the animal was shot and where the shot entered the animal. If lead shot was used, every effort should be taken to avoid the wounded area of the animal when taking tissue for a sample. It is recommended that lead shot should not be used as it may contaminate the sample; and
- Any additional details that maybe useful for the project or laboratory team, such as, unusual behaviour and/or physical appearance (e.g., healthy, calf, cow, or bull moose or deer, other).

Muscle and organ samples from larger SCs (e.g, large-bodied fish, black bear, moose, deer) will target samples from a portion of the animal that does not contain bullet fragments, while for smaller mammals (e.g., snowshoe hare) and birds (aquatic and upland), the whole animal will be requested for submission and will be frozen before being dissected by a consultant in a laboratory setting to obtain a muscle sample, hair/feather sample, and ageing structures for submission.

Berries, mushrooms, and other plant species will be handpicked wearing nitrile gloves. Samples will primarily be collected during the summer to early fall months (July through September) and will be bagged, labelled, frozen, and stored locally before being transported to the laboratory for chemical analysis.

Finally, where possible it is recommended that ageing structures on lethally collected samples be submitted if attainable. This will include submitting a number of different samples of for the varying species, including teeth for terrestrial and aquatic mammals (black bear - premolars), (moose - lower mandible), otoliths, fin rays, and/or cleithra (fish).

Beaver, muskrat, wolf, and lynx are secondary SCs and, thus, do not require lethal sampling (i.e., there is no need to obtain a large amount of sample for metal and radionuclide analysis). However, these SCs may be trapped locally in the area, and if a stakeholder or rights-holder provides a sample, then it may be submitted for analysis. If samples are submitted, it will also be advantageous to collect hair samples and a small muscle plug sample in order to collect data to support deriving a relationship between the hair and muscle concentrations (see Section 4.2.1.5.3).

4.2.1.5.3 Secondary Sampling Methods

For SCs where lethal sampling is not possible or desirable, or for SCs where sufficient sample cannot be obtained for analysis of radionuclides, samples will be submitted for metal analysis using laser ablation and ICP-MS for analysis of biological tissues on a microscopic level. Very small samples can be submitted for this analysis (50 mg of tissue versus 5 to 10 g for traditional metals analyses). This new innovative technique allows for the completion of conventional metal analyses using laser ablation, all while maintaining industry-standard laboratory techniques and detection limits.

Although using non-lethal methods omits the inclusion of radionuclide analyses, it provides a non-intrusive and cost effective method for obtaining some data from these endpoints. Hair samples are appropriate for monitoring changes to SCs, compared to tissue samples that should be gathered to support the human health assessment.

Samples of the following secondary SCs will be collected by consultants with the assistance of stakeholders and rights-holders for chemical analyses:

- Feathers of piscivorous aquatic birds (e.g., merganser or grebe);
- Hair and/or small muscle plug of semi-aquatic mammals (e.g., beaver, muskrat, mink);
- Hair and/or small muscle plug of large carnivorous mammals (e.g., wolf, lynx);
- Whole small-bodied fish (e.g., spottail shiner, longnose dace; organs removed)
- Organs (liver) from small-bodied fish species selected;
- Amphibians (e.g., wood frog, green frog, tadpole); and
- Emergent aquatic insects (e.g., dragonfly or damselfly) and terrestrial insects (e.g., caterpillar or beetle).

4.2.1.5.3.1 Non-Lethal Sampling

Hair wire traps will be set in the study areas of interest to increase the chances of obtaining hair samples of larger mammals such as wolves and lynx; this sampling will be coordinated with the BIS. Additionally, if hair samples from black bear are collected, they can be utilized to supplement the tissue chemistry data collected for the primary SC component. The MNRF staff conduct barbed wire hair trap surveys to update Ontario bear population estimates. The MNRF hair samples undergo DNA analysis to determine the sex and identity of these bears, and how many bears are new or returning bears occur at a particular site. It is recommended that the tissue study team work with the local MNRF staff and BIS team to obtain black bear hair samples for submission.

For those animals that may be lethally trapped (e.g., beaver, muskrat, lynx) by local stakeholders and rights-holders, a small number of hairs will be plucked from the animal along with a small muscle sample. This will allow for a relationship between the hair and muscle to be developed. Preferably 5 guard hairs (longer, thicker hairs) will be plucked from each individual sample ideally with the root bulb attached, although this is not necessary. Hair will be placed into labelled bags. In addition to the hair sample, a small plug of muscle tissue should be collected (between 100 mg and 1 g in size), placed into a labelled vial, and frozen until submitted for chemical analysis.

Feathers will be collected non-lethally and non-invasively where possible by a consultant from within both the LSA_{TIS} and RSA_{TIS}. However, many species of birds migrate and it is not always clear when the feather grew and whether it grew in the local environment. The most ideal feathers would be from chicks, as they will be local and their parent would have fed them from local sources. If chick feathers cannot be collected, there are two options: 1) assume the most recent feather growth was local, and only the first 1 cm or less of the feather is analyzed (closest to the root); 2) don't assume anything, and split the feathers into halves along the rachis from root to tip. The first half will be segmented into 1 cm or less pieces along the length and can be sent to a lab for Hydrogen Stable Isotope results, which will help determine when or where the feather segment grew relative to the bird's migration path. Then only the segment(s) considered local, as opposed to its wintering grounds, would be analyzed.

4.2.1.5.3.2 Lethal Sampling

Small-bodied fish samples (e.g., spottail shiner or longnose dace or alternative species) will be collected within the LSA_{TIS} and RSA_{TIS}. Small-bodied fish will be retained during community sampling being conducted as part of the BIS; thus, SOPs for sample collections are not provided herein. Target fish captured for chemical analysis will be measured to the nearest mm (fork or total, depending on species), weighed (± 1%), and assessed for condition (health). Target fish will be retained for ageing and whole body (organs removed) tissue analysis. In addition, the livers from the selected fish species will be submitted for chemistry. Primary (otolith) and secondary (scales if possible) ageing structures will be removed from target fish. Small-bodied fish will be placed into labelled vials or bags, frozen, and submitted for whole body (organs removed) chemistry.

Green frog or wood frog tadpoles will be collected with a dip net in the spring from ponds in the LSA_{TIS} and RSA_{TIS}. This sampling will also be coordinated with the BIS amphibian field surveys. Frog tadpoles will be targeted, as they are easily identified to species in the field. Tadpole samples will photographed and measured. Each sample will be placed into a labelled vial, frozen, and submitted for chemical analysis.

Insects will be collected lethally using insect's traps (pitfall traps) and nets (largemouth aerial) or by hand within LSA_{TIS} and RSA_{TIS}. Target species will include whole dragonflies or damselflies and caterpillars or beetles. Insect samples will photographed and measured. Each sample will be placed into a labelled vial, frozen, and submitted for chemical analysis.

4.2.1.6 Species at Risk

Tulloch Engineering (Tulloch 2018a) Technical Memo #1 included a list of SAR and rare species in the Ignace area. SAR include species identified federally under the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and provincially under the Committee on the Status of Species at Risk in Ontario (COSSARO). Species and their habitat listed as endangered or threatened are regulated federally under the Canadian *Species at Risk Act* (SARA S.C. 2002 c.29) and provincially under the Ontario *Endangered Species Act* (ESA S.O. 2007 c.6). Some consideration was given to species that were of Special Concern. Phase 2 studies identified 31 SAR species associated with the Ignace and surrounding Kenora region. To determine the potential presence of any SAR identified by Tulloch, an online search of the NHIC Make A Map: Natural Heritage Areas of the MNRF was conducted to identify SARs that may be present within the LSA_{TIS} or RSA_{TIS}. The NHIC 1-km grids containing the site was selected, as well as the surrounding grids to ensure all SAR that may come into contact with the site were captured. Of the 31 identified, only 1 species, eastern wood-pewee, was listed as being observed in the area (the date last observed was not reported).

SAR are evaluated differently than more common species that are expected to be present in the area. It is not reasonable to lethally sample a SAR or a rare species; therefore, a surrogate approach was applied. Surrogate species were identified to represent SAR based on similar dietary niches and habitat. The SAR and surrogates are located in Appendix F.

4.2.1.7 Special Collection Permits

A number of scientific collection, sampling, and wildlife handling permits will need to be obtained for the tissue sampling component and need to be secured from both the provincial and federal government authorities to carry out the work discussed. The permits needed will be determined in collaboration with the BIS being developed and may need to be submitted to the provincial and federal regulators before sampling programs begin. Requisite special permits may include, but are not limited to:

- Fur trapping permit/licence;,
- Fisheries special collection permit(s);
- Permission from rights-holders;
- Permission from landowners when trapping on private lands;
- Approved animal care protocols, if applicable (e.g., for non-destructive sampling);
- Federal bird sampling permits; and migratory game hunting permit (s); and
- Endangered Species Act permits or authorizations.

It is the responsibility of the consultant to ensure all applicable permits and authorizations are obtained prior to mobilization for sample collection. For the traditional harvested SCs, only samples that have been legally obtained through traditional harvesting rights-holders or permitted activities will be accepted for the study.

4.2.1.8 QA/QC for Sample Collection and Laboratory Analyses

Specific QA/QC methods to be employed by the consultant(s), community coordinator(s), and stakeholders/rights-holders during the tissue sampling program are detailed in the SOPs provided in Appendix J.

Samples of animals that are thought to be sick or diseased will not be deemed as appropriate representative samples for the program. If a (deceased) sick animal is expected to be diseased, there may be an opportunity to send a sample to the Canadian Wildlife Health Cooperatives of Veterinary Medicine laboratory to determine wildlife disease issues.

Tissue samples will be submitted to a laboratory selected by the NWMO that is certified and accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA). As such, the laboratory will adhere to strict QA/QC standards and protocols and will conduct internal QA/QC measures, such as method blanks, reference materials, laboratory duplicates, and spiked samples. Additionally, all ageing structures will be submitted to a qualified person for analysis with a QA/QC program employed.

4.2.2 Traditional Foods Dietary Survey

A Traditional Foods Dietary Survey is proposed and would collect information on the quantity, type, and general harvest locations of traditional foods consumed by local stakeholders and rights-holders close to the proposed Project area. Generally, the information is collected through an interview process using a food frequency questionnaire that is designed collaboratively with rights-holder input. If the study cannot be completed in time to help inform Year 1 of the EMBP, the collected data would be valuable to provide site-specific information for a risk assessment completed as the Project moves forward and to inform Years 2 and 3 of the tissue sampling program.

This study and mapping component will enable stakeholders and rights-holders to conduct their own IK-based dietary survey to help fine tune the SCs to be sampled and the hunting, fishing, and gathering locations that are of the highest importance from a local stakeholder and rights-holder perspective. The study could be completed by local stakeholders and rights-holders who would be hired and trained in the interview process. This will provide a short-term employment opportunity and allow community members to be further engaged in the tissue component of the EMBP.

4.2.3 Stakeholder and Rights-Holder Involvement

An essential component of the tissue sampling program is the involvement of stakeholders and rights-holders at all stages. This will enable stakeholders and rights-holders to test the components and locations of the environment that are of most concern to them before the Project begins. It is recommended that at least one rights-holder and one local community member are employed alongside a consultant for each component of the tissue sampling program. This will provide a training opportunity, capacity building, and temporary employment to these communities.

In several instances (e.g., larger game, organs, plants, and traditional medicines), the sampling program will rely primarily on local stakeholders and rights-holders to submit these samples that have been harvested for testing (see Section 4.2.1.5.2). The harvest of fish and wildlife resources for food purposes by First Nations and Métis individuals is under the authority of and constitutionally protected by Treaty or Aboriginal rights. A special collection permit will be required for the Study Team to be legally allowed to collect and accept and fish and wildlife resources from First Nations and Métis for scientific purposes for the tissues program.

For the tissues component of the program to be completed successfully, it is recommended that one community coordinator be selected from both the local Indigenous communities (First Nations and Métis) as well as the local communities near the project site (Ignace, Dyment, etc.) to help coordinate with the sample submission to carry out this work. The knowledge of both local hunters, trappers and fisherman as well as the IK of where community members harvest each of the species will be extremely valuable information as the project moves forward on where to collect the samples.

4.2.3.1 Ethics, Confidentiality, and Consent

The tissue sampling program will need to engage locally with stakeholders and rights-holders in the region as the approach to collecting a number of the tissue samples is tied to these relationships. It is recommended that study agreements or Memorandum of Understandings (MOUs) be established with stakeholders and rights-holders whose communities wish to participate in the tissue sampling component. Ethical considerations, including consent, confidentiality, and data sharing clauses, should be considered and discussed with First Nations Chiefs and councils and Métis leadership prior to the sampling program to ensure that individual and community knowledge and privacy is being protected where applicable. Ethical considerations should also include the assurance of privacy and respectful treatment of any participant who chooses to submit a sample(s) for chemical testing.

The First Nations principles of OCAP are a set of standards that establish how First Nations data should be collected, protected, used, or shared (FNIGC 2014). The four components of OCAP include Ownership, Consent, Access, and Possession and should be considered when planning the tissue sampling program to ensure that the principles and values of stakeholders and rights-holders are included in the tissue sampling program. The Canadian Institute of Health Research (CIHR), in conjunction with the Institute of Indigenous Peoples' Health, also have Guidelines for Health Research Involving Indigenous People (CHIR 2014). These guidelines help assist researchers and institutions in carrying out ethical and culturally competent research involving Indigenous people. Their intent is to promote health through research that is in keeping with values and traditions. The following are several considerations that are recommended and should implemented with the stakeholders and rights-holders who are participating in the tissue sampling program:

- Individual Consent Form – participants will be informed of tissue study objectives and provide free consent to participate and submit a sample for the study. All individuals who wish to participate in the study are required to read and sign off on a consent form before submitting a sample.
- Leadership – it is important that the First Nations Chiefs and councils and the Métis leadership agree and approve of the sampling program and that they are directly involved in the selection of rights-holders samplers.
- Protection of participant identity – participants will be asked if they would like to provide their name when submitting a sample to the program. If individuals choose not to, they will be assigned an identification number, and any information they provide will be linked to their number, and their identity will be omitted from the data compilations. Personal information, including names, contact information, and precise harvest locations of those will who participate in the program, will not be released unless permission has been granted by the individual.
- Oath of Confidentiality – those working on the Study Team, including the community coordinator(s) may be entrusted with potentially sensitive and personal information, such as hunting and harvesting locations, names, phones numbers, and other personal data that may be recorded when a sample is submitted.
- All detailed traditional harvest locations identified during the study will remain property of the rights-holders and should not be shared with any other individuals, communities, or government agencies outside of the Study Team without further permission from leadership.
- The culture, ceremonies, prayers, and harvesting celebrations that take place by the local rights-holders need to be respected and considered before any of the tissue sampling components begin. The selected Study Team will need to work in collaboration with rights-holders on the appropriate timing of the various sampling tissue components to ensure the program does not impact their treaty rights or cultural ceremonies.

4.3 Cost Estimate

A Class 2 cost estimate (-15% to +20% accuracy) based on the Cost Estimate Classification System of the Association for the Advancement of Cost Engineering (AACE International 2005) for the tissue sampling component is presented in Appendix E. The estimate includes professional fees, travel and accommodation costs, equipment disbursements for larger items, and laboratory analyses costs. A seasonal break down of the SCs by season (quarter) and year and their associated chemistry costs are presented in Appendix E.

5.0 HYDROLOGY

This section contains the design details for the hydrology component of the EMBP, which will consist of monitoring and collecting data regarding nearby waterways (e.g., rivers, streams, and lakes) and local meteorology. Detailed study design information is provided below and summarized in Appendix E.

5.1 Data Objectives and Use

The purpose of the hydrology component of the EMBP is to determine the existing hydrology conditions within the Local and Regional Local Study Areas for hydrology (LSA_{HYD} and RSA_{HYD}) over three years in order to assess the potential impacts and feasibility of the design, construction, and operation of the Project on the local environment.

5.1.1 Data Objectives

Given the topography, small drainage basins, and number of wetlands, it will be important to understand the flow ranges in these streams, including whether some of them (or wetland areas) are intermittent, when/if any seasonal flooding may occur, and the current and intended land uses within the LSA_{HYD} and RSA_{HYD}. Understanding the flows will also inform the Project site design for water withdrawal and effluent discharge needs and how to effectively reduce water quality impacts.

Comparisons will be made between years to determine if any one year of the baseline data collection was a drought or flood condition and to understand the variability possible at the monitoring sites. The water level and flow data in applicable rivers will be compared spatially and temporally to understand spatial and seasonal trends in data. Based on the results of the data comparison, the local MNRF office and local community members may be consulted to better understand if any alterations or updates to dam structures have taken place during the study time period.

The objective of the lake water level monitoring in the small and large lakes, in conjunction with the bathymetry data, is to compare lake volumes between sites and over the years of the EMBP to better understand the variability in water volume over time.

The nearest meteorological stations are approximately 40 km to 100 km from the LSA_{HYD} and are not appropriate to represent site-specific conditions. The collection of site-specific data will help to better understand weather conditions and seasonal patterns in the immediate area and will also help to form an understanding of seasonal flood and flow conditions. Specifically, site-specific precipitation and meteorological data are required to better understand the hydrology in the LSA_{HYD}, especially regarding seasonal weather patterns (rainfall and snow depth) and to assess the potential for flooding and freezing near the Project. This information will also be important for stormwater and hydrology modelling to understand how much water is running off the Project and the characteristics of the effluent discharge location(s).

The meteorological data collected will be compared between the years of the study and to nearby meteorological stations to understand the spatial and temporal variability of the data.

The objective of the aerial photo survey is to capture the spatial extent of snow and ice cover in the RSA_{HYD}, which will inform an understanding the hydrology and for assessing flowing seeps during winter.

As the Project progresses, the data collected as part of the EMBP will be compared to data collected during subsequent phases of the Project to monitor for potential hydrological impacts from the Project.

5.1.2 Data End Use

The hydrology readings and data collections (e.g., flow and water level, lake characteristics [e.g., bathymetry], meteorology, and aerial survey data) have the following data end uses:

- Characterizing seasonal changes and higher flows in rivers for understanding the potential for local flooding and their potential as water supply sources as well as the impacts of treated effluent release on the receiving water, which may impact the Project design.
- Characterizing higher flows in the smaller streams of the LSA_{HYD} to better understand the potential for local flooding, which may impact the Project design.
- Monitoring water levels in various small lakes, large lakes, and reference lakes.
- Monitoring the local meteorology in the LSA_{HYD} to inform any hydrologic and stormwater analyses necessary for the site, and to assist in characterizing a 1-in-500-year storm event.
- Collecting data to support a hydrology model for the LSA_{HYD}, the IA, and cumulative effects assessment.

- Collecting bathymetry data in the applicable lakes in the LSA_{HYD}, Mennin Lake, and the reference lakes to understand the volume of water and habitat that may be impacted by the Project, and to aid in study area selection for the surface water parameters component.
- Conducting an aerial survey in the winter, under clear skies, to assess how much open water exists in the lakes and rivers in the LSA_{HYD} and RSA_{HYD}.
- Observing various changes in data and aerial imagery and performing analysis of the hydrology or local data to observe and measure external impacts which may have an effect on hydrology (i.e., new development in the area, extreme weather events such as ice causing changes in river paths, logging activities, forest fires, man-made and animal [beaver] dams being built or altered, etc.).

Data collection related to the hydrology component were not included as part of the EMBP if the data would not assist in meeting the objectives listed above. For example, data are not being collected for waterbodies that are within the study area if they are unlikely candidates for water withdrawal and assimilating effluent discharges, and meteorological parameters that may not improve the understanding of the baseline hydrology are not included.

5.1.2.1 Evaluation Criteria

The focus of this hydrology data collection program is to identify local and regional differences within the LSA_{HYD} and RSA_{HYD} hydrology, identify local differences versus the reference sites, and develop a refined conceptual model of the hydrology in the LSA_{HYD} and RSA_{HYD}.

The sample design includes a broad study area, with specific SCs, COPC, and data collection locations included to address the potential for various Project interactions and cumulative effects assessments. The hydrology sampling design also includes field collection sites that can act as reference areas in the future once the Project is operational. As a result, the hydrology study design provides the ability to analyze the data for spatial and temporal differences/trends. The sample design will be modified for future iterations of the sampling program as needed as more data are obtained, as more detailed Project plans are formulated, and as decisions on evaluation criteria are determined to ensure data quality objectives are being met.

5.2 Data Collection

The approach for developing the hydrology data collection program was to identify site locations for monitoring that provide baseline characteristics for both the local hydrology for the Project site planning and for assessing the existing variability in hydrology across the region and understanding potential Project impacts in the region.

Additional factors that played into the sampling design involved the number of lakes, rivers, and water courses in the LSA_{HYD} and RSA_{HYD}, access to area, topography, remoteness of the site, and cost. Assessing the type of data collection at each site was determined based on the size and type of waterbody, such as large rivers vs. small rivers and small lakes vs. large lakes.

5.2.1 Sampling Details

5.2.1.1 Study Areas and Sampling Locations

The LSA_{HYD} has the same boundaries as the AOI/SSA (defined in Section 3.2.1), as shown in Figure 5.1. The AOI was selected as the LSA_{HYD} because it defines the Project area where local flooding and runoff can directly impact the Project. Waterbody maps have confirmed the presence of many wetlands, streams, rivers, and lakes within the LSA_{HYD}. Historic and more recent flow data are not available for the streams within the LSA_{HYD}. More detailed and site-specific information on flow, floods, and wetlands are required to better characterize the LSA_{HYD} and to better understand potential interactions between surface water features and the Project.

Outside of the LSA_{HYD}, the RSA_{HYD} is defined by areas downstream of the AOI on the Revell River and below Mennin Lake on Mennin River (Figure 5.2). The Mennin and Revell rivers appear to be the largest rivers in the area. Given the larger flows in these two rivers, they are more likely candidates than the small streams in the LSA_{HYD} for water withdrawals and assimilating effluent discharges and, thus, the baseline conditions of both rivers are being studied.

Land use in the LSA_{HYD} and RSA_{HYD} consists largely of crown land with small pockets of privately-owned land and conservation reserve lands, as well as forestry (Figure 3.6). Some of the forest has been logged in the recent past, and this will have influence on the local hydrology and runoff characteristics.

Many of the waterbodies in the LSA_{HYD} are in headwater basins that contribute flow to Mennin Lake, with water flowing generally to the southwest. In addition, the northwest area of the LSA_{HYD} crosses with the ridge line between the Revell River and Mennin River basins, which both eventually flow into the Wabigoon River. Close to Mennin Lake, the surface topography appears to be relatively flat (range of 30 m to 40 m) with multiple stream courses and wetlands criss-crossing the landscape.

Given the location of lakes, watercourses and wetlands[6], there are three sites within the AOI on which the Project could be situated that would not impinge upon watercourses or wetlands. These sit between two small sub-basins within the upper Mennin Lake watershed and include:

1. In the northeast center area of the AOI between Route 17 and Dyment Road;
2. In the center of the AOI on the northwest side of the Dyment Road; and
3. Further along Dyment Road than the second site, where borehole logs have previously been taken.

This information will be important for the construction, operation, and extended monitoring phases of the Project.

Flow and water level monitoring will be carried out in small streams, larger rivers (i.e., Mennin and Revell rivers), and Mennin and Revell lakes. Staff gauges will be placed in lakes within the AOI, Mennin Lake, and four lakes in the RSA_{HYD} (including Revell Lake) that will act as reference lakes (see Section 6.0). Bathymetry surveys will also be completed for these waterbodies. The locations are shown in Figure 5.3.

Lastly, at least one aerial photographic survey will be completed in winter to better understand the extent of ice cover over the waterbodies in the winter across the RSA_{HYD}. The aerial survey will be conducted using drones.

[6] Lakes, watercourses, and wetlands have been defined by existing Ecological Land Classification (ELC) data, which is a specific habitat mapping dataset in Ontario. The definitions will be updated based on observations made during Year 1 of the field program.

Figure 5.1 The Mennin Lake drainage in the Area of Interest

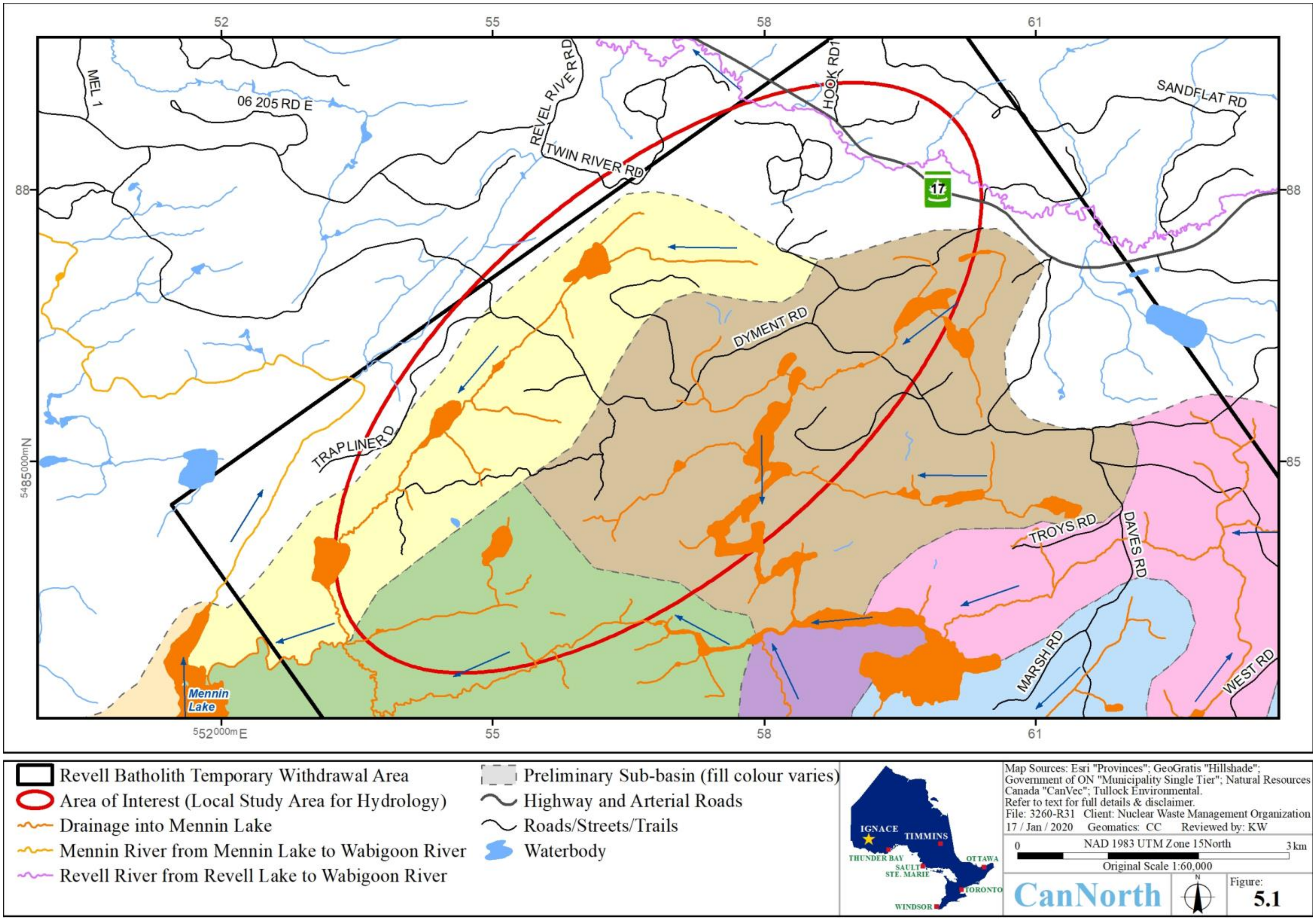


Figure 5.2 Locations of the Mennin Lake and Revell Lake drainages

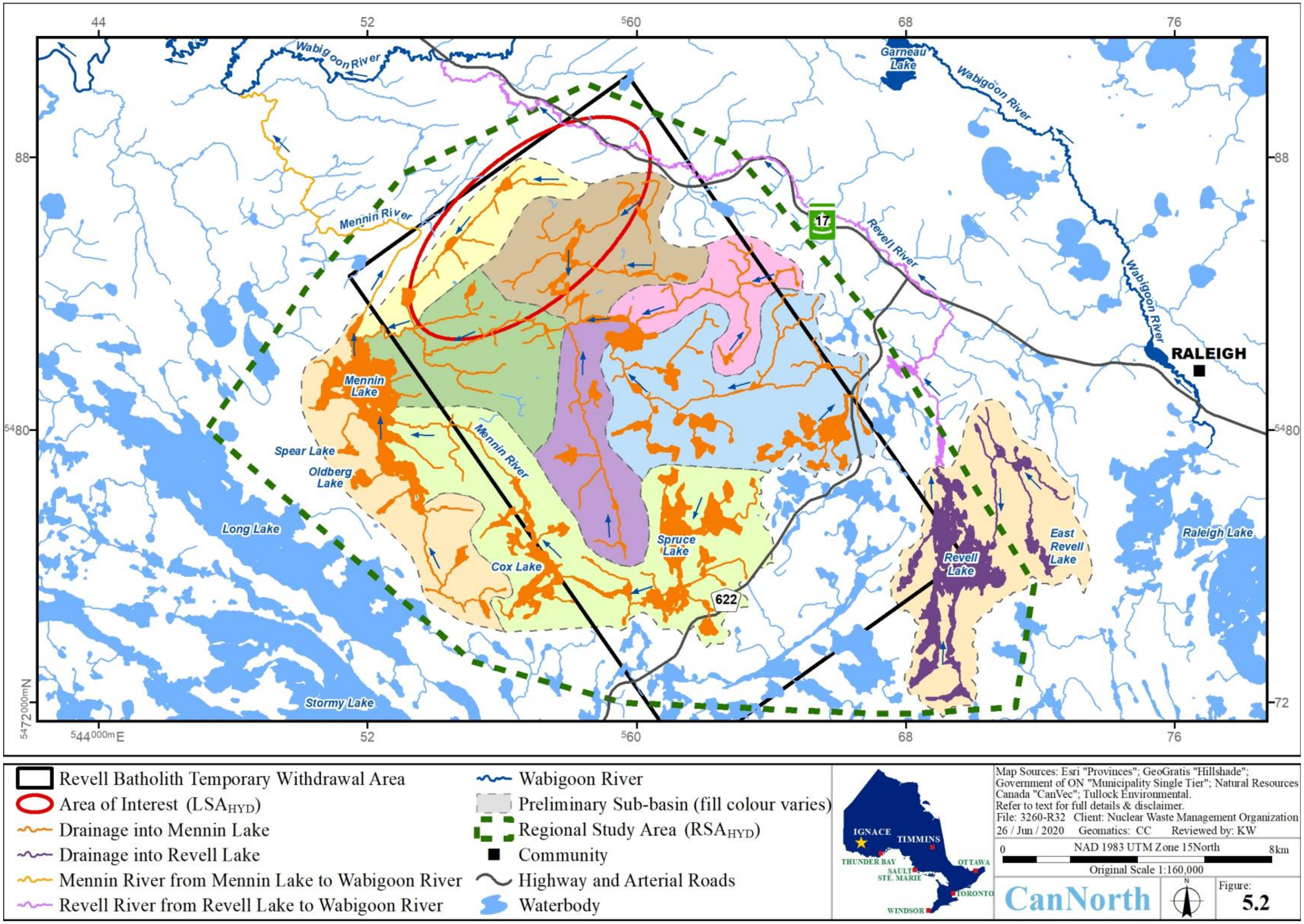
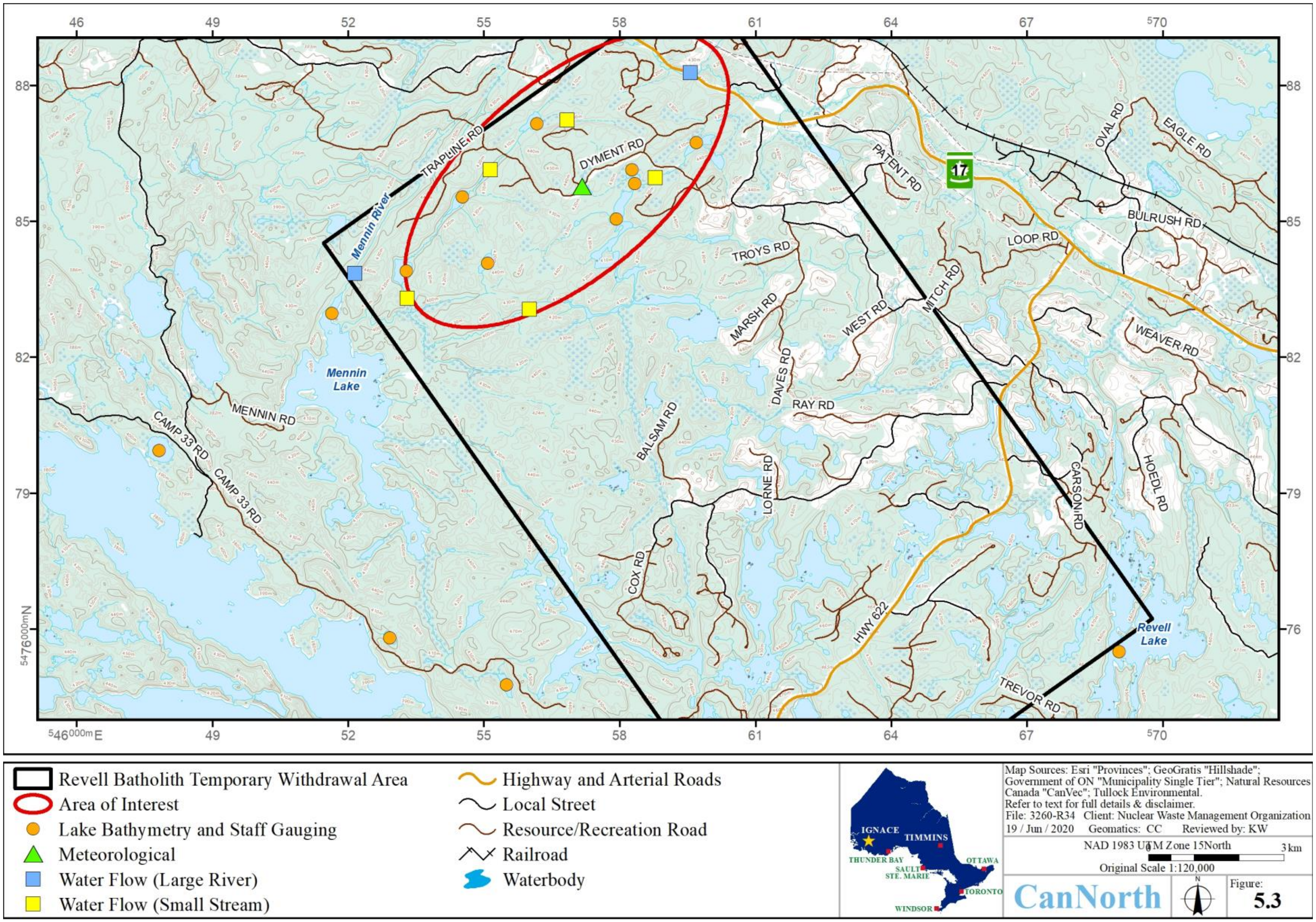


Figure 5.3 Proposed hydrology and meteorology sampling locations



5.2.1.2 Study Components

The SCs of the hydrology component of the EMBP include several components that are intended to provide an understanding the baseline hydrology in the LSA_{HYD} and RSA_{HYD} and then an understanding of potential impacts of the Project. The hydrology SCs include:

- Stream and river flow
  - Increases in river and stream flow that result in flooding.
  - Decreases in river and stream flow that result in drought conditions (i.e., loss of aquatic habitat).
- Lake water level and characteristics
  - Increase in lake water level that might result in flooding.
  - Decrease in lake water level that might result from drought conditions.
  - Increases or decreases in lake levels that affect aquatic habitat and water quality.
- Bathymetry
  - Changes in lake features and basin depths that could affect the flow and pooling of surface water (i.e., sedimentation in the lakes), aquatic habitat, and water quality.
- Meteorology
  - Frequency of intense rainfall and major flooding events.
  - Lack of rainfall (and combined with high air temperatures).
  - Increase or decrease in snow coverage and snowfall events.
  - Longer term climate change analyses.
- Aerial survey via drones
  - The extent of ice cover over the waterbodies in winter in the RSA_{HYD}.

5.2.1.3 Endpoints

The list below itemizes the endpoints for the various field data collection programs in the hydrology component in the EMBP.

- Rivers and streams
  - Increase in flow (flooding), decrease in flow (drought), which may impact assimilative capacity for discharging and withdrawing for supply and aquatic habitat.
- Bathymetry and staff gauges

    - Changes in lake water levels from deposition or erosion or from lakes drying up. Increase or decrease in lake water levels which may impact assimilative capacity for discharging and withdrawing for supply and aquatic habitat.
- Meteorology
    - Air temperature, total precipitation (rainfall and estimate of snowfall), snow depth, wind direction and wind speed, relative humidity or dew point temperature, atmospheric pressure, soil moisture, and solar radiation.
- Aerial Survey
    - Assessment of ice cover on lakes, ponds, and rivers in winter, which influences the aquatic habitat and provide an additional assessment of winter conditions in combination with the meteorology.

5.2.1.4 Sample Size and Frequency

The list below demonstrates the various sample size and frequency considerations for the various subcategories.

- Rivers and streams
    - In Year 1 of the EMBP (Fall 2020 to the end of Summer 2021), for the Mennin and Revell rivers, a minimum of six site visits should occur to measure stream flow to develop water level discharge rating curves. The number of site visits will, however, depend on how well the range of river flows can be measured.
    - For the smaller streams, the site visits for flow measurements should be once in the spring melt time period and once in the late summer dry season. The frequency of field visits and measurements can be tied in with surface water quality monitoring and other field efforts.
    - Starting in the first year but continuing throughout the Program duration, hourly water level staff gauge stations on the Mennin and Revell rivers will be installed. For smaller streams, the sites would be visited a minimum of twice a year for manual flow and water level measurements.
- Bathymetry and Staff Gauges
    - The bathymetry survey will be completed in Year 1 only, when temperatures are warmer and the most daylight is available (late spring to early fall).

    - Staff gauges will be installed in Year 1 and checked at a minimum of quarterly throughout the duration of the EMBP. The frequency of field visits and measurements can be tied in with surface water quality monitoring and other field efforts.
- Meteorology
    - A 15-minute frequency data collection will be conducted using a continuous meteorological station. Measurements will be retained throughout the three years of the EMBP and potentially during the Project implementation.
- Aerial Survey
    - One aerial survey will be completed in the winter of Year 1 using drones. A second survey will be required if the first survey does not provide quality results.

5.2.1.5 Sampling Methods

General descriptions of methods are described below, while more detailed instructions are provided in the following SOPs and field datasheets that accompany this report (Appendix J):

- Manual Flow Measurements (Large Rivers and Small Streams)
- Lake Bathymetry
- Manual Staff Water Level Gauge Measurements
- Continuous Water Level Gauge Measurements
- Meteorological Station Measurements

5.2.1.5.1 Estimating Flow in Smaller Streams

Estimating flows of smaller streams involves manually monitoring each year for seasonal flow measurements. During the three years of the EMBP, manual flow measurements will be conducted during the spring melt and in the late summer dry period (at the same stations) to enable quantitative comparisons with the high flows once snow melt has ceased. Five stations within the LSA_{HYD} are to be sampled (Figure 5.3).

As per the guidelines of the Ontario Stream Assessment Protocol (OSAP 2017) and MTO guidance (MTO 1997, 2016, 2019), the manual flow measurements will be obtained via the following steps:

1. Dividing the river channel cross-section into equally spaced segments;

2. Taking depth measurements to obtain the cross-sectional area of each section;
3. Taking velocity measurements of each section; and
4. Multiplying the velocity by cross-sectional area to get a flow through each section.

This methodology assumes the smaller streams and creeks are narrow with limited flow and can be readily traversed by foot.

5.2.1.5.2 Estimating Flow in Larger Rivers

To estimate flow in the larger rivers (i.e., Mennin River and Revell River), stream flows and water levels must first be measured so that a stage-discharge rating curve can be developed in Year 1. This relationship can then be used in subsequent years to convert measured water levels to flow estimates. This approach will result in a more complete dataset of the flow variability in the two rivers that may be used for withdrawal and for effluent discharge. Developing the stage discharge relationship is essential for converting water level measurements to estimates of flow in subsequent years. This may aid in facilitating other sampling program field visits.

Manual flow measurements will be obtained during Year 1 of the EMBP, using the methodology outlined previously for smaller streams (Section 5.2.1.5.1). It should be completed during the first three to six field site visits in order to estimate river flow under a variety of flow conditions so an accurate curve can be developed. The first field visit should include surveying in a detailed channel cross-section below and above the water line to bank full or flood conditions.

Continuous water level measurements will be obtained using the following methods:

- Installing one water level sensor (pressure transducer or other) for hourly water level measurements on the Mennin and Revell rivers during the same mobilization trip to the site. This will include an instrumentation box, solar panels, tripod stand or pole in concrete, and other equipment away from the river channel. Data will be transmitted via radio or cell depending on the availability of local receiving networks.
- Once installed, the water level gauge stations will be visited at a minimum quarterly to check on equipment, replace batteries, download data if necessary, and troubleshoot any equipment issues.

- The frequency of site visits should be coordinated with other field studies to reduce costs and limit carbon footprint, but additional visits are recommended to ensure no issues arise with the equipment or data collected.
- If the data being collected is in real-time or near real-time and can be transmitted by the Study Team, then this may aid in facilitating other sampling program field visits.

5.2.1.5.3 Lake Bathymetry and Water Levels

The bathymetry survey will involve collecting data within the LSA_{HYD} and RSA_{HYD} (see Figure 5.3):

- Estimate the lake surface area by digitizing shoreline from existing aerial imagery during the summer.
- Use the estimated area to define an approximate geometric shape (e.g., rectangle) to be used for estimating the average length and width of the lake.
- Use the estimated length and width to calculate the number of transects necessary to cover the defined grid spacing:
  - Small lakes (<0.40 square kilometre [km^{2}]) – grid spacing should be 10 metres (m).
  - Medium lakes (>0.40 km^2 and <2.02 km^2) – grid spacing should be 15 m/50 ft.
  - Large lakes (>2.02 km^2) – grid spacing should be 30.5 m.
- Use the grid line estimates to calculate the total distance to travel.
- Estimate travel speed of vessel.
  - Autonomous boat – 0.91 metres/second (m/s).
  - Motorboat – 1.83 m/s.
- Calculate the estimated time to cover the total distance of the grid.

Periodically monitoring the water level involves installing a staff gauge in each lake and manually monitoring for the three years of the EMBP. Monitoring the water level in the lakes will be obtained using the following process.

During the first site field visit, install one permanent staff gauge in each of the lake locations (see Figure 5.4). It is not critical the staff gauge be tied to an elevation, but it may be useful later if measurements can be related to any other surveyed information (water level monitoring on the Mennin River, for example). Subsequently, periodic field visits will include taking visual staff gauge readings. The frequency of site visits can be coordinated with other field studies to reduce costs, but at a minimum of every other month during the thaw season (four times a year).

5.2.1.5.4 Meteorology

As part of the hydrology component of the EMBP, a meteorological station will be installed in the LSA_{HYD} for a minimum of three years. This data will support not only the hydrology component, but also the surface water, air, and soil components. The data will also be useful to the NWMO for several programs related to baseline and impact studies for the Project.

The NWMO is planning to install a meteorological station and, therefore, discussion of the relevant components are provided in this section for informational purposes. If the data being collecting is in real-time or near real-time and can be transmitted to the Study Team, then this may aid in facilitating other sampling program field visits.

The meteorological station is to be located along Dyment Road in the AOI (Figure 5.3). This location is preferred since it is less likely to be vandalized or damaged, and it would not require coordination or permission from the MTO. The station should include a soil moisture probe, and the data can be included in the analysis of the hydrological conditions of the study area. Measuring soil moisture will be coordinated with the soil component of the EMBP, discussed in Section 8.0. Indigenous Knowledge should be leveraged to select appropriate location and possible timing for placing the meteorological station and revisiting it for maintenance.

The meteorological station should measure air temperature, total precipitation (rainfall and est. of snowfall), snow depth, wind speed and direction, relative humidity or dew point temperature, atmospheric pressure, soil moisture (coordinated with the soil component of the EMBP), and solar radiation. Measurements should be taken on a 15-minute basis using a continuous meteorological station and should be collected for the three years of the EMBP at a minimum.

The meteorological station will require ongoing maintenance, including checking equipment, troubleshooting issues, calibrating instruments, swapping out batteries or other faulty equipment, cleaning equipment as necessary, and downloading data (if telemetry is not used). The frequency of site visits can be coordinated with other field studies to reduce costs, but at a minimum of three times during the thaw season. A detailed strategy should be developed for how the meteorological station will operate over the winter without losing power and handling extreme cold temperatures.

5.2.1.5.5 Aerial Survey

The aerial photography survey will be conducted to assess the amount of ice cover on pond, lakes, and rivers during the winter as well as identifying flowing seeps during winter. The aerial photography survey will involve collecting aerial imagery from flying drones over the SSA_{HYD}, LSA_{HYD}, and RSA_{HYD} (including Revell Lake, approximately a spatial area 11 km by 21 km) during the first year. The duration and cost will vary depending on whether the drones are local or need to be brought from Thunder Bay or Toronto. The results of the survey should include a comprehensive photo survey that results in a deliverable of an ortho-rectified image mosaic with 20 cm to 30 cm distance resolution for each pixel.

5.2.1.6 QA/QC for Data Collection

Specific QA/QC methods for each hydrology sampling component are detailed in the SOPs provided in Appendix J. Basic QA/QC measurements/field procedures should be implemented during data collection in order to maintain quality assurance and control of measurements. Some of these include double and triple checking readings and field observations, taking replicate field measurements, statistical analysis of readings and analysis of any anomalies, noting if replicate measurements are used in data analyses, and senior and technical peer review during applicable stages. The hydrology component of the EMBP does not include any laboratory analysis of samples.

5.2.1.7 Data Evaluation Recommendations

The following section provides data evaluation recommendations to be done either during data collection or after the three years of field work for the baseline study.

- Flows
    - Analyzing the seasonal flows from the Mennin River below Mennin Lake and the Revell River for their assimilative capacity for estimated effluent discharge from the Project. The flow records should be evaluated spatially and temporarily to understand spatial or seasonal changes.

- Analyzing the flows in the Mennin River below Mennin Lake to understand the flow through the lake and the ability of the lake to serve as a water supply source for the Project.
- Estimating aquatic dilution factors for understanding water quality impacts to local aquatic habitat and species.
- Using the flow record downstream of Mennin Lake and change in volume of the lake to estimate the amount of water that comes into the lake during the years of the EMBP and to assess how variable the volume is, both within a given year and between years.
- Water flow measurements in the smaller streams should be compared between sites and over time to evaluate what seasonal and spatial patterns exist at these sites and how these sites compare with the larger rivers (Mennin River and Revell River). This evaluation will help bracket what are the baseline hydrology conditions in the LSA_{HYD}, including the impact of beaver and man-made dams that may exist.
- Comparing the flow measurements in the smaller streams between sites and over time to evaluate seasonal and spatial patterns. In addition, comparing and correlating these sites with the larger rivers (Mennin River and Revell River) to bracket the baseline conditions for the smaller streams in the LSA_{HYD}.
- Analyzing the spring snow melt flow measurements in the smaller streams near where the Project may be placed to understand how high flows could be in these smaller sub-basins. This would also support developing local hydrology and storm flood models. The data and local hydrology could also be used to understand the impact of a 1-in-500-year storm event.
- Attempting to develop statistical correlations for river flow between the Mennin River and Revell River to better understand if the runoff from each basin shows a similar hydrologic response pattern. Attempt to develop flow correlations with other stream gauges in similar basins with longer-term flow records. This could potentially result in development of an estimated longer-term flow record for these two rivers, which would allow for a better evaluation of Project impacts with future monitoring to understand when the Project may cause impacts (drought or floods) on the local stream system.

- Water level
  - Analyzing the water level in Mennin Lake to understand the seasonal conditions and to determine potential impacts if it is to be used as water supply source or if the river below the lake is to be used to assimilate an effluent discharge.
  - Using the bathymetry data from Mennin Lake to develop a volume-elevation curve for the lake and, given the water level data collected, estimating the seasonal change in lake volume.
  - Using the water level measurements and bathymetry data to develop volume-elevation curves for each lake and then using the water level measurements to assess how much the volume in each lake changes over a season or over longer time periods.
  - Developing temporal and spatial comparisons of the water level data in the RSA_{HYD} between the monitoring sites to better understand the temporal variability between the sites and over the years.
- Meteorology
  - Analyzing the meteorology data to understand the seasonal trends in precipitation, snow depth, and air temperatures and comparing these measurements with flow measurements in the larger river(s) and smaller streams to get a basic understanding of how meteorology correlates with flows. Results for these field measurements should be analyzed in conjunction with soil moisture data and shallow groundwater data.
  - Analyzing the on-site meteorology data collected with other meteorology data collected in the region (40+ km away), which may have longer term records, to understand if there are similar trends in the data and whether these longer records can inform characterizing a 1-in-500- year storm event.
  - Developing temporal and spatial comparisons of the meteorological data with nearby meteorological monitoring sites and statistical correlations with other parameters (such as precipitation or snow pack and river discharge from the Mennin and Revell rivers and the small stream flows) to assess the spatial and temporal variability of the EMBP and assist in evaluating the potential impacts of the Project on local hydrology.
  - Providing the necessary data to use in modelling to predict and assess the Project impacts in an IA, such as using the meteorology data to derive a localized hydrology model of the LSA_{HYD}, if necessary, which can be used

as a local baseline model of the LSA_{HYD} to support any Probable Maximum Precipitation (PMP) or climate change analyses.

5.2.2 Stakeholder and Rights-Holder Involvement

Ideally, IK should be used if available to help select appropriate locations and timing for conducting flow measurements in the field. IK should also be used if available to help select appropriate access locations and timing for collecting bathymetric data and installing staff gauges at each lake.

The hydrology component of the EMBP can provide opportunities to train, involve, and employ local community members to conduct field monitoring and maintenance of the equipment, if desired. There are several areas where local community members can be engaged, including, providing field assistance with:

1. Planning access and sampling points;
2. Installing and maintaining the water level gauges on the larger rivers;
3. Developing the stage-discharge relationship on the larger rivers;
4. Manually measuring flow on the smaller streams;
5. Manually measuring the water level in lakes;
6. Installing and maintaining the meteorological station;
7. Conducting bathymetry surveys of the lakes; and
8. Conducting an aerial photo survey of the RSA_{HYD} via drones.

For the more technical stage-discharge relationship development and the continuous meteorological and water level gauge stations, the consultant conducting the first year of sampling should do so alongside community members to establish the stations, field sampling protocols, and enable training. Future monitoring could be entirely transferred to community members if they so desire.

5.3 Cost Estimate

A Class 2 cost estimate (-15% to +20% accuracy) based on the Cost Estimate Classification System of AACE International (2005) has been prepared for annual execution of the hydrology component over three years and is presented in Appendix E. The cost estimate is based on a number of assumptions that are also presented in Appendix E, including professional fees, travel and accommodation costs, equipment disbursements for larger items, and laboratory analyses costs.

6.0 SURFACE WATER PARAMETERS

This section contains design details for the surface water parameters component of the EMBP, which includes surface water quality, sediment quality, plankton, and benthic invertebrates. Detailed study design information is provided below and summarized in Appendix E.

6.1 Data Objectives and End Use

6.1.1 Data Objectives

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. COPC may be dissolved or suspended in the water and could be transported off site, be taken up by organisms, or be transferred to other media such as sediment (BCMOE 2016).

The data objectives for the Local Study Area for surface water parameters (LSA_{SW}) are driven by potential direct Project interactions with the environment, the potential for cumulative effects, and input received from stakeholders and rights-holders. Project components that have the potential to impact the environment during each project phase (Project interactions) are detailed in the CSM provided in Appendix C. Key potential Project interactions for surface water parameters could include soil run-off or accidental spills during the construction phase, effluent discharge and water withdrawal during the operational phases, potential interactions with the excavated rock management area, as well as contaminant sources from ancillary infrastructure such as roads. An important aspect in the sample design is the consideration of cumulative effects from other anthropogenic activities occurring in the area; for example, forestry activities (refer to Section 3.3).

During community engagement workshops conducted in Ignace, Dyment, and WLON, taking care of water and monitoring surface water were common themes expressed by stakeholders and rights-holders (Appendix B). Since surface water emerged as such a vitally expressed theme, it is especially important that the EMBP be inclusive of a wide network of sampling locations, COPC, and SCs, that a high level of community involvement be maintained, and that data be transparent. Beyond ensuring pertinent data are collected for scientific purposes, an additional data objective is to provide community assurance, address perceptions, and build relationships. To meet this data objective, the sample design was extended beyond sampling locations and COPC with the potential for direct Project interactions. This included adding the herbicide glyphosate to the COPC list and incorporating a water quality monitoring program in the Regional Study Area for surface water quality (RSAsw) that will sample locations identified as important areas to monitor by stakeholders and rights-holders.

The data needs identified to meet these data objectives include directly testing surface water and sediment quality, as well as assessing select biological media that provide information on water and sediment quality. Phytoplankton, zooplankton, and benthic invertebrate communities are listed as elements of aquatic ecology that should be characterized when doing baseline programs for a DGR (CNSC 2018). Phytoplankton composition and biomass (primary production) provides an assessment of water-quality conditions and an indication of eutrophication (nutrient enrichment), while zooplankton composition and biomass (secondary production) supports both the water-quality and ecological assessment by providing insight to the quality of the food chain and the energy flow through the system (Green et al. 2015). Benthic invertebrates are important to sample as part of the EMBP because they are commonly used in biological effects monitoring programs to assess potential Project related impacts during the operational period (CSA 2010; Environment Canada 2012b; CNSC 2017). They are an important food source in aquatic ecosystems.

Plankton and benthic invertebrate community data are also important components for evaluating biodiversity and, as such, the BIS plans to expand on the study design discussed herein to ensure biological diversity data objectives are met (Zoetica 2020). Important site characterization information, such as aquatic habitat types, will be collected in the LSAsw in Year 1 as part of the Tier 1 BIS (Zoetica 2020). This information will be used by the EMBP to ensure dominant habitat types in the LSAsw are being sampled. For this reason, benthic invertebrate community studies are planned to commence in Year 2 of the EMBP so that station locations can be selected using site-specific data, and the data needs can be further aligned between programs.

The majority of surface water SCs are being studied in the LSAsw and RSAsw for the first time, with the exception of select preliminary studies completed in the AOI during Phase 1 and Phase 2 studies (summarized in Section 2.0). As a result of the lack of existing data and the preliminary stage of Project planning, the primary objectives of Year 1 of the EMBP for surface water parameters are to 1) characterize ponds, lakes, and rivers in the LSAsw alongside the BIS including documenting information on potential cumulative effects, 2) locate suitable sampling station locations and reference areas and obtain site characterization information to inform benthic invertebrate station locations for Year 2, and 3) establish variability in COPC concentrations and other endpoints to re-evaluate the sample design following Year 1.

6.1.2 Data End Use

The surface water parameters baseline data will enable an assessment of potential Project impacts by providing a comprehensive description of water and sediment quality in the LSAsw prior to implementation of the Project. These data can be compared to data obtained in the future during various Project stages to monitor potential changes. The baseline program includes sampling study areas that can act as reference areas once the Project commences, as this will provide a means for evaluating if changes observed are natural or due to other causes like climate change or various anthropogenic impacts. Furthermore, the surface water quality monitoring program to be conducted in the RSAsw is designed as a long-term community-based program to involve local community members and to provide regional data for a wide area surrounding the Project. The data end uses specifically include the following:

- Monitor SCs and locations identified during the stakeholder and rights-holder engagement.
- Establish sampling stations in the LSAsw and reference areas prior to the Project commencing that are representative of the area, are suitably located, and consider influences that could contribute to cumulative effects.
- Ensure the data collected sufficiently capture spatial and temporal variability and provide adequate information to ensure statistical rigour when comparing exposure and reference data and examining potential temporal trends.
- Compare water and sediment COPC concentrations to relevant guidelines (see Section 3.5) to determine if there are COPC that are naturally elevated prior to the Project commencing.
- Provide necessary data to use in modelling, Project planning, and to predict and assess Project impacts in the IA, including the cumulative effects assessment and the human health and ecological risk assessment.
- Share information with the communities and build capacity, as needed.

6.1.2.1 Evaluation Criteria

The sample design includes a broad study area, with specific SCs, COPC, and sampling locations included to address the potential for various Project interactions and cumulative effects assessments. The design also includes sampling study areas that can act as reference areas in the future once the site is operational. This results in a BACI study design and creates the ability to analyze the data for spatial and temporal differences/trends. The sample design will be modified for future iterations of the sampling program as needed as more data are obtained, as more detailed Project plans are formulated, and as decisions on evaluation criteria, such as desired CES, are determined to ensure data quality objectives are being met.

The evaluation criteria include using federal and provincial guidelines and criteria established by the NWMO to assess if COPC concentrations are naturally elevated or are potentially elevated due to past or current activity in the area. These criteria are discussed in Section 3.5.

6.2 Data Collection

6.2.1 Sampling Details

6.2.1.1 Study Areas

Study areas were selected in the LSAsw to represent potential exposure areas near to and downstream of the Project and locations that could act as reference areas once the Project commences. Factors such as potential Project interactions, stakeholder and rights-holder input, representativeness, potential accessibility (by ATV), and suitability for data analyses/modelling needs were all taken into account when selecting study areas (CCME 2015). However, the specific sampling locations illustrated on Figure 6.1 were selected in absence of detailed site specific information on land use, actual accessibility, habitat types, hydrology, and biological information. The proposed reference areas presented herein are tentative and subject to change as they will be aligned to the extent possible with the BIS. During Year 1 of the field program, effort will need to be expended by the field crew to select suitable sampling locations and to collect detailed site characterization information. Further information is provided in Section 6.2.1.3, Study Design Overview.

During early baseline studies, it is recommended that the scope of sampling be broader until variability and trends are better understood (Green et al. 2015; BCMOE 2016). Since the EMBP is being completed over multiple years, the data from each study year, together with the evolution of Project plans, will be used to optimize the program. The sample design will also be modified as needed following the collection of site characterization data describing lake depths through bathymetric mapping, thermal stratification through vertical profiling, and aquatic habitat types through the BIS and Year 1 of the surface water sampling program.

6.2.1.1.1 Local Study Area

The LSA_{SW} includes waterbodies with the potential of being impacted by the Project, as well as potential reference areas. Locations for water withdrawal and treated effluent release from the Project are not currently known; thus, assumptions have been made in order to initiate data collections for the EMBP (see Appendix C). For the surface water parameters sample design, an assumption is being made that treated effluent will be discharged through a single discharge point into either the Mennin River or the north part of the Revell River located downstream of the AOI. Furthermore, it is assumed that discharge will not occur upstream of Mennin Lake due to the small size and assimilative capacity of the upstream waterbodies located in the AOI. Therefore, potential Project interactions differ between waterbodies in the LSAsw and are briefly discussed below.

The waterbodies located in the AOI could be subject to impacts from construction activities, water drawdown caused by dewatering, accidental releases, or aerial dispersion. Since it is not currently known where in the AOI the Project site may be located, it is also not known which waterbodies would be most likely to be subject to potential impacts. Therefore, Year 1 of the EMBP is focused on characterizing spatial variability in the physical environment (water and sediment chemistry) throughout the AOI, with sampling occurring in the six largest ponds (Figure 6.1)[7]. As Project details and contaminant dispersion information evolves, SCs and sampling effort in the various ponds in the AOI will be added or deleted, as needed.

The sample design includes obtaining the same data from three reference ponds. Potentially suitable reference locations have been selected along Camp 33 Road north of Long Lake with considerations of potential accessibility, size, predominant wind direction, and distance from the Project (Figure 6.1). However, these locations are subject to change if more suitable ponds are located during sample design for the BIS, or if during Year 1 of the program these ponds are found to be not suitable or to be influenced by anthropogenic activities that would cause them to not be reflective of reference conditions.

A sampling area is planned for the creek extending from the AOI and entering Mennin Lake at the north end (Figure 6.1). Depending on Project plans, this study area may capture

[7] There are seven stations proposed as one of the larger ponds appears to include two distinct basins.

COPC contributions from the AOI before they enter Mennin Lake or may act as an additional reference area in the future for the riverine exposure areas described below.

Potential Project interactions with Mennin Lake are currently unclear and could include water withdrawal, treated effluent release, and/or COPC contributions from the AOI in the north end of the lake where the inflow is located (Figure 6.1). To characterize Mennin Lake, study areas will be established in the north and south bays as well as the deep central area of the lake (Figure 6.1). Depending on Project plans and lake mixing, the sampling area at the south end of the lake has the potential to act as a reference area for the north end of the lake in the future.

Revell Lake is the proposed reference lake for Mennin Lake since both lakes are classified as cool water thermal regimes, and according to Aquatic Resources Area (MNRF 2015b), these two lakes have quite similar large-bodied fish species, surface areas, depths, and Secchi depths. Two study areas will be sampled in Revell Lake in order to match depths of both the shallow bays and the deep area being sampled in Mennin Lake (Figure 6.1). The suitability of Revell Lake to act as a reference lake will be assessed during Year 1 of the program and will include an evaluation of potential cumulative effects.

The Mennin River and Revell River are being sampled as potential exposure locations for treated effluent release. Two sampling areas are planned in the Mennin River downstream of Mennin Lake, with one located near the outflow (co-located with flow meter) and the second located approximately halfway between Mennin Lake and the Wabigoon River (Figure 6.1). One sampling area is planned for the Revell River located in the AOI (co-located with the flow meter; Figure 6.1). The exact sampling area locations will be dependent on access and habitat suitability. Whether sampling takes place in erosional or depositional habitats will be dependent on the predominant habitat types in the study areas; however, habitat types will be matched between the exposure and reference areas.

The Mennin River exits the north end of Mennin Lake and extends for approximately 14 km before discharging into the Wabigoon River. The Revell River flows north through the AOI before entering the Wabigoon River. Far-field sampling areas are planned in the Wabigoon River upstream of the confluence of the Revell and Wabigoon Rivers and at potential exposure locations downstream of the confluences of the Revell and Wabigoon rivers and the Mennin and Wabigoon rivers (Figure 6.1). In the absence of information on the receiving environment, effluent quality and quantity, and the predicted spatial extent of effluent transport, the confluence with the Wabigoon River is a logical far-field sampling area for Year 1. The need to alter the size of the LSAsw will be re-evaluated as Project plans progress.

The potential riverine reference areas will be located on the Mennin River upstream of Mennin Lake and on the Wabigoon River upstream of the confluence with the Revell River, assuming suitable habitat can be located to match to the exposure areas and assuming these areas are not subject to other potential impacts (Figure 6.1). If the Mennin River is selected for treated effluent release and the Revell River is unimpacted, then the sampling area located upstream of the confluence of the Mennin and Wabigoon rivers can act as an additional reference area in the future. If the Revell River is selected, then the sampling area located downstream of the confluence of the Mennin and Wabigoon rivers can act as a far-field exposure location.

The need to collect baseline surface water parameter data from additional waterbodies downwind of the AOI related to aerial dispersion of COPC was considered, but has not been included in the sample design at this time. If the air quality monitoring program and dispersion modelling indicate the potential for impacts on a broader spatial scale, then additional monitoring stations will be added to the program in subsequent years. The waterbodies surrounding the AOI are largely inaccessible; thus, it is recommended that additional information be acquired to more accurately pinpoint sampling locations prior to monitoring for this data objective.

6.2.1.1.2 Regional Study Area

Surface water quality will also be evaluated in a RSASW with a data quality objective of community assurance and involvement. The purpose is to establish a monitoring program with sampling locations selected by WLON and Ignace community members that can be conducted by community members (once sufficiently trained), meets community needs, and provides regional information. The study area will include waterbodies of significance to stakeholders and rights-holders that were identified during engagement workshops and through follow-up meetings. The potential lakes to be sampled are shown in Figure 6.2; this map provides a starting point for identifying waterbodies to sample and is being used to gather further input. The cost estimate assumes that water samples will be collected from eight significant waterbodies in the region, but these locations are still to be determined.

A second data objective for a regional water quality program is to assess potential cumulative effects related to a population increase in Ignace and the surrounding area caused by the Project. The predicted extent and potential for non-negligible impacts are being evaluated in preparation for the IA and are not currently known. Lakes in the near vicinity to Ignace, such as Agimak, Michel, and Sandbar lakes, provide an abundance of recreational activities for Ignace residents, and numerous tourism activities occur in the area at resorts, outfitters, Sandbar Lake Provincial Park, and other recreation sites. In addition, Michel Lake is the drinking water source for Ignace. Select monitoring conducted through provincial programs tests aspects of water quality in the Ignace area, such as *E. coli* concentrations in Sandbar Lake Provincial Park and Secchi disk depth and total phosphorus concentrations in Agimak Lake, but the data are sporadic.

For Year 1 of the EMBP, water chemistry data will be collected at one station in each of Agimak, Michel, Sandbar lakes quarterly to initiate baseline data collections. These lakes may be included in the eight waterbodies selected by community members, or if they are not selected, they will be sampled regardless. The cost estimate allows for a total of 10 waterbodies in the regional program to allow for their inclusion. The need for more rigorous data collection will continue to be evaluated throughout the EMBP as information becomes available on the potential for, and scope of, potential impacts related to this data objective.

Figure 6.1 Proposed sampling locations for surface water parameters in the Local Study Area

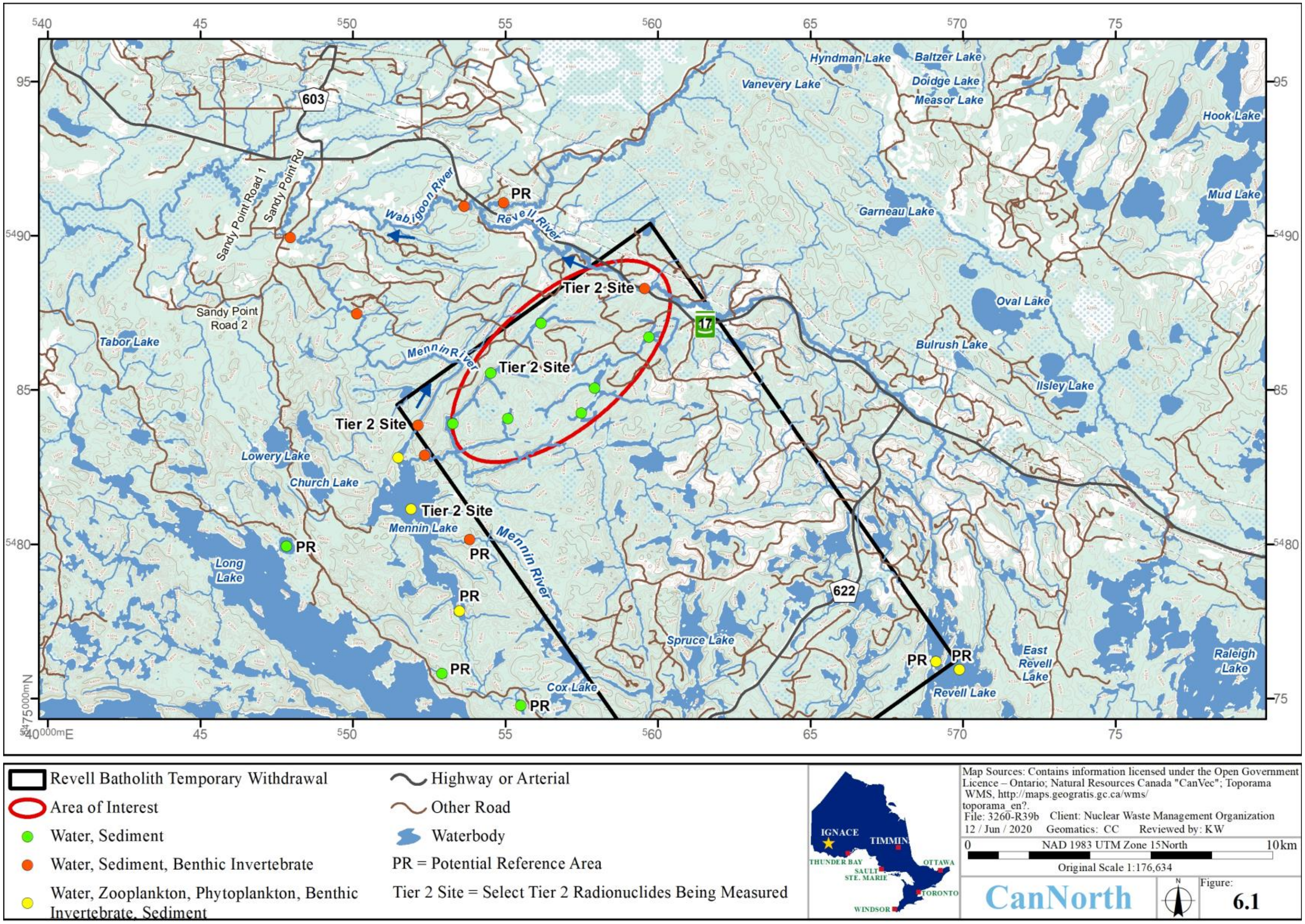
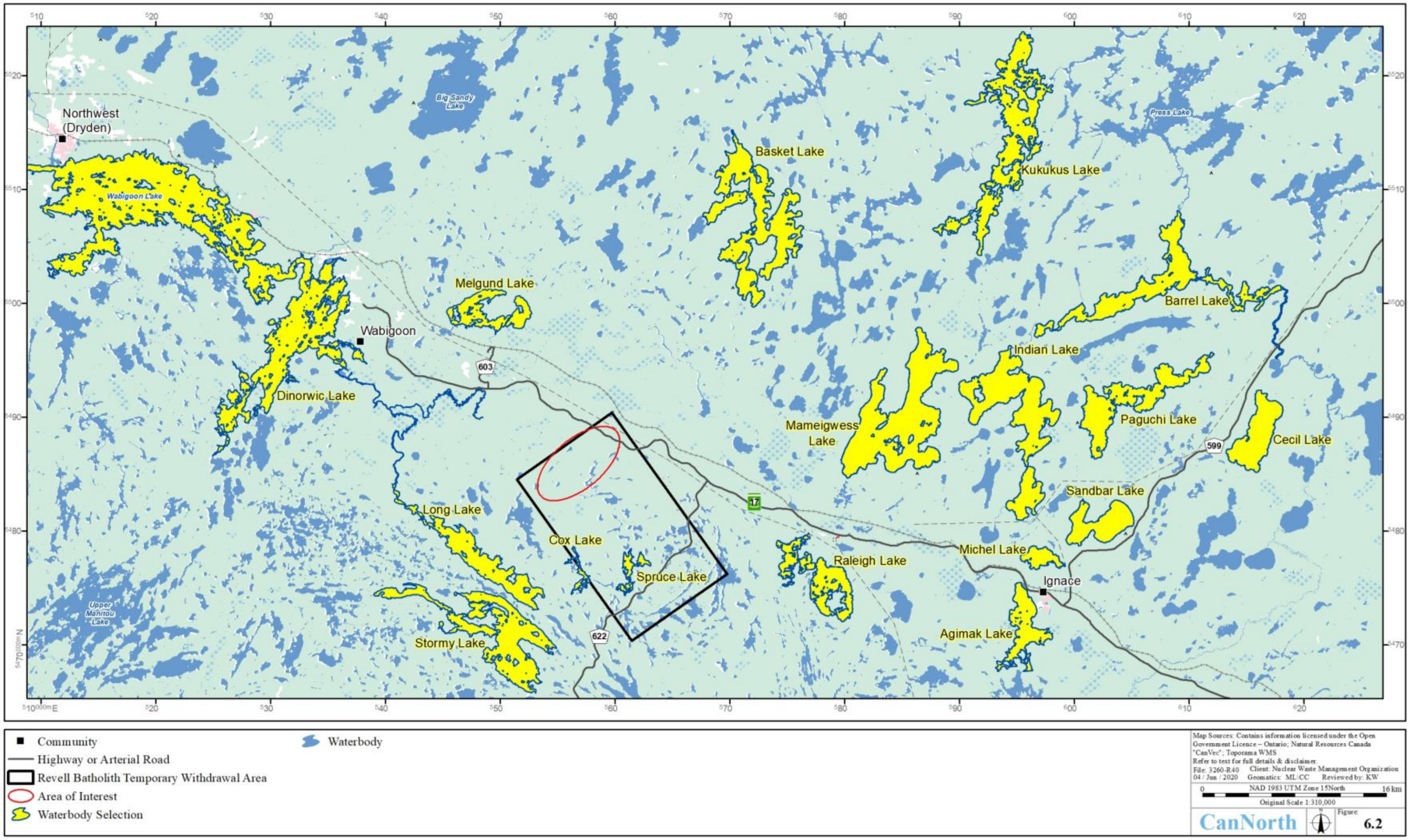


Figure 6.2 Potential lakes for monitoring surface water quality in the Regional Study Area



6.2.1.2 Study Components

The SCs selected for the surface water parameters component of the EMBP are routine for mining IAs and are recommended in guidance documents (BCMOE 2016; CCME 2016a), especially the CNSC (CNSC 2018) "Guidance on Deep Geological Repository Site Characterization". The SCs, which were also selected with consideration if stakeholder and rights-holder input, include:

- Surface water quality and characterization;
- Sediment quality and characterization;
- Phytoplankton and zooplankton community composition and biomass; and
- Benthic invertebrate community composition and biomass.

Additional SCs may be considered in years 2 or 3 once habitat types in the LSA_{SW} have been delineated, once Year 1 data have been evaluated, and once Project details are further evolved. In addition, as discussed below in Section 6.2.1.3, not all SCs are currently planned to be collected in all study areas. The inclusion or exclusion of SCs in each study area will be re-evaluated following each year of the EMBP.

6.2.1.3 Study Design Overview

The initial overall experimental design for lentic surface water (i.e., lakes and ponds) is a control-impact study that will transition to a BACI study once the Project commences. The design is unbalanced with greater sampling effort in areas expected to be defined as "exposure" areas. While the overall experimental design for lotic surface water (i.e., river and creeks) is also a control-impact study, some of the lotic sampling locations were selected to assess potential gradient effects. The cost-benefit analysis of estimating within-location variability received considerable attention; the current sampling design reflects a balance between collecting some within-location samples to rule out future sub-sampling costs (primarily associated with chemical analyses rather than a small incremental cost for physically collecting additional within-waterbody samples) and the overall cost of the surface water program.

The surface water parameters component of the EMBP was designed so that physical data (i.e., water and sediment) are co-located with biological collections (i.e., plankton and benthic invertebrate communities). The SCs being sampled and the number of stations being sampled depends on the study area and includes the following:

- In each of the AOI and reference ponds, a total of three stations will be established from which water and sediment data will be collected in the fall[8]. In addition, surface water quality data will be collected at one of the three stations in the spring, summer, and winter. The rationale for sampling multiple replicate stations during only one time period is to allow for an examination of within pond variability without oversampling these small study areas.
- In Mennin and Revell lakes, a total of five stations will be established in depositional areas from which sediment and benthic invertebrate data will be collected starting in the Fall of Year 2. Surface water and plankton samples will be collected at three of the five stations quarterly (spring, summer, fall, and winter) starting in Year 1.
- In Mennin, Revell, and Wabigoon rivers, a total of five stations will be established from which sediment and benthic invertebrate data will be collected starting in the Fall of Year 2. Surface water will be collected at three of the five stations quarterly (spring, summer, fall, and winter) starting in Year 1. The type of habitat sampled will be dependent on the dominant habitat types present in the sampling locations.

In each study area, replicate stations will be spaced to ensure sufficient physical separation for samples to be considered statistical replicates, and the extent of the separation will depend on study area size and habitat availability. In the study areas situated in lakes, the geographic extent of each replicate station should be at least 10 m x 10 m and each station should be separated by at least 20 m (Environment Canada 2012b). In the study areas situated in rivers, the amount of separation between replicate stations will depend on river morphology and habitat availability, but there should be separation of a minimum of three and preferably six times the bankfull width of similar habitat between replicate stations (Environment Canada 2012b, 2012c). Station depths and site characteristics, such as habitat type, sediment particle size, and aquatic macrophyte growth, must be kept as similar as possible between stations within a study location to reduce confounding factors for data comparisons particularly between associated exposure and reference areas. This will be challenging in Year 1 of the program in the absence of study area information. Station locations can be modified for years 2 and 3, if needed, once information is available from bathymetric mapping, aquatic habitat assessments, water and sediment quality data, site characterization data collected during Year 1, and potential influences of cumulative effects from current or historical activities.

[8] Year 1 will include only water as all sediment sampling in the LSA_{SW} is being obtained in Year 2.

During Year 1 of the program, reconnaissance will need to be conducted to establish sampling locations in the exposure and their associated reference areas that apply the above stated criteria. The focus of Year 1 sampling is surface water chemistry (and plankton at the lake stations); however, forethought needs to be given to the future sampling of sediment and benthic invertebrates that are to be paired with the water sampling locations. It will be important to sample exposure locations first to establish desirable sampling depths, spacing between replicate stations, substrate types, and habitat characteristics for the reference locations. Detailed notes need to be recorded on habitat characteristics of the selected locations, particularly in the rivers to determine if erosional or depositional habitats should be sampled for benthic invertebrates and to aid in sampling method selection (refer to Section 6.2.1.7). This information will be supplemented with the habitat descriptions being obtained in the LSAsw as part of the Tier 1 BIS (Zoetica 2020).

Another important component of site characterization will be recording land use and other relevant information at each sampling location to enable an assessment of potential cumulative effects and if historical or current anthropogenic impacts in the area may deem the study area not representative of baseline or reference conditions. This assessment will include recording:

- Land use;
- Road proximity;
- Nearby industry or agriculture;
- Community use such as cabins, fishing, and drinking water; and
- Indications of soil run-off or contaminants entering the water, such as discolored water, oil sheens, or odor.

Data categories to document the above listed components have been included on the field forms (Appendix J). In addition, IK and local knowledge may also be able to indicate areas impacted by historical activities that are not identified through desktop research and environmental records.

In summary, Year 1 of the surface water program consists of collecting water quality data from all stations, plankton data from lake stations, and site characterization information. During Year 2, the water quality/plankton program will be repeated and the sediment quality and benthic invertebrate community studies will occur during the Fall field program. During Year 3, the water quality, plankton, and benthic invertebrate community monitoring programs will be repeated and an autonomous water quality sampler will be installed (described below).

6.2.1.4 Surface Water Chemistry

6.2.1.4.1 Local Study Area

6.2.1.4.1.1 Sampling Locations, Sample Size, and Frequency

Sampling locations are discussed in Section 6.2.1.1 and are illustrated in Figure 6.1; however, the exact station locations need to be somewhat flexible depending on access, depths, habitat type availability, and the potential for cumulative effects.

The number of samples required to achieve a certain monitoring precision depends on the variability; the greater the variation, the greater the number of samples needed to obtain a statistically sound estimate (CCME 2015). In absence of variance estimates and the determination of CES (refer to Section 3.4), it is proposed that three replicate stations be sampled to evaluate the potential for, or degree of, inter-waterbody variation. This level of sampling may be excessive considering the likely small size and mixing potential of many of the waterbodies in the LSAsw; this will be evaluated following Year 1.

Quarterly (e.g., spring, summer, fall, and winter) sampling will be conducted at all stations to capture seasonal data; however, once existing data are evaluated, there is the potential that monthly data may be required during critical seasons (e.g., freshet, summer/winter low flows, etc.) to further establish variability or, conversely, that sampling intensity could be reduced.

6.2.1.4.1.2 Contaminants of Potential Concern

An extensive COPC list will be measured in the LSA_{SW} (see Appendix D and Appendix E) including general water chemistry parameters, nutrients, ions, total and dissolved metals, parameters related to treated sewage effluent (5 day Biological Oxygen Demand [BOD], E.coli, and total coliforms), and a comprehensive list of radionuclides, including gross-α and gross-β and Tier 1 and Tier 2 radionuclides. Certain Tier 2 radionuclides that do not exist in nature and are very expensive to measure in the laboratory are only being measured at select stations as a means of confirming their absence (details are provided in Appendix E). Glyphosate is included as a COPC in surface water in the AOI and associated reference areas to aid in addressing stakeholder and rights-holder concerns and cumulative effects assessments. In addition, the cost of including iodine as a COPC is provided in Appendix E.

Once the temporal and spatial variability of water quality parameters are established, COPC that have low variation and a low probability of exceeding water quality guidelines may be analyzed less frequently. Radionuclide laboratory analyses is very expensive; thus, there is the possibility of reducing the amount of analyses conducted once initial baseline data are obtained, particularly if levels are below laboratory detection limits.

During development of the COPC list, PAHs, PHCs, and VOCs were identified as having potential Project interactions (Appendix C). However, the NWMO initiated an annual sampling program in the AOI in 2017 that includes measuring suites of these parameters in surface water, sediment, and soil. Since baseline data are already being collected for these parameters at various locations throughout the AOI and near vicinity, they are not included in the EMBP for surface water quality in the LSA_{SW}. In the AOI and associated reference areas; however, Semivolatile Organic Compounds (SVOCs) are included since these have not been previously measured.

6.2.1.4.1.3 Sampling Methods

6.2.1.4.1.3.1 Routine Sampling

Surface water sampling methods and the QA/QC program are based on guidance documents that provide common best practices (Alberta Environment 2006; CCME 2011; Environment Canada 2012b; Green et al. 2015; CCME 2016a; BCMOE 2016). Water quality investigations will involve taking limnological measurements and collecting water samples for chemical analyses. An SOP and field data sheet are provided in Appendix J.

Standard *in situ* water quality parameters (temperature [°C], dissolved oxygen [mg/L and %], pH, specific conductance [µS/cm], and ORP [mV]) will be measured using a digital multi-probe meter. These parameters are commonly measured and are consistent with the water sampling program that has been conducted in the AOI in support of the borehole drilling since 2017 (Tulloch 2018c). Measurements will be taken throughout the water column at 0.5-m intervals at stations ≤2 m deep and at 1-m intervals at deeper stations. Obtaining measurements throughout the water column will illustrate differences with depth and will aid in determining locations of thermoclines and chemoclines, if present. During open water conditions, water clarity or optical depth will be measured with a 20 cm diameter black and white Secchi disc. During the winter, ice thickness and snow depth at the sampling station will be measured.

Water collections for laboratory analyses will be conducted using grab samplers such as Van Dorn or Kemmerer samplers, ensuring the samplers used are appropriate for metal analyses. The samples obtained will be depth-integrated discrete samples consisting of water composited from near surface, the middle, and near bottom of the water column. However, in cases where there is a thermocline, discrete samples will be collected at two depth intervals: the subsurface (epilimnion) and near bottom (hypolimnion) in order to obtain samples from above and below the thermocline (Environment Canada 2012b; BCMOE 2016; CCME 2016a). If the water depth is ≤2 m, it is sufficient to collect water samples only at mid-depth, or at least 15 cm below the surface.

The water will be field filtered for dissolved parameters using a 0.45 µM filter (CCME 2016a), and all samples will be preserved following laboratory requirements. Samples will be kept at approximately 4°C prior to laboratory submission, and sample submission will occur as soon as possible to ensure that holding times are not exceeded for certain parameters.

6.2.1.4.1.3.2 Autonomous Water Quality Meter

The use of an autonomous water quality meter that collects and transmits continuous, real-time data is an emerging technology with benefits over the routine water quality monitoring described above in that it does not require field surveys, produces large data sets that capture variability, and uses remote data transmission. However, there are also drawbacks such as the inability to measure all required COPC for this program (particularly radionuclides), the lack of inclusion of local community members in sampling, the higher cost, and the potential for instrumentation failure. Following discussions with the NWMO on the Preliminary Sample Design Feasibility Assessment report (CanNorth et al. 2019), it was decided to include installation of one of these meters during Year 3. The rationale is to use information collected during Years 1 and 2 along with refined Project plans to select a location to best utilize this technology moving forward. Provided below is a brief description of the recommended instrument and sensors to be used. A detailed quotation is provided in Appendix G[9].

EHP Environment Ltd. (EHP) has developed a continuous monitoring water quality station that can be tailored specifically to the EMBP. It is noted that this company provides these monitoring systems to Posiva at the Finnish DGR site and has several large mining clients. The EHP QMS is a surface water quality monitoring station that has been designed specifically for field conditions: it is well suited to be installed in ponds, basins, lakes, rivers, channels, and pipes; it can be subjected to harsh, cold weather; it is easy to move;

[9] An updated quote will likely need to be obtained prior to initiation of this component as this quote may be outdated.

and sensors can be added and/or removed over time to meet changing needs. Monitoring data is transmitted wirelessly via a GSM/GPRS modem and each station is powered by rechargeable batteries and solar panels. The EHP QMS can monitor numerous parameters with detection limits comparable to laboratory reporting detection limits. The monitoring stations are typically functional for over ten years.

The cost estimate provided in Appendix G includes the cost of installation and sensors for measuring water level, pH, conductivity, turbidity, dissolved oxygen, total organic carbon, nitrate, and ammonia. There are also ongoing costs associated with this technology that include a monthly internet user interface cost, a monthly cell/satellite phone data transmission cost, and maintenance.

6.2.1.4.1.4 QA/QC for Sample Collection and Laboratory Analyses

Specific QA/QC methods to be employed during the water quality sampling program in the LSA_{SW} are detailed in the SOP provided in Appendix J.

The following set of QA/QC samples will be collected during each sampling trip to ensure sample quality (Environment Canada 2012b; CCME 2016a):

- One field blank will be used to check for contamination from all potential sources of contamination in the field. A field blank sample is collected by bringing deionized water in the field supplied by the laboratory. The field blank sample undergoes the same sample collection, handling, and processing steps as the test samples.
- One trip blank sample will be used to check for contamination from sample bottles, caps, and preservatives during transport, storage, and analyses. The sample bottle is filled with deionized water in the laboratory and preserved in the same manner as the test samples. The trip blank sample is transported to and from the field without modification and opened at the time of analyses.
- One filter blank sample will be used to check for contamination from the filtering apparatus. The filter blank is collected by running the laboratory deionized water through the filtering process.
- Field duplicate samples will be taken at a frequency of 10% of the test samples to ensure that sampling and laboratory analyses produce repeatable results (precision test); details on the number of samples and COPC are provided in Appendix E.

Water samples will be submitted to a laboratory selected by the NWMO that is certified and accredited by CALA. As such, the laboratory will adhere to strict QA/QC standards and protocols and will conduct internal QA/QC measures, such as method blanks, reference materials, laboratory duplicates, and spiked samples.

6.2.1.4.2 Regional Study Area

6.2.1.4.2.1 Sampling Locations, Sample Size, and Frequency

The objective of the regional community-based monitoring program is to obtain an extended temporal data set over the long-term in waterbodies selected and sampled by community members (once trained) as well as those located close to Ignace. Therefore, as discussed in Section 6.2.1.1, the RSA_{sw} will include waterbodies of significance to the communities that are participating in the engagement workshops and those relevant to assessing the potential for cumulative effects due to potential changes to the population of Ignace. A preliminary map of potential sampling lakes was created (see Figure 6.2), and this map is being used to gather further community input from the WLON and Ignace community members. The cost estimate includes budget to sample 10 waterbodies, but these locations are still to be determined. The sample size will consist of one sample per waterbody at a frequency of quarterly (e.g., spring, summer, fall, and winter) or during the open water season at a minimum.

6.2.1.4.2.2 Contaminants of Potential Concern

The proposed COPC list for the RSA_{SW} is reduced from that in the LSA_{SW} in that parameters related to treated sewage effluent, dissolved metals, SVOCs, glyphosate, and Tier 2 radionuclides are not included (Appendix E). The COPC were selected so that field filtering will not be required, and *in situ* limnological measurements will not be taken so that specialized equipment is not required.

6.2.1.4.2.3 Sampling Methods

The regional water quality monitoring program will involve training community members if they wish to independently collect and preserve grab water samples. This could involve multiple training sessions by the consultant conducted throughout Year 1 or, at a minimum, the consultant accompanying the community member during the initial sampling trip. Ideally, samples will be taken from the middle of a lake or in an area of special importance or concern (i.e., near to the public beaches in Agimak or Sandbar lakes, or near to a known fishing hotspot). However, it is anticipated the majority of the samples will be taken near shore so that boats are not required; this can vary depending on the sampling location and equipment availability. The sampling programs will be coordinated and managed by the consultant, who will coordinate with the laboratory and conduct data management, transfer, and analyses. An SOP and field data sheet are provided in Appendix J.

6.2.1.4.2.4 QA/QC for Sample Collection and Laboratory Analyses

This program will require a high level of oversight from the consultant to ensure a high level of QA/QC. The community members recruited to complete the sampling will undergo training prior to independently collecting samples. Ideally, individuals who have undergone environmental monitoring training and have already participated in water quality sampling for the NWMO will complete some of this work. This will ensure a knowledge base, previous experience, and will provide further capacity building.

The cost estimate includes one duplicate sample be collected per sampling trip, which will be a check on data precision. It is not known at this time how many individuals will be conducting the regional water quality monitoring program. Ideally a QA/QC duplicate sample will be collected by each sampler at least once annually.

The consultant will arrange sample transport and will submit the water samples to a laboratory selected by the NWMO that is certified and accredited by CALA. As such, the laboratory will adhere to strict QA/QC standards and protocols and will conduct internal QA/QC measures, such as method blanks, reference materials, laboratory duplicates, and spiked samples.

6.2.1.5 Sediment Quality

6.2.1.5.1 Sampling Locations, Sample Size, and Frequency

Monitoring of sediments should be focused on depositional areas where sediments and associated contaminants are expected to accumulate (CSA 2010; BCMOE 2016). It is also important for the sampling locations to be coincident with benthic invertebrate community sampling to provide information on habitat characteristics and COPC concentrations. Detailed information on sampling locations is provided in sections 6.2.1.1 and 6.2.1.3, and the sample design includes sediment sampling at five stations per location.

Sediment sampling will only occur in Year 2 of the three-year program. Less frequent sampling is required for sediment as compared to the water column as sediment accumulation increases slowly over time, particularly in northern environments with low sedimentation rates (CSA 2010). The sampling will occur in the Fall of Year 2, coincident with the benthic invertebrate sampling.

6.2.1.5.2 Contaminants of Potential Concern

The COPC list for sediment includes metals, moisture, total organic carbon, particle size, nutrients, and a comprehensive list of radionuclides, including gross-α and gross-β and Tier 1 and Tier 2 radionuclides that are included as COPC (Appendix D) and in the study design summary presented in Appendix E. Certain Tier 2 radionuclides that do not exist in nature and are very expensive to measure in the laboratory are only being measured at select stations as a means of confirming their absence (details are provided in Appendix E).

6.2.1.5.3 Sampling Methods

Based on the Preliminary Sample Design Feasibility Assessment report (CanNorth et al. 2019) and associated feedback, where possible, a gravity core sampler (e.g., Tech-ops corer) will be used for sediment sampling to maintain the integrity of a sediment profile and to obtain information from distinct vertical sediment horizons. In addition, coring devices have the advantage of creating minimal water disturbance during descent and leaving fines and chemicals at the sediment-water interface minimally disturbed (CCME 2016b, 2016a). Finer sediment particles are of greater interest in terms of contaminant loads because most chemical contaminants preferentially bind to silts and clays (BCMOE 2016). In depositional habitats, every effort should be made to use a core sampler; however, there may be locations where the sediment composition is too firm to permit gravity core sampling. If erosional habitats are sampled in the rivers, then a grab sampler (i.e., Ekman dredge or Petite Ponar) will be used to obtain sediment from at, or near to, the stations depending on sediment availability. Both of these sampling methods are recognized in guidance documents as accepted practices (CCME 2016a, 2016b). An SOP and field data sheet are provided in Appendix J.

Sediment sampling will focus on the biologically active zone located in the upper sediment horizon to provide the most relevant data for future risk assessments (CCME 2016a). Using a coring device, the uppermost 2 cm sediment horizon will be sliced and placed in labelled sampling bags for laboratory submission. In addition, the 2 to 4 cm and 4 to 6 cm sediment horizons will be collected and temporarily archived in a freezer in case data from deeper depths is needed. Compositing multiple cores per sample will likely be required; however, it is important that the coring device used have a large enough diameter to enable efficient collection of adequate sediment volume to measure all COPC with desired reporting detection limits. Information on required minimum sediment volumes will be acquired from the laboratory prior to the field survey. Sediment samples will be bagged, labelled, and frozen prior to laboratory submission.

If the grab sampler is used, the top approximately 5 cm of the sediment will be scooped out of the top of the Ekman dredge or Petit Ponar sampler and retained in labelled sampling bags and frozen prior to laboratory submission.

One core per station will be logged, which will involve taking a photograph and providing a physical description of the core, including total core depth, and depth and description of each distinct layer for factors such as color, moisture content, organic material and macrophyte content, sediment type, and odour (Alberta Environment 2006). The same type of physical description will be used to characterize sediment samples taken using grab samplers.

6.2.1.5.4 QA/QC for Sample Collection and Laboratory Analyses

The specific QA/QC methods to be employed during the sediment field sampling program are detailed in the SOP provided in Appendix J.

For the sediment QA/QC program, field duplicate samples will be taken at a frequency of 10% of the test samples to ensure that sampling and laboratory analyses produce repeatable results (precision test); details on the number of samples and COPC are provided in Appendix E.

Sediment samples will be submitted to a laboratory selected by the NWMO that is certified and accredited by the CALA. As such, the laboratory will adhere to strict QA/QC standards and protocols and will conduct internal QA/QC measures, such as method blanks, reference materials, laboratory duplicates, and spiked samples.

6.2.1.6 Plankton

The primary objective of the plankton sampling program is to document baseline community composition and abundance in select lentic environments (i.e., lakes) that may be exposed to treated effluent from the Project in the future, along with reference locations. To achieve this objective, the following studies are planned:

1. Seasonal sampling of phytoplankton and zooplankton communities in select locations in the LSAsw. Samples will be submitted to qualified taxonomists for identification, enumeration, and biomass estimations.
2. In addition to traditional taxonomic laboratory analyses, the inclusion of building an environmental DNA (eDNA) barcode sequence library for zooplankton in the study area will be conducted to enable future biomonitoring using eDNA. Refer to Section 6.2.1.8 for more information.
3. Chlorophyll *a* will be measured as a parameter in all water samples collected as part of the LSAsw water quality monitoring program.
4. The autonomous remote water quality meter discussed in Section 6.2.1.4 will have sensors added to collect real-time, continuous data monitoring chlorophyll *a* and blue green algae concentrations. Currently, the sample design includes installing one autonomous remote water quality meter during Year 3 of the EMBP.

6.2.1.6.1 Sampling Location, Size, and Frequency

Phytoplankton and zooplankton sampling will be conducted in Mennin Lake and Revell Lake (Figure 6.1; refer to Section 6.2.1.1). To establish variability, three stations will be sampled at each sampling location in Year 1, particularly since plankton distribution can be patchy (Findlay and Kling 2003; BCMOE 2016). Chlorophyll *a* will be measured in all waterbodies and watercourses sampled as part of the LSAsw water quality monitoring program (refer to Section 6.2.1.4).

The sampling will be completed quarterly (e.g., spring, summer, fall, and winter) coincident with the surface water sampling. Quarterly sampling is assumed to capture seasonal data; however, there is the potential that monthly data may be required during critical seasons (e.g., summer algal blooms) to further establish variability.

6.2.1.6.2 Endpoints

Phytoplankton and zooplankton taxonomic enumeration and biomass estimations will enable endpoints of density, richness, and community composition to be assessed and compared spatially and temporally. Chlorophyll *a* will be measured as an indicator of primary production.

6.2.1.6.3 Sampling Methods

6.2.1.6.3.1 Phytoplankton

Phytoplankton methods are based on guidance documents that provide common best practices (Findlay and Kling 2003; Alberta Environment 2006; Hambrook Berkman and Canova 2007; CCME 2011; Green et al. 2015). An SOP and field data sheet are provided in Appendix J.

At each station, samples will be taken in the euphotic zone, which is estimated as twice the Secchi disc depth. Sampling will occur at mid-day to optimize light transparency. Station depth, Secchi disc depth, sampling depth, and time of day will all be recorded on the data sheet.

A depth integrated sample will be collected in the water column, with care taken to avoid contact with periphyton or macrophytes at the bottom that could contaminate the samples with non-planktonic species of algae. If the water depth is less than the Secchi depth, samples will be collected starting from 1 m off the bottom. Various methods can be used for collecting a depth integrated sample including weighted tubing or a composite of multiple discrete-depth samples taken using a bottle sampler such as a Van Dorn or Kemmerer. For this program, it is recommended that depth integrated samples be collected using a sampling tube as described in Section 6.2.9 of CCME (CCME 2011).

Phytoplankton samples will be placed in labelled, non-transparent sample jars and preserved using Lugol's solution, or according to the taxonomist's specifications. The samples will be stored in a dark location until submission to a qualified taxonomist for taxonomic identification and enumeration and for biomass estimation of major taxonomic groups.

Chlorophyll *a* concentrations will be measured in all water samples collected as part of the LSA_{sw} surface water quality monitoring program. Prior to installation of the autonomous water quality meter, samples will be collected following laboratory SOPs; upon installation, the data will be collected continuously via the meter.

6.2.1.6.3.2 Zooplankton

Following recognized and standardized protocols (Paterson 2001; Alberta Environment 2006; CCME 2011; Green et al. 2015), zooplankton will be sampled using a fine mesh conical plankton net (e.g., Wisconsin net, bongo net). An SOP and field data sheet are provided in Appendix J.

It is important that the mesh size used be consistent between sampling locations and Mack et al. (2012) found that only fine mesh nets (64 μm) effectively capture small-bodied zooplankton (small cladocerans, copepod nauplii, and rotifers). The zooplankton net will be drawn vertically through the euphotic zone to capture zooplankton distribution within the water column at a continuous rate of 0.5 m/s. As with phytoplankton sampling, it is important to avoid disturbing the bottom sediment; therefore, if the water column is shallower than two times the Secchi depth, sampling will start one metre off the bottom to correspond with the phytoplankton sampling. Paterson (2001) recommends compositing three to ten net tows to ensure a sufficient sample size. Since zooplankton density is currently unknown in the study areas, each sample will be a composite of five hauls during Year 1. The size of composites (number of hauls) may be altered in future years depending on the results in Year 1.

Zooplankton samples will be placed in labelled sample jars and preserved using 95% ethanol since the type of preservative used will also need to enable eDNA analyses (refer to Section 6.2.1.8). The samples will be submitted to a qualified taxonomist for taxonomic identification and enumeration, and biomass estimation of major taxonomic groups.

6.2.1.6.4 QA/QC for Sample Collection and Laboratory Analysis

Specific QA/QC methods to be employed during the plankton community sampling program are detailed in the SOP provided in Appendix J.

Depth-integrated quantitative sampling for both phytoplankton and zooplankton that is completed as a continuous tow through the water column (e.g., Wisconsin net, Nalgene tubing) requires that the apparatus be pulled nearly vertical. If the tow is horizontal, the volume of water sampled will not be known. Any samples where the tow deviates from vertical should be discarded, the net rinsed, and the haul completed again. Similarly, if the haul speed changes or is halted during a tow, the sample must be discarded and redone.

A qualified taxonomist will have robust QA/QC checks to ensure the data are accurate. To ensure consistency in identification, the same person will ideally complete all laboratory analyses; however, a sub-sample (~10%) should be analyzed by a second person to ensure accuracy of identification and counts. Replicate counts should be within 10% to 20% of the first count (U.S. EPA 2016; Findlay and Kling 2003). The taxonomist will develop a reference library of voucher samples for every taxon identified.

6.2.1.7 Benthic Invertebrates

The primary objective of the EMBP benthic invertebrate monitoring is to document baseline community composition and abundance in depositional and erosional environments that may be exposed to treated effluent from the Project in the future, along with reference locations. To achieve this objective, the following studies are planned:

1. Sampling of benthic invertebrate communities in select locations in the LSAsw during a period of low emergence (fall). Samples will be submitted to a qualified taxonomist for identification, enumeration, and biomass estimations.
2. In addition to traditional taxonomic laboratory analyses, the inclusion of building an eDNA barcode sequence library for benthic invertebrates in the study area will be conducted to enable future biomonitoring using eDNA. Refer to Section 6.2.1.8 for more information.

The BIS will expand on this program to achieve additional data objectives such as studying food webs, habitat for fish, and cumulative effects. Thus, a plethora of benthic invertebrate community data will be available for the study area that can be utilized to meet multiple objectives.

6.2.1.7.1 Sampling Location, Size, and Frequency

Benthic invertebrate sampling will be conducted in Mennin and Revell lakes and the Mennin, Revell, and Wabigoon rivers, and will be co-located with the sediment and water sampling stations (Figure 6.1; refer to Section 6.2.1.1). The number of stations (n=5) to be sampled at each location is based on other regulatory monitoring programs, such as the federally-mandated metal mining environmental effects monitoring program (Environment Canada 2012b). Once site-specific data are obtained, the extent of data variability can be used to calculate samples sizes required to achieve a desired CES for this program. In the study areas situated in Mennin and Revell lakes, the geographic extent of each replicate station should be at least 10 m x 10 m and separated by at least 20 m (Environment Canada 2012b). In the study areas situated in the rivers, the amount of separation between replicate stations will depend on river morphology and habitat availability, but there should be separation of a minimum of three (preferably six) times the bankfull width of similar habitat between replicate stations (Environment Canada 2012c, 2012b).

Benthic invertebrates are sampled once per year and with consistent timing each year, usually during periods of low emergence (fall), to avoid confounding the data with seasonal variance in the communities (U.S. EPA 2003; Environment Canada 2012b; CCME 2016a). Benthic invertebrate sampling will occur in the Fall of Year 2 and Year 3 of the EMBP.

Benthic invertebrates samples should be collected from the most ecologically relevant habitats within the exposure areas, and similar habitats should be located and sampled within the reference areas (Environment Canada 2012b). As discussed in Section 6.2.1.3, the habitat information collected in Year 1 during the BIS and surface water quality sampling program will be used to determine the benthic invertebrate target habitat types and sampling locations. In the lakes, depositional areas will be sampled, but in the rivers, whether depositional or erosional habitats should be sampled is still to be determined.

6.2.1.7.2 Endpoints

Benthic invertebrate taxonomic enumeration and biomass estimations will enable endpoints of density, richness, and community composition to be assessed and compared spatially and temporally.

6.2.1.7.3 Sampling Methods

For depositional sampling in lentic systems, each sample will consist of a composite of five sub-sample grabs using a standard Ekman dredge or Petite Ponar sampler (Alberta Environment 2006; CCME 2011). The number of field sub-samples needs to be sufficient to give a mean and variance that provide confidence that a representative number of organisms has been captured (Environment Canada 2012b). In the absence of data, five sub-samples will be collected during the first year of sampling. This number can be re-evaluated as part of the annual program reviews. Samples will be sieved through a 500 μm (Jones et al. 2007; CCME 2011; Environment Canada 2012b) nitex mesh bag and the retained material will be transferred into a labelled sample jar and preserved. Since the type of preservative also needs to be suitable for eDNA analyses (refer to Section 6.2.1.8), 95% ethanol will be used instead of formalin. Supporting information will be collected from each replicate location, including station depth and macrophyte growth (type and extent). If for some reason the benthic invertebrate sampling location is not co-located with a water and sediment sampling location, then measurements of sediment particle size, sediment total organic carbon content, and water temperature, dissolved oxygen, specific conductance, pH, and redox potential will be taken. An SOP and field data sheet are provided in Appendix J.

Benthic invertebrate sampling methods for lotic systems (streams and rivers) are discussed in numerous guidance documents and include a variety of options that depend on study objectives and the habitat types being sampled (Rosenberg et al. 1998; Alberta Environment 2006; Jones et al. 2007; CCME 2011; Environment Canada 2012b, 2012c; OSAP 2017). These predominantly include grab samplers, Neill or Hess cylinder samplers, Surber samplers, drift net samplers, artificial substrates, and kick and sweep methods. Study methods outlined in the Ontario Benthos Biomonitoring Network (OBBN) and Canadian Aquatic Biomonitoring Network (CABIN) use rapid bioassessment protocols and a Reference Condition Approach (Jones et al. 2007; Environment Canada 2012c). These programs were designed to amalgamate a large amount of data from various study areas and apply coarse methods for sampling, sorting, and taxonomic identification (Borisko et al. 2007). The study design for the NWMO benthic invertebrate community monitoring program is a BACI design that relies on comparing site-specific exposure and reference data from consistent habitat types. Thus, having replicate stations per study area, minimizing confounding habitat and temporal differences between study areas, and ensuring a high level quality assurance in sample collection and taxonomic methods are important study design components.

The sampling methods and data collections to be employed will be decided once additional habitat information is available following Year 1 of the program; thus, an SOP and field data sheet have not yet been provided. For erosional sampling in lotic systems, it is recommended that a quantitative travelling kick and sweep method be employed; however, a Neill or Hess cylinder sampler is also a good option if the substrate is suitable. For the travelling kick and sweep method, each sample will consist of a composite of three timed travelling kick net transects. Each transect will be completed over three minutes by zig-zagging from bank to bank using a D-frame net with a 500 µm mesh working from downstream to upstream within the sampling reach. For depositional sampling in lotic systems or non-wadeable rivers, five composite grab samples collected using an Ekman dredge or Petit ponar sampler will be composited per sample. Supporting information collected will include:

- Land use;
- Upland and riparian description;
- Evidence of contaminants or erosion;
- Stream discharge at the start and end of each sampling reach;
- Percent canopy cover;

- Wetted width;
- Bankfull width;
- Bank steepness and stability;
- Substrate composition;
- Rock embeddedness;
- Amount and type of riparian and instream vegetation and periphyton;
- Type of obstructions within sampling reach; and
- Percent composition of riffles, runs, glides, and pools.

Detailed information on these measurements is provided in Jones et al. (2007) and Environment Canada (2012c). If not co-located with a water sampling location, temperature, dissolved oxygen, specific conductance, pH, and redox potential will also be collected. This same site characterization information is to be collected at proposed benthic invertebrate station locations where water samples are retained during Year 1 of the program to evaluate station suitability.

Benthic invertebrate samples will be placed in labelled sample jars and preserved. Since the type of preservative also needs to be suitable for eDNA analyses (refer to Section 6.2.1.8), 95% ethanol will be used instead of formalin.

All benthic invertebrate samples will be submitted to a qualified taxonomist for taxonomic identification and enumeration, and biomass estimation of major taxonomic groups.

6.2.1.7.4 QA/QC for Sample Collection

Specific QA/QC methods to be employed during the benthic invertebrate community sampling program conducted in depositional habitats using a grab sampler are detailed in the SOP provided in Appendix J.

Laboratory procedures, including QA/QC requirements, will follow those outlined elsewhere (Glozier et al. 2002; Environment Canada 2012b). The QA/QC program will include a verification of sorting efficiency in approximately 10% of the randomly selected samples. The criterion for an acceptable sort is that more than 90% of the total number of organisms is picked during the initial sort. Another criterion that requires a re-sort is if the entire taxonomic group of invertebrates was overlooked during the initial sort.

If sub-sampling is required, then the effects of sub-sampling on abundance estimates will be examined on approximately 10% of benthic invertebrate samples that undergo sub-sampling. Each randomly selected sample will be subdivided into five equal portions and each will be sorted in their entirety. The five estimates will then be compared to the total actual count, and the accuracy of the five estimates will be calculated as recommended by Environment Canada (2012b). The data quality objective for both sub-sampling accuracy and precision should be set at <20% (Glozier et al. 2002; Environment Canada 2012b).

The taxonomist will develop a reference library of voucher samples for every taxon identified.

6.2.1.8 Environmental DNA

A novel and emerging method for identifying species presence/absence in the environment is the use of eDNA. This technology is becoming standard methodology for baseline monitoring programs and, considering monitoring for the Project is anticipated to continue for 100+ years, it could prove advantageous to look towards the future, as existing taxonomic methods are being augmented with and will eventually be replaced by eDNA. Research initiatives are currently being undertaken between academia and industry to move this technology forward as a monitoring tool, and new uses for this technology are continually emerging. For example, several federal departments are exploring its application to monitor for invasive alien species, quarantine pests, and vectors of zoonotic diseases infecting livestock and humans.

Environmental DNA refers to any genetic material that is deposited to the environment such as shed skin, hair, or tissues; secretions such as mucous or blood; reproductive propagules such as larvae or spores; and intact organisms such as bacteria. Analyzing eDNA from a water sample and comparing the resultant sequences to a reference library can reveal information on all species present (both targeted and incidental) in the environment as long as the species have been genetically profiled in the DNA reference sequence library. The shift to eDNA-based biomonitoring eliminates the need to physically observe, isolate, and identify individual specimens. It is also more objective, rapid, and accurate than conventional methods. One benefit is that eDNA analyses can provide species level resolution where it may be difficult to identify the organisms beyond family or genus using existing conventional taxonomic methods. At this time, eDNA analyses do not provide robust information on density, abundance, or biomass of each species, which are key metrics. However, eDNA abundance has been shown to correlate with these metrics and with additional research, may also be used for this purpose in the future.

For the surface water parameters component of the EMBP, an approach is being taken whereby zooplankton and benthic invertebrates will be collected, identified, and enumerated using traditional methods as described above, and a second set of samples will be collected and submitted for eDNA metabarcoding to determine species presence/absence. In addition to this, specimens that have been identified by the taxonomists will be subsequently submitted for conventional Sanger sequence analyses to aid in building the barcode reference sequence library. This phase of library construction involves putting the provenance data (what it is, who identified it, when/where it was collected, digital images of the voucher) into the Barcode of Life Database (BOLD) and then adding the genetic barcode for each specimen. This approach will ensure reference libraries are comprehensive and will provide method validation and assurance that eDNA metabarcoding of the samples is capable of detecting all organisms present in the study area.

Dr. Robert Hanner from the University of Guelph has been retained to provide expertise on eDNA analyses, to provide support and training to the selected consultant for field collections and sample transfer, and to conduct the eDNA analyses in the laboratory. All sample collections for the eDNA analyses will occur during the fall field trips when benthic invertebrate samples are being collected. Dr. Hanner's lab will provide a technician that will act as a field assistant and will also provide all required field equipment (e.g., backpack pump, filters, DNA extraction kits, etc.). This will ensure proper sterile sample collection and will provide training to the consultant and community members.

At a sub-sample of the zooplankton and benthic invertebrate sampling locations, duplicate samples will be collected (one for taxonomy and one for eDNA analyses). Locations were selected to represent various areas and habitat types and include one of the shallow areas and the deep, central area of Mennin Lake, one area in the Mennin River immediately downstream of Mennin Lake, and one area in the Revell River. For the eDNA analyses, both water and sediment samples will be collected to compare the difference in organisms obtained from the media types and to ensure comprehensive coverage of species detection. Since barcode analyses will be conducted on the organisms being submitted for taxonomic enumeration, preservatives typically used, such as formalin, cannot be used and will be replaced with 95% ethanol. Detailed information on sample collection and preservation requirements for benthic invertebrates in sediment will be provided prior to the field surveys. The eDNA metabarcoding and Sanger barcode sequence analyses will be conducted by the University of Guelph.

A comprehensive eDNA program is also being planned as part of the BIS that will include seasonal sampling (paired with the surface water quality program), microhabitat sampling locations, and a wide diversity of taxa. The eDNA sampling for the EMBP and the BIS is being coordinated so that methods are consistent and multiple data objectives are met.

6.2.2 Stakeholder and Rights-Holder Involvement

The surface water monitoring component affords an excellent opportunity to ensure continued community member involvement in the EMBP. For the more technical water quality studies proposed for the LSA_{SW} that include use of a limnology meter and water sampler, it is proposed that a consultant conduct the first year of sampling alongside community members to establish the stations and sample protocols and to enable training. There is the option that future monitoring could be entirely transferred to community members if desired; however, data quality would need to be a consideration.

As described above in Section 6.2.1.4, the regional water quality monitoring program in the RSA_{SW} has been designed to be completed entirely by community members, if desired, with the oversight of the consultant. This includes selecting sampling locations, receiving training on water sample collections, data recording, sample transfer, and conducting the quarterly sampling. This could involve multiple training sessions by the consultant conducted throughout Year 1 or, at a minimum, by the consultant accompanying the community member during the initial sampling trip.

Since sediment, plankton, and benthic invertebrate sampling requires experience with sampling equipment, protocols, QA/QC procedures, and data recording, it is recommended that community members be involved in the sampling program as field assistants to the consultant retained to conduct the EMBP. This will provide a training opportunity, capacity building, and temporary employment to community members.

6.3 Cost Estimate

A Class 2 cost estimate (-15% to +20% accuracy) based on the Cost Estimate Classification System of AACE International (2005) for the surface water parameters is presented in Appendix E. The estimate is based on a number of assumptions that are also presented in Appendix E, including professional fees, travel and accommodation costs, equipment disbursements for larger items, and laboratory analyses costs.

Accessibility is an issue in the LSA_{sw} particularly for the ponds in the AOI. For the cost estimate, it was assumed that these study areas will be accessed using ATV. Mennin and Revell lakes are accessible via road. The proposed sampling locations on the North Inlet to Mennin Lake, the Mennin River, the Revell River, the Wabigoon River, and proposed reference areas can be modified to some extent to accommodate accessibility via truck, ATV, or boat.

7.0 AIR QUALITY, NOISE, AND LIGHT

This section contains the design details for the recommended option for the air quality, noise, and light component of the EMBP. Detailed study design information is provided below and summarized in Appendix E.

7.1 Data Objectives and End Use

7.1.1 Data Objectives

The Project has the potential to interact with aspects of the atmospheric environment, including local and regional air quality conditions, the local noise environment, and the introduction of artificial light to a relatively undisturbed setting. Air emissions from Project-related sources will disperse in the atmosphere and may eventually be inhaled by humans and non-human biota. Further, air emissions may also be deposited on soil and vegetation, which may be consumed by humans and non-human biota. Emissions of noise will attenuate with distance from the site, but may change the noise environment in the vicinity of the Project and be audible at sensitive habitats or human settlements. Similarly, artificial lights such as those associated with security and safety lighting systems will diminish in intensity with distance from the site but may be visible from off-site locations. Noise and light are generally considered nuisance effects, while air quality impacts can range from nuisance to health effects.

The potential Project-environment interactions for air quality, noise, and light are detailed in the CSM, provided in Appendix C. The data objectives for the program are to characterize the existing levels of those COPC that the Project has the potential to impact during each distinct phase of its life cycle. During the community engagement workshops conducted in 2018 and 2019 (see Section 3.1), addressing the cumulative atmospheric impact of the Project was raised as a topic of importance (i.e., considering the impact of the Project in combination with the impacts of other local industry and other past, present, and future sources of atmospheric emissions, such as transportation). By measuring the baseline conditions in the area directly, prior to the commencement of any Project-related activity, the impacts of current and past local sources will be accounted for in the baseline dataset, which will provide the necessary data to address this important concern of the stakeholders and rights-holders.

To achieve these data objectives, a comprehensive baseline air quality, noise, and light monitoring program is to be established. This will involve continuous and ongoing measurement of air quality COPC over a spatial extent that is representative of the nearest communities and sensitive habitats, and a temporal extent that will represent annual variability. In addition, seasonal measurements of background noise conditions in the area will be completed and baseline light conditions will be measured under the atmospheric conditions in which Project sources would be expected to be the most impactful (i.e., the darkest baseline condition). The noise and light monitoring will be completed in Year 1.

7.1.2 Data End Use

The data collected under the EMBP will form the basis for the assessment of potential Project impacts, by providing a comprehensive description of the atmospheric environment prior to the implementation of the Project phases. This will allow for COPC concentrations from predictive modelling studies, as well as from future monitoring initiatives, to be compared directly to the COPC concentrations that were formerly present in the area, in order to determine the degree of change or whether any guideline or regulatory limits are exceeded. The end uses for the baseline air quality, noise, and light data include the following:

- Establish accurate and representative air quality, noise, and light levels prior to Project commencement.
- Assess spatial and temporal variability as part of the EMBP, as recommended by the CNSC, Health Canada, Environment and Climate Change Canada (ECCC), MECP, and international organizations such as the International Association for Impact Assessment (IAIA).
- Achieve the statistical objectives for the program, as derived during the program execution (i.e., with consideration to the observed degree of change, and accounting for sampling frequency, and number of locations and samples).
- Assess the current conditions relative to standards and limit values for COPC.
- Provide necessary data inputs to predict and assess Project-related and cumulative effects in the IA and, in particular, the air quality, noise, and light impact assessments and the human health and ecological risk assessment.
- Provide ongoing and reliable information to aid in the determination of air quality trends over time.
- Share information with the community about air quality, noise, and light levels and build capacity, if needed.

7.1.2.1 Evaluation Criteria

Where applicable, concentrations of the COPC will be compared to relevant ambient air quality standards to provide context to the measured results and also to available data from provincial, federal, or international (e.g., Minnesota) monitoring stations to evaluate how the local air quality compares to that of the broader region. The most relevant sources of ambient air quality objectives/standards include the most recent Ambient Air Quality Criteria (AAQC) from the MECP (2019) and the Canadian Ambient Air Quality Standards (CAAQS) from the CCME (2017). These limits are discussed in Section 3.5

It is important to note that the air quality baseline levels that are measured as part of this program will also be used as a point of comparison to the predicted levels with the Project implemented in its various phases. This is a standard approach for impact assessments in Canada, and internationally (IAIA 2017). As this comparison relies upon a quantitative baseline, it is important that the laboratory detection limits not only allow for a comparison to the guideline limits, but also, where possible, are low enough to result in detection of the amounts of the COPC that is actually present, such that a true comparison can be made to future predictions and monitoring data. For air quality COPC that have no provincial or guideline limits, the measured levels will be archived for comparison to future predictions and/or ongoing monitoring initiatives.

With respect to noise, sound levels will be compared to applicable federal and provincial limits (human) and available literary sources with respect to non-human biota exposures. The most relevant sources of noise limits include the most recent guidance from Health Canada and the MECP (Health Canada 2017; MOECC 2013). These are discussed in Section 3.5.

There are no provincial or federal guideline limits for the quantitative assessment of light levels. It is currently the standard industry practice to instead apply limits from the Commission Internationale de L'Eclairage (CIE, or International Commission on Illumination) “Guide on the limitation of the effects of obstructive light from outdoor lighting installations” (CIE 2003).

7.2 Data Collection

7.2.1 Sampling Details

7.2.1.1 Air Quality

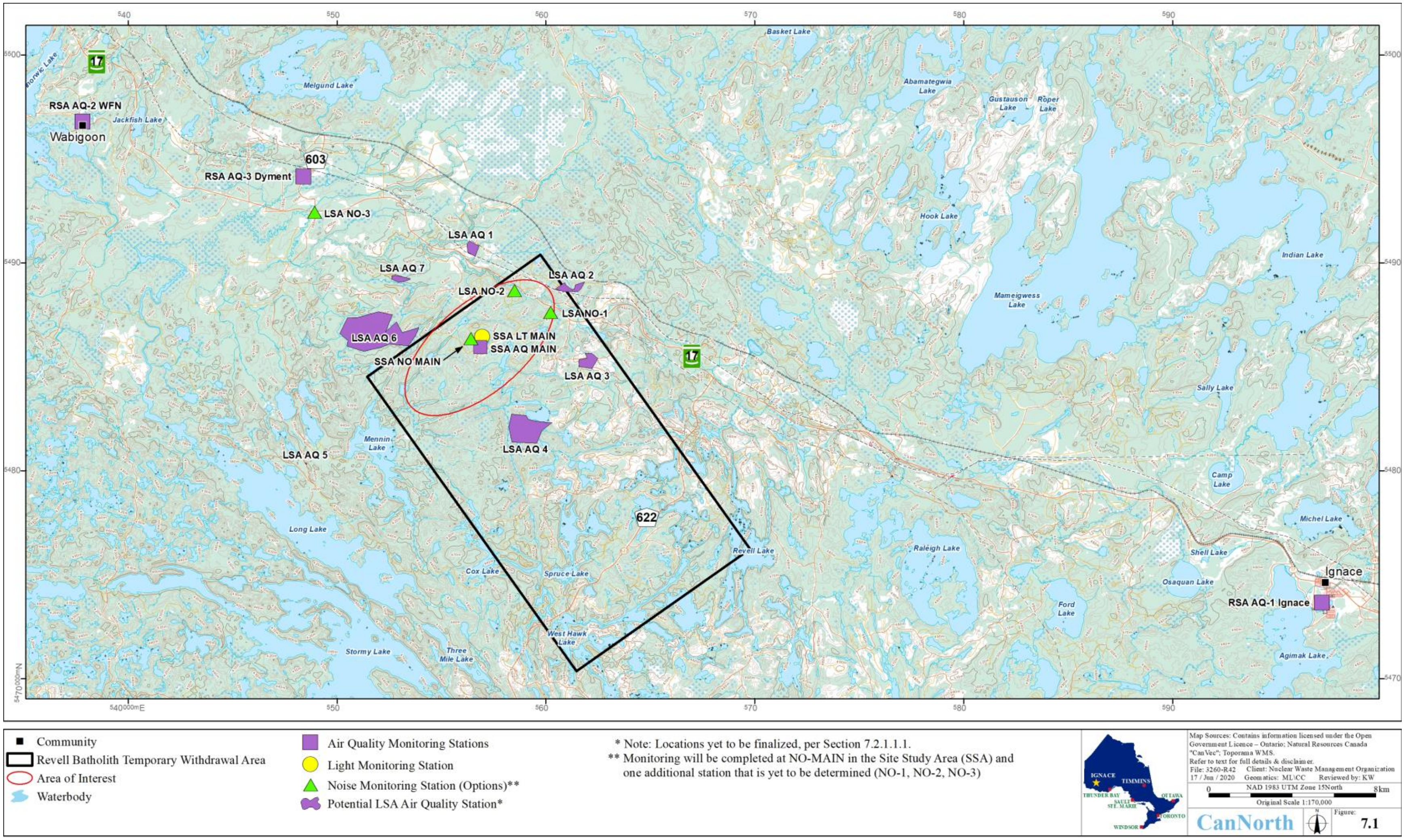
7.2.1.1.1 Study Areas and Sampling Locations

The SSA will be defined by the eventual property boundary of the facility, located somewhere within the AOI. For Year 1, the SSA and associated air quality station have been defined to be centrally located within the AOI, near to borehole 1 (see Figure 7.1).

The LSA for air quality (LSA_{AQ}) includes the lands beyond the SSA where there is a potential for air quality effects to occur from the Project. For the EMBP, this has been defined as the lands within approximately 10 km of the SSA, which includes the nearest community of Borups Corners. There are other sources of air releases in the LSA_{AQ}, such as local industry (e.g., TransCanada Pipelines Station 58), transportation (e.g., Trans-Canada Highway), and intermittent and seasonal sources (e.g., forest fires), all of which will contribute to existing and future air quality conditions within the LSA_{AQ}. A total of four air quality stations are proposed in the LSA_{AQ} at this time (see Figure 7.1); however, the locations of these stations have not been established and will be determined based on the results of the air dispersion modelling, feedback received from the stakeholders, rights-holders, the BIS on critical habitats or area of significance, and siting and accessibility constraints.

The RSA for air quality (RSA_{AQ}) includes lands beyond the LSA_{AQ} that are relevant to the assessment of potential long-range air quality effects of the Project on local communities. Typically, the RSA_{AQ} is set with consideration of nearby existing air quality monitoring networks, such as those operated by the federal (ECCC) and provincial (MECP) governments, in order to assist with the description of existing conditions. Given the remote location, there are no existing air quality monitoring stations within a reasonable distance from the Project. The nearest stations that measure the types of chemical parameters typically included in an Air Quality Assessment are in Thunder Bay (approximately 250 km from the LSA_{AQ}) and Winnipeg (approximately 350 km from the LSA_{AQ}). As a result, the EMBP is intended to fill this data gap. The RSA_{AQ} has been defined as the lands within approximately 50 km of the LSA_{AQ}, which extends to the Town of Ignace, Dryden, and the WLON reserve. A total of three stations are proposed in the RSA_{AQ} (see Figure 7.1). Again, the locations may change based on stakeholder and rights-holder input and results of the atmospheric dispersion modelling study.

Figure 7.1 Proposed sampling station locations for air quality, light, and noise monitoring



7.2.1.1.2 Study Components

Air quality is a common SC considered in an IA that is used as an indicator of change in human and environmental health. In this context, members of the community and non-human biota (e.g., aquatic plants, invertebrates and fish, amphibians, reptiles, birds and mammals) could be exposed to COPC in air produced by activities during the construction, operation, and decommissioning phases of the Project. Air quality is also an important pathway that could lead to the transmission of COPC to other media (e.g., deposition of air contaminants into freshwater, soil, plants, etc.).

7.2.1.1.3 Contaminants of Potential Concern

The COPC considered in the air quality component of the EMBP are detailed in Appendix D and Appendix E. The Tier 1 (primary) COPC include (a) conventional air quality contaminants that are expected to be readily measurable within the SSA, LSA_{AQ}, or RSA_{AQ} and (b) key radiological COPC that may be of greater concern to stakeholders and rights-holders. Conventional parameters include those that are the subject of provincial and national air monitoring initiatives. The Tier 2 (secondary) COPC include other air quality contaminants that are (a) expected to be present in low-level amounts in the SSA, LSA_{AQ}, or RSA_{AQ}, (b) associated with a future project interaction, and (c) may be of concern within the community. The Tier 2 COPC list includes trace organics/toxics (VOCs, PAHs) and trace metals (naturally occurring or the product of local industry), and other radionuclides of interest to the NWMO.

7.2.1.1.4 Sample Size and Frequency

The sample size and frequency are to be set in a manner that achieves the statistical objectives of the study, as outlined in Section 3.4, to ensure the CES is appropriately defined; however, as there is currently no air quality monitoring occurring in the area, the data variability cannot be ascertained until a robust set of sample data is available. As such, the sample size and frequency for Year 1 have been based on practicality and professional judgement but will be re-evaluated after the first year of program.

In practice, the sample size and frequency of measurement will vary by sample method and COPC. Sample sizes and frequency of sample collection is often stipulated by, or limited by, the sample method and analysis requirements. For example, detection of radionuclides in air typically requires a large amount of sample to be provided to the laboratory for analysis. To achieve large sample volumes, the air sampler needs to be run continuously for as long as possible, which in turn reduces the number of samples that can be collected. Alternatively, some COPC are readily measurable and detectable, and instrumentation is available that can provide concentration data on a continuous basis, resulting in a large data set. The following general equipment types and COPC are included in the program, with an indication of the sample frequency and sample size:

- Continuous samplers (NO_x, SO_2, CO, O_3, NH_3, PM_{10}/$PM_{2.5}$): continuous 1-hour measurements throughout the duration of the program.
- Intermittent samplers (e.g., high-volume air samplers (HVAS) and Summa® canisters, used for TSP, PAHs, PHCs, SVOCs, VOCs): 24-hour samples collected monthly.
- Passive sampling systems (NO, NO_2, SO_2, VOCs, NH_3, PAHs, SVOCs, PHCs, dustfall): exposed for a 30-day period, collected monthly.
- Passive radiation-related sampling systems (H-3, C-14, radon, gamma): monthly or quarterly exposures.
- Active radiation-related sampling systems (H-3, C-14, Kr-85, radionuclides suite): 30-day samples, collected monthly (or monthly composites).

The sampling systems and planned operating schedules are discussed in further detail in the following section.

7.2.1.1.5 Sampling Methods

As noted above, the study areas for air quality have been characterized in terms of the SSA, LSA_{AQ}, and RSA_{AQ} and the proposed air quality sampling differs by study area. The central monitoring station is to be commissioned in the SSA and will include the most sophisticated of the proposed monitoring systems (i.e., reference methods), as well as monitoring systems that mirror those in the LSA_{AQ} and RSA_{AQ}, for validation against the reference methods. In other words, all monitoring systems that are being proposed for the EMBP will be represented at the SSA station, and the LSA_{AQ} and RSA_{AQ} stations will be pared down versions of the central SSA station, depending on the data needs for those locations. The LSA_{AQ} is largely comprised of natural areas, and so the selection of parameters to be measured at these locations were largely driven by the needs of the other IA disciplines (e.g., biodiversity, surface water, etc.).

The RSA_{AQ} includes the nearest communities and First Nation reserve lands, and so the parameters to be measured at these locations are those of primary concern to the communities (i.e., radiation-related COPC). A summary of all of the monitoring systems is provided in Table 7.1 with an indication of which methods will be used in which study areas. A discussion of each monitoring system is provided, by study area, in the sections that follow. Appendix H provides additional details on the various monitoring methodologies, while SOPs and field data sheets are provided in Appendix J.

Table 7.1 Air quality sampling methods

Sampling Method	COPC	SSA	LSA_{AQ}	RSA_{AQ}
Continuous NO_x Analyzer (Chemiluminescence)	NO_2, NO, NO_x	•		
Continuous SO_2 Analyzer (UV Fluorescence)	SO_2	•		
Continuous CO Analyzer (NDIR gas filter correlation)	CO	•		
Continuous NH_3 Analyzer (Chemiluminescence)	NH_3	•		
Suspended Particulate Matter <10 µm (Gravimetric/beta attenuation/light scatter)	PM_{10}	•		
Suspended Particulate Matter <2.5 µm (Gravimetric/beta attenuation/light scatter)	$PM_{2.5}$	•		
TSP HVAS	TSP, metals	•		
TSP HVAS	Radionuclides	•		•
PUF HVAS	PAHs, SVOCs, PHCs	•		
Summa® Canister	VOCs, SVOCs, PHCs	•		
Tritium/C-14 Active Sampler	H-3, C-14	•		•
Krypton-85	Kr-85	•		•
Alpha Track Dosimeter	Radon	•	•	•
Thermo-luminescent Dosimeter	External gamma	•	•	•
Passive Cartridge	NO/NO_2, SO_2, NH_3, VOCs	•	•	
Passive PUF Disk	PAHs, SVOCs, PHCs	•	•	
Dustfall	Dustfall, metals, radionuclides	•	•	

7.2.1.1.5.1 Site Study Area

The main feature of the central monitoring station in the SSA will be a suite of continuous analyzers that collect and log air concentration data on a set interval (typically 1-hour), which can then be linked into a web portal system for viewing by the public. A critical requirement for this station is that these sample methods represent those that are currently accepted reference methods endorsed by the MECP, ECCC and/or U.S. EPA, to ensure the highest data quality. The COPC that are to be measured using continuous analyzers, along with the approved reference sampling/analysis methods to be utilized, are summarized in Table 7.2.

Table 7.2 Continuous sampling methods at the SSA air quality station

COPC	Sampling Method
NO_2, NO, NO_x	Chemiluminescence
SO_2	UV Fluorescence
CO	NDIR gas filter correlation
NH_3	Chemiluminescence
PM_{10}	Gravimetry, beta attenuation, or light scatter
$PM_{2.5}$	Gravimetry, beta attenuation, or light scatter

In addition to the continuous samplers, there will also be a number of intermittent, or non-continuous, samplers. These include High-Volume Air Sampler (HVAS) systems, Summa® canisters, and an active tritium and carbon-14 sampler.

Table 7.3 Non-continuous sampling methods at the SSA air quality station

COPC	Sampling Method
TSP, metals	TSP HVAS
Radionuclides	TSP HVAS
PAHs, SVOCs, PHCs	PUF HVAS
VOCs, SVOCs, PHCs	Summa® canister
H-3, C-14	Tritium/C-14 active sampler
Kr-85	Kr-85 active sampler
Radon	Alpha track dosimeter
External gamma	Thermo-luminescent dosimeter
NO/NO_2, SO_2, NH_3, VOCs	Passive cartridge
PAHs, SVOCs, PHCs	Passive PUF disk
Dustfall, metals, radionuclides	Dustfall

There will be a total of three HVAS monitors at the SSA station. Two of these will be TSP HVAS units (one for particulates and metals and the other for radionuclides which is discussed further under the RSA_{AQ} sampling methods) and one will be a polyurethane foam (PUF) HVAS unit. Each of these will be used to collect 24-hour air samples, on a monthly basis. The TSP systems draw ambient air across a filter, depositing any airborne particulates on the filter surface, which will be used to evaluate the total suspended particulate concentrations (gravimetry), as well as the metals and radionuclides. The PUF HVAS draws air through a filter and PUF cartridge, and these will be used to evaluate the levels of PAHs, SVOCs, and PHCs in ambient air.

Summa® canisters will also be employed to quantify concentrations of VOCs, SVOCs, and PHCs in air. Summa® canisters are evacuated metal containers, prepared by a laboratory and provided under vacuum with a flow controller that will draw ambient air into the canister evenly over a 24-hour period. Such samples will be collected for analysis once per month.

The SSA station will also house an active sampler H-3 and C-14. This system draws sample air through canisters or vials containing absorptive media or a molecular sieve, which are then provided to a laboratory for analysis via liquid scintillation counting. Due to the low levels expected, these samplers are typically run continuously for a period of 30 days.

The remaining sampling methods at the SSA station are duplicated elsewhere in the program and are discussed in the following sections.

7.2.1.1.5.2 Local Study Area

Levels of particulate matter in the LSA_{AQ} will be measured using dustfall samples, which is a method endorsed by the MECP and is often applied in remote locations where there is no access to power. This sampling method provides information on particulate settling and deposition, which is of use to other IA disciplines, and can also be used to provide speciation data of metals and radionuclide in ambient air. This method involves placing an open-topped container (provided pre-cleaned and sealed by a laboratory) in a bracket that is suitably protected from wildlife interference (e.g., elevated, and with a bird ring), adding an anti-freeze agent or algaecide to the container, and exposing it to ambient conditions for a period of 30 days. Upon collection, the container is sealed and provided to the laboratory for analysis.

For conventional gaseous parameters (NO_2, NO_x, SO_2) and other COPC of concern such as VOCs, PAHs and ammonia, neither the MECP nor the U.S. EPA explicitly endorse passive methods; however, these methods are often necessary for baseline monitoring in remote areas where there is no access to power. It is recommended that such samples be collected using chemically-treated badges/cartridges that are deployed in rain shelters for protection from the elements. The passive PAH samples are collected using a PUF disk, similarly installed in a shelter where it is protected from the elements. Each of the sample media are typically exposed for a period of 30 days and then returned to the laboratory that prepared them for analysis. The laboratory provides the cartridges in protective cases such that first exposure of the diffusion barrier occurs upon installation in the field. The laboratory also provides blanks with each shipment, which are not to be exposed, but rather returned to the laboratory with the shipment of exposed cartridges.

The remaining passive samplers recommended for the LSA_{AQ} are related to radioactivity, which is the focus of the RSA_{AQ} monitoring and are, therefore, discussed in the following section.

7.2.1.1.5.3 Regional Study Area

There are three proposed sampling stations in the RSA_{AQ}, located at the communities nearest to the AOI (i.e., Dyment, Ignace, WLON). These locations have the advantage of not only being representative of the nearest human exposures, but also having access to power. The monitoring at these stations focuses on the COPC related to radiation (for which the collection of a large amount of sample is beneficial for analysis), and so the use of active samplers is advantageous. As such, each of these stations will include one TSP HVAS, which will be operated for as long as possible without impacting filter loading. Typically, this period is approximately two to four weeks. Depending on the loading encountered, the period may be extended, or an additional filter may be run in order to composite samples together for greater characterization. The filters from the TSP HVAS will be analyzed for the full suite of radionuclides, identified in Appendix E. It is being recommended that these samples be collected quarterly to account for any seasonal variability.

In addition to the TSP HVAS, the RSA_{AQ} stations will each include additional monitors for other radioactivity-related COPC: H-3, C-14, Kr-85, external gamma, and radon. It should be noted that all of these monitors will also be located at the SSA station, while gamma and radon monitors will be located at the LSA_{AQ} stations. External gamma and radon are each measured using dosimeter badges, which are simply attached to a vertical surface (e.g., post) and exposed to the ambient air for a period of 90 days. As the dosimeters will begin registering gamma and radon upon preparation at the laboratory, they are issued with travel blanks and field blanks that are prepared at the same time, for use in adjusting the final results. The travel blank is returned to the lab immediately upon receiving the shipment and is used to identify how much gamma and radon was registered between the point of preparation and receipt in the field (i.e., during travel). The field blanks are kept and taken to each monitoring station during the commissioning but are not installed. The field blanks are returned to the site office and kept in a safe place until the exposed dosimeters are retrieved, at which time they are taken back out to site to collect the exposed dosimeters, and all dosimeters are returned to the lab together.

The RSA_{AQ} stations will employ active samplers for H-3 and C-14. This system draws sample air through canisters or vials containing absorptive media or a molecular sieve, which are then provided to a laboratory for analysis via liquid scintillation counting. Collection methods for Kr-85 have historically included grab sampling air with an evacuated container, condensation on charcoal or molecular sieve at low temperatures, and liquefaction in a liquid nitrogen trap. The viability of these Kr-85 methods would need to be further evaluated to determine the most appropriate approach. Due to the low levels expected, these samplers are expected to run continuously for a period of 30 days.

7.2.1.1.6 QA/QC for Sample Collection

The baseline air quality monitoring program includes a number of QA/QC measures to ensure that the data being reported is accurate and reliable, by ensuring all equipment is working as designed, all sampling methods are being carried out in accordance with accepted procedures (i.e., MECP, ECCC), and all sample media are handled properly to avoid or eliminate the possibility of cross contamination. The QA/QC measures to be accounted for in the program include:

- Regular calibration of all instruments;
- Use of calibration equipment that is certified to National Institute of Standards and Technology (NIST) standards within a period recommended by the manufacturer;
- Regular zero/span checks of continuous analyzers;
- Uuse of appropriate shelters and equipment mounts to protect the samples from the elements and from wildlife interference;
- Inclusion of blank sample media in analysis;
- Co-location of non-reference methods (e.g., passive samplers) with reference methods (e.g., continuous analyzers) for validation;
- Use of duplicate co-located monitors for methods with higher uncertainty;
- Use of accredited laboratories for each type of analysis proposed;
- Use of Chain of Custody (COC) forms to track samples and analysis with each laboratory and shipment;
- Strict adherence to siting protocols to ensure representative exposure with unrestricted airflows and appropriate setbacks from intervening structures and vegetation/trees;
- Development of detailed field protocols/checklists for each sampling method;

- Use of protective equipment during sample handling to avoid sample contamination;
- Regular cleaning of sample equipment; and
- Maintaining suitable conditions for sample media during storage and shipment (e.g., sample refrigerator, ice packs during shipment, where applicable).

Specific QA/QC methods to be employed for each type of air quality monitoring are detailed in the SOPs provided in Appendix J.

7.2.1.1.7 Data Processing

The air quality monitoring program includes various continuous, passive, and intermittent sampling methods, and the nature of the data collected by each can vary widely. Some of the instruments directly provide air concentration data that requires no further analysis, while others require an external laboratory to complete analysis of sample media before air concentrations can be determined. Often, further analysis using information collected in the field (and documented in the field notes) is required to arrive at air concentration data that can be compared to the various standards and limits.

The continuous analyzers that are proposed for the central monitoring station in the SSA provide air concentration data directly, without the involvement of an external laboratory. The concentration data is continuously logged using a data acquisition system, which is intended to forward data to a web portal for viewing by the public. The logged data can be downloaded from the data acquisition system for trend analysis, as well as for secondary calculations (e.g., determining 24-hour average daily concentrations from the logged 1-hour concentrations).

The remaining sampling methods each require the sample media to be forwarded to the external laboratory from which the sample media was ordered, for analysis. Upon analysis, the laboratory provides a certified report containing the analysis results. For some sample media, the laboratory reports contain air concentration data that can be compared directly to the applicable standards (e.g., Summa® canisters, passive badges). Sample media such as filters and PUF cartridges for the HVAS require detailed readings from the instrument for the associated sample run in order to calculate an air concentration.

7.2.1.2 Noise

7.2.1.2.1 Study Areas and Sampling Locations

The Local Study Area for noise (LSA_{NO}) includes the lands beyond the SSA where there is a potential for noise effects to occur from the Project. For the purposes of this assessment, this has been defined as the lands within approximately five kilometres of the SSA. Note that there are other sources of noise emissions in the LSA_{NO}, such as transportation sources, which will contribute to the existing and future noise conditions within this boundary. Given the nature of noise propagation, noise emissions from the Project (i.e. earth clearing/grubbing, access roads, building construction, traffic, ventilation systems, etc.) would not be expected to extend beyond the LSA_{NO} and a regional study area (RSA_{NO}) was, therefore, not defined. Noise monitoring will occur at one location in the SSA and at one location in the LSA_{NO} close to the Trans-Canada Highway. Three potential locations for the noise monitoring stations within the LSA_{NO} are illustrated in Figure 7.1, of which one will be selected based on accessibility and exposure. The sound levels that are measured will be used in the establishment of baseline in terms of human exposure.

In addition to the above locations, community members have expressed an interest in collecting information on wildlife bioacoustics (i.e., animal calls). This will be addressed in the BIS.

7.2.1.2.2 Study Components

The sound environment is an important SC considered in an IA as it may impact members of the community and non-human biota. Changes to the sound environment may cause nuisance effects in communities depending on the degree of change and characteristics of the sound being introduced. In terms of non-human biota, and again depending on the degree of change and nature of the sound being introduced, changes in the sound environment may influence behaviour, change migration patterns, cause certain areas to be avoided (including nesting locations), or even mask important sounds (e.g., mating calls, sounds of predators/prey, distress calls, etc.).

7.2.1.2.3 Contaminants of Potential Concern

Noise itself is considered a COPC in this context. The noise levels established in the EMBP will be used as the basis for estimating the potential degree of change associated with the Project at the IA stage.

7.2.1.2.4 Sample Size and Frequency

Baseline noise levels for human exposure assessment will be monitored on a seasonal basis, resulting in two distinct programs in the Fall and Spring of Year 1 of the EMBP. Depending on weather suitability, these may occur in the summer or winter months instead. This is expected to be sufficient to characterize the background noise levels in the SSA and LSA_{NO}. Variability in sound levels is expected to be associated with traffic patterns on the Trans-Canada Highway, rail traffic, and seasonal activity. Traffic tends to follow a diurnal pattern within a 24-hour period, as well as a weekly pattern that often sees lighter traffic volumes on the weekends. Seasonal variability may be associated with use of different vehicles (e.g., snowmobiles) and changes in traffic volumes.

Each program is to be run for two weeks, collecting sound level data on a continuous hourly basis at the two identified locations. The resulting data sets will each provide information on any diurnal patterns and weekend/weekday patterns, and the data sets considered in comparison will provide an indication of whether baseline levels vary on a seasonal basis. This significantly exceeds the minimum requirements of the MECP for the length of a baseline sound level monitoring program of 48 hours.

7.2.1.2.5 Sampling Methods

The baseline noise monitoring program for human noise exposure is based on achieving conformance with standard methods and guidance outlined by various regulatory agencies (MOECC 2013; Health Canada 2017; ISO 2017). The sound level meters that will be employed in the program will be Type 1 (Class 1) integrating sound level meters that conform to the requirements of the International Electrotechnical Commission (IEC 61672-1:2013), in accordance with ISO 1996-2. An SOP is provided in Appendix J.

The recommended baseline noise measurement program is an unattended program. The sound level meters will be commissioned at the selected locations and configured to log data continuously throughout the monitoring period. Each station should be periodically checked to ensure that the equipment has not been damaged by wildlife and that there has been no interruption to power from the battery/solar panel system. The data is logged in internal memory on each device, which is downloaded at the end of the program (or periodically during the program, by trained personnel) for further analysis.

7.2.1.2.6 QA/QC for Sample Collection

The baseline noise monitoring program includes a number of QA/QC measures to ensure that the data is representative and accurate and to ensure that the data and equipment are protected. These measures include the following:

- Using instrumentation that has been factory-calibrated to an NIST standard within one-year of its use (or other period as specified by the calibration laboratory), for human exposure program;
- Completing field calibrations before and after deployment using an acoustic calibrator that has been factory-calibrated to an NIST standard within one-year of its use (or other period as specified by the calibration laboratory), for human exposure program;
- Compiling concurrent meteorological data from the on-site station (see Section 5.2.1.5.4), for use in validating the data sets;
- Deploying the human exposure sound level meters in weather-proof hardcases, with appropriate weather and interference protection on the microphone extension (i.e., wind screen, rain guard, desiccant chamber, bird spikes);
- Siting the sound level meters (for human exposure monitoring) in accordance with MECP requirements, away from reflective surfaces and potential interferences (e.g., leaves rustling in wind);
- Auto-storing data on a set interval to avoid data loss if power is interrupted, where possible; and
- Following all calibration and siting requirements for the wildlife sound monitoring equipment, as recommended by the selected manufacturer.

7.2.1.2.7 Data Processing

The instrumentation identified for use in the assessment of baseline noise levels for human exposure is to be capable of logging the data internally on an hourly basis and outputting the logged data to a spreadsheet for further analysis. This may include, but not be limited to, plotting the hourly sound levels to identify diurnal and day-to-day trends, as well as calculating energy equivalent sound levels (L_{eq}) over various periods (daytime hours, night-time hours, 24-hour period, etc.) and other community noise metrics (e.g., day-night sound level, or L_{dn}).

It should be noted that the post-analysis will also require a comparison between the logged sound level data and relevant data from the meteorological station for each logged interval (e.g., hourly). Sound level meter manufacturers generally identify finite operating ranges for several external meteorological parameters within which the measurement data is considered valid. These include temperature (typically -10ºC to +50ºC, may vary by manufacturer) and relative humidity (typically 25% to 90%, may vary by manufacturer). The MECP also identifies acceptable meteorological conditions for background sound level measurement programs in its Publication NPC-300 (MOECC 2013) . In addition to adhering to the manufacturer temperature and relative humidity operating ranges, the MECP also requires that data collected during precipitation events and high winds be discarded. Such events result in higher measured sound levels that are not considered representative of average or minimum background conditions.

7.2.1.3 Light

7.2.1.3.1 Study Areas and Sampling Locations

The study area for the baseline light monitoring is restricted to the SSA given the nature of the surrounding environment (i.e., intrinsically dark), the location of which is shown in Figure 7.1. As such, local and regional study areas were not defined.

Ideally, light monitoring data will be collected from the same locations throughout all phases of the Project. It is anticipated that a single location will be used for sky glow and four locations for illuminance that correspond with each cardinal direction along the property boundaries.

7.2.1.3.2 Study Components

The light environment is an important SC considered in an IA as it may impact members of the community and non-human biota. The introduction of new light sources to an environment may result in nuisance effects in communities, depending on the baseline light levels and lighting design characteristics (e.g., glare from light source, spillage of light off the property, intensity of new lighting systems). In terms of non-human biota, and again depending on the characteristics of the light being introduced, changes in the local light conditions may influence growth cycles for some flora, diurnal cycles for some fauna, and may also be disorienting for organisms that navigate via natural light.

7.2.1.3.3 Contaminants of Potential Concern

Light itself is considered a COPC in this context; however, the properties of light in terms of unique impacts can be considered in the following categories:

- Sky glow (i.e., the possibility that the Project lighting would interfere with observation of the night sky);
- Light trespass/incident light (i.e., illumination of unintended areas, such as adjacent lands); and
- Glare (i.e., a light source being much brighter than its surroundings, causing discomfort or impairing vision).

Glare is a property associated with a specific light source and is not part of the EMBP but should be accounted for in the Project design.

7.2.1.3.4 Sample Size and Frequency

As the AOI is largely an undisturbed, natural setting, it is not expected to have significant spatial variability within the SSA. There will be temporal variability during the hours when artificial lighting is used, attributable largely to the lunar cycle and other natural light from the sky (e.g., bright star light). Road lighting from the Trans-Canada Highway may also be visible at the SSA but is not expected to contribute significantly to the existing light environment in the SSA. As such, a single baseline light monitoring campaign is proposed to characterize existing sky glow and illuminance levels. Illuminance will be measured at locations representing the potential boundary of the facility (e.g., fence-line).

7.2.1.3.5 Sampling Methods

There are no provincial or federal regulations or guidelines that provide measurement protocols for environmental light impact assessment or baseline data collection. It is common practice for such studies to apply procedures from the CIE (2003). Illuminance is measured using a standard hand-held light meter, in units of lux. For purposes of establishing baseline conditions, a hypothetical receiving plane that is representative of an off-site exposure location (i.e., outside of the facility's fence-line) will be scanned with the sensor and the average illumination of the plane will be logged. Baseline sky glow will be measured using a sky quality meter (e.g., Unihedron SQM), and reported in the standard units of magnitudes per square arcsecond. The results of future prediction and/or measurement studies may then be compared to these baseline levels as an indication of the effect of the Project. For each parameter, the equipment provides real-time data which is recorded by the field technician. An SOP is provided in Appendix J.

It is important to note that the maximum light impact of the Project would occur under the darkest baseline conditions. As such, the monitoring program must be carefully planned to ensure that the darkest possible conditions are represented, and these conditions must be replicated during all future monitoring initiatives associated with the next phases of the Project to ensure equivalency. Future measurements completed under conditions that differ from the baseline condition could result in the attribution of impacts to the Project when the difference may actually be due to the differing natural environmental conditions, which are unrelated to the Project.

The baseline light study (and any future light measurement studies) are to be completed during the spring/summer months, during a period with no significant light contribution from the moon, and no significant cloud cover. Summer measurements are recommended as there is no chance for snow cover, which would strongly influence the contribution of reflected light. Further, there should be no contribution of light from the moon, which means that measurements should be taken as close as possible to the new moon phase in the lunar calendar. Lastly, sky forecasts must be consulted prior to completing measurements, to ensure that a night is selected when there is no cloud cover. The presence of clouds may also increase the presence of reflected light.

7.2.1.3.6 QA/QC for Sample Collection

The baseline noise monitoring program includes a number of QA/QC measures to ensure that the data is representative and accurate, and to ensure that the data and equipment are protected. These measures include the following:

- Use of calibrated equipment;
- Documentation of precise conditions in the field in terms of observable light sources;
- Maintaining records of forecasts used; and
- Two person team for field verification and safety.

7.2.2 Stakeholder and Rights-Holder Involvement

The air quality, noise, and light components of the EMBP have been developed with the intention of involving stakeholders and rights-holders, if they desire, in the ongoing operation of the program in order to build capacity, such that they:

- Are engaged, understand the program, and take ownership;
- Can act as qualified observers/helpers;
- Can provide IK to help determine sampling locations provide valuable input; and
- Are adequately trained to take full responsibility for implementation, if desired.

Stakeholders and rights-holders could initially be involved in completing ongoing checks of the various instruments and passive stations, to observe whether instruments are operating as expected, whether any upset conditions have occurred (e.g., instrument malfunction), or whether the instruments/sampling systems have been damaged.

Stakeholders and rights-holders could be further trained in the exchange of passive sample media, record-keeping practices, sample tracking (i.e., COC forms) and shipping procedures, and all associated QA/QC practices. Once these tasks are being completed comfortably, more advanced training may then take place, which could consist of completing and documenting instrument calibrations, zero and span checks, and maintaining the continuous analyzers. At this stage, it would be possible for the stakeholders and rights-holders to manage the entire operation of program.

The noise and light monitoring will take place in distinct campaigns that are less complex compared to the air quality monitoring program. As such, it is anticipated that stakeholders and rights-holders can accompany the technical staff when the noise and light programs are being completed in order to be trained on how to set-up and utilize the equipment and gain experience. At the completion of these tasks, it would be possible for stakeholders and rights-holders to act as ongoing observers or conduct future monitoring campaigns.

7.3 Cost Estimate

The Class 2 cost estimate (-15% to +20% accuracy) conducted for the air quality, noise, and light components of the EMBP is presented in Appendix E. The cost estimate is based on a number of assumptions that are also presented in Appendix E, including professional fees, travel and accommodation costs, equipment disbursements for larger items, and laboratory analyses costs.

8.0 SOIL

This section contains the design details for the recommended option for the surficial soil component of the EMBP. Detailed study design information is provided below and summarized in Appendix E.

8.1 Data Objectives and End Use

8.1.1 Data Objectives

Understanding terrestrial soil quality and bedrock chemistry is an essential component of site characterization of a DGR facility (CNSC 2018). Soil is the main medium from which COPC may partition into groundwater and surface water (CCME 2016b). The Project may affect the surficial soil (<0.3 m) through several pathways described in Appendix C. Soil quality may be affected by excavation and construction activities, air deposition, and water (spills, runoff, leachate) and then transferred to other media such as plant tissue and subsequently up the food chain. Heterogeneous bedrock (consolidated or unconsolidated) may affect COPC distribution, especially in fractured areas (CCME 2016b).

The soil component of the EMBP includes assessing soil at the ground surface. This component is an essential part of the EMBP because the Project would include buildings and roads constructed at the land surface, excavation of near surface soil and rock for buildings and hoist footings, and shafts, all of which will affect soil and rock at the surface above the depth of the DGR. Surface soil (<0.3 m bgs) sampling is part of the EMBP; however, the deeper soils and shallow bedrock (0.3 m bgs to 100 m bgs) components are being handled by a separate group with the NWMO, and a detailed design is not included in this report.

The baseline level of radioactivity of surficial soils will be collected through an above-ground gamma survey. The gamma radiation survey will cover a pre-defined area meant to encompass the facility and excavated rock management area footprints within the SSA. The final survey boundaries will be defined in consultation with NWMO.

The purpose of the soil component of the EMBP is to determine the existing conditions within the SSA, LSA_{SOIL}, and RSA_{SOIL} within three years in order to assess the potential for impacts and feasibility of the design and construction of the Project.

8.1.2 Data End Use

The data collected under the EMBP will provide a comprehensive description of soil in the area, and the variations within each type, prior to the implementation of the Project phases. This will allow for COPC concentrations from future monitoring initiatives to be compared directly to the COPC concentrations that were formerly present in the area, in order to determine the degree of change or whether any guideline or regulatory limits are exceeded. The end uses for soil chemistry and other data include the following:

- Establish surficial soil quality to determine if there are COPC that are naturally elevated compared to either guidelines or regional data.
- Assess spatial and temporal variability as part of the EMBP, as recommended by the CNSC, Health Canada, ECCC, MECP, and international organizations such as the IAIA.
- Assess the current conditions relative to standards and limit values for COPC.
- Determine surficial soil quality/health in relation to plant growth, to serve as a baseline for an evaluation of loss of soil quality during construction and operation.
- Detect naturally occurring reactive minerals present in the surficial soil that may serve as COPC sources after being disturbed through excavation and construction activities.
- Achieve the statistical objectives of the baseline sampling program, as derived during the program execution (i.e., with consideration to the observed degree of change, and accounting for sampling frequency and quantity).
- Acquire the necessary data to use in modelling to predict and assess Project impacts in the IA, including the cumulative effects assessment.
- Support modelling in safety assessment through the development of site-specific concentration ratios.
- Provide ongoing and reliable information to aid in the determination of changes to soil quality over time.
- Share information with the community about soil quality, if needed.

8.1.2.1 Evaluation Criteria

The sample design includes specific SCs, COPC, and sampling locations that address the potential for various Project interactions and cumulative effects assessments. The sample design will be modified for future iterations of the sampling program as needed as more data are obtained, more detailed Project plans are formulated, and decisions on evaluation criteria are determined to ensure data quality objectives are being met. The evaluation criteria include utilizing federal and provincial guidelines and criteria established by the NWMO to assess if COPC concentrations are naturally elevated or are potentially elevated due to past or current activity in the area. These criteria are discussed in Section 3.5.

8.2 Data Collection, Management, and Analysis

8.2.1 Sampling Details

The experimental design is a stratified random sampling program with proportional allocation to strata. Physical compositing of samples at each selected location will take place to reduce the effects of micro-scale variability that is of little interest in assessing potential Project-related effects. Sampling details for soil are described in the sections below.

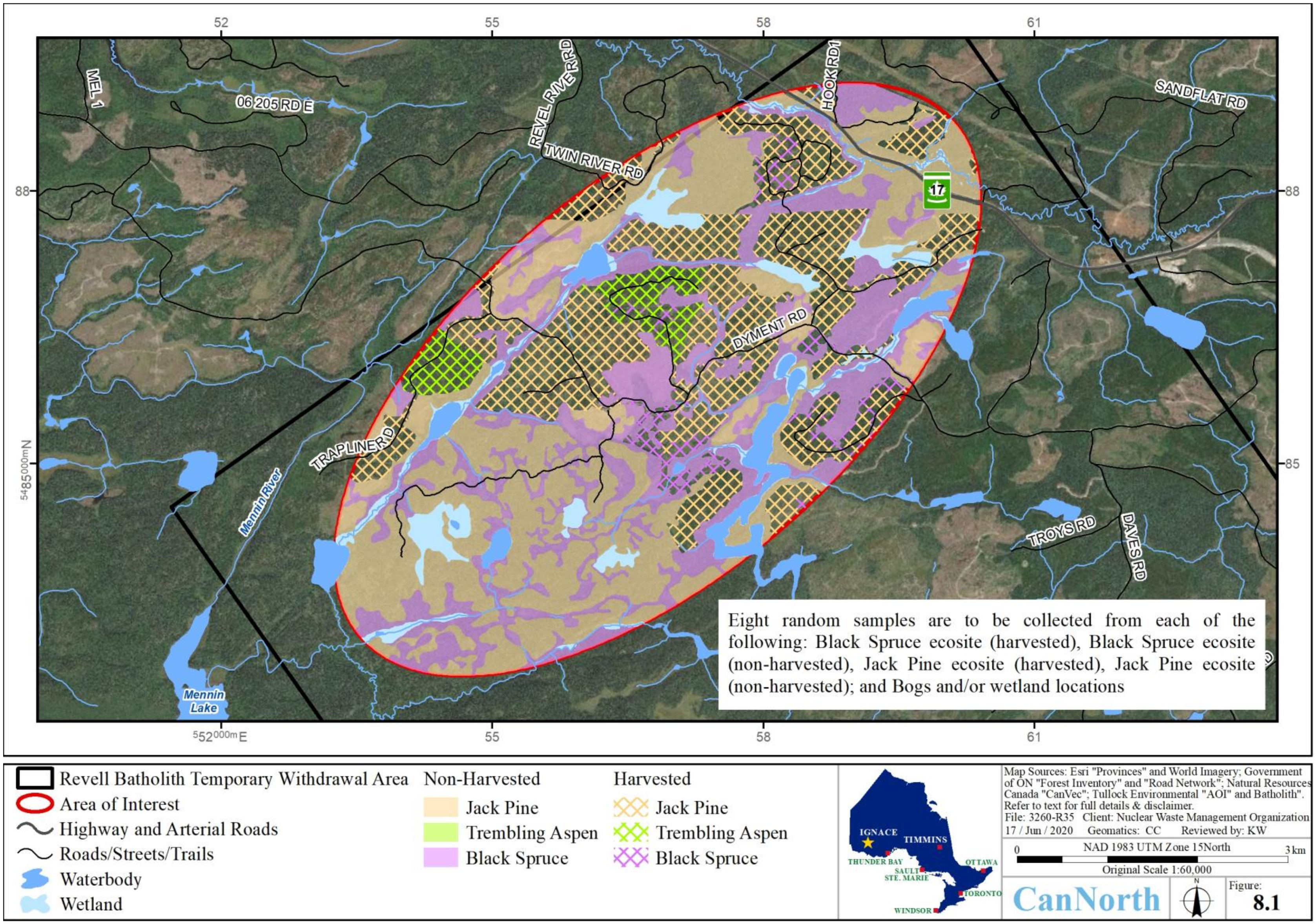
Another component that will be included in the EMBP is an above-ground gamma radiation survey that has the purpose of assessing background radiation levels in the area to support future impact and risk assessments. The sample design overview for the environmental gamma survey component is detailed below.

In addition to standard field and laboratory sampling methods, soil eDNA will be conducted in conjunction with the benthic invertebrate monitoring program, in order to complement the terrestrial environment BIS eDNA program that focusses on larger vertebrate species. The sample design for eDNA sampling of soil is detailed below.

8.2.1.1 Soil

Due to site conditions including a minimal level of rock weathering, the primary source of soil with the potential to be impacted by the Project is assumed to be surficial material collected from 0 m bgs to 0.15 m bgs. To capture the diversity of soil types in the Project area, soil sampling will be conducted on the basis of “ecosites,” ecologically distinct zones that are defined by vegetation, soil, and forest productivity information. An “ecosite” as defined by the MNRF divides wetlands from upland areas, maps the boundaries of habitat types, and provides reasonable approximations of the vegetation and soil conditions that can be anticipated in each space. Additionally, harvested and non-harvested areas within each ecosite will be considered separately for soil sampling, as harvesting may affect soil quality (see Figure 8.1).

Figure 8.1 Guidance for selecting soil sampling locations



8.2.1.1.1 Study Areas and Sampling Locations

The study areas for the soil sampling component of the EMBP will include the following:

- Local Study Area (LSA_{SOIL}) – surrounding areas that may be impacted by the facility within the SSA (i.e., through runoff, dewatering activities, etc.) and support services (roads) leading to the facility.
- Regional Study Area (RSA_{SOIL}) – areas beyond the LSA_{SOIL} associated with support services and which may be affected by soil carried by prevailing winds.

The gamma radiation survey will cover a pre-defined area meant to encompass the footprint of the facility and excavated rock management area. This area will be defined as the SSA for the gamma survey component of the baseline study. However, the location of the Project footprint in the AOI is currently unknown; therefore, the final survey boundaries will be defined in consultation with NWMO, and it is recommended that the survey occur when these Project details are known. Depending upon the size of the survey area, the total survey area may be sub-divided into survey units, which will be surveyed and reported separately.

Distinct ecosites have been identified within the LSA_{SOIL} (Tulloch 2018b). Surficial soil quality will be evaluated by collecting representative suites of samples from the harvested and the non-harvested portions of each ecosite. Wetland locations, bogs, and peat-rich areas will be grouped together as one ecosite.

Sampling areas will be ecosite-specific and may include multiple locations in the LSA_{SOIL} and RSA_{SOIL} depending on the distribution and level of harvesting of the ecosite in question. In addition to providing valuable information to the stakeholders and rights-holders, analytical results obtained through analysis of samples collected in the RSA_{SOIL} study area will serve as regional data for comparison to data collected within the LSA_{SOIL}.

8.2.1.1.2 Study Components

The SCs selected for the soil quality parameters component are routine for mining IAs, and are recommended in guidance documents (MEND 2001, 2009; CCME 2016b), including the CNSC (2018) “Guidance on Deep Geological Repository Site Characterization”. The SCs are detailed in Appendix C and include:

- Natural soil quality;

- Geochemical properties of soil;
- Natural background gamma signature of surficial soil; and
- Potential risk of metal leaching from soil to the environment.

8.2.1.1.3 Contaminants of Potential Concern

The COPC for soil quality analysis are listed in Appendix E and will include the following parameters:

- Total metals (major and trace elements)
- General chemistry, ions, and nutrients
- Organics and volatiles
- Background gamma signature
- Tier 1 and Tier 2 radionuclides
- Glyphosate

Glyphosate analyses have been included because they have not been previously carried out and will aid in addressing stakeholder and rights-holder concerns and cumulative effects assessments. All samples will be analyzed for Tier 1 radionuclides, which may be present at background levels in soil as well as the natural Tier 2 radionuclides. Only 10% of total soil samples will be analyzed for Tier 2 artificial radionuclides. A detailed of the list of radionuclides is provided in Appendix D.

Characterization of dissolved organic carbon (DOC) to determine its reactivity (quality, composition, source, and importance in an ecosystem) will be included. Organic carbon quality results will provide insight into the baseline characteristics of organic matter, particularly in the wetland environments, that will be useful for comparison during future monitoring efforts (Höll et al. 2009).

After total metals analyses are reported, a subset of soil samples will be submitted for leachability testing using standard shake-flask extraction methods (Appendix E). A smaller subset of samples will be submitted for sequential extraction procedures (e.g., the Tessier 6-step procedure) to determine the speciation of trace metals (Tessier et al. 1979). Sequential “selective” extraction methods, or Selective Extraction Procedure (SEP), mimic the release of selective metals into solution under various environmental conditions. The purpose of leachability and SEP analyses will be to capture the potential risk of metal leaching from soil to the environment. The basis of SEP is to expose a solid sample to a sequence of solution reagents that are selected to remove or dissolve a solid fraction of the sample that the COPC is associated with.

At each step of the extraction procedure, the reagents dissolve the solid fraction of the sample more aggressively, progressively releasing COPC into solution. The results of SEP relate the analysis of the leachate to a chemical phase (e.g., metal oxides, carbonates) or form (e.g., soluble, exchangeable, sorbed). Through this method, the baseline behavior of the COPC in the environment can be determined, and its behavior in response to changes to the environment (e.g., pH, Eh) can be predicted.

8.2.1.1.4 Sample Size and Frequency

Soil sampling in Year 1 will be conducted in the LSA_{SOIL} (40 samples total) and RSA_{SOIL} (10 samples total). Additional samples (maximum of 5) may be collected in Year 2 in case of a need for more data and additional analyses. Samples should be properly preserved and sufficiently large in volume for sodium adsorption ratio analysis. Eight samples are to be collected from each of the following ecosites within the LSA (Figure 8.1):

- Black Spruce ecosite (harvested)
- Black Spruce ecosite (non-harvested)
- Jack Pine ecosite (harvested)
- Jack Pine ecosite (non-harvested)
- Bogs and/or wetland locations

Each of the eight samples will be a composite consisting of eight sub-samples.

The gamma survey will be completed one time and as discussed above, it is recommended that it occur at a time when the footprint of the facility and excavated rock management area is well defined. This survey will require the development of work instructions and labour and equipment for an area of approximately 70 ha, as well as data mapping.

8.2.1.1.5 Sampling Methods

A SOP and data field sheet for the soil program are provided in Appendix J. Soil sampling will be conducted in accordance with CCME (2016b). Soil samples will be collected from the top 15 cm from relatively undisturbed areas with the top layer of litter removed. Soil samples will be discrete (e.g., split-spoon soil sampler) to minimize cross-contamination (CCME 2016b).

Physical descriptions of soils will be noted during sampling, including visual classification, grain size estimation, *in-situ* moisture content, color, and soil type. Soil classification will follow the Canadian System of Soil Classification (Soil Classification Working Group 1998).

Field parameters will be collected for each soil sample, including pH, moisture content, and the content of water-soluble nutrients such as ammonia, nitrate, and phosphate. The latter can be conducted using colorimetric methods available through commercial test kits (e.g., Hach Kits [Hach North America]).

Environmental gamma radiation data will be collected through roving transects using GPS integrated gamma radiation surveying equipment either by foot or by ATV (depending on the site terrain and access issues). Gamma radiation measurements will be taken at approximately 1 m above the ground surface. If the terrain is difficult to navigate due to growth or wetlands, which would represent a health and safety risk to the ground crews, or if there are areas where sensitive species are present, then consideration could be given to a drone-based survey. The method is still to be determined and this survey is planned for Year 3 of the EMBP; thus, an SOP and data sheet are not provided in Appendix J. For the purpose of the cost estimate, it is assumed that a traditional ground survey is appropriate.

8.2.1.1.6 QA/QC for Sample Collection

Specific QA/QC to be employed during the soil quality field sampling program are detailed in the SOP provided in Appendix J. The following set of QA/QC samples will be collected during each sampling trip to ensure sample quality:

- One rinseate blank will be used per sampling day to check contamination of the sampling device from any sources of field contamination. A rinseate blank is collected by pouring deionized water supplied by the laboratory over the soil sampling device (e.g., stainless steel trowel) and submitting the resulting water sample for analysis. Rinseate blanks will be submitted for the same analyses as the soil samples, and analysis methods for blanks must follow standard laboratory protocol.
- One trip blank will be used per sampling day to check contamination of sample jars from sources of VOCs (e.g. gasoline-fueled vehicles) during sampling and cooler transport. The trip blank sample is transported to and from the field without modification and is only opened at the time of laboratory analysis.

- One field duplicate sample will be taken per 20 of the soil samples to ensure that sampling and laboratory analyses produce repeatable results (precision test); details on the number of samples and COPC are provided in Appendix E.

Soil samples will be submitted to a laboratory selected by the NWMO that is certified and accredited by CALA. As such, the laboratory will adhere to strict QA/QC standards and protocols and will conduct internal QA/QC measures, such as method blanks, reference materials, laboratory duplicates, and spiked samples.

8.2.1.2 Samples for eDNA

The use of eDNA for identifying species presence/absence in the environment is detailed in Section 6.2.1.8. For the purpose of the soil component of the EMBP, eDNA refers to any genetic material that is deposited to the environment from vertebrate organisms. Analyzing eDNA of vertebrate organisms from soil samples will be used to survey taxonomic richness and structural diversity, as an indication of soil health. As discussed in Section 6.2.1.8, the shift to eDNA-based biomonitoring eliminates the need to physically observe, isolate, and identify individual specimens. The soil eDNA program will complement the terrestrial environment eDNA program being planned as part of the BIS that will focus on larger vertebrate species.

For the EMBP, samples will be collected and submitted for eDNA metabarcoding to determine species presence/absence. Although soil samples will not be collected, identified, and enumerated using traditional taxonomic survey methods, the soil samples submitted for Sanger sequence analyses will assist in building the barcode reference sequence library. This phase of library construction involves putting the provenance data (what it is, who identified it, when/where it was collected, digital images of the voucher) into the BOLD and then adding the genetic barcode for each specimen. This approach will ensure reference libraries are comprehensive and will provide method validation and assurance that eDNA metabarcoding of the samples is capable of detecting all organisms present in the study area.

Again, Dr. Robert Hanner from the University of Guelph has been retained to provide expertise on eDNA analyses, to provide support and training to the selected consultant for field collections and sample transfer, and to conduct the eDNA analyses in the laboratory. All sample collections for the eDNA analyses will occur during Year 1 sampling. Dr. Hanner's lab will provide a technician that will act as a field assistant and will also provide all required field equipment (e.g., filters, DNA extraction kits, etc.). This will ensure proper sterile sample collection and will provide training to the consultant and community members.

Samples submitted for eDNA analysis should be collected in accordance with CCME (2016b). In addition, the following methods will apply:

- Soil cores will be collected in the field with a coring sampler that is cleaned between each plot by removing any soil remains before a final step at high temperature (flame cleaning).
- Coring will be conducted using wide-neck barrels (15.4 L; Cat. Number: 0789.1; Roth Sochiel E.U.R.L., Lauterbourg, France).
- Each core will be homogenized in a sterile container in the field, then transferred to a sterile plastic Nalgene container.

8.2.2 Stakeholder and Rights-Holder Involvement

The soil monitoring program does not provide as direct an opportunity as other components to ensure continued stakeholder and rights-holder involvement in the EMBP. Soil sampling, gamma surveying, and eDNA sampling are complex efforts that will need to be handled and overseen by licensed and professional geoscientists. However, it is recommended that stakeholders and rights-holders be involved in the sampling program (if desired) as field assistants to the consultant retained to conduct the EMBP. This will provide a training opportunity, capacity building, and temporary employment.

For soil sampling within the RSA_{SOIL}, the intent is that a consultant conduct the first year of sampling alongside stakeholders and rights-holders to establish sample protocols and to enable training. The intent for the regional sampling is that future monitoring could be entirely transferred to stakeholders and rights-holders if desired.

8.3 Class 2 Cost Estimate

Appendix E presents the Class 2 cost estimate (-15% to +20% accuracy) that have been developed for the soil component of the EMBP based on the Cost Estimate Classification System of AACE International (2005). The estimate is based on a number of assumptions that are presented in Appendix E, including professional fees, travel and accommodation costs, equipment disbursements for larger items, and laboratory analyses costs. It was assumed that study areas will be accessible without the requirement to build new roads.

9.0 DATA ASSESSMENT AND REPORTING

The Class 2 cost estimate provided in Appendix E includes the expectation that the consultant hired to do the EMBP data collections will produce an annual data QA/QC and field report. The field and data report will include documenting deviations from study design, detailed field methods, waypoints and maps illustrating sampling locations, field observations (e.g., weather, land use, etc.), photographs, field data (e.g., sediment core logs), laboratory methods, QA/QC of laboratory and field data, and raw data tables.

Our Study Team is responsible for completing annual reviews as well as a comprehensive three-year review of the EMBP design. It is critical that the data collected for the EMBP undergo quality checks and analysis to ensure that it represents a solid foundation, achieves data objectives, and fulfills data use needs. Reviews of the EMBP will predominantly involve evaluating sample design components to ensure that assumptions are still valid, that data collections meet statistical rigour, model input, cumulative effects assessment and IA needs, and that all facets of the QA/QC program meet data quality objectives.

In the absence of existing site characterization data and Project details, Year 1 of the EMBP is broad reaching; however, the program will be continually optimized as data are collected and Project plans evolve. The program will also be further refined based on information collected as part of the BIS, the Traditional Foods Dietary Survey, and any additional input or IK received from stakeholders and rights-holders.

This report section outlines methods for completing QA/QC of the EMBP data collections, provides recommendations for design and implementation of an Information Management System (IMS), and discusses the scope of the annual and three-year reviews.

9.1 Quality Assessment/Quality Control of Data

The QA/QC requirements specific to sample collection have been discussed throughout the report for each component of the EMBP. This section pertains to QA/QC for data handling and management (refer to Section 9.2) and data analyses of the QA/QC samples. The consultant should undertake data QA/QC analysis, which is expected to include the following components:

- Monitoring continuous instrument data to ensure a quick response for instrumentation issues or failures;
- Reviewing calibration records for any *in situ* instrument measures;

- Reviewing chemistry lab reports to:
    - Ensure labs are certified and the appropriate analysis methods are utilized in accordance with the request outlined in the COC;
    - Ensure desired Reportable Detection Limits (RDLs) were achieved with the sample weights obtained and are acceptable;
    - Assess laboratory QA/QC processes including duplicate, blank, and spike sample tests and compare these data against established data quality objectives;
    - Identify any qualifying observations made by the laboratory technicians that may impact the interpretation of results;
- Reviewing taxonomic data to ensure precision, sorting efficiency, and sub-sampling accuracy meet data quality objectives and that representative specimens have been retained for reference collection;
- Validating data entries for calculations or computer programs; and
- Reviewing overall datasets for anomalies or outliers.

For chemistry components, the use of sampling blanks and duplicates will strengthen the quality of the dataset and to test precision of the results. Data analyses will include calculating the relative percent difference (RPD) between the test sample and the duplicate sample and then comparing the RPD to a set Data Quality Objective (DQO). The DQO applied varies per media type depending on the heterogeneity of the matrix. For example, surface water is more homogeneous than sediment or soil and should, therefore, have a lower DQO. The intent of applying a DQO is to facilitate an initial data screening process, which determines whether the results are acceptable or require further investigation. Other factors, such as laboratory precision for measuring each parameter and the proximity of the value to the RDL, also need to be considered. It is estimated that at concentrations near the RDL, measurement uncertainty is very high, often approaching 100% at concentrations within five times the RDL. Therefore, RPDs that exceed DQOs should only be considered a potential issue if the test and duplicate results are greater than five times the RDL, outside the range of laboratory precision, and outside of instrument accuracy. If these criteria are not met, then the laboratory needs to be contacted to request follow-up and potential re-analyses.

COPC concentrations in field and trip blank samples will be assessed against the RDLs. These blank samples should be at or below the RDLs as they are composed of deionized water. There are some exceptions, such as pH in surface water, because deionized water can absorb carbon dioxide and thereby affect pH in the blank samples. If COPC concentrations are greater than five times the RDL in the field and trip blank samples, they require further investigation.

An analysis of the data for outliers will also be completed, including a review for spatial and temporal trends. Some data components, such as surface hydrology, air, and noise, will also be checked against meteorological data to evaluate for potential anomalies or trends. Anomalous values should be verified, and follow-up should be completed with the laboratory and potential stakeholders and rights-holders. Any IK or other input from local community members could help explain anomalies related to a local event.

9.2 Data Management

The EMBP was designed with consideration of data collection, storage, and management. Stakeholders and rights-holders have indicated a desire for open access to the data collected as part of the EMBP. Although components of an IMS are reviewed below, the detailed design and implementation is outside the scope of this work.

9.2.1 Overview of an Information Management System

Fundamental and modern information management practices are paramount to facilitate complete and accurate data collection and subsequent reporting efforts. The guidance in this section is relevant for all activities performed as part of the EMBP that will generate information, including:

- Sample planning such as Sample ID nomenclature generation or pre-generation;
- Sample and data collection, including COC generation;
- Analytical data receipt and compilation; and
- QA/QC, validation, and reporting.

An IMS should be used by the consultant that is contracted to carry out the EMBP data collections to facilitate the execution of the program. The IMS is the collective term for the software, tools, and methodologies designed to facilitate the generation, organization, storage, and retrieval of all applicable information. Information in this context is generally digital data, but may also include documents (e.g., boring logs, handwritten field notes, historic reports/figures, etc.).

The implementation of a well-designed IMS that utilizes digital technology has the following benefits:

- There exists a 'single source of truth' for any piece of analytical information (i.e., field data), as each piece of data only exists in a single place, with applicable metadata.
- It eliminates transcription errors by using digital data collection technology and workflows.
- It ensures high quality data throughout the project lifecycle by using modern data management practices, tools, and methodologies.
- It ensures timely and ongoing access to other data generated by multiple parties.

9.2.1.1 Data Management Plan

The Data Management Plan (DMP) is a document that outlines specifics on the IMS and data collection workflows. It is recommended that a DMP be prepared by the consultant doing the data collection and that it be provided to the NWMO for approval before the EMBP is initiated. Details on the design and implementation of the system can be modified over time as technology and/or the program evolves. Updates or revisions to the DMP should be provided for approval prior to implementing any changes in data collection or data processing workflows.

9.2.1.2 Field Collection Tools

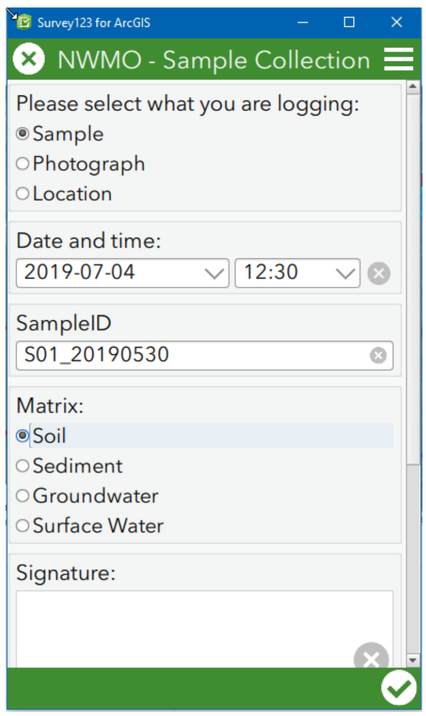
Some field data will be generated through instruments/sensor data, and these data would remain digital and should be collected in a non-proprietary, ASCII format, when possible. Sensor data can be transferred to a database via a live-link telemetry system or through manual exports with a data logger as appropriate.

It is recommended that digital datasheets be developed for use in the field for the applicable media. Draft datasheets were developed by our Study Team and are provided in Appendix J. High level SOPs are also provided; however, the consultant will be required to develop detailed SOPs for sampling that are specific to the equipment to be used, which also may also cause some modifications to the datasheets.

Digital forms could be custom-built using a combination of mapping input tools, drop-down boxes, radio buttons, and pre-populated textboxes to minimize the burden on busy field staff and limit the potential for data transcription errors. Figure 9.1 provides an illustration of a potential data collection screen. Data would be geotagged and timestamped automatically, which maximizes the value of the collected data for subsequent usage.

Consideration can be given to additional fields that may be an asset for community members collecting samples and that would allow for the maximum amount of information to be gathered. This could include adding pictures or a recording function to allow oral notes. This type of information may be useful when reviewing the information to be able to interweave Western science and IK. In addition, training modules or videos could be developed to train users on sample collection methods, to provide reminders of key steps at the time of sampling, and to provide information on accessing and viewing the data.

Figure 9.1 Example of digital field collection input on a tablet or cell phone



9.2.1.3 Data Handling and Storage

It is recommended that all digital data generated for the EMBP be stored in a database (or equivalent) that is approved or managed by the NWMO. The information must be adequately backed up and secure.

Cell service or telemetry should be used for the continuous monitors (e.g., water level, air quality, noise, and meteorology) to ensure a quick response to receiving data and understanding when there may be issues with the instrumentation.

It is recommended that automated workflows be used to push data into and out of the database. The goal of this is to eliminate delays and possible transcription errors surrounding manual processing of data generated or collected in the field, while keeping costs low. It is also recommended that laboratory data be provided in a format that can be directly imported into the database. However, prior to final database storage, data collected in the field and provided by the laboratory needs to be checked for completeness and accuracy following the QA/QC procedures outlined above (Section 9.1).

The consultant should submit the data on a regular and frequent basis to the NWMO in an approved format so that data access is maintained by the NWMO throughout the program.

9.2.1.4 Data Visualization

If the NWMO decides to make some of these data available to stakeholders, rights-holders, or the public in general, a separate web portal and database should be established to share the subset of data, with the consideration that IK owned by the community who provides it may have certain varying degrees of confidentiality restrictions applied to them. The data could be visualized using spatial plots, charts, tables and other tools, while keeping in mind the non-technical audiences and possible vision impairments (e.g. color blindness) or language differences. The publicly available data could include custom-built interactive web mapping application. Data from the continuous analyzers can be continuously provided to the web interface for viewing of the most recent data (while the data continues to be logged at the station). The remainder of data would be made available through periodic updates to the web interface. Custom reporting and data access tools may include:

- On-demand data filtering (i.e., see all data from a given location/period-of-time/component);
- Temporal trends (i.e., stream flow measurements, COPC concentrations over time);
- Spatial trends (i.e., COPC results from various locations);
- Direct links to PDF reports; and
- Other tools identified during workshops with NWMO and stakeholders and rights-holders.

Summaries of information can be provided to the public via newsletter (i.e., users can sign up for e-mail notifications) or other means (e.g., social media).

9.3 Program Reviews

Annual reviews and a comprehensive three-year review of the EMBP will be conducted to ensure the program is meeting the data objectives, to identify data gaps/redundancies, to review updates to Project design and assumptions and determine how these may alter the sample design, and to evaluate potential for cumulative effects. More specifically, the reviews will include the following:

- Determining whether there have been any significant changes to the Project design or assumptions listed in the CSM (Appendix C) that would affect the potential Project-environment interactions (e.g., Project footprint, effluent release locations, etc.).
- Confirming that the guidelines and benchmarks used in the program (see Section 3.5) are still valid.
- Identifying any policy changes that need to be addressed (e.g., changes to the IA process).
- Reviewing available information from other relevant programs, particularly the BIS and a Traditional Foods Dietary Survey, to integrate new information.
- Reviewing the EMBP data and analyses to determine whether:
  - All planned samples were collected and, if not, determine the cause and establish whether to try again or if a change is required;
  - All QA/QC checks were completed and accepted;
  - Adequate COPC RDLs were achieved; and
- Conducting a statistical review of the data to aid in establishing variances, data objectives, CES, and sample size requirements for subsequent years.
- Reviewing and identifying data gaps/redundancies.
- Review the list of COPC considering any project design changes and the data gathered. For example, the need to include the Tier 2 artifical radionuclides can be re-evaluated, particularly if levels are below laboratory detection limits.
- As additional understanding of the environment and project evolves, examining whether information should be collected to inform modelling and impact assessment (e.g. radon-222 as a tracer for studying groundwater and surface water interactions).
- Evaluating data to determine if a location that is considered reference is already impacted by another source (e.g., forestry), as this may require re-location of reference stations.

- Evaluating data for potential cumulative effects identified in the study area.
- Reviewing comments/concerns/suggestions provided by the NWMO, ERG, academic advisors, and particularly stakeholders and rights-holders.

Once these steps have been completed, the EMBP will be reviewed to determine whether any modifications are required to the sample design (e.g., revisions to sampling locations, additional samples of SCs, COPC, etc.).

10.0 MAP SOURCES AND DISCLAIMERS

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APPENDICES

APPENDIX A

LOG OF CONSULTED REPORTS

APPENDIX A

Log of completed, ongoing, and future studies.

Author	Title	Date	APM Report Number	Type of Evaluation	Relevant Component(s) of the Baseline Program						
					General Knowledge	Stakeholder/ Rights-Holder Input	Tissues	Surface Water Parameters	Shallow Groundwater	Soil	Air Quality, Noise, and Light
PHASE 1 REPORTS											
SENES Consultants	Phase 1 Preliminary Community Well-Being Assessment – Township of Ignace, Ontario	October 2013	REP-06144-0016	Desktop	X	X					
Golder Associates	Phase 1 Desktop Assessment, Environment Report – Township of Ignace, Ontario	November 2013	REP-06144-0010	Desktop	X			X	X		X
Golder Associates	Phase 1 Desktop Geoscientific Preliminary Assessment of Potential Suitability for Siting a Deep Geological Repository for Canada's Used Nuclear Fuel – Township of Ignace,	November 2013	REP-06144-0011	Desktop	X			X	X		
JD Mollard and Associates Limited	Phase 1 Geoscientific Desktop Preliminary Assessment, Lineament Interpretation – Township of Ignace, Ontario	November 2013	REP-06144-0014	Desktop					X		
Paterson, Grant & Watson Limited	Phase 1 Geoscientific Desktop Preliminary Assessment, Processing and Interpretation of Geophysical Data – Township of Ignace, Ontario	November 2013	REP-06144-0013	Desktop					X		
JD Mollard and Associates Limited	Phase 1 Geoscientific Desktop Preliminary Assessment, Terrain and Remote Sensing Study – Township of Ignace, Ontario	November 2013	REP-06144-0012	Desktop				X	X		
Nuclear Waste Management Organization	Phase 1 Preliminary Assessments, Summary Findings and Decisions	November 2013	N/A	Desktop	X	X					
PHASE 2 REPORTS											
Tulloch Engineering Inc.	Adaptive Phase Management - Phase 2 Environmental Work, Technical Memorandum 1, Ignace, ON, Version 3.2	February 2018	N/A	Desktop and field	X		X	X	X	X	
Tulloch Engineering Inc.	Phase 2 Preliminary Environmental Studies – Township of Ignace and Area, Ontario	May 2018	REP-07000-0206	Desktop and field			X	X			
Tulloch Engineering Inc.	Adaptive Phase Management - Phase 2 Environmental Work, Technical Memorandum 3, Ignace, ON, Version 2.1	May 2018	REP-07000-0206	Field			X	X	X	X	
Tulloch Engineering Inc.	NWMO Ignace APM Phase II - Environmental Studies Revell Area, 2016 to 2018	July 2018	N/A	Field	X		X	X	X	X	
Golder Associates	Phase 2 Initial Borehole Drilling and Testing, Ignace Area. WP1 Data Report - Completion of Demobilization and Post-construction Activities for /IG_BH01	November 2018	REP-01332-0228	Field						X	
Golder Associates	Phase 2 Initial Borehole Drilling and Testing, Ignace Area. WP2 Data Report - Borehole Drilling and Coring for IG_BH0l.	December 2018	REP-01332-0229	Field					X		
Golder Associates	Phase 2 Initial Borehole Drilling and Testing, Ignace Area. WP3 Data Report - Geological and Geotechnical Core Logging, Photography and Sampling for IG_BH01.	December 2018	REP-01332-0230	Field					X		
Golder Associates	Phase 2 Initial Borehole Drilling and Testing, Ignace Area. WP4b Data Report - Geomechanical Testing of Core for IG_BH01.	December 2018	REP-01332-0232	Field					X		
Golder Associates	Phase 2 Initial Borehole Drilling and Testing, Ignace Area. WP7 Data Report - Opportunistic Groundwater Sampling for IG_BH01.	December 2018	REP-01332-0236	Field					X		
Golder Associates	Phase 2 Initial Borehole Drilling and Testing, Ignace Area. WP5 Data Report - Geophysical Well Logging for IG_BH01	January 2019	REP-01332-0234	Field					X		

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Author	Title	Date	APM Report Number	Type of Evaluation	Relevant Component(s) of the Baseline Program						
					General Knowledge	Stakeholder/ Rights-Holder Input	Tissues	Surface Water Parameters	Shallow Groundwater	Soil	Air Quality, Noise, and Light
Tulloch Engineering Inc.	Phase 2: Preliminary Environmental Studies, Township of Ignace, Ontario: 2018 Surface Water, Sediment and Soil Quality Monitoring Report, Version 0.1 Draft	February 2019	N/A	Desktop and field				X		X	
Tulloch Engineering Inc.	Map of specific area of interest	March 2019	N/A	Desktop	X			X	X	X	
Tulloch Engineering Inc.	Phase 2: Preliminary Environmental Studies, Township of Ignace, Ontario: Memorandum of 2018 Environmental Field Investigation Methods and Results, Version 1.0	October 2019	N/A	Desktop and field			X	X	X	X	
MISCELLANEOUS REPORTS											
B. D. Amiro	Baseline Concentrations of Nuclear Fuel Waste Nuclides in the Environment	April 1992	N/A	Desktop	X		X	X		X	X
Ontario Hydro Nuclear	Radiological Pathways Analysis for Chromic Emissions for the Used Fuel Disposal Concept. Support Document A-2, To the Preclosure Environmental and Safety Assessment	December 1993	N/A	Desktop	X			X		X	X
Ontario Hydro Nuclear	Derivation of the Source Term for Chronic Radioactive Emissions from the Used Fuel Disposal Centre During the Preclosure Phase	December 1993	N/A	Desktop	X			X			X
Ontario Hydro Nuclear	The Disposal of Canada's Nuclear Fuel Waste: Preclosure Assessment of a Conceptual System	June 1994	N/A	Desktop	X						
United States Department of Energy	DOE Handbook, Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities, Volume I - Analysis of Experimental Data	December 1994	N/A	Desktop							X
West Kitikmeot Slave Study Society	West Kitikmeot Slave Study - Final report	March 2001	N/A	Desktop		X	X	X			
CTECH Radioactive Material Management	Conceptual Design for a Deep Geologic Repository for Used Nuclear Fuel	December 2002	N/A	Desktop	X						
SENES Consultants	West Kitikmeot Slave Study State of Knowledge Report - 2007 Update	April 2008	N/A	Desktop		X	X	X	X	X	
Nuclear Waste Management Organization	Moving Forward Together: Process for Selecting a Site for Canada's Deep Geological Repository for Used Nuclear Fuel	May 2010	N/A	Desktop	X						
Erik Mårtensson, Lars-Göran Gustafsson, DHI Sverige AB	Hydrological and Hydrogeological Effects of an Open Repository in Forsmark - Final MIKE SHE Flow Modelling Results for the Environmental Impact Assessment	July 2010	N/A	Desktop				X	X		
Lucien Nel	Conventional Safety Assessment of a Used Fuel Repository	September 2010	TM-03620-T10	Desktop	X						
EcoAnalytica	The Terrestrial Ecosystems at Forsmark and Laxemar-Simpevarp - SR-Site Biosphere	December 2010	N/A	Desktop			X				
SENES Consultants	APM Site Boundary Assessment	January 2012	TM-03630-T07	Desktop	X			X			X
ECOMatters Inc.	Field Measurements of the Transfer Factors for Iodine and Other Trace Elements (NWMO TR-2009-35)	November 2012	N/A	Field			X	X		X	
SENES Consultants	Draft Community Profile – Township of Ignace, Ontario	July 2013	REP-06144-0015	Desktop	X						
Nagra	Technischer Bericht 13-01, Standortunabhängige Betrachtungen zur Sicherheit und zum Schutz des Grundwassers	August 2013	N/A	Desktop	X				X		
Nuclear Waste Management Organization	Preliminary Assessment for Siting a Deep Geological Repository for Canada's Used Nuclear Fuel, Findings from Phase One Studies – The Corporation of the Township of Ignace, Ontario	November 2013	REP-06144-0009	Desktop	X		X	X	X	X	X
Nuclear Waste Partnership LLC (U.S. DOE)	Waste Isolation Pilot Plant Documented Safety Analysis	November 2013	N/A	Desktop	X						
IJC	International Lake of the Woods Basin Water Quality Plan of Study, Covering the Rainy-Lake of the Woods Watershed - Final Report	November 2014	N/A	Desktop		X		X	X		

APPENDIX A

Log of completed, ongoing, and future studies.

Author	Title	Date	APM Report Number	Type of Evaluation	Relevant Component(s) of the Baseline Program						
					General Knowledge	**Stakeholder/ Rights-Holder Input**	**Tissues**	**Surface Water Parameters**	**Shallow Groundwater**	**Soil**	**Air Quality, Noise, and Light**
Nuclear Waste Management Organization	Description of a Deep Geological Repository and Centre of Expertise for Canada's Used Nuclear Fuel	2015	N/A	Desktop	X						
MNRF	Steep Rock Mine Conceptual Rehabilitation Approaches	February 2016	N/A	Desktop	X			X		X	
Nuclear Waste Management Organization	Deep Geological Repository Conceptual Design Report Crystalline / Sedimentary Rock Environment	May 2016	APM-REP-00440-0015 R001	Desktop	X						
Nuclear Waste Management Organization	Sixth Case Study: Reference Data and Codes (NWMO-TR-2016-10)	December 2016	N/A	Desktop			X	X	X	X	X
Nuclear Waste Management Organization	Technical Report: Engagement Activities, 2014 to 2016	March 2017	N/A	Desktop		X					
Nuclear Waste Management Organization	Borehole Drilling: Public and Stakeholder Engagement Report - Ignace and Area	August 2017	N/A	Desktop		X					
Nuclear Waste Management Organization	Post Closure Safety Assessment of a Used Fuel Repository in Crystalline Rock (6th Safety Case Study; NWMO-TR-2017-02)	December 2017	N/A	Desktop	X		X	X	X	X	X
Nuclear Waste Management Organization	Implementing Adaptive Phased Management 2018 to 2022	March 2018	N/A	Desktop	X						
Kelly Liberda & Helen Leung	Preliminary Preclosure Accident Consequence Analysis for the APM Conceptual Design - 18090	March 2018	N/A	Desktop	X						
Canadian Nuclear Safety Commission	Class 1B facilities - Guidance on Deep Geological Repository Site Characterization. Draft. REGDOC-1.2.1	October 2018	N/A	Desktop	X						
Nuclear Waste Management Organization	What we Heard: Implementing Canada's Plan in 2018	December 2018	N/A	Desktop	X						
International Joint Commission	Watershed Board Seeks Public's Views on Spring Water Levels and Aquatic Ecosystem Health Indicators	February 2019	N/A	Desktop		X		X			
Agnico Eagle Mines Limited	Hammond Reef	May 2019 (accessed)	N/A	Desktop and field	X	X	X	X	X	X	X
Ministry of Natural Resources and Forestry	Wabigoon Forest - 130 (effective on 1997/04/01) Final Plan (2019-2029)	May 2019 (accessed)	N/A	Desktop	X						
Grand Council Treaty #3	Our Nation	May 2019 (accessed)	N/A	Desktop		X					
WP (Wataynikaneyap Power)	Phase 1	May 2019 (accessed)	N/A	Desktop	X	X	X	X	X	X	X
Treasury Metals Inc.	Goliath Gold Project - Environmental Impact Statement	May 2019 (accessed)	N/A	Desktop	X	X	X	X	X	X	X
Nuclear Waste Management Organization	What We're Doing	May 2019 (accessed)	N/A	Field		X		X	X	X	
Nuclear Waste Management Organization	MNRF Ignace Borehole Drilling Project Submission - Initial Borehole Drilling in Ignace/Wabigoon	Unknown (no date)	N/A	Desktop and field	X	X			X		
Nuclear Waste Management Organization	Sample List of Project Interactions in Mining	Unknown (no date)	N/A	Desktop	X						
Nuclear Waste Management Organization	Baseline Monitoring Design and Considerations	Unknown (no date)	N/A	Desktop	X		X	X	X		X
British Columbia Ministry of Environment	2016 B.C. Best Practices Methodology for Quantifying Greenhouse Gas Emissions	May 2016	N/A	Desktop							X
DATA FILES											
Nuclear Waste Management Organization	Shape Files	Received March 2019	N/A	Desktop	X				X		
Ministry of Environment, Conservation and Parks	Mercury in fish tissue data for lakes in the study area	Received June 2019	N/A	Field			X	X			
FUTURE STUDIES											
Nuclear Waste Management Organization	Biodiversity Impact Study for the Northwestern Ontario region	This study is currently undergoing design; data collected as part of the Environmental Media Baseline Program will inform the Biodiversity Baseline Program and vice versa during annual reviews of the programs.									

APPENDIX B

STAKEHOLDER AND RIGHTS-HOLDER INPUT

TABLE B.1

Stakeholder and rights-holder input from round 1 workshops

Category and Area of Concern	Specific Concern	Addressed in EMBP[a]?	Rationale	Alternate Resolution/Additional Information Needed
1: ACCESSIBLE, RELIABLE DATA THAT TELLS A LOCAL HOLISTIC STORY				
1F-1: Environmental management specific to our area	1F-1a: Animal behaviour concern	Indirectly	Direct monitoring of wildlife populations and behaviour is outside the scope of the EMBP	Noise component of EMBP will indirectly investigate effects on wildlife; more specific information would need to be obtained through other studies
	1F-1b: Protecting the environment	Indirectly	The EMBP will establish existing environmental conditions in order to provide a reference against which future data can be compared	The sampling locations/boundaries are being selected to capture any areas potentially affected by the Project to ensure they are protected in the long-term
	1F-1c: Aerial survey	Partially	An aerial survey is planned to assess the amount of ice cover on ponds, lakes, and rivers during the winter. Aerial surveys to confirm habitat, species, etc. will be carried out as part of a separate study, the results of which will be used to confirm the wildlife Study Components selected for inclusion in the EMBP.	This work will be paired with the Biodiversity Baseline Program
	1F-1d: Disturbance of wildlife	Indirectly	Direct monitoring of wildlife populations and behaviour is outside the scope of the EMBP	Noise component of EMBP will indirectly investigate effects on wildlife; more specific information would need to be obtained through other studies
	1F-1e: Non-lethal sampling methods	Y	The EMBP uses non-lethal sampling methods where possible	N/A
	1F-1f: Water quality	Y	Surface water quality is a component of the EMBP	N/A
	1F-1g: Sample/study the ecology of land	Partially	Some information on ecology of the land will be obtained in the EMBP (e.g. benthic invertebrate populations)	Separate Biodiversity Baseline Program will be conducted that will provide valuable information on ecology of the land.
	1F-1h: Monitor vegetation	Y	Edible vegetation has been identified as a primary Study Component of the tissue component of the EMBP	N/A
	1F-1i: Monitor wildlife	Partially	The EMBP will evaluate wildlife tissue concentrations, but direct monitoring of wildlife will be addressed as part of a separate study	The EMBP will aim to establish existing environmental conditions; the tissue data collected under the EMBP will be incorporated into the Biodiversity Baseline Program
	1F-1j: Electrofishing	Y	Electrofishing has been identified as a possible sampling method for collecting fish as part of the tissue component of the EMBP	N/A
1F-2: Relevant locations	1F-2a: Where it is happening	Y	Study areas have been set for Year 1 of the program, but may be revised in future years based on data collected and input from stakeholders/rights-holders	N/A
	1F-2b: Relevant Locations	Y	Study areas have been set for Year 1 of the program, but may be revised in future years based on data collected and input from stakeholders/rights-holders	N/A
	1F-2c: Trials in similar environments	For discussion	This does not meet the initial needs of the EMBP	As data are collected, this may be revisited (for future consideration)
1F-3: Test conduction	1F-3a: The equipment is provided	Y	NWMO will ensure people are provided with appropriate tools and equipment	N/A
	1F-3b: Direct funds from company/corporation	Y	NWMO will be fully funding the EMBP, regardless of who is executing it	N/A
	1F-3c: Qualified inspectors	Y	Local training will be provided as required to ensure that all work is being done by qualified people, as per CSA N288 standards; the data collected will be subject to rigorous QA/QC protocols (that will be defined as part of the EMBP design), and will also be reviewed annually by an external consultant to ensure data quality is acceptable and data objectives are being met	N/A
	1F-3d: Proper training	Y	The EMBP has been designed with opportunities for employment and training of local communities	N/A

Category and Area of Concern	Specific Concern	Addressed in EMBP[a]?	Rationale	Alternate Resolution/Additional Information Needed
1F-3: Test conduction (Continued)	1F-3e: Experienced experts/professional	Y	Local training will be provided as required to ensure that all work is being done by qualified people, as per CSA N288 standards	N/A
1F-4: Data transparency	1F-4a: Data/research available to public	Y	The EMBP has been designed with consideration of easy access to the data by any interested party	N/A
	1F-4b: Transparency of info and data	Y	The EMBP has been designed with consideration of easy access to the data by any interested party, and with maximal input from stakeholders/rights-holders	N/A
	1F-4c: Validity (facts, tests, info)	Y	The final EMBP will provide Quality Assurance and Quality Control requirements and methods, and the results will be reviewed annually to ensure they are valid and meeting data quality objectives	N/A
	1F-4d: Decrease in wildlife population reason	Indirectly	The EMBP will evaluate wildlife tissue concentrations, but population studies will be addressed as part of a separate study	The EMBP will aim to establish existing environmental conditions; the tissue data collected under the EMBP will be incorporated into the Biodiversity Baseline Program
	1F-4e: Background info why it's happening	Y	How to account for climate change/overall picture of changing environment is a design goal of the EMBP	The contract for analyzing the data collected under the EMBP will include requirements for backcasting and including historic information where possible; as there is not much information available, any insight or knowledge from community members would be helpful
1G-1: Understanding local impacts	1G-1a: Grass roots: trapping, hunting, harvesting	Y	The EMBP has been designed with the assumption that community members will be willing to donate tissue samples collected during regular hunting, fishing, and harvesting activities	N/A
	1G-1b: Safety and environment	Y	The goal of the EMBP is to establish enough information about the environment to make Project decisions that will protect people and the environment	N/A
	1G-1c: Forestry effects	Y	Although this will not be monitored directly, forestry effects will be captured in the cumulative effects section of the EMBP	N/A
	1G-1d: Responsibility for environmental cleanup if a disaster happens?	Indirectly	The EMBP will provide baseline conditions that can be used for reference for any cleanup.	NWMO has a commitment to the environment, including any cleanup
1G-2: Health of local ecosystem	1G-2a: Abundance and quality of berries	Y	Berries have been identified as a primary Study Component of the tissues component of the EMBP for chemical analysis	The NWMO acknowledges that chemistry is only part of the story; additional information related to abundance would need to be considered as part of a separate study
	1G-2b: Harold's blueberries	Y	If a community members provides the location of Harold's blueberries, or submits samples collected by themselves, then Harold's blueberries can be submitted for chemical analysis	N/A
	1G-2c: Wild mushrooms	Y	Wild mushrooms have been identified as a primary Study Component of the tissues component of the EMBP for chemical analysis	N/A
	1G-2d: Canadian Jays	Partially	Birds in general have been identified as a primary Study Component of the tissue component for the EMBP for chemical analysis of tissues, but exact species is to be determined; population information can be collected as part of the Biodiversity Baseline Program	Chemical analysis of songbirds, such as Canadian Jays, is not recommended as this would require lethal sampling methods. Tissue sampling is considered for the food they eat (e.g. insects), and effects up the food chain can be modelled. Other effects on songbirds and Canadian Jays, such as behaviour and population, would need to be addressed in the separate Biodiversity Program
	1G-2e: Deer health	Partially	The EMBP will evaluate wildlife tissue concentrations, but monitoring of populations and overall health will be addressed as part of a separate study	The EMBP will aim to establish existing environmental conditions; the tissue data collected under the EMBP will be incorporated into the Biodiversity Baseline Program
	1G-2f: Local cancer rates (people/animals)	Partially	The EMBP aims to establish existing environmental conditions; population health effects will be addressed as part of a separate study	The data obtained from the EMBP may be incorporated into separate health and well being studies that will directly address these issues

Category and Area of Concern	Specific Concern	Addressed in EMBP[a]?	Rationale	Alternate Resolution/Additional Information Needed
1G-2: Health of local ecosystem (continued)	1G-2g: Wild Flowers	Y	Vegetation chemistry of key edible or medicinal use plants has been identified as a primary Study Component of the tissues component of the EMBP for chemical analysis	If specific wild flowers are of interest to the community, information would be needed on which ones to sample or samples would need to be provided by community members
	1G-2h: Bird population health	Partially	The EMBP will evaluate wildlife tissue concentrations, but monitoring of populations and overall health will be addressed as part of a separate study	The EMBP will aim to establish existing environmental conditions; the tissue data collected under the EMBP will be incorporated into the Biodiversity Baseline Program
	1G-2i: Moose health	Partially	The EMBP will evaluate wildlife tissue concentrations, but monitoring of populations and overall health will be addressed as part of a separate study	The EMBP will aim to establish existing environmental conditions; the tissue data collected under the EMBP will be incorporated into the Biodiversity Baseline Program
1H-1: Quality Control/Quality Assurance	1H-1a: Peer review of analyses	Partially/for discussion	The ERG will conduct a high level review, but not a detailed analysis	The requirement for detailed analysis can be considered
	1H-1b: Accountability (arms-length monitoring)	Y	The monitoring results will be reviewed annually by qualified personnel to ensure the results are valid and meet data quality objectives	N/A
	1H-1c: Auditing (continuous quality improvement)	Y	The monitoring results will reviewed annually to ensure that data are collected following the prescribed protocols and QA/QC measures are being followed; opportunities for improvement will be identified	N/A
	1H-1d: Metadata (public information)	Y	The EMBP has been designed with consideration of easy access to the data by any interested party	N/A
	1H-1e: Maintenance standards, public information	Y	The data collected will be reviewed; NWMO is currently reviewing their data management practices and requirements, and how to share the data	N/A
	1H-1f: Continuous evaluation and improvement	Y	The EMBP will be reviewed annually and revised as needed	N/A
1H-2: Reliable, valid data through expertise, training, and awareness	1H-2a: Select appropriate indicators to measure	Y	Study Components were selected with consideration of input from stakeholders and rights-holders	N/A
	1H-2b: Valid and reliable data collection	Y	The EMBP provides Quality Assurance and Quality Control requirements and methods, and the results will be reviewed annually to ensure they are valid and meeting data quality objectives	N/A
1H-3: Evolving data collection R/T changing environment	1H-3a: Implementation/training	Y	The EMBP has been designed to identify opportunities for employment and training of local communities	N/A
	1H-3b: Operational control (training, who, competency)	Y	Local training will be provided as required to ensure that all work is being done by qualified people, as per CSA N288 standards	N/A
	1H-3c: Adaptive - changes as needed	Y	An adaptive framework is important. The EMBP will be reviewed annually and revised accordingly	N/A
	1H-3d: Scientifically based	Y	The EMBP has been designed with consideration of scientific rationale and methods, with input from experts on new and emerging technologies	N/A
	1H-3e: Protect integrity of the data collected	Y	The data collected will be reviewed; NWMO is currently reviewing their data management practices and requirements, and how to share the data	N/A
	1H-3f: Expertise (- scientific - environmental - qualified samplers)	Y	The EMBP has been designed with consideration of scientific rationale and methods, with input from experts on new and emerging technologies	Hiring of qualified personnel to complete the sampling will be assessed separately by the NWMO
	1H-3g: Earwigs (what happened to cause changes?)	Y	How to account for climate change/overall picture of changing environment (i.e., cumulative effects) is a design goal of the EMBP	The contract for analyzing the data collected under the EMBP will include requirements for backcasting and including historic information where possible; as there is not much information available, any insight or knowledge from community members would be helpful
	1H-3h: Follow industry standard measurement techniques	Y	The EMBP has been designed with consideration of standard, regulatory approved sampling and analysis techniques	N/A

Category and Area of Concern	Specific Concern	Addressed in EMBP[a]?	Rationale	Alternate Resolution/Additional Information Needed
2: SPIRIT OF EVERYTHING				
2B-1: Manito Aatsokewinan	2B-1a: All wildlife	Y	Wildlife tissue chemistry is a component of the EMBP	The NWMO acknowledges that chemistry is only part of the story, and additional information will be collected as part of separate studies, including a Biodiversity Baseline Program
	2B-1b: Wildlife/all nature	Y	Wildlife tissue chemistry is a component of the EMBP	The NWMO acknowledges that chemistry is only part of the story, and additional information will be collected as part of separate studies, including a Biodiversity Baseline Program
	2B-1c: Plants/medicines	Y	Edible and medicinal plants have been identified as primary Study Components of the tissue component of the EMBP for chemical analysis of tissue	The NWMO acknowledges that chemistry is only part of the story, and additional information will be collected as part of separate studies, including a Biodiversity Baseline Program
	2B-1d: Habitat of animals	Y	The EMBP has been designed to collect data from the terrestrial and aquatic environments in order to establish existing conditions in various habitats	The data collected will also be incorporated into the Biodiversity Baseline Program
	2B-1e: Why are animals and bids getting sick?	Y	How to account for climate change/overall picture of changing environment (i.e., cumulative effects) is a design goal of the EMBP	The contract for analyzing the data collected under the EMBP will include requirements for backcasting and including historic information where possible; as there is not much information available, any insight or knowledge from community members would be helpful
	2B-1f: Moose	Y	Ungulates (moose, deer) has been identified as a primary Study Component of the EMBP	The NWMO acknowledges that chemistry is only part of the story, and additional information will be collected as part of separate studies, including a Biodiversity Baseline Program
	2B-1g: Fish study	Partially	Fish tissue chemistry is a component of the EMBP	The NWMO acknowledges that chemistry is only part of the story, and additional information will be collected as part of separate studies, including a Biodiversity Baseline Program
	2B-1h: Deer study	Partially	Deer have been identified as a primary Study Component of the EMBP, but study of deer populations is outside of the scope of the EMBP design	The NWMO acknowledges that chemistry is only part of the story, and additional information will be collected as part of separate studies, including a Biodiversity Baseline Program
	2B-1i: Fishing	Partially	Fish tissue chemistry is a component of the EMBP, and locations have been selected based on input from stakeholders and rights-holders	The NWMO acknowledges that chemistry is only part of the story, and additional information will be collected as part of separate studies, including a Biodiversity Baseline Program; input from stakeholders/rights-holders on priority fishing locations and species would be beneficial to the final EMBP design
	2B-1j: Aatsokewinan (Spirit of everything)	Partially	Opportunties for incorporating spirituality and ceremony into the EMBP have been identified	Further input is needed from stakeholders/rights-holders to identify needs and discuss opportunities and methods for incorporating Spirit
	2B-1k: Importance of water, animals, plants	Y	The Study Team and NWMO recognize the importance of these components and have included them in the EMBP design	N/A
	2B-1l: All animals, plants, medicines, soil, water	Y	The Study Team and NWMO recognize the importance of these components and have included them in the EMBP design	Further input on species of highest importance, important sampling locations, etc. would be beneficial to the final EMBP design
	2B-1m: Water	Y	Water chemistry and flow are components of the EMBP	N/A
	2B-1n: Fish habitat	Y	The EMBP has been designed to collect data from the aquatic environment (surface water, sediment, etc.) in order to establish existing conditions in lakes	The data collected will also be incorporated into the Biodiversity Baseline Program

Category and Area of Concern	Specific Concern	Addressed in EMBP[a]?	Rationale	Alternate Resolution/Additional Information Needed
2B-2: Manachtooda Kitakeeminan (Natural Law)	2B-2a: Finding a way of keeping nature natural	Indirectly	The EMBP will establish existing environmental conditions in order to provide a reference against which future data can be compared. Cumulative effects (from other industries such as forestry) will also be captured	The sampling locations/boundaries have been selected to capture any areas potentially affected by the Project to ensure they are protected in the long-term
	2B-2b: Respect the land and the gifts - water	Partially	Suggestions for opportunities for respecting the land, through Ceremony or other identified ways, have been incorporated into the EMBP	Further input is needed from stakeholders/rights-holders to identify needs and discuss opportunities and methods for incorporating Spirit
	2B-2c: Someone with cultural/Traditional knowledge living the land	Y	The EMBP identifies opportunities for incorporating Traditional (Indigenous) Knowledge into the design, such as via the Dietary Survey	N/A
	2B-2d: Develop a new appreciation for water	For discussion	The EMBP identifies opportunities to incorporate non-corporate methods and activities, such as Ceremony, to encourage appreciation of water and the environment as a whole	Further input from stakeholders/rights-holder on how to incorporate non-corporate methods is needed
	2B-2e: Food chain involved 3 generations	Y	The EMBP will establish existing environmental conditions in order to provide a reference against which future data can be compared; it can be designed to incorporate non-corporate methods and activities, such as Ceremony	Further input from stakeholders/rights-holder on how to incorporate non-corporate methods is needed
	2B-2f: Offer tobacco to Mother Earth when collecting	Y	This has been identified as a consideration when completing the sampling, but would need to be driven by stakeholders/rights-holders	N/A
	2B-2g: Respecting nature (protection)	Partially	The EMBP is being completed to establish conditions to monitor any potential impacts in the future	N/A
	2B-2h: Knowledge transfer involving our youth	Y	The EMBP identifies opportunities for learning from the community, and sharing this knowledge with youth via involvement in sampling, school visits, etc.	N/A
	2B-2i: Natural Law	Y	The EMBP will establish existing environmental conditions in order to provide a reference against which future data can be compared; the EMBP has been designed to include all parts of the environment, as all parts are important	N/A
	2B-2j: Elder Knowledge keepers - site visit verification	Y	The EMBP identifies opportunities for community involvement in the site selection and sampling process	N/A
	2B-2l: Water	Y	Surface water parameters, including surface water quality, is a component of the EMBP	N/A
	2B-2m: What happens to animals, will happen to us	Partially	The EMBP includes tissue sampling of wildlife so that potential exposures to humans can be estimated in future risk assessment work	N/A
2B-3: Holistic environmental awareness	2B-3a: Environment is a corporate word	For discussion	The EMBP identifies opportunities to incorporate non-corporate methods and activities, such as Ceremony, to encourage appreciation of water and the environment as a whole	Further input from stakeholders/rights-holder on how to incorporate non-corporate methods is needed
	3B-3b: Our view of the environment is the most important	Y	Input from stakeholder/rights-holder has been critical to the design of the EMBP	N/A
	2B-3c: Garbage on water, oil	Y	Contaminants and garbage related to project interactions have been incorporated into the EMBP	N/A
	2B-3d: Drugs in the water system	N	Pharmaceuticals in the water system as a result of flushing are not being monitored by the EMBP	Not currently incorporated but an issue for discussion going forward
	2B-3e: Use of spraying	Y	Glyphosate is included in EMBP	N/A
	2B-3f: Effects of spruce bud worm on trees	Indirectly	The EMBP will evaluate wildlife tissue concentrations, but population studies will be addressed as part of a separate study	The EMBP will aim to establish existing environmental conditions; the tissue data collected under the EMBP will be incorporated into the Biodiversity Baseline Program
	2B-3g: Air quality	Y	Air quality is a component of the EMBP	N/A

Category and Area of Concern	Specific Concern	Addressed in EMBP[a]?	Rationale	Alternate Resolution/Additional Information Needed
2C-1: Aatsokewinan (all spirits)	2C-1a: Spirituality	Partially	Opportunties for incorporating spirituality and ceremony into the EMBP have been identified	Further input is needed from stakeholders/rights-holders to identify needs and discuss opportunities and methods for incorporating Spirit
	2C-1b: Rock - ceremony bringing Rock up to surface that never should have seen light	Partially	Opportunties for incorporating spirituality and ceremony into the EMBP have been identified	Further input is needed from stakeholders/rights-holders to identify needs and discuss opportunities and methods for incorporating Spirit
	2C-1c: Anishinaabe ceremonies	Partially	Opportunties for incorporating spirituality and ceremony into the EMBP have been identified	Further input is needed from stakeholders/rights-holders to identify needs and discuss opportunities and methods for incorporating Spirit
3: PROTECTION OF LOCAL RESOURCES				
3A-1: Cooperation between people and the land	3A-1a: Accurate presentation of all the facts	Y	The preliminary design for the EMBP was discussed with stakeholders and rights-holders for review and input to inform the final design. All data collectedas part of the EMBP will be shared.	N/A
	3A-1b: Trust - b/w the company and the people surveying the wildlife, water, land	Y	The EMBP has been designed to include input from stakeholders/right-holders and identify opportunities for further input and involvement in the hopes of fostering a trusting relationship	N/A
	3A-1c: Regular updates	Y	Stakeholders and rights-holders are being informed frequently and at all aspects of EMBP design; results of sampling will be made publicly available	N/A
	3A-1d: Transparency	Y	Stakeholders and rights-holders are being informed frequently and at all aspects of EMBP design; the data collected will be shared	N/A
	3A-1e: Frequent community discussion	Y	Stakeholders and rights-holders are being informed frequently and at all aspects of EMBP design	N/A
	3A-1f: Training for qualifications	Y	The EMBP has been designed with consideration of hiring and training stakeholders/rights-holders to be actively involved with the sampling	N/A
3A-2: Prevention and protection	3A-2a: Wolves are increasing	Indirectly	The EMBP will evaluate wildlife tissue concentrations, but population studies will be addressed as part of a separate study	The EMBP will aim to establish existing environmental conditions; the tissue data collected under the EMBP will be incorporated into the Biodiversity Baseline Program
	3A-2b: Spruce bud worm - why?	Y	How to account for climate change/overall picture of changing environment (i.e., cumulative effects) is a design goal of the EMBP	The contract for analyzing the data collected under the EMBP will include requirements for backcasting and including historic information where possible; as there is not much information available, any insight or knowledge from community members would be helpful
	3A-2c: Are problems curable?	Y	How to account for climate change/overall picture of changing environment (i.e., cumulative effects) is a design goal of the EMBP	N/A
	3A-2d: Beaver dams	Indirectly	The EMBP includes monitoring of surface water flows (hydrology)	Hydrology can be affected by beaver dams

Category and Area of Concern	Specific Concern	Addressed in EMBP[a]?	Rationale	Alternate Resolution/Additional Information Needed
3B-1: Medicines and foods	3B-1a: Roots	Y	Edible plants, including roots, have been identified as a primary Study Component of the EMBP for chemical analysis of tissue	N/A
	3B-1b: Wild rice	Y	Wild rice has been identified as a primary Study Component of the EMBP for chemical analysis of tissue	N/A
	3B-1c: Edible plants	Y	Edible plants have been identified as a primary Study Component of the EMBP for chemical analysis of tissue	N/A
	3B-1d: Water levels	Y	Hydrology, including water levels, is a component of the EMBP	N/A
	3B-1e: Medicines	Y	Medicinal plants have been identified as a primary Study Component of the EMBP	N/A
	3B-1f: Soil testing	Y	Soil quality is a component of the EMBP	N/A
3B-2: Insects and worms	3B-2a: Bees (pollinate, make honey, medicine)	For discussion	The EMBP will evaluate wildlife tissue concentrations, but direct collection of bees is not recommended; monitoring of bee populations can be addressed as part of a separate study	Chemical analysis of bees is not recommended as this would require lethal sampling, and local populations are difficult to source; bees can be included in the Biodiversity Baseline Program
	3B-2b: Insects	Y	Insects have been identified as a secondary Study Component of the tissue component of the EMBP	N/A
	3B-2c: Worms	For discussion	Worms have been identified as Not Required for the tissue component of the EMBP (Appendix F) as concentrations can be modelled using soil chemistry data	If desired, consideration can be given toi ncluding worms in years 2 or 3 of the EMBP
3C-1: What we protect	3C-1a: Importance of animals, water, plants	Y	The Study Team and NWMO recognize the importance of these components and have included them in the EMBP	N/A
	3C-1b: All animals, plants, medicines, soil, water	Y	The Study Team and NWMO recognize the importance of these components and have included them in the EMBP	N/A
	3C-1c: Water	Y	Surface water parameters, including surface water quality, is a component of the EMBP	N/A
	3C-1d: Fish habitat	Y	The EMBP has been designed to collect data from the aquatic environment (surface water, sediment, etc.) in order to establish existing conditions in lakes	The data collected will also be incorporated into the Biodiversity Baseline Program
	3C-1e: Impacts of our people if they make money, get trained	Indirectly	The EMBP has been designed to maximize community involvement, but impacts on the community will be addressed as part of a separate study	This will be considered as part of a separate socioeconomic study, which will take into consideration the level of community involvement in the EMBP
3D-1: Monitoring edible natural plants	3D-1a: Blueberries, cranberries, raspberries	Y	Edible plants, including berries, have been identified as primary Study Components of the tissue component of the EMBP for chemical analysis of tissues	N/A
	3D-1b: Flowering bushes (ruby throated humming bird)	Y	Plants have been identified as Study Components of the tissue component of the EMBP for chemical analysis of tissue	N/A
	3D-1c: Low bush cranberries	Y	Edible plants, including berries, have been identified as primary Study Components of the tissue component of the EMBP for chemical analysis of tissue	N/A
	3D-1d: Mountain-ash (for jelly and food for birds)	Y	Edible plants have been identified as primary Study Components of the tissue component of the EMBP for chemical analysis of tissue	N/A
	3D-1e: Traditional medicines (balsam, blueberry stem)	Y	Medicinal plants have been identified as primary Study Components of the tissue component of the EMBP for chemical analysis of tissue	N/A

Category and Area of Concern	Specific Concern	Addressed in EMBP[a]?	Rationale	Alternate Resolution/Additional Information Needed
4: UNDERSTANDING OF THE WATER SYSTEM				
4B-1: Take care of Nibi (water)	4B-1a: Water quality	Y	Monitoring water quality is a component of the EMBP	N/A
	4B-1b: Water sampling	Y	Surface water parameters, including surface water quality, is a component of the EMBP	N/A
	4B-1c: Talk about watersheds	Y	Importance of local watersheds to local communities has been considered when selecting sampling locations for the aquatic environment (surface water quality, sediment, fish, etc.).	N/A
4D-1: Water quality	4D-1a: Water quality	Y	Monitoring water quality is a component of the EMBP	N/A
	4D-1b: Water environment (fishing, food chain, wild rice)	Y	Surface water parameters and wildlife tissue are components of the EMBP	N/A
4D-2: Monitor water to keep it in check	4D-2a: Monitor springs	Y	If spring water sources have the potential to be impacted by the Project, then water quality monitoring at these locations can be incorporated into the EMBP design	Input from stakeholders/rights-holders on important springs potentially affected by the Project would be required
	4D-2b: Monitor tributaries to Mennin	Y	This has been considered in the EMBP design	N/A
	4D-2c: Monitor water quality	Y	Water quality is a component of the EMBP	N/A
4G-1: Water quality and education	4G-1a: Water quality of downstream watershed	Y	Downstream locations are included in the surface water quality component of the EMBP	N/A
	4G-1b: Water quality	Y	Surface water quality is a component of the EMBP	N/A
	4G-1c: Sample fish and water	Y	Monitoring water quality and fish tissue concentrations is a component of the EMBP	N/A
	4G-1d: Water quality effects	Y	The EMBP includes monitoring of surface water quality	N/A
	4G-1e: Health of the population monitor water quality	Y	The EMBP includes monitoring of surface water quality	N/A
	4G-1f: Air quality	Y	Monitoring of air quality is a component of the EMBP	N/A
	4G-1g: Water quality of spring water	Y	If spring water sources have the potential to be impacted by the Project, then water quality monitoring at these locations can be incorporated into the EMBP design	Input from stakeholders/rights-holders on important springs potentially affected by the Project would be required
	4G-1h: Water quality of surface water	Y	Monitoring water quality is a component of the EMBP	N/A
4G-2: Engage local stakeholders	4G-2a: Education, employment, youth moving to cities	Y	The EMBP has been designed to incorporate as many opportunities as possible for involvement and training of local communities, including youth	N/A
	4G-2b: Local impact	Y	The EMBP will establish existing environmental conditions in the local study area, and rely on input from local stakeholders and rights-holders	The sampling locations/boundaries are being selected to capture any areas potentially affected by the Project, with a focus on areas that are used by community members for hunting, fishing, etc.
	4G-2c: Educate local population	Y	NWMO has been and continues to be active in educating the nearby communities on Project progress, and education is an important component of the EMBP design	N/A
	4G-2d: Engage local stakeholders	Y	Input from stakeholders and rights-holders has been incorporated into the design of the EMBP; the EMBP identifies opportunities for continued inolvement	N/A
	4G-2e: Local jobs for local people	Y	The EMBP has been designed to incorporate as many opportunities as possible for involvement and training of local communities	N/A
4H-1: Communication and reporting	4H-1a: Internal/external communication and reporting	Y	Development of a data management tool for the collection, storage, visualization, and sharing of data has been identified in the EMBP as critical to its success	N/A
	4H-1b: Provide clear answers to questions	Y	Every effort is being made to clearly and concisely answer all questions and concerns brought forward by stakeholders and rights-holders	N/A
	4H-1c: Addresses priority areas/impacts of nuclear waste storage	Y	Selection of sampling locations for the EMBP has been considered with input from stakeholders/rights-holders to help identify priority areas	N/A

Category and Area of Concern	Specific Concern	Addressed in EMBP[a]?	Rationale	Alternate Resolution/Additional Information Needed
5: CLEAR AND ACCESSIBLE COMMUNICATIONS				
5B-1: Action and communication	5B-1a: Trust each other	Y	Every effort is being made to address all questions and concerns and share development of the Project and EMBP as they progress in the hopes of fostering a trusting relationship	N/A
	5B-1b: Listen to each other	Y	Every effort is being made to address all questions and concerns and share development of the Project and EMBP as they progress	N/A
	5B-1c: Meaningful dialogue	Y	Every effort is being made to address all questions and concerns and share development of the Project and EMBP as they progress	N/A
	5B-1d: Look at what others have done - nuclear storage comparison	Y	A detailed review was completed in determining potential Project interactions and identifying Contaminants of Potential Concern (COPC)	N/A
5F-1: Public outreach	5F-1a: Social media outlets for transparency	For discussion	The data collected under the EMBP will be publically available, but specifics have not been determined	It is intended that there will be a media sharing platform set up; input from the community on preferred options and methods is welcomed
	5F-1b: Pictures to prove their statements	Y	Requirements for taking photos have been incorporated into the design of the EMBP where practical, which can then be stored and shared with the public	N/A
	5F-1c: More videos on how to help explain work	Y	Opportunities for training, including videos, have been identified as part of the EMBP design	N/A
	5F-1d: Social media page	For discussion	The data collected under the EMBP will be publically available, but specifics have not been determined	It is intended that there will be a media sharing platform set up; input from the community on preferred options and methods is welcomed
5G-1: Clear and concise communications	5G-1a: Trustworthy communication of information	Y	Every effort is being made to address all questions and concerns and share development of the Project and EMBP as they progress	N/A
	5G-1b: Keep us all informed	Y	The NWMO is sharing progress of the Project and EMBP as they progress	N/A
	5G-1c: Honesty	Y	Every effort is being made to address all questions and concerns and share development of the Project and EMBP as they progress in the hopes of creating trust between all interested parties	N/A
	5G-1d: Openness	Y	The NWMO is sharing progress of the Project and EMBP as they progress. All data collected in the baseline program will be shared.	N/A
	5G-1e: Full information	Y	The NWMO is sharing progress of the Project and EMBP as they progress. All data collected in the baseline program will be shared.	N/A
	5G-1f: Communication in languages and methods that are accepted	For discussion	The information and data can be translated	Input from the community is needed to identify preferred translations
	5G-1g: How do we know what to ask	Y	NWMO has been holding information and engagement sessions to help facilitate information exchange	N/A
5H-1: Clear and concise communications	5H-1a: Share information through many mediums	Partially	Considerations for information sharing have been identified in the EMP; the mediums will be determined by NWMO	NWMO will consider how to share information on EMBP effectively
	5H-1b: Ensure info is relatable (e.g., social media)	Partially	Considerations for information sharing have been identified in the EMP; the mediums will be determined by NWMO	NWMO will consider how to share information on EMBP effectively
	5H-1c: Opportunity to share in all/any languages	For discussion	The information and data can be translated	Input from the community is needed to identify preferred translations

Category and Area of Concern	Specific Concern	Addressed in EMBP[a]?	Rationale	Alternate Resolution/Additional Information Needed
5H-1: Clear and concise communications (continued)	5H-1d: Literacy make it simple	Y	Efforts are being made to keep the EMBP design simple and easy to read	Detailed information is provided in appendices, and the executive summary will be publicly accessible
	5H-1e: K.I.S.S presentation/on web	Y	Efforts are being made to keep the EMBP design simple and easy to read - detailed information is provided in appendices, and the executive summary will be publicly accessible	N/A
	5H-1f: Make data readily available / access to data	Partially	The EMBP design identifies considerations for development of a data management tool for the collection, storage, visualization, and sharing of data	The design of the data management tool is a separate program
	5H-1g: Training, awareness, competent	Y	The EMBP has been designed to incorporate as many opportunities as possible for involvement and training of local communities	N/A
	5H-1h: Design	Y	Efforts are being made to keep the EMBP design simple and easy to read	Detailed information is provided in appendices, and the executive summary will be publicly accessible
	5H-1i: Data collection	Y	The EMBP identifies areas where straightforward training to interested community members can be obtained via training videos or via a graded approach directly in the field (high involvement of trained personnel in Year 1, with gradual reduction in oversight in subsequent years)	N/A
	5H-1j: Strategic direction	Y	The EMBP has been designed with input from stakeholders and rights-holders	The EMBP can be refined in subsequent years based on further input from stakeholders and rights-holders
6: LOCAL KNOWLEDGE, RESOURCES, AND CONCERNS ARE IMBEDDED IN THE PROGRAM				
6F-1: Local community	6F-1a: Community involvement	Y	The EMBP has been designed with input from stakeholders and rights-holders, and with a high priority of identifying opportunities for further involvement from nearby communities	N/A
	6F-1b: Involving people from the community x 3	Y	The EMBP has been designed with input from stakeholders and rights-holders, and with a high priority of identifying opportunities for further involvement from nearby communities	N/A
	6F-1c: Youth involvement programs	Y	The EMBP identifies opportunities for learning from the community, and sharing this knowledge with youth via involvement in sampling, school visits, etc.	N/A
	6F-1d: Community building	Y	The EMBP has been designed with input from stakeholders and rights-holders, and with a high priority of identifying opportunities for further involvement from nearby communities	N/A
	6F-1e: Committed community group	For discussion	The EMBP has been designed with input from stakeholders and rights-holders, and with a high priority of identifying opportunities for further involvement from nearby communities	The formation of a committed community group can be discussed further with NWMO; membership and roles would be defined based on input from the community
	6F-1f: Local training and employment x 2	Y	The EMBP has been designed to incorporate as many opportunities as possible for involvement and training of local communities	N/A
	6F-1g: Community sharing/input	Y	The EMBP has been designed with input from stakeholders and rights-holders, and with a high priority of identifying opportunities for further input and knowledge sharing from nearby communities	N/A
	6F-1h: Who's involved	For discussion	The EMBP has been designed to incorporate as many opportunities as possible for involvement and training of local communities	Input from the community is needed to gauge interest in level of involvement

Category and Area of Concern	Specific Concern	Addressed in EMBP[a]?	Rationale	Alternate Resolution/Additional Information Needed
6G-1: End user validation of data	6G-1a: Audit of data collected; needs to be trusted	Y	The data collected will be subject to rigorous QA/QC protocols, and will also be reviewed annually by an external consultant to ensure data quality is acceptable and data objectives are being met	N/A
	6G-1b: Monitoring done by those interested in the activity	Y	The EMBP has been designed to incorporate as many opportunities as possible for involvement and training of local communities to maintain a high degree of relevance	N/A
	6G-1c: Seasonal changes weather	Y	Seasonality considerations are part of the design of the EMBP	N/A
	6G-1d: Boundaries? What is the impact and the footprint?	Y	Study areas for the different components of the EMBP have been defined as part of the design	The boundaries and study areas may be refined in future years as Project design plans evolve
6H-1: Including the community and stakeholders	6H-1a: Community inclusion (Ignace and neighbouring communities)	Y	The EMBP has been designed with input from stakeholders and rights-holders, and with a high priority of identifying opportunities for further input and knowledge sharing from nearby communities	N/A
	6H-1b: Local participation in program	Y	The EMBP has been designed with input from stakeholders and rights-holders, and with a high priority of identifying opportunities for further involvement from nearby communities	N/A
	6H-1c: Incorporate human observations and historical knowledge	Y	The EMBP has been designed with input from stakeholders and rights-holders, and with a high priority of identifying opportunities for further involvement and knowledge sharing from nearby communities. Observations and knowledge provided during sample collection will be captured to help with the interpretation	N/A
	6H-1d: Community partners involved with data collection	Y	The EMBP has been designed to incorporate as many opportunities as possible for involvement and training of local communities	N/A
	6H-1e: Community input - all stakeholders	Y	The EMBP has been designed with input from stakeholders and rights-holders, and with a high priority of identifying opportunities for further input and knowledge sharing from nearby communities	N/A
	6H-1f: Continuous updates and community involvement	Y	The EMBP has been designed with input from stakeholders and rights-holders, and with a high priority of identifying opportunities for further input and knowledge sharing from nearby communities	N/A
	6H-1g: Consider ALL options	Y	Details of options are presented in detailed appendix tables, regardless of whether or not the option is preferred	N/A
	6H-1h: Consider current practices of hunting/trapping	Y	Efforts have been made to obtain information on preferred hunting areas and patterns to help inform sample locations; submission of voluntary samples from community members is part of the EMBP design	N/A
	6H-1i: Stakeholder oversight	Y	The EMBP has been designed with input from stakeholders and rights-holders, and with a high priority of identifying opportunities for further input and knowledge sharing from nearby communities	N/A

Category and Area of Concern	Specific Concern	Addressed in EMBP[a]?	Rationale	Alternate Resolution/Additional Information Needed
7: EDUCATION AND TRAINING TO BUILD LOCAL CAPACITY				
7A-1: Education and learning	7A-1a: Qualified worker	Partially	The EMBP is designed such that qualified people are always involved in sample collection. The goal is to train local community members to become the qualified personnel.	Hiring of contractors to carry out the EMBP will be handled by the NWMO
	7A-1b: Sample dirt for blasto *(assumed this is blastomycosis)*	N	There is currently no known method for measuring levels of blastomycosis in the environment	This can be re-evaluated during the annual reviews to determine whether new methods have emerged to measure it
	7A-1c: Wood ticks - can we get sick if bitten?	N	Although a design goal of the EMBP is how to account for climate change/overall picture of changing environment, the abundance of infected ticks and subsequent transmission of diseases is outside the scope of the EMBP	The migration of disease-carrying species due to climate change or other factors will be indirectly incorporated into the Biodiversity Baseline Program
7A-2: Learning the earth	7A-2a: Sample dirt	Y	Soil quality is a component of the EMBP	N/A
	7A-2b: Soil sample	Y	Soil quality is a component of the EMBP	N/A
7A-3: Sample training	7A-3a: Sample fish x 2	Y	Fish tissue chemistry is a component of the EMBP	N/A
	7A-3b: Sample water	Y	Water quality is a component of the EMBP	N/A
	7A-3c: Fish sampling	Y	Fish tissue chemistry is a component of the EMBP	N/A
7B-1: Nini kong Kaadinaatisiwant (where the water beings live)	7B-1a: Amphibian study frogs/turtle	Partially	Amphibian tissue sample was considered as part of the EMBP. However a full study of amphibians and reptiles would be addressed as part of a separate study	Although tissue can be sampled as part of the EMBP, tissue concentrations can also be successfully modelled from water and soil concentrations; a study on amphibian and reptile populations would need to be considered as part of a separate Biodiversity Baseline Program
	7B-1b: Fish study	Partially	Fish tissue chemistry is a component of the EMBP	The NWMO acknowledges that chemistry is only part of the story, and additional information will be collected as part of separate studies, including a Biodiversity Baseline Program
	7B-1c: Fish x 3	Y	Fish tissue chemistry is included in the EMBP	N/A
	7B-1d: Study of insects	Partially	Insects have been identified as a Secondary Study Component of the tissue component of the EMBP and are thus an option for inclusion	The NWMO acknowledges that chemistry is only part of the story, and additional information will be collected as part of separate studies, including a Biodiversity Baseline Program
7D-1: Education	7D-1a: Hands-on learning	Y	Opportunities for training, including videos, have been identified as part of the EMBP design	N/A
	7D-1b: Teaching the people	Y	Opportunities for training, including videos, have been identified as part of the EMBP design	N/A
	7D-1c: Our relationship with the land	Y	The EMBP has been designed with consideration of community input and Indigenous Knowledge	N/A
7E-1: 7 Generation and the new 8th	7E-1a: Include different age groups in monitoring process	Y	The EMBP design identifies opportunities for learning from the community, and sharing this knowledge with youth via involvement in sampling, school visits, etc.	N/A
	7E-1b: Youth and elders learning together	Y	The EMBP design identifies opportunities for learning from the community, and sharing this knowledge with youth via involvement in sampling, school visits, etc.	N/A

Category and Area of Concern	Specific Concern	Addressed in EMBP[a]?	Rationale	Alternate Resolution/Additional Information Needed
8: TWO-WAY KNOWLEDGE SHARING				
8C-1: Ga Kina mot tii min	8C-1a: Community is presented data	Y	The EMBP has been designed with consideration of easy access to the data by any interested party	N/A
	8C-1b: Ga Kina mot tii min	For discussion	It is unclear what is meant by this	Clarification is required to explain what is meant by this and how it could be incorporated
	8C-1c: Who pays for our studies Joint/alone	Y	NWMO will be fully funding the EMBP, regardless of who is executing it	N/A
8C-2: Circle of knowledge	8C-2a: Elder's knowledge	Y	The EMBP identifies opportunities for incorporating Indigenous Knowledge into the design	Input from stakeholders/rights-holders on methods of incorporating Elder's knowledge is welcomed
	8C-2b: Elder knowledge and keeper input	Y	The EMBP identifies opportunities for incorporating Indigenous Knowledge into the design	Input from stakeholders/rights-holders on methods of incorporating Elder's knowledge is welcomed
	8C-2c: Community monitors	Y	The EMBP design identifies opportunities for communality involvement in the site selection and sampling process, as community monitors or otherwise	N/A
8D-1: Cooperative oversight	8D-1a: Have professionals involved (training)	Y	The EMBP has been designed with consideration of hiring and training local residents to complete aspects of the sampling, which would be done by qualified professionals	N/A
	8D-1b: Specialists for each category	Y	Academic experts that are leaders in their fields have shared knowledge and provided input to the preliminary design of the various components of the EMBP	N/A
	8D-1c: Do it together	Y	Input from stakeholders and rights-holders was critical in the design of the EMPB	N/A
	8D-1d: Train people	Y	Opportunities for training, including videos, have been identified as part of the EMBP design	N/A
8E-1: Shared knowledge and transparency	8E-1a: Clear and easy to understand the data presented to us	Y	The EMBP has been designed with consideration of easy access to the data by any interested party	N/A
	8E-1b: Keep everything known	Y	The NWMO is sharing progress of the Project and EMBP as they progress. All data collected in the baseline program will be shared.	N/A
8E:-2: Diversity of knowledge	8E-2a: Monitors with different knowledge bases	Y	The EMBP identifies opportunities for involvement of local communities with firsthand knowledge; different people with different knowledge bases can participate in different aspects of the EMBP	N/A
	8E-2b: Monitors with varying cultural backgrounds	Y	The EMBP identifies opportunities for involvement of local communities with firsthand knowledge; different people with different backgrounds can participate in different aspects of the EMBP	N/A

Category and Area of Concern	Specific Concern	Addressed in EMBP[a]?	Rationale	Alternate Resolution/Additional Information Needed
9: ANTICIPATION OF FUTURE NEEDS AND TECHNOLOGY AND LONG TERM COMMITMENT				
9D-1: Long-term commitment to build trust	9D-1a: Be done regularly	Y	The EMBP has been designed with regular monitoring of the environment and on-going communication	N/A
	9D-1b: Guarantee long-term commitment	For discussion	Discussions with communities are being held to establish partnerships and determine long-term involvement	Input from the community is needed to determine what these partnerships would ideally look like
	9D-1c: Post results for community	Y	The EMBP has been designed with consideration of easy access to the data by any interested party	N/A
9E-1: Future technology	9E-1a: Autonomous monitoring system that actively finds new data	Partially	An autonomous water quality meter for surface water quality is part of the EMBP	N/A
	9E-1b: Use of satellite and remote technology	Y	The EMBP has been designed with consideration of new and emerging technologies, while ensuring that the results will be defensible and statistically sound	N/A
	9E-1c: An active monitor, like Siri or autonomous action unit (machine learning?)	Y	Methods for collecting and accessing data will be developed with consideration of new and emerging technologies	N/A
9F-1: Anticipation of future events	9F-1a: Chain Reactions (studying aftermath of decisions)	Y	The EMBP will undergo annual reviews to ensure it is relevant and collecting the desired data; it will be modified as necessary based on updated information learned from other studies (i.e., Biodiversity Baseline Program) and people (i.e., Indigenous Knowledge)	N/A
	9F-1b: What will be affected	Y	The EMBP has been designed to consider what components of the environment have the potential to be impacted by the Project	N/A
	9F-1c: What will happen in the future?	Y	The EMBP will establish existing environment conditions over multiple years so that current trends can be seen and compared to predictions for the future	N/A
	9F-1d: Year-round observation and research	Y	Some components of the EMBP will be monitoring year-round	N/A
	9F-1e: Willingness to make changes	Y	The EMBP will be reviewed annually and revised as needed	N/A
9H-1: Sustainable life-long monitoring	9H-1a: Design Stations for 50 years of continuous service	For discussion	The longevity of the monitoring stations has not been set	Input is needed from the community
	9H-1b: Understanding historic pollutants	Y	How to account for climate change/overall picture of changing environment (i.e., cumulative effects) is a design goal of the EMBP; glyphosate is included in the EMBP	N/A
	9H-1c: Sustainability funding for monitoring	Y	NWMO is committed to funding the monitoring should the site be selected	NWMO is looking to help communities set up their own monitoring capabilities (capacity building)
	9H-1d: Implication for all (population, environment, health, social)	Y	Input from discussions will be incorporated	N/A

Category and Area of Concern	Specific Concern	Addressed in EMBP[a]?	Rationale	Alternate Resolution/Additional Information Needed
10: ACCOUNTABILITY TO THE COMMUNITY				
10A-1: Holding each other responsible	10A-1a: Agreed upon standards	Y	The EMBP has been developed with consideration of approved regulatory standards, but also with input from stakeholders/rights-holders	N/A
	10A-1b: Firewood for members use wood stoves	For discussion	This is a forest management issue, but NWMO will accommodate this to the extent possible while working within the regulatory framework	Further discussion will be required to look at ways of accomplishing this while adhering to regulatory requirements
	10A-1c: Cultural based	Y	The EMBP has been designed with consideration of input from stakeholders/rights-holders, including ways to incorporate cultural traditions such as Ceremony	Further input from stakeholders/rights-holder on opportunities for incorporating cultural traditions is welcomed
	10A-1d: Firewood	For discussion	This is a forest management issue, but NWMO will accommodate this to the extent possible while working within the regulatory framework	Further discussion will be required to look at ways of accomplishing this while adhering to regulatory requirements
	10A-1e: Teaching culture for survival	Y	The EMBP has been designed to incorporate as many opportunities as possible for involvement and training of local communities, and to incorporate Indigenous Knowledge	Input on how Traditional practices and health and culture can be integrated is welcomed
10C-1: Community - the people's plan	10C-1a: Community defines what is important	Y	Input from stakeholders and rights-holders has been critical in the EMBP design	The EMPB can be refined in future years based on further input
	10C-1b: Comprehensive community/plan engagement	Y	Input from stakeholders and rights-holders has been critical in the EMBP design	The EMPB can be refined in future years based on further input
	10C-1c: Well though-out program (due diligence, transparency, comprehensive)	Y	The EMBP has been developed with consideration of stakeholder/rights-holder input, regulatory standards, statistical and scientific rigour, and all potential Project-environment interactions	N/A
	10C-1d: Length of time for study	Y	The EMBP has been designed to be carried out for three years, which is comprehensive for a baseline program study. It will provide the foundation for the monitoring that would be ongoing through all phases of the project.	N/A
10H-1: Integrity	10H-1a: Honesty	Y	Every effort is being made to address all questions and concerns and share development of the Project and EMBP as they progress in the hopes of creating trust between all interested parties	N/A
	10H-1b: Transparency x 2	Y	The EMBP has been designed with consideration of easy access to the data by any interested party, and with maximal input from stakeholders/rights-holders	N/A
	10H-1c: Decommissioning strategy and funding transparency	Indirectly	This will be part of the integrated Impact Assessment	Further discussion can be incorporated as part of the partnership discussions
	10H-1d: Share positive and negative information	Y	The EMBP has been designed with consideration of easy access to the data by any interested party (not hidden/secret), and with maximal input from stakeholders/rights-holders	N/A
	10H-1e: Be straight with the public	Y	The EMBP has been designed with consideration of easy access to the data by any interested party (not hidden/secret), and with maximal input from stakeholders/rights-holders	N/A

Category and Area of Concern	Specific Concern	Addressed in EMBP[a]?	Rationale	Alternate Resolution/Additional Information Needed
11: INDIGENOUS KNOWLEDGE AND LOCAL WISDOM				
11D-1: Local wisdom	11D-1a: Walleye and northern pike in Mennin	Y	These species are included in the EMBP	N/A
	11D-1b: Lake northwest of BH2 has northern pike	Y	This species is included in the EMBP	N/A
11D-2: Preservation of wildlife and forest	11D-2a: Leave timber to preserve wildlife	For discussion	This is a forest management issue, but NWMO will accommodate this to the extent possible while working within the regulatory framework	Further discussion will be required to look at ways of accomplishing this while adhering to regulatory requirements
	11D-2b: Monitor animals	Partially	The EMBP will evaluate wildlife tissue concentrations, but direct monitoring of wildlife will be addressed as part of a separate study	The EMBP will aim to establish existing environmental conditions; the tissue data collected under the EMBP will be incorporated into the Biodiversity Baseline Program
	11D-2c: Takes >30 yrs for forest to regrow	Indirectly	The EMBP will provide existing conditions in plants against which long-term data can be compared, and health will also be considered as part of a separate study	The EMBP will aim to establish existing environmental conditions; the tissue data collected under the EMBP will be incorporated into the Biodiversity Baseline Program
	11D-2d: Forest loss = wildlife loss	Partially	The EMBP will evaluate wildlife tissue concentrations, but direct monitoring of wildlife populations will be considered as part of a separate study	The EMBP will aim to establish existing environmental conditions; the tissue data collected under the EMBP will be incorporated into the Biodiversity Baseline Program
	11D-2e: Existing wildlife loss	Indirectly	How to account for climate change/overall picture of changing environment is a design goal of the EMBP	The contract for analyzing the data collected under the EMBP will include requirements for backcasting and including historic information where possible; as there is not much information available, any insight or knowledge from community members would be helpful
	11D-2f: Monitor 3rd cut health	Indirectly	The EMBP will provide existing conditions in plants against which long-term data can be compared, and health will also be considered as part of a separate study	The EMBP will aim to establish existing environmental conditions; the tissue data collected under the EMBP will be incorporated into the Biodiversity Baseline Program
11F-1: Cultural consultation	11F-1a: First Nation Involvement	Y	The EMBP has been designed with consideration of input from stakeholders/rights-holders, and hiring and training local residents to complete aspects of the sampling	NWMO is working with WLON and others to build their environmental capacity
	11F-1b: Indigenous Rights	Y	WLON and other Indigenous groups, such as Metis, are being consulted and actively engaged as part of the development of the EMBP	N/A
	11F-1c: Cultural consultation	Y	The EMBP has been designed with consideration of input from stakeholders/rights-holders, including ways to incorporate cultural traditions such as Ceremony	Further input from stakeholders/rights-holder on opportunities for incorporating cultural traditions is welcomed
11G-1: First Nations	11G-1a: First Nation inclusion and education	Y	The EMBP has been designed with consideration of input from stakeholders/rights-holders, and hiring and training local residents to complete aspects of the sampling	NWMO is working with WLON to build their environmental capacity
	11G-1b: Languages, communications, remote locations	For discussion	The information and data can be translated, and methods for sharing the information can be discussed	Input from the community is needed to identify preferred translations and methods for data sharing

Category and Area of Concern	Specific Concern	Addressed in EMBP[a]?	Rationale	Alternate Resolution/Additional Information Needed
12: CLEAR PROCESS FOR REVIEW AND TRACEABLE INPUT				
12C-1: Review and action	12C-1a: Peer review by aboriginal groups (e.g.. GCT #3)	Y	The draft EMBP design was presented to stakeholders/rights-holders for input before the plan was finalized	The EMBP can be refined in subsequent years based on further input from stakeholders and rights-holders
	12C-1b: Independent studies from NWMO	For discussion	NWMO is open to further discussions on this	Further input from the community is needed to define these studies
	12C-1c: Transparency of data	Y	The EMBP has been designed with consideration of easy access to the data by any interested party, and with maximal input from stakeholders/rights-holders. All data collected during the program will be shared.	N/A
	12C-1d: Impacts addressed in a timely fashion	Indirectly	The EMBP will establish existing environmental conditions in order to provide a reference against which future data can be compared	The data will be analyzed to establish trends so that any impacts can be identified early in the process
12G-1: Clear priorities and resolution	12G-1a: Conflict resolution process (clear and easy)	For discussion	This can be incorporated into the design but further input is needed	Input from community members is required to define the goals and methods of such processes
	12G-1b: Where is the line drawn on compromise ($ and priorities/changes)	Y	The EMBP design provides recommendations for obtaining scientifically rigorous and defensible data, while trying to work within a reasonable budget	N/A

Note: [a]EMBP - Environmental Media Baseline Program
Numbering is defined as follows: 1A-1a:
1A-1a: Category Number - broad category of concern common to groups
1A-1a: Group Letter (also identified by colour for ease of differentiation)

Group A
Group B
Group C
Group D
Group E
Group F
Group G
Group H

1A-1a: Specific area of concern unique to each group
1A-1a: Concern identified by group
Highlighting signifies opportunities for further input and clarification

TABLE B.2

Stakeholder and rights-holder input from round 2 workshops

Area of Relevance	Comment
Workshop #1	
General community view after Gallery Walk	Expressed that the community has mixed feelings about the Project
	Overfishing and hunting a concern, as well as reduced tourism
VCs	No snow goose
	Swans, pelicans and cranes have been seen in the area
	Good knowledge of fish in local lakes – walleye, pike, lake trout, bass, sucker, perch
	People in area pick blueberries, raspberries, strawberries, rhubarb, chanterelle mushrooms
	Partridge, moose, deer (although more in Dryden area), and bear are hunted
	Move black bear to primary and demote snow goose
Locations	Orange flesh lake trout in Raleigh Lake
	Honey – apiary in community garden in Ignace
	Generally fish in lakes up 599 (north of Ignace)
	A few people trap up 599 or down 622 (bush roads)
Locations	Some people have fished in Mennin Lake
	There is walleye in Stormy Lake, Lake Trout in Raleigh Lake, and Revell Lake has walleye, perch, and northern pike
	Fish more in lakes than rivers
	Fishing and berry picking focused in area surrounding Ignace; no one at the session fishes west of Revell Lake
General community view	Expressed general fear about the project and that "the world is already dying"
	Suggested that older community members do not want the Project
Workshop #2	
General	Interested in getting information on what is measured in other baselines
	Air quality – wondering about green energy
	Wondering how drilling and clear cutting affects baseline – lots of forestry going on – cumulative effects
	General comment that there are lots of options presented with a lot of information
VCs	Agree that community members hunt and eat bear
	Lots of liver flukes and spots – avoid moose liver generally
	No comment on Mennin or Revell lakes – stay closer to Ignace to fish, gather, and hunt
	Curious why honey was not included
	No specific thoughts on moving primary, secondary tissue VCs
	Question during surface water about asbestos particles
Sampling program	Concern about about killing animals – sampling should be done in an environmentally conscious way
	Sampling (by the community) has to be easy
	Preference from one person to do non-lethal sampling
Data Sources	MTO vehicle strike data raised as a possible source of data
	MNRF does controlled bear hunts; suggested as a sample source
General	Curious where the power supply for the project will be coming from
	Surprised by the amount of information and detail that was presented

Area of Relevance	Comment
Workshop #3	
VCs	Toxic algae found in Kenora – concern that it is moving to the area
	Sprayed blueberries a big concern
	Butcher moose at grocery store, nuisance bears from MNR, road kill
	Wondering about transfer of contaminants from mosquitos
	Mentioned hunting dogs that go into bush
	More deer than moose in Dryden
	Community garden has bees
	Agree community members tend to fish closer to Ignace
	Surface water – one person was concerned about the unanticipated consequences of what is being put down the drainage for parameters you can't treat
	Pets (hunting dogs, that go out into the bush and also eat Canada geese in the yards)
	Mosquitos – do they transfer metals and radionuclides
	Red squirrels – people eat them
Workshop #4	
Loations	Input received on lakes that are fished near to the AOI
Workshop #5	
Tissues	One person eats owl (but this person is from further away near Lac Seul) and squirrel
Community Involvement	If we are hoping to get samples from the community, we will have to follow their schedule (WLON hunts in Sept/Oct, about two weeks before open season; for fishing, they net a lot in early fall to stock up until ice freezes, and then again in early spring before the ice lets out)
Tissues - locations	For blueberries, the bushes often follow a fireline
COPC	Glyphosate was brought up repeatedly; concerns about it on blueberries, and on it going into the water system and getting into water plants (wild rice, wild ginger)
VCs/Concerns	African flies with red eyes (brought in to control tent caterpillar, then crappy brought in to control them)
	Tree frogs
	Mice, squirrels, grouse, owl
	Pincherries, bear berries, wintergreen (under moss)
	One person from nearer to Lac Seul area uses wild ginger, which grows in creeks near bulrushes
	Bottom part of bulrush stem is used for flour
	There was mention of wild rice worm - the worms are eating and destroying some wild rice crops in the area
Tissue	Black bear is generally not eaten and is often connected to a clan; consumed by non-Indigenous people in Ignace and area
Atmospheric Sciences	Interest in learning about air quality, noise and light
	Suggestion that we speak to the Women's/Men's Group about ceremony (moon and tobacco ceremonies)
Workshop #6	
VCs/Concerns	Tumour fish (walleye in area have tissue growth on outside of their heads)
Atmospheric Sciences	Some input into possible station locations within clear-cut areas within the local study area as well as at the WLON property
Spirit/ceremony	Proper ceremonies need to take place as per Elder's requests before sampling takes place (i.e. water blessings, etc.)
General	Mention of an area that was devastated by local exploration company north of the community (blue dot on map); water was black, left behind destruction
	More pictures, diagrams, videos and using some of the tools you use to take samples and measurements would be a good way of displaying some information and engaging youth

Area of Relevance	Comment
Workshop #7	
General	The use of the word Industry Standard is not properly reflecting what we are intending to communicate; we mean our environmental industry but really it is regulatory standards. There is a very clear feeling that Industry Standard is not a good standard to hold ourselves to. Industry is taken to mean mining, paper, logging etc. industry and not our environmental industry.
VCs/Concerns	A lot of concerns about spraying/glyphosate from forestry, and how it is affecting vegetation like blueberries
	No one eats bear or owl
	Pincherries (jams), bearberries, strawberries, raspberries, blackberries, Saskatoon berries
	Earthworms – they are at the bottom of the food chain, so need to make sure get a good understanding of them
	Peppermint (for tea) - along shores
	Labrador tea
	Low bush cranberries
Spirit	You should pray to give you the best knowledge for how to look after it; always give thanks; keep in mind that everything is alive
Locations	Blueberries are gathered out north of Sioux Lookout, where they are currently spraying
	Hunting along Snake Bay Road, Atikokan Road
	Very little trapping – died off because of forestry machines and clearing, and also no market for furs anymore
	Low bush cranberries in swampy areas, along Long Lake River
General	With all the different studies being completed by so many different people, need to make sure that the scope remains broad enough and overlaps so that information isn't missed
	The use of the word Traditional Food – are we really capturing what we want? What we call Traditional Food is what WLON considers staples (conversely, for example, we may view turkey as a traditional food for thanksgiving). When I asked Tyson if he had suggestions for another word to convey what we want (i.e., it is being used to differentiate it from supermarket foods), he said we'd need to go to Chief and Council for that one
	Something to look into – Terry Tobias, and his publications on the use of the word Traditional
	Conversely, heard from other people that the use of this word is accurate, and there are no other better words (also heard this from other community groups on other projects, who prefer the use of this over 'Country Foods')
Atmospheric Sciences	Suggested using ceremony to ask how we should consider each element of our work
	Discussion about the importance and relevance of certain animal sounds, which have specific meaning to WLON, such as loons calls (believed to be a way to "call the wind"); also spoke about howling of wolves, which could be used to inform hunting decisions as well as establish pack size and number of unique packs; frog calls during mating season where also mentioned
	Talked about the idea of measuring these kind of animal calls and sharing this information with the community
	Discussion about the Moon Ceremony (fire side, burn offerings, singing), which is completed during full moons; talked about using this Ceremony as a launch point for the light monitoring campaign, which would need to be completed without the moon
	Using the tobacco ceremony prior to the start of monitoring campaigns was also suggested
Ceremony	The only way to understand water and life that it brings to all animals and living things to go without water (fast); this is truly the only way to appreciate it and the power it brings
	There was mention of Water Ceremony taking place before water sampling locations are sampled; i.e. taking someone from Elders group to the location at the start of the program to complete this Ceremony and choose final location – you need to spend time on the land to understand it
Water	Long and Stormy Lakes you can drink from – but the lake in front of Wabigoon you cannot because of previous flooding in the past; the reserves use to have water wells in between every 3-4 houses but they have since been plugged they believe and they have a water treatment system in the community
General	May want to consider taking off the purple reserve boundaries on the map as the whole area has largely been used by our people over time; reserve boundaries means little for how we use the land
	A lot of the Wabigoon's knowledge has been lost over the years due to the residential schooling; lost language; colonialism; Indian act. Some of this is coming back from those who were not sent away and being shared in the community. Balance is essential, our ancestors knew it and we lost it

Area of Relevance	Comment
Workshop #8	
Locations	Hunt along 622
	Lower Manitou Lake – in the past there was wild ginger there (not sure if there is or not still, hasn't gone in years)
	Dinorwic – used to be wild plum trees there, but not anymore
VCs	No one eats deer anymore
	Increasing wolf population because no one hunts them for fur anymore (no market)
	Decreasing rabbits because of all the wolves and foxes
	Pincherries, cranberries, raspberries – but all hard to find anymore
	Invasive species including zebra mussels were brought up
	Pesticides and spraying by forestry companies was discussed as were salts on the roads.
	Spores/bacteria (blastomycosis) in soils in the area are dangerous – people should have the right PPE and know about this further before completing baseline studies
General	Expressed importance of doing better than "industry standard" and meeting "regulatory requirements"
	Broad concern that the area is already heavily impacted
	Use of term "industry" instills mistrust
Atmospheric Sciences	Identified importance of whip-poor-will (species-at-risk) and suggested including monitoring its calls as part of the program
	One person asked if the choice of technology would alter the data quality
Workshop #9	
VCs	There are so many garter snakes in Dyment, and a lot of shed snake skins (to consider for analysis)
	Loons – concern about why on the list as a secondary VC, as you can't kill loons (clarified that that is an example of a fish eating duck, and can be considered with collection of feathers; other fish eating ducks would be considered if using lethal methods)
	Beaver and muskrat – one person likes to eat it, but you aren't allowed to kill them unless you're a trapper
	Dogs – eat beaver
	Grasshoppers – so many this year
Locations	Berries – may be some near Borehole 1 where it has been cleared in the past
	Long Lake, Stormy Lake, Mennin Lake (Walleye, trout); Basket Lake, Melgund Lake
	Trapping along road 8C (road 8 and 8c not shown on our maps, but goes right in our area, just south of Borups corner)
Miscellaneous	Check with Thunder Bay Highway Maintenance to inquire about possibility of getting samples from the road kill they clear
	One trapper from the area still traps beaver and muskrat
Water/groundwater	One person is willing to have their well water tested; they have spring fed water well and enjoys excellent water
Miscellaneous	Questions were asked about spraying glyphosphate again; the community was wondering if the site after cleared would be sprayed in the future to keep hardwoods etc. under control or if he would be cleared manually
General comments	Concern expressed about the clearing of lands and the application of herbicides
Workshop #10	
Tissue collection	Tourist lodges in the area
	Thunder Bay Highway Maintenance – Miller (road kill)
	One of the participants works for this company; will need to discuss with him later about possibility of getting tissue samples
	Commercial fisheries in the area – incidental catches
Miscellaneous	Iron ore mine at Bending Lake (Ambershaw Metallics) that is going through EA process now
	Treasury Metals has an open pit mine west of Dryden that has gone through the EA process
VCs	Livestock (a few farms in Dyment; horses, goats, chickens, guinea hens)
Data	Information on age and sex of animals collected would be important

Area of Relevance	Comment
Tissue	Regarding moose ageing (above comment), Study Team discussed how they can be aged if the lower jaw is submitted by hunters or if the animal is road kill; fish ageing is proposed
Tissue	Approximately 40 + moose killed per spring to fall season; work with road crews to get notice on when and where moose are killed to obtain samples
Tissue	People around Ignace do consume black bear; spring/fall bear hunts in the area and working with hunting lodges and MNRF would be a good way to gather samples for the program including fish
General - tissues	Are we doing too much? It seems like a lot of samples of tissue(s)
Data	MNRF may have some additional data worth looking into from the area although would lack radionuclides
General	Work with local naturists (botanists and birders in the area) to help collect data and data points through a potential working group or app that people can help contribute though local knowledge and community groups
Atmospheric Sciences	Concern raised that sampling program may not capture the fire season and not accurately reflect true baseline; noted that there have not been any fires in the last 5 years; how do you ensure that you have captured the natural variability without fires
	Talked about the idea of including fire modelling to supplement the baseline work in the event that there are no fires during the baseline program
	Concern expressed that there are too many possible variables to capture a complete picture of "air quality"
	One individual indicated that there were a number of meteorological stations managed by MNRF that might make good locations for monitoring

APPENDIX C

CONCEPTUAL SITE MODEL

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APPENDIX C: CONCEPTUAL SITE MODEL

C.1 Introduction

This document provides the working Conceptual Site Model (CSM) that has been used to develop the Environmental Media Baseline Program (EMBP) for the Nuclear Waste Management Organization's (NWMO) Deep Geological Repository (DGR) and Centre of Expertise (the Project). The CSM integrates information from the various disciplines involved in the EMBP in order to describe the local environment and identify how the various Project components interact with one another and the environment. It is intended to be based on Project- and site-specific information. The development of a robust and solid CSM is crucial to evaluating the feasibility of various potential sampling programs.

Development of the CSM discussed herein involved a thorough review of documents provided by the NWMO prior to April 20, 2019 related to the DGR in general and environmental work carried out in the Northwestern Ontario region. It also required the application of numerous assumptions since the facility design and location have not been finalized. Any modifications to these assumptions based on updated design information are likely to impact the CSM and may affect the EMBP design.

This document provides a narrative description of the study area and existing environment for each component (e.g., selected receptors, species of conservation concern, contaminants, release mechanisms, environmental fate and transport, etc.), summarizes the project-environment interactions in tabular format, 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.

The CSM has been prepared with consideration of the following five major stages of the Project (NWMO 2017):

- Construction: The site will be prepared for construction by clearing, site grading, installing fencing, installing temporary construction services, and establishing a storm water management system. 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

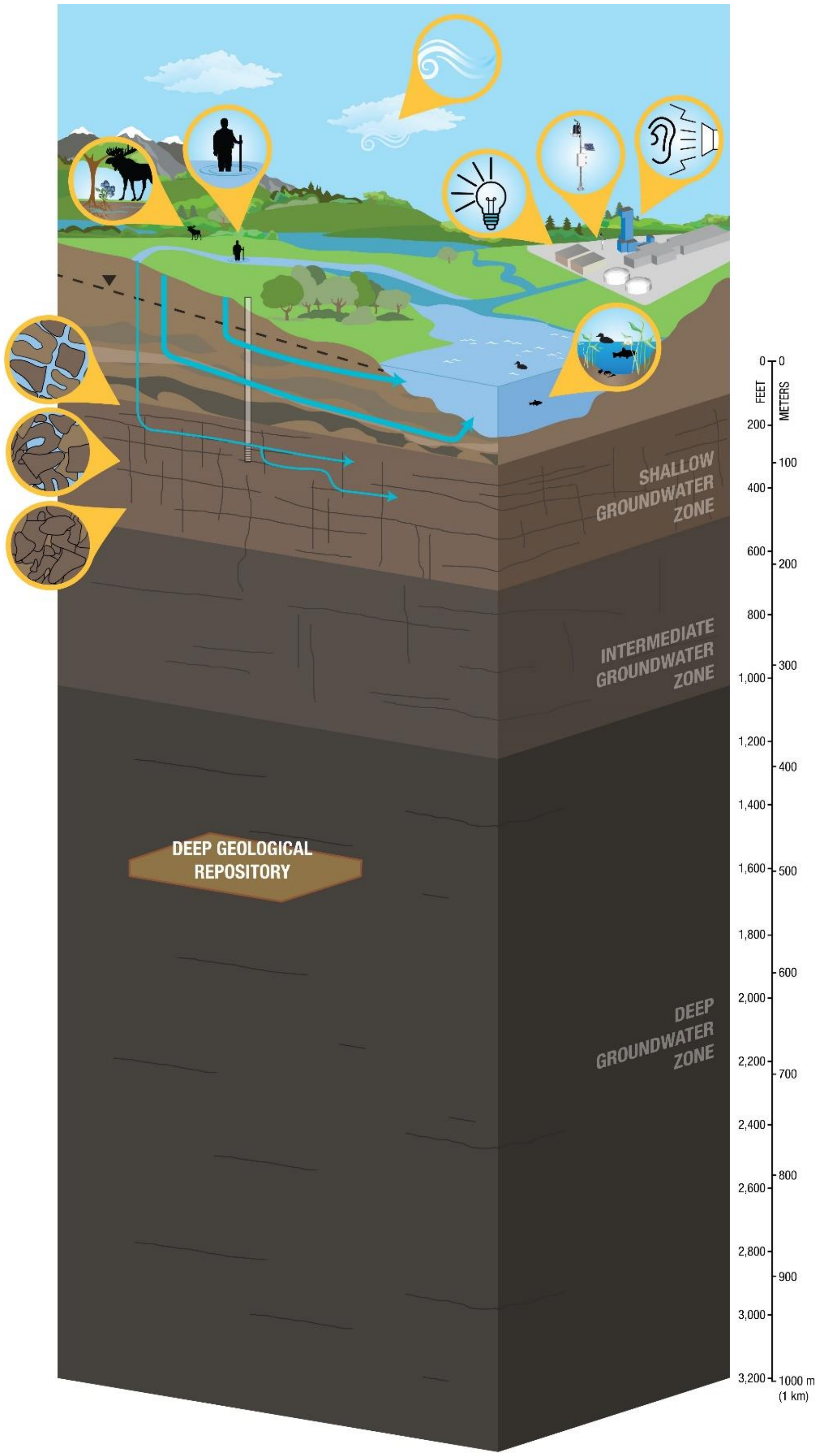
containers in the repository, and continued underground development. These operational activities are expected to last about 40 years.

- 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: 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, the period of decommissioning is assumed to be 10 to 30 years (NWMO 2016, 2017).
- Postclosure: The postclosure period starts at the end of decommissioning, after the shafts have been sealed and the surface facilities have been dismantled. The postclosure period will last approximately one million years (NWMO 2017).

C.2 Conceptual Site Model

Figure C.1 below provides a graphical representation of the information discussed within the following section, summarizing how the environment may potentially interact with the Project and the environmental fate and transport of possible releases from the DGR.

Figure C.1 Conceptual Site Model



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

C.2.1 Study Area and Existing Environment

The NWMO has selected a potential geologically suitable area for the Project that is located approximately 40 km west of Ignace, Ontario, within the northern portion of the Revell Batholith within the Wabigoon Subprovince of the Superior Province in the Canadian Shield. The Wabigoon Subprovince is host to a series of granitic to granodioritic units that intrude metamorphosed volcanic and sedimentary rocks of greenstone belts. These greenstone belts contain a number of base metal (copper, nickel, and lead) and gold occurrences, some of which are located within a 10 km radius of the proposed Site area (Golder 2013). Granitic intrusive units in the area include the Revell, Indian Lake, White Otter Lake, and Basket Lake batholiths (Paterson Grant and Watson Limited 2013).

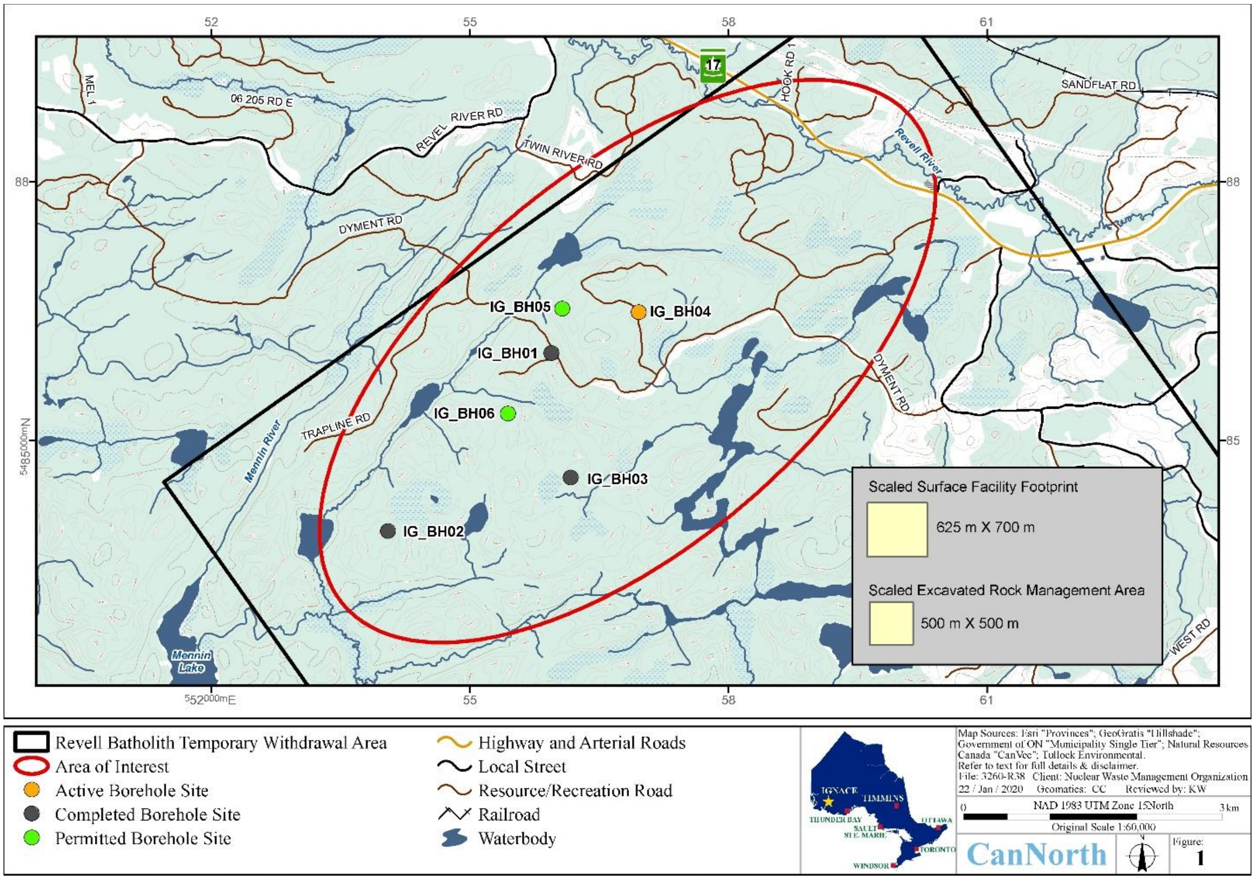
The potential geologically suitable area (Area of Interest, or AOI) is defined by an ellipse (oval) that is approximately 4.4 km by 8.7 km and extends from immediately north of Highway 17 in a southwest direction (see Figure C.2). Within the AOI are two primary roads (Dyment and Trapline roads), a network of operations roads and temporary access roads constructed to support borehole drilling and logging, and several small watercourses and wetlands. Based on published maps and aerial photographs of the AOI, it is relatively flat (elevation range of ~30 m) and consists of several small lakes, streams, and wetlands; there are, however, several larger waterbodies in the area, such as Mennin Lake which is located approximately 2 km southwest of the outer extremity of the ellipse delineating the AOI, and Raleigh Lake which is approximately 20 km southeast of the AOI.

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 offsite excavated rock management area. There is also likely to be a buffer that will be cleared beyond the fence boundary to serve as a fire break in the event of a forest fire in the future. Since the area is heavily forested, it is assumed there will be a 100-m fire break buffer for the DGR surface facilities and a 30-m buffer for the excavated rock management area. Additional land will be required for access roads and potentially for a camp site. The location of the Project infrastructure within the AOI is currently unknown.

A series of nested study areas has been established to evaluate the effects of the Project with increasing distance from the Site (Site Study Area [SSA], Local Study Area [LSA], and Regional Study Area [RSA]). For each medium, the SSA will be identical and will be defined by the eventual property boundary of the facility, located somewhere within the

AOI. The LSA and RSA for each medium are expected to largely overlap due to the interactions between media (e.g., atmospheric deposition onto soil); however there may be a different area of focus for each medium as discussed below.

Figure C.2 Area of Interest



C.2.1.1 Aquatic Environment

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

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

Hydrology

Aerial photos indicate there has been considerable logging in the northeast region of the AOI which will influence the local hydrology, causing more runoff due to a decrease in interception and reduced infiltration. While there is a moderate change in elevation between the lowland areas with wetlands and watercourses, it is unclear whether local flooding occurs within the AOI.

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

Given the topography, small drainage basins, and number of wetlands it will be important to understand the flow ranges in these streams, including whether some of them are intermittent, whether the wetland areas may be intermittent, and whether any seasonal flooding may occur. Understanding the flows will also inform the site design for water withdrawal needs and effluent discharge needs and how to effectively reduce water quality impacts. Given the location of watercourses and wetlands, there are three or four sites within the AOI that would not impinge upon watercourses or wetlands. This information will be important for the Construction, Operations, and Extended Monitoring phases of the facility.

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

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

For the hydrological component, the LSA (LSA_{HYD}) is defined by the same boundaries of the AOI (i.e., the ellipse shown in Figure C.2). Waterbody maps have confirmed the presence of many wetlands within the LSA_{HYD}. Historic and more recent flow data are not available for the streams within the LSA_{HYD}. More detailed and site-specific information on flow, floods, and wetlands are required to better characterize the LSA_{HYD} and to better understand potential interactions between surface water features and the facility.

Outside of the LSA_{HYD}, the RSA_{HYD} is defined by areas downstream of the AOI on the Revell River and below Mennin Lake on Mennin River. The baseline conditions on both rivers should be studied to better understand the interactions that may occur from either a water withdrawal or effluent discharge, which are more likely to occur in these larger rivers than the small streams in the AOI.

Surface Water Parameters (Water and Sediment Quality Markers)

Few studies have been conducted to characterize the aquatic environment in the AOI and the majority have been desktop assessments, such as stream reach classifications. In 2016, some fish community information was collected from select lakes and streams in a larger study area within the Revell Batholith (Tulloch 2018a). Results illustrated that three species (white sucker, blacknose shiner, and Iowa darter) were unique to the Revell Batholith study area (i.e., were not captured in the other study areas investigated within the Northwestern Ontario region). White sucker were observed at 12 of the 23 sites sampled, but it is not known if they were specifically captured within the current AOI as the AOI only overlaps with a small portion of the larger study area assessed. In 2017, aquatic habitat assessments were conducted within select areas of the AOI in support of borehole drilling and temporary access road development (Tulloch 2018b). Aquatic habitat was documented at one permanent (Mennin Lake Tributary) and two intermittent watercourses in the AOI. The Mennin Lake Tributary was considered direct fish habitat due to the permanence of the watercourse and connectivity to Mennin Lake and the intermittent streams were determined to be indirect fish habitats that act as tributaries to the main watercourse (Tulloch 2018b).

The LSA for surface water parameters (LSA_{SW}) includes waterbodies with the potential of being impacted by the Project, as well as potential reference areas. An assumption is being made that treated effluent will be discharged through a single discharge point into either the Mennin River or the north part of the Revell River located downstream of the AOI. Furthermore, it is assumed that discharge will not occur upstream of Mennin Lake due to the small size and assimilative capacity of the upstream waterbodies located in the AOI. In addition, the LSA_{SW} includes reference waterbodies located upstream of the AOI within the same Wabigoon watershed.

The RSA_{SW} incorporates lakes of significance to the communities that are engaging with the NWMO. The objective of sampling the regional waterbodies is to obtain baseline data on components of concern identified during various engagement workshops (such as water quality and invasive species) so that there are baseline data for comparison to long-term monitoring data collected during subsequent Project phases. Waterbodies near to Ignace that may be of fishing importance may include, among others, Agimak, Osaquan, Michel, and Indian lakes; however, none of these lakes are downstream of the AOI.

C.2.1.2 Hydrogeological Environment

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

Well records in the Ignace area only contain hydrogeological information on the overburden and shallow bedrock aquifers. From the MECP water well database, there are 120 water wells in the Ignace area, of which only 85 provide useful information regarding the aquifer, yields, and other hydrogeological parameters. None of the existing wells are within the AOI, one well is located within the LSA_{HYG} and a portion of the remainder will be within the RSA_{HYG} once that is defined. No information is available on the deep bedrock hydrogeology at the typical repository depth of approximately 500 m. Overburden aquifer wells ranged from 4.5 m to 42 m deep and shallow bedrock aquifer wells ranged from 5.5 m to 154 m deep. Aquifer tests conducted on these wells measured pumping rates of 4.5 L/min to 930 L/min for the overburden layer and 0 L/min to 206 L/min (typically 30 L/min to 40 L/min) for the shallow bedrock (Golder 2013).

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

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

C.2.1.3 Soil

Soil is the naturally occurring, unconsolidated mineral or organic material at least 10 cm in thickness that occurs at the earth's surface and is capable of supporting plant growth (Soil Classification Working Group 1998). Scientifically, the term "naturally occurring" for soils includes the disturbance of the surface horizons by human activities such as cultivation and logging, but not displaced materials such as stockpiled gravel or excavated rock. The definition of the soil medium for this baseline study is expanded to include soil and rock that is placed on surface as a result of excavation during construction activities (including consolidated and unconsolidated material). Environmental baseline characterization will be required to describe and characterize the distribution of existing surface terrain and associated soil quality and sensitivities within the soils LSA and RSA. Geochemical characterization will also be required to inform decisions on excavated rock and overburden placement within the SSA and ensure that storage of excavated materials is designed using best engineering practices.

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

The study areas for the soil sampling component of the baseline studies include the following:

- LSA_{SOIL} – Includes the land beyond the SSA where there is potential for effects to occur from the Project (e.g., through runoff, dewatering activities, etc.) and where target Study Components (SCs) can be retained.
- RSA_{SOIL} – Areas beyond the LSA_{SOIL} associated with support services and which may be affected by soil carried by prevailing winds.

C.2.1.4 Atmospheric Environment (Air Quality, Noise, and Light)

The local atmospheric environment is characteristic of a northern Ontario air shed, where local, regional, and national/international sources of Contaminants of Potential Concern (COPC) contribute to local air quality. Within the Ignace area, there are several industrial sources that release COPC into the air shed, including the Domtar Inc. Dryden Mill, Produits Forestiers Résolu, Ignace Sawmill, and TransCanada PipeLines Ltd.'s Station 58. These industries contribute to releases of fuel combustion by-products (i.e., CO, NO_X, SO_2, particulates) and in some cases, releases of Volatile Organic Compounds VOCs), Polycyclic Aromatic Hydrocarbons (PAHs), dioxins and furans, metals, chlorinated hydrocarbons, and sulphides. In addition, the intersecting rail corridor and Trans-Canada highway also contribute to releases of fugitive dust as well as fuel combustion by-products.

Diesel-fired power generators in remote First Nation communities also contribute to releases of fuel combustion by-products.

The LSA for air quality (LSA_{AQ}) includes the lands beyond the SSA where there is a potential for air quality effects to occur from the Project. For the purposes of this assessment, this has been defined as the lands within 10 km of the SSA, which includes the nearest community of Borups Corners. Note that there are other sources of air releases in the LSA_{AQ}, such as local industry (e.g. TransCanada Station 58), transportation (e.g., Trans-Canada Highway), and intermittent and seasonal sources (i.e., forest fires) which will contribute to existing and future air quality within this boundary.

The RSA_{AQ} includes lands beyond the LSA_{AQ} that are relevant to the assessment of long-range air quality effects of the Project on local communities. Typically, the RSA_{AQ} is set with consideration to existing air quality monitoring networks, such as those operated by the Federal and Provincial Governments (Environment and Climate Change Canada [ECCC] and the Ontario Ministry of Environment, Conservation and Parks [MECP]), in order to assist with the description of existing conditions. Given the remote location, there are no existing air quality monitoring stations within a reasonable offset from the AOI. The nearest stations that measure the types of chemical parameters typically included in an Air Quality Assessment are in Thunder Bay (approximately 250 km from the LSA_{ATM}) and Winnipeg (approximately 350 km from the LSA_{AQ}). As a result, the baseline monitoring study is intended to fill this data gap. The RSA_{AQ} has been defined as the lands within 50 km of the LSA_{AQ}, which extends to Ignace and Dryden.

The local study area for noise (LSA_{NO}) includes the lands beyond the SSA where there is a potential for noise effects to occur from the Project. For the purposes of this assessment, this has been defined as the lands within 5 km of the SSA. Note that there are other sources of noise emissions in the LSA_{NO}, such as transportation sources, which will contribute to the existing and future noise conditions within this boundary. Given the nature of noise propagation, noise emissions are not expected to extend beyond the LSA_{NO} and a regional study area for noise was not assessed.

The study area for the baseline light monitoring is restricted to the SSA given the nature of the surrounding environment (i.e., intrinsically dark). As such, local and regional study areas for light were not defined.

C.2.1.5 Tissues

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

Information characterizing habitat types in the AOI is largely based on desktop information with some ground truthing studies. In 2017, environmental studies were conducted in a central portion of the AOI that included three borehole sites, four proposed access road alignments, and areas within 120 m for buffer (Tulloch 2018a). Ecological land classification of this study area identified 15 ecosite types that are considered regionally common. The majority of the TM3 study area (89%) was comprised of undeveloped upland habitat that was almost exclusively dominated by mixes of black spruce and jack pine. Wetlands comprised 11% of the study area and were primarily black spruce dominated swamps (Tulloch 2018a).

As part of the Phase 2 assessments, trail cameras, song meters, bird point counts, amphibian breeding surveys, and an Eastern Whip-poor-will survey were conducted in the AOI; however, these data are not yet available. Thus, site-specific information on wildlife and plant species that occur in the AOI cannot be provided. High level fish, wildlife, and land use information in the Ignace region is available from the Ontario Ministry of Natural Resources and Forestry (MNRF) databases (e.g., fish community composition in larger lakes) and from community sources.

Tourism is an important industry in the region, with the area surrounding the community of Ignace containing numerous provincial parks, conservation reserves, and hunting and fishing lodges (SENES 2013). The community of Ignace website describes some of the most popular hunting targets as being moose, bear, deer, and small game such as grouse and snowshoe hare (https://www.ignace.ca). The NWMO has held several workshops with stakeholders and First Nations' rights-holders to receive input on the environmental baseline study design. Preliminary results indicate that concerns have been expressed over potential Project impacts to hunting (including deer and moose), fishing, berry and mushroom picking, wild rice, birds, and insects. The input received from these workshops has been considered in the design of the EMBP.

A Traditional Foods Dietary Survey is proposed and would collect information on the quantity, type, and general harvest locations of traditional foods consumed by local stakeholders/rights-holders close to the proposed Project area. The information collected from this survey would help to further define the study areas for the tissue sampling component of the baseline studies. The proposed study areas include the following:

- LSA_{TIS} – Portions of the AOI and the Mennin Lake drainage that are most relevant to the Project interactions and contain habitat types where target SCs can be obtained.
- RSA_{TIS} – Lands and waterbodies beyond the AOI and the Mennin Lake drainage that stakeholders and rights-holders consider being of high importance and express concern over the potential for Project interactions.

C.2.2 Study Components

Potential SCs to consider for the future federal IA which might have residual environmental effects:

Biological Environment	Physical Environment
• Change in populations[1] and/or concentrations: ○ Berries ○ Honey ○ Wild rice ○ Browse ○ Aquatic vegetation ○ Phytoplankton and zooplankton ○ Benthic invertebrates ○ Edible mushrooms ○ Lichen ○ Terrestrial Insects ○ Fish (various trophic levels) ○ Herptiles ○ Waterfowl ○ Terrestrial birds, including songbirds ○ Mammals ○ Moose ○ Deer	• Change in aquatic habitat • Change in surface water quantity and quality • Change in sediment quantity and quality • Change in topography • Change in surface soil characteristics and chemistry • Change in runoff characteristics (impervious area, drainage networks) during construction and then during operations • Change in overburden/shallow bedrock/deep bedrock groundwater quantity and quality • Change in surface water– groundwater interactions • Change in slope stability and water quality

[1]Note: The biological environment populations component for this contract is limited to plankton and benthic invertebrates.

It is not anticipated that all of the above-listed SCs will be sampled during the tissue samples component of the EMBP. Tissue types to be sampled will be a mixture of the following:

- Those relevant to evaluating human exposure to COPC, such as berries, fish, and game;
- Those relevant to addressing stakeholders and rights-holders concerns, such as fish, wild rice, and game; and
- Those relevant to evaluating ecological exposure to COPC, such as browse, aquatic macrophytes, lichen, small mammals and birds, and insects.

Existing environment data has been used to create a list of species known to occur in the local and regional study areas. This information, in combination with input from the stakeholders and rights-holders, the likelihood and significance of Project interactions, and consideration of program objectives, statistical objectives, data quality objectives, data usage, and budget, was used to select target species for the tissue samples component of the environmental baseline studies.

C.2.3 Potential Project Interactions

For planning purposes, a preliminary description of the Project was developed by NWMO that describes the works and activities likely to be associated with the Construction, Operation, Extended Monitoring, and Decommissioning phases. This understanding forms the basis of the baseline sampling program design. The current surface facilities layout is provided in Figure C.3. To focus the baseline data collection program, the Project Team reviewed the preliminary project description to consider where the Project was likely to interact with the environment. The potential Project-Environment interactions are described in Table C.1.

Figure C.3 Surface facilities layout

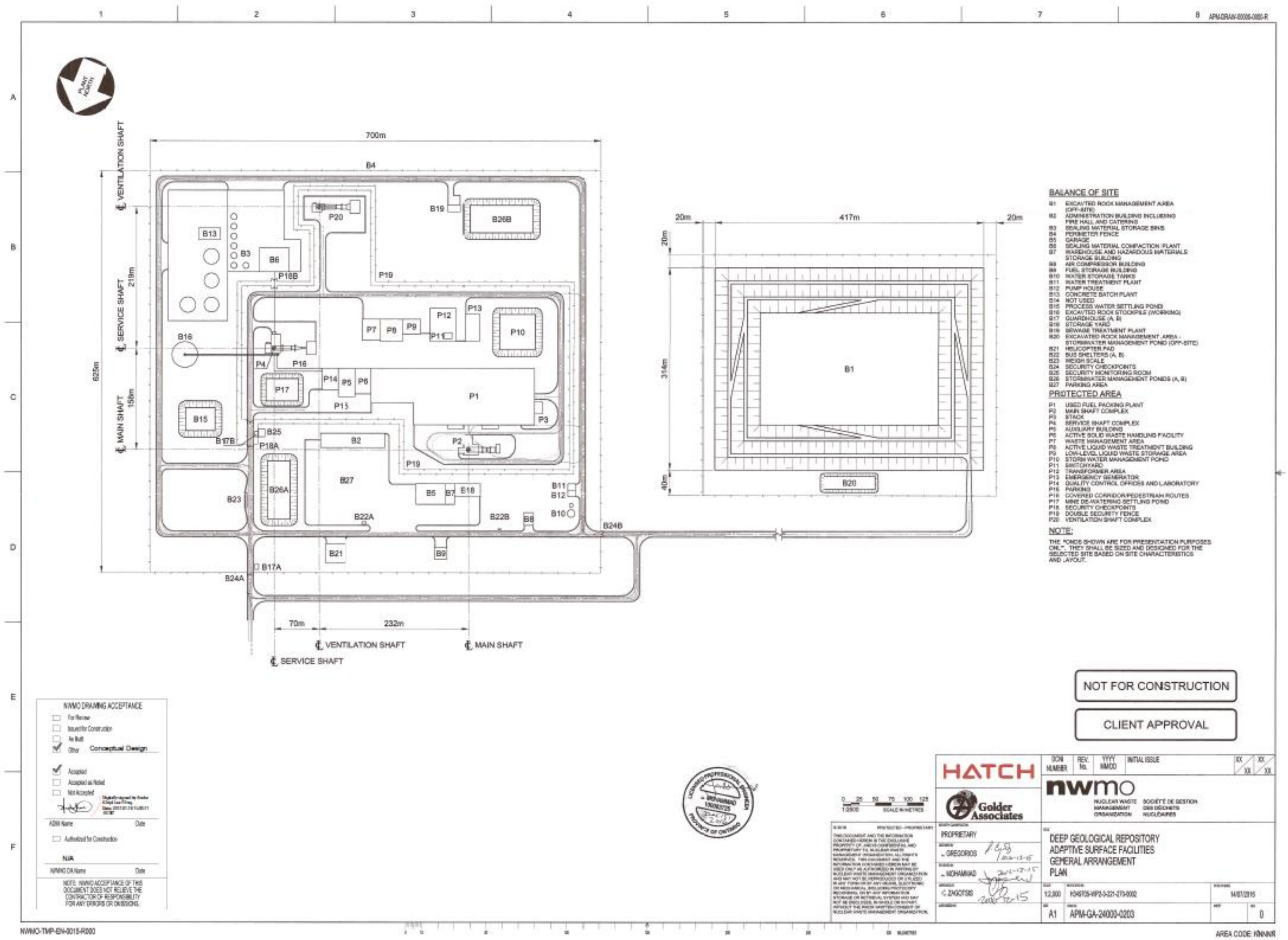


Table C.1 Potential Project-environment interactions during the major stages of the Project

Project Phase	Atmospheric Environment	Aquatic Environment	Hydrogeological Environment	Soil	Tissues
Construction	– Increased release of combustion by-product emissions (primarily NOx, CO, SO_2 but also metals and PAHs) due to vehicle/ equipment exhausts and blasting – Increased release of suspended particulate matter (SPM, PM_{10} and $PM_{2.5}$) due to excavation, earth-moving, loading, hauling, dumping, blasting, vehicle travel and exhaust – Increased noise from clearing and machinery – Increased light from lighting at the site	– Water supply requirements may cause lowered water levels and volumes in the source waterbody, potentially impacting aquatic habitat (e.g., reduced flow, increased stream temperature, reducing the volume of aquatic habitat, etc.) – Dewatering could lead to a lowering of groundwater levels, causing surface water drawdown and subsequent water level alterations; this could disturb wetlands and sediments, and lead to changes in geochemical conditions that could potentially result in mobilization of minerals and contaminants – Discharge of treated effluent (sewage, dewatering, stormwater) of unknown quantity and quality to a local waterbody will impact water quantity and quality in the receiving waterbody (Understanding the volume of the effluent discharge and its quality will determine what size and types of waterbodies can be used as receiving waters) – Direct deposition of particulate or runoff containing particulates affecting surface water quality and sediment composition – Discharge of treated runoff of unknown quantity and quality from disturbed soils and off-site excavated rock pile may impact water quantity and quality in the receiving waterbody and sediment composition – Vibrations – Accidental surface releases of fuels could potentially impact surface water and sediment composition	– Dewatering could potentially cause a change in the ambient groundwater flow/transport in the overburden and shallow and deep bedrock layers – Dewatering could lead to a lowering of groundwater levels, causing surface water drawdown; a better understanding of the surface water hydrology and connection to groundwater will be important – Disturbance of fractured rock formation may increase the weathering potential of the shallow bedrock and the connection between shallow and deep bedrock through more open fractures and flow paths – There is the potential for potentiometric surface mounding beneath stormwater management ponds and excavated rock piles – Leaching of metals/minerals and residual explosives from excavated rock and soil can potentially impact the shallow aquifer system; potential for generation of acid rock drainage (ARD) due to sulfide content of the rock – Accidental surface releases of non-radiological chemicals and fuels could potentially impact the shallow aquifer via overburden/shallow bedrock infiltration – Deep groundwater release at surface could impact shallow groundwater chemistry	– Site excavation will disturb ambient overburden conditions – Changes to surface conditions may induce soil disturbance (e.g. erosion/compaction) – Soil and/or sediment disturbance, or fine particle fraction of excavated rock placed on surface may result in aqueous transport of suspended particulates – Leaching of metals/minerals and residual explosives may occur from excavated rock and soil; potential for generation of acid rock drainage (ARD) due to sulfide content of the rock – Accidental surface releases of non-radiological chemicals and fuels could potentially impact soil – Dewatering could lead to a lowering of groundwater levels, causing changes in soil moisture – Deep groundwater release at surface could impact soil chemistry	– Changes in tissue concentrations of COPC in aquatic biota from changes in sediment and surface water quality – Uptake of COPC by plant roots from soil and deposition of dust onto plant leaves – Ingestion of COPC in food (plants, fish, prey) by aquatic and terrestrial animals and biomagnification up the food chain – Soil disturbances introduced by changes in surface conditions may affect plant quantity and quality
Operation	– Increased release of combustion by-product emissions (primarily NOx, CO, SO_2) due to heating and ventilation systems, vehicle/equipment exhausts, emergency generators; – Increased release of suspended particulate matter (SPM, PM_{10} and $PM_{2.5}$) due to fugitive sources (i.e. stockpiles), concrete batching, material handling, dust collectors and ventilation systems, etc. – Potential for releases of radiation/radioactivity and other COPC from material, waste and fuel handling, preparation and storage, ventilation systems.	– Water supply requirements may cause lowered water levels and volumes in the source waterbody, potentially impacting aquatic habitat (e.g., reduced flow, increased stream temperature, reducing the volume of aquatic habitat, etc.) – Dewatering could lead to a cone of depression, causing water drawdown; a better understanding of the surface water hydrology and connection to groundwater will be important – Discharge of treated effluent (sewage, dewatering, stormwater) of unknown quantity and quality to a local waterbody will impact water quantity and quality in the receiving waterbody (Understanding the volume of the effluent discharge and its quality will determine what size and types of waterbodies can be used as receiving waters)	– Dewatering could potentially cause a change in the ambient groundwater flow/transport in the overburden and shallow and deep bedrock layers – Dewatering could lead to a cone of depression, causing water drawdown. A better understanding of the surface water hydrology and connection to groundwater will be important – There is the potential for potentiometric surface mounding beneath stormwater management ponds and excavated rock piles – Accidental surface releases of non-radiological chemicals and fuels could potentially impact the shallow aquifer via overburden/shallow bedrock infiltration – Accidental surface releases of radiological contaminants could potentially impact the	– Soil and/or sediment disturbance, or fine particle fraction of excavated rock placed on surface may result in aqueous transport of suspended particulates – Leaching of metals/minerals and residual explosives may occur from waste rock and soil; potential for generation of acid rock drainage (ARD) due to sulfide content of the rock – Accidental surface releases of non-radiological chemicals and fuels could potentially impact soils – Accidental surface releases of radiological contaminants could impact soils	– Changes in tissue concentrations of COPC in aquatic biota from changes in sediment and surface water quality – Uptake of COPC by plant roots from soil and deposition of dust onto plant leaves – Ingestion of COPC in food (plants, fish, prey) by aquatic and terrestrial animals and biomagnification up the food chain

Project Phase	Atmospheric Environment	Aquatic Environment	Hydrogeological Environment	Soil	Tissues
		– Discharge of treated runoff of unknown quantity and quality from the off-site excavated rock pile may impact water quantity and quality in the receiving waterbody – Accidental surface releases of chemicals, radionuclides and fuels could potentially impact surface water	shallow aquifer via overburden/shallow bedrock infiltration – Failure of seals in monitoring wells could lead to surface water impacts to shallow groundwater, or mixing of groundwater types – Deep groundwater release at surface could impact shallow groundwater chemistry		
Extended Monitoring	– Continued release of combustion by-product emissions (primarily NOx, CO, SO_2) due to heating and ventilation systems, vehicle/equipment exhausts, emergency generators; – Potential for releases of radiation/radioactivity from ventilation systems and other passive releases (although unlikely)	– Water supply requirements may cause lowered water levels and volumes in the source waterbody, potentially impacting aquatic habitat (e.g., reduced flow, increased stream temperature, reducing the volume of aquatic habitat, etc.) – Dewatering (if still required) could lead to a cone of depression, causing water drawdown; a better understanding of the surface water hydrology and connection to groundwater will be important – Discharge of treated effluent (sewage, dewatering, stormwater) of unknown quantity and quality to a local waterbody will impact water quantity and quality in the receiving waterbody (Understanding the volume of the effluent discharge and its quality will determine what size and types of waterbodies can be used as receiving waters) – Discharge of treated runoff of unknown quantity and quality from the off-site excavated rock pile may impact water quantity and quality in the receiving waterbody – Accidental surface releases chemicals, radionuclide and fuels could potentially impact surface water	– Dewatering could potentially cause a change in the ambient groundwater flow/transport in the overburden and shallow and deep bedrock layers – Dewatering could lead to a cone of depression, causing water drawdown. A better understanding of the surface water hydrology and connection to groundwater will be important – There is the potential for potentiometric surface mounding beneath stormwater management ponds and excavated rock piles – Accidental surface releases of non-radiological chemicals and fuels could potentially impact the shallow aquifer via overburden/shallow bedrock infiltration – Failure of seals in monitoring wells or poor abandonment of obsolete monitoring wells could lead to surface water impacts to shallow groundwater, or mixing of groundwater types	– Soil and/or sediment disturbance, or fine particle fraction of excavated rock placed on surface may result in aqueous transport of suspended particulates – Leaching of metals/minerals and residual explosives may occur from excavated rock and soil; potential for generation of acid rock drainage (ARD) due to sulfide content of the rock – Accidental surface releases of chemicals and fuels could potentially impact soils	– Changes in tissue concentrations of COPC in aquatic biota from changes in sediment and surface water quality – Uptake of COPC by plant roots from soil and deposition of dust onto plant leaves – Ingestion of COPC in food (plants, fish, prey) by aquatic and terrestrial animals and biomagnification up the food chain
Decommission-ing	– Increased release of suspended particulate matter (SPM, PM_{10} and $PM_{2.5}$) due to building and shaft, underground deconstruction / de-commissioning, and vehicle equipment exhausts – Increased release of combustion by-product emissions (primarily NOx/NO_2, CO, SO_2 but also metals and PAHs) due to vehicle/ equipment exhausts. – Potential for releases of radiation/radioactivity from decommissioning and decontamination activities, ongoing operation of ventilation systems and other passive releases (although unlikely)	– Discharge of treated runoff of unknown quantity and quality from disturbed soils and off-site excavated rock pile may impact water quantity and quality in the receiving waterbody and sediment composition	– Poor abandonment of obsolete monitoring wells could lead to surface water impacts to shallow groundwater or mixing of groundwater types – Poor shaft sealing could lead to surface water impact to shallow groundwater or mixing of groundwater types	– Soil and/or sediment disturbance, or fine particle fraction of excavated rock placed on surface may result in aqueous transport of suspended particulates – Leaching of metals/minerals and residual explosives may occur from excavated rock and soil; potential for generation of acid rock drainage (ARD) due to sulfide content of the rock	– Changes in tissue concentrations of COPC in aquatic biota from changes in sediment and surface water quality – Uptake of COPC by plant roots from soil and deposition of dust onto plant leaves – Ingestion of COPC in food (plants, fish, prey) by aquatic and terrestrial animals and biomagnification up the food chain
Postclosure	– Potential radiological and non-radiological releases over the long-term from waste in the repository after transport	– Potential radiological and non-radiological releases over the long-term from waste in the repository	– Potential radiological and non-radiological releases over the long-term from waste in the repository	– Potential radiological and non-radiological releases over the long-term from waste in the repository	– Potential radiological and non-radiological releases over the long-term from waste in the repository

C.2.4 Assumptions

The current set of project assumptions that have been made to develop the CSM are described below. These assumptions will be carried through the development of Year 1 of the EMBP:

- The Project footprint (SSA) will avoid as many waterbodies and wetlands as possible, realizing that it will likely not be possible to entirely avoid wetlands given their abundance in the AOI.
- The above ground features of the facility will consist of five ponds (three storm water management ponds, one process water settling pond, and one mine dewatering settling pond) that have been sized to accommodate a 1-in-500-year storm event. These ponds will be lined to prevent seepage to the groundwater. The mine dewatering settling pond may contain sediments, nitrogen compounds, and high salinity and uranium.
- 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.
- It will be possible to use a watercourse from within or adjacent to the AOI for water withdrawal. Service water will be sourced from a local waterbody and up to 90% of the used water is expected to be recycled. The total annual service water requirements for excavation and other uses will be approximately 110 million litres, while the required water supply rate for the above ground features is expected to be between 97 m3/day to 134 m3/day (NWMO 2016).
- Potable water will be produced on site at the water treatment plant using the fresh/fire water tank as a supply source.
- Treated effluent will be discharged during the project phases except for postclosure. On-site treated effluent from dewatering, stormwater run-off, and sewage will be discharged into a single location in the local receiving water course. The receiving waterbody is currently not known, nor is the quantity and quality of effluent; it is assumed that it would likely discharge to the Mennin River or Revell River, due to their larger size (solely based on size of river using aerial photography) and higher assimilative capacity. The amount of water discharged will be greater than the water withdrawn because of the stormwater and dewatering effluent streams. For the design of the surface water component for Year 1 of the EMBP, our Project Team is assuming that treated effluent will be discharged through a single discharge point into the Mennin River drainage.

- The stormwater runoff will be captured, treated, and released at the treated effluent release point. Stormwater management ponds will be appropriately designed to minimize the potential of groundwater mounding (assumed that under anticipated conditions, stormwater management ponds are not likely to influence and cause adverse effects on the local shallow groundwater flow.
- 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.
- Characterization of the overburden unit is required from a desktop study. In some NWMO design reports, if the native overburden has a relatively low infiltration capacity it can be assumed that the impacts from surface water runoff infiltration into the subsurface will be minimal (i.e. additional design safety factor).
- Excavated rock, overburden and soil piles will be designed using best engineering practices. Appropriate covers, underlying pile drainage and liners, and silt curtains will be installed to minimize leaching and ARD generation. Under the anticipated project conditions, excavated rock piles are not likely to influence and cause adverse effects on the local shallow groundwater flow.
- Dewatering rates utilized during the initial construction and operations will not significantly impact off-site and regional groundwater flow regimes. Alteration of the groundwater flow regime could impact native sediments and wetland areas.
- Appropriate operational protocols will be executed during the lifespan of the DGR, and accidental surface releases of non-radiological chemicals and fuels will be prevented to the extent possible.
- Hypothetical Hydraulic Conductivity of Crystalline Rock is 10 m/s to 11 m/s (NWMO 2016)
- Dewatering Sump Pumping Rate is 550 m^3/day (NWMO 2016).
- Given the surficial geology in most of the LSA is bedrock and the high number of wetland areas, surface water does not infiltrate much and instead remains as surface flow that keeps the wetlands wet throughout the summer.

C.2.5 Contaminants of Potential Concern

The COPC are discussed separately (see Appendix D) but include a range of radionuclides, metals, organic compounds, atmospheric parameters (e.g. dust), nutrients, and general chemistry parameters. Glyphosate has also been included in select media to address stakeholder and rights-holder concerns over its use by the forestry industry in the area.

C.3 Data Gaps

The design of the EMBP would be greatly aided and can be tailored to be more site-specific if the following information can be provided:

- Identify which receiving waters can assimilate the various effluent discharges from the facility.
- Identify the extent and orientation of the air shed that could be impacted from ventilation system discharges.
- Identify if any of the sites within the AOI flood seasonally or more often.
- Assess how much stormwater will be generated for the facility and the rock pile areas.
- Assess which watercourses can be used as a water supply without adversely impacting the aquatic environment and without costing too much to pump the water uphill.
- Identify abundance and likelihood of occurrence of plant, fish, and wildlife species residing in the AOI, LSA_{SW}, and RSA_{SW}.
- Refine the understanding of the magnitude and quality of the various effluent discharges.
- Better understand the size of the rock pile footprints on the land surface and the characteristics of the rocks and the water quality from erosion due to exposure to rainfall and snow
- Identification of COPC for each phase of the Project.

Additionally, data needs are summarized in Table C.2. These data are required to define the site, local and regional-scale boundaries for environmental media, and to inform the sampling and analytical EMBP design. These are all key data needs; however, much of these data needs are beyond the scope of the EMBP, Some parameters could be estimated from literature or proxy location through openly accessed environmental databases (e.g., Environment Canada, MNRF, etc.); however, site specific data are preferable if available. Much of the site-specific bedrock and groundwater characteristics will be collected from various programs during the next few years and integrated in a descriptive geoscientific site model.

Table C.2 Data needs

CSM Parameter	Units
Overburden Thickness	m
Overburden Horizontal K	m/s
Overburden Vertical K	m/s
Overburden Specific Storage	1/m
Overburden Porosity	dimensionless
Overburden Lithologic Description	--
Evapotranspiration	mm/d
Runoff	m/s
Rate of capillary rise or upward flow up water into surface soil	mm/s
Surficial Shallow Aquifer Thickness	m
Surficial Shallow Aquifer Horizontal K	m/s
Surficial Shallow Aquifer Vertical K	m/s
Surficial Shallow Aquifer Specific Storage	l/m
Surficial Shallow Aquifer Porosity	dimensionless
Surficial Shallow Aquifer Lithologic Description	--
Shallow Bedrock Mean Aperture	m
Shallow Bedrock Mean Fracture Spacing	m
Shallow Bedrock Matrix Porosity	dimensionless
Shallow Bedrock Fracture Porosity	dimensionless
Shallow Bedrock Equivalent K Horizontal	m/s
Shallow Bedrock Equivalent K Vertical	m/s
Shallow Bedrock Specific Storage	l/m
Deep Bedrock Mean Aperture	m
Deep Bedrock Mean Fracture Spacing	m
Deep Bedrock Matrix Porosity	dimensionless
Deep Bedrock Fracture Porosity	dimensionless
Deep Bedrock Equivalent K Horizontal	m/s
Deep Bedrock Equivalent K Vertical	m/s
Deep Bedrock Specific Storage	l/m
Site-Scale Hydraulic Gradient	dimensionless & direction
Regional-Scale Hydraulic Gradient	dimensionless & direction
Recharge/Discharge Locations (Local)	identify
Recharge/Discharge Locations (Regional)	identify
Groundwater/surface water elevations: measured at GW/SW locations on-site or in the regional watershed	m from a reference datum
Groundwater extraction rate (initial construction, within the shallow aquifer/bedrock system)	m^3/day
Groundwater extraction rate (initial construction, within the deep bedrock system)	m^3/day
Groundwater extraction rate (operations, within deep bedrock system)	m^3/day
Waterbodies for water supply (initial construction)	identify
Waterbodies for water supply (operations)	identify
Waterbodies for receiving effluent discharges (initial construction)	identify
Waterbodies for receiving effluent discharges (operations and other project stages)	identify
Waterbody characteristics within the AOI: size, aquatic presence, extent of wetland seasonally	various

CSM Parameter	Units
Site-specific meteorological data: rainfall and snow, air temperature, relative humidity or dew point temperature, atmospheric pressure, solar radiation, wind speed and direction	various
Site-specific stream flow rate: average (seasonal) and peak flow rates	m/s
Site-specific soil infiltration rate	mm/hr
Estimation of rock extracted through construction and development	mass/time
Refined topography within the AOI	identify

C.4 Literature Cited

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APPENDIX D

CONTAMINANTS OF POTENTIAL CONCERN

APPENDIX D

Summary of selected Contaminants of Potential Concern

Group	Parameters
Surface Water (LSA and Reference Area)	
Radionuclides	<u>Top tier</u>: H-3, C-14, Sr-90, I-129, Cs-137 [and associated Co-60, Se-79, Ru-106], gross-α, gross-β <u>Second tier</u>: Cl-36, Co-60, Se-79, Ru-106, Np-237, Pu-238, Pu-239, Pu-240, Pu-241 Am-241, Cm-244 Ra-226, U-238, U-234, U-235, U-238, K-40, Th-228, Th-230, Th-232
Metals (Total and Dissolved)	Aluminum, Antimony, Arsenic, Barium, Beryllium, Bismuth, Boron, Cadmium, Cesium, Chromium (total, trivalent, hexavalent), Cobalt, Copper, Iron, Lead, Lithium, Mercury, Manganese, Molybdenum, Nickel, Rhodium, Ruthenium, Samarium, Selenium, Silver, Strontium, Thallium, Tin, Titanium, Uranium, Vanadium, Zinc, Zirconium
Organics	SVOCs
In situ limnology	Dissolved Oxygen (DO), Temperature, pH, Conductivity, Redox Potential
Nutrients and General Chemistry	Conductivity, Sulphate, Sum of Ions, 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, Iodine* 5 day Biological Oxygen Demand (BOD5), E. coli, Total Coliforms
Other	Glyphosate
Surface Water (RSA)	
Radionuclides	<u>Top tier</u>: H-3, C-14, Sr-90, I-129, Cs-137 [and associated Co-60, Se-79, Ru-106], gross-α, gross-β
Metals (Total)	Aluminum, Antimony, Arsenic, Barium, Beryllium, Bismuth, Boron, Cadmium, Cesium, Chromium (total, trivalent, hexavalent), Cobalt, Copper, Iron, Lead, Lithium, Mercury, Manganese, Molybdenum, Nickel, Rhodium, Ruthenium, Samarium, Selenium, Silver, Strontium, Thallium, Tin, Titanium, Uranium, Vanadium, Zinc, Zirconium
Organics	None
In situ limnology	None as water samples are being collected for laboratory analyses by community members; although these parameters could potentially be measured by community members depending on equipment availability and training
Nutrients and General Chemistry	Conductivity, Sulphate, Sum of Ions, 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, Iodine*
Other	None
Sediment	
Radionuclides	<u>Top tier</u>: H-3, C-14, Sr-90, I-129, Cs-137 [and associated Co-60, Se-79, Ru-106], gross-α, gross-β <u>Second tier</u>: Cl-36, Co-60, Se-79, Ru-106, Np-237, Pu-238, Pu-239, Pu-240, Pu-241 Am-241, Cm-244 Ra-226, U-238, U-234, U-235, U-238, K-40, Th-228, Th-230, Th-232
Metals	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
Organics	SVOCs
Nutrients and General Characterization	Moisture, Total Organic Carbon (TOC), Particle Size (5 fraction EEM), Ammonia as Nitrogen, Nitrate + Nitrite, Nitrate (NO_3), Total Phosphorus, Total Kjeldahl Nitrogen, Iodine*
Other	None
Tissues	
Radionuclides	<u>Top tier</u>: H-3, C-14, Sr-90, I-129, Cs-137 [and associated Co-60, Se-79, Ru-106], gross-α, gross-β
Metals	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
Organics	None; these parameters readily biodegrade and do not bioaccumulate
General Characterization	Cyanide, % moisture
Other	Iodine and Glyphosate (in select samples only)
Soils	
Radionuclides	<u>Top tier</u>: H-3, C-14, Sr-90, I-129, Cs-137 [and associated Co-60, Se-79, Ru-106], gross-α, gross-β <u>Second tier</u>: Cl-36, Co-60, Se-79, Ru-106, Np-237, Pu-238, Pu-239, Pu-240, Pu-241 Am-241, Cm-244 Ra-226, U-238, U-234, U-235, U-238, K-40, Th-228, Th-230, Th-232 Gamma survey
Metals	Aluminum, Antimony, Arsenic, Barium, Beryllium, Bismuth, Boron, Bromine, Cadmium, Calcium, Cesium, Chromium (total, hexavalent), 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 Acid generation and leaching potential
Organics	PAHs, VOCs, SVOCs, PHCs
General Chemistry and Characterization	Inorganic nitrogen compounds (nitrogen, nitrate, nitrite), pH, Moisture, Total Organic Carbon (TOC), Dissolved Organic Carbon (DOC), Electrical Conductivity, Sodium Absorption Ratio, Iodine* Grain size distribution
Other	Glyphosate
Air Quality	
Radionuclides (in TSP and dustfall)	<u>Top tier</u>: Sr-90, I-129, Cs-137 [and associated Co-60, Se-79, Ru-106], gross-α, gross-β <u>Second tier</u>: Cl-36, Co-60, Se-79, Ru-106, Np-237, Pu-238, Pu-239, Pu-240, Pu-241 Am-241, Cm-244 Ra-226, U-238, U-234, U-235, U-238, K-40, Th-228, Th-230, Th-232
(whole air)	<u>Top tier</u>: H-3, C-14, Rn-222, Kr-85
(other)	Gamma (TLD monitors)
Metals (in TSP and dustfall)	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
Organics (in TSP and dustfall)	PAHs, PHCs (F3, F4)
(whole air)	VOCs, SVOCs, PHC (F1, F2)
Nutrients	Ammonia
Air Quality	Carbon monoxide (CO), nitrogen oxides (NO_X), sulphur dioxide (SO_2), suspended particulate matter (SPM), particulate matter <10 microns (PM_{10}) and particulate matter <2.5 microns ($PM_{2.5}$)

* Iodine may be measured in media. For tissue, select vegetation samples would be included

APPENDIX E

DETAILED STUDY DESIGN INFORMATION

Table E.1a

Quarterly cost breakdown for chemistry costs associated with the tissues component of the Environmental Media Baseline Program

Study Component Category	Year 1					Year 2					Year 3				
	# of Samples Fall	# of Samples Winter	# of Samples Spring	# of Samples Summer	Total # of Samples	# of Samples Fall	# of Samples Winter	# of Samples Spring	# of Samples Summer	Total # of Samples	# of Samples Fall	# of Samples Winter	# of Samples Spring	# of Samples Summer	Total # of Samples
Primary Samples															
Piscivore (fish)[a]	32	0	64	0	96	0	0	0	48	48	0	0	0	0	0
Benthivore (fish)[a]	64	0	32	0	96	0	0	24	0	24	0	0	0	0	0
Aquatic Macrophyte (shoots, roots, and associated sediment)	0	0	0	0	0	0	0	0	117	117	18	0	0	0	18
Aquatic Bird (herbivore, omnivore)	0	0	0	0	0	21	0	0	0	21	21	0	0	0	21
Berry[b,c]	0	0	0	21	21	0	0	0	21	21	21	0	0	0	21
Terrestrial Vegetation[b,c]	21	0	0	0	21	0	0	0	21	21	0	0	0	21	21
Soil (co-located with berries)	0	0	0	9	9	0	0	0	9	9	9	0	0	0	9
Soil and Lichen	0	0	0	0	0	0	0	0	42	42	0	0	0	0	0
Upland Game Bird	12	0	0	0	12	9	0	0	0	9	0	0	0	0	0
Large Mammal (black bear)	0	0	3	0	3	0	0	3	0	3	0	0	3	0	3
Small Mammal	0	0	0	0	0	0	21	0	21	42	0	0	0	21	21
Ungulate (muscle)	6	0	0	0	6	6	0	0	0	6	6	0	0	0	6
Ungulate (organ)	12	0	0	0	12	12	0	0	0	12	12	0	0	0	12
Total	147	0	99	30	**276**	48	21	27	279	**375**	87	0	3	42	**132**
Secondary Samples															
Small-bodied Fish[a]	0	0	0	0	0	0	0	0	35	35	0	0	0	0	0
Small-bodied Fish (organ)	0	0	0	0	0	0	0	0	35	35	0	0	0	0	0
Amphibian (tadpole)	0	0	0	0	0	0	0	24	24	48	0	0	0	0	0
Semi-aquatic Mammal	0	0	0	0	0	12	12	18	0	42	0	11	10	0	21
Aquatic Bird (piscivore)	5	0	0	0	5	0	0	5	0	5	0	0	5	0	5
Emergent Insect	0	0	0	0	0	0	0	0	35	35	0	0	0	0	0
Large mammal (carnivore)	0	3	0	0	3	0	3	0	0	3	0	3	0	0	3
Terrestrial Vegetation (browse)	0	0	0	0	0	0	0	0	0	0	21	0	0	0	21
Terrestrial Insect	0	0	0	0	0	0	0	0	35	35	0	0	0	0	0
Total	5	3	0	0	**8**	12	15	47	164	**238**	21	14	15	0	**50**

Note: The sampling of SCs by season is for planning and budgeting purposes, but actual timing may change depending on availability and submission of samples by stakeholders and rights-holders.

[b] Glyphosate will be tested in 21 berry and 9 terrestrial vegetation samples per year.

[c] Including iodine as a COPC is an option and it is recommended that if added, this analyses be completed on 21 berry samples and the co-located soil samples.

TABLE E.1b

Summary of Study Components by quarter and year for tissues component of the Environmental Media Baseline Program

Study Component Category	Study Component											
	Year 1				Year 2				Year 3			
	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer
Aquatic												
Large-bodied Fish – Piscivore[a]	Lake trout (RSA)	-	Northern pike, walleye (RSA)	-	-	-	-	Northern pike, walleye (LSA)	-	-	-	-
Large-bodied Fish – Benthivore[a]	Lake whitefish, cisco (RSA)	-	White sucker (RSA)	-	-	-	White sucker (LSA)	-	-	-	-	-
Aquatic Macrophyte	-	-	-	-	-	-	-	Sedge (roots, shoots, and sediment) and wild rice	Rat root (sweet flag)	-	-	-
Aquatic Bird - Herbivore	-	-	-	-	Canada goose	-	-	-	-	-	-	-
Aquatic Bird - Omnivore	-	-	-	-	-	-	-	-	Mallard duck	-	-	-
Terrestrial												
Berry[b]	-	-	-	Blueberry	-	-	-	Raspberry	Cranberry[b]	-	-	-
Soil (co-located with berry)	-	-	-	Soil	-	-	-	Soil	Soil	-	-	-
Vegetation – Edible or Medicinal Use[c]	Wild mushroom	-	-	-	-	-	-	Chaga	-	-	-	Labrador tea
Soil and Lichen	-	-	-	-	-	-	-	Soil and Lichen	-	-	-	-
Upland Game Bird	Spruce grouse (RSA)	-	-	-	Spruce grouse (LSA)	-	-	-	-	-	-	-
Large Mammal[d]	-	-	Black bear	-	-	-	Black bear	-	-	-	Black bear	-
Small Mammal[e]	-	-	-	-	-	Snowshoe hare	-	Mouse or vole	-	-	-	Shrew
Ungulate (muscle)	Moose, deer	-	-	-	Moose, deer	-	-	-	Moose, deer	-	-	-
Ungulate (organ)	Kidney or liver	-	-	-	Kidney or liver	-	-	-	Kidney or liver	-	-	-
Secondary Samples												
Small-bodied Fish - Planktivore[f]	-	-	-	-	-	-	-	Spottail or dace	-	-	-	-
Small-bodied Fish - Planktivore (organ)[f]	-	-	-	-	-	-	-	Spottail or dace	-	-	-	-

TABLE E.1b

Summary of Study Components by quarter and year for tissues component of the Environmental Media Baseline Program

Study Component Category	Study Component											
	Year 1				Year 2				Year 3			
	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer
Amphibian[g]	-	-	-	-	-	-	Green or wood frog tadpole	Green or wood frog tadpole	-	-	-	-
Semi-aquatic Mammal[h]	-	-	-	-	Beaver and muskrat	Beaver and muskrat	Beaver and muskrat	-	-	Mink	Mink	-
Aquatic Bird - Piscivore[i]	Grebe or merganser (RSA)						Grebe or merganser (LSA)				Grebe or merganser (RSA)	
Emergent Insect	-	-	-	-	-	-	Dragonfly or damselfly	-	-	-	-	-
Large Mammal (carnivore)		Wolf or lynx				Wolf or lynx				Wolf or lynx		
Terrestrial Vegetation - Browse	-	-	-	-	-	-	-	-	Willow	-	-	
Terrestrial Insect	-	-	-	-	-	-	-	Caterpillar or beetle	-	-	-	-

Note: The following table is an illustration of the proposed Study Components (SCs) by season for the purpose of the quarterly cost schedule. Several of the selected SCs may be collected in a variety of seasons, and actual timing may change depending on availability and submission of samples by stakeholders and rights-holders.

[a] Large-bodied fish will be targeted in the RSA after their spawning period when they are easiest to catch but could be collected during any season. In the LSA the recommended season is summer of Year 2 so that sampling can be completed coincidentally with the Biodiversity Impact Studies (BIS)

[b] Bog cranberry is often collected in the fall months after the first frost but if high bush cranberry or other berry species is selected this could shift to summer months.

[c] Confirmation with stakeholder/right-holders should take place before the following edible/medicinal samples are collected. Species may be switched between years and seasons where appropriate.

[d] Black bear hunting may take place in spring and/or fall and it has been assumed samples will be gifted to the program. Samples have been placed in the spring for the purpose of the quarterly cost table but may be submitted in other months.

[e] Snowshoe hare would be harvested primarily during the winter months by stakeholder/right-holders whereas mouse/vole and shrew would be collected primarily by consultant during the summer studies.

[f] Small-bodied fish will be collected in the summer of Year 2 alongside the BIS studies but may also be collected in the sping or fall months of Year 2 weather permitting.

[g] Green or wood frog tadpole samples will be collected in the RSA during the spring and the LSA during the summer BIS studies, but could also be collected during the same period.

[h] Beaver, muskrat, and mink samples hair and or plug samples will be collected primarily by trappers and seasons may alter but were placed here for the purpose of the quarterly cost table.

[i] Feather samples will be collected in the spring and or fall by a biologist.

TABLE E.1c

Study design details for the tissues component of the Environmental Media Baseline Program

Survey Type	Sampling Areas	Sampling Frequency/Timing	Sample Size by Species	Sampling Method/Approach	Contaminants of Potential Concern/Endpoints	Analytical Methods
Primary VCs - lethal sampling methods						
Large-bodied Fish - Piscivore (Muscle)	3 LSA and 4 RSA LSA: Sampling Area 1 = Pond in AOI Sampling Area 2 = Mennin Lake Sampling Area 3 = Mennin River to Wabigoon River RSA: Sampling Area 1 = Revell Lake Sampling Area 2 = Dinorwic Lake Sampling Area 3 = Long Lake Sampling Area 4 = 1 lake north of Ignace	Years 1 and 2 (fall through summer)	Year 1 = 8 walleye, 8 northern pike, and 8 lake trout each from 4 RSA locations (n = 96) Year 2 = 8 walleye and 8 northern pike each from 3 LSA locations (n = 48) Year 3 = any fish not obtained from Year 1 or Year 2 (n = 144)	Tissue sampling will be paired with the surface water sample waterbodies where applicable. Targeted standard fishing methods including gill netting, angling, and electrofishing is recommended. Fish processing procedures will include fork length, weight, gonad weight, liver weight, stomach fullness, stomach contents, and internal and external health. Fish ageing structures (cleithra for northern pike, fin rays for white sucker, and otoliths for remaining species) will be collected from each fish sampled and submitted.	**Radionuclides:** H-3, C-14, Sr-90, I-129, Cs-137 (Co-60, Ru-106), Gross-α, Gross-β **Metals (total):** Aluminum, Antimony, Arsenic, Barium, Beryllium, Bismuth, Boron, Cadmium, Cesium, Chromium (total, trivalent, hexavalent), Cobalt, Copper, Iron, Lead, Lithium, Mercury, Manganese, Molybdenum, Nickel, Rhodium, Ruthenium, Samarium, Selenium, Silver, Strontium, Thallium, Tin, Titanium, Uranium, Vanadium, Zinc, Zirconium **Other:** Cyanide and % moisture (Note: Sediment = same as above but also includes: **Radionuclides:** U-238, U-234, U-235, U-238, K-40, Th-228, Th-230, Th-232, Ra-226 **General characterization and nutrients:** Moisture, Total Organic Carbon, Particle Size (5 fraction EEM), Ammonia as Nitrogen, Nitrate + Nitrite, Nitrate (NO_3), Phosphorus, Total Kjeldahl Nitrogen)	The minimum weight/sample needed to analyse radionuclides with acceptable method detection limits will need to be verified with the laboratory. Standard laboratory procedures.
Large-bodied Fish - Benthivore (Muscle)		Years 1 and 2 (fall through spring)	Year 1 = 8 white sucker, 8 lake whitefish, and 8 cisco each from 4 RSA locations (n = 96) Year 2 = 8 white sucker from 3 LSA locations (n = 24) Year 3 = any fish not obtained from Year 1 or Year 2 (n = 120)			
Aquatic Macrophyte	LSA: Sampling Area 1 = AOI Sampling Area 2 = Mennin Lake Sampling Area 3 = Mennin River to Wabigoon River RSA: Sampling Area 1 = Revell Lake Sampling Areas 2-4 = waterbodies within the RSA frequently used for the collection of wild rice and rat root Year 2 = sedge 4 LSA and 3 RSA Year 2 = wild rice/manoomin 4 RSA - locations TBD by rights-holders Year 3 = rat root/sweet flag 3 LSA and 3 RSA	Years 2 and 3 (summer through fall)	Year 2 = 5 sedge samples (roots, shoots, and sediments co-located) from 4 LSA and 3 RSA locations (n = 105) Year 2 = 3 wild rice/manoomin samples from 4 RSA locations (n = 12) Year 3 = 3 rat root/sweet flag samples from 3 LSA and 3 RSA locations (n = 18) (n = 135)	Aquatic roots (sedge, wild rice, and rat root), aquatic shoots (sedge only), and sediment (sedge only) in each location where harvested. Where possible, aquatic macrophyte samples will be collected at waterbodies where surface water and/or fish tissue are collected. Sediments associated with sedge sampling locations should be collected with an Ekman dredge or stainless steel shovel		
Aquatic Bird - Herbivore (Muscle)	LSA: Sampling Area 1 = AOI Sampling Area 2 = Mennin Lake Sampling Area 3 = Mennin River to Wabigoon River RSA: Sampling Area 1 = Revell Lake Sampling Areas 2-4 = locations TBD by rights-holders	Year 2 (fall)	3 Canada goose from 3 LSA and 4 RSA locations (n = 21)	Waterfowl will be hunted during the fall hunting period usin steel shot.		
Aquatic Bird - Omnivore (Muscle)	LSA: Sampling Area 1 = AOI Sampling Area 2 = Mennin Lake Sampling Area 3 = Mennin River to Wabigoon River RSA: Sampling Area 1 = Revell Lake Sampling Areas 2-4 = locations TBD by rights-holders	Year 3 (fall)	3 dabbling duck species total from 3 LSA and 4 RSA locations (i.e., mallard, shoveler, black duck) (n = 21)			
Ungulate (Muscle)	LSA or RSA: UTMs will be collected by hunter where the animal was harvested as animals have large range	Yearly (fall)	3 moose samples per year 3 whitetail deer samples per year (n = 9)	Opportunistic samples will be retained from stakeholder/rights holders during their routine harvesting activities and local Ministry of Natural Resources and Forestry office to obtain samples where possible. Community liaisons from the stakeholders and rights-holders will be identified to help to coordinate sample collection. Harvester will be asked to submit an incisor (if available) for ageing purposes.		
Ungulate (Organ)			3 moose liver and 3 kidney per year (n = 12 per year) 3 deer liver and 3 kidney per year (n = 12 per year) (n = 36)			
Large Mammal (Muscle)	LSA or RSA: UTMs will be collected by hunter where the animal was harvested as animals have large range	Yearly (bear hunting season - spring)	3 black bear per year (n = 9)	Consultant and stakeholders/rights-holders will work togethe to obtain samples of black bear from local hunting camps, hunters, and local Ontario Natural Resources and Forestry office to obtain samples where possible.		

TABLE E.1c

Study design details for the tissues component of the Environmental Media Baseline Program

Survey Type	Sampling Areas	Sampling Frequency/Timing	Sample Size by Species	Sampling Method/Approach	Contaminants of Potential Concern/Endpoints	Analytical Methods
Upland Game Bird (Muscle)	LSA: Sampling Area 1 = AOI Sampling Area 2 = Mennin Lake Sampling Area 3 = Mennin River to Wabigoon River RSA: Sampling Area 1 = Revell Lake Sampling Areas 2-4: locations TBD by rights-holders	Years 1 and 2 (fall)	Year 1 = 3 grouse from 4 RSA locations (n = 12) Year 2 = 3 grouse from 3 LSA locations (n = 9) (n = 21)	Consultant and stakeholders/rights-holders will work togethe to obtain samples of grouse using standard hunting methods (e.g., steel shot) during fall.	**Radionuclides**: Gross-α, Gross-β, H-3, C-14, Sr-90, I-129, Cs-137 (Co-60, Ru-106) **Metals (total)**: Aluminum, Antimony, Arsenic, Barium, Beryllium, Bismuth, Boron, Cadmium, Cesium, Chromium (total, trivalent, hexavalent), Cobalt, Copper, Iron, Lead, Lithium, Mercury, Manganese, Molybdenum, Nickel, Rhodium, Ruthenium, Samarium, Selenium, Silver, Strontium, Thallium, Tin, Titanium, Uranium, Vanadium, Zinc, Zirconium **Other**: Cyanide and % moisture	The minimum weight/sample needed to analyse radionuclides with acceptable method detection limits will need to be verified with the laboratory. Standard laboratory procedures.
Small Mammal (Muscle or Whole)	LSA: Sampling Area 1 = AOI Sampling Area 2 = Mennin Lake Sampling Area 3 = Mennin River to Wabigoon River RSA: Sampling Area 1 = Revell Lake Sampling Areas 2-4: locations TBD by rights-holders	Years 2 and 3 (winter and summer)	Year 2 = 3 snowshoe hare (muscle) from 3 LSA and 4 RSA locations (winter; n = 21) Year 2 = 3 mice or voles (whole) from 3 LSA and 4 RSA locations (summer; n = 21) Year 3 = 3 shrews (whole) from 3 LSA and 4 RSA locations (summer; n = 21) (n = 63)	Samples will be retained with stakeholders and rights-holders during their routine harvesting activities or targeted periods. Snaring (snowshoe hare) and/or trapping methods are generally employed. Consultant will sample mice, voles, and shrew with small mammal traps at comparable locations to those established in Year 1 for snowshoe hare.		
Soil (Co-located with Berry Samples)	LSA locations only: Sampling Area 1 = AOI Sampling Area 2 = Mennin Lake Sampling Area 3 = Mennin River to Wabigoon River	Yearly (summer and fall)	Year 1 = 3 soils per blueberry/area (summer; n = 9) Year 2 = 3 soils per raspberry/other/area (summer; n = 9) Year 3 = 3 soils per cranberry/area (fall; n = 9) (n = 27)	Consultant and stakeholders/rights-holders will work togethe to obtain samples of soils and berries in the LSA. Bog cranberry is often collected in the fall months after the first frost but if high bush cranberry or other berry species is selected then Year 3 sampling could shift to summer months	Same radionuclides and metals (total) as co-located berries as well as cyanide <u>Also:</u> **Additional radionuclides:** U-238, U-234, U-235, U-238, K-40, Th-228, Th-230, Th-232, Ra-226 **General chemistry, ions, and nutrients:** Inorganic nitrogen compounds (nitrogen, nitrate, nitrite), pH, Moisture, Total Organic Carbon (TOC), Dissolved Organic Carbon (DOC), Organic Carbon Quality, Electrical Conductivity, Sodium Adsorption Ratio, Grain Size Distribution **Organics and volatiles:** PAHs, VOCs, SVOCs and PHCs	The minimum weight/sample needed to analyse radionuclides with acceptable method detection limits will need to be verified with the laboratory. Standard laboratory procedures. Soils = Standard laboratory methods and procedures, appropriate under EPA SW-846.
Berry	LSA: Sampling Area 1 = AOI Sampling Area 2 = Mennin Lake Sampling Area 3 = Mennin River to Wabigoon River RSA: Sampling Area 1 = Revell Lake Sampling Areas 2-4: locations TBD by rights-holders	Yearly (summer and fall)	Year 1 = 3 blueberry from 3 LSA and 4 RSA locations (summer; n = 21) Year 2 = 3 raspberry from 3 LSA and 4 RSA locations summer; (n = 21) Year 3 = 3 cranberry from 3 LSA and 4 RSA locations (fall; n = 21) (n = 63)	Berries will be sampled by consultants and stakeholders/rights-holders in the LSA. Bog cranberry is often collected in the fall months after the first frost but if high bush cranberry or other berry species is selected then Year 3 sampling could shift to summer months.	**Radionuclides:** Gross-α, Gross-β,H-3, C-14, Sr-90, I-129, Cs-137 (Co-60, Ru-106) **Metals (total):** Aluminum, Antimony, Arsenic, Barium, Beryllium, Bismuth, Boron, Cadmium, Cesium, Chromium (total, trivalent, hexavalent), Cobalt, Copper, Iron, Lead, Lithium, Mercury, Manganese, Molybdenum, Nickel, Rhodium, Ruthenium, Samarium, Selenium, Silver, Strontium, Thallium, Tin, Titanium, Uranium, Vanadium, Zinc, Zirconium **Other:** Cyanide and % moisture; Glyphosate in berries, and in a subset of medicinal plants from areas nearest to spraying	
Vegetation - Edible or Medicinal Use	LSA: Sampling Area 1 = AOI Sampling Area 2 = Mennin Lake Sampling Area 3 = Mennin River to Wabigoon River RSA: Sampling Area 1 = Revell Lake Sampling Areas 2-4: locations TBD by rights-holders	Yearly (fall and summer)	Year 1 = 3 wild mushroom from 3 LSA and 4 RSA locations (fall; n = 21) Year 2 = 3 chaga from 3 LSA and 4 RSA locations (summer; n = 21) Year 3 = 3 Labrador tea from 3 LSA and 4 RSA locations (summer; n = 21) (n = 63)	Hand grab by community members when sampling with a biologist within the regional area. Late summer early fall sampling period recommended depending on species. Rights holders including elders from these communities should be consulted and be included in the sampling of these VCs.		
Soil and Lichen	LSA: Sampling Area 1-3 = AOI RSA: Sampling Area 1 = Revell Lake Sampling Areas 2-4: locations TBD	Year 2 (summer)	3 soil samples from 3 LSA and 4 RSA locations (n = 21) 3 lichen samples from 3 LSA and 4 RSA locations (n = 21) (n = 42)	Establishing Permanent Sampling Plots (PSPs) in three exposure (LSA) and four reference (RSA) locations to assess for potential impacts from air dispersion to biological tissues. Consultants and stakeholders/rights-holders will work together to set up long-term PSPs to obtain samples of lichen and co-located soil samples using standard operating procedures.	<u>Lichen</u> **Radionuclides:** Gross-α, Gross-β, H-3, C-14, Sr-90, I-129, Cs-137 (Co-60, Ru-106) **Metals (total):** Aluminum, Antimony, Arsenic, Barium, Beryllium, Bismuth, Boron, Cadmium, Cesium, Chromium (total, trivalent, hexavalent), Cobalt, Copper, Iron, Lead, Lithium, Mercury, Manganese, Molybdenum, Nickel, Rhodium, Ruthenium, Samarium, Selenium, Silver, Strontium, Thallium, Tin, Titanium, Uranium, Vanadium, Zinc, Zirconium **Other:** Cyanide and % moisture <u>Soils</u> Same as for soils co-located with berries (above)	The minimum weight/sample needed to analyse radionuclides with acceptable method detection limits will need to be verified with the laboratory. Standard laboratory procedures. Soils = Standard laboratory methods and procedures, appropriate under EPA SW-846.

TABLE E.1c

Study design details for the tissues component of the Environmental Media Baseline Program

Survey Type	Sampling Areas	Sampling Frequency/Timing	Sample Size by Species	Sampling Method/Approach	Contaminants of Potential Concern/Endpoints	Analytical Methods
Secondary VCs - Non-lethal sampling where applicable						
Small-bodied Fish - Planktivore (Whole Body (organs removed))	LSA: Sampling Area 1 = Pond in AOI Sampling Area 2 = Mennin Lake, Sampling Area 3 = Mennin River to Wabigoon River RSA: Sampling Area 1 = Revell Lake Sampling Areas 2-4 = locations TBD	Year 2 (summer)	5 spottail shiner or longnose dace from 3 LSA and 4 RSA locations (n = 35)	Boat or backpack electrofishing will be utilized to capture small-bodied fish. Minnow traps and box nets can be set up in the project area and be checked periodically while completing other surveys.	**Metals (total)**: Aluminum, Antimony, Arsenic, Barium, Beryllium, Bismuth, Boron, Bromine, Cadmium, Cesium, Chromium (total, trivalent, hexavalent), Cobalt, Copper, Iron, Lead, Lithium, Mercury, Manganese, Molybdenum, Nickel, Samarium, Selenium, Silver, Strontium, Thallium, Tin, Titanium, Uranium, Vanadium, Zinc, Zirconium **Other:** % moisture	Laser ablation ICP-MS.
Small-bodied Fish - Planktivore (Organ (liver))	LSA: Sampling Area 1 = Pond in AOI Sampling Area 2 = Mennin Lake, Sampling Area 3 = Mennin River to Wabigoon River RSA: Sampling Area 1 = Revell Lake Sampling Areas 2-4 = locations TBD	Year 2 (summer)	5 spottail shiner or longnose dace from 3 LSA and 4 RSA locations (n = 35)			
Aquatic Bird - Piscivore (Feather)	LSA: Sampling Area 1 = AOI RSA: Sampling Area 1 = Revell Lake Sampling Area 2 = location TBD	Yearly (spring/fall)	5 grebe or merganser feathers from 1 LSA and 2 RSA locations (fall in Year 1, spring in Years 2 and 3; n = 5 per year) (n = 15)	Consultant will work with local birders and wildlife technicians to help to locate known nests. Feather samples will be obtained by consultant.		
Semi-aquatic Mammal (Fur and/or Muscle)	LSA: Sampling Area 1 = AOI Sampling Area 2 = Mennin Lake Sampling Area 3 = Mennin River to Wabigoon River RSA: Sampling Area 1 = Revell Lake Sampling Areas 2-4 = locations TBD by rights-holders	Years 2 and 3 (winter)	Year 2 = 3 beaver fur and/or muscle tissue samples from 3 LSA and 4 RSA locations (n = 21) Year 2 = 3 muskrat fur and/or muscle tissue samples from 3 LSA and 4 RSA locations (n = 21) Year 3 = 3 mink fur and/or muscle tissue samples from 3 LSA and 4 RSA locations (n = 21) (n = 63)	Opportunistic samples will be retained from stakeholder/rights-holders during their routine trapping activities and they will be asked to provide hair samples along with a small muscle tissue sample. Additional samples from the AOI and the RSA if required will be collected non-lethally by consultant using barb snares		
Amphibian (Tadpole)	LSA: Sampling Area 1 = Pond in AOI Sampling Area 2 = Mennin Lake Sampling Area 3 = Mennin River to Wabigoon Lake RSA: Sampling Area 1 = Revell Lake Sampling Areas 2 and 3 = locations TBD	Year 2 (spring through summer)	8 wood frog/green frog tadpoles (whole) from 3 LSA and 3 RSA locations (n = 48)	Sampling with dip net by consultant.		
Large Mammal - Carnivore (Fur and/or Muscle)	LSA or RSA: UTMs will be collected by hunter where the animal was harvested as animals have large range	Yearly	3 wolf or 3 lynx per year (likely winter). (n = 9; the sample size may be reduced depending on population size)	Opportunistic samples will be retained from stakeholders/rights-holders during their routine trapping activities and they will be asked to provide hair samples along with a small muscle tissue sample. Additional samples, if required, will be collected non-lethally by consultant using barb snares.		
Terrestrial Vegetation (Browse)	LSA: Sampling Area 1 = AOI Sampling Area 2 = Mennin Lake Sampling Area 3 = Mennin River to Wabigoon Lake RSA: Sampling Area 1 = Revell Lake Sampling Area 2 = Dinorwic Lake Sampling Area 3 = Long Lake Sampling Area 4 = 1 lake north of Ignace	Year 3 (fall)	3 willow samples from 3 LSA and 4 RSA locations (n = 21)	Hand picked new growth.		
Terrestrial and Emergent Insects (Whole)	LSA: Sampling Area 1 = AOI Sampling Area 2 = Mennin Lake Sampling Area 3 = Mennin River to Wabigoon River RSA: Sampling Area 1: Revell Lake Sampling Area 2 = Dinorwic Lake Sampling Area 3 = Long Lake Sampling Area 4 = 1 lake north of Ignace	Year 2 (summer)	5 caterpillars/beetles samples from 3 LSA and 4 RSA locations (n = 35) 5 dragonflies/damselflies from 3 LSA and 4 RSA locations (n = 35) (n = 70)	Insect traps, netting, and hand picked - lethal sampling.		

TABLE E.2

Study design details for the hydrology component of the Environmental Media Baseline Program

Survey Type	Sampling Areas	Sampling Frequency/Timing	Sample Size	Sampling Method/Approach	Contaminants of Potential Concern/Endpoints	Analytical Methods
Rivers and Streams	Large rivers - Mennin and Revell rivers	Hourly permanent stations on the Mennin and Revell rivers will be installed. For smaller streams the sites would be visited twice a year for manual flow and water level measurements.	First year for Mennin and Revell rivers, three to six visits to develop water level discharge rating curve. For smaller streams the site visits would be once in the spring melt time period for flow measurements and once in the late summer dry season. The frequency of field visits and measurements can be tied in with surface water quality monitoring and other field efforts.	Small streams associated with wetland and small lakes would have simple flow measurements made manually each spring and in the dry late summer time period for three years. Flow monitoring stations on Mennin River and Revell River would consist of a more continuous (hourly) water level sensors and periodic flow measurements to develop stage discharge rating curve for each site. Field monitoring would follow Ontario Stream Assessment Protocols.	Increase in flow (flooding), decrease in flow (drought) which may impact assimilative capacity for discharging and withdrawing for supply.	N/A
	Small streams - five points					N/A
Bathymetry and Staff Gauges	8 lakes within the AOI, 3 small lakes southwest of the AOI, Mennin Lake and Revell Lake	The Bathymetry survey would completed in year one only, when temperatures are warmer and the most daylight is available (late spring to early fall). The staff gauges would be installed in year one in 13 lakes and checked quarterly in all three years. The frequency of field visits and measurements can be tied in with surface water quality monitoring and other field efforts.	13 Lakes (ten lakes are <50 acres, one is ~200 acres, and Mennin and Revell rivers are each ~1,300 acres).	Following applicable components (i.e., relevant data quality assurance measures) of the Standards for Hydrographic Surveys by the Department of Fisheries and Oceans Canada (DFO). General horizontal accuracy should be < 1 meter(m) and depth is <0.1 m. 13 lake water levels measurements would be made manually on a quarterly basis, at minimum, for three years.	Changes in bathymetry from deposition or erosion, lakes drying up. Increase or decrease in lake water levels which may impact assimilative capacity for discharging and withdrawing for supply.	N/A
Meteorology	LSA	15-minute sampling frequency using a continuous meteorological station.	One year, at most three years.	Canadian Federal guidelines or Ontario provincial guidelines similar to US EPA's Meteorological Monitoring Guidance for Regulatory Modeling Applications (2000) (EPA-454/R-99-005).	Intense rainfall, lack of rainfall, high air temperature. The meteorological station will measure air temperature, total precipitation (rainfall and est. of snowfall), snow depth, wind direction and wind speed, relative humidity or dew point temperature, atmospheric pressure, and solar radiation.	N/A
Aerial Survey	SSA, LSA, RSA	Aerial photos would be taken during the first year to assess the amount of ice cover in the lakes and rivers.	One aerial survey unless the first one does not provide quality results.	Following Canadian Aviation Regulations for Remotely Piloted Aircraft Systems (RPAS 2019)	Assessment of ice cover on lakes, ponds and rivers in winter, which influences habitat.	N/A

TABLE E.3

Study design details for the surface water parameters component of the Environmental Media Baseline Program

Survey Type	Sampling Areas	Sampling Frequency/Timing	Sample Size	Sampling Method/Approach	Contaminants of Potential Concern/Endpoints	Analytical Methods
Surface Water (includes reporting)	AOI Ponds (n=6) Reference Ponds (n=3)	Quarterly	1 station/area in spring, summer, winter (n=9/season) 3 stations/area in fall (n=27)[a] Total of n=54/year	*In situ* limnology measurements taken using a limnology meter (e.g., YSI multi-meter) and a water sample for chemical analyses taken using a water sampler (e.g., Van Dorn)	***In situ* limnology:** Dissolved Oxygen, Temperature, pH, Conductivity, Redox Potential, Secchi Disc Depth (Ice and Snow Depth in winter) **Radionuclides:** H-3, C-14, Sr-90, I-129, Cs-137 [and associated Co-60, Ru-106], gross-α, gross-β, U-238, U-234, U-235, U-238, K-40, Th-228, Th-230, Th-232, Ra-226 **General chemistry, ions, and nutrients:** Alkalinity, Bicarbonate, Bromide, Calcium, Carbonate, Chloride, Chlorophyll a, Cyanide, Fluoride, Hydroxide, Magnesium, pH, Potassium, Sodium, Specific conductivity, Sulphate, Sum of Ions, Total Dissolved Solids, Total Hardness, Total Suspended Solids, Turbidity, Ammonia as Nitrogen, Nitrate + Nitrite, Nitrate (NO3), Total Organic Carbon, Inorganic Carbon, Dissolved Organic Carbon, Phosphorus, Total Kjeldahl Nitrogen, 5 day Biological Oxygen Demand (BOD5), E. coli, Total Coliforms analyses **Metals (total and dissolved):** Aluminum, Antimony, Arsenic, Barium, Beryllium, Bismuth, Boron, Cadmium, Cesium, Chromium (total, trivalent, hexavalent), Cobalt, Copper, Iron, Lead, Lithium, Mercury, Manganese, Molybdenum, Nickel, Rhodium, Ruthenium, Samarium, Selenium, Silver, Strontium, Thallium, Tin, Titanium, Uranium, Vanadium, Zinc, Zirconium **Organics:** SVOCs **Other:** Glyphosate	*In situ* limnology measurements and standard laboratory procedures.
	AOI Pond (n=1)[b]	Quarterly	1 station/area in spring, summer, winter 3 stations/area in fall (n=3)[a] Total of n=6/year	Same as above	Same as above plus Cl-36, Se-79, Np-237, Pu-238, Pu-239, Pu-240, Pu-241 Am-241, Cm-244	Same as above.
	Mennin Lake (n=2) Mennin River (n=2) North Inflow to Mennin Lake (n=1) Wabigoon River (n=3) Reference Lake (n=2)	Quarterly	3 stations/area (n=30/season) Total of n=120/year	Same as above	***In situ* limnology:** Dissolved Oxygen, Temperature, pH, Conductivity, Redox Potential, Secchi Disc Depth (Ice and Snow Depth in winter) **Radionuclides:** H-3, C-14, Sr-90, I-129, Cs-137 [and associated Co-60, Ru-106], gross-α, gross-β, U-238, U-234, U-235, U-238, K-40, Th-228, Th-230, Th-232, Ra-226 **General chemistry, ions, and nutrients:** Alkalinity, Bicarbonate, Bromide, Calcium, Carbonate, Chloride, Chlorophyll *a* , Cyanide, Fluoride, Hydroxide, Magnesium, pH, Potassium, Sodium, Specific conductivity, Sulphate, Sum of Ions, Total Dissolved Solids, Total Hardness, Total Suspended Solids, Turbidity, Ammonia as Nitrogen, Nitrate + Nitrite, Nitrate (NO_3), Total Organic Carbon, Inorganic Carbon, Dissolved Organic Carbon, Phosphorus, Total Kjeldahl Nitrogen, 5 day Biological Oxygen Demand (BOD5), *E. coli* , Total Coliforms analyses **Metals (total and dissolved):** Aluminum, Antimony, Arsenic, Barium, Beryllium, Bismuth, Boron, Cadmium, Cesium, Chromium (total, trivalent, hexavalent), Cobalt, Copper, Iron, Lead, Lithium, Mercury, Manganese, Molybdenum, Nickel, Rhodium, Ruthenium, Samarium, Selenium, Silver, Strontium, Thallium, Tin, Titanium, Uranium, Vanadium, Zinc, Zirconium	Same as above.
	Mennin Lake (n=1)[b] Mennin River (n=1)[b] Revell River (n=1)[b]	Quarterly	3 stations/area (n=9/season) Total of n=36/year	Same as above	Same as above plus Cl-36, Se-79, Np-237, Pu-238, Pu-239, Pu-240, Pu-241 Am-241, Cm-244	Same as above.
	QAQC Samples	Quarterly	1 trip blank, 1 field blank, 1 filter blank and 5 duplicate samples per season[c] (n=8/season) Total of n=24/year	Water sample for chemical analyses taken using a water sampler (e.g., Van Dorn)	Same as the study area being sampled in ponds, rivers, or lakes, but does not include Tier 2 radionuclides (Cl-36, Se-79, Np-237, Pu-238, Pu-239, Pu-240, Pu-241 Am-241, Cm-244).	Same as above.

TABLE E.3

Study design details for the surface water parameters component of the Environmental Media Baseline Program

Survey Type	Sampling Areas	Sampling Frequency/Timing	Sample Size	Sampling Method/Approach	Contaminants of Potential Concern/Endpoints	Analytical Methods
Surface Water	To Be Determined	Continuous	1 location	Install a continuous remote water quality station	Conductivity, pH Turbidity, Dissolved Oxygen, Total Organic Carbon, Nitrate, Ammonia, Chlorophyll *a* , Blue-green algae	N/A
	RSA (n=10) Sampling lakes to be determined by communities	Quarterly	1 station/lake + 1 QA/QC duplicate sample/season (n=44/year)	A surface grab method is used by community members to obtain water samples for chemical analyses	**Radionuclides:** H-3, C-14, Sr-90, I-129, Cs-137 [and associated Co-60, Ru-106], gross-α, gross-β **General chemistry, ions, and nutrients:** Alkalinity, Bicarbonate, Bromide, Calcium, Carbonate, Chloride, Cyanide, Fluoride, Hydroxide, Magnesium, pH, Potassium, Sodium, Specific conductivity, Sulphate, Sum of Ions, Total Dissolved Solids, Total Hardness, Total Suspended Solids, Turbidity, Ammonia as Nitrogen, Nitrate + Nitrite, Nitrate (NO_3), Total Organic Carbon, Inorganic Carbon, Dissolved Organic Carbon, Phosphorus, Total Kjeldahl Nitrogen **Metals (total):** Aluminum, Antimony, Arsenic, Barium, Beryllium, Bismuth, Boron, Bromine, Cadmium, Cesium, Chromium (total, trivalent, hexavalent), Cobalt, Copper, Iron, Lead, Lithium, Mercury, Manganese, Molybdenum, Nickel, Rhodium, Ruthenium, Samarium, Selenium, Silver, Strontium, Thallium, Tin, Titanium, Uranium, Vanadium, Zinc, Zirconium	Standard laboratory procedures.
Sediment	AOI Ponds (n=6) Reference Ponds (n=3)	Fall	3 stations/area (n=27/year)	Composite sediment samples collected preferably using a core sampler (e.g., Tech-ops corer); surficial horizon (0 to 2 cm) retained for analyses; deeper horizons (2 to 4 cm and 4 to 6 cm) archived in freezer. If the substrate is not penetrable, then the 0 to 5 cm horizon will be retained using a grab sampler.	**Radionuclides:** H-3, C-14, Sr-90, I-129, Cs-137 [and associated Co-60, Ru-106], gross-α, gross-β, U-238, U-234, U-235, U-238, K-40, Th-228, Th-230, Th-232, Ra-226 **General characterization and nutrients:** Moisture, Total Organic Carbon, Particle Size (5 fraction EEM), Ammonia as Nitrogen, Nitrate + Nitrite, Nitrate (NO_3), Phosphorus, Total Kjeldahl Nitrogen **Metals:** 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 **Organics:** SVOCs	Standard laboratory procedures.
	AOI Pond (n=1)	Fall	3 stations/area (n=3)	Same as above	Same as above plus Cl-36, Se-79, Np-237, Pu-238, Pu-239, Pu-240, Pu-241 Am-241, Cm-244	Same as above.
	Mennin Lake (n=2) Mennin River (n=2) North Inflow to Mennin Lake (n=1) Wabigoon River (n=3) Reference Lake (n=2)	Fall	5 stations/area (n=50/year)	Same as above	**Radionuclides:** H-3, C-14, Sr-90, I-129, Cs-137 [and associated Co-60, Ru-106], gross-α, gross-β, U-238, U-234, U-235, U-238, K-40, Th-228, Th-230, Th-232, Ra-226 **General characterization and nutrients:** Moisture, Total Organic Carbon, Particle Size (5 fraction EEM), Ammonia as Nitrogen, Nitrate + Nitrite, Nitrate (NO3), Phosphorus, Total Kjeldahl Nitrogen **Metals:** 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	Same as above.
	Mennin Lake (n=1) Mennin River (n=1)[b] Revell River (n=1)[b]	Fall	5 stations/area (n=15/year)	Same as above	Same as above plus Cl-36, Se-79, Np-237, Pu-238, Pu-239, Pu-240, Pu-241 Am-241, Cm-244	Same as above.
	QAQC Samples	Fall	6 Duplicate samples[c]	Same as above	Same as the study area being sampled in ponds, rivers, or lakes, but does not include Tier 2 radionuclides (Cl-36, Se-79, Np-237, Pu-238, Pu-239, Pu-240, Pu-241 Am-241, Cm-244)	Same as above,

TABLE E.3

Study design details for the surface water parameters component of the Environmental Media Baseline Program

Survey Type	Sampling Areas	Sampling Frequency/Timing	Sample Size	Sampling Method/Approach	Contaminants of Potential Concern/Endpoints	Analytical Methods
Phytoplankton	Mennin Lake (n=3) Reference Lake (n=2)	Quarterly	3 stations/area (n=15/season) Total of n=60/year	Depth integrated sample take using Tygon or Nalgene tubing	Phytoplankton taxonomic identification, enumeration, and biomass	Standard laboratory procedures using a taxonomist.
Zooplankton	Mennin Lake (n=3) Reference Lake (n=2)	Quarterly	3 stations/area (n=15/season) Total of n=60/year	A zooplankton sample for laboratory analyses is collected using a tow net (e.g., Wisconsin net)	Zooplankton taxonomic identification, enumeration, and biomass	Standard laboratory procedures using a taxonomist.
Benthic Invertebrates	Mennin Lake (n=3) Mennin River (n=3) North Inflow to Mennin Lake (n=1) Wabigoon River (n=3) Revell River (n=1) Reference Lake (n=2)	Fall	5 stations/area (n=65/year)	A benthic invertebrate sample for laboratory analyses is collected using a grab sampler (e.g., Ekman dredge)	Benthic invertebrate taxonomic identification, enumeration, and biomass	Standard laboratory procedures using a taxonomist.
Zooplankton and Benthic Invertebrates (eDNA)	Mennin Lake (n=2)[d] Mennin River (n=1)[d] Revell River (n=1)[d]	Fall	5 stations/area/media + QA/QC Total of n=48	A water sample and a sediment sample are collected for eDNA analyses[e]	eDNA metabarcoding and Sanger barcode sequence analyses	University of Guelph Standard Operating Procedures.

[a] Three stations will be sampled coincident with the sediment sampling program to assess within-pond variability.

[b] Select stations where Tier 2 artificial radionuclides will be tested in one year (see Figure 6.1).

[c] The number of QA/QC duplicate samples is approximately 10% of the number of test samples.

[d] The eDNA sampling will be completed in 4 areas during Years 2 and 3 of the program: Mennin Lake (n=2, shallow and deep), Mennin River downstream of Mennin Lake (n=1), and Revell River (n=1).

[e] In-field sample collection and processing will be led by a technician from the University of Guelph following their Standard Operating Procedures and using their equipment.

Table E.4

Study design details for the air, light, and noise components of the Environmental Media Baseline Program

Survey Type	Sampling Areas	Sampling Frequency/Timing	Sample Size (annual)	Sampling Method/Approach	Contaminants of Potential Concern/Endpoints	Analytical Methods
Air	SSA	Continuous hourly air samples (annually)	8760	Chemiluminescence	Nitrogen dioxide (NO_2) Nitrogen oxide (NO) Oxides of nitrogen (NOx)	Inline analyzer
		Continuous hourly air samples (annually)	8760	UV Fluorescence	Sulphur dioxide (SO_2)	Inline analyzer
		Continuous hourly air samples (annually)	8760	NDIR gas filter correlation	Carbon monoxide (CO)	Inline analyzer
		Continuous hourly air samples (annually)	8760	Chemiluminescence	Ammonia (NH_3)	Inline analyzer
		Continuous hourly air samples (annually)	8760	Gravimetry; or Beta Attenuation; or Light Scatter	Suspended particulate matter less than 10 micron (PM10)	Inline analyzer
		Continuous hourly air samples (annually)	8760	Gravimetry; or Beta Attenuation; or Light Scatter	Suspended particulate matter less than 2.5 micron (PM2.5)	Inline analyzer
		Intermittent 24-hour air samples on a monthly basis	12	PUF HVAS	Polycyclic aromatic hydrocarbons (PAHs), Petroleum hydrocarbons (F3, F4)	GC/MS on filter and PUF cartridge per EPA TO-13a
		Intermittent 24-hour air samples on a monthly basis	12	PUF HVAS	Petroleum hydrocarbons (F3, F4)	GC/MS on filter and PUF cartridge
		Intermittent 24-hour air samples on a monthly basis	12	Evacuated canister (Summa®)	Volatile organic compounds (VOCs)	Gas chromatography/ Mass spectrometry (GC/MS)
		Intermittent 24-hour air samples on a monthly basis	12	Evacuated canister (Summa®)	Semi volatile organic compounds (SVOCs)	Gas chromatography/ Mass spectrometry (GC/MS)
		Intermittent 24-hour air samples on a monthly basis	12	HVAS with brushless motor and mechanical timer	Total suspended particulate matter (TSP)	Gravimetry
		Intermittent 24-hour air samples on a monthly basis	12	HVAS with brushless motor and mechanical timer	**Metals (in TSP):** 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	EPA 6010 (ICP-AES)
		Monthly	12	HVAS with brushless motor and mechanical timer	**Radionuclides (in TSP):** <u>Top tier</u>: Sr-90, I-129, Cs-137 [and associated Co-60, Se-79, Ru-106], gross-α, gross-β <u>Second tier</u>: Cl-36, Co-60, Se-79, Ru-106, Np-237, Pu-238, Pu-239, Pu-240, Pu-241 Am-241, Cm-244 U-238, U-234, U-235, U-238, K-40, Th-228, Th-230, Th-232, Ra-226	Neutron Activation Analysis

Table E.4

Study design details for the air, light, and noise components of the Environmental Media Baseline Program

Survey Type	Sampling Areas	Sampling Frequency/Timing	Sample Size (annual)	Sampling Method/Approach	Contaminants of Potential Concern/Endpoints	Analytical Methods
Air (Continued)	SSA (Continued)	Monthly	12	Molecular sieve	Tritium (H-3), Carbon-14, Krypton-85[a]	Beta counting in liquid scintillation detector
Air (Continued)	SSA (Continued)	Quarterly	8	Alpha Track Dosimeter	Radon	Alpha track
Air (Continued)	SSA (Continued)	Quarterly	8	Thermoluminescent dosimeter (TLD)	Gamma	Optically stimulated luminescence
Air (Continued)	SSA (Continued)	Monthly	8	Passive cartridge	Nitrogen dioxide (NO_2) nitrogen oxide (NO) oxides of nitrogen (NOx)	SOP PTC SOP-00148
Air (Continued)	SSA (Continued)	Monthly	8	Passive cartridge	Sulphur dioxide (SO_2)	SOP PTC SOP-00149
Air (Continued)	SSA (Continued)	Monthly	8	Passive cartridge	Ammonia (NH_3)	ASTM D6919-09
Air (Continued)	SSA (Continued)	Monthly	8	Passive badge	Volatile organic compounds (VOCs)	Hydrocarbons, BP 36-126 C – NIOSH Method 1500
Air (Continued)	SSA (Continued)	Monthly	12	PUF Disk	PAH	GC/MS on PUF disk per EPA TO-13a
Air (Continued)	SSA (Continued)	Monthly	4	Dustfall	Total suspended particulate matter (TSP)	Gravimetry
Air (Continued)	SSA (Continued)	Monthly	4	Dustfall	**Metals (in TSP):** 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	EPA 6010 (ICP-AES)
Air (Continued)	SSA (Continued)	Monthly	12	Dustfall	**Radionuclides (in TSP):** Top tier: Sr-90, I-129, Cs-137 [and associated Co-60, Se-79, Ru-106], gross-α, gross-β Second tier: Cl-36, Co-60, Se-79, Ru-106, Np-237, Pu-238, Pu-239, Pu-240, Pu-241 Am-241, Cm-244 U-238, U-234, U-235, U-238, K-40, Th-228, Th-230, Th-232, Ra-226	Neutron Activation Analysis

Table E.4

Study design details for the air, light, and noise components of the Environmental Media Baseline Program

Survey Type	Sampling Areas	Sampling Frequency/Timing	Sample Size (annual)	Sampling Method/Approach	Contaminants of Potential Concern/Endpoints	Analytical Methods
Air (Continued)	LSA	Monthly	32	Passive cartridge	Nitrogen dioxide (NO_2) Nitrogen oxide (NO) Oxides of nitrogen (NOx)	SOP PTC SOP-00148
		Monthly	32	Passive cartridge	Sulphur dioxide (SO_2)	SOP PTC SOP-00149
		Monthly	32	Passive cartridge	Ammonia (NH_3)	ASTM D6919-09
		Monthly	32	Passive badge	Volatile organic compounds (VOCs)	Hydrocarbons, BP 36-126 C – NIOSH Method 1500
		Monthly	32	PUF Disk	PAH	GC/MS on PUF disk per EPA TO-13a
		Monthly	16	Dustfall	Total suspended particulate matter (TSP)	Gravimetry
		Monthly	48	Dustfall	**Metals (in TSP):** 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	EPA 6010 (ICP-AES)
		Monthly	4	Dustfall	**Radionuclides (in TSP):** Top tier: Sr-90, I-129, Cs-137 [and associated Co-60, Se-79, Ru-106], gross-α, gross-β Second tier: Cl-36, Co-60, Se-79, Ru-106, Np-237, Pu-238, Pu-239, Pu-240, Pu-241 Am-241, Cm-244 U-238, U-234, U-235, U-238, K-40, Th-228, Th-230, Th-232, Ra-226	Neutron Activation Analysis
		Quarterly	16	Alpha Track Dosimeter	Radon	Alpha track
		Quarterly	16	Thermoluminescent dosimeter (TLD)	Gamma	Optically stimulated luminescence
	RSA	Monthly	36	HVAS with brushless motor and mechanical timer	**Radionuclides (in TSP):** Top tier: Sr-90, I-129, Cs-137 [and associated Co-60, Se-79, Ru-106], gross-α, gross-β Second tier: Cl-36, Co-60, Se-79, Ru-106, Np-237, Pu-238, Pu-239, Pu-240, Pu-241 Am-241, Cm-244 U-238, U-234, U-235, U-238, K-40, Th-228, Th-230, Th-232, Ra-226	Neutron Activation Analysis
		Quarterly	12	Alpha Track Dosimeter	Radon	Alpha track
		Quarterly	24	Thermoluminescent dosimeter (TLD)	Gamma	Optically stimulated luminescence
Noise	SSA	Continuous hourly samples (Leq)	Continuous monitoring over 1-2 week period; seasonally	Class 1 Integrating Sound Level Meter	Sound levels (Noise)	IEC 61672-1:2013
	LSA	Continuous hourly samples (Leq)	Continuous monitoring over 1-2 week period; seasonally	Class 1 Integrating Sound Level Meter	Sound levels (Noise)	IEC 61672-1:2013
Light	SSA	Discrete campaign based samples	Summer campaign covering	Light Meter and Sky Quality Meter	Illuminance / sky glow	CIE 150:2003

[a] HVAS filters would be analyzed quarterly for Tier 1 radionuclides. Composite of quarterly samples would be analyzed for Tier 2 radionuclides as well.

Table E.5

Study design details for the soil component of the Environmental Media Baseline Program

Survey Type	Sampling Areas	Sampling Frequency/Timing	Sample Size	Sampling Method/Approach	Contaminants of Potential Concern/Endpoints	Analytical Methods
Soil	LSA (n = 5 ecosites) RSA (n = 1 direction)	Years 1 and 2	LSA (n = 40) RSA (n = 10)	LSA: Eight samples collected from Black Spruce Ecosite that has been harvested; 8 from Black Spruce Ecosite that has not been harvested; 8 from Jack Pine Ecosite that has been harvested; 8 from Jack Pine Ecosite that has not been harvested; 8 from bogs/wetland locations. Split-spoon samples to be collected from top 0.15 mbgs. Each sample will be a composite sample of 8 sub-samples. RSA: A maximum of 10 soil samples to be collected up to 3 km away from the midpoint of the LSA, in the direction of prevailing wind. A minimum of 3 soil samples should be collected from each new ecosite encountered. One new soil sample may be collected for ecosites already present in the LSA. Approximately 5 samples are expected to be collected in Year 2, in case of a need for more data and detailed analyses.	**Metals (total):** 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 **General chemistry, ions, and nutrients:** Inorganic nitrogen compounds (nitrogen, nitrate, nitrite), pH, Moisture, Total Organic Carbon (TOC), Dissolved Organic Carbon (DOC), Organic Carbon Quality, Electrical Conductivity, Sodium Adsorption Ratio, Grain Size Distribution **Organics and volatiles:** PAHs, VOCs, SVOCs and PHCs **Radionuclides (Tier 1):** H-3, C-14, Sr-90, I-129, Cs-137 [and associated Co-60, Ru-106], gross-α, gross-β, U-238, U-234, U-235, U-238, K-40, Th-228, Th-230, Th-232, Ra-226 **Radionuclides (Tier 2; 10% of samples)[a]:** Cl-36, Co-60, Se-79, Ru-106, Np-237, Pu-238, Pu-239, Pu-240, Pu-241 Am-241, Cm-244 **Other:** Glyphosate	Standard laboratory methods and procedures, appropriate under EPA SW-846
	To be determined following total metals survey in Year 1	Year 2	LSA/RSA (n = 10 subset of samples from 40 LSA and 10 RSA samples)	Selected by screening of total metals and radionuclides after year 1 sampling and analysis. A maximum of 10 samples is assumed.	To be determined after total metals analyses are reported	Modified ASTM D3987 (standard test method for shake extraction of solid waste with water) method
			LSA/RSA (n = 5 subset of samples from ASTM D3987 shake flask extraction testing)	Selected by screening of readily mobilized metals an+E6:E8d radionuclides after ASTM D3987 shake flask testing. A maximum of 5 samples is assumed.	To be determined after short-term leach analyses are reported	Appropriate sequential extraction procedures, assumed Tessier method 6-step procedure (REF, Sudbury Soils program and Tessier paper).
	QA/QC Samples	Year 1	5 trip blanks; 5 field blanks; 7 duplicates	Same as above	Same as above	Same as above

Table E.5

Study design details for the soil component of the Environmental Media Baseline Program

Survey Type	Sampling Areas	Sampling Frequency/Timing	Sample Size	Sampling Method/Approach	Contaminants of Potential Concern/Endpoints	Analytical Methods
Soil (eDNA)	LSA (n = 5 ecosites) RSA (n = 1 direction)	Years 1 and 2	LSA (n = 40) RSA (n = 10) QA/QC for eDNA (n = 5)	Composite samples collected from a random selection of 1-square-meter plots in each ecozone. Approximately 8 composite samples to be collected from each ecosite: Harvested Black Spruce Ecosite, Unharvested Black Spruce Ecosite, Harvested Jack Pine Ecosite, Unharvested Jack Pine Ecosite, and bogs/wetland areas. A maximum of 10 samples should be collected up to 3 km away from the midpoint of the LSA, in the direction of prevailing wind. A minimum of 3 samples should be collected from each new ecosite encountered. One new sample may be collected for ecosites already present in the LSA. Five quality control samples to be collected specifically for eDNA analysis: a field blank, a positive and negative control, and two duplicate analyses for precision estimates. Approximately 5 samples are expected to be collected in Year 2, in case of a need for more data and detailed analyses. Soil cores will be collected in the field with a coring sampler that is cleaned between each plot, by removing any soil remains before a final step at high temperature (flame cleaning). - Coring will be conducted using a wide-neck barrels (15.4 L; Cat. Number: 0789.1; Roth Sochiel E.U.R.L., Lauterbourg, France). - Each core will be homogenized in a sterile container in the field, then transferred to a sterile plastic Nalgene container.	eDNA metabarcoding and Sanger barcode sequence analyses	University of Guelph Standard Operating Procedures
Gamma Radiation Survey	LSA (n = 1 pre-defined area)	Year 3	The gamma radiation survey will cover a pre-defined area, meant to encompass the facility and excavated rock management area footprints within the SSA. The final survey boundaries will be defined in consultation with NWMO as Project details evolve.	Environmental gamma radiation data will be collected through roving transects using a GPS integrated gamma radiation surveying equipment either by foot or by ATV (depending on the site terrain and access issues). Gamma radiation measurements will be taken at a distance of approximately 1 m above the ground surface.	Gamma	Collected data will be mapped to ensure adequate coverage, accuracy and confirm any identified areas of radiological contamination. A reference area will also be included in the survey.

a The 10% of soil samples that will be tested for Tier 2 artificial radionuclides will be tested in Year 1.

APPENDIX F

STUDY COMPONENT DETAILS FOR THE TISSUES COMPONENT

TABLE F.1

Study Component category selection matrix for tissues component of Environmental Media Baseline Program

Study Component (SC) Category	Example SCs that Occur in Region	Score					Baseline Measurement Priority	Rationale
		Community	HHRA	ERA	Is Sample Size Achievable?	Total		
Large-bodied Fish - Piscivore	Walleye, northern pike, lake trout (RSA_{TIS} only)	3	3	3	3	12	Primary	High cultural/stakeholder significance; First Nations Food, Nutrition and Environment Study (FNFNES) important pathway; identified in Table 2-1 of Federal Contaminated Sites Action Plan (FCSAP) and satisfies Table 7-1 of N288.6 (fish)
Large-bodied Fish - Benthivore	Lake whitefish (RSA_{TIS} only), cisco (RSA_{TIS} only), white sucker, lake sturgeon (RSA_{TIS} only)	3	3	3	3	12	Primary	High cultural/stakeholder significance; FNFNES important pathway; identified in Table 2-1 of FCSAP and satisfies Table 7-1 of N288.6 (fish).
Ungulate	Moose, whitetail deer	3	3	3	3	12	Primary	Mentioned repeatedly in stakeholder/rights-holder engagement (Appendix B); high cultural value and known traditional food source; FNFNES important pathway; identified in Table 2-1 of FCSAP, satisfies Table 7-1 of N288.6 (large mammal).
Upland Game Bird	Ruffed grouse/spruce grouse	3	3	3	3	12	Primary	Mentioned repeatedly in stakeholder/rights-holder engagement (Appendix B) and known traditional food source; FNFNES important pathway (partridge); satisfies Table 2-2 of FCSAP (omnivorous bird), satisfies Table 7-1 of N288.6 (bird species with terrestrial habitat).
Aquatic Macrophytes and Sediment	Sedge species, wild rice/manoomin (RSA_{TIS} only), rat root/sweet flag (RSA_{TIS} only)	3	3	3	2	11	Primary	Manoomin and rat root/sweet flag specifically identified as culturally significant and harvested and consumed by local community members; aquatic macrophytes identified in Table 2-1 of FCSAP, satisfies Table 7-1 of N288.6 (aquatic plant species).
Aquatic Bird - Herbivore	Canada goose	3	3	3	2	11	Primary	Canada geese are hunted in the region and are a known traditional food source; FNFNES important pathway (goose); goose identified in Table 2-1 and 2-2 of FCSAP.
Aquatic Bird - Omnivore	Dabbling duck (mallards, shovelers, black duck)	3	3	3	2	11	Primary	Ducks are hunted in the region and are a known traditional food source; FNFNES important pathway (duck); although all doses low, some of the highest calculated values were for mallard (NWMO 2017); dabbling duck identified in Table 2-1 of FCSAP, satisfies Table 7-1 of N288.6 (bird species with aquatic habitat).
Terrestrial Berries	Blueberry, cranberry, raspberry	3	3	2	2	10	Primary	Mentioned repeatedly in stakeholder/rights-holder engagement (Appendix B) and important traditional food; FNFNES important pathway (strawberry, blueberries); plants is important pathway for I-129 (Sixth Safety Case).
Terrestrial Vegetation - Edible or Medicinal Use	Wild mushrooms, chaga, Labrador tea	3	3	2	2	10	Primary	Mentioned repeatedly in stakeholder/rights-holder engagement (Appendix B) and important traditional food; FNFNES important pathway (strawberry, blueberries); plants is important pathway for I-129 (Sixth Safety Case).
Small Mammal	Mouse, shrew, vole, snowshoe hare	3	2	3	2	10	Primary	Small mammals including snow shoe hare are trapped/snared and a potential traditional food source; identified in Table 2-2 of FCSAP (e.g. vole, shrews, bat, hare), satisfies Table 7-1 of N288.6 (small mammals).
Large Mammal - Omnivore	Black bear	3	2	2	3	10	Primary	Mention of consumption repeatedly in stakeholders in Ignace as bear hunting takes place; culturally important; medium HHRA concern; identified in Table 2-2 of FCSAP (bear), satisfies Table 7-1 of N288.6 but information captured with large mammal carnivore category.
Semi-aquatic Mammal	Beaver, muskrat, mink	2	3	3	1	9	Secondary	Locally trapped and culturally significant; FNFNES important pathway (beaver); although all doses low, some of the highest calculated values were for mink, beaver and muskrat (NWMO 2017); Table 2-1 of FCSAP recommends muskrat, mink; satisfies Table 7-1 of N288.6 (small mammal).

TABLE F.1

Study Component category selection matrix for tissues component of Environmental Media Baseline Program

Study Component (SC) Category	Example SCs that Occur in Region	Score					Baseline Measurement Priority	Rationale
		Community	HHRA	ERA	Is Sample Size Achievable?	Total		
Large Mammal - Carnivore	Wolf, lynx	2	2	3	2	9	Secondary	Possibly trapped for furs; lynx sometimes consumed by Elders, wolf have high cultural significance; satisfies Table 2-2 of FCSAP (carnivorous mammal).
Amphibian	Wood frog, tree frog	2	1	3	2	8	Secondary	Frogs and toads identified in stakeholder/rights-holder engagement (Appendix B; comment 7B-1a); not a concern for HHRA; although all doses low, some of the highest calculated values were for northern leopard frog (NWMO 2017); amphibian identified in Table 2-1 and Table 2-2 of FCSAP, satisfies Table 7-1 of N288.6; risks for non-radiological COPC generally assessed using environmental concentrations; concentrations can be successfully modelled based on water and soil chemistry input.
Aquatic Bird - Piscivore	Merganser, grebe	1	2	3	2	8	Secondary	Not specifically mentioned in stakeholder/rights-holder engagement; although all doses low, some of the highest calculated values were for loon (NWMO 2017; piscivorous identified in Table 2-1 of FCSAP (loon, merganser, osprey), satisfies Table 7-1 of N288.6 (bird species with aquatic habitat).
Terrestrial Vegetation - Browse	Willow, red-osier dogwood	2	1	3	2	8	Secondary	Terrestrial vegetation mentioned repeatedly in stakeholder/rights-holder engagement (Appendix B) in terms of ecosystem and moose/deer health; not a HHRA concern; identified in Table 2-2 of FCSAP, satisfies Table 7-1 of N288.6 (terrestrial plant).
Insects	Dragonflies, caterpillars	2	1	3	2	8	Secondary	Insects mentioned in stakeholder/rights-holder engagement (Appendix B; comments 3B-2b and 7B-1d); not a HHRA concern; identified in Table 2-2 of FCSAP, satisfies Table 7-1 of N288.6 but can be successfully modelled based on soil chemistry input.
Small-bodied Fish (whole) and organs - Planktivore	Spottail shiner, blacknose shiner, longnose dace (LSA_{TIS})	2	1	2	2	7	Secondary	Fish mentioned repeatedly in stakeholder/rights-holder engagement (Appendix B) in terms of overall protection; not a HHRA concern; identified in Table 2-1 of FCSAP, satisfies Table 7-1 of N288.6 (fish) but can be successfully modelled based on water chemistry input.
Benthic Invertebrates	Chironomids	1	1	3	1	6	Not Required	Not identified as a concern in stakeholder/rights-holder engagement; not a concern for HHRA; identified in Table 2-1 of FCSAP, satisfies Table 7-1 of N288.6 (benthic invertebrates) but can be successfully modelled based on water chemistry/sediment input.
Bird - Insectivore	Swallow, flycatcher	2	1	3	1	7	Not Required	Songbirds (Canadian Jays) mentioned in stakeholder/rights-holder engagement (Appendix B; comment 1G-2d); not a concern for HHRA; swallow identified in Table 2-1 of FCSAP, surrogate for SARA species, can be successfully modelled.
Soil Invertebrates	Earthworms	2	1	2	1	6	Not Required	Mentioned in stakeholder/rights-holder engagement (Appendix B; comment 3B-2c); not a concern for HHRA; identified in Table 2-2 of FCSAP, satisfies Table 7-1 of N288.6 (soil invertebrate) but can be successfully modelled based on soil chemistry input.
Bird - Carnivore	Hawk, owl	1	1	2	1	5	Not Required	Not identified as a concern in stakeholder/rights-holder engagement; not a concern for HHRA; identified in Table 2-2 of FCSAP, can be successfully modelled based on small mammal input.
Honey, bees	Honeybee	2	2	1	1	6	Not Required	Mentioned in stakeholder/rights-holder engagement (Appendix B; comment 3B-2a); not required for an ERA; locally difficult to source.

TABLE F.1

Study Component category selection matrix for tissues component of Environmental Media Baseline Program

Study Component (SC) Category	Example SCs that Occur in Region	Score					Baseline Measurement Priority	Rationale
		Community	HHRA	ERA	Is Sample Size Achievable?	Total		
Herptile	Not captured in amphibians listed above	2	1	2	1	6	Not Required	Amphibian and reptile study (frogs and turtles) was mentioned in stakeholder/rights-holder engagement (Appendix B; comment 7B-1a); not a HHRA concern; identified in Table 2-1 and 2-2 of FCSAP but can be successfully modelled based on water and soil chemistry input.

Note: Study Component (SC) categories of aquatic primary producers (phytoplankton) and pelagic invertebrates (zooplankton) covered by surface water chemistry input; see main report for complete references.

Ranking System

Community

Rank = 1	No specific mention in stakeholder/rights-holder engagement; not a known food source (Appendix B; Chan et al. 2014; CanNorth 2011, 2014, 2017, 2018a, 2018b)
Rank = 2	Mentioned by stakeholders; potential food source; cultural importance; tourism/economic importance (Appendix B; Chan et al. 2014; CanNorth 2011, 2014, 2017, 2018a, 2018b)
Rank = 3	Consistently brought up by stakeholders/rights holders; known traditional food source; cultural importance; tourism/economic importance (Appendix B; Chan et al. 2014; CanNorth 2011, 2014, 2017, 2018a, 2018b)

HHRA (Human Health Risk Assessment)

Rank = 1	Not included in HHRA
Rank = 2	Included in HHRA but expected to be minor
Rank = 3	Important to HHRA (Chan et al. 2014; CCME 2016a, 2016b)

ERA (Ecological Risk Assessment)

Rank = 1	Not specifically identified in sources (CSA 2012; Environment Canada 2012; CCME 2016b; NWMO 2017)
Rank = 2	Identified by at least 1 source (CSA 2012; Environment Canada 2012; CCME 2016b; NWMO 2017)
Rank = 3	Identified by all 3 sources (CSA 2012; Environment Canada 2012; CCME 2016b; NWMO 2017)

Sample Size

Rank = 1	Sample weight or sample number unlikely to be sufficient to achieve meaningful results
Rank = 2	Sample weight or sample number will be sufficient to achieve meaningful results
Rank = 3	Sample weight or sample number achievable and meaningful

Total Score/Baseline Measurement Priority

10-12	Primary Target
7-9	Secondary Target
5-6	Not Required

Literature Cited:

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Environment Canada. 2012. Federal contaminated sites action plan (FCSAP) ecological risk assessment guidance. Prepared for Environment Canada by Azimuth Consulting Group, March.

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TABLE F.2

Species at Risk and selected surrogates

Common Name	Scientific Name	Status in Canada[a]	Status in Ontario[a]	Habitat Description	Additional Notes	Observed	Dietary Niche	Surrogate Species Type	Species	Rationale	Confidence in Species Surrogate[b]	Food Surrogate	Species	Confidence in Food Surrogate[b]
Mammals														
American Badger (Northwestern Population)	*Taxidea taxus*	END	END	Open habitat (grasslands, meadows, golf courses, farmland, sand barrens and roadways) both man-made or natural, with friable soil to allow for burrowing			Primary diet: carnivore (terrestrial vertebrates) Animal foods: birds, mammals, amphibians, reptiles, insects, terrestrial non-insect arthropods Foraging behaviour: stores or caches food	Large mammals - carnivore	Wolf, lynx	Similar diet	2	Small mammals	Mouse, shrew, vole, snowshoe hare	3
Caribou (Boreal Population	*Rangifer tarandus*	THR	THR	Large, undisturbed tracts of boreal forest; in upland forests, caribou prefer old, mature conifer forests; in lowland areas, preference is to jack pine or black spruce dominated forest types			Primary diet: herbivore, folivore Plant foods: leaves, roots and tubers, wood, bark or stems, bryophytes, lichens Other foods: fungus	Ungulates	Moose, whitetail deer	Similar diet, although caribou consume more lichen	2	Terrestrial vegetation - browse	Willow, birch, red-osier dogwood	2
Cougar or Mountain Lion	*Puma concolor*	Data Deficient	END	Large, undisturbed forests or other natural areas where there is little human activity	Forest must also support white tailed deer		Primary diet: carnivore (terrestrial vertebrates) Animal foods: birds, mammals, fish, mollusks Foraging behaviour: stores or caches food	Large mammals - carnivore	Wolf, lynx	Similar habitat and diet	3	Small mammals; ungulates	Mouse, shrew, vole, snowshoe hare; deer	3
Eastern Small-footed Myotis	*Myotis leibii*	END	END	Uses a variety of roosting habitats, including: under rocks, in rock outcrops, in buildings, under bridges, on or in caves, mines or hollow trees; winters in caves and abandoned mines			Primary diet: insectivore Animal foods: insects	Small mammals	Mouse, shrew, vole, snowshoe hare	Similar diet	1	Insects	Dragonflies, caterpillars	2
Gray Fox	*Urocyon cinereoargenteus*	THR	THR	Gray foxes prefer to live in deciduous forests interspersed with brushy, woodland areas.			Primary Diet: omnivore Animal foods: rodents, eastern cottontail rabbits, insects, fruit, carrion	Large mammals - carnivore	Wolf, lynx	Similar diet	3	Small mammals	Mouse, shrew, vole, snowshoe hare	3
Little Brown Myotis	*Myotis lucifugus*	END	END	Uses caves, quarries, tunnels, and hollow trees on buildings for roosting; winters in humid caves; maternity sites occur in dark warm areas such as attics and barns, as well as old dead trees and snags; feeds primarily in wetlands			Primary diet: carnivore (insectivore) Animal foods: insects	Small mammals	Mouse, shrew, vole, snowshoe hare	Similar diet	1	Insects	Dragonflies, caterpillars	2
Northern Long eared Myotis	*Myotis septentrionalis*	END	END	Hibernates during the winter in mines or caves; during the summer males roost alone and females form maternity colonies of up to 60 adults; roosts in houses and manmade structures but prefers hollow trees or under loose bark; hunts within forests below the canopy			Primary diet: carnivore (insectivore) Animal foods: insects	Small mammals	Mouse, shrew, vole, snowshoe hare	Similar diet	1	Insects	Dragonflies, caterpillars	2
Tri-colored Bat	*Perimyotis subflavus*	END	END	These bats prefer edge habitats near areas of mixed agricultural use			Primary diet: insectivore Animal foods: large hatches of grain moths emerging from corn cribs	Small mammal	Mouse, shrew, vole, snowshoe hare	Similar diet	1	Insects	Dragonflies, caterpillars	2
Wolverine	*Gulo gulo*	No Status	THR	Large undisturbed tracts of boreal forest with individual ranges from 500-1500 km^2	Associated with large ungulate populations		Primary diet: carnivore (terrestrial vertebrates), scavenger, omnivore Animal foods: birds, mammals, eggs, carrion Foraging behaviour: stores or caches food	Large mammal - carnivore	Wolf, lynx	Similar diet	2	Small mammals; ungulates	Mouse, shrew, vole, snowshoe hare; deer	3

TABLE F.2

Species at Risk and selected surrogates

Common Name	Scientific Name	Status in Canada[a]	Status in Ontario[a]	Habitat Description	Additional Notes	Observed	Dietary Niche	Surrogate Species Type	Species	Rationale	Confidence in Species Surrogate[b]	Food Surrogate	Species	Confidence in Food Surrogate[b]
Birds														
American White Pelican	*Pelecanus erythrorhynchos*	No Status	THR	Nest in groups on remote islands that are barren or sparsely treed located in lakes, reservoirs, or on large rivers	Requires remote islands on large lakes and rivers; more likely to be near areas of relatively shallow water		Primary diet: carnivore, piscivore Animal foods: amphibians, fish, aquatic crustaceans	Aquatic bird - piscivore	Merganser, grebe	Similar diet, habitat	3	Small-bodied fish - planktivore	Spottail shiner, blacknose shiner, longnose dace	3
Bald Eagle	*Haliaeetus leucocephalus*	No Status	SC	Require large continuous area of deciduous or mixed woods around large lakes, rivers; 30 to 50% canopy cover; nest in tall trees 50 to 200 m from shore; require tall, dead, partially dead trees within 400m of nest for perching; sensitive to toxic chemicals	All possible ecosites from Key 3-9, and 11 within 200 m of large lakes or rivers	Observed 3 times Ignace area (Table 10; TM-1)	Primary diet: carnivore (terrestrial vertebrates), piscivore Animal foods: birds, mammals, fish eggs, carrion	Aquatic bird - piscivore	Merganser, grebe	Similar diet	2	Small-bodied fish; small mammals	Spottail shiner, blacknose shiner, longnose dace; mouse, shrew, vole, showshoe hare	3
Bank Swallow	*Riparia riparia*	No Status	THR	Nest in burrows in natural and human-made settings where there are vertical faces in silt and sand deposits; many nests are on banks of rivers and lakes, but they are also found in active sand and gravel pits or former ones where the banks remain suitable			Primary diet: carnivore (insectivore) Animal foods: insects	Bird - insectivore				Insects	Dragonflies, caterpillars	3
Barn Swallow	*Hirundo rustica*	No Status	THR	Farmlands or rural areas; cliffs, caves, rock niches; buildings or other man-made structures for nesting; open country near body of water			Primary diet: carnivore (insectivore) Animal foods: insects	Bird - insectivore				Insects	Dragonflies, caterpillars	3
Black Tern	*Chlidonias niger*	No Status	SC	Floating nests in loose colonies in shallow marshes, especially in cattails			Primary diet: insectivore, piscivore Foods: damselflies, dragonflies, grubs and larvae, other small mollusks during the breeding season; small marine fish (e.g., anchovies, silversides) and plankton rest of the year	Aquatic birds - omnivore	Mallard duck	Similar diet	2	Insects; small bodied fish - planktivore	Dragonflies, caterpillars; spottail shiner, blacknose shiner, longnose dace	3
Bobolink	*Dolichonyx oryzivorus*	No Status	THR	Large, open expansive grasslands with dense ground cover; hayfields, meadows or fallow fields; marshes; requires tracts of grassland >50 ha	Must have grasslands greater than 50 ha		Primary diet: omnivore, carnivore (insectivore), herbivore, granivore Animal foods: insects Plant foods: seeds, grains, and nuts	Upland game bird	Ruffed grouse/spruce grouse	Similar diet	1	Insects	Dragonflies, caterpillars	2
Canada Warbler	*Wilsonia canadensis*	THR	SC	Interior forest species breeding in a wide variety of deciduous and mixed coniferous forests, usually with a moist to wet moisture regime; forest understory must contain a well-developed shrub layer for nest concealment as this species nests near or on the ground; ideal habitats would be >30 ha in size	The identified ecosites are only suitable if a well-developed shrub layer is present; preferred habitat is >30 ha		Primary diet: carnivore (insectivore) Animal foods: insects	Bird - insectivore				Insects	Dragonflies, caterpillars	3
Common Nighthawk	*Chordeiles minor*	THR	SC	Historically, nesting habitat consisted of open areas with little to no ground cover such as burned-over areas, forest clearings and rock barrens; has also adapted to use cultivated fields, orchards, urban parks, mine tailings and along gravel roads and railways	Areas within the identified ecosites in early succession following forestry activity have a higher chance of providing suitable habitat		Primary diet: carnivore (insectivore) Animal foods: insects	Bird - insectivore				Insects	Dragonflies, caterpillars	3
Eastern Whip-poor-will	*Antrostomus vociferus*	THR	THR	Dry, open, deciduous woodlands with small to medium trees, generally oak or beech with ample clearings and shaded leaf litter; wooded edges and forest clearings with little herbaceous growth; associated with forests >100 ha; habitat characterization using GIS indicates that eastern whip-poor-will prefer about a 50:50 matrix of forest clearings and sparse forest as habitat	Must contain a mix of open and prefers pine/ oak forested areas (i.e. rock barren beside mixed forest); forests must be >100 ha	Observed (heard) 1 times Ignace area (Table 10; TM-1)	Primary diet: carnivore, insectivore Animal foods: birds, amphibians, insects	Bird - insectivore				Insects	Dragonflies, caterpillars	3

TABLE F.2

Species at Risk and selected surrogates

Common Name	Scientific Name	Status in Canada[a]	Status in Ontario[a]	Habitat Description	Additional Notes	Observed	Dietary Niche	Surrogate Species Type	Species	Rationale	Confidence in Species Surrogate[b]	Food Surrogate	Species	Confidence in Food Surrogate[b]
Eastern Wood-Pewee	*Contopus virens*	No Status	SC	Mid-canopy layer of forest clearings and edges of deciduous and mixed forests; most abundant in intermediate-age forest stands with little understory vegetation	Clearings and edges; ecosites suitable will include a forest ecosite, and associated clearing ecosite (i.e.: B030 and B033)	No Observation date in NHIC Search	Primary diet: carnivore (insectivore) Animal foods: insects, terrestrial non-insect arthropods Plant foods: seeds, grains, nuts, fruit	Bird - insectivore				Insects	Dragonflies, caterpillars	3
Evening Grosbeak	*Coccothraustes vespertinus*	SC	SC	Coniferous and deciduous forests are the preferred habitats. During migration and winter the birds can be found in broad-leafed trees and open environments with fruiting shrubs. During breeding season, mixed coniferous forests are where these birds will be found. The preferred trees of evening grosbeaks are spruce and fir.			Primary diet: granivore Animal food: spruce budworm Plant foods: seeds	Aquatic bird - herbivore	Canada goose	Some similar dietary elements	1	Seeds		1
Golden Eagle	*Aquila chrysaetos*	No Status	END	Remote bedrock cliffs overlooking clearings such as burns, lakes or tundra			Primary diet: carnivore (terrestrial vertebrates) Animal foods: birds, mammals, reptiles, fish	Aquatic bird - piscivore	Merganser, grebe	Some similar dietary elements	1	Small mammals	Mouse, shrew, vole, snowshoe hare	3
Horned Grebe	*Podiceps auritus*	SC	SC	During the breeding season, horned grebes are found predominantly on prairie and boreal freshwater lakes with both open waters and marsh vegetation. They may also nest in marshes, small sloughs with weedy margins, ponds, and occasionally on rivers. Horned grebes overwinter in coastal saltwater habitats such as protected bays and exposed shores, and occasionally on large freshwater lakes			Primary diet: carnivore Animal foods: aquatic arthropods, fish and crustaceans (winter), leeches, tadpoles, salamanders (summer) Plant foods: occasionally eats plant material	Aquatic bird - piscivore	Merganser, grebe	Similar diet	2	Small-bodied fish - planktivore	Spottail shiner, blacknose shiner, longnose dace	3
Least Bittern	*Ixobrychus exilis*	THR	THR	Deep marshes, open bogs and marshy borders of lakes, ponds and streams, usually >5 ha; abundant emergent vegetation such as cattails, bulrushes or sedges must be present for nesting and concealment; this species in highly intolerant of human disturbance and habitat alteration	Requires wetlands (bogs/ marshes) >5 ha		Primary diet: piscivore Animal foods: fish, snakes, frogs	Aquatic bird - piscivore	Merganser, grebe	Similar diet	2	Small-bodied fish - planktivore	Spottail shiner, blacknose shiner, longnose dace	3

TABLE F.2

Species at Risk and selected surrogates

Common Name	Scientific Name	Status in Canada[a]	Status in Ontario[a]	Habitat Description	Additional Notes	Observed	Dietary Niche	Surrogate Species Type	Species	Rationale	Confidence in Species Surrogate[b]	Food Surrogate	Species	Confidence in Food Surrogate[b]
Olive-sided Flycatcher	*Contopus cooperi*	THR	SC	Most often found along natural forest edges and openings; will use forests that have been logged or burned; breeds in mixed and conifer forest, adjacent to wetlands ponds, lakes or rivers; common nest tree species include white and black spruce, jack pine, and balsam fir	Requires tall trees for foraging perch		Primary diet: insectivore Animal foods: flying insects including flying ants, wasps, bees, dragonflies, grasshoppers, beetles, moths, flies Plant foods: occasionally fruit (berries)	Bird - insectivore				Insects	Dragonflies, caterpillars	3
Peregrine Falcon	*Falco peregrinus*	SC	SC	Nests on tall, steep rock cliffs and crags, especially situated near water; this species has also adapted to use the ledges of tall buildings in urban centres			Primary diet: carnivore (terrestrial vertebrates) Animal foods: birds, mammals, amphibians, reptiles, fish, insects Foraging behaviour: stores or caches food	Bird - carnivore				Upland game birds	Ruffed grouse/spruce grouse	2
Red-necked Phalarope	*Phalaropus lobatus*	SC	SC	During the breeding season, the birds inhabit the tundra/forest tundra areas near lakes or wetlands with marshy riparian zones that include an abundance of grasses, moss, and sedges. They have also been found in sparsely vegetated lava deserts in Iceland, coastal moorlands, on floodplains of large rivers, as well as bogs. During migration these birds will find saline lakes to use, and the winter season is spent at sea in upwelling zones and ocean slicks.			Primary diet: insectivore Secondary diet: seeds	Aquatic bird - omnivore	Mallard duck	Similar diet	1	Insects; aquatic macrophytes	Dragonflies, caterpillars; sedge species	1
Rusty Blackbird	*Euphagus carolinus*	SC	Not at Risk	Foraging habitat includes marshes, swamps, pond edges; breeding habitat preference is boreal forest (wet areas), beaver ponds and bogs	Wet forest types		Primary diet: insectivore Animal foods: insects (summer) Plant foods: acorns, pine seeds, fruit (winter)	Bird - insectivore				Insects	Dragonflies, caterpillars	3
Short-eared Owl	*Asio flammeus*	SC	SC	Open areas such as grasslands, marshes and tundra where it nests on the ground and hunts for small mammals, especially voles			Primary diet: carnivore (terrestrial vertebrates) Animal foods: birds, mammals	Bird - carnivore				Small mammals	Mouse, shrew, vole, snowshoe hare	3
Yellow Rail	*Coturnicops noveboracensis*	SC	SC	Marshes with little standing water; often associated with sedges, rushes and grasses; edges of marshes, estuaries and coastlines			Primary diet: carnivore (molluscivore) Animal foods: insects, terrestrial non-insect arthropods, mollusks, aquatic crustaceans Plant foods: seeds, grains, nuts	Aquatic bird - omnivore	Mallard duck	Similar diet	1	Insects	Dragonflies	2
Fish														
Lake Sturgeon (Great Lakes - Upper St. Lawrence population)	*Acipenser fulvescens*	No Status	THR	Found in large rivers and lakes and near the mouths of large rivers; Great Lakes populations usually was associated with silt substrate, while infrequently associated with gravel or sand substrates	Sturgeon requires large water bodies and is found in the benthic zone of lakes; only possible in limnetic zone during spawning migration		Primary diet: carnivore Animal foods: insect larvae, worms, crayfish, snails, small fish	Large-bodied fish - piscivore/ benthivore	Walleye, lake trout, northern pike, burbot	Similar diet	2	Insects	Dragonflies	2
Shortjaw Cisco	*Coregonus zenithicus*	THR	THR	Spends most of the year in deep water, usually between 55 to 180 m in depth; during the breeding season, which can be spring or fall depending on the lake, it migrates to shallower water (10 to 60 m) to mate and lay eggs	No ecosites for shortjaw cisco; shortjaw cisco live in deep water (>55 m deep)		Primary diet: carnivore (non-insect arthropods), omnivore Animal foods: insects, aquatic crustaceans, zooplankton	Large-bodied fish - piscivore/ benthivore	Cisco	Similar diet, same family	3	Insects	Dragonflies	2

TABLE F.2

Species at Risk and selected surrogates

Common Name	Scientific Name	Status in Canada[a]	Status in Ontario[a]	Habitat Description	Additional Notes	Observed	Dietary Niche	Surrogate Species Type	Species	Rationale	Confidence in Species Surrogate[b]	Food Surrogate	Species	Confidence in Food Surrogate[b]
Insects														
Monarch Butterfly	*Danaus plexippus*	SC	SC	Breeding habitat is confined to where milkweed grows, since milkweed leaves are the sole food of caterpillars; different species of milkweeds grow in a variety of environments, including meadows, along roadsides and in ditches, open wetlands, dry sandy areas, short and tall grass prairies, river banks, irrigation ditches, arid valleys and south facing hillsides	Open spaces		The larva feed on a wide range of milkweeds of the genus Asclepias. The adults of the species forage for flower nectar.	Insects	Dragonflies, caterpillars	Same phylum	2	Vegetation	Sedge species, browse	1
Pygmy Snaketail	*Ophiogomphus howei*	SC	END	Larvae of the pygmy snaketail dragonfly are found in large rivers with clear, fast-flowing, and unpolluted running waters and substrates of fine sand or pea sized gravel. They are typically found at depths of 1 to 4 m. The majority of adult life is spent hidden in forests along large rivers. The forest surrounding the river is needed, particularly for females, to provide habitat for foraging and mating. The specific type of forest is most likely a mixture of deciduous and coniferous forest.			Primary diet: carnivore Animal foods: butterflies, moths, damselflies, mosquitoes, flies	Insects	Dragonflies, caterpillars	Same phylum	2	Insects	Dragonflies, caterpillars	1
Transverse Lady Beetle	*Coccinella transversoguttata*	SC	END	Transverse Lady Beetle is found on a variety of plants in a wide range of habitats.			Primary diet: insectivore Animal foods: aphids, other insects	Insects	Dragonflies, caterpillars	Same phylum	2	Insects	Dragonflies, caterpillars	1
Reptile														
Snapping Turtle	*Chelydra serpentina*	SC	SC	Variety of permanent, semi-permanent fresh waterbodies, but favours areas with abundant aquatic vegetation and soft mud or sand substrates; ideal range size would consist of waterbodies or wetlands complexes of ~28 ha			Primary diet: omnivore Animal foods: mammals, amphibians, reptiles, eggs, carrion, insects, mollusks Plant foods: leaves, algae					Insects; aquatic macrophytes	Dragonflies, caterpillars; sedge species, wild rice/manoomin, rat root/sweet flag	2
Plants														
Western Silvery Aster	*Symphyotrichum sericeum*	THR	END	Fields and open areas, including undisturbed grasslands; often found in trembling aspen/bur oak savannahs; undisturbed grasslands; rarely found at disturbed habitats, such as roadside ditches			Not applicable	Terrestrial vegetation - edible or medicinal use	Labrador tea		1	-	-	-
Small-flowered Lipocarpha	*Lipocarpha micrantha*	THR	END	Sandy strands, shores, pond and lake margins, bogs, along streams, beaches, and vernal wetlands			Not applicable	Terrestrial vegetation - edible or medicinal use	Labrador tea		1	-	-	-
Showy Goldenrod	*Solidago speciosa*	END	THR	Open habitats; grasslands and oak savannahs with south facing slopes; shallow soils over bedrock; often associated with jack pine and white pine			Not applicable	Terrestrial vegetation - browse	Willow, birch, red-osier dogwood		2	-	-	-

Notes:

[a]END - Endangered; SC - Special Concern; THR - Threatened

[b]Confidence in surrogate: 3 - high; 2 - medium; 1 - high.

Sources:

The Cornell Lab. (2020). All About Birds. https://www.allaboutbirds.org

University of Michigan. (2020). Animal Diversity Web. https://animaldiversity.org/

Information obtained from Tulloch Engineering (2018) TM-1. Appendix E-1: A list of SAR identified as having as the potential to occur in the Study Area, their habitat preferences, and ELC ecosites appropriate for the species are presented in Appendix E-1.

Information: A total of 20 species identified on the SARO List for the Kenora Region and 11 additional species described in provincial or federal SAR legislation are identified as having a possibility to occur within the Study Area. Suitable habitat determinations were made based on species' habitat preferences, range, and known occurrences within or near the Study Area.

APPENDIX G

EHP QMS QUOTATION

QUOTE
23.10.2019

CanNorth Environmental
211 Wheeler St,
Saskatoon, SK S7P 0A4

Ref: Water quality online Monitoring station to North West Ontario

EHP ENVIRONMENT

EHP Environmental Solutions Canada Ltd. supplies modern online environmental monitoring solutions for environmental online Real-time monitoring. We design, produce, install and service Online Real-time Environmental Monitoring Stations that operate year around in harsh outside conditions. The ehp-data.com cloud server is a user interface for the client to read the monitoring data. EHP has delivered this far about 1500 online monitoring stations. More information about the company is at internet www.ehpenvironment.com

EHP ENVIRONMENTAL SOLUTIONS CANADA LTD. offers the following:

Monitoring station for continuous monitoring of quality parameters of river water:

EHP QMS monitoring station to be installed outside to a river shore

a. Monitoring station is independently powered with a battery and solar panel. The water quality sensors are connected to a data logger with a cable
b. Monitoring intervals can be selected from 5 minutes to 24 hours. (Recommendation intervals 30 minutes.)
c. Monitoring data to be sent to internet server in 6 or 24 hours intervals via satellite data network. (if cell network is available it is recommended to be used due to lower costs (modem and the data)

environmental solutions.

d. Sensors: water level, pH, Conductivity, Turbidity, Dissolved Oxygen, Total Organic Carbon, Nitrate, and Ammonia (blue-green algae and chlorophyll as optional additions).

   i. Water level is measured by a pressure sensor

   ii. pH and conductivity are measured by electronic probes

   iii. Turbidity sensor is an optical sensor with a lens cleaning wiper.

   iv. Dissolved oxygen probe uses optical luminescence technology ASTM D888 –05Complinac

   v. TOC is measured by UV254 absorption photometer.

   vi. Nitrate is measured by digital, optical photometric InSitu sensor

   vii. Ammonia is measured by ion-selective electrode

   viii. blue-green algae and chlorophyll are measured by Online fluorometer sensor that's measurement principle is based for determination of colourings and pigments by measurements of fluorescence emission

pH sensor

Sensor for TOC monitoring

Technical Specifications

Measurement technology	light source	2 LED (254 nm, 530 nm)
	detector	Photo diode
Measurement principle		Attenuation, transmission
Optical path		1 mm, 2 mm, 5 mm, 10 mm, 50 mm
Parameter		SAC_{254}, CODeq, BODeq, TOCeq, UVT, Turb530
Measuring range		See parameter list p. 1
Measurement accuracy		0.2 %
Turbidity compensation		at 530 nm
Data logger		~ 2 MB
T100 response time		4 s
Measurement interval		≥ 2 s
Housing material		Stainless steel (1.4571/1.4404) or titanium (3.703
Dimensions (L x Ø)		300 mm x 48 mm (with 10 mm path)
Weight	stainless steel	~ 2.3 kg (with 10 mm path)
	titanium	~ 2.1 kg (with 10 mm path)

Turbidity sensor

- *Monitoring of streams, rivers, and water storage*
- *Hydrological run off studies*
- *Ground and bore water analysis*

Pictures and the main technical characteristics of part of the sensors within this Quote

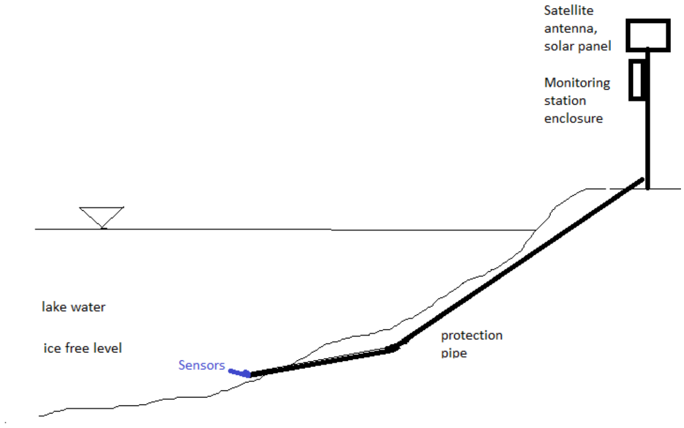
Example pictures of an installation of EHP QMS monitoring station installed to the place of monitoring at industrial site.

The EHP monitoring stations are designed and built to meet northern climate condition requirements. Their minimum operate weather temperature is -40deg C.

The monitoring station enclosure is to be installed near the river. The water quality sensors are to be installed to the river water about 2…5 meter distance from the shoreline. The sensors are to be fixed to their locations up to 0,3 m distance from the bottom. They must be situated below the ice cover at winter time. The sensors cables will be dug to the lake shore embankment and they are installed inside the protection pipes eg. plastic pipe d50mm or 100mm.

The optical sensors are recommended to have air pressure cleaning system. This proposal includes air pressure bottle and a valve controlled by the datalogger + the air pressure piping to the optical sensors. The air pressure flow to the sensor lence is programmed to clean the sensor head periodically. The air bottle is to be changed at the moment of a service of a station.

EHP will implement the installation and commissioning of the monitoring station. The installation works is typically done during one-two days work at the site.



Picture about the example installation principle of a river water monitoring station to the embankment of the river.

The monitoring data is available for reading 24/7 at www.ehp-data.com user interface. The data can be extracted from the server to client's computer in Excel, PDF, CSV etc. format.

The monitoring data can be seen as a graph of selected time period at the data service. Additionally there are different reporting functions available at the data service for cumulative, average etc. values of the measured data as well as self-diagnostics of the monitoring station.

PRICES

EHP QMS online monitoring station, with satellite data modem, one (1) unit (including water level, pH, Conductivity, Turbidity, Dissolved Oxygen, Total Organic Carbon, Nitrate, and Ammonia sensors)

58,500 CAD + HST

In case that cell network is available for the data transmission, the cost of the monitoring station is reduced by 1,800 CAD

Blue-green algae and chlorophyll as optional additions:

9,400 CAD + HST

The data user interface ehp-data.com when satellite data transmission used is 210 CAD / month
The data user interface ehp-data.com when cell network used is 150 CAD / month / monitoring station.

Installation / supervision EHP specialist 1.080 CAD / workday / specialist + HST
(estimation that two days at site is needed)

Travel time of EHP specialist 50% of the workday unit cost (in hours according the actual travelling time). EHP has an installation specialist in Thunder Bay Ontario.

Installation supervision / installation work at the site
to be invoiced according to the time used for the work.
EHP specialist rate for a workday, 8 hours: 1080 CAD / workday / specialist
2 days x 2 specialists Total 4,320 CAD

travel costs and time + accommodation to be charged according to fact, EHP specialist is based in Thunder Bay from where he'll travel to the site between Dryden Ignace.
estimation for the travel costs:
travel time from Thunder Bay to the site 4 hours, 2 persons = 540 CAD
travel time from the site to Thunder Bay 4 hours, 2 persons = 540 CAD
Truck 350km + 350 km á 0,50 CAD = 350 CAD
Accommodation 2 nights á 150 CAD x 2 persons = 600 CAD

Travel costs Total: 2,030 CAD

Total costs including the online monitoring station and the installation: 64,850 CAD + HST

Total cost when the blue-green algae and chlorophyll sensors included: 74,250 CAD + HST

Service of the monitoring station, EHP recommendation is 2 times / year.
Cost per the service (one service visit) including the travel costs
1,800 CAD

Additional costs of the replacement cartridges for the sensors (needed once a year or in two years)
DO sensor, cartridge (changed every 2 years) 950 CAD
Ammonia sensor, cartridge (changed every year) 2100 CAD

TERMS

The costs include the delivery of the monitoring station to Thunder Bay Ontario from where it will be transported with EHP installation specialists to the site between Ignace and Dryden.

The EHP monitoring stations are put together according to CE requirements.

Delivery time of the monitoring station to client: about 6-8 weeks form an order or according to an agreement.

Invoicing with one invoice after the delivery of the monitoring station. For the data service the invoicing in three months intervals, the invoice sent at the start of the period. Payment time of the invoice 14 days.

Monitoring stations have 12 months guarantee.

This proposal is valid until 31st December 2019.

Yours Sincerely

EHP Environmental Solutions Canada Ltd.
Jaakko Seppala
tel. +17787734068 / +358400 804156 jaakko.seppala@ehpenvironment.com

environmental solutions.

DISCLAIMER

1) EHP Environment Ltd (Finland) and Environmental Solutions Canada Ltd. provides comprehensive solutions for online environmental monitoring. The products and solutions presented in EHP's offers and product cards are often solutions which are designed for certain measurement or are tailor-made solutions provided by EHP. The solutions produced by EHP contain extensive knowledge and comprehensive experience and vision that can only be applied to that particular subject which is defined in the agreement. All the materials and solutions described therein are the property of EHP Environment Ltd. or EHP Environmental Monitoring Solutions Ltd.

2) If the customer has provided EHP with incorrect or incomplete information to prepare an offer or solution, then EHP shall not be liable for any problems, errors, damages or measurement errors that may arise in the operation of the respective products, measurement stations and solutions. Installations of measuring devices and solutions delivered by EHP must be done by EHP trained personnel or in accordance with the instructions provided by EHP. EHP is not responsible for any problems or damages caused by Force Majeure situations (storm, extreme temperatures, ice and so on.) to customer monitoring solutions. EHP is not responsible for communication problems caused by the inadequate functioning of the cellular network or if there are problems in the measurements.

3) If maintenance of the monitoring stations is not provided by EHP, then it must be done in the appropriate manner and in accordance to instructions given to the customer by EHP. If the customer neglects to take care of maintenance of the stations, sensor cleanings, calibrations, and so on, then EHP is not responsible for the validity of the monitoring data provided by the devices, nor are the warranty terms valid anymore.

4) Installation and maintenance of monitoring stations shall be in accordance to schedules to be agreed upon with the customer and the work methods defined by EHP. If EHP is unable, due to a customer or a third party, to carry out any tasks related to the installation, maintenance or removal of the station on a customer's premises in accordance within an agreed schedule, EHP is entitled to compensation for the waiting period that the installer / mechanic needs to wait before starting or completing the job.

5) EHP shall not be liable to customer for any direct or indirect damages caused by any monitoring stations or data produced by them.

6) If the installation of the monitoring stations requires induction, work safety training and so on, defined by the customer, EHP will invoice time spend on those in accordance with normal work practicies.

7) EHP-MS and EHP-QMS, EnMonCon and EHP Environmental Buoy are EHP registered product names and EHP Environment Ltd. has exclusive access rights concerning them.

APPENDIX H

DETAILED DESIGN INPUT FOR AIR QUALITY, NOISE, AND LIGHT MONITORING COMPONENTS

1. AIR QUALITY MONITORING PROGRAM

The baseline air quality monitoring program is a multi-tiered program, aimed at characterizing the existing conditions on a spatially and temporally varied basis, in and around the Area of Interest (AOI) for the Project. The study areas are discussed in terms of the Site Study Area (SSA), the local area outside of the SSA (the Local Study Area, or LSA_{AQ}), and the regional area outside of the LSA_{AQ} (the Regional Study Area, or RSA_{AQ}). Air quality monitoring is proposed to take place in each study area; however, the scope of the programs in each study area vary by data needs.

The monitoring to be completed in the SSA involves the most sophisticated suite of equipment, in order to establish the existing conditions at the location where the Project is intended to be constructed and operate using the most accurate and proven instrumentation available. The surrounding area (the LSA_{AQ}) consists primarily of natural, undeveloped lands, and therefore the characterization of air quality conditions is largely of interest to those studying the natural environment (e.g., non-human biota, surface water, tissues), and will be characterized using passive means due to limitations on available electrical power. The RSA_{AQ} includes the nearest communities, and the monitoring at these locations focuses on establishing radiation-related baseline. Details of the recommended monitoring programs within each study area are discussed in the following sections.

1.1 Site Study Area

Baseline air quality monitoring in the SSA will be completed at one (1) central monitoring station located in the AOI, and will be the core of the overall air quality monitoring program. The instruments in use at this location will include reference methods (or equivalent methods) published by the U.S. Environmental Protection Agency (U.S. EPA) [1], which have been subject to a rigorous testing and approvals process, and are endorsed by the Ontario Ministry of Environment, Conservation, and Parks (MECP) and Environment and Climate Change Canada (ECCC). Further, the MECP outlines additional ambient air monitoring methods that are acceptable for application in Ontario, in its *Operations Manual for Air Quality Monitoring in Ontario* [2], which have also been considered in the program. In addition, this central station will include co-located instruments matching those installed in both the LSA_{AQ} and RSA_{AQ}, for purposes of validating those methods against the reference methods.

This core program is expected to be maintained throughout the life of the project and provide information on how baseline levels change over the various stages, through the use of consistent methods and an adaptive monitoring framework. The use of reference methods at this centralized station will also allow for the evaluation and validation of any emerging technologies that may be developed during the Project life-cycle that may then be incorporated into the program in the future.

The methods that have been considered for inclusion in the central monitoring station at the SSA are discussed in the following sections. Note this discussion includes only methods that are unique to the SSA; methods that are proposed for the other study areas (and co-located at the SSA) are discussed in the sections pertaining specifically to those study areas.

1.1.1 Conventional Parameters

1.1.1.1 Particulate Matter

Airborne particulate matter is generally defined in terms of size fraction, with three size fractions being of particular relevance to air quality assessments, based on the availability of standards and guidelines issued by regulatory bodies. Total suspended particulate matter (TSP) is a measure of the aggregate of particulates in the air. Particulate matter with diameter of less than 10 micron (PM_{10}), is also described as inhalable particulate matter, while particulate matter with diameter less than 2.5 micron ($PM_{2.5}$) is also described as respirable particulate matter.

Prior to discussing the available equipment options for the measurement of particulate matter, it is important to first distinguish between the two general types of particulate monitoring instruments that are available: *continuous* and *non-continuous* monitors. Continuous particulate monitors make use of technology that allow for particulate concentrations to be quantified internally, averaged for a desired time-step (e.g., 1-hour) and reported on an ongoing basis. The use of continuous monitors would therefore allow for hourly particulate concentrations to be logged 24 hours per day, 7 days per week, resulting in a robust data set. In non-continuous particulate monitors, the particulate concentrations are established on a gravimetric basis, whereby the sample air is drawn across a pre-weighed filter, and upon completion of the sample period (e.g., 24-hours), the filter is removed and provided to a laboratory for post-weighing and any requested additional analysis (e.g., metals speciation). The main pros and cons of each type of sample method are summarized in Table 1.

Table 1: Pros and Cons of Particulate Monitoring Principles

Continuous		Non-Continuous	
Pros	**Cons**	**Pros**	**Cons**
Provide a robust data set of hourly concentrations on a 24/7 basis Concentration results available immediately (near real-time) Minimal maintenance requirements – designed to operate long-term with minimal site visits	Do not allow for subsequent analysis of metals content Often rack-mounted equipment that requires a temperature-controlled enclosure (e.g., sample trailer)	Allow for subsequent analysis of metals content High volume methods available that increase the likelihood of detectable metals content in low background areas Often self-contained stand-alone units that do not require a special enclosure	Require weekly visits from experienced field technician for filter changes, recording instrument readings, completing calibrations, maintenance When operated on NAPS schedule, only a single 24-hr sample per week is collected Increased potential for sample contamination (e.g., during filter handling, shipping) Concentration results not available until well after

Continuous		Non-Continuous	
Pros	**Cons**	**Pros**	**Cons**
			sampling has occurred (samples need to be compiled and sent to lab for analysis)

The high-volume air sampler (HVAS) is a non-continuous technology, and is the only reference method for TSP from both the Ontario MECP [2] and the U.S. EPA [1]. An HVAS draws a large volume of sample air across a filter, which deposits more particulate on the filter than instruments that use lower flow rates. This allows for a greater likelihood of detecting particulate in environment with low particulate levels, as well as a greater chance of measuring detectable metals content if a metals scan is conducted on the filter.

The Ontario MECP has outlined air quality standards for PM_{10} and $PM_{2.5}$ (on a 24-hour basis) [3], while the Canadian Council of Ministers of the Environment (CCME)/ECCC have a standard for $PM_{2.5}$ only (on both a 24-hour, and annual basis) [4]. There are numerous instruments approved by the Ontario MECP and U.S. EPA for measurement of PM_{10} and $PM_{2.5}$, with some being continuous and others being non-continuous. The technologies used to quantify the particulate concentration in the sample air varies widely amongst these instruments. For instance, many of the modern instruments use beta-attenuation technology or light-scatter spectrometry to determine particulate concentrations, while others use mass-based technology such as gravimetry or an oscillating microbalance. Several options were initially evaluated for configuring the central station at the SSA with particulate monitors, which included various combinations of the available equipment types (i.e., HVAS, continuous monitors, non-continuous monitors). In addition, due to the remote setting of the proposed site, options were considered that included only continuous methods for PM_{10} and $PM_{2.5}$, while operating HVAS instruments on a campaign basis, thus limiting the number of visits required by a field technician. The options that were considered are summarized in Table 2.

Table 2: Particulate Monitoring Options under Evaluation for Primary Program

Scenario	HVAS			Continuous			Non-Continuous		
	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
1	▪	▪				▪			
2	▪	▪							▪
3	▪				▪	▪			
4	▪							▪	▪
5	▪				▪ †				
6	▪ ‡				▪	▪			
7	▪ ‡				▪ †				

Notes:
† a single entry for both PM_{10} and $PM_{2.5}$ indicates use of a dual channel or dual output device
‡ samples collected on a campaign basis (e.g., during site visits for continuous monitor maintenance)

These options were discussed with the technical team and academic advisor, and the consensus was that it is best to take advantage of continuous technology, where possible, and particularly to use equipment that is capable of providing data for multiple COPC within a single instrument (i.e., both PM_{10} and $PM_{2.5}$). This suggests that scenario 5 or 7 would be the preferred approach. Ultimately, scenario 7 was considered to be the most practical option (TSP HVAS operated on a campaign basis, with PM_{10}/$PM_{2.5}$ being measured with a dual channel or dual output continuous monitor).

The HVAS is a manual sampling method, and a trained operator is required to prepare and exchange the sample apparatus, record instrument readings, and complete calibrations and ongoing maintenance. As such, the initial recommendation is to sample on a monthly basis, with one 24-hour sample being collected per month, during a regularly schedule site visit to maintain and calibrate (where necessary) all sampling equipment. The various U.S. EPA reference methods for PM_{10} and $PM_{2.5}$ that would be suitable to this scenario (i.e., simultaneous PM_{10} and $PM_{2.5}$, measured on a continuous basis) [1] are outlined in Table 3.

Table 3: PM_{10}/$PM_{2.5}$ Continuous Methods

Manufacturer	Model	PM_{10} Ref. Method	$PM_{2.5}$ Ref. Method	Simultaneous PM_{10}/$PM_{2.5}$	U.S. EPA Designation No.	Origin
Environnement S.A.	MP101M	•	•	Y †	EQPM-0404-151 (PM_{10}) EQPM-1013-211 ($PM_{2.5}$)	EU (France)
FAI Instruments	SWAM 5a	•	•	Y	EQPM-0912-205 (PM_{10}) EQPM-0912-204 ($PM_{2.5}$)	EU (Italy)
Grimm	EDM 180		•	Y ‡	EQPM-0311-195	EU (Germany)
Teledyne	T640X	•	•	Y	EQPM-0516-239 (PM_{10}) EQPM-0516-238 ($PM_{2.5}$)	USA
Thermo Scientific	TEOM 1405-DF	•	•	Y	EQPM-1013-208 (PM_{10}) EQPM-0609-182 ($PM_{2.5}$)	USA

Notes:
† simultaneous PM_{10} and $PM_{2.5}$ measurement requires an additional module (CPM Module), which is not an approved reference method for either size fraction
‡ while the unit can output the PM_{10} size fraction, it is only listed as a reference method for $PM_{2.5}$

Note that two of the instruments that allow for simultaneous PM_{10} and $PM_{2.5}$ measurement use technology that is considered to be outside of the approved reference method. The Environnement S.A. model MP101M is a reference method for each PM_{10} and $PM_{2.5}$ (individually); however, they offer a module add-on that allows the PM_{10} monitor to output the $PM_{2.5}$ fraction using light scatter; however, this is not an approved method for $PM_{2.5}$. Similarly, the Grimm EDM 180 can output both the PM_{10} and $PM_{2.5}$ size fractions; however, the unit is only a reference method for $PM_{2.5}$. As such, neither of these would be considered ideal choices.

The remaining instruments are the FAI Instruments SWAM 5a dual channel monitor, the Teledyne-Advanced Pollution Instrumentation (Teledyne-API) T640 with 640X option, and the Thermo Scientific TEOM 1405-DF Dichotomous Air Sampler. Based on professional experience, the TEOM 1405 is a somewhat dated technology that requires frequent maintenance by a skilled technician to keep online. The FAI Instruments SWAM 5a is technically a continuous method; however, it uses a magazine of pre-loaded 47-mm filters that get automatically fed to the instrument for sampling via beta-attenuation, and then fed to another magazine for removal. An advantage of this design is that it allows for post-analysis of the filters; however, as noted previously, it is not likely that there will be detectable metals content on the filters in a remote area, particularly with the low flow rate of this instrument. Metals content has been proposed to instead be determined using an HVAS system. In light of this, the SWAM 5a system is not an ideal choice due to practicality, as a technician would need to regularly visit the stations to reload the filter magazine with fresh filters, and remove the sampled filters, which would be discarded as they will not require post-analysis.

The Teledyne-API T640 quantifies particulates based on light-scatter technology, and when supplied with the 640X option (which is approved by the U.S. EPA), a single unit can output both PM_{10} and $PM_{2.5}$ concentrations in near real-time (1-min averages). As the instrument uses light-scatter, there is no sample media to periodically replace and so the system is very low-maintenance and intended for long-term autonomous sampling. Our technical experts have experience using the T640 for particulate measurement in the field and recommend it for its ease of use and minimal maintenance requirements. The T640 is a rack-mounted unit that is intended to be installed in a temperature-controlled enclosure.

1.1.1.2 Nitrogen Oxides

The MECP outlines in its *Operations Manual for Air Quality Monitoring in Ontario* [2] that the only acceptable method for measuring ambient Nitrogen Dioxide (NO_2) is through the use of an instrument using the *chemiluminescence* principle of measurement, and makes reference to the U.S. EPA list of reference methods for allowable instrumentation. A review of the most current list of reference methods from the U.S. EPA [1] has been completed in support of this study, and has been condensed as it contains many historic instruments that are no longer on the market, and instruments that use analysis methods other than chemiluminescence. The reduced list contains the most recent reference method technologies that are currently being marketed by the approved manufacturers. Each of the instruments under consideration include an ozone (O_3) generator that allows for the output of concentrations of nitrogen oxide (NO) and oxides of nitrogen (NO_x) in addition to NO_2. The instruments that would be suitable for use at the central station in the SSA are summarized in Table 4.

Table 4: NO_2/NO_x Analyzers

Manufacturer	Model	U.S. EPA Designation No.	Origin
DKK-TOA Corporation	GLN-114E	RFNA-0508-171	Japan
Ecotech	Serinus 40	RFNA-0809-186	Australia
Environnement S.A.	AC32e	RFNA-0118-249	EU (France)
Horiba	APNA-370	RFNA-0506-057	Japan
Recordum	Airpointer	RFNA-1194-099	EU (Austria)
Sabio	Model 6040	RFNA-0418-250	USA
Teledyne	Model T200(U)	RFNA-1194-099	USA
Thermo Environmental Inst.	Model 42i(Q)	RFNA-1289-074	USA

1.1.1.3 Sulphur Dioxide

The MECP outlines in its *Operations Manual for Air Quality Monitoring in Ontario* [2] that the only acceptable method for measuring ambient sulphur dioxide (SO_2) is through the use of an instrument using *ultraviolet (UV) fluorescence*, and makes reference to the U.S. EPA list of reference methods for allowable instrumentation. As with NO_2, a review of the most current list of reference methods from the U.S. EPA [1] has been completed, in order to consider only technologies that are currently being marketed by the approved manufacturers. The instruments that would be suitable for measurement of SO_2 at the central station in the SSA are summarized in Table 5.

Table 5: SO_2 Analyzers

Manufacturer	Model	U.S. EPA Designation No.	Origin
DKK-TOA Corporation	GFS-312E	EQSA-1107-168	Japan
Ecotech	Serinus 50	EQSA-0809-188	Australia
Environnement S.A.	AF22e	EQSA-0802-149	EU (France)
Horiba	APSA-370	EQSA-0506-159	Japan
Recordum	Airpointer	EQSA-0486-060	EU (Austria)
Sabio	Model 6020	RFSA-0616-237	USA
Teledyne	Model T100(U)	EQSA-0495-100	USA
Thermo Environmental Inst.	Model 43i(Q)	EQSA-0486-060	USA

1.1.1.4 Carbon Monoxide

While the MECP does not outline any requirements for instrumentation measuring carbon monoxide (CO) [2], the U.S. EPA does provide a list of reference methods for CO monitoring [1]. As with the other gases, the list from the U.S. EPA includes historic instruments that are no longer on the market, and so the list was condensed only to those instruments that approved manufacturers are currently marketing. The instruments that would be appropriate for use in the program are summarized in Table 6.

Table 6: CO Analyzers

Manufacturer	Model	U.S. EPA Designation No.	Origin
DKK-TOA Corporation	GFC-311E	RFCA-0907-167	Japan
Ecotech	Serinus 30	RFCA-0509-174	Australia
Environnement S.A.	CO12e	RFCA-0915-228	EU (France)
Horiba	APMA-370	RFCA-0506-158	Japan
Peak Laboratories	Model 90-170	EQCA-0814-217	USA
Recordum	Airpointer	RFCA-0981-054	EU (Austria)
Sabio	Model 6050	RFCA-0817-248	USA
Teledyne	Model T300(U)	RFCA-1093-093	USA
Thermo Environmental Inst.	Model 48i(Q)	RFCA-0981-054	USA

1.1.1.5 Ozone

The MECP does not outline any requirements for instrumentation measuring ozone (O_3) in its *Operations Manual for Air Quality Monitoring in Ontario* [2]; however, the U.S. EPA does provide a list of reference methods for O_3 monitoring [1]. As with the other gases, the list from the U.S. EPA includes historic instruments that are no longer on the market, and so the list was condensed only to those instruments that approved manufacturers are currently marketing. The instruments that would be appropriate for use in the program are summarized in Table 7.

Table 7: O_3 Analyzers Under Evaluation

Manufacturer	Model	U.S. EPA Designation No.	Origin
2B Technologies	Model 202	EQOA-0410-190	USA
	Model 211(-G)	EQOA-0514-215	
Ecotech	Serinus 10	EQOA-0809-187	Australia
Environnement S.A.	$O_3$42e	EQOA-0515-225	EU (France)
Focused Photonics Inc.	AQMS-300	EQOA-0719-253	China
Horiba	APOA-370	EQOA-0506-160	Japan
KENTEK Inc.	MEZUS-410	EQOA-0219-251	Korea
Recordum	Airpointer	EQOA-0880-047	EU (Austria)
Sabio	Model 6030	EQOA-0415-222	USA
Teledyne API	Model T265	EQOA-0611-199	USA
	Model T400	EQOA-0992-087	
	Model T204	EQOA-0514-214	
	Model 430	EQOA-1015-229	
Thermo Environmental	Model 49i(Q)	EQOA-0880-047	USA

1.1.2 Radiation/Radioactivity

The radiation/radioactivity monitoring in the SSA is to be completed using active and passive means, and include the measurement of radionuclides, tritium, carbon-14, krypton-85, radon, and external gamma.

1.1.2.1 Tritium and C-14

The SSA station will include an active sampler for the measurement of tritium (H-3) and carbon-14 (C-14). Passive sampling systems have been found to be less sensitive, less accurate and more variable compared to active samplers [5]. For tritium, the systems that are commonly used in nuclear facilities in Ontario draw air either through a series of canisters containing silica gel, or a molecular sieve, at a low flow rate over the course of one month. Water vapour is extracted from the sample media in the laboratory and analyzed for tritium content using liquid scintillation counting. Sampling of carbon-14 is completed by drawing the sample air through solid or liquid phase soda lime, which absorb CO_2 from the air. In the laboratory, the exposed media are titrated to release the CO_2 which is then analyzed in a liquid scintillation counter to determine the carbon-14 content. It is recommended that the tritium and carbon-14 measurements using the active sampler occur on an ongoing monthly basis (i.e., the sampler continuously collects sample air for a period of one month, at which point the sample media is exchanged, and the sampled media is analyzed).

1.1.2.2 Krypton-85

Collection methods for Krypton-85 have historically included grab sampling air with an evacuated container, condensation on charcoal or molecular sieve at low temperatures, and liquefaction in a liquid nitrogen trap [6]. One common method involves drawing air over an activated charcoal trap maintained at the temperature of liquid nitrogen. The Krypton-85 sample would then be transferred by distillation from the charcoal trap to a copper coil containing a molecular sieve and sent for analysis. The laboratory analysis includes gas chromatographic separation of krypton gas followed by liquid scintillation counting to determine the krypton-85 concentration. Other methods include the use of low volume pumps to inflate a reinforced heavy plastic bag. Air collected in the bag is transferred by a compressor to a transport cylinder. Analysis is then performed by separating the krypton in a series of cold traps and then subjecting the purified krypton to liquid scintillation counting. The viability of the above methods would need to be further evaluated to determine the most appropriate approach, with due consideration to the minimum required sample volumes/duration, sampling frequency and overall field operating and analytical lab feasibility.

1.1.2.3 Radionuclides

It is expected that levels of the radionuclides of interest in air will be quite low during the baseline program (if present at all), and based on our experience at other nuclear facilities, are likely to remain difficult to detect upon operation of the facility. As such, it will be necessary to collect as large an air sample volume as possible in order to have an opportunity to detect measurable levels. It is recommended that an HVAS be used for this purpose, operated continuously for as long as is practicable (i.e., 30+ days) in the summer period when airborne particulate is typically at its highest levels. The filter from the HVAS would then be provided to the laboratory with appropriate blanks to estimate the radionuclide content of the collected sample using the approved analytical method.

1.1.2.4 Radon

Radon in an outdoor ambient setting is typically collected using passive long-term radon detectors. In these systems, the detector is installed in a weather-protective casing that is then attached to a post or other vertical mount (e.g., tree), and exposed to the ambient air for three (3) months (90 days). Upon retrieval, the passive sampler is returned to the laboratory for analysis, along with the field and travel blanks supplied by the manufacturer, per the manufacturer instructions.

Radon samples will be collected on a continuous quarterly basis (i.e., four samples per year per location, of 90 days each) at two (2) locations within the SSA. The additional location in the SSA for radon is to ensure both an undisturbed area, and an area with fractured rock (if present), is included.

1.1.2.5 External Gamma

External gamma is most easily measured using a dosimeter. Manufacturers typically can provide weather-proof pouches for the dosimeters for application in ambient air monitoring programs. For such a program, the dosimeter pouch is simply mounted in an open area (e.g., with the other passive samplers), exposed to the atmosphere for a period of three months, at which time it is removed, and returned to the laboratory. For this type of sampling it is important to carefully maintain travel and field blanks in accordance with the instructions from the equipment supplier, as the dosimeter will continue to detect gamma during transit.

We anticipate that the gamma monitors will be paired with the radon monitors discussed in the previous section, and follow the same sampling schedule.

1.1.2.6 Gross-α and Gross-β

Gross-α and Gross-β will be measured from the HVAS filter, described in Section 1.1.2.3.

1.1.3 Trace Organics and Toxics

1.1.3.1 VOCs, SVOCs, and PHCs (F1/F2)

The Ontario MECP [2] and U.S. EPA [1] each designate two acceptable methods for the collection of volatile organic compounds (VOC) samples in ambient air: drawing ambient air through sorbent tubes (glass tubes packed with sorbent media), or drawing ambient air into an evacuated canister under vacuum (Suma canister). In our experience, the latter approach is the simplest method available. The sorbent tube method requires a pump, calibrator and special handling of sample media upon sample collection (i.e., must be kept cool until received by the laboratory). The evacuated canister method is provided by a laboratory with a calibrated flow controller, which simply needs to be attached and opened using the flow controller valve. Upon completion of the sample event (typically 24-hours), the valve is closed and the canister is returned to the lab for analysis of VOCs in accordance with U.S. EPA Method TO-15 [6]. In addition, the gas from the Suma canister can be tested for the presence of some semi-volatile organic compounds (SVOCs) and fractions F1 and F2 of petroleum hydrocarbons (PHCs).

At this time, there is not a reference method from the Ontario MECP or U.S. EPA that allows for autonomous, continuous sampling of VOCs – both designated methods are manually operated (i.e., require an operator to be present to site the instrument, and open and close the valve at the beginning and end of the 24-hour sample period). As such, the baseline program will involve the collection of Suma canister samples on a campaign basis, or will involve training local staff or a community group to complete regular sampling, field documentation and shipping of the canisters to the selected laboratory for analysis.

1.1.3.2 Polycyclic Aromatic Hydrocarbons, SVOCs, and PHCs (F3/F4)

The Ontario MECP designates two methods for the collection of Polycyclic Aromatic Hydrocarbon (PAH) samples in ambient air [2], while the U.S. EPA designates only one [1]. The MECP provides two methods in order to provide flexibility as to whether only non-volatile PAHs are collected, or both volatile and non-volatile PAHs are collected, based on the needs of the program. The U.S. EPA method is only for the collection of both volatile and non-volatile PAHs and is equivalent to the latter MECP method.

The collection of PAH samples using the approved reference method (i.e., for both volatile and non-volatile PAHs) requires the use of a specialized, purpose-built HVAS. The sample media consists of a circular filter, placed in a filter holder that is in-line with a canister that holds a glass cartridge containing a polyurethane foam

(PUF) plug. The sample air is drawn through the filter and PUF cartridge via a motor with a flow controller that maintains a constant flow rate over the 24-hour sample period. Upon completion of the sample period, the filter and PUF cartridge are returned to the selected laboratory for analysis of PAHs in accordance with U.S. EPA Method TO-13A [7]. In addition, the sample media may also be analyzed for fraction F3 and F4 PHCs, as well as some SVOCs.

As with the HVAS for particulates, this is a manual sampling method – a trained operator is required to prepare and exchange the sample apparatus, record instrument readings, and complete calibrations and ongoing maintenance. As such, the monitoring for PAHs has been recommended on a campaign basis, with one sample being collected per month.

1.1.4 Trace Inorganics

1.1.4.1 Ammonia

In the SSA, the measurement of ammonia will be completed using a continuous analyzer, similar to those described for the conventional parameters in section 1.1.1. Neither the Ontario MECP, nor the U.S. EPA, list reference methods for the measurement of ammonia. The most common principle of operation for continuous units is chemiluminescence (i.e., the same as for nitrogen oxides, as discussed in section 1.1.1.2). As such, many of the manufacturers listed in Table 4 also manufacture ammonia monitors. It is recommended that the same manufacturer selected for the NOx analyzer also be used for the ammonia analyzer, as they will be running the same chemiluminescence procedure and will therefore have similar calibration and maintenance procedures.

1.1.4.2 Metals

The collection of samples for trace metals does not require an additional sampling method, provided that TSP is being measured as part of the program using an HVAS. As described in section 1.1.1.1, we are recommending that the baseline program include periodic sampling of TSP using an HVAS for this purpose. The current plan is to collect one TSP sample per month, which will also be analyzed for the suite of metals identified in the final COPC list, provided in the main body of the final design report.

It should be noted that for a remote setting such as the proposed site, where very low levels of metals may be expected, a 24-hour sample may not provide sufficient loading for detectable levels of metals. As such, the program may need to be adapted as results are received, to extend the sample period as necessary to be able to characterize the actual metals content and avoid simply reporting levels as below the detection limit of the laboratory instrumentation where possible.

1.2 Local Study Area

Baseline air quality monitoring in the LSA_{AQ} will be completed at four (4) locations within approximately 10 km of the SSA. The lands within the LSA_{AQ} are primarily undeveloped; however, to the north end exists the community of Borups Corners and the TransCanada highway. The nearest communities will be considered as part of the RSA_{AQ} (section 1.3). The baseline air quality conditions in the remaining undeveloped lands are primarily of interest to those completing studies of the natural environment (e.g., surface water, tissues, non-human biota). Due to the undeveloped, natural setting, the air quality monitoring in the LSA_{AQ} is proposed to be completed using passive (unpowered) methods. As noted previously, each of these passive methods will also be represented at the SSA central station, in order to validate the results against the associated reference method.

This program is expected to be maintained throughout the life of the project and provide information on how baseline levels change over the various stages, through the use of consistent methods and an adaptive monitoring framework. Note this discussion includes only methods that are unique to the LSA_{AQ}, and all sampling methods described herein will also be co-located at the SSA station.

1.2.1 Conventional Parameters

1.2.1.1 Particulate Matter

The Ontario MECP has included a standard operating procedure for the collection of dustfall samples in its *Operations Manual for Air Quality Monitoring in Ontario* [2]. This method is often applied in remote areas where there is no access to power at the preferred monitoring locations. The method involves placing a sample jar (polymer container) in a suitable bracket that can hold the jar approximately 3 m off of the ground surface. The container is typically supplied pre-cleaned by the laboratory, sealed with a screw-lid that is removed when the jar is installed for sampling, and replaced at the end of the 30-day (±2 days) sample period. The jar is often also supplied with deionized water additive (to assist with entraining the dust), and an anti-freeze or algaecide additive, as applicable depending on the season. Upon completion of the sample period, the sealed container is provided to the laboratory for analysis, whereby the jar is rinsed out through a pre-weighed filter, which is then dried and post-weighed.

As noted above, the exposure period for a dustfall sample is typically 30-days (±2 days). Per NWMOs request proposed program was modified to include collecting quarterly dustfall samples at each of the four LSA_{AQ} stations and the co-located dustfall sampler at the SSA (i.e., 4 samples per station per year).

1.2.1.2 Conventional Gases (NOx/NO_2, SO_2)

The Ontario MECP does not include passive measurement of NO_2, NOx, SO_2 in its *Operations Manual for Air Quality Monitoring in Ontario* [2] – all recommended methods require an active sampling system. Similarly, the U.S. EPA does not provide reference methods that involve passive sampling of these COPC. However, often for baseline scoping studies in remote areas it is necessary to be able to sample for these constituents where there is no access to power. This is typically addressed using chemically treated badges that are exposed to the atmosphere for a given period, before being resealed and returned to the laboratory for analysis.

The chemically treated badges are typically installed face-down in a rain head, which protects the media from the elements. Suppliers of this type of measurement system typically provide siting criteria, which require that the cartridges be installed up to 3 m off of the ground surface, and with less than a 30^o angle from the inlet to the top of the nearest obstacles. The cartridges are typically exposed to the atmosphere for a period of 30 days (±2 days), at which time they are removed and promptly returned to the laboratory, with the supplied blanks, for analysis. The measurement of NO_2, NOx and SO_2 each require their own individual cartridge, as they are each treated with different chemicals for sampling. It should be noted that the NOx cartridge is temperature-sensitive and is therefore only proposed in the summer months.

As noted above, the typical exposure period for the passive samplers is 30-days (±2 days). Per NWMOs request, the NO_2, NOx, SO_2 sampling program would be operated on a quarterly basis with samples being retrieved and replaced every 90-days. The proposed program would involves collecting samples at each of the four LSA_{AQ} stations and the co-located sampler at the SSA (i.e., 4 samples per station per year). Due to the uncertainty in the analysis procedure, the laboratories typically recommend collecting duplicate samples at each location for QA/QC purposes.

1.2.2 Radiation/Radioactivity

To characterize radionuclides in the LSA_{AQ}, the radionuclide scan will be completed on one (1) dustfall sample per location, which is expected to be from one of the summer months, or a composite of the samples collected at each location in the summer months (due to there typically being the highest dust loading in the summer).

The remaining passive monitors at the four LSA_{AQ} stations (and co-located at the SSA station) relating to radiation and radioactivity (i.e., radon and external gamma) are the same as those discussed as part of the radiological baseline monitoring in Section 1.1.2.

1.2.3 Trace Organics and Toxics

1.2.3.1 Volatile Organic Compounds (VOCs)

Passive methods using chemically-treated badges, similar to those described in section 1.2.3.1 for NO_2/NOx and SO_2 are proposed for the passive VOC monitoring program in the LSA_{AQ}. These badges are installed in duplicate for QA/QC purposes and typically exposed for a period of 30-days (± 2 days). Per NWMOs request, the VOC sampling program would be operated on a quarterly basis with samples being retrieved and replaced every 90-days.

1.2.3.2 Polycyclic Aromatic Hydrocarbons (PAHs)

The Ontario MECP and U.S. EPA do not have recommendations for passive monitoring systems for the measurement of PAHs. However, information on existing levels of PAHs are sometimes desired for remote areas, and so passive methods are typically used for this purpose as it is not feasible to run an HVAS. Outdoor passive samplers are commercially available for PAHs, which typically consist of a metal bowl (base) with a hinged metal lid, within which a PUF disk is placed. The lid, which is a larger diameter than the base, is then closed overtop and acts to keep precipitation out while still allowing ambient air to contact the PUF disk. Upon completion of the sample period (typically 30 days, ±2 days), the PUF disk is removed from the sampler and returned to the laboratory for analysis.

The proposed schedule for the passive PUF sampling matches those for the other passive approaches in the LSA_{AQ}. A passive sampler will be located at each of the four LSA_{AQ} sampling stations, as well as at the SSA station for comparison of the results to those collected via the reference method. Typically, the PUF disks are exposed for a period of 30 days ±2 days, and exchanged monthly. Per NWMOs request, the PAH sampling program would be operated on a quarterly basis with samples being retrieved and replaced every 90-days.

1.2.4 Trace Inorganics

1.2.4.1 Ammonia

Passive methods using chemically-treated badges, similar to those described in section 1.2.3.1 for NO_2/NOx and SO_2 are proposed for the passive ammonia monitoring program in the LSA_{AQ}. These badges are installed in duplicate for QA/QC purposes and typically exposed for a period of 30-days (± 2 days), and exchanged on a monthly basis. Per NWMOs request, the Ammonia sampling program would be operated on a quarterly basis with samples being retrieved and replaced every 90-days.

1.2.4.2 Metals

The characterization of metals in the LSA_{AQ} does not require an additional sample device/method, as the dustfall samples described in section 1.2.1.1 can be scanned for metals content by the selected laboratory. As such, it is proposed that analysis for the full suite of metals identified in the main report (COPC list) be requested for each dustfall sample.

1.3 Regional Study Area

Baseline air quality monitoring in the RSA_{AQ} will be completed at three (3) locations within approximately 50 km of the SSA. The selected locations represent the nearest communities to the AOI, including the Wabigoon Lake Ojibway Nation (WLON), Dyment/Borups Corners, and Ignace. The sampling locations in the RSA_{AQ} will focus on establishing the community baseline for radiation-related COPCs, as conventional and trace parameters are not expected to vary significantly from the levels being measured at the SSA and LSA_{AQ}. As noted previously, each of the sampling methods will also be represented at the SSA central station.

This program is expected to be maintained throughout the life of the project and provide information on how baseline levels change over the various stages, through the use of consistent methods and an adaptive monitoring framework. Note this discussion includes only methods that are unique to the RSA_{AQ}, and all methods discussed herein will also be co-located at the SSA (and LSA_{AQ}, where noted).

1.3.1 Conventional and Trace Parameters

The levels of conventional parameters, trace organics, and trace inorganics established at the SSA and LSA_{AQ} are expected to be broadly applicable to the levels in the region. As such, measurement of these parameters are not being proposed at the RSA_{AQ} stations. Monitoring at these locations is focused on establishing the baseline conditions related to radiation.

1.3.2 Radiation/Radioactivity

The radiation/radioactivity monitoring in the RSA_{AQ} is to be completed using active and passive means, and include the measurement of radionuclides (particulate), tritium, carbon-14, krypton-85, radon, and external gamma. As noted previously, each of the monitoring techniques noted in Section 1.1.2 that will be employed at SSA station will be co-located at the each of the three (3) RSA_{AQ} stations.

2. NOISE

2.1 Noise Monitoring for Assessment of Human Exposure

The noise baseline monitoring program will conform to standard methods and guidance outlined in the MECP's *Environmental Noise Guideline* (Publication NPC-300) [8] and associated supporting documents, Health Canada's (HC) *Guidance for Evaluating Human Health Impacts in Environmental Assessment: Noise* [9], and the International Standards Organization (ISO) *1996-2 Acoustics — Description, measurement and assessment of environmental noise — Part 2: Determination of environmental noise levels* [10].

In order to capture seasonal variability, as well as temporal trends, it is being recommended that two background noise measurement campaigns be completed, each consisting of up to 2 weeks of continuous measurement. The campaigns should be scheduled in the spring/summer period, and the fall/winter period, and conducted at two (2) locations: one within the SSA, and one at a property near the TransCanada highway. It is typical to collect sound level measurements on a continuous hourly basis at a minimum. Type 1 (Class 1) integrating sound level meters that conform to the requirements of IEC 61672-1:2002, in accordance with ISO 1996-2, are to be used for this purpose.

Per MECP requirements, a number of measures are to be taken to ensure that the background sound levels being measured are not unduly influenced by interfering sources. Each of the sound level meters must be outfitted weather protection, including a windscreen, desiccant chamber for the preamplifier, and rain protection for the microphone and sound level meter. Further, it is standard practice to outfit the windscreen with a bird deterrent (i.e., a spike to prevent birds from perching on the microphone). A tripod should be utilized to maintain the microphone at a height of at least 1 m from the ground surface, and this should not be placed within 1 m of any reflecting surface (e.g., building wall). It is also necessary to track the meteorological conditions that occur during the measurement period, to assist in the data analysis and validation process. It is our understanding that a permanent meteorological station will be installed at the site, which can be used for this purpose. The MECP requires that parameters including temperature, relative humidity, precipitation, and wind speed be tracked for purposes of data validation. The instrument manufacturers typically outline approved operating ranges regarding temperature and relative humidity, outside of which the measured sound levels may not be accurate, and so any measurements under such conditions must be removed from the final data set. The MECP also requires that any measurements collected during precipitation events or high winds similarly be removed from the final data set.

Sound level meters and peripherals (i.e., microphone, preamplifier, acoustic calibrator) must be regularly maintained and calibrated in order to provide accurate and reliable data. Calibration and maintenance is completed at an accredited laboratory, using calibration standards that are traceable to NIST standards. These are issued with certifications that identify the date of calibration, and the recommended date by which they should be re-certified. These records must be maintained, in order to demonstrate that the sound level meters used in the program were within the certified period at the time of use. Further, the sound level meters must be calibrated using a hand-held acoustic calibrator before and after use in the field. The acoustic calibrator must also be certified, demonstrating that it has been calibrated to an NIST-traceable standard, and the certification was valid at the time of use in the field.

The sound level data is stored internally (or on a USB drive), and typically various sound level metrics can be measured simultaneously. The standard unit of measurement is the energy equivalent level (Leq), and often these are measured with A-weighting applied (a standard weighting that adjusts the level based on the frequency response of the human hearing mechanism), and this would be required for this program at a minimum. It is further recommended that unweighted octave band sound levels also be measured for each interval, to provide additional data analysis opportunity (e.g., presence of tones, conversion to other weighting networks). It is also typical to measure statistical parameters, such as L90 (essentially a 10^{th} percentile sound level), for each measurement interval. Many sound level meters can measure a number of these statistical parameters simultaneously, and it is recommended for this program to assist with data analysis.

It is recommended that the sound level monitoring package used in the baseline assessment have capability with regard to event triggering. With this option, a sound level threshold is set, and when exceeded the meter will log the time, duration and sound level associated with the event. It is also possible to have the sound level meter record a WAV file of the event, which would be a benefit for the data analysis (i.e., to assist with determining whether the associated reading should be discarded due to being unrepresentative of background conditions).

3. LIGHT

The baseline light assessment should focus on the parameters that will be of interest for the Light Impact Assessment aspect of the Impact Assessment. The indicators of effects for light pollution generally include:

- sky glow;
- light trespass/incident light (illuminance); and
- glare.

Glare is not possible to include in a baseline study as it is a function of the installed light fixture(s), how they are oriented relative to an observer, and the specific properties of the lamp (e.g., temperature, intensity, etc.). As such, only general recommendations may be provided in an EA regarding glare (e.g., full cut-off luminaires, no horizontal-mounted lighting systems, dimming or other curfew type options).

There are guidelines for limiting light trespass based on environmental zoning classifications, which outlined by the CIE. The guideline values, measured in lux, are applicable to vertical illuminance on a property. The baseline lux values at a property may assist in defining the environmental zone; however, this should generally be obvious from the description of the setting. Nevertheless, baseline measurements are useful to collect at properties (or other locations of interest, such as natural habitat areas) in order to have a point of comparison to any predictive results or future measurement data collected at the same location. Commercial light models are able to output a predicted lux value on a defined vertical plane, provided sufficient details of the lighting design are available (e.g., proposed lamps, luminaires, building layouts and surface properties, as well as surface properties of the site lands, the lands of the sensitive properties, and the lands in between).

Light trespass is measured using a standard hand-held light meter (e.g., Extech EA33), and is measured over an imaginary vertical plane representing a receiving plane (e.g., window) at the location on interest. For planning future measurement initiatives (e.g., during construction, operations) it is beneficial to use a light meter that is also capable of measuring luminous intensity (candelas, or cd) as this can be used as an assessment of glare once the fixtures associated with the project are in place (however, as noted previously, glare cannot be measured as a component of the baseline study as it is linked specifically to project sources).

The baseline sky glow can be measured using a Unihedron Sky Quality Meter (SQM), such as the SQM-L. Sky glow is typically controlled by managing the Upward Light Ration (ULR) of the design in accordance with criteria offered by the CIE. ULR is not a baseline condition that can be measured in the field – the ULR can only be determined through calculations or modelling of the designed lighting system for the project. The measurement of sky brightness (or sky glow), in units of magnitudes per square arcsecond, can be tracked from baseline conditions through construction and operational phases to provide a measure of how the conditions have changed as a result of the project. It should be noted though that measurements should be conducted under equivalent conditions each time, as the atmospheric conditions, seasonal phenomena, and the lunar cycle can have a significant impact upon the results. Future measurements completed in conditions that differ from the baseline condition could result in attributing impacts to the project when the difference may actually be due to the differing natural environmental conditions, which are unrelated to the project.

In general, light studies should be completed in the summer, during a period with no significant light contribution from the moon, and no significant cloud cover. Summer measurements are recommended as there is no chance for snow cover, which would increase the reflected light component. Further, there should be no contribution from the moon, which means that measurements should be taken as close as possible to the New Moon phase in the lunar calendar. Lastly, sky forecasts should be used to select a night when there is no cloud cover, as presence of clouds may also increase the presence of reflected light.

4. REFERENCES

[1] United States Environmental Protection Agency, "List of Designated Reference and Equivalent Methods," 15 December 2019. [Online]. Available: https://www.epa.gov/amtic/air-monitoring-methods-criteria-pollutants.

[2] Ontario Ministry of the Environment, "Operations Manual for Air Quality Monitoring in Ontario," MOE, Toronto, 2008.

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[4] Canadian Council of Ministers of the Environment, "2017 Air Quality," CCME, [Online]. Available: http://airquality-qualitedelair.ccme.ca/en/. [Accessed 28 May 2019].

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[6] U.S. Environmental Protection Agency, "Compendium Method TO-15 Determination of Volatile Organic Compounds (VOCs) in Air Collected in Specially-Prepared Canisters and Analyzed by Gas Chromatography Mass Spectrometry (GC/MS)," Center for Environmental Research Information, Office of Research and Development, Cincinnati, 1999.

[7] U.S. Environmental Protection Agency, "Compendium Method TO-13A Determination of Polycyclic Aromatic Hydrocarbons (PAHs) in Ambient Air Using Gas Chromatography Mass Spectrometry (GC/MS)," Center for Environmental Research Information, Office of Research and Development, Cincinnati, 1999.

[8] Ontario Ministry of the Environment and Climate Change, "Environmental Noise Guideline: Stationary and Transportation Sources - Approval and Planning," MOECC, Toronto, 2013.

[9] Health Canada, "Guidance for Evaluating Human Health Impacts in Environmental Assessment: Noise," Health Canada, Ottawa, 2017.

[10] International Organization for Standardization, "Acoustics - Description, measurement and assessment of environmental noise - Part 2: Determination of environmental noise levels," ISO, Geneva, 2007.

APPENDIX I

LABORATORY CONTACT INFORMATION

APPENDIX I

Contact information for laboratories considered for the Environmental Media Baseline Program

Category	Laboratory	Phone Number	Contact Person	Title	Email	Component: Tissues	Component: Hydrology	Component: Surface Water Parameters	Component: Air Quality, Noise, and Light	Component: Soil
Chemistry	ALS	905-881-9887	Melissa Tran	Business Development Representative, Environmental	melissa.tran@alsglobal.com	✓		✓	✓	✓
	Kinetrics	416-207-6000	Ruwan Wijesundera	Manager - Radiochemistry	ruwan.wijesundera@kinetrics.com	✓		✓	✓	✓
	TrichAnalytics Inc.	250-532-1084	Dr. Jennie Christensen	CEO	Jennie.christensen@trichanalytics.com	✓				
In-situ Sampling	EHP Environmental Solutions Canada Ltd.	1-778-773-4068	Jaakko Seppala	President	jaakko.seppala@ehpenvironment.com			✓		
Taxonomy*	Jack Zloty Ltd.	250-317-8680	Jack Zloty	Aquatic Biologist/Insect Taxonomist	ameletus@gmail.com			✓		
	Biologica	250-479-3868	Jenny Thomson	Project Coordinator	jenny@biologica.ca			✓		
e-DNA	University of Guelph	519-824-4120	Dr. Robert Hanner	Associate Professor	rhanner@uoguelph.ca			✓		✓
Radon and TLD	Landauer/Radnova	708-441-8522	Sarah Berry	Business Development Specialist	sberry@landauer.com				✓	
Geochemical Testing	SGS	705-652-2618	Catharine Arnold	Project Specialist, Environment, Health & Safety	catharine.arnold@sgs.com					✓

* Consultant should feel free to use any qualified taxonomist and these individuals are provided for information purposes only.

APPENDIX J

STANDARD OPERATING PROCEDURES AND DATASHEETS

TABLE J.1

List of Standard Operating Procedures and Datasheets

Component	Category	Name
Tissues	Standard Operating Procedure	Aquatic Macrophytes and Sediments - Sampling by Consultant Bird and Mammal Collection - Sampling by Consultant Fish Tissue Collection - Sampling by Consultant Insect Collection - Sampling by Consultant Soil, Edible Berries/Plants, and Browse Collection - Sampling by Consultant Soil and Lichen PSP - Sampling by Consultant Tadpole Tissue Collection - Sampling by Consultant Traditionally Harvested Sample Collection - Sampling by Consultant/Community
	Datasheet	Aquatic Macrophyte Collection Datasheet Bird and Mammal Tissue Collection Datasheet Fish Tissue Collection Datasheet Non-lethal Tissue Collection Datasheet Soil, Edible Berries/Plants, and Browse Collection Datasheet Soil and Lichen PSP Collection Datasheet Tadpole and Insect Collection Datasheet Traditionally Harvested Sample Collection Datasheet
Hydrology	Standard Operating Procedure	Aerial Photography Survey via Drones Lake Bathymetry and Water Levels via Staff Gauge Meteorological Monitoring River and Stream Flow Sampling (Large Rivers and Small Streams)
	Datasheet	Aerial Survey by Drones Datasheet Bathymetric Survey Datasheet Continuous Water Level Measurements (Large Rivers) Datasheet Manual Flow Measurements (Small and Large Rivers) Datasheet Manual Water Level Measurements (Lakes) Datasheet Meteorological Station Monitoring Datasheet
Surface Water	Standard Operating Procedure	Benthic Invertebrate Sample Collection – Depositional Habitats Phytoplankton and Zooplankton Sample Collection Sediment Sample Collection Surface Water Limnology and Water Sample Collection - LSA Surface Water Sample Collection - RSA
	Datasheet	Limnology, Water, and Plankton Datasheet - LSA Sediment and Depositional Benthic Invertebrate Sample Collection Datasheet Surface Water Sample Collection Datasheet - RSA
Air Quality, Noise, Light	Standard Operating Procedure	Active Measurement of C-14, H-3 and Kr-85 Continuous Particulate Measurement (Teledyne-API T640X) Continuous Sampling of Ammonia (NH_3) using Chemiluminescence Continuous Sampling of Carbon Monoxide (CO) using NDIR Gas Filter Correlation Continuous Sampling of Nitrogen Oxides (NO_x) using Chemiluminescence Continuous Sampling of Ozone (O_3) using UV Absorption Continuous Sampling of Sulphur Dioxide (SO_2) using UV Fluorescence Collection of Total Dustfall (Settleable Particulates) High-Volume Air Sampler (HVAS): Filter and PUF Cartridge High-Volume Air Sampler (HVAS): Particulate Sampler Measurement of Volatile Organic Compounds using an Evacuated Canister Passive Measurement of Gamma Radiation Dose (Thermoluminescence Dosimetry) Passive Measurement using Polyurethane Foam (PUF) Disk Passive Measurement of Radon (Alpha Track Etch Detector) Passive Measurement of Trace Gases Sound Level Meter (Human Exposure) Light Monitoriong (Human Exposure)
	Datasheet	Dustfall Sampling Datasheet Evacuated Canister Datasheet Gamma TLD Datasheet Particulate High-Volume Air Sampler (HVAS) Datasheet Passive Sampling of Trace Gases Datasheet Polyurethane Foam (PUF) High-Volume Air Sampler (HVAS) Datasheet Radon Datasheet
Soil	Standard Operating Procedure	Surficial Soil Sample Collection
	Datasheet	Surficial Soils Datasheet

J.1

TISSUES

Standard Operating Procedure:

Aquatic Macrophytes and Sediments - Sampling by Consultant

<table>
<tr><th colspan="2">DATASHEETS</th></tr>
<tr><td colspan="2">▪ Aquatic Macrophyte Collection Datasheet
▪ Field maps
▪ Chain of Custody (COC) forms</td></tr>
<tr><th colspan="2">CONTAMINANTS OF POTENTIAL CONCERN</th></tr>
<tr><td colspan="2">▪ See Appendix E of Environmental Media Baseline Program Final Sample Design report</td></tr>
<tr><th colspan="2">REFERENCE INFORMATION</th></tr>
<tr><td>REFERENCE DOCUMENTS</td><td>▪ CCME Protocols manual for water quality sampling in Canada (CCME 2011)
▪ CCME Guidance manual on environmental site characterization (CCME 2016).
▪ BC MOE Water and air baseline monitoring guidance document for mine proponents and operators (BCMOE 2016)
▪ Government of Alberta Aquatic ecosystems field sampling protocols (Government of Alberta 2006)</td></tr>
<tr><th colspan="2">OPERATION, SERVICE, AND MAINTENANCE</th></tr>
<tr><td colspan="2">▪ The operation, service, and maintenance of the sampling equipment that is selected for use in the program should be completed in accordance with the INSTRUMENT MANUFACTURER’S OPERATING MANUAL</td></tr>
<tr><th colspan="2">EQUIPMENT REQUIRED</th></tr>
<tr><td colspan="2">▪ Stainless steel shovel; Ekman dredge or grab sampler
▪ Teflon or stainless steel scissors
▪ Spring weight scale - 1 kg and 500 g
▪ GPS equipment
▪ Depth sounder, pole/or weighted depth tape to measure station depth
▪ Digital multi-probe meter for limnological measurements
▪ Spare parts, maintenance kit, batteries, and instruction manual
▪ Personal protective equipment including nitrile gloves
▪ Sampling bags for macrophytes and sediments
▪ Digital camera
▪ Coolers for transporting samples
▪ Decontamination equipment (e.g., phosphate free soap)</td></tr>
<tr><th colspan="2">SAMPLING DETAILS</th></tr>
<tr><td colspan="2">▪ Direct sampling of sedge and rat root/sweet gale will be completed by consultants working with local stakeholders/rights-holders.</td></tr>
</table>

- If the sampling is not co-located with a water station, then limnology measurements must also be taken at one station per study area (see SOP for Surface Water Limnology and Water Sample Collection - LSA).
- Five replicate sedge samples consisting of shoots, roots, and sediment from the rooting zone will be collected from locations within the LSA and RSA.
- Three replicate rat root/sweet flag samples will be collected from locations within the LSA.
- Roots and shoots will be collected by hand using nitrile gloves and separated using Teflon coated scissors. Samples will be rinsed of debris with water from the sampling location. Samples will be weighed by a spring type scale to ensure sufficient material will be available for all the required chemical analyses. The amount of material required needs to be ascertained with the laboratory prior to sampling.
- Sediment samples from the top 5 cm of the sedge rooting zone will be collected with a clean stainless steel shovel or grab sampler.
- Root, shoot, and sediment samples will all be placed into separated labeled sampling bags. Samples will be frozen prior to submission to the laboratory to ensure the macrophyte samples do not desiccate.

CUMULATIVE EFFECTS

In order to gather additional information about the study area and assess the potential for cumulative effects, land use information (e.g., undisturbed forest, community, forestry, cabins, agriculture) and other pertinent information (e.g., industry, contaminant sources, road proximity) is to be recorded at each sampling location and along access routes as relevant. This information is to be recorded the first time a new sampling location is visited or if land use changes at that sampling location. Record the information on the data sheets and be sure to take lots of pictures.

QA/QC REQUIREMENTS

GENERAL MEASURES	▪ Sampling should be conducted while wearing nitrile gloves ▪ The sampling equipment should always be washed with phosphate free soap following sample collection and then triple rinsed with water from the next sampling site prior to sampling ▪ Ensure that appropriate and clean sample bags are used ▪ Do not allow the inner surfaces of sample bags to come in contact with anything other than the sample ▪ All samples will be frozen the day they are collected or within a 12 hour period where possible to minimize the breakdown of tissue until submission to the laboratory ▪ When loading the samples into coolers for transport, check-off the laboratory COC to double-check that all samples are accounted for ▪ Do not ship samples unless you absolutely have to; use proper COC and mark the shipping container appropriately ▪ Ensure the COC is submitted and contains accurate information regarding each of the samples, parameters to measure, and contact information

REFERENCES

BCMOE. 2016. Water and air baseline monitoring guidance document for mine proponents and operators. Version 2, June. https://www2.gov.bc.ca/assets/gov/environment/waste-management/industrial-waste/industrial-waste/mining-smelt-energy/guidance-documents/ug_water_and_air_baseline.pdf.

CCME. 2011. Protocols manual for water quality sampling in Canada. Canadian Council of Ministers of the Environment. PN 1461.

CCME. 2016. Guidance manual for environmental site characterisation in support of human health risk assessment. Volume 2 Checklists. Canadian Council of Ministers of the Environment. December.

Government of Alberta. 2006. Aquatic ecosystems field sampling protocols. W0605.

Standard Operating Procedure:

Bird and Mammal Collection - Sampling by Consultant

DATASHEETS

- Bird and Mammal Tissue Collection Datasheet
- Field maps
- Chain of Custody (COC) forms

CONTAMINANTS OF POTENTIAL CONCERN

- See Appendix E of Environmental Media Baseline Program Final Sample Design report

REFERENCE INFORMATION

REFEREMCE DOCUMENTS	▪ British Columbia Ministry of Environment, Lands and Parks. Inventory methods for small mammals: shrews, voles, mice and rats: Standards for components of British Columbia's biodiversity no. 31 (BCMOE 1998). ▪ Barnett, A. & Dutton, J. Expedition field techniques: Small mammals (excluding bats) (Barnett and Dutton 1995) ▪ CCME Guidance manual on environmental site characterization (CCME 2016).

EQUIPMENT REQUIRED

- Snap traps and dry pitfall traps
- Steel shot and waterfowl hunting gun
- GPS equipment
- 1 kg and 500 g Spring-type scale to ensure sufficient material
- Personal protective equipment
- Sampling bags for tissue samples
- Digital camera
- Coolers for transporting samples
- Decontamination equipment (e.g., phosphate free soap)

SAMPLING DETAILS

- Direct sampling of small mammals (mice and shrew wholebody and snowshoe hare muscle) and herbivorous and omnivorous aquatic birds (Canada goose and dabbling duck muscle), and upland game birds (Ruffed grouse/spruce grouse muscle) will be completed by consultants working with local stakeholders/rights-holders within the LSA.
- Samples will be retained by trapping or hunting. When hunting, steel shot will be utilized.
- Once samples are retained, they will be processed prior to submission for chemical analysis. Muscle tissue will be kept from snowshoe hare, Canada goose, and dabbling ducks, while mice and shrews will be retained whole.
- The Bird and Mammal Tissue Collection Datasheet will be used to record the sample identification, location, species, sex, and maturity information. Any abnormalities will be recorded and

photographed. For mice and shrew, record the morphometric measurements and weight of each animal. Indicate on the datasheet which specimens need to be composited to retain sufficient material for chemical analysis. The amount of material required needs to be ascertained with the laboratory prior to going in the field.

- Once processed, all tissue samples will be placed into labelled sampling bags and frozen prior to submission to the laboratory for analysis.

CUMULATIVE EFFECTS

In order to gather additional information about the study area and assess the potential for cumulative effects, land use information (e.g., undisturbed forest, community, forestry, cabins, agriculture) and other pertinent information (e.g., industry, contaminant sources, road proximity) is to be recorded at each sampling location and along access routes as relevant. This information is to be recorded the first time a new sampling location is visited or if land use changes at that sampling location. Record the information on the data sheets and be sure to take lots of pictures.

QA/QC REQUIREMENTS

GENERAL MEASURES	▪ Sampling will be conducted while wearing nitrile gloves and dissection equipment will be cleaned using phosphate free soap between samples ▪ Ensure lead shot is not utilized as it will contaminate the sample ▪ Ensure that appropriate and clean sample bags are used ▪ Do not allow the inner surfaces of sample bags to come in contact with anything other than the sample ▪ All samples will be frozen the day they are collected or within a 12 hour period where possible to minimize the breakdown of tissue until submission to the laboratory ▪ When loading the samples into coolers for transport, check-off the laboratory COC to double-check that all samples are accounted for ▪ Do not ship samples unless you absolutely have to; use proper COC and mark the shipping container appropriately ▪ Ensure the COC is submitted and contains accurate information regarding each of the samples, parameters to measure, and contact information

REFERENCES

Barnett, A., and J. Dutton. 1995. Expedition Field Techniques: Small Mammals (Excluding Bats). Expedition Advisory Centre.

BCMOE. 1998. Inventory methods for small mammals: shrews, voles, mice and rats: Standards for components of British Columbia’s biodiversity No. 31.

CCME. 2016. Guidance manual for environmental site characterisation in support of human health risk assessment. Volume 2 Checklists. Canadian Council of Ministers of the Environment. December.

Standard Operating Procedure:

Fish Tissue Collection - Sampling by Consultant

DATASHEETS

- Fish Tissue Collection Datasheet
- Field maps
- Chain of Custody (COC) forms

CONTAMINANTS OF POTENTIAL CONCERN

- See Appendix E of Environmental Media Baseline Program Final Sample Design report

REFERENCE INFORMATION

REFERENCE DOCUMENTS	▪ Bonar et al. Standard methods for sampling North American freshwater fishes (Bonar et al. 2009) ▪ Environment Canada Environment Effects Monitoring Guidance Document (Environment Canada 2012) ▪ USGS national field manual for the collection of water-quality data; lakes and reservoirs (Green et al. 2015) ▪ CCME guidance manual for environmental site characterization (CCME 2016) ▪ BC MOE Water and air baseline monitoring guidance document for mine proponents and operators (BCMOE 2016)

OPERATION, SERVICE, AND MAINTENANCE

- The operation, service, and maintenance of the sampling equipment that is selected for use in the program should be completed in accordance with the INSTRUMENT MANUFACTURER’S OPERATING MANUAL

EQUIPMENT REQUIRED

- Gill nets, trap nets, angling gear, or electrofishing
- Global positioning system (GPS) and extra batteries
- Fish measuring board
- Spring-type scale for large-bodied fish to nearest 1 g, 5 g, or 20 g
- 2 decimal scale for small-bodied measured to the nearest 0.01 g
- Fish dissection kit
- Fish dissection board and Saran wrap
- Spare parts, maintenance kit, calibration standards, batteries, instruction manual, and calibration log
- Personal protective equipment including nitrile gloves
- Sampling bags for fish tissue
- Digital camera
- Coolers for transporting samples
- Decontamination equipment (e.g., phosphate free soap)

SAMPLING DETAILS

▪ Sampling of large and small-bodied fish will be completed by consultants working with local stakeholders/rights-holders within the LSA. Fish capture will be completed as part of the Biodiversity Impact Studies and are therefore not included in this SOP.
▪ The amount of material required needs to be ascertained with the laboratory prior to going in the field.
▪ Large and small-bodied fish retained for chemistry will be processed prior to submission for chemical analysis as follows:
    ▪ Sample tissue identification numbers will be recorded on the Fish Tissue Collection. Note that one fish may have multiple sample tissue identification numbers if multiple tissue types are being assessed (e.g. Wholebody, Flesh, or Liver).
    ▪ Species length (total or fork length), weight, sex, stomach content, and internal and external condition descriptions will be recorded on the data sheet.
    ▪ Ageing structures will be removed for age determination.
    ▪ Photographs of any abnormalities will be taken.
▪ Once processed, all tissue samples will be placed into labelled sampling bags and frozen prior to submission to the laboratory for analysis.
▪ Ageing structures will be placed into labelled ageing envelopes and submitted to the laboratory for age analysis.

CUMULATIVE EFFECTS
In order to gather additional information about the study area and assess the potential for cumulative effects, land use information (e.g., undisturbed forest, community, forestry, cabins, agriculture) and other pertinent information (e.g., industry, contaminant sources, road proximity) is to be recorded at each sampling location and along access routes as relevant. This information is to be recorded the first time a new sampling location is visited or if land use changes at that sampling location. Record the information on the data sheets and be sure to take lots of pictures.

QA/QC REQUIREMENTS	
GENERAL MEASURES	▪ Sampling will be conducted while wearing nitrile gloves and dissection equipment will be cleaned using phosphate free soap between samples ▪ The fish dissection board will be wrapped in Saran wrap and the wrap will be changed between samples ▪ Balances should be calibrated regularly to ensure accurate weight measures ▪ Ensure that appropriate and clean sample bags are used ▪ Do not allow the inner surfaces of sample bags to come in contact with anything other than the sample ▪ All samples will be frozen the day they are collected or within a 12 hour period where possible to minimize the breakdown of tissue until submission to the laboratory ▪ When loading the samples into coolers for transport, check-off the laboratory COC to double-check that all samples are accounted for ▪ Do not ship samples unless you absolutely have to; use proper COC and mark the shipping container appropriately.

	▪ Ensure the COC is submitted and contains accurate information regarding each of the samples, parameters to measure, and contact information

REFERENCES

BCMOE. 2016. Water and air baseline monitoring guidance document for mine proponents and operators. Version 2, June. https://www2.gov.bc.ca/assets/gov/environment/waste-management/industrial-waste/industrial-waste/mining-smelt-energy/guidance-documents/ug_water_and_air_baseline.pdf.

Bonar, S.A., W.A. Hubert, and D.W. Willis. 2009. Standard Methods for Sampling North American Freshwater Fishes. American Fisheries Society.

CCME. 2016. Guidance manual for environmental site characterisation in support of human health risk assessment. Volume 2 Checklists. Canadian Council of Ministers of the Environment. December.

Environment Canada. 2012. Metal mining technical guidance for environmental effects monitoring. Environment Canada, National Environmental Effects Monitoring Office, Science Policy and Environmental Quality Branch, Ottawa, Ontario.

Green, W.R., D.M. Robertson, and F.D. Wilde. 2015. USGS national field manual for the collection of water-quality data; lakes and reservoirs: Guidelines for study design and sampling. Techniques of Water-Resources Investigations Book 9.

Standard Operating Procedure:

Insect Collection - Sampling by Consultant

DATASHEETS	
▪ Tadpole and Insect Collection Datasheet ▪ Field maps ▪ Chain of Custody (COC) forms	
CONTAMINANTS OF POTENTIAL CONCERN	
▪ See Appendix E of Environmental Media Baseline Program Final Sample Design report	
REFERENCE INFORMATION	
REFERENCE DOCUMENTS	▪ Collecting and Preserving Insects and Mites: Techniques and Tools (USDA 1986). ▪ CCME Guidance manual on environmental site characterization (CCME 2016)
EQUIPMENT REQUIRED	
▪ Largemouth aerial net and pitfall traps ▪ GPS equipment ▪ Personal protective equipment including nitrile gloves ▪ Sampling envelopes ▪ Digital camera ▪ Coolers for transporting samples	
SAMPLING DETAILS	
▪ Direct sampling of winged and non-winged insects will be completed by consultants working with local stakeholders/rights-holders within the LSA and RSA. ▪ Taxon selected will be dependent on occurrence within the LSA and RSA. ▪ The amount of material required needs to be ascertained with the laboratory prior to going in the field. ▪ Flying insects, such as dragonflies or damselflies, will be captured using a largemouth aerial net, while non winged insects, such as caterpillars, will be collected by hand or with the use of pitfall traps. ▪ Insects will be retained in labelled sampling envelopes and frozen prior to submission to the laboratory for total metals analysis.	
CUMULATIVE EFFECTS	
In order to gather additional information about the study area and assess the potential for cumulative effects, land use information (e.g., undisturbed forest, community, forestry, cabins, agriculture) and other pertinent information (e.g., industry, contaminant sources, road proximity) is to be recorded at each sampling location and along access routes as relevant. This information is to be recorded the first	

time a new sampling location is visited or if land use changes at that sampling location. Record the information on the data sheets and be sure to take lots of pictures.	
QA/QC REQUIREMENTS	
GENERAL MEASURES	▪ Sampling will be conducted while wearing nitrile gloves ▪ Ensure that appropriate and clean sample vials are used ▪ All samples will be frozen the day they are collected or within a 12 hour period where possible to minimize the breakdown of tissue until submission to the laboratory ▪ When loading the samples into coolers for transport, check-off the laboratory COC to double-check that all samples are accounted for ▪ Do not ship samples unless you absolutely have to; use proper COC and mark the shipping container appropriately ▪ Ensure the COC is submitted and contains accurate information regarding each of the samples, parameters to measure, and contact information

REFERENCES

CCME. 2016. Guidance manual for environmental site characterization in support of environmental and human health risk assessment. Volume 3 Suggested Operating Procedures. PN 1555.

USDA. 1986. Collecting and Preserving Insects and Mites: Techniques and Tools. Edited by M. E. Schauff. Washington: Systematic Entomology Laboratory, USDA, National Museum of Natural History.

Standard Operating Procedure:

Soil, Edible Berries/Plants, and Browse Collection - Sampling by Consultant

DATASHEETS	
▪ Soil, Edible Berries/Plants, and Browse Collection Datasheet ▪ Field maps ▪ Chain of Custody (COC) forms	
CONTAMINANTS OF POTENTIAL CONCERN	
▪ See Appendix E of Environmental Media Baseline Program Final Sample Design report	
REFERENCE INFORMATION	
REFERENCE DOCUMENTS	▪ CCME Guidance manual on environmental site characterization assessment (CCME 2016).
EQUIPMENT REQUIRED	
▪ Soil hand corer ▪ GPS equipment ▪ 1 kg and 500 g Spring-type scale for to ensure sufficient material ▪ Teflon-coated or stainless steel scissors ▪ Personal protective equipment including nitrile gloves ▪ Sampling bags for soil, berry, or edible plant samples ▪ Digital camera ▪ Coolers for transporting samples ▪ Decontamination equipment (e.g., phosphate free soap)	
SAMPLING DETAILS	
▪ Sampling of edible berries, edible plants, browse, and soil samples will be completed by consultants working with local stakeholders/rights-holders within the LSA. Soil samples will be co-located with berry sampling. ▪ Berry and edible plant samples will be handpicked. ▪ Soil samples will be collected using a hand corer to a depth of 10 cm. The surficial loose organic debris from the top of the core sample will be removed. Each soil sample will be a composite of multiple cores to achieve the required sample weight. ▪ New growth of representative browse species (e.g., willow) will be collected with Teflon coated scissors. If possible, co-locate browse samples near the edible berry and soil sampling locations. ▪ Samples will be weighed to ensure sufficient material is available to run the required chemical analyses. The amount of sample required for each media type needs to be ascertained with the laboratory prior to the field survey. ▪ Once collected, all samples will be placed into labelled sampling bags and frozen prior to submission to the laboratory for analysis.	

CUMULATIVE EFFECTS	
In order to gather additional information about the study area and assess the potential for cumulative effects, land use information (e.g., undisturbed forest, community, forestry, cabins, agriculture) and other pertinent information (e.g., industry, contaminant sources, road proximity) is to be recorded at each sampling location and along access routes as relevant. This information is to be recorded the first time a new sampling location is visited or if land use changes at that sampling location. Record the information on the data sheets and be sure to take lots of pictures.	
QA/QC REQUIREMENTS	
GENERAL MEASURES	▪ Sampling will be conducted while wearing nitrile gloves and equipment will be cleaned using phosphate free soap between samples ▪ Ensure that appropriate and clean sample bags are used ▪ Do not allow the inner surfaces of sample bags to come in contact with anything other than the sample ▪ All samples will be frozen the day they are collected or within a 12 hour period where possible to minimize the breakdown of tissue until submission to the laboratory ▪ When loading the samples into coolers for transport, check-off the laboratory COC to double-check that all samples are accounted for ▪ Do not ship samples unless you absolutely have to; use proper COC and mark the shipping container appropriately ▪ Ensure the COC is submitted and contains accurate information regarding each of the samples, parameters to measure, and contact information

REFERENCES

CCME. 2016. Guidance manual for environmental site characterisation in support of human health risk assessment. Volume 2 Checklists. Canadian Council of Ministers of the Environment. December.

Standard Operating Procedure:

Soil and Lichen Permanent Sampling Plot (PSP) - Sampling by Consultant

DATASHEETS	
▪ Soil and Lichen PSP Collection Datasheet ▪ Field maps ▪ Chain of Custody (COC) forms	
CONTAMINANTS OF POTENTIAL CONCERN	
▪ See Appendix E of Environmental Media Baseline Program Final Sample Design report	
REFERENCE INFORMATION	
REFERENCE DOCUMENTS	▪ CCME guidance manual for environmental site characterization assessment (CCME 2016)
OPERATION, SERVICE, AND MAINTENANCE	
▪ The operation, service, and maintenance of the sampling equipment that is selected for use in the program should be completed in accordance with the INSTRUMENT MANUFACTURER'S OPERATING MANUAL	
EQUIPMENT REQUIRED	
▪ Soil hand corer ▪ Soil knife ▪ GPS equipment ▪ 1 kg and 500 g Spring-type scale for to ensure sufficient material ▪ Personal protective equipment including nitrile gloves ▪ Sampling bags ▪ Digital camera ▪ Coolers for transporting samples ▪ Decontamination equipment (e.g., phosphate free soap)	
SAMPLING DETAILS	
▪ Soil and lichen sampling at PSPs will be completed consultants working with local stakeholders/rights-holders within the LSA and RSA. ▪ Once a location to situate a PSP is identified (situated near planned location, contains adequate quantities of lichen), a 10 m by 10 m area will be delineated and the location will be marked using a GPS. Take a photograph of the PSP prior to and following sampling. ▪ Lichen will be collected with Teflon-coated scissors. Only the heads (top 2 cm to 3 cm) of the plants will be collected. ▪ Soil samples will be collected at the same location as the lichen using a hand corer to a depth of 10 cm. The surficial loose organic debris from the top of the core sample will be removed using a soil	

knife until the surface of the underlying mineral soil is visible. Each soil sample will be a composite of multiple cores to achieve the required sample weight.

- Samples will be weighed to ensure sufficient material is available to run the required chemical analyses; the amount of lichen and soil required will need to be ascertained with the laboratory prior to the field survey.
- Once collected, all samples will be placed into labelled sampling bags and frozen prior to submission to the laboratory for analysis.

CUMULATIVE EFFECTS

In order to gather additional information about the study area and assess the potential for cumulative effects, land use information (e.g., undisturbed forest, community, forestry, cabins, agriculture) and other pertinent information (e.g., industry, contaminant sources, road proximity) is to be recorded at each sampling location and along access routes as relevant. This information is to be recorded the first time a new sampling location is visited or if land use changes at that sampling location. Record the information on the data sheets and be sure to take lots of pictures.

QA/QC REQUIREMENTS

GENERAL MEASURES	▪ Sampling will be conducted while wearing nitrile gloves and equipment will be cleaned using phosphate free soap between samples ▪ Lichen samples will be cleaned at the time of collection to ensure non-lichen material such as pine needles are removed ▪ Ensure that appropriate and clean sample bags are used ▪ Do not allow the inner surfaces of sample bags to come in contact with anything other than the sample ▪ All samples will be frozen the day they are collected or within a 12 hour period where possible to minimize the breakdown of tissue until submission to the laboratory ▪ When loading the samples into coolers for transport, check-off the laboratory COC to double-check that all samples are accounted for ▪ Do not ship samples unless you absolutely have to; use proper COC and mark the shipping container appropriately ▪ Ensure the COC is submitted and contains accurate information regarding each of the samples, parameters to measure, and contact information
DUPLICATES – 10% OF TEST SAMPLES	Field duplicate soil samples will be taken at a frequency of 10% of the test samples to ensure that sampling and laboratory analyses produce repeatable results. A duplicate sample requires collecting a full second test sample at the station.

REFERENCES

CCME. 2016. Guidance manual for environmental site characterisation in support of human health risk assessment. Volume 2 Checklists. Canadian Council of Ministers of the Environment. December.

Standard Operating Procedure:

Tadpole Tissue Collection - Sampling by Consultant

DATASHEETS	
▪ Tadpole and Insect Collection Datasheet ▪ Field maps ▪ Chain of Custody (COC) forms	
CONTAMINANTS OF POTENTIAL CONCERN	
▪ See Appendix E of Environmental Media Baseline Program Final Sample Design report	
REFERENCE INFORMATION	
REFERENCE DOCUMENTS	▪ National Oceanic and Atmospheric Administration (NOAA 2007) ▪ CCME Guidance manual on environmental site characterization assessment (CCME 2016).
EQUIPMENT REQUIRED	
▪ Dip net, seine, and minnow traps ▪ GPS equipment ▪ Personal protective equipment including nitrile gloves ▪ Sampling vials for tadpoles ▪ Digital camera ▪ Coolers for transporting samples	
SAMPLING DETAILS	
▪ Sampling of tadpoles will be completed by consultants working with local stakeholders/rights-holders. ▪ Tadpoles will be collected from suitable habitat within the LSA and RSA using a dip net, seine, or minnow traps and identified to species. ▪ The species selected will be dependent on occurrence within the LSA and RSA, but may be wood frogs or green frog tadpoles. ▪ Each tadpole will be examined for abnormalities, photographed, placed into labelled vials, and frozen. ▪ The amount of sample weight required will need to be ascertained with the laboratory before the field survey.	
CUMULATIVE EFFECTS	
In order to gather additional information about the study area and assess the potential for cumulative effects, land use information (e.g., undisturbed forest, community, forestry, cabins, agriculture) and other pertinent information (e.g., industry, contaminant sources, road proximity) is to be recorded at each sampling location and along access routes as relevant. This information is to be recorded the first time a new sampling location is visited or if land use changes at that sampling location. Record the information on the data sheets and be sure to take lots of pictures.	

QA/QC REQUIREMENTS	
GENERAL MEASURES	▪ Sampling will be conducted while wearing nitrile gloves ▪ Ensure that appropriate and clean sample vials are used ▪ All samples will be frozen the day they are collected or within a 12 hour period where possible to minimize the breakdown of tissue until submission to the laboratory ▪ When loading the samples into coolers for transport, check-off the laboratory COC to double-check that all samples are accounted for ▪ Do not ship samples unless you absolutely have to; use proper COC and mark the shipping container appropriately ▪ Ensure the COC is submitted and contains accurate information regarding each of the samples, parameters to measure, and contact information

REFERENCES

CCME. 2016. Guidance manual for environmental site characterisation in support of human health risk assessment. Volume 2 Checklists. Canadian Council of Ministers of the Environment. December.

NOAA. 2007. Data report for the collection of bullfrog (Rana Catesbeiana) tadpoles and near-shore sediment samples from the Hudson River, New York. New York.

Standard Operating Procedure:

Traditionally Harvested Sample Collection - Sampling by Consultant/Community

DATASHEETS

- Traditionally Harvested Sample Collection Datasheet
- Field maps

EQUIPMENT REQUIRED

- GPS equipment (is possible)
- Sampling bags
- Sampling envelopes
- Digital camera
- Waterproof markers, pens, pencils

SAMPLING DETAILS

- If you would like to submit a sample of a traditional food (mammal, fish, and bird tissue or vegetation sample, medicinal plants) you harvested or found, please read below and fill out the Traditionally Harvested Sample Collection Datasheet
- We are hoping to get a number of traditionally harvested samples of the following animals and plants from local rights-holders and stakeholders:
  - Fish (lake trout, walleye, northern pike, lake whitefish, cisco, and white sucker)
  - Canada goose, mallard duck
  - Beaver, muskrat, mink (muscle and hair)
  - Moose and whitetail deer (muscle and organs)
  - Lynx and bear (muscle and hair)
  - Snowshoe hare (muscle or whole)
  - Ruffed grouse (whole)
  - Berries (blueberry, cranberry, raspberry)
  - Edible or medicinal plants (wild mushroom, Labrador tea, Chaga, wild rice, and rat root)
- A description of the sampling location, or preferably UTM coordinates taken using a GPS, should be recorded on the datasheet.
- If possible, please fill out the land use section on the datasheet and take pictures.
- If possible, it is best to get a sample of mammal tissue from the hind quarter of the animal to keep it consistent between species and individuals.
- The laboratory needs a lot of sample material to complete some of the analyses. Please send a minimum of 500 g to 1 kg of tissue of larger animals such as moose, deer, bear, etc.
- Fish, birds, and snowshoe hare can be sent in whole and processed by the community coordinator/consultant.
- If known, please provide a note as to whether steel shot or lead shot was used if the animal was shot. If lead shot was used, try to avoid the wounded area of the animal when taking meat

for a sample. It is highly recommended that steel shot be used for hunting to avoid contamination.

- If you have a beaver, muskrat, mink, or part of a lynx, or bear that you are submitting; also pluck 5 guard hairs (the longer hair) and place in envelope.
- Place whole samples in clean, labelled, plastic bag (double bag if possible). Place the envelope with the hair samples in with the rest of the sample.
- Samples should be stored in a clean, sealed plastic bag (double bagged zip-lock if possible). The sample bag should be labelled as follows:

NWMO
Species Collected
Location
Date

- All samples should be frozen on the day they are collected, if possible, and should remain frozen until they are dropped off to the community coordinator/consultant.
- Please submit samples and the datasheet to the community coordinator/consultant as soon as possible.
- If shipping samples, ensure that they are shipped frozen and properly labelled and secure in a small cooler. Mark the cooler to say “Keep Frozen.”

Additional details: Please provide any additional information that may be useful for the project team and the laboratory, such as, unusual behaviour and/or physical appearance (healthy, found dead, parasite/tumour, calf, cow, or bull etc. and estimated age). This information can also be filled out on the Traditionally Harvested Sample Collection Datasheet, or communicated to the community coordinator/consultant.

QA/QC REQUIREMENTS	
GENERAL MEASURES	▪ Ensure that appropriate and clean sample bags are used ▪ Do not allow the inner surfaces of sample bags to come in contact with anything other than the sample if possible ▪ Clean tools and knives should be used to process the samples and thoroughly washed with soap and water after or between samples ▪ All samples will be frozen the day they are collected or within a 12 hour period where possible to minimize the breakdown of tissue until submission

Aquatic Macrophyte Collection Datasheet

Waterbody:	Station Depth (m):
Field Crew:	Date:
Weather:	Time:
Study Area ID:	Coordinates:
Replicate Station #:	Photo #:

Type Collected
- ☐ Sedge
- ☐ Rat Root/Sweet Gale
- ☐ Wild Rice
- ☐ Other (write down)______________________

Sampling Components Collected
- ☐ Shoots
- ☐ Roots
- ☐ Sediment
- ☐ Limnological data collected

Comments/Observations:

Field QAQC (initial to indicate all fields are complete):

Land Use Information
(to be completed during first visit, if station location changes, or if land use changes)

What is the land use (e.g., undisturbed forest, community, forestry, cabin, agriculture, etc.)?

Is there a road near the station? Yes / No

If yes, approximately how far away is the road from the station (specify units)?

Is there disturbance caused by industry or other human activities (e.g., forestry cleaning, cabin)? Yes / No

If yes, please describe and take photos.

If yes, approximately how far away is the disturbance from the station (specify units)?

Are there point sources of contaminants (e.g., sewage outfall) near the station? Yes / No

If yes, please describe and indicate if historical or unknown.

Are there non-point sources of contaminants (e.g., manure, livestock) near the station? Yes / No

If yes, please describe and indicate if historical or unknown.

Is there livestock access to the waterbody? Yes / No

If yes, please describe and indicate if historical or unknown.

Are there barriers (e.g., beaver dam, culvert) near the station? Yes / No

If yes, please describe and indicate if historical or unknown.

Are there popular fishing spots near the station? Yes / No

If yes, how far away are the fishing spots?

If yes, what species?

If yes, please indicate if fishing spots are historical or unknown.

Is the lake known to be used for drinking water? Yes / No

Comments/Observations:

Nuclear Waste Management Organization (NWMO) *Deep Geological Repository (DGR) Project*	**Environmental Media Baseline Program** *Tissues*

Bird and Mammal Tissue Collection Datasheet

Field Crew:	Date:
Weather:	Time:
Study Area ID:	Coordinates:
Capture Method:	

Sample IDs (incl IDs for all tissues)	Species	Sex (M/F)	Maturity	Moroph. (mm)	Weight (g)	Condition (Describe)	Photo #

Include sample ID for each tissue collected from each animal (e.g., muscle, liver, kidney, heart, etc.)
Maturity: Juvenile, Adult, Unknown
Describe overall health condition of animal, record any abnormalities and photograph.

Field QAQC (initial to indicate all fields are complete):

Land Use Information (to be completed during first visit, if station location changes, or if land use changes)
What is the land use (e.g., undisturbed forest, community, forestry, cabin, agriculture, etc.)?
Is there a road near the station? Yes / No If yes, approximately how far away is the road from the station (specify units)?
Is there disturbance caused by industry or other human activities (e.g., forestry cleaning, cabin)? Yes / No If yes, please describe and take photos. If yes, approximately how far away is the disturbance from the station (specify units)?
Are there point sources of contaminants (e.g., sewage outfall) near the station? Yes / No If yes, please describe and indicate if historical or unknown.
Are there non-point sources of contaminants (e.g., manure, livestock) near the station? Yes / No If yes, please describe and indicate if historical or unknown.
Is there livestock access to the waterbody? Yes / No If yes, please describe and indicate if historical or unknown.
Are there barriers (e.g., beaver dam, culvert) near the station? Yes / No If yes, please describe and indicate if historical or unknown.
Are there popular fishing spots near the station? Yes / No If yes, how far away are the fishing spots? If yes, what species? If yes, please indicate if fishing spots are historical or unknown.
Is the lake known to be used for drinking water? Yes / No
Comments/Observations:

Nuclear Waste Management Organization (NWMO) *Deep Geological Repository (DGR) Project*	**Environmental Media Baseline Program** *Tissues*

Fish Tissue Collection Datasheet

Waterbody:	Capture Method:
Field Crew:	Date:
Weather:	Time:
Study Area ID:	Coordinates:

Sample IDs (incl IDs for all tissues)	**Species**	**Length (mm)**	**Weight (g)**	**Sex (M/F)**	**Age Structure**	**Stomach Contents**		**External Condition (Describe)**	**Internal Condition (Describe)**	**Photo #**
						% Full	**Description**			

Capture method: gill netting, angling, trap netting, electrofishing
Length should be fork length or total length, based on species
Ageing structure options - Primary: cleithra, otolith, fin ray; Secondary: Scal
Describe overall internal and external health of the fish including any abnormalities or parasites

Field QAQC (initial to indicate all fields are complete):

Land Use Information (to be completed during first visit, if station location changes, or if land use changes)
What is the land use (e.g., undisturbed forest, community, forestry, cabin, agriculture, etc.)?
Is there a road near the station? Yes / No If yes, approximately how far away is the road from the station (specify units)?
Is there disturbance caused by industry or other human activities (e.g., forestry cleaning, cabin)? Yes / No If yes, please describe and take photos. If yes, approximately how far away is the disturbance from the station (specify units)?
Are there point sources of contaminants (e.g., sewage outfall) near the station? Yes / No If yes, please describe and indicate if historical or unknown.
Are there non-point sources of contaminants (e.g., manure, livestock) near the station? Yes / No If yes, please describe and indicate if historical or unknown.
Is there livestock access to the waterbody? Yes / No If yes, please describe and indicate if historical or unknown.
Are there barriers (e.g., beaver dam, culvert) near the station? Yes / No If yes, please describe and indicate if historical or unknown.
Are there popular fishing spots near the station? Yes / No If yes, how far away are the fishing spots? If yes, what species? If yes, please indicate if fishing spots are historical or unknown.
Is the lake known to be used for drinking water? Yes / No
Comments/Observations:

Nuclear Waste Management Organization (NWMO) *Deep Geological Repository (DGR) Project*	**Environmental Media Baseline Program** *Tissues*

Non-lethal Tissue Collection Datasheet

Field Crew:	Collection Method:
Weather:	Date:
Study Area ID:	Time:

Co-ordinates	**Sample ID**	**Species**	**Media**	**Comments**	**Photo #**

Indicate media sampled such as hair, feather, or muscle plug.

Field QAQC (initial to indicate all fields are complete):

Land Use Information (to be completed during first visit, if station location changes, or if land use changes)
What is the land use (e.g., undisturbed forest, community, forestry, cabin, agriculture, etc.)?
Is there a road near the station? Yes / No If yes, approximately how far away is the road from the station (specify units)?
Is there disturbance caused by industry or other human activities (e.g., forestry cleaning, cabin)? Yes / No If yes, please describe and take photos. If yes, approximately how far away is the disturbance from the station (specify units)?
Are there point sources of contaminants (e.g., sewage outfall) near the station? Yes / No If yes, please describe and indicate if historical or unknown.
Are there non-point sources of contaminants (e.g., manure, livestock) near the station? Yes / No If yes, please describe and indicate if historical or unknown.
Is there livestock access to the waterbody? Yes / No If yes, please describe and indicate if historical or unknown.
Are there barriers (e.g., beaver dam, culvert) near the station? Yes / No If yes, please describe and indicate if historical or unknown.
Are there popular fishing spots near the station? Yes / No If yes, how far away are the fishing spots? If yes, what species? If yes, please indicate if fishing spots are historical or unknown.
Is the lake known to be used for drinking water? Yes / No
Comments/Observations:

Nuclear Waste Management Organization (NWMO) *Deep Geological Repository (DGR) Project*	**Environmental Media Baseline Program** *Tissues*

Soil, Edible Berries/Plants, and Browse Collection Datasheet

Field Crew:	Collection Method:
Weather:	Date:
Study Area ID:	Time:

Co-ordinates	**Sample ID**	**Species/Media**	**Sample Weight (g)**	**Comments**	**Photo #**

Co-locate editble berry and plants with soil sample where possible.

Field QAQC (initial to indicate all fields are complete):

Land Use Information **(to be completed during first visit, if station location changes, or if land use changes)**
What is the land use (e.g., undisturbed forest, community, forestry, cabin, agriculture, etc.)? **Take pictures**
Is there a road near the station? Yes / No If yes, approximately how far away is the road from the station (specify units)?
Are there any signs of disturbance (e.g., forestry cleaning, cabins, recent forest fire)? Yes / No If yes, please describe and take pictures. If yes, approximately how far away is the disturbance from the station?
Are there any sources of contaminants (e.g., manure, livestock) near the station? Yes / No **If yes, please describe and indicate if historical or unknown.**
Comments/Observations:

Nuclear Waste Management Organization (NWMO) *Deep Geological Repository (DGR) Project*					**Environmental Media Baseline Program** *Tissues*	
Soil and Lichen PSP Collection Datasheet						
Field Crew:					Collection Method:	
Weather:					Date:	
Study Area ID:					Time:	
PSP#	**Sample ID**	**Co-ordinates**	**Species/Media**	**Sample Weight (g)**	**Comments**	**Photo #**
Field QAQC (initial to indicate all fields are complete):						

Date: June 2020
Version No.: 1.0

Land Use Information (to be completed during first visit, if station location changes, or if land use changes)
What is the land use (e.g., undisturbed forest, community, forestry, cabin, agriculture, etc.)? **Take pictures**
Is there a road near the station? Yes / No If yes, approximately how far away is the road from the station (specify units)?
Are there any signs of disturbance (e.g., forestry cleaning, cabins, recent forest fire)? Yes / No If yes, please describe and take pictures. If yes, approximately how far away is the disturbance from the station?
Are there any sources of contaminants (e.g., manure, livestock) near the station? Yes / No If yes, please describe and indicate if historical or unknown.
Comments/Observations:

Nuclear Waste Management Organization (NWMO) *Deep Geological Repository (DGR) Project*	**Environmental Media Baseline Program** *Tissues*

Tadpole and Insect Collection Datasheet

Waterbody:	Capture Method:
Field Crew:	Date:
Weather:	Time:
Study Area ID:	Coordinates:

Sample ID	Species	Comment	Photo #

Describe any abnormalities and photograph.

Field QAQC (initial to indicate all fields are complete):

Date: June 2020
Version No.: 1.0

Land Use Information (to be completed during first visit, if station location changes, or if land use changes)
What is the land use (e.g., undisturbed forest, community, forestry, cabin, agriculture, etc.)?
Is there a road near the station? Yes / No If yes, approximately how far away is the road from the station (specify units)?
Is there disturbance caused by industry or other human activities (e.g., forestry cleaning, cabin)? Yes / No If yes, please describe and take photos. If yes, approximately how far away is the disturbance from the station (specify units)?
Are there point sources of contaminants (e.g., sewage outfall) near the station? Yes / No If yes, please describe and indicate if historical or unknown.
Are there non-point sources of contaminants (e.g., manure, livestock) near the station? Yes / No If yes, please describe and indicate if historical or unknown.
Is there livestock access to the waterbody? Yes / No If yes, please describe and indicate if historical or unknown.
Are there barriers (e.g., beaver dam, culvert) near the station? Yes / No If yes, please describe and indicate if historical or unknown.
Are there popular fishing spots near the station? Yes / No If yes, how far away are the fishing spots? If yes, what species? If yes, please indicate if fishing spots are historical or unknown.
Is the lake known to be used for drinking water? Yes / No
Comments/Observations:

Nuclear Waste Management Organization (NWMO) *Deep Geological Repository (DGR) Project*	**Environmental Media Baseline Program** *Tissues*

Traditionally Harvested Sample Collection Datasheet

Sampler Full Name: ______________________________

Location (if on lake, record lake name): ______________________________

Sampling location description (or UTM coordinates): ______________________________

Did you mark the location on a map or do you have a GPS/coordinates? Yes / No

What animal species is this sample: ______________________________

Date of Death (if known): ______________________________

How did you catch it? ☐ Hunting ☐ Fishing ☐ Trapping ☐ by Hand (berries, plants)

What part of the animal did you include in the sample?

☐ Berries ☐ Whole ☐ Heart ☐ Kidney

☐ Leaves ☐ Muscle ☐ Liver

If a mammal, indicate the following if known: Male / Female

Young / Adult

Is there anything you noticed that wasn't normal about this sample? ______________________________

Has anything changed in the nearby land use since your last visit to this location? ______________________________

Comments/Observations:

Land Use Information **(to be completed during first visit, if station location changes, or if land use changes)**
What is the land use (e.g., undisturbed forest, community, forestry, cabin, agriculture, etc.)?
Is there a road near the station? Yes / No If yes, approximately how far away is the road from the station (specify units)?
Is there disturbance caused by industry or other human activities (e.g., forestry cleaning, cabin)? Yes / No If yes, please describe and take photos. If yes, approximately how far away is the disturbance from the station (specify units)?
Are there point sources of contaminants (e.g., sewage outfall) near the station? Yes / No If yes, please describe and indicate if historical or unknown.
Are there non-point sources of contaminants (e.g., manure, livestock) near the station? Yes / No If yes, please describe and indicate if historical or unknown.
Is there livestock access to the waterbody? Yes / No If yes, please describe and indicate if historical or unknown.
Are there barriers (e.g., beaver dam, culvert) near the station? Yes / No If yes, please describe and indicate if historical or unknown.
Are there popular fishing spots near the station? Yes / No If yes, how far away are the fishing spots? If yes, what species? If yes, please indicate if fishing spots are historical or unknown.
Is the lake known to be used for drinking water? Yes / No
Comments/Observations:

J.2

HYDROLOGY

Standard Operating Procedure:

Aerial Photography Survey via Drones

DATASHEETS	
▪ Aerial Survey by Drones Datasheet ▪ Field maps	
ENDPOINTS	
▪ Ortho-rectified photographic imagery ▪ Snow and ice cover over ponds, lakes, and rivers	
REFERENCE INFORMATION	
REFERENCE DOCUMENTS	▪ Canadian Aviation Regulations for Remotely Piloted Aircraft Systems (RPAS): https://www.tc.gc.ca/en/transport-canada/corporate/acts-regulations/regulations/sor-96-433.html (RPAS 2019) ▪ Instrument Manufacturer Operating Manual for selected drone(s)
OPERATION, SERVICE, AND MAINTENANCE	
Specific instrument procedures may vary widely by various manufacturers and models that have been approved for the drone. As such, the operation, service, and maintenance of the equipment that are selected for use in the program should be completed in accordance with the INSTRUMENT MANUFACTURER'S OPERATING MANUAL AND FEDERAL AND/OR PROVINCIAL LEGAL REQUIREMENTS. Instrumentation should be calibrated based on the INSTRUMENT MANUFACTURER'S OPERATING MANUAL.	
EQUIPMENT REQUIRED	
▪ Drone pilot certificate ▪ Drone and associated equipment ▪ Spare batteries for drone ▪ Anemometer (to verify suitable wind speed) ▪ GNSS equipment (RTK and GNSS logging base station) ▪ GPS equipment ▪ Digital camera	
SAMPLING DETAILS	
▪ The aerial survey will be conducted only during Year 1 unless the first survey does not provide quality results. The survey will be conducted in the winter and under clear skies. ▪ During the aerial survey event, the field staff will set up an anemometer to verify suitable wind speeds, set up the RTK and GNSS equipment and establish ground control points, and monitor airspace during flight, battery life, and flight drone diagnostics.	

<table>
<tr><td colspan="2">

- Prior to the aerial survey event, the field team is required to plan the following (not a complete list):
  - ensuring the work complies with the federal and provincial regulations;
  - ensuring the weather during the survey dates will be appropriate for the work (clear skies, low to no winds);
  - completing a data search for existing topographic information;
  - completing a data search for known localized points for calibration purposes (local site control points or Continuously Operating Reference Stations);
  - determining the flying altitude and flying route; and
  - estimating the total duration of the sampling event based on the time for mobilization and demobilization, flying altitude, footprint of the area, battery life of the drone, and weather conditions.

</td></tr>
<tr><th colspan="2">CUMULATIVE EFFECTS</th></tr>
<tr><td colspan="2">In order to gather additional information about the study area and assess the potential for cumulative effects, land use information (e.g., undisturbed forest, community, forestry, cabins, agriculture) and other pertinent information (e.g., industry, contaminant sources, road proximity) is to be recorded at each sampling location and along access routes as relevant. This information is to be recorded the first time a new sampling location is visited or if land use changes at that sampling location. Record the information on the data sheets and be sure to take lots of pictures.</td></tr>
<tr><th colspan="2">INSTRUMENTATION QA/QC REQUIREMENTS</th></tr>
<tr><td>REGULAR PERFORMANCE CHECK AND/OR SCHEDULED CALIBRATION</td><td>The following performance checks on the drone and GNSS equipment are to be completed <u>at least every day of operation:</u>

- visual inspection of the drone and associated equipment (damage, cleanliness)
- fully charged batteries for the drones and drone controller

Specific equipment should be calibrated at the following intervals:

- prior to performing the aerial survey
- in between surveying the AOI and individual lakes
- after any maintenance (e.g., parts replacement)
- after issues that arise with the data

The calibrations are to be recorded, and associated documentation kept in the permanent project record for use in subsequent analysis</td></tr>
</table>

REFERENCES

RPAS. 2019. Canadian Aviation Regulations (SOR/96-433). https://www.tc.gc.ca/en/transport-canada/corporate/acts-regulations/regulations/sor-96-433.html.

Standard Operating Procedure:

Lake Bathymetry and Water Levels via Staff Gauge

DATASHEETS	
▪ Manual Water Level Measurements (Lakes) Datasheet ▪ Bathymetric Survey Datasheet ▪ Field maps	
ENDPOINTS	
▪ Surface area, geometric shape, and depth of lakes ▪ Cross-section transects across lakes ▪ Water level via staff gauge	
REFERENCE INFORMATION	
REFERENCE DOCUMENTS	▪ Lake Bathymetry: Refer to The Department of Fisheries and Oceans Canada (DFOs) "Standards for Hydrographic Surveys, Edition 3" (U.S. EPA Equivalent Method for Lake Bathymetry is not available) (DFO 2019) ▪ http://www.charts.gc.ca/documents/data-gestion/standards-normes/standards-normes-2019-eng.pdf ▪ Canadian Federal guidelines or Ontario provincial guidelines: o Ontario Stream Assessment Protocol (OSAP 2017) o MTO Hydrology Requirement Checklist (MTO 2016) o MTO Drainage Management (MTO 2019) ▪ Water Level: Refer to U.S. EPA's "*National Rivers and Streams Assessment 2018/19 – Field Operations Manual Non Wadeable*" (EPA-841-B-17-003b) (U.S. EPA 2019) ▪ https://www.epa.gov/sites/production/files/2019-05/documents/nrsa_1819_fom_nonwadeable_version_1.2.pdf ▪ Instrument Manufacturer Operating Manual for selected field equipment and staff gauge stations
OPERATION, SERVICE, AND MAINTENANCE	
Specific instrument procedures may vary widely by various manufacturers and models that have been approved for bathymetry survey and staff gauge equipment. As such, the installation, operation, service, and maintenance of the equipment that are selected for use in the program should be completed in accordance with the INSTRUMENT MANUFACTURER'S OPERATING MANUAL. Instrumentation should be periodically calibrated based on the INSTRUMENT MANUFACTURER'S OPERATING MANUAL.	

EQUIPMENT REQUIRED
▪ Bathymetry survey specific equipment (RTK GPS and base station, autonomous boat, communications, or boat/motor with mounted depth sounder) ▪ Staff gauges, installation gear (rebar, T-post, etc.) ▪ Survey equipment and established survey benchmarks ▪ Aerial imagery ▪ GPS equipment ▪ Digital camera and photos of staff gauges taken from preceding field visits
SAMPLING DETAILS
▪ Bathymetric surveys will be conducted by running transects covering the lakes. The number of transects necessary to cover the lake will depend on the size of the lake (small, medium, or large), and the average lake length and width, which will be estimated from the lake surface area and geometric shape of the lake (e.g., rectangle) using aerial imagery. ▪ The method used for completing bathymetric mapping will depend whether an autonomous boat or a depth sounder mounted on a boat driven by an operator is used; follow instrumentation instructions. The data sheet provided is for use of an autonomous boat. ▪ One permanent staff gauge will be installed in each lake location during the first site field visit. ▪ Given the number of lakes to be monitored, there should be enough survey benchmarks (min of 8) to tie each lake level gauge to a benchmark. ▪ Visual staff gauge readings will be taken during periodic field visits, which can be coordinated with other field studies, but at a minimum of every other month during the thaw season (4 times a year). ▪ Properly trained staff with confirmation of the original staff gauge location (e.g., from photos, GPS coordinates, etc.) will confirm the correct location functioning operation of the gauges and perform maintenance when required (i.e., if gauge is not in the correct place). In addition, the staff gauge should be resurveyed into local benchmarks annually in the spring.
CUMULATIVE EFFECTS
In order to gather additional information about the study area and assess the potential for cumulative effects, land use information (e.g., undisturbed forest, community, forestry, cabins, agriculture) and other pertinent information (e.g., industry, contaminant sources, road proximity) is to be recorded at each sampling location and along access routes as relevant. This information is to be recorded the first time a new sampling location is visited or if land use changes at that sampling location. Record the information on the data sheets and be sure to take lots of pictures.

INSTRUMENTATION QA/QC REQUIREMENTS	
REGULAR PERFORMANCE CHECK AND/OR SCHEDULED CALIBRATION	The following performance checks on the staff gauges are to be completed <u>at least every other month during thaw season (minimal 4 times per year)</u>: ▪ visual inspection of the staff gauges and associated equipment (damage, cleanliness) ▪ resurvey the staff gauge against the local benchmarks to address possible movement from ice heaving ▪ compare location of the staff gauge to previous field site visits and the original placement of the staff gauge (based on photos) Bathymetry survey specific equipment should be calibrated at the following intervals: ▪ prior to surveying a new lake location ▪ after any maintenance (e.g., parts replacement) ▪ after issues the arise with the data The calibrations are to be recorded, and associated documentation kept in the permanent project record for use in subsequent analysis

REFERENCES

DFO. 2019. Canadian Hydrographic Service. http://www.charts.gc.ca/documents/data-gestion/standards-normes/standards-normes-2019-eng.pdf.

MTO. 2016. MTO hydrology requirement checklist. http://www.mto.gov.on.ca/english/publications/drainage/hydrology/section3.shtml (accessed July 3, 2019).

MTO. 2019. Drainage Management. http://www.mto.gov.on.ca/english/publications/drainage/index.shtml (accessed July 3, 2019).

OSAP. 2017. Ontario Stream Assessment Protocol. Version 10. Edited by Les Stanfield.

U.S. EPA. 2019. National Rivers and Streams Assessment 2018/19. Field Operations ManualNon-Wadeable. Washington.

Standard Operating Procedure:

Meteorological Monitoring

DATASHEETS	
▪ Meteorological Station Monitoring Datasheet	
ENDPOINTS	
▪ Total precipitation ▪ Snow depth ▪ Air temperature ▪ Wind direction and wind speed ▪ Relative humidity or dew point temperature ▪ Atmospheric pressure ▪ Soil moisture ▪ Solar radiation	
REFERENCE INFORMATION	
REFERENCE DOCUMENTS	▪ Canadian federal guidelines such as the *Manual of Surface Weather Observation Standards* (ECCC 2019) ▪ U.S. EPA *Sampling Methods for Meteorological Parameters* (U.S. EPA 2020) ▪ Instrument Manufacturer Operating Manual for selected meteorological monitoring station
OPERATION, SERVICE, AND MAINTENANCE	
Specific procedures may vary widely by various manufacturers and models that have been approved for meteorological monitoring. As such, the installation, operation, service, and maintenance of the meteorological monitoring station that is selected for use in the program should be completed in accordance with the INSTRUMENT MANUFACTURER'S OPERATING MANUAL. Instrumentation should be periodically calibrated based on the INSTRUMENT MANUFACTURER'S OPERATING MANUAL	
EQUIPMENT REQUIRED	
▪ Laptop (for data collection) and solar power supply ▪ GPS equipment ▪ Lock, fencing, tripod for instrumentation, and a concrete slab for snow measurements ▪ Communications (e.g., satellite or telemetry antennas, etc.) ▪ Calibration equipment	
SAMPLING DETAILS	
▪ The sampling frequency is to be 15 minutes over a 24-hour period, from midnight-to-midnight, over a period of at least one year but likely three years or more.	

▪ The meteorological station will require ongoing maintenance, including checking equipment, troubleshooting issues, calibrating instruments, swapping out batteries or other faulty equipment, cleaning equipment as necessary, and downloading data (if telemetry is not used). ▪ The frequency of site visits can be coordinated with other field studies to reduce costs, but at a minimum of three times during the thaw season. A detailed strategy should be developed for how the meteorological station will operate over the winter without losing power and handling extreme cold temperatures.	
CUMULATIVE EFFECTS	
In order to gather additional information about the study area and assess the potential for cumulative effects, land use information (e.g., undisturbed forest, community, forestry, cabins, agriculture) and other pertinent information (e.g., industry, contaminant sources, road proximity) is to be recorded at each sampling location and along access routes as relevant. This information is to be recorded the first time a new sampling location is visited or if land use changes at that sampling location. Record the information on the data sheets and be sure to take lots of pictures.	
INSTRUMENTATION QA/QC REQUIREMENTS	
REGULAR PERFORMANCE CHECK	The following is to be completed <u>three times per year</u>: ▪ visual inspection of the meteorological station (damage, cleanliness) ▪ confirm data collection and operation is being maintained over sampling time period within identified allowable ranges of the instruments ▪ confirm laptop are set to the correct date, local time, and sample duration
SCHEDULED CALIBRATION	Calibrations are to be completed at the following intervals: ▪ after any maintenance (e.g., parts replacement) ▪ after issues the arise with the data The calibrations are to be recorded, and associated documentation kept in the permanent project record for use in subsequent analysis

REFERENCES

ECCC. 2019. MANOBS: Manual or Surface Weather Observation Standards. En56-238/2-2018E-PDF, eight edition, February.

U.S. EPA. 2020. Sampling methods for meteorological parameters. AQS Reference Table. https://aqs.epa.gov/aqsweb/documents/codetables/methods_met.html (accessed June 22, 2020).

Standard Operating Procedure:

River and Stream Flow Sampling (Large Rivers and Small Streams)

DATASHEETS

- Continuous Water Level Measurements (Large Rivers) Datasheet
- Manual Flow Measurements (Small and Large Rivers) Datasheet
- Field Maps

ENDPOINTS

- Detailed channel cross-section
- Depth to bottom
- Water velocity
- Water level

REFERENCE INFORMATION

REFERENCE DOCUMENTS	▪ Canadian Federal and Ontario provincial guidelines: ○ Ontario Stream Assessment Protocol (OSAP 2017) ○ MTO Hydrology Requirement Checklist (MTO 2016) ○ MTO Drainage Management (MTO 2019) ▪ USGS Techniques and Methods for *Discharge Measurements at Gaging Stations* (Chapter 8 of Book 3, Section A) ▪ Instrument Manufacturer Operating Manual for selected field equipment and gauge stations

OPERATION, SERVICE, AND MAINTENANCE

Specific instrument procedures may vary widely by various manufacturers and models that have been approved for water level and velocity sampling. As such, the installation, operation, service, and maintenance of the equipment that is selected for use in the program should be completed in accordance with the INSTRUMENT MANUFACTURER'S OPERATING MANUAL. Instrumentation should be periodically calibrated based on the INSTRUMENT MANUFACTURER'S OPERATING MANUAL.

EQUIPMENT REQUIRED

- Velocimeter
- Staff gauge
- Continuous water level gauge stations using a pressure transducer or similar technology and data recorder
- Instrumentation box, solar panels, tripod stand
- GPS equipment
- Digital camera
- Communications for transmitting real-time data (e.g., satellite or telemetry antennas, etc.)

SAMPLING DETAILS
Manual Water Level and Water Velocity Measurements: For site locations in large rivers, measurements are to be collected three to six times in the first year. For locations in small streams, measurements are to be collected at least two times per year, preferably once in the spring melt time period and once in the later summer dry season. **Continuous Water Level Measurements:** For site locations in large rivers only, a pressure transducer will be installed at each location to measure water levels on a continuous basis with the sampling frequency of 15-min or hourly over a 24-hour period, from midnight-to-midnight.
CUMULATIVE EFFECTS
In order to gather additional information about the study area and assess the potential for cumulative effects, land use information (e.g., undisturbed forest, community, forestry, cabins, agriculture) and other pertinent information (e.g., industry, contaminant sources, road proximity) is to be recorded at each sampling location and along access routes as relevant. This information is to be recorded the first time a new sampling location is visited or if land use changes at that sampling location. Record the information on the data sheets and be sure to take lots of pictures.

INSTRUMENTATION QA/QC REQUIREMENTS	
REGULAR PERFORMANCE CHECK AND/OR SCHEDULED CALIBRATION	The following is to be completed <u>at least quarterly:</u> ▪ visual inspection of the continuous water level gauge stations and associated equipment (damage, cleanliness) ▪ confirm data collection, data transmission, and operation are being maintained within identified allowable ranges of the instruments ▪ confirm loggers are set to the correct date, local time, and sample duration Calibrations are to be completed at the following intervals: ▪ prior to deployment (for manual water depth and velocity measurements) ▪ upon installation ▪ after any maintenance (e.g., parts replacement) ▪ after issues the arise with the data The calibrations are to be recorded, and associated documentation kept in the permanent project record for use in subsequent analysis.

REFERENCES

MTO. 2016. MTO hydrology requirement checklist. http://www.mto.gov.on.ca/english/publications/drainage/hydrology/section3.shtml (accessed July 3, 2019).

MTO. 2019. Drainage Management. http://www.mto.gov.on.ca/english/publications/drainage/index.shtml (accessed July 3, 2019).

OSAP. 2017. Ontario Stream Assessment Protocol. Version 10. Edited by Les Stanfield.

U.S. EPA. 2019. National Rivers and Streams Assessment 2018/19. Field Operations ManualNon-Wadeable. Washington.

Aerial Survey by Drones Datasheet	
Waterbody: ______________________________ Field Crew: ______________________________ Weather: ______________________________ Study Area ID: ______________________________ Survey Equipment Used: ______________________________ ______________________________	Date: ______________________ Time: ______________________

Has the field crew reviewed all applicable instrument instructions and understand the procedures? Yes / No
Instructions include safety guidelines, specifications, and maintenance recommendations of the instruments.

Has the field crew reviewed the specific federal, provincial and/or local jurisdictions related to the flight operation? Yes / No

Does the field crew include qualified personnel pilot with the required licences/certification? Yes / No

Is there an insurance plan for the drone? Yes / No
If yes, does the insurance plan cover the drone for the dates of flight operation? Yes / No

Does the flight operation require access to restricted airspace? Yes / No

Does the flight operation require waiver for operational permission? Yes / No

Base Station Setup **(Land Surveyed Elevation Point Information)**
Record coordinates of the station: ____________________ GPS antenna and RTK survey models: ____________________ Ground elevation of station (specify units and associated datum): ____________________ GPS antenna vertical height from ground (specify units): ____________________ Horizontal offsets of GPS antenna relative to base station (specify units): ____________________
Are there any wear and damages on the GPS equipment? Yes / No If yes, please describe and take photos. If yes, have corrective actions been implemented? Yes / No
Record the calibration results of the RTK system and modifications performed in the field:

Are the RTK configurations settings set up for the current survey?   Yes / No
Record the calibration results of the GPS antenna and modifications performed in the field: Record the antenna reference point (ARP): ___________________________________
Comments/Observations:

Drone Pre-Flight Checklist **(to be completed prior to each flight operation)**
Assess the weather conditions and take photos. Set up the anemometer and record wind speed: ________________________ Is the wind speed within an acceptable range? Yes / No Is visibility acceptable for the area of flight? Yes / No If precipitation is present, is the precipitation within acceptable range? Yes / No Additional comments:
Pilot name: ____ Pilot certification number: ____ Drone model and number: ____

Drone weight (specify units): ____

Estimate flight time using one battery: _________________________________

Target flight altitude: ____

Maximum flight altitude: ____

Is the drone battery charged to acceptable range and securely fixed into the drone? Yes / No

Are the spare drone batteries charged to acceptable range? Yes / No

Is the drone controller battery charged to acceptable range? Yes / No

Are the spare drone controller batteries charged to acceptable range? Yes / No

Are the drone lights and sensors been cleaned and clear of debris and dirt? Yes / No

Are there any wear and damages on the drone? Yes / No
Inspect all components including propellers, motors, indicator lights, screws, GPS system, landing gear, wiring, etc.

If yes, describe below and take photos.

If yes, have corrective actions been implemented (i.e., repairs and replacements)? Yes / No

Are the RTK configurations settings set up for the current survey? Yes / No

Record the calibration results for the GPS antenna and modifications performed in the field:

Record the calibration results for the compass and modifications performed in the field:

Record the calibration results for the GPS system and modifications performed in the field:

Additional calibration comments and observations:

Has a suitable launch pad been located? Yes / No

Is the area and overhead of launch pad clear of obstructions? Yes / No

Is the drone stable on ground of the launch pad? Yes / No

Take photos of launch pad.

Comments/Observations:

Post-Flight Checklist
(to be completed at the end of each flight operation)

Is the flight drone and flight pilot information the same as the information recorded on the pre-flight checklist? Yes / No

If no, complete the following:

Pilot name: ____

Drone model and number: _____________________________________

Drone weight (specify units): ___________________________________

Did the drone successfully land? Yes / No

Are all batteries (drone and controller) safely removed and cooled down? Yes / No

Is the drone and controller properly powered off and cooled down? Yes / No

Are the drone lights and sensors been cleaned and clear of debris and dirt? Yes / No

Are there any wear and damages on the drone and batteries? Yes / No
Inspect all components including propellers, motors, indicator lights, screws, GPS system, landing gear, wiring, etc.

If yes, describe below and take photos.

If yes, have corrective actions been implemented (i.e., repairs and replacements)? Yes / No

Comments/Observations:

Data Download Checklist
(to be completed for each flight operation)

Waterbody: ____

Does the photographic imagery successfully capture the targeted area? Yes / No

Is the data successfully downloaded? Yes / No

If no please specify which datasets were unsuccessfully downloaded (i.e., instrumentation, date/time range).

Where is the data saved (e.g., USB stick)? ____

Comments/Observations:

Land Use Information **(to be completed during first visit, if station location changes, or if land use changes)**
What is the land use (e.g., undisturbed forest, community, forestry, cabin, agriculture, etc.)?
Is there a roads in the area? Yes / No If yes, approximate location?
Is there disturbance caused by industry or other human activities (e.g., forestry cleaning, cabin)? Yes / No If yes, please describe. If yes, approximately how far away is the disturbance (specify units)?
Are there point sources of contaminants (e.g., sewage outfall)? Yes / No If yes, please describe and indicate if historical or unknown.
Are there non-point sources of contaminants (e.g., manure, livestock)? Yes / No If yes, please describe and indicate if historical or unknown.

Is the lake water known to be used for drinking? Yes / No
Comments/Observations:
General Observations of Significance
Comments/Observations:

Bathymetric Survey Datasheet

Waterbody: ______________________________ Field Crew: ______________________________ Weather: ______________________________ Study Area ID: ______________________________ Survey Equipment Used: ______________________________ ______________________________	Date: ____________________ Time: ____________________

Has the field crew reviewed all applicable instructions and understand procedures? Yes / No
Instructions include safety guidelines, specifications, and operating of the equipment.

Does the field crew include qualified boat operator with the required federal/provincial boat license(s)? Yes / No

Base Station Setup
(Land Surveyed Elevation Point Information)

Record coordinates of the station: ______________________________

GPS antenna and RTK survey models: ______________________________

Ground elevation of station (specify units and associated datum): ______________________________

GPS antenna vertical height from ground (specify units): ______________________________

Horizontal offsets of GPS antenna relative to base station (specify units): ______________________________
Are there any wear and damages on the GPS equipment? Yes / No If yes, please describe and take photos. If yes, have corrective actions been implemented? Yes / No
Record the calibration results of the RTK system and modifications performed in the field: Are the RTK configurations settings set up for the current survey? Yes / No
Record the calibration results of the GPS antenna and modifications performed in the field: Record the antenna reference point (ARP): ______________________________

Comments/Observations:

Boat Information

Boat Model: ______________________________	Boat Draft (specify units): ______________________
Boat Length (specify units): ____________________	Location of the echo sounder: ___________________
Boat Width (specify units): _____________________	

Are there any wear and damages on the boat? Yes / No
If yes, please describe and take photos.

If yes, have corrective actions been implemented? Yes / No

Transducer model: ____

GPS antenna model: ____

Depth of transducer below water surface (specify units): ____

Vertical distance from transducer to boat mounted GPS antenna (specify units): __________________________

Horizontal offsets of boat mounted GPS antenna relative to transducer: ______________________________

Record the calibration results of the GPS antenna and modifications performed in the field:

Record the antenna reference point (ARP): ___________________________

Comments/Observations:

Bar Check

(complete at least twice per day – once at beginning and end of day)

Date: ______________________________ Time: ______________________________

Actual Known Depth (plate from bottom of echo sounder)	Measured Depth (from transducer)
______________________________	______________________________
______________________________	______________________________
______________________________	______________________________
______________________________	______________________________
______________________________	______________________________
______________________________	______________________________
______________________________	______________________________
______________________________	______________________________
______________________________	______________________________
______________________________	______________________________

Land Use Information **(to be completed during first visit, if station location changes, or if land use changes)**
What is the land use (e.g., undisturbed forest, community, forestry, cabin, agriculture, etc.)?
Is there a road near the waterbody? Yes / No If yes, approximately how far away is the road (specify units)? ____________________
Is there disturbance caused by industry or other human activities (e.g., forestry cleaning, cabin)? Yes / No If yes, please describe and take photos. If yes, approximately how far away is the disturbance (specify units)?
Are there point sources of contaminants (e.g., sewage outfall) near to the waterbody? Yes / No If yes, please describe and indicate if historical or unknown.
Are there non-point sources of contaminants (e.g., manure, livestock) near to the waterbody? Yes / No If yes, please describe and indicate if historical or unknown.

Is there livestock access to the water body? Yes / No If yes, please describe and indicate if historical or unknown.
Are there barriers (e.g., beaver dam, culvert)? Yes / No If yes, please describe and indicate if historical or unknown.
Are there popular fishing spots at the waterbody? Yes / No If yes, where are the fishing spots? If yes, what species? If yes, please indicate if fishing spots are historical or unknown.
Is the lake water known to be used for drinking? Yes / No
Comments/Observations:

Data Download Checklist **(to be completed for each transect)**
Waterbody: ____ Total calculated number of transects: ________________________ Calculated grid spacing for waterbody: ______________________ Transect Number: ____________________________________ Distance of transect from edge of waterbody: _________________ North / South / West / East
Sketch geometric shape of the waterbody and the transect line

Boat speed (specify units): ____

Time of data collection: ____

Number of target data points to collect along transect: _________________

Confirm that the transect is saved in the GPS system: Yes / No

Confirm that data points are successfully recorded and saved. Yes / No

Comments/Observations

Continuous Water Level Measurements (Large Rivers) Datasheet

General Information

Organization: ______________________________

Field Crew: ______________________________

Arrival Time: ____________________ Departure Time: ____________________

Air Temperature: __________ Weather Condition: __________ Precipitation Past 24 hours:__________

Stream Name: ______________________________

Stream Code/Identifier: ____________________Site Code: ____________________

What does the water features banks look like: Stable, vegetated, etc.;______________________________

____

GPS Location (Record using NAD83 datum (Zone, Easting, Northing) or Longitude and Latitude):______________________________

____

Date/Time/Season: ______________________________

Location: ______________________________

Weather Conditions: ______________________________

Equipment/Software Used and was it checked and/or calibrated:______________________________

____

____

Continuous Water Level Measurements Checklist (Large Rivers)

Are there noticeable differences from the previous site visit? Yes / No

Take pictures of the equipment/reading point and the surroundings – and record photo identifier (i.e., number, code, etc.).

If yes, please describe.

Describe the site and access route – make a small sketch

Be sure to include enough detail in sketches to ensure that someone could find the site again; include a north arrow and the locations of all markers and noted features. The artist should also sign the sketches.

What way does the wind appear to be blowing?

Are their waves on the lakes or river/stream – describe.

What is the condition of the transducer or other equipment (e.g., damaged, broken, unable to read, out of place, missing, etc.,)? Does it require any parts, batteries, maintenance, etc.?

Continuous Water Level Measurements Data Section (Large Rivers) **(to be completed for each station)**
Is the data logger set to the correct date, local time and sampling duration? Yes / No Is the data logger in working condition? Yes / No Are the measurements recorded in the specified sampling duration and frequency? Yes / No Previous retrieval data date/time (refer to data sheet from previous site visit): ____ What is the date/time range of the data retrieved? ________________________________ to __________________________________ Is the data successfully downloaded? Yes / No If no please specify which datasets were unsuccessfully downloaded (i.e., instrumentation, date/time range).   Where is the data saved (e.g., USB stick)? ____
Comments/Observations

Land Use Information at the Station (to be completed during first visit or if land use changes)
What is the land use (e.g., undisturbed forest, community, forestry, cabin, agriculture, etc.)?
Is there a road near your station? Yes / No If yes, approximately how far away is the road (please specify units)? ____________________
Is there disturbance caused by industry or other human activities (e.g., forestry cleaning, cabin)? Yes / No If yes, please describe and take photos. If yes, approximately how far away is the disturbance?
Are there point sources of contaminants (e.g., sewage outfall)? Yes / No Indicate if point sources are historical or unknown.
Are there non-point sources of contaminants (e.g., manure, livestock)? Yes / No Indicate if non-point sources are historical or unknown.

Is there livestock access to the water body? Yes / No Indicate if livestock access is historical or unknown.
Are there barriers (e.g., beaver dam, culvert) near the station? Yes / No Indicate if barriers are historical or unknown.
Are there popular fishing spots near the station? Yes / No If yes, how far away are the fishing spots? If yes, what species? Indicate if fishing spots are historical or unknown.
Is the lake and/or water known to be used for drinking? Yes / No Indicate if historical or unknown.
Comments/Observations:

General Observations of Significance
Comments/Observations:

Manual Flow Measurements (Small and Large Rivers) Datasheet

General Information

Organization: ____

Field Crew: ____

Arrival Time: ____________________ Departure Time: ____________________

Air Temperature: __________ Weather Condition: __________ Precipitation Past 24 hours:__________

Stream Name: ____

Stream Code/Identifier: ____________________Site Code: ____________________

What does the water features banks look like: Stable, vegetated, etc.;______________________

____

GPS Location (Record using NAD83 datum (Zone, Easting, Northing) or Longitude and Latitude):____

____

Date/Time/Season: ____

Location: ____

Weather Conditions: ____

Equipment/Software Used and was it checked and/or calibrated:______________________

____

____

Manual Flow Measurements Checklist (Small and Large Rivers)

Are there noticeable differences from the previous site visit? Yes / No

Take pictures of the equipment/reading point and the surroundings – and record photo identifier (i.e., number, code, etc.).

If yes, please describe.

Describe the site and access route – make a small sketch

Be sure to include enough detail in sketches to ensure that someone could find the site again; include a north arrow and the locations of all markers and noted features. The artist should also sign the sketches.

What way does the wind appear to be blowing?

Are their waves on the lakes or river/stream – describe.

How does the equipment look (e.g., damaged, broken, unable to read, out of place, missing, etc.,)? Does it require any parts, batteries, maintenance, etc.?

Manual Flow Measurements Data Section (Small and Large Rivers)
(to be completed for each station)

How did you or are you accessing the data and/or readings, describe:

Stream Discharge Measurements:

Spin before measurement: ___________ Spin after measurement: __________ Checked by: _____________

Beginning Stage:____________ Ending Stage:_____________ Total Flow (Q):_______________

Channel Width:_______________ Total Area:________________ Average Velocity:__________

Distance from Datum to Water Surface: ______________ Start: ____________ End: ________________

Time	Station #/Name	Angle Coefficient	Distance (from initial point metres (m))	Width (m)	Depth (m)	Observation Depth	Revolutions	Interval Time (in seconds (s))	Velocity (m/s)		Adjusted for Horizontal Angle	Section Area (m^2)	Section Discharge (cfs) (distance across the river transect)
									At Point	Mean in Vertical			

Time	**Station #/Name**	**Angle Coefficient**	**Distance (from initial point metres (m))**	**Width (m)**	**Depth (m)**	**Observation Depth**	**Revolutions**	**Interval Time (in seconds (s))**	**Velocity (m/s)**		**Adjusted for Horizontal Angle**	**Section Area (m^2)**	**Section Discharge (cfs) (distance across the river**
									At Point	**Mean in Vertical**			

Sheet Calculated Discharge: ______________________________

Comments/Observations:

Land Use Information at the Station (to be completed during first visit, if station location changes, or if land use changes)
What is the land use (e.g., undisturbed forest, community, forestry, cabin, agriculture, etc.)?
Is there a road near the station? Yes / No If yes, approximately how far away is the road from the station (specify units)?
Is there disturbance caused by industry or other human activities (e.g., forestry cleaning, cabin)? Yes / No If yes, please describe and take photos. If yes, approximately how far away is the disturbance from the station (specify units)?
Are there point sources of contaminants (e.g., sewage outfall) near the station? Yes / No If yes, please describe and indicate if historical or unknown.
Are there non-point sources of contaminants (e.g., manure, livestock) near the station? Yes / No If yes, please describe and indicate if historical or unknown.

Is there livestock access to the water body? Yes / No If yes, please describe and indicate if historical or unknown.
Are there barriers (e.g., beaver dam, culvert) near the station? Yes / No If yes, please describe and indicate if historical or unknown.
Are there popular fishing spots near the station? Yes / No If yes, how far away are the fishing spots? If yes, what species? If yes, indicate if fishing spots are historical or unknown.
Is the lake water known to be used for drinking? Yes / No
Comments/Observations:
General Observations of Significance
Comments/Observations:

Manual Water Level Measurements (Lakes) Datasheet
General Information
Organization: ____________________
Field Crew: ____________________
Arrival Time: ____________________ Departure Time: ____________________
Air Temperature: __________ Weather Condition: __________ Precipitation Past 24 hours __________
Stream Name: ____________________
Stream Code/Identifier: ____________________Site Code: ____________________
What does the water features banks look like: Stable, vegetated, etc.;____________________ ____________________
GPS Location (Record using NAD83 datum (Zone, Easting, Northing) or Longitude and Latitude):____________________ ____________________
Date/Time/Season: ____________________
Location: ____________________
Weather Conditions: ____________________
Equipment/Software Used and was it checked and/or calibrated:____________________ ____________________ ____________________
Manual Water Level Measurements Checklist (Lakes)
Are there noticeable differences from the previous site visit? Yes / No *Take pictures of the equipment/reading point and the surroundings – and record photo identifier (i.e., number, code, etc.).*

If yes, please describe.
Describe the site and access route – make a small sketch Be sure to include enough detail in sketches to ensure that someone could find the site again; include a north arrow and the locations of all markers and noted features. The artist should also sign the sketches.
What way does the wind appear to be blowing? Are their waves on the lakes or river/stream – describe. How does the water level meter equipment or other equipment look (e.g., damaged, broken, unable to read, out of place, missing, etc.,)? Does it require any parts, batteries, maintenance, etc.?

Manual Water Level Measurements Data Section (13 lakes) (to be completed for each station)			
Water Level Reading in metres (m):		Time:	
Water Level Reading in metres (m):		Time:	
Water Level Reading in metres (m):		Time:	
Water Level Reading in metres (m):		Time:	
Water Level Reading in metres (m):		Time:	
Water Level Reading in metres (m):		Time:	
Water Level Reading in metres (m):		Time:	
Water Level Reading in metres (m):		Time:	
How did you or are you accessing the data and/or readings, describe:			
Comments/Observations:			

Land Use Information at the Station **(to be completed during first visit, if station location changes, or if land use changes)**
What is the land use (e.g., undisturbed forest, community, forestry, cabin, agriculture, etc.)?
Is there a road near the station? Yes / No If yes, approximately how far away is the road (specify units)?
Is there disturbance caused by industry or other human activities (e.g., forestry cleaning, cabin)? Yes / No If yes, please describe and take photos. If yes, approximately how far away is the disturbance from the station (specify units)?
Are there point sources of contaminants (e.g., sewage outfall) near the station? Yes / No If yes, please describe and indicate if historical or unknown.
Are there non-point sources of contaminants (e.g., manure, livestock) near the station? Yes / No If yes, please describe and indicate if historical or unknown.

Is there livestock access to the water body? Yes / No If yes, please describe and indicate if historical or unknown.
Are there barriers (e.g., beaver dam, culvert) near the station? Yes / No If yes, please describe and indicate if historical or unknown.
Are there popular fishing spots near the station? Yes / No If yes, how far away are the fishing spots? If yes, what species? If yes, indicate if fishing spots are historical or unknown.
Is the lake and/or water known to be used for drinking? Yes / No
Comments/Observations:
General Observations of Significance
Comments/Observations:

Meteorological Station Monitoring Datasheet	
General Information	
Location: ______________________________ Field Crew: ______________________________ Weather: ______________________________ Study Area ID: ______________________________ Equipment Used: ______________________________ ______________________________	Date: ____________________ Time: ____________________
Has the field crew reviewed all applicable instrument instructions and understand the procedures? Yes / No *Instructions include safety guidelines, specifications, and maintenance recommendations of the instruments.* Does the field crew include qualified personnel for installation, use and maintenance? Yes / No *The meteorological station consists of high structures (towers and tripods) and electrical components.*	
Meteorology Checklist	
Are there noticeable differences, including land use, from the previous site visit? Yes / No *Take pictures of the meteorological station and its surroundings.* If yes, please describe.	

Are there any wear and damages on the primary components (e.g., rain gage, sensors, anemometer, etc.)? Yes / No
Wear and damages include corrosion, debris, stress cracks, loose cable clamps, frayed cables, cable tightness, etc.

If yes, please describe and take photos.

If yes, have corrective actions been implemented? Yes / No

Are there any wear and damages on the secondary components (e.g., fencing, concrete slab, tripod, etc.)? Yes / No

If yes, please describe and take photos.

If yes, have corrective actions been implemented? Yes / No

Are there any wear and damages on the electrical ground connections and power supply? Yes / No

If yes, have corrective actions been implemented? Yes / No

Calibration, Repairs and Replacement (to be completed during every inspection)
Is the temperature sensor in acceptable condition? Yes / No Is the temperature sensor cleaned and free of dirt and debris? Yes / No Record the calibration results of the temperature sensor:
Is the sonic transducer (or other instrumentation for measuring snow-depth) in acceptable condition? Yes / No Is the sonic transducer cleaned and free of dirt and debris? Yes / No Record the calibration results of the sonic transducer:

Is the rain gauge in acceptable condition? Yes / No Is the rain gauge cleaned and free of dirt and debris? Yes / No Record the calibration results of the rain gauge:
Is the anemometer in acceptable condition? Yes / No Is the anemometer cleaned and free of dirt, debris and other obstructions? Yes / No Record the calibration results of the anemometer:

Is the soil moisture probe in acceptable condition? Yes / No Is the soil moisture probe cleaned and not damaged? Yes / No Record the calibration results of the soil moisture probe:
Is the solar panel (and solar gauge dome) in acceptable condition? Yes / No Is the solar panel cleaned and not damaged? Yes / No Record the calibration results of the solar panel:

Is the data logger in acceptable condition? Yes / No

Is the data logger recording all desired measurements and at the desired sampling frequencies? Yes / No

If no, indicate which measurements and sample date ranges were not recorded successfully:

If no, has the data logger been troubleshot?

Record the calibration results of the data logger:

Comments/Observations:

Document details on calibration, inspections, replacements and repair below, including instrumentation that were not listed above.

Data Download Checklist
Is the data logger set to the correct date, local time and sampling duration? Yes / No Is the data logger in working condition? Yes / No Are the measurements recorded in the specified sampling duration and frequency? Yes / No Previous retrieval data date/time (refer to data sheet from previous site visit): ______________________________ What is the date/time range of the data retrieved? ______________________ to ______________________ Is the data successfully downloaded? Yes / No If no please specify which datasets were unsuccessfully downloaded (i.e., instrumentation, date/time range).   Where is the data saved (e.g., USB stick)? ____
Comments/Observations

J.3

SURFACE WATER PARAMETERS

Standard Operating Procedure:

Benthic Invertebrate Sample Collection – Depositional Habitats

DATASHEETS

- Sediment and Depositional Benthic Invertebrate Sample Collection Datasheet
- Field maps
- Chain of Custody (COC) form

ENDPOINTS

- Taxonomic enumeration to the lowest possible level
- Biomass estimations

REFERENCE INFORMATION

REFERENCE DOCUMENTS	▪ CCME protocols manual for water quality sampling in Canada (CCME 2011) ▪ Government of Alberta aquatic ecosystems field sampling protocols (Government of Alberta 2006) ▪ EC Metal mining technical guidance for environmental effects monitoring (Environment Canada 2012) ▪ Instrument Manufacturer Operating Manuals

OPERATION, SERVICE, AND MAINTENANCE

- The operation, service, and maintenance of the sampling equipment that is selected for use in the program should be completed in accordance with the INSTRUMENT MANUFACTURER'S OPERATING MANUAL

EQUIPMENT REQUIRED

- Ekman dredge or Petit ponar sampler
- Labelled sampling containers
- 500 µm mesh nitex net
- Personal protective equipment including nitrile gloves
- 95% ethanol
- Coolers for transporting samples
- GPS equipment
- Digital camera

SAMPLING DETAILS

- It is important stations have comparable habitat characteristics such as depth, particle size, and vegetation and spaced far enough apart to be considered statistical replicates (>20 m; EC 2012).
- Benthic invertebrate sampling will be co-located with sediment sampling. If for some reason the benthic invertebrate sampling location is not co-located with a sediment sampling location, then sediment samples must be collected for measurements of sediment particle size and total organic carbon.

- If the sampling is not co-located with a water station, then limnology measurements must also be taken at one station per study area (see SOP for Surface Water Limnology and Water Sample Collection - LSA).
- Record detailed notes on sampling location, station depth, weather, date, time, station code, equipment, and other relevant information on the datasheet.
- Each benthic invertebrate sample will be a composite of 5 grabs (subsamples).
- Samples will be sieved through the 500 µm nitex net and the retained material will be transferred into a labelled sample jar and preserved using 95% ethanol (important NOT to use formalin because of use for eDNA analyses).
- Samples will be stored at room temperature until submission to a qualified taxonomist.

CUMULATIVE EFFECTS

In order to gather additional information about the study area and assess the potential for cumulative effects, land use information (e.g., undisturbed forest, community, forestry, cabins, agriculture) and other pertinent information (e.g., industry, contaminant sources, road proximity) is to be recorded at each sampling location and along access routes as relevant. This information is to be recorded the first time a new sampling location is visited or if land use changes at that sampling location. Record the information on the data sheets and be sure to take lots of pictures.

QA/QC REQUIREMENTS

GENERAL MEASURES	▪ Sampling equipment will be thoroughly cleaned prior to the start of sampling and between stations ▪ Samples will be discarded if the sampling quality control measures are not met (e.g., sediment overflowing out of the top or sides of the grab sampler; grab sampler insufficiently full) ▪ Sampling equipment will be thoroughly checked to ensure all organisms were retained after each sample is collected ▪ When loading the samples into coolers for transport, check-off the laboratory COC to double-check that all samples are accounted for ▪ Do not ship samples unless you absolutely have to; if shipping is required, ensure the containers are upright and well-sealed; use proper COC and mark the shipping container appropriately ▪ Ensure the COC contains accurate information regarding samples and parameters to measure

REFERENCES

CCME. 2011. Protocols manual for water quality sampling in Canada. Canadian Council of Ministers of the Environment. PN 1461.

Environment Canada. 2012. Metal mining technical guidance for environmental effects monitoring. Environment Canada, National Environmental Effects Monitoring Office, Science Policy and Environmental Quality Branch, Ottawa, Ontario.

Government of Alberta. 2006. Aquatic ecosystems field sampling protocols. W0605.

Standard Operating Procedure:

Phytoplankton and Zooplankton Sample Collection

DATASHEETS	
▪ Limnology, Water, and Plankton Datasheet – LSA ▪ Field maps ▪ Chain of Custody (COC) form	
ENDPOINTS	
▪ Taxonomic enumeration ▪ Biomass estimations of major taxonomic groups	
REFERENCE INFORMATION	
REFERENCE DOCUMENTS	▪ CCME protocols manual for water quality sampling in Canada (CCME 2011) – Section 6.2.9 protocol for collecting depth integrated and/or composite integrated samples and Section 15.0 protocol for sampling zooplankton ▪ Government of Alberta aquatic ecosystems field sampling protocols (Government of Alberta 2006)
OPERATION, SERVICE, AND MAINTENANCE	
▪ The operation, service, and maintenance of the equipment that is selected for use in the program should be completed in accordance with the MANUFACTURER'S OPERATING MANUAL	
EQUIPMENT REQUIRED	
▪ Fine mesh (64 µm) conical Wisconsin net with attached rope ▪ Deionized water and squeeze bottle for rinsing Wisconsin net ▪ Tubing (Tygon or Nalgene) weighted at one end that is a sufficient depth to sample 2 x the euphotic zone at all stations ▪ Secchi disk (standard black and white, 20 cm diameter) and rope ▪ Labelled sampling containers (amber glass or Nalgene bottles for phytoplankton because they are light sensitive) ▪ Personal protective equipment including nitrile gloves ▪ Lugol's solution for phytoplankton preservation ▪ 95% ethanol for zooplankton preservation ▪ Coolers for transporting samples ▪ GPS equipment ▪ Digital camera	
SAMPLING DETAILS	
▪ Record detailed notes on sampling location, station depth, weather, date, time, station code, equipment, and other relevant information on the datasheet.	

- Plankton samples will be taken in the euphotic zone, which is estimated as twice the Secchi disk depth. If the water depth is less than the Secchi depth, samples will be collected starting from 1 m off the bottom.
- Depth integrated phytoplankton samples be collected by lowering the weighted end of the sampling tube (Nalgene or Tygon tubing) slowly (approx. 1 m per sec.) and vertically through the euphotic zone. Each sample will be a composite of two hauls.
- The water contained in the sampling tube (phytoplankton sample) will be placed in labelled, non-transparent sample jars and preserved using 1% Lugol's solution (or according to the taxonomist's specifications). The samples will be stored in a dark location until submission to a qualified taxonomist.
- The Wisconsin net will be drawn vertically through the euphotic zone to capture zooplankton distribution within the water column at a continuous rate of 0.5 m/s; each sample will be a composite of five tows. Use the squeeze bottle to ensure organisms are removed from the net and sample bucket on the net.
- Zooplankton samples will be placed in labelled sample jars and preserved with 95% ethanol; note that formalin is NOT to be used as the type of preservative also needs to enable eDNA analyses. The samples will be stored at room temperature until submission to a qualified taxonomist.

CUMULATIVE EFFECTS

In order to gather additional information about the study area and assess the potential for cumulative effects, land use information (e.g., undisturbed forest, community, forestry, cabins, agriculture) and other pertinent information (e.g., industry, contaminant sources, road proximity) is to be recorded at each sampling location and along access routes as relevant. This information is to be recorded the first time a new sampling location is visited or if land use changes at that sampling location. Record the information on the data sheets and be sure to take lots of pictures.

QA/QC REQUIREMENTS

GENERAL MEASURES	▪ Sampling equipment will be thoroughly cleaned prior to the start of sampling and between each sampling location ▪ Soak the body of the Wisconsin net in lake water prior to use (2 min) ▪ Sampling equipment will be thoroughly rinsed and checked to ensure all organisms were collected after each sampling event ▪ Samples will be discarded if sediment or macrophytes are detected - rinse sampling gear a minimum of three times if this occurs ▪ Any samples where the tow deviates from vertical will be discarded, the net rinsed, and the haul completed again ▪ If the haul speed changes or is halted during a tow, the sample will be discarded and redone ▪ When loading the samples into coolers for transport, check-off the laboratory COC to double-check that all samples are accounted for ▪ If shipping is required, ensure the containers are upright and well-sealed ▪ Ensure the COC contains accurate information regarding samples

REFERENCES

CCME. 2011. Protocols manual for water quality sampling in Canada. Canadian Council of Ministers of the Environment. PN 1461.

Government of Alberta. 2006. Aquatic ecosystems field sampling protocols. W0605.

Standard Operating Procedure:

Sediment Sample Collection

DATASHEETS	
▪ Sediment and Depositional Benthic Invertebrate Sample Collection Datasheet ▪ Field maps ▪ Laboratory Chain of Custody (COC) form	
CONTAMINANTS OF POTENTIAL CONCERN	
▪ See Appendix E of Environmental Media Baseline Program Final Sample Design report	
REFERENCE INFORMATION	
REFERENCE DOCUMENTS	▪ CCME protocols manual for water quality sampling in Canada (CCME 2011) ▪ CCME guidance manual for environmental site characterisation in support of environmental and human health risk assessment (CCME 2016) ▪ Government of Alberta aquatic ecosystems field sampling protocols (Government of Alberta 2006) ▪ Instrument Manufacturer Operating Manuals
OPERATION, SERVICE, AND MAINTENANCE	
▪ The operation, service, and maintenance of the sampling equipment that is selected for use in the program should be completed in accordance with the INSTRUMENT MANUFACTURER'S OPERATING MANUAL	
EQUIPMENT REQUIRED	
▪ Gravity coring device and all ancillary components (e.g., Tech ops extruder corer – head piece, rope/extension poles, weights, valves, core tubes (1 per study area), bungs, hose clamps, drill, stand, measuring device, horizon slicer, long waterproof gloves) ▪ Grab sampler (Ekman dredge or Petit ponar), scoop ▪ Labelled sampling containers or bags ▪ Spare parts, tool kit, instruction manuals ▪ Personal protective equipment including nitrile gloves ▪ Coolers for transporting samples ▪ Decontamination equipment (e.g., phosphate free soap and scrub brush) ▪ GPS equipment ▪ Digital camera	
SAMPLING DETAILS	
▪ Compositing multiple cores per sample will likely be required; however, it is important that the coring device used has a large enough diameter to enable efficient collection of adequate sediment	

volume to measure all COPC with desired reporting detection limits. Information on required minimum sediment volumes must be acquired from the laboratory prior to the field survey.

- It is important stations have comparable habitat characteristics such as depth, particle size, and vegetation and spaced far enough apart to be considered statistical replicates (>20 m; EC 2012).
- Record detailed notes on sampling location, station depth, weather, date, time, station code, equipment, and other relevant information on the datasheet.
- Using a coring device, the uppermost 2 cm sediment horizon (0 cm to 2 cm) will be retained for laboratory submission. In addition, the 2 cm to 4 cm and 4 cm to 6 cm sediment horizons will be collected and temporarily archived in a freezer.
- Non-sediment material (e.g., sticks, rocks, vegetation) should be recorded on the data sheet and carefully removed from the sediment sample prior to placing the sample in the container.
- If the sediment is too firm or an erosional riverine habitat is being sampled, a grab sampler may need to be used instead of a gravity corer. If a grab sampler is used, the top approximately 5 cm of the sediment will be scooped out of the top of the grab sampler and retained for laboratory submission.
- One core per station will be logged, which will involve taking a photograph and providing a physical description of the core, including total core depth, and depth and description of each distinct layer for factors such as color, consistency, odour, and organic material/macrophyte content. The same type of physical description will be used to characterize sediment samples taken using grab samplers. See datasheet for category descriptions.

CUMULATIVE EFFECTS

In order to gather additional information about the study area and assess the potential for cumulative effects, land use information (e.g., undisturbed forest, community, forestry, cabins, agriculture) and other pertinent information (e.g., industry, contaminant sources, road proximity) is to be recorded at each sampling location and along access routes as relevant. This information is to be recorded the first time a new sampling location is visited or if land use changes at that sampling location. Record the information on the data sheets and be sure to take lots of pictures.

QA/QC REQUIREMENTS

GENERAL MEASURES	▪ Sampling should be conducted using nitrile gloves ▪ Sampling equipment will be thoroughly cleaned prior to the start of sampling (all core tubes acid washed), and a new core tube will be used at each waterbody ▪ Samples will be discarded if the sampling quality control measures are not met (e.g., sediment overflowing out of the top of the core tube or grab sampler, or insufficient material retained) ▪ Samples will be discarded if mixing of the surficial horizons occurs while retrieving the core, or if there is an indication that the same spot in the lake was sampled ▪ When loading the samples into coolers for transport, check-off the laboratory COC to double-check that all samples are accounted for ▪ Do not ship samples unless you absolutely have to; if shipping is required, ensure the containers are upright and well-sealed; use proper COC and mark the shipping container appropriately

	▪ Submit samples to the laboratory as soon as possible; if there is going to be a delay, then freeze the sediment samples prior to submission ▪ Ensure the COC contains accurate information regarding samples and parameters to measure
DUPLICATES – 10% OF TEST SAMPLES	Field duplicate samples will be taken at a frequency of 10% of the test samples to ensure that sampling and laboratory analyses produce repeatable results. A duplicate sample requires collecting a full second test sample at the station.

REFERENCES

CCME. 2011. Protocols manual for water quality sampling in Canada. Canadian Council of Ministers of the Environment. PN 1461.

CCME. 2016. Guidance manual for environmental site characterisation in support of human health risk assessment. Volume 2 Checklists. Canadian Council of Ministers of the Environment. December.

Government of Alberta. 2006. Aquatic ecosystems field sampling protocols. W0605.

Standard Operating Procedure:

Surface Water Limnology and Water Sample Collection - LSA

DATASHEETS	
▪ Limnology, Water, and Plankton Datasheet – LSA ▪ Field maps ▪ Laboratory Chain of Custody (COC) forms	
CONTAMINANTS OF POTENTIAL CONCERN & LIMNOLOGY PARAMETERS	
▪ See Appendix E of Environmental Media Baseline Program Final Sample Design report	
REFERENCE INFORMATION	
REFERENCE DOCUMENTS	▪ CCME protocols manual for water quality sampling in Canada (CCME 2011) ▪ BC MOE water and air baseline monitoring guidance document for mine proponents and operators (BCMOE 2016) ▪ Government of Alberta aquatic ecosystems field sampling protocols (Government of Alberta 2006) ▪ EC Metal mining technical guidance for environmental effects monitoring (Environment Canada 2012) ▪ Instrument Manufacturer Operating Manuals for digital multi-meter for limnology measurements (e.g., YSI), water sampler (Kemmerer or Van Dorn), and field filtering equipment for dissolved parameters and Chlorophyll a
OPERATION, SERVICE, AND MAINTENANCE	
▪ The operation, service, and maintenance of the equipment should be completed in accordance with the INSTRUMENT MANUFACTURER'S OPERATING MANUAL. ▪ The water sampler must be suitable for trace metal analyses and must be thoroughly washed with phosphate free soap prior to the trip and between each sampling station. It is also recommended the water sampler be acid washed by the laboratory prior to each trip. ▪ The limnology meter must be calibrated before and during each trip as per instructions outlined in the operator's manual. A calibration log must be kept.	
EQUIPMENT REQUIRED	
▪ Digital multi-probe meter for limnological measurements ▪ Spare parts, maintenance kit, calibration standards, batteries, instruction manual, and calibration log for digital multi-probe meter ▪ Kemmerer or Van Dorn water sampler including rope and spare parts ▪ Laboratory-provided sampling containers and preservatives ▪ Personal protective equipment including nitrile gloves ▪ Secchi disk (standard black and white, 20 cm diameter) and rope	

- Metre stick (for measuring snow and ice in the winter and measuring Secchi disk depth in open water)
- QA/QC samples and necessary bottles and deionized water provided by lab (trip blank, deionized water, extra bottles for other blanks such as field blank, filter blank, and duplicates)
- Equipment for field filtering dissolved samples using 0.45 µM filters
- Chlorophyll-a filtration equipment
- Coolers and ice packs for transporting samples
- Decontamination equipment (e.g., phosphate free soap and scrub brush)
- GPS equipment
- Digital camera

SAMPLING DETAILS

- Record detailed notes on sampling location, station depth, weather, date, time, station code, equipment, and other relevant information on the datasheet.
- Limnology measurements are taken throughout the water column at 0.5 m intervals at stations ≤2 m deep, and at 1 m intervals at deeper stations. In the winter, take an additional reading at the ice/water interface. Regardless of station depth, take a reading as close as possible to the sediment/water interface.
- The water samples will be depth-integrated discrete samples consisting of water composited from near surface, the middle, and near bottom of the water column. However, in cases where there is a thermocline, discrete samples will be collected at two depth intervals: the subsurface (epilimnion) and near bottom (hypolimnion) in order to obtain samples from above and below the thermocline. If the water depth is ≤2 m, collect water samples only at mid-depth, or at least 15 cm below the surface.
- Water samples will be field-filtered and preserved as required in the field and stored at 4°C until submission to the laboratory for analysis.

CUMULATIVE EFFECTS

In order to gather additional information about the study area and assess the potential for cumulative effects, land use information (e.g., undisturbed forest, community, forestry, cabins, agriculture) and other pertinent information (e.g., industry, contaminant sources, road proximity) is to be recorded at each sampling location and along access routes as relevant. This information is to be recorded the first time a new sampling location is visited or if land use changes at that sampling location. Record the information on the data sheets and be sure to take lots of pictures.

QA/QC REQUIREMENTS

GENERAL MEASURES	▪ Limnology meter must be calibrated as required and daily checks should be performed against standards; a calibration log must be kept ▪ Water sampling should be conducted using nitrile gloves ▪ The sampling equipment should be washed with phosphate free soap following sample collection and then triple rinsed with water from the next sampling site prior to sampling ▪ Ensure that appropriate and clean sample containers are used ▪ Do not allow the inner surfaces of sample containers or lids to come in contact with anything other than the sample

	▪ When loading the samples into coolers for transport, check-off the laboratory COC to double-check that all samples are accounted for ▪ Do not ship samples unless you absolutely have to; if shipping is required, ensure the containers are upright and well-sealed; use proper COC and mark the shipping container appropriately ▪ Sample submission to the laboratory will occur as soon as possible to ensure that holding times are not exceeded for certain parameters ▪ Ensure the COC contains accurate information regarding samples, parameters to measure, and field filtering
FIELD BLANK – ONE PER SURVEY	A field blank will be collected by bringing deionized water into the field that is supplied by the laboratory. The deionized water will undergo all sample collection, handling, and processing steps that the test samples undergo.
DUPLICATES – 10% OF TEST SAMPLES	Field duplicate samples will be taken at a frequency of 10% of the test samples to ensure that sampling and laboratory analyses produce repeatable results. A duplicate sample requires collecting a full second test sample at the station.
FILTRATION BLANK – ONE PER SURVEY	A filtration QA/QC sample will consist of running deionized water supplied by the laboratory through the filtration system, putting it into the sample containers, and preserving the samples.
TRIP BLANK – ONE PER SURVEY	A trip blank sample is used to check contamination from transport, storage, and analyses. The sample bottles will be filled with deionized water in the laboratory and preserved in the same manner as the test samples. These samples will be transported to and from the field without modification, and are opened by the laboratory at the time of analyses.

REFERENCES

BCMOE. 2016. Water and air baseline monitoring guidance document for mine proponents and operators. Version 2, June. https://www2.gov.bc.ca/assets/gov/environment/waste-management/industrial-waste/industrial-waste/mining-smelt-energy/guidance-documents/ug_water_and_air_baseline.pdf.

CCME. 2011. Protocols manual for water quality sampling in Canada. Canadian Council of Ministers of the Environment. PN 1461.

Environment Canada. 2012. Metal mining technical guidance for environmental effects monitoring. Environment Canada, National Environmental Effects Monitoring Office, Science Policy and Environmental Quality Branch, Ottawa, Ontario.

Government of Alberta. 2006. Aquatic ecosystems field sampling protocols. W0605.

Standard Operating Procedure:

Surface Water Sample Collection - RSA

DATASHEETS

- Surface Water Sample Collection Datasheet – RSA
- Field Map

EQUIPMENT REQUIRED

- Pre-labelled sampling bottles and preservatives provided by coordinator
- Cooler and ice packs for transporting samples
- Datasheet, field map, pencils, and waterproof marker (Sharpie)
- Nitrile gloves
- Optional: GPS, depth sounder
- Digital camera

PROCEDURE

- Obtain pre-labelled sample bottles, data sheet, and field map from the coordinator. Make sure you have all necessary sample bottles and preservatives and you are clear on which preservative is to be added to which bottle during sampling. Also make sure you have nitrile gloves, a pencil, and a Sharpie to bring to the field.
- Once at the sampling area, mark the station location on the field map and write the approximate location on the datasheet (e.g., northern bay of Indian Lake near road access); or take a waypoint and record UTM coordinates if using a GPS.
- If this is the first visit to this station, fill out the land use section on the datasheet. During follow-up visits, this section only needs to be filled out if the station location is changed or if land use has changed. Please take pictures of land use near the station.
- Record the following on the datasheet:
    - Your full name
    - Date
    - Time
    - Weather (approximate temperature, rain/snow/sun, wind)
    - Waterbody name
    - How the sample was collected (near shore on foot, from a boat)
    - Approximate location (see above)
    - Approximate station depth - this may not be possible from a boat unless the boat is equipped with a depth finder
    - Observations on water quality such as odor or oily sheens or dirt entering the water from shore (see datasheet for more information); if found, please take pictures

- Fill in the date on each pre-labelled sample bottle. If the bottle comes unlabelled and you need to label it, write the following on each bottle with a Sharpie:

  NWMO
  Station ID (if there is one)
  Waterbody Name
  Date
- To collect samples from near shore, aim to select a sampling station deep enough that sediment (mud stirred up from the lake bottom) will not contaminate the sample. Ideally the station will be at least 1 m deep. Make sure before collecting the sample you wait until any sediment that was disturbed by getting to the sampling spot has resettled. The water should be as clear as possible. Ideally, the sample will be taken from shore or a dock, but wading may be required. Another option is use of a sampling pole.
- If sampling in a stream or river, be sure to approach the sampling station from downstream so the sediment is not disturbed.
- If sampling from a boat, drop the anchor and then wait until the sediment has resettled before taking the water sample. The water should be as clear as possible. If possible, record the station depth (using a depth finder). If not, please try to estimate water depth.
- To collect a sample, hold the bottle near the base and plunge bottle, with the opening directly down, into the water, extending your arm to approximately 15 cm below the water surface (past your wrist). Rotate the bottle upward to allow water to enter and air to escape, but do NOT bring the bottle mouth above water. The bottle should be far enough beneath the surface to prevent materials in the surface film from entering the bottle.
- Once the bottle is full, remove it from the water by forcing it directly upward.
- Attempt to minimize air space within the bottle by filling the bottle until almost the top, but leave enough room for preservative to be poured in the bottle, if required.
- If a preservative is already in a bottle, then fill a spare sample bottle and use that bottle to fill the bottle containing the preservative. Please be sure not to overfill the bottle containing the preservative.
- If required, add preservative, secure the lid tightly, and shake the sample well. Some water bottles will require a preservative and some won't. Information about which sample bottle requires which preservative will be provided by the coordinator prior to sampling.
- Make sure all sample bottles are filled.
- Make sure each bottle is properly labelled, the lid is tight, and put it upright in the cooler.
- Drop off the cooler containing the samples and ice packs to the sampling coordinator at a predetermined location. If this cannot be done immediately, then temporarily store the samples in a fridge. The bottles can be put in the fridge individually or the whole cooler can be put in the fridge.

QA/QC REQUIREMENTS	
GENERAL MEASURES	▪ Sampling should be conducted using nitrile gloves ▪ Ensure that appropriate and clean sample containers are used ▪ Do not allow the inner surfaces of sample containers or lids to come in contact with anything other than the sample ▪ Get the samples to the coordinator as soon as possible
DUPLICATE SAMPLE	During some sampling trips, you may be asked to collect a duplicate sample by the coordinator. This means filling two sets of water bottles instead of one using the same methods.

Nuclear Waste Management Organization (NWMO) *Deep Geological Repository (DGR) Project*	**Environmental Media Baseline Program** *Surface Water Parameters*

Limnology, Water, and Plankton Datasheet - LSA

Waterbody:	Date:
Field Crew:	Time:
Weather:	Coordinates:
Station ID:	Photo #:
Station Depth (m):	Limno Meter:
Secchi Depth (m):	DO Calibration (%):
Snow Depth (m): Ice Depth (m):	

Was a water sample collected? Yes / No

Equipment: ☐ Kemmerer (vertical) ☐ Van Dorn (horizontal) ☐ Hand Grab Other:__________

Sample Type: ☐ Discrete (depth ≤ 2 m) ☐ Composite (depth > 2m) ☐ Discrete top and bottom samples separate

QA/QC samples taken? Yes / No Types:__________

Is there any indication of abnormal sedimentation or erosion near the station? Yes / No

Is there any indication of discolored water, oil sheens, or odour at the station? Yes / No

If yes, please describe and take pictures __________

Are there any notable changes in nearby land use since your last visit? __________

Depth (m)	Temp (^{o}C)	DO (mg/L)	DO (%)	Sp. Cond (µS/cm)	pH	ORP (mV)	Comments/Observations

Plankton Sample Information

☐ Phytoplankton Sampling Depth (m):________ Number of hauls:________
Number of sample jars:________ Equipment ________

☐ Zooplankton Sampling Depth (m):________ Number of hauls:________
Number of sample jars:________ Equipment ________

Field QAQC (initial to indicate all fields are complete):

Date: June 2020
Version No.: 1.0

Land Use Information **(to be completed during first visit, if station location changes, or if land use changes)**
What is the land use (e.g., undisturbed forest, community, forestry, cabin, agriculture, etc.)?
Is there a road near the station? Yes / No If yes, approximately how far away is the road from the station (specify units)?
Is there disturbance caused by industry or other human activities (e.g., forestry cleaning, cabin)? Yes / No If yes, please describe and take photos. If yes, approximately how far away is the disturbance from the station (specify units)?
Are there point sources of contaminants (e.g., sewage outfall) near the station? Yes / No If yes, please describe and indicate if historical or unknown.
Are there non-point sources of contaminants (e.g., manure, livestock) near the station? Yes / No If yes, please describe and indicate if historical or unknown.
Is there livestock access to the waterbody? Yes / No If yes, please describe and indicate if historical or unknown.
Are there barriers (e.g., beaver dam, culvert) near the station? Yes / No If yes, please describe and indicate if historical or unknown.
Are there popular fishing spots near the station? Yes / No If yes, how far away are the fishing spots? If yes, what species? If yes, indicate if fishing spots are historical or unknown.
Is the lake known to be used for drinking water? Yes / No
Comments/Observations:

Sediment and Depositional Benthic Invertebrate Sample Collection Datasheet

Waterbody:	Sediment Sampling Equipment:
Field Crew:	Date:
Weather:	Time:
Study Area ID:	Coordinates:
Replicate Station #:	Photo #:
Station Depth (m):	

Horizon Collected:
- ☐ 0-2 cm
- ☐ 2-4 cm
- ☐ 4-6 cm
- ☐ Other (write down horizon)

Number of Composite Cores/Sample:
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ Other (write down)

Description of non-sediment material removed (if any): ____________________

QA/QC duplicate taken? Yes / No (Fill out a separate datasheet for QA/QC)

Core Log Photo #: ___________

Total Core Height (cm):

Core Horizons (cm)	**Color (e.g., reddish brown, dark brown)**	**Consistency (circle one)**	**Organics (circle one)**	**Odour**	**Comments (including description of organics and macrophyte types)**
		Loose Medium Firm	A S M D		
		Loose Medium Firm	A S M D		
		Loose Medium Firm	A S M D		
		Loose Medium Firm	A S M D		
		Loose Medium Firm	A S M D		
		Loose Medium Firm	A S M D		

A = absent, S = sparse, M = moderate, and D = dense

Benthic Invertebrate Community Sampling Using a Grab Sampler	Equipment Type	Size	# Grabs/Sample	# Jars/Sample
Description of grab samples (i.e., aquatic macrophyte type and extent, algal growth)				
Average fullness of grab samples (%)				

Comments/Observations:

Field QAQC (initial to indicate all fields are complete):

Land Use Information (to be completed during first visit, if station location changes, or if land use changes)
What is the land use (e.g., undisturbed forest, community, forestry, cabin, agriculture, etc.)?
Is there a road near the station? Yes / No If yes, approximately how far away is the road from the station (specify units)?
Is there disturbance caused by industry or other human activities (e.g., forestry cleaning, cabin)? Yes / No If yes, please describe and take photos. If yes, approximately how far away is the disturbance from the station (specify units)?
Are there point sources of contaminants (e.g., sewage outfall) near the station? Yes / No If yes, please describe and indicate if historical or unknown.
Are there non-point sources of contaminants (e.g., manure, livestock) near the station? Yes / No If yes, please describe and indicate if historical or unknown.
Is there livestock access to the waterbody? Yes / No If yes, please describe and indicate if historical or unknown.
Are there barriers (e.g., beaver dam, culvert) near the station? Yes / No If yes, please describe and indicate if historical or unknown.
Are there popular fishing spots near the station? Yes / No If yes, how far away are the fishing spots? If yes, what species? If yes, indicate if fishing spots are historical or unknown.
Is the lake known to be used for drinking water? Yes / No
Comments/Observations:

Nuclear Waste Management Organization (NWMO) *Deep Geological Repository (DGR) Project*	**Environmental Media Baseline Program** *Surface Water Parameters*

Surface Water Sample Collection Datasheet - RSA

General Information

Sampler full name: ______________________

Date: ______________________

Time: ______________________

Weather:

Sampling Information

Waterbody name: ______________________

Sampling location description (or UTM coordinates): ______________________

Approximate station depth (m): ______________________

Did you mark the sampling location on a map? Yes / No

Sample collection type:
- Grab sample from near shore? ❑
- Grab sample from a boat? ❑
- Other?

Is there any indication of dirt or other substances entering the water near the station? Yes / No

Is there any indication of discolored water, oil sheens, or odour at the station? Yes / No

If yes, please describe and take pictures ______________________

Are there any notable changes in nearby land use since your last visit? ______________________

Comments/Observations:

Date: June 2020
Version No.: 1.0

Land Use Information **(to be completed during first visit, if station location changes, or if land use changes)**
What is the land use (e.g., undisturbed forest, community, forestry, cabin, agriculture, etc.)?
Is there a road near the station? Yes / No If yes, approximately how far away is the road from the station (specify units)?
Is there disturbance caused by industry or other human activities (e.g., forestry cleaning, cabin)? Yes / No If yes, please describe and take photos. If yes, approximately how far away is the disturbance from the station (specify units)?
Are there point sources of contaminants (e.g., sewage outfall) near the station? Yes / No If yes, please describe and indicate if historical or unknown.
Are there non-point sources of contaminants (e.g., manure, livestock) near the station? Yes / No If yes, please describe and indicate if historical or unknown.
Is there livestock access to the waterbody? Yes / No If yes, please describe and indicate if historical or unknown.
Are there barriers (e.g., beaver dam, culvert) near the station? Yes / No If yes, please describe and indicate if historical or unknown.
Are there popular fishing spots near the station? Yes / No If yes, how far away are the fishing spots? If yes, what species? If yes, indicate if fishing spots are historical or unknown.
Is the lake known to be used for drinking water? Yes / No
Comments/Observations:

J.4

AIR QUALITY, NOISE, AND LIGHT

Standard Operating Procedure:

Active Measurement of C-14, H-3 and Kr-85

DATASHEETS	
▪ To be determined by equipment supplier	
CONTAMINANTS OF POTENTIAL CONCERN	
▪ C-14, H-3 and Kr-85	
REFERENCE INFORMATION	
U.S. EPA DESIGNATED REFERENCE AND EQUIVALENT METHOD	Not designated as a reference or equivalent method by the U.S. EPA
REFERENCE DOCUMENTS	▪ CNSC REGDOC-2.9.1 v1.1 "*Environmental Protection: Environmental Principles, Assessments and Protection Measures*" (CNSC 2017) ▪ NCRP Report No. 169, *"Design of Effective Radiological Effluent Monitoring and Environmental Surveillance Programs"* (NCRP 2010) ▪ Operating procedure/instructions from the equipment supplier
OPERATION, SERVICE, AND MAINTENANCE	
The selected provider for the active monitoring system(s) will provide detailed instructions for their use.	
ADDITIONAL EQUIPMENT REQUIRED	
▪ To be determined by equipment supplier	
CUMULATIVE EFFECTS	
In order to gather additional information about the study area and assess the potential for cumulative effects, land use information (e.g., undisturbed forest, community, forestry, cabins, agriculture) and other pertinent information (e.g., industry, contaminant sources, road proximity) is to be recorded at each sampling location and along access routes as relevant. This information is to be recorded the first time a new sampling location is visited or if land use changes at that sampling location. Record the information on the data sheets and be sure to take lots of pictures.	

INSTRUMENTATION QA/QC REQUIREMENTS	
REGULAR PERFORMANCE CHECK	The following is to be completed at each sampler changeover: ▪ visual inspection of the sampler (e.g., for damage) ▪ confirm exposure period and assignment of sample ID (e.g., serial number) to correct period and location
SCHEDULED CALIBRATION	▪ to be determined by equipment supplier

REFERENCES

CNSC. 2017. Environmental protection: Environmental principles, assessments and protection measures. Regulatory document REGDOC-2.9.1, version 1.1, April.

NCRP. 2010. Design of effective radiological effluent monitoring and environmental surveillance programs. Report No. 169.

Standard Operating Procedure:

Continuous Particulate Measurement (Teledyne-API T640X)

DATA / FIELD SHEETS	
Data collection will be managed by an automated data acquisition systems. Calibration datasheets will be specific to the selected equipment (refer to INSTRUMENT MANUFACTURER'S OPERATING MANUAL)	
CONTAMINANTS OF POTENTIAL CONCERN	
▪ Particulate matter less than 10 micron (PM_{10}) ▪ Particulate matter less than 2.5 micron ($PM_{2.5}$)	
REFERENCE INFORMATION	
U.S. EPA DESIGNATED REFERENCE AND EQUIVALENT METHOD	Refer to the U.S. EPA's most recent "*List of Designated Reference and Equivalent Methods*" (U.S. EPA 2018): https://www.epa.gov/amtic/air-monitoring-methods-criteria-pollutants
REFERENCE DOCUMENTS	Note: the Teledyne-API T640X was recommended in the final design due to its ability to measure both PM_{10} and $PM_{2.5}$ simultaneously and without consumables, resulting in autonomous operation with minimum maintenance requirements. This method does not appear in the Ontario MECP Operations Manual for Air Quality Monitoring in Ontario; however, the Ontario MECP defers to the U.S. EPA in terms of equipment selection, as noted in section 6.4 of the Manual. As the Teledyne-API T640X is a U.S. EPA reference method for both PM_{10} and $PM_{2.5}$, it's inclusion is justified. ▪ U.S. EPA "*List of Designated Reference and Equivalent Methods*" (U.S. EPA 2018) ▪ Ontario MECP "*Operations Manual for Air Quality Monitoring in Ontario*" (MECP 2008) ▪ Instrument Manufacturer Operating Manual
OPERATION, SERVICE, AND MAINTENANCE	
The Teledyne-API T640X is intended to run relatively autonomously, with minimal service and maintenance requirements. The operation, service, and maintenance should be completed in accordance with the most recent INSTRUMENT MANUFACTURER'S OPERATING MANUAL. Data output from the particulate analyzer should be fed into an automated data acquisition system (DAS) in conjunction with other continuous analyzers. In light of the available standards for PM_{10} and $PM_{2.5}$, concentrations should be logged on a continuous 1-hour basis.	

ADDITIONAL EQUIPMENT REQUIRED	
▪ Teledyne SpanDust photomultiplier tube (PMT) calibrator ▪ NIST-traceable flow transfer standard (e.g., DryCal)	
SAMPLING DETAILS	
▪ Data output from the particulate analyzer should be fed into an automated data acquisition system (DAS) in conjunction with other continuous analyzers. In light of the available standards for PM_{10} and $PM_{2.5}$, concentrations should be logged on a continuous 1-hour basis.	
CUMULATIVE EFFECTS	
In order to gather additional information about the study area and assess the potential for cumulative effects, land use information (e.g., undisturbed forest, community, forestry, cabins, agriculture) and other pertinent information (e.g., industry, contaminant sources, road proximity) is to be recorded at each sampling location and along access routes as relevant. This information is to be recorded the first time a new sampling location is visited or if land use changes at that sampling location. Record the information on the data sheets and be sure to take lots of pictures.	
INSTRUMENTATION QA/QC REQUIREMENTS	
REGULAR PERFORMANCE CHECK	The following is to be completed <u>monthly</u>: ▪ clean the sample inlet ▪ check the PMT performance using SpanDust and make adjustment if necessary ▪ check the pump performance
SCHEDULED CALIBRATION/SERVICE	In addition to the above performance checks, the following are to be completed and documented: ▪ check the volume flow rate using a flow transfer standard that is NIST-traceable, and adjust where necessary (*quarterly*) ▪ perform a leak check (*quarterly*) ▪ inspect the optical chamber and RH/temperature sensor (*semi-annually*) ▪ replace flow filters (*annually*) ▪ inspect sampling line (*annually*) The calibrations and service measures are to be recorded, and associated documentation kept in the permanent project record for use in subsequent analysis. The documentation must include the date that the calibration/service was completed in the field, a record of any adjustments made, the serial number of the calibration devices used, and copies of the certification that accompanied the calibration devices.

REFERENCES

MECP. 2008. Operations manual for air quality monitoring in Ontario. Toronto.

U.S. EPA. 2018. List of designated reference and equivalent methods. http://www.epa.gov/ttn/amtic/criteria.html (accessed March 5, 2019).

Standard Operating Procedure:

Continuous Sampling of Ammonia (NH_3) using Chemiluminescence

DATASHEETS	
Data collection will be managed by an automated data acquisition systems. Calibration datasheets will be specific to the selected equipment (refer to INSTRUMENT MANUFACTURER'S OPERATING MANUAL)	
CONTAMINANTS OF POTENTIAL CONCERN	
▪ Ammonia (NH_3)	
REFERENCE INFORMATION	
U.S. EPA DESIGNATED REFERENCE AND EQUIVALENT METHOD	The U.S. EPA does not designate reference or equivalent methods for the measurement of NH_3.
REFERENCE DOCUMENTS	▪ Instrument Manufacturer Operating Manual for selected model Note: neither the U.S. EPA or Ontario MECP identify approved methods for the continuous measurement of ammonia. The most common principle of measurement for continuous NH_3 analyzers is chemiluminescence, which is the same technology as is approved by both the U.S. EPA and Ontario MECP for NO_2/NOx.
OPERATION, SERVICE, AND MAINTENANCE	
Specific procedures may vary widely by various analyzer manufacturers and models that have been approved by the U.S. EPA for sampling of NH_3. As such, the operation, service, and maintenance of the NH_3 continuous analyzer that is selected for use in the program should be completed in accordance with the selected INSTRUMENT MANUFACTURER'S OPERATING MANUAL	
ADDITIONAL EQUIPMENT REQUIRED	
▪ Inline zero gas source ▪ Inline span source ▪ Solenoid valves for inline zero/span and sample lines ▪ Certified zero and span gases (cylinders) ▪ Flow and pressure calibrator ▪ Replacement inlet particulate filters	
SAMPLING DETAILS	
▪ Data output from the NH_3 analyzer should be fed into an automated data acquisition system (DAS) in conjunction with other continuous analyzers. In light of the available standards for NH_3, concentrations should be logged on a continuous 1-hour basis.	

CUMULATIVE EFFECTS	
In order to gather additional information about the study area and assess the potential for cumulative effects, land use information (e.g., undisturbed forest, community, forestry, cabins, agriculture) and other pertinent information (e.g., industry, contaminant sources, road proximity) is to be recorded at each sampling location and along access routes as relevant. This information is to be recorded the first time a new sampling location is visited or if land use changes at that sampling location. Record the information on the data sheets and be sure to take lots of pictures.	
INSTRUMENTATION QA/QC REQUIREMENTS	
REGULAR PERFORMANCE CHECK	Automatic internal zero/span checks are to be performed <u>daily</u>, necessitating the instrument to have sources of both zero gas (e.g., external scrubber) and span gas (e.g., permeation tube) connected and outfitted with solenoid valves that allow automatic switching between zero/span and sample lines. Preferably, the zero and span checks are to be scheduled to bridge two consecutive hours evenly to avoid data loss (e.g., if the zero/span cycle time is 20 minutes, then it should be schedule to being 10 minutes before the selected hour). By default, the bridge point hour should be 01:00, unless this time is inappropriate for project reasons. <u>Note</u>: it is not necessary to use certified zero/span gases for the daily performance checks. Ensure all automatic zero and span check instructions from the selected instrument manufacturer's operating manual are followed. In accordance with the *Operations Manual for Air Quality Monitoring in Ontario*, an auto-span adjustment is not recommended for regular performance checks.
SCHEDULED CALIBRATION	Scheduled calibration is to occur at the following times: ▪ upon installation ▪ upon relocation of the instrument (if applicable) ▪ monthly ▪ after a period of downtime of more than 3 days ▪ when automatic span shows a drift of 5-10% ▪ after any repairs are made to the analyzer It is important to note that scheduled calibrations are to be completed with <u>certified calibration gases</u>, rather than the gas sources used for the automatic zero/span checks. The details of the calibrations are to be recorded, and associated documentation kept in the permanent project record for use in subsequent analysis. At a minimum, the documentation must include the date that the calibration was completed in the field, certification details for the calibration gases (i.e., certification authority, certification date), and copies of the certifications.

Standard Operating Procedure:

Continuous Sampling of Carbon Monoxide (CO) using NDIR Gas Filter Correlation

DATASHEETS	
Data collection will be managed by an automated data acquisition systems. Calibration datasheets will be specific to the selected equipment (refer to INSTRUMENT MANUFACTURER'S OPERATING MANUAL)	
CONTAMINANTS OF POTENTIAL CONCERN	
▪ Carbon Monoxide (CO)	
REFERENCE INFORMATION	
U.S. EPA DESIGNATED REFERENCE AND EQUIVALENT METHOD	Refer to the U.S. EPA's most recent "*List of Designated Reference and Equivalent Methods*": https://www.epa.gov/amtic/air-monitoring-methods-criteria-pollutants
REFERENCE DOCUMENTS	▪ U.S. EPA "*List of Designated Reference and Equivalent Methods*"(U.S. EPA 2018) ▪ Ontario MECP "*Operations Manual for Air Quality Monitoring in Ontario*" (MECP 2008) ▪ Instrument Manufacturer Operating Manual for selected model
OPERATION, SERVICE, AND MAINTENANCE	
Specific procedures may vary widely by various analyzer manufacturers and models that have been approved by the U.S. EPA for sampling of CO. As such, the operation, service, and maintenance of the CO continuous analyzer that is selected for use in the program should be completed in accordance with the selected INSTRUMENT MANUFACTURER'S OPERATING MANUAL.	
ADDITIONAL EQUIPMENT REQUIRED	
▪ Inline zero gas source/external scrubber ▪ Inline span gas source (e.g., NIST-traceable CO span cylinder, low concentration 0-50 ppm) ▪ Solenoid valves for inline zero/span and sample lines ▪ Certified zero and span gases (e.g., NIST-traceable CO cylinder, high concentration 1,000 ppm with gas dilution system) ▪ Flow and pressure calibrator ▪ Replacement inlet particulate filters	
SAMPLING DETAILS	
▪ Data output from the CO analyzer should be fed into an automated data acquisition system (DAS) in conjunction with other continuous analyzers. In light of the available standards for CO, concentrations should be logged on a continuous 1-hour basis.	

CUMULATIVE EFFECTS	
In order to gather additional information about the study area and assess the potential for cumulative effects, land use information (e.g., undisturbed forest, community, forestry, cabins, agriculture) and other pertinent information (e.g., industry, contaminant sources, road proximity) is to be recorded at each sampling location and along access routes as relevant. This information is to be recorded the first time a new sampling location is visited or if land use changes at that sampling location. Record the information on the data sheets and be sure to take lots of pictures.	
INSTRUMENTATION QA/QC REQUIREMENTS	
REGULAR PERFORMANCE CHECK	▪ Automatic internal zero/span checks are to be performed <u>daily</u>, which requires that the instrument has sources of both zero gas (e.g., external scrubber) and span gas (e.g., permeation tube) connected and outfitted with solenoid valves that allow automatic switching between zero/span and sample lines. Preferably, the zero and span checks are to be scheduled to bridge two consecutive hours evenly to avoid data loss (e.g., if the zero/span cycle time is 20 minutes, then it should be scheduled to being 10 minutes before the selected hour). By default, the bridge point hour should be 01:00, unless this time is inappropriate for project reasons. ▪ Ensure all automatic zero and span check instructions from the selected instrument manufacturer's operating manual are followed. In accordance with the *Operations Manual for Air Quality Monitoring in Ontario*, an auto-span adjustment is not recommended for regular performance checks.
SCHEDULED CALIBRATION	Scheduled calibration is to occur at the following times: ▪ upon installation ▪ upon relocation of the instrument (if applicable) ▪ monthly ▪ after a period of downtime of more than 3 days ▪ when automatic span shows a drift of 5-10% ▪ after any repairs are made to the analyzer It is important to note that scheduled calibrations are to be completed with <u>certified calibration gases</u>, rather than the gas sources used for the automatic zero/span checks. The details of the calibrations are to be recorded, and associated documentation kept in the permanent project record for use in subsequent analysis. At a minimum, the documentation must include the date that the calibration was completed in the field, certification details for the calibration gases (i.e., certification authority, certification date), and copies of the certifications.

REFERENCES

MECP. 2008. Operations manual for air quality monitoring in Ontario. Toronto.

U.S. EPA. 2018. List of designated reference and equivalent methods. http://www.epa.gov/ttn/amtic/criteria.html (accessed March 5, 2019).

Standard Operating Procedure:

Continuous Sampling of Nitrogen Oxides (NO_x) using Chemiluminescence

DATASHEETS	
Data collection will be managed by an automated data acquisition systems. Calibration datasheets will be specific to the selected equipment (refer to INSTRUMENT MANUFACTURER'S OPERATING MANUAL)	
CONTAMINANTS OF POTENTIAL CONCERN	
▪ Nitrogen dioxide and nitrogen oxides (NO_2/NOx)	
REFERENCE INFORMATION	
U.S. EPA DESIGNATED REFERENCE AND EQUIVALENT METHOD	Refer to the U.S. EPA's most recent "*List of Designated Reference and Equivalent Methods*": https://www.epa.gov/amtic/air-monitoring-methods-criteria-pollutants
REFERENCE DOCUMENTS	▪ U.S. EPA "*List of Designated Reference and Equivalent Methods*" (U.S. EPA 2018) ▪ Ontario MECP "*Operations Manual for Air Quality Monitoring in Ontario*" (MECP 2008) ▪ Instrument Manufacturer Operating Manual for selected model
OPERATION, SERVICE, AND MAINTENANCE	
Specific procedures may vary widely by various analyzer manufacturers and models that have been approved by the U.S. EPA for sampling of NO_2/NOx. As such, the operation, service, and maintenance of the NO_2/NOx continuous analyzer that is selected for use in the program should be completed in accordance with the selected INSTRUMENT MANUFACTURER'S OPERATING MANUAL	
ADDITIONAL EQUIPMENT REQUIRED	
▪ Inline zero gas source/external scrubber ▪ Inline span gas source (e.g., permeation tube) ▪ Solenoid valves for inline zero/span and sample lines ▪ Certified zero and span gases (cylinders) ▪ Flow and pressure calibrator ▪ Replacement inlet particulate filters	
SAMPLING DETAILS	
▪ Data output from the NO_2/NOx analyzer should be fed into an automated data acquisition system (DAS) in conjunction with other continuous analyzers. In light of the available standards for NO_2/NOx, concentrations should be logged on a continuous 1-hour basis.	

CUMULATIVE EFFECTS	
In order to gather additional information about the study area and assess the potential for cumulative effects, land use information (e.g., undisturbed forest, community, forestry, cabins, agriculture) and other pertinent information (e.g., industry, contaminant sources, road proximity) is to be recorded at each sampling location and along access routes as relevant. This information is to be recorded the first time a new sampling location is visited or if land use changes at that sampling location. Record the information on the data sheets and be sure to take lots of pictures.	
INSTRUMENTATION QA/QC REQUIREMENTS	
REGULAR PERFORMANCE CHECK	Automatic internal zero/span checks are to be performed daily, necessitating the instrument to have sources of both zero gas (e.g., external scrubber) and span gas (e.g., permeation tube) connected and outfitted with solenoid valves that allow automatic switching between zero/span and sample lines. Preferably, the zero and span checks are to be scheduled to bridge two consecutive hours evenly to avoid data loss (e.g., if the zero/span cycle time is 20 minutes, then it should be schedule to being 10 minutes before the selected hour). By default, the bridge point hour should be 01:00, unless this time is inappropriate for project reasons. Note: it is not necessary to use certified zero/span gases for the daily performance checks. Ensure all automatic zero and span check instructions from the selected instrument manufacturer's operating manual are followed. In accordance with the *Operations Manual for Air Quality Monitoring in Ontario*, an auto-span adjustment is not recommended for regular performance checks.
SCHEDULED CALIBRATION	Scheduled calibration is to occur at the following times: ▪ upon installation ▪ upon relocation of the instrument (if applicable) ▪ monthly ▪ after a period of downtime of more than 3 days ▪ when automatic span shows a drift of 5-10% ▪ after any repairs are made to the analyzer It is important to note that scheduled calibrations are to be completed with certified calibration gases, rather than the gas sources used for the automatic zero/span checks. The details of the calibrations are to be recorded, and associated documentation kept in the permanent project record for use in subsequent analysis. At a minimum, the documentation must include the date that the calibration was completed in the field, certification details for the calibration gases (i.e., certification authority, certification date), and copies of the certifications.

REFERENCES

MECP. 2008. Operations manual for air quality monitoring in Ontario. Toronto.

U.S. EPA. 2018. List of designated reference and equivalent methods. http://www.epa.gov/ttn/amtic/criteria.html (accessed March 5, 2019).

Standard Operating Procedure:

Continuous Sampling of Ozone (O_3) using UV Absorption

DATASHEETS	
Data collection will be managed by an automated data acquisition systems. Calibration datasheets will be specific to the selected equipment (refer to INSTRUMENT MANUFACTURER'S OPERATING MANUAL)	
CONTAMINANTS OF POTENTIAL CONCERN	
▪ Ozone (O_3)	
REFERENCE INFORMATION	
U.S. EPA DESIGNATED REFERENCE AND EQUIVALENT METHOD	Refer to the U.S. EPA's most recent "*List of Designated Reference and Equivalent Methods*": https://www.epa.gov/amtic/air-monitoring-methods-criteria-pollutants
REFERENCE DOCUMENTS	▪ U.S. EPA "*List of Designated Reference and Equivalent Methods*" (U.S. EPA 2018) ▪ Ontario MECP "*Operations Manual for Air Quality Monitoring in Ontario*" (MECP 2008) ▪ Instrument Manufacturer Operating Manual for selected model
OPERATION, SERVICE, AND MAINTENANCE	
Specific procedures may vary widely by various analyzer manufacturers and models that have been approved by the U.S. EPA for sampling of O_3. As such, the operation, service, and maintenance of the O_3 continuous analyzer that is selected for use in the program should be completed in accordance with the selected INSTRUMENT MANUFACTURER'S OPERATING MANUAL	
ADDITIONAL EQUIPMENT REQUIRED	
▪ Inline zero gas source/external scrubber ▪ Inline span source (e.g., internal lamp) ▪ Solenoid valves for inline zero/span and sample lines ▪ Certified zero and span gases (cylinders, O_3 generator) ▪ Flow and pressure calibrator ▪ Replacement inlet particulate filters	
SAMPLING DETAILS	
▪ Given the number of other analyzers that will be operating at the same location, it is likely that the data output will be fed to a data acquisition system (DAS) for download of all parameters. The analyzer and the DAS should each be configured to local time (CST). In light of the available standards for O_3, concentrations should be logged on a continuous 1-hour basis.	
CUMULATIVE EFFECTS	

In order to gather additional information about the study area and assess the potential for cumulative effects, land use information (e.g., undisturbed forest, community, forestry, cabins, agriculture) and other pertinent information (e.g., industry, contaminant sources, road proximity) is to be recorded at each sampling location and along access routes as relevant. This information is to be recorded the first time a new sampling location is visited or if land use changes at that sampling location. Record the information on the data sheets and be sure to take lots of pictures.

INSTRUMENTATION QA/QC REQUIREMENTS	
REGULAR PERFORMANCE CHECK	Automatic internal zero/span checks are to be performed daily, necessitating the instrument to have sources of both zero gas (e.g., external scrubber) and span gas (e.g., permeation tube) connected and outfitted with solenoid valves that allow automatic switching between zero/span and sample lines. Preferably, the zero and span checks are to be scheduled to bridge two consecutive hours evenly to avoid data loss (e.g., if the zero/span cycle time is 20 minutes, then it should be schedule to being 10 minutes before the selected hour). By default, the bridge point hour should be 01:00, unless this time is inappropriate for project reasons. Note: it is not necessary to use certified zero/span gases for the daily performance checks. Ensure all automatic zero and span check instructions from the selected instrument manufacturer's operating manual are followed. In accordance with the *Operations Manual for Air Quality Monitoring in Ontario*, an auto-span adjustment is not recommended for regular performance checks.
SCHEDULED CALIBRATION	Scheduled calibration is to occur at the following times: ▪ upon installation ▪ upon relocation of the instrument (if applicable) ▪ monthly ▪ after a period of downtime of more than 3 days ▪ when automatic span shows a drift of 5-10% ▪ after any repairs are made to the analyzer It is important to note that scheduled calibrations are to be completed with certified calibration gases, rather than the gas sources used for the automatic zero/span checks. The details of the calibrations are to be recorded, and associated documentation kept in the permanent project record for use in subsequent analysis. At a minimum, the documentation must include the date that the calibration was completed in the field, certification details for the calibration gases (i.e., certification authority, certification date), and copies of the certifications.

REFERENCES

MECP. 2008. Operations manual for air quality monitoring in Ontario. Toronto.

U.S. EPA. 2018. List of designated reference and equivalent methods. http://www.epa.gov/ttn/amtic/criteria.html (accessed March 5, 2019).

Standard Operating Procedure:

Continuous Sampling of Sulphur Dioxide (SO_2) using UV Fluorescence

DATASHEETS	
Data collection will be managed by an automated data acquisition systems. Calibration datasheets will be specific to the selected equipment (refer to INSTRUMENT MANUFACTURER'S OPERATING MANUAL).	
CONTAMINANTS OF POTENTIAL CONCERN	
▪ Sulphur dioxide (SO_2)	
REFERENCE INFORMATION	
U.S. EPA DESIGNATED REFERENCE AND EQUIVALENT METHOD	Refer to the U.S. EPA's most recent "*List of Designated Reference and Equivalent Methods*": https://www.epa.gov/amtic/air-monitoring-methods-criteria-pollutants
REFERENCE DOCUMENTS	▪ U.S. EPA "*List of Designated Reference and Equivalent Methods*" (U.S. EPA 2018) ▪ Ontario MECP "*Operations Manual for Air Quality Monitoring in Ontario*" (MECP 2008) ▪ Instrument Manufacturer Operating Manual for selected model
OPERATION, SERVICE, AND MAINTENANCE	
Specific procedures may vary widely by various analyzer manufacturers and models that have been approved by the U.S. EPA for sampling of SO_2. As such, the operation, service, and maintenance of the SO_2 continuous analyzer that is selected for use in the program should be completed in accordance with the selected INSTRUMENT MANUFACTURER'S OPERATING MANUAL	
ADDITIONAL EQUIPMENT REQUIRED	
▪ Inline zero gas source/external scrubber ▪ Inline span gas source (e.g., permeation tube) ▪ Solenoid valves for inline zero/span and sample lines ▪ Certified zero and span gases (cylinders) ▪ Flow and pressure calibrator ▪ Replacement inlet particulate filters	
SAMPLING DETAILS	
▪ Given the number of other analyzers that will be operating at the same location, it is likely that the data output will be fed to a data acquisition system (DAS) for download of all parameters. The analyzer and the DAS should each be configured to local time (CST). In light of the available standards for SO_2, concentrations should be logged on a continuous 1-hour basis.	

CUMULATIVE EFFECTS	
In order to gather additional information about the study area and assess the potential for cumulative effects, land use information (e.g., undisturbed forest, community, forestry, cabins, agriculture) and other pertinent information (e.g., industry, contaminant sources, road proximity) is to be recorded at each sampling location and along access routes as relevant. This information is to be recorded the first time a new sampling location is visited or if land use changes at that sampling location. Record the information on the data sheets and be sure to take lots of pictures.	
INSTRUMENTATION QA/QC REQUIREMENTS	
REGULAR PERFORMANCE CHECK	Automatic internal zero/span checks are to be performed daily, necessitating the instrument to have sources of both zero gas (e.g., external scrubber) and span gas (e.g., permeation tube) connected and outfitted with solenoid valves that allow automatic switching between zero/span and sample lines. Preferably, the zero and span checks are to be scheduled to bridge two consecutive hours evenly to avoid data loss (e.g., if the zero/span cycle time is 20 minutes, then it should be schedule to being 10 minutes before the selected hour). By default, the bridge point hour should be 01:00, unless this time is inappropriate for project reasons. Note: it is not necessary to use certified zero/span gases for the daily performance checks. Ensure all automatic zero and span check instructions from the selected instrument manufacturer's operating manual are followed. In accordance with the *Operations Manual for Air Quality Monitoring in Ontario*, an auto-span adjustment is not recommended for regular performance checks.
SCHEDULED CALIBRATION	Scheduled calibration is to occur at the following times: ▪ upon installation ▪ upon relocation of the instrument (if applicable) ▪ monthly ▪ after a period of downtime of more than 3 days ▪ when automatic span shows a drift of 5-10% ▪ after any repairs are made to the analyzer It is important to note that scheduled calibrations are to be completed with certified calibration gases, rather than the gas sources used for the automatic zero/span checks.

	The details of the calibrations are to be recorded, and associated documentation kept in the permanent project record for use in subsequent analysis. At a minimum, the documentation must include the date that the calibration was completed in the field, certification details for the calibration gases (i.e., certification authority, certification date), and copies of the certifications.

REFERENCES

MECP. 2008. Operations manual for air quality monitoring in Ontario. Toronto.

U.S. EPA. 2018. List of designated reference and equivalent methods. http://www.epa.gov/ttn/amtic/criteria.html (accessed March 5, 2019).

Standard Operating Procedure:

Collection of Total Dustfall (Settleable Particulates)

DATASHEETS	
▪ Dustfall Sampling Datasheet	
CONTAMINANTS OF POTENTIAL CONCERN	
▪ See Appendix E of Environmental Media Baseline Program Final Sample Design report	
REFERENCE INFORMATION	
U.S. EPA DESIGNATED REFERENCE AND EQUIVALENT METHOD	Not designated as a reference or equivalent method by the U.S. EPA
REFERENCE DOCUMENTS	▪ Ontario MECP "*Operations Manual for Air Quality Monitoring in Ontario*" (MECP 2008) ▪ ASTM D1739-98 (2017) "*Standard Test Method for Collection and Measurement of Dustfall (Settleable Particulate Matter)*" (ASTM 2017)
OPERATION, SERVICE, AND MAINTENANCE	
The dustfall container should be sited in accordance with the requirements outlined in Section 3.2.3 of the *Operations Manual for Air Quality Monitoring in Ontario*. This sampling method does not require calibration.	
ADDITIONAL EQUIPMENT REQUIRED	
▪ Stand and holder for container that includes a bird ring ▪ Collar bracket and jar picker are optional to minimize/eliminate the use of ladders ▪ Coolers to protect the plastic containers during return shipment to the lab ▪ Deionized water provided by lab for rinsing containers ▪ Depending on season, the lab may recommend the use of an algaecide or anti-freeze agent	
SAMPLING DETAILS	
▪ It is standard practice to set the samplers out for a 30-day exposure period, ±3 days, and the start of the sample period should be as close to the beginning of a calendar month as possible. ▪ The detailed protocol should be adaptive, allowing the sample period to be extended in the event that levels are not detectable from a 30-day exposure period.	
CUMULATIVE EFFECTS	
In order to gather additional information about the study area and assess the potential for cumulative effects, land use information (e.g., undisturbed forest, community, forestry, cabins, agriculture) and other pertinent information (e.g., industry, contaminant sources, road proximity) is to be recorded at each sampling location and along access routes as relevant. This information is to be recorded the first	

time a new sampling location is visited or if land use changes at that sampling location. Record the information on the data sheets and be sure to take lots of pictures.	
INSTRUMENTATION QA/QC REQUIREMENTS	
REGULAR PERFORMANCE CHECK	The following is to be completed at <u>each container changeover</u>: ▪ visual inspection of the sampler (e.g., for damage) ▪ visual inspection of sampler contents (excessive interferences such as algae, insects, or bird droppings) ▪ confirm exposure period and assignment of sample to correct month and location
SCHEDULED CALIBRATION	This sampling method does not require calibration; however, on a quarterly basis, each location should be reassessed in terms of the siting criteria in Section 3.2.3 of the *Operations Manual for Air Quality Monitoring in Ontario*, and any siting issues corrected, changes to surrounding topography should be noted (e.g., clearing of trees), and any ongoing sample collection issues should be addressed in coordination with the laboratory that prepares the containers (e.g., excessive algae).

REFERENCES

ASTM. 2017. Standard test method for collection and measurement of dustfall (settleable particulate matter). ASTM D1739-98.

MECP. 2008. Operations manual for air quality monitoring in Ontario. Toronto.

Standard Operating Procedure:

High-Volume Air Sampler (HVAS): Filter and PUF Cartridge

DATASHEETS	
▪ Polyurethane Foam (PUF) High-Volume Air Sampler (HVAS) Datasheet	
CONTAMINANTS OF POTENTIAL CONCERN	
▪ See Appendix E of Environmental Media Baseline Program Final Sample Design report	
REFERENCE INFORMATION	
U.S. EPA DESIGNATED REFERENCE AND EQUIVALENT METHOD	Not designated as a reference or equivalent method by the U.S. EPA, which is for designated "criteria pollutants" only; however, the method is approved by the U.S. EPA for monitoring "air toxics" under the "Toxic Organic Compendium", Method TO-13A https://www3.epa.gov/ttnamti1/airtox.html
REFERENCE DOCUMENTS	▪ Ontario MECP "*Operations Manual for Air Quality Monitoring in Ontario*" (MECP 2008) ▪ U.S. EPA Compendium Method TO-13A "*Determination of polycyclic aromatic hydrocarbons (PAHS) in ambient air using gas chromatography/mass spectrometry (GC/MS)*" (U.S. EPA 1999) ▪ ASTM D6209-13 "*Standard Test Method for Determination of Gaseous and Particulate Polycyclic Aromatic Hydrocarbons in Ambient Air*" (ASTM 2013) ▪ Instrument Manufacturer Operating Manual for selected HVAS model
OPERATION, SERVICE, AND MAINTENANCE	
Specific procedures may vary widely by various manufacturers and HVAS models that meet the minimum U.S. EPA requirements. As such, the operation, service, and maintenance of the HVAS system that is selected for use in the program should be completed in accordance with the INSTRUMENT MANUFACTURER'S OPERATING MANUAL	
ADDITIONAL EQUIPMENT REQUIRED	
▪ Filter and PUF cartridge holder with gaskets ▪ Teflon-coated glass fibre or quartz filter (102 mm circular) ▪ Glass cartridge containing PUF or XAD-2 resin cartridge ▪ Aluminum foil to wrap glass cartridges upon retrieval after sampling ▪ Cooler and ice packs to hold samples at <4ºC during shipping to lab after collection ▪ Refrigerator to keep samples at <4ºC between retrieval after sampling and shipping to lab ▪ Flow controller capable of maintaining a flow rate of 8 CFM (±10%) over 24 hours	

▪ Flow charts (if necessary based on selected model) ▪ Flow calibration device that has been calibrated to an NIST standard within the period recommended by the manufacturer ▪ Certification for flow calibration device that outlines the calibration coefficients for use in flow calculations	
SAMPLING DETAILS	
▪ It is standard practice to run the HVAS PUF instruments at approximately 8 CFM (±10%). ▪ The sampling is to occur over a 24-hour period, from midnight-to-midnight (CST) and the total volume of sampled air must be greater than 300 m^3. ▪ The detailed protocol should be adaptive, allowing the sample period to be extended or flow rate to be increased in the event that levels are not detectable from a 24-hour sample collected at the standard flow rate.	
CUMULATIVE EFFECTS	
In order to gather additional information about the study area and assess the potential for cumulative effects, land use information (e.g., undisturbed forest, community, forestry, cabins, agriculture) and other pertinent information (e.g., industry, contaminant sources, road proximity) is to be recorded at each sampling location and along access routes as relevant. This information is to be recorded the first time a new sampling location is visited or if land use changes at that sampling location. Record the information on the data sheets and be sure to take lots of pictures.	
INSTRUMENTATION QA/QC REQUIREMENTS	
REGULAR PERFORMANCE CHECK	The following is to be completed at <u>each filter changeover</u>: ▪ visual inspection of the sampler (damage, cleanliness) ▪ confirm flow is being maintained over sampling period within identified allowable range ▪ confirm timers are set to the correct date, local time, and sample duration
SCHEDULED CALIBRATION	Calibrations are to be completed at the following intervals: ▪ upon installation ▪ after any maintenance (e.g., parts replacement) ▪ quarterly The calibrations are to be recorded, and associated documentation kept in the permanent project record for use in subsequent analysis. In addition to the flow-specific parameters, the documentation must include the date that the calibration was completed in the field, the serial number of the calibration orifice used, and copies of the certification that accompanied the calibration orifice. The certification should show the date of certification, confirmation that the orifice has been certified to an NIST-traceable standard, and any coefficients required in the flow calculations.

REFERENCES

ASTM. 2013. ASTM D6209-13. Standard test method for determination of gaseous and particulate polycyclic aromatic hydrocarbons in ambient air.

MECP. 2008. Operations manual for air quality monitoring in Ontario. Toronto.

U.S. EPA. 1999. Compendium Method TO-13A. Determination of polycyclic aromatic hydrocarbons (PAHS) in ambient air using gas chromatography/mass spectrometry (GC/MS).

Standard Operating Procedure:

High-Volume Air Sampler (HVAS): Particulate Sampler

DATASHEETS	
▪ Particulate High-Volume Air Sampler (HVAS) Datasheet	
CONTAMINANTS OF POTENTIAL CONCERN	
▪ See Appendix E of Environmental Media Baseline Program Final Sample Design report	
REFERENCE INFORMATION	
U.S. EPA DESIGNATED REFERENCE AND EQUIVALENT METHOD	Refer to the U.S. EPA's most recent "*List of Designated Reference and Equivalent Methods*": https://www.epa.gov/amtic/air-monitoring-methods-criteria-pollutants
REFERENCE DOCUMENTS	▪ U.S. EPA "*List of Designated Reference and Equivalent Methods*" (U.S. EPA 2018) ▪ U.S. Code of Federal Regulations: 40 CFR Part 50 Appendix B, Volume 47 and 48 (U.S. Government 2012) ▪ Ontario MECP "*Operations Manual for Air Quality Monitoring in Ontario*" (MECP 2008) ▪ Instrument Manufacturer Operating Manual for selected HVAS model
OPERATION, SERVICE, AND MAINTENANCE	
Specific procedures may vary widely by various manufacturers and HVAS models that have been approved by the U.S. EPA for sampling of TSP. As such, the operation, service, and maintenance of the HVAS system that is selected for use in the program should be completed in accordance with the INSTRUMENT MANUFACTURER'S OPERATING MANUAL. It should be noted that separate HVAS systems are proposed for the monitoring of TSP and metals, and radionuclides, which require consideration to different sampling periods and therefore will have different operating protocols, and service and maintenance schedules.	
EQUIPMENT REQUIRED	
▪ 8"x10" filter ▪ Filter holder for 8"x10" filter ▪ Flow charts (if necessary, based on selected model) ▪ Flow controller capable of maintaining a flow rate of 40 CFM (±10%) ▪ Flow calibration device that has been calibrated to an NIST standard within the period recommended by the manufacturer ▪ Certification for flow calibration device that outlines the calibration coefficients for use in flow calculations	

<table>
<tr><th colspan="2">SAMPLING DETAILS</th></tr>
<tr><td colspan="2">It is standard practice to run the HVAS instruments at 40 CFM (±10%).
The sampling for TSP and metals is to occur over a 24-hour period, from midnight-to-midnight (CST).
The sampling for radionuclides is to occur continuously until the filter loading begins to have flow implications (i.e., HVAS is unable to maintain a flow of 40 CFM ±10%) and would generally be >30 days.</td></tr>
<tr><th colspan="2">CUMULATIVE EFFECTS</th></tr>
<tr><td colspan="2">In order to gather additional information about the study area and assess the potential for cumulative effects, land use information (e.g., undisturbed forest, community, forestry, cabins, agriculture) and other pertinent information (e.g., industry, contaminant sources, road proximity) is to be recorded at each sampling location and along access routes as relevant. This information is to be recorded the first time a new sampling location is visited or if land use changes at that sampling location. Record the information on the data sheets and be sure to take lots of pictures.</td></tr>
<tr><th colspan="2">INSTRUMENTATION QA/QC REQUIREMENTS</th></tr>
<tr><td>REGULAR PERFORMANCE CHECK</td><td>The following is to be completed at <u>each filter changeover</u>:
visual inspection of the sampler (damage, cleanliness)
confirm flow is being maintained over sampling period within identified allowable range
confirm timers are set to the correct date, local time, and sample duration</td></tr>
<tr><td>SCHEDULED CALIBRATION</td><td>Calibrations are to be completed at the following intervals:
upon installation
after any maintenance (e.g., parts replacement)
quarterly
The calibrations are to be recorded, and associated documentation kept in the permanent project record for use in subsequent analysis. In addition to the flow-specific parameters, the documentation must include the date that the calibration was completed in the field, the serial number of the calibration orifice used, and copies of the certification that accompanied the calibration orifice. The certification should show the date of certification, confirmation that the orifice has been certified to an NIST-traceable standard, and any coefficients required in the flow calculations.</td></tr>
</table>

REFERENCES

MECP. 2008. Operations manual for air quality monitoring in Ontario. Toronto.

U.S. EPA. 2018. List of designated reference and equivalent methods. http://www.epa.gov/ttn/amtic/criteria.html (accessed March 5, 2019).

U.S. Government. 2012. 40 CFR Appendix E to Part 58 - Probe and monitoring path siting criteria for ambient air quality monitoring. 71 FR 61323, Oct. 17, 2006, as amended at 75 FR 6535, Feb. 9, 2010; 76 FR 54342, Aug. 31, 2011. https://www.govinfo.gov/app/details/CFR-2012-title40-vol6/CFR-2012-title40-vol6-part58-appE.

Standard Operating Procedure:

Measurement of Volatile Organic Compounds using an Evacuated Canister

DATASHEETS	
▪ Evacuated Canister Datasheet	
CONTAMINANTS OF POTENTIAL CONCERN	
▪ See Appendix E of Environmental Media Baseline Program Final Sample Design report	
REFERENCE INFORMATION	
U.S. EPA DESIGNATED REFERENCE AND EQUIVALENT METHOD	Not designated as a reference or equivalent method by the U.S. EPA, which is for designated “criteria pollutants” only; however, the method is approved by the U.S. EPA for monitoring “air toxics” under the “Toxic Organic Compendium”, Method TO-15 https://www3.epa.gov/ttnamti1/airtox.html
REFERENCE DOCUMENTS	▪ Ontario MECP “*Operations Manual for Air Quality Monitoring in Ontario*”(MECP 2008) ▪ U.S. EPA Compendium Method TO-15 “*Determination of Volatile Organic Compounds (VOCs) in Air Collected in Specially-Prepared Canisters and Analyzed by Gas Chromatography/Mass Spectrometry (GC/MS)*” (U.S. EPA 1999) ▪ ASTM D5466 “*Standard Test Method for Determination of Volatile Organic Compounds in Atmospheres (Canister Sampling Methodology)*” (ASTM 2015) ▪ Supplier instructions/procedures
OPERATION, SERVICE, AND MAINTENANCE	
Specific procedures may vary by suppliers that meet the minimum U.S. EPA requirements. As such, the operation, service, and maintenance of the system that is selected for use in the program should be completed in accordance with the INSTRUMENT MANUFACTURER’S OPERATING MANUAL	
ADDITIONAL EQUIPMENT REQUIRED	
▪ Flow controller capable of maintaining a flow of 3.5 mL/min over the 24-hour sampling period ▪ Stainless steel vacuum gauge capable of measuring 0.05 mm Hg within 20% ▪ Adjustable crescent wrench ▪ Sample air inlet line (stainless steel tubing) ▪ Sintered stainless steel in-line filter (2 µm)	

SAMPLING DETAILS	
▪ In accordance with the MECP *Operations Manual for Air Quality Monitoring in Ontario,* a 24-hour sample is to run at a flow of 3.5 mL/min, and the vacuum in the canister is monitored via a vacuum gauge. ▪ As the sample run is initiated and ended manually (i.e., by manually opening and closing the flow controller valve), it is likely not practical to operate the sampler from midnight to midnight. Start and stop times are to be logged, and it must be ensured that there is vacuum remaining in the canister at the time the valve is closed (-5 to -10 inches Hg).	
CUMULATIVE EFFECTS	
In order to gather additional information about the study area and assess the potential for cumulative effects, land use information (e.g., undisturbed forest, community, forestry, cabins, agriculture) and other pertinent information (e.g., industry, contaminant sources, road proximity) is to be recorded at each sampling location and along access routes as relevant. This information is to be recorded the first time a new sampling location is visited or if land use changes at that sampling location. Record the information on the data sheets and be sure to take lots of pictures.	
INSTRUMENTATION QA/QC REQUIREMENTS	
REGULAR PERFORMANCE CHECK	The following is to be completed for <u>each sample</u>: ▪ visual inspection of the sampler (damage) ▪ confirm vacuum gauge is functional (initial reading should be approximately -29 inches Hg, and should change significantly within the first few minutes of sampling) ▪ at the conclusion of sampling, the flow controller valve is to be closed while there is still vacuum remaining in the canister (-5 to -10 inches Hg) ▪ confirm correct date, local time, and vacuum gauge readings are recorded at sample initiation and conclusion
SCHEDULED CALIBRATION	There are no field calibration requirements for this method; however, twice per year there is to be a review of the calibration records for the vacuum gauges and flow controllers being used in the program. Vacuum gauge/flow controllers are to be calibrated and certified annually, using equipment that is calibration equipment that is traceable to an NIST standard.

REFERENCES

ASTM. 2015. ASTM D5466. Standard test method for determination of volatile organic compounds in atmospheres (Canister Sampling Methodology).

MECP. 2008. Operations manual for air quality monitoring in Ontario. Toronto.

U.S. EPA. 1999. Air Method, Toxic Organics-15 (TO-15): Compendium of methods for the determination of toxic organic compounds in ambient air, second edition: Determination of Volatile Organic Compounds (VOCs) in air collected in specially-prepared canisters and analyzed.

Standard Operating Procedure:

Passive Measurement of Gamma Radiation Dose (Thermoluminescence Dosimetry)

DATASHEETS	
▪ Gamma TLD Datasheet	
CONTAMINANTS OF POTENTIAL CONCERN	
▪ Gamma radiation	
REFERENCE INFORMATION	
U.S. EPA DESIGNATED REFERENCE AND EQUIVALENT METHOD	Not designated as a reference or equivalent method by the U.S. EPA
REFERENCE DOCUMENTS	▪ CNSC REGDOC-2.9.1 v1.1 "*Environmental Protection: Environmental Principles, Assessments and Protection Measures*" (CNSC 2017) ▪ Operating procedure/instructions from the dosimeter supplier
OPERATION, SERVICE, AND MAINTENANCE	
The selected provider for the thermoluminescence dosimeters (TLDs) will provide detailed instructions for their use.	
ADDITIONAL EQUIPMENT REQUIRED	
▪ Weather protective case for dosimeters	
SAMPLING DETAILS	
▪ In general, the TLDs are provided with several "control" dosimeters that should be clearly marked. ▪ The "transit control" is to be returned to the laboratory immediately upon receipt at the project site. This is used to determine the amount of radiation received by the dosimeter during shipping. ▪ The "deploy control" is to be brought to the monitoring location when the field dosimeter is deployed, but then returned to the field office and held in a secure location until the field dosimeter is retrieved. The deploy control is brought along to retrieve the field dosimeter, then both are returned to the laboratory. The "deploy control" is used to account for radiation received outside of the field exposure window. ▪ It is standard practice to set the samplers out for a 90-day exposure period, and the start of the sample period should be as close to the beginning of a calendar month as possible.	
CUMULATIVE EFFECTS	
In order to gather additional information about the study area and assess the potential for cumulative effects, land use information (e.g., undisturbed forest, community, forestry, cabins, agriculture) and other pertinent information (e.g., industry, contaminant sources, road proximity) is to be recorded at each sampling location and along access routes as relevant. This information is to be recorded the first	

time a new sampling location is visited or if land use changes at that sampling location. Record the information on the data sheets and be sure to take lots of pictures.	
INSTRUMENTATION QA/QC REQUIREMENTS	
REGULAR PERFORMANCE CHECK	The following is to be completed at <u>each sampler changeover</u>: ▪ visual inspection of the sampler (e.g., for damage) ▪ confirm exposure period and assignment of sample ID (e.g., serial number) to correct period and location
SCHEDULED CALIBRATION	This sampling method does not require field calibration

REFERENCES

CNSC. 2017. Environmental protection: Environmental principles, assessments and protection measures. Regulatory document REGDOC-2.9.1, version 1.1, April.

Standard Operating Procedure:

Passive Measurement using Polyurethane Foam (PUF) Disk

DATASHEETS	
▪ Passive Sampling of Trace Gases Datasheet	
CONTAMINANTS OF POTENTIAL CONCERN	
▪ See Appendix E of Environmental Media Baseline Program Final Sample Design report	
REFERENCE INFORMATION	
U.S. EPA DESIGNATED REFERENCE AND EQUIVALENT METHOD	Not designated as a reference or equivalent method by the U.S. EPA.
REFERENCE DOCUMENTS	It should be noted that while this method is not included in the MECP *Operations Manual for Air Quality Monitoring in Ontario* or U.S. EPA documentation for ambient air monitoring, it was identified that monitoring of PAHs is desired in the LSA and so passive means of measurement were required due to the natural setting. At the time this SOP was prepared, there were no reference methods for this type of sampling; however, the MECP siting requirements for passive samplers applies to this type of sampling. ▪ Ontario MECP "*Operations Manual for Air Quality Monitoring in Ontario*" (MECP 2008) ▪ Operating procedure/instructions from the passive sampling system supplier
OPERATION, SERVICE, AND MAINTENANCE	
Specific procedures may vary by supplier. As such, the operation, service, and maintenance of the system that is selected for use in the program should be completed in accordance with the INSTRUMENT MANUFACTURER'S OPERATING MANUAL	
ADDITIONAL EQUIPMENT REQUIRED	
▪ Weather shelter ▪ PUF disk container provided by the supplier ▪ Cooler and ice packs for return shipment to the laboratory	
SAMPLING DETAILS	
▪ The passive samplers should be sited in accordance with the requirements outlined in Section 5.2.9 of the *Operations Manual for Air Quality Monitoring in Ontario*.	

▪ As with the other forms of passive sampling included in the program (trace gases and dustfall), the samplers out for a 30-day exposure period, ±3 days, and the start of the sample period should be as close to the beginning of a calendar month as possible. ▪ The detailed protocol should be adaptive, allowing the sample period to be extended in the event that levels are not detectable from a 30-day exposure period.	
CUMULATIVE EFFECTS	
In order to gather additional information about the study area and assess the potential for cumulative effects, land use information (e.g., undisturbed forest, community, forestry, cabins, agriculture) and other pertinent information (e.g., industry, contaminant sources, road proximity) is to be recorded at each sampling location and along access routes as relevant. This information is to be recorded the first time a new sampling location is visited or if land use changes at that sampling location. Record the information on the data sheets and be sure to take lots of pictures.	
INSTRUMENTATION QA/QC REQUIREMENTS	
REGULAR PERFORMANCE CHECK	The following is to be completed for <u>each sample</u>: ▪ visual inspection of the sampler (damage) ▪ confirm correct date, local time, sample ID and sample location are recorded at sample initiation and conclusion
SCHEDULED CALIBRATION	This sampling method does not require calibration; however, on a quarterly basis, each location should be reassessed in terms of the siting criteria in Section 5.2.9 of the *Operations Manual for Air Quality Monitoring in Ontario*, and any siting issues corrected, changes to surrounding topography should be noted (e.g., clearing of trees), and proximity to any site operations should be logged.

REFERENCES

MECP. 2008. Operations manual for air quality monitoring in Ontario. Toronto.

Standard Operating Procedure:

Passive Measurement of Radon (Alpha Track Etch Detector)

DATASHEETS	
▪ Radon Datasheet	
CONTAMINANTS OF POTENTIAL CONCERN	
▪ Radon	
REFERENCE INFORMATION	
U.S. EPA DESIGNATED REFERENCE AND EQUIVALENT METHOD	Not designated as a reference or equivalent method by the U.S. EPA
REFERENCE DOCUMENTS	▪ CNSC REGDOC-2.9.1 v1.1 "*Environmental Protection: Environmental Principles, Assessments and Protection Measures*" (CNSC 2017) ▪ Operating procedure/instructions from the dosimeter supplier
OPERATION, SERVICE, AND MAINTENANCE	
The selected provider for the track etch detectors will provide detailed instructions for their use and maintenance. Calibration is not required.	
ADDITIONAL EQUIPMENT REQUIRED	
▪ Weather protective case for detector	
SAMPLING DETAILS	
▪ In general, the detectors are set out in the field for a 90-day exposure period. ▪ The start of the sample period should be as close to the beginning of a calendar month as possible.	
CUMULATIVE EFFECTS	
In order to gather additional information about the study area and assess the potential for cumulative effects, land use information (e.g., undisturbed forest, community, forestry, cabins, agriculture) and other pertinent information (e.g., industry, contaminant sources, road proximity) is to be recorded at each sampling location and along access routes as relevant. This information is to be recorded the first time a new sampling location is visited or if land use changes at that sampling location. Record the information on the data sheets and be sure to take lots of pictures.	

INSTRUMENTATION QA/QC REQUIREMENTS	
REGULAR PERFORMANCE CHECK	The following is to be completed at <u>each sampler changeover</u>: ▪ visual inspection of the sampler (e.g., for damage) ▪ confirm exposure period and assignment of sample ID (e.g., serial number) to correct period and location
SCHEDULED CALIBRATION	This sampling method does not require field calibration.

REFERENCES

CNSC. 2017. Environmental protection: Environmental principles, assessments and protection measures. Regulatory document REGDOC-2.9.1, version 1.1, April.

Standard Operating Procedure:

Passive Measurement of Trace Gases

DATASHEETS	
▪ Passive Sampling of Trace Gases Datasheet	
CONTAMINANTS OF POTENTIAL CONCERN	
▪ See Appendix E of Environmental Media Baseline Program Final Sample Design report	
REFERENCE INFORMATION	
U.S. EPA DESIGNATED REFERENCE AND EQUIVALENT METHOD	Not designated as a reference or equivalent method by the U.S. EPA
REFERENCE DOCUMENTS	▪ Ontario MECP "*Operations Manual for Air Quality Monitoring in Ontario*" (MECP 2008) ▪ Operating procedure/instructions from the passive sampling system supplier
OPERATION, SERVICE, AND MAINTENANCE	
The passive samplers should be sited in accordance with the requirements outlined in Section 5.2.9 of the *Operations Manual for Air Quality Monitoring in Ontario*.	
ADDITIONAL EQUIPMENT REQUIRED	
▪ Weather protective cartridge holder (i.e., rain head) ▪ Re-sealable bags provided by supplier ▪ Storage containers for cartridges provided by supplier ▪ Freezer for storage of unexposed NOx cartridges (-20^{o}C) ▪ Refrigerator for storage of exposed and unexposed cartridges (4^{o}C)	
SAMPLING DETAILS	
▪ It is standard practice to set the samplers out for a 30-day exposure period, ±3 days, and the start of the sample period should be as close to the beginning of a calendar month as possible. The detailed protocol should be adaptive, allowing the sample period to be extended in the event that levels are not detectable from a 30-day exposure period. ▪ It should be noted that NOx is only to be measured in the summer months, when average temperatures are above 15^{o}C, due to limitations of the collection media and analysis procedure for this COPC.	

CUMULATIVE EFFECTS	
In order to gather additional information about the study area and assess the potential for cumulative effects, land use information (e.g., undisturbed forest, community, forestry, cabins, agriculture) and other pertinent information (e.g., industry, contaminant sources, road proximity) is to be recorded at each sampling location and along access routes as relevant. This information is to be recorded the first time a new sampling location is visited or if land use changes at that sampling location. Record the information on the data sheets and be sure to take lots of pictures.	
INSTRUMENTATION QA/QC REQUIREMENTS	
REGULAR PERFORMANCE CHECK	The following is to be completed at <u>each sampler changeover</u>: ▪ visual inspection of the sampler (e.g., for damage) ▪ confirm exposure period and assignment of sample to correct month and location
SCHEDULED CALIBRATION	This sampling method does not require calibration; however, on a quarterly basis, each location should be reassessed in terms of the siting criteria in Section 5.2.9 of the *Operations Manual for Air Quality Monitoring in Ontario*, and any siting issues corrected, changes to surrounding topography should be noted (e.g., clearing of trees), and proximity to any site operations should be logged.

REFERENCES

MECP. 2008. Operations manual for air quality monitoring in Ontario. Toronto.

Standard Operating Procedure:

Sound Level Meter (Human Exposure)

ENDPOINTS	
▪ Noise	
REFERENCE INFORMATION	
REFERENCE DOCUMENTS	▪ Ontario MECP *Publication NPC-300 Environmental Noise Guideline* (MECP 2013) ▪ Health Canada *Guidance for Evaluating Human Health Impacts in Environmental Assessment: Noise* (Health Canada 2017) ▪ ISO *1996-2 Acoustics – Description, Measurement and Assessment of Environmental Noise – Part 2: Determination of Environmental Noise Levels* (ISO 2017) ▪ Instrument Manufacturer Operating Manual for selected model
OPERATION, SERVICE, AND MAINTENANCE	
Specific procedures may vary widely by various sound level meter manufacturers. As such, the detailed steps to operate, service, and maintain the sound level meter that is selected for use in the program should be developed in accordance with the selected INSTRUMENT MANUFACTURER'S OPERATING MANUAL	
ADDITIONAL EQUIPMENT REQUIRED	
▪ Weatherproof hardcase for the sound level meter ▪ Environmental shroud for the microphone (including wind screen, desiccant, rain protection) ▪ Tripod ▪ Extension cables for the microphone ▪ Power source for the sound level meter, allowing 2-week operation (e.g., AC power, battery pack) ▪ Acoustic calibrator (hand-held) ▪ USB drive	
SAMPLING DETAILS	
▪ The sound level meter should be configured to local time (CST), and sound levels are to be logged on a continuous basis for a period of up to two (2) weeks for each campaign. To provide flexibility in data analysis, the sampling interval should be no greater than 1 hour. ▪ Most modern sound level meters are capable of logging multiple sound level metrics and weighting schemes simultaneously. At a minimum, the sound level meters should be configured to log the A-weighted energy equivalent sound level (Leq), unweighted (or linear) octave band sound levels, and a suite of statistical parameters including the L90. ▪ It is further recommended that the selected sound level meter have event triggering capability, whereby a sound level exceeding a set threshold will trigger the collection of additional parameters	

including the time that the event occurred, the duration of the event, various sound level metrics describing the event, and a WAV file of the event.	
CUMULATIVE EFFECTS	
In order to gather additional information about the study area and assess the potential for cumulative effects, land use information (e.g., undisturbed forest, community, forestry, cabins, agriculture) and other pertinent information (e.g., industry, contaminant sources, road proximity) is to be recorded at each sampling location and along access routes as relevant. This information is to be recorded the first time a new sampling location is visited or if land use changes at that sampling location. Record the information on the data sheets and be sure to take lots of pictures.	
INSTRUMENTATION QA/QC REQUIREMENTS	
REGULAR PERFORMANCE CHECK	The sound level meter should be visited regularly during the monitoring period (preferably daily), to check for: ▪ physical damage (e.g., wildlife interference) ▪ continued operation (i.e., sound level meter is operating as expected, logging data)
SCHEDULED CALIBRATION	The sound level meter assembly (i.e., the meter, the preamplifier, and the microphone) is to be calibrated using the hand-held acoustic calibrator at the outset of the monitoring program (i.e., once the meter is set up in the field, just prior to initiating the measurement) and at the conclusion of the program (i.e., immediately after stopping the meter from logging data). Each component of the assembly, as well as the hand-held acoustic calibrator, are to be calibrated to an NIST-traceable standard at an accredited laboratory prior to use in the program. Certification records are to be maintained, allowing demonstration that the instrumentation deployed in the field had been certified by an accredited laboratory within the period of validity of the certification (typically 1 year). Instrumentation for which the certification has expired is not to be used in the program.

REFERENCES

Health Canada. 2017. Guidance for evaluating human health impacts in Environmental Assessment: Noise. Ottawa.

ISO. 2017. Acoustics — Description, measurement and assessment of environmental noise — Part 2: Determination of environmental noise levels. ISO 1996-2:2017.

MECP. 2013. Environmental noise guideline - Stationary and transportation sources - Approval and planning (NPC-300). https://www.ontario.ca/page/environmental-noise-guideline-stationary-and-transportation-sources-approval-and-planning.

Standard Operating Procedure:

Light Monitoring (Human Exposure)

ENDPOINTS	
▪ Light	
REFERENCE INFORMATION	
REFERENCE DOCUMENTS	▪ Refer to the CIE for available monitoring methods (http://cie.co.at/)
OPERATION, SERVICE, AND MAINTENANCE	
Specific procedures may vary widely by various light meter and sky glow meter manufacturers. As such, the detailed steps to operate, service, and maintain the sound level meter that is selected for use in the program should be developed in accordance with the selected INSTRUMENT MANUFACTURER'S OPERATING MANUAL. In general, light studies should be completed in the summer, during a period with no significant light contribution from the moon, and no significant cloud cover. Measurements should be conducted under equivalent conditions each time, as the atmospheric conditions, seasonal phenomena, and the lunar cycle can have a significant impact upon the results. Summer measurements are recommended as there is no chance for snow cover, which would increase the reflected light component. Sky forecasts should be used to select a night when there is no cloud cover, as presence of clouds may also increase the presence of reflected light. The sensor faceplate should be also cleaned before taking measurements and unit should be allowed to equilibrate to surrounding temperature conditions.	
ADDITIONAL EQUIPMENT REQUIRED	
▪ None	
INSTRUMENTATION QA/QC REQUIREMENTS	
REGULAR PERFORMANCE CHECK	▪ In accordance with manufacturer's specification
SCHEDULED CALIBRATION	▪ In accordance with manufacturer's specification

Dustfall Sampling Datasheet					
Station ID:		**Station Location:**		**UTM-E m** **UTM-N m**	
Field Crew:					

Sample ID	**Deployment**			**Retrieval**			**Observations**[2]
	Date	**Time**	**Additive Type**[1]	**Additive Volume (mL)**	**Date**	**Time**	

Notes:

[1] Additives may include an algaecide, anti-freeze agent, or deionized water, at the discretion of the laboratory

[2] Examples: Equipment malfunction, damage to equipment or sample media, irregularities in sampling, changes to land use and area, etc.

Evacuated Canister Datasheet					
Station ID:		**Station Location:**		**UTM-E m** **UTM-N m**	
Field Crew:					

Canister ID	Flow Controller ID	Deployment			Retrieval			Sampler Initials	Observations[1]
		Date	Time	Pressure Gauge Reading (in. Hg)	Date	Time	Pressure Gauge Reading (in. Hg)		

[1] Examples: Equipment malfunction, damage to equipment or sample media, irregularities in sampling, changes to land use and area, etc.

Gamma TLD Datasheet					
Station ID:		**Location:**		**UTM-E m** **UTM-N m**	
Field Crew:					

Sample ID	**Deployment**		**Retrieval**		**Sampler Initials**	**Observations**[1]
	Date	**Time**	**Date**	**Time**		

[1] Examples: Equipment malfunction, damage to equipment or sample media, irregularities in sampling, changes to land use and area, etc.

Particulate High-Volume Air Sampler (HVAS) Datasheet					
Station ID:		**Station Location:**		**UTM-E m** **UTM-N m**	
Field Crew:					

Sample Start				**Sample End**		**Flow Chart Reading**		**Operator Initials**	**Observations[1]**
Date	**Time**	**Filter ID**	**Timer Reading**	**Date**	**Timer Reading**	**Start**	**End**		

[1] Examples: Equipment malfunction, damage to equipment or sample media, irregularities in sampling, changes to land use and area, etc.

Passive Sampling of Trace Gases Datasheet					
Station ID:		**Station Location:**		**UTM-E m** **UTM-N m**	
Field Crew:					

COPC	**Sampler Head**	**Badge No.**	**Deployment**		**Retrieval**		**Sampler Initials**	**Observations**[1]
			Date	**Time**	**Date**	**Time**		
NO_2	1							
	2							
NO_x	1							
	2							
SO_2	1							
	2							
VOC	1							
	2							
NH_3	1							
	2							
PAH	1							
	2							

[1] Examples: Equipment malfunction, damage to equipment or sample media, irregularities in sampling, changes to land use and area, etc.

Polyurethane Foam (PUF) High-Volume Air Sampler (HVAS) Datasheet					
Station ID:		**Station Location:**		**UTM-E m** **UTM-N m**	
Field Crew:					

Sample Start						**Sample End**			**Operator Initials**	**Observations[1]**
Date	**Time**	**Filter ID**	**PUF ID**	**Timer Reading**	**Magnehelic Reading**	**Date**	**Timer Reading**	**Magnehelic Reading**		

[1] Examples: Equipment malfunction, damage to equipment or sample media, irregularities in sampling, changes to land use and area, etc.

Radon Datasheet					
Station ID:		**Station Location:**		**UTM-E m** **UTM-N m**	
Field Crew:					

Sample ID	Deployment		Retrieval		Sampler Initials	Observations[1]
	Date	Time	Date	Time		

[1] Examples: Equipment malfunction, damage to equipment or sample media, irregularities in sampling, changes to land use and area, etc.

J.5

SOIL

Standard Operating Procedure:

Surficial Soil Sample Collection

DATASHEETS	
▪ Surficial Soils Datasheet ▪ Field maps ▪ Laboratory Chain of Custody (COC) forms	
CONTAMINANTS OF POTENTIAL CONCERN (COPC)	
▪ See Appendix E of Environmental Media Baseline Program Final Sample Design report	
REFERENCE INFORMATION	
REFERENCE DOCUMENTS	▪ U.S. EPA *Soil Sampling – Field Branches Quality System and Technical Procedures* (U.S. EPA 2014) ▪ CCME *Guidance Manual for Environmental Site Characterization* (CCME 2016) ▪ USDA *Sampling Soils for Nutrient Management* (USDA 2012), based on Schoeneberger et al. (2012) ▪ Instrument Manufacturer Operating Manual for selected sampler model
OPERATION, SERVICE, AND MAINTENANCE	
Specific procedures may vary widely by various manufacturers and samplers that have been approved by the U.S. EPA for surficial soil sampling. As such, the operation, service, and maintenance of the sampler that is selected for use in the program should be completed in accordance with the INSTRUMENT MANUFACTURER'S OPERATING MANUAL.	
EQUIPMENT REQUIRED	
▪ Soil sampler (e.g. stainless steel trowel) ▪ Laboratory-provided sampling containers ▪ Personal protective equipment (nitrile gloves) ▪ Plastic sheeting to protect equipment from cross-contamination ▪ Decontamination equipment (e.g., Liquinox) ▪ Container for mixing aliquots (e.g., stainless steel mixing bowl) ▪ GPS equipment ▪ Digital camera	
SAMPLING DETAILS	
▪ Soil samples should be properly preserved and sufficiently large in volume for sodium adsorption ratio analysis; consult laboratory prior to analyses to determine sample volumes. ▪ Physical descriptions of soils will be noted during sampling, including visual classification, grain size estimation, *in-situ* moisture content, color, and soil type. Soil classification will follow the Canadian System of Soil Classification (Soil Classification Working Group 1998).	

- Additional parameters are to be recorded on soil sampling field forms, including GPS data, weather, short description of the sample location, and two photographs of the sample location.
- Field parameters will be collected for each soil sample, including pH, moisture content, and the content of water-soluble nutrients such as ammonia, nitrate, and phosphate. The latter can be conducted using colorimetric methods available through commercial test kits (e.g., Hach Kits [Hach North America]).

CUMULATIVE EFFECTS

In order to gather additional information about the study area and assess the potential for cumulative effects, land use information (e.g., undisturbed forest, community, forestry, cabins, agriculture) and other pertinent information (e.g., industry, contaminant sources, road proximity) is to be recorded at each sampling location and along access routes as relevant. This information is to be recorded the first time a new sampling location is visited or if land use changes at that sampling location. Record the information on the data sheets and be sure to take lots of pictures.

SAMPLING QA/QC REQUIREMENTS

GENERAL MEASURES	▪ Visual inspection of the sampling instrument for scratches or other damage is required ▪ Sampling should be conducted using nitrile gloves ▪ Ensure that appropriate and clean sample containers are used ▪ Do not allow the inner surfaces of sample containers or lids to come in contact with anything other than the sample ▪ Between each sample, all equipment should be decontaminated in three steps: 1) thoroughly rinse with deionized water; 2) rinse with a dilute solution of mild soap (e.g. Liquinox); and 3) rinse with deionized water ▪ When loading the samples into coolers for transport, check-off the laboratory COC to double-check that all samples are accounted for ▪ If shipping is required, ensure the containers are upright and well-sealed; use proper COC and mark the shipping container appropriately ▪ Sample submittal to the laboratory will occur as soon as possible to ensure that holding times are not exceeded for certain parameters ▪ Ensure the COC contains accurate information regarding samples collection date and time and analyses requested
DUPLICATES – 20% OF TEST SAMPLES	Field duplicate samples will be taken at a frequency of 20% of the test samples to ensure that sampling and laboratory analyses produce repeatable results. A duplicate sample requires collecting a full second test sample at the sample location.

RINSEATE BLANK	One rinseate blank will be used per sampling day to check contamination of the sampling device from any sources of field contamination. A rinseate blank is collected by pouring deionized water supplied by the laboratory over the soil sampling device (e.g., stainless steel trowel) and submitting the resulting water sample for analysis.
TRIP BLANK – ONE PER SAMPLING DAY	One trip blank will be used per sampling day to check contamination of sample jars from sources of VOCs (e.g., gasoline-fueled vehicles) during sampling and cooler transport. The trip blank sample is transported to and from the field without modification and is only opened at the time of laboratory analysis.

REFERENCES

CCME. 2016. Guidance manual for environmental site characterization in support of environmental and human health risk assessment. Volume 3 Suggested Operating Procedures. PN 1555.

Schoeneberger, P.J., D.A. Wysocki, E.C. Benham, and Soil Survey Staff. 2012. Field book for describing and sampling soils. Version 3.0. Natural Resources Conservation Service, National Soil Survey Center, Lincoln, NE.

U.S. EPA. 2014. Field branches quality system and technical procedurs: Soil sampling. SESDPROC-300-R3, August.

USDA. 2012. Sampling soils for nutrient management. Natural Resources Conservation Service, June.

Surficial Soils Datasheet					
Sample ID:		**Sample Location:**	SSA/LSA/RSA (circle one) Ecosite Name:	**Coordinates:**	

Sample Collection		**Sample Description**						**Sampler Initials**	**Visual Observations**
Date	**Time**	**Depth (m)**	**Color**	**Grain Size**	**Grain Sorting**	**Moisture**	**Photo #**		

Land Use Information **(to be completed during first visit, if station location changes, or if land use changes)**
What is the land use (e.g., undisturbed forest, community, forestry, cabins, agriculture, etc.)? **Take pictures.**
Is there a road near the station? Yes / No If yes, approximately how far away is the road from the station (specify units)?
Is there sign of disturbance (e.g., forestry clearing, cabins, recent forest fire)? Yes / No If yes, please describe and take pictures. If yes, approximately how far away is the disturbance from the station?
Are there any sources of contaminants (e.g., manure, livestock) near the station? Yes / No If yes, please describe and indicate if historical or unknown.
Comments/Observations: