# *D10 HUMAN HEALTH RISK ASSESSMENT UPDATE*

# MARATHON PALLADIUM PROJECT – HUMAN HEALTH RISK ASSESSMENT UPDATE

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# MARATHON PALLADIUM PROJECT – HUMAN HEALTH RISK ASSESSMENT UPDATE

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# EXECUTIVE SUMMARY

Generation PGM Inc. (GenPGM) proposes to develop the Marathon Palladium Project (the "Project"), which is a platinum group metals (PGM), copper (Cu) and possibly iron (Fe) open-pit mine and processing operation near the Town of Marathon, Ontario. The Project is being assessed in accordance with the *Canadian Environmental Assessment Act* (CEA Act, 2012) and Ontario's *Environmental Assessment Act* (EA Act) through a Joint Review Panel (the Panel) pursuant to the *Canada-Ontario Agreement on Environmental Assessment Cooperation* (2004).

The information presented in this assessment of human health is based on information provided in the Environmental Impact Statement (EIS) Addendum Volumes 1 and 2, updated 2020 Baseline Reports, responses to Information Requests, 2012 Supporting Information Documents (SIDs) and original Environmental Impact Statement (EIS) (2012). This assessment looks at potential effects on human health in the context of air quality, water quality, country foods, noise and electromagnetic fields. Predicted concentrations of constituents of potential concern (CoPCs) and environmental stressors were evaluated to identify issues requiring further assessment from a human health perspective, as described in the following sections.

**Air Quality**

During all active phases of the Project, atmospheric emissions of suspended particulate matter ($PM_{10}$, $PM_{2.5}$, total suspended particulates (TSP) and the crystalline silica component of $PM_{10}$), sulphur and nitrogen oxides ($SO_2$ and $NO_x$), carbon monoxide (CO), polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs) and metals will occur. Modelling results indicated that most airborne parameters are predicted to remain below relevant health-based air quality criteria and therefore below levels associated with potential human health effects.

A small number of CoPCs exceeded either their short-term and/or long-term criteria and were evaluated in more detail either quantitatively as was the case for benzene, and benzo(a)pyrene, or qualitatively as was the case for nickel, crystalline silica and nitrogen dioxide. Potential adverse effects on human health were evaluated for short-term exposure scenarios for visitors near the modelled property boundary, and for short-term and long-term exposure scenarios for seasonal residents at Hare Lake, subsistence harvesters at Hare Lake, Bamoos Lake and Pic River, and residents of Marathon near the potential rail load-out area.

With mitigation and environmental protection measures implemented, residual effects on human health from changes in air quality are not expected to be significant during any phase of mine life. For the CoPCs predicted to exceed relevant air quality criteria, either the Project contribution is small, the predicted residual effects are infrequent at potentially susceptible receptors, or the geographic extent is restricted to within the modelled property

boundary or immediate surroundings. Although relevant air quality criteria were exceeded at some model locations, either the exceedances do not occur at locations of potentially susceptible receptors, or the predicted exposure ratios and cancer risk estimates are below target benchmarks set by Health Canada.

As changes to air quality were not identified as an adverse effect on human health and did not differ substantially from background where subsistence harvesters may harvest country foods, no CoPCs from Project-related air emissions were identified as being likely to deposit on soil and/or accumulate in country foods at levels of concern to human health.

Consistent with the original EIS and responses to information requests, the updated assessment indicated that changes to air quality from the Project are not expected to result in adverse human health effects.

**Drinking Water Quality**

No existing or foreseeable groundwater users are located in the areas where groundwater quality is predicted to exceed provincial and/or federal drinking water standards. The potable water supply well for the Project is expected to be located either cross- or up-gradient from potential sources of mine-related CoPCs in groundwater. Groundwater recharge from the PSMF is predicted to be less than provincial and federal drinking water standards therefore, no adverse effects on human health are expected from drinking surface water or from potential future water supply wells at Hare Lake.

Groundwater in the Town of Marathon and Biigtigong Nishnaabeg First Nation is used for potable purposes. The Town of Marathon Official Plan shows that an area to the south of the Project site is designated as a Groundwater Protection Zone. The Groundwater Protection Zone is not hydraulically connected to the shallow groundwater at the Project site and therefore there is no potential for the Project site to impact the Town's drinking water supply. The Town's wells are 6 km from the southern edge of the Process Solids Management Facility (PSMF). The groundwater supply wells for Biigtigong Nishnaabeg are located over 15 km from the southern edge of the PSMF and Mine Rock Storage Area (MRSA). There is no connectivity between the groundwater flow paths for the Project site and the groundwater supply wells for Biigtigong Nishnaabeg and therefore there is no potential for the Project site to impact the drinking water supply for Biigtigong Nishnaabeg.

No adverse effects on human health are expected because no potable water supply wells are expected to be affected by changes in groundwater quality related to the Project. No CoPCs in drinking water were carried forward for further assessment.

Consistent with the original EIS and responses to information requests, the updated assessment indicated that changes to groundwater quality from the Project are not expected to result in adverse human health effects from drinking groundwater.

**Surface Water Quality**

During operations, excess water from the PSMF and MRSA will report to Hare Lake. Surface water quality in Hare Lake is not predicted to exceed applicable surface water quality benchmarks, which are protective of aquatic life and human health, or will be in the range of existing background concentrations. Therefore, no constituents in surface water during operations were identified for further assessment.

Post-closure, drainage from the PSMF will report to the Stream 105 and 106 subwatersheds, and drainage from the MRSA, open pits and water management pond will report to the Pic River. Surface water concentrations of constituents in the Stream 105 and 106 subwatersheds and the Pic River are not predicted to exceed applicable surface water quality benchmarks or will be in the range of existing background concentrations. No adverse effects on human health are anticipated from exposure pathways related to surface water quality. Therefore, no constituents in surface water post-closure were identified for further assessment.

Consistent with the original EIS and responses to information requests, the updated assessment indicated that changes to surface water quality from the Project are not expected to result in adverse human health effects.

**Country Foods**

No herbicide or pesticide use is anticipated at the mine site or along the proposed transmission line corridor; therefore, no CoPCs related to herbicide or pesticide use are identified for country foods.

Overall, there are minimal predicted Project-related effects on concentrations of constituents in the environment that would result in changes to concentrations of constituents in country foods where country foods are likely to be harvested. The screening of predicted air and water quality did not identify any CoPCs to carry forward into a country foods assessment. Therefore, adverse effects on human health from country foods consumption are not expected from Project-related air and water emissions.

Consistent with the original EIS and responses to information requests, the updated assessment indicated that the Project will have limited effects on concentrations of constituents in the environment, country foods and human health.

**Noise**

Current noise levels in the vicinity of the Project site are typical of a rural setting, dominated by natural sounds. Current noise levels at the intersection of Highway 17 and Peninsula Road are higher, characteristic of an urban hum. An updated noise assessment was undertaken to assess noise levels at noise sensitive receptors in close proximity the Project site, along Highway 17 transportation corridor, along the transportation corridor to the

potential concentrate rail load-out facility, and at the potential concentrate rail load-out facility.

Noise levels are not predicted to exceed guidelines for community annoyance and sleep disturbance and are not expected to adversely affect human health during any phase of the Project. Consistent with the original EIS and responses to information requests, the updated assessment indicated that the Project will have limited effects on the acoustic environment.

**Electromagnetic Fields**

Health Canada and the Federal-Provincial-Territorial Radiation Protection Committee believe that there is insufficient scientific evidence to conclude that exposures to EMFs from power lines cause health problems. Further, the closest receptor to the proposed project power line is a cottage on Hare Lake, and it is approximately 2 to 3 km from this line. Therefore, exposure to EMFs was not identified as a human health issue requiring further assessment.

**Summary of the Human Health Risk Assessment**

With the proposed mitigation and management measures, environmental exposures from Project-related changes in air quality, water quality and noise are predicted to be less than benchmarks protective of human health and are not expected to adversely affect human health. The screening of predicted air and water quality did not identify any CoPCs to carry forward into a country foods assessment.

GenPGM recognizes the importance of traditional land and resource use and activities and is committed to working with Indigenous communities to monitor country foods. GenPGM will continue to engage BN and other interested Indigenous groups in monitoring activities for the Project. The program can be used as a means to communicate results of environmental monitoring to help alleviate concerns Indigenous resource users may have regarding potential Project impacts.

Consistent with the original EIS and responses to information requests, the updated assessment indicated that Project-related changes in air quality, water quality, country foods, noise and EMFs are not expected to adversely affect human health.

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# ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| AIR | Additional Information Request |
| ANFO | Ammonium Nitrate Fuel Oil |
| BN | Biigtigong Nishnaabeg |
| CCME | Canadian Council of Ministers of the Environment |
| CEAA | Canadian Environmental Assessment Act |
| CEA | Canadian Environmental Assessment |
| CIAR | Canadian Impact Assessment Registry |
| CMC | Carboxymethyl Cellulose |
| CO | Carbon Monoxide |
| COAP | Cancer Outdoor Air Prorating |
| CoPCs | constituent of potential concern |
| CSF | Cancer Slope Factor |
| CSM | Conceptual Site Model |
| Cu | Copper |
| dB | Decibel |
| DE | Diesel Exhaust |
| DPM | Diesel Particulate Matter |
| EA | Environmental Assessment |
| ECA | Environmental Compliance Approval |
| EDS | Environmental Design Storm |
| EEM | Environmental Effects Monitoring |
| EIS | Environmental Impact Statement |
| ELF | Extremely Low Frequency |
| EMF | Electromagnetic Field |
| EMMP | Environmental Monitoring and Management Program |
| ER | Exposure Ratio |
| Fe | Iron |
| FNFNES | First Nations Food, Nutrition and Environmental Study |
| FMZ | Fish Management Zone |
| GCDWQ | Guidelines for Canadian Drinking Water Quality |
| GenPGM | Generation PGM Inc. |
| GLC | Ground Level Concentration |
| %HA | Percent Highly Annoyed |
| HC | Health Canada |
| HHRA | Human Health Risk Assessment |
| ILCR | Incremental Lifetime Cancer Risk |
| IR | Information Request |
| IUR | Inhalation Unit Risk |
| JSL | Jurisdictional Screening Levels |
| KPI | Key Person Interviews |
| kV | Kilovolt |
| $L_d$ | Daytime equivalent sound level |

| | |
|---|---|
| $L_{dn}$ | Day-night average sound level |
| $L_n$ | Nightime equivalent sound level |
| LSA | Local Study Area |
| m | Metre |
| MDL | Method Detection Limit |
| MECP | Ontario Ministry of the Environment, Conservation and Parks |
| MMER | Metal Mining Effluent Regulations |
| MNO | Métis Nation of Ontario |
| MNRF | Ministry of Natural Resources and Forestry |
| MOE | Ontario Ministry of the Environment |
| MOVES | Motor Vehicle Emission Simulator |
| MRSA | Mine Rock Storage Area |
| NAPS | National Air Pollution Surveillance |
| Non-PAG | Non-Potentially Acid Generating |
| $NO_2$ | Nitrogen dioxide |
| $NO_x$ | Nitrogen Oxides |
| NSR | Noise Sensitive Receptor |
| $O_3$ | Ozone |
| OCIP | Ontario Coalition of Indigenous People |
| ODWQS | Ontario Drinking Water Quality Standards, Objectives and Guidelines |
| O. Reg. | Ontario Regulation |
| PAG | Potentially Acid Generating |
| PAH | Polycyclic Aromatic Hydrocarbons |
| PGM | Platinum Group Metal |
| PM | Particulate Matter |
| PMFM | Pic Mobert First Nation |
| PORs | Points of Reception |
| PPFN | Pays Plat First Nation |
| PQRA | Preliminary Quantitative Risk Assessment |
| PSMF | Process Solids Management Facility |
| PTTW | Permit to Take Water |
| PWQO | Provincial Water Quality Objective |
| QA/QC | Quality Assurance Quality Control |
| RAF | Relative Absorption Factor |
| RSA | Regional Study Area |
| RSMIN | Red Sky Métis Independent Nation |
| SID | Supporting Information Document |
| SIR | Supplemental Information Request |
| SME | Site Mix Emulsion |
| SNSMC | Superior North Shore Métis Council |
| $SO_2$ | Sulphur Dioxide |
| SSA | Site Study Area |
| $SO_2$ | Sulphur Dioxide |
| TEF | Toxic Equivalency Factor |

| | |
|---|---|
| TGCL | True Grit Consulting Ltd. |
| TLRU | Traditional Land And Resource Use |
| TRV | Toxicity Reference Value |
| TSP | Total Suspended Particulate |
| TWA | Time Weighted Average |
| um | Micrometers |
| URF | Unit Risk Factor |
| US EPA | United States Environmental Protection Agency |
| VOC | Volatile Organic Compound |
| WMP | Water Management Pond |
| WMU | Wildlife Magement Unit |

# 1.0 Introduction

Generation PGM Inc. (GenPGM) proposes to develop the Marathon Palladium Project (the "Project"), which is a platinum group metals (PGM), copper (Cu) and possibly iron (Fe) open-pit mine and processing operation near the Town of Marathon, Ontario. The Project is being assessed in accordance with the *Canadian Environmental Assessment Act* (CEA Act, 2012) and Ontario's *Environmental Assessment Act* (EA Act) through a Joint Review Panel (the Panel) pursuant to the *Canada-Ontario Agreement on Environmental Assessment Cooperation* (2004).

The Project is located approximately 10 km north of the Town of Marathon, Ontario (**Figure 1-1**). Marathon is a community of approximately 3,300 people (Statistics Canada, 2017) located adjacent to the Trans-Canada Highway (Highway 17) on the northeast shore of Lake Superior approximately 300 km east of Thunder Bay and 400 km northwest of Sault Ste. Marie. The centre of the Project footprint sits at approximately 48° 47′ N latitude, 86° 19′ W longitude (UTM NAD83 N16 Easting 550197 and Northing 5403595). The footprint of the proposed mine location is roughly bounded by Highway 17 and the Marathon Airport to the south, the Pic River and Camp 19 Road to the east, Hare Lake to the west, and Bamoos Lake to the north. Access is currently gained through Camp 19 Road.

Ecometrix Incorporated (Ecometrix) was retained by GenPGM to conduct an updated assessment of potential effects on human health as a result of the Project. This report provides an update to the human health effects assessment described in the information currently on the record, including:

- Section 6.2.9 of the Marathon PGM-Cu Environmental Impact Statement prepared by Stillwater Canada Inc. (2012) (CIAR# 224)
- Response to SIR10 (CIAR #582) – Human Health Risk Assessment (HHRA)
- Response to AIR16 (CIAR #659) – Human Health Risk Assessment (including monitoring plan for country foods)

This updated human health assessment has been completed to inform the Addendum to the Marathon Palladium Project Environmental Impact Statement (EIS Addendum Vol 1 and 2) as input to the Joint Review Panel process. It has been prepared pursuant to CEA Act, 2012 and in consideration of the *Guidelines for the Preparation of an Environmental Impact Statement – Marathon Platinum Group Metals and Copper Mine Project* (EIS Guidelines) (Canadian Environmental Assessment Agency (CEA Agency) and Ontario Ministry of the Environment (MOE, now the Ontario Ministry of the Environment, Conservation and Parks (MECP)), 2011).

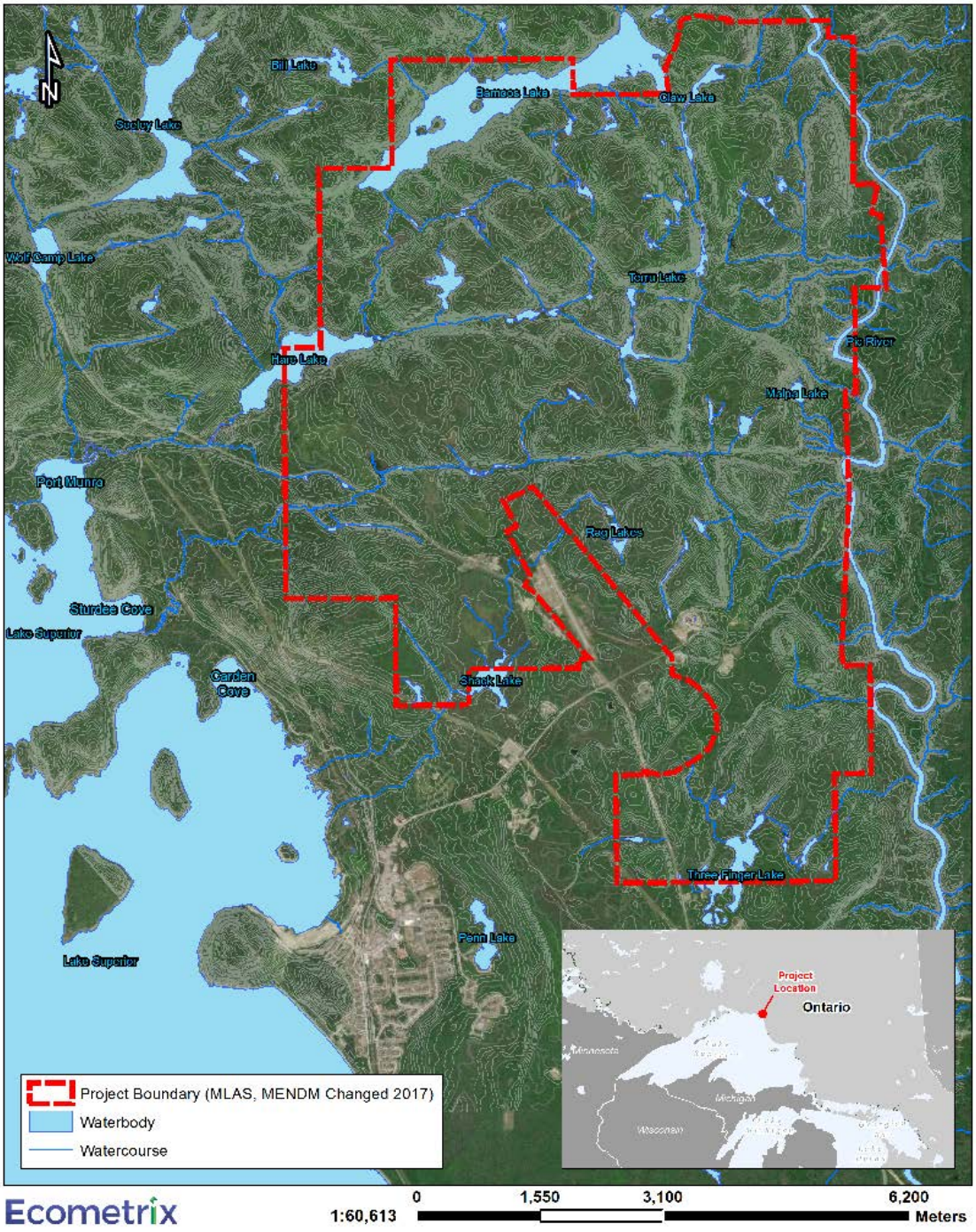


**Figure 1-1: Location of the Marathon Palladium Project**

## 1.1 Assessment Purpose and Objectives

GenPGM has implemented a series of refinements to the Project (including mine design, project activities and external locations/processes) to improve the efficiency of mining operations, to address changes to mining practices, and to reduce potential effects to the environment. Many of these refinements were also informed through the comments received during consultation and engagement activities for the Project.

The purpose of this updated human health effects assessment is to address changes relative to the original EIS submission, including

- Changes to the characterization of existing baseline conditions since previous baseline studies
- Changes to applicable criteria, standards, guidelines and/or thresholds for determining the significance of potential residual environmental effects
- Changes to the Project, including refinements to project components and activities implemented by GenPGM

The information presented in this report is intended to identify changes in air quality, water quality, country foods, noise and electromagnetic fields to determine potential effects of the Project on human health.

The impact assessment includes the following sections:

- Project overview and purpose of this assessment, as well as the identification of spatial and temporal Project boundaries (Section 1.0)
- Summary of previous impact assessment findings (Section 2.0)
- Identification of regulatory framework used for the assessment (Section 3.0)
- Review of existing conditions (Section 4.0)
- Human health risk assessment (Section 5.0)
  - Problem formulation to identify linkages between constituents of potential concern (CoPCs) and receptors and create a conceptual site model (CSM) based on knowledge of traditional and recreational land uses (Section 5.1)
  - Exposure assessment to quantify potential exposure of receptors via routes of exposure (Section 5.2)
  - Hazard assessment to determine toxicity benchmarks and factors affecting toxicity based on the relationships between exposures and incidence/severity of effects (Section 5.3)
  - Risk characterization to predict risk to human health (Section 5.4)

- Results and Discussion (Section 6.0)
  - Discussion of uncertainties, conservatism and confidence in predicted effects (Section 6.1)
  - Determination of residual health risks to provide the rationale for classification of residual effects (Section 6.2)
  - Mitigation measures to describe measures to eliminate, reduce or control unacceptable health risks (Section 6.3)
  - Monitoring plan to describe monitoring to validate the accuracy of predictions and effectiveness of mitigation measures and to engage communities (Section 6.4)
- Updated summary of potential predicted residual effects (Section 7.0)

References consulted in the preparation of this report are listed in Section 8.0.

## 1.2 Assessment Boundaries

The spatial and temporal boundaries of the assessment of the Project are presented in Sections 2.4 and 2.5 of the EIS Addendum, respectively. The changes to spatial boundaries used to assess potential effects on human health reflect refinements to the Project footprint and claim boundary, and the addition of spatial boundaries for land and resource users. The changes to temporal boundaries used to assess potential effects on human health reflect reflect refinements to the timing and duration of the phases of the Project.

### 1.2.1 Spatial Boundaries

The spatial boundaries for the assessment of environmental effects are presented in Section 2.4 of this EIS Addendum (Vol 2). The Site Study Area (SSA) is consistent across all VECs whereas the Local and Regional Study Areas (LSAs and RSAs) are defined based on the extent of potential effects specific to each VEC. The spatial boundaries for assessing human health effects encompass the areas where there are potential Project-related changes in air quality, water quality, country foods and noise that could affect human health. The Human Health spatial boundaries are generally consistent with those used in the original EIS (2012). The changes to spatial boundaries for each VEC relevant to the assessment of human health effects are described in Sections 6.2.1.3.4 (air quality), 6.2.2.3.4 (noise), 6.2.3.3.4 (water quality) and 6.2.9.3.4 (land and resource use) of this EIS Addendum (Vol 2).

The updated Human Health spatial boundaries are shown on **Figure 1-3**. The changes to Human Health spatial boundaries reflect refinements to the project footprint and claim boundary, and the addition of spatial boundaries for land and resource users.

- Site Study Area: The SSA is the direct footprint of the Project. The SSA is the same for all VECs. The SSA has been revised from the original EIS (2012) to reflect changes and

refinements to the Project design. The immediate area in which Project activities and components may occur is shown in **Figure 1-2**.

- Local Study Area: The Human Health LSA represent the maximum area within which environmental effects from Project activities and components can be predicted or measured with a reasonable degree of accuracy and confidence. The Human Health LSA includes the atmospheric, acoustic, aquatic and land and resource use LSAs as shown in **Figure 1-3**. These LSAs represent the areas where residual air quality and/or noise effects could reasonably be expected to occur, where local subwatersheds drain and where local wildlife movements on and off the site could reasonably be expected to occur. The LSAs consist of the SSA and adjacent areas where Project related environmental effects are reasonably expected to occur based on available information and professional judgment.

- Regional Study Area: The Human Health RSA is the area within which residual environmental effects from Project activities and components may interact cumulatively with the residual environmental effects of other past, present and future (i.e., certain or reasonably foreseeable) physical activities. The RSA is based on the potential for interactions between the Project and other existing or future potential projects in regard to human health effects from biophysical changes. The Human Health RSA includes the atmospheric, acoustic, aquatic and land and resource use RSAs, as shown in **Figure 1-3**.

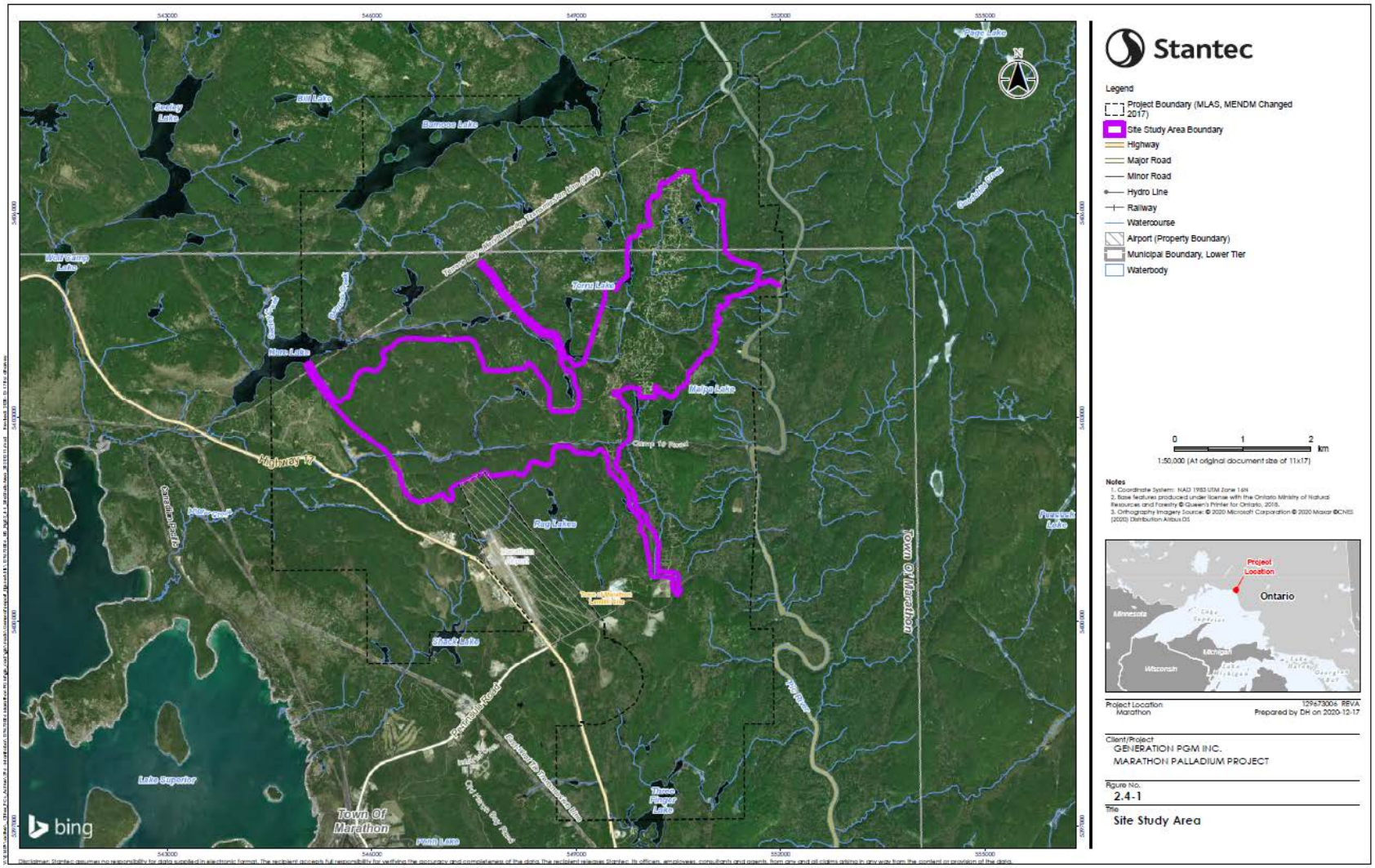


**Figure 1-2: Site Study Area**

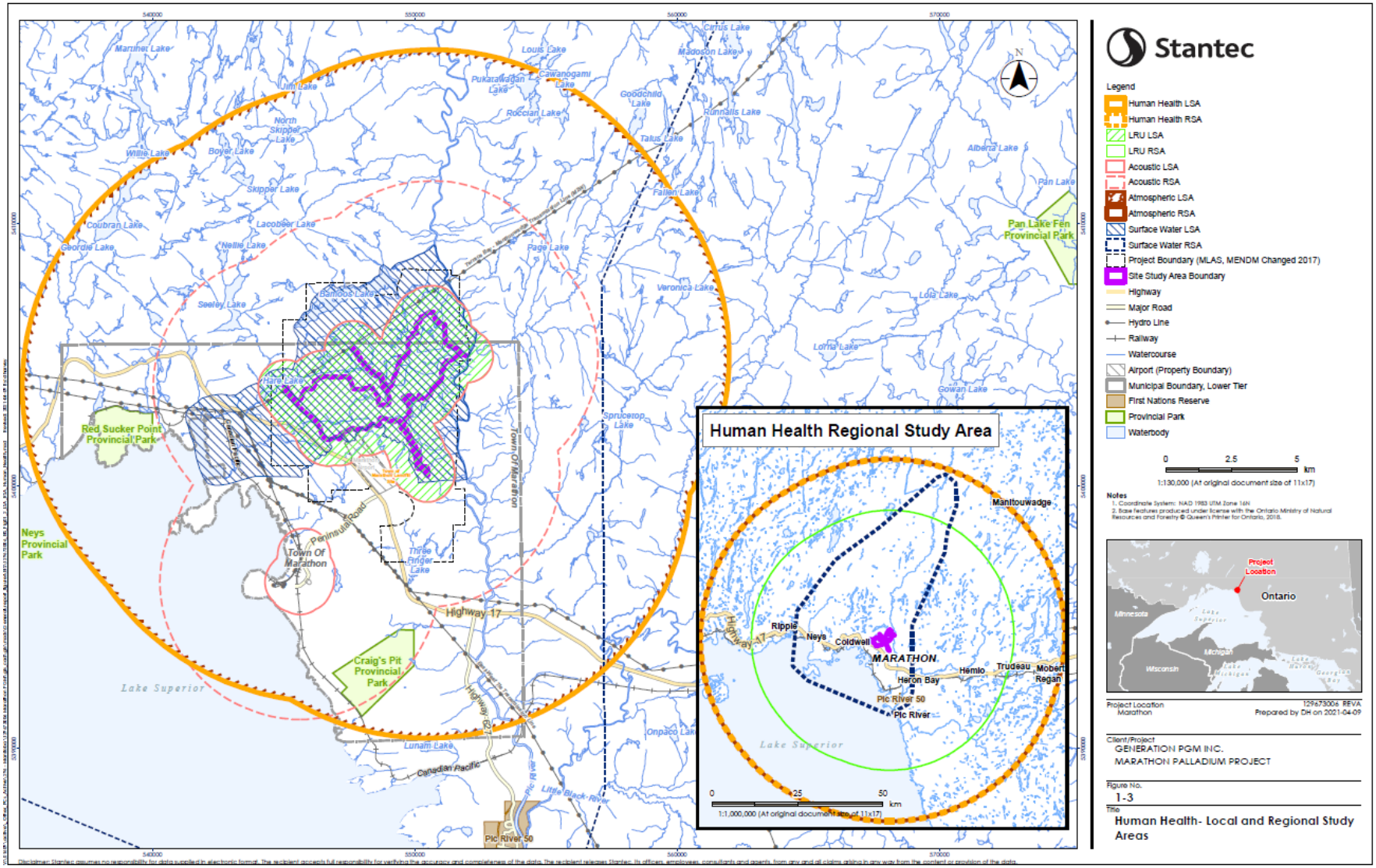


**Figure 1-3: Human Health - Local and Regional Study Areas**

### 1.2.2 Temporal Boundaries

The temporal boundaries for the Project considered in the determination of environmental effects are described in Section 2.5 of the EIS Addendum (Vol 1). The temporal boundaries used to assess potential effects on human health span all phases of mine life.

The assessments of potential effects on human health from noise and air emissions focus on the site preparation/construction and operation phases of the Project. Project-related effects from noise and air emissions during decommissioning are expected to be less than predicted effects during the site preparation/construction and operation phases of the Project. No Project-related noise or air emissions are expected during the post-closure phase.

The assessment of potential effects on human health from water emissions focuses on the operation and post-closure phases of the Project. The discharge of excess treated water to Hare Lake is expected to begin during the operation phase. Project-related effects from water emissions during the site preparation/construction and decommissioning phases are expected to be less than predicted effects during the operation and post-closure phases of the Project.

## 1.3 Project Description

The Project site is located within the Abitibi Plains ecoregion of the Boreal Shield ecozone. The terrain is moderate to steep, with frequent bedrock outcrops and prominent east-west oriented valleys. Several watercourses and lakes traverse the area, with drainage flowing either eastward to the Pic River or westward to Lake Superior. The climate of this area is typical of northern areas within the Canadian Shield, with long winters and short, warm summers.

The Project is proposed on Crown Land, with GenPGM holding surface and/or mineral rights for the area. Regional land use activities in the area include hunting, fishing, trapping and snowmobiling, as well as mineral exploration (and mining) and forestry. Other localized land uses in the area include several licensed aggregate pits, the Marathon Municipal Airport, the Marathon Landfill, a municipal works yard and several commercial and residential properties.

The primary industries in the area have historically been forestry, pulp and paper, mining and tourism. Exploration for copper and nickel deposits in the area extend as far back as the 1920s. A large copper-PGM deposit was discovered in 1963. Advanced exploration programs have continued across the site since then. These programs have been supported by various feasibility studies to confirm the economic viability of extracting the deposits.

Several First Nation and Métis groups were originally identified as having a potential interest in the Project based on Treaty Rights, asserted traditional territory and proximity to the Project. Traditional uses which they have identified as occurring in the area include hunting, trapping, fishing and plant harvesting, with activities generally focused on the larger waterways, such as the Pic River, Bamoos Lake and Hare Lake.

The Project is based on the development of an open pit mining and milling operation for copper and PGMs. Ore will be mined from the pits and processed (crushed, ground, concentrated) at an on-site processing facility. Final concentrates containing copper and PGM will be transported off-site via existing roadways and/or rail to a smelter and refinery for subsequent metal extraction and separation. An iron sulfide concentrate may also be produced, depending upon the results of further metallurgical testing and market conditions at that time.

Two options are currently being considered for concentrate delivery to an existing third-party facility for further processing:

- construction of a concentrate rail load-out facility either in the Town of Marathon or within the general area (not yet defined), with material transported from the site to the facility by transport truck then by train to a third-party processing facility
- delivery of concentrate material via transport truck from the site to a third-party processing facility

It is anticipated that a potential rail load-out facility would be situated on an existing rail siding in close proximity to the CP rail line. Various rail siding locations are under consideration but have not yet been confirmed. For the purposes of the human health effects assessment, the location of the rail load-out facility was considered to be located in the Town of Marathon. This location is expected to provide a "worst-case" assessment of the potential effects of the rail load-out due to its proximity to residential areas.

The construction workforce will average approximately 450 to 550 people, with a peak workforce of 900 people, and will be required for between 18 and 24 months. During operations, the work force will comprise an estimated 350 workers. The mine workforce will reside in local and surrounding communities, as well as in an Accommodations Complex that will be constructed off-site.

Most of the mine rock produced through mining activities is non-acid generating (non-PAG) and will be permanently stored in a purposefully built Mine Rock Storage Area (MRSA). The non-PAG rock (also referred to as Type 1 mine rock) will also be used in the construction of access roads, dams and other site infrastructure, as needed. Drainage from the MRSA will be collected in a series of collection basins and contact water collected will be pumped to the water management pond (WMP) in the PSMF. The collection system will be sized to manage the Environmental Design Storm (EDS), which is based on a 1 in 25 year storm event. Events larger than EDS will be conveyed through constructed overflows to Pic River. The remaining small portion of mine rock is considered to be potentially acid generating (PAG) (also referred to as Type 2 mine rock) and will be stored in the open pits or the Process Solids Management Facility (PSMF). This will ensure that drainage from the Type 2 mine rock will be contained during operations. Following closure, the Type 2 mine rock will be permanently stored below water by flooding the open pits and maintaining saturated conditions in the PSMF to prevent acid generation in the future.

Most of the process solids produced at the site will be non-PAG (Type 1 process solids) with the minority being PAG (Type 2 process solids). Both the Type 1 and Type 2 process solids will be stored in the PSMF and potentially within the open pits. In both cases, the Type 2 process solids will be managed to prevent acid generation during both the operation and closure phases of the project. Water collected within the PSMF as well as water collected around the mine site (other than the MRSA), such as water pumped from the pits or run-off collected from the plant site, will be managed within the PSMF. Excess water not needed for processing ore will be discharged, following treatment as necessary, to Hare Lake.

Access to the Project is currently provided by the Camp 19 Road, opposite Peninsula Road at Highway 17. The existing road will be upgraded and utilized from its junction with Highway 17 to a new road running north that will be constructed to access the Project site.

The Project will also require the construction of a new 115 kV transmission line that will connect to the Terrace Bay-Manitouwadge transmission line (M2W Line). The new transmission line will run approximately 2.2 km to a substation north of the Process Plant. The width of the transmission corridor will be approximately 30 m.

Power during construction will be provided by diesel generators and/or a power distribution line connected to the existing powerline located along the Camp 19 road. The power distribution line would support site preparation and construction activities until such time as the 115 kV electrical transmission line is completed.

Disturbed areas of the Project footprint will be reclaimed in a progressive manner during all Project phases. Natural drainage patterns will be restored as much as possible. The ultimate goal of mine decommissioning will be to reclaim land within the Project footprint to permit future use by resident biota and as determined through consultation with the public, Indigenous people and government. A certified Closure Plan for the Project will be prepared as required by Ontario Regulation (O. Reg.) 240/00 as amended by O. Reg.194/06 "Mine Development and Closure under Part VII of the Mining Act" and "Mine Rehabilitation Code of Ontario".

The general site layout of the components of the mine site, the transmission line corridor and access road are provided in **Figure 1-4**. For a more detailed description of the Project, refer to Chapter 1 of the EIS Addendum (CIAR #727, Volume 1).

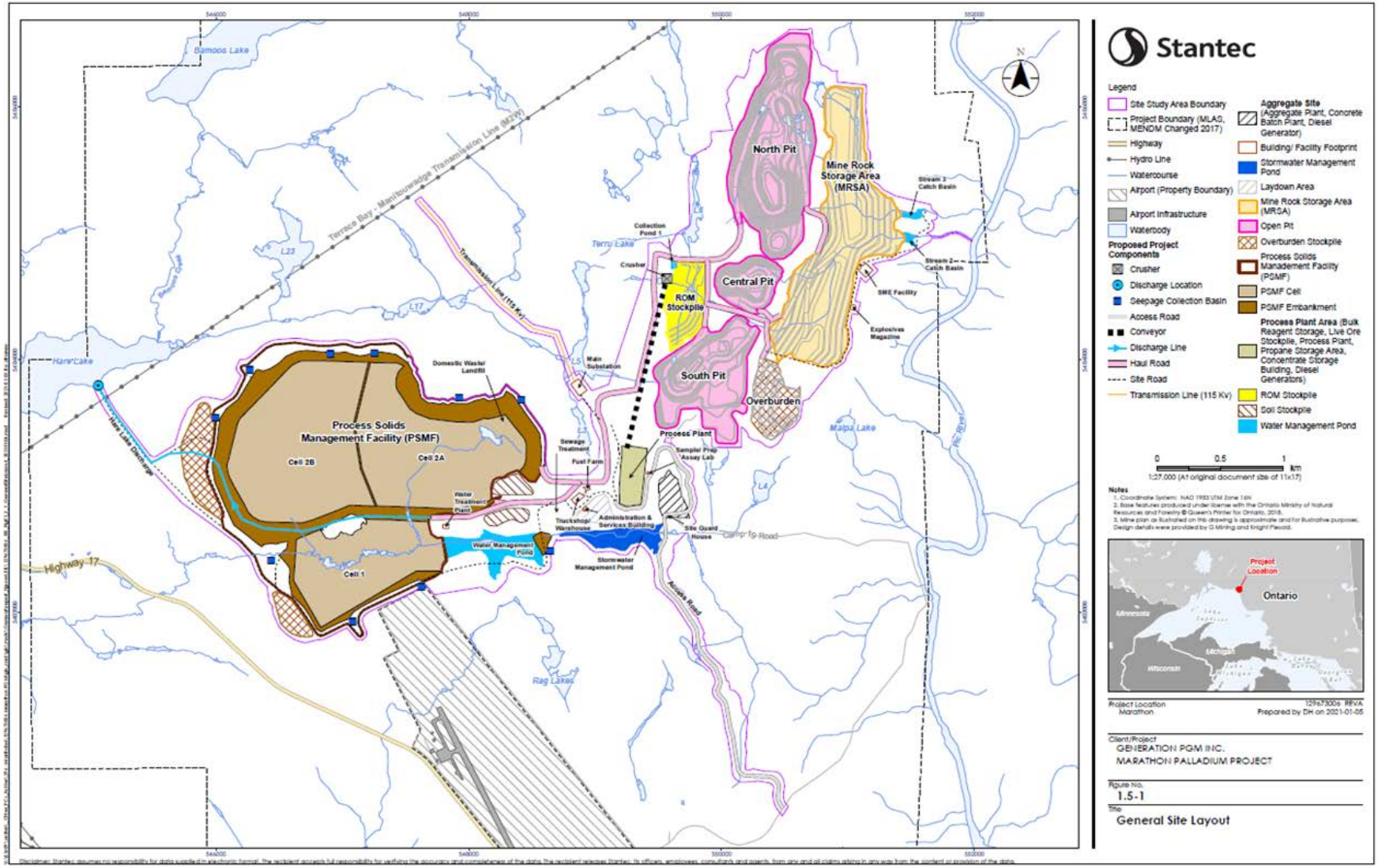


**Figure 1-4: General Site Layout**

# 2.0 Previous Assessment of Potential Effects

Section 6.2.9 of the original EIS (2012), which included human health in conjunction with other socio-economic and culture components of the environment, and subsequent responses to information requests (IRs), supplemental information requests (SIRs) and additional information requests (AIRs) from the Panel, provided an assessment of the following effects on human health conditions as a result of the Project:

- change in human health from changes in air quality, water quality, country foods, noise and electromagnetic fields (EMFs).

Additional information on the assessment of effects on human health was provided in responses to the following IRs:

- Response to IR8.2 (CIAR# 458) – Aboriginal Health as a VEC
- Response to IR11.6 (CIAR # 444) – Effects of Blasting Noise on Humans
- Response to IR12.7 (CIAR# 396) – Contaminants of Potential Concern
- Response to IR12.8 (CIAR# 396) – Use of IMPACT Model
- Response to IR22.3 (CIAR# 462) – Country Foods (fishery in Pit Lake)
- Response to IR24.1 (CIAR# 399) – Potable Water Supply for Project
- Response to IR24.2 (CIAR# 399) – Drinking Water Quality
- Response to IR24.15 (CIAR# 468) – Groundwater Leachate from the PSMF and MRSA
- Response to SIR5 (CIAR # 583) – Impacts of PSMF Discharge to Hare Lake (including bioaccumulation of CoPCs in biota at Hare Lake and Hare Creek)
- Response to SIR10 (CIAR # 582) – Human Health Risk Assessment (HHRA)
- Response to AIR16 (CIAR # 659) – Human Health Risk Assessment (including monitoring plan for country foods)

In the original EIS and responses to the information requests (IRs, SIRs, AIRs), predicted changes in air quality, surface and ground water quality, country foods, noise and EMFs related to the Project were not expected to adversely affect human health during any phase of the Project.

Metal-contaminated dust that could be of potential concern for inhalation or accumulation in soils and country foods was far below provincial criteria at the modelled property boundary during all phases of the Project. Therefore, no risks related to dust inhalation, soil ingestion or consumption of country foods were identified in relation to airborne emissions.

Predicted air concentrations met applicable provincial criteria at the modelled property boundary, with the exception of NOx. The predicted 1-hour NOx exceedances during the construction and operational phases were not considered significant because they were intermittent both spatially and temporally, occurring at only one or two locations along the modelled property boundary and only approximately 1% of the time under worst-case conditions.

Surface water quality was generally predicted to remain near background levels and/or meet applicable surface water quality guidelines during all phases of the Project. Therefore, no risks related to drinking water, recreational water or consumption of country foods were identified in relation to waterborne emissions.

No herbicide or pesticide use was anticipated at the mine site or along the proposed transmission line corridor therefore no risks related to herbicide or pesticide use were identified.

Changes in noise and electromagnetic fields were not identified as human health issues requiring further assessment during any phases of the Project.

A conceptual plan for monitoring concentrations of constituents of potential concern (CoPCs) in country foods (AIR16) was proposed as part of the larger Environmental Monitoring and Management Program (EMMP) for the Project. In consultation with local resource users, the expanded EMMP would include key country foods, such as blueberries, moose and fish. The purpose of the monitoring plan was to verify the prediction of minimal Project effects on CoPC concentrations in the environment and therefore on human health, including minimal Project-related risks from harvesting country foods.

The HHRA (SIR10) summarized the key mitigation measures proposed in the original EIS (2012) to avoid, reduce and/or offset potential effects of the Project on human health, including the following:

- Mitigation measures for potential effects on Indigenous health, including:
    - reduced footprint of the mine to avoid Bamoos Lake
    - realigned access away from Pic River
    - maintaining access to Bamoos Lake
    - on-going consultation with Indigenous communities to inform closure plans and monitoring programs
- Mitigation measures for airborne emissions, including:
    - posting speed limits and applying dust inhibitors to reduce fugitive emissions from vehicle traffic on unpaved roads, following a Dust Management Plan
    - covering trucks hauling concentrate to prevent losses during transport
    - reducing the amount of exposed beach and wetting of storage piles and the PSMF
    - covering the active ore stockpile and housing the stacker conveyor system
    - using baghouses or scrubbers in the mill to control emissions during crushing operations

  - use of low sulphur fuels, implementation of anti-idling policies and use of Tier 2 equipment or better to reduce emissions of CoPCs

- Mitigation measures for waterborne emissions, including:
  - implementation of standard erosion and sediment controls (i.e., sediment curtains, setbacks from surface water features, vegetative buffers, settling ponds) during construction
  - constructing and operating the PSMF as a closed-loop system with discharges of excess water to the environment outside of low flow scenarios to be controlled and monitored
  - installing diffusers to induce mixing of the discharge to Hare Lake within close proximity of the discharge location
  - construction and operation of a water treatment plant as part of the water management system
  - seepage mitigation strategy for the PSMF embankments, and if needed, a pump-back system
  - collection and management of runoff from the MRSA to reduce discharges to the Pic River and monitoring to manage water quality
  - submersion and covering of Type 2 (PAG) materials to prevent acidification or leaching of metals
  - decommissioning of the PSMF and MRSA areas to include monitoring of surface water quality against applicable criteria and decommissioning / naturalization of these areas once surface water run-off (PSMF, MRSA) and seepage (MRSA) have been consistently measured and proven to meet the applicable criteria

The original EIS (2012) and responses to the information requests (IRs, SIRs, AIRs) concluded that there would be no significant adverse effect on human health from Project-related changes to air quality, water quality, country foods, noise or EMFs during any phase of the Project.

# 3.0 Regulatory Background and Assessment Criteria

Generation PGM Inc. (GenPGM) proposes to develop the Marathon Palladium Project (the Project), which is a platinum group metals (PGM) and copper open-pit mine and milling operation near the town of Marathon, Ontario (**Figure 1-1**). The Project is being assessed in accordance with the *Canadian Environmental Assessment Act* (CEAA, 2012) and Ontario's *Environmental Assessment Act* (EA Act) through a Joint Review Panel (the Panel) pursuant to the *Canada-Ontario Agreement on Environmental Assessment Cooperation* (2004).

The EIS Addendum provides a list of principal agreements, conventions, policies and guidelines in Section 1.3.3 for the overall Project, Section 6.2.1.3.1 for air quality, Section 6.2.2.3.1 for noise and Section 6.2.3.3.1 for water quality. Since completion of the original EIS, new guidance for evaluating human health impacts in environmental assessment was developed by Health Canada. The updated human health risk assessment (HHRA) for the Project has been prepared in accordance with the requirements of the Environmental Impact Statement (EIS) Guidelines 2011 (Appendix C of the EIS Addendum) and draws on the following guidance documents from Health Canada:

1. Health Canada 2019. Guidance for Evaluating Human Health Impacts in Environmental Assessment: Human Health Risk Assessment
2. Health Canada 2018. Guidance for Evaluating Human Health Impacts in Environmental Assessment: Country Foods
3. Health Canada 2017. Guidance for Evaluating Human Health Impacts in Environmental Assessment: Noise
4. Health Canada 2016. Guidance for Evaluating Human Health Impacts in Environmental Assessment: Air Quality
5. Health Canada 2016. Human Health Risk Assessment for Diesel Exhaust
6. Health Canada 2016. Guidance for Evaluating Human Health Impacts in Environmental Assessment: Drinking and Recreational Water Quality
7. Health Canada 2012. Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment, Version 2.0
8. Health Canada 2010. Part V: Guidance on Human Health Detailed Quantitative Risk Assessment

# 4.0 Existing Conditions

An overview of existing environmental conditions is provided in Section 4.0 of the EIS Addendum (Vol 1) (CIAR #727). The overview describes how baseline conditions have changed since the original EIS and/or how the understanding of the baseline conditions has evolved.

The following sections describe communities, land and resource use, and results from the *First Nations Food, Nutrition and Environmental Study (FNFNES): Results from Ontario (2011/2012)* (Chan, et al., 2014) related to human health risks from the consumption of country foods.

## 4.1 Communities

The Town of Marathon is the closest population centre to the Project site. The current population of Marathon is approximately 3,300 people (Statistics Canada, 2017). The Town of Marathon is located 10 km south of the site

Nine communities are located within approximately an hour's commuting time to Marathon:

- Town of Marathon;
- Pic River 50 reserve lands (10 km from Marathon);
- Pic Mobert North and South reserve lands (73 km from Marathon);
- Terrace Bay Township (82 km from Marathon);
- Schreiber Township (96 km from Marathon);
- White River (96 km from Marathon);
- Manitouwadge Township (99 km from Marathon); and
- Pays Plat IR 51 (126 km from Marathon).

In addition to the nine communities within the RSA (i.e., within approximately 100 km of Marathon), some of the residents living within the Thunder Bay Unorganized Census Subdivision are within commuting distance of Marathon. However, most residents in this large subdivision live beyond commuting range to Marathon.

GenPGM and its predecessors have been engaged in consultation with a number of Indigenous communities with respect to the Project since 2004, including

- Pic River First Nation (now Biigtigong Nishnaabeg);
- Pic Mobert First Nation (PMFN);
- Pays Plat First Nation (PPFN);
- Red Sky Métis Independent Nation (RSMIN);
- Jackfish Métis, a community-based affiliate organization of the Ontario Coalition of Indigenous People (OCIP); and

- Superior North Shore Métis Council (SNSMC), a chartered community council of the Métis Nation of Ontario (MNO).

The closest First Nation community to the site is Biigtigong Nishnaabeg (BN). Their reserve at Heron Bay is located about 20 km south of the Project site. Their total membership is approximately 1,200. The on-reserve population is approximately 500.

The Robinson-Superior Treaty confers certain rights to Indigenous peoples in the area in which the Project site is located. BN maintains that it was not a signatory to the Robinson-Superior Treaty of 1850 and has maintained their Aboriginal title since time immemorial. BN claims exclusive Aboriginal title over traditional territory that includes the Project site.

## 4.2 Land and Resource Use

Several First Nation and Métis groups were identified as having a potential interest in the Project based on Treaty Rights, asserted traditional territory, and proximity to the Project. Traditional uses which they have identified as occurring in the area include hunting, trapping, fishing and plant harvesting, with activities generally focused on the larger waterways, such as Pic River, Bamoos Lake and Hare Lake. The harvesting of country foods is reported to play an important role in the economic, social, cultural and spiritual lives of Indigenous communities.

While all Indigenous groups indicated some current or historical general land and resources uses in the RSA, Biigtigong Nishnaabeg (BN) alone reports extensive use of the SSA/LSA for traditional land and resource related pursuits. BN reports that the preponderance of traditional dietary habits within the community is relatively high. The community has indicated that the Project site is one of a small number of areas within their asserted traditional lands utilized for such purposes. This is understood to be because the site is relatively close to their reserve (officially known as Pic River 50) and in particular can be accessed by an existing road and is at least in part accessible via the Pic River, which historically would have been a significant north-south trade and travel route.

Biigtigong Nishnaabeg reports extensive traditional land and resources uses in the general vicinity of the Project site such as hunting, trapping, fishing, plant harvesting and timber harvesting. Speckled and rainbow trout, moose, "partridge", rabbit, beaver and blueberries were identified as preferred country foods (PRFN KPI Program 2013). Rabbit, "partridge" and fish are harvested year-round as needed. The community gathers for an annual Fish Camp at the mouth of the Pic River before the biigtig (river breaks) in early spring. Moose hunting season is in the fall with the community gathering for an annual Moose Camp after the full moon in September. Some duck hunting occurs in the spring, however the region is not a good flyway. Gull eggs are collected in the spring and blueberries are collected in the summer. The airport was identified as a good spot for berry picking. The PRFN have not provided specific consumption rates for country foods but estimate that most of the community consumes at least some country foods each week. In particular, moose is estimated to be consumed three times per week on average. Large animals, such as moose and other seasonally-available animals, are frozen for consumption year-round.

Information provided by the other local Indigenous groups was more generic in nature but similarly identified the harvesting and use of animals and plants by their members in the RSA. As indicated in IR 8.2, Pic Mobert First Nation (PMFN) undertake traditional activities such as hunting, fishing and trapping to supplement their monetary economy and provide food. Almost half of the PMFN fish, and a smaller number hunt. An estimated 10 to 20% of their food is from country food sources however this amount varies by season and by family, with fall hunting providing a larger portion of country food than other seasons. There is no indication currently however of regular use of the LSA by PMFN, given the approximate 50 km distance from the Project site to the PMFN reserve.

Pays Plat First Nation (PPFN) reported that they historically used the area alongside the lower reaches of Hare Creek (Stream 5), the stream that drains Hare Lake to Lake Superior, as a camp/transient accommodation site and for related purposes in connection with past travel back and forth to Biigtigong Nishnaabeg to collect payments under the Robinson-Superior Treaty. This area has cultural importance to the PPFN. As noted in IR response 16.7, no effects or impacts from the Project have been identified in relation to PPFN use of this area.

As indicated in IR 17.2, the Métis Nation of Ontario (MNO) regional study of traditional land use and knowledge identifies the use/harvesting of several species of animals and plants in the study area (including land within a "claim boundary" that was attributed to Stillwater) including moose, rabbits, partridge, upland game birds, walleye (Three Finger Lake), lake trout (Bamoos Lake), pike, speckled trout (Bamoos Lake and rivers downstream), sturgeon (Pic River), perch (Bamoos Lake) as well as berries. Most of this activity appears to be focused in the RSA and to some extent the LSA; there was no specific information provided in the report on animal or plant harvesting use within the SSA.

The Ministry of Natural Resources and Forestry (MNRF) issues Outdoors Cards, hunting licences, validation tags and game seals to manage wildlife resources in a wildlife management unit (WMU). The LSA is located within WMU 21A and 21B. Within WMU 21A and 21B, hunting is permitted for moose, white tail deer, black bear, small game, and fur bearing animals. A variety of furbearing species are available for trapping within WMU 21A and 21B, including beaver, otter, bobcat, lynx, mink, muskrat, fisher, marten, raccoon, fox, skunk, red squirrel, weasel, black bear, wolf and coyote. Migratory waterfowl hunted in WMU 21A and 21B include ducks, rails, gallinules, coots, snipes, geese, woodcock and mourning dove.

The SSA and LSA are located within Fish Management Zone (FMZ) 7. The RSA is located in FMZ 7 and FMZ 9. Fish managed in FMZ 7 include Walleye, Sauger, Largemouth and Smallmouth bass, Northern Pike, Yellow Perch, Sunfish, Brook Trout, Brown Trout, Lake Trout, Splake, Chinook Salmon, Atlantic Salmon and Lake Whitefish. There is no recreational or Indigenous fishing in the SSA, as most of the waterbodies in the SSA are fishless or the fish community is limited to forage fish (SID #1, EcoMetrix, 2012). The LSA provides opportunities to collect coolwater large-bodied fish such as Yellow Perch and Northern Pike, as well as resident and migrating salmonids.

The province divides the territory into bait fish harvesting areas. The SSA is located within a single bait fish harvest area (NI3502). The LSA is located within two bait harvest areas (NI3101, NI3502), and the RSA is located within 23 bait harvest areas. Bait harvesting in the RSA is a licensed commercial activity.

The list of species identified as having traditional value or interest to First Nation and Métis communities was updated in Tables 12 and 13 of the *Terrestrial Baseline Updated Report* (Northern Bioscience, 2020) based on Project-specific TLRU and TEK studies and consultation input. Information about land and resource use for traditional and recreational purposes is presented in IRs 8.2, 15.2 and 17.2 and the *Socio-economic and Current Resource Use Updated Baseline Report* (Stantec, 2020) and in section 6.2.12 of the EIS Addendum (2021 [Vol 2]). The

following sections provide additional information about animal, plant and fish harvesting, as well as recreational activities, site access, habitation sites and Highway 17 land uses.

### 4.2.1 Animal Harvesting

Two registered trap lines are located in the SSA, one is registered to Biigtigong Nishnaabeg and held in trust for the community, and the other is registered to an individual who is a member of the BN community. The two trap line permit areas within the boundaries of the Project site (TR022, TR023) are shown in Figure 2.2 1. There is a trapper cabin located in TR023, to the northeast of the Project site, on Pukatawagan Lake. The majority of this trapping currently occurs in close proximity to the Camp 19 and site access roads.

The primary furbearers harvested over two winters on TR023 (2007-08 and 2008-09) were American marten (*Martes americana*), beaver (*Castor canadensis*), red fox (*Vulpes vulpes*), red squirrel (*Tamiasciurus hudsonicus*), fisher (*Martes pennant*), Canada lynx (*Lynx canadensis*) and weasel. In the 1990s, a small number of coyote (*Canis latrans*) and grey wolf were also harvested from TR023. Beaver are common in the study area with a number of active beaver lodges throughout. A beaver lodge survey was conducted in 2009 identifying 12 active lodges. American marten are the most heavily harvested and most sought after furbearer in the study area. Although harvest numbers cannot be assumed to directly reflect the population, it appears that marten are much more common than some other medium sized furbearers including fisher and Canada lynx.

As indicated in IR 17.2, while the Métis report trapping in the RSA, there are no known Métis traplines in the LSA or SSA.

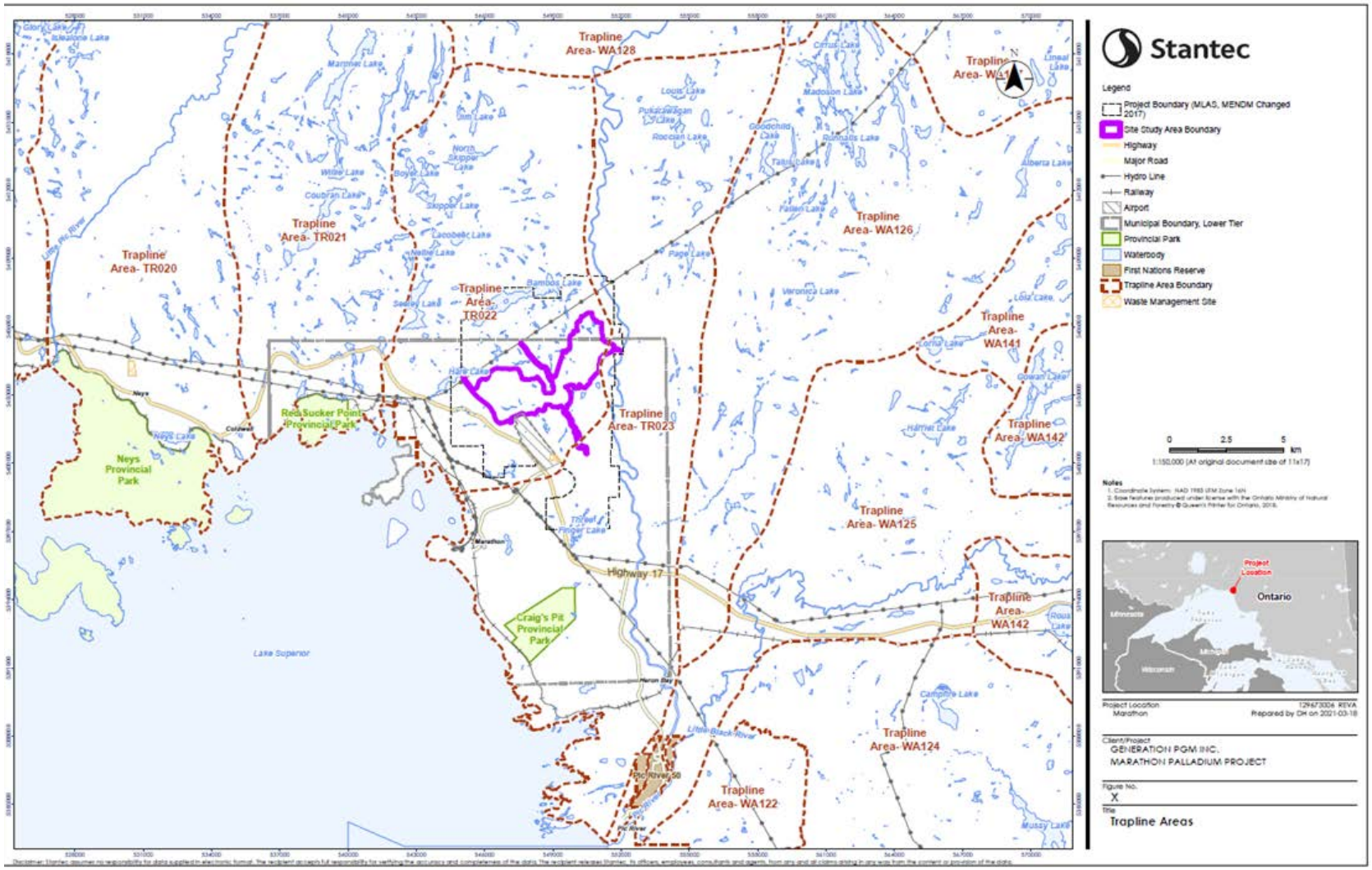


**Figure 4-1: Trap Line License Areas in the Vicinity of the Project Site**

Biigtigong Nishnaabeg reports that the SSA and LSA are important animal harvesting locations. Animal harvesting via trapping and hunting includes the collection of furbearers, large mammals and ungulates and birds. The entire SSA and a large portion of the LSA is within the BN community trap line area (**Figure 4-1**), which BN reports is used extensively with its proceeds shared within the community. BN reports utilization of animals or parts thereof (e.g., eggs, feathers) for food, cultural and medicinal purposes. Information about the range of animals collected by BN and their uses is summarized in **Table 4-1**.

**Table 4-1: Animals or Parts Thereof Identified by BN in the SSA and/or LSA as Utilized for Food, Cultural and/or Medicinal Purposes**

| Animal | Reported Use | | |
|---|---|---|---|
| | Food | Cultural | Medicinal |
| **Beaver** | ✓ | ✓ | |
| **Black Bear** | ✓ | ✓ | ✓ |
| **Lynx** | | ✓ | |
| **Deer** | ✓ | | |
| **Fisher** | ✓ | ✓ | |
| **Marten** | ✓ | ✓ | |
| **Mink** | ✓ | ✓ | |
| **Muskrat** | ✓ | | |
| **Moose** | ✓ | ✓ | |
| **Otter** | ✓ | | |
| **Porcupine** | ✓ | ✓ | |
| **Red Fox** | | ✓ | |
| **Rabbit** | ✓ | | |
| **Squirrel** | ✓ | | |
| **Weasel** | ✓ | | |
| **Wolf** | | | ✓ |
| **Blackbird** | ✓ | | |
| **Crow** | ✓ | | |
| **Duck** | ✓ | | |
| **Eagle** | | ✓ | |
| **Killdeer** | | ✓ | |
| **Geese** | ✓ | | |
| **Gulls** | ✓ | | |
| **Sandpiper** | | ✓ | |
| **Owl** | | ✓ | |
| **Papasay (woodpecker)** | | ✓ | |
| **Spruce Grouse** | ✓ | | |

A list of animal species of interest to Indigenous communities, compiled from consultations in conjunction with the Marathon project, is presented in **Table 4-2**.

**Table 4-2: Animal Species of Interest to Indigenous Communities**

| Group | Common Name | Scientific Name |
|---|---|---|
| Bird | Broad-billed Hummingbird | *Cynanthus latirostris* |
| | Broad-winged Hawk | *Buteo platypterus* |
| | Canada Goose / Goose | *Branta canadensis* |
| | Canada Warbler | *Cardellina canadensis* |
| | Common Loon | *Gavia immer* |
| | Common Nighthawk | *Chordeiles minor* |
| | Crow | *Corvus brachyrhynchos* |
| | Duck | |
| | Ferruginous Hawk | *Buteo regalis* |
| | Golden Eagle | *Aquila chrysaetos* |
| | Gulls [Herring, Ring-billed] | *Larus spp.* |
| | Killdeer | *Charadrius vociferus* |
| | Mallard Duck | *Anas platyrhynchos* |
| | Mourning Dove | *Zenaida macroura* |
| | Olive-sided Flycatcher | *Contopus cooperi* |
| | Papasay (woodpecker) | *various* |
| | Partridge / Ruffed Grouse | *Bonasa umbellus* |
| | Peregrine Falcon | *Falco peregrinus* |
| | Pheasants | *Phasianus colchicus* |
| | Piping Plover | *Charadrius melodus* |
| | Raven | *Corvus corax* |
| | Red-shouldered Hawk | *Buteo lineatus* |
| | Red-tailed Hawk | *Buteo jamaicensis* |
| | Rough-legged Hawk | *Buteo lagopus* |
| | Ruby-throated Hummingbird | *Archilochus colubris* |
| | Rufous Hummingbird | *Selasphorus rufus* |
| | Sandpiper [Spotted] | *Actitis macularius* |
| | Short-eared Owl | *Asio flammeus* |
| | Songbirds | |
| | Spruce Grouse | *Falcipennis canadensis* |
| | Swainson's Hawk | *Buteo swainsoni* |
| | Turkey Vultures | *Cathartes aura* |
| | Whip-poor-will | *Caprimulgus vociferus* |
| | Whiskey Jack [Canada Jay] | *Perisoreus canadensis* |
| | Wild Turkey | *Meleagris gallopavo* |
| Mammal | Beaver | *Castor canadensis* |
| | Black Bear | *Ursus americanus* |
| | Bobcat | *Lynx rufus* |
| | Chipmunk [Easter, Least] | *Neotamias minimus, Tamias striatus* |
| | Coyote | *Canis latrans* |
| | Elk | *Cervus elaphus* |
| | Ermine / Weasel | *Mustela erminea* |
| | Fisher | *Pekania pennanti* |

| Group | Common Name | Scientific Name |
|---|---|---|
| | Fox / Red Fox | *Vulpes vulpes* |
| | Hare / Rabbit [Snowshoe Hare] | *Lepus americanus* |
| | Lynx | *Lynx canadensis* |
| | Marten | *Martes americana* |
| | Mink | *Neovison vison* |
| | Moose | *Alces americanus* |
| | Mountain Lion [Cougar] | *Puma concolor* |
| | Muskrat | *Ondatra zibethicus* |
| | Northern Brown Bat [Northern Myotis] | *Myotis septentrionalis* |
| | Otter | *Lontra canadensis* |
| | Porcupine | *Erethizon dorsatum* |
| | Racoon | *Procyon lotor* |
| | Skunk | *Mephitis mephitis* |
| | Small Footed Brown Bat | *Myotis leibii* |
| | Squirrel [Red Squirrel] | *Tamiasciurus hudsonicus* |
| | White-tailed Deer | *Odocoileus virginianus* |
| | Wolf | *Canis lupus* |
| | Wolverine | *Gulo gulo* |
| | Woodland Caribou | *Rangifer tarandus* |
| Other | Crayfish | *Orchonectes virilis* |
| | Honey Bee | *Apis mellifera* |
| Reptile & Amphibian | American Toad | Anaxyrus americanus |
| | Blue-spotted Salamander | *Ambystoma laterale* |
| | Boreal Chorus Frog | *Pseudacris maculata* |
| | Eastern Gartersnake / Snakes | *Thamnophis sirtalis* |
| | Eastern Red-striped Salamander | |
| | Eastern Red-backed Salamander | *Plethodon cinereus* |
| | Four Toed Salamander | *Hemidactylium scutatum* |
| | Green Frog | *Lithobates clamitans* |
| | Mink Frog | *Lithobates septentrionalis* |
| | Northern Leopard Frog | *Lithobates pipiens* |
| | Spotted Salamander | *Ambystoma maculatum* |
| | Spring Peeper | *Pseudacris crucifer* |
| | Tortoise | |
| | Turtle [Painted, Snapping] | *Chrysemys picta, Chelydra serpentina* |
| | Wood Frog | *Lithobates sylvaticus* |

### 4.2.2 Plant Harvesting

Biigtigong Nishnaabeg has identified a wide variety of plants that are periodically collected from the SSA and LSA for food, ceremonial and and/or medicinal purposes. The plant species identified for these purposes by BN are summarized in **Table 4-3**.

**Table 4-3: Plants Identified by BN on or around the Project Site Harvested for Food, Cultural and/or Medicinal Purposes**

| Plant | Reported Use | | |
|---|---|---|---|
| | Food | Cultural | Medicinal |
| Balsam Fir (seeds) | | | ✓ |
| Bear Root | | | ✓ |
| Birch | | ✓ | ✓ |
| Black Ash | | ✓ | |
| Blueberry | ✓ | | ✓ |
| Bunch Berry | ✓ | | |
| Cedar | | | ✓ |
| Choke Cherry | ✓ | | ✓ |
| Dandelion | | | ✓ |
| Gooseberries | ✓ | | |
| Hazelnut | ✓ | | |
| Highbush Cranberry | ✓ | | ✓ |
| Labrador Tea | | | ✓ |
| Moss | | ✓ | |
| Mountain Ash | ✓ | | ✓ |
| Pine | | | ✓ |
| Poplar | | | ✓ |
| Raspberry | ✓ | | |
| Red Osier Dogwood | | | ✓ |
| Red Willow | | | ✓ |
| Rosehip | ✓ | | |
| Sage | | | ✓ |
| Saskatoon Berry | | | ✓ |
| Speckled Alder | | | ✓ |
| Spruce (White) | | | ✓ |
| Spruce (Black) | | | ✓ |
| Sweetgrass | | | ✓ |
| Tamarac | | | ✓ |
| White Ash | | | ✓ |
| Wild Strawberry | ✓ | | |
| Willow | | | ✓ |

As discussed in IR 15.2, key person interviews (KPIs) with BN resource users in January 2013 confirmed that plant collection, particularly blueberries, occurs in the SSA and LSA (PRFN KPI Program 2013). However, as noted in IR response 8.2, the SSA is not particularly productive blueberry habitat. In addition to the plant species identified in Table 2 3, Section 5.11.7.4 of the Main EIS Report indicates that timber is harvested by BN members for firewood and other purposes within the LSA; no specific harvest locations for timber were identified in the SSA.

Reports provided to Stillwater by the three Métis organizations note that plant collection and use for food, cultural and medicinal purposes are important to local Métis people. Each

organization provided information on plants collected in the RSA, and in the case of the MNO, in the LSA. The MNO report blueberry, raspberry and other berry and edible fruit collection in the RSA and LSA, including along the banks of rivers that flow from areas within the Project claim boundaries. The Métis organizations did not provide SSA-specific plant species information.

A list of plant species of interest to Indigenous communities, compiled from consultations in conjunction with the Marathon project, is presented in **Table 4-4** below.

**Table 4-4: Plant Species of Interest to Indigenous Communities**

| Type | Common Name | Scientific Name |
|---|---|---|
| Herbaceous | Agrimony | *Agrimonia striata* |
| | Bear Root | *Ligusticum porteri* |
| | Bedstraw | *Galium spp.* |
| | Bracken Fern | *Pteridium aquilinum* |
| | Bunch Berries | *Cornus canadensis* |
| | Catalpa | *Catalpa spp.* |
| | Cattails | *Typha latifolia, T. angustifolia* |
| | Chamomile | *Tripleurospermum inodorum* |
| | Chanterelles | *Cantharellus spp.* |
| | Cinnamon Fern | *Osmunda cinnamonea* |
| | Clover | *Trifolium spp.* |
| | Coltsfoot | *Petasites spp.* |
| | Dandelion | *Taraxacum officinale* |
| | Golden Rod | *Solidago spp.* |
| | Gooseberries | *Ribes spp.* |
| | Grasses | various |
| | Greater Celandine | *Chelidonium majus* |
| | Horse Tail | *Equisetum* spp. |
| | Horseradish | *Armoracia rusticana* |
| | Lamb's Quarters | *Chenopodium album* |
| | Leeks | *Allium tricoccum* |
| | Lichen | multiple species |
| | Lung Wart [Lungwort] | *Pulmonaria officinalis* |
| | Mallow | *Malva* spp. |
| | Milkweed | *Asclepias* spp. |
| | Mint | *Mentha arvensis* |
| | Morels | *Morchella* |
| | Moss | various |
| | Ostrich Fern / Fiddleheads | *Matteuccia struthiopteris* |
| | Peatland | |
| | Plantain | *Plantago major* |
| | Puffball | *various* |
| | Red-Rooted Pigweed | *Amaranthus retroflexus* |
| | Rhubarb | *Rheum rhabarbarum* |

| Type | Common Name | Scientific Name |
|---|---|---|
| | Royal Fern | *Osmunda regalis* |
| | Sage | *Salvia officinalis* |
| | Sedges | *Carex* spp. |
| | Shaggy Mane | *Coprinus comatus* |
| | Shepherd's Purse | *Capsella bursa-pastoris* |
| | Stinging Nettle | *Urtica dioica* |
| | Strawberries | *Fragaria virginiana* |
| | Sweetgrass | *Anthoxanthum hirtum* |
| Non-Woody | Wild Mushrooms | various |
| | Wild Onions | *Allium* spp. |
| | Wild Potatoes | *Solanum* spp. |
| | Wild Strawberries | *Fragaria virginiana* |
| | Wild Thyme | *Thymus* sp. |
| | Wood Sorrell | *Oxalis montana* |
| | Yarrow | *Achillea millefolium* |
| Shrubs | Comfrey | *Symphytum officinale* |
| | Alder | *Alnus incana, A. crispa* |
| | Bare Berry | *Arctostaphylos uva-ursi* |
| | Beaked Hazel | *Corylus cornuta* |
| | Bilberry | *Vaccinium uligonosum* |
| | Blackberries | *Rubus sp.* |
| | Blueberries | *Vaccinium angustifolium, V. myrtilloides* |
| | Bog Cranberry | *Vaccinium oxycoccos* |
| | Choke Cherry | *Prunus virginiana* |
| | Elderberry | *Sambucus racemosa* |
| | Gray Birch | *Betula populifolia* |
| | Hazelnut | *Corydalus cornuta* |
| | Highbush Cranberries | *Viburnum trilobum* |
| | Labrador Tea | *Rhododendron groenlandicum* |
| | Mountain Ash | *Sorbus* spp. |
| | Raspberries | *Rubus idaeaus* |
| | Red Osier Dogwood | *Cornus sericea* |
| | Red Willow | |
| | Rosehip | *Rosa acicularis* |
| | Saskatoon Berries | *Amerlanchier* spp. |
| | Speckled Alder | *Alnus incana* |
| | Sumac | *Rhus glabra* |
| | Swamp Birch | *Betula pumila* |
| | Wild Choke Berries | *Prunus virginiana* |
| | Willow | *Salix* spp. |
| Trees | American Chestnut | *Castanea dentata* |
| | Amur Maple | *Acer* |
| | Apple Tree | *Malus sp.* |
| | Balsam fir seeds | *Abies balsamea* |

| Type | Common Name | Scientific Name |
|---|---|---|
| | Basswood | *Tilia americana* |
| | Birch | *Betula spp.* |
| | Black Ash | *Fraxinus nigra* |
| | Black Cherry | *Prunus serotina* |
| | Black Maple | *Acer nigrum* |
| | Black Spruce | *Picea mariana* |
| | Black Walnut | *Juglans nigra* |
| | Butternut | *Juglans cinerea* |
| | Cedar | *Thuja occidentalis* |
| | Hickory | *Carya* spp. |
| | Horse Chestnut | *Aesculus glabra* |
| | Jack Pine | *Pinus banksiana* |
| | Manitoba Maple | *Acer negundo* |
| | Mountain Maple | *Acer spicatum* |
| | Norway Maple | *Acer platanoides* |
| | Paper Birch | *Betula papyrifera* |
| | Pine | *Pinus* |
| | Poplar [Trembling Aspen, Balsam Poplar] | *Populus tremuloides, P. balsamea* |
| | Prehistoric Woods? | |
| | Red Maple | *Acer rubrum* |
| | Red Oak | *Quercus rubra* |
| | Red Pine | *Pinus resinosa* |
| | Silver Maple | *Acer saccharinum* |
| | Striped Maple | *Acer pensylvanicum* |
| | Sugar Maple | *Acer saccharum* |
| | Sycamore | *Platanus* spp. |
| | Tamarac | *Larix laricina* |
| | White Ash | *Fraxinus* |
| | White Pine | *Pinus strubus* |
| | White Spruce | *Picea glauca* |
| | Yellow Birch | *Betula alleghaniensis* |

### 4.2.3 Fish Harvesting

No recreational or Indigenous fishery is located within the SSA. Within the LSA, local recreational and Indigenous fishing activity is focused on the Pic River, which contains a variety of coldwater and coolwater fish species, Bamoos Lake, which has a resident Lake Trout population, and Lake Superior and its tributary streams. Hare Lake does not appear to be actively/regularly fished. The primary large-bodied fish species found in Hare Lake include Yellow Perch and Northern Pike.

A number of different fish species are reportedly harvested by BN by a variety of means (net, hook, trap) in the general vicinity of the Project site, however the SSA does not provide food fish harvesting opportunities. The waterbodies and connecting channels within the SSA are largely

fishless, with resident fish communities where they occur being limited to forage fish such as stickleback. The LSA includes Bamoos Lake, Hare Lake, Hare Creek, Angler Creek (Stream 106), the near shore area of Lake Superior in the vicinity of watercourses that drain the Project site (Hare Creek, Angler Creek [Stream 106]) and the Pic River, and fishing is generally reported by BN in these locations. BN has a commercial fish licence for Lake Superior.

Fish species of interest as reported by BN include : carp (Lake Superior), Lake Trout (Bamoos Lake, Lake Superior), Muskellunge (Pic River), perch (Hare Lake, Lake Superior), Walleye (Pic River, Lake Superior), smelt (Pic River), Brook Trout (Bamoos Lake), Lake Sturgeon (Pic River, Lake Superior), suckers (ubiquitous), whitefish (Bamoos Lake, Lake Superior) and migratory salmonids such as Rainbow Trout, Coho Salmon and Chinook Salmon (Lake Superior, Pic River, Hare Creek, Angler Creek [Stream 106]).

Activity of any kind within the Project site is limited due to difficulty in accessing the interior of the site and the overall ruggedness of the terrain. The existing access road, which forms the southern limit of the site before turning north along the Pic River, is likely used by anglers to access the Pic River and by snowmobile users in the winter.

There is no recreational fishery associated with the SSA. Recreational fishing activity is likely focused on the Pic River, which contains a variety of coldwater and coolwater fish species, Bamoos Lake and the near shore area of Lake Superior. Hare Lake is road accessible from its southwest corner and has two cottages. Regular fishing of Hare Lake has not been observed. Northern Pike and Yellow Perch are the primary large-bodied fish species that can be found in Hare Lake. Bamoos Lake, which is upstream from Hare Lake within the same catchment, is accessible by air and portage from Hare Lake/Creek and is accessible during the winter using snow machines. Lake Trout and Brook Trout are the primary large-bodied fish species that can be found in Bamoos Lake.

A list of fish species of interest to Indigenous communities, compiled from consultations in conjunction with the Marathon project, is presented in **Table 4-5** below.

**Table 4-5: Fish Species of Interest to Indigenous Communities**

| Common Name | Scientific Name |
|---|---|
| **Brook Trout (Speckled Trout)** | *Salvelinus fontinalis* |
| **Burbot** | *Lota lota* |
| **Carp** | *Cyprinus carpio* |
| **Chub** | *Leuciscidae (Family)* |
| **Cisco** | *Coregonus artedi* |
| **Coho Salmon** | *Oncorhynchus kisutch* |
| **Crappie** | *Poxomis sp.* |
| **Lake Sturgeon** | *Acipenser fulvescens* |
| **Lake Trout** | *Salvelinus namaycush* |
| **Largemouth Bass** | *Micropterus salmoides* |
| **Longnose Dace** | *Rhinichthys cataractae* |
| **Muskellunge** | *Esox masquinongy* |
| **Northern Pike** | *Esox lucius* |
| **Yellow Perch** | *Perca flavescens* |
| **Rainbow Smelt** | *Osmerus mordax* |
| **Rainbow Trout** | *Oncorhynchus mykiss* |
| **Slimy Sculpin** | *Cottus cognatus* |
| **Smallmouth Bass** | *Micropterus dolomieu* |
| **Splake** | *Salvelinus fontinalis x S. namaycush* |
| **Sucker** | *Catostomus sp.* |
| **Threespine Stickleback** | *Gasterosteus aculeatu* |
| **Walleye (Pickerel)** | *Sander vitreus* |
| **Whitefish** | *F. Salmonidae* |

### 4.2.4 Recreational Activities, Site Access and Habitation Sites

Outdoor recreational activities such as hiking, hunting, fishing, swimming, boating, canoeing, biking, picnicking, birding, trapping, cross-country skiing, snowshoeing and snowmobiling are popular in the region.

The existing access road (Camp 19 Road) is an old forest access road which forms the southern limit of the site before turning north along the Pic River. It provides access to the Pic River and can also be used to access the interior of the site, though access to the interior of the Project site has been limited for the last number of years by a security gate. It is municipally owned for the first 700 m, after which the unpaved portion falls under Crown ownership and Land Use Permit (LUP 1177-52) issued to GenPGM. It provides access to an aggregate operation located approximately 1 km from the Highway 17 intersection, and access for hunting, fishing and other recreational uses. In the winter, it is used as a snowmobile trail. The Marathon Sno-kickers Snowmobile Club operates and maintains a network of trails around the town of Marathon, including the trail along Camp 19 Road that extends from Highway 17 to the east of the Pic River.

Indigenous communities have identified several structures (e.g., cabins, tents, lean-tos, etc.) within the LSA and RSA. The locations and specific uses are considered confidential.

There are two cabins located on Hare Lake within the LSA, one of which is owned by GenPGM.

### 4.2.5 Highway 17 Land Uses

Commercial, residential and industrial land uses along Highway 17 within the Town of Marathon are listed in **Table 4-6** and shown in **Figure 4-2**. The Hemlo Mine is located approximately 40 km east of Marathon.

**Table 4-6: Highway 17 Land Uses**

| Land Use | Location | Location within SSA and/or LSA |
|---|---|---|
| **Marathon Airport** | Located at the northeast corner of the Highway 17 and Camp 19 Road/Peninsula Road intersection (approximately 219 ha) | LSA |
| **Travelodge Hotel and Gas Station** | Located at the northwest corner of the Highway 17 and Camp 19 Road/Peninsula Road intersection | LSA |
| **Town Entrance Park and Picnic Area** | Located at the southeast corner of the Highway 17 and Camp 19 Road/Peninsula Road intersection | SSA, LSA |
| **Highway Maintenance Yard** | Located on the north side of Highway 17 northwest of the Marathon Airport | LSA |
| **May's Gifts (residences)** | Located on the north side of Highway 17 northwest of the Marathon Airport | LSA |
| **Peninsula Hotel** | Located on the north side of Highway 17 northwest of the Marathon Airport (adjacent to May's Gifts) | LSA |
| **Wayfare Inn** | Located the south side of Highway 17 northwest of the Marathon Airport (opposite May's Gifts) | LSA |

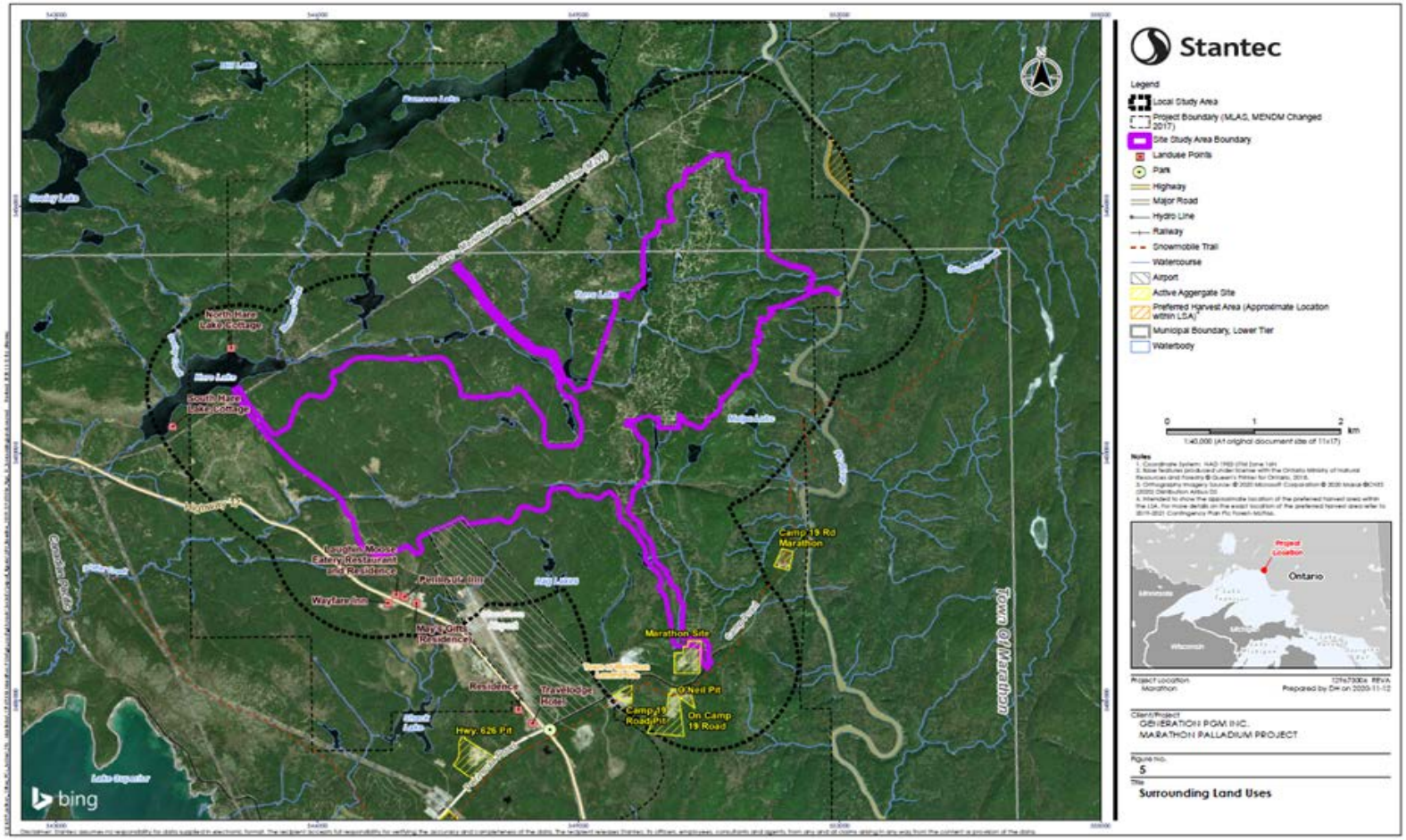


**Figure 4-2: Surrounding Land Uses**

## 4.3 First Nations Food, Nutrition and Environmental Study

After the original EIS was submitted, new baseline information about human health risks from the consumption of country foods became available. The First Nations Food, Nutrition and Environmental Study (FNFNES): Results from Ontario (2011/2012) (Chan, et al., 2014) provides an assessment of the quality and safety of traditionally-harvested foods in Ontario. The FNFNES is the first study of this nature to be conducted for regions across Canada. The FNFNES included:

1) Household interviews to collect information on dietary patterns, lifestyle and general health status, environmental concerns and food security;

2) Drinking water sampling for trace metals;

3) Hair sampling for exposure to mercury;

4) Surface water sampling for pharmaceuticals; and

5) Traditional food sampling for chemical contaminant content.

Data were collected for the FNFNES from 18 First Nations communities in four Ecozones in Ontario. The Project site falls within the geographic area of Ecozone 1, defined as the Boreal Shield/Subarctic culture area (Chan, et al., 2014).

The average and 95th percentile of daily intake of traditional foods were used to characterize the traditional diet for an "average consumer" and "heavy consumer". Fish made up a large portion of the diet of First Nation adults in Ecozone 1, followed by large game (meat and organs) and birds.

The FNFNES concluded that potential chemical exposures to mercury and lead could pose a risk to "heavy consumers" or sensitive populations in Ecozone 1. The top contributor to elevated exposure to mercury in the traditional diet was identified as predatory fish (e.g., walleye, northern pike) due to biomagnification along the food chain. The top contributor to elevated exposure to lead in the traditional diet was identified as large and small game. Chan et al. (2014) speculated that lead in game and birds was likely associated with lead residuals from lead shot or lead-based ammunition.

Based on sampling of mercury in hair results, the FNFNES concluded that body burden of mercury is generally low in Ontario and the perceived risk of mercury exposure from fish consumption is not warranted. However, since approximately 30% of the women of child bearing age in Ecozone 1 exceeded the Health Canada hair mercury guidance, the FNFNES recommended that women of child-bearing age in the region should be advised to choose fish that are likely to contain lower levels of contaminants, such as whitefish, and eat less predatory fish, to lower their mercury intake.

Appendix A provides a summary of background concentrations of metals in fish in the Project area and sport fish consumption advisories in the Project area. The Guide to Eating Ontario Fish

(MECP, 2017) provides sport fish consumption advisories for the sensitive population (women of child-bearing age and children under 15) and the general population. Key findings included:

- Mean mercury concentrations in Northern Pike muscle tissue from Hare Lake exceeded the total consumption restriction value of 1.84 mg/kg for the general population.
- Mean mercury concentrations in Northern Pike liver tissue from Hare Lake were above the values at which complete restriction is advised for the sensitive population (0.52 mg/kg) and consumption restrictions begin for the general population (0.61 mg/kg).
- Mean mercury concentrations in Lake Trout muscle and liver tissue from Bamoos Lake marginally exceeded the value at which complete restriction is advised for the sensitive population (0.52 mg/kg) but were below 0.61 mg/kg, the value at which consumption restrictions for the general population begin.

# 5.0 Human Health Risk Assessment

The purpose of the human health risk assessment is to help people better understand risks to human health associated with the Project. Since November 2013 when the original human health risk assessment was completed for the Project, there have been changes to regulatory guidelines and Project design. This updated human health risk assessment reflects these regulatory and Project design changes, as well as updates to baseline studies and assessments of Project effects.

The focus of this assessment is the evaluation of human health risks related to chemical releases to the environment from Project activities. Environmental stressors such as noise and electromagnetic fields are also considered. The sources of chemical releases during all Project phases (site preparation, construction, operation, decommissioning and post closure) include:

- Atmospheric emissions and dust deposition during all Project phases prior to closure;
- Releases of excess treated water to Hare Lake during operations;
- Drainage from the reclaimed PSMF to the Stream 105 and 106 subwatersheds (Hare and Angler creeks) after closure; and
- Drainage from the reclaimed MRSA, open pits and water management ponds to the Pic River after closure.

Atmospheric emissions could affect air and soil quality, vegetation, wildlife and consumers of country foods. Water releases could affect water and sediment quality, aquatic life, wildlife and consumers of country foods.

This assessment draws on the following sources of guidance and information:

- Sections 2.7.1.1 and 2.7.3.5 of the EIS Guidelines for the Project;
- Health Canada guidance documents (see Section 3.0);
- Information provided in the updated baseline studies and updated effects assessments for the EIS Addendum, original EIS, supporting technical documents, and responses to information requests (IRs, SIRs, AIRs); and
- Information concerning Indigenous people's health-related traditional activities, including country food consumption (hunting, fishing, trapping, harvesting of plants).

For safety reasons, public access to the SSA will be prohibited during the construction, operations and decommissioning phases of the Project, however safe access in the LSA may be provided as long as it is outside the mine's direct zone of influence. Post-closure, public access to the open pits will be prohibited and limited by a perimeter berm per the requirements of the Mine Rehabilitation Code (O.Reg. 240/00).

## 5.1 Problem Formulation

Problem formulation is a systematic approach for identifying the major factors to be considered in an assessment. The framework includes the identification of constituents of potential concern (CoPCs) and environmental stressors, selection of human and ecological receptors and identification of exposure pathways. The problem formulation culminates in the development of the conceptual site model. The conceptual site model (CSM) provides a description and graphic representation of potentially complete direct and indirect pathways by which human receptors could be exposed to CoPCs released to the environment through Project activities.

The CoPCs that exceed health based guidelines and background concentrations and have the potential to affect human health through complete exposure pathways are carried forward to the exposure and hazard assessments, and risk characterization.

### 5.1.1 Constituents of Potential Concern and Environmental Stressors

Project activities will result in releases of chemicals to air, surface water and ground water. These releases have the potential to influence the quality of environmental media and human health. The constituents to be further assessed in the HHRA are selected based on comparing predicted concentrations of constituents in environmental media to screening criteria protective of human health, or natural background concentrations where natural background exceeds guideline values or where no objectives or guidelines are available.

Constituents predicted to exceed screening benchmarks and natural background are advanced to the pathways analysis to identify feasible exposure pathways for receptors of concern. Concentrations of CoPCs predicted to remain below screening benchmarks or natural background are not advanced for further assessment.

The screening of predicted air and water concentrations is presented in Sections 5.1.1.1 and 5.1.1.2. The potential effects of changes in country foods, noise and electromagnetic fields (EMFs) on human health are discussed in Sections 5.1.1.3, 5.1.1.4 and 5.1.1.5.

#### 5.1.1.1 Air

The purpose of the air effects assessment is to evaluate the potential effects of Project activities on human health. Project-related air emissions during all phases of the Project could affect human health by inhalation of ambient air over short or long periods of time. The potential effect of air releases on country foods is discussed in Section 5.1.1.3.

##### 5.1.1.1.1 Updated Air Quality Modelling

The updated air quality modelling is summarized in Section 6.2.1 of the EIS Addendum and described in further detail in the *Air Quality Updated Effects Assessment* (Appendix D1 of this EIS Addendum [Vol 2]). The U.S. EPA's AERMOD air dispersion model, which is an MECP-approved model, was used to estimate the maximum off-site short-term (1-hour, 8-hour, 24-hour), and long-term (30-day and annual average) ground-level concentrations (GLC) for the CoPCs assessed. Several dispersion modelling scenarios were developed to represent construction and

operation phases of the Project. For all CoPCs with background concentrations, the dispersion model predictions were added to the background levels to determine the total change in air quality (Project + background), in addition to Project only predictions.

The air quality model provided predictions for special receptors and at the modelled property boundary (fence line) in all directions. Special receptor locations were described as being locations where human activity more regularly takes place. The closest special receptors outside of the modelled property boundary included residences surrounding the Project and in Marathon, and receptor locations identified for the HHRA.

GenPGM has proposed mitigation measures to avoid or reduce Project-related effects on air quality. These mitigation measures have been considered in the air quality modelling. Mitigation measures related to airborne emissions are summarized in Section 8 of the EIS Addendum (Vol 2).

Activities conducted during construction and commissioning (construction phase) of the mine are similar to those that will be carried out during mine decommissioning, although emissions during construction are expected to be greater given the activities that are associated with site preparation, such as drilling and blasting. Given the similarities between the two project phases, emissions from construction were considered a conservative estimate of emissions expected during decommissioning and closure. As a result, no further assessment of emissions during decommissioning and closure was conducted. Additionally, no emissions from the site are expected during post closure phase of the mine.

Due to the numerous updates to Project emissions estimates, dispersion model/methodologies and applicable regulatory criteria, the air quality residual effects in the 2012 assessment are not directly comparable to those presented in this HHRA based on the *Air Quality Updated Effects Assessment* (Appendix D1 of this EIS Addendum [Vol 2]).

The summary of the updated air quality assessment, presented in the context of human health effects, focuses on inhalation of ground-level ambient air.

#### 5.1.1.1.2 Air Quality Benchmarks

The principal air quality parameters that could be affected by the site preparation and construction, operation, decommissioning and closure phases of the mine include:

- Particulate matter (PM): defined as liquid or solid particles, or a mixture of both, less than 100 micrometers (um) in diameter. PM includes total suspended particulates (TSP), particulate matter less that 10 um (PM10), particulate matter less than 2.5 um (PM2.5), and the crystalline silica component of PM10;
- Secondary pollutants: formed in the atmosphere through the reaction of gaseous precursors from Project sources. These include ground-level ozone (O3), and a portion of the total PM2.5 concentrations;

- Other ambient air pollutants: associated with the use of heavy equipment, fuel combustion by-products, and road transportation activities. These include PM, nitrous oxides (NOx), sulphur dioxide (SO2), carbon monoxide (CO), polycyclic aromatic hydrocarbons (PAHs) such as benzo(a)pyrene, volatile organic compounds (VOCs) such as acetaldehyde, formaldehyde, benzene, 1,3-butadiene, and acrolein, and metals associated with particulate matter, such as cadmium, lead, mercury, manganese, arsenic and nickel.
- No herbicide or pesticide use is anticipated at the mine site or along the transmission line corridor.

The benchmarks used in this screening were the most conservative of Ontario and Canadian ambient air quality criteria, Ontario ministry derived air quality standards (Ontario Regulation 419/05), and jurisdictional screening levels (JSL). Ambient air quality criteria AAQCs are based on the most sensitive effect identified through a review carried out at the time of AAQC development. Ontario ministry derived screening levels are values taken from an in house toxicological assessment which recommends a concentration that is considered to be protective against adverse effects. The Ontario JSL are generally based on a review of air quality values available in other jurisdictions for chronic exposures and converted to short-term (24-hr) averaging period. The selected screening benchmarks for short-term and long-term exposures for the modelled parameters, their basis and their source are summarized in **Table 5-1**.

**Table 5-1: Air Quality Screening Benchmarks**

| Parameter | Criteria | | | |
|---|---|---|---|---|
| | Concentration (µg/m3) | Period | Basis for criterion | Reference |
| | | | | |
| 1,3-Butadiene | 10 | 24-hr | Health - Converted from the annual AAQC to allow assessment of the 24-hour air quality data | Ontario AAQC (2020) |
| Acetaldehyde | 500 | 0.5-hr | Health | Ontario AAQC (2020) |
| | 500 | 24-hr | Health | Ontario AAQC (2020) |
| Acrolein (2-propenal) | 4.5 | 1-hr | Health | O.Reg 419/05 Standard Ontario AAQC |
| | 0.4 | 24-hr | Health | O.Reg 419/05 - Standard |
| Aluminum (Al) | 12 | 24-hr | Health | O.Reg 419/05 - Standard |
| Antimony (Sb) | 25 | 24-hr | Health | O.Reg 419/05 - Standard Ontario AAQC (2020) |
| Arsenic (As) | 0.3 | 24-hr | Health - Applies to arsenic and compounds | Ontario AAQC (2020) |
| Barium (Ba) | 10 | 24-hr | Health | Ontario AAQC (2020) - total water soluble |
| Benzene | 2.3 | 24-hr | Health - Converted from the annual AAQC to allow assessment of 24-hour air quality data. | Ontario AAQC (2020) |
| Benzo(a)pyrene | 5.00E-05 | 24-hr | Health - Converted from the annual AAQC to allow assessment of 24-hour air quality data. | O.Reg 419/05 – Standard Ontario AAQC (2020) |
| Beryllium (Be) | 0.01 | 24-hr | Health | O.Reg 419/05 - Standard Ontario AAQC (2020) |

| Parameter | Criteria | | | |
|---|---|---|---|---|
| | Concentration (µg/m3) | Period | Basis for criterion | Reference |
| Bismuth (Bi) | 2.5 | 24-hr | Health | JSL |
| Boron (B) | 120 | 24-hr | Particulate (Visibility) - Assumes the contaminant is more likely emitted as TSP (SPM), and therefore the AAQC for TSP is applied. | O.Reg 419/05 - Standard<br>Ontario AAQC (2020) |
| Bromine (Br) | 20 | 24-hr | Health | O.Reg 419/05 - Standard<br>Ontario AAQC (2020) |
| Cadmium (Cd) | 0.025 | 24-hr | Health - Converted from the annual AAQC to allow assessment of 24-hour air quality data. | O.Reg 419/05 - Standard<br>Ontario AAQC (2020) |
| Methane ($CH_4$) | 37330 | 24-hr | Health | O.Reg 419/05 - Standard<br>SL-PA |
| Chromium (Cr) | 0.5 | 24-hr | Health - Applies to either chromium metallic (CASRN 7440-47-3), divalent (CASRN 22541-79-3), and trivalent (CASRN 16065-83-1), or to the percentage of Cr metallic, divalent and trivalent relative to total chromium | O.Reg 419/05 - Standard<br>Ontario AAQC (2020) |
| Carbon Monoxide (CO) | 6000 | 0.5 hr | | O.Reg 419/05 - Standard |
| | 36200 | 1 hr | Health | Ontario AAQC (2020) |
| | 15700 | 8 hr | Health | Ontario AAQC (2020) |
| Cobalt (Co) | 0.1 | 24-hr | Health | Ontario AAQC (2020) |
| Copper (Cu) | 50 | 24-hr | Health | O.Reg 419/05 - Standard<br>Ontario AAQC (2020) |

| Parameter | Criteria | | | |
|---|---|---|---|---|
| | Concentration (µg/m3) | Period | Basis for criterion | Reference |
| Formaldehyde | 65 | 24-hr | Health | O. Reg 419/05 Standard Ontario AAQC (2020) |
| Gold (Au) | 1.25 | 24-hr | Health | JSL |
| Hydrochloric Acid (HCl) (Hydrogen chloride) | 20 | 24-hr | Health | O.Reg 419/05 - Standard |
| Hydrofluoric Acid (HF) (Gaseous fluorides (as HF)) | 0.86 | 24-hr | Ecological - Vegetation (growing season) | O.Reg 419/05 - Standard |
| Iron (Fe) | 4 | 24-hr | Health - For metallic iron (Note 3) | O.Reg 419/05 - Standard Ontario AAQC (2020) |
| Lanthanum Chloride ($LaCl_3$) | 2.5 | 24-hr | Health | JSL |
| Lead (Pb) | 0.5 | 24-hr | Health - Converted from the 30-day AAQC to allow assessment of 24-hour air quality data | O.Reg 419/05 - Standard Ontario AAQC (2020) |
| Magnesium (Mg) | 72 | 24-hr | Health - Ministry-derived screening level that represents a concentration that is considered to be protective against adverse effects. | O.Reg 419/05 - Standard |
| Manganese (Mn) (Note 1) | 0.1 | 24-hr | Health - For manganese and manganese compounds in particulates; derived from a value of 0.1 µg/$m^3$ based on adverse neurological effects associated with exposure to Mn in the $PM_{2.5}$ fraction | O.Reg 419/05 - Standard; Ontario AAQC (2020): 0.4 (TSP), 0.2 (PM10) and 0.1 (PM2.5) |

| Parameter | Criteria | | | |
|---|---|---|---|---|
| | Concentration (µg/m3) | Period | Basis for criterion | Reference |
| Mercury (Hg) | 2 | 24-hr | Health | O.Reg 419/05 - Standard<br>Ontario AAQC (2020) |
| Molybdenum (Mo) | 120 | 24-hr | Particulate (Visibility) - Assumes the contaminant is more likely emitted as TSP (SPM), and therefore the AAQC for TSP is applied. | Ontario AAQC (2020) |
| Nitrous oxide ($N_2O$) | 9000 | 24-hr | Health | Ontario AAQC (2020) |
| Naphthalene | 50 | 10-min | Odour - geometric mean of available odour detection thresholds | Ontario AAQC (2020) |
| | 22.5 | 24-hr | Health | Ontario AAQC (2020) |
| Nickel (Ni) (Note 1) | 0.1 | 24-hr | Health - Converted from the annual criterion to allow assessment of the 24-hr data. Intended to protect from development of chronic effects. | Ontario AAQC (2020)<br>Ontario AAQC is 0.2 (TSP), and 0.1 (PM10) |
| Nitric Acid ($HNO_3$) | 35 | 24-hr | Corrosion | O.Reg 419/05 |
| Nitrogen Dioxide ($NO_2$) | 400 | 1-hr | Health - Standards for $NO_X$; based on health effects of $NO_2$ | O.Reg 419/05 - Standard<br>Ontario AAQC (2020) |
| | 200 | 24-hr | Health - Standards for $NO_X$; based on health effects of $NO_2$ | O.Reg 419/05 - Standard<br>Ontario AAQC (2020) |
| Palladium (Pd) | 10 | 24-hr | Health - water soluble compounds | Ontario AAQC (2020) |

| Parameter | Criteria | | | |
|---|---|---|---|---|
| | Concentration (µg/m3) | Period | Basis for criterion | Reference |
| Phosphorus (P) | 0.5 | 24-hr | Health - Ministry-derived screening level that represents a concentration that is considered to be protective against adverse effects. | O.Reg 419/05 - Standard |
| Platinum (Pt) | 0.2 | 24-hr | Health - water soluble compounds | Ontario AAQC (2020) |
| $PM_{10}$ (Note 2) | 50 | 24-hr | Health | Ontario AAQC (interim) |
| $PM_{2.5}$ (Note 12) | 27 | 24-hr | Health - The 24-hour CAAQS is referenced to the 98$^{th}$ percentile daily average concentration averaged over 3 consecutive years. | Canadian AAQC (2012, effective 2020) |
| Potassium (K) | 1 | 24-hr | Health | JSL |
| Propylene (propene, methyl ethylene) | 4000 | 24-hr | Health | O.Reg 419/05 - Standard Ontario AAQC (2020) |
| Crystalline Silica (respirable silica, crystabolite <10µm diameter) | 5 | 24-hr | Health - Derived from occupational exposure data; near 0% risk of developing silicosis over a lifetime of ambient exposure to PM10 with 10% crystalline silica | O.Reg 419/05 - Standard |
| Silicon (Si) | 27 | 24-hr | Health | O.Reg 419/05 - Standard Previously accepted screening level |
| Silver (Ag) | 1 | 24-hr | Health | O.Reg 419/05 - Standard Ontario AAQC (2020) |

| Parameter | Criteria | | | |
|---|---|---|---|---|
| | Concentration (µg/m3) | Period | Basis for criterion | Reference |
| Sulphur Dioxide ($SO_2$) | 100 | 1-hr | Health - 40 ppb equivalent. Converted from the 10-minute AAQC to allow assessment of 1-hour air quality data for implementation; 1 ppb of sulphur dioxide is equal to 2.66 µg/$m^3$ at 20.0°C and 1 atmosphere | Ontario AAQC (2020) |
| Sodium Carboxymethyl Cellulose | 120 | 24-hr | Health and particulate | O. Reg 419/05 - Standard |
| Strontium (Sr) | 120 | 24-hr | Particulate (Visibility) - Assumes the contaminant is more likely emitted as TSP (SPM), and therefore the AAQC for TSP is applied. | Ontario AAQC (2020) |
| Thallium (Tl) | 0.5 | 24-hr | Health | JSL |
| Titanium (Ti) | 120 | 24-hr | Particulate (Visibility) - Assumes the contaminant is more likely emitted as TSP (SPM), and therefore the AAQC for TSP is applied. | O.Reg 419/05 - Standard<br>Ontario AAQC (2020) |
| TOC (as Methane) | 37330 | 24-hr | Health | O.Reg 419/05 - Standard<br>Previously accepted standard |
| Toluene | 2000 | 24-hr | Odour - geometric mean of available odour detection methods | O.Reg 419/05 - Standard<br>Ontario AAQC (2020) |
| Total Suspended Particulates (TSP) (Note 2) | 120 | 24-hr | Visibility | O.Reg 419/05 - Standard<br>Ontario AAQC (2020) (suspended particulate mattre (SPM)) |
| Tungsten (W) | 5 | 24-hr | Health | JSL |

| Parameter | Criteria | | | |
|---|---|---|---|---|
| | Concentration (µg/m3) | Period | Basis for criterion | Reference |
| Uranium (U) | 0.15 | 24-hr | Health - Uranium in PM10 fraction; converted from the annual AAQC to allow assessment of 24-hour air quality data | Ontario AAQC (2020) (PM10) |
| Vanadium (V) | 2 | 24-hr | Health | O.Reg 419/05 - Standard<br>Ontario AAQC (2020) |
| Xylenes | 3000 | 10-Min | Odour - Geometric mean of available odour detection thresholds. Applies to o-Xylene, p-Xylene, and m-Xylene, individually or as a mixture | Ontario AAQC (2020) |
| | 730 | 24-hr | Health - Applies to o-Xylene, p-Xylene, and m-Xylene, individually or as a mixture | O.Reg 419/05 - Standard<br>Ontario AAQC (2020) |
| Zinc (Zn) | 120 | 24-hr | Particulate (Visibility) - Assumes the contaminant is more likely emitted as TSP (SPM), and therefore the AAQC for TSP is applied. | O.Reg 419/05 - Standard<br>Ontario AAQC (2020) |
| | | | | |
| 1,3-Butadiene | 2 | annual | Health | Ontario AAQC (2020) |
| Benzene | 0.45 | annual | Health | O.Reg 419/05 - Standard<br>Ontario AAQC (2020) |
| Benzo(a)pyrene | 1.00E-05 | annual | Health - B[a]P is used as a surrogate of total Polycyclic Aromatic Hydrocarbons (PAHs). This AAQC does not apply to naphthalene (CASRN 91-20-3) or for any other PAH for which an AAQC may be derived separately. | O.Reg 419/05 – Standard<br>Ontario AAQC (2020) |

| Parameter | Criteria | | | |
|---|---|---|---|---|
| | Concentration (µg/m3) | Period | Basis for criterion | Reference |
| Cadmium (Cd) | 0.005 | annual | Health - Applies to cadmium and cadmium compounds | O.Reg 419/05 - Standard Ontario AAQC (2020) |
| Nickel (Ni) (Note 1) | 0.02 | annual | Health - Ontario AAQC (PM10). Protection from cancer and non-cancer effects from respirable particles | O.Reg 419/05 - Standard Ontario AAQC (2020); 0.04 (TSP) and 0.02(PM10) |
| $PM_{2.5}$ (Note 2) | 8.8 | annual | Health - The annual CAAQS is referenced to the 3-year average of the annual average concentrations. | Canadian AAQC (2012, effective 2020) |
| Sulphur Dioxide ($SO_2$) | 10 | annual | Vegetation - 4 ppb equivalent | Ontario AAQC (2020) Where 1 ppb of sulphur dioxide is equal to 2.66 µg/$m^3$ (at 20.0°C and 1 atmosphere) |
| Total Suspended Particulates (TSP) (Note 2) | 60 | annual | Visibility - Geometric mean of daily measurements over a year | Ontario AAQC (2020) |
| Uranium (U) | 0.03 | annual | Health - Uranium in $PM_{10}$ fraction; based on kidney effects modelled over a 50-year period | O. Reg 419/05 - Standard Ontario AAQC (2020) |
| Dustfall (g/$m^2$) (Note 4) | 7 | month | Soiling - Aesthetics effects from deposition | Ontario AAQC (2020) |

| Parameter | Criteria | | | |
|---|---|---|---|---|
| | Concentration (µg/m3) | Period | Basis for criterion | Reference |

Notes:
1 - Ontario, Regulation Decision Notice (June 22, 2011): The AAQCs for manganese and nickel were set to TSP because of difficulties measuring different metal particulate fractions in emissions, or the lack of availability of size-specific emissions factors. Air quality screening for the HHRA is based on the critical toxicological endpoints for PM10 fraction for nickel and PM2.5 fraction for manganese represent health-based AAQCs.
2 - Estimated maximum concentrations are for air quality model results excluding roads and stockpile wind erosion (MECP Guideline A-10, Section 7.4.1 for facilities with a fugitive dust BMP).
3 – Project-related iron emissions are associated with dust rich in oxides of iron. For the HHRA it is assumed that iron is more likely emitted as TSP (SPM), and therefore the AAQC for TSP is applied.
4 - Dustfall is not assessed for direct human health effects. Exceedance of the dustfall criterion is aesthetic and not health based. An exceedance is used to interpret potential adverse human health effects from airborne parameters through the country food pathway (deposition to soil and uptake by country foods).

#### 5.1.1.1.3 Screening of Air CoPCs

The purpose of this section is to identify those Project-related constituents in air that may be of concern for human and/or ecological health and require further assessment. Constituents of potential concern (CoPCs), as defined by Health Canada (HC, 2016a) are chemicals whose concentration(s) may become elevated in ambient air as a result of project-related activities, and which have the potential for adverse health impacts based on documented scientific evidence or suspected causal relationships. If the maximum predicted concentration for a parameter is below the selected benchmark, then no adverse health effects for human and ecological receptors in the study area are expected to occur and the parameter is not assessed further.

To identify CoPCs requiring further assessment, the maximum predicted concentrations of air quality parameters are compared to short-term (24-hr and less than 24-hr) and long-term (annual) air quality benchmarks protective of human health. The screening is provided in **Table 5-2** and the results are summarized in **Table 5-3** for the construction and operations phases. As discussed in IR 10.13, the air quality parameters were screened against ambient air quality criteria.

Parameters that were modeled but did not have screening criteria were not assessed in the HHRA, with the exception of carcinogenic PAHs that were qualitatively assessed using benzo(a)pyrene as a surrogate (see Section 5.4.2.2.1).

The maximum predicted concentrations used in this screening are the maximum from Project plus background (total) ground-level air concentrations. Where background concentrations were available, the total concentrations include contributions from background sources as well as from the Project. Background air quality was characterized using baseline air quality data from the most recent 5 years of available data from the Winnipeg NAPS station (this is further described in the *Air Quality Updated Effects Assessment* (Appendix D1 of this EIS Addendum [Vol 2]). For polycyclic aromatic hydrocarbon (PAHs) such as benzo(a)pyrene, 3 years of data from 2009-2011 were available and used to characterize background conditions. The derivation of background air quality followed MECP methodology which requires taking the maximum annual average over the individual years, and for short-term averages (hourly and 24-hour) taking the maximum 90th percentile over the individual years assessed.

Estimates for background air quality used in the modelling, were determined from published regional concentrations. A full discussion on baseline air quality is presented in the *Air Quality Updated Effects Assessment* (Appendix D1 of this EIS Addendum [Vol 2]). The historical long-term ambient air concentrations measured at the nearest NAPS stations operated by Environment Canada were used as the basis to establish background ambient concentrations in the LSA. The Marathon Project site is located on the north side of Highway 17 in a remote area of northwestern Ontario with baseline ambient air quality expected to be typical for rural areas. The available NAPS data were from Winnipeg, which is a more developed municipality than Marathon. As such, the baseline air quality data are likely to over-estimate background air quality levels in the LSA.

**Table 5-2: Primary Screening of Maximum Predicted Concentrations (µg/m$^3$) of Air Quality Parameters for all Modelled Special Receptor and Fence Line Locations**

| Parameter | Criteria | | Background Concentration | Construction Phase | | Operations Phase | |
|---|---|---|---|---|---|---|---|
| | Concentration | Period | | Special Receptors | Fence Line Receptors | Special Receptors | Fence Line Receptors |
| | | | | | | | |
| 1,3-Butadiene | 10 | 24-hr | 1.09E-01 | 1.13E-01 | 1.17E-01 | 1.27E-01 | 1.13E-01 |
| Acetaldehyde | 500 | 0.5-hr | 1.18E+01 | 1.31E+01 | 1.45E+01 | 1.52E+01 | 1.38E+01 |
| | 500 | 24-hr | 4.00E+00 | 4.35E+00 | 4.73E+00 | 5.36E+00 | 4.37E+00 |
| Acrolein (2-propenal) | 4.5 | 1-hr | 1.22E-01 | 2.80E-01 | 4.40E-01 | 5.33E-01 | 3.57E-01 |
| | 0.4 | 24-hr | 5.00E-02 | 1.01E-01 | 1.55E-01 | 2.47E-01 | 1.04E-01 |
| Aluminum (Al) | 12 | 24-hr | 5.88E-01 | 1.39E+00 | 3.43E+00 | 2.39E+00 | 3.81E+00 |
| Antimony (Sb) | 25 | 24-hr | 2.71E-02 | 2.73E-02 | 2.77E-02 | 2.74E-02 | 2.77E-02 |
| Arsenic (As) | 0.3 | 24-hr | nv | 1.67E-04 | 5.93E-04 | 3.77E-04 | 1.40E-03 |
| Barium (Ba) | 10 | 24-hr | 3.99E-02 | 4.30E-02 | 5.09E-02 | 4.69E-02 | 5.23E-02 |
| Benzene | 2.3 | 24-hr | 1.44E+00 | 1.51E+00 | 1.58E+00 | 1.70E+00 | 1.51E+00 |
| Benzo(a)pyrene | 5.00E-05 | 24-hr | **2.06E-04** | **2.58E-04** | **2.13E-04** | **2.92E-04** | **2.09E-04** |
| Beryllium (Be) | 0.01 | 24-hr | nv | 3.74E-05 | 1.33E-04 | 8.40E-05 | 1.50E-04 |
| Bismuth (Bi) | 2.5 | 24-hr | nv | 1.42E-04 | 5.03E-04 | 7.77E-04 | 4.65E-03 |
| Boron (B) | 120 | 24-hr | nv | 6.87E-04 | 2.44E-03 | 1.55E-03 | 2.75E-03 |
| Bromine (Br) | 20 | 24-hr | nv | ne | ne | 1.52E-02 | 1.96E-02 |
| Cadmium (Cd) | 0.025 | 24-hr | 1.20E-02 | 1.20E-02 | 1.21E-02 | 1.22E-02 | 1.29E-02 |
| Methane ($CH_4$) | 37330 | 24-hr | nv | 3.70E-01 | 7.71E-01 | 1.41E+00 | 4.39E-01 |
| Chromium (Cr) | 0.5 | 24-hr | 1.46E-03 | 7.51E-03 | 2.29E-02 | 1.52E-02 | 2.59E-02 |

| Parameter | Criteria | | Background Concentration | Construction Phase | | Operations Phase | |
|---|---|---|---|---|---|---|---|
| | Concentration | Period | | Special Receptors | Fence Line Receptors | Special Receptors | Fence Line Receptors |
| Carbon Monoxide (CO) | 6000 | 0.5 hr | 1.17E+03 | 3.15E+03 | 3.51E+03 | 2.25E+03 | 2.32E+03 |
| | 36200 | 1 hr | 9.65E+02 | 2.60E+03 | 2.89E+03 | 1.86E+03 | 1.92E+03 |
| | 15700 | 8 hr | 9.65E+02 | 1.19E+03 | 1.23E+03 | 1.37E+03 | 1.16E+03 |
| Cobalt (Co) | 0.1 | 24-hr | nv | 2.09E-03 | 7.41E-03 | 4.70E-03 | 2.01E-02 |
| Copper (Cu) | 50 | 24-hr | nv | 1.69E-02 | 5.68E-02 | 1.82E+00 | 1.10E+01 |
| Formaldehyde | 65 | 24-hr | 5.40E+00 | 6.50E+00 | 7.68E+00 | 9.65E+00 | 6.57E+00 |
| Gold (Au) | 1.25 | 24-hr | nv | 6.98E-07 | 2.47E-06 | 4.09E-05 | 2.46E-04 |
| Hydrochloric Acid (HCl) (Hydrogen chloride) | 20 | 24-hr | nv | ne | ne | 5.76E-03 | 7.35E-03 |
| Hydrofluoric Acid (HF) (Gaseous fluorides (as HF)) | 0.86 | 24-hr | nv | ne | ne | 7.29E-03 | 9.42E-03 |
| Iron (Fe) (as TSP) | 120 | 24-hr | 3.85E-01 | 4.05E+00 | 1.34E+01 | 8.67E+00 | 1.51E+01 |
| Lanthanum Chloride ($LaCl_3$) | 2.5 | 24-hr | nv | ne | ne | 8.56E-02 | 1.05E-01 |
| Lead (Pb) | 0.5 | 24-hr | 5.74E-03 | 5.92E-03 | 6.39E-03 | 7.38E-03 | 1.55E-02 |
| Magnesium (Mg) | 72 | 24-hr | nv | 9.55E-01 | 3.39E+00 | 2.16E+00 | 3.85E+00 |
| Manganese (Mn) | 0.4 | 24-hr | 1.42E-02 | 4.93E-02 | 1.39E-01 | 9.34E-02 | 1.55E-01 |
| Mercury (Hg) | 2 | 24-hr | nv | 6.88E-05 | 2.44E-04 | 1.55E-04 | 2.76E-04 |
| Molybdenum (Mo) (as TSP) | 120 | 24-hr | nv | 8.41E-05 | 2.98E-04 | 1.90E-04 | 8.89E-04 |
| Nitrous oxide ($N_2O$) | 9000 | 24-hr | nv | 1.15E+00 | 2.41E+00 | 4.41E+00 | 1.59E+00 |
| Naphthalene | 50 | 10-min | 2.37E+00 | 2.38E+00 | 2.38E+00 | 2.37E+00 | 2.37E+00 |
| | 22.5 | 24-hr | 2.39E-01 | 2.40E-01 | 2.41E-01 | 2.39E-01 | 2.39E-01 |
| Nickel (Ni) | 0.1 | 24-hr | 2.60E-03 | 8.00E-03 | 2.17E-02 | 4.46E-02 | **2.85E-01** |
| Nitric Acid ($HNO_3$) | 35 | 24-hr | nv | ne | ne | 7.08E-03 | 9.14E-03 |

| Parameter | Criteria | | Background Concentration | Construction Phase | | Operations Phase | |
|---|---|---|---|---|---|---|---|
| | Concentration | Period | | Special Receptors | Fence Line Receptors | Special Receptors | Fence Line Receptors |
| Nitrogen Dioxide ($NO_2$) | 400 | 1-hr | 6.34E+01 | 3.16E+02 | **4.60E+02** | 1.48E+02 | 1.55E+02 |
| | 200 | 24-hr | 3.17E+01 | 9.78E+01 | 1.45E+02 | 6.52E+01 | 6.93E+01 |
| Palladium (Pd) | 10 | 24-hr | nv | 2.36E-06 | 6.87E-06 | 4.08E-04 | 2.45E-03 |
| Phosphorus (P) | 0.5 | 24-hr | nv | 9.31E-02 | 3.31E-01 | 2.10E-01 | 3.75E-01 |
| Platinum (Pt) | 0.2 | 24-hr | nv | 1.28E-06 | 4.51E-06 | 8.52E-05 | 5.12E-04 |
| $PM_{10}$ (Note 2) | 50 | 24-hr | 2.28E+01 | 4.13E+01 | 4.37E+01 | 3.51E+01 | 4.52E+01 |
| $PM_{2.5}$ (Note 2) | 27 | 24-hr | 1.23E+01 | 1.39E+01 | 2.39E+01 | 1.44E+01 | 1.74E+01 |
| Potassium (K) | 1 | 24-hr | 2.79E-01 | 3.32E-01 | 4.67E-01 | 3.99E-01 | 4.92E-01 |
| Propylene (propene, methyl ethylene) | 4000 | 24-hr | nv | 3.20E-02 | 4.53E-02 | 6.07E-03 | 9.13E-03 |
| Crystalline Silica (respirable silica, crystabolite <10µm diameter) | 5 | 24-hr | nv | **1.10E+01** | **3.51E+01** | **1.94E+01** | **3.52E+01** |
| Silicon (Si) | 27 | 24-hr | nv | 4.41E-04 | 7.75E-04 | 3.95E-01 | 2.38E+00 |
| Silver (Ag) | 1 | 24-hr | nv | 1.58E-05 | 5.57E-05 | 4.94E-04 | 2.97E-03 |
| Sulphur Dioxide ($SO_2$) | 100 | 1-hr | 2.76E+00 | 3.25E+01 | 3.63E+01 | 2.31E+01 | 2.45E+01 |
| Sodium Carboxymethyl Cellulose | 120 | 24-hr | nv | ne | ne | 2.96E-03 | 5.35E-03 |
| Strontium (Sr) (as TSP) | 120 | 24-hr | 4.36E-03 | 1.02E-02 | 2.52E-02 | 1.76E-02 | 2.80E-02 |
| Thallium (Tl) | 0.5 | 24-hr | nv | 6.91E-04 | 2.45E-03 | 1.55E-03 | 2.77E-03 |
| Titanium (Ti) (as TSP) | 120 | 24-hr | 1.89E-02 | 8.16E-02 | 2.42E-01 | 1.61E-01 | 2.72E-01 |
| TOC (as Methane) | 37330 | 24-hr | nv | 1.08E+00 | 1.53E+00 | 2.05E-01 | 3.08E-01 |
| Toluene | 2000 | 24-hr | 2.81E+00 | 2.81E+00 | 2.81E+00 | 2.81E+00 | 2.81E+00 |

| Parameter | Criteria | | Background Concentration | Construction Phase | | Operations Phase | |
|---|---|---|---|---|---|---|---|
| | Concentration | Period | | Special Receptors | Fence Line Receptors | Special Receptors | Fence Line Receptors |
| Total Suspended Particulates (TSP) (Note 2) | 120 | 24-hr | 4.41E+01 | 8.01E+01 | 1.20E+02 | 7.17E+01 | 1.03E+02 |
| Tungsten (W) | 5 | 24-hr | nv | 3.97E-03 | 1.41E-02 | 8.92E-03 | 1.59E-02 |
| Uranium (U) | 0.15 | 24-hr | nv | 7.00E-04 | 2.48E-03 | 1.58E-03 | 2.82E-03 |
| Vanadium (V) | 2 | 24-hr | 3.14E-03 | 1.44E-02 | 4.32E-02 | 2.86E-02 | 4.85E-02 |
| Xylenes | 3000 | 10-Min | 8.28E+00 | 8.30E+00 | 8.30E+00 | 8.29E+00 | 8.29E+00 |
| | 730 | 24-hr | 2.06E+00 | 2.06E+00 | 2.06E+00 | 2.06E+00 | 2.06E+00 |
| Zinc (Zn) (as TSP) | 120 | 24-hr | 3.35E-02 | 3.72E-02 | 4.68E-02 | 4.21E-02 | 8.48E-02 |
| | | | | | | | |
| 1,3-Butadiene | 2 | annual | 7.32E-02 | 7.46E-02 | 7.56E-02 | 7.81E-02 | 7.42E-02 |
| Benzene | 0.45 | annual | **9.02E-01** | **9.25E-01** | **9.42E-01** | **9.75E-01** | **9.19E-01** |
| Benzo(a)pyrene | 1.00E-05 | annual | **1.03E-04** | **1.20E-04** | **1.05E-04** | **1.35E-04** | **1.04E-04** |
| Cadmium (Cd) | 0.005 | annual | 3.62E-03 | 3.63E-03 | 3.67E-03 | 3.66E-03 | 3.97E-03 |
| Nickel (Ni) | 0.02 | annual | 1.00E-03 | 2.44E-03 | 7.03E-03 | 1.26E-02 | **1.15E-01** |
| $PM_{2.5}$ (Note 2) | 8.8 | annual | 6.80E+00 | 7.26E+00 | 8.52E+00 | 7.16E+00 | 8.20E+00 |
| Sulphur Dioxide ($SO_2$) | 10 | annual | 2.48E+00 | 2.52E+00 | 2.55E+00 | 2.61E+00 | 2.52E+00 |
| Total Suspended Particulates (TSP) (Note 2) | 60 | annual | 2.44E+01 | 2.80E+01 | 4.66E+01 | 2.82E+01 | 4.37E+01 |
| Uranium (U) | 0.03 | annual | nv | 1.87E-04 | 7.83E-04 | 5.35E-04 | 1.06E-03 |
| Dustfall ($g/m^2$) | 7 | month | nv | 2.65E+00 | **7.68E+00** | 5.12E+00 | **1.02E+01** |

| Parameter | Criteria | | Background Concentration | Construction Phase | | Operations Phase | |
|---|---|---|---|---|---|---|---|
| | Concentration | Period | | Special Receptors | Fence Line Receptors | Special Receptors | Fence Line Receptors |

Notes:
Bold font indicates exceedance of the ambient air quality criterion
nv - no value
ne - not estimated
na - not applicable

**Table 5-3: Summary of Air Quality Parameters and Receptor Locations where Maximum Predicted Concentrations Exceed Short-term or Long-term Exposure Criteria**

| Parameter | Criteria Exceedances during Construction | | Criteria Exceedances during Operations | |
|---|---|---|---|---|
| | Short-term | Long-term | Short-term | Long-term |
| **Benzene** | No exceedance | Background | No exceedance | Background |
| | | Special Receptors | | Special Receptors |
| | | Fence Line | | Fence Line |
| **Benzo(a)pyrene** | Background | Background | Background | Background |
| | Special Receptors | Special Receptors | Special Receptors | Special Receptors |
| | Fence Line | Fence Line | Fence Line | Fence Line |
| **Crystalline Silica** | Special Receptors | na | Special Receptors | na |
| | Fence Line | | Fence Line | |
| **Nickel** | No exceedance | No exceedance | Fence Line | Fence Line |
| **Nitrogen Dioxide ($NO_2$) (Note 1)** | Fence Line | na | No exceedance | na |
| **Dustfall (monthly) (Note 2)** | Fence Line | | Fence Line | |

Notes:
na indicates that there was no screening benchmark value
1 - Predicted maximum $NO_2$ concentrations at the fence line (modelled property boundary), during construction, exceeded the 1-hr AAQC but not the 24-hr AAQC.
2 - Dustfall is not assessed for direct human health effects. Exceedance of the dustfall criterion is aesthetic and not health based. An exceedance is used to interpret potential adverse human health effects from airborne parameters through the country food pathway (deposition to soil and uptake by country foods).

#### 5.1.1.1.4 Air CoPCs Requiring Further Assessment

The following sections provide a secondary level of screening for maximum total concentrations of CoPCs identified in **Table 5-3** at the receptor locations considered in the HHRA. The purpose of this section is to identify CoPCs in air that require further quantitative or qualitative assessment.

The HHRA receptor locations are locations where human health receptors may be present for prolonged periods of time and can be exposed to CoPCs in air for short or long periods of time, so where relevant, consideration is given to exposures based on 24-hr and annual concentrations. The HHRA receptor locations are a subset of the special receptor locations in the *Air Quality Updated Effects Assessment* (Appendix D1 of this EIS Addendum [Vol 2]). With respect to the air quality model, HHRA receptor locations are summarized in **Table 5-4**. Human receptors are not expected to be present at the modelled property boundary for prolonged periods of time but, where relevant, consideration is given to short-term exposures based on 24-hr (or shorter) concentrations predicted for the modelled property boundary and in the LSA in proximity to the modelled property boundary.

**Table 5-4: Receptor Locations Selected for the Human Health Risk Assessment**

| Human Health Risk Assessment Receptor Locations | Air Quality Model Receptor ID | UTM Easting (m) | UTM Northing (m) |
|---|---|---|---|
| Bamoos Lake | W_10 | 546975.32 | 5406486.49 |
| Hare Lake | PS_1 | 545001.33 | 5404050.49 |
| Pic River | M_5 | 551637 | 5402371 |
| Residences near the potential rail loadout | Air Quality Model locations (R_1 to R_22) (Note 1) | | |
| Maximum at modelled property boundary | Air Quality Model locations (Notes 1, 2) | | |

Notes:
1 - The maximum predicted air concentration for all of the Air Quality Model locations associated with the HHRA receptor location was used for the human health risk assessment.
2 - Human receptors near the modelled property boundary are assessed only for short-term exposure scenarios because human receptors are not expected to be present at the modelled property boundary for prolonged periods of time.

Based on the screening of air quality parameters in Section 5.1.1.1.3, benzene (long-term exposures), benzo(a)pyrene (short-term and long-term exposures), crystalline silica (short-term exposures), nickel (short-term and long-term exposures), nitrogen dioxide (short-term exposures) and dustfall (indirect human health effects from country foods) were identified as requiring additional assessment.

##### 5.1.1.1.4.1 Benzene

The predicted maximum concentrations of benzene at HHRA receptor locations, for the Project only and for the Project plus background, are compared to background concentrations and

health-based criteria in **Table 5-5**. Benzene did not exceed the short-term screening criterion at any location therefore the Project is not expected to result in adverse health effects for any human receptor for short-term exposures to benzene.

**Table 5-5: Secondary Screening for Benzene – Long Term Exposure (Predicted Maximum Annual Concentrations) (µg/m$^3$) at HHRA Receptor Locations**

| HHRA Receptor Locations and AQ Model Location | Construction | | Operations | |
|---|---|---|---|---|
| | Project Only | Total Project and Background | Project Only | Total Project and background |
| **Screening Criterion** | **0.45** | | | |
| Background | 9.02E-01 | | | |
| Bamoos Lake (W_10) | 2.60E-03 | 9.05E-01 | 2.13E-03 | 9.04E-01 |
| Hare Lake (PS_1) | 2.16E-03 | 9.04E-01 | 1.63E-03 | 9.04E-01 |
| Pic River (M_5) | 4.57E-03 | 9.07E-01 | 2.67E-03 | 9.05E-01 |
| Residences near the potential rail loadout | | | | |
| R_1 Residence | 3.81E-03 | 9.06E-01 | 1.28E-02 | 9.15E-01 |
| R_2 Residence | 2.79E-03 | 9.05E-01 | 5.39E-03 | 9.07E-01 |
| R_3 Bergagnini Apartment Rental | 2.90E-03 | 9.05E-01 | 1.16E-02 | 9.14E-01 |
| R_4 Residence | 2.01E-03 | 9.04E-01 | 6.69E-03 | 9.09E-01 |
| R_5 Condominium | 4.88E-03 | 9.07E-01 | 2.88E-02 | 9.31E-01 |
| R_6 Residence | 2.01E-03 | 9.04E-01 | 1.02E-02 | 9.12E-01 |
| R_7 I Sew Studio and Residence | 1.48E-03 | 9.03E-01 | 2.92E-02 | 9.31E-01 |
| R_8 Bayview Apartments | 1.35E-03 | 9.03E-01 | 2.85E-02 | 9.30E-01 |
| R_9 Residence | 1.26E-03 | 9.03E-01 | 1.59E-02 | 9.18E-01 |
| R_10 Residence | 1.23E-03 | 9.03E-01 | **7.28E-02** | **9.75E-01** |
| R_11 Residence | 1.22E-03 | 9.03E-01 | 2.33E-02 | 9.25E-01 |
| R_12 Residence | 1.32E-03 | 9.03E-01 | 1.76E-02 | 9.20E-01 |
| R_13 Residence | 1.51E-03 | 9.04E-01 | 4.72E-02 | 9.49E-01 |
| R_14 Residence | 1.61E-03 | 9.04E-01 | 3.13E-02 | 9.33E-01 |

| HHRA Receptor Locations and AQ Model Location | Construction | | Operations | |
|---|---|---|---|---|
| | Project Only | Total Project and Background | Project Only | Total Project and background |
| R_15 Residence | 1.46E-03 | 9.03E-01 | 1.68E-02 | 9.19E-01 |
| R_16 Residence | 1.63E-03 | 9.04E-01 | 6.04E-03 | 9.08E-01 |
| R_17 Residence | 1.51E-03 | 9.04E-01 | 3.96E-03 | 9.06E-01 |
| R_18 Residence | 1.41E-03 | 9.03E-01 | 3.23E-03 | 9.05E-01 |
| R_19 Residence | 1.14E-03 | 9.03E-01 | 1.45E-03 | 9.03E-01 |
| R_20 Residence | 1.13E-03 | 9.03E-01 | 1.35E-03 | 9.03E-01 |
| R_21 Residence | 1.11E-03 | 9.03E-01 | 1.14E-03 | 9.03E-01 |
| R_22 Residence | **5.55E-03** | **9.08E-01** | 3.08E-03 | 9.05E-01 |

Notes:
Bold and underlined - indicates the maximum predicted concentrations at a residence near the proposed rail loadout
Grey Cell - indicate exceedance of the screening criterion

The predicted maximum Project-related emissions for benzene are below the screening criterion for long-term exposures. However, when background and Project-related sources are combined, predicted maximum concentrations exceed the criterion. This is because the selected background concentration for benzene of 0.90 µg/m3 exceeds the screening criterion of 0.45 µg/m3. The benzene background concentration used in the air quality model was the maximum of annual concentrations reported for the 5-year period from 2014 to 2018, inclusive, at the Winnipeg NAPS station. Winnipeg NAPS data were not available for benzene for 2019. During this period of time the annual average benzene concentrations ranged from 0.44 µg/m3 in 2016 to 0.90 µg/m3 in 2014, as shown in **Table 5-6**. With the exception of 2014, the annual average background concentration for benzene was at or below the screening criterion for all other years in the dataset. As shown in **Table 5-5**, the Project-related concentrations for benzene are less than background levels. Also, the Project contributes only a small portion, generally 5% or less, to the predicted total annual concentration during any Project stage.

**Table 5-6: Range of Annual Average Background Concentration of Benzene from the Winnipeg NAPS (70119) for the Period 2014 to 2018**

| Year | Annual Mean (µg/m$^3$) |
|---|---|
| 2014 | **9.02E-01** |
| 2015 | 4.87E-01 |
| 2016 | 4.17E-01 |
| 2017 | 4.30E-01 |
| 2018 | 4.83E-01 |

Benzene is volatile and the potential route of exposure for human receptors is through inhalation. Benzene is retained for further quantitative evaluation of potential effects from inhalation for long-term exposures.

Benzene does not accumulate in biota. Therefore, benzene is not retained for assessment of potential risk to human receptors through pathways analysis (i.e., country foods), as discussed in Section 5.1.1.3.2.

#### 5.1.1.1.4.2 Benzo(a)pyrene

The predicted maximum total (Project plus background) annual concentrations of benzo(a)pyrene at HHRA receptor locations are compared to background concentrations and health-based criteria in **Table 5-7**. Benzo(a)pyrene also exceeded the short-term screening criterion at all model locations. The 24-hour screening criterion was the Ontario AAQC for the same exposure period. The 24-hour criterion was converted from the annual AAQC to allow assessment of 24-hour air quality data. A reputable acute (short-term) benzo(a)pyrene inhalation toxicological reference value is not available to quantitively assess acute risks to human receptors that inhale benzo(a)pyrene in outdoor air. As such, acute risks to human receptors who inhale benzo(a)pyrene in outdoor air were qualitatively assessed.

**Table 5-7: Secondary Screening for Benzo(a)pyrene – Long Term Exposure (Predicted Maximum Annual Concentrations) (µg/m$^3$) at HHRA Receptor Locations**

| HHRA Receptor Locations and AQ Model Location | Construction | | Operations | |
|---|---|---|---|---|
| | Project Only | Total Project and Background | Project Only | Total Project and Background |
| **Screening Criterion** | **5.00E-05** | | | |
| Background | 1.03E-04 | | | |
| Bamoos Lake (W_10) | 2.35E-07 | 1.03E-04 | 1.20E-07 | 1.03E-04 |
| Hare Lake (PS_1) | 2.43E-07 | 1.03E-04 | 1.17E-07 | 1.03E-04 |
| Pic River (M_5) | 4.35E-07 | 1.03E-04 | 1.96E-07 | 1.03E-04 |
| Residences near the potential rail loadout | | | | |
| R_1 Residence | 7.40E-06 | 1.10E-04 | 7.19E-06 | 1.10E-04 |
| R_2 Residence | 2.77E-06 | 1.06E-04 | 2.62E-06 | 1.06E-04 |
| R_3 Bergagnini Apartment Rental | 6.76E-06 | 1.10E-04 | 6.15E-06 | 1.09E-04 |
| R_4 Residence | 3.12E-06 | 1.06E-04 | 2.13E-06 | 1.05E-04 |
| R_5 Condominium | **1.66E-05** | **1.20E-04** | 9.77E-06 | 1.13E-04 |
| R_6 Residence | 3.60E-06 | 1.07E-04 | 3.35E-06 | 1.06E-04 |
| R_7 I Sew Studio and Residence | 1.49E-06 | 1.04E-04 | 4.68E-06 | 1.08E-04 |
| R_8 Bayview Apartments | 1.10E-06 | 1.04E-04 | 4.85E-06 | 1.08E-04 |
| R_9 Residence | 8.43E-07 | 1.04E-04 | 3.46E-06 | 1.06E-04 |
| R_10 Residence | 7.91E-07 | 1.04E-04 | 1.94E-05 | 1.22E-04 |
| R_11 Residence | 7.76E-07 | 1.04E-04 | 9.60E-06 | 1.13E-04 |
| R_12 Residence | 1.01E-06 | 1.04E-04 | 9.75E-06 | 1.13E-04 |
| R_13 Residence | 1.70E-06 | 1.05E-04 | **3.23E-05** | **1.35E-04** |
| R_14 Residence | 2.07E-06 | 1.05E-04 | 2.05E-05 | 1.23E-04 |
| R_15 Residence | 1.52E-06 | 1.05E-04 | 8.21E-06 | 1.11E-04 |

| HHRA Receptor Locations and AQ Model Location | Construction | | Operations | |
|---|---|---|---|---|
| | Project Only | Total Project and Background | Project Only | Total Project and Background |
| R_16 Residence | 1.75E-06 | 1.05E-04 | 2.49E-06 | 1.05E-04 |
| R_17 Residence | 1.06E-06 | 1.04E-04 | 1.52E-06 | 1.05E-04 |
| R_18 Residence | 7.43E-07 | 1.04E-04 | 1.23E-06 | 1.04E-04 |
| R_19 Residence | 2.87E-07 | 1.03E-04 | 4.18E-07 | 1.03E-04 |
| R_20 Residence | 2.71E-07 | 1.03E-04 | 3.72E-07 | 1.03E-04 |
| R_21 Residence | 2.36E-07 | 1.03E-04 | 2.83E-07 | 1.03E-04 |
| R_22 Residence | 9.19E-07 | 1.04E-04 | 6.94E-07 | 1.04E-04 |

Notes:
Bold and underlined - indicates the maximum predicted concentrations at a residence near the proposed rail loadout
Grey Cell - indicate exceedance of the screening criterion

The predicted maximum Project-related concentrations for benzo(a)pyrene are below the screening criterion for long-term exposures. However, when background and Project-related sources are combined, predicted maximum concentrations exceed the criterion. This is because the selected background concentration for benzo(a)pyrene of 1.03E-04 µg/m3 exceeds the screening criterion of 5.00E-05 µg/m3. The benzo(a)pyrene background concentration used in the air quality model was the maximum of annual concentrations reported for the period from 2009 to 2011, inclusive, because the Winnipeg NAPS station data for PAHs, including benzo(a)pyrene, were only available for the 3-year period from 2009 to 2011. During this period of time the annual average benzo(a)pyrene concentrations ranged from 7.79E-05 µg/m3 in 2009 and 2011 to 1.03E-04 µg/m3 in 2011, as shown in **Table 5-8**. For all three years in the dataset the annual average background concentration for benzo(a)pyrene exceeded the screening criterion. As shown in **Table 5-7**, the Project-related concentrations for benzo(a)pyrene are less than background levels. The Project contributes only a small portion, generally less than 10%, to the predicted total annual concentration during any Project stage. The proportion on Project-related concentrations in the total annual average ambient concentration can be between 10 and 20% at some locations near the proposed rail loadout, such as at the R_5 Condominium during construction and R_13 Residence during operations. The final location for the proposed rail loadout area has not yet been determined.

**Table 5-8: Range of Annual Average Background Concentration of Benzo(a)pyrene from the Winnipeg NAPS (70119) for the Period 2009 to 2011**

| Year | Annual Mean (µg/m3) |
|---|---|
| 2009 | 7.79E-05 |
| 2010 | 7.79E-05 |
| 2011 | **1.03E-04** |

Benzo(a)pyrene is not volatile and the potential route of exposure for human receptors is through inhalation of contaminated airborne particulates. As shown in Section 5.1.1.1.3, the predicted maximum concentrations of total suspended particulates, and inhalable particulate matter (PM10 and PM2.5) were below their respective screening criteria for all Project stages and for short and long-term exposure durations. This suggests that inhalable benzo(a)pyrene may not be of concern for human receptors. Regardless, benzo(a)pyrene is retained for further quantitative evaluation of potential effects from inhalation for long-term exposures.

Benzo(a)pyrene is not expected to accumulate in biota. Therefore, benzo(a)pyrene is not retained for assessment of potential risk to human receptors through pathways analysis (i.e., country foods), as discussed in Section 5.1.1.3.2.

#### 5.1.1.1.4.3 Crystalline Silica

The predicted maximum 24-hour concentrations of crystalline silica at HHRA receptor locations and along the modelled property boundary are compared to short-term health-based criteria in **Table 5-2**. During construction, the maximum concentrations are expected to occur near the

haul road to the PSMF. During operations, the maximum concentrations are expected to occur near the mine entrance and near the potential rail loadout area. Elevated concentrations are predicted near Bamoos Lake and in a very localized area near the potential loadout area. The predicted maximum 24-hour concentrations of crystalline silica at HHRA receptor locations are compared to the health-based criterion in **Table 5-9**.

**Table 5-9: Secondary Screening for Crystalline Silica – Short Term Exposure (Predicted Maximum 24-hour Concentrations) (µg/m$^3$) at HHRA Receptor Locations**

| HHRA Receptor Locations and AQ Model Location | Construction | Operations |
|---|---|---|
| | Project Only | Project Only |
| **Screening Criterion** | **5.00E+00** | |
| Background | nv | |
| Bamoos Lake (W_10) | 5.75E+00 | 3.46E+00 |
| Hare Lake (PS_1) | 2.66E+00 | 2.02E+00 |
| Pic River (M_5) | 3.52E+00 | 4.62E+00 |
| Residences near the potential rail loadout | | |
| R_1 Residence | 2.33E+00 | 2.45E+00 |
| R_2 Residence | 2.33E+00 | 2.47E+00 |
| R_3 Bergagnini Apartment Rental | 1.48E+00 | 1.61E+00 |
| R_4 Residence | 1.53E+00 | 1.33E+00 |
| R_5 Condominium | 1.43E+00 | 1.18E+00 |
| R_6 Residence | 1.35E+00 | 1.27E+00 |
| R_7 I Sew Studio and Residence | 1.27E+00 | 1.23E+00 |
| R_8 Bayview Apartments | 1.23E+00 | 1.16E+00 |
| R_9 Residence | 1.18E+00 | 1.14E+00 |
| R_10 Residence | 1.23E+00 | 1.08E+00 |
| R_11 Residence | 1.26E+00 | 1.02E+00 |
| R_12 Residence | 1.32E+00 | 1.12E+00 |
| R_13 Residence | 1.35E+00 | 1.10E+00 |
| R_14 Residence | 1.36E+00 | 1.11E+00 |
| R_15 Residence | 1.31E+00 | 1.11E+00 |
| R_16 Residence | 1.44E+00 | 1.30E+00 |
| R_17 Residence | 1.42E+00 | 1.35E+00 |
| R_18 Residence | 1.34E+00 | 1.33E+00 |
| R_19 Residence | 1.19E+00 | 1.25E+00 |
| R_20 Residence | 1.19E+00 | 1.27E+00 |
| R_21 Residence | 1.21E+00 | 1.27E+00 |

| HHRA Receptor Locations and AQ Model Location | Construction Project Only | Operations Project Only |
|---|---|---|
| R_22 Residence | **4.52E+00** | **6.30E+00** |
| Maximum at modelled property boundary | 3.51E+01 | 1.94E+01 |

Notes:
Bold and underlined - indicates the maximum predicted concentrations at a residence near the proposed rail loadout
Grey Cell - indicates exceedance of the screening criterion
nv - indicates that background concentrations were not available

The screening criterion for crystalline silica, is an O.Reg 419/05 health-based standard of 5 µg/m3 that is the same as the US EPA (1996) ambient air level for 24-hr continuous exposure to crystalline silica. The US EPA criterion was derived from an occupational time weighted average (TWA), of 1 mg/m$^3$ year. The US EPA (1996) TWA was associated with a near 0% cumulative risk of developing silicosis (US EPA, 1996) among miners in South Africa, North Dakota, and Canada. The occupational TWA was converted to a 24-hr ambient air level of 5 µg/m$^3$ when the potential exposure duration was extrapolated to a 70-year lifetime of exposure to crystalline silica in ambient air. This calculation uses the US EPA equation (US EPA, 1996):

US EPA (1996) 24-hour continuous exposure =

TWA * (days/week days) * (inhalation rate/daily inhalation rate) / duration (years);

US EPA (1996) 24-hour continuous exposure = (1 mg/m$^3$-year) * (5 days/7 days) * (10 m$^3$/day / 20 m$^3$/day) / 70 years;

US EPA (1996) 24-hr continuous exposure = 0.005 mg/m$^3$, or 5 µg/m$^3$

The frequency and duration of exceedances of the screening criterion were calculated in the *Air Quality Updated Effects Assessment* (Appendix D1 of this EIS Addendum [Vol 2]). The predicted frequency of exceedances at the HHRA receptor locations where exceedances were predicted to occur are summarized in **Table 5-10**. As shown in **Table 5-10**, exceedances of the screening criterion at Bamoos Lake and at residences near the proposed rail loadout are predicted to occur less than 1% of the time. At the modelled property boundary, the maximum concentrations are expected to be greater than the criterion for longer periods of time (between 84 and 89%). However, human receptors are not expected to be in proximity of the modelled property boundary for prolonged periods of time. In addition, the duration of the construction period (2 years) and the operations period (12.7 years) are much shorter than the 70-year exposure period assumed for the screening criterion.

**Table 5-10: Frequency of Criterion Exceedances at HHRA Receptor Locations for Crystalline Silica**

| HHRA Receptor Locations and AQ Model Location | Construction | | Operations | |
|---|---|---|---|---|
| | Maximum Predicted 24-hr Average | % of Time Greater than Criteria | Maximum Predicted 24-hr Average | % of Time Greater than Criteria |
| Bamoos Lake (W_10) | 5.7 | 0.05% | na | na |
| R_22 Residence | na | na | 6.2 | 0.38% |
| Maximum at Modelled Property Boundary | | | | |
| Modelled Property Boundary Close to Mine Entrance | na | na | 37 | 89% |
| Modelled Property Boundary - Near Haul Road to PSMF | 35 | 84% | na | na |

Note:
na - indicates that there were no exceedances of the screening criterion

The US EPA (1996) concluded that, for healthy individuals not compromised by other respiratory ailments, and for ambient environments expected to contain 10% or less crystalline silica fraction in PM10, maintenance of a 24-hour ambient PM10 concentration of 50 µg/m3 should be adequate to protect against silicosis effects from ambient crystalline silica exposures. This suggests that the crystalline silica screening criterion of 5 µg/m3 may be highly conservative. The maximum predicted 24-hr concentrations of PM10 for the Project, both including and without background contributions, were below the screening criterion of 50 ug/m3 at all locations and for all Project stages.

Based on this secondary screening, potential human health effects from exposure to crystalline silica in air will be qualitatively assessed. Since potential adverse effects are from the inhalation pathway, crystalline silica is not retained for assessment of potential risk to human receptors through pathways analysis (i.e., country foods) as discussed in Section 5.1.1.3.2.

#### 5.1.1.1.4.4 Nickel

The predicted maximum total (background plus Project) concentrations of nickel exceeded the screening criterion at fence line receptor locations as shown in **Table 5-2** for both short-term and long-term exposures. The screening benchmark values of 0.1 µg/m$^3$ for 24-hours and 0.02 µg/m$^3$ annual average, are based on nickel associated with airborne particulate matter. The critical toxicological endpoints for nickel are associated with the $PM_{10}$ fraction. For the screening of CoPCs, all of the nickel in air was assumed to be associated with the respirable $PM_{10}$ fraction of airborne particulates. Potential adverse health effects from exposure to nickel in air are for chronic effects associated with long-term exposure scenarios rather than short-term exposures. The 24-hour Ontario AAQC was derived from the annual health-based criterion to allow assessment of the 24-hr data and is meant to be protective of non-cancer and cancer effects from long-term exposures to nickel in air through inhalation. The predicted maximum annual average concentrations of crystalline silica at HHRA receptor locations are compared to the health-based criterion in **Table 5-11**.

**Table 5-11: Secondary Screening for Nickel – Long Term Exposure (Predicted Maximum Annual Average Concentrations) (µg/m$^3$) at HHRA Receptor Locations**

| HHRA Receptor Locations and AQ Model Location | Construction | | Operations | |
|---|---|---|---|---|
| | Project Only | Total Project and Background | Project Only | Total Project and Background |
| **Screening Criterion** | **2.00E-02** | | | |
| **Background** | **0.001** | | | |
| Bamoos Lake (W_10) | 3.70E-04 | 1.37E-03 | 3.86E-04 | 1.39E-03 |
| Hare Lake (PS_1) | 2.70E-04 | 1.27E-03 | 3.92E-04 | 1.39E-03 |
| Pic River (M_5) | 5.20E-04 | 1.52E-03 | 8.35E-04 | 1.84E-03 |
| Residences near the potential rail loadout | | | | |
| R_1 Residence | 2.50E-04 | 1.25E-03 | 6.52E-04 | 1.65E-03 |
| R_2 Residence | 2.50E-04 | 1.25E-03 | 6.36E-04 | 1.64E-03 |
| R_3 Bergagnini Apartment Rental | 1.70E-04 | 1.17E-03 | **3.74E-03** | **4.74E-03** |
| R_4 Residence | 1.60E-04 | 1.16E-03 | 2.96E-03 | 3.96E-03 |
| R_5 Condominium | 1.50E-04 | 1.15E-03 | 1.76E-03 | 2.76E-03 |
| R_6 Residence | 1.50E-04 | 1.15E-03 | 3.22E-03 | 4.22E-03 |
| R_7 I Sew Studio and Residence | 1.40E-04 | 1.14E-03 | 3.29E-03 | 4.29E-03 |
| R_8 Bayview Apartments | 1.40E-04 | 1.14E-03 | 2.28E-03 | 3.28E-03 |
| R_9 Residence | 1.30E-04 | 1.13E-03 | 1.86E-03 | 2.86E-03 |
| R_10 Residence | 1.30E-04 | 1.13E-03 | 1.36E-03 | 2.36E-03 |
| R_11 Residence | 1.30E-04 | 1.13E-03 | 1.09E-03 | 2.09E-03 |
| R_12 Residence | 1.30E-04 | 1.13E-03 | 1.09E-03 | 2.09E-03 |
| R_13 Residence | 1.40E-04 | 1.14E-03 | 1.35E-03 | 2.35E-03 |
| R_14 Residence | 1.40E-04 | 1.14E-03 | 1.42E-03 | 2.42E-03 |

| HHRA Receptor Locations and AQ Model Location | Construction | | Operations | |
|---|---|---|---|---|
| | Project Only | Total Project and Background | Project Only | Total Project and Background |
| R_15 Residence | 1.40E-04 | 1.14E-03 | 1.57E-03 | 2.57E-03 |
| R_16 Residence | 1.50E-04 | 1.15E-03 | 1.32E-03 | 2.32E-03 |
| R_17 Residence | 1.50E-04 | 1.15E-03 | 1.16E-03 | 2.16E-03 |
| R_18 Residence | 1.50E-04 | 1.15E-03 | 9.72E-04 | 1.97E-03 |
| R_19 Residence | 1.30E-04 | 1.13E-03 | 5.37E-04 | 1.54E-03 |
| R_20 Residence | 1.30E-04 | 1.13E-03 | 5.18E-04 | 1.52E-03 |
| R_21 Residence | 1.30E-04 | 1.13E-03 | 4.77E-04 | 1.48E-03 |
| R_22 Residence | **5.10E-04** | **1.51E-03** | 9.77E-04 | 1.98E-03 |

Notes:
Bold and underlined - indicates the maximum predicted concentrations at a residence near the proposed rail loadout
Grey Cell - indicated exceedance of the screening criterion

The exceedance of the annual nickel criterion is predicted to occur near the modelled property boundary near the potential rail loadout area, and is associated with loading of concentrate to rail cars, as described in the *Air Quality Updated Effects Assessment* (Appendix D1 of this EIS Addendum [Vol 2]). Members of the public are not expected to spend substantial periods of time near the modelled property boundary. Nickel did not exceed screening values at the residences near the potential rail loadout area in Marathon. The area affected by elevated nickel concentrations extends to no more than about 25 meters from the property line, as shown in Figure 14j and Figure 14k of the *Air Quality Updated Effects Assessment* (Appendix D1 of this EIS Addendum [Vol 2]).

Since predicted annual nickel concentrations do not exceed the annual average screening benchmark value at the HHRA receptor locations, potential human health effects from exposure to nickel in air will be qualitatively assessed. Also, because nickel does not exceed the screening criterion at HHRA receptor locations, it is not retained for assessment of potential risk to human receptors through pathways analysis (i.e., country foods).

#### 5.1.1.1.4.5 Nitrogen Dioxide ($NO_2$)

As shown in **Table 5-2**, the predicted maximum short-term (1 hour) concentrations of nitrogen dioxide exceed the 1-hour criterion at fence line receptor locations during construction but not at HHRA receptor locations. Nitrogen dioxide concentrations will be below their respective health-based screening criteria for 24-hours and annual averaging periods during construction and operations. Members of the public are not expected to spend substantial periods of time near the modelled property boundary, but could be present for short periods of time, such as a 1-hour period.

The maximum predicted total (background plus Project) 1-hour concentration of 460 µg/m3 exceeds the screening criterion of 400 µg/m3 by approximately 15%. The background $NO_2$ level used in the air quality model is based on a 90th percentile background level and is expected to be conservative in terms of both amplitude and likelihood of occurrence.

The Project-related $NO_2$ emissions are related to the use of explosives during construction and operations. The higher predicted $NO_2$ levels expected during construction relative to during operations will be due to the type of explosives used that have higher associated NOx emissions than those used during operations (Appendix D1 of this EIS Addendum [Vol 2]). During construction, explosives used for drilling and blasting will range from pre-packaged design to ammonium-nitrate fuel oil (ANFO) and/or site mixed emulsion (SME) explosive-based products for large blasts. During operations, the pits will be excavated by blasting using a site mixed emulsion (SME) explosive, and an ammonium-nitrate fuel oil (ANFO) explosive may also be used. Blasting will be infrequent during construction, usually once per day, therefore peaks in ambient concentrations at the modelled property boundary will be infrequent.

Based on conservative assumptions used for estimating 1-hour contributions from background, and the infrequency of blasting during construction, potential human health effects from exposure to $NO_2$ in air will be qualitatively assessed. Since potential adverse effects are from the

inhalation pathway, $NO_2$ is not retained for assessment of potential risk to human receptors through pathways analysis (i.e., country foods).

#### 5.1.1.1.4.6 Dustfall

Dustfall was expected to exceed its monthly screening criterion at fence line receptors during construction and operations as shown in **Table 5-2**, and the area in which total (background plus Project) dustfall levels are above the criterion was predicted to be limited to near the modelled property boundary (Appendix D1 of this EIS Addendum [Vol 2]). Dustfall did not exceed its monthly criterion at HHRA receptor locations at Hare Lake, Bamoos Lake and the Pic River, or at residences in the Town of Marathon near the potential rail loadout area. The screening criterion for dustfall is based on aesthetic effects from deposition of dust on surfaces, rather than on health concerns. Dust is composed of particulate matter, and the predicted maximum 24-hour and annual concentrations of particulate matter in the forms of TSP, PM10 or PM2.5 did not exceed their respective health-based screening criteria. For these reasons, dustfall is not considered further in the HHRA.

### 5.1.1.1.5 Summary of Parameters in Air Retained for Further Assessment

**Table 5-12** provides a summary of the parameters in air retained for further assessment and the type of assessment for each parameter. Based on the screening in Section 5.1.1.1.3 and the additional evaluations provided in Section 5.1.1.1.4, potential human health risks from benzene and benzo(a)pyrene in air will be quantitatively assessed for long-term exposures and qualitatively assessed for short-term exposures. The potential human health risks from project-related air parameters that were below screening criteria in **Table 5-2**, as well as crystalline silica, nickel, $NO_2$ and dustfall are qualitatively assessed.

**Table 5-12: Assessment Type for Parameters in Air Retained for Further Assessment**

| Parameter | Assessment Type |
|---|---|
| Air parameters that did not exceed screening criteria | Qualitative |
| Benzene | Quantitative/ Long-term exposures<br>Qualitative/ Short-term exposures |
| Benzo(a)pyrene | Quantitative/ Long-term exposures<br>Qualitative/ Short-term exposures |
| Crystalline silica | Qualitative/ Long-term and short-term exposures |
| Nickel | Qualitative/ Long-term and short-term exposure |
| $NO_2$ | Qualitative/ Long-term and short-term exposures |
| Dustfall | Qualitative/ monthly exposures |

The screening did not identify any CoPCs (e.g., PAHs, metals) in Project-related air emissions that are likely to deposit to soil and/or accumulate in biota (country foods) at levels of concern to human health.

#### 5.1.1.2 Water

The purpose of the water effects assessment is to evaluate the potential effects of Project activities on human health. Project-related water emissions during all phases of the Project could affect human health by affecting drinking and recreational water quality. The potential effect of water releases on country foods is discussed in Section 5.1.1.3.

##### 5.1.1.2.1 Updated Water Modelling

Water quality modelling, three-dimensional numerical groundwater flow modelling, site water balance, field data and geochemical characterization of overburden, ore, waste rock and tailings were used to assess groundwater and surface water quality during the life of the mine for the updated Project design. The updated water modelling is summarized in Section 6.2.3 of the EIS Addendum and described in further detail in the *Water Quality Assessment Update* (Appendix D11 of this EIS Addendum [Vol 2]) and *Hydrogeology Updated Effects Assessment* (Appendix D4 of this EIS Addendum [Vol 2]). The summary of the updated water quality assessment presented in the context of human health effects focuses on drinking and recreational water quality, as described in the *Guidance for Evaluating Human Health Impacts in Environmental Assessment: Drinking and Recreational Water Quality* (Health Canada, 2016c).

The assessment was undertaken in a manner similar to that described in the original EIS, incorporating updated information as available. The modelling was used to assess the influence of drainage from Project components (MRSA, ore stockpile, PSMF and water management pond) on groundwater quality, and the influence of discharges to surface water on water quality in Hare Lake and the Pic River. Measurable parameters were selected based on professional judgement, other EISs for mining projects in Ontario, and comments provided during consultation.

##### 5.1.1.2.2 Surface Water Quality Benchmarks

Guidelines for the protection of aquatic life, guidelines for the protection of livestock, Guidelines for Canadian Drinking Water Quality (GCDWQ), Ontario Drinking Water Quality Standards (ODWQS) and background water quality are shown in **Table 5-13**.

Provincial Water Quality Objectives (PWQO) and federal water quality benchmarks developed by the Canadian Council of Ministers of the Environment (CCME) were used to assess potential effects of Project-related changes in surface water quality on the health of surface water users. These assessment benchmarks represent constituent concentrations that are protective of aquatic life, as well as other water uses including drinking and recreational water use. The aquatic life benchmarks relevant to this assessment are generally the same as, or lower than, those associated with drinking water standards therefore where a constituent concentration is below an aquatic life benchmark the drinking water use is protected. The surface water quality benchmarks protective of aquatic life are also considered protective of consumers of country foods such as fish and game because the benchmarks are lower than those associated with the protection of livestock.

In some cases, the water quality benchmarks for Hare Lake and the Pic River are associated with ambient water quality and are therefore waterbody/watercourse specific. This is the case, for example, for constituents that are hardness-dependent – that is, their toxicological effects are influenced by water hardness. Accordingly, independent benchmarks are shown for Hare Lake and the Pic River.

For the parameters analyzed as part of the Project, the GCDWQ generally have the same values as the ODWQS. Where the criteria for the GCDWQ and ODWQS differed, the criteria based on the most recent update were selected. These benchmarks are used to assess the potential effects of Project-related changes in water quality on drinking water and the health of surface water and groundwater users.

Natural background concentrations of constituents such as aluminum, iron and manganese exceed benchmark values. These elevated concentrations are typical of surface water and groundwater in Ontario, reflecting natural mineralization and geochemical processes. Where natural background exceeds benchmark values, natural background is selected as the appropriate water quality benchmark.

The updated background surface water quality for small receiving waters is based on the 75$^{th}$ percentile of data collected from monitoring stations S10, S11, S12, S13, S14, S15, S30, S31, S41, LHare, Bamoos1 and Bamoos2 in the Stream 105 and 106 subwatersheds during the baseline sampling program over the period between 2008 and 2019. These subwatersheds are similar receiving environments and were assumed to have a common background water quality.

The updated background surface water quality for the Pic River is based on data collected from stations PR1, PR2, PR3 and PR4 on the Pic River – a station upstream of the Project site, two stations adjacent to the Project site, and one station downstream of the Project site – during the baseline sampling program over the period between 2008 and 2014.

**Table 5-13: Benchmarks for Assessing Water Quality**

| Constituent | Hare Lake | | | Pic River | | | Livestock (mg/L) | ODWQS or GCDWQ (mg/L) |
|---|---|---|---|---|---|---|---|---|
| | Background (mg/L) | PWQO (mg/L) | CCME (mg/L) | Background (mg/L) | PWQO (mg/L) | CCME (mg/L) | | |
| Aluminum (filtered) | 0.17 | 0.075 | 0.1 | 0.5 | 0.075 | 0.1 | 5 (total) | 0.1 |
| Antimony | <0.005 | 0.02 | - | <0.005 | 0.02 | - | - | 0.006 |
| Arsenic | <0.001 | 0.005 | 0.005 | <0.001 | 0.005 | 0.005 | 0.025 | 0.010 |
| Boron | <0.05 | 0.2 | 1.5 | <0.05 | 0.2 | 1.5 | 5 | 5 |
| Cadmium | <0.00009 | 0.0001 | 0.00005 | <0.00009 | 0.0001 | 0.0002 | 0.08 | 0.005 |
| Chromium | 0.0005 | 0.0089 | 0.0089 | 0.004 | 0.0089 | 0.0089 | 0.05 | 0.05 |
| Cobalt | <0.0005 | 0.0009 | - | 0.001 | 0.0009 | - | 1 | - |
| Copper | <0.001 | 0.005 | 0.002 | 0.004 | 0.005 | 0.003 | 0.5 | 1 |
| Iron | 0.9 | 0.3 | 0.3 | 2.7 | 0.3 | 0.3 | - | 0.3 |
| Lead | <0.001 | 0.001 | 0.001 | <0.001 | 0.005 | 0.005 | 0.1 | 0.005 |
| Manganese | 0.08 | - | 0.32 | 0.08 | - | 0.26 | - | 0.12 |
| Mercury (filtered) | <0.000005 | 0.0002 | 0.000026 | <0.0001 | 0.0002 | 0.000026 | 0.003 | 0.001 |
| Molybdenum | <0.001 | 0.04 | 0.073 | <0.001 | 0.04 | 0.073 | 0.5 | - |
| Nickel | <0.002 | 0.025 | 0.025 | 0.004 | 0.025 | 0.12 | 1 | - |
| Selenium | <0.001 | 0.1 | 0.001 | <0.001 | 0.1 | 0.001 | 0.05 | 0.05 |
| Silver | <0.0001 | 0.0001 | 0.00025 | <0.0001 | 0.0001 | 0.00025 | - | - |
| Thallium | <0.0003 | 0.0003 | 0.0008 | <0.0003 | 0.0003 | 0.0008 | - | - |
| Uranium | <0.005 | 0.005 | 0.005 | <0.005 | 0.005 | 0.005 | 0.2 | 0.02 |
| Vanadium | <0.001 | 0.006 | - | 0.005 | 0.006 | - | 0.1 | - |
| Zinc | 0.006 | 0.02 | 0.008 | 0.009 | 0.02 | 0.041 | 50 | 5 |
| Hardness | 20 | - | - | 138 | - | - | - | - |
| Sulphate | 3.5 | - | - | 2.6 | - | - | 1000 | 500 |

| Constituent | Hare Lake | | | Pic River | | | Livestock (mg/L) | ODWQS or GCDWQ (mg/L) |
|---|---|---|---|---|---|---|---|---|
| | Background (mg/L) | PWQO (mg/L) | CCME (mg/L) | Background (mg/L) | PWQO (mg/L) | CCME (mg/L) | | |
| Nitrate (N) | 0.11 | - | 3.0 | 0.08 | - | 3.0 | 100 (nitrate and nitrite as N) | 10 |
| Total Ammonia (N) | 0.06 | - | 1.04 | 0.03 | - | 1.04 | - | - |
| Phosphorous | 0.01 | 0.02 | 0.01 to 0.02 | 0.08 | 0.02 | 0.01 to 0.02 | - | - |

Notes:

Total concentrations unless denoted.

PWQO: Provincial Water Quality Objectives. Where interim PWQOs are available, the interim value is used.

CCME: Canadian Council of Ministers of the Environment; values shown are federal water quality benchmarks for the protection of aquatic life.

ODWQS: Ontario Drinking Water Quality Standards (Provincial)

GCDWQ: Guidelines for Canadian Drinking Water Quality (Federal)

Livestock: CCME guidelines for the protection of agricultural water uses are designed to protect livestock.

#### 5.1.1.2.3 Predicted Water Quality

Project activities may interact with surface water quality in all Project phases:

- During site preparation and construction, the primary effect pathway relates to the mobilization of suspended material into natural surface water features as the result of land disturbance and clearing.
- During operations, excess water from the PSMF and MRSA beyond that which is needed as process water or can be stored in the water management ponds will be released to Hare Lake. In the original EIS (2012), water associated with the MRSA was to be released to the Pic River. In the updated Project design, drainage associated with the MRSA will be pumped to a water management pond.
- After closure, the discharge to Hare Lake will cease and natural site drainage will be restored to the extent possible. Drainage from the rehabilitated PSMF will be directed to the Stream 106 subwatershed (Angler Creek). Drainage from the water management ponds for the PSMF will be directed to the Stream 101 subwatershed. Drainage from the MRSA will be directed to the Pic River. Once filled, water from the open pits will flow to Pic River subwatersheds (Stream 102 and 103 subwatersheds).

The following sections compare predicted water quality to benchmarks to assess the potential for adverse effects on human health from Project-related discharges to surface water and seepage to groundwater.

##### 5.1.1.2.3.1 Construction

During site preparation and construction, potential effects on water quality are related to the mobilization of suspended material into natural surface water features as a result of land disturbance and clearing. With mitigation by virtue of the mine development plan and implementation of standard water management and sediment control practices, no downstream adverse effects to local surface waters and local users of surface water are expected. According to the site water balance, there is no planned discharge to Hare Lake during construction, though the potential influence of such discharge, if it was to occur, would be bounded by the analyses of water and sediment quality in Hare Lake during the operations phase.

##### 5.1.1.2.3.2 Operations

During operations, excess water not used as Process Water will be treated and released to Hare Lake. In the original EIS, water from the MRSA was to be released to the Pic River. In the updated Project design, drainage from the MRSA will be pumped to and managed within the water management pond and surplus water will be released to Hare Lake.

Water from Hare Lake may be used for drinking water and recreation by a seasonal resident at a cottage on Hare Lake and by subsistence harvesters from local communities who fish, hunt, trap and harvest country foods in the vicinity of the Project.

The discharge of excess treated water to Hare Lake during operations is predicted to increase the concentrations of some constituents in water and sediment relative to background. Predicted water quality in Hare Lake under the expected discharge scenario is provided in **Table 5-14**. Time series graphs showing the constituent concentrations in Hare Lake water and sediment over the operations phase of the project are provided in the *Water Quality Assessment Update* (Appendix D11 of this EIS Addendum [Vol 2]).

Constituent concentrations in Hare Lake during operations are not predicted to exceed water quality benchmarks protective of human health. Therefore, no adverse effects on human health are expected from Project-related changes to surface water quality in Hare Lake during operations, for people using water in Hare Lake for drinking water and recreational purposes. No CoPCs in Hare Lake were identified for further assessment in country foods, as discussed in Section 5.1.1.3.

**Table 5-14: Maximum Predicted Constituent Concentrations in Hare Lake during the Operations Phase**

| Constituent | Benchmarks | | | Background WQ | Avg. Conc. Prediction (Ops) | Max. Conc. Prediction (Ops) |
|---|---|---|---|---|---|---|
| | PWQO (mg/L) | CCME (mg/L) | ODWQS or GCDWQ (mg/L) | (mg/L) | (mg/L) | (mg/L) |
| Aluminum (filtered) | 0.075 | 0.1 | 0.1 | 0.17 | 0.17 | 0.17 |
| Antimony | 0.02 | - | 0.006 | <0.005 | 0.005 | 0.005 |
| Arsenic | 0.005 | 0.005 | 0.010 | <0.001 | 0.001 | 0.001 |
| Boron | 0.2 | 1.5 | 5 | <0.05 | 0.05 | 0.05 |
| Cadmium | 0.0001 | 0.00005 | 0.005 | <0.00009 | 0.00009 | 0.00009 |
| Chromium | 0.0089 | 0.0089 | 0.05 | 0.0005 | 0.0005 | 0.0006 |
| Cobalt | 0.0009 | - | - | <0.0005 | 0.0004 | 0.0005 |
| Copper | 0.005 | 0.002 | 1 | <0.001 | 0.001 | 0.001 |
| Iron | 0.3 | 0.3 | 0.3 | 0.9 | 0.9 | 0.9 |
| Lead | 0.001 | 0.001 | 0.005 | <0.001 | 0.0009 | 0.001 |
| Manganese | - | 0.32 | 0.12 | 0.08 | 0.08 | 0.09 |
| Mercury (filtered) | 0.0002 | 0.000026 | 0.001 | <0.000005 | 0.000005 | 0.000006 |
| Molybdenum | 0.04 | 0.073 | - | <0.001 | 0.001 | 0.002 |
| Nickel | 0.025 | 0.025 | - | <0.002 | 0.002 | 0.002 |
| Selenium | 0.1 | 0.001 | 0.05 | <0.001 | 0.001 | 0.001 |
| Silver | 0.0001 | 0.00025 | - | <0.0001 | 0.0009 | 0.001 |
| Thallium | 0.0003 | 0.0008 | - | <0.0003 | 0.0002 | 0.0003 |
| Uranium | 0.005 | 0.005 | 0.02 | <0.005 | 0.004 | 0.005 |
| Vanadium | 0.006 | - | - | <0.001 | 0.002 | 0.002 |
| Zinc | 0.02 | 0.008 | 5 | 0.006 | 0.006 | 0.007 |
| Hardness | - | - | - | 20 | 20 | 20 |
| Sulphate | - | - | 500 | 3.5 | 4.5 | 5.9 |
| Nitrate (N) | - | 3.0 | 10 | 0.11 | 0.3 | 0.6 |
| Total Ammonia (N) | - | 1.04 | - | 0.06 | 0.08 | 0.11 |

| Constituent | Benchmarks | | | Background WQ | Avg. Conc. Prediction (Ops) | Max. Conc. Prediction (Ops) |
|---|---|---|---|---|---|---|
| | PWQO (mg/L) | CCME (mg/L) | ODWQS or GCDWQ (mg/L) | (mg/L) | (mg/L) | (mg/L) |
| Phosphorous | 0.02 | 0.01 to 0.02 | - | 0.01 | 0.02 | 0.02 |

Notes:
Total concentrations unless denoted.
PWQO: Provincial Water Quality Objectives. Where interim PWQOs are available the interim value is used.
CCME: Canadian Council of Ministers of the Environment; values shown are federal water quality benchmarks.
ODWQS: Ontario Drinking Water Quality Standards (Provincial)
GCDWQ: Guidelines for Canadian Drinking Water Quality (Federal)

#### 5.1.1.2.3.3 Post-Closure

**Surface Water**

Following the cessation of mining operations, the discharge to Hare Lake will cease. The site-wide water management system will continue to operate such that GenPGM will remain in control of water affected by site aspects via the water management pond. Runoff and shallow seepage from the PSMF and MRSA, and contact water from the developed portion of the site (e.g., mine dewatering water, runoff from temporary stockpiles, process plant site) will continue to be collected and diverted to the water management pond. Water from the water management pond will be directed to the open pit complex, where there are decades worth of water storage capacity.

For planning purposes, it is assumed that these diversions will continue for a period of five years following the cessation of mining operations. This strategy ensures control of water quality on and off site while site decommissioning and rehabilitation activities are implemented, allowing the water quality associated with these site aspects to stabilize. Following this five-year period, it is expected that natural surface water drainages will be restored to the extent possible.

Drainage from the rehabilitated PSMF will be directed to the Stream 106 subwatershed (Angler Creek). Post-closure surface water quality in the Stream 106 subwatershed downgradient of the PSMF is predicted to remain similar to its pre-mine development condition, as shown in **Table 5-15**.

Constituent concentrations in the Stream 106 subwatershed are not predicted to exceed water quality benchmarks protective of human health. Therefore, no adverse effects on human health are expected from Project-related changes to surface water quality in the Stream 106 subwatershed for people using water for drinking water and recreational purposes. No CoPCs in the Stream 106 subwatershed were identified for further assessment in country foods, as discussed in Section 5.1.1.3.

**Table 5-15: Long-term Predicted Constituent Concentrations (Average) in the Stream 106 Subwatershed (Angler Creek) Post-closure after Restoration of Pre-development Surface Water Drainage Patterns**

| Constituent | Benchmarks | | | Background WQ | Avg. Conc. Prediction (Post-Closure) |
|---|---|---|---|---|---|
| | PWQO (mg/L) | CCME (mg/L) | ODWQS or GCDWQ (mg/L) | (mg/L) | (mg/L) |
| Aluminum (filtered) | 0.075 | 0.1 | 0.1 | 0.17 | 0.17 |
| Antimony | 0.02 | - | 0.006 | 0.005 | 0.003 |
| Arsenic | 0.005 | 0.005 | 0.010 | 0.001 | 0.002 |
| Boron | 0.2 | 1.5 | 5 | 0.05 | 0.05 |
| Cadmium | 0.0001 | 0.00005 | 0.005 | 0.00009 | 0.00009 |
| Chromium | 0.0089 | 0.0089 | 0.05 | 0.0005 | 0.0007 |
| Cobalt | 0.0009 | - | - | 0.0005 | 0.0004 |
| Copper | 0.005 | 0.002 | 1 | 0.001 | 0.001 |
| Iron | 0.3 | 0.3 | 0.3 | 0.9 | 0.7 |
| Lead | 0.001 | 0.001 | 0.005 | 0.001 | 0.001 |
| Manganese | - | 0.32 | 0.12 | 0.08 | 0.07 |
| Mercury (filtered) | 0.0002 | 0.000026 | 0.001 | 0.000005 | 0.000005 |
| Molybdenum | 0.04 | 0.073 | - | 0.001 | 0.003 |
| Nickel | 0.025 | 0.025 | - | 0.002 | 0.002 |
| Selenium | 0.1 | 0.001 | 0.05 | 0.001 | 0.001 |
| Silver | 0.0001 | 0.00025 | - | 0.0001 | 0.0001 |
| Thallium | 0.0003 | 0.0008 | - | 0.0003 | 0.0002 |
| Uranium | 0.005 | 0.005 | 0.02 | 0.005 | 0.004 |
| Vanadium | 0.006 | - | - | 0.001 | 0.002 |
| Zinc | 0.02 | 0.008 | 5 | 0.006 | 0.006 |
| Hardness | - | - | - | 20 | 20 |
| Sulphate | - | - | 500 | 3.5 | 7.2 |
| Nitrate (N) | - | 3.0 | 10 | 0.11 | 0.30 |
| Total Ammonia (N) | - | 1.04 | - | 0.06 | 0.28 |
| Phosphorous | 0.03 | 0.01 to 0.02 | - | 0.01 | 0.03 |

Notes:

Total concentrations unless denoted.

PWQO: Provincial Water Quality Objectives. Where interim PWQOs are available the interim value is used.

CCME: Canadian Council of Ministers of the Environment; values shown are federal water quality benchmarks.

ODWQS: Ontario Drinking Water Quality Standards (Provincial)

GCDWQ: Guidelines for Canadian Drinking Water Quality (Federal)

After closure, the water management ponds associated with the PSMF will be rehabilitated (e.g., dredged of deposited solids) and drainage will be directed to the Stream 101 subwatershed. Water quality in the Stream 101 subwatershed is expected to be similar to existing baseline conditions after the natural flow regime has been restored.

Drainage from the MRSA will be collected by ditching and catch basins and allowed to flow to the Pic River. Predictions of water quality in the Pic River during this phase of site closure (i.e., more than five years after operations cease) are shown in **Table 5-16**. Based on predicted

maximum post-closure concentrations, no incremental changes in concentration relative to background are expected for the majority of constituents and no exceedances of water quality benchmarks in the Pic River result from the MRSA drainage. In the few instances where background water quality exceeds water quality benchmark levels (e.g., aluminum, iron), no incremental increase in concentration relative to background is noted.

Constituent concentrations in the Pic River are not predicted to exceed water quality benchmarks protective of human health during the initial phase of the post-closure period. Therefore, no adverse effects on human health are expected from Project-related changes to surface water quality in the Pic River for people using water for drinking water and recreational purposes. No CoPCs in the Pic River were identified for further assessment in country foods, as discussed in Section 5.1.1.3.

**Table 5-16: Predicted Constituent Concentrations in the Pic River during the Initial Phase of the Post-closure Period after Initial Restoration of Drainage from MRSA**

| Constituent | Benchmarks | | | Background WQ | Max. Conc. Prediction (Post-Closure) |
|---|---|---|---|---|---|
| | PWQO (mg/L) | CCME(mg/L) | ODWQS or GCDWQ (mg/L) | (mg/L) | (mg/L) |
| Aluminum (filtered) | 0.075 | 0.1 | 0.1 | 0.5 | 0.5 |
| Antimony | 0.02 | - | 0.006 | <0.005 | 0.005 |
| Arsenic | 0.005 | 0.005 | 0.010 | <0.001 | 0.001 |
| Boron | 0.2 | 1.5 | 5 | <0.05 | 0.05 |
| Cadmium | 0.0001 | 0.0002 | 0.005 | <0.00009 | 0.00009 |
| Chromium | 0.0089 | 0.0089 | 0.05 | 0.004 | 0.005 |
| Cobalt | 0.0009 | - | - | 0.001 | 0.001 |
| Copper | 0.005 | 0.003 | 1 | 0.004 | 0.004 |
| Iron | 0.3 | 0.3 | 0.3 | 2.7 | 2.7 |
| Lead | 0.005 | 0.005 | 0.005 | <0.001 | 0.001 |
| Manganese | - | 0.26 | 0.12 | 0.08 | 0.09 |
| Mercury (filtered) | 0.0002 | 0.000026 | 0.001 | <0.0001 | 0.0001 |
| Molybdenum | 0.04 | 0.073 | - | <0.001 | 0.001 |
| Nickel | 0.025 | 0.12 | - | 0.004 | 0.004 |
| Selenium | 0.1 | 0.001 | 0.05 | <0.001 | 0.001 |
| Silver | 0.0001 | 0.00025 | - | <0.0001 | 0.0001 |
| Thallium | 0.0003 | 0.0008 | - | <0.0003 | 0.0003 |
| Uranium | 0.005 | 0.005 | 0.02 | <0.005 | 0.005 |
| Vanadium | 0.006 | - | - | 0.005 | 0.005 |
| Zinc | 0.02 | 0.041 | 5 | 0.009 | 0.009 |
| Hardness | - | - | - | 138 | 138 |
| Sulphate | - | - | 500 | 2.6 | 2.8 |
| Nitrate (N) | - | 3.0 | 10 | 0.08 | 0.2 |
| Total Ammonia (N) | - | 1.04 | - | 0.03 | 0.04 |
| Phosphorous | 0.03 | 0.01 to 0.02 | - | 0.08 | 0.08 |

Notes:
Total concentrations unless denoted.
PWQO: Provincial Water Quality Objectives. Where interim PWQOs are available the interim value is used.
CCME: Canadian Council of Ministers of the Environment; values shown are federal water quality benchmarks.
ODWQS: Ontario Drinking Water Quality Standards (Provincial)
GCDWQ: Guidelines for Canadian Drinking Water Quality (Federal)

Post-closure, public access to the open pits will be prohibited and limited by a perimeter berm per the requirements of the Mine Rehabilitation Code (O.Reg. 240/00). After the open pits fill, water will begin to drain naturally with overflow from the open pits and runoff from the MRSA flowing to the Pic River (Stream 102 and 103 subwatersheds). Downstream of the MRSA and open pits, no exceedances of water quality assessment benchmarks in the Pic River are predicted for the post-closure phase 35 years after operations have ceased, as shown in **Table 5-17**. Therefore, no adverse effects on human health are expected from Project-related changes to surface water quality in the Pic River for people using water for drinking water and recreational purposes over the long-term post-closure period. No CoPCs in the Pic River were identified for further assessment in country foods, as discussed in Section 5.1.1.3.

**Table 5-17: Predicted Constituent Concentrations in the Pic River over the Long-term Post-closure Period after Controlled Release of Water from the Open Pit**

| Constituent | Benchmarks | | | Background WQ | Max. Conc. Prediction (Post-Closure) |
|---|---|---|---|---|---|
| | PWQO (mg/L) | CCME(mg/L) | ODWQS or GCDWQ (mg/L) | (mg/L) | (mg/L) |
| Aluminum (filtered) | 0.075 | 0.1 | 0.1 | 0.5 | 0.5 |
| Antimony | 0.02 | - | 0.006 | <0.005 | 0.005 |
| Arsenic | 0.005 | 0.005 | 0.010 | <0.001 | 0.001 |
| Boron | 0.2 | 1.5 | 5 | <0.05 | 0.05 |
| Cadmium | 0.0001 | 0.0002 | 0.005 | <0.00009 | 0.00009 |
| Chromium | 0.0089 | 0.0089 | 0.05 | 0.004 | 0.005 |
| Cobalt | 0.0009 | - | - | 0.001 | 0.001 |
| Copper | 0.005 | 0.003 | 1 | 0.004 | 0.004 |
| Iron | 0.3 | 0.3 | 0.3 | 2.7 | 2.7 |
| Lead | 0.005 | 0.005 | 0.005 | <0.001 | 0.001 |
| Manganese | - | 0.26 | 0.12 | 0.08 | 0.09 |
| Mercury (filtered) | 0.0002 | 0.000026 | 0.001 | <0.0001 | 0.0001 |
| Molybdenum | 0.04 | 0.073 | - | <0.001 | 0.001 |
| Nickel | 0.025 | 0.12 | - | 0.004 | 0.004 |
| Selenium | 0.1 | 0.001 | 0.05 | <0.001 | 0.001 |
| Silver | 0.0001 | 0.00025 | - | <0.0001 | 0.0001 |
| Thallium | 0.0003 | 0.0008 | - | <0.0003 | 0.0003 |
| Uranium | 0.005 | 0.005 | 0.02 | <0.005 | 0.005 |
| Vanadium | 0.006 | - | - | 0.005 | 0.005 |
| Zinc | 0.02 | 0.041 | 5 | 0.009 | 0.010 |
| Hardness | - | - | - | 138 | 138 |
| Sulphate | - | - | 500 | 2.6 | 2.9 |
| Nitrate (N) | - | 3.0 | 10 | 0.08 | 0.3 |
| Total Ammonia (N) | - | 1.04 | - | 0.03 | 0.06 |
| Phosphorous | 0.03 | 0.01 to 0.02 | - | 0.08 | 0.08 |

Notes:

Total concentrations unless denoted.

PWQO: Provincial Water Quality Objectives. Where interim PWQOs are available the interim value is used.

CCME: Canadian Council of Ministers of the Environment; values shown are federal water quality benchmarks.

ODWQS: Ontario Drinking Water Quality Standards (Provincial)

GCDWQ: Guidelines for Canadian Drinking Water Quality (Federal)

### Groundwater

Seepage from the MRSA, ore stockpile, PSMF and water management pond will travel from the Project components through the aquifer over the span of decades to centuries. Residual effects on groundwater are expected within the SSA, with a portion of the groundwater flow paths from the MRSA and PSMF extending into the LSA/RSA. Seepage from the MRSA, ore stockpile, PSMF and water management pond has the potential to affect groundwater, and surface water quality where groundwater discharges to surface water. Changes to surface water quality may affect

subsistence harvesters, seasonal residents and recreational users if users are located where groundwater recharge originating from the PSMF and MRSA discharges to surface water.

Changes to groundwater quality could affect local groundwater users if users are located within the predicted zone of influence. No existing or foreseeable groundwater users are located in the areas where groundwater quality is predicted to exceed provincial and/or federal drinking water standards (ODWQS and/or GCDWQ). No groundwater supply wells or active groundwater Permit To Take Water (PTTW) holders were identified within the SSA. Groundwater originating from the MRSA, ore stockpile, PSMF and water management pond is predicted to discharge to the open pit and/or surface water and not to areas where groundwater supply users are known to be located. As a result, no adverse effects on human health are expected from groundwater affected by Project-related changes to groundwater quality.

Potable water for the Project will be supplied to the site by a groundwater well and/or supplemented as required by a bulk water supplier. Groundwater will be pumped to the surface, stored and treated to ensure compliance with ODWQS, and supplied to the site as needed through the associated water distribution infrastructure. The potable water supply well for the Project is expected to be located either cross- or up-gradient from potential sources of mine-related CoPCs in groundwater. No adverse effects on human health are expected because the potable water supply for the Project is not expected to be affected by changes in groundwater quality related to the Project.

Two seasonal cottages on Crown lease are located on Hare Lake therefore surface water and groundwater use as drinking water was considered. Groundwater recharge from beneath the PSMF discharges primarily to the Stream 106 subwatershed (70%) (Angler Creek) with the remainder of discharge to the Stream 105 subwatershed (30%) (Hare Lake and its tributaries). Groundwater recharge from the PSMF is predicted to be less than provincial and federal drinking water standards (ODWQS and GCDWQ), as shown in **Table 5-18**. Therefore, no adverse effects on human health are expected from drinking surface water or from potential future water supply wells at Hare Lake that could be affected by Project-related changes to groundwater quality.

Bamoos Lake does not receive drainage from the Project therefore surface water and groundwater quality at Bamoos Lake is not anticipated to be affected by the Project.

**Table 5-18: Predicted Metal Concentrations in Groundwater Recharge from the PSMF**

| Constituent | Drinking Water Quality Guidelines (ODWQS or GCDWQ) (mg/L) | PSMF Predicted Geomean (mg/L) |
|---|---|---|
| Aluminum | 0.1 | 0.087 |
| Arsenic | 0.010 | 0.00060 |
| Cadmium | 0.005 | 0.000033 |
| Cobalt | - | 0.000060 |
| Copper | 1 | 0.00050 |
| Iron | 0.3 | 0.076 |
| Lead | 0.005 | 0.000020 |
| Molybdenum | - | 0.028 |
| Nickel | - | 0.0030 |
| Selenium | 0.05 | 0.00057 |
| Uranium | 0.02 | 0.00015 |
| Vanadium | - | 0.0011 |
| Zinc | 5 | 0.0020 |

Notes:
Dissolved concentrations
ODWQS: Ontario Drinking Water Quality Standards (Provincial)
GCDWQ: Guidelines for Canadian Drinking Water Quality (Federal)

The nearest community water supplies are in the Town of Marathon and on the Biigtigong Nishnaabeg reserve. There is no connectivity between the groundwater flow paths for the Project site and the Town of Marathon and the BN groundwater supply wells. The Town of Marathon's water supply wells are in a different groundwatershed and approximately 6 kilometres from the southern edge of the PSMF; there is no potential for them to be impacted by Project site groundwater. The Project site is outside the area designated by the Town as a groundwater protection zone. Groundwater originating in the PSMF is not expected to flow in the direction towards wells along Highway 17. The BN water supply wells near Long Lake are located over 15 km from the southern edge of the PSMF and MRSA; there is no potential for them to be impacted by Project site groundwater. There is no foreseeable risk of Project site groundwater migrating into the capture zones of the wells in either the Town of Marathon or BN.

The CoPCs discussed in this drinking water assessment are limited to those that may be influenced by the Project. Other parameters commonly considered in determining whether water is safe to drink, such as bacteria and other microorganisms, are not expected to be influenced by the Project. Proper water treatment for such organisms is always recommended and this assessment should not be interpreted as indicating otherwise.

No complete exposure pathway was identified between groundwater affected by the Project and the potable water supply for the Project, Town of Marathon, or BN or more local wells. Subsistence harvesters who continue to access Bamoos Lake and Pic River are not expected to experience adverse health effects from exposures to CoPCs in surface water or groundwater.

Based on this assessment, no CoPCs in potential drinking water sources are identified for further assessment.

#### 5.1.1.2.4 Summary for Water Quality

Discharges to surface water during all mine phases are not expected to increase constituent concentrations in surface water in excess of water quality benchmarks therefore no adverse effects on human health are expected during any phase of the Project. No adverse effects on human health are expected from groundwater affected by Project-related changes to groundwater quality because no existing or foreseeable groundwater users are located in the areas where groundwater quality is predicted to exceed provincial and/or federal drinking water standards.

Consistent with the original EIS and responses to information requests (IRs, SIRs, AIRs), changes to water quality from the Project are not expected to result in adverse human health effects.

### 5.1.1.3 Country Foods

The purpose of the country foods assessment is to evaluate the potential for Project activities to affect the quality of country foods and health of consumers of country foods. Air and water emissions from Project activities during construction, operation and decommissioning of the mine could affect human health through the accumulation of constituents in country foods harvested in the LSA and RSA.

Country foods are the traditional foods that are trapped, fished, hunted, harvested or grown for subsistence or medicinal purposes, outside of the commercial food chain (Health Canada, 2018). Community-based research summarized in the original EIS and responses to information requests (IRs, SIRs, AIRs) provided qualitative information about the country foods diet for Indigenous people who use resources from the LSA and RSA. The list of wildlife, plants and fish species identified as having traditional value or interest to First Nation and Métis communities was updated in Tables 12 and 13 of the *Terrestrial Baseline Updated Report* (Northern Bioscience, 2020) based on Project-specific TLRU and TEK studies and consultation input. Information on species of interest is often considered confidential, but has been listed in general non-community specific terms in the *Terrestrial Baseline Updated Report* (Northern Bioscience, 2020) and summarized in Section 4.2 of this HHRA. Only non-confidential information from TLRU and TEK studies is presented in this assessment, where applicable to the Project, to respect the preferences of First Nation and Métis communities. The country food groups considered in this assessment include game birds, large and small game mammals, plants and fish.

Project-related increases in concentrations of constituents in air, water and sediment were reviewed to determine if in any constituents were predicted to exceed the range of background conditions and relevant benchmarks, and were expected to represent a concern to human health because of potential uptake into country foods. These CoPCs would be carried through to a quantitative assessment. If constituents are not elevated in environmental media compared to background conditions or benchmarks, Project-related changes in country foods are assessed qualitatively. This approach is consistent with the approach followed in the original EIS.

Potentially operable exposure pathways that could affect the quality of country foods during construction, operations and post-closure are discussed in the following sections.

Potential residual effects on human health from consumption of country foods were assessed qualitatively because quantitative modelling of CoPCs in environmental media resulted in small changes from background concentrations in the LSA and RSA, and the changes did not exceed levels suggestive of unacceptable risks to human health. Project-related effects on air quality (Section 6.2.1.6.1 of the EIS Addendum), water quality (Section 6.2.3.6.4 of the EIS Addendum) and sediment quality (Section 6.2.3.6.5 of the EIS Addendum) are expected to result in small changes to CoPC concentrations in plants and animals in the country food diet.

#### 5.1.1.3.1 Construction

During Project construction, the predicted changes in CoPC concentrations in environmental media and therefore changes in uptake into country food items were determined to be limited to a small area around the SSA, and did not extend to the areas of the LSA and RSA where country foods are obtained. Air emissions during site preparation activities and mine construction were predicted to increase CoPC concentrations in air in the SSA and near the modelled property boundary (Section 6.2.1.6.1 of the EIS Addendum).

According to the site water balance, there is no planned discharge to Hare Lake or the Pic River during construction. The site water management system will be constructed early on during this phase and it is planned that all potential contact waters will be collected and diverted for storage, and no water will be released from the site. In the event that it is necessary to divert run off from areas where, for example, land clearing is occurring, standard industry mitigation practices (e.g., sediment control) will be employed to ensure there are no downstream adverse effects to local surface waters that could manifest as uptake of CoPCs in country foods.

Since changes to air quality and water quality were not identified to have an adverse effect on human health and did not differ substantially from background where subsistence harvesters may harvest country foods, no CoPCs from Project-related emissions were identified as being likely to accumulate in country foods at levels of concern to human health during construction.

#### 5.1.1.3.2 Operations

During Project operation, emissions of air CoPCs were mainly associated with the combustion of diesel fuel in mining equipment and other stationary equipment, and from mining activities. The conservative maximum emission scenarios for mining activities indicated that the changes in air quality above background would be restricted to the LSA and any concentrations above air quality criteria (dustfall and nickel) were limited to a small area near the SSA (Section 6.2.1.6.1 of the EIS Addendum), and did not extend to the areas where country foods may be harvested.

During operations, the primary potential water quality effect from the Project is the seasonal (April to November) discharge of excess treated water from the site water management system to Hare Lake. There will be no routine discharge to the Pic River during operations – drainage associated with the MRSA will be collected and pumped to the water management pond. Small

incremental changes in the concentrations of several parameters are predicted in Hare Lake during periods of treated mine discharge, but water quality in Hare Lake is predicted to meet benchmarks protective of aquatic biota at all times (Section 6.2.3.6.4 of the EIS Addendum). As indicated above, since constituent concentrations will meet relevant water quality benchmarks, there is no expectation that the small changes in predicted concentrations would result in country food pathway risks for human health. It is noted that recommendations on prohibitions on fish consumption in Hare Lake related to mercury are currently in place, as discussed in Section 4.3 and Appendix A. Such recommendations are common in lakes in this area. No increase in mercury concentrations in Hare Lake are predicted during periods of treated mine water discharge and therefore the Project is not expected to affect the existing consumption prohibitions. Generally, CoPC concentrations in sediment were predicted to be within the range of background except for molybdenum and vanadium (Section 6.2.3.6.5 of the EIS Addendum). Molybdenum and vanadium in water are predicted to remain below water quality benchmarks protective of aquatic life and are not expected to accumulate in country foods to levels that would adversely affect human health.

The potential effects of the accumulation of constituents on biota in Hare Lake during operations are assessed in Section 6.2.2.5 of the *Water Quality Assessment Update* (Appendix D11 of this EIS Addendum [Vol 2]). The assessment considered the potential effects of the discharge of treated water during operations on representative species, including northern pike, muskrat, mink and moose, at Hare Lake. An exposure pathways model, IMPACT™, was used to provide a screening evaluation of estimated risks to these animals from aquatic exposure pathways, including ingestion of water and foods exposed to Hare Lake water and sediment. Predicted risks for the representative species indicated that adverse effects are not likely to occur.

Overall, changes to air, water and sediment quality are not expected to have an adverse effect on human health via country food consumption because CoPC concentrations in these environmental media during operations are predicted to meet relevant environmental benchmarks and/or to not differ substantially from background conditions at locations where subsistence harvesters may harvest country foods. Project-related air and water emissions are not expected to cause CoPCs to accumulate in country foods to levels of concern for human health.

#### 5.1.1.3.3 Closure

Air emissions during decommissioning are expected to be less than those during construction and operations. Air emissions are anticipated to be negligible after closure. Discharges to Hare Lake will cease following the cessation of mining operations. Surface water and sediment quality in Hare Lake will return to background conditions. Sediments in Hare Lake affected by increased concentrations of molybdenum and vanadium are expected to recover to within the range of measured background levels within 10 to 15 years following the cessation of discharge.

The site wide water management system will continue to operate such that GenPGM will remain in control of site affected water via the water management pond. During this time, water (runoff

and shallow seepage) from the PSMF, drainage (run-off and shallow seepage) associated with the MRSA and contact water from the developed portion of the site (including for example, mine dewatering water, runoff from temporary stockpiles, runoff from the process plant site) will continue to be collected and diverted to the water management pond. From the water management pond, the water will be directed to the open pit complex, where there exists decades worth of water storage capacity. For planning purposes, it is assumed that these diversions will continue for a period of five years following the cessation of mining operations. This strategy ensures control of water quality on and off site while site decommissioning and rehabilitation activities are implemented, allowing the water quality associated with these site aspects to stabilize.

Following this five-year period and the completion of site rehabilitation, assuming that water quality has in fact stabilized and is of a quality that would be protective of aquatic life, surface water drainage patterns in keeping with pre-mining conditions will be restored. For the PSMF, that means surface runoff and seepage will be re-directed into subwatershed 106. Runoff from the area of the water management ponds associated with the PSMF will be directed to subwatershed 101. For the MRSA, drainage (run-off and shallow seepage) that will be collected by ditching and catch basins will be allowed to flow to the Pic River through the lower reaches of subwatersheds 102 and 103, rather than diverting it to the water management system.

After the open pit has filled, water in the open pit will be allowed to passively discharge in the Stream 103 subwatershed through the MRSA and subsequently into the Pic River. This scenario represents the long-term configuration of the mine site from a surface water drainage perspective. Water quality predictions associated with the short-term and long-term phases of closure indicate that water quality will meet relevant benchmarks in the restored drainage areas and in the Pic River.

Post-closure, public access to the open pits will be prohibited and limited by a perimeter berm per the requirements of the Mine Rehabilitation Code (O.Reg. 240/00). The potential use of the open pit as one of the means to offset losses of fish habitat associated with development of the Project may be considered. In this case, the likely viability of the development of a fishery within the open pit as it concerns open pit water quality will be considered with the habitat offsetting framework at that time. In addition to water quality considerations, it would also be necessary to demonstrate no risks to human health would accrue via fish consumption.

The uptake of CoPCs by country food items is expected to be less during decommissioning and post-closure than during operations because air emissions will decrease and cease, and the treated mine water discharge to Hare Lake will cease. When natural drainage is restored, no incremental changes in concentrations in surface water relative to background are predicted for the majority of constituents and no exceedances of water quality benchmarks are predicted to occur because of Project-related drainage.

Changes to air and water quality after closure are not predicted to adversely affect human health as predicted concentrations do not differ substantially from background at locations where subsistence harvesters may harvest country foods. No CoPCs from Project-related air and

water emissions are expected accumulate in country foods at levels of concern to human health during decommissioning and post-closure.

#### 5.1.1.3.4 Summary for Country Foods

Overall, there are minimal predicted Project-related effects on concentrations of constituents in the environment that would result in changes to concentrations of constituents in country foods where country foods are likely to be harvested. The screening of predicted air and water quality did not identify any CoPCs to carry forward into a country foods assessment. Therefore, adverse effects on human health from country foods consumption are not expected from Project-related air and water emissions. This is consistent with the conclusion in the original EIS that the Project will have limited effects on concentrations of constituents in the environment, and country foods, and therefore no adverse effect on human health.

### 5.1.1.4 Noise

The purpose of the noise effects assessment is to evaluate the potential effects of Project activities on human health. Noise created by Project activities during construction, operation and decommissioning of the mine could affect human health by causing annoyance or sleep disturbance.

#### 5.1.1.4.1 Updated Noise Modelling

Predictive noise modelling for the updated Project design is described in the updated noise assessment, as summarized in Section 6.2.2 of the EIS Addendum and described in further detail in the *Updated Noise Effects Assessment Report* (Appendix D2 of this EIS Addendum [Vol 2]) (Appendix D2 of the EIS Addendum [Vol 2]). The summary of the updated noise assessment presented in the context of human health effects focuses on community annoyance and sleep disturbance metrics, as described in the *Guidance for Evaluating Human Health Impacts in Environmental Assessment: Noise* (Health Canada, 2017). Other noise assessment methodologies (e.g., air blast setback) are summarized in the updated noise assessment.

The updated noise assessment is expected to overstate effects because all sources were assumed to operate constantly during the entire day or entire night. The updated noise assessment considered noise emissions from the following sources:

- stationary steady-state equipment operating within the SSA (construction and operation);
- traffic along the access road, Highway 17 and within the Town of Marathon (construction and operation);
- the rail load-out facility – Option 2 (operation only); and
- blasting (construction and operation).

Noise during decommissioning and site closure is expected to result from the use of heavy mobile equipment/machinery, diesel generators, material handling and vehicle and haul truck traffic. As the amount of heavy equipment operating during the decommissioning and closure

of the mine is expected to be less than that required during Project construction and operation, noise levels during decommissioning and site closure are expected to be similar to, or less than, noise levels during the site preparation, construction and operational phases of the Project. Noise levels during decommissioning and site closure were not assessed quantitatively.

Noise sensitive receptors (NSRs) included representative receptors (typically the closest to the Project activities) identified as Points of Reception (PORs) adjacent to the SSA and within the Town of Marathon. The remaining NSRs in the LSA and RSA are expected to experience lower sound levels due to increased setback distances and screening provided by intervening structures. The NSRs included in the *Noise Updated Effects Assessment* (Appendix D2 of the EIS Addendum [Vol 2]) are presented in **Figure 5-1**.

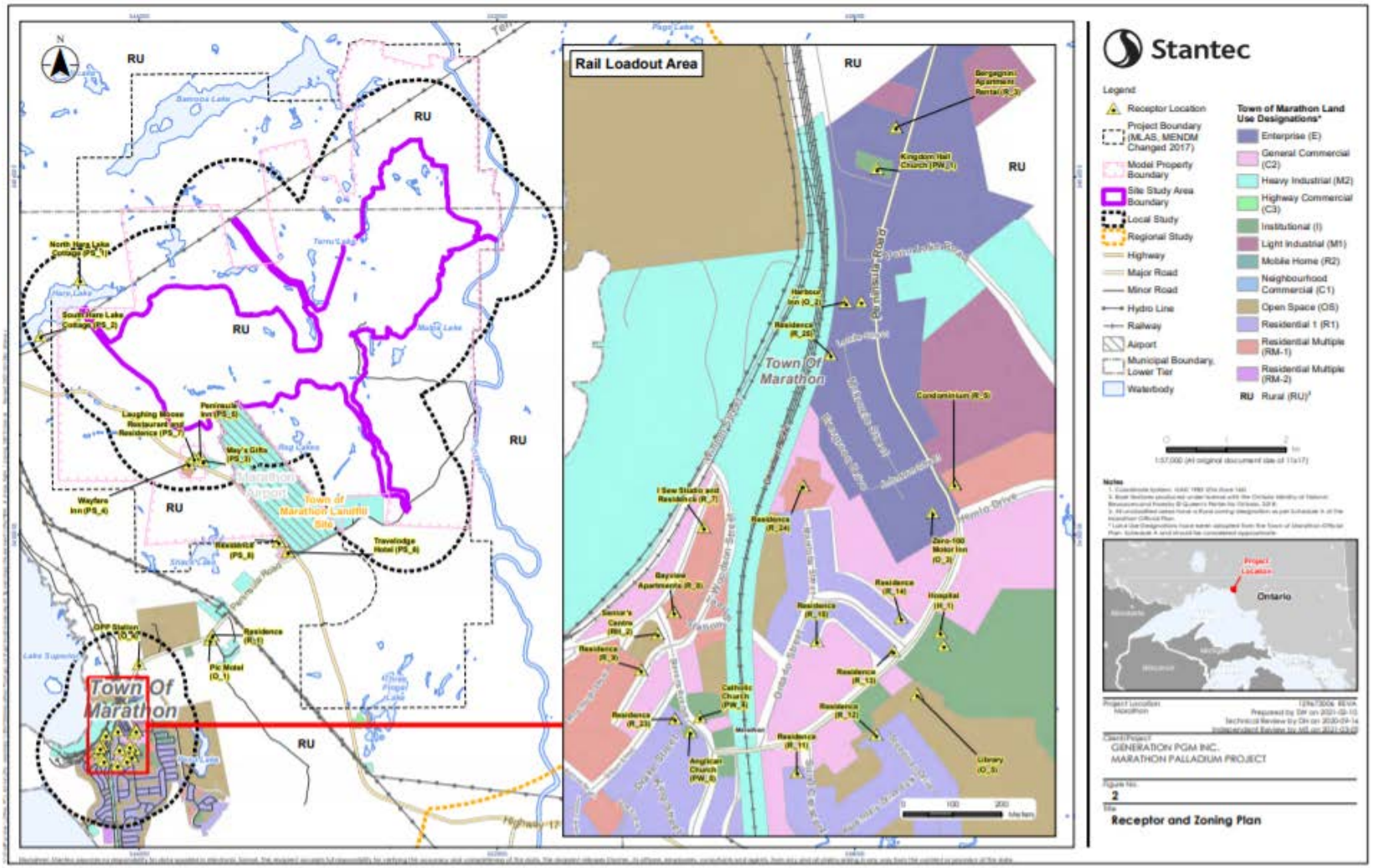


**Figure 5-1: Noise Sensitive Receptors in the Vicinity of the Project Site**

#### 5.1.1.4.2 Noise Benchmarks

The Health Canada (2017) methodology for noise assessment considers community annoyance and sleep disturbance. To assess activities lasting longer than 12 months, the metric for community annoyance is the change in percent highly annoyed (%HA), as described in Section 6.2.2.3.1 of the EIS Addendum and Section 5.7 of the *Updated Noise Effects Assessment Report* (Appendix D2 of the EIS Addendum [Vol 2])).

The %HA is an estimate of the percentage of people who are potentially annoyed by noise emissions and is based on studies completed by the United States Environmental Protection Agency (US EPA). To calculate the %HA, the daytime equivalent sound levels (or $L_d$) and nighttime equivalent sound levels (or $L_n$) are combined to calculate an adjusted day-night average sound level (or $L_{dn}$). In the $L_{dn}$ calculation, the $L_n$ value is increased by 10 dB to account for higher sensitivity to noise emissions at night. The $L_{dn}$ is then used to calculate the change in %HA due to project-related noise emissions.

Health Canada (2017) recommends noise mitigation when the change in %HA is greater than 6.5% for long-term construction or operational noise compared to the baseline. If the change in %HA threshold is exceeded, effects are considered to be of concern and may require mitigation.

Health Canada also identifies that noise levels (from Project construction or operations) greater than 75 dBA $L_{dn}$ can expect strong opposition due to operational or construction noise, and levels greater than 62 dBA can expect "widespread complaints" from the community related to Project noise.

Health Canada (2017) identifies sleep disturbance as difficulty falling asleep, awakenings, curtailed sleep duration, alterations of sleep stages or depth, and increased body movements during sleep. Health Canada (2017) has adopted a noise limit of 60 dBA outside a residence for any Project-related instantaneous noise to address sleep disturbance. This is based on the WHO recommended maximum indoor sound level of 45 dBA, and the Health Canada (2017) recommendation to use an outdoor-to-indoor transmission loss of 15 dB for windows. Further, this 60 dBA $L_{max}$ criterion for Project-related instantaneous noise level has a frequency limit of no more than 10-15 exceedances per night (Health Canada, 2017).

#### 5.1.1.4.3 Predicted Noise

With mitigation, Project activities are not predicted to create noise in excess of Health Canada (2017) guidelines for community annoyance and sleep disturbance during any phase of the Project. Predicted noise impacts from all Project activities (including mining construction, mining operation, traffic noise and the rail load out facility) are below the noise level thresholds for assessing community annoyance and sleep disturbance, as described in the following sections.

#### 5.1.1.4.3.1 Construction

The construction phase of the Project is anticipated to occur over a period of 18 – 24 months, with year 1 considered to be the worst-case with respect to emissions of noise. Noise impacts for Project construction activities and traffic during construction were predicted from the noise modeling for noise sensitive receptors closest to Project activities.

Community annoyance analysis was completed using the Percent Highly Annoyed (%HA) method from the Health Canada (2017) Noise Guideline. Baseline Day-Night Noise Level ($L_{dn}$) and %HA, the baseline plus Project impact $L_{dn}$ and %HA, and the change in %HA from baseline to baseline plus Project, were determined to evaluate whether the change in %HA was greater than 6.5%.

The predicted changes in %HA for Project construction, considering steady state noise sources with the SSA only, are presented in Table 6.2.2 14 of the EIS Addendum. The predicted changes in %HA for Project traffic during construction are presented in Table 6.2.2 15 of the EIS Addendum.

The predicted changes in %HA for noise related to Project construction activities and traffic during construction are generally insignificant (minimal change in %HA) for most of the NSRs. The highest predicted change in %HA is at the Peninsula Inn (PS_5) with a 2.4%HA change from the baseline to Project plus baseline. As the change in %HA from baseline to baseline plus Project at the NSRs is less than 6.5%, there is no expected noise impact on community annoyance related to mining construction activities and traffic during construction.

The Health Canada noise limit of 60 dBA applies outside a residence to reduce noise-induced sleep disturbance from Project-related instantaneous noise. The maximum predicted sound levels ($L_{max}$) during Project construction are presented in Table 6.2.2 16 of the EIS Addendum. The maximum predicted sound levels at noise sensitive receptors are below the noise-induced sleep disturbance criteria recommended by the WHO in the Health Canada (2017) Noise Guideline.

#### 5.1.1.4.3.2 Operations

The operation phase of the Project is anticipated to last 12.7 years with year 2 considered to be the worst-case with respect to emissions of noise. Noise impacts for Project operations and traffic during operations were predicted from the noise modeling for noise sensitive receptors closest to Project activities. It was assumed that the Project equipment within the SSA would operate 24 hours per day and seven days per week.

The predicted changes in %HA for Project operation, considering steady-state noise sources within the SSA, are presented in Table 6.2.2-23 of the EIS Addendum. The predicted changes in %HA for Project traffic during operation are presented in Table 6.2.2-24 of the EIS Addendum. The predicted changes in %HA for Project operation, considering steady-state noise sources at the rail load-out facility, are presented in Table 6.2.2-25 of the EIS Addendum.

The predicted changes in %HA for noise related to Project operation activities within the SSA and at the rail load-out facility, and traffic during operations are generally insignificant (minimal change in %HA) for most of the NSRs. The highest predicted change in %HA is at the Peninsula Inn (PS_5) with a 2.4%HA change from the baseline to Project plus baseline. As the change in %HA from baseline to baseline plus Project at the NSRs is less than 6.5%, there is no expected noise impact on community annoyance related to Project operation activities within the SSA, and at the rail load-out facility, and related to traffic during operations.

The maximum predicted sound levels ($L_{max}$) during Project operation are presented in Table 6.2.2-26 of the EIS Addendum. The maximum predicted sound levels from Project operation activities within the SSA are below the noise-induced sleep disturbance criteria recommended by the WHO in the Health Canada (2017) Noise Guideline.

#### 5.1.1.4.4 Summary for Noise

Noise levels are not predicted to exceed guidelines for community annoyance and sleep disturbance and are not expected to adversely affect human health during any phase of the Project. This is consistent with the conclusion in the original EIS that the Project will have limited effects on the acoustic environment.

### 5.1.1.5 Electromagnetic Fields

Low frequencies of electric and magnetic fields (EMFs) are produced every time electricity and electrical devices are used. An electric field is created whenever you plug an electrical device into an outlet. The flow of current forms a magnetic field. The electric and magnetic fields radiate out like a wave. Power lines emit extremely low frequency EMFs (below 300 Hertz). The EMFs from electrical devices and power lines can cause weak electric fields and currents in the human body.

The International Agency for Research on Cancer (IARC, 2002) has classified extremely low frequency (ELF) magnetic fields as "possibly carcinogenic to humans" (Group 2B), meaning there is some evidence that ELF magnetic fields can cause cancer in humans but at present the evidence is far from conclusive. This classification was based on a possible link between childhood leukemia and exposure to ELF magnetic fields. The IARC classified ELF electric fields as “unclassifiable as to carcinogenicity in humans” (Group 3), meaning there is no evidence at present that electric fields cause cancer in humans.

No Canadian government guidelines for exposure to EMFs have been set because Health Canada (2019) and the Federal-Provincial-Territorial Radiation Protection Committee (2008) believe that there is insufficient scientific evidence to conclude that exposures to EMFs from power lines cause health problems. Health Canada (2019b) does not consider that any precautionary measures are needed for daily exposures to EMFs at extremely low frequencies because no conclusive evidence of harm has been found at these exposure levels. Health Canada (2019b) is in agreement with both the World Health Organization (2007) and IARC that additional research on the possible health effects from exposure to EMFs at extremely low frequencies is warranted.

As discussed in Section 1.5.4.12 of the EIS Addendum, power to the Project site will be provided via a new 2.2 km 115 kV overhead transmission line that will be constructed from a purposefully built junction point on the existing Terrace Bay-Manitouwadge transmission line (M2W Line) that runs north of the Project. The new line will be run from the existing transmission corridor to a transformer substation located north of the Process Plant (see Figure 1-4). The width of the transmission corridor will be approximately 30 m.

The new transmission line will not be constructed near residential populations. Residents of the Town of Marathon or the surrounding municipalities are not expected to be exposed to EMFs from the new transmission line. Exposure to EMFs is greatest directly underneath the transmission line and diminishes significantly as distance from the source increases.

The current Canadian position on EMFs, as articulated by Health Canada (2019b) and the Federal-Provincial-Territorial Radiation Protection Committee (2008), is that there is insufficient scientific evidence to conclude that exposures to EMFs from power lines cause health problems. Further, the closest receptor to the proposed power line for the Project is a cottage on Hare Lake, and it is approximately 2 to 3 km from the proposed power line. Therefore, exposure to EMFs as a human health issue was not considered further within this assessment.

### 5.1.2 Human Receptors

Human receptors were selected to assess of potential effects on human health from exposure to airborne or waterborne constituents based on known or reasonably-anticipated types of human activities in the Project area. Communities and land uses are described in Sections 4.1 and 4.2. The closest communities are the Town of Marathon, located 10 km south of the Project site, and the Biigtigong Nishnaabeg reserve, located about 20 km south of the Project site. Habitation sites such as cabins, tent sites, lean-tos or other overnighting locations are located within the local and regional study areas.

GenPGM is committed to maintaining safe access to and through areas of the SSA that are outside of the primary areas of mining activity. Access to the mine site will be restricted through the use of gates and signage due to safety concerns associated with mining activities (e.g., blasting, machinery, vehicle traffic). GenPGM will continue to provide access to Bamoos Lake and Pic River. An existing recreational trail from Hare Lake can be used to provide safe access to Bamoos Lake. A protocol will be developed for use of the initial portion of the Camp 19 Road to provide safe access to Pic River. Beyond the location where the Camp 19 Road meets the Pic River, a gate will prevent access to the west and north.

The proposed human receptors and exposure assumptions are summarized in **Table 5-19** and each is described in the following sections based on the available baseline information.

Mine worker health is addressed as part of the facility's Health and Safety Program and not included in this assessment. Worker health and safety issues were originally addressed in SID #19 (TGCL, 2012e). Section 7.3 of the EIS Addendum provides an update on GenPGM's commitments related to Occupational Health and Safety.

#### 5.1.2.1 Subsistence Harvester

The subsistence harvester represents members of Indigenous communities who hunt, trap, fish, harvest timber and gather berries/plants in the vicinity of the Project, such as a resident of the BN community, or possibly Métis who live in Marathon or nearby communities. While in the Project vicinity, it is assumed that surface water is used for drinking water.

The types of exposures for a subsistence harvester and recreational user are expected to be similar. The assessment for a subsistence harvester is expected to be protective of a recreational user, meaning that if the predicted risk to the subsistence harvester from Project-related exposures is acceptable, then the risk to the recreational user is also acceptable.

#### 5.1.2.2 Country Food Consumer

A hunter/trapper/fisher/gatherer may bring country foods back for family and community members. The country food consumer represents a community member who consumes country foods year-round from the Project area and does not spend time in the vicinity of the Project site.

#### 5.1.2.3 Seasonal Resident

The seasonal resident represents a cottager at Hare Lake. The seasonal resident is assumed to consume water, game, fish and plants from in and around Hare Lake. Based on Stillwater communications with one cottage resident, drinking water is obtained from the Town of Marathon, and not from Hare Lake.

#### 5.1.2.4 Permanent Resident at the Town of Marathon

The permanent resident represents a resident of the Town of Marathon who resides in the vicinity of the proposed rail loadout area. The permanent resident is characterized using Health Canada (2010) assumptions for a resident.

### 5.1.3 Exposure Pathways

The following section provides an overview of the exposure scenarios and pathways evaluated in the HHRA. The exposure scenarios evaluated involve direct and indirect exposures of human receptors to airborne and waterborne CoPCs from Project-related activities. The exposure assessment in Section 4.0, will evaluate the available data related to all CoPCs, receptors and operable exposure pathways identified during this problem formulation phase. Operable exposure pathways are those exposure pathways that link Project-related sources of CoPCs to a receptor.

The following exposure routes were considered as potentially operable exposure pathways for human receptors:

- Inhalation of dust and vapours in outdoor air;
- Incidental ingestion of and dermal contact with soils;

- Incidental ingestion of and dermal contact with water;
- Incidental ingestion of and dermal contact with sediment; and
- Ingestion of country foods (plants, wild game and fish).

Not all of the exposure routes are applicable to each of the receptor groups identified in Section 5.1.2. The indoor air pathway is not considered to be an operable pathway for this assessment.

The Subsistence Harvester and Seasonal Resident may be exposed to Project-related CoPCs in:

- Ambient outdoor air from inhalation of dust and vapours;
- Soil from incidental ingestion of and dermal contact with soil;
- Water from drinking water ingestion and swimming (dermal contact and incidental ingestion of water and sediment); and
- Country foods (plants, wild game and fish).

The Country Food Consumer is assumed to be exposed to CoPCs from Project activities only through ingestion of country foods.

#### 5.1.3.1 Pathways Related to Air Emissions

Based on the screening in Section 5.1.1.1, two CoPCs are identified to occur at levels in ambient air that are of potential concern for human health from inhalation and are assessed quantitatively:

- Benzene and
- Benzo(a)pyrene.

Air parameters that are below screening criteria in **Table 5-2**, as well as crystalline silica, nickel, $NO_2$ and dustfall, are assessed qualitatively.

The screening did not identify any CoPC in Project-related air emissions that are likely to deposit to soil and/or accumulate in biota (country foods) at levels of concern to human health. Many of the parameters are gases and inhalation is considered the relevant exposure pathway. The area potentially affected by elevated dustfall is predicted to be limited to near the modelled property boundary and does not extend to HHRA receptor locations at Hare Lake, Bamoos Lake and the Pic River where country foods harvesting may occur.

#### 5.1.3.2 Pathways Related to Water Emissions

Based on the screening in Section 5.1.1.2, predicted water quality remains below surface water quality benchmarks or within the range of existing background concentrations. The discharge of excess treated water to Hare Lake during operations and post-closure drainage from Project components (PSMF, MRSA, open pits and water management pond) to subwatersheds of the Pic River are not expected to adversely affect human health and the use of country foods.

Bamoos Lake does not receive drainage from the Project; therefore, water quality in Bamoos Lake is not anticipated to be affected by the Project. Water quality in Hare Lake, Stream 106 and the subwatersheds of the Pic River is not predicted to be adversely affected by releases from the mine site. Therefore, any fishery resources in these areas are not expected to be affected by Project-related releases of CoPCs and no impacts on human health from fish consumption in the Project area are expected to result because of the Project. Similarly, no impact on aquatic plants and wildlife with linkages to the aquatic environment is expected to result from Project-related releases of CoPCs to the surface water environments.

No CoPCs in surface water were identified for further assessment. No adverse effects on wildlife are anticipated and no impacts on human health from the consumption of country foods in the Project area are expected to result because of the Project.

The Project is not anticipated to adversely affect drinking water quality because no interaction between groundwater affected by the Project and potable water supply wells is expected.

In summary, no exposure pathways related to surface water and groundwater releases from the Project were identified as requiring further assessment based on the screening of predicted concentrations of constituents in water.

#### 5.1.3.3 Country Food Pathways

Indigenous communities have stated they are concerned with background levels of constituents in country foods that can influence human health. Indigenous communities have indicated they fish and consume fish from Hare Lake, Hare Creek, Bamoos Lake, Stream 106 (Angler Creek) and the Pic River, and want to ensure the safety of human consumption of fish from those waterbodies.

Potential exposure pathways for human receptors from consumption of country foods during all phases of the Project were considered. Country food items, such as fish, game meat and birds, and plants, could accumulated Project-related CoPCs from soil affected by atmospheric depositions, water affected by aqueous releases to the aquatic environment, and accumulation through the food chain.

- No CoPCs in country foods were identified in relation to air emissions that would deposit to soil and potentially enter the food chain through uptake by plants and animals that are considered in the country food diet.
- No CoPCs in country foods were identified in relation to waterborne emissions. The predicted quality of surface water receiving seepage, runoff and treated effluent discharge from the Project is expected to remain near background levels and/or meet applicable surface water quality benchmarks.
- No herbicide or pesticide use is anticipated at the mine site or along the transmission line corridor therefore no CoPCs in country foods related to herbicide or pesticide use are anticipated during any phase of the Project.

- Post-closure, public access to the open pits will be prohibited and limited by a perimeter berm per the requirements of the Mine Rehabilitation Code (O.Reg. 240/00).

In summary, there are minimal predicted Project-related effects on constituent concentrations in the environment which would result in changes to constituent concentrations in country foods where country foods may be harvested in the LSA and RSA. Therefore, the Project is not expected to result in adverse human health effects from consuming country foods and continued hunting, fishing, trapping and plant harvesting activities in the LSA and RSA. This is consistent with the findings of the original HHRA (2013) that concluded there would be limited Project-related effects on constituent concentrations in the environment.

### 5.1.4 Conceptual Site Model

The release of constituents through Project-related air and water emissions can affect human health by changing the quality of environmental media such as air, water and country foods. Potential pathways by which constituents from air and water emissions can travel through the environment to people who consume country foods are illustrated in the human heath conceptual site model in Figure 5-2**.**

A country food diet may include plants, game birds, large and small game mammals and fish that are harvested through gathering, hunting, trapping and fishing. Plants can be affected through the deposition of constituents from air, both directly and indirectly through uptake from soil. Birds and game can be affected by changes to air and water quality through the food chain, water ingestion and incidental soil and sediment ingestion. Fish can be affected by changes to water quality.

In this assessment, two constituents (benzene and benzo(a)pyrene) are identified to occur at levels in ambient air that are of potential concern for human health from inhalation and are carried through for quantitative assessment. No constituents in country foods were identified in relation to airborne or waterborne emissions

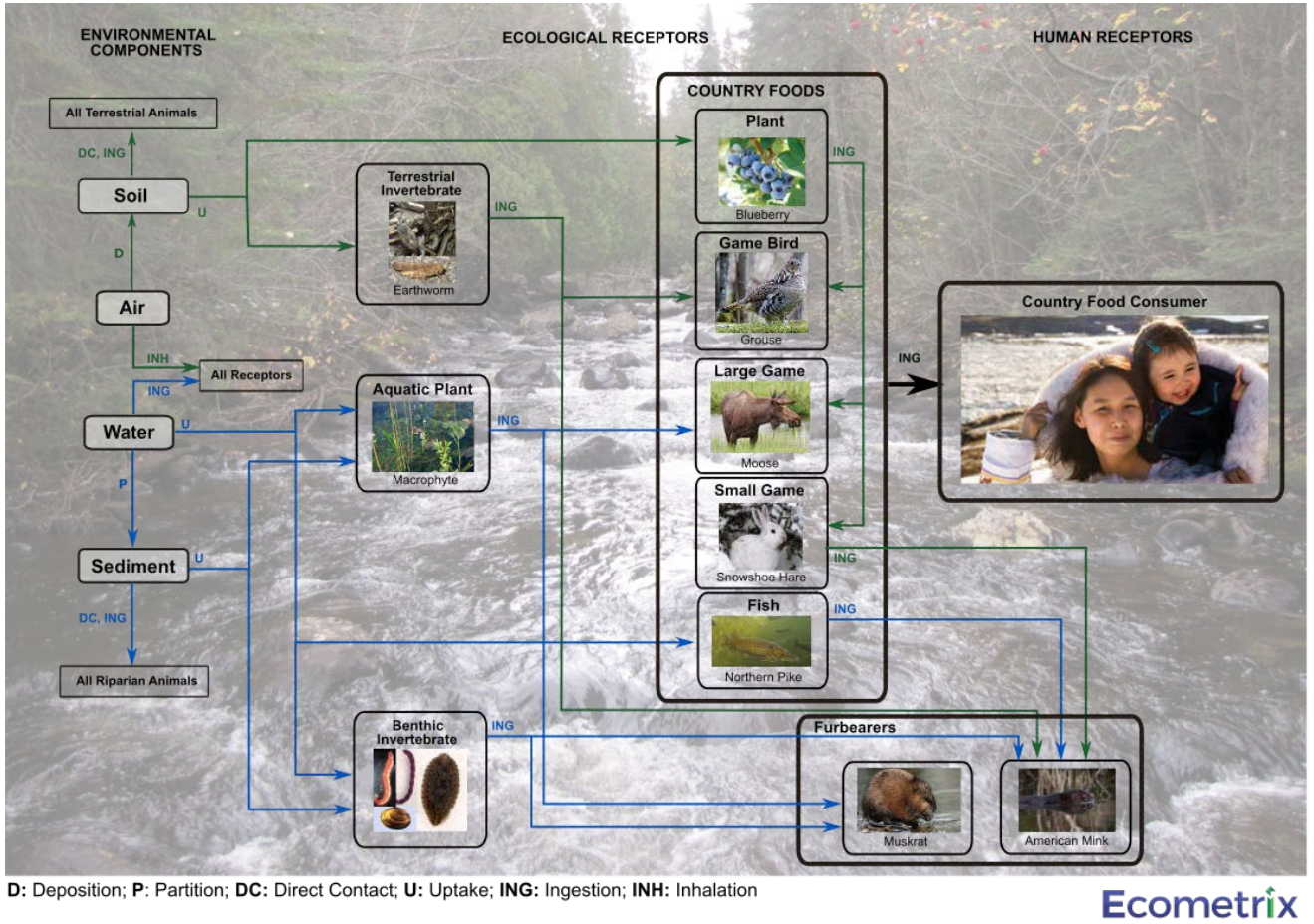


**Figure 5-2: Human Health Conceptual Site Model**

## 5.2 Exposure Assessment

The exposure assessment uses the estimated maximum concentrations of the CoPCs, the exposure characteristics of the receptors, and the exposure pathways to estimate exposure of the receptors to CoPCs. Based on the screening conducted at the problem formulation stage, exposure to CoPCs in air was the only pathway identified for further assessment.

### 5.2.1 Receptor Characteristics

To estimate exposure in the Project area, the assumptions in **Table 5-19** were used for seasonal residents at Hare Lake, subsistence harvesters at Hare Lake, Bamoos Lake and the Pic River, and permanent residents of the Town of Marathon.

An outdoor residency factor of 0.2 (cl. 6.14.3 CSA N288.1-14) was assumed for the seasonal residents at Hare Lake. This is equal to 4.8 hours/day spent outdoors and 19.2 hours/day spent indoors. Subsistence harvesters were assumed to spend 8 hours/day outdoors in the LSA and 16 hours/day indoors or away from the Project area. Permanent residents in Marathon were assumed to spend 3 hours/day spent outdoors and 21 hours/day spent indoors (Health Canada, 2010).

The exposure frequencies in **Table 5-19** were assumed to apply during every year of life. This assumption is expected to provide a conservative estimate of potential exposures and incremental cancer risk because the Project duration is expected to be much less than an 80-year lifetime.

**Table 5-19: Exposure Assumptions for Human Receptors**

| Receptor | Days per week in the LSA or RSA | Weeks per year in the LSA or RSA | Hours per day outdoors | Lifetime (years) |
|---|---|---|---|---|
| Seasonal Resident | 7 | 8 | 4.8 | 80 |
| Subsistence Harvester | 7 | 8 | 8 | 80 |
| Permanent Resident | 7 | 52 | 3 | 80 |

## 5.2.2 Exposure Point Concentrations

### 5.2.2.1 Maximum Ambient Air Concentrations

Maximum 24-hr and annual ambient air concentrations for relevant airborne CoPCs were estimated by modelling, as described in the *Air Quality Updated Effects Assessment* (Appendix D1 of this EIS Addendum [Vol 2]). For the HHRA, air quality model locations that coincide with locations of human receptors identified in Section 5.2.1 are considered. These are locations where members of the public, such as visitors, seasonal residents, and subsistence harvesters (see Section 5.2.1) and residents may be present for long periods of time. These locations include Bamoos Lake, Hare Lake, the Pic River (which are the closest HHRA receptors to the SSA) and residences in the Town of Marathon near the proposed rail loadout facility.

Benzene and benzo(a)pyrene were CoPCs in ambient air identified in Section 5.1.1 as requiring quantitative assessment for long-term exposures for sensitive human receptors. Inhalation of Project-related CoPCs in air by members of the public who may be present near the modelled property boundary for short periods of time was not identified in Section 5.1.1 as requiring quantitative assessment.

Maximum predicted concentrations ($\mu g/m^3$) of benzene and benzo(a)pyrene for the relevant receptor locations are used as exposure point concentrations in the HHRA. These are summarized in **Table 5-20** and **Table 5-21**, for construction and operations respectively.

**Table 5-20: Maximum Annual Concentrations of Benzene and Benzo(a)pyrene at HHRA Receptor Locations during Construction**

| CoPC | HHRA Receptor Location | Background (µg/m3) | Project Only (µg/m3) | Background and Project (µg/m3) |
|---|---|---|---|---|
| Benzene | M_5 Pic River | 9.02E-01 | 4.57E-03 | 9.07E-01 |
| | PS_1 Hare Lake | | 2.16E-03 | 9.04E-01 |
| | W_10 Bamoos Lake | | 2.60E-03 | 9.05E-01 |
| | Residences near the potential rail loadout* | | 5.55E-03 | 9.08E-01 |
| Benzo(a)pyrene | M_5 Pic River | 1.03E-04 | 4.35E-07 | 1.03E-04 |
| | PS_1 Hare Lake | | 2.43E-07 | 1.03E-04 |
| | W_10 Bamoos Lake | | 2.35E-07 | 1.03E-04 |
| | Residences near the potential rail loadout* | | 1.66E-05 | 1.20E-04 |

* The maximum concentrations from a residence near the proposed rail loadout facility as identified in Table 5-5 for benzene and Table 5-7 for benzo(a)pyrene.

**Table 5-21: Maximum Annual Concentrations of Benzene and Benzo(a)pyrene at HHRA Receptor Locations during Operations**

| CoPC | HHRA Receptor Location | Background (µg/m3) | Project Only (µg/m3) | Background and Project (µg/m3) |
|---|---|---|---|---|
| Benzene | M_5 Pic River | 9.02E-01 | 2.67E-03 | 9.05E-01 |
| | PS_1 Hare Lake | | 1.63E-03 | 9.04E-01 |
| | W_10 Bamoos Lake | | 2.13E-03 | 9.04E-01 |
| | Residences near the potential rail loadout* | | 7.28E-02 | 9.75E-01 |
| Benzo(a)pyrene | M_5 Pic River | 1.03E-04 | 1.96E-07 | 1.03E-04 |
| | PS_1 Hare Lake | | 1.17E-07 | 1.03E-04 |
| | W_10 Bamoos Lake | | 1.20E-07 | 1.03E-04 |
| | Residences near the potential rail loadout* | | 3.23E-05 | 1.35E-04 |

* The maximum concentrations from a residence near the proposed rail loadout facility as identified in Table 5-5 for benzene and Table 5-7 for benzo(a)pyrene.

In the assessment of exposure, a relative absorption factor (RAF) is applied to account for the bioavailability of the CoPC, as compared to that in the study identified in the hazard assessment for the relevant toxicity reference value. The RAF for inhalation of soil particulates was assumed to be 1 (MOE, 2011).

Exposures to CoPCs in ambient air were not pro-rated for the assessment of potential non-cancer risks. For non-cancer effects all receptors at the HHRA locations were assumed to be exposed to the maximum air concentrations at their location for a sufficient period of time for chronic effects to develop.

Exposures to CoPCs in ambient air were prorated for the assessment of potential cancer based on the various exposure frequencies of the different receptors for outdoor air. Cancer outdoor air prorating (COAP) factors for each of the receptors were calculated using the following equation and assuming potential exposures over a lifetime of 80 years, and the results are summarized in **Table 5-22**:

$$COAP = \frac{EF_a \times EF_b \times EF_{c(d)} \times ED}{APC \times C_4} \quad \text{..... (Eq.6.1)}$$

Where:

EFa: Exposure Frequency (days/week) (Health Canada, 2012)
EFb: Exposure Frequency (weeks/year) (Health Canada, 2012)
EFc: Exposure Frequency (hours/day) (Permanent Resident - Health Canada, 2010) (Seasonal Resident - CSA N288.1-14) (Subsistence Harvester – assumed)
ED: Exposure Duration (years) - per lifestage: infant (0 to 6 months inclusively); toddler (7 months to 4 years inclusively); child (5 years to 11 years inclusively); teen (12 years to 19 years inclusively); adult (20 years to 80 years inclusively) (Health Canada, 2010 and 2012)
APC: Averaging Period (years), cancer (lifetime) (Health Canada, 2010 and 2012)
C4: Unit conversion factor (Health Canada, 2012)

**Table 5-22: Cancer Outdoor Air Prorating Factors for Human Receptors**

| Receptor | $EF_a$ | $EF_{b\ (in)}$ | $EF_c$ | APC | $C_4$ | COAP |
|---|---|---|---|---|---|---|
| | (days/week) | (weeks/year) | (hours/day) | (years) | (hours/year) | (Unitless) |
| Permanent Resident | 7 | 52 | 3 | 80 | 8760 | 1.32E-01 |
| Seasonal Resident | 7 | 8 | 4.8 | 80 | 8760 | 3.26E-02 |
| Subsistence Harvester | 7 | 8 | 8 | 80 | 8760 | 5.43E-02 |

Note:
Refer to Section 5.2.1 for residency assumptions for the HHRA receptors

## 5.3 Hazard Assessment

A hazard assessment was conducted for the CoPCs and exposure pathways carried forward to quantitative assessment. The purpose of the hazard assessment is to classify the potential toxicological effects of a CoPC as carcinogenic or non-carcinogenic, or both, and to determine toxicological reference values relevant to the exposure pathways and exposure durations identified for the receptors.

A hazard assessment is conducted for all CoPCs that are screened into the assessment and considers possible modes of toxicity for different routes and durations of exposure. The hazard assessment provides an estimate of how much chemical exposure may occur without unacceptable health effects and provides a basis to interpret exposure rates.

### 5.3.1 Toxicity Reference Values

Toxicity reference values (TRVs) to be used to characterize health risks were selected for each CoPC.

Toxicity reference values endorsed by the MECP were utilized as first priority, when available. In circumstances where TRVs were not presented by MECP, and when TRVs for a particular CoPC were available from multiple regulatory agencies, values were reviewed, and the professional judgment of an experienced toxicologist and/or risk assessor was used to select the most appropriate TRV. A number of different considerations went into selecting a TRV for use, including the following:

- The TRVs are derived by a reputable regulatory agency.
- There is sufficient documentation available concerning the derivation of the TRV.
- The TRV derivation is current.
- The TRV is relevant for the exposure route and duration of exposure.

A priori, the TRVs employed in this assessment were obtained from reputable regulatory agencies including, but not limited to:

- Ontario Ministry of the Environment, Conservation and Parks (MECP);
- Health Canada; and
- United States Environmental Protection Agency Integrated Risk Information System (US EPA IRIS).

A non-carcinogenic constituent is known as a threshold constituent because an adverse health effect may occur in the human receptor when a specific threshold dose of the constituent is exceeded. This TRV, or dose, is called the threshold dose.

A carcinogenic constituent is known as a non-threshold constituent because an adverse health effect to a human receptor can occur at any dose. TRVs used to assess cancer risk are known as cancer slope factors (CSF) and unit risk factors (URF). Slope factors for carcinogenic compounds

are derived for the most sensitive or affected organ or system (the target) in the studied species. In cases where only animal data are available, it is generally assumed that the target organ or system would be the same for a human subject. Unit risk factors are specific to the medium in which human contact occurs (U.S. EPA, 1995), and they define the relationship between concentration in a given medium and cancer response.

#### 5.3.1.1 Inhalation Non-cancer and Cancer TRVs

Following the screening in Section 5.1.1.1, two CoPCs, benzene and benzo(a)pyrene, were identified for quantitative assessment from long-term exposures via inhalation. For chronic exposures, both benzene and benzo(a)pyrene may present non-cancer and cancer hazards through inhalation.

The selected chronic non-cancer inhalation TRVs and inhalation unit cancer risks- for benzene and benzo(a)pyrene, as well as the key critical health outcomes and regulatory sources for each TRV, are provided in **Table 5-23** and **Table 5-24**, respectively.

**Table 5-23: Selected Chronic Non-cancer Inhalation TRVs**

| CoPC | Non-cancer Inhalation TRV ($mg/m^3$) | | | |
|---|---|---|---|---|
| | Duration | Value | Critical Effect | Source |
| Benzene | Chronic | 3E-02 | Decreased lymphocyte count | US EPA IRIS, 2003: MECP 2020 |
| Benzo(a)pyrene | Chronic | 2E-06 | Decreased embryo/fetal survival | MECP 2020; US EPA IRIS, 2017 |

**Table 5-24: Selected Inhalation Unit Risk TRVs**

| CoPC | Inhalation Unit Risk ($(mg/m^3)^{-1}$) | | | |
|---|---|---|---|---|
| | Duration | Value | Critical Effect | Source |
| Benzene | Chronic | 2.2E-03 | Leukemia | US EPA IRIS, 2000; MECP 2020 |
| Benzo(a)pyrene | Chronic | 6.00E-01 | Upper respiratory tract and pharynx tumours, all treated as incidental to death | MECP, 2020; US EPA IRIS, 2017 (TEF=1) |

## 5.4 Risk Characterization

The risk characterization combines the results of the exposure assessment and toxicity assessment to estimate the potential for cancer and non-cancer human health effects from exposure to the CoPCs.

Both quantitative and qualitative approaches were used in the HHRA. The results of the quantitative assessment are discussed in Section 5.4.1. The results of the qualitative assessment are discussed in Section 5.4.2.

### 5.4.1 Quantitative Interpretation of Risk

Risks for each receptor were characterized separately for non-cancer and cancer effects.

*Non-cancer Risks*

Potential non-cancer risks were evaluated as exposure ratios (ER), where the predicted long-term exposure point concentration (maximum annual concentration) was compared to a chronic concentration-based toxicity reference value (TRV):

$$Exposure\ Ratio\ (ER) = \frac{Exposure}{TRV} \quad \text{(Eq.5.1)}$$

Exposure ratios were calculated for the Project alone to assess incremental exposure risk, and for the Project plus background to assess total exposure risk. The ERs for the Project alone were compared to a target quotient of 0.2. The ERs for the Project plus background were compared to a target quotient of 1 where air was considered to be the only complete exposure pathway for human receptors for the CoPC. The use of a benchmark ER value of 0.2 for incremental exposures is consistent with the approach taken by Health Canada (2010) in their guidance on human health preliminary quantitative risk assessment (PQRA) and also with other jurisdictions such as the Ontario Ministry of the Environment (2011) in their rationale for the development of soil and groundwater standards. An ER higher than 0.2 for incremental exposure, and an ER higher than 1 for total exposure do not indicate a health risk, but rather indicate that a potential risk to receptors cannot be ruled out, and that further investigation or risk management measures may be needed.

*Cancer Risks*

Potential cancer risks were assessed by estimating incremental lifetime cancer risks (ILCRs) by multiplying the estimated Project-related exposure over a lifetime by the relevant unit risk factor. For inhalation,this is called an inhalation unit risk (IUR). The IUR can be multiplied by an estimate of lifetime exposure to estimate the lifetime cancer risk:

$$ILCR = Exposure \times Unit\ Risk\ Factor \quad \text{(Eq.5.2)}$$

The calculated ILCR is compared to the Health Canada's target of 1 in 100,000 (or 1 x $10^{-5}$) (Health Canada, 2012). If the calculated ILCR is below the target, then the risk is considered essentially negligible compared to the cancer risk level from all background causes. A calculated ILCR in excess of the target indicates a need for further investigation and/or risk management to reduce the risk to an acceptable level.

#### 5.4.1.1 Quantitative Assessment of Air Exposure Pathways

##### 5.4.1.1.1 Non-cancer Risk

The estimated maximum ER values were calculated by comparing the maximum predicted annual average concentrations of benzene and benzo(a)pyrene at the HHRA receptor locations to the relevant TRV. Estimated maximum ER values for benzene and benzo(a)pyrene are orders of magnitude below the ER target of 0.2 for the project only and the ER target of 1 for the project and background sources, as shown in **Table 5-25** for construction period and in **Table 5-26** for the operations.

The background concentrations represent the maximum annual mean concentration from the Winnipeg NAPS station. As such, predicted air concentrations that include Project plus background can be interpreted as accounting for the effects of the Project with other sources of benzene and benzo(a)pyrene in ambient air. Since both of these CoPCs are typically associated with the use of heavy equipment, fuel combustion by-products, and road transportation activities, the background concentrations for benzene and benzo(a)pyrene, based on available NAPs data from Winnipeg, may over-estimate background levels in Marathon.

**Table 5-25: Maximum Annual Average Exposure Ratio Values for Benzene and Benzo(a)pyrene at HHRA Receptor Locations during Construction**

| CoPC | Location | Project Only (µg/m3) | | | Background and Project (µg/m3) | | |
|---|---|---|---|---|---|---|---|
| | | Maximum | TRV | ER (unitless) | Maximum | TRV | ER (unitless) |
| Benzene | M_5 Pic River | 4.57E-03 | 3.00E+01 | 1.52E-04 | 9.07E-01 | 3.00E+01 | 3.02E-02 |
| | PS_1 Hare Lake | 2.16E-03 | | 7.19E-05 | 9.04E-01 | | 3.01E-02 |
| | W_10 Bamoos Lake | 2.60E-03 | | 8.66E-05 | 9.05E-01 | | 3.02E-02 |
| | Residences near the proposed rail loadout | 5.55E-03 | | 1.85E-04 | 9.08E-01 | | 3.03E-02 |
| Benzo(a)pyrene | M_5 Pic River | 4.35E-07 | 2.00E-03 | 2.17E-04 | 1.03E-04 | 2.00E-03 | 5.17E-02 |
| | PS_1 Hare Lake | 2.43E-07 | | 1.22E-04 | 1.03E-04 | | 5.16E-02 |
| | W_10 Bamoos Lake | 2.35E-07 | | 1.18E-04 | 1.03E-04 | | 5.16E-02 |
| | Residences near the potential rail loadout | 1.66E-05 | | 8.29E-03 | 1.20E-04 | | 5.98E-02 |

**Table 5-26: Maximum Annual Average Exposure Ratio Values for Benzene and Benzo(a)pyrene at HHRA Receptor Locations during Operations**

| CoPC | Location | Project Only (µg/m3) | | | Background and Project (µg/m3) | | |
|---|---|---|---|---|---|---|---|
| | | Maximum | TRV | ER (unitless) | Maximum | TRV | ER (unitless) |
| Benzene | M_5 Pic River | 2.67E-03 | 3.00E+01 | 8.91E-05 | 9.05E-01 | 3.00E+01 | 3.02E-02 |
| | PS_1 Hare Lake | 1.63E-03 | | 5.44E-05 | 9.04E-01 | | 3.01E-02 |
| | W_10 Bamoos Lake | 2.13E-03 | | 7.09E-05 | 9.04E-01 | | 3.01E-02 |
| | Residences near the proposed rail loadout | 7.28E-02 | | 2.43E-03 | 9.75E-01 | | 3.25E-02 |
| Benzo(a)pyrene | M_5 Pic River | 1.96E-07 | 2.00E-03 | 9.78E-05 | 1.03E-04 | 2.00E-03 | 5.16E-02 |
| | PS_1 Hare Lake | 1.17E-07 | | 5.86E-05 | 1.03E-04 | | 5.16E-02 |
| | W_10 Bamoos Lake | 1.20E-07 | | 6.00E-05 | 1.03E-04 | | 5.16E-02 |
| | Residences near the potential rail loadout | 3.23E-05 | | 1.62E-02 | 1.35E-04 | | 6.77E-02 |

#### 5.4.1.1.2 Cancer Risk

The estimated maximum ILCRs were calculated by multiplying the Project-related maximum predicted concentrations of benzene and benzo(a)pyrene at the HHRA receptor location prorated over a lifetime of exposure, by the relevant TRV. A cancer outdoor air prorating (COAP) factor was estimated for each of the human receptors using receptor characteristics from the Health Canada (2010) guidance for exposure frequency and duration for each life stage, prorated over an 80-year lifetime, as shown in Section 5.2 and listed in **Table 5-22**. The estimated maximum ILCR is therefore expected to be a conservative estimate of potential incremental cancer risk because the durations of the construction and operations stages of the Project are much less than a lifetime.

Estimated maximum ILCR values for benzene and benzo(a)pyrene are orders of magnitude below the target of $1 \times 10^{-5}$ for all Project stages, as shown in **Table 5-27** for residents near the proposed rail loadout area, in **Table 5-28** for seasonal residents at Hare Lake and Bamoos Lake, and in **Table 5-29** for subsistence harvesters at Hare Lake, Bamoos Lake and Pic River.

The estimated maximum ILCRs for the Project are also well below the target ILCR of $1 \times 10^{-5}$.

**Table 5-27: Maximum Estimated ILCR for Residents near the Proposed Rail Loadout Area during Construction and Operations**

| CoPC | Location | Estimated Concentration in Outdoor Air Project Only ($ug/m^3$) | COAP (Unitless) | $Exposure_{air}$ ($ug/m^3$) | Inhalation Unit Risk ($ug/m^3$) | ILCR (Unitless) |
|---|---|---|---|---|---|---|
| **Construction** | | | | | | |
| Benzene | R_22 Residence | 5.55E-03 | 1.25E-01 | 6.92E-04 | 2.20E-06 | 1.52E-09 |
| Benzo(a)pyrene | R_5 Condominium | 1.66E-05 | 1.25E-01 | 2.07E-06 | 6.00E-04 | 1.24E-09 |
| **Operations** | | | | | | |
| Benzene | R_10 Residence | 7.28E-02 | 1.25E-01 | 9.08E-03 | 2.20E-06 | 2.00E-08 |
| Benzo(a)pyrene | R_13 Residence | 3.23E-05 | 1.25E-01 | 4.03E-06 | 6.00E-04 | 2.42E-09 |

**Table 5-28: Maximum Estimated ILCR for Seasonal Residents at Hare Lake during Construction and Operations**

| CoPC | Location | Estimated Concentration in Outdoor Air Project Only ($\mu g/m^3$) | COAP (Unitless) | $Exposure_{air}$ ($\mu g/m^3$) | Inhalation Unit Risk ($\mu g/m^3$) | ILCR (Unitless) |
|---|---|---|---|---|---|---|
| **Construction** | | | | | | |
| Benzene | PS_1 Hare Lake | 2.16E-03 | 3.07E-02 | 6.62E-05 | 2.20E-06 | 1.46E-10 |
| Benzo(a)pyrene | PS_1 Hare Lake | 2.43E-07 | 3.07E-02 | 7.47E-09 | 6.00E-04 | 4.48E-12 |
| **Operations** | | | | | | |
| Benzene | PS_1 Hare Lake | 1.63E-03 | 3.07E-02 | 5.01E-05 | 2.20E-06 | 1.10E-10 |
| Benzo(a)pyrene | PS_1 Hare Lake | 1.17E-07 | 3.07E-02 | 3.60E-09 | 6.00E-04 | 2.16E-12 |

**Table 5-29: Maximum Estimated ILCR for Subsistence Harvesters at Hare Lake, Bamoos Lake and Pic River during Construction and Operations**

| CoPC | Location | Estimated Concentration in Outdoor Air Project Only ($ug/m^3$) | COAP (Unitless) | $Exposure_{air}$ ($ug/m^3$) | Inhalation Unit Risk ($ug/m^3$) | ILCR (Unitless) |
|---|---|---|---|---|---|---|
| **Construction** | | | | | | |
| Benzene | M_5 Pic River | 4.57E-03 | 5.11E-02 | 2.33E-04 | 2.20E-06 | 5.14E-10 |
| | PS_1 Hare Lake | 2.16E-03 | | 1.10E-04 | | 2.43E-10 |
| | W_10 Bamoos Lake | 2.60E-03 | | 1.33E-04 | | 2.92E-10 |
| Benzo(a)pyrene | M_5 Pic River | 4.35E-07 | 5.11E-02 | 2.22E-08 | 6.00E-04 | 1.33E-11 |
| | PS_1 Hare Lake | 2.43E-07 | | 1.25E-08 | | 7.47E-12 |
| | W_10 Bamoos Lake | 2.35E-07 | | 1.20E-08 | | 7.22E-12 |
| **Operations** | | | | | | |
| Benzene | M_5 Pic River | 2.67E-03 | 5.11E-02 | 1.37E-04 | 2.20E-06 | 3.01E-10 |
| | PS_1 Hare Lake | 1.63E-03 | | 8.35E-05 | | 1.84E-10 |
| | W_10 Bamoos Lake | 2.13E-03 | | 1.09E-04 | | 2.39E-10 |
| Benzo(a)pyrene | M_5 Pic River | 1.96E-07 | 5.11E-02 | 1.00E-08 | 6.00E-04 | 6.00E-12 |
| | PS_1 Hare Lake | 1.17E-07 | | 6.00E-09 | | 3.60E-12 |
| | W_10 Bamoos Lake | 1.20E-07 | | 6.13E-09 | | 3.68E-12 |

## 5.4.2 Qualitative Interpretation of Risk

### 5.4.2.1 Air Quality Parameters

The principal air quality parameters that could be affected by the site preparation and construction, operation, decommissioning and closure phases of the mine include:

- Particulate matter (PM): defined as liquid or solid particles, or a mixture of both, less than 100 micrometers (µm) in diameter. PM includes total suspended particulates (TSP), particulate matter less that 10 um ($PM_{10}$), particulate matter less than 2.5 um ($PM_{2.5}$), and the crystalline silica component of $PM_{10}$;
- Secondary pollutants: formed in the atmosphere through the reaction of gaseous precursors from Project sources. These include ground-level ozone ($O_3$), and a portion of the total PM2.5 concentrations;
- Other ambient air pollutants: associated with the use of heavy equipment, fuel combustion by-products, and road transportation activities. These include PM, nitrous oxides (NOx), sulphur dioxide ($SO_2$), carbon monoxide (CO), polycyclic aromatic hydrocarbons (PAHs) with the exception of benzo(a)pyrene which was assessed quantitatively, volatile organic compounds (VOCs) such as acetaldehyde, formaldehyde, 1,3-butadiene, and acrolein, (with the exception of benzene which was assessed quantitatively) and metals associated with particulate matter, such as cadmium, lead, mercury, manganese, arsenic and nickel.

The predicted maximum exposure point concentrations for Project-related CoPCs in air were screened in Section 5.1.1.1.3, for short and long-term exposures. The predicted maximum concentrations are from the *Air Quality Updated Effects Assessment* (Appendix D1 of this EIS Addendum [Vol 2]). Those chemical parameters that were below the screening criteria were assumed to be at levels not associated with potentially unacceptable human health effects.

### 5.4.2.2 Chemical Mixtures

#### 5.4.2.2.1 Polycyclic Aromatic Hydrocarbons

Benzo(a)pyrene was used as a surrogate for airborne carcinogenic polycyclic aromatic hydrocarbons (PAHs) that did not have an O.Reg 419/05 annual air quality criterion for the screening. The individual PAHs that were modeled and that may be assessed using benz(a)pyrene as a surrogate included: acenaphthene, acenaphthylene, anthracene, benz(a)anthracene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, dibenz(a,h)perylene, fluorantene, fluorene, indeno(1,2,3-c,d)pyrene, phenanthrene, and pyrene. Naphthalene was assessed separately, because it has an O.Reg. 419/04 criterion, and it was found to be at levels well below those associated with adverse health effects.

Although Project-related benzo(a)pyrene emissions were well below the screening value at all HHRA receptor locations, total concentrations of benzo(a)pyrene from Project and background sources exceeded the screening value. Therefore, incremental lifetime cancer risks for benzo(a)pyrene were estimated for the human receptors in the HHRA. Incremental risks are

based on predicted emissions from Project activities in Section 5.4.1.1.2. The Project's contribution to the total predicted concentrations of benzo(a)pyrene was insignificant at most receptor locations. The maximum annual average benzo(a)pyrene emissions, from Project activities, were higher during operations that during construction. The area most affected by Project-related emissions was located at residences in the Town of Marathon near the potential rail load-out area. Of the total benzo(a)pyrene emissions from road traffic, only 3.8% is expected to be due to the Project based on the *Air Quality Updated Effects Assessment* (Appendix D1 of this EIS Addendum [Vol 2]).

As shown in Section 5.4.1.1.2, the worst case ILCR for benzo(a)pyrene from Project sources was $2.42x10^{-9}$. It was conservatively calculated over a lifetime of exposure for a permanent resident living near the proposed rail loadout area. This worst-case ILCR was almost four orders of magnitude below Health Canada's target value of $1x10^{-5}$. Since the potential incremental cancer risk from the Project from benzo(a)pyrene was considered to be negligible even under the conservative exposure assumptions of continuous lifetime exposure used in the HHRA, the potential additional risk from other airborne carcinogenic PAHs associated with Project activities were therefore also considered to be negligible and adverse human health effects from PAH mixtures in ambient air are not expected.

Ontario's MECP also recognizes the use of the toxic equivalency factor (TEF) approach for assessing potential health effects from PAH mixtures in the environment relative to benzo(a)pyrene. The MECP has established TEFs for carcinogenic PAHs (MECP, 2018), that were used to derive inhalation unit risk values for individual PAHs. In **Table 5-30**, incremental lifetime cancer risks for the individual carcinogenic PAHs are calculated and summed for the HHRA receptor location most affected by PAHs in traffic related emissions (R_13), following the method described in Section 5.4.1.1.2. The sum of ILCRs for the PAH mixture in air near the potential rail load out area is $3.72x10^{-9}$, which is well below the target ILCR. The ILCRs for PAH mixtures at the other HHRA receptor locations would be even less. An estimated maximum ILCR for the same PAH mixture for Project-related and background emissions at the same location during operations would be higher, $1.64x10^{-8}$, but would still be below the target ILCR.

Both the surrogate and the TEF approaches used to qualitatively assess potential health effects from Project-related PAH mixtures in air indicate that adverse human health effects from PAH mixtures in ambient air are not expected.

**Table 5-30: Estimated Maximum Incremental Lifetime Cancer Risk for PAH Mixtures in Air at a HHRA Receptor Location**

| PAH | Maximum Annual Average Concentration in Outdoor Air | COAP (Unitless) | $Exposure_{air}$ ($\mu g/m^3$) | Inhalation Unit Risk ($\mu g/m^3$) | ILCR (Unitless) |
|---|---|---|---|---|---|
| Acenaphthene | 2.43E-04 | 1.25E-01 | 3.03E-05 | 6.00E-07 | 1.82E-11 |
| Acenaphthylene | 4.13E-04 | 1.25E-01 | 5.14E-05 | 6.00E-06 | 3.09E-10 |
| Anthracene | 1.80E-04 | 1.25E-01 | 2.24E-05 | 6.00E-06 | 1.34E-10 |
| Benzo(a)anthracene | 4.97E-05 | 1.25E-01 | 6.20E-06 | 6.00E-05 | 3.72E-10 |
| Benzo(a)pyrene | 3.23E-05 | 1.25E-01 | 4.03E-06 | 6.00E-04 | 2.42E-09 |
| Benzo(b)fluoranthene | 1.42E-05 | 1.25E-01 | 1.76E-06 | 6.00E-05 | 1.06E-10 |
| Benzo(g,h,i)perylene | 3.78E-07 | 1.25E-01 | 4.72E-08 | 6.00E-06 | 2.83E-13 |
| Benzo(k)fluoranthene | 1.13E-05 | 1.25E-01 | 1.41E-06 | 6.00E-05 | 8.44E-11 |
| Chrysene | 3.25E-05 | 1.25E-01 | 4.05E-06 | 6.00E-06 | 2.43E-11 |
| Fluoranthene | 3.09E-04 | 1.25E-01 | 3.86E-05 | 6.00E-06 | 2.31E-10 |
| Indeno(1,2,3-c,d)pyrene | 1.66E-08 | 1.25E-01 | 2.07E-09 | 6.00E-05 | 1.24E-13 |
| Pyrene | 3.27E-04 | 1.25E-01 | 4.08E-05 | 6.00E-07 | 2.45E-11 |
| **Total PAH Risks (B[a]P)** | | | | | **3.72E-09** |

Notes:
Maximum annual average concentrations for individual PAHs are from the updated air quality model (REFERENCE HERE) for Project-only emissions during Operations at the model location R_13

#### 5.4.2.2.2 Diesel Exhaust

##### 5.4.2.2.2.1 Components of Diesel Exhaust

Diesel exhaust comprises a complex mixture of gaseous and particulate components including coarse, fine and ultrafine particulate matter (such as PM10, PM2.5, PM<2.5), PAHs (such a benzo(a)pyrene), and semi-volatile and volatile organic compounds (such as benzene) (Health Canada, 2016b). There is a general consensus within the scientific community that there is an association between occupational exposures to diesel exhaust and an increased incidence of lung cancer (Health Canada, 2016b). However, there is also general consensus that that there is currently insufficient epidemiological evidence to support the development of a quantitative exposure-response relationship for a unit risk for diesel emissions (PHO, 2016).

Various components of diesel exhaust were modelled separately and each of their maximum total concentrations, that included Project and background sources, were screened in the HHRA (Section 3.1.1) against their respective health-based screening criteria. Individual components of diesel exhaust with screening criteria, except benzene and benzo(a)pyrene, were predicted to be at levels that are below those associated with adverse effects on human health. Benzene and benzo(a)pyrene were quantitatively assessed, and were also determined to be below levels associated with adverse effects on human health.

##### 5.4.2.2.2.2 Evaluation of Relative Risk

Potential effects from diesel exhaust can be qualitatively assessed using a relative risk approach. For the relative risk approach, elemental carbon is used as a proxy for diesel exhaust based on work done by Vermeulen et al. (2014), and Vermeulen and Portengen (2016). The outcome is the increased risk of mortality from lung cancer from exposure to elemental carbon compared to a reference group that is assume to be "unexposed". A relative risk of 1.0 means risk for an exposed group is equal to that of an unexposed group. A relative risk greater than 1.0 indicates increased risk. The relative risk from background conditions and the relative risk from Project sources are calculated to qualitatively gauge the magnitude of increased relative risk due to Project activities compared to the current conditions and to an unexposed population.

Elemental carbon was not modelled in the air quality model. To assess potential relative risk, the PM2.5 component of particulate matter can be used to estimate elemental carbon, in the absence of measured and predicted concentrations. As described in the *Air Quality Updated Effects Assessment* (Appendix D1 of this EIS Addendum [Vol 2]), modelled Project-related concentrations of PM2.5 included all emissions sources but for the purposes of this qualitative assessment all project-related emissions of PM2.5 were assumed to be diesel particulate matter (DPM). The concentrations of PM2.5 for background conditions represented a general background condition from NAPS data for Winnipeg where PM2.5 is likely to be from various urban sources and not primarily from diesel exhaust. The Ontario Agency for Health Protection and Promotion (Public Health Ontario) has reported that only 11% of the PM2.5 in the general environment is attributable to diesel (PHO, 2016). Therefore, baseline diesel particulate matter

concentrations were considered equivalent to 11% of the predicted background concentrations of PM2.5. The annual average background concentration for PM2.5 was 6.80 µg/m3, resulting in an estimated DPM of 0.748 µg/m3 for background conditions.

The maximum annual average concentrations for PM2.5 at HHRA receptor locations during any Project phase were predicted to occur at residences near the potential rail loadout area, as shown in **Table 5-31**. Therefore, the highest maximum predicted PM2.5 concentration for any of these residences was used in **Table 5-32** to calculate maximum exposure concentrations for elemental carbon for each Project phase. The maximum annual average Project-only PM2.5 concentrations from all Project sources at residences near the potential rail loadout area were 0.356 µg/m3 at R_1 during construction, and 1.08 µg/m3 at R_13 during operations. For the HHRA, all of the Project-related PM2.5 was assumed to be DPM.

**Table 5-31: Predicted Maximum Annual Concentrations for PM2.5 from all sources for Project only sources (µg/m$^3$)**

| AQ Model Location/ HHRA Receptor Locations | Construction | Operations |
|---|---|---|
| Screening Criterion | - | |
| Background | 6.80E+00 | |
| Bamoos Lake (W_10) | 2.23E-01 | 2.09E-01 |
| Hare Lake (PS_1) | 1.71E-01 | 1.74E-01 |
| Pic River (M_5) | 3.46E-01 | 4.25E-01 |
| Residences near the potential rail loadout | | |
| R_1 Residence | **3.56E-01** | 4.21E-01 |
| R_2 Residence | 2.30E-01 | 2.63E-01 |
| R_3 Bergagnini Apartment Rental | 2.74E-01 | 3.84E-01 |
| R_4 Residence | 1.52E-01 | 2.34E-01 |
| R_5 Condominium | 3.28E-01 | 5.06E-01 |
| R_6 Residence | 1.49E-01 | 2.77E-01 |
| R_7 I Sew Studio and Residence | 1.13E-01 | 4.16E-01 |
| R_8 Bayview Apartments | 1.03E-01 | 3.94E-01 |
| R_9 Residence | 9.62E-02 | 2.79E-01 |
| R_10 Residence | 9.34E-02 | 9.41E-01 |
| R_11 Residence | 9.26E-02 | 4.36E-01 |
| R_12 Residence | 9.94E-02 | 4.10E-01 |
| R_13 Residence | 1.13E-01 | **1.08E+00** |

| AQ Model Location/ HHRA Receptor Locations | Construction | Operations |
|---|---|---|
| R_14 Residence | 1.19E-01 | 7.31E-01 |
| R_15 Residence | 1.10E-01 | 3.83E-01 |
| R_16 Residence | 1.22E-01 | 2.02E-01 |
| R_17 Residence | 1.13E-01 | 1.68E-01 |
| R_18 Residence | 1.06E-01 | 1.53E-01 |
| R_19 Residence | 8.52E-02 | 1.04E-01 |
| R_20 Residence | 8.46E-02 | 1.02E-01 |
| R_21 Residence | 8.30E-02 | 9.74E-02 |
| R_22 Residence | 3.37E-01 | 4.10E-01 |

Notes:
Bold and underlined - indicates the maximum predicted concentrations at a residence near the potential rail loadout.
Predicted maximum concentrations are for all $PM_{2.5}$ emissions sources from Project-only sources.

US EPA's Motor Vehicle Emission Simulator (MOVES) database (US EPA, 2014) provides emission factors for elemental carbon and primary exhaust PM2.5 from diesel trucks (i.e., DPM). Elemental carbon in conventional diesel exhaust ranges from 46.7% during start and extended idle to 79% during running where start/extended idle is based on idle test cycles, and running emissions are based on the transient cycles (Moves2014). Assuming that diesel engines would be idling more often than running at the site an EC:PM2.5 ratio between 0.47 and 0.79 could be appropriate. A ratio between these emission factors of 0.57 would represent engines that idle 2/3 of the time and run 1/3 of the time. Therefore, estimates of elemental carbon concentrations were calculated for background and for Project contributions by multiplying DPM concentrations by 0.57 in **Table 5-32**.

**Table 5-32: Calculated Maximum Annual Average Concentration of Elemental Carbon in Ambient Air for a HHRA Receptor Location**

| Project Phase | DPM (µg/m3) | | | Calculated Elemental Carbon (EC) (µg/m3) (Note 3) | | |
|---|---|---|---|---|---|---|
| | Project only (note 1) | Background (note 2) | Project and Background | Project only | Background | Project and Background |
| Construction | 0.356 | 0.748 | 1.10 | 0.203 | 0.426 | 0.629 |
| Operations | 1.08 | | 1.83 | 0.616 | | 1.04 |

Notes:
All $PM_{2.5}$ from Project sources are assumed to be diesel particulate matter (DPM)
1-Diesel particulate matter was assumed to be equal to the predicted annual average $PM_{2.5}$ concentration from all Project sources.
2-Background DPM concentration of 0.748 µg/$m^3$ was estimated by multiplying the background $PM_{2.5}$ concentration of 6.8 µg/$m^3$ by a factor of 0.11 to account for the proportion of $PM_{2.5}$ in the general environment that is attributable to diesel (PHO, 2016).
3-Elemental Carbon was estimated by multiplying $PM_{2.5}$ by a factor of 0.57, from US EPA (2014).

The relative risk from airborne diesel particulate matter is estimated using the equation from Vermeulen et al. (2014):

$$RR = e^{(0.000982 * ED * EC)} \quad \text{(Eq.5-3)}$$

Where:
RR = relative risk (unitless)
ED = exposure duration (years)
EC = elemental carbon concentration (µg/$m^3$)

Assuming an exposure duration (ED) of 2 years, for the construction period, and 12.7 years for the operational periods and using the estimated concentrations for elemental carbon from **Table 5-32**, the estimated relative risks from exposure to elemental carbon from background and Project sources are shown in **Table 5-33**.

**Table 5-33: Worst-case Estimated Relative Risk from Exposure to Background and Project Related Elemental Carbon Compared to an Unexposed Population over the Duration of the Project**

| Project Phase | Relative Risk* (no units) | | |
|---|---|---|---|
| | Background | Project only | Total |
| Construction | 1.01 | 1.00 | 1.01 |
| Operations | | 1.01 | 1.02 |

Notes:
*Relative risks are calculated for a Project exposure duration period of 2 years for constriction and 12.7 years for operations.

The HHRA estimated relative risk for the worst-case scenario for maximum annual concentrations of Project-related PM2.5 for the construction and operational phases (Health Canada, 2010). These scenarios represent highly conservative scenarios that assume that both elevated background conditions and maximum Project conditions occur simultaneously and over the construction and operational phases of the Project. Under more likely scenarios, exposure to diesel exhaust would be less.

Based on the conservative estimates for Project activities, the health risks from exposure to diesel exhaust during construction (1.00) and operations (1.01) will not be substantially different than if receptors were not exposed to diesel exhaust. As well, the estimated relative risks from Project and background sources during construction (1.01) and operations (1.02) are not substantially different than the estimated relative risk from background alone (1.01). The predicted maximum concentrations of PM2.5, and by extrapolation, of diesel exhaust, at other HHRA receptor locations are lower than those evaluated here and therefore the relative risks from exposure to diesel exhaust are expected to be even less. This approach to qualitatively evaluate potential health risks using relative risk supports the earlier rationale that diesel exhaust from Project activities alone, and from Project activities plus background, are not expected to be at levels associated with adverse effects on human health.

### 5.4.3 Summary of Risk

The potential for airborne CoPCs associated with Project activities to adversely affect the health of visitors and longer-term residents of the LSA and RSA were assessed. Most of the airborne CoPCs were predicted to remain below health-based screening criteria and therefore do not represent a likely health risk for people in the LSA and RSA for either short-term or long-term exposures. A small number of CoPCs in air, including benzene, benzo(a)pyrene, crystalline silica, nickel and $NO_2$, were assessed further, and were also found to be below any level associated with health risks from long-term exposures, as summarized below in **Table 5-34**. Many of the assumptions used to assess potential health risks were highly conservative, especially for cancer risk, and actual risks are expected to be even lower than those presented in this assessment. The maximum predicted exposure concentrations for CoPCs were for residents of the Town of

Marathon near the potential rail loadout area. The actual location of the potential loadout area has not been determined and the results of this assessment will support the siting of the future loadout area during licensing.

**Table 5-34: Summary of Effects from Long-term Exposures to Constituents of Potential Concern in Air at Human Health Receptor Locations for all Project Phases**

| CoPC | Assessment Type | Effects Assessed | Maximum Predicted Exposure Concentration at a HHRA Receptor Location (µg/m$^3$) (annual average) | | Assessment Results | | | Most Affected HHRA Receptor |
|---|---|---|---|---|---|---|---|---|
| | | | | | Target | Target Value | Maximum Estimated ER or ILCR | |
| Benzene | Quantitative | Non-cancer<br>Cancer | 0.97<br>0.073 | Project and background<br>Project only | ER<br>ILCR | 1.0<br>1 x $10^{-5}$ | 0.03<br>2.0 x $10^{-8}$ | Residences near the potential rail loadout during operations |
| B(a)P | Quantitative | Non-cancer<br>Cancer | 0.00014<br>0.00003 | Project and background<br>Project only | ER<br>ILCR | 1.0<br>1 x $10^{-5}$ | 0.07<br>2.4 x $10^{-9}$ | Residences near the potential rail loadout during operations |
| Crystalline silica | Qualitative | Non-cancer | 6.3 | Project only (24-hour) | Short-term, infrequent peaks in concentrations do not fit the occupational exposure profile associated with adverse health effects | | | Residences near the potential rail loadout during operations |
| Nickel | Qualitative | Non-cancer | 0.0047 | Project and background | Air quality exceedances are limited to a small area near the fence line where people are not present for extended periods of time | | | Residences near the potential rail loadout during operations |
| Nitrogen dioxide ($NO_2$) | Qualitative | Non-cancer | 27.5 | Project and background | Short-term, infrequent peaks in concentrations (1-hr) in a small area near the fence line where people are not present for extended periods of time | | | Residences near the potential rail loadout during operations |

| CoPC | Assessment Type | Effects Assessed | Maximum Predicted Exposure Concentration at a HHRA Receptor Location (µg/m³) (annual average) | Assessment Results | | | Most Affected HHRA Receptor |
|---|---|---|---|---|---|---|---|
| | | | | Target | Target Value | Maximum Estimated ER or ILCR | |
| Carcinogenic PAHs | Qualitative | Cancer | Not estimated | Negligible incremental health risks from carcinogenic PAHs that have screening criteria, including B(a)P. | | | Residences near the potential rail loadout during operations |
| Diesel Exhaust | Qualitative | Cancer | Not estimated | Components of diesel exhaust (fine particulates, criteria PAHs including B(a)P, and semi volatile and volatile organic compounds including benzene) were below levels associated with health risks | | | Residences near the potential rail loadout during operations |

Notes:
B(a)P: Benzo(a)pyrene
CoPC: Constituent of potential concern
ER: Exposure ratio
ILCR: Incremental lifetime cancer risk
PAH: Polycyclic aromatic hydrocarbon

# 6.0 Results and Discussion

## 6.1 Prediction Confidence

The updated human health risk assessment is based on the updated predictive modeling conducted for changes in air quality, water quality and noise. Confidence in the conclusion that changes in air quality, water quality, country foods and noise will not have a significant adverse effect on human health is high because of the conservative assumptions made in the modeling of predicted effects from air, water and noise emissions. The following assumptions are expected to result in conservative predictions for air quality, groundwater and surface water quality and noise:

- Prediction confidence in the assessment of human health effects from changes in air quality is high because predicted maximum concentrations and conservative exposure assumptions were used to estimate human exposure to CoPCs in air in the LSA. The air quality modeling was conservative (i.e., likely to overestimate human health risk) because of conservative emissions estimates, maximum equipment operating times and schedules, and conservative background air quality levels.
- Prediction confidence in the assessment of human health effects from changes in groundwater quality is high because predicted reductions in groundwater discharge to the natural environment did not consider the attenuation of groundwater quality along the groundwater flow path from the source to the receptor. Furthermore, conservative estimates of groundwater recharge beneath the MRSA and PSMF were applied in the groundwater modelling, which overestimate the loadings to groundwater.
- Prediction confidence in the assessment of human health effects from changes in surface water quality is high because the geochemical source terms used to predict mass loadings from site aspects (MRSA, PSMF) were conservative in nature (generally upper bound testing results), the water quality predictions did not consider physical or chemical processes that may attenuate concentrations in the receiving environment, and baseline water quality was defined by the 75$^{th}$ percentile concentrations. Use of the 75$^{th}$ percentile instead of a measure of central tendency reduces the assimilative capacity associated with modeling of the receiving environment.
- Prediction confidence in the assessment of human health effects from changes in country foods is high because prediction confidence in the assessment of air and water quality effects is high.
- Prediction confidence in the assessment of human health effects from changes in noise is high because all sources were assumed to operate constantly during the entire day or entire night, the equipment noise emissions are well-understood and predictions were based on equipment totals and published and measured sound power levels for similar equipment, existing noise levels were based on measured

sound level monitoring data collected near the SSA, sound pressure levels were predicted using industry-standard software and international calculation standards (i.e. ISO 9613), and predictive analysis with the latest software versions (TNM 3.0) showed good correlation with the results presented.

The information summarized in this HHRA indicates that there will be minimal Project effects on environmental constituent concentrations and therefore on human health, including risks from harvesting country foods. Consultation with BN identified the country foods harvested in the LSA and RSA, and in the case of moose, an approximate frequency of consumption. A quantitative site-specific evaluation of baseline risks from consumption of country foods would require more detailed information on consumption rates for most food items. GenPGM will consult further with Biigtigong Nishnaabeg, who are the primary resource users in the Project area, on whether and when such a quantitative evaluation would be useful.

Some uncertainty is associated with potential effects from constituents in air and water that do not have benchmarks. However, given that human health risks were not identified for the air and water exposure pathways for constituents with benchmarks, no adverse health effects are anticipated for constituents without benchmarks.

GenPGM is committed to follow-up monitoring and adaptive management as outlined in Chapter 7 of the EIS Addendum.

## 6.2 Determination of Residual Health Risks

Using the characterization of residual effects on human health presented in Table 6.2.10-3 of Section 6.2.10 of the EIS Addendum, Project-related changes in air quality, water quality, country foods and noise were determined to be not significant for human health based on the following ratings:

- Direction: Adverse. The Project is expected to increase Project-related environmental exposures.
- Magnitude: Low to Medium. Taking into consideration proposed mitigation and management measures, Project-related environmental exposures related to changes in air quality, water quality, country foods and noise are expected to be less than benchmarks protective of human health and are not expected to change human health.
- Geographic Extent: Medium. Residual effects on factors relevant to human health are expected to be limited to the LSA.
- Timing: Not Sensitive. Potential human health effects are not expected to be sensitive to the timing of Project commencement.
- Duration: Medium. Residual effects on factors relevant to hHuman health effects are expected to occur during all mine phases.

- Frequency: Low (air) to High (water, country foods, noise). Increases in CoPC concentrations to above air quality criteria will occur intermittently and infrequently where people may reside. Increases in CoPC concentrations in surface water are expected to occur at regular intervals during operations when treated mine water is discharged to Hare Lake and continuously post-closure after natural drainage is restored. Increases in CoPC concentrations in country foods are expected to occur continuously. Increases in noise levels are expected to occur continuously during Project activities.
- Reversibility: Negligible (air, noise) to Medium (water, country foods). Human health effects from changes in noise and air quality relevant to human health will cease immediately after the cessation of Project activities. Human health effects from changes in water quality and country foods relevant to human health during operations will begin to decrease after the discharge of treated mine water ceases. Human health effects from changes in surface water quality post-closure are expected to be negligible.
- Ecological and Socio-economic Context: High. Human health, the quality of the environment, and traditional land and resource use are highly valued, as expressed though consultation with Indigenous people and interested parties.

Consistent with the original EIS, no significant adverse effects on human health are expected from Project-related changes in air quality, water quality, country foods and noise during any phase of the Project.

## 6.3 Mitigation Measures

Mitigation and enhancement measures to reduce emissions to the atmospheric, acoustic and aquatic environment will reduce the risk of adverse effects on human health. Mitigation and enhancement measures to avoid or reduce Project-related effects on the atmospheric, acoustic and aquatic environment are described in Section 6.2.1.6.1 (air quality), Section 6.2.2.6.1 (acoustic) and Section 6.2.3.6 (water quality) of the EIS Addendum.

Table 8.1 in Chapter 8 of the EIS Addendum provides an updated consolidation of Project commitments based on the results of the EIS Addendum. These commitments pertain to the implementation of mitigation measures and enhancement measures, contingency planning, monitoring, and reclamation / rehabilitation of the site upon closure. GenPGM is committed to implementing these commitments should the Project be approved.

## 6.4 Monitoring

The Environmental Monitoring and Management Program (EMMP) includes follow-up and monitoring programs to verify the accuracy of effects assessment predictions and effectiveness of proposed mitigation measures for the Project. The monitoring program for the Project is described in Section 7.3 of the EIS Addendum.

As part of ongoing aquatic environmental effects monitoring (EEM) for the mine during operations, water quality, sediment quality, benthic communities and fish chemistry will be analyzed. In addition, groundwater monitoring, air quality monitoring, terrestrial environmental monitoring and country food monitoring will be undertaken. The response to AIR16 (CIAR # 659) provided a conceptual plan for monitoring country foods, including blueberries, fish and moose.

# 7.0 Summary and Conclusions

A human health risk assessment was conducted to evaluate potential effects on human health in the context of air quality, water quality, country foods, noise and electromagnetic fields. Predicted concentrations of constituents of potential concern (CoPCs) and other environmental stressors were evaluated to identify issues requiring further assessment from a human health perspective.

The sources of chemical releases during all Project phases (site preparation, construction, operation, decommissioning and post-closure) include:

- Atmospheric emissions and dust deposition during all Project phases prior to closure;
- Releases of excess treated water to Hare Lake during operations;
- Drainage from the reclaimed PSMF to the Stream 105 and 106 subwatersheds (Hare and Angler creeks) after closure; and
- Drainage from the reclaimed MRSA, open pits and water management ponds to the Pic River after closure.

Atmospheric emissions could affect air and soil quality, vegetation, wildlife and consumers of country foods. Water releases could affect water and sediment quality, aquatic life, wildlife and consumers of country foods.

For safety reasons, public access to the site study area (SSA) will be prohibited during the construction, operations and decommissioning phases of the Project, however safe access in the local study area (LSA) may be provided as long as it is outside the mine's direct zone of influence. Post-closure, public access to the open pits will be prohibited and limited by a perimeter berm per the requirements of the Mine Rehabilitation Code (O.Reg. 240/00).

**Air Quality**

During all active phases of the Project, atmospheric emissions of suspended particulate matter ($PM_{10}$, $PM_{2.5}$, total suspended particulates (TSP) and the crystalline silica component of $PM_{10}$), sulphur and nitrogen oxides ($SO_2$ and $NO_x$), carbon monoxide (CO), polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs) and metals will occur. Modelling results indicated that most airborne parameters are predicted to remain below relevant health-based air quality criteria and therefore below levels associated with potential human health effects.

A small number of CoPCs exceeded either their short-term and/or long-term criteria and were evaluated in more detail either quantitatively as was the case for benzene, and benzo(a)pyrene, or qualitatively as was the case for nickel, crystalline silica and nitrogen dioxide. Potential adverse effects on human health were evaluated for short-term exposure scenarios for visitors near the modelled property boundary, and for short-term and long-term exposure scenarios for seasonal residents at Hare Lake, subsistence harvesters at Hare

Lake, Bamoos Lake and Pic River, and residents of Marathon near the potential rail load-out area.

With mitigation and environmental protection measures implemented, residual effects on human health from changes in air quality are not expected to be significant during any phase of mine life. For the CoPCs predicted to exceed relevant air quality criteria, either the Project contribution is small, the predicted residual effects are infrequent, particularly where people may reside, or the geographic extent is restricted to within the modelled property boundary or immediate surroundings. Although relevant air quality criteria were exceeded at some model locations, either the exceedances do not occur at locations where people may reside, or the predicted exposure ratios and cancer risk estimates are below target benchmarks set by Health Canada.

As changes to air quality were not identified as an adverse effect on human health and did not differ substantially from background where subsistence harvesters may harvest country foods, no CoPCs from Project-related air emissions were identified as being likely to deposit on soil and/or accumulate in country foods at levels of concern to human health.

Consistent with the original EIS and responses to information requests, the updated assessment indicated that changes to air quality from the Project are not expected to result in adverse human health effects.

**Drinking Water Quality**

No existing or foreseeable groundwater users are located in the areas where groundwater quality is predicted to exceed provincial and/or federal drinking water standards. The potable water supply well for the Project is expected to be located either cross- or up-gradient from potential sources of mine-related CoPCs in groundwater. Groundwater recharge from the PSMF is predicted to be less than provincial and federal drinking water standards; therefore, no adverse effects on human health are expected from drinking surface water or from potential future water supply wells at Hare Lake.

Groundwater in the Town of Marathon and Biigtigong Nishnaabeg First Nation is used for potable purposes. The Town of Marathon Official Plan shows that an area to the south of the Project site is designated as a Groundwater Protection Zone. The Groundwater Protection Zone is not hydraulically connected to the shallow groundwater at the Project site and therefore there is no potential for the Project site to impact the Town's drinking water supply. The Town's wells are 6 km from the southern edge of the Process Solids Management Facility (PSMF). The groundwater supply wells for Biigtigong Nishnaabeg are located over 15 km from the southern edge of the PSMF and Mine Rock Storage Area (MRSA). There is no connectivity between the groundwater flow paths for the Project site and the groundwater supply wells for Biigtigong Nishnaabeg and therefore there is no potential for the Project site to impact the drinking water supply for Biigtigong Nishnaabeg.

No adverse effects on human health are expected because no potable water supply wells are expected to be affected by changes in groundwater quality related to the Project. No CoPCs in drinking water were carried forward for further assessment.

Consistent with the original EIS and responses to information requests, the updated assessment indicated that changes to groundwater quality from the Project are not expected to result in adverse human health effects from drinking groundwater.

**Surface Water Quality**

During operations, excess water from the PSMF and MRSA will report to Hare Lake. Surface water quality in Hare Lake is not predicted to exceed applicable surface water quality benchmarks, which are protective of aquatic life and human health, or will be in the range of existing background concentrations. Therefore, no constituents in surface water during operations were identified for further assessment.

Post-closure, drainage from the PSMF will report to the Stream 105 and 106 subwatersheds, and drainage from the MRSA, open pits and water management pond will report to the Pic River. Surface water concentrations of constituents in the Stream 105 and 106 subwatersheds and the Pic River are not predicted to exceed applicable surface water quality benchmarks, or will be in the range of existing background concentrations. No adverse effects on human health are anticipated from exposure pathways related to surface water quality. Therefore, no constituents in surface water post-closure were identified for further assessment.

Consistent with the original EIS and responses to information requests, the updated assessment indicated that changes to surface water quality from the Project are not expected to result in adverse human health effects.

**Country Foods**

No herbicide or pesticide use is anticipated at the mine site or along the proposed transmission line corridor; therefore, no CoPCs related to herbicide or pesticide use are identified for country foods.

Overall, there are minimal predicted Project-related effects on concentrations of constituents in the environment that would result in changes to concentrations of constituents in country foods where country foods are likely to be harvested. The screening of predicted air and water quality did not identify any CoPCs to carry forward into a country foods assessment. Therefore, adverse effects on human health from country foods consumption are not expected from Project-related air and water emissions.

Consistent with the original EIS and responses to information requests, the updated assessment indicated that the Project will have minimal effects on concentrations of constituents in the environment, country foods and human health.

**Noise**

Current noise levels in the vicinity of the Project site are typical of a rural setting, dominated by natural sounds. Current noise levels at the intersection of Highway 17 and Peninsula Road are higher, characteristic of an urban hum. An updated noise assessment was undertaken to assess noise levels at noise sensitive receptors in close proximity the Project site, along the Highway 17 transportation corridor, along the transportation corridor to the potential concentrate rail load-out facility, and at the potential concentrate rail load-out facility.

Noise levels are not predicted to exceed guidelines for community annoyance and sleep disturbance and are not expected to adversely affect human health during any phase of the Project. Consistent with the original EIS and responses to information requests, the updated assessment indicated that the Project will have minimal effects on the acoustic environment.

**Electromagnetic Fields**

Health Canada and the Federal-Provincial-Territorial Radiation Protection Committee believe that there is insufficient scientific evidence to conclude that exposures to EMFs from power lines cause health problems. Further, the closest receptor to the proposed project power line is a cottage on Hare Lake, and it is approximately 2 to 3 km from this line. Therefore, exposure to EMFs was not identified as a human health issue requiring further assessment.

**Summary of the Human Health Risk Assessment**

With the proposed mitigation and management measures, environmental exposures from Project-related changes in air quality, water quality and noise are predicted to be less than benchmarks protective of human health and are not expected to adversely affect human health. The screening of predicted air and water quality did not identify any CoPCs to carry forward into a country foods assessment.

GenPGM recognizes the importance of traditional land and resource use and activities and is committed to working with Indigenous communities to monitor country foods. GenPGM will continue to engage BN and other interested Indigenous groups in monitoring activities for the Project. The monitoring program can be used as a means to communicate results of environmental monitoring to help alleviate concerns Indigenous resource users may have regarding potential Project impacts.

Consistent with the original EIS and responses to information requests, Project-related changes in air quality, water quality, country foods, noise and EMFs are not expected to adversely affect human health.

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# Appendix A Fish Chemistry Data and Sport Fish Consumption Advisories

This appendix provides a summary of fish chemistry data and sport fish consumption advisories in the Project area.

As reported in SID #1 (EcoMetrix, 2012), Northern Pike (*Esox lucius*) and Spottail Shiner (*Notropis hudsonius*) were collected in Hare Lake and Lake Trout (*Salvelinus namaycush*) and Lake Chub (*Couesius plumbeus*) were collected in Bamoos Lake in 2009 for metals analysis. Boneless, skinless fillets and liver samples were collected from five Northern Pike from Hare Lake and five Lake Trout from Bamoos Lake. Five composite samples of wholebody Spottail Shiner from Hare Lake and five composite samples of whole-body Lake Chub from Bamoos Lake were collected.

A summary of mean metal concentrations for whole-body Spottail Shiners and Northern Pike muscle and liver tissues from Hare Lake and whole-body Lake Chub and Lake Trout muscle and liver tissues is presented in **Table A-1**. Mean levels of mercury in muscle tissue for a variety of fish from Lake Superior, Bamoos Lake and Gowan Lake are provided in **Table A-2** for comparison.

In the Guide to Eating Ontario Fish (MECP, 2017), sport fish consumption advisories and complete restrictions for consuming fish containing mercury are provided for the sensitive population (women of child-bearing age and children under 15) and the general population. For the sensitive population, restrictions on consuming fish containing mercury begin at levels of 0.26 mg/kg with complete restriction advised for levels above 0.52 mg/kg. For the general population, restrictions on consuming fish containing mercury begin at levels above 0.61 mg/kg with complete restriction advised for levels above 1.84 mg/kg.

Mean mercury concentrations in Northern Pike muscle tissue from Hare Lake exceeded the total consumption restriction value of 1.84 mg/kg for the general population. Mean mercury concentrations in Northern Pike liver tissue from Hare Lake were above the values at which complete restriction is advised for the sensitive population (0.52 mg/kg) and consumption restrictions begin for the general population (0.61 mg/kg).

Mean mercury concentrations in Lake Trout muscle and liver tissue from Bamoos Lake marginally exceeded the value at which complete restriction is advised for the sensitive population (0.52 mg/kg), but were below 0.61 mg/kg, the value at which consumption restrictions for the general population begin.

The Guide to Eating Ontario Fish (MECP, 2017) provides recommendations on the number of meals of sport fish to consume per month to limit exposure to contaminants in sport fish. The advisory tables provide sport fish consumption advice according to fish location, species and length based on contaminant analyses. The total length of the fish is measured from the tip of the nose to the tip of the tail. The fish length is expressed in both centimetres (cm) and inches (in) at the top of the tables.

Sport fish consumption advice for Bamoos Lake, Pic River below Black River confluence and Peninsula Harbour of Lake Superior is summarized in **Tables A-3 to A-5**. These advisories are based on the mercury content of the fish, with the exception of Round Whitefish in Peninsula Harbour which is based on PCBs. The "G" row indicates the recommended number of meals per month for the general population. The "S" row indicates the recommended number of meals per month for the sensitive population (i.e., women of child-bearing age and children under 15).

**Table A-1: Mean Fish Tissue Metal Concentrations for Hare Lake and Bamoos Lake in 2009**

| | | | | Hare Lake | | | Bamoos Lake | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Spottail Shiner | Northern Pike | | Lake Chub | Lake Trout | |
| **Parameter** | **n** | **Units** | **MDL** | **whole** | **muscle** | **liver** | **whole** | **muscle** | **liver** |
| Aluminum | 5 | mg/kg | 2 | <2 | <2 | 2 | 1 | <2 | 2 |
| Arsenic | 5 | mg/kg | 0.01 | 0.07 | 0.24 | 0.07 | 0.05 | 0.11 | 0.13 |
| Cadmium | 5 | mg/kg | 0.1 | <0.1 | <0.1 | 0.3 | <0.1 | <0.1 | 0.8 |
| Cobalt | 5 | mg/kg | 0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| Copper | 5 | mg/kg | 0.1 | 0.8 | 0.2 | 11.8 | 0.8 | 0.3 | 24.8 |
| Iron | 5 | mg/kg | 1 | 16 | 3 | 168 | 17 | 3 | 149 |
| Lead | 5 | mg/kg | 0.02 | 0.04 | <0.02 | <0.02 | 0.01 | <0.02 | <0.02 |
| Mercury | 5 | mg/kg | 0.002 | 0.182 | 2.084 | 1.510 | 0.079 | 0.539 | 0.526 |
| Molybdenum | 5 | mg/kg | 0.01 | 0.04 | 0.02 | 0.13 | 0.04 | 0.01 | 0.19 |
| Nickel | 5 | mg/kg | 0.1 | 0.3 | 0.1 | 0.1 | 0.2 | 0.1 | <0.1 |
| Selenium | 5 | mg/kg | 0.2 | 0.9 | 0.9 | 3.1 | 0.9 | 0.7 | 9.8 |
| Zinc | 5 | mg/kg | 0.1 | 54.8 | 3.7 | 41.6 | 61.3 | 3.0 | 33.8 |

Notes:
MDL – method detection limit
Means were calculated using half MDL when the sample metal concentration was below the MDL.

**Table A-2: Historical Mean Mercury Levels in Fish for Waterbodies near the Marathon Palladium Site**

| | | | Mercury |
|---|---|---|---|
| **Waterbody** | **Species** | **n** | **(mg/kg)** |
| **Lake Superior** | Lake Trout | 390 | 0.41 |
| | Northern Pike | 1 | 0.74 |
| | Rainbow Trout | 5 | 0.26 |
| | Walleye | 12 | 0.24 |
| | Longnose Sucker | 196 | 0.79 |
| | White Sucker | 56 | 0.78 |
| | Redhorse Sucker | 7 | 0.91 |
| | Lake Whitefish | 154 | 0.48 |
| | Round Whitefish | 17 | 0.23 |
| | Cisco | 1 | 1.50 |
| | Burbot | 5 | 0.91 |
| | Gizzard Shad | 7 | 0.24 |
| | Rainbow Smelt | 12 | 0.28 |

| | | | | Mercury |
|---|---|---|---|---|
| | | | | |
| **Bamoos Lake** | Lake Trout | | 13 | 0.37 |
| | | | | |
| **Gowan Lake** | Northern Pike | | 6 | 1.37 |

Note:
Data from the MOE Sport Fish Contamination Program, 1976 to 2007.

## Table A3: Sport Fish Consumption Advice (Meals/Month) for Bamoos Lake, O'Neill Township, Thunder Bay District

| ***Length (cm) →*** | | ***15-20*** | ***20-25*** | ***25-30*** | ***30-35*** | ***35-40*** | ***40-45*** | ***45-50*** | ***50-55*** | ***55-60*** | ***60-65*** | ***65-70*** | ***70-75*** | ***>75*** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Length (in) →*** | | *6-8* | *8-10* | *10-12* | *12-14* | *14-16* | *16-18* | *18-20* | *20-22* | *22-24* | *24-26* | *26-28* | *28-30* | *>30* |
| Lake Trout | G | | | **16** | **16** | **16** | **12** | **12** | **8** | **4** | **4** | **2** | **2** | |
| | S | | | **12** | **8** | **4** | **4** | **4** | **4** | **0** | **0** | **0** | **0** | |

Notes:
Coordinates: 48°49'01"N, 86°21'15"W
Lake Trout in Bamoos Lake were tested for mercury and PCBs.
G = General Population; S = Sensitive Population: Women of child-bearing age and children under 15

## Table A4: Sport Fish Consumption Advice (Meals/Month) for Pic River below Black River Confluence, Pic Township

| ***Length (cm) →*** | | ***15-20*** | ***20-25*** | ***25-30*** | ***30-35*** | ***35-40*** | ***40-45*** | ***45-50*** | ***50-55*** | ***55-60*** | ***60-65*** | ***65-70*** | ***70-75*** | ***>75*** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Length (in) →*** | | *6-8* | *8-10* | *10-12* | *12-14* | *14-16* | *16-18* | *18-20* | *20-22* | *22-24* | *24-26* | *26-28* | *28-30* | *>30* |
| Northern Pike | G | | | | | | | | | | | | **0** | **0** |
| | S | | | | | | | | | | | | **0** | **0** |
| Walleye | G | | **16** | **16** | **12** | **12** | **8** | **8** | | | | | | |
| | S | | **8** | **4** | **4** | **4** | **4** | **4** | | | | | | |

Notes:
Coordinates: 48°37'13"N, 86°16'18"W
Northern Pike and Walleye in Pic River were tested for mercury. In inland locations, the MOE often only analyze fish for mercury because mercury is likely the only contaminant to cause consumption restrictions.
G = General Population; S = Sensitive Population: Women of child-bearing age and children under 15

## Table A5: Sport Fish Consumption Advice (Meals/Month) for Lake Superior 8a - Peninsula Harbour, Harbour and Immediate Vicinity

| ***Length (cm) →*** | | ***15-20*** | ***20-25*** | ***25-30*** | ***30-35*** | ***35-40*** | ***40-45*** | ***45-50*** | ***50-55*** | ***55-60*** | ***60-65*** | ***65-70*** | ***70-75*** | ***>75*** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Length (in) →*** | | *6-8* | *8-10* | *10-12* | *12-14* | *14-16* | *16-18* | *18-20* | *20-22* | *22-24* | *24-26* | *26-28* | *28-30* | *>30* |
| Burbot (Ling) | G | | | | | | **4** | **4** | **4** | | | | | |
| | S | | | | | | **0** | **0** | **0** | | | | | |
| Lake Trout | G | | | | **8** | **8** | **8** | **8** | **4** | **2** | **1** | **0** | **0** | **0** |
| | S | | | | **8** | **8** | **8** | **8** | **4** | **0** | **0** | **0** | **0** | **0** |
| Lake Whitefish | G | | | | **32** | **16** | **16** | **16** | **16** | | | | | |
| | S | | | | **16** | **16** | **16** | **16** | **16** | | | | | |
| Longnose Sucker | G | | **4** | **4** | **2** | **2** | **1** | **1** | **0** | | | | | |
| | S | | **4** | **4** | **0** | **0** | **0** | **0** | **0** | | | | | |
| | G | | **8** | **4** | **4** | **2** | **2** | | | | | | | |

| *Length (cm) →* | | *15-20* | *20-25* | *25-30* | *30-35* | *35-40* | *40-45* | *45-50* | *50-55* | *55-60* | *60-65* | *65-70* | *70-75* | *>75* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Redhorse Sucker | S | | **0** | **0** | **0** | **0** | **0** | | | | | | | |
| Round Whitefish | G | | | | | | **1** | **0** | | | | | | |
| | S | | | | | | **0** | **0** | | | | | | |
| Walleye | G | | | | | | | **12** | **8** | | | | | |
| | S | | | | | | | **4** | **4** | | | | | |
| White Sucker | G | | **8** | **4** | **4** | **4** | **0** | **0** | | | | | | |
| | S | | **4** | **0** | **0** | **0** | **0** | **0** | | | | | | |

Notes:
Coordinates: 48°44'1"N, 86°24'16"W
Burbot (Ling), Lake Trout, Lake Whitefish, Longnose Sucker, Redhorse Sucker, Walleye and White Sucker in Peninsula Harbour of Lake Superior were tested for mercury. Lake Trout, Lake Whitefish, Longnose Sucker, Round Whitefish, Walleye and White Sucker were tested for PCBs. Lake Trout and Round Whitefish were tested for dioxin-like PCBs. Lake Whitefish were tested for dioxins/furans.

G = General Population; S = Sensitive Population: Women of child-bearing age and children under 15