HOPE BAY PROJECT

AQUATIC EFFECTS MONITORING PLAN

DRAFT

April 2018

PLAIN LANGUAGE SUMMARY

This Hope Bay Project (the Project) Aquatic Effects Monitoring Plan (the Plan) describes the comprehensive aquatic monitoring program that will be implemented to monitor potential effects on the freshwater environment of all projects operating along the Hope Bay Belt, including the Madrid-Boston Project and the Doris Project.

The Plan provides details of the sampling plan for various abiotic and biotic components of the aquatic ecosystem (i.e., water and sediment quality, phytoplankton, benthic invertebrates, and fish) to determine the potential effects of mining activities on the freshwater receiving environment. The Plan also summarizes the key mitigation measures that will be used to reduce the potential for Project effects to the freshwater environment in the Project area.

REVISION RECORD

Date	Section	Summary of Changes	Author	Approver
December 2016	Throughout	Initial Plan	TMAC	TMAC
December 2017	Throughout	Update to FEIS	ERM	TMAC
April 2018	Throughout	Update to comprehensive plan that includes Doris and Madrid-Boston, and that includes non-point source AEMP sampling as well as MMER-EEM monitoring requirements for lakes receiving effluent.	ERM	TMAC

GLOSSARY AND ACRONYMS

Term	Definition
AEMP	Aquatic Effects Monitoring Program
ANCOVA	Analysis of covariance
ANOVA	Analysis of variance
BACI	Before-after-control-impacts
The Belt	Hope Bay Belt
CCME	Canadian Council of Ministers of the Environment
CoC	Chain of custody
CTD	Conductivity temperature depth
DELTs	Deformities, erosion, lesions, and tumours
DFO	Fisheries and Oceans Canada
DOE	Department of Environment
DEIS	Draft Environmental Impact Statement
ECCC	Environment and Climate Change Canada
EEM	Environmental Effects Monitoring
FEIS	Final Environmental Impact Statement
GN	Government of Nunavut
INAC	Indigenous and Northern Affairs Canada
KIA	Kitikmeot Inuit Association
MMER	Metal Mining Effluent Regulations
NIRB	Nunavut Impact Review Board
NWB	Nunavut Water Board
the Plan	Aquatic Effects Monitoring Plan
the Project	Hope Bay Project
QA/QC	Quality assurance and quality control
TIA	Tailings Impoundment Area
TMAC	TMAC Resources Inc.
TSS	Total Suspended Solids
WLWB	Wek’èezhìi Land and Water Board

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1. INTRODUCTION

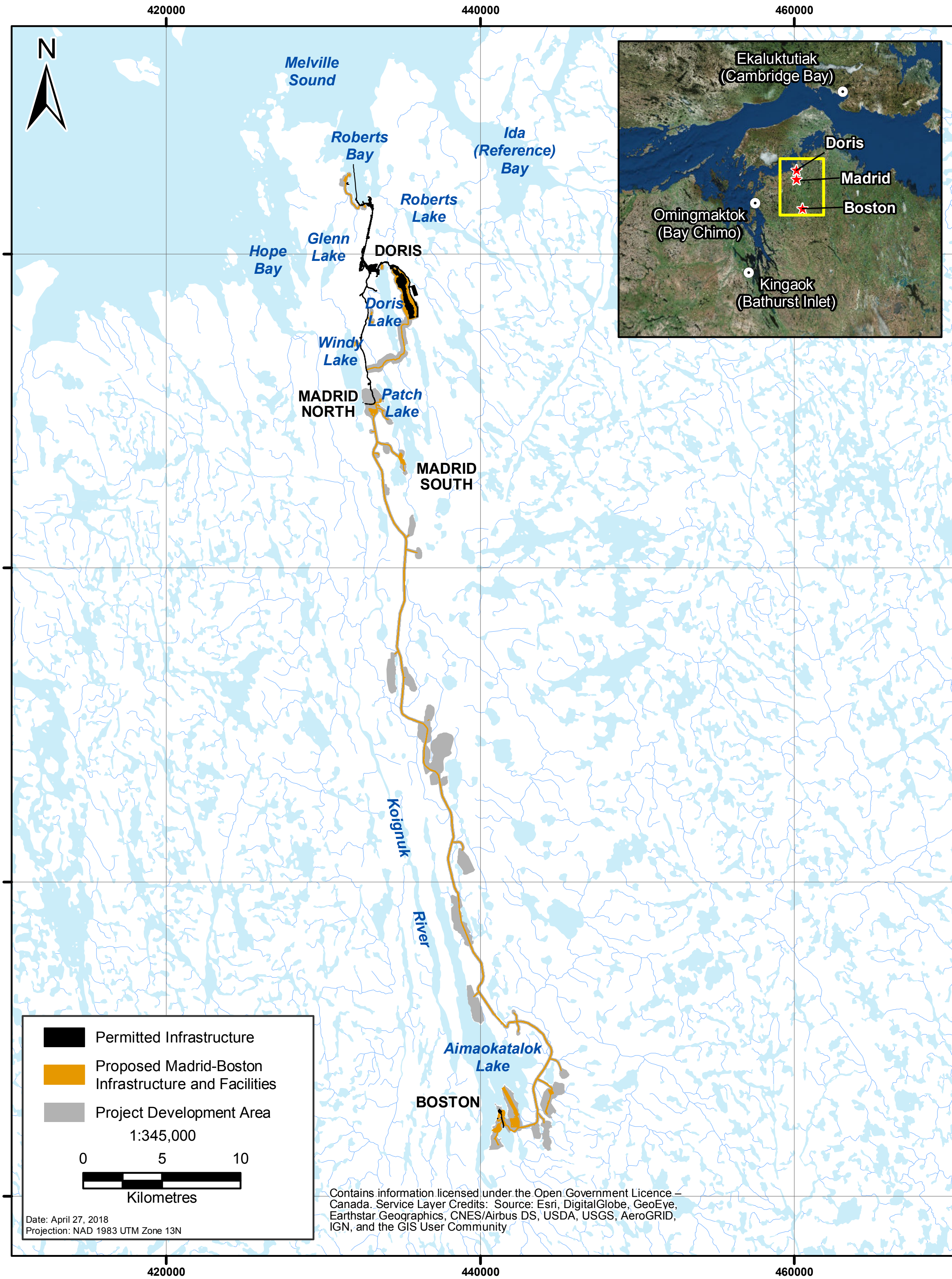
The Hope Bay Project (the Project) is a gold mining development owned by TMAC Resources Inc. (TMAC) in the West Kitikmeot region of mainland Nunavut. The Project property is approximately 153 km southwest of Cambridge Bay on the southern shore of Melville Sound and contains a greenstone belt (the Belt) that runs 80 km in a north-south direction and varies in width between 7 km and 20 km.

The Project area has been actively explored and developed since the late 1980s and consists of three developments: Doris, Madrid, and Boston (Figure 1-1). Doris is the northernmost development situated near Roberts Bay and contains the operating Doris Mine for which TMAC received an amended Project Certificate (No. 003) in September 2016 and an amended Type A Water Licence (2AM-DOH1323) in December 2016. The Madrid and Boston developments are in the north-central and southernmost parts of the Belt. TMAC is seeking to develop these areas jointly having recently submitted the *Madrid-Boston Final Environmental Impact Statement* (FEIS; TMAC 2017) to the Nunavut Impact Review Board (NIRB) and corresponding application for a Type A Water Licence to the Nunavut Water Board (NWB) in December 2017.

This Aquatic Effects Monitoring Plan (the Plan) presents the freshwater monitoring to be conducted and evaluated over the entire Project area and integrates the monitoring proposed for the Madrid-Boston Project with the monitoring currently being conducted for the Doris Aquatic Effects Monitoring Program (AEMP; TMAC 2016) under the approved Type A Water Licence (2AM-DOH1323) for the Doris Project. The Plan was originally submitted as part of the *Madrid-Boston Final Environmental Impact Statement* and focused on monitoring related to the Madrid-Boston Project. The Plan is now Belt-wide in scope, including freshwater monitoring and effects evaluation for the Doris, Madrid, and Boston developments, based on technical comments received and conversations with interveners during the Madrid-Boston FEIS process (e.g., INAC-TC-11). This Plan will supersede the Doris AEMP when approved by the NWB and other interested parties.

The primary goals of the Plan are to evaluate potential Project effects on the surrounding freshwater environment during the construction and operation of the Project, verify predictions from the Doris Project amendment (TMAC 2015) and the Madrid-Boston FEIS (TMAC 2017), support current and future Fisheries Authorizations, and provide a mechanism to respond to potential Project effects in the freshwater environment through mitigation and management actions. The Plan focuses on Aimaokatalok Lake where treated mine-related effluents will be discharged, and lakes adjacent to proposed infrastructure that have the greatest potential to receive non-point-source inputs such as runoff (e.g., Doris, Patch, Wolverine, and Stickleback lakes) and could be affected by water loss due to permitted water withdrawal and groundwater seepage into the mines through underground workings (e.g., Doris, Patch, Windy, Ogama, P.O., and Imniagut lakes). The Plan is harmonized with the Environmental Effects Monitoring (EEM) of the Metal Mining Effluent Regulations (MMER; SOR/2002-222) to provide a comprehensive aquatic monitoring program that assesses point and non-point inputs into the Project lakes.

Figure 1-1
Hope Bay Project Location



This Plan considers information from technical comments received following the Madrid-Boston FEIS submission (December 2017), the draft Environmental Impact Statement (DEIS) technical meetings (Cambridge Bay, Nunavut, June 2017), and the Doris Project Type A Water Licence technical meetings (Cambridge Bay, September 2016). The Plan further considers guidance outlined in the *Metal Mining Technical Guidance for Environmental Effects Monitoring* (Environment Canada 2012), the *Guidelines for Designing and Implementing Aquatic Effects Monitoring Programs for Development Projects in the Northwest Territories: Overview Report* (INAC 2009), and the *Guidelines for Adaptive Management - a Response Framework for Aquatic Effects Monitoring* (WLWB 2010). The monitoring, evaluation of effects, and the management response framework described in the Plan have been adapted from the Doris AEMP (TMAC 2016) that was developed in consultation with and approved by the NWB, the Kitikmeot Inuit Association (KIA), the NIRB, Environment and Climate Change Canada (ECCC), Indigenous and Northern Affairs Canada (INAC), and Fisheries and Oceans Canada (DFO).

This Plan is intended primarily for use by TMAC and its contractors to guide appropriate freshwater effects monitoring associated with the Project. The monitoring and the evaluation of the potential Project effects are designed to confirm if mitigation measures are performing as planned, and if not, then the appropriate management response is enacted to eliminate or reduce the potential for downstream environmental effects. The Plan is a “living document” and may be updated based on regulatory changes, Project-related changes, or changes to existing mitigation measures. All updates to the Plan will be submitted to the NWB for the necessary approvals.

1.1. OBJECTIVES

The purpose of this Plan is to assess the potential effects of Project activities on the freshwater environment, assess predictions of the Doris Project amendment (TMAC 2015) and Madrid-Boston FEIS (TMAC 2017), and comply with requirements set forth in the Project permitting and licensing process. The objectives of the Plan are aligned with the definition of the AEMP as outlined in the Doris Water Licence (2AM-DOH1323).

The main objectives of the Plan are to:

- detect short- and long-term effects in lakes potentially influenced by activities of the Project;
- meet the conditions of the applicable Type A Water Licences for the Project;
- evaluate the accuracy of predictions and effects assessments made in *Revisions to TMAC Resources Inc. Amendment Application No. 1 of Project Certificate No. 003 and Water Licence 2AM-DOH1323* (TMAC 2015);
- evaluate the accuracy of the predictions and effects assessments made in the *Madrid-Boston Final Environmental Impact Statement* (TMAC 2017);
- assess the efficacy of mitigation measures applied to the Project activities;
- develop a management framework that provides a mechanism to respond to potential mine-related effects in select Project lakes; and
- use that management framework to identify additional mitigation measures that will avert or reduce mine-related effects in Project lakes.

This Plan is designed to address these objectives by monitoring the receiving environment in the short-term (annually) and the long-term (during construction and operation). The sampling design allows for the detection of potential changes in the receiving environment, which would inform the determination of whether management and mitigation measures are effective. The Plan contains an aquatic response framework such that if potential effects are detected in the freshwater environment, the potential effects can be investigated and additional mitigation measures considered to eliminate or reduce the effect. Together, these measures form an effective strategy to achieve environmental protection in the Project area by limiting the potential for adverse effects in the freshwater environment.

1.2. RELEVANT LEGISLATION AND GUIDANCE

Table 1.2-1 provides a summary of federal and territorial regulations governing this Plan and associated guidelines. Additional TMAC plans and standards designed to manage sources of potential compounds to the freshwater environment were submitted as part of the Madrid-Boston FEIS (TMAC 2017) and the Doris Project amendment (TMAC 2015), including the Hope Bay Project Spill Contingency Plan, the Hope Bay Project Doris-Madrid Water Management Plan, the Hope Bay Boston Water Management Plan, the Hope Bay Air Quality Monitoring Plan among others.

Table 1.2-1. Regulations and Guidelines Pertinent to the Aquatic Effects Monitoring Plan

Regulation	Year	Governing Body	Relevance
Nunavut Environmental Protection Act	1988	Government of Nunavut	Governs the protection of the Nunavut environment including land, air, water, and organisms therein.
Nunavut Land Claim Agreement Act	1993	Government of Nunavut	Grants Inuit rights to land, water, and land-fast ice in the Nunavut settlement area.
Environmental Rights Act	2011	Government of Nunavut	Grants all Nunavut residents the ability to launch an investigation.
Nunavut Waters Regulations	2013	Nunavut Water Board	Licence for mining and milling undertaking to use water and deposit of waste in relation to the construction, operation, closure, and reclamation.
Fisheries Act	1985	Fisheries and Oceans Canada	Prohibits any work or undertaking that would cause the harmful alteration, disruption, or destruction of fish habitat.
Metal Mining Effluent Regulations (Section 36 of *Fisheries Act*)	2002	Environment and Climate Change Canada	Prohibits the deposit of deleterious substances into waters frequented by fish, unless authorized by regulations under the *Fisheries Act* or other federal legislation.
Guideline	**Year**	**Issued by**	**Relevance**
Canadian Environmental Quality Guidelines	1999 – as amended to date	Canadian Council of Ministers of the Environment (CCME)	Provides guidance on water quality for the protection of aquatic life.

1.3. PLAN MANAGEMENT AND EXECUTION

The Plan will be reviewed regularly and updated as necessary with approvals from the NWB. Personnel responsible for implementing and updating the AEMP are identified in Table 1.3-1.

Table 1.3-1. Roles and Responsibilities

Role	Responsibility
VP Environmental Affairs	• Overall responsibility for and implementation of the Plan; • Provide the on-site resources to operate and maintain the monitoring program in accordance with this Plan; and • Provide input on modifications to design and operational procedures to improve operational performance.
Environmental Director	• Review and update this Plan as required; • Support implementation of this Plan; and • Ensure staff conducting monitoring are trained in AEMP monitoring and quality assurance and quality control procedures.
Environmental Coordinator / Environmental Consultants	• Conduct AEMP sampling; • Report issues, irregularities, and non-compliances with the AEMP sampling program to the Environmental Director; • Ensure sampling gear is safe and operational; • Ensure monitoring is conducted safely; • Maintain and review AEMP records; and • Complete required AEMP reporting.

2. RATIONALE FOR AEMP DESIGN

The AEMP is a comprehensive program that considers Project-related effects on the freshwater environment and reflects the potential Project effects assessed in the *Madrid-Boston Final Environmental Impact Statement* (TMAC 2017) and *Revisions to TMAC Resources Inc. Amendment Application No. 1 of Project Certificate No. 003 and Water Licence 2AM-DOH1323* (TMAC 2015). Monitoring program design, indicators, methodologies, and sampling frequencies are based on anticipated or potential effects related to Project development. The monitoring program also considers past baseline data collection locations, methodologies, and sample collection timing. Where possible, the AEMP has been harmonized with MMER requirements and EEM guidance (Environment Canada 2012) so that monitoring data collected at AEMP sites are comparable to data collected at MMER EEM-specific sites to more robustly assess potential Projects effects to the surrounding freshwater environment.

2.1. POTENTIAL PROJECT EFFECTS ON FRESHWATER ENVIRONMENT

The Project includes the current (Doris) and future (Madrid and Boston) mining of ore deposits in the Project area, and use of existing Doris Project infrastructure such as the mill, tailings impoundment area (TIA), and ocean discharge pipeline. New infrastructure on the Belt will include underground mines at Madrid North, Madrid South, and Boston, processing plants at Boston and Madrid North, a tailings management area for subaerial deposition of dry stack tailings near Boston camp, and the associated water management features to reduce the interaction of site and mine contact water with the surrounding freshwater environment. The Madrid-Boston Project will also result in additional water use demands and groundwater inflow into the Doris, Madrid North, and Madrid South mines. The greatest potential for effects in the freshwater environment due to Project activities are predicted to be changes in surface water quantity and quality and are discussed below.

2.1.1. Surface Water Quantity

The Project has the potential to affect surface water quantity by direct water withdrawal for site and processing (domestic and industrial) activities, and through groundwater inflow into the underground mines. Water for industrial purposes will be drawn from Doris and Aimaokatalok lakes, and water for domestic purposes will be drawn from Windy and Aimaokatalok lakes. Four underground mines will be developed as part of the Project: Doris, Madrid North, Madrid South, and Boston. Of these, Doris, Madrid North, and Madrid South will mine within a portion of the taliks beneath Doris, Patch, and Wolverine lakes in the Doris Watershed. Groundwater within these taliks will be saline and is expected to seep into the underground mines. This inflow will be intercepted and conveyed to the marine environment, with the groundwater predicted to be recharged with water from the overlying lakes. This will remove these water quantities from the freshwater systems, which could affect lake levels, and by extension, fish habitat. The Boston mine will remain in permafrost and is not expected to intercept taliks. Further, water withdrawn for domestic and industrial use from Aimaokatalok Lake will be treated and returned to the lake or its watershed, reducing the potential for effects on water quantity in this lake.

2.1.2. SURFACE WATER QUALITY

The Project has the potential to affect freshwater surface water quality directly due to the discharge of treated effluent during operations and indirectly due to runoff of site and mine contact water and the use of explosives (i.e., nitrogen inputs) during the construction and operations phases (TMAC 2017). The direct discharge of treated effluent will only occur in western Aimaokatalok Lake during Boston operations and will be discharged in compliance with MMER requirements.

Project infrastructure and activities that may cause indirect inputs to nearby freshwater during construction and operations include:

- Boston, Madrid, and Doris sites;
- waste rock and ore storage;
- sediment and pollution control ponds;
- explosives storage and use;
- quarry crushing;
- fuel storage and fuelling stations;
- road construction and use; and
- tailings deposition and storage.

Changes to surface water quality in the Project lakes also have the potential to affect sediment quality and biological organisms such as primary producers, secondary producers, and fish.

2.2. MITIGATION OF POTENTIAL EFFECTS

TMAC has several management and monitoring plans that prevent or minimize potential effects to the freshwater environment (Table 2.2-1). To date, the water and air management practices outlined in the various plans have been effective in mitigating effects to the freshwater environment during the construction and operation of the Doris Mine; no effects to water, sediment, or aquatic life have been detected in any of the waterbodies monitored under the current Doris (TMAC 2016) and former Doris North (Rescan 2010) AEMPs. Based on this success, similar mitigation measures will be adopted for the Madrid and Boston developments.

The efficacy of the mitigation measures pertaining to aquatic effects throughout the Project will be evaluated through this Plan. These management plans are continuously updated to reflect improvements to mitigation measures identified through the Plan implementation process.

Table 2.2-1. TMAC Documents and Programs Related to the Aquatic Effects Monitoring Plan

Document Title	Relevance
Hope Bay Project Doris-Madrid Water Management Plan *Hope Bay Project Boston Water Management Plan*	Management of contact water from the site, TIA and underground
Hope Bay Project Air Quality Management Plan	Management of dust and air-borne emissions
Hope Bay Project Groundwater Management Plan	Management and minimization of groundwater inflow to the mine
Hope Bay Project Waste Rock and Ore and Mine Backfill Management Plan *Hope Bay Project Water and Ore/Waste Rock Management Plan for Boston Site*	Management of waste rock and ore contact water
Hope Bay Project Domestic Wastewater Treatment Management Plan	Management of treated domestic wastewater effluent
Hope Bay Project Spill Contingency Plan	Spill response procedures to minimize spill effects
Hope Bay Project, Phase 2, Doris Tailings Impoundment Area - Operations, Maintenance, and Surveillance Manual *Hope Bay Project, Boston Tailings Management Area - Operations, Maintenance, and Surveillance Manual*	Management of TIA effluent
Quality Assurance and Quality Control Plan	Approved sampling practices
Hope Bay Project Hazardous Waste Management Plan	Describes proper handling, storage and disposal procedures for hazardous wastes
Hope Bay Project Non-Hazardous Waste Management Plan	Describes proper handling, storage and disposal procedures for non-hazardous wastes

Mitigation measures protective of aquatic life implemented at the Project are outlined in the Madrid-Boston FEIS and the Doris Project amendment and include:

- Sediment control measures for works in or near waterbodies and watercourses, such as use of silt fences or coconut matting at drainage points;
- Minimizing vegetation clearing;
- Implementation of erosion control measures, such as capping of soils exposed during construction activities with rock;
- Implementation of blasting restrictions near water outlined in DFO's *Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters* (Wright and Hopky 1998);
- Treatment of discharges where necessary to maintain compliance with MMER and/or Water Licence discharge criteria;
- Screening of water intakes to prevent impingement or entrainment of fish;
- Construction of stream crossings in a manner that does not interfere with fish passage, constrict channel width, or reduce flows and in accordance with DFO recommendations;
- Reuse of water where possible and practical; and
- Minimizing groundwater inflows.

2.3. AEMP MONITORING COMPONENTS

The management and mitigation measures outlined above prevent or reduce the potential for, and magnitude of, effects to the freshwater environment. However, the potential remains for Project activities to affect aquatic habitat through changes to lake levels and changes to surface water quality from treated discharge to Aimaokatalok Lake and runoff to other lakes in the Project area. These potential Project contributions could affect other aquatic components such as sediment quality and the biota that reside in these freshwater systems. This, in combination with regulatory requirements and guidance, has informed the selection of aquatic components that will be monitored under this Plan.

2.3.1. Water Quantity

Drawdown of Doris, Ogama, P.O., Patch, Wolverine, Imniagut, and Windy lakes may result from lake water moving into the groundwater as it replaces the talik water that has seeped into underground mines. Lowered lake levels may affect fish habitat availability. To confirm these effects are not greater than those predicted following mitigation, lake water levels will be monitored in these lakes and results will be compared to baseline information and FEIS predictions, and will be used to inform potential habitat offsetting under applicable Fisheries Authorizations.

2.3.2. Water Quality

Treated effluent discharged to Aimaokatalok Lake will meet MMER discharge criteria, and will be confirmed by the sampling prescribed under the MMER. However, if concentrations of particular water quality variables increase above a certain level due to treated discharge, they could affect aquatic life in the lake. EEM monitoring related to this discharge will be conducted as per MMER EEM guidance (Environment Canada 2012), including the sampling of water quality four times a year.

Runoff from Project activities is predicted to mainly affect Stickleback, Wolverine, and Aimaokatalok lakes during construction and operations (TMAC 2017), while Doris and Patch lakes are immediately proximal to Project infrastructure. Given this, water quality will be monitored in these lakes and results will be evaluated against CCME guidelines for the protection of aquatic life and assessed to determine if concentrations are increasing in the lake due to mine activities.

2.3.3. Sediment Quality

Discharge and runoff may contribute particulate matter and other constituents to the water of lakes near Project activities, and these may interact with the sediments where they could affect aquatic life in the lake if concentrations increase above a certain level. Sediment quality will therefore be monitored in the same lakes as water quality to determine if concentrations are increasing in the lake due to mine activities. All CCME sediment parameters will be evaluated to ensure that mine activities are not affecting freshwater life.

2.3.4. Phytoplankton Biomass

Discharge and runoff may contribute nutrients to lakes near Project activities, and if particular nutrients (e.g., nitrogen and phosphorus) naturally limit primary production in these lakes, alteration of water quality could lead to increased primary production. Phytoplankton are the dominant primary producers in lakes, and phytoplankton biomass levels are estimated using the main photosynthetic pigment, chlorophyll *a*. Chlorophyll *a* concentrations will be measured in the same lakes as water and sediment quality to evaluate potential mine effects through nutrient inputs.

2.3.5. Benthic Invertebrates

Discharge and runoff have the potential to contribute particulate matter and associated constituents to the waterbodies near the Project. This could affect the water and sediment chemistry, and potentially the health of benthic invertebrates (benthos) that are in contact with the water and sediments. As a result, benthos will be monitored to determine if potential changes to water and sediment quality are affecting the benthic biota of lakes near the Project.

2.3.6. Fish

Effluent discharge has the potential to affect fish populations by decreasing fish health and affecting the biological resources used by fish. Under MMER, a fish population study related to effluent discharge will be required in Aimaokatalok Lake if the concentration of effluent in the exposure area is greater than 1% at 250 m from a final discharge point (Schedule 5, section 9). Further, MMER requires fish tissue monitoring if effluent end-of-pipe total mercury (Hg) concentration exceeds 0.1 µg/L (Schedule 5, section 9). Should these studies be required, an appropriate monitoring program following sampling recommendations in the *Metal Mining Technical Guidance for Environmental Effects Monitoring* (Environment Canada 2012) will be developed in the MMER First Study Design and carried forth under the Plan.

3. MONITORING

This chapter describes the study area, monitoring schedule, sampling methods, analysis, and the quality assurance and quality control (QA/QC) procedures used to fulfil the objectives outlined in Section 1.1.

3.1. STUDY DESIGN

3.1.1. Study Area and Monitoring Sites

Aquatic effects monitoring will be conducted in exposure lakes where Doris, Madrid, and Boston activities are most likely to occur. Monitoring will focus on Aimaokatalok, Doris, Patch, Stickleback, and Wolverine lakes (Figures 3.1-1a and 3.1-1b) as these lakes are adjacent to or downstream of most Project activities and the associated taliks in which mining will occur. Windy, Ogama, P.O., and Imniagut lakes will also be monitored for water level and ice thickness to verify predictions made in the Madrid-Boston FEIS (TMAC 2017) and support applicable Fisheries Authorizations.

Doris Lake will continue to be monitored as in the approved Doris AEMP (TMAC 2016), since the nature of potential effects to this lake remain the same as those considered in the Doris Project amendment (TMAC 2015). Doris Lake monitoring, along with monitoring at Aimaokatalok, Stickleback, Wolverine, and Patch lakes will provide information needed to assess potential non-point-source aquatic effects related to the Project, including runoff and water drawdown. Imniagut, Ogama, P.O., and Windy lakes will be monitored specifically for potential effects related to water drawdown. Water, sediment, and biological sampling locations were selected over the deep basins of each lake (Aimaokatalok [AIM-Deep], Stickleback, Wolverine, Patch, Doris, and Reference Lake B) to characterize non-point-source effects and/or align with historical sampling locations.

Monitoring in Aimaokatalok Lake also considered MMER requirements (SOR/2002-222) and EEM guidance (Environment Canada 2012) as sampling sites were selected along the effluent pathway as predicted by hydrodynamic mixing modelling (TMAC 2017; Appendix V5-4E) and followed a simple gradient design as per EEM guidance (Environment Canada 2012). The sites along the gradient were selected in target water depths of 10 to 15 m to sample similar benthic environments and reduce potential confounding environmental information related sediment particle size and sediment chemistry that could affect the interpretation of potential effects.

Monitoring will also occur at a reference lake (Reference Lake B) beyond the influence of Project activities. This will provide information on regional changes that may be occurring in the aquatic environment. Reference Lake B has been sampled annually since 2009.

3.1.2. Monitoring Schedule

Aquatic effects monitoring components have been selected to address the potential mine effects as described in Section 2. Similarly, the monitoring schedule has been tailored to address the mine development and operational sequence, and is tied to periods during which Project effects may occur. Table 3.1-1 outlines the mine-specific monitoring triggers (such as water level changes, non-point-source inputs, and/or direct discharge) that will initiate and drive the monitoring schedule.

Figure 3.1-1a
AEMP Monitoring Sites, Northern Hope Bay Belt

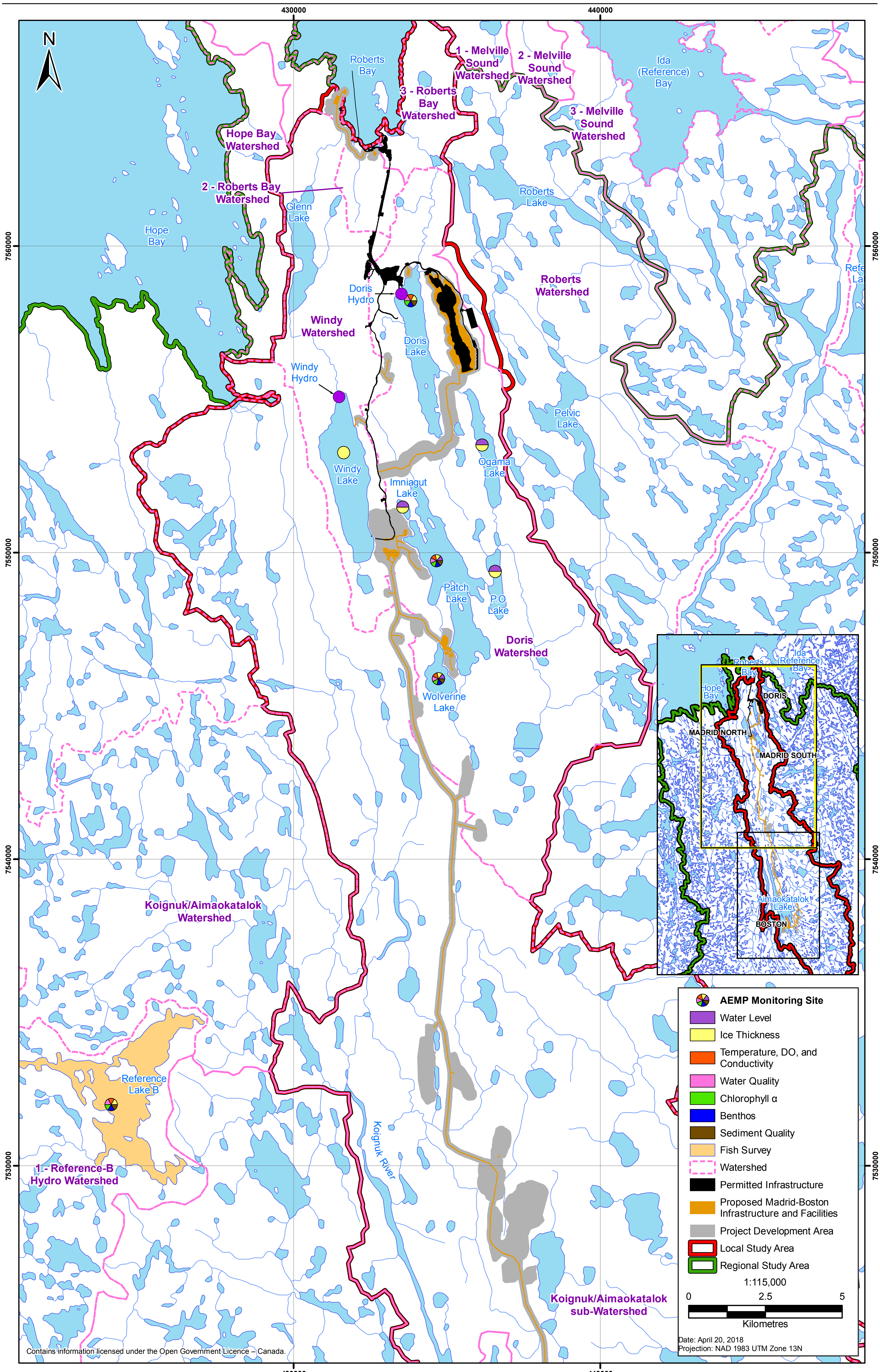


Figure 3.1-1b
AEMP and MMER EEM Monitoring Sites, Southern Hope Bay Belt

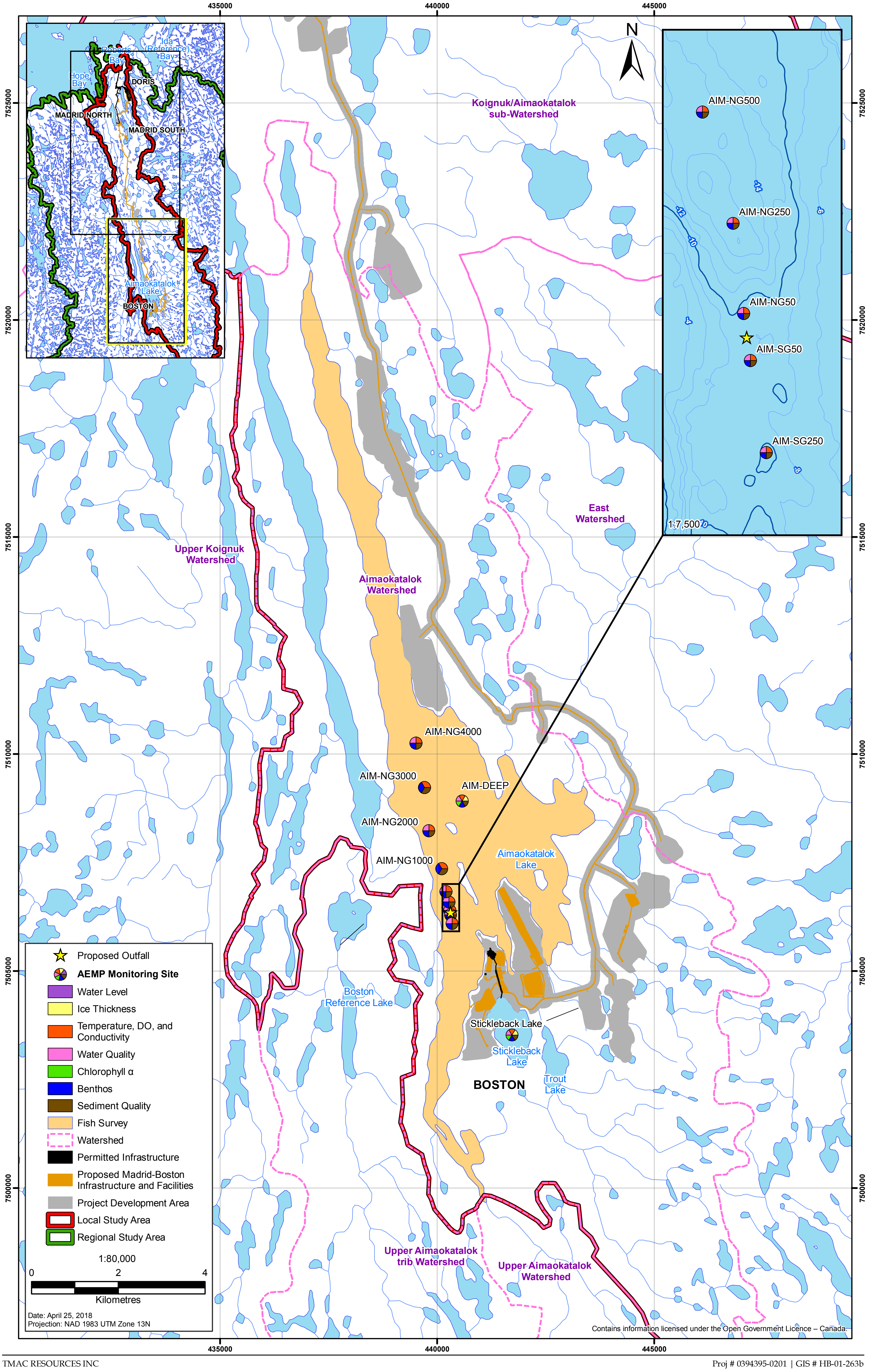


Table 3.1-1. Monitoring Location Descriptions and Monitoring Triggers

Watershed	Station	Description	Monitoring Trigger	Reason
Windy Watershed	Windy Lake	Windy Hydro hydrological monitoring station	Doris, Madrid North, and Madrid South Construction and Operations	Direct potable water withdrawal (increased accommodation at Doris)
Doris Watershed	Wolverine Lake	Deep basin representative of lake and accessible location near exposed bedrock	Madrid South Construction and Operations	Groundwater inflows; Indirect inputs due to proximity
	Patch Lake	Deep area in center of lake representative of lake and accessible location near exposed bedrock	Madrid North and South Construction and Operations	Groundwater inflows; Indirect inputs due to proximity
	Imniagut	Accessible location near exposed bedrock	Madrid North and South Operations	Groundwater inflows
	P.O.	Accessible location near exposed bedrock	Madrid North and South Operations	Groundwater inflows
	Ogama	Accessible location near exposed bedrock	Madrid North and South Operations	Groundwater inflows
	Doris Lake	Deep basin representative of lake and Doris Hydro hydrological monitoring station	Doris, Madrid North, and Madrid South Construction and Operations	Direct water withdrawal; groundwater mine inflows Indirect inputs due to proximity
			Boston Operations	Direct water withdrawal
Aimaokatalok Watershed	Stickleback Lake	Deep basin representative of lake	Boston Construction and Operations	Indirect inputs due to proximity
	Aimaokatalok Lake - Deep	Deep basin representative of lake	Boston Construction and Operations	Indirect inputs due to proximity
	Aimaokatalok NG50	MMER EEM sampling location 50 m north of diffuser, ~10-15 m depth	Discharge to Aimaokatalok Lake - MMER	Direct inputs (MMER discharge)
	Aimaokatalok SG50	MMER EEM sampling location 50 m south of diffuser, ~10-15 m depth	Discharge to Aimaokatalok Lake - MMER	Direct inputs (MMER discharge)
	Aimaokatalok NG250	MMER EEM sampling location 250 m north of diffuser, ~10-15 m depth	Discharge to Aimaokatalok Lake - MMER	Direct inputs (MMER discharge)

(continued)

Table 3.1-1. Monitoring Location Descriptions and Monitoring Triggers (completed)

Watershed	Station	Description	Monitoring Trigger	Reason
Aimaokatalok *(cont'd)*	Aimaokatalok SG250	MMER EEM sampling location 250 m south of diffuser, ~10-15 m depth	Discharge to Aimaokatalok Lake - MMER	Direct inputs (MMER discharge)
	Aimaokatalok NG500	MMER EEM sampling location 500 m north of diffuser, ~10-15 m depth	Discharge to Aimaokatalok Lake - MMER	Direct inputs (MMER discharge)
	Aimaokatalok NG1000	MMER EEM sampling location 1,000 m north of diffuser, ~10-15 m depth	Discharge to Aimaokatalok Lake - MMER	Direct inputs (MMER discharge)
	Aimaokatalok NG2000	MMER EEM sampling location 2,000 m north of diffuser, ~10-15 m depth	Discharge to Aimaokatalok Lake - MMER	Direct inputs (MMER discharge)
	Aimaokatalok NG-3000	MMER EEM sampling location 3,000 m north of diffuser, ~10-15 m depth	Discharge to Aimaokatalok Lake - MMER	Direct inputs (MMER discharge)
	Aimaokatalok NG4000	MMER EEM sampling location 4,000 m north of diffuser, ~10-15 m depth	Discharge to Aimaokatalok Lake - MMER	Direct inputs (MMER discharge)
Reference	Reference Lake B	Deep basin representative of lake	Doris, Madrid, and Boston Construction and Operations	Reference site

During Madrid North construction and operations, Madrid North-associated activities have the potential to affect Windy Lake (due to potable water use), Patch Lake (due to groundwater inflows and proximity), and Doris Lake (due to water use and upstream water loss to groundwater inflows from Patch Lake). These lakes will be monitored during Madrid North construction and operations.

During Madrid South construction and operations, Madrid South activities have the greatest potential to affect Wolverine and Patch lakes (due to groundwater inflows and proximity), Doris Lake (due to water use and upstream water loss to groundwater inflows from Patch Lake), and Windy Lake (due to potable water use). These lakes will be monitored during Madrid South construction and operations.

The Doris Mine has been operating since late 2016 and has the potential to affect Doris Lake through its proximity to Project activities and future groundwater inflows to the mine. Doris Lake has been monitored annually under the Doris AEMP (formally the Doris North AEMP) since 2010.

During Boston construction and operations, Stickleback Lake and Aimaokatalok Lake (AIM-Deep sampling location; Figure 3.1-1b) will be sampled for non-point source effects over the deepest section of the lakes. Following discharge to Aimaokatalok Lake, sampling will also be conducted at nine sampling stations (AIM-

NG50, AIM-SG50, AIM-NG250, AIM-SG250, AIM-NG500, AIM-NG1000, AIM-NG2000, AIM-NG3000, and AIM-NG4000) along the predicted north-south effluent pathway to assess point-source effects and confirm hydrodynamic mixing modeling predictions. The two southern gradient stations (AIM-SG50 and AIM-SG250) may be de-activated in the future if the monitoring data confirms the modelling predictions of little influence of the effluent south of the outfall diffuser.

The monitoring schedule and sampling frequency for each of the Plan's environmental monitoring components are outlined in Table 3.1-2.

Table 3.1-2. Monitoring Schedule and Sampling Frequency

Monitoring Parameter	Schedule and Frequency
AEMP Program	
Water Level	Continuous recording during open-water season or year round
Ice Thickness	Annually (April)
Temperature and Dissolved Oxygen Profile	2× per year (April, August)
Water Quality	2× per year (April, August)
Sediment Quality	once every 3 years (August)
Phytoplankton Biomass (as chlorophyll *a*)	Annually (August)
Benthic Invertebrates	once every 3 years (August)
MMER EEM Program	
Temperature and Dissolved Oxygen Profile	4× per year (April, July, August, September)
Water Quality	4× per year (April, July, August, September)
Sediment Quality	once every 3 years (August)
Benthic Invertebrates	once every 3 years (August)
Fish	once every 3 years, if triggered by MMER (August)

Monitoring frequency outlined in this table applies to periods during which monitoring is triggered as outlined in Table 3.1-1.

The water level in monitored lakes will be recorded year-round or during only the open-water season (depending on the hydrometric station). Ice thickness will be measured at each monitoring lake in April. Water quality and physical profiles of temperature and dissolved oxygen will be collected in April (under ice) and August (open water) at the AEMP lakes stations. Phytoplankton biomass (as chlorophyll *a*) sampling will be conducted annually in August and benthic invertebrate and sediment quality sampling will be conducted every three years during August. Sampling will be conducted on a similar schedule in Reference Lake B for all environmental components, except water level, which will not be monitored in the lake.

At Aimaokatalok Lake, MMER-related water quality sampling and physical profiling will occur four times per year (in April, July, August, and September) while sediment quality and benthic invertebrates will be sampled every three years. Fish sampling will also be conducted every three years if triggered by MMER requirements.

This Plan has been developed with a focus on construction and operations phases. The Plan will be re-evaluated prior to closure to determine the appropriate closure monitoring, and monitoring under temporary closure (care and maintenance) will be re-evaluated with interested parties if TMAC enters this phase. EEM monitoring will continue in Aimaokatalok Lake as required by MMER.

3.2. MONITORING COMPONENTS AND EFFECTS ANALYSIS

The sampling program will include the collection of water level and ice thickness data, physical limnology, water quality, sediment quality, phytoplankton biomass (as chlorophyll *a*), and benthic invertebrates. Fish will be also be monitored as per MMER requirements (Schedule 5, subsections 9(b,c)) if the concentration of effluent in the exposure area is greater than 1% in the area located within 250 m of a final discharge point and/or the concentration of total mercury in the effluent is equal to or greater than 0.10 µg/L. A summary of the AEMP and MMER EEM sampling is presented in Table 3.2-1.

3.2.1. Water Level and Ice Thickness

The objectives of the lake level and ice thickness monitoring are to confirm the lake water loss predictions from the Madrid-Boston FEIS and the Doris Project amendment and to inform potential fisheries offsetting under applicable Fisheries Authorizations. Lake level monitoring stations could be de-activated in the future if the modelling predictions are validated and offsetting measures are carried forth.

<u>Methods</u>

Lake water levels will be measured continuously year round in Doris Lake and during the open-water season (approximately June to October) at Imniagut, Ogama, Patch, P.O., Windy, and Wolverine lakes (Figure 3.1-1a, Table 3.2-1). A pressure transducer paired with a data logger will be installed in each lake, and data will be recorded in 15-minute intervals and downloaded either monthly (Doris Lake) or a minimum of semi-annually (remaining stations). The water surface will be surveyed and tied to the monitoring station datum (either local or geodetic, as applicable).

Table 3.2-1. AEMP and MMER EEM Sampling Details, Hope Bay Project

Monitoring Parameter	Lakes Sampled	# of Sampling Areas/Lake	# of Replicate Stations/Area	Depths Sampled	# of Field Subsamples/Replicate Station	Sampling Device
AEMP Program						
Water Level	Doris Imniagut Ogama Patch P.O. Windy Wolverine	1	N/A	N/A	N/A	Transducer and data logger
Ice Thickness	Aimaokatalok (Deep site) Doris Imniagut Ogama Patch P.O. Windy Wolverine Stickleback Reference Lake B	1	1	N/A	1	Manual measurement with metred rod
Temperature and Dissolved Oxygen Profile, Secchi depth	Aimaokatalok (Deep site) Doris Patch Stickleback Wolverine Reference B	1	1	Entire water column	1	Temp-DO meter; Secchi disk

(continued)

Table 3.2-1. AEMP and MMER EEM Sampling Details, Hope Bay Project (continued)

(continued)

Monitoring Parameter	Lakes Sampled	# of Sampling Areas/Lake	# of Replicate Stations/ Area	Depths Sampled	# of Field Subsamples/Replicate Station	Sampling Device
AEMP Program (cont'd)						
Water Quality	Aimaokatalok (Deep site) Doris Patch Stickleback Wolverine Reference B	1	1	1 m below the surface and 2 m above water-sediment interface	1 to 2 at each depth (target of 10% replication), discrete samples	GO-FLO or Niskin sampling bottle
Sediment Quality	Aimaokatalok (Deep site) Doris Patch Stickleback Wolverine Reference B	1	3	Lake bottom	1	Ekman grab
Phytoplankton biomass (chlorophyll *a*)	Aimaokatalok (Deep site) Doris Patch Stickleback Wolverine Reference B	1	1	1 m below the surface	3 discrete samples	GO-FLO or Niskin sampling bottle
Benthic Invertebrate Density and Taxonomy	Aimaokatalok (Deep site) Doris Patch Stickleback Wolverine Reference B	1	5	Lake bottom	3 samples pooled in the field	Ekman grab; 500 µm sieve

Table 3.2-1. AEMP and MMER EEM Sampling Details, Hope Bay Project (completed)

Monitoring Parameter		Lakes Sampled	# of Sampling Areas/Lake	# of Replicate Stations/Area	Depths Sampled	# of Field Subsamples/Replicate Station
MMER EEM Program						
Temperature and Dissolved Oxygen Profile, Secchi depth	Aimaokatalok (AIM-NG50, AIM-SG50, AIM-NG250, AIM-SG250, AIM-NG500; AIM-NG1000; AIM-NG2000; AIM-NG3000, AIM-NG4000)	9	1	Entire water column	1	Temp-DO meter; Secchi disk
Water Quality	Aimaokatalok (AIM-NG50, AIM-SG50, AIM-NG250, AIM-SG250, AIM-NG500; AIM-NG2000; AIM-NG4000)	7	1	1 m below the surface and 2 m above water-sediment interface	1 to 2 at each depth (target of 10% replication), discrete samples	GO-FLO sampling bottle
Sediment Quality	Aimaokatalok (AIM-NG50, AIM-SG50, AIM-NG250, AIM-SG250, AIM-NG500; AIM-NG1000; AIM-NG2000; AIM-NG3000, AIM-NG4000)	9	1	Lake bottom	1	Ekman grab
Benthic Invertebrate Density and Taxonomy	Aimaokatalok (AIM-NG50, AIM-SG50, AIM-NG250, AIM-SG250, AIM-NG500; AIM-NG1000; AIM-NG2000; AIM-NG3000, AIM-NG4000)	9	1	Lake bottom	3 samples pooled in the field	Ekman grab; 500 µm sieve

Table 3.2-1. AEMP and MMER EEM Sampling Details, Hope Bay Project (completed)

Monitoring Parameter	Lakes Sampled	# of Sampling Areas/Lake	# of Replicate Stations/ Area	Depths Sampled	# of Field Subsamples/Replicate Station	
Fish Population and Tissue	Aimaokatalok Reference B	N/A	N/A	N/A	Ninespine Stickleback n=60 fish/lake (20 male/20 female/20 immature); including 8 fish/site same sex/size for tissue metals sex/size† Lake Trout: 100 fish/lake†	Sinking and Floating Gill Nets, Beach Seine, Minnow Traps

Notes:
N/A = Not applicable
† Samples sizes indicated are from Environment Canada (2012) but these may not be attainable in Arctic lakes.

Discrete under-ice lake level measurements will also be collected in April at Imniagut, Ogama, Patch, P.O., Windy, and Wolverine lakes. The water surface will be surveyed through an augured hole and tied to the monitoring station bench marks. The survey will be performed using a Real Time Kinematic (RTK) system, total station, or rod and level depending on field conditions at each monitoring station. The lake bottom depth will also be measured using a depth sounder or a weighted, metred line.

Ice thickness measurements will be taken once each year in April concurrent with lake level measurements and water quality sampling. The measurement will be taken through an augured hole using a metred rod.

Effects Analysis

Water level and ice thickness data will be examined to determine if water level reductions in lakes within the Doris and Windy watersheds are consistent with predictions made in the FEIS and the Doris Project amendment. Results will inform potential offsetting under applicable Fisheries Authorizations in consultation with DFO, the KIA, and the Inuit Environmental Advisory Committee.

Quality Assurance and Quality Control (QA/QC)

The collection and analysis of water level data will follow procedures outlined in the 2014 Hydrology Report (ERM Rescan 2014). A number of field- and desk-based procedures will be used to assess the reliability of data collected from the hydrometric station. Field QA/QC procedures will include following accepted water level surveying procedures and using stable benchmarks (such as bedrock).

Field crews will be trained to employ consistent methods for measuring ice thickness to ensure comparability of data.

3.2.2. Water Quality

The objectives of the AEMP water quality monitoring are to assess if Project activities are affecting the local freshwater environment, confirm the water quality predictions in the Madrid-Boston FEIS, confirm the water quality predictions from near- and far-field plume mixing modelling exercises (e.g., TMAC 2017; Appendices V5-4B and V5-4E), and comply with MMER EEM water quality monitoring requirements (Schedule 5, Part 1, section 7). The Plan harmonizes the AEMP and MMER EEM by sampling water quality in Aimaokatalok Lake during the same periods and at similar depths for each program and using these data to jointly assess water quality in the lake.

Methods

Water quality sampling will be conducted in April and August of each year at Aimaokatalok (deep site), Stickleback, Doris, Patch, and Wolverine lakes as well as Reference Lake B. Additional samples will also be collected in April, July, August, and September at seven MMER EEM monitoring sites along a gradient extending north and south from the outfall diffuser in Aimaokatalok Lake (Figure 3.1-1a and Table 3.2-1). The MMER EEM water quality sampling in April and August will be conducted during the same period as the AEMP sampling in Aimaokatalok Lake and will follow the recommendations of Environment Canada (2012). Water quality samples for the AEMP and MMER EEM programs will be collected at the surface (1 m depth; 1 m below the ice in winter) at all lake sites and near the bottom at sites deeper than 6 m (2 m from sediments) using an acid-cleaned discrete sampling device (e.g., GO-FLO or Niskin).

All water samples will be collected using laboratory-approved clean sampling bottles, with personnel wearing powder-free latex gloves. Samples will be preserved with the appropriate chemicals and properly labelled and stored. All samples will be sent to a Canadian Association for Laboratory Accreditation (CALA)-certified analytical laboratory for analysis of the water quality variables listed in Table 3.2-2 (except temperature and dissolved oxygen which will be field-measured). Water quality samples collected from MMER EEM sites (as identified in Table 3.1-1) will also be analyzed for total cyanide and radium-226 (Table 3.2-2) as required under the MMER (Schedule 5, subsection 7(d)). Total and free cyanide will also be collected at AIM-Deep and Reference Lake B.

Table 3.2-2. Water Quality Variables

Variable	Variable
Physical Tests	**Total Metals** *(cont'd)*
Conductivity[b,d]	Calcium (Ca)
Dissolved Oxygen (Field-measured)[a,d,g]	Cesium (Cs)
Hardness (as $CaCO_3$)[b,d]	Chromium (Cr)[a]
pH[a,d]	Cobalt (Co)
Temperature (Field-measured)[a,b,d]	Copper (Cu)[a.c]
Total Suspended Solids[a,c]	Gallium (Ga)
Turbidity[a]	Iron (Fe)[a,b,d]
Water Depth	Lead (Pb)[a,c]
Anions and Nutrients	Lithium (Li)
Alkalinity, Total (as $CaCO_3$)[b,d]	Magnesium (Mg)
Ammonia, Total (as N)[a,b,d]	Manganese (Mn)
Bromide (Br)	Mercury (Hg)[a,b,d,f]
Chloride (Cl)[a]	Molybdenum (Mo)[a,b,d]
Fluoride (F)[a]	Nickel (Ni)[a,c]
Nitrate (as N)[a,b,d]	Phosphorus (P)
Nitrite (as N)[a]	Potassium (K)
Total Phosphorus[a]	Rhenium (Re)
Sulphate (SO_4)	Rubidium (Rb)
Organic Carbon	Selenium (Se)[a,b,d]
Dissolved Organic Carbon	Silicon (Si)
Total Organic Carbon	Silver (Ag)[a]
Cyanides	Sodium (Na)
Free Cyanide[a,g]	Strontium (Sr)
Total Cyanide[c,g]	Tellurium (Te)
Radiological	Thallium (Tl)[a]
Radium-226[c,e,g]	Thorium (Th)
Total Metals	Tin (Sn)
Aluminum (Al)[a,b,d]	Titanium (Ti)

Variable	Variable
Antimony (Sb)	Tungsten (W)
Arsenic (As)[a,c]	Uranium (U)[a]
Barium (Ba)	Vanadium (V)
Beryllium (Be)	Yttrium (Y)
Bismuth (Bi)	Zinc (Zn)[a,c]
Boron (B)[a]	Zirconium (Zr)
Cadmium (Cd)[a,b,d]	

Notes:
Unless otherwise indicated, variables will be analyzed in a CALA-accredited laboratory using standard methods.
a Variables for which there are CCME water quality guidelines for the protection of aquatic life (CCME 2018b).
b Variables subject to EEM Effluent Characterization Study (Schedule 5, subsection 4(1(a to h)).
c Variables listed as MMER deleterious substances in effluent (Schedule 4).
d Variables subject to EEM Water Quality Monitoring Study (Schedule 5, subsection 7(1b to d)).
e Ra-226 monitoring will be discontinued if 10 consecutive test results show that concentrations are less than 10% of the authorized monthly mean concentration (MMER, subsection 13(2)).
f Mercury monitoring may be discontinued for effluent characterization if the concentration is less than 0.10 µg/L in 12 consecutive samples (MMER Schedule 5, subsection 4(3)).
g Total and free cyanide and radium-226 will only be monitored at the MMER EEM sites and Reference Lake B indicated in Table 3.1-1. Dissolved oxygen will only be monitored in the receiving environment, and will not be measured as part of effluent characterization.

Temperature and dissolved oxygen profiling will be conducted during each water quality survey using a calibrated temperature-dissolved oxygen meter. Each open-water profile will extend from the surface to approximately 1 m above the sediment surface, with values recorded every 1 m. Under-ice profiling will begin just below the base of the ice layer (approximately 2 m) and will extend to 1 m above the sediments. All data will be recorded onto field sheets with the applicable meta-data such as date, time, personnel, weather, calibration data, and ice thickness measurements.

Analysis of Effects

For AEMP program sites, water quality variables with CCME guidelines will be evaluated for potential effects using qualitative (graphical) and quantitative (statistical) analysis methods. Profile data (temperature and dissolved oxygen) will be evaluated qualitatively. Non-CCME variables will be reported in the appendices of the annual AEMP report and could be evaluated for Project effects if warranted.

The statistical analysis of CCME water quality variables will employ either a before-after-control-impact (BACI) design or a trend analysis to assess potential mine-related effects based on the robustness of the temporal dataset for each lake. For a BACI design, 'before' data would include data collected before the start of mining construction and operations, while 'after' data would include data collected after the start of construction and operations. Reference Lake B would be the 'control' component and other monitoring sites would be the 'impact' components. The interaction between the 'before-after' and 'control-impact' terms is the BACI effect of interest. If sufficient years of data are available for a particular AEMP lake (based on examination of dataset by the program statistician), a trend analysis using LOESS (locally weighted smoothing) regression will be used as an alternative to the BACI design. In this instance, the trend in a water quality variable over time at an exposure lake will be compared to both a slope of zero and the trend at Reference Lake B to determine if there is evidence of a change over time and whether the change is also evident at the reference site. Potential effects will be assessed at a significance level of 0.05.

Results of the AEMP analysis of effects will be interpreted and adaptively managed within the context of a Response Framework (see Section 4) to detect and pre-empt adverse changes in water quality.

For the MMER EEM monitoring sites (the gradient sites in Aimaokatalok Lake), the water quality data will be reported in the appendices of the AEMP and will aid in the interpretation of the broader water quality and biology in Aimaokatalok Lake.

Quality Assurance and Quality Control (QA/QC)

Quality assurance measures will include the training of environmental staff who will carry out the sampling as well as QA/QC procedures such as using certified laboratories for analyses and using lab-approved clean bottles and high quality preservatives. On-site quality control measures will include the use of chain-of-custody (CoCs) forms to track shipped samples and collecting travel blanks, field blanks, and replicate samples to assess potential sources of contamination and variability in the sampling program. The travel and field blanks are designed to identify sources of contamination during the collection and transportation of water samples, while replicate samples identify potential *in situ* variability within the sampling environment.

Rigorous QA/QC measures will be followed at the analytical laboratory and will include identifying holding time exceedances and using split samples and spiked samples (using certified standards) to track laboratory precision and ensure that data quality objectives are met.

3.2.3. Sediment Quality

The objectives of the AEMP sediment quality monitoring are to evaluate Project effects in nearby lake sediments, confirm the sediment quality predictions in the Madrid-Boston FEIS, assess the performance of sediment and erosion control measures near Project lakes, support the interpretation of water quality and biological monitoring results, and comply with MMER EEM sediment quality monitoring requirements (Schedule 5, Part 2, section 16). The Plan harmonizes the AEMP and MMER EEM by sampling sediment quality in Aimaokatalok Lake in August every 3 years using similar methods and using these data to jointly assess sediment quality in the lake.

Methods

Surficial sediment quality samples will be collected using an Ekman grab sampler and will be collected concurrently with benthic invertebrate sampling. Three replicate samples will be collected from each AEMP sampling area (Aimaokatalok [AIM-DEEP], Doris, Patch, Stickleback, and Wolverine lakes) as has been done historically. A single sediment sample will also be collected at each of the nine MMER EEM monitoring locations along the predicted effluent path in Aimaokatalok Lake, which target effects monitoring specific to MMER-related discharge (Table 3.2-1; Figure 3.1-1b). Each sediment sample will be carefully transferred onto a plastic tray, and the top 2 to 3 cm of sediment will be removed and homogenized in a plastic bowl using a plastic spoon and placed into two containers: one for particle size and one for sediment chemistry. All samples will be kept cool and sent to an accredited analytical laboratory within the appropriate holding times.

Samples will be analyzed for the sediment quality variables outlined in Table 3.2-3.

Analysis of Effects

Sediment quality variables that have CCME guidelines will be evaluated for potential Project-related effects using graphical analysis as well as a BACI or trend analysis as described for water quality. Results of the AEMP analysis of effects will be interpreted and adaptively managed within the context of a Response Framework (see Section 4) to detect and pre-empt potential adverse changes in sediment quality. Non-CCME variables will be reported in the appendices of the annual AEMP report and could be evaluated for Project effects if warranted.

For the MMER EEM monitoring sites (the gradient sites in Aimaokatalok Lake), the sediment quality data will be reported in the appendices of the AEMP and will aid in the interpretation of the broader water quality and biology in Aimaokatalok Lake.

Table 3.2-3. Sediment Quality Variables

Variable	Variable
Physical and Nutrients	**Total Metals** *(cont'd)*
% Moisture	Lithium (Li)
pH	Magnesium (Mg)
Particle Size[b]	Manganese (Mn)
Total Nitrogen	Mercury (Hg)[a]
Total Organic Carbon[b]	Molybdenum (Mo)
Total Metals	Nickel (Ni)
Aluminum (Al)	Phosphorus (P)
Antimony (Sb)	Potassium (K)
Arsenic (As) [a]	Selenium (Se)
Barium (Ba)	Silver (Ag)
Beryllium (Be)	Sodium (Na)
Bismuth (Bi)	Strontium (Sr)
Boron (B)	Sulphur (S)
Cadmium (Cd) [a]	Thallium (Tl)
Calcium (Ca)	Tin (Sn)
Chromium (Cr) [a]	Titanium (Ti)
Cobalt (Co)	Uranium (U)
Copper (Cu) [a]	Vanadium (V)
Iron (Fe)	Zinc (Zn) [a]
Lead (Pb) [a]	

[a] Variables for which there are CCME sediment quality guidelines for the protection of aquatic life (CCME 2018a).
[b] required for EEM benthic invertebrate survey

Quality Assurance and Quality Control

The QA/QC program for sediment quality sampling will include the collection of replicates to account for within-site variability and the use of CoC forms to track samples. Rigorous QA/QC will be followed at the analytical laboratory to ensure that data quality objectives are met.

3.2.4. Phytoplankton Biomass (as chlorophyll *a*)

The objective of the AEMP phytoplankton biomass monitoring is to assess the trophic status of the Project lakes that could be affected by nutrient inputs from point-source discharge and non-point source runoff.

Methods

Triplicate samples will be collected for phytoplankton biomass (as chlorophyll *a*) at AEMP sites from 1-m depth using a discrete sampling device. Each replicate sample will be collected in a foil-wrapped bottle and filtered onto a 0.45 µm filter. The volume of water filtered will be recorded, the filter frozen, and samples sent to a laboratory for analysis of chlorophyll *a*.

Analysis of Effects

Potential changes in phytoplankton biomass will be evaluated using qualitative (graphical) analysis in conjunction with a BACI or trend analysis similar to that described for water quality, with chlorophyll *a* as the response variable. Results of the analysis of effects will be interpreted and adaptively managed within the context of a Response Framework (see Section 4).

Quality Assurance and Quality Control

The QA/QC program for chlorophyll *a* sampling will include collecting the water in a opaque bottle (to prevent further photosynthesis), keeping the filtered sample frozen at all times prior to analysis, collecting replicate samples, and using CoC forms to track sample shipment.

3.2.5. Benthic Invertebrates

The objectives of the AEMP benthic invertebrate monitoring are to determine if Project activities are affecting benthic invertebrate communities in nearby lakes, confirm the assessments in the Madrid-Boston FEIS, and comply with MMER EEM benthic invertebrate monitoring requirements (Schedule 5, Part 2, section 9). The Plan harmonizes the AEMP and MMER EEM by sampling benthic invertebrates in Aimaokatalok Lake in August every 3 years using similar methods for each program and using these data to jointly assess the abundance and diversity of benthic invertebrates in the lake due to Project activities.

Methods

Benthic invertebrates will be collected using an Ekman grab sampler. Five replicate samples will be collected from each AEMP sampling area (Aimaokatalok (Deep station), Doris, Patch, Stickleback, and Wolverine lakes). A single sample will be collected from each of the nine MMER EEM monitoring locations along the projected effluent path in Aimaokatalok Lake to evaluate effects specific to MMER-related discharge (Table 3.2-1; Figure 3.1-1b). Each benthos sample will consist of a composite of three pooled field subsamples. Each composited sample will be sieved to 500 µm, preserved with formalin, and sent to a taxonomist for identification and enumeration. Benthos samples will be collected concurrently with the sediment quality samples.

Analysis of Effects

The benthos endpoints or indicators that will be evaluated include: total density, Simpson's evenness index, taxa richness, and Bray-Curtis similarity index. For the AEMP monitoring sites, potential changes in benthos indicators will be evaluated using graphical analysis as well as a BACI or trend analysis as described for water quality. Results of the AEMP analysis of effects will be interpreted and adaptively managed within the context of a Response Framework (see Section 4).

For the MMER EEM sites along the projected effluent gradient, benthos indicators will be evaluated using a regression analysis (by determining if there is any change in the benthos indicator with distance from the discharge pipeline outfall). The critical effects sizes summarized in Environment Canada (2012) will be used to evaluate the magnitude of effects for benthos indicators. To confirm a mine-related effect on benthos, there would need to be a similar type of effect (same direction from zero) found for the same benthos indicator in studies from two consecutive three-year phases of EEM biological monitoring (Environment Canada 2012).

Quality Assurance and Quality Control

The QA/QC program for benthos sampling will include the collection of subsamples and replicates to account for within-site variability and the use of CoC forms to track samples.

A re-sorting of randomly selected sample residues will be conducted by the taxonomist on a minimum of 10% of the benthos samples to determine the level of sorting efficiency. The criterion for an acceptable sorting will be that more than 90% of the total number of organisms will be recovered from the initial sort. The number of organisms initially recovered from the sample will be expressed as a percentage of the total number after the re-sort (total of initial and re-sort count). Any sample not meeting the 90% removal criterion will be re-sorted a third time.

3.2.6. Fish

The objective of the EEM fish population monitoring is to comply with MMER fish monitoring requirements when such a study is triggered (fish population and/or fish tissue). Under MMER, a fish population survey is required if the effluent in the exposure area is greater than 1% at 250 m from the final discharge point (MMER, Schedule 5, Part 2, subsection 9(b)). If triggered, fish population surveys will be undertaken in Aimaokatalok Lake and Reference Lake B (reference area; Figure 3.1-1a and 3.1-1b). This component is designed to determine if mine effluent has affected fish abundance or biological status.

A fish tissue survey will also be initiated in exposure and reference areas if, during effluent characterization, the concentration of total mercury in the effluent discharged to Aimaokatalok Lake is equal to or greater than 0.10 ug/L (MMER, Schedule 5, subsection 9(c)). This component is designed to determine if mine effluent has affected fish usability as measured by tissue mercury concentration by comparing contaminants in edible fish tissue. The mercury concentration in fish tissue is used to determine if fish are safe for human consumption.

<u>Methods</u>

Fish Population Survey

If triggered, fish monitoring will follow EEM guidance (Environment Canada 2012). Fish population and health sampling will be conducted on two target species, Lake Trout (*Salvelinus namaycush*) and Ninespine Stickleback (*Pungitius pungitius*), once every three years according to the schedule outlined in Table 3.1-2. Sampling will focus on Aimaokatalok Lake where point-source effluent discharge effects are most likely to be detected, and the reference site, Reference Lake B (Figure 3.1-1a and 3.1-1b).

Lake Trout are a large-bodied, long-lived species and thus highly susceptible to long-term population level effects from lethal sampling. To avoid any negative effects on population size and structure, non-lethal biological sampling will be employed for Lake Trout. Non-lethal sample sizes of up to 100 adults are recommended for each site (Environment Canada 2012); however, it is recognized that this may not always be attainable for Lake Trout in northern waterbodies. Lethal sampling will be employed on the small-bodied, short-lived, Ninespine Stickleback. The objective will be to collect data from 20 mature male, 20 mature female, and 20 juvenile Ninespine Stickleback from each lake. EEM guidance suggests that greater numbers of juvenile small-bodied fish be captured for a robust analysis of age; however, a minimum of 60 lethal samples of Ninespine Stickleback may also be unattainable in some Arctic lakes. The EEM guidance document recognizes that this number samples is unlikely to be caught in many waterbodies (Environment Canada 2012).

Fish population and health surveys will take place every three years in August using gillnets for Lake Trout, and beach seines and minnow trapping for Ninespine Stickleback. Sampling locations will be determined randomly and conducted throughout each lake to collect fish of all species and determine an unbiased catch-per-unit-effort (CPUE) within lakes. To meet power requirements with the low sample sizes, individual fish selected for tissue metal sampling should be of the same sex and approximate size (Environment Canada 2012). Therefore, if random sampling does not result in sufficient sample size to meet these requirements, additional sampling may be conducted using targeted methods. For example, sampling for Ninespine Stickleback may be conducted at a specific area of the lake, or a single gillnet mesh size may be used to capture Lake Trout of a certain size. CPUE for these methods will be recorded separately so as not to bias the results of the random sampling.

Survival, growth, reproductive, and condition parameters will be collected from the fish and compared between sites and over time to properly assess changes in fish populations and health over the life of the mine. Lethal sampling of Ninespine Stickleback will measure and assess all the biological variables and effects endpoints listed in Table 3.2-4, while only a subset of variables will be assessed from non-lethal sampling of Lake Trout.

The estimates of survival, growth, condition and reproduction will be based upon measurements conducted on individual fish. Live sampled fish will be identified to species, given a unique sample number, measured for fork length to the nearest 1 mm and weighed to the nearest 0.1 g using a calibrated electronic balance. Information on the external deformities, erosion, lesions, and tumours (DELTs) and pectoral fin rays and scale samples will be collected and placed in labeled envelopes. For lethally sampled fish (Ninespine Stickleback), each individual will be identified to species, given a unique sample number, measured for total length to the nearest 1 mm and weighed to the nearest 0.01 g using a calibrated electronic balance. Once dissected, livers will be weighed to the nearest 0.001 g. Because Ninespine Stickleback will be used for the reproductive endpoint, it is unlikely that the minimum of 100 eggs will be met to measure egg weight (Environment Canada 2012). As such, gonad weight (ripe ovary weight) and egg size will be used as variables for the reproductive endpoint (Table 3.2-4). Information on the internal and external DELTs, and pectoral fin rays and scale samples will be collected and placed in labeled envelopes. Ageing structures will be non-lethally sampled from Lake Trout by taking the first four pectoral fin rays. Otoliths will be removed from Ninespine Stickleback for ageing analysis.

Table 3.2-4. Fish Biological Variables and Effects Endpoints

Effects Endpoints	Biological variables	Lake Trout	Ninespine Stickleback
Survival	Age frequency	X	X
	Length frequency	X	X
Growth	Length at age	X	X
	Weight at age	X	X
Condition	Body weight at length	X	X
	Liver weight at body weight		X
	DELT	X	X
Reproduction	Gonad weight at body weight		X
	Gonad weight at length		X
	Egg Size		X

Fish Tissue Survey

If triggered, fish tissue data will be incorporated into the fish health sampling program. Tissue samples from Lake Trout and Ninespine Stickleback will be collected and analyzed for metals and moisture in tissue. For each species, a minimum of eight samples of the same sex and approximate body size will be collected from Aimaokatalok Lake and Reference Lake B (Environment Canada 2012) every three years in August. To avoid negative effects on population size and structure, non-lethal sampling using tissue plugs will be undertaken for Lake Trout. Tissue plugs will be collected from Lake Trout for analysis using methods developed by Baker et al. (2004), whereas Ninespine Stickleback will be sacrificed for whole-body tissue metal analysis.

<u>Analysis of Effects</u>

Descriptive summary statistics will be reported for all collected biological parameters. Potential effects to fish size (length and weight) and age will be determined using analysis of variance (ANOVA). All ANOVA assumptions will be met prior to analysis, including normally distributed populations, equal variances between populations, and sample independence. If populations or variances are unequal, the appropriate transformation will be applied before the ANOVA.

The remaining effects endpoints, except DELT, will be analyzed for statistical differences and interactions between the exposure and reference sites using analysis of covariance (ANCOVA). Assumptions of normality and constant variance will be met before an ANCOVA is applied. The assumption of equal regression slopes will also need to be met for relative fecundity to control for variability in weight. However, for most of the endpoints (excluding relative fecundity), the slope of the natural log of the dependent variable and covariate is the endpoint of interest (e.g., the slope of ln (weight) and ln(length) is condition). Thus, it is the differences in slope that indicates significant effect, and the assumption of equal regression slopes will not apply.

Potential differences in DELT characteristics between exposure and reference sites will be compared using the chi-squared (X^2) test.

For fish population and health endpoints, the critical effects sizes summarized in Environment Canada (2012) will be used to evaluate the magnitude of effects. For fish tissue, an effect on fish usability is defined as a measurement of total mercury that exceed 0.5 mg/kg wet weight of fish tissue taken from an exposure area and that is statistically different from fish tissue measured in a reference area (MMER, Schedule 5, section 1).

To confirm a mine-related effect on fish population and health or fish tissue, there would need to be a similar type of effect (same direction from zero) found for the same endpoint in studies from two consecutive three-year phases of EEM biological monitoring (Environment Canada 2012).

Quality Assurance and Quality Control

QA/QC measures will be followed throughout the data, field, and laboratory phases. Data quality will be screened for entry errors and will be checked for outliers using the appropriate boxplot, residual plot or quantile-quantile plot. In the field, all personnel will have suitable expertise to conduct surveys and perform dissections. All standard operating procedures will be followed. Proper sampling gear (e.g., dissecting equipment) and methods (e.g., electrofishing) will be employed by personnel while in the field. All sampling information will be appropriately documented, preserved (as necessary), stored, and shipped. CoC forms will used to track all sample shipments.

Fish samples will be analyzed by accredited laboratories with trained staff. If sub-sampling is required (e.g., fecundity, egg size), efficiency and accuracy results of the technique must be documented and the information used to calculate appropriate correction or scaling factors to minimize potential differences in methods and efficiency. All records of lesions, parasites, and other deformities will be noted.

4. RESPONSE FRAMEWORK

4.1. BACKGROUND

Potential Project-related effects to the freshwater receiving environment will be adaptively managed through the implementation of a Response Framework, which links the results of the AEMP to management actions so that significant adverse effects can be avoided. The Response Framework is largely based on the concepts presented in the *Guidelines for Adaptive Management — a Response Framework for Aquatic Effects Monitoring* (WLWB 2010). The Response Framework is founded on the concept of comparing monitoring results to an 'action level', which is "*a magnitude of environmental change which […] triggers a management action"* (WLWB 2010). The Response Framework is the "*systematic approach to responding when the results of an aquatic effects monitoring program indicate that an action level has been reached*" (WLWB 2010).

This framework was adopted from the Doris AEMP (TMAC 2016) that was reviewed and approved by the NWB, the Kitikmeot Inuit Association (KIA), the NIRB, Environment and Climate Change Canada (ECCC), Indigenous and Northern Affairs Canada (INAC), and Fisheries and Oceans Canada (DFO) during the Doris Project Type A Water Licence amendment process.

4.2. OBJECTIVES AND APPROACH

The overarching objective of the Response Framework is to protect the freshwater receiving environment in the Hope Bay Project area. The Response Framework acts as an early-warning system with defined action levels that trigger monitoring and/or management actions within an adequate timeframe so that significant adverse effects do not occur. The Response Framework consists of the following components:

- appropriate benchmarks and action levels such that Project-related environmental effects are investigated, and if necessary, mitigated, prior to any significant environmental effect occurring;
- a procedure by which mine-related environmental effects are assessed against defined action levels;
- a procedure for reporting exceedances of action levels;
- a procedure for developing Response Plans and proposing mitigation actions that may be implemented if action levels are exceeded; and
- a procedure for submitting Response Plans, and defining the process for reviewing and amending the Response Plans.

The Response Framework defines the process by which the results of the AEMP are compared to the benchmarks or triggers associated with pre-defined action levels, and the potential management responses initiated in response to reaching an action level. Figure 4.2-1 presents an overview of how the AEMP feeds into the Response Framework. The action levels used to screen the results of the AEMP are assigned the magnitudes ‘low’, ‘medium’, and ‘high’, which correspond to increasing magnitudes of effects to the aquatic environment, culminating in the exceedance of a ‘significance threshold’. A significance threshold is defined as “*the magnitude of environmental change which, if reached, would result in significant adverse effects*” (WLWB 2010). Setting low, medium, and high action levels below the significance threshold requires that mitigative action (if necessary) is taken well before a significant threshold is reached, so that any potentially adverse trends are stopped or reversed by the implementation of management actions in response to exceedances of action levels.

4.3. SIGNIFICANCE THRESHOLDS

A significance threshold is a level of change in any monitored variable that would be unacceptable to reach because it would result in a significant adverse effect to the aquatic environment (WLWB 2010). The significance thresholds are specific to each component of the AEMP.

For water and sediment quality, the significance threshold is defined as:

- The water and/or sediments of the monitored lakes have changed in such a way that a healthy aquatic ecosystem can no longer be supported.

For benthic invertebrates and plankton biomass, the significance threshold is defined as:

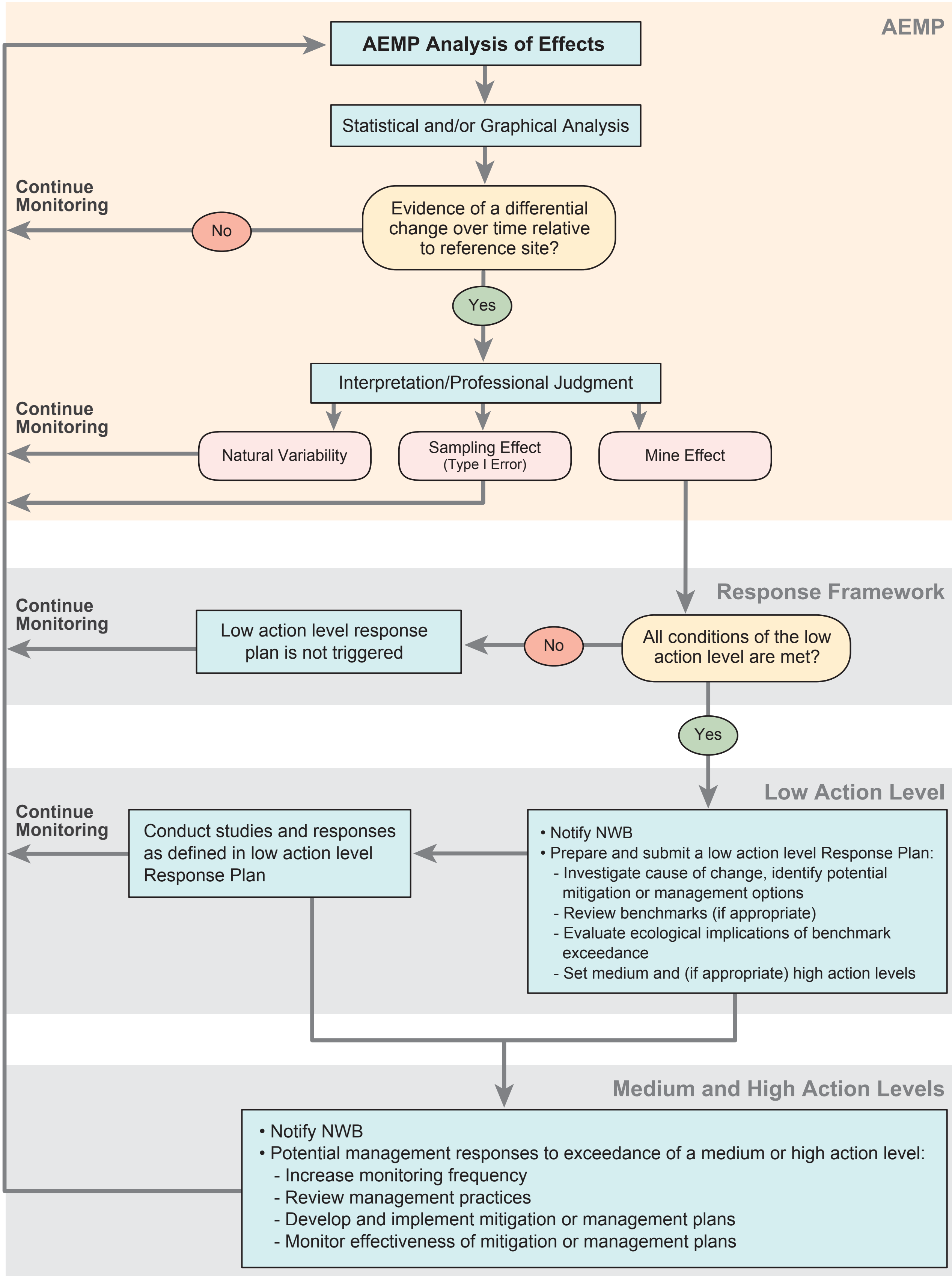
- The primary or secondary producers in the monitored lakes have changed in such a way that sufficient food for fish is no longer available.

4.4. ACTION LEVELS

The Response Framework includes three tiers of action levels: low, medium, and high. Low action levels are defined below for each monitored component. Medium and, if appropriate, high action levels will only be defined within the low action level Response Plan once the low action level is reached for any monitoring component (WLWB 2010). In some cases, the definition of the high action level may be deferred if specific and appropriate rationale is provided (e.g., additional research is required). The low action level for each monitored component is based on baseline data, and/or water or sediment quality guidelines, and/or recommended critical effects sizes for that component. Variation in monitored components within the normal baseline range, as defined by the data collected to date, will be considered negligible and will not trigger the low action level.

Figure 4.2-1

AEMP Analysis of Effects and Response Framework



4.4.1. Water Quality

The benchmarks used for water quality variables are the CCME water quality guidelines for the protection of aquatic life (CCME 2018b), presented in Table 4.4-1. Note that if the CCME guideline for a particular variable is updated after the submission of this Plan, the most up-to-date guideline will be used as a benchmark.

For each assessed water quality variable, the following conditions must be met for an exceedance of the low action level:

1. identification of a statistically significant and potentially adverse change[1] from baseline conditions when assessing the results of the AEMP for that water quality variable; and
2. the concentration of the water quality variable is outside of the normal range based on baseline concentrations; and
3. the concentration of the water quality variable exceeds 75% percent of a water quality benchmark; and
4. the absence of a similar change at the reference location.

Table 4.4-1. Freshwater Water Quality Benchmarks

Indicator	Variable	Benchmark[a]
pH	pH	6.5 – 9.0 pH units
TSS	TSS	Maximum average increase of 5 mg/L from background (for clear-flow waters; long-term exposure)
Turbidity	Turbidity	Maximum average increase of 2 NTUs from background (for clear-flow waters; long-term exposure)
Dissolved Oxygen	Dissolved Oxygen	9.5 mg/L (cold-water biota: early life stages); 6.5 mg/L (cold-water biota: other life stages)
Anions	Chloride	120 mg/L (long term)
	Fluoride	0.12 mg/L
Nutrients	Total Ammonia as N	pH- and temperature-dependent[b]
	Nitrate as N	3 mg/L (long term)
	Nitrite as N	0.06 mg/L
Metals	Aluminum	0.005 mg/L (if pH < 6.5); 0.1 mg/L (if pH ≥ 6.5)
	Arsenic	0.005 mg/L
	Boron	1.5 mg/L (long term)
	Cadmium	0.00004 mg/L for hardness (as $CaCO_3$) of < 17 mg/L; $10^{(0.83[\log(hardness)]-2.46)}/1000$ mg/L for hardness of ≥ 17 to ≤ 280 mg/L; 0.00037 mg/L for hardness of > 280 mg/L (long term)

[1] For most water quality constituents, only an increase would be considered a potentially adverse change; however, for dissolved oxygen concentration, only a decrease would be considered potentially adverse, and for pH, a change in either direction would be considered potentially adverse.

Indicator	Variable	Benchmark[a]
	Chromium	0.001 mg/L (hexavalent); 0.0089 mg/L (trivalent)
	Copper	0.002 mg/L for hardness (as $CaCO_3$) of <82 mg/L; $0.2*e^{(0.8545[\ln(hardness)]-1.465)}/1000$ mg/L for hardness of ≥ 82 to ≤ 180 mg/L; 0.004 mg/L for hardness of > 180 mg/L
	Iron	0.3 mg/L
	Lead	0.001 mg/L for hardness (as $CaCO_3$) of ≤60 mg/L; $e^{(1.273[\ln(hardness)]-4.705)}/1000$ mg/L for hardness of > 60 to ≤ 180 mg/L; 0.007 mg/L for hardness of > 180 mg/L
	Mercury	0.000026 mg/L
	Molybdenum	0.073 mg/L
	Nickel	0.025 mg/L for hardness (as $CaCO_3$) of ≤60 mg/L; $e^{(0.76[\ln(hardness)]+1.06)}/1000$ mg/L for hardness of > 60 to ≤ 180 mg/L; 0.15 mg/L for hardness of > 180 mg/L
	Selenium	0.001 mg/L
	Silver	0.00025 mg/L (long term)
	Thallium	0.0008 mg/L
	Uranium	0.015 mg/L (long term)
	Zinc	0.03 mg/L
Cyanide	Free Cyanide	0.005 mg/L (as free cyanide)

Notes:

[a] Source: The Canadian Water Quality Guidelines for the Protection of Aquatic Life, Summary Table (CCME 2018b). Note that when multiple guidelines are given (e.g., short and long term), the most conservative (i.e., lowest) guideline is included in the table.

[b] The CCME guideline for total ammonia depends on pH and temperature. For circumneutral freshwater (pH 6.5 - 7.5) at conservative temperatures (15°C), the guideline for total ammonia as N is 1.83 to 18.1 mg/L.

4.4.2. Sediment Quality

The benchmarks used for sediment quality variables are the CCME sediment quality guidelines for the protection of aquatic life (CCME 2018a), presented in Table 4.4-2. Note that if the CCME guideline for a particular variable is updated after the submission of this Plan, the most up-to-date guideline will be used as a benchmark. For each assessed sediment quality variable, the following conditions must be met for an exceedance of the low action level:

1. identification of a statistically significant increase in concentration from baseline conditions when assessing the results of the AEMP for that sediment quality variable; and
2. the concentration of the sediment quality variable is outside of the normal range based on baseline concentrations; and
3. the concentration of the sediment quality variable exceeds 75% percent of a sediment quality benchmark; and
4. the absence of a similar change at the reference location.

Table 4.4-2. Freshwater Sediment Quality Benchmarks

Sediment Quality Variable	Benchmark[a] (mg/kg)	
	ISQG	PEL
Arsenic	5.90	17.0
Cadmium	0.60	3.50
Chromium	37.3	90.0
Copper	35.7	197
Lead	35.0	91.3
Mercury	0.170	0.486
Zinc	123	315

Notes:
ISQG = Interim Sediment Quality Guideline; PEL = Probable Effects Level
[a] Source: The Canadian Sediment Quality Guidelines for the Protection of Aquatic Life, Summary Table (CCME 2018a).

4.4.3. Phytoplankton Biomass (as Chlorophyll *a*)

All of the following conditions must be met for an exceedance of the low action level for chlorophyll *a* concentration:

1. identification of a statistically significant change from baseline conditions when assessing the results of the AEMP for chlorophyll *a*; and
2. the concentration of chlorophyll *a* is outside of the normal range based on baseline concentrations; and
3. the absence of a similar change at the reference location.

4.4.4. Benthic Invertebrates

All of the following conditions must be met for an exceedance of the low action level for benthos community indicators (i.e., total density, Simpson's evenness index, taxa richness, and Bray-Curtis similarity index):

1. identification of a statistically significant change from baseline conditions when assessing the results of the AEMP for benthic community indicators; and
2. the benthos indicator is outside of the normal range based on baseline levels; and
3. the absence of a similar difference at the reference location; and
4. the magnitude of change exceeds the critical effects size of ± 2 within-reference-area standard deviations (SD), as recommended by Environment Canada (2012).

4.5. RESPONSE PLANS

If a low action level is exceeded, a Response Plan will be developed that contains the following components:

- general description of the monitoring component or variable;
- determination or confirmation of the action level exceedance;

- likely cause(s) of the exceedance;
- ecological consequences of the exceedance;
- proposed monitoring and management responses;
- definition of medium and, if appropriate, high action levels; and
- a proposed schedule for responses and any additional reporting.

These Response Plans will be specific to the environmental variable for which a low action level response has been triggered.

4.5.1. Low Action Levels

For low action levels, the Response Plan will include the setting of medium and potentially high action levels. In some cases, the definition of the high action level may be deferred if specific and appropriate rationale is provided (e.g., additional research is required). Monitoring and management response actions for a low action level Response Plan will be largely investigative, and may include the following:

- an investigation to verify the source(s) of observed change;
- a comparison to predictions made in the evaluation of effects (TMAC 2015, 2017);
- the evaluation or confirmation of ecological relevance;
- increased monitoring frequency;
- the planning or initiation of an issue-specific information collection program or study to define the magnitude, spatial extent, and reversibility of the effect;
- a review of the water or sediment quality benchmark or development of a site-specific objective; or
- the identification of possible mitigation options.

If a likely cause can be identified, management responses for a low action level may include updates to best management practices or standard operating procedures to improve the mitigation or avoidance of the mine-related effect.

4.5.2. Medium and High Action Levels

The management response actions in medium or high action level Response Plans will usually involve greater intervention to reflect the increased risk of exceedance of significance thresholds. These plans will incorporate options identified during investigations when the low action level is exceeded. Additional monitoring and management responses in medium and high action level Response Plans may include the following:

- an investigation to verify the causes(s) of observed change;
- investigation of mitigation options;
- increased monitoring frequency;
- monitoring additional aquatic components;
- further review of the water or sediment quality benchmarks or development of site-specific objectives;

- review and revision of facility water use and groundwater management practices to reduce water loss from Project lakes;
- selecting, planning for, and implementing a mitigation option such as modification of management plans, and/or modification of water and air quality management practices; or
- an assessment of the effectiveness of implemented mitigation options as part of the Response Plans for the variable in question.

4.6. CYCLICAL MONITORING AND REPORTING PROCESS

The environmental monitoring data collected through the AEMP will be fed into the Response Framework for assessment against action levels. The assessment will be conducted annually as part of the AEMP. If an action level exceedance is observed, a Response Plan will be prepared and submitted to the NWB along with the annual AEMP report or at a later date if approved by the NWB. Response Plans will also be reviewed and amended or updated as required.

5. REPORTING

5.1. ANNUAL AEMP REPORT

Following each AEMP monitoring year, an annual report will be prepared and submitted to the NWB by March 31 of the following year for distribution at their discretion. The annual report will include the following:

- All raw monitoring data obtained during that year of monitoring, including that collected under the MMER EEM program in Aimaokatalok Lake;
- A summary of annual Project activities;
- Description of the methods used for data collection;
- Description of QA/QC measures and results;
- A detailed evaluation of effects on the monitored components and variables;
- Results from the evaluation of effects, in text and figures;
- Conclusions from the evaluation of effects; and
- Response plans as triggered through the Response Framework.

5.2. MMER REPORTS

5.2.1. First Study Design Report

MMER requires that an initial study design be submitted to an authorization officer within 12 months of the mine becoming subject to MMER (Schedule 5, subsection 14(a)) and six months before biological monitoring is initiated (Schedule 5, section 15). Once triggered, this report will contain:

- a site characterization;
- a description of how the study respecting the fish population will be conducted;
- a description of how the study respecting the fish tissue will be conducted;

- a description of how the study respecting the benthic invertebrate community will be conducted;
- a sampling schedule for the biological monitoring; and
- a description of the QA/QC measures that will be implemented to ensure the validity of the data collected.

5.2.2. Cycle 1 Interpretative EEM Report

Pursuant to Schedule 5, subsection 18(a) of the MMER, the first interpretative report will be submitted within 30 months after the mine becomes subject to MMER. Once triggered, this report will contain the following information:

- documentation of latitude and longitude of sampling areas and a sufficient description of sampling areas to allow proper identification;
- schedule of sample collection;
- sample sizes;
- the results of data assessment with appropriate statistical analyses and all supporting raw data;
- the identification of any biological effects;
- the conclusions of biological monitoring and water quality studies, taking into account any other potential factors not related to the effluent (anthropogenic or natural), and a description of QA/QC measures that were implemented;
- a description of how future study design for monitoring will be affected by the results; and
- the date when next biological EEM cycle will commence.

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