BACK RIVER PROJECT

AQUATIC EFFECTS MANAGEMENT PLAN

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DOCUMENT DETAILS

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PROJECT NAME	Back River Project
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DOCUMENT HISTORY

Version	Date	Comments
Revision E.1	December 2013	This version of the Aquatic Effects Management Plan (AEMP) was the first conceptual design presented as a part of the draft Environmental Impact Statement (DEIS).
Revision G.1	November 2015	Revised AEMP submitted as part of the Final Environmental Impact Statement (FEIS). Updates were made to reflect improvements to the Project design, comments from DEIS reviewers, and inclusion of relevant commitments from the Nunavut Impact Review Board (NIRB) Pre-hearing Conference (PHC) Decision Report (December 2014). Specific updates related to sampling locations and descriptions, power analysis, AEMP sampling design and frequencies, and statistical analysis for water quality.
Revision G.2	February 2017	“Significantly Revised” AEMP that was submitted as part of the FEIS Addendum. As defined in the FEIS Addendum, “Significantly Revised” denotes new or updated information to that provided in the FEIS, such that the new document does not resemble the original document in respect of either format or content. Among the changes to the previous AEMP was the removal of the marine sampling component to focus the AEMP on the Project area under the jurisdiction of the Nunavut Water Board (NWB). In addition, the Proponent committed to working with the Kitikmeot Inuit Association (KIA) prior to the first technical meeting of the NWB water licensing process to update this AEMP and to develop adaptive management thresholds (Commitment FA-KIA-C-1).
1	October 2017	Update of the conceptual AEMP design plan from the FEIS to meet the requirements for the Type A Water Licence Application, and the objectives of an AEMP. Updated with consideration of Environment Canada’s Metal Mining Effluent Regulation (MMER) Environmental Effects Monitoring (EEM) technical guidance (MMTGD; Environment Canada 2012) and Aboriginal Affairs and Northern Development Canada’s (AANDC) AEMP guidance (AANDC 2009). This version was approved by NWB as part of the Water Licence approval.
2.0	December 2024	Updates to the document based on commitments made with respect to submissions received during the Technical and Public Hearing process for the Back River Project Type A Water Licence Application and according to the terms and conditions of the Type A Water Licence. Updates were also made to re-align the AEMP with recent changes to the Metal and Diamond Mining Effluent Regulations (MDMER), to update the Project description according to the 2019 Modification Package, to incorporate recommendations from the Aquatic Baseline Synthesis Report (Appendix A), to refine details of the sampling design and Response Framework, to reflect the change in Project ownership, and to consider the discharge of treated effluent from Echo Pit.

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ACRONYMS AND ABBREVIATIONS

AANDC	Aboriginal Affairs and Northern Development Canada (now CIRNAC)
AEMP	Aquatic Effects Management Plan
ANCOVA	analysis of covariance
ANOVA	analysis of variance
ARD/ML	acid rock drainage/metal leaching
B2Gold Nunavut	B2Gold Back River Corp.
BACI	before-after-control-impact
BCI	Bray-Curtis index
BMP	Best management practice
CALA	Canadian Association for Laboratory Accreditation Inc.
CCME	Canadian Council of Ministers of the Environment
CES	critical effect size
CI	control-impact
CIRNAC	Crown-Indigenous Relations and Northern Affairs Canada (previously AANDC)
CPUE	catch-per-unit-effort
DFO	Fisheries and Oceans Canada
ECCC	Environment and Climate Change Canada
EEM	Environmental Effects Monitoring
EIS	Environmental Impact Statement
FEIS	Final Environmental Impact Statement
GPS	global positioning system
GSI	gonadosomatic index
ISQG	Interim Sediment Quality Guideline
K	Fulton’s condition factor
KIA	Kitikmeot Inuit Association
LSI	liver somatic index
MAD	Main Application Document
MLA	Marine Laydown Area

MDMER	Metal and Diamond Mining Effluent Regulations
MMTGD	metal mining technical guidance document
NIRB	Nunavut Impact Review Board
n/a	not applicable
nMDS	non-metric multidimensional scaling
NWB	Nunavut Water Board
PEL	Probable Effect Level
QA/QC	quality assurance and quality control
SD	standard deviation
SDI	Simpson's diversity index
SE	standard error
SEI	Simpson's evenness index
SR	studentized residuals
SWP	Saline Water Pond
TF	Tailings Facility
the Project	Back River Project
TK	Traditional Knowledge
TOC	total organic carbon
TSS	total suspended solids
WIR	winter ice roads
WLB	water and load balance
WMP	Water Management Plan
YOY	young-of-the-year

1. INTRODUCTION

1.1 BACKGROUND

The Back River Project (the Project) is a gold project formerly owned by Sabina Gold & Silver Corp., now owned by B2Gold Back River Corp. (B2Gold Nunavut). The Project is located within the West Kitikmeot region of southwestern Nunavut. It is situated approximately 400 kilometres (km) southwest of Cambridge Bay, 95 km southeast of the southern end of Bathurst Inlet, and 520 km northeast of Yellowknife, Northwest Territories. The Project is located predominantly within the Queen Maud Gulf Watershed (Nunavut Water Regulations, Schedule 4).

The Project consists of two main areas with interconnecting winter ice roads (WIR): the Marine Laydown Area (MLA), situated along the western shore of southern Bathurst Inlet, and the Goose Property, where the mine site is located, approximately 160 km inland of the MLA. The majority of annual resupply is shipped to the MLA during the open water season and then transported down the approximately 160 km long WIR to the Goose Property during winter.

A conceptual Aquatic Effects Management Plan (AEMP) was prepared for the draft Environmental Impact Statement (EIS) and revised based on comments during the EIS evaluation process, with a version (Revision G.2) submitted in February 2017 as part of the final EIS addendum. A key revision was the removal of the MLA marine sampling program (which was instead outlined in a Marine Monitoring Plan) to focus the AEMP on the Goose Property area where the mining activity for the Project will occur. The AEMP was subsequently updated in October 2017 and included in the Water Licence application. This Version 1.0 was approved; however, the Type A Water Licence also required an updated AEMP to be submitted to NWB that addressed all comments and commitments made during the regulatory review of the Water Licence application. This document (Version 2.0) is the updated AEMP.

1.2 SCOPE AND OBJECTIVES

The overall purpose of the AEMP is to monitor the aquatic environment for Project-related effects, to assess and update predictions, and to provide the basis for informed management decisions to minimize, mitigate, and/or manage potential adverse effects on the environment. The core components of the AEMP includes monitoring of water quality, sediment quality, benthic invertebrate communities, and fish (health and tissue chemistry).

The AEMP is harmonized to meet Metal and Diamond Mining Effluent Regulations (MDMER) and associated Environmental Effects Monitoring (EEM) requirements (Government of Canada 2002). Should the Back River Project become subject to the MDMER, then this AEMP will satisfy the MDMER requirements as noted in Section 7.2.

This version of the AEMP was developed in consideration of commitments made during the regulatory review process. A number of these commitments were related to a review and supplementation of the baseline dataset (i.e., historical data collected up to 2016 and supplemental data collected more recently in 2017, 2018, 2021 to 2024); to meet these commitments, an Aquatic Baseline Synthesis Report was developed to report the results of the 2018 AEMP sampling program and evaluate the overall baseline dataset (data up to 2018). The updated AEMP refers to this synthesis report for baseline information. Other commitments were also addressed in this AEMP, specifically those made to the NWB and Environment and Climate Change Canada (ECCC) during the regulatory review of the Water Licence application.

The AEMP is a living document and will be updated, as necessary, based on regulatory changes, Project-related changes (including those described in the Modification Package [Sabina 2020]), incident investigations, the need for changes to existing mitigation measures, and input from regulators and the Kitikmeot Inuit Association (KIA). The AEMP includes an adaptive management response framework (Response Framework), which is central to the effective implementation of the AEMP, as it serves to identify changes to early-warning indicators that can trigger additional investigation, monitoring, or the implementation of additional mitigation measures.

Environmental monitoring outside the AEMP can be found in the Marine Monitoring Plan, Environmental Management and Protection Plan and the Water Management Plan (WMP).

1.3 APPLICABLE STANDARDS, GUIDELINES, AND REGULATION

This AEMP has been designed to comply with existing regulations and follow the available guidelines provided by the federal government and the Government of Nunavut. Applicable regulations and guidelines include the following:

- *Fisheries Act* (Government of Canada 1985), including the MDMER (Government of Canada 2002);
- Environment Canada's metal mining technical guidance document for EEM (MMTGD; Environment Canada 2012);
- Nunavut *Environmental Protection Act* (Government of Northwest Territories 1988);
- Nunavut Land Claim Agreement Act (Government of Canada 1993); and
- Mackenzie Land and Water Board and Aboriginal Affairs and Northern Development Canada AEMP Guidance (MVLWB and AANDC 2019).

2. MINE OVERVIEW

The Project involves the Construction, Operations, Closure, and Post-Closure of four open pit mines and four underground mines at the Goose Property.

The mine plan consists of open pit and underground mining at each of four deposits, supporting a 3,000 to 4,000 tonnes per day milling operation over an estimated 15-year mine life followed by a period of closure and reclamation. The four deposits are as follows:

- Echo;
- Umwelt;
- Llama; and
- Goose Main.

2.1 PROJECT PHASES

The AEMP has been designed to consider all phases of mine development, but with emphasis placed on construction and early operation in the current version. Updates are anticipated to the AEMP study design as the mine progresses through the four phases of development: Construction, Operations, Closure, and with additional monitoring and mitigation continuing into Post-Closure as needed.

Construction is defined as any activities undertaken for the purposes of establishing or constructing components, infrastructure, and facilities required for the development of a mine. Construction is currently underway and will continue in parallel to mining activity. Construction will involve dewatering, pit excavation and construction of tailing management and water management structures as well pads and roads. Major mine development infrastructure will be constructed at both the Goose property and the MLA. The AEMP will not be implemented until dewatering or effluent discharge is initiated to the freshwater receiving environment.

Operations is defined as the period that the Process Plant is operating and producing a commodity (i.e., gold). The mine is expected to operate for 15 years. Operations at the Project will focus on the economic recovery of gold and delivery to market. Pre-production activities (e.g., open pit pre-stripping, underground ramp pre-development) may occur as part of construction activities prior to, or in parallel with, the initiation of the Operations Phase. Other activities during Operations will include ongoing exploration supported by the Project Infrastructure and ongoing progressive reclamation.

Closure and Post-Closure is defined as an Operator ceasing operations at a facility without the intent of resuming mining activities. Most of the mine workings, tailings structures, and water management structures will be decommissioned during this time. Closure will occur over approximately seven years.

B2Gold Nunavut has proposed that Post-Closure monitoring be implemented for a minimum of five years, during which time performance monitoring and adaptive management will occur, if needed. The expectation is that the site will be reclaimed and Post-Closure monitoring will continue until it can be demonstrated that the mine site is both chemically and physically stable.

2.2 DISCHARGES TO THE RECEIVING ENVIRONMENT

Water on the Project site is categorized into three types: contact water (includes site contact water and mine contact water), non-contact water (i.e., runoff from undisturbed areas and raw water being dewatered from lakes), and intercepted groundwater (which is saline). Only non-contact water will be diverted off-site without treatment. Each type of water will be managed separately throughout each Project phase. Project discharges to the freshwater receiving environment include:

- dewatering of raw non-contact water from Llama and Umwelt lakes to Goose Lake, with or without treatment;
- dewatering of open pit contact water to Goose Lake (likely via tundra discharge), with or without treatment; and
- passive overflow of meromictic open pits and tailings facilities (TFs) containing contact and/or saline water to Goose Lake during post-closure via spillways where required.

Detailed descriptions of Project water management can be found in the WMP (which includes the Saline Water Management Plan) and the Dewatering Plan. All water discharged will meet applicable water licence discharge criteria established for the protection of the freshwater receiving environment, including raw non-contact water dewatered from Llama and Umwelt lakes. Any effluent discharged to the freshwater receiving environment must additionally meet MDMER discharge requirements.

2.3 ENVIRONMENTAL PROTECTION MEASURES

The WMP outlines B2Gold Nunavut's environmental protection measures for site water management. The objectives of the water management strategies are to:

- minimize the amount of water in contact with mine ore and wastes to reduce the volume of water requiring management;
- appropriately manage all contact water and discharges to protect aquatic resources; and
- implement water conservation and recycling practices to maximize water reuse and minimize the use of natural water.

Protection measures include the planning and design of engineered structures, the application of control technologies, the implementation of best management practices, and applying specific requirements from regulatory authorizations. With regards to managing Project effects on water quality, measures include:

- **Water use and conservation**: Water will be recycled to the maximum extent possible. Freshwater intake and discharge pipelines will be designed to limit erosion and sedimentation, and to prevent fish impingement on screens as per the *Freshwater Intake End-of-Pipe Fish Screen Guideline* (DFO 1995). Water withdrawal guidance will be followed to minimize impacts to fisheries.
- **Construction of fish-bearing water crossings**: Fisheries and Oceans Canada best management practices (BMP) will be implemented related to the construction, operation, and decommissioning of all fish-bearing water crossings. These practices include appropriate culvert design, timing windows for construction, sediment and erosion control, and protection of riparian vegetation.

- **Sediment and erosion control measures:** Surface water will be managed within the Project footprint such that sediment-laden runoff is minimized, intercepted and/or treated prior to entering downstream receiving waters or mine process facilities. Sediment and erosion management and control during initial and ongoing construction may involve establishing contact water collection ditches/berms, constructing sediment ponds, limiting land disturbance to a practical minimum, reducing water velocities across the ground through surface texturing and re-contouring, and progressively rehabilitating and stabilizing disturbed land surfaces to minimize erosion.
- **Saline water management:** Saline water inflows into the underground mine workings will be managed with the Saline Water Management Plan (included in the WMP). The strategy consists of collecting saline water from Llama Open Pit and the underground mine workings, then temporarily storing this groundwater in a dedicated storage facility (i.e., the Saline Water Pond) until it can be dewatered into Umwelt Reservoir and pumped back into the underground workings.
- **Mine runoff water management**: All mine runoff water will be collected through the use of diversions, collection ditches/berms and pipelines, and recycled to the extent possible. Mine contact water will be treated prior to discharge. Mine contact water will be discharged to land instead of direct discharge to surface water. Discharge to aquatic receiving environments will only occur if discharge criteria are meet.
- **Acid rock drainage/metal leaching (ARD/ML)**: Goose Property mine workings and waste rock represent a moderate ARD/ML potential; thus, the mine plan has been designed to minimize exposure time of the mine workings and waste rock to air/water. The bulk of the tailings that will be stored in the TSF will have a moderate to high ARD/ML potential, which has been taken into account by the Tailings Management Plan to prevent the development of ARD.

3. CONCEPTUAL SITE MODEL

3.1 INTRODUCTION

The conceptual site model for the AEMP considers linkages between the stressors identified in the Final Environmental Impact Statement (FEIS), changes to water and sediment quality from those stressors, the response by the receptors from changes in water and sediment quality, and changes in aquatic ecosystem function related to changes in aquatic interactions. Aspects of this conceptual site model inform water quality modelling for the Project with respect to predictions of water quality in the receiving environment.

3.2 STRESSORS OF CONCERN AND TRANSPORT PATHWAYS

As part of the FEIS, the residual effects (i.e., effects that remain following application of the management and mitigation measures outlined in the FEIS) of Project activities on valued ecosystem components were assessed. Residual effects of the Project were identified for water (FEIS Volume 6, Chapter 4, Section 4.5.4) and sediment quality (FEIS Volume 6, Chapter 5, Section 5.5.4). No residual effects were identified for fish (FEIS Volume 6, Chapter 6, Section 6.5.5).

Four Project components or activities with the potential for residual effects were identified:

- **Construction and Decommissioning Activities** - Project activities during the Construction phase include the clearing of overburden to construct Project infrastructure (e.g., buildings, roads, and mine works) and the construction of water management structures such as ditches, diversion structures, and berms. Dismantling of this infrastructure will occur in the Closure phase. These ground works have the potential to affect water quality in Goose Lake through runoff (i.e., the transport of material in overland flow by precipitation or snowmelt). Dewatering of Llama and Umwelt lakes to Goose Lake during the Construction phase also has the potential to affect water quality in Goose Lake.
- **Site Contact Water** - Runoff from Project infrastructure, including pad areas, laydown areas, roads, and airstrips has the potential to affect water quality in Goose Lake. There is the potential for effects in the Construction phase, before all water management structures are in place, and in the Closure and Post-Closure phases. Effluent from water management facilities, such as the emergency discharge pond (Sabina 2021) used to manage contact water, runoff or snowmelt (e.g., runoff or snowmelt collected in the Open Pits) may also be discharged to land if effluent discharge criteria defined in the Type A Water Licence are met.
- **Closure Release of Mine Contact Water** - Water that contacts mine surfaces once water management facilities are decommissioned, including runoff from waste rock storage areas and ore storage areas have the potential to affect water quality in Goose Lake. Overflow from the pits to Goose Lake will occur starting in the Closure Phase; overflow water quality from the pits may affect water quality in Goose Lake so it must meet water licence and MDMER criteria.
- **Explosives** - Project activities related to the use of explosives during all phases of the Project have the potential to deposit blasting residues (ammonia, nitrate, and nitrite) onto surfaces, with subsequent possibility of transport in runoff to Goose Lake.

A summary of the Project activities, water quality interaction pathways, and stressors of concern are provided in Table 3.2-1.

Table 3.2-1. Matrix of Project Activities, Interaction Pathways, and Residual Effects to Water Quality

Project Activity	Interaction Pathway	Project Phase	Stressors of Concern
Construction and decommissioning activities	Surface runoff	Construction, Closure	pH, TSS, major ions, nutrients, metals
	Direct discharge (lake dewatering)	Construction	TSS
Site contact water	Surface runoff	Construction, Operation, Closure, Post-Closure	pH, TSS, major ions, nutrients, metals
Mine contact water	Surface runoff, direct discharge (pit overflow)	Operation, Closure, Post-Closure	pH, TSS, major ions, nutrients, metals
Explosives	Surface runoff	Construction, Operation, Closure, Post-Closure	Nutrients (nitrogen species)

As a result of the above-noted Project linkages with surface water, predictions were made regarding residual effects of the Project to water quality. These predictions indicated that the effect would be:

- negative, with low to moderate magnitude;
- short to medium term in duration;
- sporadic and local in extent; and
- reversible.

The overall significance of these residual effects was rated as not significant (FEIS Volume 6, Chapter 4, Section 4.10).

3.3 EXPOSURE MEDIA AND ECOLOGICAL RECEPTORS

The aquatic monitoring components of the AEMP include exposure media (i.e., water quality, sediment quality, and fish tissue [when considering the consumption of fish]) and ecological receptors (i.e., benthic invertebrate communities and fish). Biological responses of ecological receptors to changes in water and sediment quality are considered through the AEMP. For example, changes in water quality or sediment quality may influence benthic invertebrate communities, which in turn may influence small and young fish upon which larger fish feed. The inclusion of exposure media and ecological receptors in the AEMP study design enables effective monitoring of the aquatic environment for changes that may result from Project activities.

Data will be collected through the AEMP to monitor changes in assessment and measurement endpoints (Table 3.3-1). Assessment endpoints reflect the overarching valued ecosystem components (i.e., water quality, sediment quality, fish/aquatic habitat, and fish communities) in the study area as specified in the FEIS. Measurement endpoints are the quantifiable and measurable metrics included in the AEMP, such as concentrations of metals or nutrients in water, or the density of benthic invertebrates (Table 3.3-1).

Table 3.3-1. Measurement and Assessment Endpoints

Aquatic Monitoring Component	Assessment Endpoint	Measurement Endpoint	Supporting Evidence
Water Quality	Suitability of water to support an aquatic ecosystem Suitability of water as a drinking source for people and wildlife Suitability of water for traditional and downstream uses	Concentrations of major ions, nutrients, and metals in direct discharge and surface waters in the receiving environment	Concentrations of toxicity-modifying parameters (e.g., pH, hardness, dissolved organic carbon) Sediment chemistry Concentrations of other parameters (e.g., chlorophyll *a*)
		Chronic toxicity response to the direct discharge	Water chemistry Sediment chemistry
Sediment Quality		Concentrations of metals and nutrients in surficial sediments	Water chemistry Sediment particle size and total organic carbon Sediment chemistry
Benthic Invertebrate Community	Maintenance of a functional benthic invertebrate community	Total invertebrate density and relative densities of dominant invertebrate groups	Water chemistry Sediment chemistry Physical habitat characteristics
		Taxonomic richness	
		Diversity and evenness	
		Benthic community composition	
		Benthic community similarity between exposure and reference areas	
Fish Health	Maintenance of fish health	Reproduction (energy use)	Water chemistry Sediment chemistry Benthic invertebrate communities Target species abundance (catch per unit effort) Fish tissue chemistry
		Condition (energy storage)	
		Survival (length-frequency distribution, age)	
Fish Tissue	Maintenance of fish tissue metal concentrations that do not pose a risk to wildlife or human health	Fish tissue chemistry (small-bodied fish, all metals; large-bodied fish, mercury only)	Water chemistry Sediment chemistry

3.4 IMPACT HYPOTHESES

The pathways and stressors of the conceptual site model were identified and developed with consideration of the residual effects identified in the FEIS (Table 3.2-1), and the measurement and assessment endpoints (Table 3.3-1). Based on this information, two impact hypotheses are proposed:

- Toxicological Impairment Hypothesis - toxicity to aquatic organisms due to release of substances of toxicological concern.
- Nutrient Enrichment Hypothesis – increased productivity from the release of nutrients.

Data collected and analyzed through the AEMP will be used to assess these hypotheses.

3.5 SUMMARY OF WATER QUALITY PREDICTIONS

During the Construction Phase, Llama and Umwelt lakes will be dewatered to Goose Lake. Llama and Umwelt lakes are upstream of Goose Lake and thus the quality of this dewatering discharge is expected to be similar to that in Goose Lake. If necessary, dewatering discharge will be treated prior to discharge to meet effluent quality limits for total suspended solids (TSS), turbidity, aluminum, and pH per Part D Item 26 of the Water Licence 2AM-BRP1831 (NWB 2021). Therefore, no changes to Goose Lake water quality are expected as a result of this dewatering discharge.

During the Construction and Operations phases, accumulated surface water runoff and snowmelt in open pits may be discharged to land to allow for mining to continue. This dewatering discharge will be treated to meet MDMER limits (Schedule 4, Table 1) and Type A Water licence limits (2AM-BRP1831 Amendment 1 Part F, Items 21 and 22), and discharged to land such that it is expected that the flow will ultimately reach Goose Lake. Although this discharge is expected to be limited in quantity, it is possible that the water quality in Goose Lake will be affected.

Starting in the first year of Closure (following an expected 15 years of operations), overflows from the pits that are compliant with water licence and MDMER criteria will discharge to Goose Lake, which may affect water quality in this lake and downstream. A hydrodynamic and water quality model was developed to assess the potential effects of Project activities on the water balance and water quality of Goose Lake (Golder 2022a). This modelling applied results from the updated water and load balance (WLB) model, which incorporated mitigation measures and modifications to the mine water management plan, including treatment. The following is a concise summary of the water quality predictions that are presented and discussed in more detail in Golder (2022a); this summary is focussed on results of most relevance to the design of the AEMP.

The modelling results indicate that concentrations of water quality parameters in Goose Lake are predicted to remain below applicable water quality guidelines and objectives at the edge of each mixing zone during closure, with the exception of phosphorus. Total phosphorus is predicted to be above benchmarks during the ice-cover period; however, exceedances may largely be the result of the conservative modelling approach adopted, whereby phosphorus is modelled conservatively (e.g., assuming no biological uptake). At closure, daily iron concentrations are predicted to be above the water quality benchmark for a short period during the ice-cover season at Goose Lake's tail, which is a small area that is seasonally disconnected from rest of Goose Lake. It should also be noted that, the lake outflow is frozen during the ice-cover season and no discharges from Goose Lake are anticipated during this period.

Given that the overflows from the pits are not expected to occur until the onset of closure, there will be time during Operations to improve the understanding of the system and chemistry of the water to be discharged. During this time, B2Gold Nunavut will continue to monitor site water quality, inflows' quantity and quality to the lake, and lake water quality. This information will be used to improve and refine the assumptions and approaches used in WLB and Goose Lake models, such as incorporating updates to source terms, water quality assumptions, the water management approach, updating site-specific water quality objectives, and if necessary, implementing mitigation (e.g., treatment options) before discharging to Goose Lake.

4. AQUATIC EFFECT MANAGEMENT PLAN OVERVIEW

4.1 KEY AEMP OBJECTIVES AND AEMP SCOPE

The impact hypotheses for the Project focus on toxicological impairment and nutrient enrichment. To address these hypotheses four key AEMP objectives were developed:

1. Comply with Water Licence conditions relevant to the AEMP requirements.
2. Determine the short and long-term effects of the Project on the aquatic environment.
3. Evaluate the accuracy of the Project effect predictions.
4. Assess the effectiveness of proposed mitigation and management measures and provide input to the adaptive management response framework.

The AEMP study design presented herein has been updated to address these AEMP objectives and key questions. Results of the AEMP will be evaluated annually and interpreted relative to these objectives.

The core of the AEMP was also designed to be consistent with the regulatory requirements of the MDMER as specified in the MMTGD (Environment Canada 2012) with respect to water quality monitoring (i.e., annual monitoring) and biological monitoring (i.e., surveys every three years for benthic invertebrates and fish). This will allow the AEMP to meet MDMER requirements when the Project becomes subject to the MDMER. Additional monitoring is included where necessary to meet the needs of the Type A Water Licence and FEIS commitments (i.e., additional water quality and biological sampling). Results from other monitoring programs for the Project may also be used to aid in the interpretation of the AEMP data, as appropriate.

Effluent characterization and water quality monitoring in Section 5 will meet the requirements of the MDMER (if/when it is applicable) and the Type A Water Licence, but will also support the interpretation of biological data. During the Construction Phase, effluent characterization involves collection of lake and/or pit dewatering discharge at the last point of control; these samples will be analyzed for concentrations of deleterious substances and other parameters, and tested for acute and chronic toxicity. Results will be incorporated in the annual AEMP report to support interpretation of water, sediment, and biological data.

4.2 STUDY DESIGN OVERVIEW

The study design and approach consider monitoring requirements in the Type A Water Licence and in the MDMER related to EEM, in addition to commitments made during the Water Licence regulatory process. The selection of sampling areas and stations considered those presented in the currently approved AEMP design (Sabina 2017), commitments made to ECCC during the Water Licence Application process, and areas sampled during previous baseline studies as reviewed in the Aquatic Baseline Synthesis Report, to the extent possible. The integrated approach to the study design facilitates alignment among components and effective use of the data collected. The proposed sampling effort involved is consistent with other comparable programs designed to monitor Project-related effects in Nunavut and the Northwest Territories.

4.2.1 BASELINE DATA EVALUATION

The Aquatic Baseline Synthesis Report evaluated sampling area compatibility, suitability of the compiled baseline dataset to support the AEMP design, and sufficiency of baseline data to support normal range calculations.

For all AEMP components, the exposure (Goose and Propeller lakes) and reference (Reference B Lake) areas were found to be compatible, such that statistical differences between exposure and reference areas can be evaluated with minimal potential confounding factors. Briefly:

- Overall, they have similar water and sediment quality, although some variability was noted within and among lakes.
- Stations have been identified that are similar in depth and sediment characteristics between Goose and Reference B Lakes, such that differences in benthic invertebrate communities can be assessed.
- Benthos in the reference and exposure areas are similar in community composition.
- Both target fish species (i.e., Slimy Sculpin [*Cottus cognatus*] and Lake Trout [*Salvelinus namaycush*]) are present in the study lakes, and their populations appear healthy and sufficient in number to support future fish health surveys; metal concentrations in tissues are similar in reference and exposure lakes.

The compiled baseline dataset was determined suitable for conducting a before-after-control-impact (BACI) statistical analysis for water quality, sediment quality, and benthic invertebrate community components, and for conducting a control-impact (CI) statistical analysis for the fish health and fish tissue chemistry components.

The compiled baseline data are sufficient to support normal range calculations. An adequate characterization of baseline conditions for normal range calculation requires that samples are collected across multiple years and seasons to address seasonal and year-to-year variability, and that spatial variability is appropriately represented. Sufficient baseline data are available to satisfy these criteria for all monitoring components and measurement endpoints for Goose Lake, which is the primary lake that may be impacted by dewatering discharge and mining activities.

The Aquatic Baseline Synthesis Report also identified the following needs for additional data to support the AEMP:

- Additional under-ice water quality data will be collected prior to the implementation of the AEMP to augment the under-ice dataset.
- Additional data for all components will be collected from Propeller Lake prior to the end of the Operations phase, before pit overflow discharge will result in a potential Project-related influence on this lake.

The NWB completed its technical review of the Aquatic Baseline Synthesis Report in November 2020 (NWB 2020). The following commitments were made in response to technical comments by KIA, CrownIndigenous Relations and Northern Affairs Canada (CIRNAC), and ECCC:

- To collect water quality data in Propeller Lake starting in Year 8 to accumulate at least three years of data before a potential Project-related influence on Propeller Lake water quality is expected to be observable[1].
- To collect another year of under-ice water quality data for Goose Lake and Reference B Lake.
- To collect additional Lake Trout data during the fish health surveys to augment the baseline dataset for normal range calculations.
- To replace non-detect analytical chemistry results with one-half the detection limit when calculating summary statistics and normal ranges, and before the data are statistically analyzed.

Additional baseline data were collected in 2021 including:

- Water quality during the ice-cover season in four areas in Goose Lake (i.e., West Bay, Central Basin, Southeast Basin, and Goose Lake Tail), one area in Reference B Lake, and one area in Propeller Lake (near centre).
- Water quality during the open-water season in four areas in Goose Lake (i.e., West Bay, Central Basin, Southeast Basin, and Goose Lake Tail) and two areas within Propeller Lake (i.e., north and south basins).
- Water quality during the open-water season, including during freshet, at several inflows and outflows of Goose Lake.
- Sediment quality and benthic invertebrate community in two areas in Propeller Lake (i.e., north and south basins).
- Fish health and tissue chemistry (mercury) of Lake Trout from Goose Lake and Propeller Lake.
- Fish health and tissue chemistry (metals) of Slimy Sculpin from two areas in Propeller Lake.

Water quality during the ice-cover season was also collected in 2022 in four areas in Goose Lake (i.e., West Bay, Central Basin, Southeast Basin, and Goose Lake Tail), two areas in Propeller Lake (north and south basins), and one area in Reference B Lake.

The data collection in 2021 and 2022 fulfilled all commitments for additional baseline data collection to support the AEMP.

4.2.2 SAMPLING AREAS

As summarized in the FEIS (Sabina 2015), the region surrounding the Project is characterized by extensive networks of lakes and streams within a hummocky landscape with low elevation relief and exposed bedrock uplands. Winter is extremely cold (mean monthly temperature is -33°C) and lakes are covered in ice between October and July, with ice thickness ranging from 1.5 to 2 m. Shallow lakes (<1.5 m) freeze to the bottom. Air temperature is highest in July (mean monthly temperature is 14°C). From 2006 to 2012, total annual precipitation ranged from 125 mm (2009) to 344 mm (2007), as measured by regional meteorological stations. Hydrology in the Project area is snowmelt-dominated, with peak flows in early May to mid-June. Streams are generally small and shallow, with low flows and water levels during the summer; many streams are ephemeral and flow only during freshet.

[1] At the time the commitment was made, it was assumed that open pit and TF overflow would start in Year 11 of Operations. The current mine plan (WMP, B2Gold Nunavut 2024a) indicates that overflow is not expected until Closure (i.e., starting in Year 16). Consistent with the spirit of the commitment, additional data collection in Propeller Lake is planned starting at least three years before overflow is expected.

The exposure area is defined as "all fish habitat and waters frequented by fish that are exposed to effluent," and the reference area is defined as "water frequented by fish that is not exposed to effluent and that has fish habitat that, as far as practical, is most similar to that of the exposure area" (Schedule 5, Section 1; Government of Canada 2002). Using these definitions, Goose Lake and Propeller Lake were selected as the exposure areas and Reference B Lake was selected as the reference area (Figure 4.2-1). A summary of the characteristics of these three waterbodies is provided below:

Goose Lake is located in the Ellice River Watershed, adjacent to the majority of the proposed mine infrastructure. This lake is located downstream and to the east of the Umwelt and Llama pits and north of the Goose Main and Echo pits. The lake receives inflows from several smaller lakes and ponds from the Giraffe, Llama, and Goose sub-watersheds. Goose Lake is approximately 278 metres above sea level (masl). Deep spots with a maximum depth of 34.6 m occur in the West Bay at the mouth of the lake (Rescan 2012). However, these deep spots are only located in isolated small areas within the West Bay; the majority of Goose Lake (including the West Bay) is shallower (ranging from 4 to 14 m in depth). Goose Lake has an estimated volume of 10,669,533 m^3, a surface area of 3,236,275 m^2, and shoreline length of 18,603 m (Sabina 2015). The outlet flows into Propeller Lake from the east end.

Propeller Lake is located in the Ellice River Watershed, downstream of Goose Lake and northeast of the proposed mine infrastructure. Propeller Lake is approximately 277 masl with a maximum depth of 17.1 m (Rescan 2014). Propeller Lake is approximately four times the size of Goose Lake with an estimated volume of 52,778,800 m^3, a surface area of 12,647,950 m^2, and shoreline length of 38,870 m (Sabina 2015). The outlet flows to the east and eventually enters the Arctic Ocean at the Queen Maud Gulf approximately 280 km north from the north end of Propeller Lake.

Reference B Lake is located in the Back River Watershed, approximately 15 km southeast of the Goose Property. Reference B Lake is approximately 313 masl with a maximum depth of 5.1 m (Rescan 2014). Reference B Lake is approximately a tenth of the size of Goose Lake with an estimated volume of 862,148 m^3, a surface area of 332,402 m^2, and shoreline of 2,980 m (Rescan 2014). The outlet flows to the southeast and enters the Arctic Ocean at Cockburn Bay over 500 km northeast from the southeastern end.

The exposure area (for water and biological sampling) is the area surrounding the point of entry of effluent from the final discharge point (Government of Canada 2002). This area varies during the Project life:

- During the Construction Phase, Llama and Umwelt lakes will be dewatered with discharge directed to Goose Lake. The expected path of the dewatering discharge will be through Goose Lake inflow into the west bay of Goose Lake ("Goose Neck"). Echo Pit will also be dewatered to manage snowmelt and runoff during freshet; this water will be treated to meet MDMER effluent quality limits and those of Part D, Item 21 of the Water Licence 2AM-BRP1831 before being discharged and eventually entering Goose Lake near the Echo Outflow, which is also near Goose Neck.
- During the Operations Phase, all site contact water will be stored on-site in the pits and ponds. There will be no direct discharge to Goose Lake.
- During the Closure Phase, Goose Main Reservoir and Umwelt TF will be actively filled with freshwater from Goose Lake or Big Lake while Llama Open Pit passively fills. Open pits and TFs will be equipped with spillways (where required) and allowed to overtop and discharge compliant water

to the receiving environment of Goose Lake, once monitoring confirms that discharge limits have been achieved. These discharges will enter the west bay and southeast basins of Goose Lake.

- During the Post-Closure Phase (and after reclamation and filling of the pits with water), the pits will continue overflow in perpetuity, and there will be runoff from the reclaimed facilities (e.g., stockpiles) to Goose Lake.

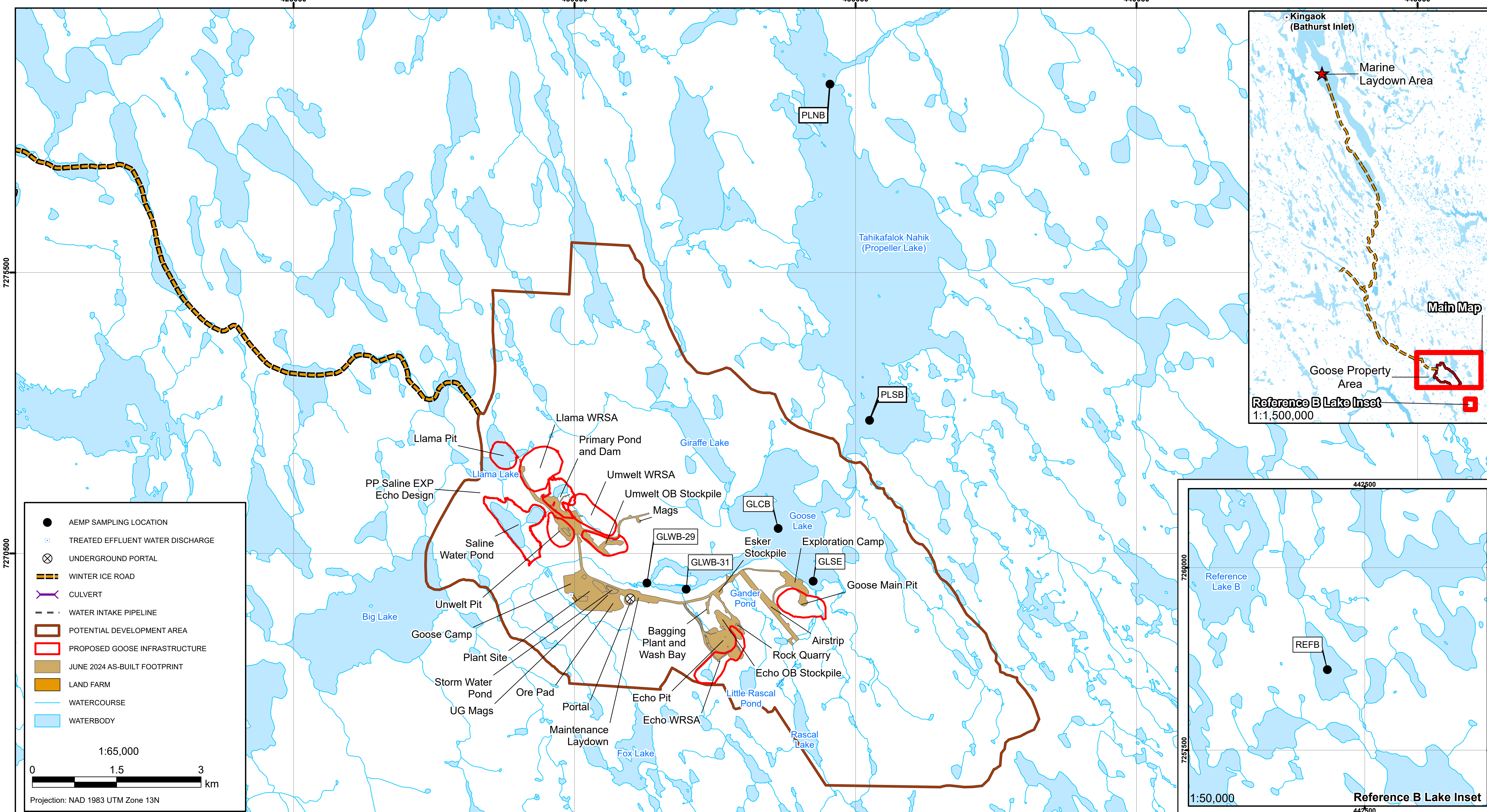
Given the variability of where discharge will first occur in Goose Lake, several sampling areas were established; a summary of sampling areas and locations are provided in Table 4.2-1.

Table 4.2-1. Waterbodies and Sampling Stations Included in the AEMP

Sampling Area	Waterbody	Waterbody Area	Type of Area	Sampling Location ID	Abbreviation
Exposure Area	Goose Lake	West Bay-inflow	Near-field for dewatering discharge in Construction, and for pit overflow in Closure	BRP-29A (near Goose Lake inflow)	GLWB-29
		West Bay-Echo	Near-field for Echo Pit dewatering discharge in Construction	BRP-31 (near Echo Outflow)	GLWB-31
		Central Basin	Mid-field	BRP-32	GLCB
		Southeast Basin	Near-field for pit overflow in Closure	BRP-33	GLSE
	Propeller Lake	South Basin	Far-field	BRP-35	PLSB
		North Basin	Within lake reference	BRP-36	PLNB
Reference Area	Reference B Lake	Mid-lake	Reference for Goose Lake	BRP-38	REFB

In Goose Lake, three near-field areas were established: one in West Bay near the Goose Lake inflow, one in West Bay near Echo Outflow, and one in the Southeast Basin (Figure 4.2-1). These near-field areas correspond to areas where discharges (dewatering and pit overflow) will first influence Goose Lake water quality, and will be the focus of biological monitoring studies. A mid-field area in the centre of the lake (Central Basin) will provide an overall indication of Project-related effects during non-discharge years.

In Propeller Lake, two sampling areas were identified during a reconnaissance survey in 2021: one area in the south basin and one in the north basin (Golder 2022b). Given the relatively large size of Propeller Lake, it is possible that the north basin can be used as a within-lake reference area for the south basin. Five stations that were within the target depth of 3 to 5 m were selected within each sampling area. Additional baseline data were collected in Propeller Lake in 2021 and 2022. In 2021, baseline data were collected on water quality, sediment quality, benthic invertebrate community, fish health and tissue chemistry (metals) in Slimy Sculpin, and fish health and tissue chemistry (mercury) in Lake Trout (Golder 2022b). In 2022, water quality during ice-cover conditions was measured at both sampling areas in Propeller Lake.



B2GOLD NUNAVUT

Figure 4.2-1

AEMP Sampling Locations
Goose Property Area, Back River Project

4.2.3 STATISTICAL DESIGN

The AEMP will initially employ a BACI statistical design approach to analyze the water quality, sediment quality, and benthic invertebrate data in Goose Lake and Reference B Lake. This design requires matching data between exposure (*impact*) and reference (*control*) areas, and between *before* and *after* periods. Five stations per sampling area are recommended to achieve sufficient power to detect a two standard deviation (SD) difference between exposure and reference areas in a control-impact analysis (Environment Canada 2012). Experience on other northern monitoring programs has also shown that five stations per sampling area results in an appropriate level of sensitivity to detect Project-related effects in a BACI analysis (e.g., De Beers 2019).

For the water and sediment quality components, the BACI test will be used to analyze data for "parameters of interest" identified by a multi-step screening assessment for each component. For the benthic invertebrate component, the BACI test will used to analyze calculated effect endpoints with the exception of the Bray-Curtis index, where Mantel's test will be used to compare communities between Goose Lake and Reference B Lake. In addition, benthic invertebrate data in these lakes will be summarized using the non-parametric ordination method of non-metric multidimensional scaling (nMDS; Clarke 1993) to evaluate potential differences in community structure among sampling areas and over time. Relationships with habitat variables will be evaluated if warranted by the degree of variation in habitat measurements, using tools such as Spearman rank correlation coefficients and examining scatter plots.

Effects in Propeller Lake will be assessed in consideration of those identified in Goose Lake (i.e., if there are no Project-related effects in Goose Lake, then no effects would be expected in Propeller Lake located downstream of Goose Lake). Should water quality in Goose Lake indicate the potential for effects in Propeller Lake, then the baseline data collected in Propeller Lake will be reviewed and an appropriate study design will be proposed for this lake.

For the fish health and tissue chemistry component, a CI statistical analysis will be used[2]. Normal ranges will also be used to evaluate whether effects are occurring due to the Project.

4.2.4 SAMPLING DESIGN AND FREQUENCY

The overall sampling design by component, stations, and samples per stations are provided in Table 4.2-2. Water quality monitoring in the lakes will occur during under-ice and open-water conditions, whereas the other components will be monitored during open-water conditions. The months in which each component will be monitored are:

- Water quality in lakes: April (under-ice) and August (open-water)[3].
- Sediment quality and benthic invertebrate community: August.

[2] The feasibility of doing a BACI statistical design for the fish health and tissue chemistry component will be evaluated in the first AEMP report with this monitoring component.

[3] Water quality will also be monitored in the exposure and reference areas during the Lake Trout survey, which will be conducted in July. This additional monitoring will only occur in years when the Lake Trout survey is conducted.

- Fish health and tissue chemistry (Slimy Sculpin): August.
- Fish health and tissue chemistry (Lake Trout): July.

April sampling may be omitted during phases of the Project when there is no under-ice discharge[4] or when there is no effluent discharge during the previous open-water season.

In years with effluent discharge to Goose Lake, water quality sampling in the near-field and reference areas will occur four times in the year: April, July, August, and September.

The sampling frequency will be:

- Annual for water quality.
- Every three years for sediment quality, benthic invertebrate community, and fish health.
- Every six years for fish tissue chemistry[5].

Not all sampling areas will be monitored every year. The schedule considers which near-field areas are most likely to be directly affected by each type of discharge, based on timing of discharge. That is, direct discharge to Goose Lake will be intermittent, in that the only planned discharge events are the dewatering of Llama and Umwelt lakes to Goose Lake in the Construction Phase, and the pit overflow discharge starting in the first year of the Closure Phase. The dewatering of Echo Pit may also occur in the Construction Phase. Dewatering discharge from Llama and Umwelt lakes and Echo Pit is also expected to enter Goose Lake via the West Bay, whereas pit overflow discharge will enter both via the West Bay and Southeast Basins. If measurable effects on water quality are observed in Goose Lake, then monitoring can be extended downstream to Propeller Lake to evaluate the geographic extent of the effects.

In the first few years of the AEMP, when dewatering discharge is expected to reach Goose Lake, monitoring will occur in Goose Lake West Bay (GLWB), Goose Lake Central Basin (GLCB), and Reference B Lake (REFB):

- In years when the Echo Pit is dewatered of surface runoff and snowmelt, and this dewatering discharge is expected to enter Goose Lake via Echo Outflow. The exposure areas to be monitored in Goose Lake in association with this discharge are GLWB-29 and GLCB.
- In years that the Llama and Umwelt lakes will be dewatered, water quality will be monitored at GLWB-31 (near Goose Lake inflow) as well as at GLWB-29 and GLCB in Goose Lake.

Sediment quality, benthic invertebrate community, and fish health and tissue chemistry will be monitored in the year after the dewatering discharge was initiated[6].

When there is no direct discharge to Goose Lake, monitoring will be reduced to annual water quality sampling in GLCB and REFB, except as necessary to maintain compliance with the MDMER. Aspects of the schedule, such as the sampling areas and monitored components, may be revised based on the

[4] No under-ice discharge is planned.

[5] Frequency of fish tissue chemistry monitoring may increase to every three years if triggered under the MDMER or if a fish-tissue related effect is observed.

[6] B2Gold Back River Corp. committed to ECCC and KIA to initiate biological monitoring studies in the year after dewatering discharge.

results of the previous years' monitoring. For example, an action in response to a Low Action Level exceedance in the Response Framework may be to add an unplanned sampling area or event to the next year's monitoring.

Per B2Gold Nunavut's commitment to collect supplemental information in Propeller Lake at least three years prior to the initiation of pit overflow to augment the existing baseline dataset, monitoring in this lake will be initiated later in the operations phase for all components (i.e., water quality, sediment quality, benthic invertebrate community, and fish health and tissue chemistry). Monitoring in Goose Lake Southeast Basin (GLSE) would also be added at this time.

Previous versions of the AEMP included water quality monitoring at lake outlets in early spring (June; one to two weeks after freshet) and August. Stream sampling was removed from this version of the AEMP according to the following rationale:

- Water quality monitoring in lakes is sufficient to track changes in water quality due to the Project, and to characterize water quality entering downstream waterbodies.
- Previous versions of the AEMP selected stream sampling stations to be similar to the locations modelled in the water quality model and assumed that these stations could be used as compliance points. In the updated water quality model for the Project, the hydrodynamic model can predict water quality at multiple locations within the lake, and can identify where in the lake water quality guidelines and objectives will be met. Thus, monitoring at lake stations will be sufficient to evaluate the accuracy of the Project effect predictions.

Table 4.2-2. Overview of the Aquatic Effects Management Plan Sampling Design by Component, Stations, and Samples per Station

Waterbody	Sampling Area[1]	Sampling Location ID	Number of Stations[2]	Number of Samples per Station or Area per Sampling Event							
				Water Quality		Sediment Quality (composite)	Benthic Invertebrate Community (composite)[3]	Fish Health		Fish Tissue	
				Full Chemistry	Chlorophyll *a*			Slimy Sculpin (Lethal Survey)	Lake Trout (Non-lethal Survey)	Slimy Sculpin (Lethal Survey)	Lake Trout (Non-lethal Survey)
Goose Lake	West Bay at Echo Outflow (GLWB-31)	BRP-31	5	1 or 2[4]	1 (average of triplicates)	1	1	60 per area[5]	100 per lake	8 male and 8 female per species per area[5]	16 (range of body lengths)
	West Bay at Goose Lake Inflow (GLWB-29)	BRP-29a	5	1 or 2[4]	1 (average of triplicates)	1	1	-		-	
	Central Basin (GLCB)	BRP-32	5	1 or 2[4]	1 (average of triplicates)	1	1	-		-	
	Southeast Basin (GLSE)	BRP-33	5	1 or 2[4]	1 (average of triplicates)	1	1	60 per area		8 male and 8 female per species per area	
Propeller Lake	South Basin (PLSB)	BRP-35	5	1 or 2[4]	1 (average of triplicates)	1	1	60 per area	100 per lake	8 male and 8 female per species per area	16 (range of body lengths)
	North Basin (PLNB)	BRP-36	5	1 or 2[4]	1 (average of triplicates)	1	1	60 per area		8 male and 8 female per species per area	
Reference lake	Reference (REFB)	BRP-38	5	1 or 2[4]	1 (average of triplicates)	1	1	60 per area	100 per lake	8 male and 8 female per species per area	16 (range of body lengths)

Notes: - = area not sampled for monitoring component.
1. Not all sampling areas will be monitored in every year. GLWB will be monitored in the year of dewatering discharge and the following year. GLWB, GLSE, PLSB, and PLNB will be monitored later in operations, prior to initiation of pit overflow. GLCB and REFB will be monitored in every year.
2. Number of stations applies to water quality, sediment quality, and benthic invertebrate community sampling only; fish will be sampled in the same areas, but from habitat appropriate to the sentinel species.
3. At one station per sampling area, three individual grab samples will be preserved, processed, and identified separately, to provide an indication of within-station variability and verify adequacy of three subsamples per composite sample. Once within-station variability is established, this will be discontinued and five composite samples will be collected within each area for processing and taxonomic identification.
4. Lake water samples will be collected at 1 m below water or bottom of ice, which is consistent with baseline sampling methods. For lake stations greater than six metres deep, an additional sample will be collected at mid-depth.
5. The first small-bodied fish health survey (i.e., the year after the first dewatering discharge) will focus on the exposure area in Goose Lake where discharge is expected to have the greatest influence.

4.3 INCORPORATION OF TRADITIONAL KNOWLEDGE/INUIT QAUJIMAJATUQANGIT

Traditional Knowledge (TK) can be defined as a "cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission" (NIRB 2007). Traditional Knowledge studies provide a valuable way of documenting spatial and temporal patterns of hunting, harvesting, fishing, habitation and travel in a given area. They can also provide detailed information on local ecological processes, socio-cultural patterns and institutions, spirituality, ethical, and other matters.

B2Gold Nunavut recognizes the inherent value of TK and the importance local communities place on its use in the environmental assessment of proposed developments. As such, B2Gold Nunavut has made significant efforts to engage local communities through incorporation of their TK into Project planning and design. Volume 3 of the FEIS describes B2Gold Nunavut's approach to TK and the methods used to collect and interpret it. Specific details as to how TK has been incorporated into these activities are summarized in Volume 3, Section 3.1, Table 3.1-1 "Uses of Traditional Knowledge in Sabina's Final Environmental Impact Statement for the Back River Project" of the FEIS, and are described in further detail in relevant volumes of the FEIS.

B2Gold Nunavut has utilized six primary sources of TK:

- a Naonaiyaotit Traditional Knowledge Project database report for the Project;
- theme-based TK workshops;
- a report on existing and publicly available Northwest Territories TK;
- the results of public consultation and engagement activities;
- a TK study on the Bernard Harbour Arctic Char fishery; and
- other sources.

Likewise, Inuit Qaujimajatuqangit values have helped guide the decision making for the Project and have been incorporated into the design of the company's overall Project management approach. B2Gold Nunavut partnered with the KIA on two key elements of its TK work: preparation of the Naonaiyaotit Traditional Knowledge Project database report and execution of the theme-based TK workshops. The basis of this partnership was a TK Agreement signed between Sabina (now B2Gold Nunavut) and the KIA in May 2012. Signing of this agreement provided B2Gold Nunavut with access to TK held by the KIA in the Naonaiyaotit Traditional Knowledge Project database. The agreement also outlines the terms and conditions pertaining to B2Gold Nunavut's use of the TK. B2Gold Nunavut and the KIA additionally cooperated in the collection and reporting of new (or otherwise unrecorded) TK in the Project area.

Traditional Knowledge and Inuit Qaujimajatuqangit collected through the FEIS process was considered in the development of the AEMP. For example, Lake Trout was identified as a preferred species (FEIS Volume 3, Section 3.1, Table 3.1-1) and this species has been carried forward as one of the sentinel species for use in the AEMP. Linkages between water quality and wildlife and fish are recognized by the Inuit, and thus monitoring for water quality, and detecting of changes to water quality, is a key component to the AEMP; water quality monitoring is considered an early warning to potential changes or effects to biological and human receptors. B2Gold Nunavut has also established and Inuit

Environmental Advisory Committee with whom project monitoring programs and program results are regularly reviewed and input, TK, and recommendations gathered. During future program revision and interpretation of results, TK and Inuit Qaujimajatuqangit will continue to be considered and integrated as appropriate.

5. AEMP STUDY DESIGN DETAILS

5.1 WATER QUALITY

5.1.1 OBJECTIVES

The water quality program was designed to meet the Type A Water Licence requirements as well as MDMER water quality monitoring requirements for EEM with objectives as follows:

- Characterize and interpret water quality in the aquatic receiving environment (i.e., Goose Lake and Propeller Lake) for the purpose of identifying Project-related effects.
- Verify predictions made in the FEIS and other submissions to the NWB regarding effects on water quality, as applicable.
- Collect water quality as supporting data for the fish and benthic invertebrate components.
- Support and inform the Action Level assessment as part of the Response Framework (Section 6).
- Recommend any necessary and appropriate changes to the water quality component of the AEMP for future years.

5.1.2 SAMPLING APPROACH

Water quality samples in the exposure and reference areas will be collected to evaluate Project effects on water quality, and provide supporting information for the assessment of benthic invertebrate communities and fish. The parameter suite is provided in Table 5.1-2. Sampling frequency is as stated in Section 4.2.4. Within each lake sampling area, water quality samples will be collected from five replicate stations chosen to be of similar water depth and substrate type (to the extent possible) and at least 20 m apart (per Environment Canada 2012) and within a target water depth of 3.0 to 5.0 m to be consistent with baseline data.

Table 5.1-2. Summary of Field Measurements and Analytical Parameters to be Measured in Receiving Environment Samples

Group	Receiving Environment (Water Quality)
Field Measurements	Field pH, specific conductivity, dissolved oxygen, turbidity, water temperature, Secchi depth (open-water), total depth, ice thickness (winter)
Conventional Parameters	Turbidity, laboratory pH, specific conductivity, total hardness, total alkalinity, TDS (measured and calculated), TSS
Major Ions	Calcium, chloride, fluoride, magnesium, potassium, sodium, sulphate
Nutrients	Ammonia-nitrogen (total and un-ionized), total Kjeldahl nitrogen, nitrate-nitrogen, nitrite-nitrogen, orthophosphate, total dissolved phosphorus, TP, DOC, reactive silica
Cyanide	Total cyanide, free cyanide, WAD cyanide
Total and dissolved metals[1]	Aluminum, arsenic, barium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, silver, strontium, thallium, uranium, vanadium, zinc
Other	Radium-226, chlorophyll *a* (open water only)

Notes:
1. The term metals as used includes non-metals (i.e., selenium) and metalloids (i.e., arsenic).

TDS = total dissolved solids; TSS = total suspended solids; TP = total phosphorus; DOC = dissolved organic carbon; WAD = weak acid dissociable.

5.1.3 FIELD METHODS AND LABORATORY ANALYSIS

The following field measurements will be recorded when samples are collected from lake stations:

- field profiles (measured every 0.5 m) of specific conductivity, pH, water temperature, dissolved oxygen, and turbidity;
- total water depth;
- sample collection depth;
- ice thickness (in winter); and
- Secchi depth (in open-water).

Lake water samples will be collected at 1 m below the water or ice surface, consistent with baseline sampling methods, with an additional sample to be collected at mid-depth for lake stations greater than six metres deep. Lake samples will be collected with a Kemmerer (or similar) discrete sampler.

Samples will be collected in bottles provided by the analytical laboratory, and sample processing will be undertaken according to laboratory instructions and best practices. Ice-packs will be added to the coolers to keep the samples as cool as possible during shipping, and samples will be shipped to the analytical laboratory as soon as possible after sample collection and processing. The suite of parameters to be analyzed in the receiving environment samples is provided in Table 5.1-2. Samples will be analyzed by an accredited laboratory at detection limits lower than applicable water quality guidelines. Target analytical detection limits and recommended analytical methods for each parameter are provided in Appendix B, Table B-1.

5.1.4 DATA ANALYSIS AND INTERPRETATION

Effluent Characterization

Information about effluent quality (chemistry and toxicity) and quantity (total volume) as collected under the WMP and Dewatering Plan will be obtained from the annual reports to support interpretation of the AEMP results.

Lake Water Quality

Descriptive statistics will be calculated from data collected from each exposure area and the reference area for all water quality parameters (i.e., mean, median, minimum, maximum, SD and standard error [SE] values). Field measurements at 1 m below water surface of specific conductivity, pH, water temperature, dissolved oxygen, and turbidity will be included in the calculation of these summary statistics. Field vertical profile data will also be plotted to evaluate any changes in water quality with depth.

Water quality data from the lake exposure areas will be evaluated by a multi-step process that involves comparisons to AEMP benchmarks and normal ranges. This approach serves to focus statistical analysis on parameters of interest to provide information most relevant for the Action Level Assessment and to evaluate whether effects are occurring due to the Project. A BACI statistical analysis will be used to analyze the water quality data further to compare exposure and reference areas, both spatially and over time. Evaluation of the statistical results will also be supported by visual evaluation of time series plots for parameters of interest.

Comparisons to AEMP Benchmarks

Water quality data will be compared to AEMP benchmarks. The AEMP benchmarks will be based on current and applicable federal aquatic life guidelines for the protection of aquatic life (e.g., CCME 1999, Government of Canada 2023) and drinking water quality guidelines (Health Canada 2024), in addition to approved Site-specific Water Quality Objectives (SSWQO) for the Project. If parameter concentrations naturally exceeded water quality guidelines under baseline conditions[7], then the AEMP benchmark will be based on the baseline mean plus two standard deviations. When the AEMP benchmark is based on baseline mean plus two standard deviations, a comparison will also be made to water quality guidelines.

Normal Range Calculations

Water quality parameters will be compared to normal ranges. The Aquatic Baseline Synthesis Report confirmed that the compiled 2010 to 2018 baseline dataset is suitable to support normal range calculations for water quality variables for Goose Lake. Review and analysis of the compiled baseline dataset indicated that water quality data collected in Goose Lake was similar among sampling areas and thus normal ranges can be calculated on the pooled data for the entire Goose Lake. Some variability was observed at Goose Lake West Bay area during under-ice conditions, with slightly higher concentrations of some parameters but concentrations were low, with median and 95th percentile concentrations varying less than two-fold among sampling areas. The additional baseline under-ice water quality data collected in 2021, 2022, and 2024 will address this uncertainty. If appropriate, normal ranges may be updated with future AEMP reference area data as they become available to further characterize natural variability.

Project-related influence on Propeller Lake water quality is not expected until closer to the end of operations/closure, and B2Gold Nunavut has committed to collecting three years of additional baseline data prior to closure as part of the AEMP for further characterization to support normal range calculations for this lake in the future.

Identification of Parameters of Interest

Parameters with mean/median values that exceed the normal range will be identified as “parameters of interest” and further evaluated in the BACI statistical analysis. Parameters with mean/median concentrations below the upper limit of their normal range will not be evaluated further because those concentrations are within the expected range for background conditions without the Project.

Part I, item 2 of the Water Licence states that the AEMP must include an adaptive approach to managing nutrients in Goose Lake through an adaptive management response framework. This condition is in response to a concern raised by KIA with regards to modelled projections of elevated phosphorus concentrations during ice-covered conditions, and the potential for increased algal growth during the open-water season. To address this concerns, nutrients (specifically TP and TN) and chlorophyll *a* will be carried forward as parameters of interest and evaluated under the adaptive management response framework (Section 6) regardless of whether concentrations exceed the normal range.

[7] The Aquatic Baseline Synthesis Report identified some parameters that naturally exceeded applicable guidelines under baseline conditions.

Analysis of Parameters of Interest

A BACI design will be employed to statistically compare exposure and reference areas, spatially and over time, supported by visual assessment of time series and spatial plots. This approach will provide an analysis of spatial patterns and visually assessed temporal trends to determine if parameters are increasing over time, if parameters are increasing above guidelines, if there are differences between the exposure and reference areas, and if concentrations are diverging over time. Statistical tests will be considered significant at a *P*-value less than (<) 0.1, as recommended by the MMTGD. The results of the lake water quality assessment will feed directly into the Action Level Assessment described in Section 6.

Comparison to Water Quality Predictions

If a significant difference between reference and exposure areas is identified that reflects divergence from background conditions, it will be evaluated further to determine whether the observed change in water quality is within FEIS and updated water quality predictions (e.g., from the hydrodynamic model [Golder 2022a]).

Description of Effluent Mixing in the Receiving Environment

Llama and Umwelt lakes will be dewatered to Goose Lake via the West Bay. Results from the analysis of dewatering discharge and water quality monitoring in the GLWB-31 area will be used to describe the manner in which the dewatering discharge mixes within this exposure area.

The treated effluent from the Echo Pit dewatering will eventually enter Goose Lake via Echo Outflow. During the discharge period when treated effluent is expected to occur in the GLWB-29 area, a plume delineation study will be conducted to assess the mixing and dispersion of the treated effluent in the lake. Specific conductivity will be used as an indicator of the presence of treated effluent in the lake. Characterization of the plume will be completed by assessing the spatial delineation of the plume, both vertical and horizontal. To do this, specific conductivity will be measured at multiple locations and three depths (1 m below water surface, mid-depth, 1 m above lake bottom) in GLWB-29 along radiating transects from Echo Outflow. The concentration of effluent at 100 m and 250 m from Echo Outflow will be calculated based on the results from the analysis of effluent monitoring.

Starting in the first year of the Closure Phase, pit overflow discharge will occur to Goose Lake. A plume delineation study will be planned during discharge to describe how the pit overflow discharge mixes in Goose Lake.

5.1.5 QUALITY ASSURANCE AND QUALITY CONTROL

The Quality Assurance and Quality Control (QA/QC) procedures govern all aspects of the AEMP, including field methods, laboratory analyses, data management and reporting. The Quality Assurance/Quality Control Plan, developed as required by the Water Licence (Part I, Item 14), applies to B2Gold Nunavut's monitoring programs for the Project, including the AEMP. The objectives of the Plan are to confirm that the chemical data collected are representative, of known quality, properly documented, and scientifically defensible. A brief summary of QA/QC procedures specific to the water quality component are provided below:

- Samples will be collected following a standard sampling protocol by qualified personnel using suitable sampling equipment.
- Quality control samples (i.e., duplicates and blanks) will comprise a minimum of 10% of all samples collected.
- Appropriate procedures for sample collection, preservation, and handling will be detailed in specific work instructions provided to and reviewed with the field crews. Samples for laboratory analysis will be filtered and preserved (as required), and stored in a cool environment before shipping to the laboratory.
- Samples will be analyzed by a commercial laboratory accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA).
- Upon receipt of data from the laboratory, the field blank and duplicate analyses will be verified for potential contamination and accuracy, respectively.

In addition to the above, the following steps to confirm that the data are of acceptable quality will include:

- verification that all samples were analyzed and that parameters requested were analyzed to target detection limits;
- review of laboratory QC results (e.g., method blanks, laboratory duplicates, certified reference materials) for unacceptable variation;
- evaluation of field QC results against data quality objectives (e.g., relative percent difference of >25% for field duplicates; measurable results of more than five times the detection limit in blanks);
- logic checks on total dissolved solids and conductivity, hardness and alkalinity, total and dissolved phosphorus, total and dissolved carbon, and total and dissolved metals; and
- check of any unusual results in follow-up discussion with the laboratory.

Office-related QA includes using appropriately trained personnel for each task, senior review of work, standardized data handling/summary tools, filing of original data, and establishment of a data management system (e.g., database).

5.2 SEDIMENT QUALITY

5.2.1 OBJECTIVES

The sediment quality program was designed to meet the Type A Water Licence requirements and MDMER sediment quality monitoring requirements for EEM with objectives as follows:

- Characterize and interpret sediment quality in the aquatic receiving environments (i.e., Goose Lake and downstream in Propeller Lake) for the purpose of identifying Project-related effects.
- Verify predictions made in the FEIS and other submissions to the NWB regarding effects on lake bottom sediment quality, as applicable.
- Collect sediment quality data to support the benthic invertebrate component.
- Support and inform the Action Level assessment as part of the Response Framework (Section 6).
- Recommend any necessary and appropriate changes to the sediment quality component of the AEMP for future years.

In the currently approved AEMP study design, sediment quality is intended to be a supporting component of the AEMP, in that sediment quality, on its own, will not be used as a basis for triggering response actions through the Response Framework. Rather, sediment quality data will be used to support the benthic invertebrate community component that will be used as a basis for triggering response actions.

5.2.2 SAMPLING APPROACH

Sediment sampling stations are co-located with the benthic invertebrate stations, and aligned with the sampling of other components, where possible. Sediment samples will be collected in the exposure and reference areas to provide supporting information for the assessment of benthic invertebrate communities and evaluate Project effects on lake sediments. Sampling frequency is as stated in Section 4.2.4.

Sampling during late summer/fall (e.g., August) is proposed, and five replicate stations will be sampled within each area. Sampling station locations within each lake area have been selected to be of similar water depth and substrate type (to the extent possible and to be confirmed in the field), and at least 20 m apart, at a targeted depth range between 3.0 and 5.0 m. For a given year, there might be some variability in specific sampling locations to standardize water depth and substrate.

5.2.3 FIELD METHODS AND LABORATORY ANALYSIS

Bottom sediment samples will be collected within each area during the benthic invertebrate program in accordance with the MMTGD (Environment Canada 2012), as well as the specific handling requirements of the accredited laboratory. Samples will be collected using a standard grab sampler from five stations per area, within the targeted depth range to the extent possible. Surficial sediment will be collected from the top 2 cm of the grab, and material from three grabs will be combined and homogenized into a composite sample in the field. Physical descriptions of the sediment samples will be recorded and photographs of samples taken to provide visual documentation.

Samples will be collected in containers provided by an accredited analytical laboratory, with sample processing undertaken according to laboratory instructions and best practices. Ice-packs will be added to the coolers to keep the samples as cool as possible during shipping, and samples will be shipped to the analytical laboratory as soon as possible after sample collection and processing. The suite of parameters to be analyzed in the samples is listed in Table 5.2-1. Sediment quality samples will be analyzed by an accredited laboratory at detection limits lower than applicable sediment quality guidelines. The proposed analytical detection limits for each parameter are provided in Appendix B, Table B-2.

Table 5.2-1. Sediment Quality Parameters

Group	Parameters
Particle Size[1] and Moisture	gravel, sand, silt, clay, moisture
Nutrients and Carbon	total phosphorus, total nitrogen, total organic carbon
Metals[2]	aluminum, antimony, arsenic, beryllium, boron cadmium, chromium, copper, iron, lead, manganese, mercury, molybdenum, nickel, silver, strontium, thallium, tin, titanium, uranium, vanadium, and zinc

1. PSA-3 Sieve-SK/PSA-pipet+Gravel-SK [sieve+pipette]) as recommended by the MMTGD (Environment Canada 2012). A comparison of current and previous analytical methods is provided in Appendix A.
2. The term metals as used includes metalloids (i.e., arsenic).

Supporting environmental information of field profiles (pH, water temperature, dissolved oxygen, specific conductivity, turbidity), total water depth, will also be collected as described in Section 5.1.3. Sediment characteristics will be recorded.

5.2.4 DATA ANALYSIS AND INTERPRETATION

Descriptive statistics will be calculated from data collected from each exposure area and the reference area for all sediment quality parameters (i.e., mean, median, minimum, maximum, SD and standard error [SE] values).

As with the water quality data analysis, sediment quality data from the lake exposure areas will be evaluated by a multi-step process that involves comparisons to sediment quality guidelines and normal ranges. This approach serves to focus statistical analysis on parameters of interest to provide information most relevant for the Action Level Assessment and to evaluate whether effects are occurring due to the Project. A BACI statistical analysis will be used to analyze the sediment quality data further to compare exposure and reference areas, spatially and over time. Evaluation of the statistical results will also be supported by visual evaluation of time series plots for parameters of interest.

Comparisons to Sediment Quality Guidelines

Sediment quality AEMP benchmarks are not proposed; rather, applicable Canadian Sediment Quality Guidelines developed by the CCME will be used (i.e., interim sediment quality guidelines [ISQGs] and probable effect levels [PELs] (CCME 1999, 2002). The ISQG is the concentration of a substance below which an adverse effect on aquatic life is unlikely, and the PEL is the concentration of a substance above which adverse effects are expected to occur frequently, but not always. In practice, the application of generic numeric guidelines has yielded a high percentage of false positives (Chapman and Mann 1999). The observation of a sediment concentration above the PEL value for a given parameter should not be interpreted as an indication that actual ecological harm has occurred or will occur, but rather that this is a possibility.

Normal Range Calculations

Within Goose Lake, sediment quality was comparable among sampling areas, with the exception of Southeast Basin, which was characterized by sandier sediments, lower total organic carbon (TOC), and lower concentrations of most metals. Consequently, two normal ranges will be calculated for Goose

Lake; one for Goose Lake West Bay and Central Basin combined, and one for Goose Lake Southeast Basin. This will make sure that the normal ranges captured the natural spatial and temporal variability in particle-size and some metals, as identified within and among AEMP sampling areas by the baseline synthesis report. As appropriate, normal ranges may be updated with future AEMP reference area data as they become available to further characterize natural variability.

Identification of Parameters of Interest

Parameters with mean/median values that exceed the normal range will be identified as "parameters of interest" and further evaluated in the BACI statistical analysis. Parameters with mean/median concentrations below their normal range will not be evaluated further because concentrations are within the expected range for background conditions without the Project.

Analysis of Parameters of Interest

A BACI design will be employed to statistically compare exposure and reference areas, spatially and over time, supported by time series and spatial plots. This approach will provide an analysis of spatial patterns and visually assessed temporal trends to determine if parameters are increasing over time, if parameters are increasing above guidelines, if there are differences between the exposure and reference areas, and if concentrations are diverging over time. Statistical tests will be considered significant at a *P*-value less than 0.1, as recommended by the MMTGD.

For those parameters identified for further evaluation, available data will be reviewed and if metal concentrations show a strong relationship with fine sediments and/or TOC, normalization of the metals data to fines and/or TOC will be considered. Environment Canada (2012) recommends that particle-size and TOC results be used to determine if there are habitat differences between exposure and reference areas. Normalization of metal data is a procedure that aims to reduce the influence of particle-size or TOC on metal concentrations to minimize these potential confounding factors on comparisons between sampling areas.

The results of the lake sediment assessment will provide supporting information to interpret the results of the benthic invertebrate Action Level Assessment described in Section 6.

Comparison to FEIS Predictions

If a significant BACI effect is obtained that suggests divergence from background conditions in a sampling area, it will be evaluated further to determine whether the observed change in sediment quality is mine-related and within FEIS predictions. The FEIS predicted changes in water quality due to release of mine contact water to the aquatic receiving environment, which could result in increased concentrations of some metals (e.g., arsenic, copper) and nitrogen (due to explosive use) in sediments (Sabina 2015). More recent modelling, as summarized in Section 3.5, also indicated that phosphorus concentrations in lake water may increase, which could also result in increased concentrations in sediment. Lake sediments may act as a sink for nutrients, but some of the deposited phosphorus may be released back into the water column during periods of low dissolved oxygen concentrations at the lake bottom. This may enhance plankton biomass, which would eventually settle to the lake bottom, potentially resulting in an increased food supply for benthic invertebrates.

5.2.5 QUALITY ASSURANCE AND QUALITY CONTROL

The summary of the QA/QC procedures provided in Section 5.1.5 also pertains to sediment quality with a few minor differences. For both water and sediment, the QA/QC procedures will be documented in the annual AEMP reports and the QC data will undergo an assessment against data quality objectives.

5.3 BENTHIC INVERTEBRATE COMMUNITY

5.3.1 OBJECTIVES

Benthic invertebrate community monitoring was designed to meet the Type A Water Licence requirements and MDMER monitoring requirements for EEM with objectives as follows:

- Evaluate benthic invertebrate communities in the aquatic receiving environment for the purpose of identifying Project-related effects.
- Verify predictions made in the FEIS and other submissions to the NWB regarding effects on benthic invertebrate communities, as applicable.
- Support and inform the Action Level assessment as part of the Response Framework (Section 6).
- Recommend any necessary and appropriate changes to the benthic invertebrate community component of the AEMP for future years.

5.3.2 SAMPLING APPROACH

Benthic invertebrates will be sampled in conjunction with sediment quality to collectively provide biological and supporting data to evaluate Project effects on benthic invertebrate communities. Benthic samples will be collected within a standard depth range and comparable substrate type at the sampling stations. A synthesis of the 2010 to 2018 baseline benthic invertebrate data for Goose and Reference B lakes in the Aquatic Baseline Synthesis Report identified sampling stations similar in depth and sediment characteristics between Goose and Reference B Lakes, such that differences in benthic invertebrate communities could be assessed with minimal interference from among-lake habitat variation.

Benthic invertebrate samples will be collected in the exposure and reference areas to evaluate Project effects on benthic invertebrate communities. Sampling frequency is as stated in Section 4.2.4. Five replicate stations will be sampled within each area. Sampling station locations within each lake area have been selected to be of similar water depth and substrate type (to the extent possible and to be confirmed in the field), and at least 20 m apart, at a targeted depth range between 3.0 and 5.0 m. For a given year, there might be some variability in specific sampling locations to standardize water depth and substrate.

Sampling in August is proposed, because sampling benthic invertebrates in late summer/early fall is preferrable in Canada due to relatively high diversity at this time and presence of larger invertebrates that can be sampled using standard sampling equipment and identified to the desired taxonomic levels in the laboratory (Environment Canada 2012).

5.3.3 FIELD METHODS AND LABORATORY ANALYSIS

Benthic invertebrate samples will be collected according to the MMTGD (Environment Canada 2012) using a standard grab sampler (Ekman) from a boat anchored at each sampling station. Samples will be collected at a 10 to 15 cm penetration depth and percent grab fullness will be documented for each grab.

At four of the five replicate stations per area, three individual grabs will be combined to prepare a composite sample. All samples will be sieved through a 500 µm mesh screen, and material retained in the mesh will be placed into a single pre-labelled container. Samples will be preserved in 10% neutral buffered formalin. A second internal waterproof label will be inserted into each sample bottle and the sample bottle lids will be sealed prior to shipping. At the fifth station, the three grab samples will be processed as three separate field sub-samples to characterize within-station variability. Once within station variability has been sufficiently characterized for the AEMP, and adequacy of three subsamples per composite sample verified, one composite field sample will be collected at all replicate stations. An evaluation will be conducted in the first year of benthic invertebrate sampling resulting in a recommendation to inform future sampling programs.

Sediment samples for chemistry (e.g., metals, nutrients, and carbon content) and particle size distribution will be collected concurrently at each replicate station as described in Section 5.2.3. Other supporting environmental information will include in situ water quality measurements (i.e., field profiles of pH, water temperature, dissolved oxygen, specific conductivity), water depth, and photographs of the sampling areas and representative samples.

Preserved benthic invertebrate samples will be shipped to a qualified taxonomist for processing, enumeration, and identification to the lowest taxonomic level (typically genus) using current literature and nomenclature. Organisms that cannot be identified to the desired taxonomic level (e.g., immature, or damaged specimens) will be reported as a separate category at the lowest level of taxonomic resolution possible. This will typically be the family level, which is the level recommended in the MMTGD (Environment Canada 2012).

5.3.4 DATA ANALYSIS AND INTERPRETATION

Data Storage and Screening

Raw invertebrate abundance data will be received from the taxonomist in electronic format. Review of raw invertebrate abundance data for subsequent data analysis will involve removal of non-benthic organisms (e.g., Cladocera, Copepoda), meiofauna that are not reliably enumerated using 500 µm mesh sampling gear (e.g., Nematoda and Harpacticoida; Environment Canada 2012, 2014), and terrestrial invertebrates. Consistent with the approach taken in the Aquatic Baseline Synthesis Report for the 2011 to 2018 baseline dataset analysis, Ostracoda will also be excluded from the dataset prior to analysis because these invertebrates can be found in patches of extremely high numbers and can there therefore bias sample densities, thus affecting the benthic community analysis. For that reason, Environment Canada (2014) recommended Ostracods be removed before data analysis.

Prior to data analysis, data from individual grab samples (field sub-samples) will be pooled so all replicate stations will be represented by one set of taxon abundances.

Benthic Effect Endpoints and Community Composition

Consistent with the MMTGD, the following benthic invertebrate effect endpoints will be calculated from the taxonomic data and used to evaluate whether changes in the benthic invertebrate community have occurred:

- total invertebrate density (as organisms per m^2);
- lowest taxonomic level richness, which is the total number of taxa present at a station at the lowest taxonomic level;
- family-level richness, which is the number of families present at a station;
- Simpson's diversity index (SDI) and Simpson's evenness index (SEI), calculated based on family-level data; and
- Bray-Curtis index (BCI), calculated based on family-level data.

For the community endpoints listed above, the following descriptive statistics will be calculated for each sampling area: mean, median, SD, SE, and minimum and maximum values. Benthic community variables will be presented graphically for each sampling area to allow visual evaluation of spatial and temporal patterns.

Community composition will be further represented by relative abundances (i.e., as percentage of total density) of major taxonomic groups. Changes in benthic invertebrate community composition over time at the major group level will be assessed by plotting the mean relative densities of major taxa by sampling area, as stacked bar graphs.

Normal Range Calculations

The benthic invertebrate endpoints listed above will be compared to normal ranges. The Aquatic Baseline Synthesis Report confirmed that the compiled 2011 to 2018 baseline dataset is suitable to support normal range calculation for benthic invertebrate endpoints for Goose Lake, to meet AEMP objectives. Data collected since 2018 (e.g., in 2021) will be added to the dataset. Additional sampling will be required in Propeller Lake to allow calculation of normal ranges. The potential for Project-related influence on Propeller Lake water quality is not expected until closer to the end of operations/closure. Additional baseline data can therefore be collected prior to this period to support normal range calculations for this lake.

Normal ranges will be calculated using pre-discharge data available from Goose and Reference B Lakes, with one or more normal ranges potentially calculated for Goose Lake to account for habitat differences among lake areas. Inclusion of these data in the normal range calculation is intended to make sure that the normal ranges capture the natural spatial and temporal variability in benthic community variables, as identified within and among AEMP sampling areas by this baseline report. As appropriate, normal ranges may be updated with future AEMP reference area data as they become available, to further characterize natural variability.

Statistical Analysis

Statistical analyses will be conducted to evaluate potential differences between exposure and reference areas, over time. The analysis will be focussed on addressing the benthic invertebrate community component objectives. Statistical tests will be considered significant at a *P*-value less than 0.1, as recommended by the MMTGD. Post hoc power analysis will be conducted for non-significant results to determine the actual power to detect an ecologically meaningful effect (i.e., the critical effect size [CES]) in the relevant endpoints.

Prior to statistical analysis, data will be screened for outliers and potential data entry errors using box-and-whisker plots for each endpoint. The validity of outliers will be confirmed, and if warranted, these values will be corrected or removed from the data matrix. Outliers that are removed from the analyses will be reported and reasons for removal will be documented.

Before-After-Control-Impact (BACI) Statistical Analysis and Comparison to Normal Ranges

With the exception of the BCI, a BACI statistical analysis will be used to analyze the benthic invertebrate endpoints listed above to compare exposure and reference areas both spatially and over time. This analysis will be undertaken to assess potential effects on the benthic invertebrate community resulting from changes in water and sediment quality in near-field (West Bay, Southeast Basin) and mid-field (Central Basin) areas of Goose Lake. Evaluation of the statistical results will be supported by visual evaluation of time series plots for parameters of interest. In addition to the BACI analysis and time series plots, normal ranges will be used to evaluate whether effects are occurring due to the Project. Magnitude of effects will be assessed by comparing community endpoints in near-field and mid-field areas in Goose Lake to a normal range relevant to the exposure area.

Where significant differences between reference and exposure areas are identified for standard EEM endpoints, the magnitude of differences between area means will also be calculated, as required by the MDMER. The CES will be calculated as plus or minus two SD (±2 SD) of the reference area mean.

Bray-Curtis Index - Mantel's Test

For the BCI, a statistical analysis approach will be employed that uses a combination of Bray-Curtis dissimilarity matrices on log-transformed data combined with a Mantel's test (Mantel's test of dissimilarity matrix comparison), as recommended by Borcard and Legendre (2013). Mantel's test is a statistical test based on a linear correlation between two dissimilarity matrices. Borcard and Legendre (2013) recommend use of the Pearson correlation coefficient between two dissimilarity matrices, and concluded that the BCI - Mantel's test combination provides sufficient power for data with lognormal distributions and avoids the risk of an inflated Type I error. The MDMER does not set a CES for the BCI; because Mantel's test is a multivariate test of a correlation, a CES cannot be calculated as a difference between means. Borcard and Legendre (2013) suggest an alternate approach which will be further evaluated during analysis of the benthic invertebrate data.

Non-metric Multidimensional Scaling (nMDS)

To further assess differences in benthic community composition between sampling areas, community structure will also be summarized using the non-parametric ordination method of non-metric multidimensional scaling (Clarke 1993). This ordination method allows visual identification of community-level differences among areas by representing abundance data in two or three dimensions. A Bray-Curtis dissimilarity matrix will be generated on log(x+1) data, and the nMDS procedure will be applied to this matrix where, using rank order information, the relative position of stations in terms of taxa abundances can be determined on an ordination plot. Goodness-of-fit will be determined by examining stress values.

Lower stress values (i.e., less than 0.10) indicate a greater goodness-of-fit of ordination results to the input data, whereas higher stress values (i.e., greater than 0.20) must be interpreted with caution, and higher dimensions (i.e., 3-D) might be needed to describe the dataset (Clarke 1993).

Assessment of Relationships with Habitat Variables

If warranted based on the magnitude of habitat variation, relationships between habitat variables and benthic invertebrate endpoints will be evaluated using Spearman rank correlation coefficients and examining scatter plots. Habitat variables to be considered may include water depth, sediment grain size (e.g., percent fine sediments), and total organic carbon content, aquatic vegetation cover and potentially other variables. In addition, where appropriate, the findings of the benthic invertebrate data analysis will be further interpreted in light of results of other monitoring components, such as changes in sediment and water quality.

Comparison to FEIS Predictions

If BACI analysis identifies a significant divergence between reference and exposure area benthic communities over time, results will be evaluated further to determine whether the observed change in the benthic community is within FEIS predictions. The FEIS predicted changes in water and sediment quality but all concentrations were predicted to remain below toxicity thresholds for primary producers, aquatic invertebrates, and fish (Sabina 2015). Toxicological impairment of lower trophic organisms is not expected. Increased nutrients (e.g., nitrogen, phosphorus) in water (Sabina 2015; Golder 2022a) may increase productivity of phytoplankton, and ultimately the benthic invertebrate community. It is expected that ecological function of the benthic invertebrate community will be maintained.

5.3.5 QUALITY ASSURANCE AND QUALITY CONTROL

Office-related QA will include using appropriately trained personnel for each task, senior review of work, standardized data handling/summary tools, filing of original data, and establishment of a data management system (e.g., database). Samples will be collected following standard sampling protocols by qualified personnel using appropriate sampling equipment. Samples will be analyzed by qualified taxonomists using techniques consistent with the MMTGD.

Quality control procedures will include estimating sample sorting efficiency and subsampling accuracy and precision, should subsampling be required. Ten percent of the samples will be re-sorted. A reference collection will be prepared, consisting of several representative specimens from each taxon. The reference collection will be archived with the taxonomist, for possible comparative purposes with benthic invertebrate community data from future studies and QC of future taxonomic identification.

5.4 FISH

5.4.1 OBJECTIVES

The fish health and tissue chemistry program was designed to meet the Type A Water Licence requirements and MDMER biological monitoring requirements for EEM with objectives as follows:

- Evaluate fish health and fish tissue chemistry in the aquatic receiving environment for the purpose of identifying Project-related effects on the growth, reproduction, survival or condition of fish, or on metal concentrations in fish tissue.
- Verify predictions made in the FEIS and other submissions to the NWB regarding effects on fish health and tissue chemistry, as applicable.
- Support and inform the Action Level assessment as part of the Response Framework (Section 6).
- Recommend any necessary and appropriate changes to the fish health and tissue chemistry component of the AEMP for future years.

5.4.2 SAMPLING APPROACH

Biological sampling to assess fish health and fish tissue chemistry will employ a lethal and a non-lethal fish health survey. The fish health survey will focus on two fish species, per the MMTGD. The lethal survey will target Slimy Sculpin, and the non-lethal survey will target Lake Trout. Fish will be monitored in at least Goose Lake and Reference B Lake[8], in habitat appropriate to the species.

Slimy Sculpin are small-bodied, relatively short-lived fish that occupy small home-ranges and, therefore, reflect local conditions. As outlined in Section 4.2.4, multiple sampling areas have been identified in Goose Lake. The selection of the near-field area corresponds to where the greatest influence to water quality is expected to occur. The fish health and fish tissue chemistry survey will target Slimy Sculpin in the fall (i.e., August), as they begin to develop their gonads for spawning the following spring.

Lake Trout are susceptible to long-term population level effects from lethal sampling, therefore, a non-lethal sampling program is proposed. Due to the relatively large home range of Lake Trout (i.e., Lake Trout are anticipated to move freely throughout Goose Lake), sampling is anticipated to occur throughout Goose Lake, while focusing effort in suitable habitat within the near-field area as reasonable. The survey will target Lake Trout in the spring (i.e., July), as they are most active in the spring and target sample sizes may be best achieved during this time.

5.4.3 FIELD METHODS

5.4.3.1 TARGET NUMBERS

The lethal fish health survey with Slimy Sculpin will initially target 20 mature male, 20 mature female, and 20 juveniles from each site. A power analysis will be conducted after the first year of data collection to determine whether these target sample sizes are sufficient to achieve appropriate statistical power as

[8] As discussed in Section 4.2.4, monitoring in Propeller Lake will occur at least three years prior to the initiation of pit overflow, and may be occur earlier pending the results of previous years' monitoring.

described in the MMTGD. The survey will be conducted in the year following dewatering discharge and every three years thereafter if there is effluent discharge to Goose Lake[9].

Slimy Sculpin carcass (i.e., whole body with internal organs and head removed) samples will be collected during the fish health survey and submitted for fish tissue chemistry analyses. Unless required to meet EEM requirements, tissue chemistry will only be analyzed every six years. Schedule 5, Part 2, Section 9(1)(c) of the MDMER requires a fish tissue study regarding mercury and selenium to be conducted as part of the EEM study if effluent characterization reveals an annual mean concentration of total mercury in effluent that is equal to or greater than 0.10 µg/L (based on a detection limit less than 0.10 µg/L) or if effluent characterization reveals either a concentration of total selenium in effluent that is equal to or greater than 10 µg/L or an annual mean concentration of total selenium that is equal to or greater than 5 µg/L.

For the non-lethal Lake Trout population survey, a minimum target sample size of 100 Lake Trout (juvenile and adult) is proposed for each lake, in line with the MMTGD. Non-lethal tissue samples will be collected using biopsy plugs (Baker et al. 2004) from a subsample of fish covering a range of sizes. A target sample size of eight fish per lake is proposed. A power analysis will be conducted after the first year of data collection to determine whether these target samples sizes are sufficient to achieve appropriate statistical power. With non-lethal sampling, it is not possible to differentiate between male and female Lake Trout in the spring, therefore, biopsy samples will be collected from individuals of unknown sex. Unless required more frequently to meet EEM requirements (as described above for Slimy Sculpin), tissue chemistry will be analyzed every six years.

5.4.3.2 COLLECTION METHODS

Fish will be collected via angling, gillnets, beach seines, and backpack electrofishing. Sampling locations will be determined by the presence of appropriate habitat. As much as is reasonably possible, the same amount of effort will be expended using each fishing method within each lake to minimize any possible sampling bias among lakes. For each sampling event, the following information will be recorded:

- time (in hours [for netting and trapping] or seconds [for electrofishing]) for each fishing effort for each gear type, including check and re-set times;
- gear specific parameters (e.g., distance/area seined);
- water depth for each fishing effort by gear-type;
- Global Positioning System (GPS) coordinates of each fishing effort;
- water quality field measurements (e.g., dissolved oxygen, water temperature, pH, specific conductivity); and
- number of each fish species captured.

Observations of substrate type and weather conditions may also be recorded, when notable. Fish collected for the surveys will be held in aerated containers before processing; non-lethally sampled fish will be live-released near the location of capture following processing. All fishes collected will be enumerated and measured for length and weight and released live (including non-target species).

9 Similar to the MDMER EEM requirements, biological monitoring is not expected to be conducted when there has been no effluent discharge to Goose Lake in the 36 months previous to the last biological monitoring study.

5.4.3.3 LETHAL SURVEY

Slimy Sculpin to be processed as part of the lethal survey will be sacrificed by a concussive blow to the back of the head followed by cervical dislocation (i.e., cutting the spinal cord immediately behind the head). An internal examination will proceed immediately following sacrifice. The work area will be covered with clean plastic wrap that will be changed after each fish to minimize cross-contamination, and all utensils will be washed and rinsed with 10% nitric acid between fish.

An external photograph will be taken of each lethally sampled Slimy Sculpin and the following information will be documented:

- species name;
- total length (± 1 millimetres [mm]);
- total body weight (± 0.001 grams [g]);
- physical abnormalities (e.g., wounds, tumours, parasites, fin fraying, gill parasites, or lesions);
- internal pathology (e.g., liver and kidney colour, fat content);
- parasite weight (if present; ± 0.001 g);
- sex;
- liver weight (± 0.001 g);
- whole gonad weight (± 0.001 g);
- photograph of whole gonad (under 10× magnification on microscope, if possible);
- state of maturity (i.e., reproductive development categories per Table 5.4-1);
- carcass weight (± 0.001 g); and
- age (by laboratory analysis, ± 1 year).

The following tissue samples will be collected:

- gonad for histology to confirm reproductive stage; each fish (2 lobes male, 1 lobe female);
- gonad from adult females for fecundity analysis; 1 lobe;
- carcass for tissue chemistry (whole body minus head, gut, and aging structures); 8 adult male and 8 adult female; and
- otoliths for laboratory ageing; adults only.

All samples collected will be labelled and stored appropriately. All sample labels will include fish identification number, tissue type, and analyses required. For tissue chemistry, carcasses will be placed in separate clean plastic bags and labelled appropriately, including fish identification number, tissue type, and analyses required.

Internal pathology (i.e., tissue colour and condition) will be observed and recorded immediately following the opening of the body cavity. Liver weight will be recorded and, during the excision of the liver, if the gall bladder is observed, percent fullness of the gall bladder will be recorded. Stomach fullness will be noted along with a general description of gut contents and parasite load.

Gonads will be weighed (i.e., total gonad weight) for all lethally sampled fish. Photographs will be taken of representative normal gonads, as well as any abnormalities. If possible, a photograph will be taken of each gonad, through the microscope to support the QA/QC and interpretation of gonad histology results. All gonads will be placed individually in labelled vials and preserved in 10% buffered formalin for histology. If eggs are visible macroscopically, the gonad lobes will be weighed individually and preserved in separate, appropriately labelled vials; one lobe will be submitted for a gonad maturity histology assessment, and the other will be submitted for fecundity analysis.

Carcass weight (i.e., body without liver, gonads, stomach, intestines, other viscera and ageing structures) will be measured and recorded for each fish.

5.4.3.4 POPULATION SURVEY

All Lake Trout captured during the program will be examined non-lethally and undergo an external health assessment. Features of the fish that do not appear normal (e.g., wounds, tumours, parasites, fin fraying, gill parasites, or lesions) will be recorded in detail, and if necessary, submitted for further analysis (e.g., histopathology). External examinations will be completed following the recommendations outlined in Chapter 3 of the MMTGD. Photographs will be taken of fish with abnormal external features.

For each fish (all species) to be live-released, the following variables will be recorded on the catch record field data sheet:

- total length (± 1 mm);
- fork length, if applicable (± 1 mm);
- total body weight, if possible (± 0.001 g); and
- species name.

Pelvic fin rays and scales will be collected from each fish for aging analysis.

5.4.4 LABORATORY ANALYSIS

Gonad samples from lethally sampled Slimy Sculpin will be submitted to a qualified histopathologist to confirm sex and maturity based on a histological assessment of gonad tissues with the aid of a light microscope, per the histological features listed in Table 5.4-1.

If visible eggs are present, fecundity samples from female fish will be analyzed by qualified biologists; fecundity will be calculated by counting all developing eggs contained within the ovary using a dissecting microscope (and recording the total number of eggs in the ovary lobe). Egg weight and/or diameter will also be recorded.

Sagittal otolith pairs will be collected from all lethally sampled Slimy Sculpin. Ageing structures will be sent to a qualified fish ageing specialist where aging structures will undergo sectioning and mounting to determine the age of the fish. Non-lethal Lake Trout aging structures (i.e., pelvic fin rays and scales) will also be submitted for age determination.

Tissue chemistry samples will be analyzed by an accredited laboratory for moisture and metals including metals (for Slimy Sculpin) and for mercury only (for Lake Trout). Tentative detection limits are provided in Appendix B.

Table 5.4-1: Gonad Maturity Categories to be Used in the Lethal Fish Health Survey

Sex	Stage	Code	Macroscopic Features	Histological Features
Unknown sex		0X	Unable to determine sex.	Unable to determine sex.
Female	Unknown stage	10	Unable to determine stage.	Unable to determine stage.
	Immature	11	Small ovaries, often clear, blood vessels indistinct.	Only oogonia and PG oocytes present. No atresia or muscle bundles. Thin ovarian wall and little space between oocytes.
	Early Stage Development	12	Enlarging ovaries, blood vessels more distinct. Granular in appearance.	PG, CA, Vtg1, and Vtg2 oocytes present. No evidence of POFs or Vtg3 oocytes. Some atresia can be present.
	Late Stage Development	13	Large ovaries filling the body cavity, prominent blood vessels. Individual oocytes visible.	Vtg3 oocytes present or POFs in batch spawners. Atresia of vitellogenic and/or hydrated oocytes may be present. Early stages of OM can be present.
	Ripe	14	Eggs released with gentle pressure on abdomen.	Oocytes undergoing late OM including GVM, GVBD and hydration, or ovulation.
	Spent	15	Deflated ovaries, blood vessels prominent.	Presence of oocyte atresia and, in some species, POFs. Few if any Vtg2 or Vtg3 oocytes.
	Reabsorbing	16	Small atretic oocytes throughout the ovaries, which are hard and white.	Advanced stage oocytes are atretic and no POFs are present.
	Resting	17	Small ovaries, blood vessels reduced but present.	Only oogonia and PG oocytes present. Muscle bundles, enlarged blood vessels, thick ovarian wall, atresia and degenerating POFs may be present.
Male	Unknown stage	20	Unable to determine stage.	Unable to determine stage.
	Immature	21	Small testes, often clear and threadlike.	Sg1 only; no lumen in lobules.
	Early Stage Development	22	Small testes, semi-translucent, but easily identified.	Spermatocysts evident along lobules. Sg2, Sc1, Sc2, St and Sz can be present in spermatocysts. Sz not present in lumen of lobules or in sperm ducts. GE continuous throughout.
	Late Stage Development	23	Testes large, firm and lobate. White to purplish in colour. Granular appearance.	Sz in lumen of lobules and/or sperm ducts. All stages of spermatogenesis (Sg2, Sc, St, Sz) can be present. Spermatocysts throughout the testis, active spermatogenesis. GE may be continuous or discontinuous.
	Ripe	24	Milt released with gentle pressure on abdomen.	Based on macroscopic observation only.
	Spent	25	Small and deflated testes. Blood vessels obvious. Violet-pink in colour.	Residual Sz present in lumen of lobules and in sperm ducts. Widely scattered spermatocysts near periphery containing Sc2, St, Sz. Little to no active spermatogenesis. Spermatogonial proliferation and regeneration of GE common in periphery of testes.
	Reabsorbing	26	Not typically observed in males.	Not typically observed in males.
	Resting	27	Small testes, often threadlike.	No spermatocysts. Lumen of lobule often nonexistent. Proliferation of spermatogonia throughout testes. GE continuous throughout. Small amount of residual Sz occasionally present in lumen of lobules and in sperm duct.

Note: X = the stage code, if stage can be determined, when sex is unknown.

***CA = cortical alveolar** (i.e., a non-vitellogenic haploid secondary growth oocyte, considered an indicator gonads have entered the spawning preparation phase [Brown-Peterson et al. 2011]); **GVBD = germinal vesicle breakdown** (i.e., process by which the nuclear envelope breaks down, beginning the process of oocyte maturation; this occurs 2-4 days before ovulation in salmonids [Jobling 1995]), **GVM = germinal vesicle migration** (i.e., the phase of oocyte maturation where the nucleus moves to animal pole of cell, indicating the completion of the first meiotic prophase [Yaron and Sivan 2006]), **OM = oocyte maturation** (i.e. process by which oocytes develop and mature from oogonia through primary oocytes [diploid, previtellogenesis] and secondary oocytes [haploid, vitellogenesis], through to final oocyte [haploid] maturation [Parenti and Grier 2004]), **PG = primary growth** (i.e., a diploid germ cell at a non-vitellogenic stage of oocyte development, where the cortical alveoli are present and the yolk nucleus first appears [Parenti and Grier 2004]), **POF = postovulatory follicle complex** (i.e., the cellular remnants left behind after ovulation, including the follicle, basement membrane, and the theca, including its blood vessels [Parenti and Grier 2004]), **Vtg1 = primary vitellogenic** (i.e., early period of oocyte development where yolk deposition is occurring), **Vtg2 = secondary vitellogenic** (i.e., mid-period of oocyte development where yolk deposition is continuing), **Vtg3 = tertiary vitellogenic** (i.e., late period of oocyte development where yolk deposition is complete), **GE = germinal epithelium** (i.e., the cellular origin of follicles in the fish ovary [Grier 2000, in Parenti and Grier 2004]), **Sc1 = primary spermatocyte** (i.e., diploid germ cells that are derived from spermatogonium, presence considered an indicator gonads have entered the spawning preparation phase [Brown-Peterson et al. 2011]), **Sc2 = secondary spermatocyte** (i.e., haploid germ cells that are derived from primary spermatocytes and give rise to spermatids), **Sg1 = primary spermatogonia** (i.e., diploid germ cells from which haploid spermatocytes develop), **Sg2 = secondary spermatogonia** (i.e., diploid male germ cells from which spermatocytes develop), **St = spermatid** (i.e., haploid germ cells that are derived from spermatocytes and give rise to spermatozoa), **Sz = spermatozoa** (i.e., sperm, the mature haploid male sex cell)*

5.4.5 DATA ANALYSIS AND INTERPRETATION

All data collected in the fish survey will be maintained in Excel spreadsheets.

5.4.5.1 CATCH DATA SUMMARY

Catch-per-unit-effort (CPUE) will be calculated to estimate the relative abundance of fish in each sampling area by standardizing the catch data according to fishing effort. CPUE will be summarized both by area and sampling method to document the amount of effort expended to collect the required number of fish.

5.4.5.2 FISH HEALTH INDICES

The following fish health indices will be calculated:

- Fulton's Condition Factor[10] (K) = (body weight/total length^3) × 100,000;
- Gonadosomatic Index (GSI[11]; lethal survey only) = (gonad weight/total weight) × 100; and
- Liver Somatic Index (LSI; lethal survey only) = (liver weight/total weight) × 100.

If large parasites (e.g., tapeworms) are observed in individual fish, in addition to total weight, indices may be calculated with adjusted body weight in the above equations for supporting analyses. Adjusted body weight is the total body weight minus parasite weight.

5.4.5.3 DESCRIPTIVE STATISTICS

Descriptive statistics (i.e., sample size, mean, median, SD, SE, minimum, and maximum) will be calculated for all qualitative fish health endpoints and indices. The incidence of abnormalities and parasites will be quantified for each area. Descriptive statistics for each variable will be determined separately, by sampling area, for male, female, and juvenile Slimy Sculpin and for adults, juveniles and young-of-the-year (YOY) for Lake Trout.

Descriptive statistics will be calculated for all fish for the following biological variables:

- total length (mm);
- total body weight (g);
- Fulton's Condition Factor (K); and
- age (years).

Additional descriptive statistics will be calculated for lethally sampled fish for the following biological variables:

- adjusted body weight (i.e., if large parasites are present, then total body weight minus parasite weight will be calculated; g);

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[10] Note that Fulton's condition factor is an index and only used in descriptive statistics. Condition, which is used in the inferential statistics, describes the relationship between fish weight and length and is analyzed using analysis of covariance.

[11] Similar to Fulton's condition factor and condition, Gonadosomatic Index and Liver Somatic Index are indices used in the descriptive statistics, whereas relative liver weight and relative gonad weight describe relationships between organ weights and fish length, analyzed using analysis of covariance.

- carcass weight (g);
- age (years);
- gonad weight (g);
- liver weight (g);
- LSI; and
- GSI.

When possible, analyses will proceed with non-parasitized fish only (i.e., fish with tapeworms will be excluded from the overall statistical analyses if sufficient sample sizes [e.g., n = 20 or more fish] of non-parasitized fish are achieved from each study area). Tapeworms were observed in fish from Goose and Reference B lakes in the 2018 baseline study (Appendix A).

5.4.5.4 LETHAL SURVEY WITH SLIMY SCULPIN

The lethal fish health analyses will consider those effect endpoints that impact survival (length frequency distribution, age), energy storage (condition; relative liver size), and energy use (size-at-age; relative gonad size).

- **Survival** is a measure of the difference in the mean age of all fish (separated by species and sex) between the near-field area and the reference area. A healthy population should exhibit variability in age. While laboratory-based age is the preferred indicator of survival, length may also be considered as a surrogate for age.
- **Energy Storage** is a measure of the energy reserves of the fish population. Condition and relative liver size provide valuable information on food quality and availability to the fish population. A healthy fish will demonstrate a greater body weight to length ratio than an unhealthy fish and will have a liver weight that is proportional to its body size. Stressors from the environment, whether they are natural or anthropogenic, can influence the condition of a fish and affect the relative liver size (e.g., enlarged liver because of contaminant depuration processes or increased lipid storage related to eutrophication and increased food availability).
- **Energy Use** is a measure of the ability of the fish population to utilize resources in their environment to grow and reproduce. It is also an indicator as to whether a population is growing and reproducing normally and successfully.

In addition to these effect endpoints, the supporting endpoints of length frequency distribution, liver weight at length, total body weight, length, liver or gonad weight, gonad weight at length, and length at age may be statistically analyzed and reported if significant differences are observed in the effect endpoints, and these additional analyses are warranted to provide additional information on the effects of dewatering discharge on fish survival, growth, reproduction, and condition.

To identify whether an effect has occurred on the fish population in Goose Lake, fish health endpoints will be statistically compared between the near-field exposure area and the reference area. In EEM, an “effect” is defined as a statistically significant difference in effect indicators, as measured between an area exposed to treated effluent and a reference area. Fish health response effect indicators, endpoints, dependent variables and covariates (as appropriate) are presented in Table 5.4-2, along with the statistical procedures applicable to the fish health component of the AEMP and defined CES. Support endpoints will not be used to determine an effect on the fish population.

Fish health data will be divided by sex, state of maturity (i.e., adult male and female fish data will be separated from juvenile fish) and presence or absence of large parasites (i.e., tapeworms). This is necessary due to different energetic requirements associated with reproduction, which result in differences in growth patterns (i.e., growth rate, body weight, gonad size, and liver size) (Environment Canada 2012). Parasitism is also considered due to the influence some parasites can have on nutrient uptake and energy available for reproduction and growth, especially tapeworms. Juvenile fish will not be analyzed for statistical differences.

Table 5.4-2: Statistical Procedures to be Used for Identifying Differences between Near-field Area and the Reference Area for Slimy Sculpin

Type of Response	Endpoint	Dependent Variable (Y)	Covariate (X)	Statistical Procedure	Effect or Support[1]	Critical Effect Size
Survival	Age	n/a	n/a	ANOVA	Effect	25%
	Length-frequency distribution	n/a	n/a	K-S test	Support	-
Energy Storage	Condition	Body weight[2]	Total length	ANCOVA	Effect	10%
	Relative liver size	Liver weight	Body weight[2]	ANCOVA	Effect	25%
		Liver weight	Total length	ANCOVA	Support	-
Energy Use	Total length	n/a	n/a	ANOVA	Support	-
	Fecundity	n/a	n/a	ANOVA	Support	-
	Relative gonad size	Gonad weight	Body weight[2]	ANCOVA	Effect	25%
		Gonad weight	Total length	ANCOVA	Support	-
	Size-at-age	Body weight[2]	Age	ANCOVA	Effect	25%
		Total Length	Age	ANCOVA	Support	-

1. Effect or supporting endpoints as defined by Environment Canada 2012.

2. Adjusted body weight may be included in addition to total body weight if there is a high prevalence of large parasites (e.g., tapeworms) in fish included in the statistical analyses.

n/a = not applicable; - = no critical effect size defined in the MDMER; K-S test = Kolmogorov-Smirnov test; ANOVA = Analysis of Variance; ANCOVA = Analysis of Covariance.

Data will be screened for potential outliers by visual examination of box-and-whisker plots and linear regression plots. Outliers will be checked, and their validity will be confirmed. Outliers that are removed will be reported, and the reasons for their exclusion will be included in the final interpretative report. During analysis, evaluation of studentized residuals (SR) will be used as an additional screening tool. Observations that have a SR of more than 3.5 (i.e., SR > |3.5|) will be checked and validity confirmed; data points will only be removed if warranted. All statistical analyses, including screening, will be conducted using appropriate statistical software.

Differences in the length-frequency distributions between sampling areas will be assessed using the non-parametric, two-sample Kolmogorov-Smirnov test. All other statistical tests (i.e., analysis of variance [ANOVA] and analysis of covariance [ANCOVA]) will be preceded by normality and equality of variance testing of the respective parameters. If data are determined to be either non-normal or have unequal variance, the data will be $\log_{10}$ transformed and normality and variance tests will be repeated. If deviations from assumptions are considered unacceptable following $\log_{10}$ transformation, a non-parametric alternative (e.g., Kruskal-Wallis test) will be used. However, if deviations from assumptions are judged to be minor (e.g., normality test p-values > 0.001), then parametric statistics will proceed due to the ability of ANOVA and ANCOVA to withstand minor deviations in normality and equality of variance. The results of these screening procedures, and the subsequent decisions regarding parametric testing of raw or log data, will be reported. Alpha (α) and beta (β) will be set equal at 0.1, providing for 90% power (i.e., 1 – β), per the MMTGD.

Magnitude of effects will be calculated as:

$$\text{Magnitude} = \frac{(\text{Exposure Mean - Reference Mean})}{\text{Reference Mean}} \times 100$$

The adjusted mean value obtained from the ANCOVA will be used for effect endpoints other than age.

For endpoints that are not statistically different (i.e., ANOVA or ANCOVA p-values are > 0.1), post-hoc power analyses will be performed to determine (1) the power of the analyses to detect differences between the areas and (2) the required sample size to detect a difference (if power was < 90%).

5.4.5.5 POPULATION SURVEY WITH LAKE TROUT

The non-lethal fish health analyses with Lake Trout will statistically analyzed and report those effect endpoints that impact survival (length- and age-frequency distributions), energy storage (condition), and energy use (size-at-age, relative abundance of YOY) (Table 5.4-3). If possible, size (i.e., length and weight) of YOY will be analyzed. In addition to these effect endpoints, the supporting endpoints of size (i.e., length and weight) of 1+ fish, and length-at-age may be statistically analyzed and reported if significant differences are observed in the effect endpoints, and these additional analyses are warranted to provide supporting information about Project effects on fish survival, growth, reproduction, and condition.

While it is possible to estimate state-of-maturity (i.e., YOY, juvenile, or adult) for Lake Trout based on length, it is not possible to determine sex from an external examination. Therefore, non-lethal population survey data will not be sub-divided by sex. Analyses will consider YOY, juvenile and adult fish.

Table 5.4-3: Statistical Procedures to be Used for Identifying Differences between Exposure and Reference Areas for Lake Trout

Type of Response	Endpoint	Dependent Variable (Y)	Covariate (X)	Statistical Procedure	Effect or Support[1]	Critical Effect Size
Survival	Length-frequency distribution	n/a	n/a	K-S test	Effect	-
	Age-frequency distribution	n/a	n/a	K-S test	Support	-
Energy Storage	Condition	Body weight	Total length	ANCOVA	Effect	10%
Energy Use	Total body weight	n/a	n/a	ANOVA	Effect / Support[2]	-
	Fork length	n/a	n/a	ANOVA	Effect / Support[2]	-
	Size-at-age	Body weight	Age	ANCOVA	Effect	25%
		Total Length	Age	ANCOVA	Support	-
	Relative abundance of YOY	n/a	n/a	Chi square test	Effect	-

1. Effect or supporting endpoints as defined by Environment Canada 2012.
2. Total body weight and fork length are effect endpoints for YOY and supporting endpoints for age 1+ fish.
n/a = not applicable; K-S test = Kolmogorov-Smirnov test; ANCOVA = Analysis of Covariance; ANOVA = Analysis of Variance; - = no critical effect size defined in the MDMER.

5.4.5.6 TISSUE CHEMISTRY

Prior to performing statistical analyses on the fish tissue chemistry data, values reported below the DL will be reviewed. When data are confirmed below the DL, they are considered censored. Censored values will be replaced with appropriate values (e.g., 0.5 × DL).

If tissue metals concentrations are above the DL in more than 50% of the samples, concentrations in the exposure and reference areas will be compared to determine if there are statistically significant differences. Metals concentrations will be analyzed using an ANOVA, with the exception of mercury and selenium which will be analyzed using an ANCOVA. The covariate (i.e., length or weight) with the strongest regression relationship (i.e., smallest p-value) will be used as the covariate for the ANCOVA analysis. If more than 50% of samples are below the DL for a given parameter, comparisons will be made using a non-parametric alternative to ANOVA (e.g., Kruskal-Wallis test) or rank ANCOVA (e.g., ANCOVA on data expressed as ranks).

The critical effect size for the fish tissue chemistry component will be a magnitude of difference of 100%. This effect size is intended to ensure that differences in concentrations between the exposure and reference areas are real differences and less likely to be attributed to analytical variability and uncertainty, and spatial and temporal variation.

Descriptive statistics and statistical comparisons will be presented in an appendix for all metals concentrations; however, only metals with relevant guidelines (e.g., mercury, selenium) or that have been identified as contaminants of concern for the site (e.g., arsenic) will be discussed in detail in the report.

For fish tissue, an effect on fish usability is defined as total mercury concentrations that exceed 0.5 mg/kg wet weight as measured in an exposure area, and that are statistically different and greater than mercury concentrations measured from a reference area (Government of Canada 2002). Effects endpoints will be considered statistically different between exposure and reference areas at $\alpha = 0.1$, and target sample sizes of at least eight fish per group are expected to achieve sufficient power (i.e., >0.9). Sample sizes and achieved power will be re-assessed as part of the regular reporting requirements.

5.4.5.7 NORMAL RANGE CALCULATIONS

Normal ranges will be developed for key fish health effect indicators of relative body weight, relative liver weight, and relative gonad weight as well as for relevant fish tissue parameters based on the compiled baseline dataset. As appropriate, normal ranges may be updated with future AEMP reference area data as they become available, to further characterize natural variability.

5.4.5.8 COMPARISON TO FEIS PREDICTIONS

If statistical analysis identifies significant differences in fish health and fish tissue chemistry between exposure and reference fish populations, then results will be evaluated further to determine whether the observed changes are within FEIS predictions. The FEIS predicted changes in water and sediment quality, but all concentrations were predicted to remain below toxicity thresholds for primary producers, aquatic invertebrates, and fish (Sabina 2015). Toxicological impairment of fish health or increases in metal concentrations in fish tissue that impair fish health or human consumption is not expected. Increased nutrients (e.g., nitrogen, phosphorus) in water (Sabina 2015; Golder 2022a) may increase productivity of fish communities through increased food supply. It is expected that fish health and fish tissue metal concentrations will be maintained at levels that do not pose a risk to wildlife or human health.

5.4.6 QUALITY ASSURANCE AND QUALITY CONTROL

Samples will be collected following standard sampling procedures by qualified personnel using suitable sampling equipment. Data quality will be screened for entry errors and will be checked for outliers using boxplots and regression plots. Data entry errors will be corrected, while outliers may be removed to avoid strong leverage. If there is no clear explanation for an outlier, analysis will be conducted in the presence and in the absence of the outlier(s) to determine the magnitude of influence it has on the conclusions, per MMTGD.

The following quality assurance/quality control procedures apply to laboratory analyses:

- To verify that histology data quality objectives are met, histology results will be cross-referenced with field designated sex and maturity stages, external and internal photographs, as well as biological data. Discrepancies will be reviewed by a second qualified biologist.
- Ten percent of the total fecundity counts and measurements will be checked by a second qualified biologist.
- For age analysis, a second independent ageing specialist will re-age 10% of the structures as a QA/QC check.

- Fish tissue chemistry samples will be analyzed by an accredited laboratory by qualified staff. Analyses will be conducted following recognized protocols and methods with properly calibrated and maintained instrumentation. All results of internal QA/QC processes will be reviewed and deviations from acceptable limits will be reported. If acceptable limits are exceeded, samples will be re-run (if sample volumes allow) and re-assessed.

Office-related QA includes using appropriately trained personnel for each task, senior review of work, standardized data handling/summary tools, filing of original data, and establishment of a data management system (e.g., database).

6. ADAPTIVE MANAGEMENT RESPONSE FRAMEWORK

6.1 INTRODUCTION

The Response Framework within an AEMP links the interpretation of monitoring results to management actions, with the intent of meeting FEIS assessment predictions and maintaining assessment endpoints (e.g., suitability of water to support an aquatic ecosystem, Table 3.3-1). The Response Framework follows a systematic approach of evaluation and interpretation of results, and implementation of follow-up action (e.g., confirmation of results, further study) or mitigation, at pre-defined levels of change (i.e., Action Levels) to reduce or reverse unacceptable or unexpected effects and prevent a significant adverse effect.

This Response Framework was developed in consideration of guidance from the Guidelines for Aquatic Effects Monitoring Programs (MVLWB and AANDC 2019).

6.2 APPROACH

Within the Response Framework, an effect is a change that follows an event or cause and is not inherently negative or positive. A linkage must be established between a measured change and a cause before appropriate management actions can be determined. The type of action taken depends on the magnitude or severity of an effect relative to an assessment endpoint. This is termed the "Action Level". If an effect is detected during the AEMP that triggers an Action Level, a corresponding action will occur.

The goal of the Response Framework is to systematically respond to monitoring results such that the potential for adverse effects is identified and necessary mitigation actions are undertaken. This is accomplished by implementing appropriate mitigation at predefined Action Levels, which are triggered before a significant adverse effect could occur. The magnitude of an effect is determined by comparing measurement endpoints between exposure and reference areas, or to background values, or benchmark values.

Action Levels (i.e., Low, Moderate, and High) will be used within the Response Framework to determine if follow-up action is required to manage and reverse any detected changes in the aquatic environment. If a Low Action Level is reached for one or more AEMP component measurement endpoints, for one or both of the impact hypotheses, a response action will be initiated. Specific terms used in the Response Framework include: Benchmarks, Action Levels, and Significance Threshold, and are defined as follows:

- Benchmark
  - For purposes of the AEMP, a benchmark is a generic term used to refer to a set of numerical standards that are appropriate for the Project and are used for screening of monitoring results. Benchmarks may be derived from generic aquatic life guidelines, generic drinking water guidelines, site-specific water quality guidelines, or baseline concentrations. Benchmarks are set at a level to be protective of aquatic life or drinking water quality.

- Action Levels
  - Action Levels (Low, Moderate, and High) are pre-defined levels of environmental change, often but not exclusively linked to benchmarks, results of statistical tests, or a combination of the two. A Low Action Level exceedance serves as an early-warning indication of the potential for future adverse effects on an ecosystem component. Exceedance of a Low Action Level indicates that effects are measurable but well below the Significance Threshold. Moderate and High Action Levels are designed to identify measurable effects that are trending towards the Significance Threshold, and may trigger follow-up management actions or responses to slow, stop, or reverse the trend.
- Significance Threshold
  - The Significance Threshold is a level of change that would result in significant adverse effects to key values of the environment that are to be protected. This is considered an unacceptable level of change or ”no go condition”. Significance Thresholds are based on the assessment endpoints provided in Table 3.3-1. Failure to meet the assessment endpoints (e.g., suitability of water to support an aquatic ecosystem) would result in the Significance Threshold being met.

If a change in the monitoring data is detected that exceeds a Low Action Level, the type of action taken will depend upon the type of effect observed. Examples of response actions are provided in Table 6.2-1.

Table 6.2-1. Examples of Action Level Responses

Action Level	Examples of Action Level Response
Low	Confirm the effect that triggered the Action Level
	Investigate further to identify contributing factors from the Project
	Examine ecological significance
	Confirm that existing benchmarks are appropriate, and revise if warranted
	Compare to FEIS predictions
	Identify potential mitigation options
	Increase monitoring (frequency or locations)
	Revise Low Action level, if warranted and scientifically defensible
	Set Moderate and High Action Levels
Moderate	Confirm the effect that triggered the Action Level
	Investigate further to identify contributing factors from the Project
	Examine ecological significance
	Compare to FEIS predictions
	Increase monitoring (frequency or locations)
	Implement mitigation and examine effectiveness of mitigation
	Develop a Response Plan
	Revise Moderate Action level, if warranted and scientifically defensible

Action Level	Examples of Action Level Response
High	Confirm the effect that triggered the Action Level
	Investigate further to identify contributing factors from the Project
	Revise High Action level, if warranted and scientifically defensible
	Compare to FEIS predictions
	Develop a Response Plan
	Identify and implement improved mitigation to reverse trend
	Initiate remediation

6.3 ACTION LEVELS AND SIGNIFICANCE THRESHOLDS

Action Levels are intended to represent increasing levels of change towards the Significance Thresholds, which lead to appropriate actions to further understand or mitigate potential effects, thereby preventing reaching the Significance Thresholds. The Significance Thresholds for this AEMP are:

- Water is not suitable to support an aquatic ecosystem with a functional benthic invertebrate community and healthy fish.
- Water is not suitable as a drinking source for people.
- Fish tissue metal concentrations pose a risk to wildlife or human health.

The Project has the potential to result in toxicological impairment and nutrient enrichment. Action Levels for these hypotheses were developed for water quality, benthic invertebrate communities, fish health, and fish tissue chemistry. Proposed Low Action levels for these AEMP components, as they pertain to the Significance Thresholds, are provided in Table 6.3-1. In response to a Low Action Level exceedance, Moderate and High Action Levels will be developed.

6.4 PLAN EFFECTIVENESS

The AEMP is intended to provide a clear and defensible monitoring design, and through annual reporting of monitoring results, verify that mitigation and management measures are effective at avoiding adverse effects on the freshwater receiving environment, and that relevant laws and regulations are met. As part of environmental reporting, the AEMP report will be submitted the Nunavut Water Board and Nunavut Impact Review Board and made publicly available on their registries and distributed through their distribution lists. This report will describe monitoring activities, results, and the success of mitigation and management, if applicable. B2Gold Nunavut may also conduct periodic evaluations of the efficacy of monitoring, mitigation and management activities using relevant methods, such as power analysis or time series analysis. In the event that new and relevant monitoring methods become available, or the existing design is found to lack statistical power, updated methods will be proposed. This plan will be updated periodically as required.

Table 6.3-1. Proposed Low Action Levels for the Toxicological Impairment and Nutrient Enrichment Hypotheses

Water Quality		Sediment Quality	Benthic Invertebrate Community	Fish	
Aquatic Life[1]	Human Consumption[2]			Aquatic Life	Human Consumption[2]
Statistically significant BACI effect on concentration in the exposure area, with the average concentration above the normal range[3]	Statistically significant BACI effect on concentration in the exposure area, with the average concentration above the normal range[3]	Statistically significant BACI effect on concentration in the exposure area, with the average concentration above the normal range[3]	Statistically significant BACI effect on total density or richness in the exposure area, with the average value outside the normal range[3]	Statistically significant difference in fish health effect endpoints[4] or fish tissue chemistry parameters relative to reference that are outside the normal range[3]	Statistically significant difference in mercury concentrations in Lake Trout relative to reference that are above the normal range[3]
AND	AND	AND	AND	AND	AND
Average concentration above the AEMP benchmark	Drinking water parameters in exposure area above Health Canada's human health drinking water quality guideline (maximum acceptable concentration)	Average concentration above the CCME ISQG	Difference in invertebrate density or richness with magnitude ≥CES[5] between the reference area and near-field area	Magnitude of effect above the CES[6]	Mean metal concentrations in Lake Trout above a fish consumption guideline that is protective of human health

AEMP = Aquatic Effects Management Plan; CCME = Canadian Council of Ministers of the Environment; ISQG = interim sediment quality guideline; CES = Critical Effect Size.
1. Applies to parameters of interest, which will include nutrients (TP and TN), chlorophyll a, and any other parameters as determined in Section 5.1.4.
2. Applies to the toxicological impairment hypothesis but not the nutrient enrichment hypothesis.
3. Normal range will be developed for key variables assessed by each monitoring component.
4. The fish health effect indicators considered under the Action Level assessment include relative body weight, relative liver weight, and relative gonad weight.
5. Critical effect size for benthic invertebrate community will be two standard deviations of the current monitoring year's reference area data.
6. Critical effect sizes are differences of 10% for relative body weight, 25% for relative liver weight and 25% for relative gonad weight, and 100% for fish tissue chemistry parameters.

7. REPORTING

7.1 ANNUAL AEMP REPORT

Per Part B Item 2 of the Water Licence, an Annual Report must be submitted to NWB no later than March 31 of every year. Per Schedule B Item 14 of the Water Licence, this Annual Report must include the results of monitoring related to the AEMP. These results will be presented in an AEMP Report, which will be an attachment to the main Annual Report. The AEMP Report will include:

- A summary of Project activities during the monitoring interval.
- A summary of the monitoring data obtained during the most recent reporting period.
- Description of the methods used for data collection and analysis, if they differ from those presented in this AEMP.
- Evaluation of Project-related effects on the measurement endpoints.
- Results of the Action Level assessment.
- Recommendations (e.g., additional sampling or analysis, adaptive management).

7.2 REPORTS UNDER MDMER

The AEMP was also designed to meet MDMER EEM requirements, if/when the Project becomes subject to the MDMER. Reporting requirements for the EEM include:

- Within 12 months of becoming subject to the MDMER and at least six months prior to the initiation of biological monitoring[12], the submission of an EEM Study Design to ECCC.
- Within 36 months of the Mine becoming subject to the MDMER or 36 months since submission of the last report, submission of an EEM Interpretative Report to ECCC[13].
- The required information to be included in the first and subsequent EEM Study Designs are listed in Table 7.2-1. Some of the requirements cannot be met in this AEMP (e.g., description of how effluent mixes in the receiving environment and results of effluent characterization and water quality monitoring). Therefore, a technical memorandum with these requirements will be attached to this AEMP and the package provided to ECCC by the EEM Study Design submission deadline.

[12] For subsequent EEM programs, if there is no discharge in the previous 36 months, then an EEM Study Design must be submitted no later than 12 months after the day on which the previous EEM Interpretative Report was required to be submitted or would have been required to be submitted.

[13] For subsequent EEM programs, if there is no discharge in previous 36 months, then an EEM Interpretative Report is not required to be submitted to ECCC per the MDMER.

Table 7.2-1. Reporting Requirements for an EEM Study Design

Reporting Requirements for an EEM Study Design	Location of Information in this AEMP
First EEM Study Design:	
10(a)(i) a description of the manner in which the effluent mixes within each exposure area, during a period in which there are deposits, including an estimate of the concentration of effluent in the exposure area at 100 m and 250 m from every point at which the effluent enters the area from a final discharge point and — in respect of each calendar year — any supporting data, including raw data, for the estimate	To be provided separately[1]
10(a)(ii) a description of the exposure and reference areas where the biological monitoring studies would be conducted — whether or not they are required — that includes information on the geological, hydrological, oceanographical, limnological, chemical and biological features of those areas	Section 4.2.2 and Appendix A
10(a)(iii) the type of production process used by the mine and the environmental protection practices in place at the mine	Sections 2.2 and 2.3
10(a)(iv) a description of any anthropogenic, natural or other factors that are not related to the effluent but that may reasonably be expected to affect the results of any biological monitoring study, whether or not it is required	To be provided separately[1]
10(a)(v) any additional information that would enable a determination as to whether studies would be conducted in accordance with generally accepted standards of good scientific practice	Sections 4 and 5
10(b) a description of how any required study respecting fish population, fish tissue mercury and fish tissue selenium will be conducted that includes (i) a description of and the scientific rationale for (A) the fish species selected, taking into account the abundance of the species most exposed to effluent, (B) the sampling areas selected within the exposure area and the reference area, (C) the sampling period selected, (D) the sample size selected, and (E) the field and laboratory methodologies selected, and (ii) an explanation as to how, in the case of the study respecting fish population or fish tissue mercury, the study will provide the information necessary to determine if the effluent has an effect on fish population or on fish tissue from mercury	Section 5.4
10(c) a description of how any required study respecting the benthic invertebrate community will be conducted that includes (i) a description of and the scientific rationale for (A) the sampling areas selected, taking into account the benthic invertebrate diversity and the area most exposed to effluent, (B) the sampling period selected, (C) the sample size selected, and (D) the field and laboratory methodologies selected, and (ii) an explanation as to how the study will provide the information necessary to determine if the effluent has an effect on the benthic invertebrate community	Section 5.3
10(d) the month in which the samples will be collected for each required biological monitoring study	Section 4.2.4
10(e) a description of the quality assurance and quality control measures that will be implemented for each required biological monitoring study to ensure the validity of the data that is collected	Sections 5.3.5 and 5.4.6
10 (f) a summary of the results of any studies to determine whether the effluent was causing an effect on the fish population, fish tissue from mercury or the benthic invertebrate community and of any studies in the exposure and reference areas respecting fish tissue selenium completed before the mine becomes subject to section 7 of these Regulations and any scientific data to support the results	Not applicable

Reporting Requirements for an EEM Study Design	Location of Information in this AEMP
Subsequent EEM Study Designs:	
13(2)(a) a summary of the information referred to in paragraph 10(a) and a description of any changes to that information since the submission of the most recent study design, as well as — in respect of each calendar year — any supporting data, including raw data, for the estimate referred to in subparagraph 10(a)(i), whether or not the estimate has changed	To be provided separately[1]
13(2)(b) the information referred to in paragraphs 10(b) to (e)	Sections 4.2, 5.3, 5.4
13(2)(c) a summary of the results of any biological monitoring studies conducted after June 6, 2002	To be provided separately[1]
13(2)(d) if the study referred to in paragraph 9(1)(e) is required, (i) the month in which the study will start, and (ii) a description of how the study will be conducted that includes any field and laboratory methodologies that will be used to determine the cause of the effect	To be provided separately[1]
13(2)(e) if the cause of an effect on the fish population, on fish tissue from mercury or on the benthic invertebrate community is known, the cause of the effect and any supporting data, including raw data	To be provided separately[1]

Notes: Requirements per the MDMER Schedule 5 (Government of Canada 2002).
1. To be provided in a separate technical memorandum to be submitted as an appendix of this AEMP to ECCC.

An EEM Interpretative Report is required every three years unless there is no effluent discharge in the previous 36 months. The requirements for this report are listed in Table 7.2-2. The AEMP Report structure will be amended as needed to make sure these requirements are provided in an AEMP Report that will also be submitted as an EEM Interpretative Report.

Table 7.2-2. Reporting Requirements for an EEM Interpretative Report

Reporting Requirements for an EEM Interpretative Report
First EEM Interpretative Report:
12(1)(a) a description of any deviation from the study design that occurred while the biological monitoring studies were being conducted and any impact that the deviation had on the studies;
12(1)(b) the latitude and longitude of sampling areas and a description of the sampling areas sufficient to identify the location of the sampling areas;
12(1)(c) the dates and times when samples were collected;
12(1)(d) the sample sizes;
12(1)(e) the mean, median, standard deviation, standard error and minimum and maximum values in the sampling areas
12(1)(e)(i) in the case of the study respecting fish population, effect indicators of growth, reproduction, condition and survival that include, if practicable, the length, total body weight and age of the fish, the weight of its liver or hepatopancreas and, if the fish are sexually mature, the egg weight, fecundity and gonad weight of the fish
12(1)(e)(ii) in the case of the study respecting the benthic invertebrate community, effect indicators of the total benthic invertebrate density, evenness index, taxa richness and, if the study is conducted in an area where it is possible to sample sediment, total organic carbon content of sediment and particle size distribution of sediment

Reporting Requirements for an EEM Interpretative Report
12(1)(e)(iii) in the case of the study respecting fish tissue mercury, the effect indicator of the concentration of total mercury (wet weight) in the fish tissue
12(1)(e)(iv) in the case of the study respecting fish tissue selenium, the concentration — in the muscle or whole body and, if practicable, in the ovaries or eggs — of total selenium (dry weight) reported in µg/g and the percentage of the moisture content of the sample
12(1)(f) in the case of the study respecting the benthic invertebrate community, a calculation of the similarity index effect indicator
12(1)(g) an identification of the sex of the fish sampled and of the presence of any lesions, tumours, parasites or other abnormalities and, in the case of the study respecting fish tissue selenium, the type of fish tissue studied and the scientific rationale for the selection of that tissue
12(1)(h) a determination as to whether there is a statistically significant difference between the sampling areas for the calculations under subparagraphs (e)(i) to (iii) and paragraph (f) taking into consideration the information identified under paragraph (g), with the statistical comparison made separately and independently for each effect indicator
12(1)(i) a statistical analysis of the results of the calculations under subparagraphs (e)(i) to (iii) and paragraph (g) that indicates the probability of correctly detecting an effect of a pre-defined size and the degree of confidence that can be placed in the calculations
12(1)(j) for an effect indicator referred to in paragraph (e) with an assigned critical effect size, a comparison of the magnitude of the effect — calculated in accordance with subsection (2) or (3), as the case may be — to its critical effect size
12(1)(k) any supporting data, including raw data, for the information provided under paragraphs (e) to (j)
12(1)(l) a description of any quality assurance or quality control measures that were implemented and the data related to the implementation of those measures
12(1)(m) based on the information referred to in paragraphs (e) to (k), the identification of: (i) any effect on the fish population; (ii) any effect on the benthic invertebrate community; (iii) any effect on fish tissue from mercury
12(1)(n) for an effect indicator with an assigned critical effect size, a statement as to whether the absolute value of the magnitude of the effect is equal to or greater than the absolute value of its critical effect size
12(1)(o) a summary of the results of effluent characterization, sublethal toxicity testing and water quality monitoring reported under paragraph 8(e) beginning on the day on which the mine becomes subject to section 7 of these Regulations
12(1)(p) the conclusions of the biological monitoring studies, and a description of how those conclusions will impact the study design for subsequent biological monitoring studies, taking into account: (i) the results of any studies referred to in paragraph 10(f); (ii) the presence of anthropogenic, natural or other factors that are not related to the effluent under study and that may reasonably be expected to contribute to any observed effect; (iii) the results of the statistical analysis conducted under paragraphs (h) and (i); and (iv) the data referred to in paragraph (l)
12(1)(q) the month in which the next biological monitoring studies will start, if any biological monitoring studies are required
12(1)(r) the date when the next interpretative report is required to be submitted or would be required to be submitted but for the application of subsection 16(3)

Reporting Requirements for an EEM Interpretative Report
12(2) For the purpose of the study respecting fish population, the magnitude of the effect for an effect indicator is to be calculated using the following formula: (A – B)/B × 100 where A is (a) for the purpose of the age indicator, the mean value for the indicator in the exposure area, and (b) for the purpose of the indicators other than age, the adjusted mean value — obtained using the analysis of covariance (ANCOVA) statistical test method — for the indicator in the exposure area; and B is (a) for the purpose of the age indicator, the mean value for the indicator in the reference area, and (b) for the purpose of the indicators other than age, the adjusted mean value — obtained using the analysis of covariance (ANCOVA) statistical test method — for the indicator in the reference area.
12(3) For the purposes of the study respecting the benthic invertebrate community, the magnitude of the effect for an effect indicator is to be calculated using the following formula: (A – B)/C where A is the mean value for the indicator in the exposure area; B is the mean value for the indicator in the reference area; and C is the standard deviation for the indicator in the reference area.
Subsequent EEM Interpretative Reports:
15(a) for a study referred to in paragraphs 9(1)(a) to (d), the information referred to in paragraphs 12(1)(a) to (n) and (p) to (r)
15(b) a summary of the results of effluent characterization, sublethal toxicity testing and water quality monitoring reported under paragraph 8(e) after the day on which the previous interpretative report was required to be submitted or would have been required to be submitted but for the application of subsection 16(3)
15(c) if the study design includes the description required under paragraph 13(2)(d), (i) the cause of the effect, if determined, and any supporting data, including raw data, or (ii) if the cause of the effect was not determined, an explanation of why and a description of any steps that need to be taken in the next study to determine that cause

Notes: Requirements per the MDMER Schedule 5 (Government of Canada 2002).

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APPENDIX A SABINA GOLD & SILVER CORP. BACK RIVER PROJECT – AQUATIC BASELINE SYNTHESIS REPORT. PREPARED BY GOLDER ASSOCIATES LTD. FOR SABINA GOLD & SILVER CORP., JULY 2019.

The Aquatic Baseline Synthesis Report was submitted to Nunavut Water Board (NWB) on 21 September 2020 and posted for public review, with comments received on or before 13 October 2020. Sabina Gold & Silver Corp. (Sabina) provided their responses to the interveners' comments on 23 October 2020. Confirmation of satisfaction with Sabina's responses was received from Environment and Climate Change Canada (ECCC) and the Kitikmeot Inuit Association (KIA) on 26 October 2020 and 30 October 2020, respectively. On 3 November 2020, NWB acknowledged that the Aquatic Baseline Synthesis Report addressed the requirements of the Water Licence and accepted the report.

The Aquatic Baseline Synthesis Report and all relevant correspondence is available from the NWB's file transfer protocol (FTP) site at the following link:

ftp://ftp.nwb-oen.ca/registry/2%20MINING%20MILLING/2A/2AM%20-%20Mining/2AM-BRP1831%20Sabina/3%20TECH/I%20AQUATIC%20EFFECTS%20MONITORING/I2%20Baseline%20Data/

APPENDIX B TARGET DETECTION LIMITS FOR WATER QUALITY, SEDIMENT QUALITY, AND FISH TISSUE ANALYSES

Table B-1 Parameter List for Analyses of AEMP Water Quality Samples

Parameter	Units	Target Detection Limit	Analytical Method/ Instrumentation
Conventional Parameters			
Field pH	unitless	0.1	YSI water quality meter (or equivalent) APHA 4500-H
Specific Conductivity	µS/cm	2	YSI water quality meter APHA 4500-H, 2510, 2320
Hardness (as $CaCO_3$)	mg/L	0.5	APHA 2340 B-calculation
Alkalinity (total as $CaCO_3$)	mg/L	1	APHA 4500-H, 2510, 2320
Total Dissolved Solids (measured)	mg/L	13	APHA 2540 C
Total Suspended Solids	mg/L	3	APHA 2540 D-Gravimetric
Turbidity	NTU	0.1	APHA 2130 B-Nephelometer
Total Organic Carbon	mg/L	0.5	APHA 5310 B-Instrumental
Dissolved Organic Carbon	mg/L	0.5	APHA 5310 B-Instrumental
Bicarbonate	mg/L	5.0	APHA 4500-H, 2510, 2320
Calcium	mg/L	0.01	EPA 6020B (mod) -ICP-MS
Chloride	mg/L	0.5	EPA 300.1 (mod)
Cyanide, Total	mg/L	0.005	ISO 14403 (mod)
Cyanide, WAD	mg/L	0.005	APHA 4500-CN I (mod)
Cyanide, free	mg/L	0.005	ASTM D7237 (mod)
Fluoride	mg/L	0.02	EPA 300.1 (mod)
Magnesium	mg/L	0.005	EPA 6020B (mod) -ICP-MS
Potassium	mg/L	0.005	EPA 6020B (mod) -ICP-MS
Sodium	mg/L	0.01	EPA 6020B (mod) -ICP-MS
Sulphate	mg/L	0.3	EPA 300.1 (mod)
Sulphide	mg/L	0.0015	APHA 4500-S Colorimetry
Soluble Reactive Silica (as SiO_2)	mg/L	0.5	APHA 4500 -SiO2 E
Radium226	Bq/L	0.037	EPA 903.1
Nutrients			
Nitrate, as N	mg/L	0.005	EPA 300.1 (mod)
Nitrite, as N	mg/L	0.001	EPA 300.1 (mod)
Total ammonia	mg/L	0.005	Method Fialab 100, 2018
Total Kjeldahl Nitrogen	mg/L	0.2	Method Fialab 100, 2018
Orthophosphate-dissolved, as P	mg/L	0.001	APHA 4500-P Phosphorus
Total Dissolved Phosphorus, as P	mg/L	0.001	APHA 4500-P Phosphorus
Total Phosphorus, as P	mg/L	0.001	APHA 4500-P Phosphorus
Chlorophyll *a*	µg/L	0.002	EPA 445.0 (mod)
Total Metals, Metalloids, and Non-Metals			
Aluminum	mg/L	0.0002	EPA 6020B (mod) -ICP-MS
Antimony	mg/L	0.000005	EPA 6020B (mod) -ICP-MS
Arsenic	mg/L	0.00001	EPA 6020B (mod) -ICP-MS
Barium	mg/L	0.00002	EPA 6020B (mod) -ICP-MS
Beryllium	mg/L	0.000002	EPA 6020B (mod) -ICP-MS
Bismuth	mg/L	0.000001	EPA 6020B (mod) -ICP-MS
Boron	mg/L	0.005	EPA 6020B (mod) -ICP-MS
Cadmium	mg/L	0.0000025	EPA 6020B (mod) -ICP-MS
Chromium	mg/L	0.00004	EPA 6020B (mod) -ICP-MS
Cobalt	mg/L	0.000005	EPA 6020B (mod) -ICP-MS
Copper	mg/L	0.00005	EPA 6020B (mod) -ICP-MS
Iron	mg/L	0.0005	EPA 6020B (mod) -ICP-MS
Lead	mg/L	0.000005	EPA 6020B (mod) -ICP-MS
Lithium	mg/L	0.0001	EPA 6020B (mod) -ICP-MS
Manganese	mg/L	0.000005	EPA 6020B (mod) -ICP-MS
Mercury (ultra-low)	µg/L	0.0005	EPA 1631E
Molybdenum	mg/L	0.00001	EPA 6020B (mod) -ICP-MS
Nickel	mg/L	0.00002	EPA 6020B (mod) -ICP-MS
Selenium	mg/L	0.000025	EPA 6020B (mod) -ICP-MS

Table B-1 **Parameter List for Analyses of AEMP Water Quality Samples**

Parameter	Units	Target Detection Limit	Analytical Method/ Instrumentation
Silicon	mg/L	0.05	EPA 6020B (mod) -ICP-MS
Silver	mg/L	0.000002	EPA 6020B (mod) -ICP-MS
Strontium	mg/L	0.00002	EPA 6020B (mod) -ICP-MS
Sulphur	mg/L	0.5	EPA 6020B (mod) -ICP-MS
Thallium	mg/L	0.000001	EPA 6020B (mod) -ICP-MS
Titanium	mg/L	0.00005	EPA 6020B (mod) -ICP-MS
Tin	mg/L	0.00001	EPA 6020B (mod) -ICP-MS
Uranium	mg/L	0.000001	EPA 6020B (mod) -ICP-MS
Vanadium	mg/L	0.00001	EPA 6020B (mod) -ICP-MS
Zinc	mg/L	0.0001	EPA 6020B (mod) -ICP-MS
Zirconium	mg/L	0.00001	EPA 6020B (mod) -ICP-MS
Dissolved Metals			
Aluminium	mg/L	0.0002	EPA 6020B (mod) -ICP-MS
Antimony	mg/L	0.000005	EPA 6020B (mod) -ICP-MS
Arsenic	mg/L	0.00001	EPA 6020B (mod) -ICP-MS
Barium	mg/L	0.00002	EPA 6020B (mod) -ICP-MS
Beryllium	mg/L	0.000002	EPA 6020B (mod) -ICP-MS
Bismuth	mg/L	0.000001	EPA 6020B (mod) -ICP-MS
Boron	mg/L	0.005	EPA 6020B (mod) -ICP-MS
Cadmium	mg/L	0.0000025	EPA 6020B (mod) -ICP-MS
Chromium	mg/L	0.00004	EPA 6020B (mod) -ICP-MS
Cobalt	mg/L	0.000005	EPA 6020B (mod) -ICP-MS
Copper	mg/L	0.00005	EPA 6020B (mod) -ICP-MS
Iron	mg/L	0.0005	EPA 6020B (mod) -ICP-MS
Lead	mg/L	0.000005	EPA 6020B (mod) -ICP-MS
Lithium	mg/L	0.0001	EPA 6020B (mod) -ICP-MS
Manganese	mg/L	0.000005	EPA 6020B (mod) -ICP-MS
Mercury (ultra-low)	µg/L	0.0005	APHA 3030 B/EPA 1631E
Molybdenum	mg/L	0.00001	EPA 6020B (mod) -ICP-MS
Nickel	mg/L	0.00002	EPA 6020B (mod) -ICP-MS
Selenium	mg/L	0.000025	EPA 6020B (mod) -ICP-MS
Silicon	mg/L	0.05	EPA 6020B (mod) -ICP-MS
Silver	mg/L	0.000002	EPA 6020B (mod) -ICP-MS
Strontium	mg/L	0.00002	EPA 6020B (mod) -ICP-MS
Sulphur	mg/L	0.5	EPA 6020B (mod) -ICP-MS
Thallium	mg/L	0.000001	EPA 6020B (mod) -ICP-MS
Titanium	mg/L	0.00005	EPA 6020B (mod) -ICP-MS
Tin	mg/L	0.00001	EPA 6020B (mod) -ICP-MS
Uranium	mg/L	0.000001	EPA 6020B (mod) -ICP-MS
Vanadium	mg/L	0.00001	EPA 6020B (mod) -ICP-MS
Zinc	mg/L	0.0001	EPA 6020B (mod) -ICP-MS
Zirconium	mg/L	0.00001	EPA 6020B (mod) -ICP-MS

APHA = American Public Health Association; EPA = Environmental Protection Agency; ICP-MS = inductively coupled plasma mass spectrometry; ISO = International Organization for Standardization; µS/cm = microsiemens per centimetre; NTU = nephelometric turbidity units; $CaCO_3$ = calcium carbonate; SiO_2 = silicon dioxide; N = nitrogen; P = phosphorus; mg/L = milligrams per litre; µg/L = micrograms per litre; n/a = not applicable.

Table B-2 Parameter List for Analyses of AEMP Sediment Quality Samples

Parameter	Units	Target Detection Limit	Analytical Method/ Instrumentation
Particle Size and Moisture			
Moisture	%	0.5	Oven dry 105C-Gravimetric
Sand (2.0 mm to 0.063 mm)	% dw	1.0	Micro-pipette method[1]
Silt (0.063 to 0.004 mm)	% dw	1.0	Micro-pipette method[1]
Clay (<0.004 mm)	% dw	1.0	Micro-pipette method[1]
Carbon and Nitrogen Content			
Total organic carbon	% dw	0.05	Calculation[2]
Total nitrogen	% dw	0.02	Combustion
Total Metals, Metalloids, and Non-Metals			
Aluminum	mg/kg dw	50	EPA 200.2/6020A [mod] - ICP-MS
Antimony	mg/kg dw	0.1	EPA 200.2/6020A [mod] - ICP-MS
Arsenic	mg/kg dw	0.1	EPA 200.2/6020A [mod] - ICP-MS
Barium	mg/kg dw	0.5	EPA 200.2/6020A [mod] - ICP-MS
Beryllium	mg/kg dw	0.1	EPA 200.2/6020A [mod] - ICP-MS
Bismuth	mg/kg dw	0.2	EPA 200.2/6020A [mod] - ICP-MS
Boron	mg/kg dw	5.0	EPA 200.2/6020A [mod] - ICP-MS
Cadmium	mg/kg dw	0.02	EPA 200.2/6020A [mod] - ICP-MS
Calcium	mg/kg dw	50	EPA 200.2/6020A [mod] - ICP-MS
Chromium	mg/kg dw	0.5	EPA 200.2/6020A [mod] - ICP-MS
Cobalt	mg/kg dw	0.1	EPA 200.2/6020A [mod] - ICP-MS
Copper	mg/kg dw	0.5	EPA 200.2/6020A [mod] - ICP-MS
Iron	mg/kg dw	50	EPA 200.2/6020A [mod] - ICP-MS
Lead	mg/kg dw	0.5	EPA 200.2/6020A [mod] - ICP-MS
Lithium	mg/kg dw	2.0	EPA 200.2/6020A [mod] - ICP-MS
Magnesium	mg/kg dw	20	EPA 200.2/6020A [mod] - ICP-MS
Manganese	mg/kg dw	1.0	EPA 200.2/6020A [mod] - ICP-MS
Mercury	mg/kg dw	0.005	EPA 200.2/1631E [mod] - CVAFS
Molybdenum	mg/kg dw	0.1	EPA 200.2/6020A [mod] - ICP-MS
Nickel	mg/kg dw	0.5	EPA 200.2/6020A [mod] - ICP-MS
Phosphorus	mg/kg dw	50	EPA 200.2/6020A [mod] - ICP-MS
Potassium	mg/kg dw	100	EPA 200.2/6020A [mod] - ICP-MS
Selenium	mg/kg dw	0.2	EPA 200.2/6020A [mod] - ICP-MS
Silver	mg/kg dw	0.1	EPA 200.2/6020A [mod] - ICP-MS
Sodium	mg/kg dw	50	EPA 200.2/6020A [mod] - ICP-MS
Strontium	mg/kg dw	0.5	EPA 200.2/6020A [mod] - ICP-MS
Thallium	mg/kg dw	0.05	EPA 200.2/6020A [mod] - ICP-MS
Tin	mg/kg dw	2.0	EPA 200.2/6020A [mod] - ICP-MS
Titanium	mg/kg dw	1.0	EPA 200.2/6020A [mod] - ICP-MS
Uranium	mg/kg dw	0.05	EPA 200.2/6020A [mod] - ICP-MS
Vanadium	mg/kg dw	0.2	EPA 200.2/6020A [mod] - ICP-MS
Zinc	mg/kg dw	2.0	EPA 200.2/6020A [mod] - ICP-MS

1. particle size distribution (sand, silt, clay) micro-pipette method (SSIR-51 Method 3.2.1.2.2) includes pre-treatment of the dry sediment sample with hydrochloric acid to remove carbonates, and then the hydrogen peroxide to remove organic matter. The silt fraction is determined by calculation from the clay and sand fractions.

2. Total organic carbon is calculated as the difference between total carbon determined by combustion and thermal conductivity detection (Nelson and Sommers 1996) and total inorganic carbon is determined by pH standard curve method (Loeppert and Suarez 1996).

mm = millimetre; % dw = percent dry weight; mg/kg dw = milligrams per kilogram as dry weight; ICP-MS = inductively coupled plasma mass spectrometry; CVAFS = cold vapour atomic fluorescence spectrophotometry .

Table B-3 Parameter List for Analyses of AEMP Fish Tissue Chemistry Samples

Parameter[1]	Units	Tentative Detection Limit[2]	Analytical Method/ Instrumentation
Moisture content	%	2.0	Oven dry 105C-Gravimetric
Aluminum	mg/kg ww	1.0	Microdigestion, HR-ICP-MS (EPA 200.3/200.8)
Antimony	mg/kg ww	0.0020	Microdigestion, HR-ICP-MS (EPA 200.3/200.8)
Arsenic	mg/kg ww	0.0060	Microdigestion, HR-ICP-MS (EPA 200.3/200.8)
Barium	mg/kg ww	0.010	Microdigestion, HR-ICP-MS (EPA 200.3/200.8)
Beryllium	mg/kg ww	0.0020	Microdigestion, HR-ICP-MS (EPA 200.3/200.8)
Bismuth	mg/kg ww	0.0020	Microdigestion, HR-ICP-MS (EPA 200.3/200.8)
Boron	mg/kg ww	0.20	Microdigestion, HR-ICP-MS (EPA 200.3/200.8)
Cadmium	mg/kg ww	0.0020	Microdigestion, HR-ICP-MS (EPA 200.3/200.8)
Calcium	mg/kg ww	4.0	Microdigestion, HR-ICP-MS (EPA 200.3/200.8)
Cesium	mg/kg ww	0.0010	Microdigestion, HR-ICP-MS (EPA 200.3/200.8)
Chromium	mg/kg ww	0.040	Microdigestion, HR-ICP-MS (EPA 200.3/200.8)
Cobalt	mg/kg ww	0.0040	Microdigestion, HR-ICP-MS (EPA 200.3/200.8)
Copper	mg/kg ww	0.040	Microdigestion, HR-ICP-MS (EPA 200.3/200.8)
Iron	mg/kg ww	1.0	Microdigestion, HR-ICP-MS (EPA 200.3/200.8)
Lead	mg/kg ww	0.0100	Microdigestion, HR-ICP-MS (EPA 200.3/200.8)
Lithium	mg/kg ww	0.10	Microdigestion, HR-ICP-MS (EPA 200.3/200.8)
Magnesium	mg/kg ww	0.40	Microdigestion, HR-ICP-MS (EPA 200.3/200.8)
Manganese	mg/kg ww	0.010	Microdigestion, HR-ICP-MS (EPA 200.3/200.8)
Mercury[3]	mg/kg ww	0.0010	Microdigestion, CVAFS (EPA 200.3, EPS 245.7)
Molybdenum	mg/kg ww	0.0080	Microdigestion, HR-ICP-MS (EPA 200.3/200.8)
Nickel	mg/kg ww	0.040	Microdigestion, HR-ICP-MS (EPA 200.3/200.8)
Phosphorus	mg/kg ww	2.0	Microdigestion, HR-ICP-MS (EPA 200.3/200.8)
Potassium	mg/kg ww	4.0	Microdigestion, HR-ICP-MS (EPA 200.3/200.8)
Rubidium	mg/kg ww	0.010	Microdigestion, HR-ICP-MS (EPA 200.3/200.8)
Selenium	mg/kg ww	0.020	Microdigestion, HR-ICP-MS (EPA 200.3/200.8)
Silver	mg/kg ww	0.0010	Microdigestion, HR-ICP-MS (EPA 200.3/200.8)
Sodium	mg/kg ww	4.0	Microdigestion, HR-ICP-MS (EPA 200.3/200.8)
Strontium	mg/kg ww	0.020	Microdigestion, HR-ICP-MS (EPA 200.3/200.8)
Tellurium	mg/kg ww	0.0040	Microdigestion, HR-ICP-MS (EPA 200.3/200.8)
Thallium	mg/kg ww	0.00040	Microdigestion, HR-ICP-MS (EPA 200.3/200.8)
Tin	mg/kg ww	0.020	Microdigestion, HR-ICP-MS (EPA 200.3/200.8)
Titanium	mg/kg ww	0.10	Microdigestion, HR-ICP-MS (EPA 200.3/200.8)
Uranium	mg/kg ww	0.00040	Microdigestion, HR-ICP-MS (EPA 200.3/200.8)
Vanadium	mg/kg ww	0.020	Microdigestion, HR-ICP-MS (EPA 200.3/200.8)
Zinc	mg/kg ww	0.20	Microdigestion, HR-ICP-MS (EPA 200.3/200.8)
Zirconium	mg/kg ww	0.040	Microdigestion, HR-ICP-MS (EPA 200.3/200.8)

1. All parameters to be measured in whole body Slimy Sculpin samples; only mercury in Lake Trout tissue plugs.
2. Detection limits provided based on low volume analysis. Actual detection limits may vary, with the best achievable detection limit for low volume analysis offered by the analytical laboratory used.
3. Total mercury.
mg/kg ww = milligrams per kilogram wet weight; HR-ICP-MS = high resolution inductively coupled plasma mass spectrometry; CVAFS = cold vapour atomic fluorescence spectrophotometry .