



**Lynn Lake Gold Project:
Aquatic Effects Monitoring Plan**

Version 0

January 30, 2025

**LYNN LAKE GOLD PROJECT:
AQUATIC EFFECTS MONITORING PLAN**

Document History

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Acronyms and Abbreviations

AEMP	Aquatic Effects Monitoring Plan
Alamos	Alamos Gold Inc.
ANOVA/ ANCOVA	analysis of variance/analysis of covariance
ARD/ML	Acid Rock Drainage and Metal Leaching
BACI	before-after-control-impact
BMMP	Blasting Management and Monitoring Plan
Bq/L	becquerels per litre
°C	degrees Celsius
CALA	Canadian Accredited Laboratory Association
CCME	Canadian Council of Ministers of the Environment
CEAA	<i>Canadian Environmental Assessment Act</i>
CES	critical effect size
cm	centimetre
cm ²	centimetre squared
CRM	certified reference material
CWQG-FAL	Canadian Water Quality Guidelines for the Protection of Freshwater Aquatic Life
CVAFS	Cold vapour atomic fluorescence spectrometry
DFO	Fisheries and Oceans Canada
DL	detection limit
dw	dry weight
EAC	Environmental Advisory Committee
ECCC	Environment and Climate Change Canada
EEM	Environmental Effects Monitoring
EIS	Environmental Impact Statement
EPT	Ephemeroptera, Plecoptera, and Trichoptera
ETMA	East Tailings Management Area

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g	gram
GIS	Geographic information system
GPS	Global Positioning System
GMMP	Groundwater Management and Monitoring Plan
ha	hectare
HBI	Hilsenhoff biotic index
HDPE	high density polyethylene
HEC-RAS	Hydrologic Engineering Center-River Analysis System
ICP-MS	inductively coupled plasma mass spectrometry
ISQG	interim sediment quality guideline
km	kilometre
km ²	square kilometres
LAA	Local Assessment Area
m	metre
mm	millimetre
m ³ /day	cubic metres per day
MDMER	<i>Metal and Diamond Mining Effluent Regulations</i>
mg/kg	milligrams per kilogram
mg/L	milligrams per litre
MECC	Manitoba Environment and Climate Change (formerly Manitoba Environment, Climate and Parks, and formerly Manitoba Conservation and Climate)
MMER	<i>Metal Mining Effluent Regulations</i>
MRSA	Mine Rock Storage Area
MWAT	Maximum weekly average temperature
MWQSOG-FAL	Manitoba Water Quality Standards, Objectives, and Guidelines for the protection of aquatic life
MWS	Manitoba Water Stewardship
PDA	Project Development Area

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PEL	probable effect level
POPC	parameter of potential concern
PPE	personal protective equipment
PSQG	Provincial Sediment Quality Guidelines
QA/QC	Quality Assurance/Quality Control
RGMPs	Responsible Gold Mining Principles
RPD	Relative Percent Difference
RTK-GPS	Real-time Kinematic Geographic Positioning System
SD	standard deviation
SE	standard error
SWMMP	Surface Water Management and Monitoring Plan
TBD	to be determined
TDR	Technical Data Report
TMF	Tailings Management Facility
TSS	total suspended solids
WUA	weighted useable area
ww	wet weight
µg/L	micrograms per litre
µm	micrometre

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1.0 INTRODUCTION

This Aquatic Effects Monitoring Plan ('AEMP' or 'the Plan') describes the management and monitoring activities that will be implemented to reduce and monitor potential effects to fish, fish habitat, and other aquatic biota during the construction, operation, decommissioning/closure, and post-closure phases of the Lynn Lake Gold Project ('LLGP' or 'the Project'). It is one component of the overall Environmental Management and Monitoring Program ('EMMP') for the Project. For clarity, the term "follow-up programs", as stated in the federal Decision Statement, refers to "management and monitoring programs" as outlined in the provincial Licenses. Both terms are interchangeable but refer to the same monitoring activities that extend through all mine phases.

1.1 PURPOSE

The AEMP has two purposes. The first is to summarize the management and mitigation measures identified in the Environmental Impact Statement (EIS) and during the EIS technical review phase. These management and mitigation measures are commitments that Alamos Gold Inc. (Alamos) will implement during construction, operation, and decommissioning/closure of the Project. The second is to describe the monitoring plan that, when implemented, will provide an early warning system before adverse effects to fish and aquatic biota occur so that adaptive management measures can be implemented.

1.2 OBJECTIVES

As part of Alamos Gold Inc.'s (Alamos') approach to environmental management, the company sets, implements, and maintains documented environmental objectives that consider the Project's environmental risks and compliance obligations. These obligations are aligned with the Project's Environmental Policy and are communicated to employees, contractors, and interested parties, regularly monitored, and updated as appropriate. Objectives are set to drive continuous improvement in environmental performance and are aligned with the overall strategic goals of the Project. Objectives are measurable (where possible), monitored, communicated, and updated as appropriate.

Alamos' overarching environmental objective is to avert adverse effects, where technologically and economically feasible, and mitigate adverse effects that are unavoidable. Adherence to the AEMP will provide results which are measurable (where possible) and reportable. In support of Alamos' underlying environmental objectives (i.e., to work to limit or mitigate adverse environmental effects, meet or surpass regulatory requirements, and strive to continually improve environmental practices and performance), Alamos has established the following performance objectives for the AEMP that consider key Project interactions and compliance obligations:

- Describe the monitoring activities and data requirements needed to assess the accuracy of Project-specific and cumulative effect predictions made in the EIS.

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- Describe the monitoring activities and data requirements needed to assess the effectiveness of avoidance and mitigation measures designed to eliminate or reduce Project-specific and cumulative effects to fish, fish habitat, and other aquatic biota and included in the Project design, the Assessment of Potential Effects on Fish and Fish Habitat (i.e., Chapter 10 of the EIS; Stantec 2020), or committed to during the EIS technical review phase.
- Identify whether additional mitigation measures are necessary to reduce or eliminate Project-related or cumulative effects on fish and aquatic biota.
- Maintain compliance with regulatory requirements set out in Project approvals, licenses, and authorizations.

1.3 RELATIONSHIP TO OTHER MANAGEMENT PLANS

This AEMP relies on information, particularly avoidance and mitigation measures, from the following management and monitoring plans:

- Acid Rock Drainage and Metal Leaching (ARD/ML) Management and Monitoring Plan
- Air Quality Management and Monitoring Plan
- Blasting Management and Monitoring Plan (BMMP)
- Explosives Management Plan
- Mine Closure Plan
- Emergency Response and Spill Prevention and Contingency Plan
- Erosion and Sediment Control Plan
- Fish Salvage Plan
- Groundwater Management and Monitoring Plan (GMMP)
- Soil Management and Rehabilitation Plan
- Surface Water Monitoring and Management Plan (SWMMP)
- Waste Management Plan

Monitoring of potential changes in surface water quality and surface water quantity are addressed in the SWMMP. Monitoring potential changes in groundwater quantity and quality are addressed in the GMMP. Monitoring of potential changes in underwater noise associated with use of explosives in the open pits is addressed in the BMMP. This AEMP is limited to monitoring of potential changes in fish and aquatic biota. However, it includes measures to monitor the effects of potential changes in groundwater quantity and quality and surface water quantity and quality and, therefore, is closely tied to the SWMMP and GMMP.

The Project will have effluent discharges greater than 50 cubic metres per day (m³/day). Therefore, a separate Environmental Effects Monitoring (EEM) Plan will be prepared and submitted to Environment and Climate Change Canada (ECCC) at least six months prior to effluent discharge at the Gordon or MacLellan sites. The EEM Plan's purpose will be to monitor potential effects of mine effluent discharged to the

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downstream receiving environment and will be designed specifically to address requirements of Schedule 5 of the Metal and Diamond Mine Effluent Regulations (MDMER) under the *Fisheries Act*.

While elements of the EEM Plan overlap with this AEMP, the AEMP addresses components of the aquatic environment that the EEM Plan does not, while meeting the monitoring requirements set out in the licenses issued to the Project by the Manitoba government under *The Environment Act* and the federal Decision Statement issued for the Project by the Impact Assessment Agency of Canada (IAAC) under the *Canadian Environmental Assessment Act* (CEAA), 2012. However, the AEMP has been developed to increase efficiencies in sampling methods, timing, and locations with those necessary for the EEM Plan where and when possible.

This AEMP will provide information, particularly the need for any additional avoidance and mitigation measures, to the following management and monitoring plans:

- Air Quality Management and Monitoring Plan
- Country Foods Plan
- Erosion and Sediment Control Plan
- Wildlife Management and Monitoring Plan.

1.4 APPROACH AND SCOPE

1.4.1 Study Design

For most components of the AEMP, a “before-after-control-impact” (BACI) study design will be used to determine if potential Project effects on fish and aquatic biota are occurring. A BACI design compares data from “impact” sites downstream of the Project influence collected “before” and “after” construction, operation, and decommissioning/closure and to data collected from “control” sites located upstream or beyond the Project’s influence. Such a design allows for a robust statistical analysis by increasing the likelihood of isolating potential Project effects from background “noise” inherent to most biological data. A BACI design is considered optimal to help isolate the effect of the development from natural variability if the timing and location of the impact are known, and adequate pre-data are collected (Smokorowski and Randall 2017).

Where appropriate, a gradient study design may also be used. Such a design compares data from sites downstream at progressively further distances from the Project influence. This design is most appropriate for detecting potential effects on fish or aquatic biota due to changes in water or sediment quality.

Control sites (referred to as reference sites in this AEMP) have been selected based on the similarity of their habitat to “impact” sites at the Gordon and MacLellan sites. Reference lakes were selected based on the similarity of their surface area, average and maximum water depth, and location in the watershed to “impact” lakes. At both mine sites, these included smaller (i.e., <100 ha), headwater lakes and larger (>200 ha) lakes further downstream in their watershed. Reference sites in streams were selected based on the similarity of their stream order, channel width, substrate composition, and gradient. Reference sites in

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streams included sites in depositional areas (i.e., slower flowing areas with lower gradients and fine substrates, such as silt, sand, and/or organics) for comparison of sediment and benthic invertebrate data and erosional areas (i.e., faster flowing areas with higher gradients and coarser substrates, such as gravel, cobbles, and boulders) for comparison of chlorophyll *a* concentrations in periphyton, benthic invertebrates and small-bodied fish tissue data

Alamos conducted reconnaissance surveys in 2024 to determine the most appropriate reference sites for each impact lake and stream site downstream of the Gordon and MacLellan mine sites. This was done by visiting a list of candidate sites identified during previous baseline surveys and from analysis of aerial imagery. From these efforts, Alamos has identified a suite of reference sites that it believes best approximates conditions at a corresponding impact site. Alamos will continue to evaluate other candidate sites in 2025 and will adjust the final selection of reference sites, if necessary, before construction or operation of the Project begins to affect habitat, water quality, or water quantity in the downstream receiving environment. In particular, erosional habitats in small, headwater streams are rare at the Gordon and MacLellan sites and continued effort to find erosional habitats of similar size, substrate composition, and gradient to erosional habitats downstream of the mine sites will be a focus. A summary of the physical characteristics of the currently selected reference sites and their corresponding impact sites in lakes and streams is provided in Table 1-1 and Table 1-2, respectively.

Table 1-1 Comparison of Physical Characteristics at Impact and Reference Lakes at the Gordon and MacLellan Sites

Waterbody	Impact/Reference	Surface Area (ha)	Average Depth (m)	Maximum Depth (m)	Watershed Position
Gordon Site					
Swede Lake	Impact	230	3.2	9.0	Upper
White Owl Lake	Reference ¹	238	TBD	TBD	Upper
Gordon Lake	Impact	19	1.4	2.8	Headwater
Farley Lake	Impact	77	1.3	10.8	Headwater
Susan Lake	Impact	12	3.1	5.5	Headwater
Low Lake	Reference ²	40	TBD	TBD	headwater
MacLellan Site					
Cockeram Lake	Impact	2,105	3.0	4.0	Middle
Burge Lake	Reference ³	485	TBD	TBD	Middle
Payne Lake	Impact	60	1.3	3.7	Headwater
Minton Lake	Impact	65	1.5	2.2	Headwater
Carr Lake	Reference ⁴	99	TBD	TBD	headwater
Notes: ¹ Reference Lake For Comparison To Swede Lake ² Reference Lake For Comparison To Gordon, Farley, And Susan Lakes ³ Reference Lake For Comparison To Cockeram Lake ⁴ Reference Lake For Comparison To Payne And Minton Lakes Tbd = To Be Determined					

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Table 1-2 Comparison of Physical Characteristics at Impact and Reference Streams at the Gordon and MacLellan Sites

Watercourse	Impact/Reference	Depositional/Erosional Habitat	Stream order	Average Channel width (m)	Substrate Composition (Dominant/subdominant)	Average Gradient (%)
Gordon Site						
Farley Creek	Impact	Depositional	3	50-70	Silt/organics	<1
Farley Creek	Impact	Erosional	3	3.5	Boulder/cobble	>5
Mac Lake outlet	Reference ¹	Depositional	3	25-40	Silt/organics	<1
White Owl Lake outlet	Reference ²	Erosional	3	1.5-2.0	Boulder/cobble	2
Hughes River	Impact	Depositional	>4	100-250	Silt/sand	<1
Hughes River	Impact	Erosional	>4	45-55	Boulder/cobble	3
Hughes River	Reference ³	Depositional	>4	50-175	Fine sand/silt	<1
Hughes River	Reference ⁴	Erosional	>4	30-40	Boulder/cobble	3
MacLellan Site						
Tributary KEE3-B1	Impact	Depositional	2	15-30	Silt/organics	<1
Carr Lake outlet	Reference ⁵	Depositional	3	5-15	Silt/organics	<1
Keewatin River	Impact	Depositional	>4	100-200	Sand/silt	<1
Keewatin River	Impact	Erosional	>4	25-30	Cobble/gravel	3
Keewatin River	Reference ⁶	Depositional	>4	100-150	Silt/sand	<1
Keewatin River	Reference ⁷	Erosional	>4	20-30	Boulder/cobble	3
Notes:						
¹ reference site for comparison of sediment and benthic invertebrate data from depositional habitats in Farley Creek ² reference site for comparison of periphyton (chlorophyll a concentrations) and benthic invertebrate data from erosional habitats in Farley Creek ³ upstream reference site for comparison of sediment and benthic invertebrate data from depositional habitats in the Hughes River downstream of the effluent pipe ⁴ upstream reference site for comparison of periphyton (chlorophyll a concentrations) and benthic invertebrate data from erosional habitats in the Hughes River downstream of the effluent pipe ⁵ reference site for comparison of sediment and benthic invertebrate data from depositional habitat in tributary KEE3-B1 ⁶ upstream reference site for comparison of sediment and benthic invertebrate data from deposition habitat in the Keewatin River downstream of the effluent pipe ⁷ upstream reference site for comparison of periphyton (chlorophyll a concentrations), benthic invertebrate, and small-bodied fish tissue data in erosional habitat in the Keewatin River downstream of the effluent pipe						

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Monitoring locations, including “impact” and “reference” sites, for all media included in the AEMP have been consolidated for the Gordon and MacLellan sites in Appendix B, Map B-21 and Map B-22, respectively, to show the spatial distribution of sampling sites, where sampling for different media will be conducted at co-located sites, and to show to location of “impact” sites and “control” (i.e., reference) sites in relation to mine infrastructure.

1.4.2 Pathways of Effects

The AEMP focuses on the three principal pathways of effects from the Project on fish and aquatic biota assessed in the Fish and Fish Habitat Effects Assessment (Chapter 10 of the EIS):

- Physical changes in the quantity or quality of fish habitat
- Changes in surface water quality that may result in toxicological effects on the health, growth, survival, or reproduction of fish and aquatic biota
- Changes in surface water quantity (i.e., lake levels and stream flows) that may affect the abundance, access, or suitability of fish habitat

Physical changes in the quantity and quality of fish habitat (excluding habitat directly affected by the Project footprint) and changes in surface water quantity may occur due to changes in the groundwater table resulting from the development of the open pits and tailings management facility (TMF), changes in catchment area run-off, and/or water management activities (e.g., diversion of non-contact water and collection of contact water). Changes in surface water quality may occur primarily due to mine effluent discharge. At the Gordon site, effluent pipes will discharge to Gordon Lake and Farley Lake. At the MacLellan site, an effluent pipe will discharge to the Keewatin River.

1.4.3 Scope

Monitoring of potential changes in surface water quality and quantity are described in the SWMMP. Therefore, the AEMP includes the following components of the aquatic environment:

1. Sediment Quality
2. Benthic Invertebrate Communities
3. Fish Habitat
4. Fish Tissues

For each of these components, the AEMP identifies:

- Project pathways of effects on fish and aquatic biota that are unlikely to be avoided or for which the effectiveness of mitigation measures to eliminate or reduce the effect is uncertain
- End-point receptors that will be monitored to assess the validity of these pathways and the effectiveness of avoidance or mitigation measures
- Metrics for each end-point receptor that will be used to determine whether effects are occurring

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- Methods to be used to sample, analyze, and interpret monitoring data
- Thresholds for each metric that, if exceeded, will trigger adaptive management
- Adaptive management actions to be implemented should metric thresholds be exceeded
- Schedule, duration, frequency, and methods for sampling, analysis, and reporting

The measurable end-points for concluding the monitoring program are included in the AEMP. These end-points will be achieved either at permanent closure or earlier if it can be demonstrated that there are no further impacts warranting continued monitoring.

1.5 REGULATORY CONTEXT

An EIS for the Project was submitted to the former Canadian Environmental Assessment Agency (now IAAC) pursuant to CEAA, 2012, and to Manitoba Environment and Climate Change (MECC; formerly Manitoba Conservation and Climate) as an Environment Act Proposal pursuant to *The Environment Act* of Manitoba. The relevant federal and provincial regulatory requirements related to this AEMP are described below.

1.5.1 Federal Regulatory Requirements

1.5.1.1 Fisheries Act

Section 36(3) of the *Fisheries Act* prohibits the deposition of deleterious substances into waters frequented by fish in Canada unless authorized by regulation. The MDMER under the *Fisheries Act* regulates the deposit of deleterious mine effluents, tailings, and waste rock into waters frequented by fish, as authorized by ECCC. The MDMER came into effect on June 1, 2018 and amends the Metal Mining Effluent Regulations (MMER). The MDMER defines mine effluent as:

“(a) hydrometallurgical facility effluent, milling facility effluent, mine water effluent, tailings impoundment area effluent, treatment pond effluent or treatment facility effluent other than effluent from a sewage treatment facility; or (b) any seepage or surface runoff containing any deleterious substance that flows over, through or out of the site of a mine.”

The MDMER applies to metal and diamond mines with an effluent flow rate of greater than 50 m³/day based on effluent deposited from all final discharge points of the mine. For these mines, the MDMER allows the discharge of mine effluent containing deleterious substances listed in Schedule 4 if:

1. the effluent is not acutely lethal
2. the pH is equal to or greater than 6.0 but not greater than 9.5
3. concentrations of deleterious substances do not exceed concentration limits identified in Schedule 4 of the MDMER at the final discharge point(s).

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New mines are metal and diamond mines that begin commercial operations within three years of the amended MDMER coming-into-force on June 1, 2021 (i.e., mines which begin operations on or after June 1, 2018) or, in the case of a recognized closed mine, that return to commercial operation on or after June 1, 2021. The Lynn Lake Gold Project will be in commercial operations after June 1, 2021 and, therefore, will be subject to the effluent discharge limits for new mines (Table 1-3).

Table 1-3 Metal and Diamond Mining Effluent Regulation Authorized Effluent Limits for New Mines in Canada

Substance	Maximum Authorized Monthly Mean Concentration ¹	Maximum Authorized Concentration in a Composite Sample ¹	Maximum Authorized Concentration in a Grab Sample ¹
Arsenic	0.10	0.15	0.20
Copper	0.10	0.15	0.20
Cyanide	0.50	0.75	1.00
Lead	0.08	0.12	0.16
Nickel	0.25	0.38	0.50
Zinc	0.40	0.60	0.80
Unionized ammonia	0.50	N/A ²	1.00
Total suspended solids	15.00	22.50	30.00
Radium 226	0.37	0.74	1.11
Notes:			
¹ All units in milligrams per litre (mg/L), except for Radium 226, which is expressed in becquerels per litre (Bq/L), and unionized ammonia which is expressed as mg/L nitrogen (N)			
² N/A = not applicable			

Deposition of mine effluent, tailings, and waste rock into waterbodies frequented by fish is prohibited by the *Fisheries Act* unless those waterbodies are designated as a Mine Waste Disposal Area by the Parliament of Canada and listed in Schedule 2 of the MDMER. No amendments (i.e., addition of waterbodies) to Schedule 2 of the MDMER are anticipated for the Project because the TMF and all mine rock storage areas (MRSAs) have been sited away from fish-bearing waterbodies and watercourses.

Schedule 5 of the MDMER outlines the requirements for EEM for mines that discharge effluent to the receiving environment at greater than 50 m³/day. This monitoring requires effluent characterization, sublethal toxicity testing, water quality monitoring, and biological studies. Exemptions to conducting biological studies apply if:

1. effluent concentrations in the receiving environment are diluted to ≤1% within 100 m or 250 m from the final discharge point
2. fish tissue concentrations for mercury or selenium are less than certain threshold concentrations; or
3. results of the two previous biological studies showed differences between “control” and “impact” samples were less than the associated “critical effect sizes” (CES)

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1.5.1.2 Canadian Water Quality Guidelines for the Protection of Freshwater Aquatic Life

The Canadian Water Quality Guidelines for the Protection of Freshwater Aquatic Life (CWQG-FAL) are established by the Canadian Council of Ministers of the Environment (CCME 2023) and are updated to incorporate current guideline derivation approaches and toxicological data. The CWQG-FAL are intended to be protective of all forms of aquatic life and all aspects of the aquatic life cycle due to acute and/or chronic exposure (i.e., short-term or long-term). These guidelines will be used, in conjunction with the most stringent of the Tier I, II, and III Manitoba Water Quality Standards, Objectives, and Guidelines for the Protection of Aquatic Life (MWQSOG-FAL; Manitoba Water Stewardship [MWS] 2011), to identify parameters of potential concern (POPCs) during monitoring and to provide benchmarks for adaptive management, as appropriate.

1.5.2 Provincial Regulatory Requirements

1.5.2.1 The Environment Act

Alterations to stream channels that affect fish mobility and/or fish habitat and works resulting in modification of lake or river levels for a water surface area greater than two square kilometres (km²) are considered Class 2 developments under section 3(9) of the Classes of Development Regulations pursuant to *The Environment Act* of Manitoba. Consequently, any proposed alteration to streams or lakes in Manitoba is subject to provincial assessment and licensing requirements.

1.5.2.2 The Water Protection Act

The Water Protection Act of Manitoba provides for the protection and stewardship of Manitoba's water resources and aquatic ecosystems. Part 2 of the Act allows for setting and adoption of Manitoba Water Quality Standards, Objectives, and Guidelines (MWQSOG; MWS 2011) and requires consideration of relevant MWQSOG for approvals or decisions issued under *The Environment Act* of Manitoba or other relevant acts or regulations.

1.5.2.3 Manitoba Water Quality Standards, Objectives, and Guidelines

MWQSOG for the protection of aquatic life (MWQSOG-FAL; MWS 2011) include Tier I (Standards), II (Objectives), and III (Guidelines) that, when followed, protect drinking water, water for livestock, and fish and aquatic biota from short-term and long-term effects of water quality deterioration. The MWQSOG identify the minimum standards for water quality and include:

- Tier I standards describe minimum technology-based standards for industrial and municipal wastewater and other effluents.

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- Tier II water quality objectives are defined for a limited number of common pollutants, including dissolved metals, and are based on a water quality-based approach when additional restrictions need to be developed to protect important uses of groundwater and surface water beyond those defined in Tier I standards. Tier II objectives for metals typically are for one maximum four-day period every three years during periods of infrequent or extreme low stream flows to avoid aquatic communities being in continual recovery.
- Tier III water quality guidelines include federal water quality, sediment quality, and fish tissue guidelines for the protection of freshwater aquatic life, wildlife consumers, and human consumers of fish or other aquatic life tissues. They also include narrative water quality guidelines for those parameters for which numerical guidelines cannot be reasonably developed. Tier III guidelines, including those for total metals, are used to evaluate ambient water quality data in relation to the protection of freshwater aquatic life and human uses, including drinking water, irrigation, and recreation.

1.5.2.4 The Mines and Minerals Act

The Mines and Minerals Act requires that water removed from workings under a mine lease be disposed in a safe and secure manner. Regulation 67/99 of the Act stipulates requirements for restoration of watercourses during mine closure.

1.5.3 Corporate or Other Policies

As a member of the World Gold Council, Alamos Gold Inc. (Alamos) is a proud supporter of the Responsible Gold Mining Principles (the RGMPs). The ten RGMPs provide a framework that sets expectations for consumers, investors, and the downstream gold supply chain as to what constitutes responsible gold mining, addressing key environmental, social and governance issues for the gold mining sector. They are designed to provide confidence to governments, investors, employees and contractors, communities, supply chain partners and civil society that gold has been produced responsibly. Following the release of the RGMPs in September 2019, Alamos has implemented and aligned to the framework, and obtained external assurance to provide further confidence that the gold produced by Alamos is responsibly mined. In 2023, Alamos communicated its progress on implementing the RGMPs through Alamos' 2022 RGMP Progress Report which received independent audit/assurance from EEM EHS Management Inc. (Alamos 2023). The 2022 RGMP Progress Report reflects Alamos' third year reporting under the RGMP. Alamos will continue to implement the RGMPs through 2024 and beyond. The RGMPs are only applicable to operating mines. The Lynn Lake Gold Project will be incorporated as it transitions through construction into operation.

Working with its members, the World Gold Council has set out RGMPs to address key environmental, social and governance issues for the gold mining sector. One of the key principles is Water, Energy and Climate Change.

Alamos has a series of guiding corporate sustainability standards, including Environmental Monitoring, Hazard Identification & Risk Management, and Incident Classification, Investigation & Reporting. These policies are described in Table 1-4.

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Alamos' standards are regularly updated to reflect the latest developments. For the most current and up-to-date standards, please refer to the online version.

Table 1-4 Corporate Sustainability Standards

Corporate Policy	Requirement
Environmental Monitoring (CSS-ENV-10.1)	Sites shall develop and implement an environmental monitoring program. The site's environmental monitoring program will be documented as to list of points monitored, coordinates of points monitored, description of points (including the reason for monitoring (e.g., regulatory compliance, baseline, trend analysis, etc.), frequency of monitoring, anticipated duration of monitoring (e.g., the life of the mine), and parameters monitored. The monitoring program will be of sufficient scope to allow for the timely identification of potential environmental impacts prior to their migration offsite. Sites will regularly review their monitoring programs and update changes at the mine site as required. At a minimum, the program will meet all environmental regulatory requirements.
Environmental Monitoring (CSS-ENV-10.2)	Compliance monitoring data will be subject to Quality Assurance/Quality Control (QA/QC) verification. Sample results that do not meet QA/QC guidelines will be disregarded and sample collection repeated. Sites must use reliable and accredited labs.
Environmental Monitoring (CSS-ENV-10.3)	Monitoring data will be stored in an electronic database.
Environmental Monitoring (CSS-ENV-10.4)	When compliance monitoring results indicate exceedances of permit or regulatory requirements, or significant deviation from previous results, the results will be reconfirmed with the person or company that did the analysis, and a confirmatory monitoring or sample will be taken immediately if the result is reconfirmed. Sites will also follow any permit-specific or jurisdictional requirements.
Environmental Monitoring (CSS-ENV-10.5)	Monitoring data will be reviewed at least quarterly by the responsible manager to identify trends that may indicate potential for future exceedances of permit conditions or applicable standards, and potential risk. The site General Manager will be formally notified of any exceedances and emerging compliance issues. Refer to CSS-GOV-08 Incident Reporting Standard for any moderate, major, or catastrophic incidents.
Environmental Monitoring (CSS-ENV-10.6)	Sites will assess the need for a monitoring program involving external stakeholders.
Hazard Identification & Risk Management (CSS-GOV-2.1)	All Alamos locations shall maintain systems to identify, prevent and/or manage sustainability risks that face its operations and those that its activities may pose to others. This includes but is not limited to hazards and risks related to the: <ul style="list-style-type: none"> • Health and Safety of our workforce and communities, • Environmental impacts of our activities (local and downstream), • Societal and community impacts, and • Security and protection of people and property.
Hazard Identification & Risk Management (CSS-GOV-2.2)	Site Managers are responsible for ensuring that appropriate resources, both internal and external, are available to identify, quantify, manage, and report sustainability hazards and risks. Assessments shall consider all site activities including: <ul style="list-style-type: none"> • Contractor works, • Regulatory requirements, • Permit or license requirements, • Alamos Sustainability Standards requirements, and • Other site-specific requirements.

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Table 1-4 Corporate Sustainability Standards

Corporate Policy	Requirement
Hazard Identification & Risk Management (CSS-GOV-2.3)	Sites shall maintain a risk registry of all site risks. The risk registry will be updated at least quarterly or when major changes/incidents occur. Clear responsibility and authority for implementing, managing, reporting, and coordinating updates to the risk registry shall be designated to a specific employee(s).
Hazard Identification & Risk Management (CSS-GOV-2.4)	All corporate, site and task-level risks shall be assessed against the Alamos Risk Matrix, including likelihood and consequence assessments.
Hazard Identification & Risk Management (CSS-GOV-2.5)	Sites shall apply the hierarchy of controls considering (in order of priority): <ol style="list-style-type: none"> 1. Elimination – remove the hazard 2. Substitution – replace the hazard 3. Engineering control – physically control or isolate the hazard (e.g., dikes, guarding, interlocks) 4. Administrative control – control response/avoidance of hazard (e.g., training, procedures, reducing employee exposure to hazards, signage) 5. PPE (personal protective equipment) or mitigation – protect people (PPE) or the environment (spill kits) from the hazard. This is the last line of defense. Extreme and high risks that exist after controls have been applied should go through a formal review with the Site Manager.
Hazard Identification & Risk Management (CSS-GOV-2.6)	Sites shall ensure effective communication of risks and controls to the workforce based on the nature of the activity and related risk. The nature of communication may change based on the risk frequency and consequence. For example, communication may include induction training, refresher training, policies, procedures and/or signage.
Hazard Identification & Risk Management (CSS-GOV-2.7)	For each identified risk, management shall assess and manage the risk appropriately with consideration to the risk rating. In considering risk mitigation, management must evaluate the cost of controls versus the benefit derived and ensure the resultant control framework is effective.
Hazard Identification & Risk Management (CSS-GOV-2.9)	The Alamos Executive and Internal Audit Director shall review and verify enterprise risks on a quarterly basis.
Incident Classification, Investigation & Reporting (CSS-GOV-8.3)	The Corporate Sustainability Team shall maintain an Incident Alert email group user list comprised of, at a minimum: <ul style="list-style-type: none"> • Alamos Executive and Management • Country Managers • General Managers • Project Managers
Incident Classification, Investigation & Reporting (CSS-GOV-8.6)	The Corporate Sustainability Team shall provide a report on significant incidents on a quarterly basis to senior management and the Technical & Sustainability Committee of the Board.
Incident Classification, Investigation & Reporting (CSS-GOV-8.7)	Corporate Sustainability and Risk Management teams shall annually review and revise the Alamos Risk Assessment Consequence Table to ensure that thresholds are consistent with the Alamos Enterprise Risk Management system.

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1.5.4 Approval-Related Requirements

The conditions relating to fish and aquatic resources included in the federal Decision Statement issued under CEAA, 2012, provincial Environment Act Licence No. 3390 (Gordon), and provincial Environment Act Licence No. 3391 (MacLellan) are summarized in Table 1-5. This table does not include conditions relating to water quantity (i.e., water levels in lakes, flows in streams) or water quality; those conditions are included in the SWMMP. This table also excludes conditions relating to groundwater quantity and quality (included in the GMMP), management of potential acid rock drainage/metal leaching (ARD/ML; included in the ARDML management plan) or fish habitat offsetting (included in the Fish Habitat Offsetting Plan).

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Table 1-5 Approval-Related Requirements

Licence	Condition	Corresponding AEMP Section
CEAA, 2012	2.1 The Proponent shall ensure that its actions in meeting the conditions set out in this Decision Statement during all phases of the Designated Project are considered in a careful and precautionary manner, promote sustainable development, are informed by the best information and knowledge available at the time the Proponent takes action, including policies, guidelines and directives and community and Indigenous knowledge, are based on methods and models that are recognized by standard-setting bodies, are undertaken by qualified individuals, and have applied the best available economically and technically feasible technologies.	All
CEAA, 2012	2.2 The Proponent shall ensure that its actions in meeting the conditions set out in the Decision Statement are taken in a way that is consistent with any applicable recovery strategy and action plans for listed species at risk.	N/A ¹
CEAA, 2012	2.5 The Proponent shall, where a follow-up program is a requirement of a condition set out in this Decision Statement, determine, as part of the development of each follow-up program and in consultation with Indigenous groups and any other parties being consulted during the development, the following information, unless otherwise specified in the condition: 2.5.1 the methodology, location, frequency, timing and duration of monitoring associated with the follow-up program;	3.4, 4.4, 5.4, 6.4, 7.4
CEAA, 2012	2.5.2 the scope, content and frequency of reporting of the results of the follow-up program to the parties consulted for the development of the follow-up program;	9.0
CEAA, 2012	2.5.3 the minimum frequency at which the follow-up program must be reviewed and, if necessary, updated;	9.0
CEAA, 2012	2.5.4 the levels of environmental change relative to baseline that would require the Proponent to implement modified or additional mitigation measure(s), including instances where the Proponent may require Designated Project activities causing the environmental change to be stopped;	3.2, 4.2, 5.2, 6.2, 7.2
CEAA, 2012	2.5.5 the technically and economically feasible mitigation measures to be implemented by the Proponent if monitoring conducted as part of the follow-up program shows that the levels of environmental change referred to in condition 2.5.4 have been reached or exceeded; and	8.0
CEAA, 2012	2.5.6 the specific and measurable end points that must be achieved before the follow-up program can end. Those end points should indicate that the accuracy of the environmental assessment has been verified and/or that the mitigation measures are effective.	8.0, 9.0
CEAA, 2012	2.6 The Proponent shall update the information determined for each follow-up program pursuant to condition 2.5 during the implementation of each follow-up program, at the minimum frequency determined pursuant to condition 2.5.3 and in consultation with Indigenous groups and any other parties being consulted during the development of each follow-up program.	9.0

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Licence	Condition	Corresponding AEMP Section
CEAA, 2012	2.7 The Proponent shall provide details of the follow-up programs referred to in conditions 3.12, 3.13, 3.14, 3.15, 4.5, 4.6, 6.3, 6.4, 6.5, 9.3, 10.5 and 12.2, including the information determined for each follow-up program pursuant to condition 2.5, to the Agency and to Indigenous groups and any other parties being consulted during the development of each follow-up program prior to the implementation of each follow-up program. The Proponent shall also provide any update made pursuant to condition 2.6 to the Agency and to Indigenous groups and any other parties being consulted during the development of each follow-up program within 30 days of the follow-up program being updated.	9.0
CEAA, 2012	2.8 The Proponent shall, where a follow-up program is a requirement of a condition set out in this Decision Statement: 2.8.1 implement the follow-up program according to the information determined pursuant to condition 2.5; 2.8.2 conduct monitoring and analysis to verify the accuracy of the environmental assessment as it pertains to the particular condition and/or to determine the effectiveness of any mitigation measure; 2.8.3 determine whether modified or additional mitigation measure(s) are required based on the monitoring and analysis undertaken pursuant to condition 2.8.2; 2.8.4 if modified or additional mitigation measure(s) are required pursuant to condition 2.8.3, develop and implement these mitigation measure(s) as soon as feasible and monitor them pursuant to condition 2.8.2. The Proponent shall notify the Agency in writing within 48 hours of any modified or additional mitigation measure being implemented. If the Proponent implements any additional or modified mitigation measure not previously submitted to the Agency pursuant to condition 2.5, the Proponent shall submit a detailed description of the measure(s) to the Agency within 7 days of their implementation; and 2.8.5 report all results of the follow-up program to the Agency no later than March 31 following each reporting year during which the follow-up program is implemented and, subject to information determined pursuant to 2.5.2, to the parties being consulted during the development of the follow-up program.	3.0, 4.0, 5.0, 6.0, 7.0, 8.0
CEAA, 2012	2.9 Where consultation with Indigenous groups is a requirement of a follow-up program, the Proponent shall discuss the follow-up program with each group and shall determine, in consultation with each group, opportunities for their participation in the implementation of the follow-up program, including the conduct of monitoring, the analysis and reporting of follow-up results and the determination of whether modified or additional mitigation measure(s) are required, as set out in condition 2.8, and opportunities for training to support participation in monitoring. The Proponent shall permit the participation of any interested Indigenous group in the identified follow-up program and training.	9.0

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Licence	Condition	Corresponding AEMP Section
CEAA, 2012	2.10 The Proponent shall prepare an annual report for each reporting year that sets out: 2.10.1 the activities undertaken by the Proponent to comply with each of the conditions set out in this Decision Statement; 2.10.2 how the Proponent complied with condition 2.1; 2.10.3 for conditions set out in this Decision Statement for which consultation is a requirement, how the Proponent considered any views and information that the Proponent received during or as a result of the consultation, and the resources provided to support their participation in consultation activities; 2.10.4 the information referred to in conditions 2.5 and 2.8 for each follow-up program; 2.10.5 a summary of the available results of the follow-up program requirements identified in conditions 3.12, 3.13, 3.14, 3.15, 4.5, 4.6, 6.3, 6.4, 6.5, 9.3, 10.5 and 12.2; 2.10.6 for any plan that is a requirement of a condition set out in this Decision Statement, any update(s) to the plan that have been made during the reporting year; and 2.10.7 any modified or additional mitigation measure implemented or proposed to be implemented by the Proponent, as determined pursuant to condition 2.8.	9.0
CEAA, 2012	2.11 The Proponent shall submit to the Agency the annual report referred to in condition 2.10, including a plain language executive summary in both official languages, no later than March 31 following the reporting year to which the annual report applies.	9.0
CEAA, 2012	2.12 The first reporting year for which the Proponent shall prepare an annual report pursuant to condition 2.10 shall start on the day the Minister of the Environment issues the Decision Statement pursuant to subsection 54 (1) of the <i>Canadian Environmental Assessment Act, 2012</i> .	9.0
CEAA, 2012	3.3 The Proponent shall install exclusion screens on intake pipes prior to their operation, taking into account <i>Fisheries and Oceans Canada's Freshwater Intake End-of-Pipe Fish Screen Guideline</i> , and in a manner consistent with the <i>Fisheries Act</i> and its regulations.	6.1
CEAA, 2012	3.8 The Proponent shall develop, prior to construction and in consultation with Indigenous groups and relevant authorities, measures to protect fish and fish habitat when undertaking activities in or near fish-bearing water bodies, in a manner that complies with any authorization issued under the <i>Fisheries Act</i> for the Designated Project. The Proponent shall implement these measures during all phases of the Designated Project. In doing so, the Proponent shall:	6.0
CEAA, 2012	3.8.1 salvage and relocate fish prior to conducting any Designated Project activity requiring the removal of fish habitat, including dewatering;	6.1
CEAA, 2012	3.8.2 conduct activities in or near fish-bearing water bodies in accordance with Fisheries and Oceans Canada's <i>Manitoba Restricted Activity Timing Windows for the Protection of Fish and Fish Habitat</i> and <i>Measures to Protect Fish and Fish Habitat (DFO 2020)</i> , unless otherwise authorized by relevant authorities;	6.1

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Licence	Condition	Corresponding AEMP Section
CEAA, 2012	<p>3.8.3 maintain, during all phases of the Designated Project, a buffer of undisturbed vegetation of at least 30 meters from the high-water mark, as follows:</p> <p>3.8.3.1 around fish-bearing water bodies, including wetlands, within and adjacent to the Project development areas that are not required to be removed for construction of the Designated Project, in a manner that complies with any authorization issued under the <i>Fisheries Act</i>;</p> <p>3.8.3.2 around wetlands, within and adjacent to the Project development areas that are not required to be removed for construction of the Designated Project, unless not technically or economically feasible. If work within 30 meters of wetlands is required, the Proponent shall use weight-distributing materials under machinery to limit soil compaction and give preference to using existing access roads to access areas near wetlands.</p>	6.1
CEAA, 2012	<p>3.11 The Proponent shall develop, prior to construction and in consultation with Indigenous groups and relevant authorities, and implement and maintain during all phases of the Designated Project, measures to control erosion and sedimentation within the Project development areas in a manner consistent with the Fisheries Act and its regulations, and taking into account Environment and Climate Change Canada's <i>Environmental Code of Practice for Metal Mines</i>, and Fisheries and Oceans Canada's <i>Measures to Protect Fish and Fish Habitat</i>. The Proponent shall submit these measures to the Agency before implementing them. As part of these measures, the Proponent shall:</p> <p>3.11.1 install intake pipes pointing upwards and away from sediment; and</p> <p>3.11.2 equip contact water discharge pipes with diffusers.</p>	6.1
CEAA, 2012	<p>3.14 The Proponent shall develop, prior to construction and in consultation with Indigenous groups, Fisheries and Oceans Canada, Environment and Climate Change Canada and any other relevant authorities, a follow-up program to determine the effectiveness of the mitigation measures and verify the accuracy of the environmental assessment predictions identified in Volume 2 Chapter 10 of the Environmental Impact Statement as they pertain to adverse environmental effects of the Designated Project on fish and fish habitat, taking into account Environment and Climate Change Canada's <i>Metal Mine Technical Guidance for Environmental Effects Monitoring</i>. The Proponent shall implement the follow-up program during all phases of the Designated Project. As part of the follow-up program, the Proponent shall:</p> <p>3.14.1 monitor, during all phases of the Designated Project, water temperature in Farley Creek, Farley Lake, Gordon Lake, the Hughes River, the Keewatin River, Minton Lake, the new diversion channel, and any additional locations identified in consultation with relevant authorities, taking into account predictions in Volume 2 Chapter 10 of the Environmental Impact Statement;</p>	6.3

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Licence	Condition	Corresponding AEMP Section
CEAA, 2012	3.14.2 monitor total invertebrate density, taxon richness, Simpson's Evenness Index, Bray-Curtis Index, and chlorophyll a to characterize benthic invertebrate, plankton and periphyton communities in Farley Creek, Farley Lake, Gordon Lake, the Hughes River, the Keewatin River, Minton Lake, the new diversion channel, and any additional locations identified in consultation with Indigenous groups and relevant authorities, for the detection of project- related changes in nutrient and contaminant levels, taking into account predictions in Volume 2 Chapter 10 of the Environmental Impact Statement;	5.0
	3.14.3 identify, in consultation with Indigenous groups, Fisheries and Oceans Canada and any other relevant authorities, fish species to monitor, including species used for traditional purposes by Indigenous groups. Species shall include northern pike (<i>Esox lucius</i>), lake whitefish (<i>Coregonus clupeaformis</i>), and white sucker (<i>Catostomus commersonii</i>); and	6.0
	3.14.4 monitor, starting prior to construction and during all phases of the Designated Project, fish habitat quality and quantity end points for all species identified pursuant to condition 3.14.3, in Farley Creek, Farley Lake, Gordon Lake, the Keewatin River, Minton Lake, the new diversion channel, fish-bearing wetlands within and downstream of the Project development areas, and any additional locations identified in consultation with Indigenous groups and relevant authorities.	4.0
Environment Act Licence No. 3390 (Gordon)	19. The licensee shall, prior to operation of the development: a) prepare and submit to the director for approval, the following comprehensive environmental management plans: iv) Aquatic Effects Monitoring Program	All
Environment Act Licence No. 3390 (Gordon)	26. The licensee shall, during construction and maintenance of the development, prevent the introduction and spread of foreign aquatic and terrestrial biota by cleaning equipment prior to its delivery to the site of the development in accordance with the requirements of Regulation 173/2015 respecting Aquatic Invasive Species, or any future amendment thereof.	6.1
Environment Act Licence No. 3390 (Gordon)	27. The licensee shall not remove, destroy or disturb species unless otherwise authorized pursuant to Manitoba Regulation 25/98, respecting Threatened, Endangered and Extirpated Species, or any future amendment thereof, and pursuant to the federal <i>Species at Risk Act</i> .	6.1
Environment Act Licence No. 3390 (Gordon)	28. The licensee shall not undertake construction or maintenance activities in connection with the development in fish bearing waters or potentially fish bearing waters between April 15 and June 30 of any year, or during periods of high stream flow, unless otherwise authorized by the director.	6.1
Environment Act Licence No. 3391 (MacLellan)	19. The licensee shall, prior to operation of the development: a) prepare and submit to the director for approval, the following comprehensive environmental management plans: iv) Aquatic Effects Monitoring Program	All

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Licence	Condition	Corresponding AEMP Section
Environment Act Licence No. 3391 (MacLellan)	27. The licensee shall, during construction and maintenance of the development, prevent the introduction and spread of foreign aquatic and terrestrial biota by cleaning equipment prior to its delivery to the site of the development in accordance with the requirements of Regulation 173/2015 respecting Aquatic Invasive Species, or any future amendment thereof.	6.1
Environment Act Licence No. 3391 (MacLellan)	28. The licensee shall not remove, destroy or disturb species unless otherwise authorized pursuant to Manitoba Regulation 25/98, respecting Threatened, Endangered and Extirpated Species, or any future amendment thereof, and pursuant to the federal <i>Species at Risk Act</i> .	6.1
Environment Act Licence No. 3391 (MacLellan)	29. The licensee shall not undertake construction or maintenance activities in connection with the development in fish bearing waters or potentially fish bearing waters between April 15 and June 30 of any year, or during periods of high stream flow, unless otherwise authorized by the director.	6.1
<p>Note: ¹ there are no provincially or federal listed fish or other aquatic species near the Lynn Lake Gold Project</p>		

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2.0 ENVIRONMENTAL SETTING

Existing conditions for fish and fish habitat are described in detail in the Fish, Fish Habitat, and Fish Tissue Baseline Technical Data Report (Stantec 2017) and associated Validation Report (Volume 4, Appendix J) while existing conditions for sediment and benthic macroinvertebrate are described in detail in the Sediment Quality and Lower Trophic Community Baseline Technical Data Report and associated Validation Report (Volume 4, Appendix K) submitted with the EIS.

2.1 OVERVIEW

The Project is in the Churchill River Upland Ecoregion of the Boreal Shield Ecozone, within the Reindeer Lake Eco-district in northwestern Manitoba (Smith et al. 1998). Outcrops of Precambrian bedrock interspersed with glacial and fluvio-glacial deposits dominate the region, overlain by a thin layer of mineral soils. The topography is generally flat. These conditions result in abundant lake and wetland habitats connected by low-gradient stream and river habitats with few but distinct higher-gradient riffle or cascade habitats.

Lakes range in size from a few to thousands of hectares (ha). Both large and small lakes are often shallow (less than 4 m deep) and do not stratify thermally during the summer. Muskeg bogs and wetlands are frequent in headwater areas, low-lying depressions, and behind the beaver dams that proliferate in the region. Black spruce (*Picea mariana*) and tamarack (*Larix laricina*) are the dominant tree species in low-lying areas while white spruce (*Picea glauca*) and jack pine (*Pinus banksiana*) are the dominant tree species in drier areas. Peat moss (*Sphagnum* sp.), willows (*Salix* sp.), and alder (*Alnus* sp.) are the most abundant vegetation in the riparian areas of the lakes, streams, and wetlands of the region.

Drainage at the Gordon and MacLellan sites is generally to the southeast via a system of irregular bedrock-controlled streams and rivers. The Gordon site is in the Hughes River watershed and the MacLellan site is in the Keewatin River watershed (Appendix B, Map B-1). Both rivers ultimately drain into Granville Lake, immediately upstream of South Indian Lake within the Churchill River watershed.

Stream flows within the region are typically highest in May and June when snow in the surrounding watersheds melts and enters the streams and rivers as run-off. A second, smaller, peak occurs in September and October due to the onset of fall rains. However, natural variability in rainfall patterns and beaver activity between years can result in peak flows occurring at different months during the open-water season. Lowest flows occur in winter. Many headwater streams freeze completely in the winter. The snowpack dictates the duration and magnitude of the spring freshet. The frequency and intensity of rain events dictate the fall flows.

Rock of the Precambrian Shield is low in cations such as calcium, potassium, and magnesium. This chemistry provides surface waters with limited acid-neutralizing capability and is the reason Shield lakes are highly sensitive to acid precipitation (Gunn and Pitblado 2004). This characterization is accurate for lakes and streams in the Project region where surface waters are typically low in total dissolved solids (less than 80 mg/L), soft (hardness less than 75 mg/L as calcium carbonate [CaCO₃], Weiner 2008), neutral to

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slightly acidic, and slightly colored by tannins released from the decay of organic vegetation, particularly the peat moss (*Sphagnum* sp.) that dominates the landscape.

The fish community in the region includes cold and cool water species typical of the Precambrian Shield region. Common large-bodied species include northern pike (*Esox lucius*), walleye (*Sander vitreus*), lake whitefish (*Coregonus clupeaformis*), white sucker (*Catostomus commersoni*), yellow perch (*Perca flavescens*), and burbot (*Lota lota*). Common small-bodied fish species include emerald shiner (*Notropis atherinoides*), spottail shiner (*Notropis hudsonius*), brook stickleback (*Culaea inconstans*), and slimy sculpin (*Cottus cognatus*). Northern pike, walleye, and lake whitefish are the most angled fish in the area. A population of lake sturgeon (*Acipenser fulvescens*) are known to be present in the Hughes River downstream of the Gordon site and may also be present in the Keewatin River near the MacLellan site. Lake sturgeon have been identified as a culturally important fish species by many of the potentially affected Indigenous Nations.

2.2 GORDON SITE

There are two existing open pits at the Gordon site located between Gordon Lake and Farley Lake (Appendix B, Map B-2), two headwater lakes in the Ellystan Lake watershed (Appendix B, Map B-3). The Ellystan Lake watershed is a tributary watershed of the Hughes River. Both pits are filled with water and contain brook sticklebacks and white suckers. The two pits are hydraulically connected and drain east to Farley Lake. However, the pits are surrounded by a gravel/rock berms and an access road which precludes fish from moving between the natural lakes and the pits.

An existing diversion channel drains Gordon Lake to Farley Lake. This diversion channel is, on average, 8 m wide, 1.8 m deep, with a gradient of <1. Banks and bottom substrates are almost entirely comprised of angular riprap and numerous beaver dams are present.

Gordon Lake is a small (<20 ha), shallow (<2 m deep maximum) headwater lake that is anoxic in winter (<1 mg/L dissolved oxygen concentration). For this reason, Gordon Lake only supports a population of brook stickleback, the only fish species in the region that is adapted to low dissolved oxygen environments.

Farley Lake (77 ha) is larger than Gordon Lake and is comprised of three basins: northern, western, and eastern. The northern basin receives inflow from Gordon Lake. Flow from the northern basin drains to the western basin which includes the deepest portion of the lake (~10 m). Water from the western basin flows through a narrow (<200 m) constriction to the eastern basin. The eastern basin is shallow (<2 m) with extensive weed beds. Farley Lake drains into Farley Creek at the eastern-most extent of the eastern basin. Because of its greater depth and habitat diversity, Farley Lake supports populations of northern pike, white sucker, yellow perch, and brook stickleback. Burbot are also likely present in Farley Lake given their presence in Farley Creek immediately downstream.

Farley Creek extends approximately 4 km from Farley Lake to Swede Lake. It can be roughly divided into three discreet reaches: 1) an approximately 3,000 m long, low gradient (<1%), U-shaped channel within a wide (>70 m) wetland flood plain; 2) an approximately 100 m long, dual channel, boulder cascade with a 7% average gradient and nearly 100% canopy cover from riparian trees; and 3) an approximately 900 m

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long, low gradient (<1%), multi-braided channel within a wide (>50 m) wetland floodplain. White suckers and northern pike are known to migrate upstream into Farley Creek from Swede Lake to spawn in spring. Slimy sculpins are the only fish species present in the boulder cascade habitat and are not present elsewhere in Farley Creek.

Swede Lake is a larger (230 ha), deeper (average depth of 3.2 m and maximum depth of 9 m) lake than Gordon and Farley lakes with a relatively diverse littoral habitat area that includes emergent macrophytes, boulders, and gravel/cobble beaches. Swede Lake is separated from Simpson Lake, a lake upstream of Swede Lake, but not downstream of the Gordon site, by the Gordon site access road and an approximately 1,800-millimetre (mm) diameter, fish-passable, culvert. Swede Lake supports populations of northern pike, white sucker, yellow perch, burbot, walleye, lake whitefish, spottail shiner, brook stickleback, and slimy sculpin.

Swede Lake drains into Ellystan Lake which then drains into the Hughes River downstream of Hughes Lake. The Ellystan Lake watershed also includes White Owl Lake, Mac Lake, and Kenistoopechekomusku Lake, lakes that are not downstream of the Gordon site, and are therefore suitable as potential reference lakes. The Ellystan Lake watershed at its confluence with the Hughes River is approximately 47.5 km² in area.

2.3 MACLELLAN SITE

The MacLellan site is located to the east of the Keewatin River, west of Minton Lake (a headwater lake in the Cockeram River watershed), south of Payne Lake (a headwater lake of an unnamed tributary of the Keewatin River), and north of East Pond (Appendix B, Map B-4).

East Pond is a small (3.7 ha), shallow (<2 m deep) headwater lake of an unnamed tributary of the Keewatin River that is located <400 m from the existing mine infrastructure at the MacLellan site. Water quality in East Pond shows elevated concentrations of sulphate, arsenic, and total dissolved solids compared with other lakes in the MacLellan area, likely due to its proximity and downslope location in relation to the existing mine infrastructure at the MacLellan site. East Pond only supports a population of brook sticklebacks. This is primarily due to the anoxic conditions that occur in East Pond in winter and the small (<1 m wide), shallow (<0.5 m deep) channel (tributary KEE3-B1) with numerous beaver dams that connects it to the Keewatin River.

Tributary KEE3-B1 drains East Pond to the Keewatin River. This channel joins with another small (<1.5 m, 0.5 m deep) headwater tributary draining the area near the proposed MRSA. Downstream of this confluence, tributary KEE3-B1 flows south to the Keewatin River and is highly impacted by beaver dams. As a result, the stream has an approximately 7 m wide active channel flowing through a wide (>30 m) wetland floodplain. Substrates in KEE3-B1 are exclusively organic, with abundant in-channel emergent vegetation. Willows, sedges, and black spruce comprise most of the riparian vegetation. Tributary KEE3-B1 is known to support brook sticklebacks throughout and northern pike in its lower 300 m.

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Payne Lake, located immediately north of the proposed TMF, has a surface area of 60 ha, an average depth of 1.3 m, and a maximum depth of 4 m. Macrophytes provide abundant cover along the shoreline and within the littoral zone. Fine organic substrates are the dominant substrate type in the lake. Payne Lake is drained to the Keewatin River through a 2.4 km long, low gradient (<1%), braided, highly beaver-impacted channel. Brook stickleback were the only fish species captured in Payne Lake. Dissolved oxygen concentrations in Payne Lake are high enough in late winter (>3 mg/L) to support other fish species, such as northern pike, but none were captured during field surveys conducted in 2015 and 2016. The absence of northern pike and other large-bodied fish species in Payne Lake may be due to the combination of poor overwintering conditions (i.e., low dissolved oxygen) and the proliferation of beaver dams in the channel draining Payne Lake to the Keewatin River.

Minton Lake is located to the southeast of the proposed TMF. The lake has a surface area of 167 ha, a mean depth of 1.5 m, and a maximum depth of 2.2 m. Due to its shallow depth, Minton Lake does not thermally stratify in summer. Dissolved oxygen concentrations in winter typically exceed 3 mg/L. Bottom substrates are comprised of sand and fine organic material. Submergent macrophytes provide most of the cover for fish in the littoral zone of the lake. Minton Lake supports populations of northern pike, yellow perch, and brook stickleback.

Minton Lake receives most of its inflow from a tributary draining a small unnamed lake directly north and a large (~4 ha) beaver-impounded wetland area to the west. Downstream of the confluence of the wetland and the unnamed lake, habitat in the Minton Lake inlet is comprised of a series of beaver impoundments connected by numerous braided channels flowing within an approximately 24 m wide floodplain. The Minton Lake inlet drains the area northwest of the proposed TMF and MRSA (Appendix B, Map B-4).

Minton Lake drains east to the Cockeram River through a series of channels flowing through a wide (>100 m) sedge wetland. Vegetation in this wetland is dense although fish passage from the downstream lake is likely impeded but not restricted. Habitat in the inlet and outlet of Minton Lake likely provide spawning and rearing habitat for small-bodied species and those large-bodied species that spawn on aquatic vegetation (e.g., northern pike). From its confluence with the Minton Lake outlet, the Cockeram River flows south for approximately 6 km before draining into Cockeram Lake (Appendix B, Map B-5).

The Keewatin River flows from north to south adjacent to the MacLellan site and is the main tributary of Cockeram Lake downstream of the Project (Appendix B, Map B-5). Habitat in the river varies depending on the gradient and confinement of the channel and, is generally a repeating series of wide, shallow gradient (1%) runs and narrow, steeper (up to 4%) rapids. The runs have sandy substrates in the middle of the channel and silty/sandy substrates with abundant aquatic vegetation along the channel margins. The vegetation beds along the margins of the channel provide abundant rearing habitat for juvenile fish. The narrower rapid habitats have boulder and bedrock substrates, turbulent flow, and no aquatic vegetation. The diversity of habitat in the river provides spawning, rearing, and overwintering habitat for most large-bodied and small-bodied fish species in the area. Fish species known to utilize habitat in the Keewatin River for some or all of their life histories include northern pike, walleye, yellow perch, burbot, white sucker, longnose sucker (*Catostomus catostomus*), lake whitefish, cisco (*Coregonus artedii*), trout-perch (*Percopsis omiscomaychus*), slimy sculpin, lake chub (*Couesius plumbeus*), longnose dace (*Rhinichthys cataractae*), spottail shiner, emerald shiner, and brook stickleback.

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The Lynn River flows into the Keewatin River downstream of the MacLellan site but upstream of Cockeram Lake (Appendix B, Map B-5). The Lynn River is a known source of historic contamination to the Keewatin River and Cockeram Lake due to the presence of the former East Tailings Management Area (ETMA) located adjacent to its northern bank and Eldon Lake, the first lake upstream from the Lynn River and Keewatin River confluence.

Cockeram Lake is the closest and largest lake (2,105 ha) downstream the MacLellan site (Appendix B, Map B-5). It has an average depth of 3 m, and a maximum depth of 4 m. Cockeram Lake does not thermally stratify in summer due to its relatively shallow depth and exposure to prevailing winds. Habitat in Cockeram Lake is the most diverse of any lake near the MacLellan site. Littoral substrates include sand, silt, clay, gravel, cobble, and boulders depending on shoreline aspect and exposure to prevailing winds. Emergent macrophytes are the dominant vegetation type in the lake, particularly along exposed shorelines. Floating and submerged vegetation is present in protected bays. Nine fish species were captured in Cockeram Lake in 2015 and 2016: lake chub, emerald shiner, spottail shiner, white sucker, northern pike, lake whitefish, trout-perch, yellow perch, and walleye.

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3.0 SEDIMENT QUALITY MITIGATION AND MONITORING

The objective of the sediment quality monitoring is to identify changes in sediment chemistry during the construction, operation, and decommissioning/closure of the Project. This is because certain metals can adsorb fine sediment particles (e.g., silt) that can then be incorporated into the aquatic food web via periphyton or plankton communities or consumption by benthic invertebrates if these particles enter streams or lakes.

3.1 PATHWAYS OF EFFECTS

Summaries of Project-related pathways of effects, mitigation measures, and potential residual effects on sediment quality at the Gordon site and MacLellan site are provided in Appendix A, Table A-1 and Appendix A, Table A-2, respectively. Potential changes in sediment quality at both sites may occur due to:

1. Release of sediment during site preparation, stockpiling of ore and overburden, maintenance of access roads, and site closure and reclamation activities
2. Release and deposition of air-borne dust
3. Discharge of mine effluent or seepage.

3.2 MITIGATION MEASURES

Mitigation measures that will be implemented to reduce changes in sediment quality are the same as those that will be implemented to reduced changes in water quality and include:

- Implementing Best Management Practices for run-off, erosion, and sediment control as described in the Erosion and Sediment Control Plan
- Implementing dust suppression measures for exposed ground areas within the Project Area during dry periods as necessary
- Aerating Wendy and East pits prior to dewatering to encourage precipitation of elements that form oxides (e.g., iron oxide)
- Discharging aerated pit water to the Hughes River instead of Farley Lake
- Aerating groundwater from the interceptor wells at the Gordon site to encourage iron precipitation prior to discharge to Gordon and Farley lakes
- Implementing the SWMMP, including construction of non-contact diversion ditches and contact water collection ditches, sumps, and ponds
- Pumping existing water in the underground works to the TMF for storage and eventual use in the processing facility (MacLellan site only)

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- Constructing groundwater cut-off ditches to reduce the volume of groundwater seepage from the TMF (MacLellan site only)
- Treating domestic waste in a sewage treatment facility prior to discharge to the Keewatin River (MacLellan site only)
- Progressive reclamation of overburden and MRSAs
- Implementing passive treatment options (e.g., fertilizer amendments) to the open pits should water quality monitoring show that pit water quality is not suitable for release to the downstream environment.

With mitigation, potential changes in the quantity of sediment entering streams and lakes downstream of the Project are expected to be negligible. However, even with mitigation, potential changes in water quality downstream of the Gordon Project Development Area (PDA) and MacLellan PDA are predicted and, therefore, the potential exists for changes in sediment chemistry in lakes and streams downstream of the Project.

3.3 MONITORING

Monitoring of potential changes in total suspended solid (TSS) concentrations in waterbodies and watercourses downstream of activities related to site preparation, stockpiling of ore and overburden, maintenance of access roads, and site closure and within the airshed of potential air-borne dust releases is included in the SWMMP, and not in the AEMP. Therefore, the monitoring program described below is focused solely on potential changes in sediment quality due to mine effluent discharges.

3.3.1 Sampling Locations

Two types of sediment quality sites will be sampled: “fixed” sites and “randomized” sites. “Fixed” sites will include near-field, mid-field, and far-field “impact” sites downstream of proposed effluent discharge locations. These sites will be co-located with water quality (see SWMMP), benthic invertebrate (see Section 4.0), and, if possible, fish tissue residue (see Section 8.0) collection sites to allow correlation of data among these different media. “Fixed” sites downstream of the effluent discharge will be positioned in a downstream gradient and are intended to show the magnitude of effect at increasing distances downstream from the effluent discharge. “Fixed” sites will also be located in reference streams to compare with “fixed” sites in potentially “impacted” streams. Samples from “fixed” sites will be collected at the same locations each sampling period.

Sediment samples will be collected from “randomized” sites in “impacted” lakes and in unaffected “reference” lakes. Randomized samples will be collected from each lake from sites with similar depths and habitats to reduce variability. The purpose of these “randomized” samples will be to monitor potential change in sediment quality on an average basin-wide or lake-wide scale. Final sediment quality monitoring sites will be confirmed after review of this AEMP by federal and provincial regulators and the Environmental Advisory Committee (EAC) comprised of members of potentially affected Indigenous Nations.

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3.3.1.1 Gordon Site

Proposed “fixed” sediment quality monitoring sites in the Gordon Local Assessment Area (LAA) are identified in Table 3-1 and shown in Appendix B, Map B-6. They include sites within the effluent “mixing zones” in Gordon and Farley lakes and in mid-field and far-field sites in Farley Creek, downstream of Farley Lake. The number and location of “fixed” sites may be amended after the effluent plumes in Gordon and Farley lakes can be delineated using in-situ water conductivity data. “Fixed” sites also include reference sites in the outlets of two unaffected headwaters lakes for comparison with data collected in Farley Creek.

Table 3-1 “Fixed” Sediment Quality Monitoring Sites at the Gordon Site

Proposed Sampling Location	Site ID	Site Type
Gordon Lake (edge of effluent pipe “mixing zone” ¹)	AQF2	Near-field
Farley Lake (edge of effluent pipe “mixing zone” in west basin ¹)	AQF34A	Near-field
Farley Creek (outlet of Farley Lake)	AQF9	Mid-field
Farley Creek (near mouth at Swede Lake)	AQF48	Far-field
Mac Lake outlet	AQF46	Reference ²
Notes: ¹ Manitoba Water Quality Standards, Objectives, and Guidelines require mixing zones in lakes to be within a 100 m radius of the end-of-pipe ² reference site for comparison to mid-field (AQF9) and far-field (AQF48) in Farley Creek		

Proposed “randomized” sediment quality monitoring sites in the Gordon LAA are identified in Table 3-2 and shown in Appendix B, Map B-6. They include a near-field basin and two far-field lakes; Swede Lake is downstream of Farley Lake while Susan Lake is a headwater lake in a different watershed that may be affected by groundwater seepage. Data from Low Lake would be used for comparison with data collected in Gordon, Farley, and Susan lakes while data from White Owl Lake would be used for comparison with data collected from Swede Lake.

Table 3-2 “Randomized” Sediment Quality Monitoring Sites at the Gordon Site

Proposed Sampling Location	Site ID	Site Type
Farley Lake (eastern basin of lake near lake outlet)	AQF39	Near-field
Susan Lake	AQF11	Far-field
Swede Lake	AQF16	Far-field
White Owl Lake	AQF13	Reference ¹
Low Lake	AQF47A	Reference ²
Notes: ¹ reference site for comparison to Swede Lake (AQF16) ² reference site for comparison to Farley Lake (AQF39) and Susan Lake (AQF11)		

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3.3.1.2 MacLellan Site

Proposed “fixed” sediment quality monitoring sites in the MacLellan LAA are identified in Table 3-3 and shown in Appendix B, Map B-7. They include near-field sites in tributary KEE3-B1 downstream of the MRSA and open pit and in the Keewatin River downstream of the effluent pipe “mixing zone”. They also include sites in the Keewatin River in a gradient downstream from the effluent pipe and tributary KEE3-B1 confluence. A site in the Lynn River has been included to account for potential changes in sediment chemistry due to the influence of the former ETMA. The number and location of “fixed” sites may be amended after the effluent plume in the Keewatin River can be delineated using in-situ water conductivity data. A “fixed” reference site is included in the Keewatin River upstream of any influence from Payne Lake and in the Carr Lake outlet (for comparison with data collected in tributary KEE3-B1).

Table 3-3 “Fixed” Sediment Quality Monitoring Sites at the MacLellan Site

Proposed Sampling Location	Site ID	Site Type
Keewatin River tributary KEE3-B1	AQM71	Near-field
Keewatin River downstream of effluent pipe/mixing zone	AQM76	Near-field
Keewatin River downstream of KEE3-B1 confluence/upstream of Lynn River confluence	AQM20	Mid-field
Lynn River (downstream of ETMA)	AQM61	Cumulative ³
Keewatin River mouth at Cockeram Lake/downstream of Lynn River confluence	AQM63	Far-field
Keewatin River upstream of Payne Lake outlet confluence	AQM40	Reference ¹
Carr Lake outlet	AQM91	Reference ²
Notes: ¹ Reference Site For Comparison To “Impact” Sites In The Keewatin River (Aqm76, Aqm20, And Aqm63) ² Reference Site For Comparison To Keewatin River Tributary Kee3-B1 (Aqm71) ³ Data From The Lynn River To Be Used To Assist In Interpretation Of Data From Keewatin River Due To Potential Cumulative Effects		

Proposed “randomized” sediment quality sites will be in lakes immediately downslope of the MacLellan PDA within the predicted zone of groundwater influence (i.e., Minton Lake and Payne Lake) and in a reference (i.e., Carr Lake) (Table 3-4).

Table 3-4 “Randomized” Sediment Quality Monitoring Sites at the MacLellan Site

Proposed Sampling Location	Site ID	Station Type
Minton Lake	AQM16	Near-field
Payne Lake	AQM31	Near-field
Carr Lake	AQM91	Reference ¹
Note: ¹ reference site for comparison to Minton Lake (AQM16) and Payne Lake (AQM31)		

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3.3.2 Sampling Methods

3.3.2.1 Field Methods

Depositional habitats will be sampled using the same methods used during baseline studies and will be consistent with sampling methods described in the Metal Mining EEM Technical Guidance (Environment Canada 2012). Depositional habitats will be targeted because fine sediments accumulate in these areas and metals and metalloids typically bind to fine sediment.

Sediment samples will be collected in fall (see Table 3-8) in conjunction with benthic invertebrate sampling; sediment samples will be paired with benthic invertebrate samples collected in depositional habitats at the Gordon and MacLellan sites.

Five replicate samples, each comprised of three composite grabs, will be collected from each site using an Ekman dredge or Petit Ponar® grab sampler targeting the upper 3 centimetres (cm) of sediment. Power analysis will be conducted *a priori* on the existing data using the water quality POPCs identified for the Project to determine if five samples will be sufficient to detect the required effect level. Composite grabs for each replicate sample will be collected within 30 m of each other at each site.

After a visual inspection of the Ekman dredge or Petit Ponar® grab to confirm complete closure of the jaws and adequate sediment penetration, excess water will be decanted, and the remaining sample deposited onto a collection pan. This process will be repeated at least two more times to form a composite sample; additional grabs will be collected if <10 grams (g) of clay or silt are present in the sample, as this is the minimum amount needed to conduct the required laboratory analyses. Sampling equipment will be rinsed with lake water between each grab sample. The composite sample will be homogenized, then transferred to non-reactive sampling containers provided by an accredited laboratory. Composite samples from each site will be kept cold and in the dark in coolers until they can be delivered to the analytic laboratory in Winnipeg, Manitoba.

Sediment redox potential in the top 2.5 cm of sediment will be measured at each sampling location using a handheld redox meter; redox potential indicates whether metals are in an oxidized or reduced state. From this measurement, it can be estimated whether the sediment is aerobic or anaerobic and whether chemical compounds, such as iron oxides or nitrate, have been chemically reduced or are present in their oxidized forms. A high redox potential will indicate a high oxygen level while a low redox potential will indicate that conditions are conducive to anaerobic microbiological activity. Oxidizing conditions favor retention of metals in sediment while reducing conditions contribute to accelerated metals release (McLean and Bledsoe 1992).

Global Positioning System (GPS) coordinates at each sample site will be recorded with a handheld GPS unit. Site and sediment photographs, along with *in-situ* water quality data (i.e., dissolved oxygen, temperature, specific conductivity, and pH) will be collected at each sampling site. Sediment colour, odour, texture, consistency, debris, and presence of biota will be described following standardized sediment descriptors from Environment Canada (2012) and Alberta Environment (2006). Water depth, approximate distance from shore, prevailing wind, and wave conditions will be recorded at lake sites while water depth, habitat type (e.g., pool), riparian vegetation, and bank texture and stability will be recorded at stream sites.

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3.3.2.2 Laboratory Methods

In the lab, samples will be analyzed for particle size distribution and moisture content on the bulk samples. Total organic carbon and total metal (e.g., copper), metalloids (e.g., arsenic), nutrients (e.g., nitrogen) and major ion (e.g., sodium) concentrations will be analyzed on the <63 micrometre (µm) fraction using the highest resolution methods available (e.g., inductively couple plasma mass spectrometry (ICP-MS) metals scan and cold vapour mercury scan). The list of proposed analytical parameters for sediment quality monitoring is provided in Table 3-5.

Table 3-5 Analytical Parameters and Method Detection Limits for Sediments Collected for the AEMP at the Gordon and MacLellan Sites

Parameter	Method Detection Limit
Total organic carbon	0.05%
Aluminum (Al)	50 mg/kg
Antimony (Sb)	0.10 mg/kg
Arsenic (As)	0.05 mg/kg
Barium (Ba)	0.50 mg/kg
Beryllium (Be)	0.10 mg/kg
Bismuth (Bi)	0.10 mg/kg
Boron (B)	5.0 mg/kg
Cadmium (Cd)	0.020 mg/kg
Calcium (Ca)	50 mg/kg
Chromium (Cr)	0.50 mg/kg
Cobalt (Co)	0.10 mg/kg
Copper (Cu)	0.50 mg/kg
Iron (Fe)	50 mg/kg
Lead (Pb)	0.10 mg/kg
Lithium (Li)	2.0 mg/kg
Manganese (Mn)	1.0 mg/kg
Mercury (Hg)	0.005 mg/kg
Molybdenum (Mo)	0.10 mg/kg
Nickel (Ni)	0.50 mg/kg
Phosphorus (P)	50 mg/kg
Potassium (K)	100 mg/kg
Selenium (Se)	0.1 mg/kg
Silver (Ag)	0.05 mg/kg
Sodium (Na)	50 mg/kg
Strontium (Sr)	0.10 mg/kg
Sulfur (S)	500 mg/kg

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Parameter	Method Detection Limit
Thallium (Tl)	0.050 mg/kg
Tin (Sn)	0.2 mg/kg
Titanium (Ti)	1.0 mg/kg
Uranium (U)	0.050 mg/kg
Vanadium (V)	0.20 mg/kg
Zinc (Zn)	1.0 mg/kg
Zirconium (Zr)	1.0 mg/kg
Note: mg/kg = milligrams per kilogram	

3.3.2.3 Quality Assurance/Quality Control

One replicate sample at every second site will be “field split” as a duplicate to assess field sampling quality assurance/quality control (QA/QC) procedures. This will result in 1 in every 10 samples and 10% of the total number of samples being “field split”.

Laboratory quality control procedures will include analysis of certified reference materials (CRM), laboratory control samples, Relative Percent Difference (RPD) between results for laboratory duplicates, method blanks, and matrix spikes to determine accuracy and precision of instrumentation and lab analytical methods. “Sediment standards” from site-specific bulk samples and/or National Research Council Canada’s CRM Program will also be analyzed by the laboratory as part of the sediment quality QA/QC program.

3.3.3 Data Analysis

Analysis of sediment quality samples will consist of sediment particle distribution analysis, summary statistics of POPCs, statistical analysis of the spatial variability of POPC concentrations between sites, and screening POPC concentrations against provincial and federal sediment quality guidelines.

3.3.3.1 Particle Size Distribution

Particle size distribution will be analyzed to determine the relative composition of the sediment in each sample, as reported by grain size. The same particle size categories used during baseline sediment quality studies (Table 3-6) will be used to characterize sediment composition in the sediment quality monitoring program.

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Table 3-6 Sediment Particle Size Distribution Categories

Particle Size Fraction	Particle Size
Gravel	>2 mm
Coarse Sand	2.0 mm – 0.2 mm
Fine Sand	0.2 mm – 0.063 mm
Silt	0.063 mm – 4 µm
Clay	<4 µm

3.3.3.2 Summary Statistics

Summary statistics (i.e., mean, median, minimum, and maximum concentrations and standard error and standard deviation of the mean concentration) and number of samples below the laboratory detection limit (DL) will be calculated for each POPC in each sample. Parameters that have one or more sample results below the DL will be categorized as censored data. Censored data will be replaced with the full DL when calculating the summary statistics. This is a more conservative approach than other options such as replacing the DLs with zeros, using half the DL, or excluding the data entirely from the analysis, and is consistent with the approach taken during baseline studies.

Power analyses will be conducted on the sediment quality data collected during the initial years of sediment quality monitoring to determine if sufficient sample sizes are being collected to detect statistically significant differences between “impact” and “reference” sites and “before” and “after” mine construction. Power analyses will be conducted using parameters with federal/provincial sediment quality guidelines for the protection of freshwater aquatic biota (i.e., lead, mercury, cadmium, chromium, copper, arsenic, zinc) and the PoPCs predicted by the water quality models at the Gordon and MacLellan sites.

3.3.3.3 Spatial and Temporal Variability

The spatial variability of POPCs will be presented graphically by plotting mean concentrations (\pm standard error) at “impact” and “reference” sites. Statistically significant differences ($p < 0.05$) in mean concentrations between sites will be analyzed using t-tests or Analysis of Variance (ANOVA). Alternatively, the spatial variability of POPCs will be presented graphically by plotting mean concentrations (\pm standard error) with increasing distance from the effluent discharge point (i.e., gradient analysis). Statistically significant differences ($p < 0.05$) in mean concentrations between near-field, mid-field, and far-field sites will be analyzed using regression analysis or Analysis of Covariance (ANCOVA).

The temporal variability of POPCs at “impact” and “reference” sites will be assessed visually by comparing the slopes of the mean POPC concentrations at each site through time. If the variability of the sediment data permits, the statistical difference between slopes of the relationships between POPC concentrations and time at “impact” and “control” sites will be used to determine whether the Project is having a statistically significant effect on sediment chemistry over time.

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3.3.3.4 Guideline Screening

Arsenic, cadmium, chromium, copper, lead, mercury, and zinc concentrations in sediment samples collected at “impact” and “control” sites will be compared with Canadian Sediment Quality Guidelines for the Protection of Aquatic Life (CCME 2023). Guidelines include interim sediment quality guidelines (ISQG) or probable effect levels (PEL; Table 3-7). Probable effect levels represent levels above which adverse effects are likely to occur.

The frequency and magnitude of exceedances of provincial and federal sediment quality guidelines will be calculated, by site, for each parameter for which guidelines exist. Results will be compared with baseline data from the same Gordon and MacLellan sites collected prior to mine construction.

Table 3-7 Summary of Current Federal and Provincial Sediment Quality Guidelines^{1,2}

Parameter	Units ⁵	ISQG ³	PEL ⁴
Arsenic	mg/kg	5.9	17
Cadmium	mg/kg	0.6	3.5
Chromium	mg/kg	37.3	90
Copper	mg/kg	35.7	197
Lead	mg/kg	35	91.3
Mercury	mg/kg	0.17	0.486
Zinc	mg/kg	123	315
Notes: ¹ Canadian Council of Ministers of the Environment (CCME) 2023 ² Manitoba Water Stewardship (2011), Provincial Sediment Quality Guidelines (PSQG) ³ Freshwater Interim Sediment Quality Guideline (ISQG) ⁴ Freshwater Probable Effect Level (PEL) ⁵ in dry weight			

3.3.3.5 Quality Assurance/Quality Control

QA/QC will include analysis of certified reference materials, laboratory control samples, laboratory duplicates, method blanks, and matrix spikes to determine accuracy and precision of instrumentation and methods. Data reports received from the laboratory will be reviewed to check whether data meet the laboratory data quality objectives. Data QA/QC controls include:

- Collection of 10% of the sediment quality samples in duplicate.
- Analytical QA/QC in a Canadian Association for Laboratory Accreditation (CALA) certified analytical lab.
- Data review by qualified person after lab reporting.
- Statistical analyses to detect data outliers or avoid analytical skew from data anomalies.

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3.3.4 Sampling Schedule

Table 3-8 summarizes the schedule for the sediment quality monitoring component of the AEMP during each Project phase. Other than during the construction phase, sediment sampling at the “randomized” sites will be delayed and less frequent than sediment monitoring at “fixed” sites. Sediment sampling at “randomized” sites will occur once during each mine phase at the Gordon site and once during most mine phases at the MacLellan site; two sediment sampling events will occur during operation at “randomized” sites near the MacLellan site due to the longer duration of operation at the MacLellan site compared with the Gordon site. This is because changes in sediment quality at a lake-wide or basin-wide scale are expected to be slower than at “fixed” sites immediately downstream of effluent discharge locations. However, the frequency of sampling at the randomized sediment monitoring sites may be adjusted, as necessary, depending on results at “fixed” sites.

Once initiated, sediment quality monitoring at the “fixed” sites will occur in conjunction with benthic invertebrate monitoring every third year during the construction, operation, and decommissioning/closure phases of the Project and once during post-closure. Adaptive management and monitoring will allow for changes to this monitoring schedule, depending on results of previous studies. This sample timing and frequency is consistent with sediment and benthic invertebrate sampling schedule for the separate, but related, federal EEM program.

Table 3-8 Proposed Sediment Quality Monitoring Schedule

Monitoring Activity	Frequency			
	Construction	Operation	Decommissioning/ Closure	Post-Closure
Gordon Site				
“Fixed” Sites	Year -2	Years 1, 4	Years 7, 10	Year 13
“Randomized” Sites	Year -1	Year 6	Year 12	Year 19
MacLellan Site				
“Fixed” Sites	Year -2	Years 1, 4, 7, 10, 13	Years 16, 19, 22	Year 25
“Randomized” Sites	Year -1	Years 6, 12	Year 22	Year 25

3.4 METRICS AND THRESHOLDS FOR ADAPTIVE MANAGEMENT

The following metrics will be used to evaluate potential changes in sediment quality in depositional habitats downstream of the Gordon and MacLellan sites during the construction, operation, and decommissioning/closure phases of the Project:

- Particle size distribution
- Total organic carbon
- Sediment metal concentrations from the <63 µm fraction.

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Sediment quality data will not be used to trigger adaptive management. Therefore, sediment quality thresholds are not proposed. Nevertheless, the following analyses of sediment quality data collected during the program will be used as “proactive triggers” to initiate additional water quality, sediment quality, and/or benthic invertebrate sampling to determine if the observed changes in sediment quality are due to sampling error, regional phenomena, or the Project and to determine the spatial extent and potential source of changes in sediment quality:

- Any surface water quality thresholds defined in the SWMMP are exceeded.
- Any of the benthic invertebrate community end-point metric thresholds are exceeded.
- Exceedances of Canadian Interim Sediment Quality Guidelines for the Protection of Aquatic Life (CCME 2023) and Manitoba Sediment Quality Guidelines (MWS 2011).
- For parameters with mean concentrations that currently exceed these guidelines, statistically significant differences in metal concentrations in the <63 µm fraction at “impact” sites compared with “reference” sites before and after construction, operation, and closure/decommissioning.

The scope of additional sediment quality monitoring, if required, will be based on the area where exceedances are found to occur and will include reference area sampling. Additional sediment quality sampling conducted as part of adaptive management may be designed to identify cause of effect and the geographic extent of an observed effect, and/or to inform what corrective actions, if any, are required. Any corrective actions will be dictated by the nature of the observed effect, if any, developed in consultation with federal and provincial agencies and the EAC.

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4.0 BENTHIC INVERTEBRATE COMMUNITIES MITIGATION AND MONITORING

Benthic invertebrates are useful indicators of aquatic environment health because they are ubiquitous, easily sampled, provide a direct link to fish, and, depending on community composition, relatively sensitive to changes in habitat, sediment, flow, and water quality. When coupled with surface water quality and sediment quality monitoring at the same sites, benthic invertebrate monitoring increases the likelihood of detecting potential negative effects on fish and aquatic biota due to changes in water quality, sediment quality, and/or habitat.

Benthic invertebrate monitoring may be included in the Project's future EEM plan if results from water quality monitoring, effluent characterization studies, and/or sublethal toxicity testing indicate that effluent releases to the receiving environment at the Gordon and MacLellan sites have the potential to adversely affect fish and aquatic biota. Such a plan would be developed in stages, and in consultation with ECCC, and would be guided by its *Metal Mining Technical Guidance for Environmental Effects Monitoring* (Environment Canada 2012).

4.1 PATHWAYS OF EFFECTS

Summaries of Project-related pathways of effects, mitigation measures, and potential residual effects on benthic invertebrate communities at the Gordon site and MacLellan site are provided in Appendix A, Table A-3 and Table A-4, respectively. Potential changes in benthic invertebrate communities at both sites may occur due to:

1. Release of sediment during site preparation, stockpiling of ore and overburden, maintenance of access roads, and site closure and reclamation activities.
2. Discharge of existing pit water to the Hughes River (Gordon site only).
3. Discharge of pumped groundwater during construction and operation (Gordon site only).
4. Discharge of contact water or seepage during operation and closure/decommissioning.
5. Discharge of wastewater during construction, operation, and closure/decommissioning (MacLellan site only).
6. Discharge of water from end-pit lakes during closure/decommissioning.

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4.2 MITIGATION MEASURES

The mitigation measures that will be implemented to reduce potential effects to benthic invertebrate communities are the same as those that will be implemented to reduce potential effects to sediment quality and water quality and, therefore, are not repeated here.

With mitigation, potential changes in benthic invertebrate communities in streams and lakes downstream of the Project are expected to be negligible. However, even with mitigation, potential changes in water quality downstream of the Gordon PDA and MacLellan PDA are predicted and, therefore, the potential exists for changes in benthic invertebrate communities in streams and lakes downstream of the Project.

4.3 MONITORING

4.3.1 Sampling Locations

Benthic invertebrates will be sampled from the same “fixed” sites sampled for sediment quality (Section 3.3.1). Sites will include near-field, mid-field, and far-field “impact” sites in a downstream gradient from the effluent discharge locations as well as sites in reference streams and lakes to compare with sites in potentially “impacted” streams and lakes. This is a BACI study design and is consistent with the study design recommended by Environment Canada’s “Metal Mining Technical Guidance for Environmental Effects Monitoring” (EC 2012).

Where possible, benthic invertebrate sampling sites will be co-located with water quality (see SWMMP), sediment quality (see Section 4.0) chlorophyll *a* (e.g., periphyton) and, if possible, fish tissue residue (see Section 8.0) sites to allow correlation of data among these different media. For example, benthic invertebrates and sediment samples will be collected from the same sites in lakes and depositional sites in streams. Similarly, benthic invertebrates, periphyton, and small-bodied fish will be collected (if possible) from the same sites in erosional sites in streams and rivers. Final benthic invertebrate monitoring sites will be confirmed after review of this AEMP by federal and provincial regulators and the EAC comprised of members of potentially affected Indigenous Nations.

4.3.1.1 Gordon Site

Benthic invertebrate monitoring sites at the Gordon Site are identified in Table 4-1 and shown in Appendix B, Map B-8. Sites include those listed in Condition 3.14.2 of the federal Decision Statement (i.e., Farley Creek, Farley Lake, Gordon Lake, Hughes River), two proposed lake reference sites (i.e., for comparison with monitoring data from Gordon, Farley, and Swede lakes), and two proposed stream reference sites (i.e., Mac Lake outlet and White Owl Lake outlet) for comparison with monitoring data from Farley Creek. Although identified in Condition 3.14.2 of the federal Decision Statement, a sampling site in the “new diversion channel” is not included because a new diversion channel is no longer required at the Gordon site.

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As required by Condition 3.14.2 of the federal Decision Statement, benthic invertebrate monitoring sites include sites in the Hughes River. These includes sites upstream (i.e., “reference”) and downstream (i.e., “impact”) of the effluent pipe that will discharge water from the existing Wendy and East pits to the Hughes River. Sites in the Hughes River include samples from “depositional” and “erosional” habitats; samples from erosional sites are included because these habitats typically support communities comprised of Ephemeroptera, Plecoptera, and Trichoptera (EPT) taxa, taxa that are generally more sensitive to changes in water quality and habitat than taxa found in depositional habitats (e.g., chironomids).

Table 4-1 Benthic Invertebrate Monitoring Sites at the Gordon Site

Sampling Location	Site ID	Habitat Type	Site Type
Gordon Lake (edge of effluent pipe “mixing zone” ¹)	AQF2	depositional	Near-field
Farley Lake (edge effluent pipe “mixing zone” in west basin ¹)	AQF34A	depositional	Near-field
Farley Lake (eastern basin of lake near lake outlet)	AQF39	depositional	Near-field
Farley Creek (outlet of Farley Lake)	AQF9	depositional	Mid-field
Farley Creek (boulder cascade in middle of Farley Creek)	AQF40	erosional	Mid-field
Farley Creek (near mouth at Swede Lake)	AQF48	depositional	Far-field
Swede Lake	AQF16	depositional	Far-field
Hughes River (downstream of effluent pipe)	AQF40A	depositional	Near-field
Hughes River (downstream of effluent pipe)	AQF42	erosional	Near-field
Hughes River (downstream of effluent pipe)	AQF44	depositional	Far-field
Hughes River (upstream of effluent pipe)	AQF41	depositional	Reference ²
Hughes River (upstream of effluent pipe)	AQF49	erosional	Reference ³
White Owl Lake	AQF13	depositional	Reference ⁴
White Owl Lake outlet	TBD	erosional	Reference ⁷
Low Lake	AQF47A	depositional	Reference ⁵
Mac Lake outlet	AQF46	Depositional	Reference ⁶
<p>Notes:</p> <p>¹ Manitoba Water Quality Standards, Objectives, and Guidelines require mixing zones to be within a 100 m radius of the end-of-pipe</p> <p>² depositional reference site for comparison to “impact” depositional sites in the Hughes River (AQF40A, AQF44)</p> <p>³ erosional reference site for comparison to “impact” erosional site in the Hughes River (AQF42)</p> <p>⁴ reference site for comparison to Swede Lake (AQF16)</p> <p>⁵ depositional reference site for comparison to Gordon Lake (AQF2) and Farley Lake (AQF34)</p> <p>⁶ depositional reference site for comparison to Farley Creek (AQF9 and AQF48)</p> <p>⁷ erosional reference site for comparison to Farley Creek (AQF40)</p> <p>TBD = to be determined</p>			

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4.3.1.2 MacLellan Site

Benthic invertebrate monitoring sites at the MacLellan Site are identified in Table 4-2 and shown in Appendix B, Map B-9. Sites include those listed in Condition 3.14.2 of the federal Decision Statement (i.e., Minton Lake, Keewatin River) plus:

- A site in Payne Lake; Payne Lake is located immediately north of the TMF and, like Minton Lake, maybe affected by seepage.
- A site in the Lynn River downstream of the former ETMA, a known source of contamination to the Keewatin River and Cockeram Lake.
- A lake reference site (i.e., Carr Lake) for comparison with data from Minton Lake and Payne Lake.
- A stream reference sites (i.e., Carr Lake outlet) for comparison with data from KEE3-B1.

Table 4-2 Benthic Invertebrate Monitoring Sites at the MacLellan Site

Sampling Location	Waterbody ID	Habitat Type	Station Type
Minton Lake	AQM16	Depositional	Near-field
Payne Lake	AQM31	Depositional	Near-field
Keewatin River tributary KEE3-B1	AQM71	Depositional	Near-field
Keewatin River downstream of the effluent pipe/mixing zone	AQM76	Depositional	Near-field
Keewatin River downstream of the effluent pipe/mixing zone	AQM42	Erosional	Near-field
Keewatin River downstream of KEE3-B1 confluence/upstream of Lynn River confluence	AQM20	Depositional	Mid-field
Lynn River (downstream of ETMA)	AQM61	Depositional	Cumulative ⁵
Keewatin River mouth at Cockeram Lake/downstream of Lynn River confluence	AQM63	Depositional	Far-field
Keewatin River upstream of Payne Lake outlet confluence	AQM4	Erosional	Reference ¹
Keewatin River upstream of Payne Lake outlet confluence	AQM40	Depositional	Reference ²
Carr Lake	AQM91	Depositional	Reference ³
Carr Lake outlet	TBD	Depositional	Reference ⁴
<p>Notes:</p> <p>¹ erosional reference site for comparison to erosional “impact” site in the Keewatin River downstream of the effluent pipe (AQM42)</p> <p>² depositional reference site for comparison to depositional “impact” sites in the Keewatin River downstream of the effluent pipe (AQM76, AQM20, and AQM63)</p> <p>³ reference site for comparison to Minton and Payne Lakes</p> <p>⁴ reference site for comparison to Keewatin River tributary KEE3-B1</p> <p>⁵ data from the Lynn River to be used to assist interpretation of data from Keewatin River due to potential cumulative effects</p>			

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Sites in the Keewatin River include depositional and erosional sites upstream and downstream of the effluent pipe location at the MacLellan site bridge crossing and sites upstream and downstream of the Lynn River confluence. Samples from erosional sites are included because these habitats typically support communities comprised of EPT taxa, taxa that are generally more sensitive to changes in water quality and habitat than taxa found in depositional habitats (e.g., chironomids).

4.3.2 Sampling Methods

4.3.2.1 Depositional Habitats

Benthic invertebrates will be sampled in depositional habitats using a Petit Ponar® grab sampler. Five composite samples will be collected at each site, with each composite sample comprised of three separate grabs. Grabs for each composite sample will be collected within 30 m of each other in areas of similar depth and substrate composition.

After visual inspection of the grab to confirm complete closure of the jaws and adequate sediment penetration, excess water will be decanted, and the remaining sample deposited into a 500-µm mesh sieve bucket held over the side of the boat (lakes) or above the stream. The sieved sample will be transferred to high density polyethylene (HDPE) jars, with the sieved content of each grab being added to the same jar to make a composite sample.

Jars will be filled approximately half full to allow addition of a sufficient volume of preservative (e.g., 10% buffered formalin solution). Each jar will be labeled with a unique site identification number and an internal label. Samples will be kept in cool, dark conditions and sent to an accredited laboratory for sorting and identification.

In-situ water quality parameters (dissolved oxygen concentration, temperature, pH, and conductivity) will be measured at each site using a calibrated Yellow Springs Instruments-brand multi-meter near the water/sediment interface. Water depth, wave conditions, presence of macrophytes and/or algae, GPS location, and site and substrate photos will also be recorded to supplement the data.

4.3.2.2 Erosional Habitats

Erosional sites in riffles will be sampled using a Hess sampler, a sampler ideally suited for the cobble substrates typically found in erosional habitats at the Gordon and MacLellan sites. The Hess sampler will have an inside diameter of 30 cm, a height of 40 cm, a sampling area of 0.257 cm², and a mesh size of 500 µm. Ideally, sites will have moderate flow, medium to large substrates, and water depths <0.5 m.

Five composite samples will be collected at each site, with each composite sample comprised of three separate Hess samples. Benthic invertebrates will be collected by scrubbing rocks inside the Hess sampler by hand and agitating the bottom substrates to a depth of 5 to 10 cm for two minutes. Benthic invertebrates collected in the small container at the back of a collecting net will be emptied into individually labelled HDPE jars containing a sufficient volume of preservative (e.g., 10% buffered formalin solution). Benthic invertebrates captured in the subsequent Hess samples will be added to the same jar to make a composite

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sample. Samples will be kept in cool, dark conditions and sent to an accredited laboratory for sorting and identification.

4.3.2.3 Quality Assurance/Quality Control

The following QA/QC measures will be applied during sample collection:

- Field personnel will have a good understanding of the program and objectives and will be experienced with required field equipment and sampling procedures.
- Sampling equipment will be checked frequently for proper operation and maintained in good working order.
- Criteria for sample acceptability will be established (e.g., sample will be rejected if sampler jaws were not completely closed).
- A visual description of the collected sediment will be recorded.
- The sampling device will be rinsed between composite samples and between stations.
- Field sieving and preservation will be completed as soon as practical after samples are collected.
- All sample containers will be labeled internally and externally with relevant information.
- Detailed field notes will be maintained on appropriate field data sheets prepared prior to the field survey to facilitate the completeness of the field data, and subsequent data entry.
- Chain-of-custody forms and sample submission forms will be used and appropriately filed.

4.3.2.4 Laboratory Methods

Benthic macro-invertebrates will be sorted and identified in the laboratory to the lowest practical level using recently published taxonomic keys.

Percent recovery, or sorting efficiency, will be determined by re-examining the sorted debris of samples after initial sorting of organisms is complete. Any additional organisms found during the re-sort will be identified, counted, and added to the dataset. Percent recovery will be calculated using the original number of organisms found and the revised total (following re-sorting). Percent recovery will be performed on 10% of the benthic samples collected. If targets are not met, samples will be re-sorted.

Due to large volumes of material or large numbers of organisms, some samples may not be sorted in their entirety in a reasonable amount of time and, therefore, sub-sampling may be required. In these cases, a minimum of 300 organisms per sub-sample will be targeted and an analysis of sub-sampling precision and accuracy error will be performed on 10% of the sub-sampled samples.

Precision error analysis will be accomplished by sorting a new fraction of the same size as that originally sorted and determining the percent difference between the fractions. The difference between sub-samples should be no greater than 20% to fall within acceptable limits established in EEM Technical Guidance (EC 2012). If the percent difference is greater than 20% between the two sorted sub-samples, the sample will

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be sorted in its entirety. For sub-samples with exceptionally low organism density, it may be mathematically impossible to achieve the desired 20% difference regardless of sub-sampling methodology used. In these cases, the remaining samples may not be sorted.

Accuracy error will be determined by sorting the remainder of each selected sub-sampled sample and assessing how closely the original fraction, when extrapolated to the whole, approximates the actual sample density. Predicted sample densities based on sub-samples should fall within 20% of the actual sample density to meet acceptable limits established in EEM Technical Guidance (EC 2012). If the calculated difference is greater than 20%, additional samples may need to be sorted in their entirety to confirm accurate organism densities.

4.3.3 Data Analysis

Analysis of the benthic invertebrate data will follow MDMER guidance for analysis and reporting. Four primary end-point metrics will be calculated from the family-level data to assess potential Project effects on benthic invertebrate communities:

- Total benthic invertebrate density: a measure of the number of organisms present in a given area.
- Total taxa richness: a measure of the number of unique taxonomic groups (i.e., family) present.
- Simpson's evenness index: a measure of the distribution of individuals among sampled taxa. A more equitable distribution indicates a more stable benthic invertebrate community, which is not dominated by one taxonomic group. A community with a completely equitable distribution of taxa would have a Simpson's evenness index of 1 while a community dominated entirely by one taxon would have a Simpson's evenness index of 0.
- Bray-Curtis Dissimilarity index: a measure representing the difference from the "reference" and "impact" area data to the median reference community. The Bray-Curtis index is unaffected by the composition of the communities being compared and gives equal weighting to rare and abundant taxa.

The following supplemental end-points, calculated on the family-level data, will be calculated but will not be used in the final determination of effects on the benthic invertebrate communities.

- Simpson's diversity index: the probability that two organisms, selected at random, are from a different taxonomic group (range: 0 to 1). Larger values are indicative of communities that are more diverse while lower values are indicative of communities that are less diverse. Simpson's D is influenced by the numerically dominant taxa.
- Taxon proportion (percent EPT, Chironomidae, Oligochaeta, bivalves, etc. calculated as total number of organisms in each group divided by total organisms in a sample).

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The following supplemental end-points will be calculated from the lowest taxonomic level possible to provide a more complete picture of the benthic invertebrate communities in the “reference” and “impact” areas. However, these end-points will not be used in the final determination of effects on the benthic invertebrate communities.

- EPT taxa richness (erosional sites only): a measure of the number of taxa belonging to Ephemeroptera, Plecoptera, and Trichoptera orders (i.e., mayflies, stoneflies, and caddisflies, respectively). Mean and pooled EPT taxa richness will be calculated.
- Hilsenhoff biotic index (HBI): a measure used to determine the extent of enrichment due to organic nutrient pollution (Hilsenhoff 1987). The HBI is derived using data for the lowest practical level of taxonomic identification. Sensitivity values are assigned to each taxon based on its tolerance to organic nutrients, ranging from 0 (intolerant) to 10 (very tolerant). Table 4-3 shows the biotic indices used for calculation of the HBI.

Table 4-3 Hilsenhoff Rating System (Hilsenhoff 1987)

Biotic Index	Water Quality	Degree of Organic Enrichment
0.00–3.5	Excellent	No apparent enrichment
3.51–4.50	Very good	Slight enrichment
4.51–5.50	Good	Some enrichment
5.51–6.50	Fair	Fairly significant enrichment
6.51–7.50	Fairly poor	Significant enrichment
7.51–8.50	Poor	Very significant enrichment
8.51–10.00	Very poor	Severe enrichment

4.4 SAMPLING SCHEDULE

Benthic invertebrate sampling will be undertaken in conjunction with sediment quality monitoring in fall (i.e., September or October) when the relative abundance of late instar benthic invertebrate larvae is highest and when the benthic invertebrate community composition is most stable. Benthic invertebrate monitoring at the Gordon and MacLellan sites will commence during construction (Year -2) and continue every three years through the construction, operation, and decommissioning/closure phases of the Project, and once during post-closure (Table 4-4). Adaptive management and monitoring will allow for changes to this monitoring schedule, depending on results of previous studies. This sample timing and frequency is consistent with sediment and benthic invertebrate sampling schedule for the separate, but related, federal EEM program.

Monitoring in the Hughes River will commence during construction (Years -2 and -1) and continue in Year 1 of operation (Table 4-4). This sampling schedule is unique to the Hughes River because existing water in Wendy and East pits will only be discharged to the Hughes River during an approximately three-month period during the first year of mine construction (i.e., Year -2); pit dewatering is one of the first activities to occur during construction of the Gordon site.

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Table 4-4 Benthic Invertebrate Monitoring Schedule

Monitoring Activity	Frequency			
	Construction	Operation	Decommissioning/ Closure	Post-Closure
Gordon Site				
“Impact” and “Reference” sites	Year -2	Years 1, 4	Years 7, 10	Year 13
Hughes River sites	Years -2, -1	Year 1		
MacLellan Site				
“Impact” and “Reference” sites	Year -2	Years 1, 4, 7, 10, 13	Years 16, 19, 22	Year 25

4.5 METRICS AND THRESHOLDS FOR ADAPTIVE MANAGEMENT

Four end-point metrics will be calculated from the family-level data at “impact” and “reference” sites to assess potential Project effects on benthic invertebrate communities in lakes and streams downstream of the Gordon and MacLellan sites:

- Total benthic invertebrate density
- Total taxa richness
- Simpson’s evenness index
- Bray-Curtis Dissimilarity index.

Unlike water or sediment quality where exceedances of federal or provincial guidelines for the protection of freshwater aquatic life may be used as potential effect thresholds, there are no federal or provincial effect thresholds for benthic invertebrate communities. Therefore, benthic invertebrate community thresholds for each end-point metric will be the CES of ± 2 standard deviations of the mean as determined by ANOVAs comparing end-point metrics at “impact” sites to “reference” sites at the same point in time and “before” data to “after” data at the same locations. The study design for the benthic invertebrate community component of the AEMP is based on a BACI design and collection of benthic invertebrate samples at “impact” and “reference” sites, “before” and “after” construction of the Project will enable these analyses. These thresholds are based on the CES described in Schedule 5 of the MDMER.

There are three possible statistical outcomes of the benthic invertebrate community survey in any year of the AEMP: 1) no effect is detected but statistical power is not sufficient (i.e., power <0.90); 2) no effect is detected, and statistical power is sufficient (i.e., power ≥ 0.90); or 3) an effect is detected, and statistical power is sufficient (i.e., power ≥ 0.90). If any of the end-point metrics demonstrate a statistical difference between “impact” and “reference” sites (or along a gradient), then the conclusion is that there is an effect on the benthic invertebrate community (EC 2012). If the statistical power is insufficient, the number of samples collected at each site and/or the study design will be re-evaluated.

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Like EEM plans required by Schedule 5 of the MDMER, Alamos will use a phased approach to the benthic invertebrate community component of the AEMP; each year of the AEMP will be designed in consideration of results of the previous study. In the event there is a confirmed, statistically significant effect on the benthic invertebrate community in the receiving environment downstream of the effluent discharge points, Alamos will initiate the following steps, in order of implementation:

- An “Investigation of Cause” study to determine the source of confirmed effects and/or to identify the geographic extent of a confirmed effect (as part of biological studies required by Schedule 5 of the MDMER).
- Additional mitigation (e.g., improved or addition water treatment, revised operational procedures).
- Corrective actions.

Additional mitigation or remedial actions will be dictated by the nature of the observed effect and will be initiated only if required after completion of the “Investigation of Cause”. Additional mitigation or remedial actions will be developed in consultation with relevant governing agencies and stakeholders (e.g., Indigenous Nations).

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5.0 CHLOROPHYLL A CONCENTRATIONS MITIGATION AND MONITORING

Chlorophyll *a* concentrations represent the concentration of photosynthetic pigments used by periphyton (i.e., attached algae) and phytoplankton (i.e., free-floating algae) to derive energy from sunlight. Chlorophyll *a* concentrations provide a measure of periphyton and phytoplankton biomass and productivity; the higher the chlorophyll *a* concentration, the greater the biomass of phytoplankton and periphyton present, the higher the primary productivity in the lake or stream. In addition to sunlight, periphyton and phytoplankton biomass and productivity are dependent on water clarity (which influences the intensity and depth to which sunlight can penetrate the water column) and the concentration of dissolved organic carbon, nitrogen, and phosphorus in water, the three limiting nutrients for photosynthetic organisms in freshwater environments (Wetzel, 1983).

5.1 PATHWAYS OF EFFECTS

Potential changes in periphyton and phytoplankton communities at the Gordon and MacLellan sites are related to changes in TSS and nutrient concentrations in the streams and lakes downstream of the effluent discharge locations. Potential changes in TSS and nutrient concentrations at both sites may occur due to:

1. Release of sediment during site preparation, stockpiling of ore and overburden, maintenance of access roads, and site closure and reclamation activities.
2. Discharge of contact water (including blasting residues from the open pits) or seepage during operation and decommissioning/closure.
3. Discharge of wastewater during construction, operation, and decommissioning/closure (MacLellan site only).
4. Discharge of water from end-pit lakes during closure/decommissioning.

5.2 MITIGATION MEASURES

The mitigation measures that will be implemented to reduce potential effects to periphyton and phytoplankton communities are the same as those that will be implemented to reduce potential effects to sediment quality and water quality and, therefore, are not repeated here.

With mitigation, potential changes in periphyton and phytoplankton communities are expected to be negligible. However, even with mitigation, potential changes in water quality downstream of the Gordon PDA and MacLellan PDA are predicted and, therefore, the potential exists for changes in periphyton and phytoplankton communities in streams and lakes downstream of the Project.

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5.3 MONITORING

5.3.1 Sampling Locations

5.3.1.1 Gordon Site

Chlorophyll *a* monitoring sites at the Gordon site are identified in Table 5-1 and shown in Appendix B, Map B-10. Sites include those listed in Condition 3.14.2 of the federal Decision Statement (i.e., Farley Creek, Farley Lake, Gordon Lake, Hughes River), two proposed lake reference sites (i.e., for comparison with monitoring data from Gordon, Farley, and Swede lakes), one proposed stream reference sites (i.e., White Owl Lake outlet) for comparison with monitoring data from Farley Creek, and an upstream reference site in the Hughes River. Although identified in Condition 3.14.2 of the federal Decision Statement, a sampling site in the “new diversion channel” is not included because a new diversion channel is no longer required at the Gordon site.

Stream habitats with sufficient gradient to create riffles with hard substrates suitable for collection of periphyton samples are rare at the Gordon site. However, a boulder riffle exists in Farley Creek approximately 2.5 km downstream from the Farley Lake outlet and will be sampled as part of the AEMP. A similar rocky riffle was identified in could the White Owl Lake outlet channel that will be used as “reference” sites for comparison with data collected from Farley Creek.

Table 5-1 Chlorophyll *a* Monitoring Sites at the Gordon Site

Proposed Sampling Location	Site ID	Sample Type	Site Type
Gordon Lake	AQF2	Phytoplankton	Near-field
Farley Lake (west basin)	AQF34A	Phytoplankton	Near-field
Farley Creek	AQF40	Periphyton	Mid-field
Swede Lake	AQF16	Phytoplankton	Far-field
Low Lake	AQF47A	Phytoplankton	Reference ¹
White Owl Lake	AQF13	Phytoplankton	Reference ²
White Owl Lake outlet	TBD	Periphyton	Reference ³
Hughes River (downstream of effluent pipe)	AQF40	Periphyton	Near-field
Hughes River (upstream of effluent pipe)	AQF49	Periphyton	Reference ⁴
Notes:			
¹ reference site for comparison to Gordon and Farley lakes			
² reference site for comparison to Swede Lake			
³ reference site for comparison to Farley Creek (AQM40)			
⁴ reference site for comparison to “impact” site in Hughes River downstream of effluent pipe (AQF40)			
TBD = to be determined			

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5.3.1.2 MacLellan Site

Chlorophyll a monitoring sites at the MacLellan Site are identified in Table 5-2 and shown in Appendix B, Map B-11. Sites include those listed in Condition 3.14.2 of the federal Decision Statement (i.e., Minton Lake, Keewatin River), one proposed lake reference sites (i.e., for comparison with monitoring data from Minton and Payne lakes), one reference site in the Keewatin River upstream of the MacLellan site, one site in the Lynn River downstream of the former ETMA, and sites in the Keewatin River upstream and downstream of the Lynn River confluence.

Table 5-2 Chlorophyll a Monitoring Sites at the MacLellan Site

Proposed Sampling Location	Site ID	Sample Type	Site Type
Minton Lake	AQM16	Phytoplankton	Near-field
Payne Lake	AQM31	Phytoplankton	Near-field
Keewatin River upstream of Lynn River confluence	AQM8	Periphyton	Mid-field
Keewatin River downstream Lynn River confluence	AQM29C	Periphyton	Far-field
Lynn River (downstream of ETMA)	AQM61	Periphyton	Cumulative ³
Keewatin River upstream of Payne Lake outlet confluence	AQM4	Periphyton	Reference ¹
Carr Lake	AQM91	Phytoplankton	Reference ²
Notes: ¹ reference site for comparison to “impact” sites in Keewatin River downstream of effluent pipe (AQM8 and AQM20) ² reference site for comparison to Minton and Payne lakes ³ data from the Lynn River to be used to assist interpretation of data from Keewatin River due to potential cumulative effects			

5.3.2 Sampling Methods

5.3.2.1 Phytoplankton

Most lakes at the Gordon and MacLellan sites are too shallow (i.e., <3 m deep) to thermally stratify in summer. However, because the vertical distribution of phytoplankton is affected by thermal stratification in lakes, a multi-meter with a 10 m long sonde cable will be used in the deepest portion of each lake, prior to phytoplankton sampling, to determine if stratification has occurred and, if so, at what depth the thermocline has developed. The multi-meter will be used to measure water temperature, dissolved oxygen concentration, specific conductivity, and pH at 0.5 m depth intervals from the surface to the bottom. A Secchi disk depth will also be measured.

If the lake is not thermally stratified, phytoplankton samples will be collected by submerging a narrow-mouthed collection bottle approximately 0.5 m below the water surface. Each sample will be a composite of three separate “grabs” taken at different locations in the lake or within the lake basin. In this way, only one composite sample will be collected per lake or basin. The total composite sample volume will be 500 milliliters.

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If the lake is thermally stratified, a second composite phytoplankton sample will be collected from within the thermocline (but above the Secchi disk depth) using a Van Dorn water bottle. The composite sample will be comprised of three separate “grabs” collected from different locations in the lake or with the lake basin.

Samples will be transferred to 500 mL sample containers. At camp, the samples will be filtered through a 0.45 µm filter, preserved with three drops of magnesium carbonate (MgCO₃), folded in half, placed in individually labeled petri dishes wrapped in aluminum foil, and stored in cool, dark conditions. Samples will be delivered to ALS Environmental Laboratories in Winnipeg, Manitoba for analysis of chlorophyll a and phaeophytin concentrations.

5.3.2.2 Periphyton

Periphyton samples will be collected from rocky substrates in streams. Five composite samples will be collected from each site. Each composite sample will be comprised of three to five scrapings from a randomly selected rock that is submerged within the wetted perimeter of the stream. Selected rocks will be large enough that at least three separate areas can be scraped for periphyton.

Periphyton will be gently scraped from each rock from within an area defined by a rubber disc of a known surface area using a toothbrush. The scrapings will be collected in a cup filled with de-ionized water held below the rock. Once the area has been scraped clean of periphyton, the sample in the cup will be transferred to a 125-mL glass jar with an eye-dropper. The rock area inside the disc area then will be rinsed with de-ionised water and the rinsate will be transferred to the sample jar using an eye-dropper. This process will be repeated three times from each rock if the periphyton density is high and homogenous, or five times if the algae density is low or patchy to make one composite sample. Each rock will be selected from upstream of the previous rock sampled to reduce potential disturbance or contamination.

Sample jars will be immediately wrapped with aluminum foil and stored on ice in a cooler until they can be processed at camp at the end of the day. At camp, the samples will be filtered through a 0.45 µm filter, preserved with three drops of magnesium carbonate (MgCO₃), folded in half, placed in individually labeled petri dishes wrapped in aluminum foil, and stored in cool, dark conditions. Samples will be delivered to ALS Environmental Laboratories in Winnipeg, Manitoba for analysis of chlorophyll a and phaeophytin concentrations.

Observations of periphyton growth density (e.g., thick filamentous algae, “clean-looking” rocks, heavily “green” rocks) will be recorded and underwater and overview photos will be taken at each site. Water depth temperature, conductivity, pH, dissolved oxygen, and an estimate of near-bottom water velocity will also be measured.

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5.3.3 Data Analysis

Chlorophyll a and phaeopigment concentrations from the lab will be converted to microgram per liter filtered as an indicator of total biomass per sample. The mean and standard error of the replicate composite samples will be calculated for each site.

5.3.4 Sampling Schedule

Phytoplankton samples will be collected in late May, August, and late September each year that phytoplankton sampling is required. This timing will allow for the collection of data from the spring and fall algal blooms that coincide with lake turn-over and from mid-summer. Periphyton samples will be collected in August. This sample timing is consistent with baseline phytoplankton and periphyton sampling conducted at the Gordon and MacLellan sites.

Chlorophyll a monitoring at the Gordon and MacLellan sites will commence during construction (Year -2) and continue every three years through the construction, operation, and decommissioning/closure phases of the Project, and once during post-closure (Table 5-3). Adaptive management and monitoring will allow for changes to this monitoring schedule, depending on results of previous studies.

Monitoring in the Hughes River will commence during construction (Years -2 and -1) and continue in Year 1 of operation (Table 5-3). This sampling schedule is unique to the Hughes River because water in Wendy and East pits will only be discharged to the Hughes River during an approximately three-month period during the first year of mine construction (i.e., Year -2).

Table 5-3 Chlorophyll A Monitoring Schedule

Monitoring Activity	Frequency			
	Construction	Operation	Decommissioning/ Closure	Post- Closure
Gordon Site				
"Impact" and "Reference" sites	Year -2	Years 1, 4	Years 7, 10	Year 13
Hughes River sites	Years -2, -1	Year 1		
MacLellan Site				
"Impact" and "Reference" sites	Year -2	Years 1, 4, 7, 10, 13	Years 16, 19, 22	Year 25

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5.4 METRICS AND THRESHOLDS FOR ADAPTIVE MANAGEMENT

Chlorophyll *a* concentration data will not be used to trigger adaptive management. Therefore, a chlorophyll *a* concentration threshold is not proposed. Nevertheless, the following analyses will be used as “proactive triggers” to initiate additional water quality sampling to determine if the observed changes are due to sampling error, regional phenomena, or Project-induced changes in water transparency or nutrients concentrations:

- Changes in Secchi Disk depth that are consistently beyond the range of natural variability observed in area lakes during baseline surveys or observed in reference lakes during Project construction, operation, or closure/decommissioning.
- Changes in chlorophyll *a* concentrations that are consistently beyond the range of natural variability in phytoplankton and periphyton samples collected from lakes and streams during baseline surveys or observed in reference lakes during Project construction, operation, or closure/decommissioning.

The objective of these comparisons is to determine if the Project is causing a change in trophic status (e.g., eutrophic, meso-trophic, oligotrophic) in the lakes and streams downstream of the Gordon and MacLellan sites.

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6.0 FISH HABITAT MITIGATION AND MONITORING

The objective of fish habitat monitoring is to identify changes to the quantity (e.g., ha or m²) and/or quality of fish habitat used by fish for spawning, rearing, foraging, migrating, or overwintering. These changes may include, but not necessarily be limited to, changes in water depth, water temperature, or dissolved oxygen concentration in lakes or changes in water depth, water velocity, water temperature, or dissolved oxygen concentration in streams.

Compliance with, and effectiveness of, fish habitats included in the Fish Habitat Offsetting Plan submitted as part of the Project's paragraph 35(2)(b) *Fisheries Act* Authorization application will be monitored separately as described in Alamos's Fish and Fish Habitat Offsetting Plan.

6.1 PATHWAYS OF EFFECTS

6.1.1 Gordon Site

Summaries of Project-related pathways of effects, mitigation measures, and potential residual effects on fish habitat at the Gordon site are provided in Appendix A, Table A-5. Potential changes in fish habitat in lakes and streams at the Gordon site may occur due to:

1. Alteration of flows in Farley Creek due to changes to the natural run-off pattern in the Gordon and Farley Lake watersheds due to construction and operation of collection ditches and ponds around the site.
2. Alteration of flows in Farley Creek due to discharge of groundwater pumped from interceptor wells installed between Gordon and Farley lakes and the open pit during construction and operation.
3. Alteration of water temperatures in Gordon Lake, Farley Lake, and Farley Creek due to discharge of groundwater pumped from interceptor wells installed between Gordon and Farley lakes and the open pit during construction and operation.
4. Alteration of fish passage in streams crossed by site access roads.
5. Alteration of water levels in lakes and fish-bearing wetlands due to draw-down of the groundwater table during development of the open pit.

Water levels and water temperatures in Farley Lake and flows in Farley Creek will not be affected by pit dewatering during construction of the Gordon site. This is because Alamos no longer plans to discharge water from the existing open pits at the Gordon site to Farley Lake as originally proposed in the EIS. Instead, Alamos will discharge pit water to the Hughes River via an approximately 8 km long pipeline laid within the existing Gordon Mine access road right-of-way. This water will be discharged into the Hughes River immediately upstream of the Gordon mine access road bridge so that it will quickly mix with Hughes River water in the turbulent flow under and downstream of the bridge.

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6.1.2 MacLellan Site

Summaries of Project-related pathways of effects, mitigation measures, and potential residual effects on fish habitat at the MacLellan site are provided in Appendix A, Table A-6. Potential changes in fish habitat in lakes and streams at the MacLellan site may occur due to:

1. Alteration of water levels in Payne Lake and Minton Lake due to changes to the natural run-off patterns within their catchment areas due to construction and operation of collection ditches and ponds around the site.
2. Alteration of water levels in Payne Lake and Minton Lake due to changes to the groundwater table caused by development of the TMF.
3. Alteration of flows in the Keewatin River due to water withdrawals and/or effluent discharge during construction, operation, and closure/decommissioning.
4. Alteration of water temperatures in the Keewatin River due to effluent discharge during construction and operation.
5. Alteration of fish passage in streams crossed by site access roads.
6. Alteration of water levels in fish-bearing wetlands due to draw-down of the groundwater table during development of the open pit.

6.2 MITIGATION MEASURES

The mitigation measures that will be implemented to reduce potential effects to fish habitat at the Gordon and MacLellan sites include:

- Implementing the SWMMP, including the construction and operation of non-contact water diversion ditches to reduce potential changes in natural run-off patterns.
- Installing water intake pipes pointing upwards and away from sediment as required by Condition 3.11.1 of the federal Decision Statement.
- Installing and operating groundwater interceptor wells at the Gordon site to mitigate potential effects to water levels in Gordon and Farley lakes due to groundwater draw-down as required by Condition 3.4 of the federal Decision Statement.
- Sizing new culverts to convey the 1:100-year flood and using open-bottom structure where practical to maintain fish habitat values and fish passage as recommended by the Manitoba Stream Crossing Guidelines (DFO and MNR 1996).
- Maintaining a buffer of undisturbed riparian vegetation of at least 30 metres from the high-water mark around fish-bearing waterbodies and fish-bearing wetlands that are not required to be removed for construction of the Project (as required by Condition 3.8.3 of the federal Decision Statement).
- Implementing Best Management Practices for run-off, erosion, and sediment control as described in the Erosion and Sediment Control Plan.

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- Recycling water between the processing plant and the Tailings Management Pond to reduce freshwater withdrawals from the Keewatin River (MacLellan site only).
- Trucking potable water from the MacLellan site to the Gordon site to reduce the freshwater requirements from Farley Lake.

With mitigation, potential changes in habitat in streams and lakes near and downstream of the Project are expected to be negligible. However, even with mitigation, potential changes in fish habitat in lakes and streams within the Gordon PDA and MacLellan PDA may occur and monitoring of fish habitat in lakes and stream within the Gordon PDA and MacLellan PDA is necessary.

6.3 MONITORING

Monitoring of potential changes in fish habitat quantity and quality at the Gordon and MacLellan sites will include:

- Water levels in lakes
- Water levels in fish-bearing wetlands
- Stream discharge in streams and rivers
- Water temperatures, dissolved oxygen concentrations, Secchi disk depth, and TSS concentrations in lakes and streams
- Channel morphology in Farley Creek
- Fish passage at culvert upgrades.

Monitoring of water levels in lakes and fish-bearing wetlands and stream discharges in streams at the Gordon and MacLellan sites are discussed in the Surface Water Quantity Monitoring Plan within the SWMMP. Monitoring of dissolved oxygen concentrations, Secchi disk depth, and TSS concentrations in lakes and streams at the Gordon and MacLellan sites are discussed in the Surface Water Quality Monitoring Plan within the SWMMP. Therefore, only monitoring of potential changes in fish habitat quantity and quality in Farley Creek at the Gordon site, potential changes in water temperature at both sites, and potential changes in fish passage at upgraded culverts along mine site access roads at both sites are included in the AEMP. Each of these components of the AEMP are described below.

6.3.1 Farley Creek

Potential changes in the quantity and quality of fish habitat in Farley Creek due to predicted changes in flow will be monitored by:

- Collection of aerial photos from Farley Lake to Swede Lake in mid-summer. Aerial photos will be collected from a 5 km x 5 km polygon with 30 cm x 30 cm resolution.

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- Measurement of depth, wetted width, substrate composition, and vegetation density data at regular intervals at transects established in Farley Creek between Farley Lake and Swede Lake in mid-summer.
- Installation of pressure transducers at the top and bottom of the HEC-RAS hydraulic habitat model section in Reach 1 of Farley Creek.

A total of 10 transects will be established in Farley Creek (Appendix B, Map B-12): eight in the reach that extends from the Farley Lake outlet to the boulder cascade approximately 2.5 km downstream (i.e., Reach 1) and two in the reach that extends from the bottom of the boulder cascade to Swede Lake (i.e., Reach 3). Two of the transects in Reach 1 will be the upstream-most and downstream-most transects used previously for the HEC-RAS hydraulic habitat model. Transects will be established perpendicular to the flow direction and extend from tree-line to tree-line on either side of the creek so that they include the entire creek floodplain. Benchmarks will be installed on both sides of the creek at each transect so that data can be collected from the same locations during each sampling event.

Elevations will be collected at regular intervals across each transect with a Real-time Kinematic Geographic Positioning System. Elevations will be recorded at top-of-bank, water's edge, at one-meter intervals, and wherever there are sudden changes in depth. Substrate composition in the main channel will be determined using the Wolman pebble count method (Wolman 1954), by collecting sediment from with a Petite Ponar dredge, or by examination with an underwater camera, whichever is feasible and most repeatable. Sediment collected by dredge will be spread out on a white lab tray in the field and photographed. Underwater photos will be taken of a quadrat of known area placed on the channel bottom. Vegetation density will be measured by taking photos of a quadrat of known area placed at three randomly selected sites in the wetted floodplain.

Pressure transducers will be installed annually after ice-out (Appendix B, Map B-12). Pressure transducers will be downloaded every three months or sooner. Pressure transducers will be removed prior to freeze-up each year to prevent damage to the units.

6.3.2 Water Temperature

Pressure transducers installed in streams and lakes at the Gordon and MacLellan sites as part of the SWMMP all have water temperature loggers. However, not all these locations will be used to monitor the potential effect of the Project on water temperature. This is because the Project only has the potential to affect water temperature in lakes and streams downstream of the Project. Therefore, only a subset of the pressure transducers deployed for the SWMMP are relevant to this AEMP (Table 6-1). These sites include pressure transducers/temperature loggers at the locations required by Condition 3.14.1 of the federal Decision Statement (Gordon Lake, Farley Lake, Farley Creek, and the Hughes River at the Gordon site (Appendix B, Map B-13) and Minton Lake and the Keewatin River at the MacLellan site (Appendix B, Map B-14) plus pressure transducers/temperature loggers at upstream reference locations and reference streams and lakes in unaffected watersheds.

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Table 6-1 Location of Water Temperature Loggers at the Gordon and MacLellan Sites

Waterbody	Station ID	Location Description and Rationale
Gordon Site		
Gordon Lake	AQF2	Near outlet of Gordon Lake; required by Condition 3.14.1
Farley Lake	AQF34A	Western basin near effluent pipe location; required by Condition 3.14.1
Farley Creek	AQF9	Outlet of Farley Lake; required by Condition 3.14.1
Mac Lake outlet	AQF46	Reference stream for comparison with Farley Creek
Low Lake	AQF47A	Reference lake for comparison with Gordon and Farley lakes
Hughes River	AQF40	Downstream of effluent pipe discharge; required by Condition 3.14.1
Hughes River	AQF44	Far-field Downstream of effluent pipe discharge
Hughes River	AQF41	Upstream reference for comparison to Hughes River sites downstream of effluent pipe; required by Condition 3.14.1
MacLellan Site		
Minton Lake	AQM16	Downslope of TMF and MRSA; required by Condition 3.14.1
Payne Lake	AQM31	Adjacent to TMF and MRSA
Tributary KEE3-B1	AQM71	Tributary downstream of open pit and MRSA; open pit drains to KEE3-B1 post-closure
Cockeram River	AQM10	Downstream of Minton Lake
Keewatin River	AQM4	Upstream reference site (downstream of Burge Lake) for comparison to Keewatin River sites downstream of effluent pipe; required by Condition 3.14.1
Keewatin River	AQM8	Downstream of effluent pipe discharge but upstream of Lynn River confluence; required by Condition 3.14.1
Lynn River	AQM28	Major tributary to Keewatin River downstream of MacLellan site
Keewatin River	AQM29C	Downstream of effluent pipe discharge and downstream of Lynn River confluence
Carr Lake	AQM91	Reference lake for comparison with Minton Lake

Pressure transducers will be installed as soon after ice-break up as safely possible each year. Pressure transducers will be removed just before freeze-up or will be winterized at locations where water depths are sufficient to prevent the transducers from becoming frozen in ice (i.e., >75 cm deep). Pressure transducers will be set to record water temperature at least hourly and will be downloaded every three months.

6.3.3 Fish Passage at Culvert Upgrades

Culvert upgrades are required at the crossing separating Simpson Lake and Swede Lake and two fish-bearing headwater tributaries of Farley Lake on the Gordon Site Access Road (Map B-15) and at the fish-bearing Dot Lake outlet on the MacLellan Site Access Road (Map B-16).

Culverts will be assessed twice annually: in summer after spring freshet and in fall prior to freeze-up. This timing will enable monitors to observe any erosion or debris accumulation that may have occurred during the freshet and provide Alamos with the ability to conduct any necessary maintenance activities during low-

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flow conditions. Fall observations will provide the opportunity to remove any beaver dams or other debris that may have accumulated over summer to decrease the likelihood of road flooding and erosion the following spring. If annual monitoring shows that the frequency can be reduced without posing a risk to road integrity, mine infrastructure or fish passage, the schedule will be revised.

Monitoring of fish passage potential will be based on measuring the hydraulic variables that determine if fish are able to successfully pass upstream through the culverts (i.e., channel width, depth, water velocity, channel gradient, culvert gradient, outlet drop, outlet pool depth). Measurement of these hydraulic data will enable the assessment of upstream fish passage over a wide range of flow conditions while providing consistent and comparable results. Monitoring will follow the methods described in the British Columbia “Fish Passage – Culvert Inspection Procedures” (BC MELP 2000) or similar hydraulically based methods provided by Fisheries and Oceans Canada (DFO)¹.

6.3.4 Data Analysis

6.3.4.1 Farley Creek

Aerial photos will be processed, geo-rectified, and reviewed in a geographic information system (GIS) to calculate: 1) average wetted width; 2) average width and meander radius of the central channel; 3) the spatial extent of aquatic vegetation; 4) location and frequency of beaver dams; and 5) water turbidity. Geo-referenced photo-mosaics will be created for comparison with similar photo-mosaics taken during construction, operation, and closure/decommissioning phases.

Cross-sectional depth profiles at each transect in Farley Creek will be prepared each year that data is collected. From these cross-sections, the wetted width, the width and location of the main channel in relation to the left and right bank, and the spatial extent of aquatic vegetation in the channel will be determined. Cross-sectional profiles from different years will be compared graphically to assess whether the channel morphology is changing due the flow changes predicted to occur in Farley Creek during construction, operation, and decommissioning/closure phases.

Water elevation data from the pressure transducers will be used to as input to the stage-discharge relationships developed at the modelled section in Reach 1 of Farley Creek. Discharge data from this analysis will then be used as input data to the HEC-RAS model. The HEC-RAS model will be used to calculate wetted width, wetted perimeter, average water depth and average water velocity in the main channel of Farley Creek at the different flows occurring during the open water season.

Hydraulic predictions from the HEC-RAS model will be used to calculate average weighted useable area (WUA) for northern pike and white sucker spawning and rearing habitat based on habitat suitability curves developed from the published literature (Stantec 2021). Changes in WUA for northern pike and white sucker spawning and rearing during construction, operation, and decommissioning/closure will be compared with similar WUA statistics estimated from pre-mining flows in Farley Creek.

¹ Fisheries and Oceans Canada is currently developing a fish passage screening tool for culverts and will be provided to Alamos when available (L. Phalen email communication, November 14, 2024)

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6.3.4.2 Water Temperature

Water temperature data from the pressure transducers will be graphed to show the minimum, maximum, and average daily temperatures during the open water season (i.e., May to October). Monthly and weekly statistics (i.e., average, minimum, maximum, and standard deviation) will be calculated for each site. Graphs and statistics from sites downstream of effluent pipes at the Gordon site (i.e., Gordon Lake, Farley Lake, Farley Creek) and MacLellan site (i.e., Keewatin River) will be compared with their appropriate reference sites.

Maximum weekly average temperature calculated from the temperature loggers installed in lakes and stream downstream of the Project will be compared with the following Manitoba Tier II Water Quality Objectives:

- Warmer months (i.e., July and August): the optimum temperature for growth for the most temperature sensitive fish species and life stage plus 1/3rd the difference between the upper incipient lethal temperature and the optimal temperature for growth for that fish species and life stage.
- Reproductive season: the temperature range that the most temperature sensitive fish species require for successful migration, spawning, and egg incubation.
- Colder months (i.e., January to March): the maximum weekly average temperature change that the most sensitive fish species and life stage could survive if the water temperature suddenly dropped to the normal ambient temperature.

Optimal spawning and growth, upper lethal, maximum short-term exposure, and maximum winter temperature change data for the five most common fish species at the Gordon and MacLellan sites are provided in Table 6-2.

Table 6-2 Thermal Tolerances for Fish Species Present at the Gordon and MacLellan sites

Species	Water temperature (°C)			
	Optimal Spawning ¹	Optimal Summer Growth	Upper Incipient Lethal	Maximum Average Weekly Temperature Change in Winter
Northern pike	8-14	22-25	32	+8
Yellow perch	9-12	7-14	27	+15
White sucker	10-16	19-24	30	+20
Brook stickleback	15-19	<23	31	-
Burbot	1-2	11-15	23	2

Note:
¹ northern pike, yellow perch, and white suckers are spring spawners; brook stickleback spawn in late spring/early summer; burbot spawn in late winter
 Source: Wismer and Christie (1987)

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6.3.4.3 Fish Passage at Culvert Upgrades

Until a similar hydraulically based screening tool is available from DFO, successful upstream fish passage through each upgraded culvert will be determined based on the cumulative score of the following hydraulic variables measured during summer low-flow conditions (BC MELP 2000):

- Depth and degree of culvert embedment
- Outlet vertical drop
- Stream width ratio (as calculated by dividing culvert width by culvert diameter)
- Culvert slope
- Culvert length.

Values for each measured hydraulic variable will be assigned a score as shown in Table 6-3. Cumulative scores calculated from the five hydraulic variables will be used to determine if the culvert is passable by fish based on the following results (BC MELP 2000):

- Cumulative score >20 is a barrier to upstream fish passage.
- Cumulative score between 15 and 19 is a potential barrier to upstream fish passage.
- Cumulative score <15 is not a barrier to upstream fish passage.

Table 6-3 Scoring Chart for Hydraulic Variables Used to Calculate Fish Barrier Potential at Culverts

Hydraulic Variable		Score
Embeddedness	>30 cm or >20% of diameter and continuous (full)	0
	<30 cm or 20% of diameter but continuous	5
	No embedment or discontinuous	10
Outlet drop	<15 cm	0
	15 cm to 30 cm	5
	>30 cm	10
Stream width ratio	<1.0	0
	1.0 to 1.3	3
	>1.3	6
Culvert slope	<1%	0
	1% to 3%	5
	>3%	10
Culvert length	<15 m	0
	15 m to 30 m	3
	>30 m	6

Source: BC MELP 2000

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Cumulative scores between 15 and 19 will be used to determine when and where modifications to the culverts needed to be considered. Cumulative scores >20 will require that modifications be made to the culvert or other mitigation measures to improve upstream fish passage (e.g., downstream rock weir) be investigated.

6.3.5 Sampling Schedule

Monitoring of potential changes in fish habitat in Farley Creek will occur once during construction (Year -2) and then every three years afterwards into post-closure (Table 6-4). Monitoring of water temperatures in “impact” and “reference” sites at the Gordon site and MacLellan site will occur at this same frequency and duration. Monitoring of water temperatures in the Hughes River will commence during construction (Years -2 and -1) and continue in Year 1 of operation (Table 6-4). This sampling schedule is unique to the Hughes River because water in Wendy and East pits will only be discharged to the Hughes River during an approximately three-month period during the first year of mine construction (i.e., Year -2).

Culvert assessments to support maintenance will occur twice annually during all mine phases: once after the spring freshet and just prior to freeze-up. Culvert assessments for fish passage will occur twice during construction and then every three years afterwards into post-closure.

Table 6-4 Fish Habitat Monitoring Schedule

Monitoring Activity	Frequency			
	Construction	Operation	Decommissioning/ Closure	Post-Closure
Gordon Site				
Farley Creek	Year -2	Years 1, 4	Years 7, 10	Year 13
Water Temperature	Year -2	Years 1, 4	Years 7, 10	Year 13
Water Temperature: Hughes River	Years -2, -1	Year 1		
Culverts maintenance	Twice annually			
Culverts fish passage	Years -2, -1	Years 1, 4	Years 7, 10	Year 13
MacLellan Site				
Water Temperature	Year -2	Years 1, 4, 7, 10, 13	Years 16, 19, 22	Year 25
Culverts maintenance	Twice annually			
Culverts fish passage	Years -2, -1	Years 1, 4, 7, 10, 13	Years 16, 19, 22	Year 25

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6.4 METRICS AND THRESHOLDS FOR ADAPTIVE MANAGEMENT

6.4.1 Farley Creek

The following metrics and thresholds will be used to determine if adaptive management actions are required to reduce effects to fish and fish habitat in Farley Creek at the Gordon site:

- Reduction in the number of beaver dams present in Reach 1 of Farley Creek by >25% of pre-construction conditions during any scheduled monitoring year post-construction based on aerial imagery interpretation; beaver dams are frequent in Farley Creek and contribute to the hydraulic, sediment transport, and morphological conditions of the fish habitat present
- Change in the average wetted channel width of Reach 1 of Farley Creek by $\pm 25\%$ of pre-construction conditions during any scheduled monitoring year post-construction based on aerial imagery interpretation
- Reduction in the average WUA for northern pike and white sucker spawning and rearing >25% of pre-mine flow conditions as calculated from the HEC-RAS model in Reach 1 of Farley Creek. Changes in WUA for northern pike and white sucker spawning and rearing during construction, operation, and decommissioning/closure phases will be compared with similar WUA statistics estimated from pre-mining flows in Farley Creek.

6.4.2 Water Temperature

Maximum weekly average temperature calculated from the temperature loggers installed in lakes and streams downstream of the Project will be the metric used to determine if adaptive management is required. The thresholds for adaptive management will be as follows based on the Manitoba Tier II Water Quality Objectives:

- Gordon Lake: exceedance of the optimum temperature for growth for Brook stickleback (the only fish species in Gordon Lake) plus 1/3rd the difference between the upper incipient lethal temperature and the optimal temperature for growth for that fish species and life stage in August
- Farley Lake: 1) exceedance of the optimum temperature for growth for Yellow Perch (the most temperature sensitive fish species in Farley Lake) plus 1/3rd the difference between the upper incipient lethal temperature and the optimal temperature for growth for that fish species and life stage in August 2) exceedance of the upper preference temperature for Yellow Perch spawning in May; or 3) exceedance of the 8°C maximum average weekly temperature change for Northern Pike between January and March.
- Keewatin River: 1) exceedance of the optimum temperature for growth of Burbot (the most temperature sensitive fish species in the Keewatin River) plus 1/3rd the difference between the upper incipient lethal temperature and the optimal temperature for growth for that fish species and life stage in August; 2) exceedance of the upper preference temperature for Burbot spawning in March; or 3) exceedance of the 2°C maximum average weekly temperature change for Burbot between January and March.

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6.4.3 Fish Passage at Culvert Upgrades

Until a similar hydraulically based screening tool is available from DFO cumulative scores for the five measured hydraulic variables at each upgraded culvert will be used as the metric to determine if adaptive management is required. The following thresholds will be used to trigger adaptive management in any year that fish passage assessments are conducted:

- Cumulative score >20 (i.e., barrier to upstream fish passage) requires immediate alteration to improve upstream fish passage.
- Cumulative score ≥ 15 and ≤ 20 (i.e., potential barrier to upstream fish passage) requires further investigation of potential barriers at different flows and/or investigation of potential alterations to the culvert.
- Cumulative score <15 (i.e., not a barrier to upstream fish passage) does not require alteration.

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7.0 FISH POPULATIONS MITIGATION AND MONITORING

7.1 PATHWAYS OF EFFECTS

Summaries of Project-related pathways of effects, mitigation and offsetting measures, residual effects, and monitoring at the Gordon site and MacLellan site are outlined in Appendix A, Table A-7 and Table A-8, respectively. In general, fish populations in lakes and streams near the Gordon and MacLellan sites may be affected by the following pathways of effects due to construction, operation, closure/decommissioning of the Project:

- Alteration, disruption, or destruction of fish habitat within the Project footprint.
- Changes in water quality due to effluent discharge and/or groundwater seepage to Gordon and Farley lakes and the Hughes River (Gordon site) and the Keewatin River (MacLellan site).
- Changes in water levels in lakes, ponds, and fish-bearing wetlands due to changes in the groundwater table caused by development of the open pits at both sites.
- Changes in stream flow in rivers and streams due to changes in the groundwater table elevation, discharge of pumped groundwater, storage of contact water, active water withdrawals, and/or filling of the open pits.
- Entrainment or impingement of fish in water intake pipes.
- Increased fishing pressure due to the presence of the workforce and/or access to new fishing areas.
- Mortalities to fish and/or fish eggs due increased sound overpressures and peak particles velocities created by blasting in the open pits.

7.2 MITIGATION MEASURES

Mitigation measures that will be implemented to eliminate or reduce potential residual effects to fish populations include:

- Installation of fish screens on freshwater intakes placed in Farley Lake at the Gordon site and in the Keewatin River at the MacLellan site. Fish screens will be designed to preclude entrainment or impingement of juvenile burbot, the weakest swimming life stage of the weakest swimming fish species at both sites, using DFO's "End-of-Pipe" Screen Size Tool ([End-of-Pipe Screen Size Tool \(fishprotectiontools.ca\)](http://fishprotectiontools.ca)) as required by Condition 3.3 of the Federal Decision Statement.
- Installing water intake pipes pointing upwards and away from sediment as required by Condition 3.11.1 of the federal Decision Statement.
- Equipping contact water discharge pipes with diffusers as required by Condition 3.11.2 of the federal Decision Statement.

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- Installing and operating groundwater interceptor wells at the Gordon site to mitigate potential effects to water levels in Gordon and Farley lakes due to groundwater draw-down as required by Condition 3.4 of the federal Decision Statement.
- Conducting fish salvages in East Pond and Keewatin River tributary KEE3-B1 prior to their passive dewatering during mine operation (as required by Condition 3.8.1 of the federal Decision Statement)
- Maintaining, during all mine phases, a buffer of undisturbed riparian vegetation of at least 30 m from the high-water mark around fish-bearing waterbodies and fish-bearing wetlands that are not required to be removed for construction of the Project (as required by Condition 3.8.3 of the federal Decision Statement).
- Aerating Wendy and East pits to break-down thermal stratification and to increase dissolved oxygen concentrations prior to dewatering.
- Limiting charge sizes, using stemming and delays, and restricting blasting during spawning periods to reduce the mortality of fish and fish eggs due to blasting in the open pits.
- Establishing a Worker's Code of Conduct regarding recreational fishing activities during off-hours.
- Implementing Best Management Practices for run-off, erosion, and sediment control as described in the Erosion and Sediment Control Plan.
- Conducting activities in or near fish-bearing water bodies in accordance with Fisheries and Oceans Canada's Manitoba Restricted Activity Timing Windows for the Protection of Fish and Fish Habitat and Measures to Protect Fish and Fish Habitat (DFO 2020), unless otherwise authorized by relevant authorities.
- Preventing the introduction and spread of foreign aquatic and terrestrial biota by cleaning equipment prior to its delivery to the site of the development in accordance with the requirements of Regulation 173/2015 respecting Aquatic Invasive Species, or any future amendment thereof.

The mitigation measures outlined above are expected to be effective at reducing changes in surface water quality, quantity, and other sources of potential fish mortality such that no measurable reduction in the abundance, composition, or structure of fish populations at the Gordon or MacLellan site is expected.

7.3 MONITORING

Potential residual effects on fish communities and populations in lakes and streams near or downstream of the Project are related to potential changes in surface water quantity and surface water quality but also to potential changes in underwater noise from blasting in the open pits. Therefore, monitoring activities for these potential effects on fish populations are primarily described in the SWMMP and in the BMMP, respectively.

As required by Schedule 5 of the MDMER, Alamos will develop a study respecting fish populations in lakes downstream of the effluent discharge locations in Farley Lake at the Gordon site and in the Keewatin River at the MacLellan site if *"the highest concentration of effluent in the exposure area, during a period in which there are deposits, is >1% at any location that is 250 m from a point at which the effluent enters the area"*

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from a final discharge point, unless the results of the previous two biological monitoring studies indicate: 1) for all effect indicators with no assigned critical effect size, no effect on the fish population; and 2) for all effect indicators with an assigned critical effect size, no effect on the fish population or an effect on the fish population the absolute value of the magnitude of which is less than the absolute value of its assigned critical effect size.”.

Nevertheless, Alamos committed to monitoring fish populations that may be affected by construction, operation, and decommissioning/closure of the Project during review of the EIS. The monitoring program described below has been developed using guidance from the “Metal Mining Technical Guidance for Environment Effects Monitoring” (EC 2012) in preparation for a potential need to coordinate the fish population monitoring program described here for the AEMP with a potential future fish population monitoring program required for an EEM Plan.

7.3.1 Sampling Locations

Monitoring of potential effects of the Project on fish communities and populations will be limited to two “impact” sites: Swede Lake at the Gordon site (Appendix B, Map B-17) and Cockeram Lake at the MacLellan site (Appendix B, Map B-18). The reasons for this are:

1. Swede and Cockeram lakes are the first lakes downstream of the Gordon and MacLellan sites that are large and deep enough to support populations of walleye and lake whitefish, two of the most valued fish species harvested by local Indigenous Nations.
2. Gordon Lake (Gordon site) and Payne Lake (MacLellan site) only support populations of brook stickleback.
3. Farley Lake and Minton Lake are too small (<80 ha) to support fish populations that will be able to sustain the lethal sampling necessary to monitor the fish community and populations over the duration of the AEMP.
4. The Keewatin River is an “open system” where fish, particularly large-bodied species that are of greatest interest for monitoring, can migrate to different habitats at different times of the year depending on their life history and/or resource availability and, therefore, monitoring large-bodied fish in the Keewatin River is unlikely to produce repeatable data with the precision necessary to detect changes caused by the Project.

In addition to Swede and Cockeram lakes, sampling will be conducted in two reference lakes for comparison: White Owl Lake at the Gordon site (Appendix B, Map B-17) and Burge Lake at the MacLellan site (Appendix B, Map B-18).

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7.3.2 Sentinel Fish Species

Northern pike, lake whitefish, and white sucker (*Catostomus commersonii*) will be used as the sentinel species for fish population monitoring as required by Condition 3.14.3 of the federal Decision Statement. These species were selected because they are abundant and readily captured in the “reference” and “impact” lakes, provide information from species in different ecological niches (i.e., benthivores and piscivores) and have been identified as valued fish species by local Indigenous Nations. Additional sentinel fish species may be added following consultation with DFO, the Province of Manitoba, and the EAC as required by Condition 3.14.3 of the federal Decision Statement. These species may include any other fish species used for traditional purposes by local Indigenous Nations not already included in the list above.

7.3.3 Sampling Methods

Fish will be collected using gillnet gangs that target adult fish but does not bias the sample population based on fish size. A minimum sample size of 20 adult male and 20 adult female fish of each sentinel species will be collected from each lake during each sampling period. Sample sizes will be confirmed prior to the first year of monitoring by conducting a statistical power analysis on data collected during pre-construction surveys in all lakes.

Indicators of growth, reproduction, condition, and survival will be calculated from the following morphometric characteristics measured in the field: sex, length, weight, age, liver weight, gonad weight, and, for female fish, egg weight and fecundity. The presence of any lesions, tumours, parasites or other abnormalities will also be documented (Table 7-1).

Table 7-1 Fish Measurements and Required Precision

Measurement	Target Precision
Length (fork or total or standard)	+/- 1 mm
Total body weight (fresh)	+/- 1.0%
Age	+/- 1 year (10% to be independently confirmed)
Gonad weight (if fish are sexually mature)	+/- 0.1 g for large-bodied fish species
Fecundity (if fish are sexually mature)	+/- 1.0%
Liver Weight	+/- 0.1 g for large-bodied fish species
Abnormalities	N/A
Sex	N/A
Note: N/A = not applicable Source: Environment Canada (2012)	

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Field and laboratory QA/QC measures will be implemented to document consistency and accuracy of the data. Where applicable, the following measures will be part of the data collection procedures:

- Qualified personnel will collect, process, and analyze fish community data.
- Data management will include review of field notes prior to leaving a sampling location and inspections of each day’s field sheets for completeness.
- Fish species that are difficult to identify in the field will be vouchered and taken to the lab for identification by a qualified fish biologist.
- Descriptions of sample locations will be recorded, and GPS coordinates will be taken.
- GPS-equipped cameras will be used for photography and a field photo log will be maintained.
- Digital and hard copies of field notes will be made to reduce the risk of data loss.
- Fish collections will be completed under a License to Collect Fish for Scientific Purposes.

7.3.4 Data Analysis

Summary statistics for the morphometric parameters shown in Table 7-2 will be calculated from the raw data from each lake in each year of the AEMP and/or EEM.

Table 7-2 Fish Morphometric Data Requirements

Measurement	Reporting of Summary Statistics
Length (fork, total or standard)	Mean, median, SD, SE, minimum, maximum values for sampling areas
Total body weight (fresh)	Mean, median, SD, SE, minimum, maximum values for sampling areas
Age	Mean, median, SD, SE, minimum, maximum values for sampling areas
Gonad weight (if fish are sexually mature)	Mean, median, SD, SE, minimum, maximum values for sampling areas
Egg size in females (if fish are sexually mature)	Weight, (recommended minimum sub-sample sizes of 100 eggs), mean, median, SE, SD, minimum and maximum values for sampling areas
Fecundity in females (if fish are sexually mature)	Total number of eggs per female, mean, median, SE, SD, minimum and maximum for sampling areas
Weight of liver or hepatopancreas	Mean, median, SD, SE, minimum, maximum values for sampling areas
Abnormalities	Presence of any lesions, tumours, parasites, or other abnormalities
Sex	Male, female or unknown
Note: SD = standard deviation; SE = standard error	

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7.3.5 Sampling Schedule

Fish population sampling will be conducted in late summer or early fall, when gonad development for spring spawning fish species is advanced. Fish population monitoring will commence within 24 months of the Project becoming subject to the MDMER. Timing will be confirmed with ECCC and the EAC. The monitoring cycle is scheduled for every three years, in keeping with the legislated requirements of the MDMER (Table 7-3).

Table 7-3 Fish Population Monitoring Schedule

Monitoring Activity	Frequency			
	Construction	Operation	Decommissioning/ Closure	Post-Closure
Gordon Site				
"Impact" and "Reference" lakes	Year -2	Years 1, 4	Years 7, 10	Year 13
MacLellan Site				
"Impact" and "Reference" lakes	Year -2	Years 1, 4, 7, 10, 13	Years 16, 19, 22	Year 25

7.4 METRICS AND THRESHOLDS FOR ADAPTIVE MANAGEMENT

Averages of the fish population metrics will be compared between "impact" and "reference" lakes to determine whether there are statistically significant differences (p<0.05) based on the CES shown in Table 7-4. The probability of correctly detecting an effect of a pre-defined size and the degree of confidence that can be placed in the calculations will be reported.

Table 7-4 Metrics and Critical Effect Sizes

Fish Population Effect indicator	Critical Effect Size (% of reference mean)
Total body weight at age	± 25%
Gonad weight at total body weight	± 25%
Liver weight at total body weight	± 25%
Total body weight at length (condition)	± 10%
Age	± 25%

Fish population metrics and thresholds will not be used for adaptive management at the Gordon site. This is because the duration of mining at the Gordon site is only six years, which is likely too short a duration to detect a change in fish populations in Swede Lake due to the mine. Instead, adaptive management decisions will be based on media that are more likely to show detectable changes due to the Project over this relatively short time frame (i.e., water quality, water temperature, benthic invertebrates).

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Fish population metrics and thresholds will not be used for adaptive management at the MacLellan site until sufficient data is collected from Cockeram Lake over time to determine if the potentially confounding effects of the former ETMA on water quality in the Keewatin River and Cockeram Lake can be separated from the potential effects of the Project on fish populations in Cockeram Lake; the ETMA was reclaimed by the Province of Manitoba in 2021 after approximately 50 years of unabated contaminated seepage to Eldon Lake and the Lynn River, a tributary of the Keewatin River upstream of Cockeram Lake. Water quality data from baseline monitoring conducted for the Project between 2015 and 2019 showed elevated concentrations of chloride, sulphate, aluminum, cadmium, cobalt, copper, nickel, and zinc in Eldon Lake and the Lynn River downstream of the ETMA compared with unaffected waterbodies and concentrations of sulphate, copper, nickel, cadmium, cobalt, and zinc were also observed in Cockeram Lake. The efficacy of remediation activities at the former ETMA to reduce elevated water quality parameters in Cockeram Lake is currently unknown. The metrics provided in Table 7-4 will be used to support adaptive management as appropriate at the MacLellan site once a determination regarding confounding effects has been made.

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8.0 FISH TISSUES MITIGATION AND MONITORING

The objective of fish tissue monitoring is to identify changes in fish tissue metal concentrations that may occur due to changes in water quality and/or sediment quality in lakes and streams downstream of the effluent pipe locations at the Gordon site (i.e., Gordon Lake, Farley Lake) and the MacLellan site (i.e., Keewatin River) and lakes and streams downslope the MRSA at the Gordon site and downslope of the TMF and MRSA at the MacLellan site that may be affected by seepage via groundwater.

Fish tissue monitoring may be included in the Project's future EEM Plan if results from water quality monitoring, effluent characterization studies, and/or sublethal toxicity testing indicate that effluent releases to the receiving environment at the Gordon and Maclellan sites have the potential to adversely affect fish and aquatic biota. Such a plan would be developed in consultation with ECCC and would be guided by its *Metal Mining Technical Guidance for Environmental Effects Monitoring* (Environment Canada 2012). The triggers for fish tissue studies in Schedule 5 of the MDMER are:

1. Effluent samples have an annual mean concentration of total mercury that is $\geq 0.10 \mu\text{g/L}$, based on a calendar year, unless the results of the previous two biological monitoring studies indicate no effects on fish tissue from mercury; or
2. The method detection limit used in respect of mercury for the analysis of at least two of four effluent samples in a calendar year is $\geq 0.10 \mu\text{g/L}$; or
3. Effluent samples have a concentration of total selenium that is $\geq 10 \mu\text{g/L}$; or
4. Effluent samples have an annual mean concentration of total selenium $\geq 5 \mu\text{g/L}$; or
5. The method detection limit used in respect of selenium for any effluent sample is $\geq 10 \mu\text{g/L}$, or the method detection limit used in respect of selenium of at least two of four effluent samples in a calendar year is $\geq 5 \mu\text{g/L}$.

The fish tissue monitoring program of the AEMP will be coordinated with fish tissue sampling that may be required as part of Schedule 5 of the MDMER. Coordination will include the timing of sample collection, use of existing baseline data for "before" and "after" statistical comparisons, and use of data from near-field and reference sites for "impact" and "control" statistical comparisons.

8.1 PATHWAYS OF EFFECTS

Summaries of Project-related pathways of effects, mitigation measures, and potential residual effects on fish tissues at the Gordon site and MacLellan site are provided in Appendix A, Table A-9 and Table A-10, respectively. Potential changes in fish tissue metal concentrations at both sites may occur due to:

1. Discharge of existing pit water to the Hughes River (Gordon site only).
2. Discharge of pumped groundwater during construction and operation (Gordon site only).
3. Discharge of contact water during operation and decommissioning/closure.

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4. Seepage from the TMF and/or MRSA via groundwater.
5. Discharge of water from end-pit lakes during decommissioning/closure.

8.2 MITIGATION MEASURES

The mitigation measures that will be implemented to reduce potential effects to fish tissues are the same as those that will be implemented to reduce potential effects to sediment quality and benthic invertebrates and, therefore, are not repeated here.

With mitigation, potential changes in fish tissues in streams and lakes downstream of the Project are expected to be negligible. However, even with mitigation, potential changes in water quality downstream of the Gordon PDA and MacLellan PDA are predicted and, therefore, the potential exists for changes in fish tissues in streams and lakes downstream of the Project.

8.3 MONITORING

Mercury concentrations in fish tissue are not expected to increase due to the Project; mercury was not identified as a POPC in any stream or lake at the Gordon or MacLellan sites by the Surface Water Quality modelling and the Project will not result in flooding of any upland areas, a known cause of methylmercury (the toxic and bioavailable form of mercury) increases in fish tissues in northern Canada. However, Alamos understands Indigenous Nations' concerns that mercury concentrations in tissues from fish species that community members eat (e.g., northern pike, walleye, lake whitefish) are currently higher than the CCME (2000) methylmercury tissue residue guidelines for the protection of wildlife consumers of fish (i.e., 0.033 mg/kg wet weight). These guideline exceedances occur in fish from lakes downstream of the Gordon and MacLellan sites and unaffected reference lakes, indicating that mercury concentrations in fish tissues are naturally elevated in the region.

In response to Indigenous Nations' concerns, Alamos will analyze fish tissue samples collected from lakes at the Gordon and MacLellan sites (and from reference lakes) for total mercury and methylmercury. At a minimum, monitoring of methylmercury concentrations in fish tissues will occur during the first year of construction to confirm the average percentage of total mercury concentrations in fish tissue comprised of methylmercury. Methylmercury will be analyzed in fish tissue samples in subsequent years if annual average total mercury concentrations in water samples collected for effluent characterization as part of the Project's EEM plan exceed any of the mercury thresholds identified in Section 8.0 above.

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8.3.1 Sampling Locations

8.3.1.1 Gordon Site

Fish tissue monitoring sites at the Gordon site are identified in Table 8-1 and shown in Appendix B, Map B-19. Sites include Gordon Lake and Swede Lake and two reference sites (White Owl Lake and Low Lake).

Table 8-1 Fish Tissue Monitoring Locations at the Gordon Site

Sampling Location	Site ID	Fish size	Site Type
Gordon Lake	AQF2	Small-bodied	Near-field
Farley Lake ¹	AQF34A	Amphipods/mussels	Near-field
Swede Lake	AQF16	Large-bodied	Far-field
White Owl Lake	AQF13	Large-bodied	Reference ²
Low Lake ¹	AQF47	Small-bodied	Reference ³
d Farley Lake			
Notes:			
¹ amphipods and/or freshwater mussel to be sampled instead of fish in Farley Lake to protect the fish populations from depletion			
² reference site for comparison to Swede Lake			
³ reference site for comparison to Gordon Lake (brook sticklebacks) and Farley Lake (amphipods and/or freshwater mussels)			

Fish tissue monitoring is not proposed in Farley Lake, even though it will receive contact water effluent. This is because it is assumed that Farley Lake’s large-bodied fish populations (i.e., northern pike, white sucker, yellow perch, burbot) are too small to sustain the repeated lethal sampling necessary to monitor fish tissue metal concentrations through time. In 2024, Alamos investigated the potential use of amphipods (*Hyallela sp.*) and/or freshwater mussels as surrogates for monitoring changes in tissue metals concentrations in Farley Lake. It was determined that amphipods are present in Farley Lake and can be captured in a repeatable manner. While no amphipods were captured in Low Lake, , another small, headwater lake that will be the reference site for Farley Lake, freshwater mussels were abundant. Freshwater mussels were not detected in Farley Lake. Additional sampling will be conducted in Farley Lake and Low Lake to fill in these data gaps and to collect samples for initial tissue analysis from these non-fish media.

Fish tissue sampling will occur in Gordon Lake because it is known to support a population of brook sticklebacks and the density of brook sticklebacks in Gordon Lake is high enough to support repeated lethal sampling.

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Fish tissue sampling will not occur in the Hughes River even though water in the existing open pits at the Gordon site will be discharged to the Hughes River during construction. This decision was made because the duration of pit dewatering is expected to be less than three months and the pit water is expected to fully mix with water from the Hughes River within a short distance (e.g., <5 m) of the effluent pipe. Water quality, sediment quality, and benthic invertebrate monitoring in the Hughes River will be used to determine potential effects of this effluent discharge and not fish tissue for these reasons.

8.3.1.2 MacLellan Site

Fish tissue monitoring sites at the MacLellan Site are identified in Table 8-2 and shown in Appendix B, Map B-20. Sites include Payne Lake and Cockeram Lake and two reference lakes (Carr Lake and Burge Lake).

Table 8-2 Fish Tissue Monitoring Locations at the MacLellan Site

Sampling Location	Site ID	Fish size	Site Type
Payne Lake	AQM31	Small-bodied	Near-field
Minton Lake ²	AQM16	Amphipods/mussels	Near-field
Cockeram Lake	AQM9	Large-bodied	Far-field
Keewatin River (downstream of effluent pipe)	AQM42	Small-bodied	Near-field
Keewatin River (upstream of Lynn River confluence; downstream of KEE3-B1 confluence)	AQM8	Small-bodied	Far-field
Keewatin River (downstream of Lynn River confluence)	AQM29C	Small-bodied	
Keewatin River (upstream of Payne Lake outlet confluence)	AQM4	Small-bodied	Reference ³
Burge Lake	AQM23	Large-bodied	Reference ⁴
Carr Lake ¹	AQM91	Small-bodied	Reference ⁵
<p>Notes:</p> <p>¹ fish tissue sampling may be replaced by amphipod and/or freshwater mussel sampling depending on results of reconnaissance sampling conducted in 2024</p> <p>² tissue sampling would only occur if amphipod and/or freshwater mussels are found to protect the fish populations from depletion</p> <p>³ reference site for comparison to “impact” sites in the Keewatin River downstream of the effluent pipe (AQM8 and AQM20)</p> <p>⁴ reference site for comparison to Cockeram Lake</p> <p>⁵ reference site for comparison to Minton and Payne Lakes</p>			

Fish tissue monitoring is not proposed in Minton Lake, even though it may receive contact water from the TMF via groundwater seepage. This is because it is assumed that Minton Lake’s large-bodied fish populations (i.e., northern pike, white sucker, yellow perch) are too small to sustain the repeated lethal sampling necessary to monitor fish tissue metal concentrations through time. Alamos is currently investigating the potential use of amphipods (*Hyallela*) and/or freshwater mussels as a surrogate for monitoring changes in tissue metals concentrations in Minton Lake. If amphipods and/or freshwater

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mussels are found and can be captured in a repeatable manner, they will also be used at Carr Lake, another small, headwater lake that will be the reference site for Minton Lake.

Fish tissue sampling is proposed in Payne Lake because it is known only to support a population of brook sticklebacks and the density of brook sticklebacks in Payne Lake is high enough to support repeated lethal sampling.

8.3.2 Sampling Methods

8.3.2.1 Fish Species

Fish tissue samples will be collected from three large-bodied fish species in the larger lakes at the Gordon (i.e., Swede and White Owl Lakes) and MacLellan sites (i.e., Cockeram and Burge Lakes):

- Northern pike: a widely distributed, top predatory fish species known to be important to recreational anglers and local Indigenous Nations.
- White suckers: a widely distributed and abundant fish species that mainly consumes benthic invertebrates found in the sediment.
- Lake whitefish: a fish species that eats benthic invertebrates and small fish and is known to be important to recreational anglers and local Indigenous Nations. Lake whitefish have higher fat content than northern pike or white sucker and, therefore, may contain higher metal concentrations.

Lake whitefish are not present in small lakes near the Gordon site (i.e., Farley Lake, Susan Lake, Gordon Lake) and the MacLellan site (i.e., Minton Lake, Payne Lake, Carr Lake) and, therefore, cannot be used as an indicator species in these lakes.

Fish tissue samples will be collected from brook sticklebacks in Gordon Lake at the Gordon site and Payne Lake at the MacLellan site because they are the only fish species present in these lakes. Brook sticklebacks were selected because they are benthivores, are widely distributed in the Gordon and MacLellan sites, and have small home ranges. Because they do not make extensive migrations, metal concentrations in brook sticklebacks are representative of local conditions.

Slimy sculpins or longnose dace will be collected from sites in the Keewatin River. These two fish species are selected because they are known to occupy rocky riffle habitats and have small home ranges (i.e., <10 m² for slimy sculpin) throughout the year. Fish tissue samples from large-bodied fish species in the Keewatin River will not be collected because, unlike slimy sculpin and longnose dace, fish such as northern pike, white sucker, and lake whitefish are migratory and, therefore, the metals concentrations in their tissue may not accurately or consistently reflect conditions upstream and downstream of the effluent pipe in the Keewatin River.

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8.3.2.2 Sampling Gear

Northern pike, white sucker, and lake whitefish will be captured using multi-panel gillnets set in each “impact” and “reference” lake. Brook sticklebacks will be captured using baited minnow traps, small-mesh fyke nets, or backpack electrofishing. Slimy sculpin or longnose dace will be captured using backpack electrofishing in shallow, rocky riffles upstream and downstream of the effluent pipe location in the Keewatin River. Fish will be killed with a sharp blow to the head with a blunt object or euthanized with an overdose of pH buffered MS-222.

8.3.2.3 Sample Size

Based on power analyses conducted on baseline fish tissue samples, eight replicate fish tissue samples are required for each fish species from each waterbody in each year of the monitoring program to enable detection of statistically significant differences between “impact” and “reference” sites and between “before” and “after” data sets.

For each large-bodied fish species, samples will be collected from the following size classes to reduce the variability introduced by different sizes and ages of fish, particularly for parameters that bioaccumulate (i.e., mercury and selenium):

- Northern pike: 450-550 mm fork length
- White sucker: 300-400 mm fork length
- Lake whitefish: 350-450 mm fork length.

These sizes classes represent the most common length ranges of fish captured during Project baseline studies conducted in 2015 and 2016 and represent length ranges of fish that typically would be eaten by people.

8.3.2.4 Data Collection

All large-bodied fish captured for tissue analysis will be identified to species, measured for fork length, and weighed. Aging structures will be collected from each fish: cleithra from northern pike; otoliths from lake whitefish, and pectoral fins from white suckers. The following tissue samples will be collected, weighed, placed in individually labeled plastic bags, and frozen for transport to the CALA certified analytical lab in Winnipeg, Manitoba:

- Liver
- Muscle fillet
- Remaining carcass.

Samples will be a minimum of 10 grams in wet weight, the minimum required by the analytical laboratory for the list of parameters identified in Table 8-3.

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Table 8-3 Fish Tissue Analytical Parameters and Minimum Laboratory Detection Limits

Parameter	Detection Limit Objective
Moisture Content	1% wet weight
Aluminum	0.4 µg/g
Antimony	0.002 µg/g
Arsenic	0.005 µg/g
Barium	0.01 µg/g
Beryllium	0.002 µg/g
Bismuth	0.02 µg/g
Boron ¹	0.20 µg/g
Cadmium	0.002 µg/g
Calcium	2.0 µg/g
Cesium ¹	0.004 µg/g
Chromium	0.01 µg/g
Cobalt	0.004 µg/g
Copper	0.01 µg/g
Iron	1.0 µg/g
Lead	0.004 µg/g
Lithium ¹	0.20 µg/g
Magnesium	2.0 µg/g
Manganese	0.02 µg/g
Mercury (total)	0.002 µg/g
Methylmercury	0.002 µg/g
Molybdenum	0.01 µg/g
Nickel	0.01 µg/g
Phosphorus	5.0 µg/g
Potassium	10.0 µg/g
Selenium	0.02 µg/g
Silver	0.01 µg/g
Sodium	2.0 µg/g
Strontium	0.01 µg/g
Tellurium ¹	0.04 µg/g
Thallium	0.001 µg/g
Thorium ¹	0.01 µg/g
Tin	0.02 µg/g
Titanium	0.06 µg/g

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Parameter	Detection Limit Objective
Uranium	0.001 µg/g
Vanadium	0.02 µg/g
Zinc	0.1 µg/g
Zirconium ¹	06 µg/g
Note: ¹ not a parameter recommended by BC MoE (2016) but included in the ICP-MS metals suite provided by most analytical labs in Canada Source: BC Ministry of Environment (2016)	

Livers will be analyzed because they are the organ where metals are known to concentrate. Muscle fillets will be analyzed because they are the tissue most often eaten by humans. Carcasses will be analyzed because their metal content can be combined with the metal content from the other organs collected from the same individuals to determine the total average metal content in the fish. The total average metal content will measure the concentrations to which animals that tend to eat the entire fish (e.g., bears, otters, wolves) would be exposed.

Ovaries will not be collected from large-bodied fish species unless annual average concentrations of selenium in water samples collected for effluent characterization as part of the Project’s EEM Plan exceed any of the selenium thresholds identified in Section 8.0; selenium is known to concentrate in fish eggs.

Because of their smaller size, composite samples of brook sticklebacks will be collected from Gordon Lake and Payne Lake. Each composition sample will be comprised of enough fish to achieve the minimum laboratory sample weight of 10 g to conduct the analyses required. Composite samples will be weighed, placed in individually labeled plastic bags, and frozen for transport to the CALA certified analytical lab in Winnipeg, Manitoba. Similar composite samples of slimy sculpin and/or longnose dace will be collected from sites in the Keewatin River.

8.3.2.5 Laboratory Analysis

The liver, muscle fillet, and carcass samples from all fish species will be analyzed in a CALA certified laboratory for the parameters shown in Table 8-3. the same list of parameters analyzed for during baseline studies plus methylmercury. This parameter list includes the five parameters identified in Section 6.3.2 of the federal Decision Statement regarding country foods: arsenic, copper, mercury, methylmercury, and selenium.

The Project was not predicted to be a significant source of inorganic mercury and was not predicted to be a POPC in any stream or lake at the Gordon or MacLellan sites. Additionally, the Project will not result in flooding of any upland areas, a known cause of elevated methylmercury concentrations in fish tissues in northern Canada. However, Alamos acknowledges the concerns expressed by many potentially affected Indigenous Nations’ about methylmercury concentrations in tissues of fish species that community members eat (e.g., northern pike, lake whitefish). Methylmercury concentrations in these species are currently higher than the CCME (2000) methylmercury tissue residue guidelines for the protection of wildlife

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consumers of fish (i.e., 0.033 mg/kg wet weight) and Indigenous Nations are concerned that the Project could increase methylmercury concentrations in these fish species. In response to Indigenous Nations' concerns, Alamos will analyze tissue samples from large-bodied fish species (i.e., northern pike, lake whitefish, and white suckers) collected from Swede Lake and White Owl Lake (reference lake for comparison to Swede Lake) at the Gordon site and from Cockeram Lake and Burge Lake (reference lake for Cockeram Lake) at the MacLellan site for methylmercury concentrations.

Fish tissue samples will be analyzed for total arsenic concentrations during the first three years of the AEMP (i.e., Year -2, Year 1, and Year 4). Fish tissue samples will be analyzed for different arsenic species in subsequent years if total arsenic concentrations in fish tissues at "impact" sites are found to be significantly higher than total arsenic concentrations in fish tissues at "control" sites.

Metal and metalloids will be analyzed using high resolution ICP-MS except for total mercury and methylmercury which will be analyzed using Cold Vapour Atomic Fluorescence Spectrometry. All laboratory results will be reported as wet weight. Moisture content of all fish tissue samples will be analyzed by the lab so that dry weight concentrations can be calculated for comparison to dry weight guidelines (i.e., selenium).

8.3.3 Data Analysis

Power analyses will be performed on the existing fish tissue data collected from northern pike, lake whitefish, white suckers, and brook sticklebacks in the Gordon and MacLellan in 2015 and 2016 to determine the minimum sample sizes required to detect statistically significant differences greater than a CES of two standard deviations of the reference mean in POPC concentrations and/or parameters with tissue guidelines, in the following tissues and fish species:

- Liver, muscle, and whole-body tissues in northern pike and lake whitefish: fluoride, phosphorus, aluminum, arsenic, cadmium, copper, lead, mercury, and selenium.
- Ovaries in female northern pike and lake whitefish: selenium.
- Whole body tissues for brook sticklebacks: fluoride, phosphorus, aluminum, arsenic, cadmium, copper, lead, mercury, and selenium.

The initial step for the tissue metals analysis will be to summarize results by species, tissue type, parameter, and location by calculating the following metrics:

- Number of samples.
- Mean, median, minimum, and maximum concentrations.
- Standard deviation and standard error of the mean concentration.
- Number of non-detects (i.e., samples with parameter concentrations below the laboratory detection limit).
- Number of samples with parameter concentrations above applicable tissue quality guidelines.

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Statistically significant differences ($p < 0.05$), greater than two standard deviations ($> 2SD$) from the mean, between fish tissue concentrations collected from “impact” and “control” sites will be determined using ANCOVA with fork length as a covariate. Alternatively, trend analysis will be used to determine if there are statistically significant differences between the slopes of the regression lines representing the change in fish tissue concentrations at “impact” and “reference” sites through time. Exploratory plots will be generated to visually examine the data for outliers or notable trends.

Mean and maximum concentrations will be compared with applicable guidelines for the protection of human consumers of fish (i.e., arsenic, mercury, and lead), for the protection of wildlife consumers of life (i.e., methylmercury), and for the protection of freshwater aquatic life (i.e., selenium) as shown in Table 8-4. Methylmercury concentrations will be predicted as representing 90% of the total mercury concentrations in fish tissues. Selenium concentrations in eggs will not be compared with the egg/ovary selenium guideline until the collection of ovary samples from large-bodied fish species is required because selenium concentrations in the effluent exceed the Schedule 5 MDMER thresholds identified in Section 8.0.

Table 8-4 Tissue Metal Guidelines

Metal	Guideline Concentration for the Protection of Human Consumers	Guideline Concentration for the Protection of Wildlife Consumers	Guideline Concentration for the Protection of Freshwater Aquatic Life
Arsenic ¹	3.5 mg/kg wet weight	-	-
Lead ¹	0.5 mg/kg wet weight	-	-
Mercury ¹	0.5 mg/kg wet weight	-	-
Methylmercury ³	-	0.033 mg/kg wet weight	-
Selenium ²	-	-	4 mg/kg dry weight ⁴ 11 mg/kg dry weight ⁵
Notes: ¹ MWS 2011 ² BC MOE 2017 ³ CCME 2000 ⁴ Whole body and muscle tissues ⁵ Eggs/ovaries			

Results will be compared with the guidelines to count the number of exceedances. For selenium, lab results will be converted to dry weight from wet weight for comparison with the guideline, using the percent moisture value for that sample measured by the laboratory, using the formula:

$$Weight_{Dry} = \left(\frac{Weight_{Wet}}{100 - Moisture} \right) \times 100$$

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8.3.4 Sampling Schedule

Fish tissue sampling will be conducted in summer or early fall and samples will be collected on a three-year cycle over the life of the mine until the conclusion of decommissioning/closure activities. This sample timing and frequency is consistent with fish tissue sampling schedule for the separate, but related, federal EEM program.

When and where possible, fish tissue monitoring will be undertaken in conjunction with water quality, sediment quality, and benthic invertebrate sampling to maximize sampling efficiency and to limit spatial variability when correlating metal concentrations among media.

Table 8-5 summarizes the schedule for the fish tissue monitoring component of the AEMP during each Project phase.

Table 8-5 Fish Tissue Monitoring Schedule

Monitoring Activity	Frequency			
	Construction	Operation	Decommissioning/ Closure	Post-Closure
Gordon Site				
"Impact" and "Reference" sites	Year -2	Years 1, 4	Years 7, 10	Year 13
MacLellan Site				
"Impact" and "Reference" sites	Year -2	Years 1, 4, 7, 10, 13	Years 16, 19, 22	Year 25

8.4 METRICS AND THRESHOLDS FOR ADAPTIVE MANAGEMENT

The identification of biologically significant ($p < 0.05$) changes in fish tissue concentrations for the POPCs identified by the Surface Water Quality models at the Gordon site (i.e., fluoride and phosphorus) and the MacLellan site (i.e., aluminum, arsenic, cadmium, copper, and fluoride) and the parameters with federal or provincial tissue guidelines (i.e., arsenic, fluoride, lead, mercury, methylmercury, and selenium) will be the metrics and thresholds used to trigger adaptive management. A biologically significant change will be defined as:

- A statistically significant difference ($p < 0.05$) in mean tissue concentrations at "impact" sites (for the parameters identified above) that is greater than two standard deviations ($>2SD$) of the mean at "reference" sites; or
- A statistically significant difference ($p < 0.05$) in mean tissue concentrations at "impact" sites (for the parameters identified above) that is greater than two standard deviations ($>2SD$) of the baseline ("before" construction) mean over at least two sampling periods "after" construction of the Project; and

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- Mean concentrations exceeds federal or provincial fish tissue guidelines in the following samples:
 - northern pike, lake whitefish, or white sucker muscle tissues: arsenic, lead, mercury
 - northern pike, lake whitefish, or white sucker ovaries or muscle tissues: selenium
 - brook stickleback, slimy sculpin, or longnose dace whole bodies: arsenic, lead, mercury, selenium.

Mean arsenic, lead, and total mercury concentrations from samples collected in 2015 and 2016 did not exceed federal or provincial guidelines for the protection of human consumers of fish. However, conservatively assuming methylmercury concentrations comprised 100% of the total mercury concentrations in baseline fish tissue concentrations, mean methylmercury concentrations in northern pike, lake whitefish, white sucker, and brook stickleback tissue samples currently exceed the federal methylmercury tissue guideline for the protection of wildlife consumers of fish (0.033 mg/kg wet weight). Therefore, adaptive management will not be triggered by the methylmercury tissue guideline for this AEMP; adaptive management would only be triggered by statistically significant differences in methylmercury concentrations between “impact” and “reference” sites or between “before” and “after” samples at “impact” sites.

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9.0 ADAPTIVE MANAGEMENT

9.1 APPROACH

Adaptive management is a planned process for responding to uncertainty or to an unanticipated or underestimated Project effect. Information learned from monitoring Project effects will be compared with predicted effects. Where a variance between the actual and predicted effects occurs or a statistically significant and ecologically relevant difference between “before” and “after” data and/or “impact” and “reference” sites exists, a determination will be made as to whether modifications to existing mitigation measures or additional mitigation measures are required. Results from the AEMP will be used to adjust mitigation measures, add additional mitigation, and/or modify management and monitoring plans on an ongoing basis, if required, through this adaptive management process.

Adaptive management will be used to identify, assess the environmental significance of, and as appropriate, respond to an effect of the Project on fish and fish habitat beyond that predicted in the EIS or in exceedance of a regulated guideline and/or adaptive management threshold. Aspects of the adaptive management framework for this AEMP are:

- Risk narrative: description of the component and potential environmental effect and/or conditions that implementation of the adaptive management plan will limit.
- Monitoring locations, methods, and schedule.
- End-point metrics to be monitored and assessed.
- Trigger threshold: a specific threshold that initiates action when exceeded to allow timely and informative responses to be initiated before higher potential effects are observed.
- Response actions: actions to be implemented should a threshold be exceeded.
- Reporting and review: a plan to report Project-related threshold exceedances to the appropriate regulatory authorities, Indigenous Nations, and stakeholders.

This adaptive management framework allows for a systematic approach to data evaluation and identification of actions that are commensurate with the degree of risk posed to fish and fish habitat by the magnitude of change between “impact” and “reference” sites and between “before” and “after” data at “impact” sites through time. Metrics that are elevated above thresholds and that indicate a higher degree of risk to fish and fish habitat will be given priority and a more robust response compared with metrics that are not statistically different than reference data or not above a threshold. Metrics that are found to be increasing different than reference data through time will be monitored and acted upon as necessary. The nature of the response will be dictated by the nature of the effect and will be developed in consultation with the relevant federal and provincial regulators and the EAC. As indicated in the sections above, only exceedances of the trigger thresholds identified for benthic invertebrate metrics, fish habitat metrics, and fish tissue metrics will be used to initiate changes or additions to mitigation measures intended to protect

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fish and fish habitat; exceedances of sediment quality metrics, chlorophyll a concentration metrics, and fish population metrics will be used only to initiate additional monitoring.

Adaptive management will follow the following hierarchy:

1. Confirmation of effect (e.g., statistical validation of result, laboratory and field data QA/QC, follow-up sampling to confirm original result)
2. Investigation of cause (i.e., identifying and evaluating the potential causes of the observed effect)
3. Assessment of magnitude and geographic extent of observed effects
4. Corrective Actions

9.2 CORRECTIVE ACTIONS

Excluding unavoidable habitat losses under the Project footprints at the Gordon and MacLellan sites, impacts that will be counterbalanced by measures in the Fish Habitat Offsetting Plan, potential effects to sediment quality, benthic invertebrate communities, chlorophyll *a* concentrations, fish habitat, fish populations, and fish tissue contaminant concentrations at the Gordon and MacLellan sites may be caused by changes in water quality (including metals and nutrient concentrations), changes in water quantity (including water levels in lakes and flows in streams), changes in water temperature, and changes in underwater noise from blasting. As such, the corrective actions available to mitigate any observed changes in the media or biotic communities included in this AEMP involve actions to mitigate changes in water quality, water quantity, water temperature, or underwater noise.

The first response to any observed exceedance of a threshold identified in this AEMP will be to assess, and modify as necessary, the mitigation measures identified in Section 3.2, 4.2, 5.2, 6.2, 7.2 and 8.2 of this AEMP (as summarized from Chapters 8 (Groundwater), 9 (Surface Water), and 10 (Fish and Fish Habitat) of the EIS). These actions may include rectifying improperly implemented mitigation measures, adding more of the same mitigation measure, or replacing the existing mitigation with a different type of mitigation.

After observation and monitoring of these initial corrective actions, additional corrective actions may be implemented should monitoring show that thresholds continue to be exceeded. These additional corrective actions may include, but are not necessarily limited to:

- Reducing the pumping rates or discharge locations of the groundwater interceptor wells at the Gordon site during construction and operation.
- Adjusting the pumping rates of the groundwater interceptor wells at the Gordon site during decommissioning/closure to increase or decrease inflow to the open pit and increase or decrease flows in Farley Creek.
- Increasing the depth and/or size of collection ponds to increase retention times necessary to reduce temperature differences between groundwater and lakes at the Gordon site or installation of heat-exchangers.

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- Increasing the depth of seepage collection ditches to increase the capture of TMF and/or MRSA seepage otherwise reporting to surrounding lakes and streams.
- Treating collection pond effluent or discharging collection pond effluent to the Hughes River at the Gordon site.
- Treating collection pond effluent at the MacLellan site.
- Treating (i.e., fertilizing) pit water to promote stratification during pit filling.
- Replacing closed-bottom culverts with open-bottom culverts or clear-span bridges.
- Modifying charge sizes, stemming volumes, or delays used for blasting in the open pits, as required.
- Ceasing blasting outside of the reduced risk timing window for fish species at the Gordon and MacLellan sites.
- Ceasing water withdrawals from Farley Lake.

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Reporting
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10.0 REPORTING

Alamos will prepare reports summarizing the methods and results of the monitoring activities conducted at the end of each year of the AEMP. The reports will describe how monitoring activities complied with the approval-related requirements outlined in Section 1.5.4 and will include, but not be limited to:

- Tables and graphs summarizing results spatially and temporally (if data are available).
- Statistical analyses based on BACI and/or gradient study designs.
- Lab results and QA/QC information.
- Comparison of data to end-point metric thresholds.
- Any necessary corrective actions.

Reports will comment on the accuracy of the environmental assessment predictions, as warranted, and provide any recommendations for modifying the AEMP study design, sampling methods, data analysis, or timing that may become evident as the AEMP progresses.

To comply with approval-related requirements, reports will include a plain language executive summary in both official languages and will be submitted no later than March 31 following the reporting year to which the report applies or as soon as possible for those media dependent on laboratory results. Draft reports will be submitted to the appropriate federal and provincial regulatory agencies and the EAC. Final reports will be posted to Alamos's website.

Investigations completed due to an end-point metric threshold exceedance will be documented in stand-alone reports. The threshold exceedance and notifications of an investigation of cause will be documented in the AEMP reports.

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Table A-1 Project Pathway of Effects, Mitigation Measures, and Potential Residual Effects to Sediment Quality at the Gordon Site

Potential Pathway of Effect	Mine Phase	Mitigation	Predicted Residual Effect after Mitigation	Monitoring Included in AEMP (Yes/No)
Release of sediment during site preparation, construction of ore pads, overburden stockpile and MRSA areas, access roads, the diversion channel, and water management facilities.	Construction	<ul style="list-style-type: none"> • Grading perimeter and access roads to divert runoff away from the open pits and fish-bearing waterbodies. • Maintaining access roads by periodically regrading and ditching to improve water flow and reduce erosion. • Using dust suppression measures for exposed ground areas within the PDA during dry periods as necessary to reduce dust deposition to surface waters. • Designing collection pond inlets and outlets to reduce water velocities, scour (erosion of sediment) and pond stratification. • Implementing sediment and erosion control measures to limit the release of TSS and turbidity in lakes and streams. 	Negligible effect on sediment quality after mitigation measures.	No ¹
Release of POPCs during dewatering of Wendy and East pits.	Construction	<ul style="list-style-type: none"> • Aerating Wendy and East pits to encourage precipitation of elements that form oxides (e.g., iron oxide), to break down thermal and chemical stratification and to increase dissolved oxygen concentrations prior to dewatering. 	Negligible effect on sediment quality after mitigation measures.	No
Discharge of contact water, including blast residues and accumulated groundwater in the open pit and run-off from the MRSA, ore stockpile, and overburden stockpile.	Construction and Operation	<ul style="list-style-type: none"> • Constructing non-contact water ditches upslope of overburden stockpiles, MRSAs, ore stockpiles, and mine infrastructure to reduce contact water volumes. • Constructing contact water collection ditches around the MRSAs, overburden stockpiles, and ore stockpiles to convey the 1:25-year storm event to collection ponds. • Constructing contact water collection ponds to contain (without discharge) run-off from a 1:100-year storm event with active storage that considers maximum ice thickness in winter. 	Negligible effect on sediment quality after mitigation measures.	Yes

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Potential Pathway of Effect	Mine Phase	Mitigation	Predicted Residual Effect after Mitigation	Monitoring Included in AEMP (Yes/No)
The release of sediment during stockpiling of ore, overburden, and mine rock and maintenance of access roads.	Operation	<ul style="list-style-type: none"> Grading perimeter and access roads to divert runoff away from the open pits and fish-bearing waterbodies. Maintaining access roads by periodically regrading and ditching to improve water flow and reduce erosion. Using dust suppression measures for exposed ground areas within the PDA during dry periods as necessary to reduce dust deposition to surface waters. Designing collection pond inlets and outlets to reduce water velocities, scour (erosion of sediment) and pond stratification potential (chemical or thermal). Implementing sediment and erosion control measures to limit the release of TSS and turbidity in lakes and streams. 	Negligible effect on sediment quality after mitigation measures.	Yes
The release of sediment during reclamation of the overburden stockpiles, ore stockpiles, and MRSA.	Decommission, Reclamation, and Closure	<ul style="list-style-type: none"> Implementing progressive rehabilitation (placement of a vegetated soil cover) of the overburden and MRSAs to reduce infiltration rates. 	Negligible effect on sediment quality after mitigation measures.	Yes
Release of POPCs during overflow from the open pit to Farley Lake at post-closure.	Decommission, Reclamation, and Closure	<ul style="list-style-type: none"> Implementing passive treatment options (e.g., controlled pit stratification, fertilizer amendment, flow segregation) in the open pit should monitoring show that pit water quality is not suitable for release to the environment during the approximately 21 years anticipated to fill the open pit with water at the conclusion of operation. 	Negligible effect on sediment quality after mitigation measures.	Yes
Release of POPCs during discharge of groundwater pumped from the groundwater interceptor wells installed between the open pit and Gordon Lake and Farley Lake.	Construction, Operation, and Decommission, Reclamation, and Closure	<ul style="list-style-type: none"> Aerating groundwater from the interceptor wells in collection ponds to encourage iron precipitation and increase dissolved oxygen concentrations prior to discharge to Gordon Lake and Farley Lake. 	Negligible effect on sediment quality after mitigation measures.	Yes
<p>Note: ¹ monitored as part of Surface Water Management and Monitoring Plan (SWMMP)</p>				

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Table A-2 Project Pathway of Effects, Mitigation Measures, and Residual Effects in Sediment Quality at the MacLellan Site

Potential Pathway of Effect	Mine Phase	Mitigation	Predicted Residual Effect after Mitigation	Monitoring Included in AEMP (Yes/No)
Release of sediment during site preparation, construction of ore pads, overburden stockpile and MRSA areas, access roads, the TMF, and water management facilities.	Construction	<ul style="list-style-type: none"> • Grading perimeter and access roads to divert runoff away from the open pits and fish-bearing waterbodies. • Maintaining access roads by periodically regrading and ditching to improve water flow and reduce erosion. • Using dust suppression measures for exposed ground areas within the PDA during dry periods as necessary to reduce dust deposition to surface waters. • Designing collection pond inlets and outlets to reduce water velocities, scour (erosion of sediment) and pond stratification. • Implementing sediment and erosion control measures to limit the release of TSS and turbidity in lakes and streams. 	Negligible effect on sediment quality after mitigation measures.	No ¹
Release of sediment and POPCs during dewatering of the existing underground mine workings during construction.	Construction	<ul style="list-style-type: none"> • Pumping water from the existing underground works to the TMF for storage and eventual use in the processing facility. • Implementing sediment and erosion control measures during construction to limit the release of TSS and turbidity in lakes and streams. 	Negligible effect on sediment quality after mitigation measures.	No ¹

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Potential Pathway of Effect	Mine Phase	Mitigation	Predicted Residual Effect after Mitigation	Monitoring Included in AEMP (Yes/No)
Discharge of contact water, including blast residues and accumulated groundwater in the open pit and run-off from the MRSA, ore stockpile, TMF, overburden stockpile and mine infrastructure, during construction and operation.	Construction and Operation	<ul style="list-style-type: none"> • Constructing non-contact water ditches upslope of overburden stockpiles, MRSAs, ore stockpiles, TMF, and mine infrastructure to reduce contact water volumes. • Constructing contact water collection ditches around the MRSAs, overburden stockpiles, TMF, and ore stockpiles to convey the 1:25-year storm event to collection ponds. • Constructing contact water collection ponds to contain (without discharge) run-off from a 1:100-year storm event with active storage that considers maximum ice thickness in winter. • Operating the TMF as a non-discharging facility during operation through reclaiming TMF water for use in the ore processing mill. • Using a closed circuit for cyanide use and cyanide destruction in the processing plant (via Air/SO₂ oxidation and precipitation of metals) to reduce cyanide concentrations in tailings slurry prior to release of the slurry for storage in the TMF 	Negligible effect on sediment quality after mitigation measures.	Yes
Release of sediment during stockpiling of ore, overburden, and mine rock and maintenance of access roads during operation.	Operation	<ul style="list-style-type: none"> • Grading perimeter and access roads to divert runoff away from the open pits and fish-bearing waterbodies. 	Negligible effect on sediment quality after mitigation measures.	Yes
Release of sediment during reclamation of the overburden stockpiles, ore stockpiles, MRSAs, and TMF.	Decommission, Reclamation, and Closure	<ul style="list-style-type: none"> • Maintaining access roads by periodically regrading and ditching to improve water flow and reduce erosion. • Using dust suppression measures for exposed ground areas within the PDA during dry periods as necessary to reduce dust deposition to surface waters. • Implementing sediment and erosion control measures during construction to limit the release of TSS and turbidity in lakes and streams. 		

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Potential Pathway of Effect	Mine Phase	Mitigation	Predicted Residual Effect after Mitigation	Monitoring Included in AEMP (Yes/No)
Release of POPCs due to seepage from the TMF during operation and decommissioning/closure.	Operation and Decommission, Reclamation, and Closure	<ul style="list-style-type: none"> Constructing groundwater cut-off ditches to reduce the volume of groundwater seepage from the TMF post-closure. 	Negligible effect on sediment quality after mitigation measures.	Yes
Release of POPCs during overflow from the open pit to the Keewatin River tributary (KEE3-B1), and ultimately the Keewatin River, when the flooded open pit overflows during post-closure.	Decommission, Reclamation, and Closure	<ul style="list-style-type: none"> Implementing passive treatment options (e.g., controlled pit stratification, fertilizer amendment, flow segregation) in the open pit should monitoring show that pit water quality is not suitable for release to the environment during the approximately 21 years anticipated to fill the open pit with water at the conclusion of operation. 	Short-term exceedances of surface water quality POPCs are predicted to occur.	Yes
Discharge of effluent from the wastewater treatment plant.	Construction, Operation, and Decommission, Reclamation, and Closure	<ul style="list-style-type: none"> Treating domestic waste in a sewage treatment plant so that it meets the Wastewater Systems Effluent Regulations under the Fisheries Act and the MWQSOG (2002) prior to discharge to the Keewatin River via a pipeline and diffuser. 	Negligible effect on sediment quality after mitigation measures.	Yes
<p>Note: ¹ monitored as part of Surface Water Management and Monitoring Plan (SWMMP)</p>				

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Table A-3 Project Pathway of Effects, Mitigation Measures, and Residual Effects on Benthic Invertebrates at the Gordon Site

Potential Pathway of Effect	Mine Phase	Mitigation	Predicted Residual Effect after Mitigation	Monitoring Included in AEMP (Yes/No)
Release of sediment during site preparation, construction of ore pads, overburden stockpile and MRSA areas, access roads, the diversion channel, and water management facilities.	Construction	<ul style="list-style-type: none"> Grading perimeter and access roads to divert runoff away from the open pits and fish-bearing waterbodies. Maintaining access roads by periodically regrading and ditching to improve water flow and reduce erosion. Using dust suppression measures for exposed ground areas within the PDA during dry periods as necessary to reduce dust deposition to surface waters. Designing collection pond inlets and outlets to reduce water velocities, scour (erosion of sediment) and pond stratification. Implementing sediment and erosion control measures to limit the release of TSS and turbidity in lakes and streams. 	Negligible effect on benthic invertebrates after mitigation measures.	Yes
Release of POPCs during dewatering of Wendy and East pits.	Construction	<ul style="list-style-type: none"> Aerating Wendy and East pits to encourage precipitation of elements that form oxides (e.g., iron oxide), to break down of thermal and chemical stratification, and to increase dissolved oxygen concentrations prior to dewatering. Discharging pit water to the Hughes River instead of Farley Lake 	Negligible effect on benthic invertebrates after mitigation measures.	Yes
Discharge of contact water, including blast residues and accumulated groundwater in the open pit and run-off from the MRSA, ore stockpile, and overburden stockpile.	Construction and Operation	<ul style="list-style-type: none"> Constructing non-contact water ditches upslope of overburden stockpiles, MRSAs, ore stockpiles, and mine infrastructure to reduce contact water volumes. Constructing contact water collection ditches around the MRSAs, overburden stockpiles, and ore stockpiles to convey the 1:25-year storm event to collection ponds. Constructing contact water collection ponds to contain (without discharge) run-off from a 1:100-year storm event with active storage that considers maximum ice thickness in winter. 	Negligible effect on benthic invertebrates after mitigation measures.	Yes

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Potential Pathway of Effect	Mine Phase	Mitigation	Predicted Residual Effect after Mitigation	Monitoring Included in AEMP (Yes/No)
The release of sediment during stockpiling of ore, overburden, and mine rock and maintenance of access roads.	Operation	<ul style="list-style-type: none"> Grading perimeter and access roads to divert runoff away from the open pits and fish-bearing waterbodies. Maintaining access roads by periodically regrading and ditching to improve water flow and reduce erosion. Using dust suppression measures for exposed ground areas within the PDA during dry periods as necessary to reduce dust deposition to surface waters. Designing collection pond inlets and outlets to reduce water velocities, scour (erosion of sediment) and pond stratification potential (chemical or thermal). Implementing sediment and erosion control measures to limit the release of TSS and turbidity in lakes and streams. 	Negligible effect on benthic invertebrates after mitigation measures.	Yes
The release of sediment during reclamation of the overburden stockpiles, ore stockpiles, and MRSA.	Decommission, Reclamation, and Closure	<ul style="list-style-type: none"> Implementing progressive rehabilitation (placement of a vegetated soil cover) of the overburden and MRSAs to reduce infiltration rates. 	Negligible effect on benthic invertebrates after mitigation measures.	Yes
Release of POPCs during overflow from the open pit to Farley Lake at post-closure.	Decommission, Reclamation, and Closure	<ul style="list-style-type: none"> Implementing passive treatment options (e.g., controlled pit stratification, fertilizer amendment, flow segregation) in the open pit should monitoring show that pit water quality is not suitable for release to the environment during the approximately 21 years anticipated to fill the open pit with water at the conclusion of operation. 	Negligible effect on benthic invertebrates after mitigation measures.	Yes
Release of POPCs during discharge of groundwater pumped from the groundwater interceptor wells installed between the open pit and Gordon Lake and Farley Lake.	Construction, Operation, and Decommission, Reclamation, and Closure	<ul style="list-style-type: none"> Aerating groundwater from the interceptor wells in collection ponds to encourage iron precipitation and increase dissolved oxygen concentrations prior to discharge to Gordon Lake and Farley Lake. 	Negligible effect on benthic invertebrates after mitigation measures.	Yes

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Table A-4 Project Pathway of Effects, Mitigation Measures, and Residual Effects on Benthic Invertebrates at the MacLellan Site

Potential Pathway of Effect	Mine Phase	Mitigation	Predicted Residual Effect after Mitigation	Monitoring Included in AEMP (Yes/No)
Release of sediment during site preparation, construction of ore pads, overburden stockpile and MRSA areas, access roads, the TMF, and water management facilities.	Construction	<ul style="list-style-type: none"> • Grading perimeter and access roads to divert runoff away from the open pits and fish-bearing waterbodies. • Maintaining access roads by periodically regrading and ditching to improve water flow and reduce erosion. • Using dust suppression measures for exposed ground areas within the PDA during dry periods as necessary to reduce dust deposition to surface waters. • Designing collection pond inlets and outlets to reduce water velocities, scour (erosion of sediment) and pond stratification. • Implementing sediment and erosion control measures to limit the release of TSS and turbidity in lakes and streams. 	Negligible effect on benthic invertebrates after mitigation measures.	Yes
Release of sediment and POPCs during dewatering of the existing underground mine workings during construction.	Construction	<ul style="list-style-type: none"> • Pumping water from the existing underground works to the TMF for storage and eventual use in the processing facility. • Implementing sediment and erosion control measures during construction to limit the release of TSS and turbidity in lakes and streams. 	Negligible effect on benthic invertebrates after mitigation measures.	Yes

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Potential Pathway of Effect	Mine Phase	Mitigation	Predicted Residual Effect after Mitigation	Monitoring Included in AEMP (Yes/No)
Discharge of contact water, including blast residues and accumulated groundwater in the open pit and run-off from the MRSA, ore stockpile, TMF, overburden stockpile and mine infrastructure, during construction and operation.	Construction and Operation	<ul style="list-style-type: none"> • Constructing non-contact water ditches upslope of overburden stockpiles, MRSAs, ore stockpiles, TMF, and mine infrastructure to reduce contact water volumes. • Constructing contact water collection ditches around the MRSAs, overburden stockpiles, TMF, and ore stockpiles to convey the 1:25-year storm event to collection ponds. • Constructing contact water collection ponds to contain (without discharge) run-off from a 1:100-year storm event with active storage that considers maximum ice thickness in winter. • Operating the TMF as a non-discharging facility during operation through reclaiming TMF water for use in the ore processing mill. • Using a closed circuit for cyanide use and cyanide destruction in the processing plant (via Air/SO₂ oxidation and precipitation of metals) to reduce cyanide concentrations in tailings slurry prior to release of the slurry for storage in the TMF. 	Negligible effect on benthic invertebrates after mitigation measures.	Yes
Release of sediment during stockpiling of ore, overburden, and mine rock and maintenance of access roads during operation.	Operation	<ul style="list-style-type: none"> • Grading perimeter and access roads to divert runoff away from the open pits and fish-bearing waterbodies. • Using dust suppression measures for exposed ground areas within the PDA during dry periods as necessary to reduce dust deposition to surface waters. • Maintaining access roads by periodically regrading and ditching to improve water flow and reduce erosion. • Implementing sediment and erosion control measures during construction to limit the release of TSS and turbidity in lakes and streams. • Constructing groundwater cut-off ditches to reduce the volume of groundwater seepage from the TMF post-closure. 	Negligible effect on benthic invertebrates after mitigation measures.	Yes
Release of sediment during reclamation of the overburden stockpiles, ore stockpiles, MRSAs, and TMF.	Decommission, Reclamation, and Closure			

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Potential Pathway of Effect	Mine Phase	Mitigation	Predicted Residual Effect after Mitigation	Monitoring Included in AEMP (Yes/No)
Release of POPCs due to seepage from the TMF during operation and decommissioning/closure.	Decommission, Reclamation, and Closure	<ul style="list-style-type: none"> Constructing groundwater cut-off ditches to reduce the volume of groundwater seepage from the TMF post-closure. 	Negligible effect on benthic invertebrates after mitigation measures.	Yes
Release of POPCs during overflow from the open pit to the Keewatin River tributary (KEE3-B1), and ultimately the Keewatin River, when the flooded open pit overflows during post-closure.	Decommission, Reclamation, and Closure	<ul style="list-style-type: none"> Implementing passive treatment options (e.g., controlled pit stratification, fertilizer amendment, flow segregation) in the open pit should monitoring show that pit water quality is not suitable for release to the environment during the approximately 21 years anticipated to fill the open pit with water at the conclusion of operation. 	Short-term exceedances of surface water quality and POPCs are predicted to occur.	Yes
Discharge of effluent from the wastewater treatment plant during construction, operation, and decommissioning/closure.	Construction, Operation, and Decommission, Reclamation, and Closure	<ul style="list-style-type: none"> Treating domestic waste in an average 0.0007 m³/s (i.e., 60,000 L/day) sewage treatment plant so that it meets the Wastewater Systems Effluent Regulations under the Fisheries Act and the MWQSOG (2002) prior to discharge to the Keewatin River via a pipeline and diffuser. 	Negligible effect on benthic invertebrates after mitigation measures.	Yes

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Table A-5 Project Pathway of Effects, Mitigation Measures, and Residual Effects in Fish Habitat at the Gordon Site

Potential Pathway of Effect	Mine Phase	Mitigation	Predicted Residual Effect after Mitigation	Monitoring Included in AEMP (Yes/No)
Change in surface flows due to construction and operation of water management facilities (sumps, ponds, and ditches)	Construction	<ul style="list-style-type: none"> Limiting the construction footprint to the extent possible to reduce potential reductions in groundwater recharge, limit the number of watercourses overprinted by the PDA, and limit the extent of changes to catchment area runoff due to encroachment of the PDA into various watersheds. Constructing upstream perimeter ditches to divert non-contact water around Project components, reporting to the original receiving environments Using standard construction methods such as seepage cut-off collars, where trenches extend below the water table, to mitigate preferential flow paths. 	Negligible effect on fish habitat after mitigation	No ¹
Change in habitat at road crossings requiring upgrading along the Gordon site access road	Construction	<ul style="list-style-type: none"> Sizing new culverts to convey the 1:100-year flood and using open-bottom structures where practical to maintain fish habitat values and fish passage. New road crossings will be sized and installed following Manitoba Infrastructure guidelines (DFO and MNR 1996). 	Negligible effect on fish habitat after mitigation	Yes
Change in habitat in Farley Lake due to construction of the freshwater intake and collection pond and groundwater interceptor well effluent pipes.	Construction	<ul style="list-style-type: none"> Pipes will extend to the deepest part of Gordon and Farley lakes, away from weed beds or other habitat features that would attract fish. Installing intake pipes pointed upwards and away from sediment. Constructing and operating groundwater interceptor wells on either side of the open pit to capture and return groundwater and surface water to Gordon and Farley lakes that would otherwise flow into the open pit. 	Negligible effect on fish habitat after mitigation because of their small in-water footprints, their placement away from habitats that would attract fish, and the relatively small spatial and short temporal alteration of riparian habitat at the installation locations.	No
Change in habitat in Gordon Lake due to construction of the groundwater interceptor well effluent pipe.	Construction			
Change in physical habitat at effluent diffuser in Farley Lake.	Construction			

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Potential Pathway of Effect	Mine Phase	Mitigation	Predicted Residual Effect after Mitigation	Monitoring Included in AEMP (Yes/No)
Change in water levels in Gordon Lake and Farley Lake due to changes in the groundwater table as the open pit is developed.	Operation	<ul style="list-style-type: none"> Installing and operating groundwater interceptor wells between the open pit and Gordon Lake and Farley Lake to maintain water levels in Gordon and Farley lakes. 	Predicted changes in water level in Gordon Lake and Farley Lake are not expected to have a measurable effect on fish habitat. However, predicted changes in water level in Gordon Lake and Farley Lake are not expected to have a measurable effect on fish habitat.	No ¹
Change in flows in Farley Creek due to operation of groundwater interceptor wells.	Operation	<ul style="list-style-type: none"> Installing and operating groundwater interceptor wells between the open pit and Gordon Lake and Farley Lake to maintain water levels in Gordon and Farley lakes. 	Predicted flow changes in Farley Creek are above those considered likely to have a low probability (<10% change in instantaneous flow). However, changes in stream flows are not expected to have a measurable effect on fish habitat because of the stream morphology and geometry of Farley Creek.	Yes

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Potential Pathway of Effect	Mine Phase	Mitigation	Predicted Residual Effect after Mitigation	Monitoring Included in AEMP (Yes/No)
Change in water levels in Farley Lake and flows in Farley Creek due to release of contact water from the collection pond.	Operation	<ul style="list-style-type: none"> • Constructing non-contact water ditches upslope of overburden stockpiles, MRSAs, ore stockpiles, mine infrastructure and the TMF to reduce contact water volumes. • Constructing contact water collection ditches around the MRSAs, overburden stockpiles, and ore stockpiles to convey the 1:25-year storm event to collection ponds. • Constructing contact water collection ponds to contain (without discharge) run-off from a 1:100-year storm event with active storage that considers maximum ice thickness in winter. • Trucking potable water to the Gordon site from the MacLellan site to limit the freshwater withdrawal requirements at the Gordon site to those needed for fire suppression, safety showers, and truck washes. 	<p>Predicted flow changes in Farley Creek are expected to be moderate magnitude (between 10% and 30% relative change from existing conditions). However, changes in stream flows are not expected to have a measurable effect on fish habitat because of the stream morphology and geometry of Farley Creek.</p> <p>Predicted changes in water level in Gordon Lake and Farley Lake are not expected to have a measurable effect on fish habitat.</p>	Yes
Change in water levels in Gordon Lake and Farley Lake and flows in Farley Creek due to diversion of contact water to the open pit and progressive reduction in groundwater interceptor well pumping to fill the open pit with water.	Decommission, Reclamation, and Closure	<ul style="list-style-type: none"> • Continuing to operate the groundwater interceptor wells during closure while the open pit fills with water and progressively reducing their pumping rates until the water level in the open pit reaches the elevation of the surrounding groundwater table. • Directing contact water from the collection ditches around the MRSA, overburden stockpile, and mine infrastructure to the open pit during decommissioning/closure to reduce the filling period. 	<p>Predicted flow changes in Farley Creek are above those considered likely to have a low probability (<10% change in instantaneous flow). However, changes in stream flows are not expected to have a measurable effect on fish habitat because of the stream morphology and geometry of Farley Creek.</p> <p>Predicted changes in water level in Gordon Lake and Farley Lake are not expected to have a measurable effect on fish habitat.</p>	Yes
<p>Note: ¹ monitored as part of Surface Water Management and Monitoring Plan (SWMMP)</p>				

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Table A-6 Project Pathway of Effects, Mitigation Measures, and Residual Effects in Fish Habitat at the MacLellan Site

Potential Pathway of Effect	Mine Phase	Mitigation	Predicted Residual Effect after Mitigation	Monitoring Included in AEMP (Yes/No)
Change in surface flows as construction of water management facilities (sumps, ponds, and ditches) alter natural drainage patterns and catchments areas.	Construction	<ul style="list-style-type: none"> • Limiting the construction footprint to the extent possible to reduce potential reductions in groundwater recharge, to limit the number of watercourses overprinted by the PDA, and to limit the number of extent of changes to catchment area runoff due to encroachment of the PDA into various watersheds. • Constructing upstream perimeter ditches to divert non-contact water around Project components, reporting to the original receiving environments • Using standard construction methods such as seepage cut-off collars, where trenches extend below the water table, to mitigate preferential flow paths. 	Negligible effect on fish habitat after mitigation.	No
Change in habitat at road crossings requiring upgrading along the MacLellan site access road.	Construction	<ul style="list-style-type: none"> • Sizing new culverts to convey the 1:100-year flood and using open-bottom structures where practical to maintain fish habitat values and fish passage. • New road crossings will be sized and installed following Manitoba Infrastructure guidelines (DFO and MNR 1996). 	Negligible effect on fish habitat after mitigation.	No
Change in habitat at watercourse crossings along the new transmission line to the MacLellan site.	Construction	<ul style="list-style-type: none"> • Prohibiting installation of poles in the watercourse or riparian areas. • Following best management practices for erosion and sediment control measures. • Constructing the transmission line in frozen conditions. 	Negligible effect on fish habitat after mitigation.	No

**LYNN LAKE GOLD PROJECT:
AQUATIC EFFECTS MONITORING PLAN**

Appendix A Tables
January 30, 2025

Potential Pathway of Effect	Mine Phase	Mitigation	Predicted Residual Effect after Mitigation	Monitoring Included in AEMP (Yes/No)
Change in habitat at the new intake structure to be constructed in the Keewatin River	Construction	<ul style="list-style-type: none"> Pipes will extend 8 m from the riverbank away from weed beds or other habitat features that would attract fish and suspended off the river bottom. 	Negligible effect on fish habitat after mitigation because of their small in-water footprints, their placement away from habitats that would attract fish, and the relatively small spatial and short temporal alteration of riparian habitat at the installation locations.	No
Change in flows in Keewatin River due to operation of the water intake.	Construction	<ul style="list-style-type: none"> Restricting water withdrawal rates from the Keewatin River to <10% of instantaneous discharge at all times. Collecting and conveying non-contact water to the collection pond for discharge to the Keewatin River during operation. Recycling water between the processing facility and the TMF to reduce freshwater requirements from the Keewatin River during operation. 	Negligible effect on fish habitat after mitigation.	No
Change in water levels in East Pond and its outlet to the Keewatin River due to changes in the groundwater table as the open pit is developed.	Operation	<ul style="list-style-type: none"> Counterbalancing unavoidable habitat losses by implementing offsets from the suite of options described in the Fish Habitat Offsetting Plan. 	The unavoidable loss of habitat in East Pond will be counterbalanced by offsetting measures described in the Fish Habitat Offsetting Plan.	Yes

**LYNN LAKE GOLD PROJECT:
AQUATIC EFFECTS MONITORING PLAN**

Appendix A Tables
January 30, 2025

Potential Pathway of Effect	Mine Phase	Mitigation	Predicted Residual Effect after Mitigation	Monitoring Included in AEMP (Yes/No)
Alteration of water levels in Payne and Minton Lakes due to expansion of water management ditches and sumps that alter its catchment area.	Operation	<ul style="list-style-type: none"> Constructing upstream perimeter ditches to divert non-contact water around Project components, reporting to the original receiving environments. 	Negligible effect on fish habitat after mitigation.	Yes
Change in flows in Keewatin River due to operation of the water intake.	Operation	<ul style="list-style-type: none"> Restricting water withdrawal rates from the Keewatin River to <10% of instantaneous discharge at all times. Collecting and conveying non-contact water to the collection pond for discharge to the Keewatin River during operation. Recycling water between the processing facility and the TMF to reduce freshwater requirements from the Keewatin River during operation. 	Negligible effect on fish habitat after mitigation.	Yes
Change in water levels in East Pond as contact water and groundwater fill the open pit.	Decommissioning/Closure	<ul style="list-style-type: none"> Directing water from the TMF and MRSA to the open pit during decommissioning/closure to reduce the filling period. Counterbalancing unavoidable habitat losses by implementing offsets from the suite of options described in the Fish Habitat Offsetting Plan. 	The unavoidable loss of habitat in East Pond will be counterbalanced by offsetting measures described in the Fish Habitat Offsetting Plan.	No
Change in flows in the Keewatin River tributary draining East Pond and in the Keewatin River once the open pit is filled and discharging to the environment.	Decommissioning/Closure	<ul style="list-style-type: none"> Directing water from the TMF and MRSA to the open pit during decommissioning/closure to reduce the filling period. Counterbalancing unavoidable habitat losses by implementing offsets from the suite of options described in the Fish Habitat Offsetting Plan. 	Negligible effect on fish habitat after mitigation.	No

**LYNN LAKE GOLD PROJECT:
AQUATIC EFFECTS MONITORING PLAN**

Appendix A Tables
January 30, 2025

Table A-7 Project Pathway of Effects, Mitigation Measures, and Residual Effects on Fish Community and Populations at the Gordon Site

Potential Pathway of Effect	Mine Phase	Mitigation	Predicted Residual Effect after Mitigation	Monitoring Included in AEMP (Yes/No)
Changes in TSS concentrations caused by sedimentation.	Construction	<ul style="list-style-type: none"> Best Management Practices for runoff, erosion, and sediment control will be implemented to limit the exposure of fish to elevated TSS concentrations. These mitigation measures are described in detail in the Erosion and Sediment Control Plan. Maintaining riparian buffers of at least 30 metres from the high-water mark of fish-bearing waterbodies and wetlands that are not required to be removed during construction of the Project 	Negligible effect on fish community and population after mitigation.	No ¹
Changes in temperature and dissolved oxygen concentrations	construction	<ul style="list-style-type: none"> Aerating Wendy and East pits to break-down thermal stratification and to increase dissolved oxygen concentrations prior to dewatering to the Hughes River 	Negligible effect on fish community and population after mitigation.	No
Fish mortality or injury from sound overpressures and/or peak particle velocities associated with blasting in the open pits.	Construction and Operation	<ul style="list-style-type: none"> Limiting charge size and using stemming and delays to maintain appropriate set-back distances between the pit and Gordon and Farley lakes based on the Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters (Wright and Hopky 1998). 	Negligible effect on fish community and population after mitigation.	No ²
Increase in recreational fishing pressure by mine employees.	Construction and Operation	<ul style="list-style-type: none"> Establishing a Worker's code-of-conduct for employees that would restrict fishing in lakes or streams of a specific size, those used by local First Nations for subsistence or traditional purposes or determined to contain already depressed populations by MCC. 	Negligible effect on fish community and population after mitigation.	No
Introduction of invasive species or disease from equipment or materials brought to site	Construction, Operation, and Decommission, Reclamation, and Closure	<ul style="list-style-type: none"> Implementing an Aquatic Invasive Species Management Plan that includes cleaning and decontamination protocols for all machinery and equipment brought to site 	Negligible effect on fish community and population after mitigation.	No

**LYNN LAKE GOLD PROJECT:
AQUATIC EFFECTS MONITORING PLAN**

Appendix A Tables
January 30, 2025

Potential Pathway of Effect	Mine Phase	Mitigation	Predicted Residual Effect after Mitigation	Monitoring Included in AEMP (Yes/No)
Fish mortality or injury from entrainment or impingement associated with water intakes.	Operation	<ul style="list-style-type: none"> Installing screens on the water intake in Farley Lake that is sized to preclude entrainment or impingement of juvenile burbot using DFO's "End-of-Pipe" Fish Screen Size Tool. 	Negligible effect on fish community and population after mitigation.	No
Change in concentrations of fluoride and phosphorus from Project activities.	Construction, Operation, and Decommission, Reclamation, and Closure	<ul style="list-style-type: none"> Mitigation measures described in the Surface Water Monitoring and Management Plan for surface water quality (Table 7-7) will be implemented to limit the change in concentrations of POPCs. 	Negligible effect on fish community and population after mitigation.	No ¹
Change in fish habitat in Gordon Lake, Farley Lake, and Farley Creek because of changes in lake levels and stream flows during Project activities.	Construction, Operation, and Decommission, Reclamation, and Closure	<ul style="list-style-type: none"> Mitigation measures described in the Surface Water Monitoring and Management Plan for surface water quantity (Table 6-7) will be implemented to reduce changes in lake levels and streams flows. Mitigation measures described in the Groundwater Management and Monitoring Plan will be implemented to reduce potential changes in water levels in Gordon and Farley lakes 	Predicted changes in fish habitat are not expected to have a measurable effect on fish community and populations.	No ¹
<p>Notes:</p> <p>¹ addressed in Surface Water Management and Monitoring Plan</p> <p>² addressed in Blasting Management and Monitoring Plan</p>				

**LYNN LAKE GOLD PROJECT:
AQUATIC EFFECTS MONITORING PLAN**

Appendix A Tables
January 30, 2025

Table A-8 Project Pathway of Effects, Mitigation Measures, and Residual Effects on Fish Community and Populations at the MacLellan Site

Potential Pathway of Effect	Mine Phase	Mitigation	Predicted Residual Effect after Mitigation	Monitoring Included in AEMP (Yes/No)
Changes in TSS concentrations caused by sedimentation.	Construction	<ul style="list-style-type: none"> Best Management Practices for runoff, erosion, and sediment control will be implemented to limit the exposure of fish to elevated TSS concentrations. These mitigation measures are described in detail in the Erosion and Sediment Control Plan Maintaining riparian buffers of at least 30 metres from the high-water mark of fish-bearing waterbodies and wetlands that are not required to be removed during construction of the Project 	Negligible effect on fish community and population after mitigation.	No ¹
Fish mortality or injury from sound overpressures and peak particle velocities associated with blasting in the open pits.	Construction and Operation	<ul style="list-style-type: none"> Limiting charge size and using stemming and delays to maintain appropriate set-back distances between the pit and the Keewatin River based on the Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters (Wright and Hopky 1998). 	Negligible effect on fish community and population after mitigation.	No ²
Increase in recreational fishing pressure by mine employees.	Construction and Operation	<ul style="list-style-type: none"> Establishing a Worker's code-of-conduct for employees that would restrict fishing in lakes or streams of a specific size, those used by local First Nations for subsistence or traditional purposes or determined to contain already depressed populations by MCC. 	Negligible effect on fish community and population after mitigation.	No
Introduction of invasive species or disease from equipment or materials brought to site	Construction, Operation, and Decommission, Reclamation, and Closure	<ul style="list-style-type: none"> Implementing an Aquatic Invasive Species Management Plan that includes cleaning and decontamination protocols for all machinery and equipment brought to site 	Negligible effect on fish community and population after mitigation.	No
Fish mortality or injury from entrainment or impingement associated with water intakes.	Operation	<ul style="list-style-type: none"> Installing screens on the water intake in the Keewatin River that are sized to preclude entrainment or impingement of juvenile burbot using DFO's End-of-Pipe Fish Screen Size Tool. 	Negligible effect on fish community and population after mitigation.	No

**LYNN LAKE GOLD PROJECT:
AQUATIC EFFECTS MONITORING PLAN**

Appendix A Tables
January 30, 2025

Potential Pathway of Effect	Mine Phase	Mitigation	Predicted Residual Effect after Mitigation	Monitoring Included in AEMP (Yes/No)
Change in water levels in East Pond and Keewatin River tributary KEE3-B1 due to changes in the groundwater table as the open pit is developed.	Operation	<ul style="list-style-type: none"> Isolating in-water work areas and conducting fish rescues prior to drawdown. Counterbalancing unavoidable habitat losses by implementing offsets from the suite of options described in the Fish Habitat Offsetting Plan. 	The unavoidable loss of habitat in East Pond will be counterbalanced by offsetting measures described in the Fish Habitat Offsetting Plan.	No ¹
Change in concentrations of aluminum, arsenic, cadmium, copper, fluoride, phosphorous, and nitrogen.	Construction, Operation, and Decommission, Reclamation, and Closure	<ul style="list-style-type: none"> Mitigation measures described in the Surface Water Monitoring and Management Plan for surface water quality (Table 7-8) will be implemented to limit the change in concentrations of POPCs. 	Short-term exceedances of POPCs are predicted to occur, however, water quality will be monitored and amended if necessary. Therefore, a negligible effect on fish community and population is expected.	No ¹
Change in fish habitat because of changes in lake levels and stream flows during Project activities.	Construction, Operation, and Decommission, Reclamation, and Closure	<ul style="list-style-type: none"> Mitigation measures described in the Surface Water Monitoring and Management Plan for surface water quantity (Table 6-8) will be implemented to reduce changes in lake levels and streams flows. 	Predicted changes in fish habitat are not expected to have a measurable effect on fish community and populations.	No ¹
<p>Notes:</p> <p>¹ addressed in Surface Water Management and Monitoring Plan</p> <p>² addressed in Blasting Management and Monitoring Plan</p>				

**LYNN LAKE GOLD PROJECT:
AQUATIC EFFECTS MONITORING PLAN**

Appendix A Tables
January 30, 2025

Table A-9 Project Pathway of Effects, Mitigation Measures, and Residual Effects on Fish Tissue at the Gordon Site

Potential Pathway of Effect	Mine Phase	Mitigation	Predicted Residual Effect after Mitigation	Monitoring Included in AEMP (Yes/No)
Release of POPCs during dewatering of Wendy and East pits.	Construction	<ul style="list-style-type: none"> Aerating Wendy and East pits to encourage precipitation of elements that form oxides (e.g., iron oxide), to break down of thermal and chemical stratification, and to increase dissolved oxygen concentrations prior to dewatering. Dewatering Wendy and East pits to the Hughes River instead of Farley Lake 	Negligible effect on fish tissues after mitigation measures.	Yes
Discharge of contact water, including blast residues and accumulated groundwater in the open pit and run-off from the MRSA, ore stockpile, and overburden stockpile.	Construction and Operation	<ul style="list-style-type: none"> Constructing non-contact water ditches upslope of overburden stockpiles, MRSAs, ore stockpiles, and mine infrastructure to reduce contact water volumes. Constructing contact water collection ditches around the MRSAs, overburden stockpiles, and ore stockpiles to convey the 1:25-year storm event to collection ponds. Constructing contact water collection ponds to contain (without discharge) run-off from a 1:100-year storm event with active storage that considers maximum ice thickness in winter. 	Negligible effect on fish tissues after mitigation measures.	Yes
Release of POPCs during overflow from the open pit to Farley Lake at post-closure.	Decommission, Reclamation, and Closure	<ul style="list-style-type: none"> Implementing passive treatment options (e.g., controlled pit stratification, fertilizer amendment, flow segregation) in the open pit should monitoring show that pit water quality is not suitable for release to the environment during the approximately 21 years anticipated to fill the open pit with water at the conclusion of operation. 	Negligible effect on fish tissues after mitigation measures.	Yes
Release of POPCs during discharge of groundwater pumped from the groundwater interceptor wells installed between the open pit and Gordon Lake and Farley Lake.	Construction, Operation, and Decommission, Reclamation, and Closure	<ul style="list-style-type: none"> Aerating groundwater from the interceptor wells in collection ponds to encourage iron precipitation and increase dissolved oxygen concentrations prior to discharge to Gordon Lake and Farley Lake. 	Negligible effect on fish tissues after mitigation measures.	Yes

**LYNN LAKE GOLD PROJECT:
AQUATIC EFFECTS MONITORING PLAN**

Appendix A Tables
January 30, 2025

Table A-10 Project Pathway of Effects, Mitigation Measures, and Residual Effects on Fish Tissue at the MacLellan Site

Potential Pathway of Effect	Mine Phase	Mitigation	Predicted Residual Effect after Mitigation	Monitoring Included in AEMP (Yes/No)
Release of sediment and POPCs during dewatering of the existing underground mine workings during construction.	Construction	<ul style="list-style-type: none"> • Pumping water from the existing underground works to the TMF for storage and eventual use in the processing facility. • Implementing sediment and erosion control measures during construction to limit the release of TSS and turbidity in lakes and streams. 	Negligible effect on fish tissues after mitigation measures.	Yes
Discharge of contact water, including blast residues and accumulated groundwater in the open pit and run-off from the MRSA, ore stockpile, TMF, overburden stockpile and mine infrastructure, during construction and operation.	Construction and Operation	<ul style="list-style-type: none"> • Constructing non-contact water ditches upslope of overburden stockpiles, MRSAs, ore stockpiles, TMF, and mine infrastructure to reduce contact water volumes. • Constructing contact water collection ditches around the MRSAs, overburden stockpiles, TMF, and ore stockpiles to convey the 1:25-year storm event to collection ponds. • Constructing contact water collection ponds to contain (without discharge) run-off from a 1:100-year storm event with active storage that considers maximum ice thickness in winter. • Operating the TMF as a non-discharging facility during operation through reclaiming TMF water for use in the ore processing mill. • Using a closed circuit for cyanide use and cyanide destruction in the processing plant (via Air/SO₂ oxidation and precipitation of metals) to reduce cyanide concentrations in tailings slurry prior to release of the slurry for storage in the TMF. 	Negligible effect on fish tissues after mitigation measures.	
Release of POPCs due to seepage from the TMF during operation and decommissioning/closure.	Decommission, Reclamation, and Closure	<ul style="list-style-type: none"> • Constructing groundwater cut-off ditches to reduce the volume of groundwater seepage from the TMF post-closure. 	Negligible effect on fish tissues after mitigation measures.	Yes






**LYNN LAKE GOLD PROJECT:
AQUATIC EFFECTS MONITORING PLAN**

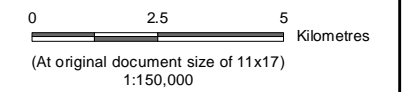
Appendix A Tables
January 30, 2025

Potential Pathway of Effect	Mine Phase	Mitigation	Predicted Residual Effect after Mitigation	Monitoring Included in AEMP (Yes/No)
Release of POPCs during overflow from the open pit to the Keewatin River tributary (KEE3-B1), and ultimately the Keewatin River, when the flooded open pit overflows during post-closure.	Decommission, Reclamation, and Closure	<ul style="list-style-type: none"> Implementing passive treatment options (e.g., controlled pit stratification, fertilizer amendment, flow segregation) in the open pit should monitoring show that pit water quality is not suitable for release to the environment during the approximately 21 years anticipated to fill the open pit with water at the conclusion of operation. 	Short-term exceedances of POPCs are predicted to occur, however, water quality will be monitored and amended if necessary. Therefore, a negligible effect on fish tissues is expected.	Yes
Discharge of effluent from the wastewater treatment plant during construction, operation, and decommissioning/closure.	Construction, Operation, and Decommission, Reclamation, and Closure	<ul style="list-style-type: none"> Treating domestic waste in a sewage treatment plant so that it meets the Wastewater Systems Effluent Regulations under the Fisheries Act and the MWQSOG (2002) prior to discharge to the Keewatin River via a pipeline and diffuser. 	Negligible effect on fish tissues after mitigation measures.	Yes

Appendix B Maps

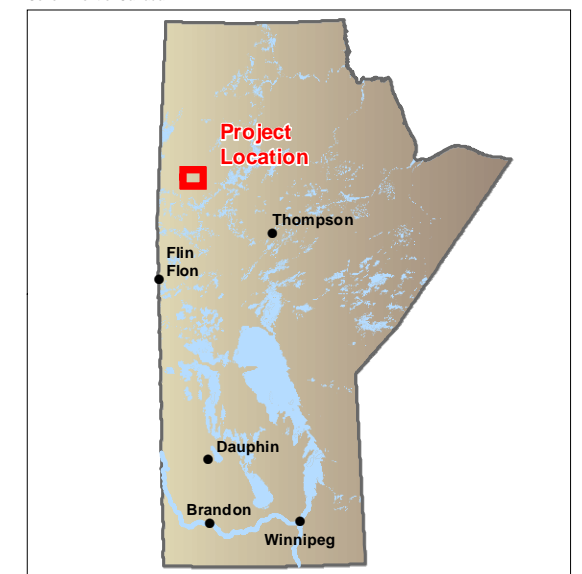
Landbase

-  Existing Access Road
-  Highway
-  Watercourse
-  Waterbody
-  First Nation Reserve



Notes

1. Coordinate System: NAD 1983 UTM Zone 14N
2. Base Data Sources: Government of Manitoba and Government of Canada



Project Location
Lynn Lake,
Manitoba

Prepared by ACampigotto on 2020-04-02
Technical Review by ASomers on 2020-04-02
Senior GIS Review by GKroupa on 2020-04-02

Client/Project
ALAMOS GOLD INC.
Lynn Lake Gold Project

111473008

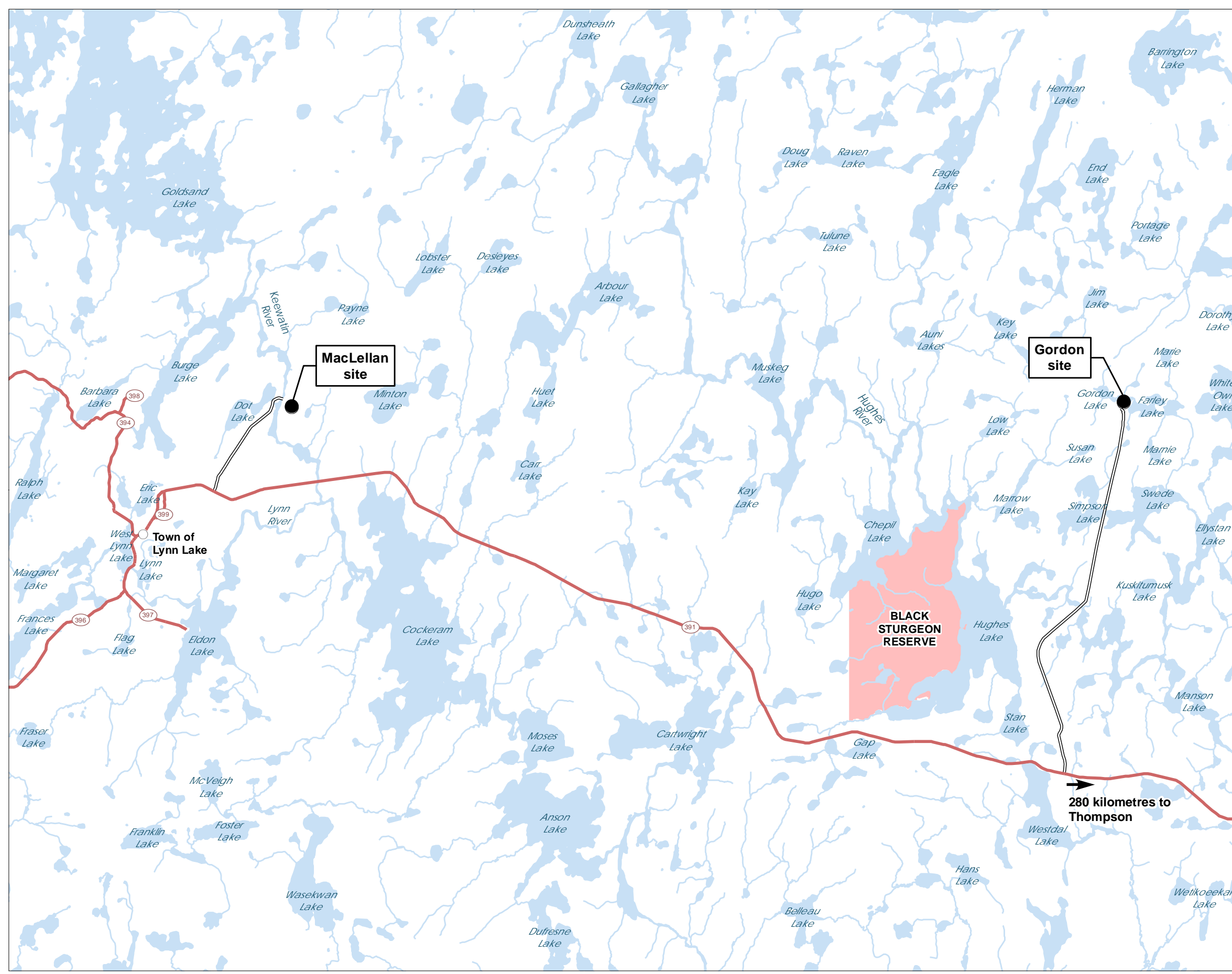
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B-1

Title

General Project Area

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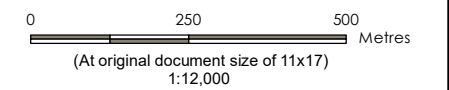


Project Infrastructure

- Interceptor Well
- Communication Tower
- Contact Water Ditch
- Mine Site Road
- Diversion Ditch
- Discharge Pipeline
- Fresh Water Intake
- Effluent Diffuser
- Collection Pond/Sumps
- Facility Area
- Gen Set Area
- Mine Rock Storage Area
- Open Pit
- Ore Storage
- Overburden Storage
- Topsoil Storage Area
- Stockpile Borrow Source
- Project Development Area (PDA)

Landbase

- Existing Access Road
- Existing Diversion Channel
- Watercourse
- Waterbody



- Notes**
1. Coordinate System: NAD 1983 UTM Zone 14N
 2. Base Data Sources: Government of Manitoba and Government of Canada.
 3. NOA Project Infrastructure features provided by Worley via Alamos.

Project Location Lynn Lake, Manitoba
 Prepared by ACompigotto on 2024-06-19
 Technical Review by KMathers on 2024-06-19

Client/Project ALAMOS GOLD INC.
 Lynn Lake Gold Project
 111473076

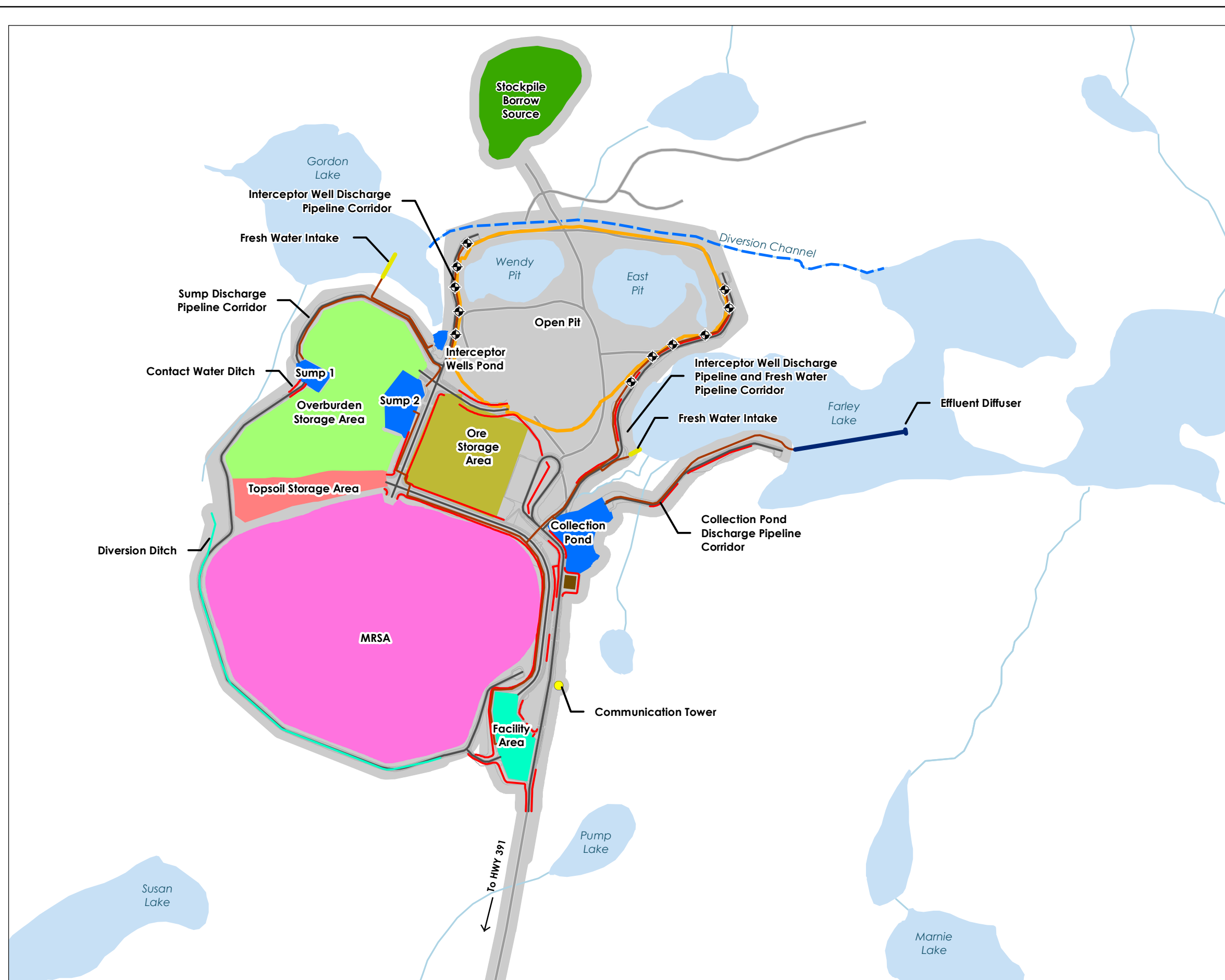
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B-2

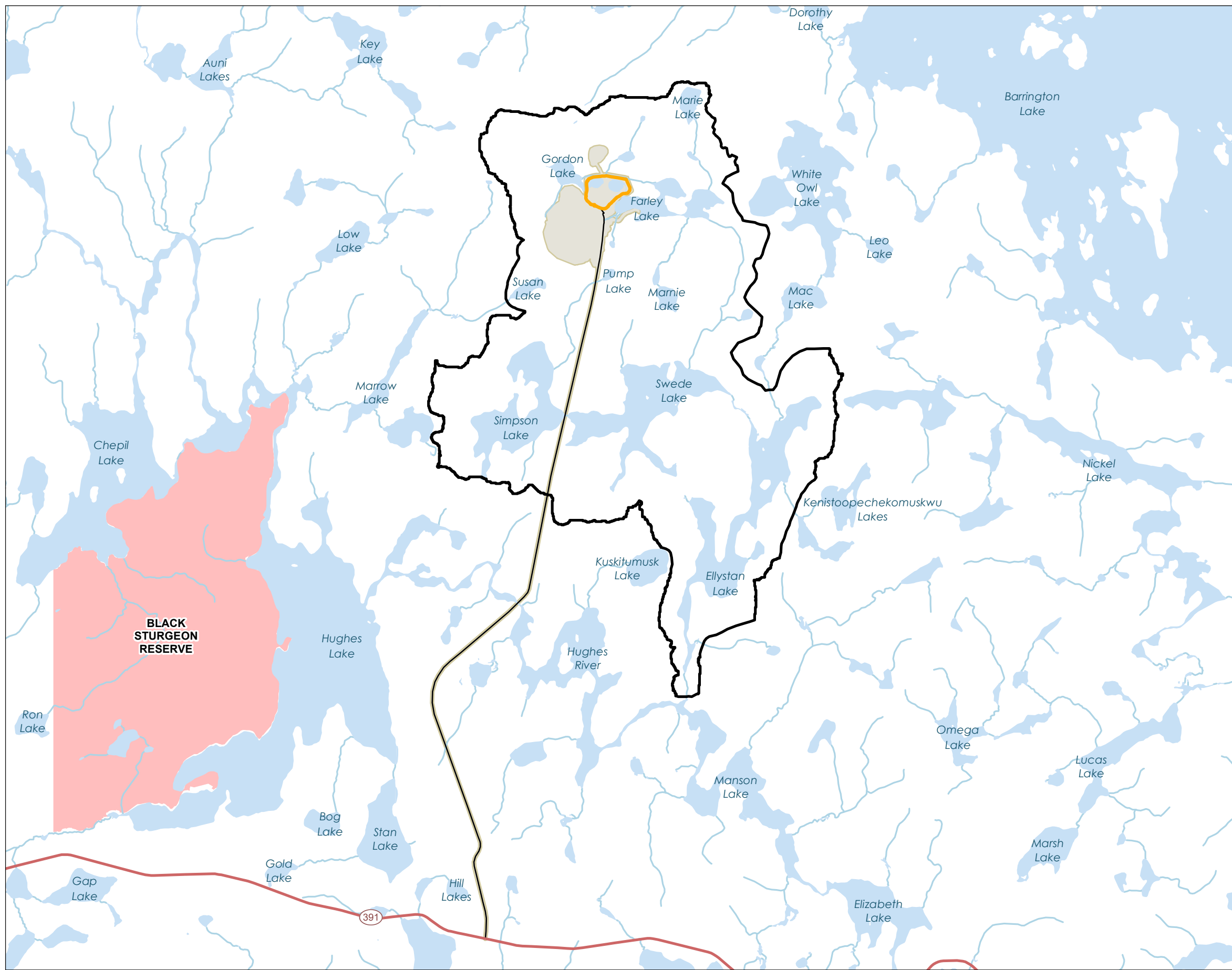
Title

**Project Development Area-
 Gordon site**

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Revised: 2024-08-26 by: ACampigotto



Project Infrastructure

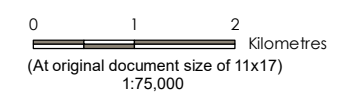
- Proposed Open Pit
- Project Development Area

Study Area

- Fish and Fish Habitat Local Assessment Area (LAA)

Landbase

- Existing Access Road
- Highway
- Watercourse
- Waterbody
- First Nation Reserve



Notes

- Coordinate System: NAD 1983 UTM Zone 14N
- Base Data Sources: Government of Manitoba and Government of Canada.

Project Location Lynn Lake, Manitoba
 Prepared by A.Campigotto on 2024-08-26
 Technical Review by KMathers on 2024-08-26

Client/Project ALAMOS GOLD INC.
 Lynn Lake Gold Project
 111473076

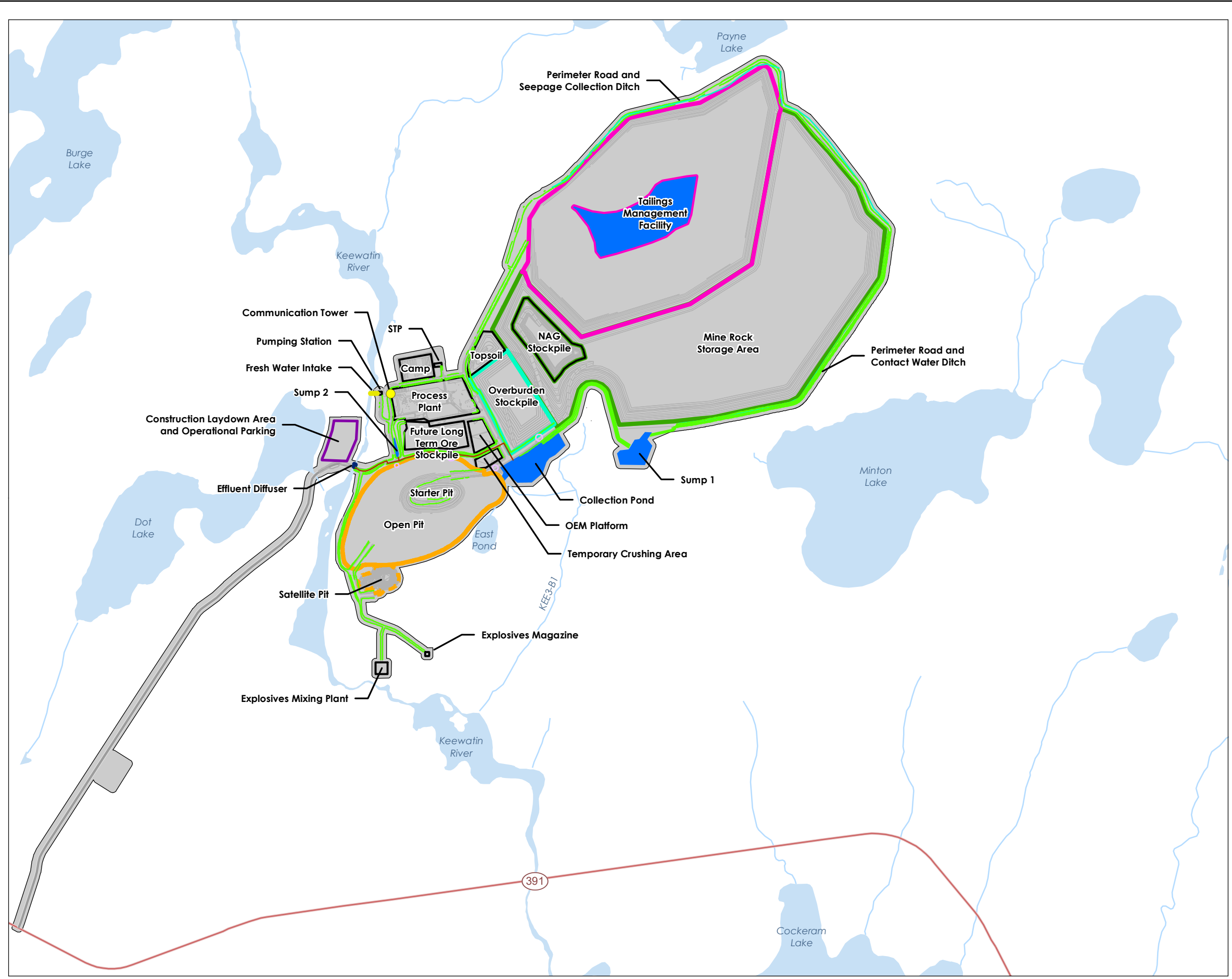
Map No.

B-3

Title

**Fish and Fish Habitat
Local Assessment Area - Gordon Site**

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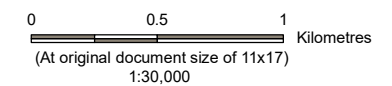


Project Infrastructure

- Communication Tower
- Culvert
- Ditching
- Corridor / Access Road
- Collection Pond Discharge
- Fresh Water Intake
- Effluent Diffuser
- Mine Rock Storage Area
- Overburden Stockpile
- Tailings Management Facility
- Open Pit
- Satellite Pit
- Collection Pond/Sumps
- Other Infrastructure
- Construction Laydown Area
- Project Development Area (PDA)

Landbase

- Highway
- Existing Access Road
- Watercourse
- Waterbody



- Notes**
1. Coordinate System: NAD 1983 UTM Zone 14N
 2. Base Data Sources: Government of Manitoba and Government of Canada.
 3. Project Infrastructure features provided by QPit and Ausenco.

Project Location Lynn Lake, Manitoba
 Prepared by ACampigotto on 2024-08-26
 Technical Review by KMathers on 2024-08-26

Client/Project ALAMOS GOLD INC.
 Lynn Lake Gold Project
 111473076

Map No.

B-4

Title

Project Development Area - MacLellan site

G:_GIS_Projects\Folder\111473076_ILGP_EA\RA\Aquatics\Monitoring\Plan\August_2024_Updates_AEWP\Map\B-5_AEWP_LAA_MacLellan_20240826.mxd Revised: 2024-08-26 by: A.Campigotto



Project Infrastructure

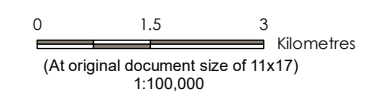
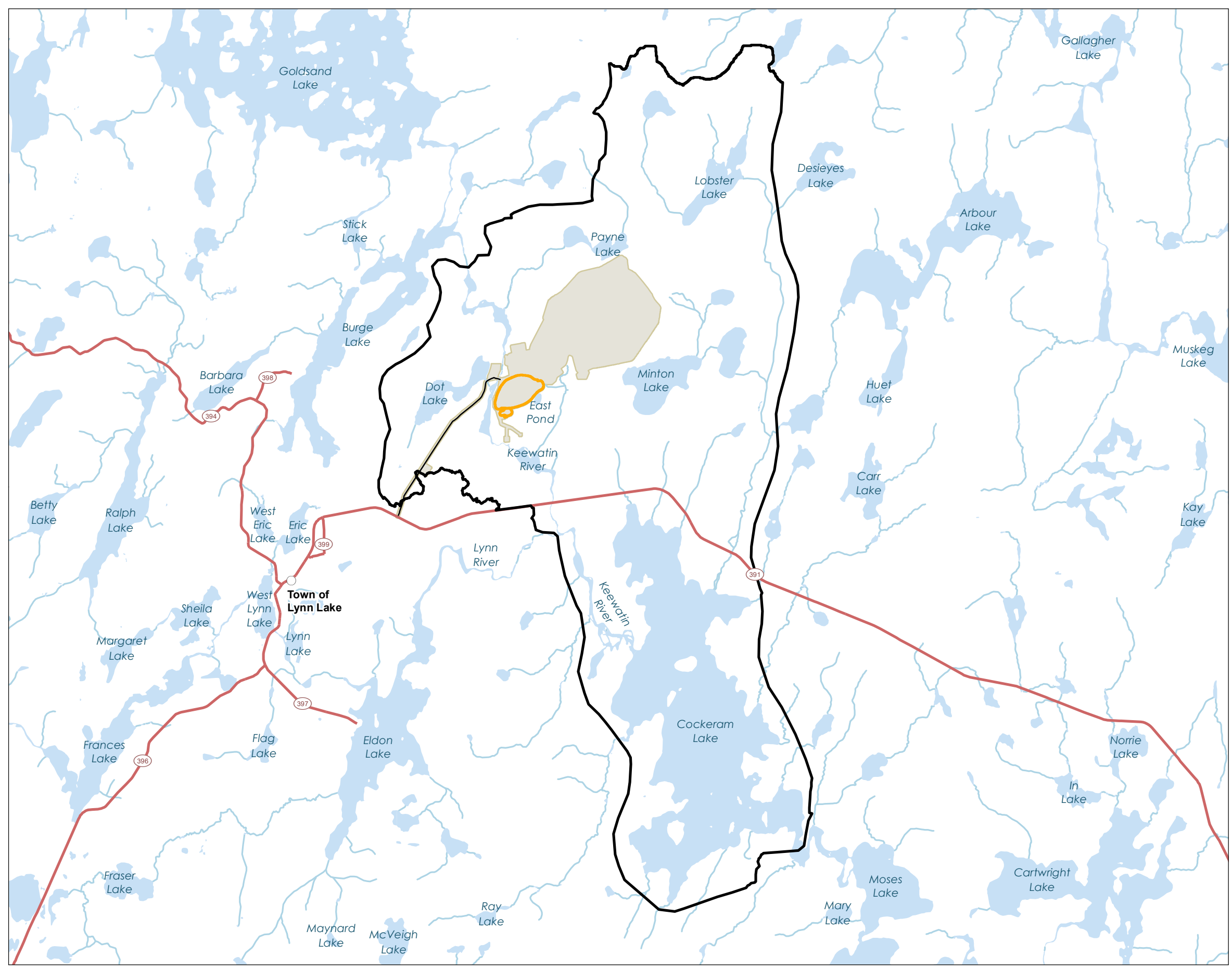
- Proposed Open Pit
- Project Development Area

Study Area

- Fish and Fish Habitat Local Assessment Area (LAA)

Landbase

- Existing Access Road
- Highway
- Watercourse
- Waterbody



Notes

- Coordinate System: NAD 1983 UTM Zone 14N
- Base Data Sources: Government of Manitoba and Government of Canada.

Project Location Lynn Lake, Manitoba Prepared by A.Campigotto on 2024-08-26
 Technical Review by KMethers on 2024-08-26

Client/Project ALAMOS GOLD INC. 111473076
 Lynn Lake Gold Project

Map No.

B-5

Title

**Fish and Fish Habitat
Local Assessment Area - MacLellan Site**

Proposed Sediment Quality Monitoring Locations

- Fixed Sample
- Random Sample

Project Infrastructure

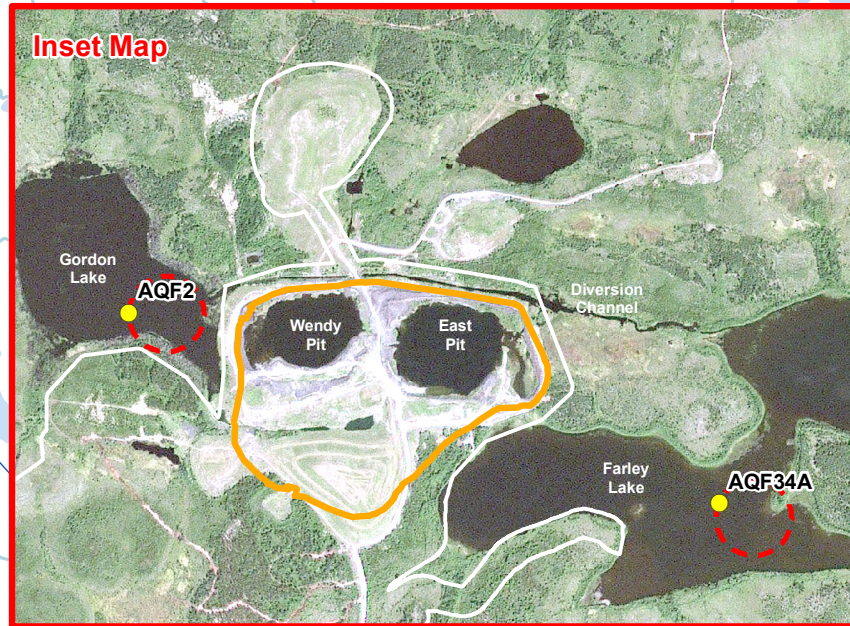
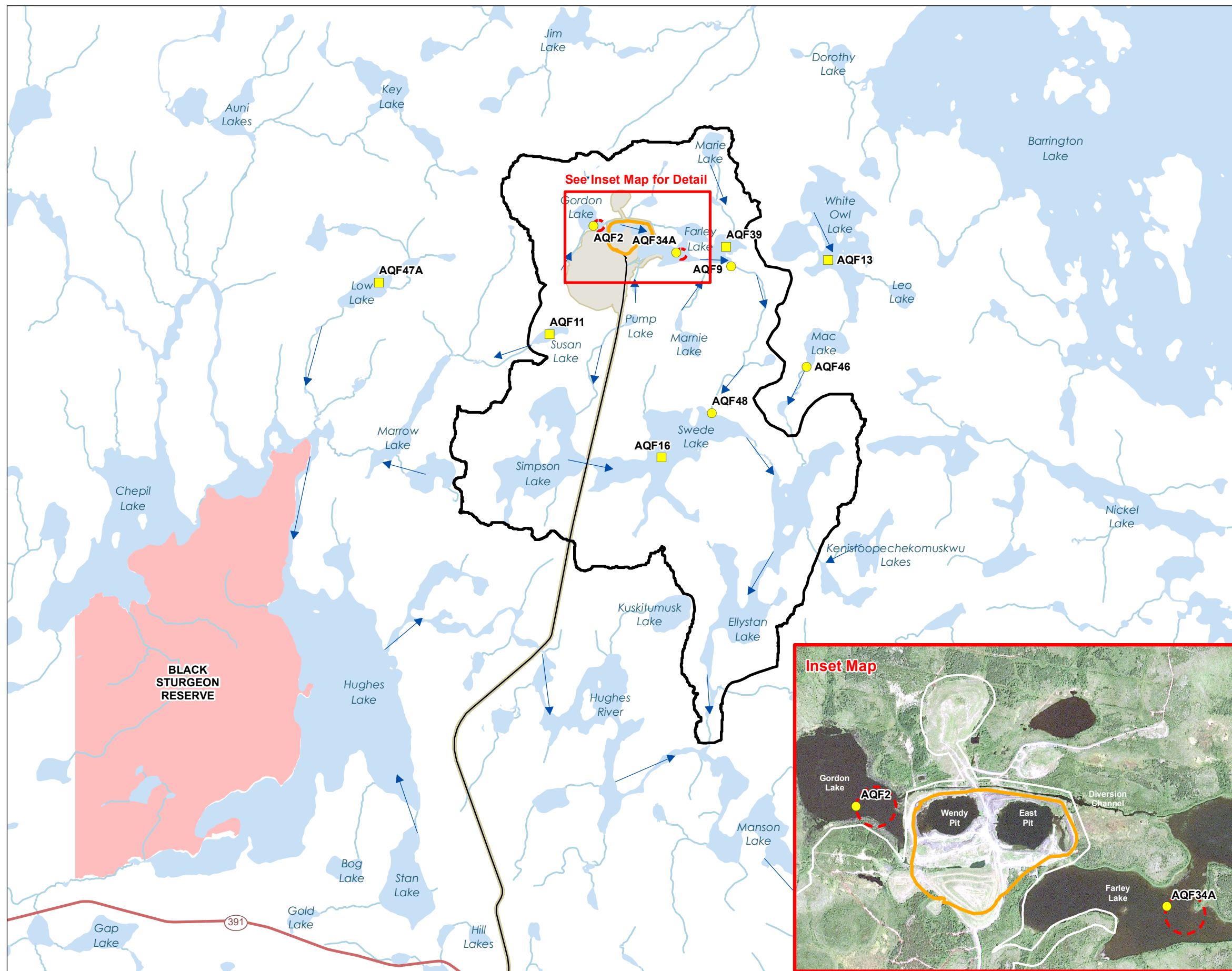
- Proposed Open Pit
- Project Development Area
- Effluent Mixing Zones

Study Area

- Fish and Fish Habitat Local Assessment Area (LAA)

Landbase

- Existing Access Road
- Surface Water Flow Direction
- Highway
- Watercourse
- Waterbody
- First Nation Reserve



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 (At original document size of 11x17)
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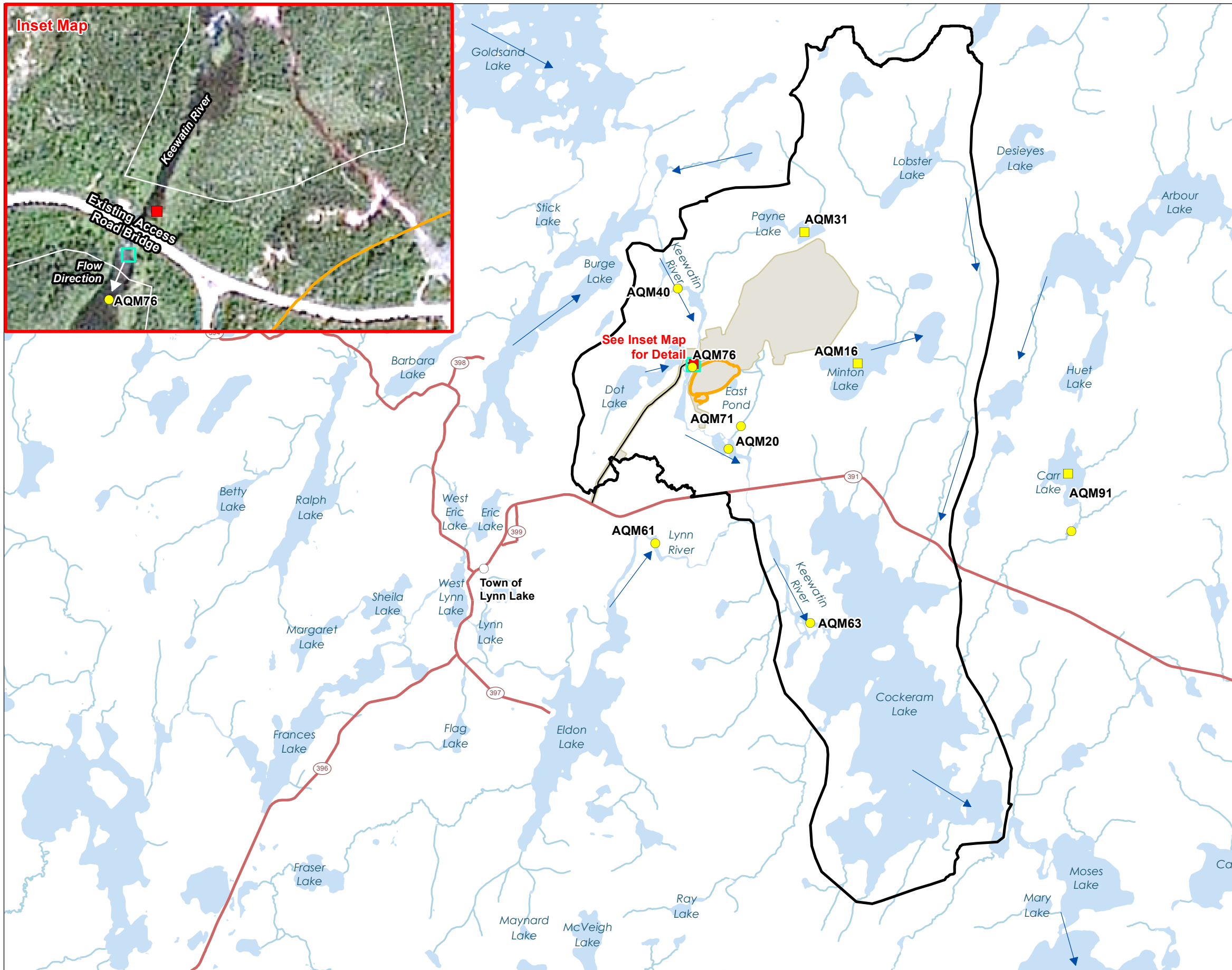
Notes
 1. Coordinate System: NAD 1983 UTM Zone 14N
 2. Base Data Sources: Government of Manitoba and Government of Canada.

Project Location
 Lynn Lake, Manitoba
 Prepared by ACampigotto on 2025-01-21
 Technical Review by BHome on 2025-01-21

Client/Project
 ALAMOS GOLD INC.
 Lynn Lake Gold Project
 111473084

Map No.
B-6
Title

Proposed Sediment Quality Monitoring Locations – Gordon site



Proposed Sediment Quality Monitoring Locations

- Fixed Sample
- Random Sample

Project Infrastructure

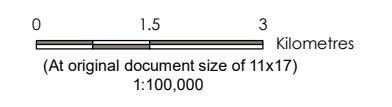
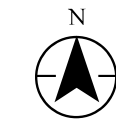
- Proposed Open Pit
- Project Development Area
- Effluent Location
- Effluent Mixing Zone

Study Area

- Fish and Fish Habitat Local Assessment Area (LAA)

Landbase

- Existing Access Road
- Surface Water Flow Direction
- Highway
- Watercourse
- Waterbody



Notes
 1. Coordinate System: NAD 1983 UTM Zone 14N
 2. Base Data Sources: Government of Manitoba and Government of Canada.

Project Location
 Lynn Lake, Manitoba
 Prepared by ACampigotto on 2025-01-20
 Technical Review by BHome on 2025-01-20

Client/Project
 ALAMOS GOLD INC.
 Lynn Lake Gold Project
 111473084

Map No.
B-7
Title

Proposed Sediment Quality Monitoring Locations – MacLellan site

Proposed Benthic Invertebrate Monitoring Locations

- Depositional Sample
- Erosional Sample

Project Infrastructure

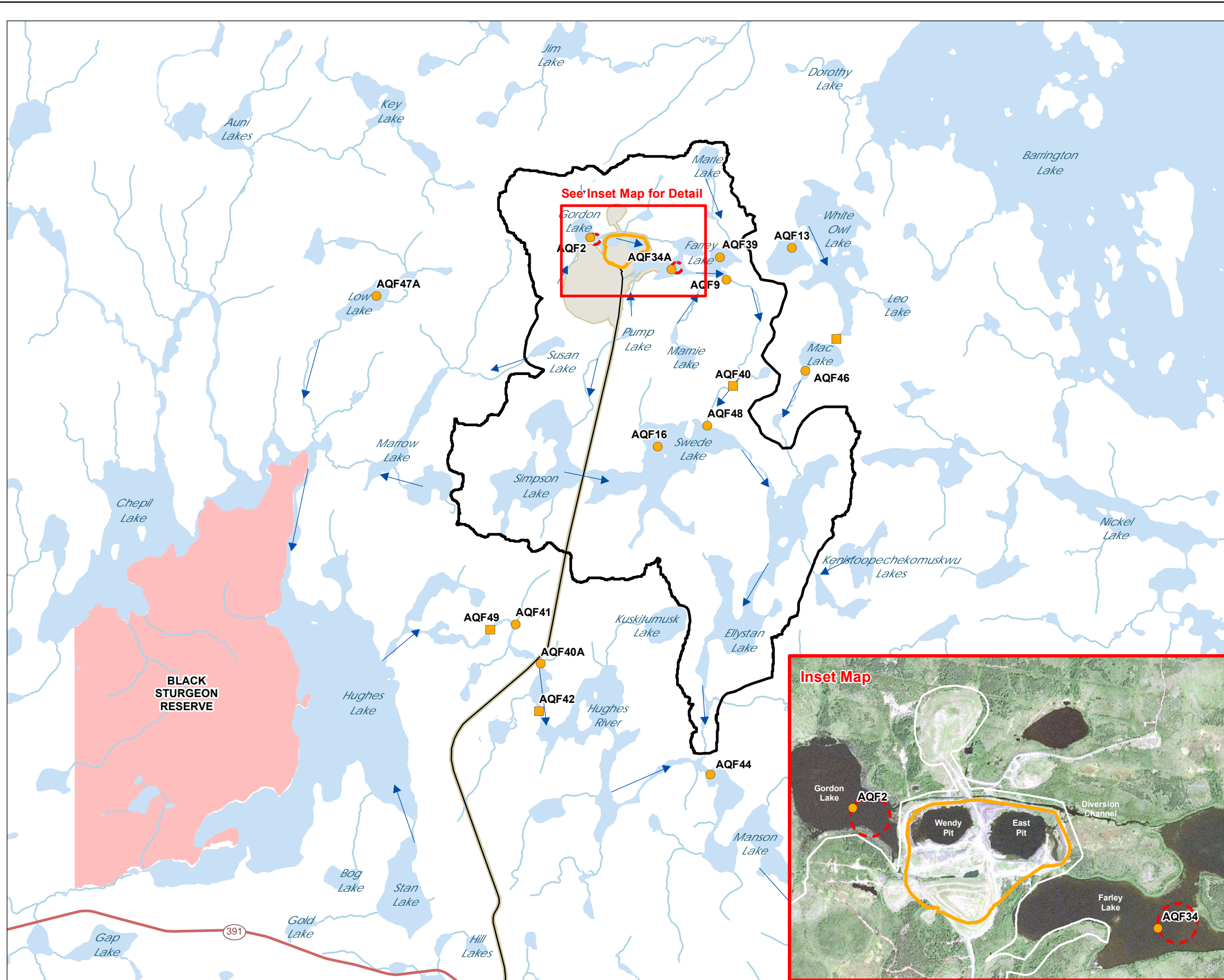
- Proposed Open Pit
- Project Development Area
- Effluent Mixing Zones

Study Area

- Fish and Fish Habitat Local Assessment Area (LAA)

Landbase

- Existing Access Road
- Surface Water Flow Direction
- Highway
- Watercourse
- Waterbody
- First Nation Reserve



Notes
 1. Coordinate System: NAD 1983 UTM Zone 14N
 2. Base Data Sources: Government of Manitoba and Government of Canada.

Project Location
 Lynn Lake, Manitoba
 Prepared by ACampigotto on 2025-01-21
 Technical Review by BHome on 2025-01-21

Client/Project
 ALAMOS GOLD INC.
 Lynn Lake Gold Project
 111473084

Map No.
B-8

Title
Proposed Benthic Invertebrate Monitoring Locations – Gordon site

Proposed Chlorophyll Monitoring Locations

- Periphyton Sample
- Phytoplankton Sample

Project Infrastructure

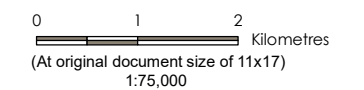
- Proposed Open Pit
- Project Development Area

Study Area

- Fish and Fish Habitat Local Assessment Area (LAA)

Landbase

- Existing Access Road
- Surface Water Flow Direction
- Highway
- Watercourse
- Waterbody
- First Nation Reserve



Notes

1. Coordinate System: NAD 1983 UTM Zone 14N
2. Base Data Sources: Government of Manitoba and Government of Canada.

Project Location

Lynn Lake,
Manitoba

Prepared by ACampigotto on 2025-01-21
Technical Review by BHome on 2025-01-21

Client/Project

ALAMOS GOLD INC.
Lynn Lake Gold Project

111473084

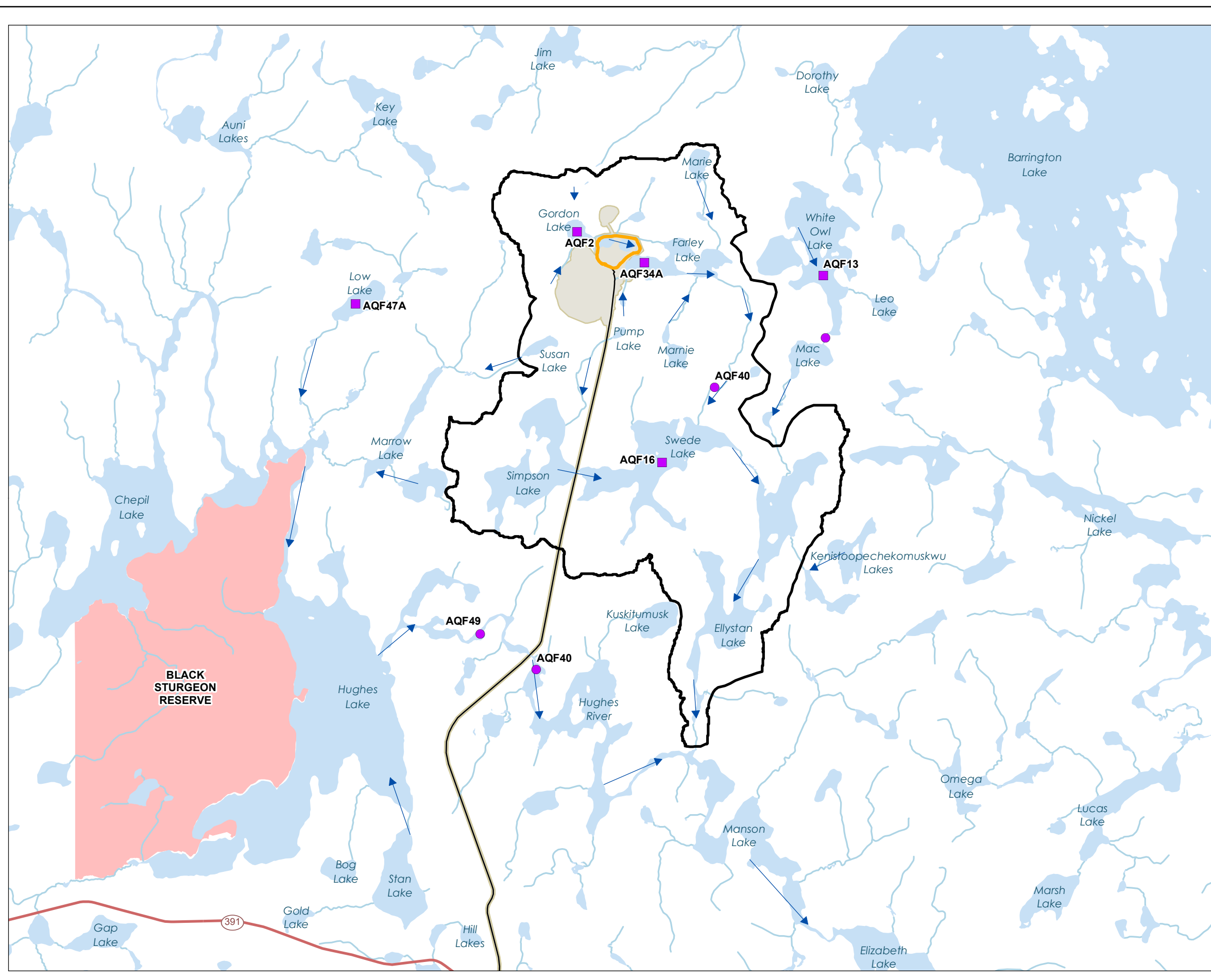
Map No.

B-10

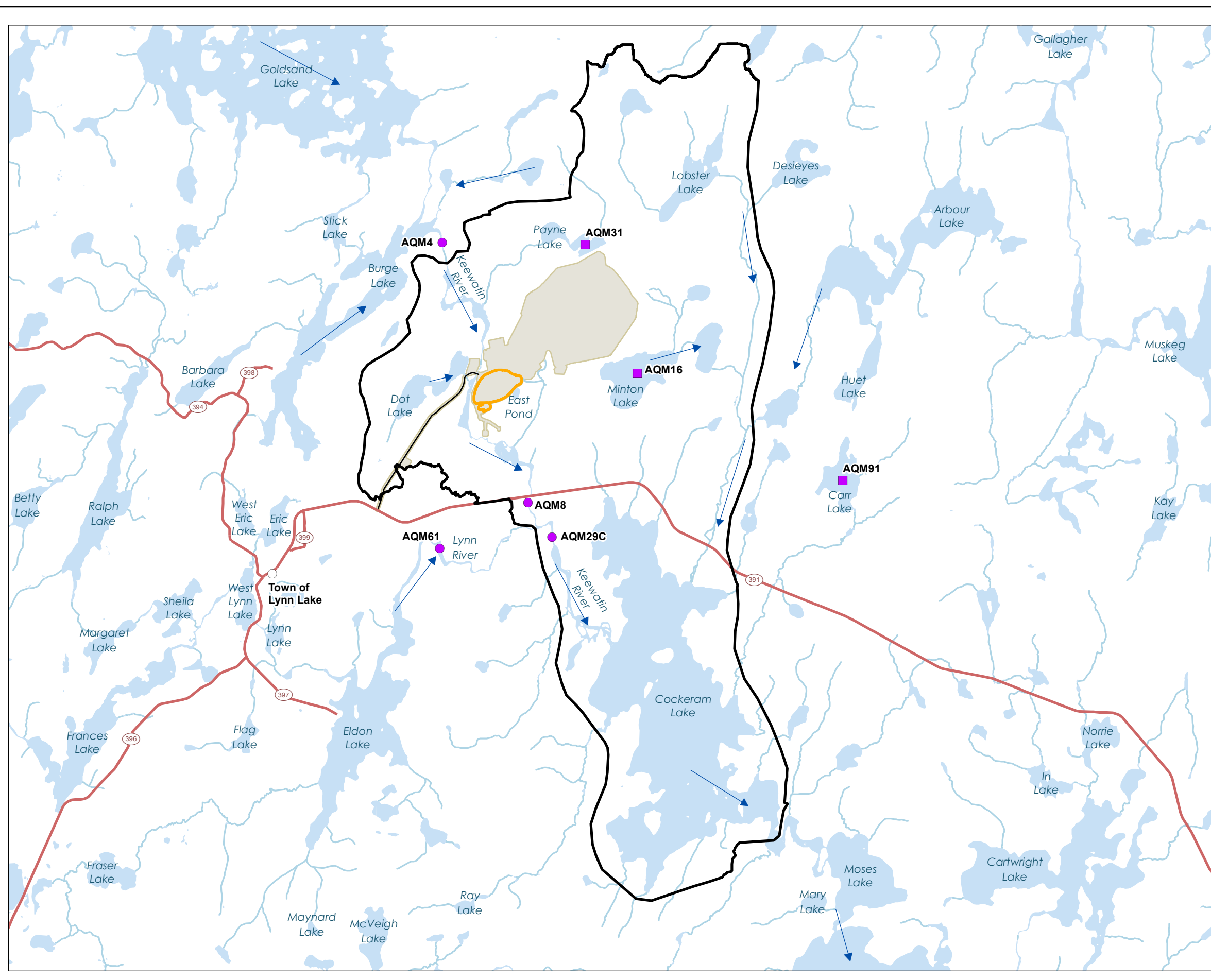
Title

**Proposed Chlorophyll
Monitoring Locations –
Gordon site**

G:\GIS\Project_Folder\111473084_ILGP_EA\RA\Aquatics_Monitoring_Plan\August_2024_Updates_ABM\Map8-10_ABM_Chlorophyll_Gordon_20250121.mxd Released: 2025-01-22 By: A.Campigotto



G:\GIS\Project_Folder\111473008_LUGP_EA\RA\Aquatics_Monitoring_Plan\August_2024_Updates_ABMP\Map8-11_ABMP_Chlorophyll_MacLellan_20250121.mxd Revised: 2025-01-21 By: ACampigotto



Proposed Chlorophyll Monitoring Locations

- Periphyton Sample
- Phytoplankton Sample

Project Infrastructure

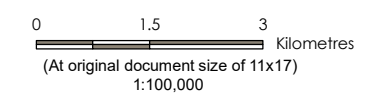
- Proposed Open Pit
- Project Development Area

Study Area

- Fish and Fish Habitat Local Assessment Area (LAA)

Landbase

- Existing Access Road
- Surface Water Flow Direction
- Highway
- Watercourse
- Waterbody



Notes
 1. Coordinate System: NAD 1983 UTM Zone 14N
 2. Base Data Sources: Government of Manitoba and Government of Canada.

Project Location
 Lynn Lake, Manitoba
 Prepared by ACampigotto on 2025-01-21
 Technical Review by BHome on 2025-01-21

Client/Project
 ALAMOS GOLD INC.
 Lynn Lake Gold Project
 111473084

Map No.
B-11

Title
Proposed Chlorophyll Monitoring Locations – MacLellan site

Project Infrastructure

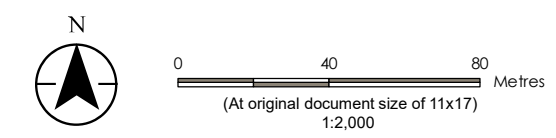
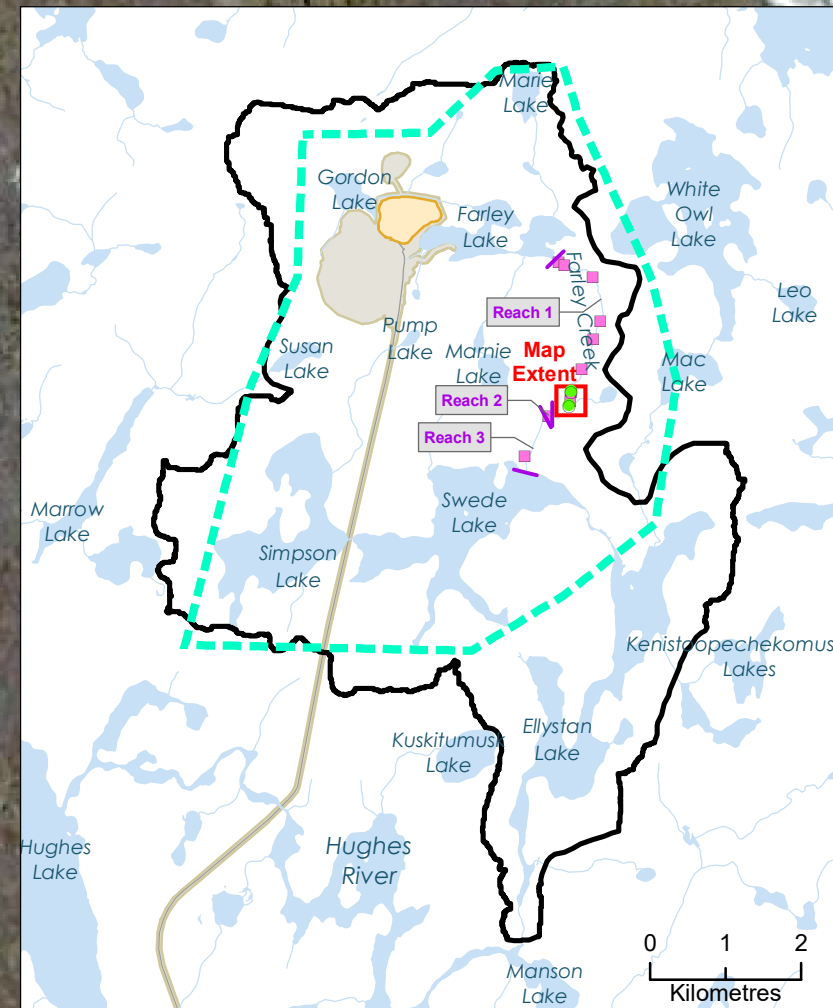
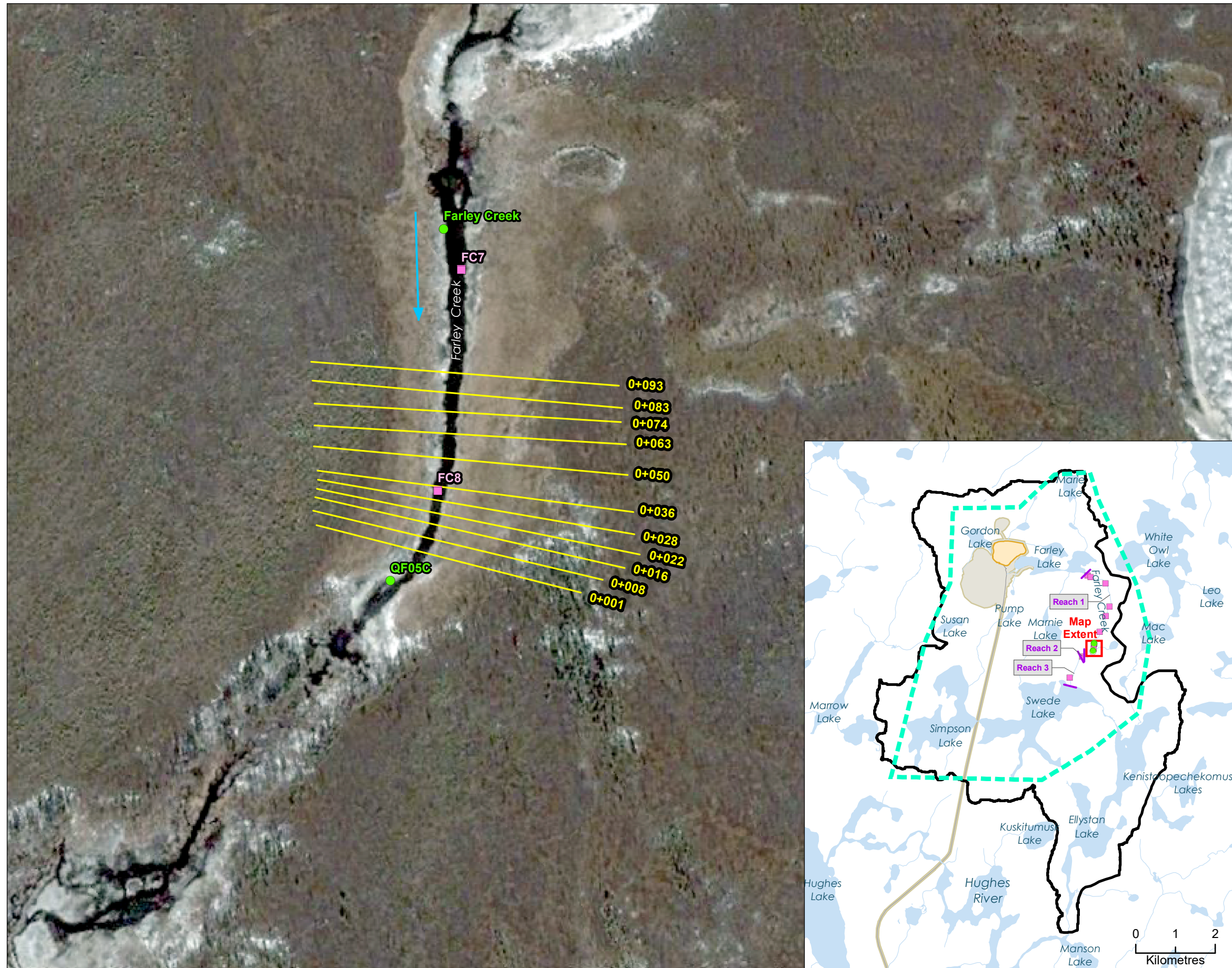
- Proposed Open Pit
- Project Development Area

Sample Locations

- Farley Creek Transect Locations, 2024
- Farley Creek Pressure Transducers
- Farley Creek Reach Breaks
- Farley Creek Transects used in HEC-RAS model in Reach 1 of Farley Creek, 2020
- Extent of Satellite Imagery

Landbase

- Surface Water Flow Direction
- Existing Access Road



- Notes**
1. Coordinate System: NAD 1983 UTM Zone 14N
 2. Base Data Sources: Government of Manitoba and Government of Canada.
 3. Imagery: Google Earth

Project Location
Lynn Lake, Manitoba
Prepared by ACampigotto on 2024-08-26
Technical Review by KMathers on 2024-08-26

Client/Project
ALAMOS GOLD INC.
Lynn Lake Gold Project
111473076

Map No.
B-12

Title
Monitoring Locations in Farley Creek - Gordon site

Proposed Water Temperature Logger Locations

- Water Temperature Logger

Project Infrastructure

- ▭ Proposed Open Pit
- ▭ Project Development Area

Study Area

- ▭ Fish and Fish Habitat Local Assessment Area (LAA)

Landbase

- Existing Access Road
- ➔ Surface Water Flow Direction
- Highway
- Watercourse
- Waterbody
- First Nation Reserve



0 1 2 Kilometres
(At original document size of 11x17)
1:75,000

Notes

- Coordinate System: NAD 1983 UTM Zone 14N
- Base Data Sources: Government of Manitoba and Government of Canada.

Project Location

Lynn Lake,
Manitoba

Prepared by ACampigotto on 2025-01-21
Technical Review by BHome on 2025-01-21

Client/Project

ALAMOS GOLD INC.
Lynn Lake Gold Project

111473084

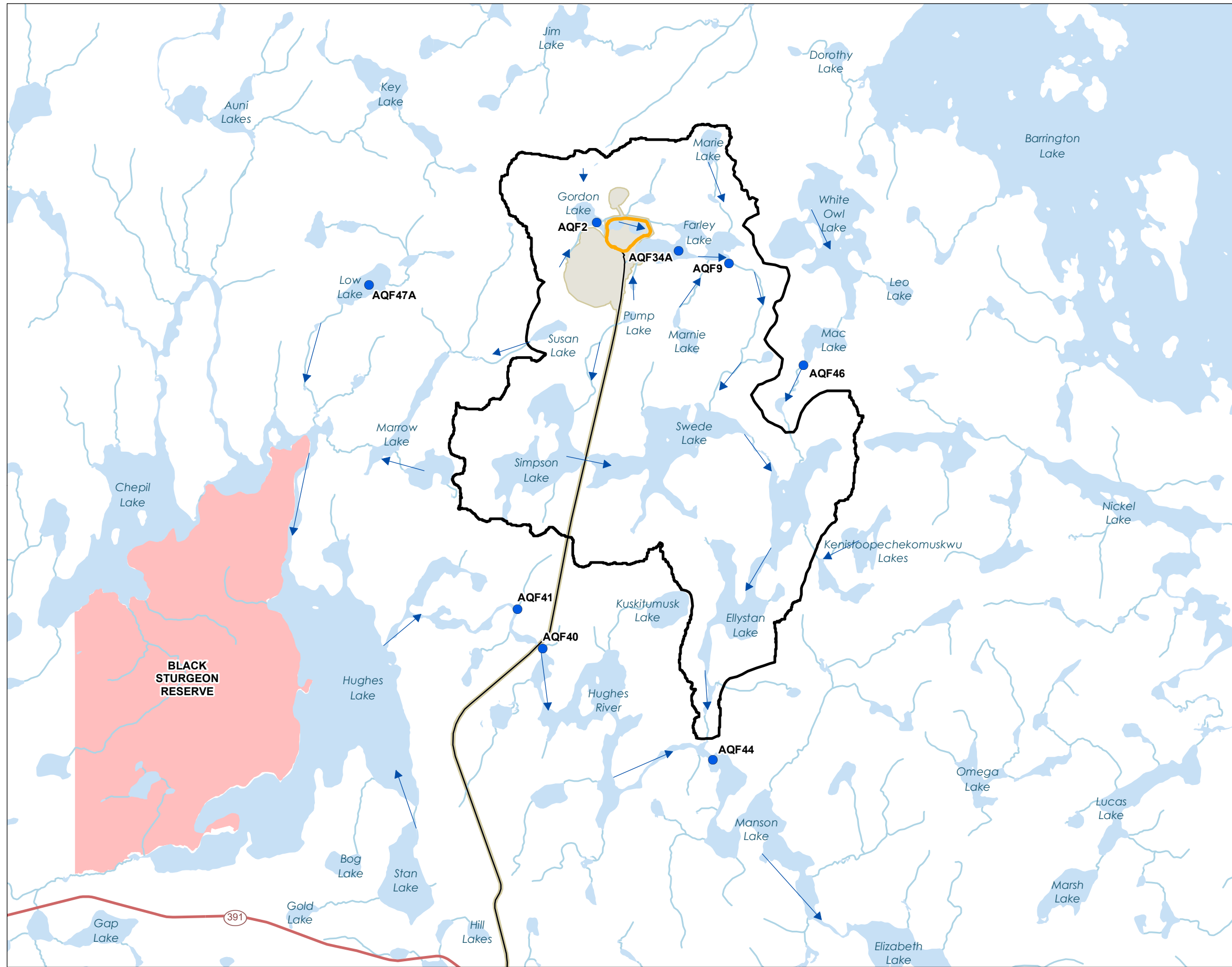
Map No.

B-13

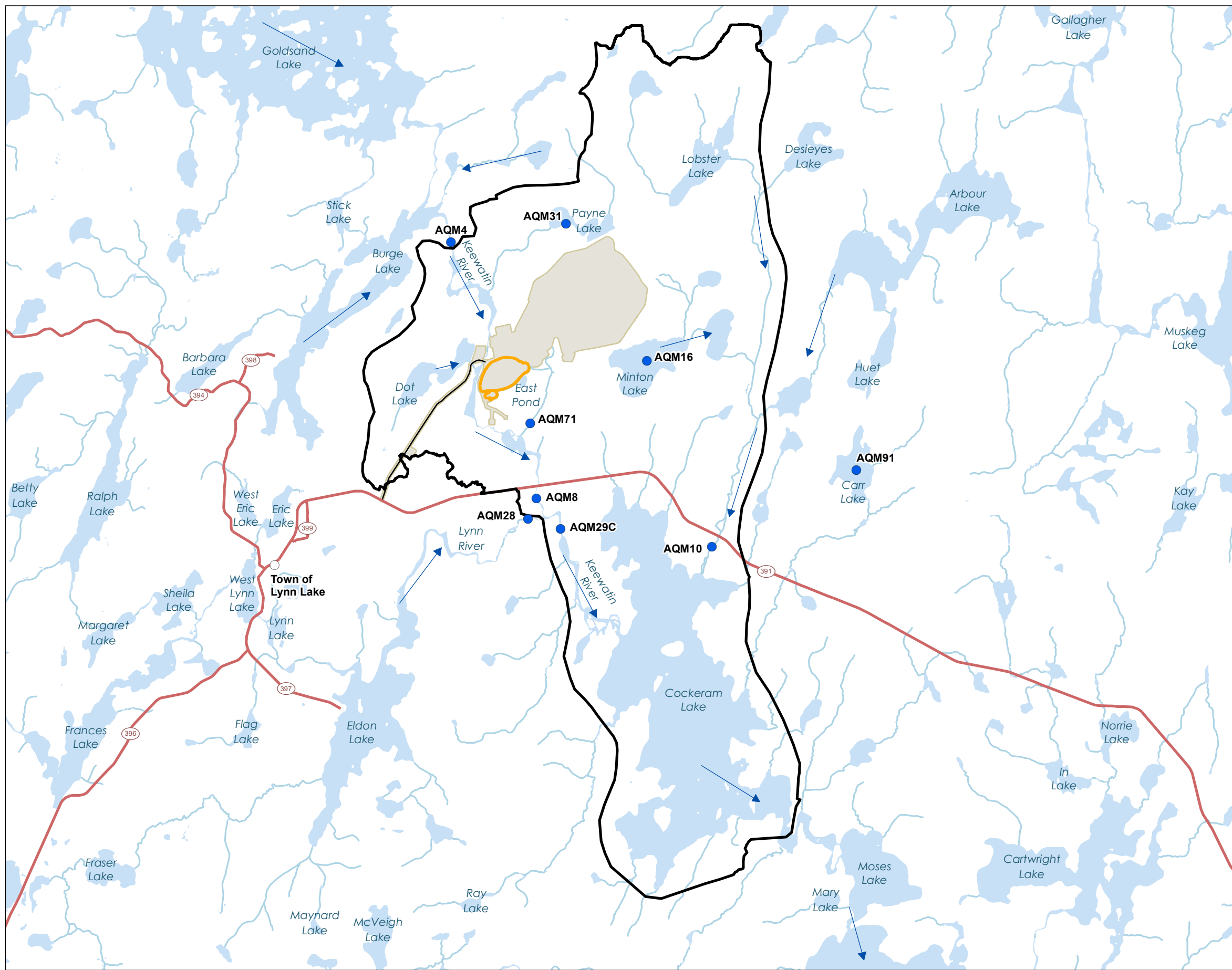
Title

**Proposed Water Temperature
Loggers – Gordon site**

G:\GIS\Project_Folder\111473084\LGP_EA\RA\Aquatics\Monitoring\Plan\August_2024\Updates_ABP\Map8-13_ABP_WaterTemperatureLoggers_Gordon_20250121.mxd Revised: 2025-01-22 By: ACampigotto



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Proposed Water Temperature Logger Locations

- Water Temperature Logger

Project Infrastructure

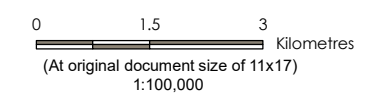
- ▭ Proposed Open Pit
- ▭ Project Development Area

Study Area

- ▭ Fish and Fish Habitat Local Assessment Area (LAA)

Landbase

- Existing Access Road
- ➔ Surface Water Flow Direction
- Highway
- Watercourse
- Waterbody



- Notes**
- Coordinate System: NAD 1983 UTM Zone 14N
 - Base Data Sources: Government of Manitoba and Government of Canada.

Project Location
Lynn Lake, Manitoba

Prepared by ACampigotto on 2025-01-21
Technical Review by BHome on 2025-01-21

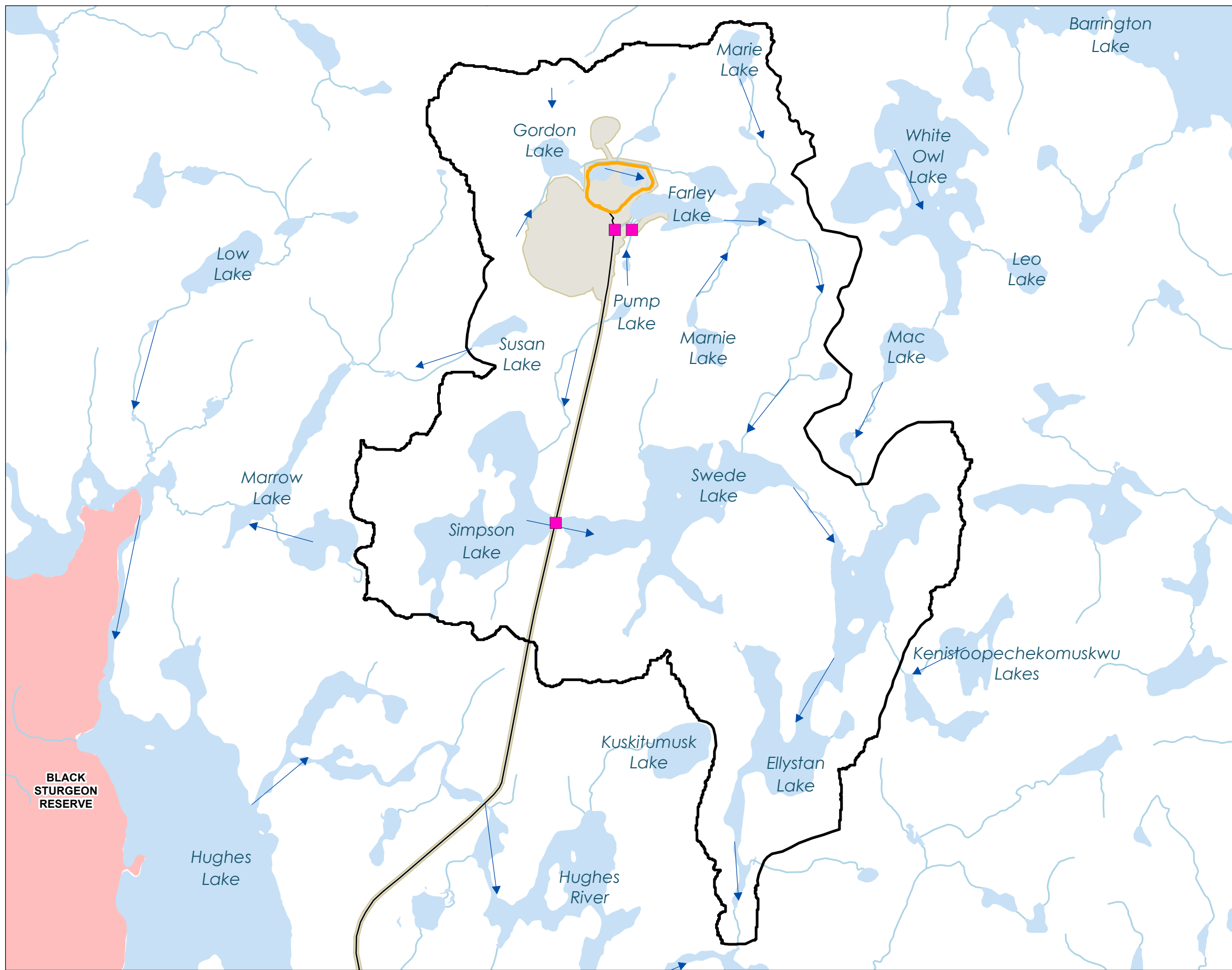
Client/Project
ALAMOS GOLD INC.
Lynn Lake Gold Project

111473084

Map No.
B-14

Title
Proposed Water Temperature Loggers – MacLellan site

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Proposed Locations

■ Proposed Culvert Location

Project Infrastructure

▭ Proposed Open Pit

▭ Project Development Area

Study Area

▭ Fish and Fish Habitat Local Assessment Area (LAA)

Landbase

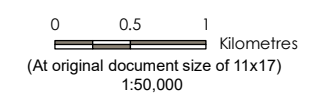
— Existing Access Road

➔ Surface Water Flow Direction

— Watercourse

■ Waterbody

■ First Nation Reserve



Notes

- 1. Coordinate System: NAD 1983 UTM Zone 14N
- 2. Base Data Sources: Government of Manitoba and Government of Canada.

Project Location

Lynn Lake, Manitoba

Prepared by ACampigotto on 2024-08-26
Technical Review by KMathers on 2024-08-26

Client/Project

ALAMOS GOLD INC.
Lynn Lake Gold Project

111473076

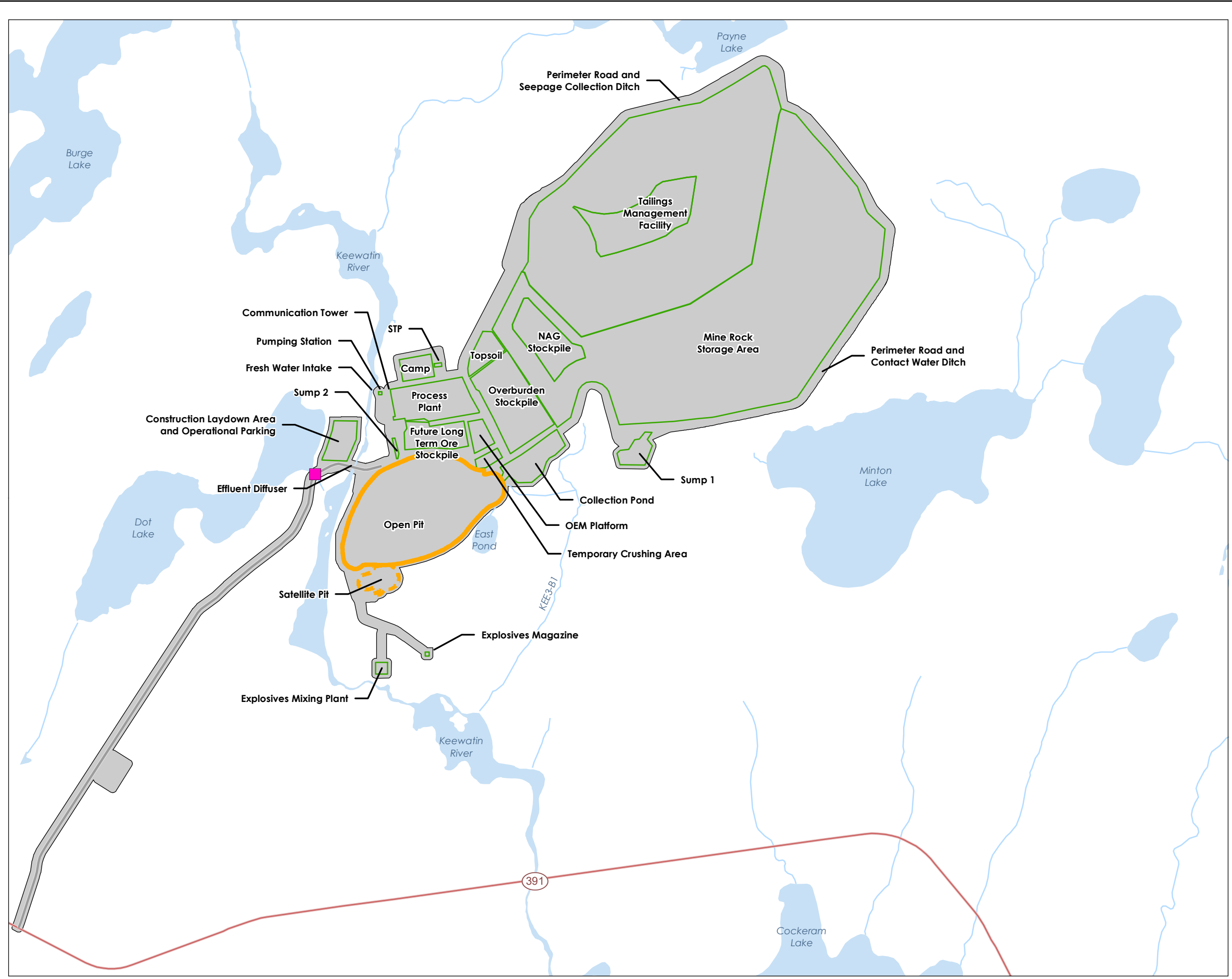
Map No.

B-15

Title

Proposed Culvert Locations – Gordon site

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Proposed Locations

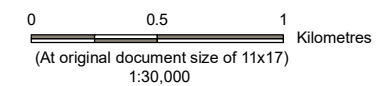
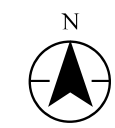
- Proposed Culvert Location

Project Infrastructure

- Open Pit
- Satellite Pit
- Other Infrastructure
- Project Development Area

Landbase

- Highway
- Existing Access Road
- Watercourse
- Waterbody



- Notes**
1. Coordinate System: NAD 1983 UTM Zone 14N
 2. Base Data Sources: Government of Manitoba and Government of Canada.
 3. Project Infrastructure features provided by QPit and Ausenco.

Project Location
Lynn Lake, Manitoba
Prepared by ACampigatto on 2024-08-26
Technical Review by KMathers on 2024-08-26

Client/Project
ALAMOS GOLD INC.
Lynn Lake Gold Project
111473076

Map No.

B-16

Title

Proposed Culvert Locations – MacLellan site

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Proposed Monitoring Locations

- Impact Location
- Reference Location

Project Infrastructure

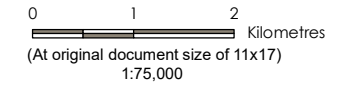
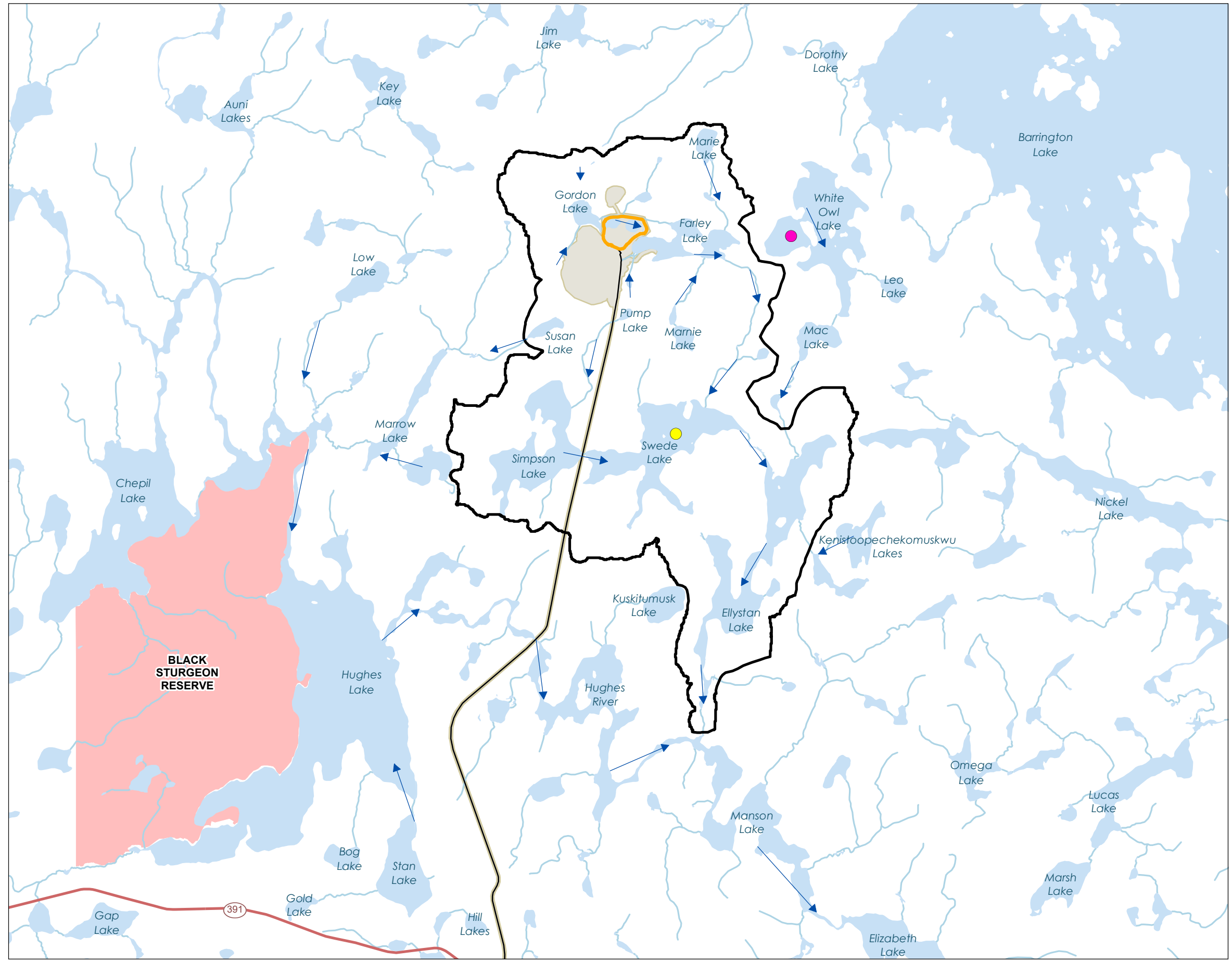
- ▭ Proposed Open Pit
- ▭ Project Development Area

Study Area

- ▭ Fish and Fish Habitat Local Assessment Area (LAA)

Landbase

- Existing Access Road
- ➔ Surface Water Flow Direction
- Highway
- Watercourse
- Waterbody
- First Nation Reserve



Notes

1. Coordinate System: NAD 1983 UTM Zone 14N
2. Base Data Sources: Government of Manitoba and Government of Canada.

Project Location
Lynn Lake,
Manitoba

Prepared by ACampigatto on 2024-08-26
Technical Review by KMathers on 2024-08-26

Client/Project
ALAMOS GOLD INC.
Lynn Lake Gold Project

111473076

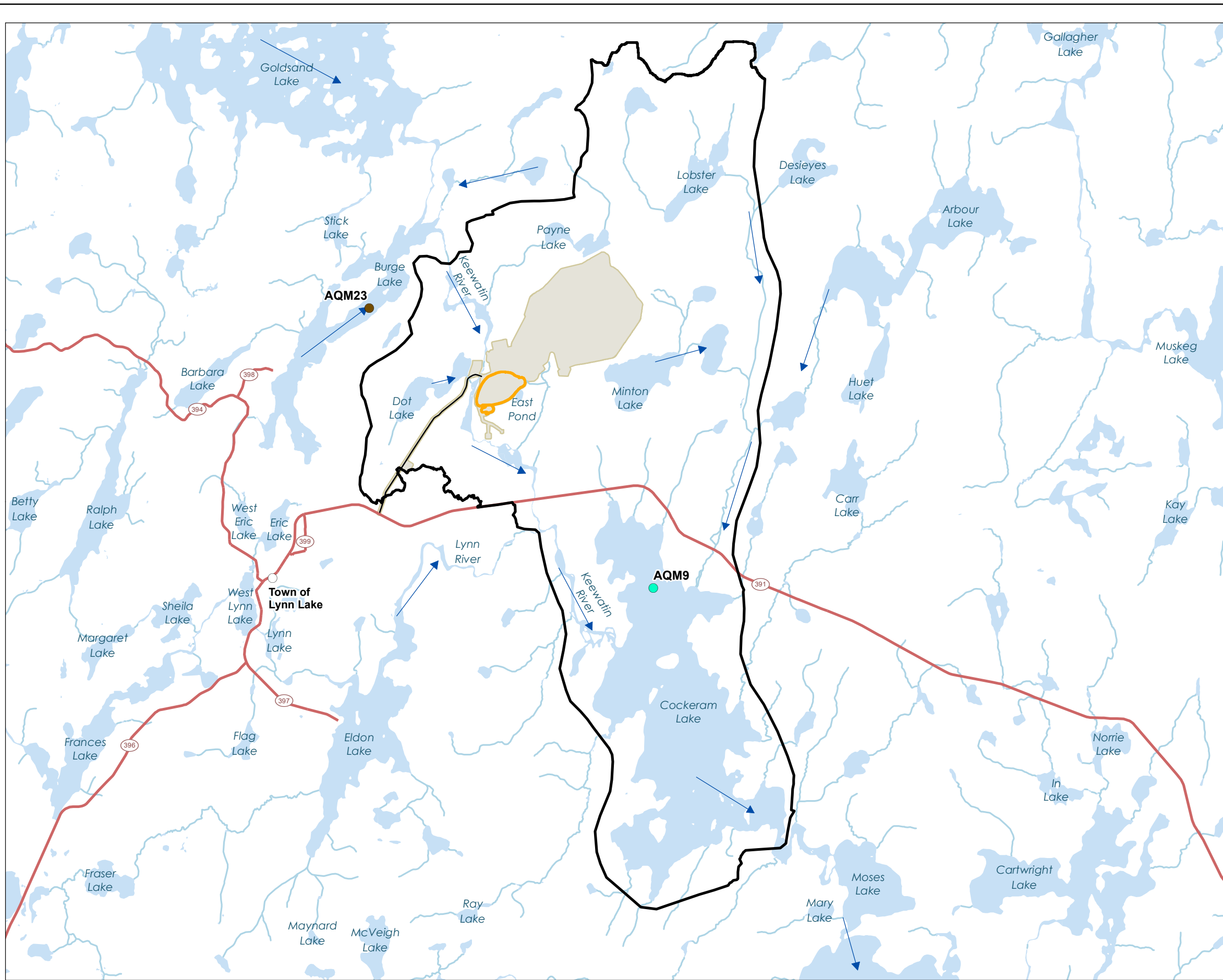
Map No.

B-17

Title

**Proposed Fish Population
Monitoring Locations –
Gordon site**

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 Revised: 2025-01-22 By: ACampigotto



Proposed Fish Population Monitoring Locations

- Impact Location
- Reference Location

Project Infrastructure

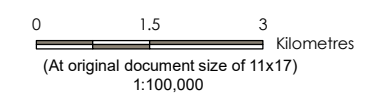
- Proposed Open Pit
- Project Development Area

Study Area

- Fish and Fish Habitat Local Assessment Area (LAA)

Landbase

- Existing Access Road
- ➔ Surface Water Flow Direction
- Highway
- Watercourse
- Waterbody



Notes
 1. Coordinate System: NAD 1983 UTM Zone 14N
 2. Base Data Sources: Government of Manitoba and Government of Canada.

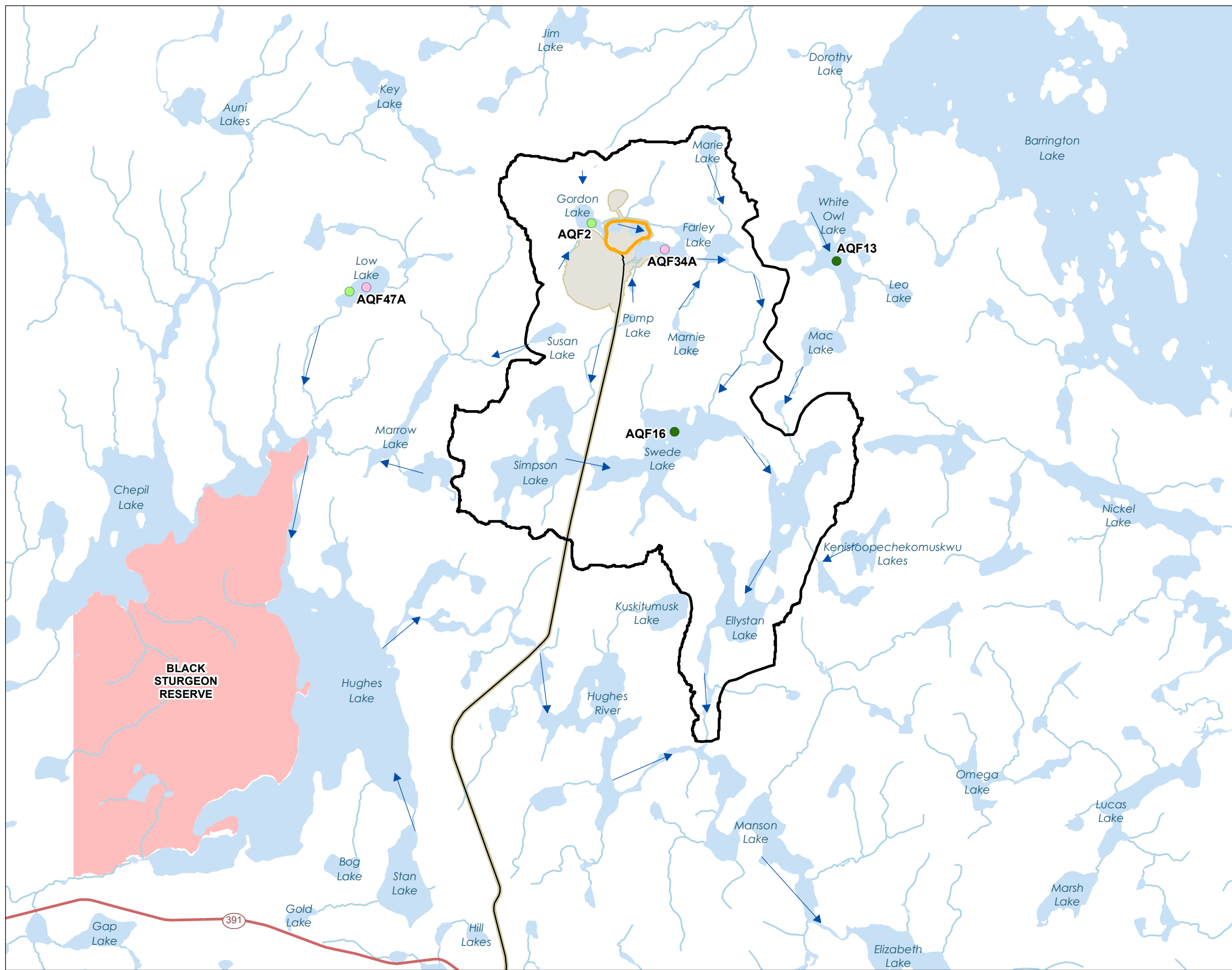
Project Location
 Lynn Lake, Manitoba
 Prepared by ACampigotto on 2025-01-20
 Technical Review by BHome on 2025-01-20

Client/Project
 ALAMOS GOLD INC.
 Lynn Lake Gold Project
 111473084

Map No.
B-18

Title
Proposed Fish Population Monitoring Locations – MacLellan site

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Proposed Fish Tissue Sampling Locations

- small-bodied fish
- large-bodied fish
- amphipod/freshwater mussel

Project Infrastructure

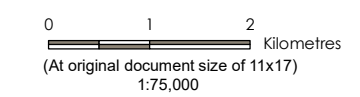
- Proposed Open Pit
- Project Development Area

Study Area

- Fish and Fish Habitat Local Assessment Area (LAA)

Landbase

- Existing Access Road
- ➔ Surface Water Flow Direction
- Highway
- Watercourse
- Waterbody
- First Nation Reserve



Notes
 1. Coordinate System: NAD 1983 UTM Zone 14N
 2. Base Data Sources: Government of Manitoba and Government of Canada.

Project Location
 Lynn Lake, Manitoba
 Prepared by ACampigotto on 2025-01-21
 Technical Review by BHome on 2025-01-21

Client/Project
 ALAMOS GOLD INC.
 Lynn Lake Gold Project
 111473084

Map No.
B-19

Title
Proposed Fish Tissue Sampling Locations – Gordon site

Proposed Fish Tissue Sampling Locations

- small-bodied fish
- large-bodied fish

Project Infrastructure

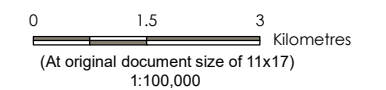
- Proposed Open Pit
- Project Development Area

Study Area

- Fish and Fish Habitat Local Assessment Area (LAA)

Landbase

- Existing Access Road
- ➔ Surface Water Flow Direction
- Highway
- Watercourse
- Waterbody



Notes
 1. Coordinate System: NAD 1983 UTM Zone 14N
 2. Base Data Sources: Government of Manitoba and Government of Canada.

Project Location
 Lynn Lake, Manitoba
 Prepared by ACampigotto on 2025-01-20
 Technical Review by BHome on 2025-01-20

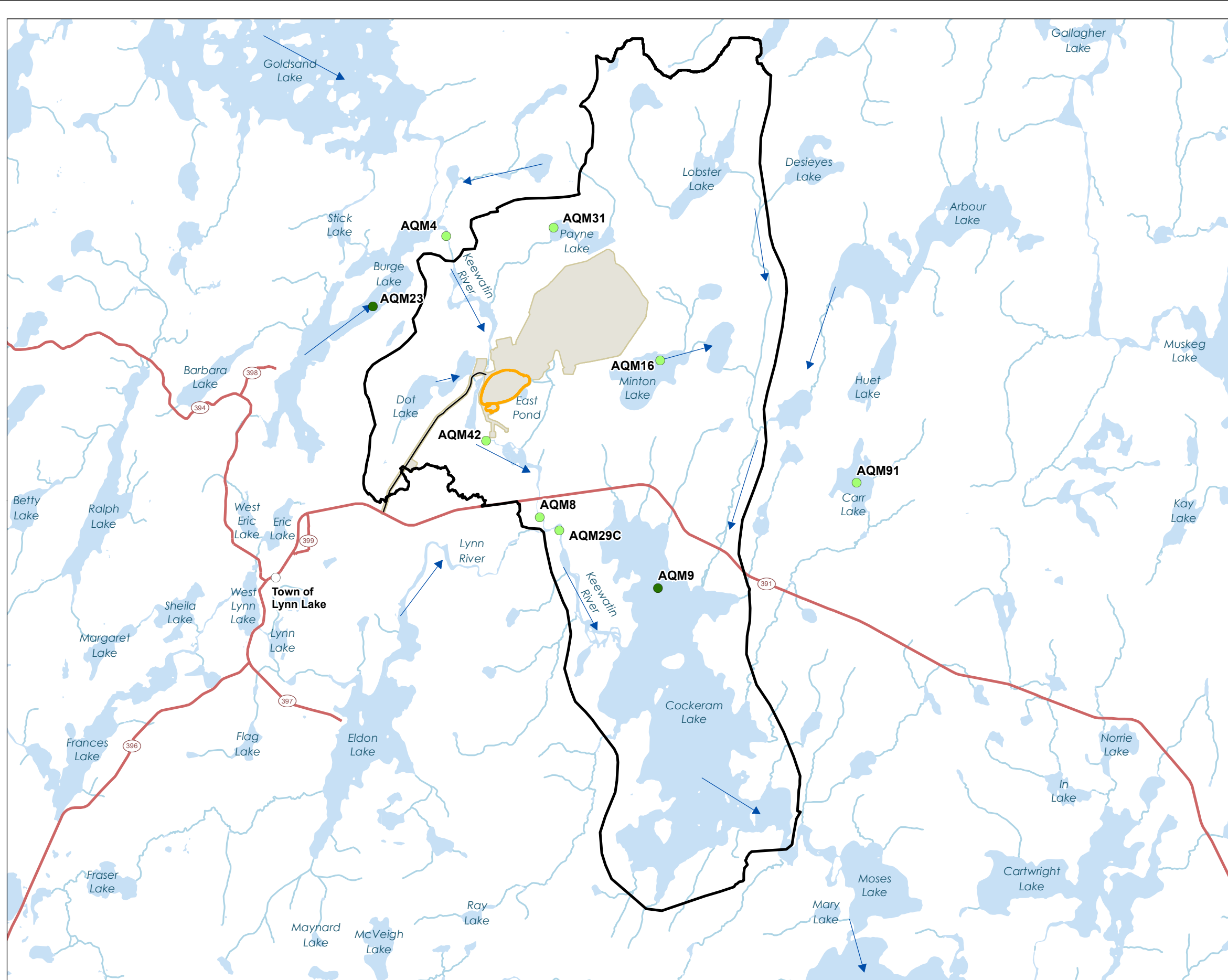
Client/Project
 ALAMOS GOLD INC.
 Lynn Lake Gold Project
 111473084

Map No.

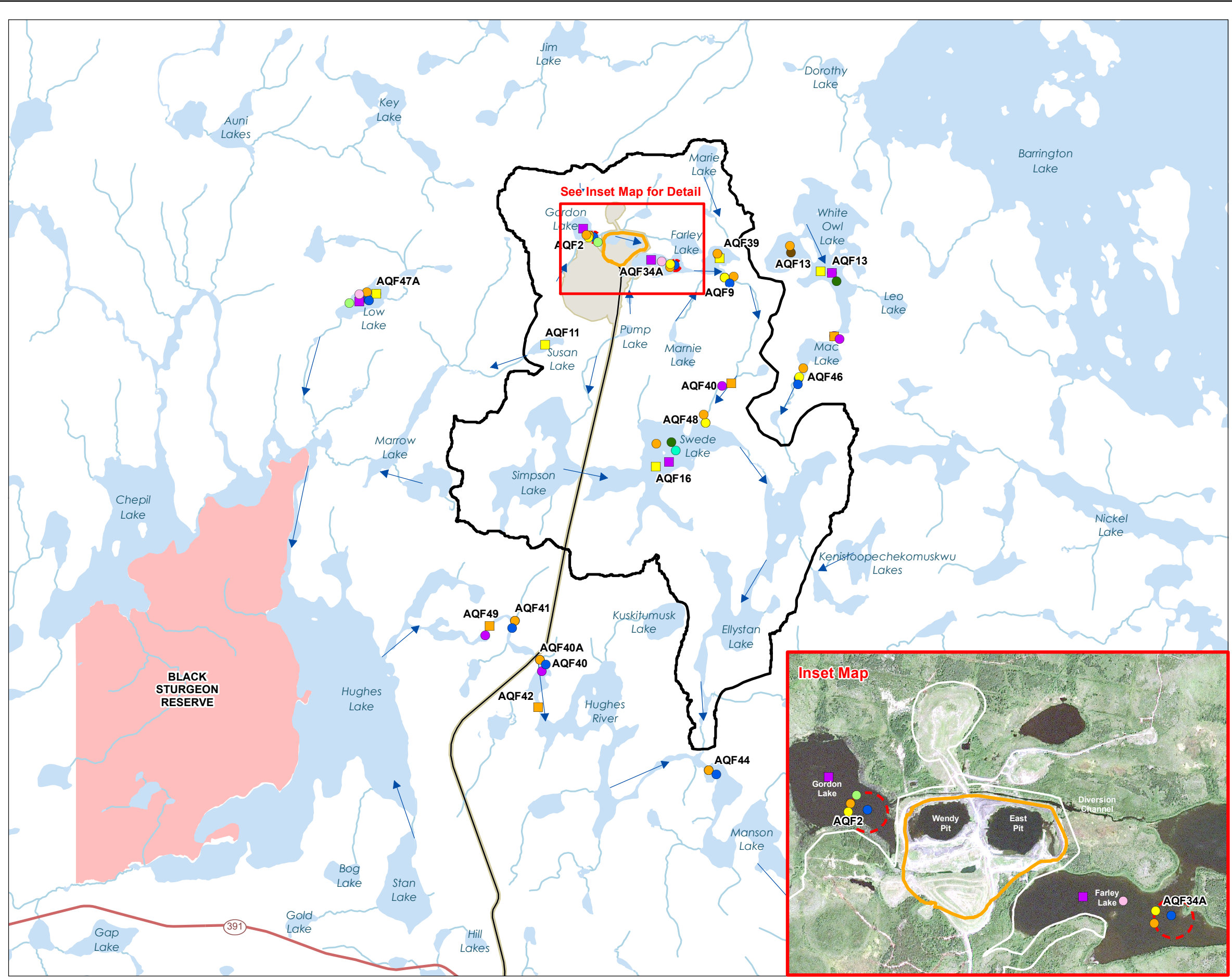
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Title

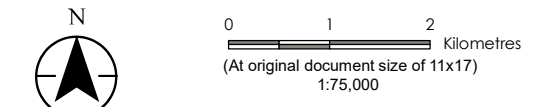
Proposed Fish Tissue Sampling Locations – MacLellan site



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- Proposed Sediment Quality Monitoring Locations**
 - Fixed Sample
 - Random Sample
- Proposed Benthic Invertebrate Monitoring Locations**
 - Depositional Sample
 - Erosional Sample
- Proposed Chlorophyll Monitoring Location**
 - Periphyton Sample
 - Phytoplankton Sample
- Proposed Water Temperature Logger Location**
 - Water Temperature Logger
- Proposed Fish Population Monitoring Location**
 - Impact Location
 - Reference Location
- Proposed Fish Tissue Sampling Location**
 - small-bodied fish
 - large-bodied fish
 - amphipod/freshwater mussel
- Project Infrastructure**
 - Proposed Open Pit
 - Project Development Area
 - Effluent Mixing Zones
- Study Area**
 - Fish and Fish Habitat Local Assessment Area (LAA)
- Landbase**
 - Existing Access Road
 - Surface Water Flow Direction
 - Highway
 - Watercourse
 - Waterbody
 - First Nation Reserve



Notes
 1. Coordinate System: NAD 1983 UTM Zone 14N
 2. Base Data Sources: Government of Manitoba and Government of Canada.

Project Location
 Lynn Lake, Manitoba
 Prepared by ACampigotto on 2025-01-20
 Technical Review by BHome on 2025-01-20

Client/Project
 ALAMOS GOLD INC.
 Lynn Lake Gold Project
 111473084

Map No.
B-21
Title

Proposed Monitoring Locations – Gordon site

