IZOK CORRIDOR PROJECT
PROJECT PROPOSAL

Volume 1













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EXECUTIVE SUMMARY

Introduction

The Izok Corridor Project ('the Project') is a proposed zinc mine development located in the Kitikmeot region of Nunavut. The nearest community to the Project is Kugluktuk, which is located on the shore of Coronation Gulf near the mouth of the Coppermine River. The Project consists of a mine site at Izok Lake and at High Lake, an all-season access road, and a port facility. The Izok and High Lake mines will produce primarily zinc, as well as some copper concentrate with a small amount of lead concentrate. The concentrate will be trucked to a port at Grays Bay on the Coronation Gulf, where it will be transported by bulk-carrier ships, during the open water season, to smelters in Asia and Europe.

Minerals and Metals Group (MMG) is submitting this Project Proposal to initiate the regulatory review of the Project. The description of the Project, its components and all environmental information contained within this Project Proposal is preliminary in nature and based on pre-feasibility design. In early 2012, MMG initiated a feasibility study for the Project. Subject to approval of the feasibility study by the MMG Executive Committee, MMG plans to deliver a DEIS to the NIRB in mid to late 2013.

MMG is initiating the NIRB process with the submission of various licence and permit applications with this Project Proposal, including a Type 'A' Water License application to the NWB, an application for Crown Land for the Grays Bay Port to Aboriginal Affairs and Northern Development Canada (AANDC), a Land Use Permit Application for the Izok Mine facilities to the Kitikmeot Inuit Association (KIA), and an application for a Section 35 Fisheries Act authorization to Fisheries and Ocean Canada (DFO). The Type 'A' Water License application is being submitted to both the NIRB and the NWB in the interest of initiating a coordinated NIRB-NWB review process.

Given that the Project footprint is entirely within the boundaries of Nunavut and MMG's initial determination that any direct effects of the Project will be limited to Nunavut, MMG anticipates that the NIRB screening will lead to a decision that the Project be reviewed under Part 12.5 of the Nunavut Land Claims Agreement.

Project Proponent

MMG is an Australian base metal mining company, based in Melbourne with Canadian headquarters in Vancouver, British Columbia. MMG has a workforce of more than 8,500 people around the world. It currently employs 33 people at its Vancouver office.

MMG is a wholly owned subsidiary of Minmetals Resources Limited (Minmetals), which is a diversified mining and metals business and one of the world's largest producers of zinc and a substantial producer of copper, lead, gold and silver. The majority shareholder of Minmetals is China Minmetals Corporation (CMC), headquartered in Beijing China. CMC was founded in 1950 and owns businesses in 26 nations and regions around the world.

MMG's corporate goal is to maintain and expand its position as a leading internationally diversified base metals group. Its objective is to be one of the top three mid-tier mining companies within five years. This goal will be achieved by developing its upstream, diversified base metals operations through exploration and discovery, organic growth, and acquisitions.

Project Description

The Izok Corridor Project involves mining the zinc-rich deposits of the Izok and High Lake properties, and processing the ore at the Izok Mine. In order to ship the concentrate to customers, MMG will construct a ~350 km all-season road (Izok Road) connecting the Izok Mine (the more southerly mine) to the High Lake Mine and north to a port at Grays Bay. Facilities at the Grays Bay Port will support loading of bulk-carrier ships, as well as re-supply of fuel and goods for the Project.

Development of the Izok Corridor Project will require land at Grays Bay for storage and port facilities and associated infrastructure, at the Izok and High Lake Mine sites for infrastructure, open pits, waste rock/overburden and tailings impoundment areas, and along the Izok Road corridor. The total land requirement for the Project is estimated at 1,160 hectares (ha).

MMG intends to file an Exceptions Application to the NIRB for authorization to proceed with pre-construction works prior to completion of the Project review. Current plans for pre-construction works include early staging of equipment and materials and other preparatory activities, including construction of the two winter roads.

Temporary winter roads will be established between the proposed Izok Mine and the Tibbitt-Contwoyto Ice Road (TCWR) and between Grays Bay and High Lake to facilitate construction. The Izok winter road will be used to bring construction equipment and materials into the site from Yellowknife. The High Lake winter road will be used to move construction equipment and materials from Grays Bay.

The preliminary Project schedule assumes that the pre-construction activities will occur in advance of receiving the Project Certificate. Following regulatory approval, construction of the Grays Bay Port and the Izok Road will begin. Current reserves indicate a mill operating life of approximately 12 years at an average production rate of approximately 2 million tonnes of ore per annum (Mtpa).

The total construction workforce will be approximately 1,140 workers, including management, trades people and labourers taking into consideration shifts and rotation. During the operations phase, the total workforce is estimated to be approximately 710 people. Given the demand for labour associated with the Izok Corridor Project, Kitikmeot residents can expect opportunities for employment and for developing skills and knowledge.

Izok and High Lake Mines

Planning for the Izok and High Lake mines is being driven by the goal of a mine closure plan that presents the lowest long-term environmental risk and the lowest risk of long-term maintenance and related costs. MMG is focused on designing waste and water management plans that will support this goal.

The Izok deposits will be will be mined by open pit and underground methods. The deposits planned for open pit mining are located directly below Izok Lake. This will require the draining of Izok Lake and diverting the water into the downstream lake (Itchen Lake) to allow extraction of the resource. Izok Lake dewatering will be guided by a detailed Water Management Plan. In addition, a Fish Management Plan and Fish Habitat Compensation Plan will also be prepared in collaboration with the Hunters and Trappers Organizations (HTOs) and Fisheries and Oceans Canada (DFO).

Potentially acid generating (PAG) and non-acid generating (NAG) mineral wastes removed from the open pit mine and underground mine will be placed largely within the outline of the drained Izok Lake to minimize the area of disturbance at closure. The majority of the PAG mineral wastes will be deposited sub-aerially and the balance deposited subaqueously deep in the worked out open pit. Potential production and release of acid rock drainage (ARD) and metal leaching (ML) will be managed by keeping the PAG mineral wastes frozen. Surface water contact with PAG mineral waste piles will be minimized by locating the piles within the topography at Izok Mine and by installing surface water diversion channels and berms as required.

The tailings design approach at the Izok Mine will be similar to that for PAG waste rock, and will involve sub-aerial frozen deposition.

Deposits at the High Lake Mine will be mined by both open pit and underground mining methods. As described for the Izok Mine, the majority of PAG mine wastes from High Lake will be sub-aerially deposited. During operations, the production and release of ARD/ML will be managed by ensuring that freezing of the PAG waste rock occurs during or shortly after deposition, and that this material remains frozen year round in perpetuity. A Mineral Waste Management Plan will be implemented to confirm waste pile design assumptions, and to identify where potential changes to the plan may be required.

Izok Road

The Izok Road will be constructed between the Izok Mine and Grays Bay Port to transport concentrate from the processing plant at the Izok Mine to the port, and to backhaul ore from the High Lake Mine to the processing plant. Izok Road will also be used to transport personnel, fuel, cement, explosives and other mine supplies from the port to the mines. Although the majority of resupply materials to the Izok Mine will be via the port and Izok Road, there may be occasions when some re-supply is required from the south via the TCWR during winter.

The proposed route of the Izok Road is based on available topographic information and preliminary route reconnaissance. Environmental and archaeological studies have also been undertaken, as well as preliminary identification of potential sources of granular fill and rock quarries. The ongoing feasibility study will include more detailed road design work and changes to the current alignment will be made to optimize the route. Key road design considerations will include minimizing the length and number of stream crossings, optimizing the use of road building material sources and avoiding disturbance of ground ice and permafrost.

MMG is considering alternate route alignments for two segments of the Izok Road based on information gathered during the feasibility study. These alternative route alignments are being considered due to MMG's interest in reducing haul distances, minimizing the number and lengths of streams crossings, avoiding challenging terrain features, reducing the potential for wildlife interactions, and increasing road user safety.

Grays Bay Port

Grays Bay Port will be located approximately 330 km northeast from the Izok Mine site, and 50 km north of the High Lake Mine site. The port will consist of two main components: land-based infrastructure such as a concentrate storage building, fuel storage and laydown area, camp and administration office; and the dock itself.

Land-based activities at the Port site will continue year round and will consist of trucks delivering the concentrate to the concentrate storage building, trucks picking up diesel, sea-containers and supplies to bring to the mine sites. A Traffic Management Plan will be developed to minimize potential interactions with wildlife, particularly the Dolphin and Union Caribou Herd prior to their spring migration to Victoria Island.

Marine activities will be limited to the ice-free months in Coronation Gulf (roughly from mid July to mid October) when fuel and supplies for the Project will be delivered and the concentrate will be loaded and transported by bulk-carrier ships. This may also involve barge traffic. At this time, MMG does not plan to break continuous landfast ice. Ice floes will be moved or broken by an ice breaker as needed during the months of July to October.

Marine Transportation

Between 450,000 and 650,000 DMT of mineral concentrates will be shipped from Grays Bay through the Coronation Gulf to ports in Europe and Asia. Diesel oil and resupply cargo will also be transported into Grays Bay every year to re-supply the port and mine operations.

Coronation Gulf is ice free for three to four months each year. Shipping access through the Coronation Gulf must, however, pass through parts of the Arctic Ocean that have narrower ice-free periods. While the length of the shipping season will depend on vessel design (ice classification) and ice conditions, the maximum length of the shipping season will be, in many cases, limited to 100 to 120 days to be consistent with the draft Kitikmeot Regional Land Use Plan. Shipping activities will also take into account sensitive coastal and offshore areas, wildlife migration timing and shipping considerations outlined in the North Baffin Regional Land Use Plan.

At this time, it is estimated that 16 round trips will be needed during the peak year of production. The current plan is to use Polar Class 6 or equivalent ships with ice-breaker support.

MMG will consult with several boards and agencies to prepare a environmental management plans to mitigate marine transport effects on marine mammals and birds as part of the Shipping Management Program.

Public Engagement

MMG recognizes the important role that public engagement plays in planning and design of the Project, managing environmental effects and developing mitigation and future monitoring programs. MMG is committed to developing a public participation program to facilitate engagement with potentially affected communities, residents, Inuit Organizations, Aboriginal groups and other governments to ensure that their input in considered in alternative options, and their views are integrated into Project planning and selection of preferred Project alternatives.

Following extensive consultation undertaken in relation to the High Lake Project in 2004-2006 and the Izok Project in 2007-2008, MMG re-initiated discussions with Nunavut regulators and Kitikmeot communities in early 2012. The purpose of these meetings and community visits was to provide updates on the Izok Corridor Project and MMG's long-term plan for its presence in Nunavut, and to seek preliminary feedback on issues and concerns that will need to be considered in the design of the Project.

Further sessions and site visits will be conducted with regulators, community advisory committees, Hunters and Trappers Organizations (HTOs), mayors and councils, and the broader Kitikmeot public throughout the Project review phase. MMG will continue to keep the Tlicho in NWT informed, and will arrange a meeting with the Inuvialuit Game Council to advise them of Project-related marine shipping proposed along the western route. Other key initiatives will include establishment of working groups with community and agency representatives, and visits to communities that have an interest in the Project.

MMG established a community liaison office in Kugluktuk in 2009. The Community Liaison Officer provides direct support to MMG in hiring seasonal staff for the exploration and environmental programs, and provides local knowledge and insight to the planning and design of field programs, development and delivery of the consultation strategy and overall advice to the MMG team. The Community Liaison Officer also assists with implementation of the MMG community sponsorship program by working closely with the mayors of Kugluktuk and Cambridge Bay in the selection of applicants for funding.

Traditional Knowledge

MMG is building on the traditional knowledge (TK) studies initiated in 2004 for the High Lake Project through a multi-part TK program for the Izok Corridor Project. The program will include continued collection of documented knowledge for the entire Project area, recording of Inuit Qaujimajatuqangit (IQ) from Inuit in the Project area (elders, HTO) and Tlicho interests around Izok Lake, and incorporating issue-specific advice from community knowledge holders.

While gathering knowledge is a core part of the work, MMG's primary interest is the application of this knowledge. In particular, MMG is interested in the contribution traditional knowledge can make to design of the Project, baseline information for the Project area, and aspects of the environmental assessment, including identification of issues, effects analysis, identification of potential mitigation measures, determination of effects significance and follow-up and monitoring programs.

Traditional knowledge collection will involve community workshops and meetings to discuss how local residents view the Project and the acceptability of its potential effects on the environment and its people within the context of local knowledge. MMG is also arranging with the KIA to obtain a traditional knowledge report for the entire Project area.

Existing Biophysical Environment

Based on regulatory and community engagement conducted in relation to the High Lake Project Draft Environmental Impact Statement (DEIS) and other Part 5 reviews for mining projects in Nunavut, MMG has developed the following preliminary list of Valued Ecosystem Components (VECs) for the Izok Corridor Project DEIS. This list of VECs will be further refined through the regulatory scoping process and ongoing public engagement.

- Air Quality
- Climate
- Noise and Vibration
- Landforms and Soils
- Vegetation
- Terrestrial Wildlife and Wildlife Habitat
- Terrestrial Birds
- Hydrogeology
- Surface Hydrology
- Water and Sediment Quality
- Aquatic Organisms, Fish and Habitat
- Marine Environment
- Water and Sediment Quality
- Aquatic Organisms and Habitat
- Marine Mammals and Habitat
- Marine Birds and Habitat

Baseline studies of the existing biophysical environment have been scoped to include the local study area around key Project components (including the Izok and High Lake mines, the Izok Road, and the Grays Bay Port) within which the maximum spatial extent of potential Project effects are expected to occur. In addition, more regional baseline information is being collected to support the assessment of Project effects that could extend beyond the boundaries of the local study area and act cumulatively with similar effects of other projects and activities in the region.

For most of the VECs, much of the existing baseline was collected during field studies conducted in 2004-2007 for the High Lake project DEIS, and more recently in 2007 and 2008 for the High Lake Project proposal. Additional field studies are currently ongoing in 2012 (including associated traditional knowledge) to support preparation of the Izok Corridor Project DEIS and provide baseline for future long-term monitoring programs that will be implemented during the Project.

Existing Human Environment

The socio-economic baseline considers communities and regional assets that can be maintained or enhanced to achieve desired outcomes of the Izok Corridor Project. The study area encompasses the entire Kitikmeot region. The Valued Socio-economic Components (VSECs) of the general community assets include:

- Human assets of the socio-economic environment, which encompass the skills and knowledge inherent in the community, the opportunities for growth and learning, access to skills and knowledge, and access to essential services that are fundamental in maintaining individual, family and community wellness
- Economic assets, which consider the opportunities available to people for employment and participation in the economic life of the community and region, including the monetary or financial resources that people and governments use to achieve their economic objectives
- Physical assets, which encompass the basic infrastructure that allows a community to function effectively
- Social assets, which include the traditional and community activities in which people participate and the facilities or amenities that they draw upon to access them

- Natural assets, which consider the biophysical environment upon which community well-being depends (air, land, waters and wildlife)

In addition to these assets, three broad VSECs are considered not necessarily as assets, but desired community well-being outcomes. These include individual and family wellness, community wellness and personal security (including financial and food security)

The Project Proposal provides a description of the baseline conditions of each these community assets within the Kitikmeot region, including available information on archaeological resources that has been collected through field programs since 2004.

Potential Biophysical Effects

The Izok Corridor Project has the potential to affect the biophysical environment through activities and infrastructure development associated with all phases of the Project (construction, operation, closure and post closure). The Project Proposal provides a preliminary identification of potential effects that could occur as a result of routine activities and facilities, as well as possible mitigation and monitoring programs that could be implemented by MMG.

MMG will be exploring opportunities to improve Project design through ongoing feasibility studies, and will consider additional specialized mitigation measures and operational strategies to minimize the potential environmental effects of the Project. MMG will also develop detailed environmental management programs and plans, based on consultation with federal and territorial agencies and other stakeholders, to support the implementation of adaptive management measures to address unanticipated adverse environmental effects of the Project.

Potential Socio-economic Effects

Potential direct effects of the Project on the socio-economic environment are largely determined by:

- Employment directly with MMG, or with a contractor
- Payment of royalties, taxes and other forms of compensation
- Changes to the biophysical environment in relation to human activities or perception

The direct socio-economic effects of the Project can be largely and effectively mitigated through measures aimed at managing human resources, protecting public and workers safety, and enhancing business development.

Indirect and induced effects may be related to the response of individuals, families and communities, and governments and other organizations (e.g., Regional Inuit Organizations, Nunavut Tunngavik Inc.) to direct Project effects on the socio-economic effects, on the natural environment, and from the Project as a whole.

The interaction between the various effects of the Project will result in various outcomes on community well-being in terms of individual and family wellness, community wellness, and personal security. The manner in which they are managed will determine whether these outcomes are beneficial or adverse. To this end, the indirect socio-economic effects of the Project can be effectively managed through adaptive approaches and collaborative problem solving such that the desired outcome is achieved. The

Project Proposal discusses the key potential effects of the Project on the socio-economic environment, and MMG's proposed approach to managing these effects.

Human Health and Ecological Risk Assessment

A Human Health and Ecological Risk Assessment (HHERA) will be conducted for the Izok Corridor Project to evaluate the potential for health effects on local people and off-work staff, and wildlife resources in the study area. The assessment will include a human health risk assessment (HHRA) and an ecological risk assessment (ERA) to evaluate potential effects on the atmospheric and aquatic environments and key wildlife species.

The HHERA program will incorporate available traditional knowledge (TK) and land use information to identify human and key ecological receptor locations, develop site-specific exposure scenarios in relation to air, soil, water and foods, and obtain information on the terrestrial and aquatic environments.

Cumulative and Transboundary Effects Assessment

The potential contribution of the Izok Corridor Project to regional cumulative effects will be assessed in accordance with NIRB requirements, and will follow the latest guidance and precedence of best practice for such assessments in various administrative jurisdictions in Canada. The cumulative effects assessment will consider the most likely cause-effect pathways through which residual Project effects could interact with other past, existing and reasonably foreseeable projects and activities both in time and space (i.e., long-range transport of a residual Project effect, residual Project effects on a broad ranging VEC, and synergistic effects of the Project that could result in a disturbance on a natural feature within a larger region under land and resource management).

Possible residual Project effects that could overlap with effects of other projects and activities to cause more regional cumulative effects includes changes in air quality, soils and vegetation from airborne dust and combustion emissions, and changes in wildlife habitat, movement patterns or mortality risk, particularly for those species that have large seasonal migration patterns or ranges (e.g., caribou, marine birds).

Cumulative effects on the socio-economic environment are anticipated to be both adverse and beneficial with overall positive outcomes on individual, family and community well-being. Any cumulative effects that occur will be the result of a complex interaction between the various effects of the Project with those of other developments, and their collective contributions to the social, cultural and economic changes or shifts occurring across Nunavut.

Applicable government plans (e.g., regional land use plans), programs and other initiatives will be identified and discussed in relation to contribution to mitigation and monitoring of cumulative biophysical and socio-economic effects.

While most residual Project effects on the biophysical environment are expected to be localized (i.e., within close proximity to the Project footprint) and therefore within Nunavut boundaries, there is the potential for some effects to be transboundary in nature (e.g., changes in air quality, effects on surface water and freshwater aquatic organisms, effects on wide-ranging wildlife species, and effects on marine mammals along the western shipping route in the NWT).

The Izok Corridor Project also has the potential to result in transboundary effects on traditional use of lands and waters for wildlife harvesting. This is due, in part, to the proximity of the Izok Mine site to the NWT border, use of a western shipping route through the Northwest Passage, and the potential for the Project to generate economic opportunities outside of Nunavut.

Accidents and Malfunctions

As part of the DEIS for the Izok Corridor Project, MMG will assess possible accidents and malfunctions that could occur during each phase of the Project, with a focus on those scenarios that have a reasonable probability of occurring. The assessment will involve a Project-wide risk assessment including the Izok and High Lake mines, the Izok Mill, Izok Road, Grays Bay Port and marine shipping.

More detailed assessments will be conducted to address the risk of transporting concentrate, fuel and reagents through the various transportation modes (i.e., via haul truck on Izok Road, via ocean-going vessels along the eastern and western shipping routes) to workers, the public and the environment.

Environmental Management Programs

Detailed management programs and plans will be developed during the Project licensing and permitting stage based on the feasibility study, further environmental studies, and consultation with federal and territorial agencies and other stakeholders. MMG has considerable management and organizational experience from its operational mines, and will be adapting this experience to arctic conditions of Nunavut for operation of the Izok Corridor Project.

MMG will prepare the following environmental management programs and plans in accordance with its Safety, Health, Environment and Community (SHEC) Management System. Inuit organizations, federal and territorial regulatory agencies and communities will be consulted during development of these plans.

- Waste Management Program
- Site Water Management Program
- Risk Management Program
- Shipping Management Program
- Roads Management Program
- Aquatic Effects Monitoring and Management Program
- Wildlife Mitigation and Monitoring Program
- Borrow Pit and Quarry Management Plan
- Explosives Management Plan
- Air Quality Monitoring and Management Plan
- Noise Abatement Plan
- No Net Loss Plan
- Closure Reclamation Plan

Adaptive strategies will be integrated into these environmental management programs and plans to assess the effectiveness of associated mitigation and management measures, and enable improvements to be made throughout the life of the Project. This will include identification of thresholds/criteria and indicators that will be used to trigger management actions based on data collection and review of analytical results, and feedback from government, public and other stakeholders.

ACRONYMS AND ABBREVIATIONS

ANFO	Ammonium Nitrate-Fuel Oil
ARD	Acid Rock Drainage
BMP	Best Management Practices
COPC	Chemicals of potential concern
EA	Environmental Assessment
EEM	Environmental Effects Monitoring
EIS	Environmental Impact Statement
EMP	Environmental Management Plan
FIFO	Fly-in and fly-out operation
GHG	Greenhouse Gases
HADD	Harmful Alteration, Disruption or Destruction
HTO	Hunters and Trappers Organization
IIBA	Inuit Impact Benefit Agreement
IOL	Inuit Owned Lands
KI	Key Indicator
KIA	Kitikmeot Inuit Association
LSA	Local Study Area
ML	Metal Leaching
MMER	Metal Mining Effluent Regulations
NAG	Non-acid Generating
NLCA	Nunavut Land Claim Agreement
NIRB	Nunavut Impact Review Board
NPC	Nunavut Planning Commission
NRLUP	North Baffin Regional Land Use Plan
PAI	Potential Acid Inputs

PAG	Potentially Acid Generating
PM	Particulate Matter
PMF	Probable Maximum Flood
RSA	Regional Study Area
SAG	Semi Autogenous Grinding
TDS	Total Dissolved Sediments
TK	Traditional Knowledge
TSP	Total Suspended Particulates
VC	Valued Component
VEC	Valued Ecosystem Component
VOC	Volatile Organic Components
VSEC	Valued Socio-economic Component
WKRLUP	West Kitikmeot Regional Land Use Plan

GLOSSARY

Acid Base Accounting	A procedure used to measures the acid- and alkaline-producing potential of soil and rock in order to determine if, after disturbance, the waste material will produce acid and subsequently leach metals
Acid Rock Drainage	A natural process in which sulphuric acid is produced when sulphides minerals in rocks are exposed to air and water. When the acidic water seeps from the rock, the resultant seepage is called ARD.
Aggradation	To fill and raise the level of (the bed of a stream) by deposition of sediment, OR the process by which the upper surface of permafrost may be raised within an embankment fill
Aggregate	Composed of mineral crystals of one or more kinds of mineral rock fragments
Ammonium Nitrate-Fuel Oil	A widely used bulk industrial explosive mixture
Alternatives Assessment	Assessments used to compare development options based on technical, economic and environmental feasibility
Archaeology	The scientific study of the material remains of the cultures of historical or pre-historical peoples
Baseline	Describes the current environmental setting, against which changes in the environment from a proposed Project can be assessed
Biodiversity	A measure of the variety of plants and animals in a particular habitat or ecosystem
Biophysical	All living organisms and the natural physical environment that sustains them (terrestrial, aquatic and atmospheric)
Block Model	A block model is a simplified representation of an ore deposit, that can be thought of as a stack of computer-generated cubes that represent small volumes of rock in a deposit. The blocks are assigned a grade by a number of different estimation methods. The mining engineer uses this model to develop mine plans and production schedules.
Borrow pit	An area from which material (usually soil, gravel or sand) is taken for use at another location
Catchment	A sub-division of terrain within which surface water collects and concentrates into streams and rivers.
Colluvium	Surficial soils and rocks that are loosened and transported down slopes by weathering and erosional processes.

Contingency	A planned allowance for unexpected events (such as an emergency) that may, but are not certain to, occur
Cumulative Environmental Effects	The residual environmental effects of the Project, plus the anticipated residual effects of other past, present, and reasonably foreseeable future actions, regardless of what agency or person undertakes such actions
Ecosystem	The complexity of a natural community of living organisms and its environment functioning as an ecological unit in nature
Environmental Impact Assessment	A process to predict the potential adverse and beneficial effects of proposed initiatives on the biophysical and socio-economic environments.
Environmental Adaptive Management	A process for improving environmental management policies and practices through a structured, iterative process of decision, with an aim to reducing uncertainty over time through system monitoring.
Esker	A ridge of sand, gravel or cobbles deposited by running water in streams within glaciers, that when melted leave an elongated mound of outwash material
Fines	Silt and clay sized particles
Flotation Circuit	An ore processing device that separates finely crushed minerals from one another by causing some to float in a froth and others to remain in suspension in the pulp
Fluvial	Produced by the action of a stream or river (e.g., sand and gravel deposits)
Freeboard	A factor of safety usually expressed as a height above the adopted flood level thus determining the actual planning level. Free board tends to compensate for factors such as wave action, localised hydraulic effects and uncertainties in the design flood levels.
Freshet	A major rise in, or a sudden overflowing of, a small stream, usually caused by heavy rains or rapidly melting snow
Geochemistry	The study of chemical composition of the earth and the physical and chemical processes responsible for it
Geographic extent	The geographic area within which an environmental effect of a defined magnitude occurs (e.g., site specific, local, regional, territorial, national)
Geology	The study of earth in the terms of its development as a planet
Geomorphology	The scientific discipline that studies the surface features of the earth, including land forms
Geotechnical	Relating to the application of engineering of soil and rock materials
Grout	A thin mortar used for filling spaces; any of various other materials (as a mixture

	of cement and water or chemicals that solidify) used for a similar purpose
Hydraulic Conductivity	Describes the ease with which water can move through soil pore spaces or rock fractures; and relates to the amount of water that will flow through a unit cross-section area of aquifer under a unit gradient of hydraulic head
Hydrocarbons	Any substance containing carbon and hydrogen in various combinations (e.g. gasoline and oil)
Hydrology	The science that deals with the occurrence, circulation, distribution, and properties of the waters of the earth, including their reactions with the environment
Inert	Gases or material that are not readily reactive with other elements
Key Indicators	Species, species groups, resources or ecosystem functions that represent components of the broader Valued Components. For practical reasons, KIs are often selected where sufficient information is available to assess potential project residual environmental effects and cumulative effects.
Lay-down Area	An area used for storage of construction materials and supplies
Leaching	The process by which a liquid (e.g., water) passes through a substance, picking up some of the material and carrying it to other places. Can occur underground in soil and rock, or above ground through piles of material.
Local Study Area	The spatial boundary established for baseline data collection to support the assessment of potential environmental effects of a project
Magnitude	A measure of the intensity or severity of an environmental effect
Metal Leaching	A naturally occurring process that is caused when minerals containing metals come in contact with both air and water
Mitigation	Technically feasible and cost-effective measures or strategies employed to minimize or avoid project environmental effects or cumulative effects, including project design features, project policies, specialized mitigation, environmental protection measures and protocols, social or community programs, benefits agreements, and compensation (e.g., habitat compensation, habitat replacement or financial compensation)
Nameplate Capacity	Refers to the intended technical full-load sustained output of a facility
Nitrate	A compound containing nitrogen that can exist in the atmosphere or as a dissolved gas in water and that can have harmful effects on humans and animals
Non-acid Generating	Classification of excavated rock, assessed based on various tests and sulphur content, as negligible potential for acidic drainage and associated metals leaching

Nunavummiut	The indigenous inhabitants of Nunavut
Ore	A rock or mineral that contains a valuable constituent, such as diamonds or a metal, for which it is mined and processed
Ore body	The occurrence of mineralization from which the metal is economically recoverable
Overburden	The waste rock or materials overlying an ore or mineral body that are displaced during mining without being processed
Permafrost	A permanently frozen layer of soil or subsoil, or even bedrock. Permafrost is ground (soil or rock) that remains at or below 0°C for two or more years, and which occurs to variable depths below the earth's surface in arctic and subarctic regions
Piezometer	An instrument for measuring pressure head, ranging from simple standpipe to devices using electrical or pneumatic transducers, and typically installed within boreholes or during construction of major geochemical structures such as dams
Plume	A visible or measureable discharge of effluent in water or emissions in air
Post-closure	The period of time, considered to be up to 30 years, following the shutdown of a mine or other facility, during which monitoring of its effects occurs
Potentially Acid Generating	Classification of excavated rock, assessed based on various tests and sulphur content, as having significant potential for acidic drainage and associated metals leaching
Prills	The coarse, porous, and hardened spherical particles of Ammonium Nitrate (AN), a raw material used in the manufacture of explosives. By using porous AN prills, fuel oil can be absorbed into the prill micropores to produce an efficient explosive
Probable Maximum Flood	The maximum runoff condition resulting from the most severe combination of hydrologic and meteorological conditions that is considered reasonably possible for a watershed
Project-Environment Interaction	A term used to describe the way in which a project action or activity acts on an environmental component spatially and temporally to cause an environmental effect
Project Footprint	The most immediate area of a development project, including the area of direct physical disturbance
Project Inclusion List	A list of all past, present and reasonable foreseeable projects, activities and actions that overlap spatially and temporally with residual environmental effects of a proposed project
Proponent	The individual or organization that wishes to carry out a development project

Quarry	A type of open-pit mine from which rock or minerals are extracted, and generally used as building materials
Raise	Steeply inclined or vertical excavation that connects multiple horizontal mining levels
Reagent	A substance used in a chemical reaction to bring about a chemical change
Reclamation	The process of restoring disturbed land to its former (or other) productive use or form
Regional Study Area	The spatial boundary established for baseline data collection to support the assessment of potential cumulative effects or indirect effects of a development project
Riparian Area/Zone	The interface between land and a river or stream, which is ecologically important because of its role in soil conservation, habitat biodiversity and aquatic ecosystems
Seepage	The slow escape of a liquid or gas through porous material
Semi Autogenous Grinding Mill	The mill responsible for grinding materials from large chunks into small, usable pieces for processingt using steel balls and big rocks for grinding
Scoping	A process that focuses study and analysis on those project-environment interactions with the greatest potential to result in environmental effects
Slurry	A thin mud or any fluid mixture of a pulverized solid with liquid
Stope	An excavation in the form of steps made by the mining of ore from steeply inclined or vertical veins
Sump	A pit or reservoir serving as a drain or receptacle for liquids
Sustainability	An economic, social and environmental concept that involves meeting the needs of the present without compromising the ability of future generations to meet their own needs
Tailings	Materials left over after the process of separating the valuable fraction from the uneconomic fraction of an ore
Tailings Impoundment	An engineered containment facility for storing tailings
Talik	A layer of year-round unfrozen ground that lies within permafrost areas. In regions of continuous permafrost, taliks often occur underneath shallow lakes and rivers, where the deep water does not freeze in winter, and thus the soil underneath will not freeze. Closed, open and through talik are terms used to refer to whether the talik is completely surrounded by permafrost, is open to the top, or open to both top and unfrozen layers beneath the permafrost

Transboundary Effect	Any effect within an area under the jurisdiction of a Party caused by a proposed activity, the physical origin of which is situated wholly or in part within the area under the jurisdiction of another Party
Utilidor	A tunnel for housing utility services such as water and sewerage pipes, electrical cabling, and also providing pedestrian access, affording all of these items protection from severe winter weather conditions
Valued Ecosystem Component	Attributes or aspects of the biophysical environment considered to be of vital importance to a particular region or community for ecological, social, cultural and/or ecologic reasons
Valued Socio-Economic Component	Attributes or aspects of the socio-economic environment that are considered to be of vital importance to a particular region or community, including components relating to the local economy, health, demographics, traditional way of life, cultural well-being, social life, archaeological resources, existing services and infrastructure, and community and local government organizations
Waste Rock	A term used for rock that contains metals in such low concentrations that it cannot be economically processed

Izok Corridor Project Proposal

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Izok Corridor Project Proposal

SECTION 1

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1 INTRODUCTION

1.1 Objectives of the Project Proposal

Minerals and Metals Group (MMG) is submitting this Project Proposal to fulfill the information requirements outlined in the Nunavut Impact Review Board (NIRB) Screening Part 2 Form (Project Specific Information Requirements; Appendix B), and initiate the regulatory review of the Izok Corridor Project (the Project). It is important to note that the description of the Project, its components and all environmental information within this Project Proposal is preliminary in nature and based on pre-feasibility design. A more detailed project description (based on feasibility-level project design) and a comprehensive effects assessment will be included in the Draft Environmental Impact Statement (DEIS). Preliminary identification of potential environmental effects of the Project is based on the pre-feasibility study (MMG 2012a), as well as earlier baseline studies and effects assessments conducted in relation to the DEIS for the High Lake project (Wolfden 2006), environmental baseline programs completed in 2007, 2008 and 2012, internal issues scoping workshops conducted in 2008 and 2012, consultation with communities, regulators and the Kitikmeot Inuit Association (KIA) in early 2012, and feedback from federal, territorial and Inuit agencies resulting from the Resource Development Advisory Group (RDAG) meeting held in Iqaluit in April 2012 organized by the Northern Program Management Office (Can Nor).

1.2 General Description of the Project

The Izok Corridor Project is a proposed zinc mine located in the Kitikmeot region of Nunavut (**Figure 1.2-1**). The Project consists of two mine sites, an all-season access road and a port facility. The proposed mine sites will be located near current MMG exploration properties. These mines will produce primarily zinc concentrate, as well as some copper concentrate and a small amount of lead concentrate.

Unlike gold or diamonds, zinc and copper concentrates are sold in large quantities (i.e., thousands of tonnes) in powdered form. In order to ship the concentrate to its customers, MMG will transport it by truck to a port where it will be loaded onto large bulk-carrier ships and transported to smelters in Europe and Asia. This will require construction of a road connecting the Izok Mine (the more southerly mine) to the High Lake Mine and north to a proposed port at Grays Bay on the Coronation Gulf (Figure 1.2-1). Facilities at the Grays Bay Port will include a dock, concentrate storage shed, fuel storage facilities and a camp. These facilities will support storage of concentrate, loading of the bulk-carrier ships, and re-supply of fuel and goods for the Project.

The Project will employ approximately 710 people during the operational phase, with 400 people on site at any one time due to the fly in/fly out rotational schedule. The average on-site workforce during construction is expected to be about 670 people.

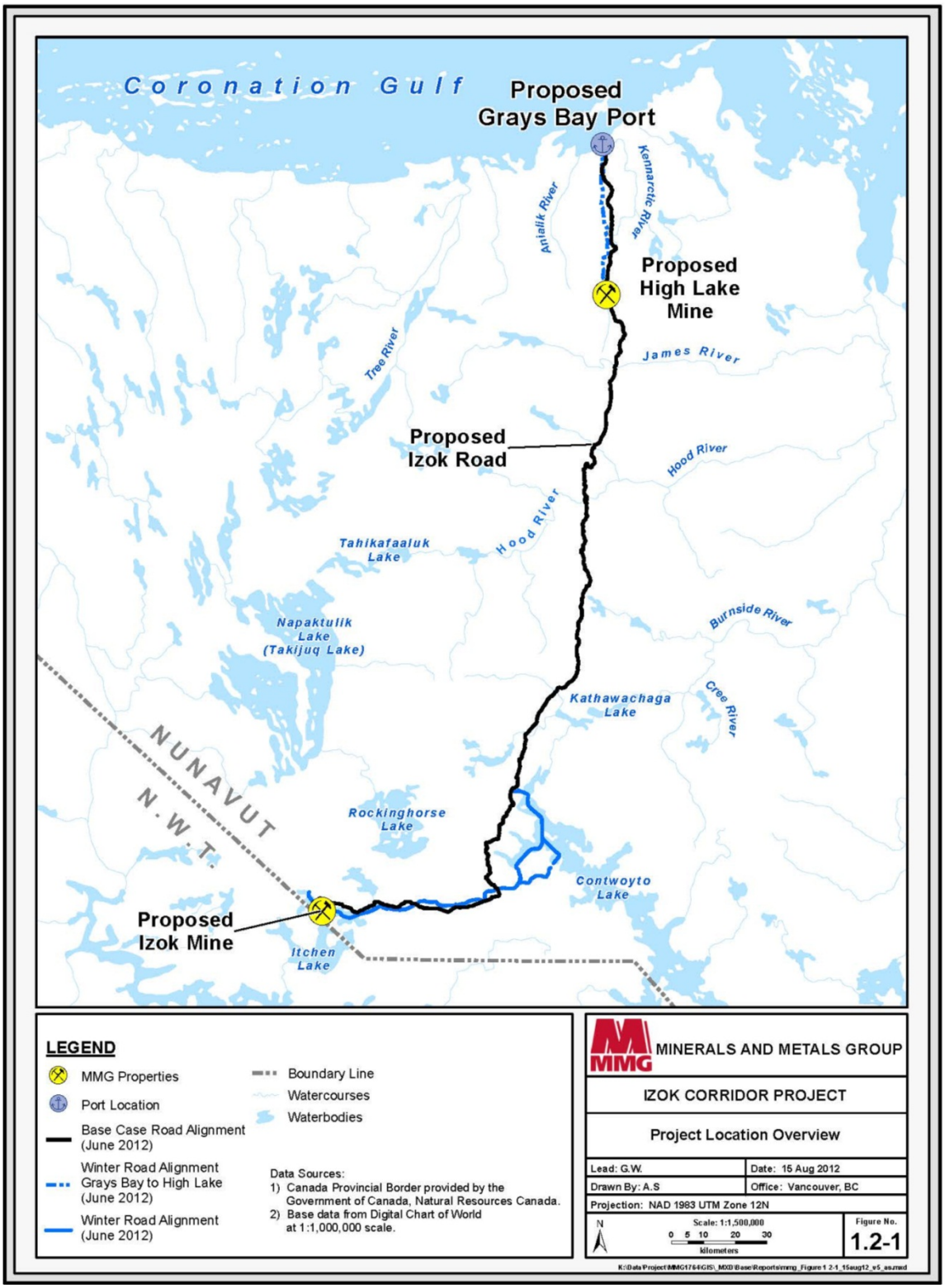


Figure 1.2-1 Izok Corridor Project Overview

1.3 Project Proponent

MMG is an Australian base metal mining company, based in Melbourne with Canadian headquarters in Vancouver, British Columbia. The company is listed on the Hong Kong Stock Exchange under Stock Code: 1208. MMG has a workforce of more than 8,500 people around the world. It currently employs 33 people at its Vancouver office.

MMG is a wholly owned subsidiary of Minmetals Resources Limited (Minmetals), which is a diversified mining and metals business and one of the world's largest producers of zinc and a substantial producer of copper. The majority shareholder of Minmetals is China Minmetals Corporation (CMC), headquartered in Beijing China. CMC was founded in 1950 and owns businesses in 26 nations and regions around the world.

MMG's corporate goal is to maintain and expand its position as a leading internationally diversified base metals group. Its objective is to be one of the top three mid-tier mining companies within five years. This goal will be achieved by developing its upstream, diversified base metals operations through exploration and discovery, organic growth, and acquisitions.

1.4 Project History

Over the last 30 years, many exploration and mining companies have investigated mineral deposits in this area of the Kitikmeot Region. The Izok deposit was discovered in the late 1970s by Texas Gulf Inc. through geophysical surveys and drilling. The deposit was subsequently acquired by Falconbridge in 1985, and then by Minnova in 1992 (renamed Metall Mining Corp). Metall Mining Corp had plans to move into production but the project was suspended in 1992. The High Lake deposit was discovered in the mid 1950s by Kennarctic Explorations Limited, which was then acquired in 1991 by Kennecott Exploration (in conjunction with Aber).

Wolfden acquired both the Izok and High Lake properties in 2001. Environmental baseline studies and a pre-feasibility engineering study were completed for the proposed High Lake Mine project, and a DEIS was submitted to the NIRB in 2006.

In 2007, Wolfden sold both the Izok and High Lake exploration properties to Zinifex, which later become part of an Australian mining conglomerate called OZ Minerals Ltd. In May 2008, OZ Minerals submitted a letter to the NIRB requesting that the High Lake Pre-Hearing Conference be postponed in light of their decision to focus on the Izok Lake project. The company advanced pre-feasibility studies, including engineering and environmental work, at the Izok property in 2007 and 2008 but stopped at the end of 2008 due to poor global economic conditions.

In 2009, MMG's parent company China Minmetals Corporation purchased OZ Minerals and its exploration properties in Nunavut. MMG resumed exploration at High Lake and Izok Lake in 2011 and completed a pre-feasibility study. In early 2012, MMG committed to initiating a feasibility study and additional environmental baseline studies for the Project.

MMG hopes to re-vitalize the economic prospects of this promising geological province in a responsible and thoughtful manner. For the last three years since MMG acquired High Lake, Izok, Ulu, Lupin and other exploration properties (e.g., Hood, High Lake East and Gondor), it has been completing market analyses, engineering studies and has been continuing exploration in the Kitikmeot region. With its focus

on zinc and base metals, MMG sold the two gold properties (i.e., Ulu and Lupin) to Elgin Mining in 2011. From 2009 to 2011, MMG revisited the numerous engineering and economic studies prepared by previous owners of these properties.

In 2010, a pre-feasibility study was completed for the Izok Lake project (AMEC 2011) that included the Bathurst Inlet Port and Road (BIPAR) and numerous other transportation options. This study demonstrated that major cost optimization was needed to define an economically viable project. In 2011 and early 2012, MMG completed a pre-feasibility study on a project design for the Izok and High Lake properties that could be economic and would support MMG's long term objectives to grow its zinc business. The key requirements for an economic project are as follows:

- The deposits at both the High Lake and Izok properties need to be developed and mined concurrently in order for concentrate sale revenues to support the construction of the extensive infrastructure required to transport and ship the zinc and copper concentrates and allow for efficient use of the Izok Road (ore backhaul from High Lake to the processing plant at the Izok Mine).
- Only one processing plant is built to process ore from both sites. To take advantage of transportation efficiencies, the processing plant needs to be located at the Izok Mine site. Ore from the Izok and High Lake mines is processed at the Izok plant. The concentrate produced at Izok is trucked north to the Grays Bay Port and unloaded in the concentrate storage shed. On the return south, empty trucks pick up loads of crushed ore at the High Lake Mine and transport it to processing plant at the Izok Mine.
- All Project facilities operate on a year-round basis.
- All of the bulk concentrate stored at Grays Bay will be shipped to overseas smelters during the open-water season from mid July to mid October.

A transportation alternatives study was completed in 2011 (MMG 2012b), which examined a number of methods and routes for shipping concentrate to smelters in North America, Europe and Asia. A pre-feasibility study was completed in early 2012 (MMG 2012a), which described the design of Project infrastructure and activities. MMG is currently undertaking a feasibility study for the Project, which will include a more detailed engineering design and costing of the construction, operation and decommissioning phases of the Project. The feasibility study will allow MMG to make a final decision in mid to late 2013 regarding whether to move forward with construction of the Project.

In anticipation of a positive decision on the feasibility study by the MMG Executive Committee and a mandate to proceed to move toward Project construction, MMG is continuing environmental baseline programs that were initiated between 2004 and 2008. MMG is also initiating or re-starting discussions about the Project with Kitikmeot communities, as well as Inuit, federal and territorial boards and agencies. Subject to approval of the feasibility study, MMG plans to deliver a DEIS to the NIRB in mid to late 2013. Detailed design and planning for Project construction, procurement of equipment, and continuation of the permitting process in support of development of the Project will take place over the period 2012 to 2014.

MMG's engagement activities currently include discussions about the Project with interested parties, including Nunavut Tunngavik Inc. (NTI), Government of Nunavut (GN) and the Kitikmeot Inuit

Association (KIA), communities, federal departments such as Fisheries and Ocean Canada (DFO) and Aboriginal Affairs and Northern Development Canada (AANDC). Section 3 provides a more detailed summary of the discussions held to date.

MMG is interested in exploring opportunities to participate in and contribute to initiatives of shared interest with these groups, particularly where these initiatives will help to support the review of the Project. MMG's long-term vision for the proposed Izok Corridor Project supports the federal and territorial government's vision of a strong economic future for all Nunavummiut. In striving for this vision, MMG will continue to respect Nunavummiut core values and work closely with local stakeholders to incorporate these values in the planning and development of the Project.

MMG intends to comply with the Nunavut Land Claims Agreement (NLCA), federal and territorial regulations, and approved land use plans. MMG hopes to gather input and feedback from a variety of sources to learn about issues, improve management plans, and enhance Project benefits to Nunavummiut. Key initiatives planned to inform MMG's approach will include establishment of working groups with community and agency representatives, observing reviews of other northern mining projects, visits to other operating mines in the Canadian Arctic, and visits to communities that have an interest in the Project to provide information about MMG and the Project and gather feedback on issues and concerns.

At this time, MMG is planning to build, operate and maintain the all-season access road using its own resources and solely for Project use. Accordingly, MMG will assume full responsibility for construction, operation, maintenance and eventual closure and reclamation of this road. In the future, MMG may consider entering into agreements with other parties regarding shared use of the road, assuming that road-related safety risks can be managed effectively and any business risks related to road capacity and schedule can be addressed in manner that does not hinder the economic viability of the Project.

1.5 Project Location and Land Tenure

The Izok Corridor Project is located in the western portion of the Kitikmeot region of Nunavut. The nearest community to the Project is the hamlet of Kugluktuk (67° 49' 32''N 115° 05' 42''W), which is located on the Coronation Gulf at the mouth of the Coppermine River (**Table 1.5-1**). Kugluktuk is the westernmost community in Nunavut. The Project footprint is located entirely within Nunavut.

Table 1.5-1 Project Location and Distance from West Kitikmeot Communities

Project Component	Coordinates (latitude and longitude)	Distance from Yellowknife (km)	Distance from Kugluktuk (km)	Distance from Cambridge Bay (km)
Proposed Izok Mine	65° 43' 22.1"N 112° 49' 16.5"W	362 km	260 km	509 km
Proposed High Lake Satellite Mine	67° 27' 17.4"N 110° 46' 06.4"W.	572 km	187 km	307 km
Proposed port at Grays Bay	67° 49' 38.5"N 110° 48' 33.2"W	853 km	179 km	279 km

The Project area covers both Crown land, and Inuit Owned Land (IOL; surface and subsurface rights).

The proposed Izok Mine site is located approximately 300 km southwest of High Lake. The property consists of three Mining Leases and two Surface Leases in Nunavut. (There are three additional Mining Leases that overlap the Nunavut/NWT border and are administered through the NWT.) At this time, MMG has no plans to develop the deposits or resources related to the NWT Mining Leases. Two of the Mining Leases in Nunavut are located wholly on Crown Land (**Figure 1.5-1**). The other Mining Lease and the two Surface Leases are located on grandfathered Crown Land, which is now part of an IOL Package (surface rights; administered by the KIA on behalf of the Inuit beneficiaries as designated under the NLCA). The Crown retains subsurface rights to these areas.

The proposed High Lake Mine site is located approximately 50 km south of Grays Bay. The property consists of three Mineral Claims, 15 Mining Leases and one Surface Lease (**Figure 1.5-2**). All Mining Leases and the Surface Lease are grandfathered Crown Land, which is now part of an IOL Package (subsurface and minerals rights; administered by Nunavut Tunngavik Inc. (NTI)). The Crown leases predate the creation of the IOL packages. The Mineral Claims are situated on Crown Land. The proposed Grays Bay Port site is situated entirely on Crown Land (**Figure 1.5-2**).

The proposed Izok Road alignment and the alternate segment cross both IOL and Crown Land (**Figure 1.5-3**).

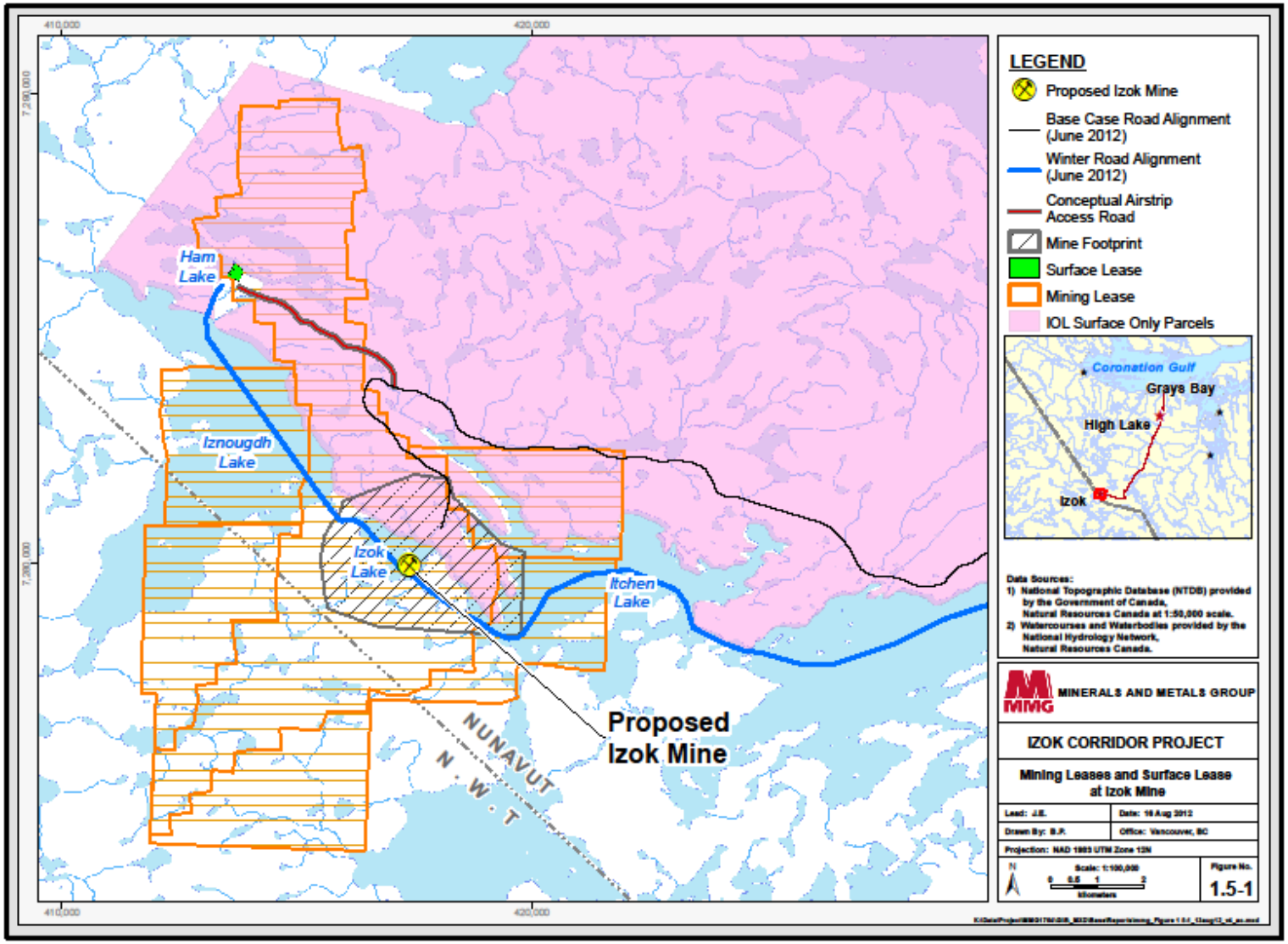


Figure 1.5-1 Mining Leases and Surface Lease at near the Proposed Izok Mine

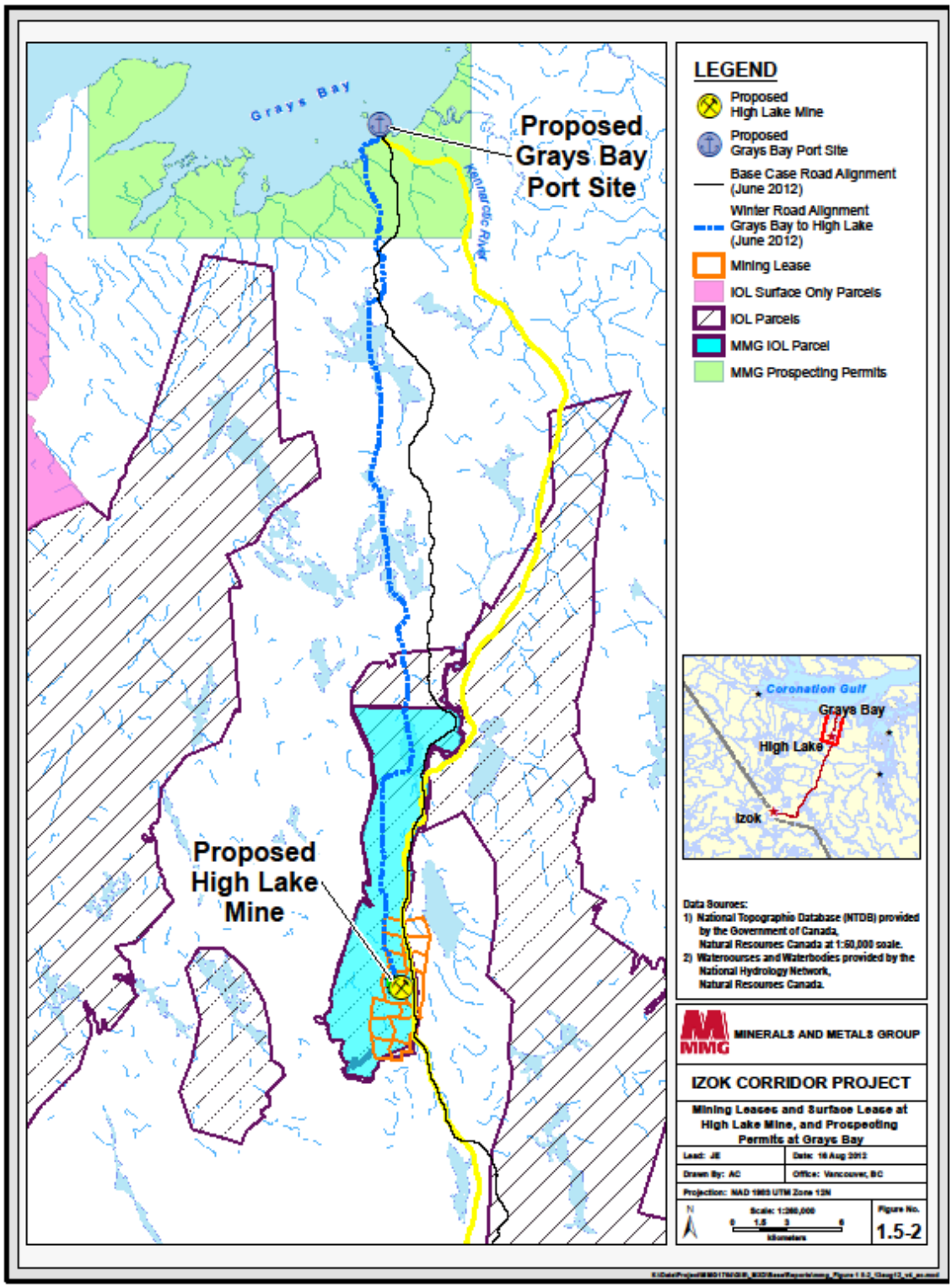


Figure 1.5-2 Mining Leases and Surface Lease near the Proposed Satellite Mine at High Lake, and Prospecting Permits near Grays Bay

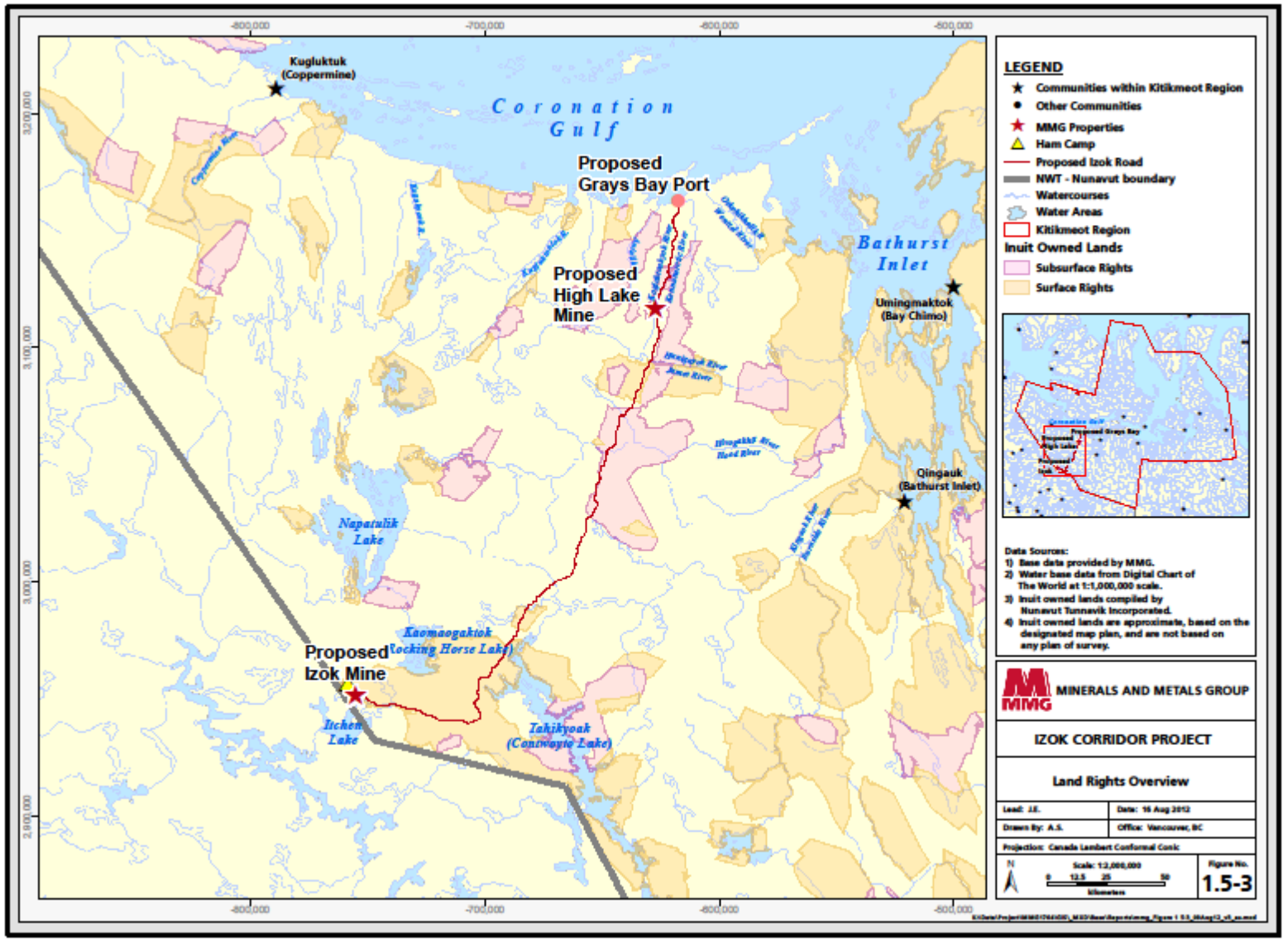


Figure 1.5-3 Land Rights Map

1.6 Existing Exploration Camps

At this time, MMG operates two exploration camps near the proposed Izok and High Lake Mine sites.

The Ham Lake Camp is located near Ham Lake, approximately 7 km northwest of the proposed Izok Mine site. It was first established in the mid 1970s and currently accommodates approximately 50 persons. Exploration at other properties in the area, Hood or Gondor properties is based at the Ham Lake Camp. It is accessible by air only using the gravel air strip near the camp. There are no camps at the Hood or Gondor exploration properties.

The High Lake Camp, located on the shore of High Lake, was established in the 1950s. It can accommodate 35 people. It is accessible by float plane in the ice-free months.

Both exploration camps are accessible by fixed wings on skis during the winter months. Transportation around these sites is primarily via helicopter with limited use of snowmobiles in winter/spring and ATVs in the summer/fall.

There are no facilities at Grays Bay and there are no roads connecting any of these sites.

1.7 Need for and Purpose of the Project

The need for the Project is based on the following factors:

- Zinc usage in emerging countries such as India, Brazil, China has increased dramatically over the past decade, and demand is expected to continue to increase.
- Zinc supply is expected to decline in the near term as several large international zinc mines are projected to close in the next decade, causing a substantial gap in the zinc supply chain.
- Maintaining zinc production levels to meet current contractual agreements following closure of MMG's Century Mine in 2016 is an important component of MMG's business plan.
- Mine development has been identified as one of the primary opportunities to enhance the economy of Nunavut. It will provide employment and business opportunities, as well as skills up-grading and training.
- There are reduced opportunities and benefits flowing from existing mines due to a reduction in the mine life of the only operating mine in Nunavut (Meadowbank) and the move to put the Doris North Mine into care and maintenance.
- There is a current capacity of trained Inuit workers in Nunavut that could be available to work on new Projects, allowing them to continue to support their families in Nunavut.
- The benefits of education, training, job attendance, financial and health benefits to MMG employees can also benefit their families and their communities.
- The opportunity for Nunavut to work with MMG to further enhance its reputation as a jurisdiction where solid processes, resourceful strategies, good management and monitoring plans for environmental protection provide a solid basis for responsible mineral development.

The purpose of the Izok Corridor Project is threefold:

- Maintain or enhance MMG's zinc concentrate production levels and business capacity
- Meet requirements for zinc-based products by industrial, commercial and residential sectors worldwide
- Provide benefits to Nunavummiut through creation of employment and business opportunities, as well as through payment of taxes and royalties to the federal, territorial and Inuit governments

1.8 Guiding Principles for Project Development

1.8.1 Health and Safety

Health and safety is a core MMG value. The company's philosophy is to conduct its operations in a responsible and socially acceptable manner to protect the environment and the health and safety of its employees and the public. As part of the Izok Corridor Project, MMG is dedicated to creating a safe environment for its workers and surrounding communities during all phases of the Project.

1.8.2 Sustainable Development

MMG's approach to sustainable development involves an ongoing commitment to communities, stakeholders, the environment, health and safety, and the economic performance of its business. Its aim is to promote a responsible culture and implement robust corporate systems to consistently meet its sustainability goals.

MMG recognizes that managing environmental responsibilities is essential to long-term success, and aims to minimize its environmental footprint and equip its people with environmental standards to effectively manage the environmental aspects of the Project. Minimizing the effects of the Project on the environment through sound risk management practices is a key objective.

MMG's approach to community involvement in the Project is to consult with, listen and respond openly to community stakeholders, and to be open, honest and as cooperative as possible when issues and concerns do arise. MMG will invest in local Inuit communities as an integral part of its sustainability objective to ensure the communities in the Kitikmeot region and Nunavut receive real benefits from its activities.

1.8.3 Public Participation and Engagement

Meaningful public participation is a fundamental objective of the NIRB review process and is required to ensure that concerns of the general public related to potential environmental effects of a proposed project are considered and addressed. Central to this is the need to engage potentially affected Nunavummiut to discuss potential Project effects on traditional and contemporary land and resource use. In initiating the NIRB review process for the Izok Corridor Project, MMG is committed to a public participation and awareness program to facilitate engagement with communities, residents, Inuit Organizations, Aboriginal groups and other governments.

MMG will engage with the public in discussions to integrate their views into Project planning and selection of the preferred Project alternatives. Further, MMG will provide regular updates throughout the review process.

1.8.4 Traditional Knowledge

MMG recognizes the very important role that Inuit traditional knowledge (TK) plays in planning and design of the Project, assessing and managing the environmental effects and developing mitigation and future monitoring programs. MMG is in discussions with the KIA to ensure that any established protocols for collection, access to and sharing of TK are followed.

1.8.5 Precautionary Principle

MMG is committed to developing the Project in a manner consistent with the precautionary principle to ensure that the Project is built, operated and decommissioned in a manner that maintains the integrity of natural systems. This will include:

- Recognizing areas of uncertainty related to interpretation of data, effects evaluations and effects mitigation and adaptive management
- Identifying assumptions made about the effects of the Project and the approaches to minimize these effects
- Identifying any follow-up and monitoring activities planned, particularly in areas where scientific uncertainty exists in the prediction of Project effects
- Presenting public views on the acceptability of residual Project effects

1.8.6 Mitigation by Design

Mitigation measures are being integrated into the design of the Izok Corridor Project through collaboration amongst the engineering, environmental and socio-economic teams. The following principles are used to guide the design of the Project.

- Minimize disturbance outside the High Lake and Izok Lake drainage areas
- Reduce freshwater consumption through process design and internal recycling
- Conserve energy and reduce fuel consumption through recycling of waste heat for use in processing
- Implement long-term waste management solutions
- Minimize disturbance to biological activities during sensitive times or seasons

1.8.7 Consideration of Climate Change

Climate change will be taken into account in the design of all structures for construction, operations and closure phases of the Project using state-of-practice technology calibrated by precedents from other similar projects in northern settings. Mitigation of the potential effects of climate change on the Project will be addressed in the DEIS and final Project design. This may include accounting for potential changes to permafrost conditions, regional water flows, and site-specific water and heat balances.

1.9 Alternatives

Alternative means of carrying out the Project and alternatives to the Project are being considered as part of the feasibility study currently underway. Plans for several of the Project elements and activities will be further refined during the detailed engineering and based on scientific information, public and regulatory input and traditional knowledge. Alternatives will be presented and assessed in detail in the DEIS.

1.9.1 Alternative Means of Carrying Out the Project

Alternative means of carrying out the Project are defined as various options that may be technically and economically feasible, meet regulatory requirements, minimize environmental and social effects, and provide opportunities for economic and social development. Previous owners of the High Lake and Izok properties and MMG have considered many project configurations and transportation options and these alternative means are described in the Project Description (Section 2). These alternatives assessments were based on pre-feasibility level engineering studies and input from the environmental and socio-economic teams.

Alternatives have been previously considered for the following Project components:

- Mine configuration
- Marine shipping route and frequency
- Processing plant location
- Mineral waste management methods and layout
- Water Management Plan
- Access road routing
- Port site design

Alternatives for selected Project features will be considered further as part of the feasibility study.

1.9.2 Alternatives to the Project

On a global scale, the proposed Izok Corridor Project is one of the most advanced zinc deposits in the world with numerous engineering studies, environmental baseline data, geological and metallurgical data available to support a detailed feasibility study. MMG has identified this Project as a promising target for zinc concentrate production that could be in production in time to offset reductions in supply

when MMG's Century Mine closes. The alternative to this Project for MMG would be to develop a zinc mine in another location or jurisdiction or country. At this time, MMG does not have another zinc property at this advanced stage of development.

1.10 Regulatory Process

MMG is initiating the Nunavut impact review process for the Izok Corridor Project with the submission of this Project Proposal and the following draft permit applications to the KIA, Aboriginal Affairs and Northern Development Canada (AANDC), Nunavut Water Board (NWB) and Fisheries and Oceans Canada (DFO) to assist these authorizing agencies in clarifying their regulatory responsibilities in relation to the Project.

- NWB – Type 'A' Water License Application
- AANDC – Application for Crown Land for the Grays Bay port
- KIA - Land Use Permit Application for the Izok Mine facilities, which are located on IOL
- DFO – Application for a Section 35 Fisheries Act authorization for draining Izok Lake

MMG is submitting the Project Proposal to the NIRB and several other groups as a courtesy, but understands that it is up to the authorizing agencies to submit the Application to the NIRB following their review.

The Type 'A' Water License application is being submitted with this Project Proposal to both the NIRB and the NWB in the interest of initiating a coordinated NIRB-NWB review process.

The Project Proposal is also being submitting to the Nunavut Planning Commission (NPC) for a conformity review against approved land use plans. The Project footprint does not lie within a region of Nunavut for which an approved Land Use Plan exists; the West Kitikmeot Regional Land Use Plan (WKRLUP) is still in draft form. However, the North Baffin Land Use Plan overlaps a portion of the eastward shipping route, requiring NPC review. Once NPC determines that the Project Proposal is in conformity with approved land use plans or a variance has been approved, NPC will forward the Project Proposal to the NIRB for screening.

Given that the Project footprint is entirely within the boundaries of Nunavut and MMG's initial determination that any direct effects of the Project will be limited to Nunavut, MMG anticipates that the screening will lead to a decision that the Project be reviewed under Part 12.5 of the NLCA.

Applications for additional permits and licenses will be filed by MMG during review of the Project and upon receipt of the Project Certificate. Major permits and licenses that will be required for the Project are listed in **Table 1.10-1**.

Table 1.10-1 Major Permits, Approvals and Licenses Required for the Izok Corridor Project

Permit/Approval/Licence	Agency	Activity
Project Certificate	Nunavut Impact Review Board	Required to proceed with Project development
Inuit Impact and Benefit Agreement	Kitikmeot Inuit Association	Required to proceed with Project development
Type 'A' Water Licence	Nunavut Water Board	Water use, waste disposal, and discharge limits to the receiving environment
Class 'A' Land Use Permit	Aboriginal Affairs and Northern Development Canada	Development of mine and roads on Crown Land
Quarry Permit	Aboriginal Affairs and Northern Development Canada	Quarrying required for construction of road, camps, mill foundations etc.
Water Lot Lease	Aboriginal Affairs and Northern Development Canada	Required for the deep-water port at Grays Bay
Quarry Concession Permit	Kitikmeot Inuit Association	Quarrying required for construction of road, camps, mill foundations etc.
Land Use Licence	Kitikmeot Inuit Association	Development of two mines, associated infrastructure, and roads on Inuit Owned Land
Commercial Lease	Kitikmeot Inuit Association	Long-term land tenure required for land use on Inuit Owned Land; land required for infrastructure and activities associated with construction, operations, and closure phases
Production Lease	Nunavut Tunngavik Inc.	Production of mine on Subsurface Inuit Owned Land
Fisheries Authorization	Fisheries and Oceans Canada	Authorization for permanent harmful alteration, destruction, or disturbance to fish habitat (HADD) and appropriate compensation
Explosives Manufacturing Licence	Natural Resources Canada	Manufacture of explosives required for blasting
Explosives Transportation Permit	Natural Resources Canada	Transport of blasting agents and explosives to the mine sites and work areas
Navigable Waters Permit	Transport Canada	Required if mine footprints or associated roads interfere with navigation(e.g., installation of bridges and culverts)
Section 23 Exemption	Transport Canada	Exemption to regulations contained in the Navigable Waters Act (1985) protecting any Canadian waterway from the dumping of wood products, earth, or stone that could impede navigability
Dredging Permit	Transport Canada	Construction of dock facilities at Grays Bay

MMG is committed to complying with all applicable laws, regulations and standards to minimize any potential adverse environmental effects resulting from the company's operations. This includes integrating protective measures into the design of the Project to ensure that regulations are fully considered early in the planning phase, and a commitment to undertaking appropriate corrective actions should unexpected environmental effects occur during the construction, operation, post closure or closure phases of the Project. **Table 1.10-2** presents the applicable legislation and responsible authorities that will likely apply to the Project.

Table 1.10-2 Legislation and Responsible Authorities for Potential Permits, Licences and Authorizations for the Izok Corridor Project

Legislation/Act	Responsible Authorities		
	Federal	Territorial	IPGs/DIO
Arctic Waters Pollution Prevention Act (Arctic Waters Pollution Prevention Regulations) (Arctic Shipping Pollution Prevention Regulations)	AANDC		
Business Corporations Act of Nunavut		DOJ-NU	
Canadian Environmental Protection Act	EC		
Commissioner's Land Act of Nunavut		CGS-NU	
Canada Shipping Act (Ballast Water Control and Management Regulations) (Oil Pollution Prevention Regulation) (Response Organization and Oil Handling Facility Regulation)	TC		
Canada Marine Act (Natural and Man-made Harbour Navigation and Use Regulations)	TC		
Canada Water Act	EC		
Canada Wildlife Act	EC		
Canadian Environmental Protection Act	EC		
Engineers, Geologists, and Geophysicists Act of Nunavut		DOJ-NU	
Emergency Medical Aid Act of Nunavut		HandSS-NU	
Environmental Protection Act of Nunavut (Spill Contingency Planning and Reporting Regulations)		DOE-NU	
Explosive Use Act of Nunavut		WCB-NU	
Explosives Act	NRCan		
Federal Policy on Wetland Conservation	EC		
Fire Prevention Act of Nunavut		CGS-NU	
International Maritime Organization Dangerous Goods Code	IMO		
Labour Standards Act of Nunavut		DOJ-NU	
Marine Transportation Security Act	TC		
Migratory Birds Act Convention Act	EC		
Navigable Waters Protection Act (Navigable Waters Permit) (Dredging Permit)	 TC TC		
Mine Health and Safety Act		DOJ-NU	
Nunavut Archeological and Paleontological Sites Regulations		CLEY-NU	

Legislation/Act	Responsible Authorities		
	Federal	Territorial	IPGs/DIO
Nunavut Land Claim Agreement (North Baffin Regional LUP Compliance) (Project Certificate) (Land Use) (Water Management) (Mineral Rights) (Inuit Impact Benefit Agreement) (Wildlife Compensation Agreement) (Entry and Access)	AANDC		NPC NIRB Regional DIO NWB NTI Regional DIO Regional DIO
Nunavut Waters and Nunavut Surface Rights Tribunal Act Nunavut Waters Regulations (Water Licence) (Inspection)	AANDC		NWB
Public Health Act of Nunavut Camp Sanitation Regulation of Nunavut		HandSS-NU	
Species at Risk Act	EC		
Transportation of Dangerous Goods Act (Transportation of Dangerous Good Regulations)	TC		
Transportation of Dangerous Goods Act of Nunavut (Transportation of Dangerous Goods Regulations of Nunavut)		CGS-NU	
Territorial Lands Act (Canada Mining Regulations) (Territorial Dredging Regulations) (Territorial Lands Regulations) (Territorial Lands Use Regulations) (Territorial Quarrying Regulations)	AANDC		
Wildlife Act of Nunavut (Wildlife Sanctuaries Regulations of Nunavut)		DOE-NU	
Worker's Compensation Act of Nunavut (Worker's Compensation Regulations of Nunavut) (Camp Sanitation Regulations of Nunavut)		WCB-NU	

CGS-NU = Department of Community & Government Services Nunavut; Cley-NU = Department of Culture, Language, Elders and Youth-Government of Nunavut; DIO = Designated Inuit Organization; DOE-NU = Department of Environment-Government of Nunavut; DOJ-NU = Department of Justice-Government of Nunavut; EC = Environment Canada; HandSS-NU = Department of Health & Social Services-Government of Nunavut; AANDC = Aboriginal Affairs and Northern Development Canada; IPG = Institutions of Public Government; NIRB = Nunavut Impact Review Board; NPC = Nunavut Planning Commission; NRCan = Natural Resources Canada; NTI = Nunavut Tunngavik Incorporated; NWB = Nunavut Water Board; PCH = Parks Canada; TC = Transport Canada; WBC-NU = Worker's Compensation Board-Government of Nunavut

1.11 Exceptions Application

After completion of the NIRB review process, mining projects in Nunavut must apply for and receive the relevant licenses and approvals prior to commencement of any site development. These approvals are conditional on a NIRB Project Certificate. However, as set out in Article 12.10.2(b) of the NLCA,

approvals or licenses for specific development activities may be issued if the activity can, according to the NIRB, proceed without being part of the review.

MMG intends to submit an Exceptions Application to the NIRB for approval to proceed with pre-construction works prior to issuance of the Project Certificate for the Izok Corridor Project (refer to section 2.1.2). Applications for any licenses or permits required to undertake these specific activities will also be submitted to the Authorizing Agencies with the Exceptions Application.

1.12 DFO Operational Statement Conformity

Fisheries and Oceans Canada has published several Nunavut Operational Statements to which activities in Nunavut must conform. The Operational Statements that apply to the Izok Corridor Project include:

- Bridge Maintenance – All-Weather Road
- Clear-Span Bridges – All-Weather Road
- Culvert Maintenance – All-Weather Road
- Ice Bridges and Snow Fills – Winter Ice Road (construction phase only)
- Installation of Moorings – Grays Bay Port Site
- Temporary Stream Crossing – All-Weather Road (construction phase only)
- Timing Windows – All-Weather Road, Izok Mine and High Lake Mine (construction phase only)

MMG will meet the conditions of these seven Operational Statements to protect fish and fish habitat in the Project area (refer to MMG Letter to DFO, Appendix D).

1.13 Conformity to Land Use Plans

Projects in Nunavut are expected to conform to applicable land use plans before any permits or authorizations are issued. In the absence of an approved land use plan, a conformity determination by the NPC is not required.

The footprint of the Izok Corridor Project is located in an area of Nunavut for which there is no approved land use plan (LUP). Nonetheless, MMG recognizes the importance of the draft WKLUP (NPC 2005) in guiding early planning and development of the Project, and has integrated many of the social, cultural and ecological goals of the plan into the Project through mitigation by design (refer to section 2.9). Mine, road and port construction and operations will be conducted in a manner that protects the long-term integrity of the environment. In particular, activities of the company and its employees will adhere to the Code of Good Conduct for Land Users as established by the NPC, and the terms of the DIAND Caribou Protection Measures (DIAND 1992).

Marine shipping activity for the Project will occur within the North Baffin planning region, for which an approved LUP exists (NPC 2000). MMG will consider requirements of the Plan to guide development of its operations, particularly as it relates to marine transportation corridor guidelines.

1.14 Organizational Structure

The Project Proposal is organized as follows.

Section 1 Introduction provides an introduction to MMG, the Izok Corridor Project, and the required federal and territorial approvals, permits, and licences.

Section 2 Project Description provides a preliminary Project description, components and activities that may interact with the environment during all phases of the Project, and information on employment.

Section 3 Public Engagement provides a description of past, current and future public engagement efforts of MMG, including issues raised by stakeholders at this early stage.

Section 4 Traditional Knowledge provides information on existing traditional knowledge in the Project area, planning for future information collection, and plans for incorporating traditional knowledge into the Project design and EIS.

Section 5 Existing Biophysical Environment describes currently available information on the existing biophysical environment, including identification and characterization of environmental components that may interact with the Project.

Section 6 Existing Human Environment describes currently available information on the existing socio-economic and cultural environment, including identification and characterization of socio-economic, cultural and archaeological components that may interact with the Project.

Section 7 Potential Project Environmental Effects provides preliminary identification of potential interactions between the Project and the environment, the potential effects of these interactions, and possible mitigation measures and monitoring programs.

Section 8 Potential Project Socio-economic Effects provides a preliminary identification of potential socio-economic and cultural interactions with the Project, the potential effects of these interactions, and possible mitigation measures and monitoring programs.

Section 9 Human Health Ecological Risk Assessment describes the approach that will be used for assessing potential ecological and human health risks and potential effects pathways associated with the Project.

Section 10 Cumulative and Transboundary Effects Assessments describes the approach that will be taken in assessing potential cumulative and transboundary effects associated with the Project.

Section 11 Accidents and Malfunctions describes the approach that will be taken in assessing the risks and consequences of potential accidents and malfunctions associated with the Project.

Section 12 Environmental Management Plans describes the planned organizational management for the Project, integrated policies, and key programs that will be implemented for all phases of the Project.

Section 13 Reference List provides citations for all literature sources cited in text.

Izok Corridor Project Proposal

SECTION 2

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2 PRELIMINARY PROJECT DESCRIPTION

2.1 Introduction

The Izok Corridor Project ('the Project') is a proposed mining development located in the Kitikmeot region of Nunavut. The Project includes development of the High Lake and Izok zinc-rich deposits. Ore mined from both deposits will be processed at a proposed mill to be located at the Izok Mine. The concentrate will be transported year round by truck on a ~350 km all-season road (Izok Road)to a port at Grays Bay on the Coronation Gulf. Concentrate will be stored at Grays Bay and shipped to smelters in Europe and Asia during the open-water season.

Temporary winter roads will be established between the proposed Izok Mine and to a point close the Tibbitt-Contwoyto Ice Road (TCWR)and between Grays Bay and the proposed High Lake Mine to facilitate construction. The Izok winter road will be used to bring construction equipment and materials into the site from Yellowknife. The High Lake winter road will be used to move construction equipment and materials from Grays Bay.

This Project description is based on a pre-feasibility study completed in early 2012 (MMG 2012a) that describes the preliminary Project infrastructure and activities. MMG is currently undertaking a feasibility study for the Project, which will result in a more detailed engineering design and costing, and resources and financial modelling. This feasibility study includes consideration of an alternate alignment for Izok Road. The feasibility study will provide more details as to the costs of construction, operation and closure and will allow MMG to make a final decision in mid to late 2013 regarding whether to move forward with construction of the Project.

2.1.1 Project Land Requirements

Development of the Izok Corridor Project will require land at Grays Bay for storage and port facilities and associated infrastructure, at the Izok and High Lake Mine sites for infrastructure, open pits, waste rock/overburden and tailings impoundment areas, and along the 347-km Izok Road corridor. The total estimated land requirement for the Project is 1,160 hectares (ha) (**Table 2.1-1**). These numbers are subject to revision during feasibility planning.

Table 2.1-1 Approximate Land Requirements for the Izok Corridor Project

Project Component	Area (ha)
Izok Mine Site and Infrastructure	290
High Lake Mine Site and Infrastructure	78
Izok Road	770
Grays Bay Port and Infrastructure	22
Total	**1,160**

2.1.2 Pre-Construction Staging

The construction and operation of major mining and infrastructure projects in the arctic requires substantial planning to deal with the logistical challenges associated with the lack of existing services and infrastructure, harsh winter conditions and the short summer season. Scheduling needs to consider

the short open-water periods and limited winter road availability for strategic delivery of materials and equipment for early works until all-season facilities are developed. Delays of a few months for specific activities may result in up to a year delay to the Project schedule. Early planning is critical.

MMG intends to apply to the NIRB for an exception to the Project review process, pursuant to Article 12.102(b) of the Nunavut Land Claim Agreement (NLCA), for authorization to proceed with pre-construction works prior to completion of the Project review by the NIRB. Current plans for pre-construction works include early staging of equipment and materials and other preparatory activities necessary to facilitate commencement of construction as soon as the Project Certificate and relevant approvals are received from the NIRB and Authorizing Agencies.

The key milestones for pre-construction works are summarized below. This assumes that pre-construction staging activities will be authorized prior to completion of the NIRB Project Review and that MMG receives the Project Certificate and associated permits in Q1/Q2 of 2015. If construction permits are not issued until later in the year, timing windows for early works would be modified, but this would not change the intent of MMG plans for pre-construction works.

Anticipated Dates	Milestone
Q2 2014	MMG submits Application for Exception from Review for selected pre-construction activities to the NIRB
Q3 2014	NIRB authorizes exceptions allowing pre-construction activities to proceed; AANDC and KIA issues the associated land use permits
Q3 2014	Pre-construction activities commence
Q1/Q2 2015	NIRB issue Project Certificate authorizing commencement of construction

As required by the NIRB, MMG will undertake public consultation in relation to the specific pre-construction activities included in the application for exceptions, and will incorporate public input and local knowledge into the planning for these activities.

More detailed information regarding planned pre-construction staging activities, timing of activities and workforce requirements will be submitted to the NIRB as part of the Exceptions Application.

MMG also intends to submit applications to AANDC and KIA for land use permits required to proceed with the pre-construction works. If necessary, MMG will also submit an application for an amendment to its Type 'B' water license to allow for the use of water and deposition of wastes (i.e., sewage, grey water, non-hazardous wastes, waste oil and other waste) for pre-construction activities.

2.1.2.1 Izok Mine Site

The TCWR will be used to transport materials and equipment to the south end of the Izok Corridor Project. The entire road is available for only about two months each year (late January through late March), although the north end of the road can have an extended life depending on climatic conditions in any given year. Consequently, all construction equipment and materials required for the Project to March of the following year will need to be delivered during the January-March 2015 period. This supply route will be used for the first two years of the Project until construction of the all-season road from Izok Mine to Grays Bay is completed.

Materials transported during the first season will include camps, offices, earth moving equipment, construction equipment (e.g., cranes and forklifts), batch plants, tools, explosive supplies, crushing plant, fuel, transport, construction materials, rebar, steel, cement, warehousing, culverts, bridges and non-perishable goods.

The main staging area for this equipment will be at the Ham Lake camp, which is accessible by ice road from the main winter road. A secondary staging of earth moving equipment may be located at a point near the Jericho Mine.

The following is a list of specific pre-construction activities that MMG will apply for permission to proceed with as part of the Exception Application.

- Upgrade the airstrip at the Ham Lake camp or a nearby selected airstrip
- Build a winter road between Ham Lake camp and the northern end of the TCWR
- Build an all-season road from the Ham Lake airstrip to the Izok Mine site
    - If study of airport locations indicates that the Ham Lake airstrip cannot accommodate larger aircraft that will be required for the Project (Hercules), an alternate location east of Izok Lake may be selected. This would require construction of an all-season road between that location and the Izok Mine site.
- Construct temporary camps, prepare laydown areas, and establish a fuel depot at the proposed Izok Mine site
- Develop quarries to allow for construction of the above facilities and Izok Road

2.1.2.2 Grays Bay South to Jericho Mine

Marine transport of equipment and materials to Grays Bay is only possible during a three-month period when the Coronation Gulf is ice free.

Materials, equipment and supplies required for port and road construction will be transported to Grays Bay via barge in August-September 2014, where they will be offloaded onto the beach and moved to a new laydown area that will be within the planned footprint of the proposed port facility.

Early works will include:

- Construction of the temporary dock for barge off-loading
- Establishment of areas for the camp and laydown warehousing
- Set up temporary facilities such as camp, batch plant, quarries, crushing plants, fuel storage and warehousing
- Construction of an airstrip near Grays Bay
- Construction of the winter road from Grays Bay to the High Lake Mine site during winter 2014/2015

2.1.3 Project Schedule

The preliminary Project schedule is provided in **Figure 2.1-1**. The schedule assumes that the pre-construction activities will occur in advance of receiving the Project Certificate and that the Project will receive the requisite permits, licenses and approvals by Q1/Q2 2015. Following regulatory approval, construction of the Grays Bay Port and Izok Road will begin.

Mining and ore stockpiling at the Izok and High Lake Mine sites will begin in 2017, when construction of the mill facility at the Izok Mine is complete. Ore concentrate production will begin in2017. The life of the Izok Mine is expected to be 11 years, and the life of the High Lake Mine is expected to be 12 years.

Current reserves indicate a mill operating life of approximately 12 years at an average production rate of approximately 2 million tonnes of ore per annum (Mtpa). While future exploration drilling may identify additional deposits in the Project area that could potentially extend the operating life of the mine, this is not considered part of the current Project. It is acknowledged that a separate Environmental Assessment and license amendments would be required prior to development.

Anticipated timing of the major Project phases is summarized as follows.

- Construction: anticipated to begin in 2015 and occur over a two-year period
- Operations: anticipated to begin in 2017and last 12years
- Progressive reclamation: ongoing over the life of the Project
- Closure and reclamation: anticipated to begin in 2028 and occur over two to three years
- Post-closure monitoring: anticipated to last 7 years after closure (closure and reclamation and post-closure monitoring will occur over a 10-year period)

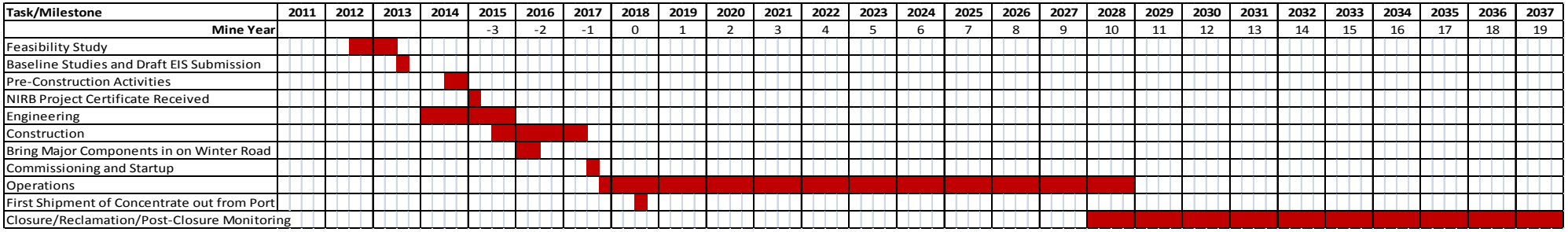


Figure 2.1-1 Project Schedule

2.2 Regional Geology

The Izok deposits are located within the western part of the Slave Structural Province, which is part of the Canadian Precambrian Shield. The area was last glaciated between 10,000 and 8,000 years ago. Erosion by the continental glaciation denuded the terrain into extensive areas of bare, fresh rock with a thin and discontinuous till cover.

Rocks are usually described from the oldest to the youngest and are often identified by major groupings and subgroups. The general bedrock in the Izok Lake area is composed of very old Precambrian rocks that were folded and metamorphosed during the Kenoran orogeny, some 2.5 billion years ago. This family of rocks belongs to the Point Lake Formation, a belt of mafic to felsic metavolcanic rocks that are part of the Yellowknife Supergroup.

The groups of rocks of interest, the deposits that contain the zinc rich ore under Izok Lake, are hosted by a complex of mainly felsic metavolcanic rocks in a partly submarine setting. The volcanic rocks are overlain by fine clastic, partly carbonate bearing sediments of the Contwoyto Formation. Synvolcanic intrusive activity emplaced sills of gabbroic composition as well as dacite dikes and sills. All of the above rocks have subsequently been intruded by granitic rocks and their pegmatitic derivatives.

The High Lake deposits are volcanogenic massive sulphide (VMS) deposits hosted within the High Lake greenstone belt in the northern part of the Slave structural province. Basement gneisses about 3.96-3.00 billion years ago (Ga) are overlain by sedimentary and volcanic rocks (2.69 Ga). Three phases of regional deformation are evident, and the province is intruded by batholiths ranging between 2.63-2.58 Ga. Generally, the supracrustal rocks trend north to northeast.

The High Lake greenstone belt extends 140 km from the Coronation Gulf coast southward (**Figure 2.2-1**). The belt exhibits greenschist grade metamorphism, and is intruded by syn-volcanic mafic to intermediate plutons and post tectonic felsic intrusions. Proterezoic age (1.27 Ga) northwesterly trending diabase dykes, which are part of the Mackenzie swarm, intrude the supracrustal sequence.

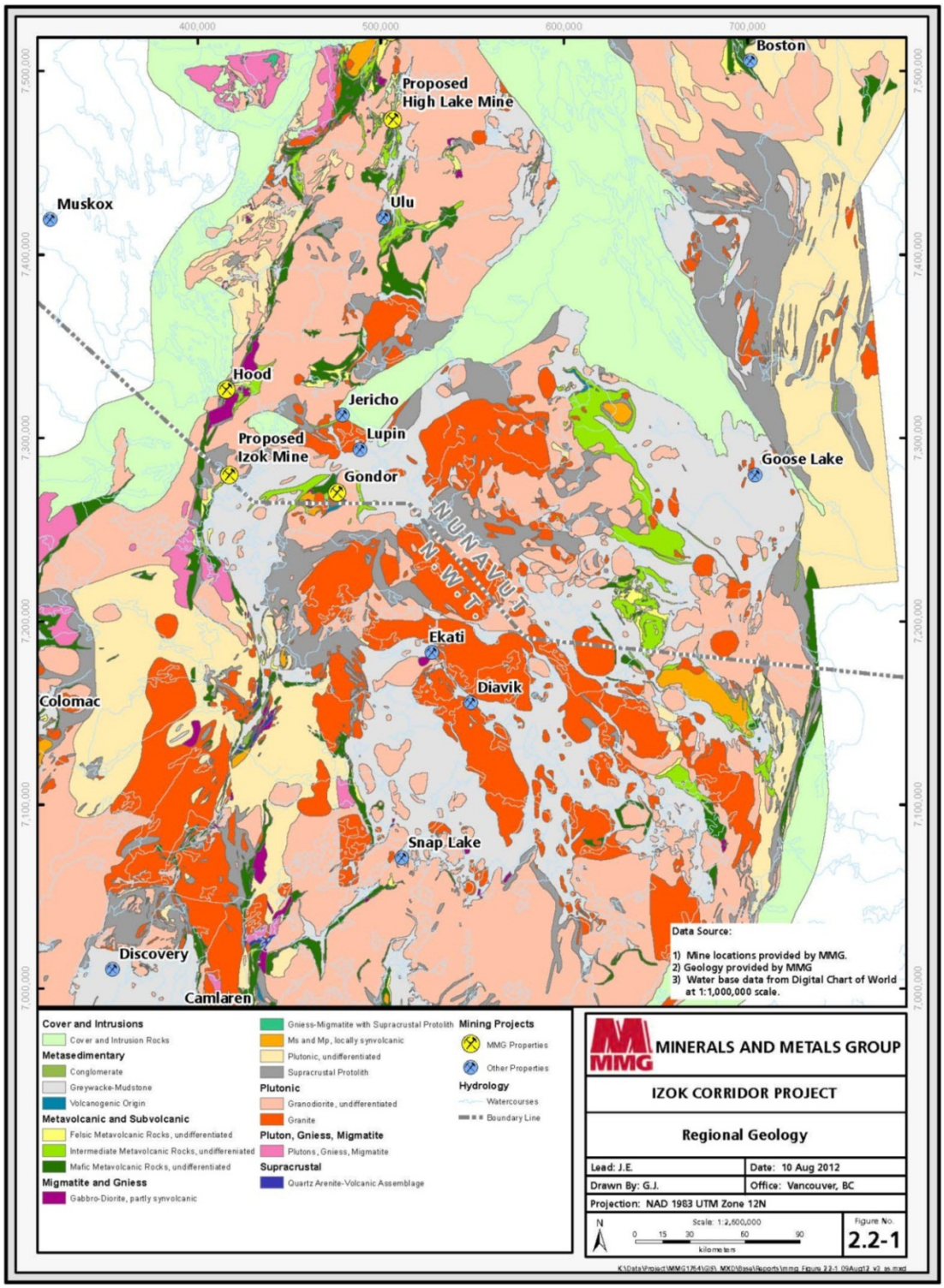


Figure 2.2-1 Regional Geology

2.3 Mining Overview

Both open pit and underground mining methods will be used for the Izok Corridor Project. Open pit mining is usually less expensive and therefore is usually the first method used. Underground mining is more expensive, and the extent and depth of underground mining is directly related to balancing the cost of recovery of the ore versus its value.

The majority of the Izok deposits will be open pit mined, while the Inukshuk deposit will be mined by underground methods.The deposits planned for open pit mining are located directly below Izok Lake. Therefore, Izok Lake will need to be drained, and the water diverted to allow extraction of the resource. The pit will be mined over 11 years in three phases.

Two deposits (AB and D) at High Lake will be open pit mined, and the West Zone deposit will be mined by underground methods.

The preliminary production schedule, presented in **Figure 2.3-1**, is based on a nominal 2 Mtpa.Approximately 1.4 Mtpa will come from the Izok Mine and 0.6Mtpafrom the High Lake Mine. These numbers may change in the next years as more information becomes available. First ore will be delivered to the mill in late 2017 to early 2018.

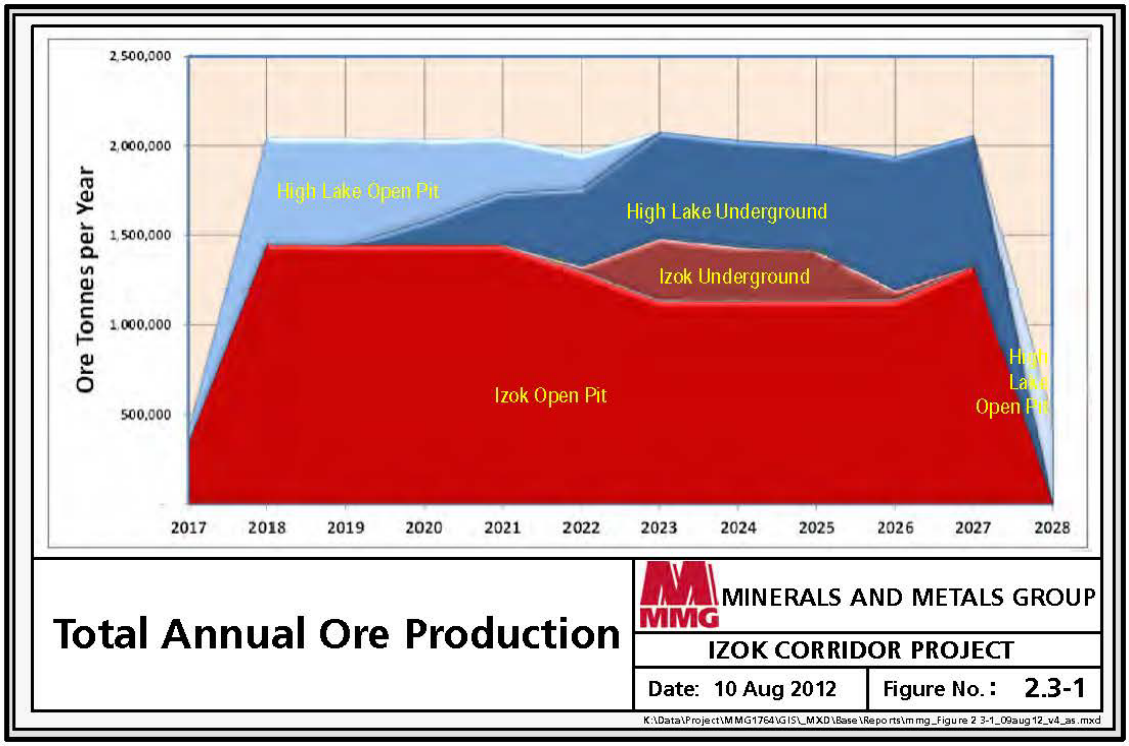


Figure 2.3-1 Total Annual Ore Production

2.4 Izok Mine Site

2.4.1 Izok Site Geology

Bedrock exposures in the immediate Izok Lake area consist of mafic to felsic metavolcanics, granitic intrusives, gabbro, and meta-sedimentary rocks. Bedrock outcrops vary from massive competent to fractured and moderately competent rock.

The Izok zinc-copper-lead deposits are VMS deposits hosted within and near the top of a succession of dominantly felsic volcanic (rhyolitic) rocks, with lesser intermediate (dacite) volcanics, and derived sediments. The deposits are overlain by a succession of felsic volcanoclastics, gabbroic intrusions, intermediate and mafic flows, iron formation, and turbidite sediments (**Figure 2.4-1**). This suite, collectively and informally named the "Izok Lake Belt," is approximately 18 km in length and ranges from 1 km to 5 km in width.

Five sulphide deposits are known to exist under and near Izok Lake: Central, North, Northwest, Inukshuk, and South (**Figure 2.4-2**).

2.4.1.1 Central Deposit

The Central deposit forms a gently warped and east-plunging, trough-shaped composite lens. The deposit is 550 m in length (east-west), 200 m in width and up to 125 m in thickness. Depths range between bedrock surface and 160 m. The deposit is divided into two large pods referred to as the East Cup and the West Cup (**Figure 2.4-3**).

A steeply dipping north limb of the Central deposit projects to surface over most of its length and develops into the two bulbous accumulations of massive sulphides representing the East and West cups. In cross section, the bulbs resemble a giant "V" with a rounded base and a closed top that either dips to the south at a rather flat angle or is locally flat (**Figure 2.4-4**and **Figure 2.4-5**). On some sections of the West Cup, the walls of the "V" are inverted toward the outside. In longitudinal section, the top of the "V" rises from a depth of 80 m to 90 m below surface at its eastern limit to 50m to 60 m through the western part of the East Cup and the eastern part of the West Cup, finally outcropping in the western part of the West Cup (refer to **Figure 2.4-3**).

Open pit mining will start in the West Cup because it carries by far the highest grades of all Izok deposits and has the largest tonnage directly at bedrock.

2.4.1.2 Northwest Deposit

The Northwest deposit forms a shallow-dipping lens 400 m (NW-SE) x 250 m (NE-SW) x 20 m average thickness between a depth of 0 m and 130 m (**Figure 2.4-6**). The deposit is generally hosted within felsic rocks but is structurally overlain by gabbro, which appears to have cut into the underlying sulphides from above at an oblique angle in some instances. Two or more horizons containing disseminated sulphides occur lateral to the main lens on some sections, which suggests that multiple lenses may have coalesced.

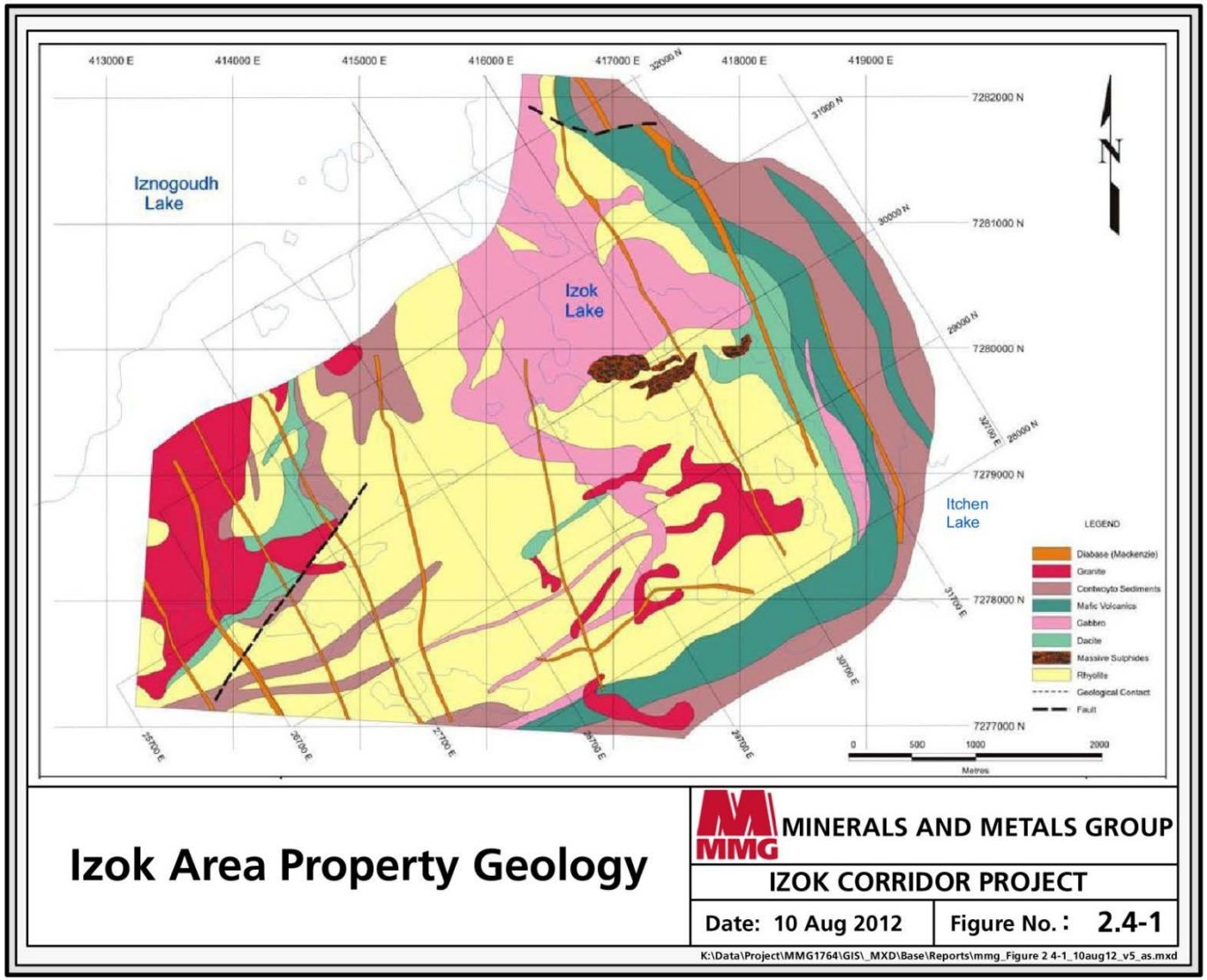


Figure 2.4-1 Izok Area Geology

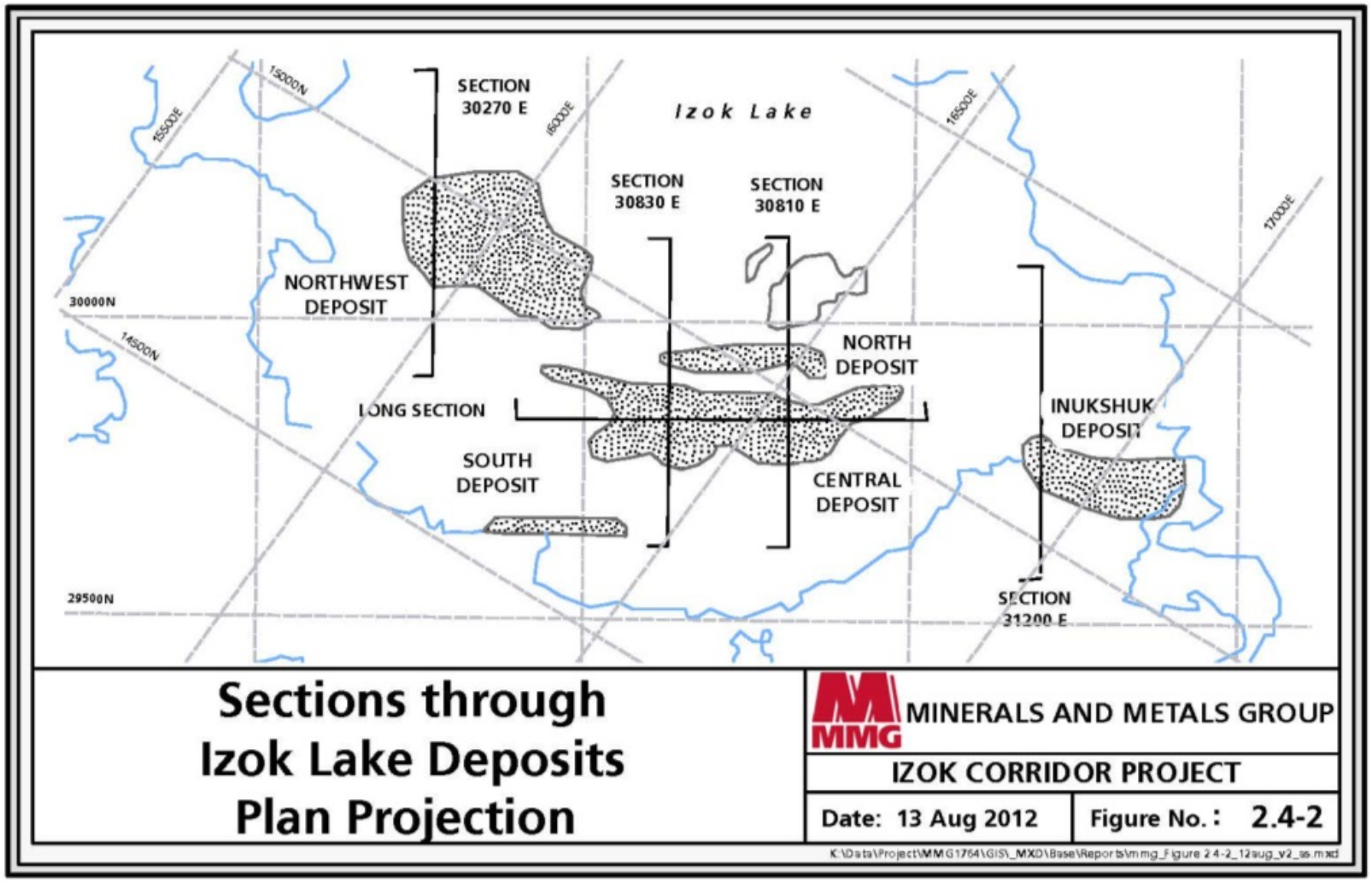
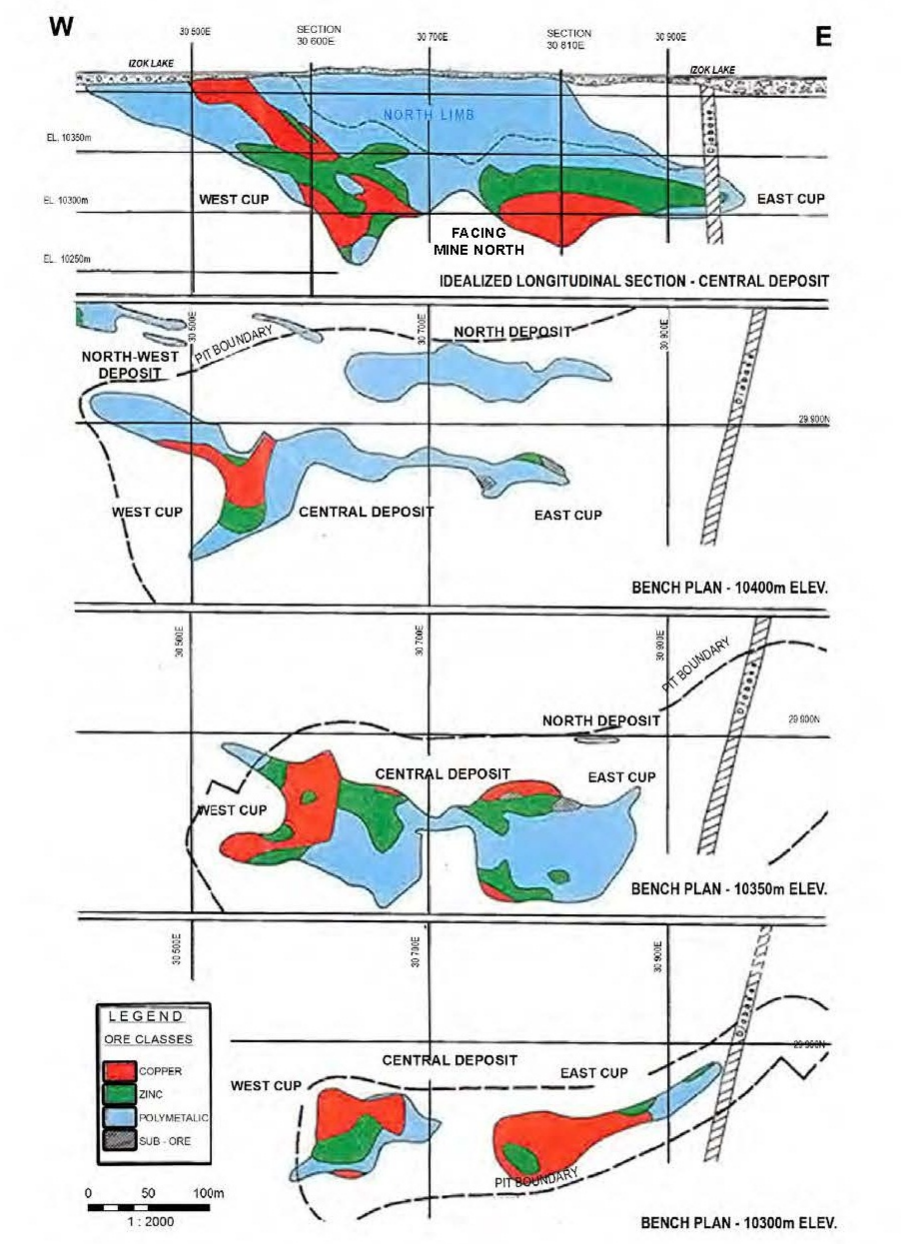


Figure 2.4-2 Sections through Izok Deposits – Plan Projection



Izok Resource Model
Idealized Long Section (top)
and Bench Plans (lower 3)

MINERALS AND METALS GROUP

IZOK CORRIDOR PROJECT

Date: 15 Aug 2012 | Figure No. 2.4-3

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Figure 2.4-3 Idealized Long Section (top)and Bench Plans (lower 3)

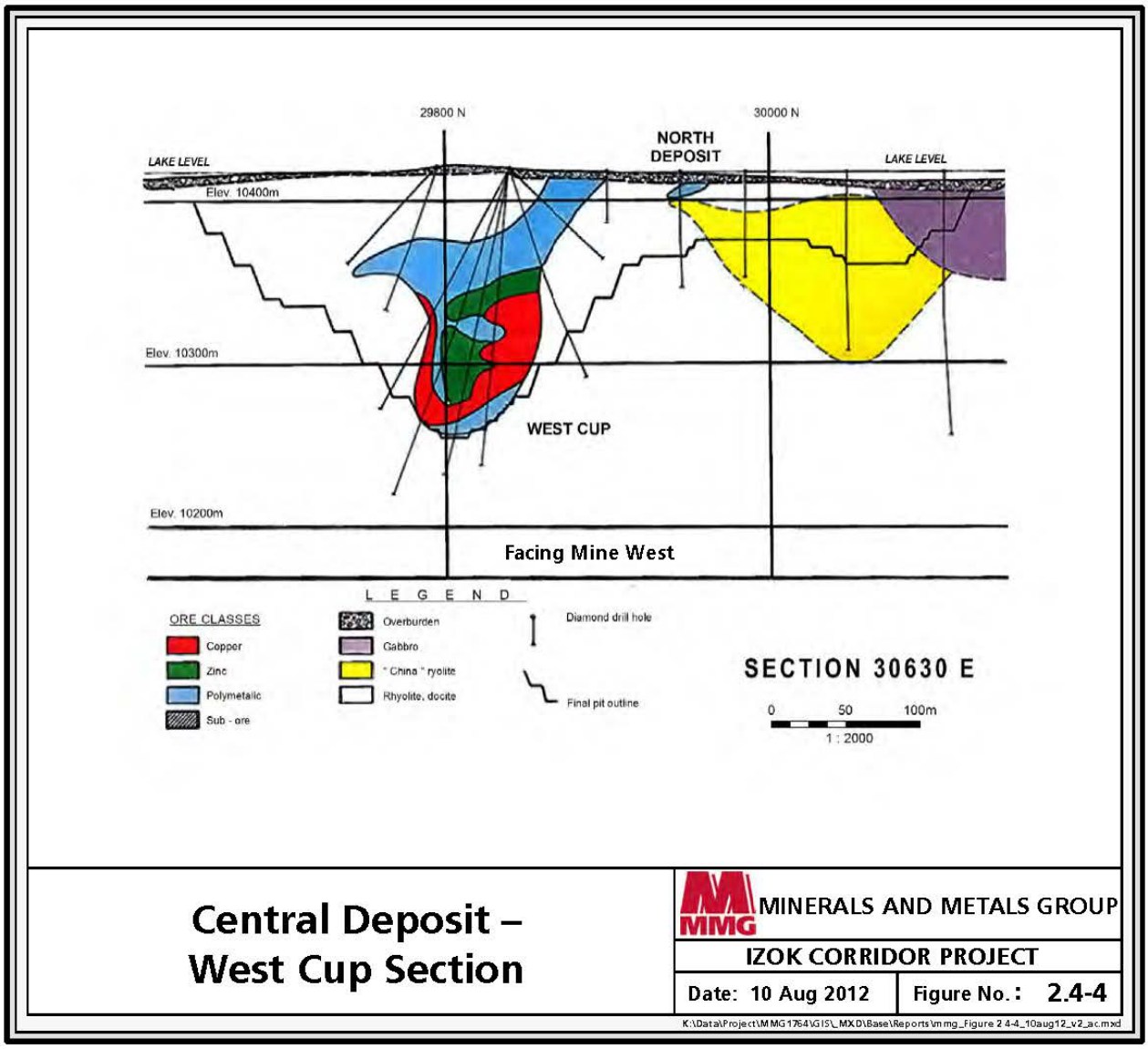


Figure 2.4-4 Central Deposit – West Cup

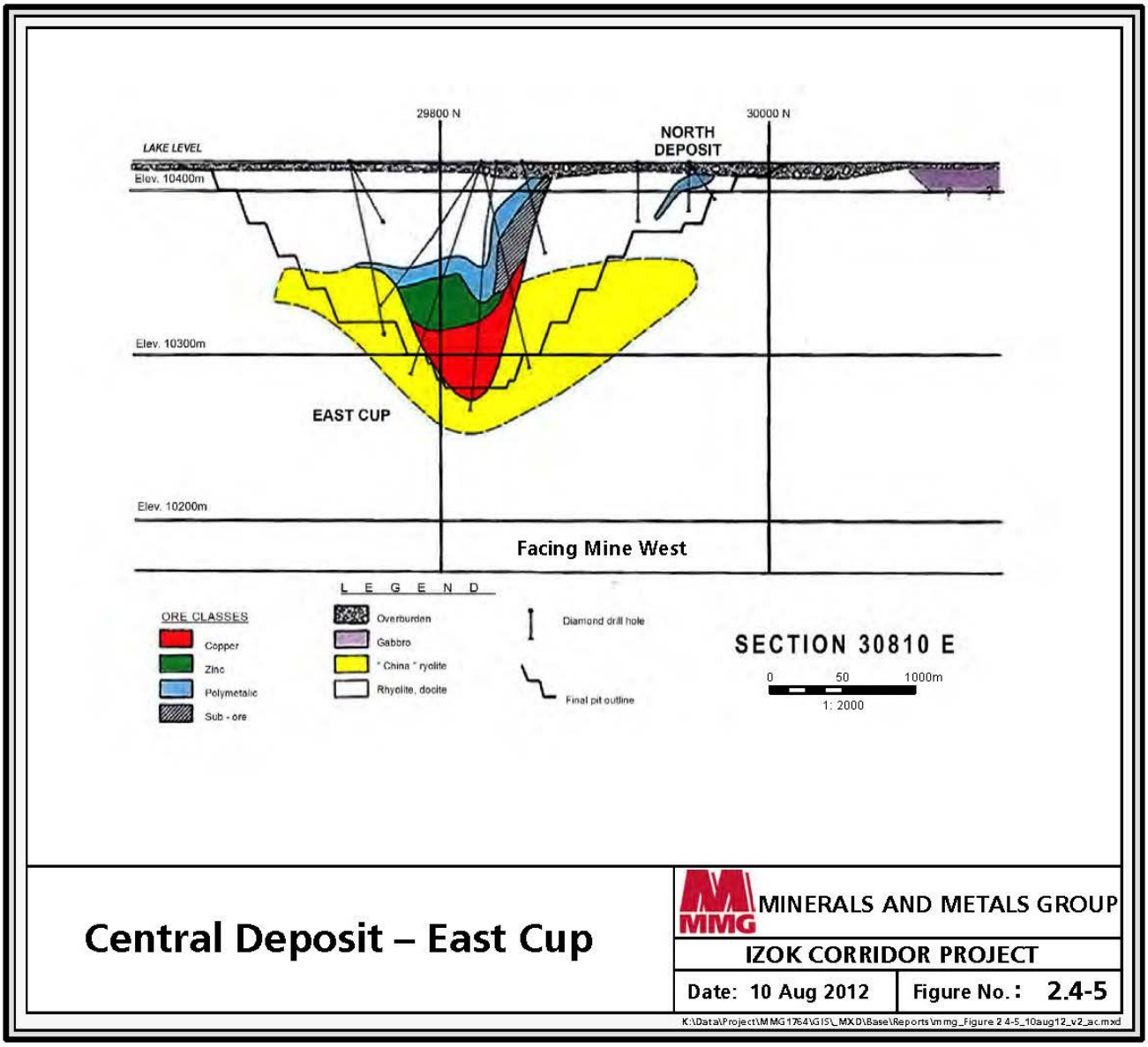


Figure 2.4-5 Central Deposit – East Cup

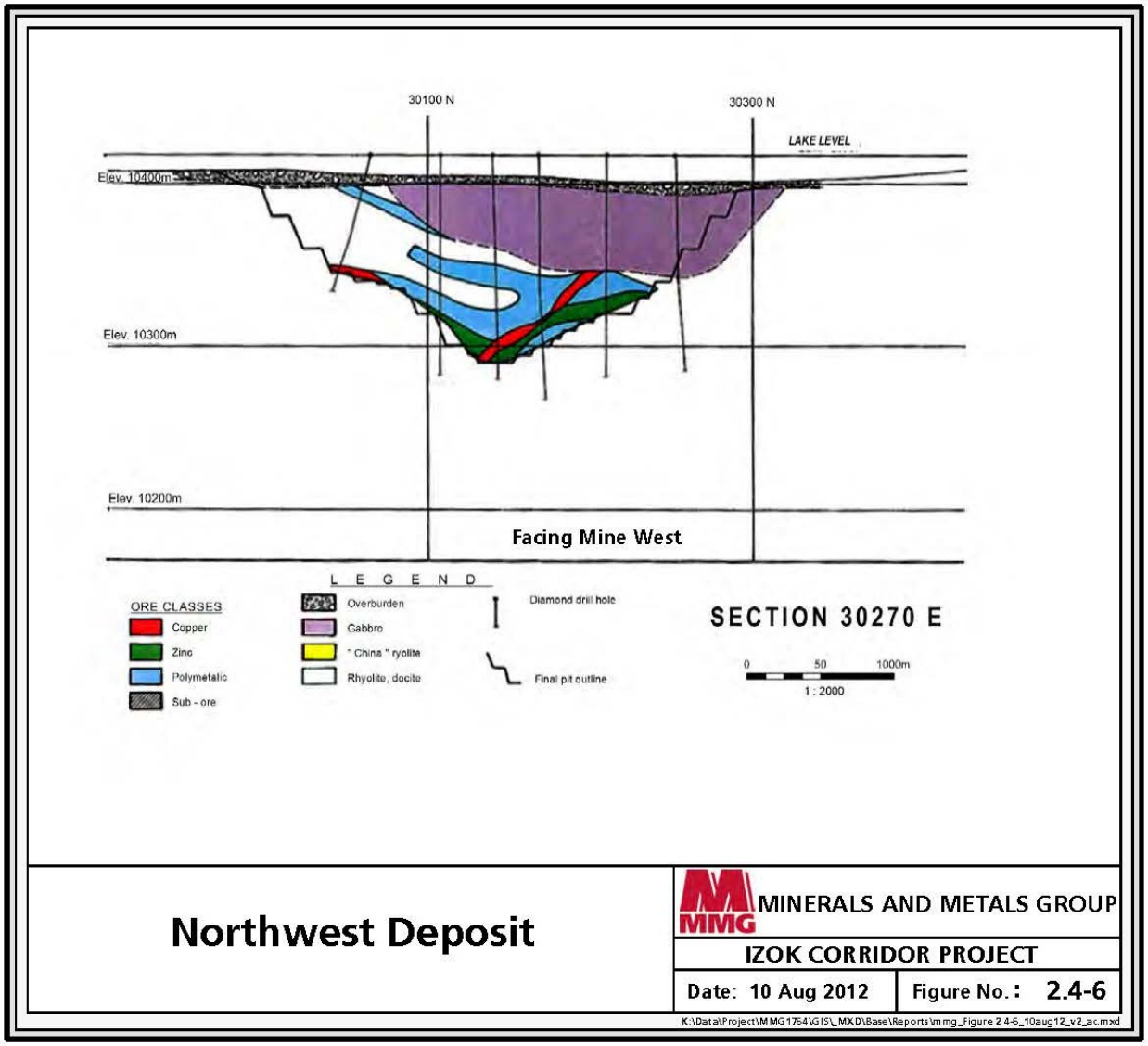


Figure 2.4-6 Northwest Deposit

2.4.1.3 North Deposit

The North deposit is a near-surface, elongate lens 350 m (E-W) x 50 m (N-S) x 15 m average thickness (refer to**Figure 2.4-6**). This deposit is an on-strike equivalent to the Northwest deposit and may represent the remnant keel of a larger, trough-shaped lens.

2.4.1.4 Inukshuk Deposit

The Inukshuk deposit is situated to the east of the East Cup of the Central Zone. Massive sulphides are found in a cigar-shaped zone, which starts 60 m below surface and plunges grid-east to 270 m below surface, some 200 m to the east for an overall plunge angle of 45°. In contrast, the footwall contact of the sulphides strikes grid northeast with a somewhat steeper dip toward grid southeast of 55°. The sulphides have a fairly constant grid north-south dimension of 80 m to 120 m. Like the other deposits at Izok, pronounced differences in thickness over relatively short distances are also found in the Inukshuk deposit. In addition, a general zoning is observed with thinner, zinc-rich material on the northern, up-dip side giving way to thicker, more copper-rich intersections toward the southern part of the deposit.

Three cross sections plotted at right angles to the changing strike of the zone show the average true thickness of the deposit to be approximately 10 m, with a maximum of 20 m (**Figure 2.4-7**).

2.4.1.5 South Deposit

Seven widely-spaced drill holes have yielded a number of intersections to a depth of 80 m in an area southwest of the West Cup (refer to **Figure 2.4-4**). Massive to semi-massive sulphide intersections appear to belong to a zone some 300 m long. Undiluted grades of five of the better drill intersections average 7% Zn, 0.7% Cu, 0.4% Pb, and 20 g/t Ag over a width of 5 m. A mineral inventory of approximately250,000 to 300,000 tonnes (t) is estimated.

2.4.2 Izok Mineral Resources and Reserves

Mineral resource estimates for the Izok deposits are outlined in **Table 2.4-1**. Additional exploration drilling will be undertaken during the life of the Project. These numbers may change as the Project advances.

Table 2.4-1 Preliminary Izok Mineral Resources as of 30 June 2010

Izok Mineral Resources									
2% Zn equivalent cut-off grade	Tonnes (Mt)	Zinc grade (% Zn)	Copper grade (% Cu)	Lead grade (% Pb)	Silver grade (g/tAg)	Contained Metal			
						Zinc (*000 t)	Copper (*000 t)	Lead (*000 t)	Silver (M oz)
Measured	-	-	-	-	-	-	-	-	-
Indicated	14.4	12.9	2.5	1.3	71	1,863.5	361.5	184.3	32.9
Inferred	0.4	6.4	3.8	0.3	54	23.6	14.0	1.0	0.6
Total Resources	**14.8**	**19.3**	**6.3**	**1.6**	**125**	**1,887.1**	**375.5**	**185.3**	**33.5**

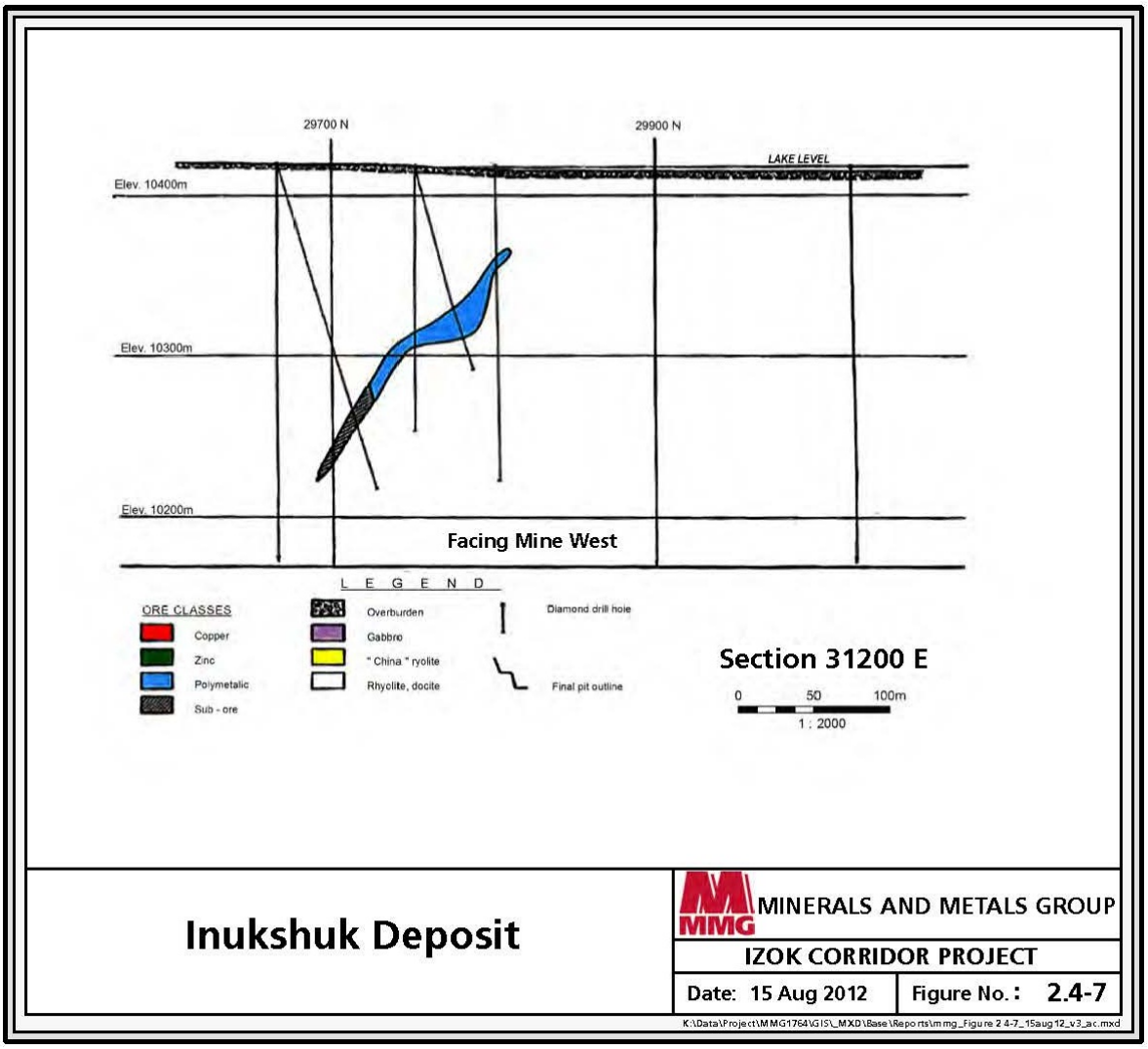


Figure 2.4-7 Inukshuk Deposit

2.4.3 Izok Lake Dewatering

Because the mineable Izok deposits are located beneath Izok Lake, draining the lake is a necessary first step in mine development. Izok Lake is located between Iznogoudh Lake (upstream) and Itchen Lake (downstream) (**Figure 2.4-8**; refer to section 5.6). It will be necessary to isolate flow from Iznogoudh Lake into Izok Lake and divert the water into Itchen Lake before starting to drain Izok Lake water into Itchen Lake. A diversion dam will be constructed to cutoff inflows from Iznogoudh Lake into Izok Lake. A diversion channel will be built to re-route this water around Izok Lake and into Itchen Lake downstream (see **Figure 2.4-9** for a preliminary typical cross section, plan and profile).

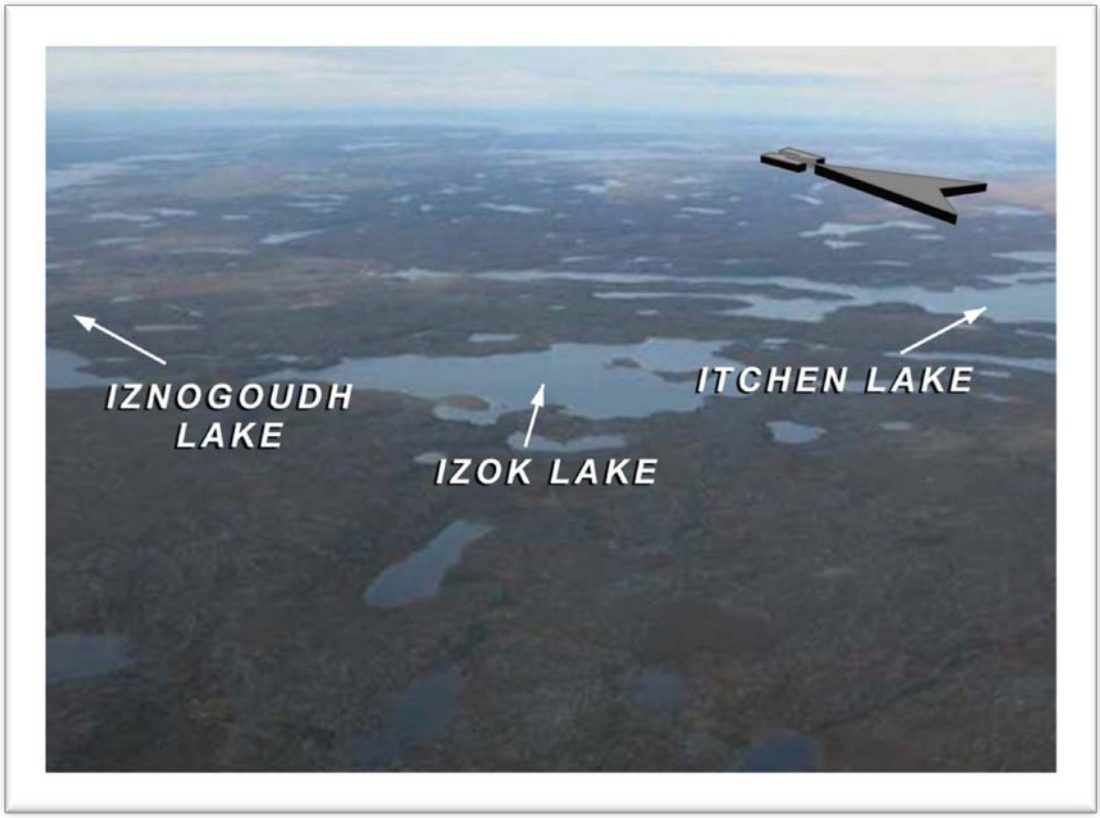


Figure 2.4-8 Izok Lake

Once inflowing water is diverted around Izok Lake, the lake will be drained. This will involve pumping approximately 6.4 Mm^3 of water into Itchen Lake, which will take several months.

Experience with draining several lakes at the Ekati Mine suggests that Izok Lake can be fished out during the summer and dewatered during the fall when there is some ice cover that will drape over mud slopes as the water level recedes, limiting re-suspension of lakebed solids as the water level drops. The upper half of Izok Lake water column is expected to beclear enough to be pumped directly to Itchen Lake, while the lower half will likely be turbid and require routing through a water holding pond for clarification before release to Itchen Lake.

Izok Lake dewatering will be guided by a detailed Water Management Plan. The objectives of the plan will be to ensure minimal to no changes in water quantity and quality of the upstream and downstream lakes. In addition, a Fish Management Plan and Fish Habitat Compensation Plan will also be prepared in collaboration with the Hunters and Trappers Organizations (HTOs) and Fisheries and Oceans Canada (DFO). Fish habitat compensation will be provided at an area ratio as agreed with DFO.

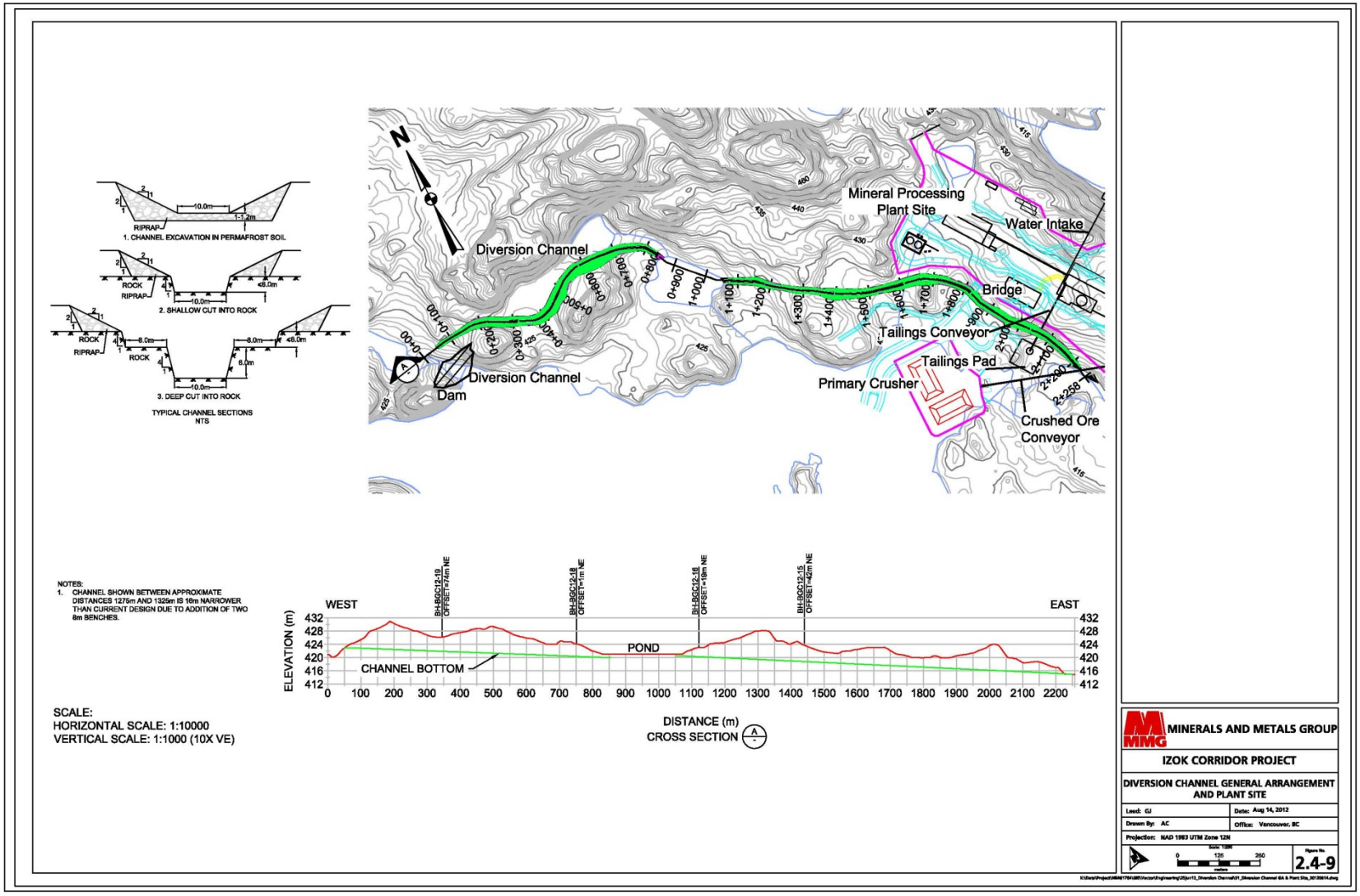


Figure 2.4-9 Diversion Channel General Arrangement and Plant Site

2.4.3.1 Diversion Dam and Diversion Channel Construction and Operation

The diversion channel, diversion dam and the water holding pond will be constructed using standard techniques typical of water containing structures in the north, and standard earthmoving and construction equipment. Blasting will be used where solid rock is encountered. MMG is conducting a sampling program to determine if acid rock drainage potential may be present.

Boulders and gravel will be placed in the bottom of the diversion channel in places to facilitate fish passage. Rock armouring will be installed where the channel is excavated in overburden to prevent erosion. Material excavated from the diversion channel will be used for berms and maintenance of a road running parallel to the channel and any excess material will be used in other areas of Project construction.

The diversion channel will be maintained through regular inspection and maintenance activities to keep the channel clear of ice, snow and debris.

2.4.3.2 Izok Lake Drainage Mitigation by Design

Waste rock and tailings will be deposited within the area of the drained lake bed not required for mining to minimize the Project footprint.

Dewatering of Izok Lake will occur during the fall when there is some ice cover on the shore that will limit re-suspension of lakebed solids. During draining of the lower half of the lake, water will be routed to a water holding pond for clarification prior to release. There will be no water loss, as water will be re-routed via the diversion channel into Itchen Lake.

The risk of contaminated water entering the diversion channel from the process plant and camp complex and making its way into Itchen Lake will be reduced by installing surface water control structures that will intercept surface run-off and pump it back to the process plant for re-use and recycling.

2.4.3.3 Drainage Alternatives

Alternative to Draining Izok Lake

The only alternative to draining Izok Lake to access the ore is to mine the ore from underground. This option was rejected because it would require a substantial thickness of solid rock in the form of a crown pillar to be left at the top of the ore body as a barrier between the lake and the underground mine workings. This would substantially reduce the percentage of the ore body available for mining and greatly diminish the economically viability Project.

Alternative Diversion Channel Routes

Several diversion channel routes were evaluated based on constructability, operability and environmental criteria (**Figure 2.4-10**). The selected option would cause the least amount of disturbance, require the least amount of excavation, and require the shallowest cuts through ridges and hills.

2.4.4 Izok Mining

Once Izok Lake is drained and lake bottom sediments removed, excavation of the Izok Mine open pit will begin. Mine planning has considered the materials that will be encountered during mine development, as well as the permafrost and groundwater regimes

2.4.4.1 Hydrogeology

Hydrogeology of the Izok Mine area is an important factor to be considered in the mine design and planning. A proper understanding allows for adequate provisions to be made to handle water seepage into the mine area, to develop methods to minimize water inflows, and to plan and manage for the treatment of inflow water. The current hydrogeologic understanding of the Izok Mine area is summarized below.

There are three hydrostratigraphic units that have been identified and characterized at the Izok Mine site.

- Overburden
- Weathered bedrock
- Fresh bedrock

The Izok Mine site lies within an area of continuous permafrost that acts as a barrier to surficial infiltration and groundwater flow. Preliminary data analysis indicates that:

- The active layer typically is between one and five metres thick
- The base of the permafrost ranges from 251 m to 300 m below ground surface
- An open talik, where permafrost is absent, exists beneath Izok Lake
- Shallow groundwater flow likely exists seasonally within the seasonal active layer above the permafrost and flow pathways are anticipated to follow surficial drainage patterns
- A portion of the groundwater beneath Izok Lake might flow downwards from surface of the deep regional groundwater system below the base of the permafrost
- Regional groundwater flows southeast towards Itchen Lake

2.4.4.2 Mining Optimization and Inventory

Mining optimization exercises performed during the pre-feasibility study resulted in an estimated mining inventory of material in all zones that could be mined economically (**Table 2.4-2**). Please note that these numbers may change as models are refined in 2012 and 2013.

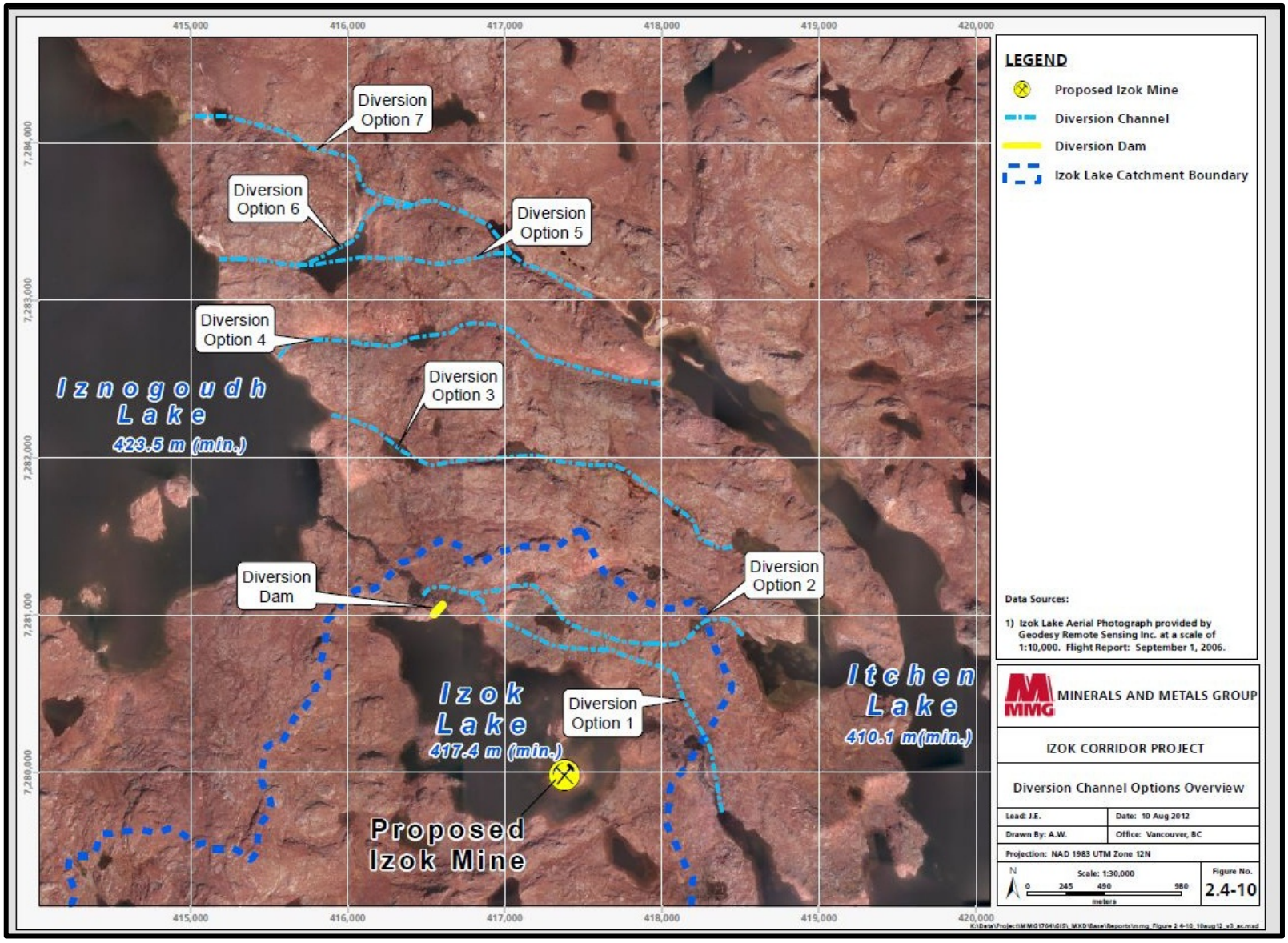


Figure 2.4-10 Diversion Channel Options Overview

Table 2.4-2 Preliminary Izok Mining Inventory

	Tonnes (Mt)	Zinc grade (% Zn)	Copper grade (% Cu)	Lead grade (% Pb)	Silver grade (g/t Ag)	Gold grade (g/ Au)	Zinc ('000 t)	Copper ('000 t)	Lead ('000 t)	Silver (M oz)
Open Pit	13.3	13.5	2.5	1.4	72	0.0	1,796	331	184	33.8
Underground	1.0	7.0	2.8	0.3	39	0.0	69	27	3	1.4
Total	14.3	13.1	2.5	1.3	70	0.0	1,865	359	186	35.1

Source:SNC-Lavalin, Prefeasibility Update(2011)

2.4.4.3 Bedrock Geotechnical Conditions

Geotechnical data indicates that rock at the Izok Mine site is very strong to extremely strong. The rock fabric has limited continuity but close spacing, which is a major consideration in mine design.

Geological models are being prepared for the Central, North, Northwest and Inukshuk deposits and a geotechnical model will be produced in 2012.At present, the geotechnical modeling has defined the rock mass based on distribution of rock lithologies at the Central, North, Northwest and Inukshuk deposits.

2.4.4.4 Preliminary Mine Design

Work carried out to date provides elementary design criteria for open pits, such as bench height, bench width, and slope angles and underground stopes. More detailed design criteria will be developed based on the new geological and geotechnical models currently being developed.

The open pit mine will be located within the talik and will not affect permafrost conditions.

The Inukshuk deposit will be mined by an underground method whereby horizontal slices, or "cuts", approximately five meters in thickness will be removed by drilling, blasting and truck haulage and once the zinc rich ore has been removed, backfilled with mining waste (**Figure 2.4-11**).Subsequent to backfilling the entire cut, the next higher cut will be mined, using the backfill previously emplaced as a working floor. This process will be repeated, working from the bottom upwards until the deposit is mined out.

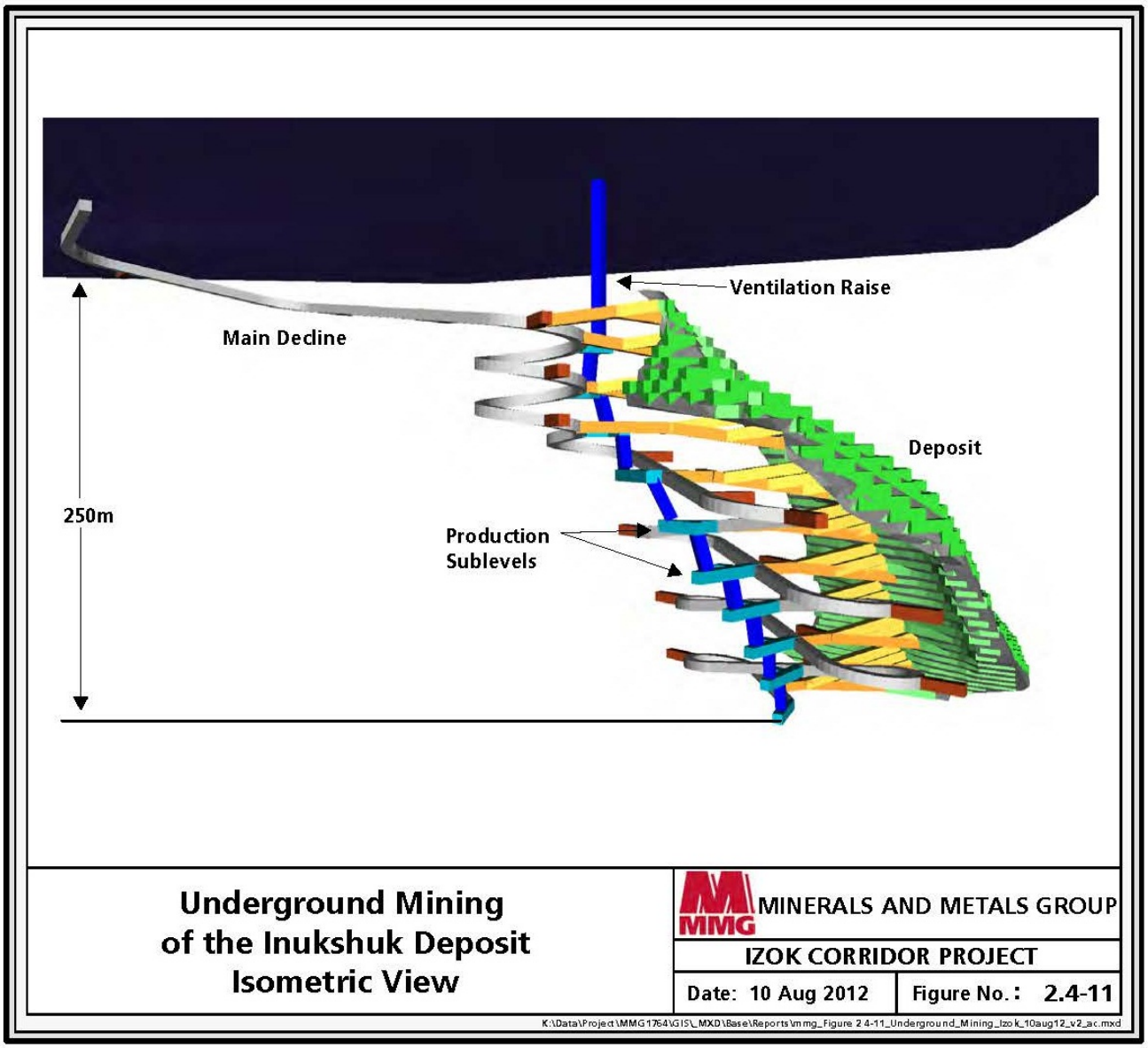


Figure 2.4-11 Underground Mining of the Inukshuk Deposit

The open pit and underground mining concepts at Izok are shown in **Figure 2.4-12**. Preliminary parameters of the open pit and underground mine are summarized in **Table 2.4-3**.

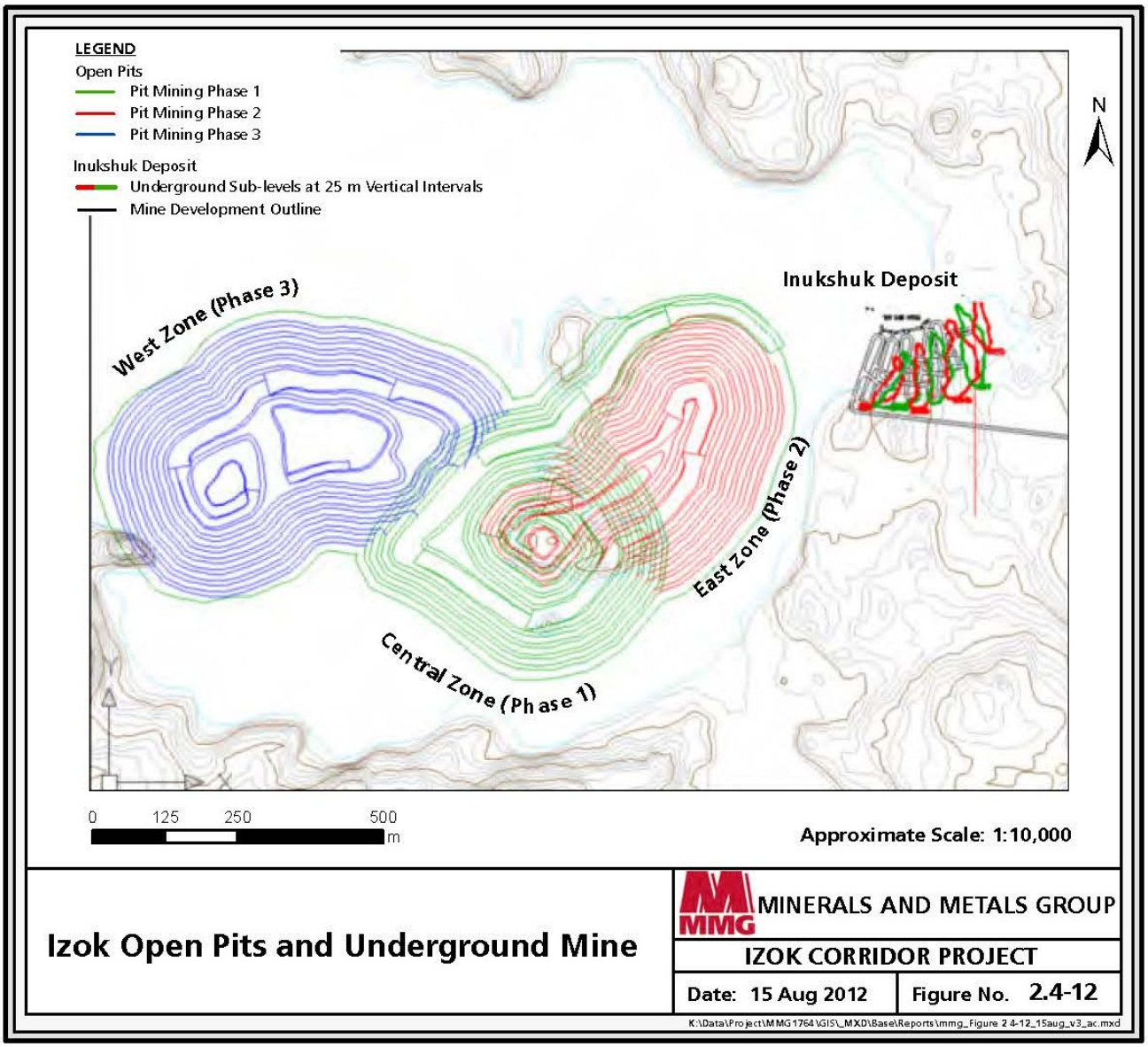


Figure 2.4-12 Izok Open Pits and Underground Mine

Table 2.4-3 Preliminary Mine Design Parameters for the Izok Deposits

Parameter	Pit Phase 1	Pit Phase 1 +2	Pit Phase 1 + 2 + 3	Inukshuk Underground
Excavated Volume			21Mm^3	0.5Mm^3
Maximum Depth (m)	160	180	180	280
Maximum Width (m)	415	435	726	80
Maximum Length (m)	435	740	1035	115

2.4.4.5 Mining Infrastructure and Processes

Underground Ventilation

The Inukshuk underground mine will not be in permafrost. There is currently an open talik under Izok Lake and once the lake is drained, it is expected that this talik will remain. Groundwater at depth will seep into the mine(refer to section 5.5.2.7).As such, the mine intake air will need to be heated to prevent inflowing water from freezing.

Mine Backfill

The Inukshuk underground mine will require backfill for mine stability. During underground mining, ore blocks (called stopes) will be excavated and the zinc rich ore brought to the plant for processing. To stabilize the large underground voids created during mining, mineral waste from surface will be crushed and trucked underground to be used to backfill the empty stopes. The backfill material may include tailings or waste rock.

Process Water Supply

At Izok, most process water will likely be drawn from groundwater inflows into the mine workings. Any requirements that exceed this source will be provided by heat-traced, insulated pipeline from the plant water supply.

Dewatering

Both the open pit and underground mines will require continuous dewatering due to their location in the talik zone. Information on groundwater inflows into the pit is being augmented by hydrogeological drilling and field testwork being conducted in 2012. The waste water will be piped to a central waste water handling facility for the Izok Mine. As all Izok Mine workings will be above sea level, no saline mine water is expected to be encountered.

Power Supply and Distribution

Electrical power will be fed from the main diesel-powered generator to a transformer and load centers located at the mines, where it will be distributed to surface and underground workings.

Fuel Supply

Fuel for mining equipment will be delivered to satellite fuel depots located at the Izok Mine or directly to the mining equipment in fuel trucks. At the Inukshuk underground mine, fuel storage will likely be located underground, protected from the weather. All fuel storage areas on surface and underground will be enclosed or bermed as per regulations in Nunavut.

Automation and Communication

Automation at the Izok Mine will be confined to systems onboard mining equipment. In the open pit, a dispatch system will be used to assist in prioritizing the deployment of equipment to working areas or for scheduled maintenance, and to collect operational data from onboard diagnostics systems.

The main communications systems will include one system for equipment and operating data collection and another for voice communications by radio sets carried by all personnel and equipment. In the underground mine, signals for communications will be carried by a leaky-feeder cable system that is run into all headings. Other systems will be used for ground movement and micro-seismic monitoring. GPS will be installed on most equipment that will operate on surface.

Services Buildings

The following central service and other buildings will be constructed at the Izok Mine.

- Accommodations
- Security
- Office & Dry Facility
- Waste Water Treatment Facility
- Maintenance Buildings
- Warehousing & Storage

Explosives Handling and Storage

Handling and storage of explosives will adhere to both the federal *Explosives Act* and the *Explosive Use Act of Nunavut*. Explosive accessories such as blasting caps, high explosive boosters and detonation cord will be transported to central storage facilities at the Izok and High Lake mines. Blasting agents, such as ammonium nitrate, fuel oil and emulsion ingredients will be transported to a central on-site facility at the High Lake Mine for the manufacture of the emulsion blasting agent. These materials will be further blended and loaded into blastholes in proportions appropriate to the wetness and temperature of the holes. Explosives and blasting agents will be transported to the work sites using purpose-built mobile equipment.

Drilling and Blasting

For the open pit, ore and waste benches have been designed on 10 m intervals. Blast holes and drill patterns will be sized to minimize dilution and ore losses.

Based on industry experience with operating mines in the NWT, it is expected that a high percentage of the blast holes will be wet. Consequently, blasts will employ emulsion explosives blended with ANFO. It has been assumed that 100% of the blastholes will be loaded with wet-hole product (a 70% emulsion/30% ANFO blend). Two mixing trucks are required at site to guarantee delivery of product to the blast holes.

Materials Handling

At this time, it is expected that two 200tonne diesel-powered hydraulic excavators (one with 8.0 m^3 and a second with 12 m^3 heavy rock buckets) will be used for ore and waste, respectively. The excavators have been matched to load 91tonnecapacity trucks. An 800 hp front-end loader with a 10.3 m^3 bucket will work at the ore stockpile to blend ore and tram feed to the crusher. The crusher loader will back-up the excavators for in-pit waste removal. Ore will be hauled from the open pit in 90 to 100 tonne trucks and hauled from underground in 40 to 60tonne trucks.

2.4.4.6 Open Pit Mine Equipment

Preliminary specifications for open pit mining equipment at the Izok Mine are listed in **Table 2.4-4**. These specifications will be refined during preparation of the feasibility study. This list includes the primary equipment for drilling, blasting, loading and haulage, as well as ancillary mine equipment for maintaining pit floors and roadways, moving equipment with limited mobility, equipment servicing, personnel transport and secondary ore and waste handling.

Table 2.4-4 Preliminary List of Izok Open Pit Equipment

Open Pit Equipment		
Function	**Equipment Type**	**Estimated Quantity**
DRILLING	225-mm Drill	3
	152-mm Drill	3
BLASTING	Bulk Powder Delivery Truck	2
	Explosive Accessories Delivery Truck	1
LOADING	200 t Hydraulic Excavator – 8m^3	1
	200 t Hydraulic Excavator – 12m^3	1
HAULING	Mechanical Drive Haul Trucks – 91t	9
CRUSHER FEEDER	Frontend Loader – 800 hp	1
SUPPORT EQUIPMENT	Crawler Dozer – 400 hp	4
	Motor Grader – 300 hp	2
MINE GENERAL	General Purpose Excavators – 350 hp	1
	Picker Truck (Large)	1
	Tractor/Lowboy (100+ tonne)	1
	Fuel Truck	1
	Fuel/Lube Truck	1
	Light Tower	8
ANCILLARY EQUIPMENT	Hydraulic Crane – 75 t	1
	Tire Manipulator	1
	Integrated Tool Carriers	2
	Mechanic/Welder Truck	2

Open Pit Equipment		
Function	**Equipment Type**	**Estimated Quantity**
	Vacuum Truck	1
	Tandem Truck	TBD
	F550 Flatdeck	3
	Crewcab	12
	Bus	2
	Suburban/Van/Ambulance	1

2.4.4.7 Underground Mine Equipment

Preliminary specifications for underground mining equipment at the Izok Mine are listed in **Table 2.4-5**. These specifications may change during preparation of the feasibility study. The list includes the primary equipment for drilling, blasting, loading, ground support and haulage, as well as ancillary mine equipment for equipment servicing, mine services and personnel transport.

Table 2.4-5 Preliminary List of Izok Underground Mine Equipment

Underground Mine Equipment		
Function	**Equipment Type**	**Estimated Quantity**
LOADING	R2900 LHD	2
DRILLING	Development Jumbo	1
HAULAGE	AD55 Truck	1
GROUND SUPPORT	Cablebolter	1
ANCILLARY	Light Vehicles	3
	Service Vehicles	2
	Agitator Truck	1

2.4.4.8 Production Schedule

The first ore produced at the Izok Mine will be from the open pit as open pit mining is usually the least expensive mining method. MMG will aim to recover construction costs as quickly as possible and will strive to truck as much concentrate as possible to the Grays Bay Port in time for the first shipping season.

Mining will start in the midsection of the Central Zone, with subsequent final wall push-backs first to the east and then to the west. Later in the mine life, the lower grade and higher cost Inukshuk deposit will be brought into production using underground methods. The preliminary production schedule for the Izok Mine is presented in **Table 2.4-6**.

Table 2.4-6 Preliminary Izok Production Schedule

Izok Open Pit	Waste Tonnes Mined	Ore Tonnes Mined	Cu grade (%)	Pb grade (%)	Zn grade (%)	Ag grade (opt)
2017	2,290,000	356,040	1.27%	2.06%	15.21%	62.41
2018	7,484,000	1,447,896	2.29%	1.43%	13.62%	58.43
2019	7,318,000	1,443,940	3.08%	1.60%	16.31%	69.78
2020	6,635,000	1,443,940	3.76%	1.34%	16.08%	73.25
2021	6,164,000	1,443,940	3.70%	1.14%	14.00%	80.63
2022	5,900,000	1,292,895	2.33%	1.22%	12.11%	54.71
2023	3,649,000	1,134,785	3.08%	0.61%	11.21%	53.85
2024	3,383,000	1,134,785	2.13%	1.32%	11.18%	84.77
2025	3,124,000	1,134,785	1.27%	1.94%	13.63%	93.43
2026	1,520,000	1,137,894	1.44%	1.79%	14.07%	85.99
2027	1,428,000	1,326,157	1.57%	1.29%	11.70%	72.07
TOTAL	**48,895,000**	**13,297,057**	**2.49%**	**1.38%**	**13.55%**	**71.99**
Inukshuk Underground	**Waste Tonnes Mined**	**Ore Tonnes Mined**	**Cu grade (%)**	**Pb grade (%)**	**Zn grade (%)**	**Ag grade (opt)**
2021	13,895					
2022	171,410	27,791	2.94%	0.18%	6.65%	40.15
2023	146,993	342,821	2.65%	0.35%	6.70%	40.74
2024	135,284	293,987	2.63%	0.23%	6.32%	34.48
2025	26,111	270,567	3.16%	0.25%	7.94%	40.82
2026	26,111	52,222	2.44%	0.33%	8.36%	37.17
TOTAL	**519,804**	**987,387**	**2.78%**	**0.28%**	**7.01%**	**38.69**
IZOK TOTALS	**Waste Tonnes Mined**	**Ore Tonnes Mined**	**Cu grade (%)**	**Pb grade (%)**	**Zn grade (%)**	**Ag grade (opt)**
2016	-	-				
2017	2,290,000	356,040	1.27%	2.06%	15.21%	62.41
2018	7,484,000	1,447,896	2.29%	1.43%	13.62%	58.43
2019	7,318,000	1,443,940	3.08%	1.60%	16.31%	69.78
2020	6,635,000	1,443,940	3.76%	1.34%	16.08%	73.25
IZOK TOTALS	**Waste Tonnes Mined**	**Ore Tonnes Mined**	**Cu grade (%)**	**Pb grade (%)**	**Zn grade (%)**	**Ag grade (opt)**
2021	6,177,895	1,443,940	3.70%	1.14%	14.00%	80.63
2022	6,071,410	1,320,686	2.35%	1.20%	12.00%	54.41
2023	3,795,993	1,477,606	2.98%	0.55%	10.16%	50.81
2024	3,518,284	1,428,772	2.23%	1.10%	10.18%	74.42
2025	3,150,111	1,405,352	1.63%	1.61%	12.53%	83.30
2026	1,546,111	1,190,116	1.48%	1.72%	13.82%	83.85
2027	1,428,000	1,326,157	1.57%	1.29%	11.70%	72.07
2028						
TOTAL	**49,414,804**	**14,284,444**	**2.51%**	**1.31%**	**13.10%**	**69.69**

2.4.4.9 Air Emissions

Mining operations at the Izok Mine will result in atmospheric emissions of gases and diesel particulate matter from combustion of diesel fuel, and fugitive dust emissions from power generation, processing equipment, and material handling and transport. Short-term dust emissions will occur during blasting. Overburden, waste rock and tailings stockpiles will also be a source of dust particles at certain times of the year.

The Izok Project is fossil fuel intensive, as alternative energy sources do not exist in the area. The combustion of diesel will produce greenhouse gases (GHG) such as carbon dioxide (CO_2), methane (CH_4) and nitrogen oxides (NO_x). Emission factors will be used to calculate GHG emissions from the quantity of fuel consumed for a given fuel type and combustion source.

Features that have been incorporated into Project design to minimize air quality effects due to combustion of fossil fuels include:

- Use of low sulphur diesel
- Regular maintenance of all equipment (vehicles and power plant) to ensure efficient operation
- Selection of high efficiency power generators – both for minimizing operating costs and reducing emissions

Primary measures that will be implemented to manage fugitive dust emissions and minimize potential effects on air quality include:

- Speed limits for vehicular traffic on mine site roads
- Application of dust suppressants to roads and exposed soil or stockpile surfaces where fugitive dust could originate
- Installation of dust collectors at crushing and grinding facilities and conveyor transfer points
- Installation of NAG rock coverings on dewatered tailings to control wind erosion

Further mitigation measures will be implemented during the operational phase of the Project as emission or nuisance dust sources are identified.

2.4.4.10 Noise Emissions

The major sources of noise at the Izok Mine site will be from mine blasting and mine diesel-powered equipment. Other sources of noise will be from the operation of pumps, compressors, generators, front end loaders, grinding mills and service vehicles.

Measures that will be implemented to mitigate noise pollution will follow Nunavut Occupational Health and Safety standards and will include the following.

- Schedule noisy construction activities during normal working hours
- Conduct regular maintenance of construction and operations vehicles and equipment to ensure they emit the lowest noise possible for their design
- Install air inlet silencers and exhaust silencers on all combustion engines

- Construct noise baffles or enclosures for particularly noisy equipment
- Develop a noise monitoring program as an integral part of the company's Health and Safety Policy

2.4.4.11 Izok Mine Closure Plan

Planning for the Izok Mine is being driven by the goal of a mine closure plan that presents the lowest long-term environmental risk and the lowest risk of long-term maintenance and related costs. MMG is focused on designing Waste and Water Management plans that will support this goal. MMG is also committed to working with stakeholders to develop and refine the closure plan.

Even with the diversion of Iznogoudh Lake outflows around the mine pit, the surface and groundwater flows reporting to the pit from the reduced catchment are anticipated to be greater than evaporation and leakage in normal weather years. It is expected that over a period of several years, the pit would fill with water. This new water body would have a smaller surface than the original lake and would include the deep pits plus areas surrounding the pits and would likely reach the natural level of the former Izok Lake of 417 m above sea level. It is likely that eventually a natural net outflow into Itchen Lake would develop.

The quality of water in the filled pit is not expected to meet discharge criteria for a number of years after closure due to water contacting PAG rock faces in the mined-out open pit and the PAG waste rock deposited in the open pits, and ARD and ML seepage from PAG waste rock piles and tailings piles. Section 2.4.6.2 provides a discussion of the preliminary Waste and Water Management plans.

For several years, excess water in the flooded pit will be treated in place or pumped to an effluent treatment plant before being discharged into Itchen Lake. The water will be treated until the quality of untreated water is suitable for release. Water balance analyses and water quality modelling will be conducted to determine the time required for water quality to meet discharge criteria at closure.

The closure plan for the Izok pit will commence immediately after closure of the mines and will involve the following monitoring and maintenance activities to manage water levels and quality in the catchment area.

- Monitoring, collection, and treatment of water to meet discharge criteria as necessary once pumping ceases, and release of treated water to Itchen Lake begins.
- Maintenance of the water level between a high and a low limit. The high water level will be several metres below the outlet level of the lake to avoid the need for a closure dam to prevent discharge of waters from the post-closure flooded pit and surrounding area into Itchen Lake. The lower water level will be several metres above the top of the PAG waste rock deposited in the mined-out open pit to maintain the necessary water cover to prevent oxidation of waste rock.

At some time after closure when water quality at all points within the catchment area meets discharge criteria without treatment, the water body will be allowed to re-flood to its natural level and excess water will flow untreated out to Itchen Lake.

Once water quality within the catchment area meets discharge criteria naturally, a decision will be made whether to leave the new lake disconnected from Iznogoudh Lake or re-establish the natural flow of

water from Iznogoudh Lake downstream. This decision will be made in consultation with DFO and other stakeholders.

2.4.5 Izok Mine Ore Processing

The processing plant will be located at the Izok Mine and will process ore from both the Izok and High Lake mines. All concentrates and related waste will be located at the Izok site as well.

Key considerations in processing of the ore will be:

- Efficient metal recovery in concentrates
- Reclaimed water management
- Engineered dry stack tailings

2.4.5.1 Milling Design Consideration and Selection

Ore Processing

The first phase of extracting the zinc or copper rich fragment of the rock is accomplished through a mechanical process. The ore is delivered to the plant as boulders, where it is crushed into very small gravel and sand size using conventional crushing and grinding systems. Once the ore is crushed and reduced to a fine sand size, it is processed chemically.

MMG will use well known and commonly used processes. The fine-grained crushed ore will under gomultiple stages of froth flotation to separate and recover mineral concentrates of chalcopyrite (copper-rich sulphide), sphalerite (zinc-rich sulphide) and galena (lead-rich sulphide). This process is entirely contained in the building itself, and all chemicals used in the process are handled according to strict safety and operational procedures.

The ore contains small quantities of payable silver and gold. Small amounts of silver will be present both in the copper and lead concentrates, and very small amounts of gold will be present in the copper concentrate. Silver and gold metal will be subsequently produced as a by-product in the off-site smelter operations. There will be no production of silver or gold bars in the processing plant.

The process plant will be located immediately to the east of the Izok Mine, and will include the following components.

- Two Run of the Mill (ROM) stockpiles (120,000 t capacity each)
- Primary jaw crusher
- Crushed ore stockpile
- Semi Autogenous Grinding mill (SAG) and ball mill
- Zinc, copper and lead flotation circuits, including a regrind mill within each flotation circuit
- Tailings thickener and filters
- Zinc, copper and lead concentrates thickeners and filters

- Process water, fire water, potable water tanks
- Reclaim water treatment facility
- Concentrate storage facility for the copper, lead and zinc concentrates
- Reagent storage and reagent mixing building

The jaw crusher will crush ore from the Izok Mine. A separate jaw crusher will crush the mined ore from the High Lake Mine prior to trucking to the Izok mill. The Izok crusher will be located in a partially enclosed building, together with the stockpile feed conveyor drive system. The coarse ore stockpile and mill feed conveyor will also be covered for protection from the elements.

Ore Processing and Grinding

The nameplate capacity of the mill will be 6,000 tonnes per day (tpd) of ore. Mill throughput rates will be approximately 6,000 tpd of ore. The maximum combined production rate of zinc, copper and lead concentrates will be approximately 670,000 tpa. Concentrate production varies mainly due to changes in the metal feed grades to the mill resulting from the mine production schedule.

The SAG mill circuit will include a cone crusher to crush the coarse pebbles that discharge from the mill. Crushed pebbles will be returned to the SAG mill. The ball mill will operate in closed circuit with a set of hydro-cyclone classifiers. The cyclone underflow product (the coarser fraction) is returned to the ball mill for further grinding. Thecyclone overflow slurry product, with an 80% passing size (p80) of 100 um, gravitates to the flotation circuit. Minerals will be recovered by sequential flotation in respective copper, lead and zinc flotation circuits. Each of these circuits includes a rougher stage to produce an intermediate quality concentrate, a regrind stage, and a cleaner flotation stage to ensure that both high recoveries and good quality final concentrate grades can be achieved.

Various chemicals are required to allow recovery of the copper, lead and zinc minerals into high quality final concentrate products. These include MIBC frother to stabilize the mineral froth, xanthate collector to help attach metal minerals to the air bubbles, copper sulphate to modify the surface of the zinc mineral and allow flotation, and lime to modify pH and depress the flotation rate of unwanted iron sulphide gangue minerals.

Tailings Dewatering and Disposal

The tailings will be dewatered to between 15% and 20% moisture content by mass and then will be stacked using an engineered dry stack tailings management system (refer to section 2.4.6 for more details).

To reduce the moisture content, the thickened flotation tailings will be pumped to a stock tank and fed through a pressure filter. The filter press will dewater the slurry to produce a filter cake, which will be conveyed outside the process plant to a tailings load-out point. The tailings will be loaded onto a truck using a front end loader and transported to the engineered dry stack tailings pad located to the southwest of the mill facility. A dozer and compactor will spread and compact the tailings on a continuous basis.

Concentrate Filtration

Zinc, copper and lead concentrates produced in the flotation sections will be thickened to 65-70% solids (w/w) and then filtered in pressure filters to 8% moisture. Filtrate will be recycled to the process water circuit and effluent treatment plant.

Concentrate Storage and Handling

Individual concentrate products in the form of filter cake will be discharged onto a conveyor and deposited in separate storage areas at the western end of the concentrator building. Concentrate will then be loaded onto concentrate trucks for delivery to a storage shed at the Grays Bay Port.

2.4.5.2 Process Alternatives

A metallurgical test program is underway. As there are some differences in ore characteristics between the different mining zones at the Izok and High Lake mines, the metallurgical performance of treated blends of ore types or campaign treating batches of separate ore types will be examined. The effects of these process strategies on Project economics and operability will be assessed.

2.4.6 Izok Mineral Waste Management

Mineral wastes are all wastes generated by mining operations that are not ore or mineral concentrate, and include PAG and NAG waste rock, tailings, overburden, and lake sediments and silts.

Closure is the foremost consideration in planning for Izok Mine mineral wastes. MMG has committed to expend capital early in the Project to devise and implement a mine closure plan that will be as close as possible to a minimum maintenance solution. Sub-aerial deposition of mineral wastes has been chosen as it most closely meets the minimum maintenance closure concept.

2.4.6.1 Waste Rock

Waste Rock Characterization

Waste rock is rock that is removed to access ore. Some waste rock types at the Izok site contains sub-economic amounts of sulphide mineralization. When these materials are exposed to air and water, they can oxidize, releasing acid and metals, referred to as acid rock drainage (ARD) and metal leaching (ML).

There are a variety of other minerals that are capable of neutralizing (buffering the acid) and removing the metals from the water. The relative proportions of acid generating and buffering materials and the reactivity of these materials determines whether acidic conditions and/or high metal concentrations are likely to develop in mineral waste produced by the Project.

MMG is working to ensure that the mineral wastes are adequately characterized prior to mining and that the results of this testing are used to develop appropriate prevention and mitigation strategies for managing the waste rock. These measures will minimize the potential for adverse effects on downstream water quality.

MMG has completed a preliminary geochemical testing program to characterize the potential for ARD and ML from the waste rock at Izok. Additional testing is in progress, including both short- and long-

term tests that can be used to predict whether acidic conditions could develop in the rock, how fast this could occur, and whether there would be elevated concentrations of metals in water that comes into contact with the waste rock.

Some preliminary conclusions from the testing are as follows.

- The quantity of sulphide minerals can be determined by analyzing the sulphur content of the rock.At the Izok site, the sulphur content of the PAG rock ranged from very low (<0.1% S) to quite high (8% S), but median sulphur concentrations were typically between 0.1 and 1%, and most samples with a higher sulphur content were located in close proximity to the ore.
- The quantity of neutralizing minerals (neutralization potential or NP), can be determined by reacting the rock with acid and measuring how much of the acid was consumed by the rock (NP), or by measuring the amount of carbonates that are present in the rock (carbonate NP).The Izok Mine waste rock tends to have relatively low amounts of both NP (ranging from <1 to 76 kg $CaCO_3$eq/t, and typically below 20 kg $CaCO_3$eq/t) and carbonate NP(ranging from <1 to 32 kg $CaCO_3$eq/t, and typically below 5 kg $CaCO_3$eq/t).The difference observed between these measurements of NP suggest that the majority of the NP is present as silicate minerals.
- In the preliminary interpretations of ARD potential, samples were classified using the more conservative carbonate NP data. Based on these results, approximately 75% of the waste rock was classified as potentially acid generating (PAG), while 25% is considered to be non-acid generating (NAG). This preliminary estimate is considered conservative and will be refined based on further testing.
- Initial kinetic test results on the Izok Mine PAG samples indicate that the sulphides oxidize quite slowly in comparison to tests from other sites with similar amounts of sulphide. These tests have now been running for four months, and acidic conditions have not yet developed.
- Under field conditions with much lower temperatures, reaction rates could be up to five times slower, suggesting that there could be a delay of at least 20 months before acidic conditions could develop in the field. Additionally, given the slower than expected oxidation rates, it is possible that buffering by silicate minerals could prevent ARD from developing over the longer term in some of these materials. This has the potential to substantially reduce the amounts of PAG that will require special management. However, further testing is needed to assess the contribution of silicates to buffering over the longer term.

Geochemical testing of mineral wastes is ongoing to more closely characterize waste rock and associated leachate water, providing the inputs necessary for additional geochemical and water quality modelling.

Waste Rock Quantities

Approximately 49Mt of PAG and NAG waste rock, including overburden, will be removed from the open pit mine and underground mine over the life of the mine to access ore. For the first half of the mine life, this waste rock will be removed to waste dumps on surface. After Year 7, waste rock will be deposited into worked-out areas in the open pit.

Preliminary estimates of ore and waste rock generated at the Izok Mine are presented in **Table 2.4-7**. These are considered to be conservative estimates of PAG rock.

Table 2.4-7 Ore and Waste Rock Generated at Izok Mine

Ore (Mt)	PAG Waste Rock (Mt)	NAG Waste Rock (Mt)	Total Waste Rock (Mt)
14	37	12	49

Waste Rock Design Approach

There are two broad approaches that can be taken to deal with PAG mineral wastes to prevent or manage ARD and ML.

1. Place freshly mined PAG mineral wastes under water to prevent oxidation and thus prevent the generation of ARD and ML
2. Isolate PAG mineral wastes from water flows to immobilize such products of oxidation and metal leaching that might exist within the waste pile

The mining industry has typically used the first approach (subaqueous storage), which typically involves placement of PAG mineral wastes in a lake or a reservoir created by a dam. By maintaining a water cover over PAG mineral wastes, contact with air and oxidation are prevented and ARD cannot be generated. A drawback of this approach is that it requires maintenance of a water cover over the PAG mineral wastes, monitoring and possibly treatment of water overflowing the dam, and dam maintenance, all in perpetuity.

The second approach involves sub-aerial storage of the majority of PAG mineral wastes, isolating these materials from contact with water. This is the method that has been selected for tailings storage at the Izok Mine in order to avoid the shortcomings of subaqueous deposition. While sub-aerial deposition will be more complex to implement and more costly during operations, it has the very clear advantage of not requiring water cover maintenance, water quality management or dam maintenance in perpetuity.

Sub-aerial deposition of PAG mineral wastes has a sound environmental record at a number of northern mines such as Nanisivik, Raglan, Ekati, Minto, and Pogo. The tailings at Nanisivik Mine were successfully covered to maintain them in a frozen state (J. Cassie, BGC, pers. comm.). Post-closure monitoring has since confirmed that the tailings are in a permanently frozen and inert condition.

During operations, potential production and release of ARD and ML into the environment will be managed by keeping the PAG mineral wastes frozen. The climate is quite harsh with subzero temperatures dominant for a substantial portion of the year and mineral waste will be managed to maximize quick freezing in the cold months and maintain frozen layers near surface during the warmer months. Models will be developed using regional and site-specific climate data and with consideration to climate change predictions to inform the development of the Mineral Waste Management Plan. Maintaining sub-zero temperatures in the mineral wastes will provide the following benefits.

- Below 3 °C, bacterial action stops
- Below freezing, the chemical oxidation of sulphide minerals, which also causes ARD and generates heat, will be attenuated to the degree that it may be considered to have effectively ceased

- Freezing will convert any ARD or ML into ice and hence will lock them in place within the rock pile
- Freezing prevents the ingress and exit of rain water to the waste pile, which will further prevent the movement of ARD or ML out of the waste pile

Keeping mineral wastes frozen will be achieved by ensuring freezing occurs during or shortly after deposition, and maintaining them in a frozen condition in perpetuity. This will be achieved by the taking the following approach.

- Freezing PAG waste rock will be achieved during deposition by selecting appropriate deposition schedules and techniques such as depositing mineral wastes in thin layers and installing thermal barriers to maintain a frozen condition.
- Thermal protection covers will be installed progressively during operations and completed at closure to keep PAG mineral wastes frozen during summer thaw conditions.
- Seepage that occurs prior to complete freezing of the mineral waste piles will be monitored, and collected and treated if necessary during operations and after closure. Once the ARD/ML prevention measures become fully active (i.e., reduced ingress of air into mineral waste piles to inhibit oxidation, reduced ingress of water to avoid mobilization of any oxidation products, and ensured freezing), ARD and ML will no longer be produced and monitoring, collection, and treatment of seepage will no longer be required.

Waste Rock Management

The proposed mining schedule at Izok Mine is as follows (refer to **Figure 2.4-12**).

- Years 5 to 11 – open pits (three phases beginning with the central zone, then the east zone, and finally the northwest zone)
- Years 6 to 10 – Inukshuk underground operation

The main elements of the Izok Mine Waste Rock Management Plan are as follows.

- PAG and NAG waste rock will be placed largely within the outline of the drained Izok Lake to minimize the area of disturbance at closure.
- PAG waste rock will be placed to prevent contact with water after closure, by one or more of the following steps:
  - placing PAG waste rock above the re-flooded water level on a NAG waste rock pad
  - placing PAG waste rock directly on the surface of the area immediately close to the pit and within the area previously occupied by Izok Lake and installing an inert rock barrier between PAG waste rock and refilled pit and flooded area placing waste rock outside the previous lake footprint
- Towards the end of mine life, some PAG waste rock will be deposited at the bottom of the worked out pit, currently estimated at between 3 and 6 Mt.PAG waste rock deposited in this manner will be submerged by water at closure. Water cover over this PAG waste rock will be deep with no likelihood of PAG waste rock being exposed to air even during low rainfall years, thereby eliminating the need for post-closure maintenance of water cover.

- Sub-aerial deposition of PAG waste rock will be completed in a manner that promotes freezing at the time of deposition during winter, and to promote ultimate freezing of the complete rock pile at or shortly after closure. Techniques will be adopted such as depositing mineral wastes in thin layers which will be exposed to frigid air for extended periods before being covered by subsequent layers, and by installing thermal barriers as soon as possible to maintain rock in a frozen condition.
- Waste rock placed during the four summer months will not freeze, but will be deposited in a thin layer to promote freezing when temperatures drop the following winter. Waste rock deposited during the warmer summer months may have a higher potential to oxidize exothermically, and temperatures within the rock pile will be closely monitored. Material found to be heating due to exothermic reaction will be removed and cooled by immersing in water.
- Thermal barrier covers will be installed over PAG waste rock once the final pile elevation has been reached. Covers will be of sufficient thickness to accommodate seasonal thawing and the projected influence of long-term climate warming. Thermal covers will typically comprise a lower layer of finer material and an upper layer of coarser material to prevent wind and water erosion of the lower layer. Depending on the particle size distribution of these materials, the cover thickness typically ranges between one and three metres.
- Covers will be placed over the sides and the upper surfaces of the PAG waste rock pile progressively during operations and over the entire pile surface at closure. ARD and ML seepage from PAG waste rock piles is possible during the mine operational phase and for some time after closure until freezing is complete. Sources of seepage are water attached to the rock at time of deposition, melting snow and summer rains.
- Seepage is expected to diminish over time as water within the rock pile progressively drains out and freezes, and seepage will ultimately decrease to negligible amounts. Seepage will be collected and re-used in the process plant, or treated to meet discharge criteria and released to the environment. Seepage flows will be modelled to predict the quantity and quality of seepage over time and hence when water quality monitoring and water treatment may no longer be required after closure.
- Surface water contact with PAG mineral waste piles will be minimized by locating the piles within the topography at Izok Mine and by installing surface water diversion channels and berms as required to keep clean water clean.
- Airborne dust will be managed per the Dust Management Plan.
    - An Adaptive Mineral Waste Management Plan will be implemented to confirm design assumptions (e.g., negligible reactivity at sub-zero temperature, temperature distribution within the waste rock pile, quantity and quality of seepage, and airborne dust generation), and to identify where changes to the plan are required. As part of this plan, field trials of thermal protection covers will be conducted to confirm their performance under site conditions and a monitoring program will be established to track the following performance indicators.
        - Temperatures within the waste rock piles
        - Oxidation products such as sulphur dioxide within and around the waste rock pile
        - Seepage quantity and quality
        - Density of deposited rock (i.e., the effectiveness of compaction)

  - In-situ moisture content
  - Measurement of ARD potential and sulphur content in the waste rock pile
  - Kinetic testing of waste rock to determine reactivity under field and laboratory conditions
  - Dust and air quality parameters

- NAG waste rock piles will be generally deposited separately from PAG waste rock piles. The management plan for NAG waste rock is relatively straightforward and includes piling this material to promote freezing. However, NAG waste rock will not be covered or contoured at closure. The piles will be designed to prevent erosion by wind and water by the choice of appropriate slope angles and bench design. Erosion control measures installed during the operational phase will remain in effect after closure.

Waste Rock Disposal Alternatives

An alternative waste rock disposal plan that was considered involves placing all PAG waste rock within the Izok Lake basin and the worked-out open pit and then submerging it after closure by constructing a series of dams to raise the lake water level. This alternative was rejected as it would require water to be pumped into Izok Lake to maintain water cover over the submerged rock during low precipitation years, management of overflowing water quality during normal precipitation years, the potential for catastrophic release of mineral wastes and contact water should a dam fail, and maintenance of at least one large dam, all in perpetuity.

Waste Rock Mitigation by Design

Sub-aerial deposition of waste rock offers considerable advantages over the typical sub-aqueous approach, particularly after closure. The following studies will be performed to confirm design assumptions.

- Site investigations to more closely characterize subsurface conditions, geothermal regimes, and their effects on mine waste rock pile design
- Diamond drilling and block model review to more closely define NAG and PAG waste rock quantities
- Modelling of seepage and runoff rates and water quality from the PAG waste rock piles
- Modelling of shallow groundwater flows
- Modelling and laboratory testing at sub-zero temperatures to predict the geochemical and metal leaching characteristics of waste rock at the temperatures that will be encountered at Izok Mine
- Modelling of water quality after closure, and as basis of design of the effluent treatment process for affected water
- Collection of field data during the early operational phase to confirm the performance of thermal protection covers

Waste Rock Closure Plan

Most PAG waste rock will be deposited sub-aerially and the balance deposited subaqueous, deep in the worked out open pit. This approach has been chosen, as it most closely matches MMG's minimum maintenance closure concept.

- At closure, NAG waste rock piles will be left substantially as they have been constructed and will not be covered or contoured.
- The closure plan for PAG waste rock will commence immediately after closure and will involve monitoring, collection, and treatment if necessary of all contact water and seepage emanating from PAG waste rock piles to meet discharge criteria before release to Itchen Lake.
- The behaviour of PAG waste rock within the pile, such as measurement of temperature and sulphur dioxide will be monitored.
- The performance of thermal protection covers will be monitored.
- Critical performance of the cover includes:
  - the ability to withstand movement induced by waste pile settlement and frost heave and to continue to provide a seal against water and air ingress
  - effectiveness of the upper armour layer in preventing wind and rain erosion of the lower sealing layer

2.4.6.2 Izok Mine Tailings

The processing of the ore results in two products: the concentrate and the tailings. Tailings have the consistency of fine, damp sand, and often contain residual sulphides and metallic minerals that will be generally reactive when exposed to oxygen and water. The oxidation reaction that takes place is exothermic (produces heat) and may result in ARD and potential for ML.

Tailings Design Approach

The tailings design approach at the Izok Mine will be similar to that for PAG waste rock (section 2.4.6.1) and will involve sub-aerial frozen deposition. The main differences between tailings and waste rock handling are in the methods of placement, due to the finer size distribution of tailings.

Tailings Quantities

The total quantity of tailings at the Izok Mine is estimated at 16 Mt. This includes tailings generated from both High Lake and Izok ore.

Tailings Characterization

Tailings will be combined as process plant feed at approximately two parts Izok ore to one part High Lake ore. Differences in the geochemistry of tailings from the Izok and High Lake mines are as follows.

Izok Mine Tailings:

- The sulphur content ranges from 25% to 35% sulphur, mainly as pyrite
- There is a limited amount of neutralization potential (< 10 kg CaCO3/t)
- Acidic conditions are expected to develop within six months if fully exposed to atmospheric oxygen at 20 °C

High Lake Mine Tailings:

- The sulphur content of the tailings ranges from 3% to 10% sulphur
- The tailings contain a moderate amount of neutralization potential (15 to 20 kg $CaCO_3$/t)
- The tailings samples are PAG. However, because they contain some neutralization potential, exposed tailings are expected to remain pH-neutral for at least a few years due to buffering provided by the NP. Kinetic testing is underway to assess the time to onset of acidic conditions in these tailings under laboratory conditions.

Tailings Management

The following are the main elements of the Tailings Management Plan.

- After dewatering in the process plant, tailings will dumped into a small stockpile (**Figure 2.4-13**), and be conveyed and/or trucked to the site of the tailings pile. Dewatered tailings will contain between 15% and 20% water, and appear as fine damp sand.



Figure 2.4-13 Typical Dry Tailings Stockpile at Process Plant

- To minimize oxidation, tailings moisture content will be kept as high as possible compatible with trucks and loaders being able to drive on them after placement.
- Tailings will be dumped from haul trucks, flattened by bulldozer into thin horizontal lifts, and compacted by roller and haul truck traffic (**Figure 2.4-14**). Compaction is important for several reasons. Firstly, it will provide a smooth upper surface, which will limit airborne dust and rain water infiltration. Secondly, it will increase the structural stability of the dry stack pile, which is important for maintaining the integrity of the covers. Thirdly, compaction will minimize the volume of air voids within the tailings and aids in freezing of the material and hence reduce ARD potential.
- Freezing of tailings will be achieved by placing tailings in thin horizontal layers during the eight months of the year with sub-zero temperatures.
- Tailings placed during the four summer months will not freeze immediately after placement but will be deposited in a thin layer that will freeze when temperatures drop below zero. Tailings deposited during the summer months may have a higher potential to oxidize exothermically and therefore temperatures in the piles will be closely monitored.



Figure 2.4-14 Tailings Dry Stack

- Thermal protection covers will be installed over tailings to keep the tailings frozen once the final pile elevation has been reached. Thermal covers will be thick enough to ensure that seasonal thawing occurs within the cover and does not to extend down to the tailings. The design cover thickness will take into consideration long-term climate warming.

- Thermal covers typically include a lower layer of dense fine material and an upper layer of coarse material to prevent wind and water erosion of the lower layer. Depending on the particle size distribution of the cover material, cover thickness can range between one and three metres for finer grained substrates. Covers will be placed over the sides and the upper surfaces of the tailings dry stack progressively during operations (**Figure 2.4-15**)and will completely cover the pile at closure.
- To reduce ingress of precipitation, intermediate and final tailings surfaces will be sloped and contoured to minimize surface ponding of rain. This will also allow the installation of covers during operations to minimize airborne dust and precipitation ingress, minimizing the work involved in installing soil covers at closure.
- Run-off water and seepage from the dry stack facility will be captured in toe-drain ditches, berms and sumps, and will be pumped to the process plant as make-up water, or treated to meet discharge criteria and released to the receiving environment.



Figure 2.4-15 Example Waste Rock Cover for Dry Stack Tailings

- Melting snow and summer rains might infiltrate open voids in the surface of the tailings pile. This together with the moisture in the tailings at time of deposition can result in some seepage of ARD and ML from the pile.

- ARD and ML seepage from tailings piles is expected to occur during the mine operational phase and possibly for some time after closure. Seepage is expected to diminish over time as water within the tailings pile progressively freezes, ultimately reducing seepage to negligible amounts. Seepage will be collected and treated prior to release to the environment if it meets discharge criteria after treatment.
- Seepage and run-off water quality and quantity will be modelled to predict when non-compliant seepage will essentially cease and monitoring, collection, and treatment of seepage can be terminated.
- Airborne dust will be managed as per the Dust Management Plan. Airborne dust will be controlled by various means, including compaction with a smooth roller, placement of temporary rock covers over tailings surfaces, the application of dust suppressants, and the application of water in summer. Best practices at similar dry stack operations will be assessed and incorporated into the Dust Management Plan.
- Surface water contact with tailings piles will be minimized by locating the piles within the topography at Izok Mine and by installing surface water diversion channels and berms.
- An Adaptive Mineral Waste Management Plan will be implemented to confirm design assumptions (e.g., reactivity at sub-zero temperature, temperature distribution within the waste rock pile, quantity and quality of seepage, and airborne dust generation), and to identify where changes to the plan are required. As part of this plan, a monitoring program will be established to track the following performance indicators:
  - Temperatures within the tailings piles
  - Oxidation products such as sulphur dioxide within and around the tailings pile
  - Seepage quantity and quality
  - Density of deposited tailings (i.e., the effectiveness of compaction)
  - In-situ moisture content
  - Measurement of ARD potential and sulphur content in the tailings pile
  - Kinetic testing of tailings to determine reactivity under field and laboratory conditions
  - Dust and air quality monitoring
  - Field trials of thermal protection covers to confirm their performance under site conditions

Tailings Disposal Alternatives

Alternative tailings management options considered include:

- Sub-aqueous deposition of tailings in, Ham Lake, Itchen Lake, other adjacent lakes and in a dammed section of Izok Lake. This method of subaqueous tailings deposition was rejected as it would involve dams, maintenance of water cover, and monitoring and possible treatment of excess water overflow after closure (i.e., would not provide a minimum maintenance solution for closure).
- Sub-aerial deposition of tailings, half in the Izok Lake catchment area and half in the Itchen Lake catchment area. This location was rejected as it involves a risk of uncontrolled release of seepage and contact run-off water into Itchen Lake should any water control structures fail to operate.

2.4.6.3 Tailings Mitigation by Design

The Tailings Management Plan mitigates environmental risk through the following design features.

- Tailings will be deposited entirely within the former Izok Lake catchment area, eliminating the potential for release of seepage or contact water into Itchen Lake or Iznogoudh Lake.
- By eliminating the need for a tailings pond and associated dams, the risks of leakage or catastrophic failure of contained wastes is eliminated.
- ARD-causing oxidation will be minimized by keeping tailings moisture content close to the saturation point to fill air voids with water.
- ARD-causing oxidation will be minimized by compaction of tailings, which will reduce air voids.
- Tailings will be kept frozen by installation of a thermal protection cover.
- Thermal protection covers will be constructed and monitored in the early years of mine operation to confirm design assumptions.
- Ingress of ARD-mobilizing precipitation will be minimized by installing low-infiltration thermal protection covers over tailings piles as soon as practical.
- Ingress of precipitation will be limited by sloping and contouring tailings surfaces to prevent ponding of precipitation.
- Side slopes of the dry stack will be designed to allow the installation of thermal protection during operations to minimize airborne dust and rain water ingress.
- Ingress of ARD-mobilizing precipitation prior to installation of thermal protection covers will be minimized by compacting exposed tailings surfaces with a smooth roller. Structural stability of the tailings pile will be improved through compaction, which is important to maintaining the integrity of the thermal covers.
- Design of tailings piles and deposition sequences will ensure freezing of tailings, which will reduce permeability, inhibit oxidation and prevent mobilization of ARD and ML out of the pile.
- Tailings placed during the summer will be deposited in a thin layer to promote freezing when temperatures drop.
- Airborne dust will be controlled by various means, including compaction with a smooth roller, placement of temporary rock covers over tailings surfaces, application of dust suppressants, and application of water in summer.
- Run-off water and seepage from the dry stack will be captured in toe-drain ditches, berms and sumps, and will be pumped to the process plant as make-up water or treated to meet discharge criteria prior to release to the receiving environment.
- Seepage and run-off water quality and quantity will be modelled to predict when non-compliant seepage is expected to cease and forecast when collection and treatment of seepage can be discontinued.

- Temperatures and oxidation products such as sulphur dioxide will be monitored continuously by means of probes and instruments installed within or close to the tailings pile.
- An Adaptive Mineral Waste Management Plan (see section 12) will be implemented to confirm design assumptions (e.g., negligible reactivity at sub-zero temperature, temperature distribution within the dry stack, seepage flow quantity and quality, and airborne dust generation).
- The design cover thickness will consider the effects of long-term climate warming.

Tailings Closure Plan

The sub-aerial approach to depositing tailings has been chosen as it most closely meets the minimum maintenance closure concept.

The closure plan for tailings will be the same as that described for waste rock (refer to section 2.4.6.1), and will involve regular monitoring and maintenance to prevent ARD, ML and erosion of the dry stacks.

2.4.7 Izok Mine Surface and Groundwater Management

Surface water management will play a key role during all phases (construction, operation, and closure) of the Izok Mine. Practical and effective water management systems will be developed to minimize risks to mine operations and the environment.

The majority of surface run-off occurs during spring freshet and from short, intense summer rainfall events. Surface runoff that does not come in contact with operations and remains pristine (non-contact water) will be diverted wherever possible directly to receiving environments of Itchen and Iznogoudh lakes. Surface run-off that comes in contact with Project facilities, ore, the dewatered lakebed, waste rock or the tailings drystack (contact water) will be collected in sumps, ponds, and ditches and transferred to sediment ponds for removal of suspended solids and particulate/colloidal-phase contaminants, and oil and grease. After monitoring to ensure compliance with discharge criteria, contact water will be routed to receiving waterbodies.

The quantity and quality of runoff from these regions will be monitored to ensure it complies with applicable direct discharge limits. Best management practices such as silt fences, sediment traps, and regular monitoring will be implemented to minimize erosion where construction, mining and closure activities take place. This will reduce the potential for sediment transport to ambient receiving waterbodies.

2.4.7.1 Surface Water Management Plan

The Surface Water Management Plan at Izok Mine will include the following major components.

- Construction water management, including water diversion from Iznogoudh Lake to Itchen Lake around Izok Lake, draining of Izok Lake, construction of a large water holding pond and various smaller water holding ponds, construction of a surface water diversion berm/ditch system, erosion prevention structures, and fish relocation and habitat compensation

- Surface water management during mine operation to control and treat surface water collected from the disturbed areas within the former Izok Lake catchment area, including management of a surface water diversion berm/ditch system, a large water holding pond for water storage, and an effluent treatment plant
- Management of Project water requirements during mine operation including site-wide water balances
- Post-closure water management, including allowing the pit and surrounding area to refill primarily with surface water at closure, post-closure water quality monitoring and water treatment, and maintaining water cover over PAG rock faces and waste rock deposited in the worked-out open pits after closure

Key considerations in the Surface Water Management Plan include:

- Construction of water diversion structures and draining of Izok Lake
- Fish salvage and habitat compensation
- Re-filling of the pit and surrounding area at closure
- Water quality at closure

A conceptual water flow diagram is presented in **Figure 2.4-16**.

The following sections briefly describe each of the water management components. The conceptual features of some key water management systems are also described. The design of these systems will be further developed in the subsequent design phases.

Izok Mine Construction Surface Water Management

Primary water management activities during the construction phase of the Izok Mine include:

- Construction of Iznogoudh Lake to Itchen Lake Diversion Dam and Diversion Channel
- Draining of Izok Lake and construction of a water holding pond (as a sedimentation pond during the construction stage) and other water containment structures
- Construction and commissioning of surface water diversion system, including surface water diversion berms/ditches, and divider berms
- Construction and commissioning of an effluent treatment plant

Best practices for the control of sedimentation in run-off water during construction will be implemented during construction, including silt traps, silt fences, settling ponds and sumps, grease traps, and monitoring and pumping systems.

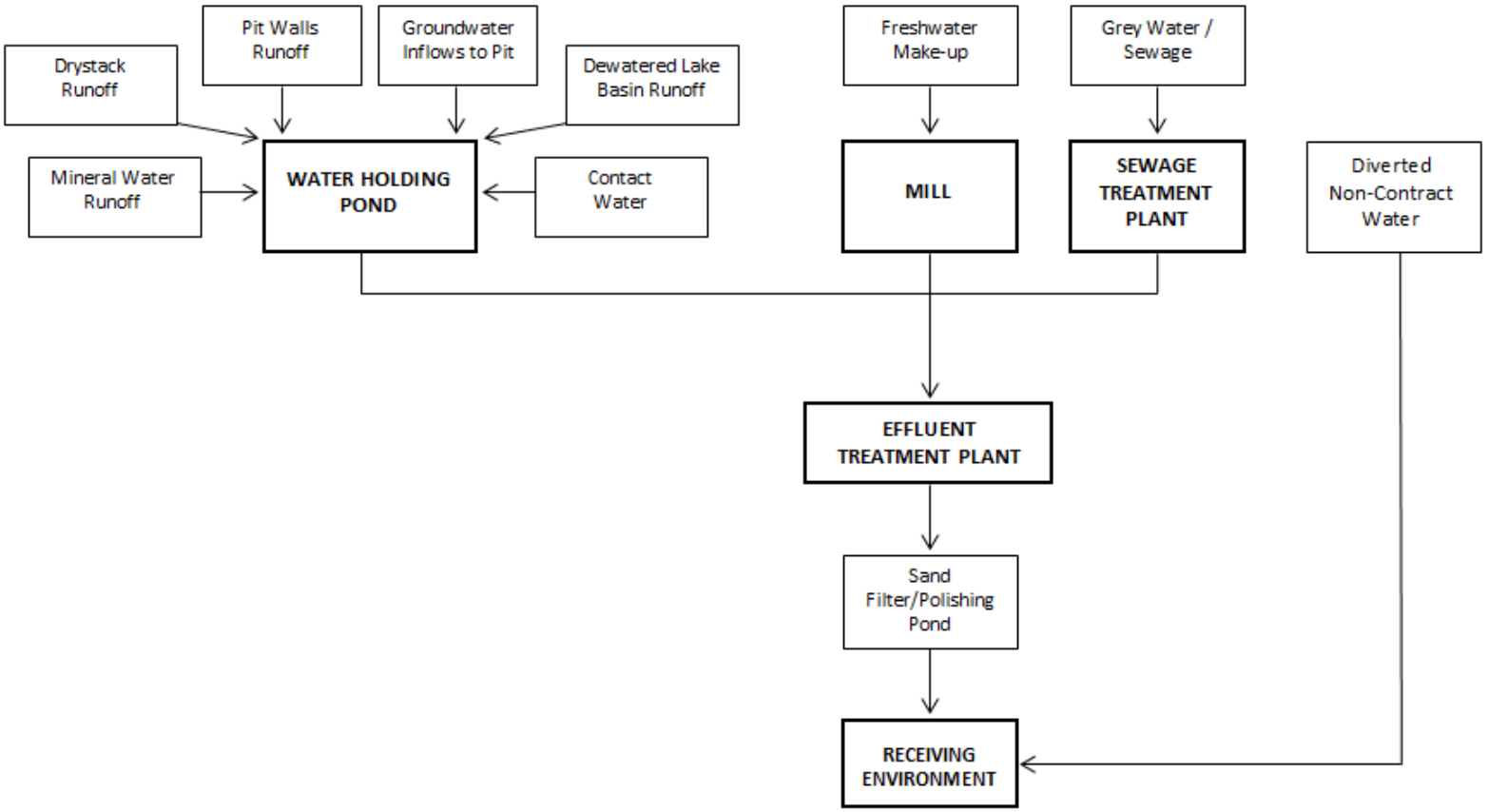


Figure 2.4-16 Conceptual Water Flows at Izok Mine

Non-Contact Water

To the extent practical, non-contact runoff water from undisturbed areas will be segregated and, when found to satisfy water quality standards, discharged directly to the receiving environment without treatment.

The conversion of non-contact water to contact water will be kept to a minimum by intercepting surface runoff water before it enters the mine site. This will be achieved through strategically located cut-off ditches and berms. Such diverted non-contact water will flow around the mine site area directly to the downstream receiving environment.

A surface water diversion berm/ditch system is proposed to divert natural run-on water from the undisturbed areas in the south of the former Izok Lake catchment area to Itchen Lake during construction and mine operation phases, as shown in the Izok Mine site plan (**Figure 2.4-17**). Without this, surface water would flow into the drained Izok Mine area and become contact water, increasing the volume of contact water management to be managed. A diversion berm/ditch will be constructed on the south side of the flooded area to divert natural run-on water from a portion (4.14 km^2) of the former Izok Lake catchment area (9.28 km^2).

Contact Water

Contact water will be collected and pumped to a water holding pond, which will have sufficient storage capacity to accommodate seasonal variations in surface water as well as groundwater inflows into the mine excavation.

The water holding pond will be used as a surface runoff water and pit water storage pond during mine operations, in addition to its function to remove suspended solids from water removed during the initial draining of Izok Lake.

Contact water will be tested periodically for contaminants, total suspended solids (TSS) and total dissolved solids(TDS) prior to treatment and/or release. Diversion ditches will be installed where necessary to route contact water to collection ponds or sumps for transfer to a water holding pond.

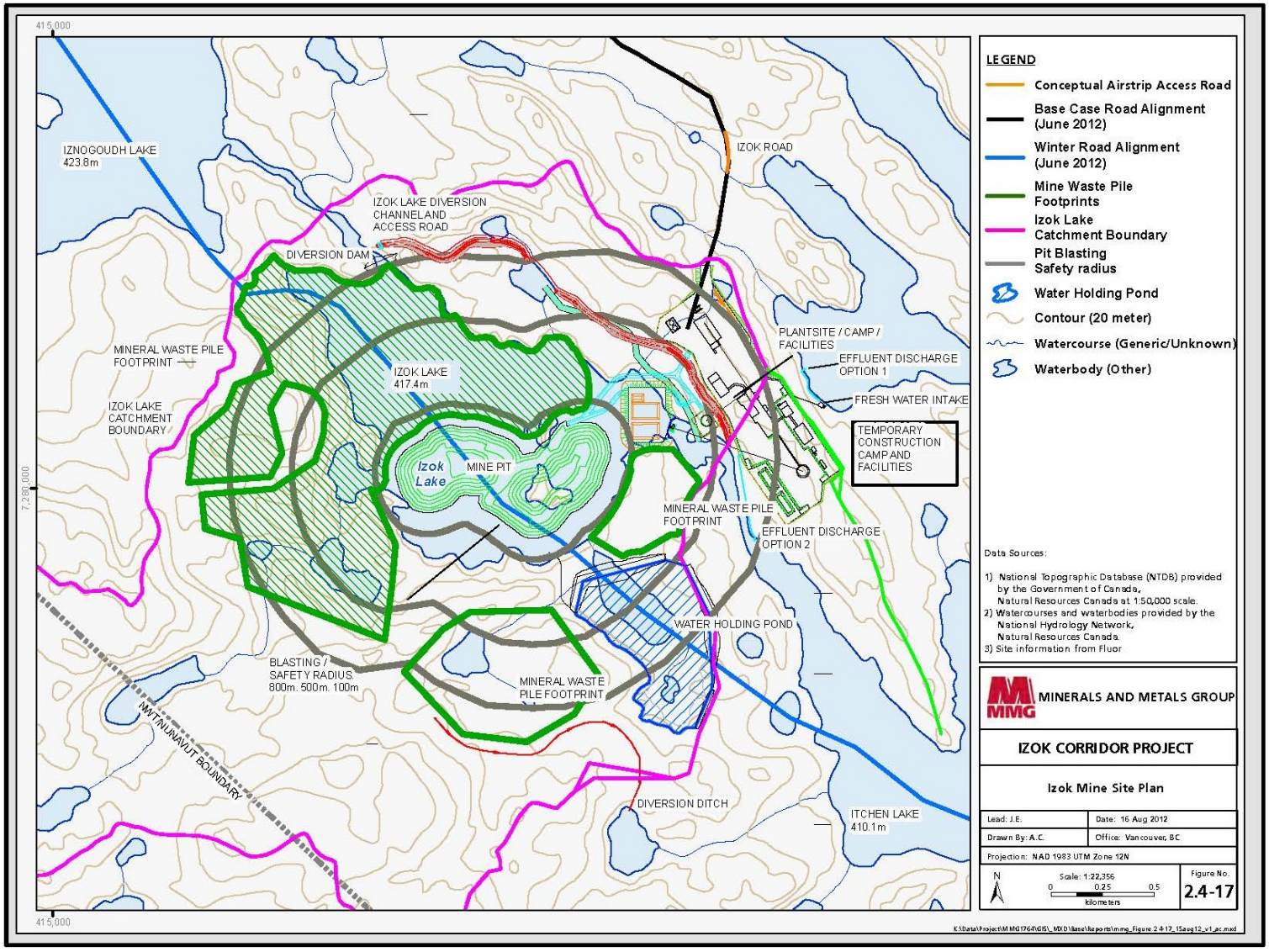


Figure 2.4-17 Izok Mine Site Plan

2.4.7.2 Surface Water Management Alternatives Considered

No alternatives to the proposed Surface Water Management Plan have been identified as it conforms to the highest industry standard best practices and regulations for protecting the environment.

2.4.7.3 Surface Water Management – Mitigation by Design

The Surface Water Management Plan mitigates the risk of uncontrolled release of contact water to the environment by intercepting, collecting, and treating such water by means of well-designed water control and containment structures.

All water retaining structures for managing contact water will be designed to handle the volumes of water resulting from exceptional weather events to ensure there is no possibility of uncontrolled release of contact water.

Water flow amounts used in design of water management systems are based on conservative assessments of global warming trends.

The volume of contact water generated at the Izok Mine will be minimized by intercepting and diverting the greatest amount of non-contact surface water around disturbed areas as the topography permits.

Liners will be installed in water retaining structures to eliminate seepage of contact water into groundwater regimes where necessary.

2.4.7.4 Surface Water Management Closure Plan

Post-closure water management at Izok Mine will commence immediately following closure and involve refilling that part of the Izok pit not filled with waste rock. Essentially, this will be where the worked-out open pits exist, plus a narrow border surrounding them (**Figure 2.4-18**).

During the post-closure phase, lake water will be allowed to rise from surface inflows, precipitation and groundwater inflows to a level that will cover waste rock deposited in the open pits. It will not, however, be allowed to rise to a level that might allow overflow from the re-flooded area to Itchen Lake. The lake water level will be kept between 5 m and 15 m below the lake outlet level by pumping excess water to a water holding pond and effluent treatment plant where it will be treated and then released into Itchen Lake. Treatment of excess water from the flooded pit and water body is expected to be necessary for several years after closure, as water quality will not meet discharge criteria until products of oxidized sulphide minerals have been washed out of the materials in the newly-flooded lake, and seepage from PAG waste rock and tailings stored above and outside the lake cease to flow into the lake.

The first source of ARD and ML in the flooded pit and area is the residual products of oxidation of sulphidic minerals from PAG waste rock submerged in the lake and exposed PAG rock faces in the open pits. Submerging these sources will effectively curtail the oxidation reaction, thus preventing the formation of new ARD and ML. The second source of ARD and ML is seepage from PAG waste rock and dry stack tailings. Once these dry stack tailings are completely frozen, ingress of precipitation and release of ARD and ML will diminish to negligible amounts, This is expected to occur within a finite time after closure (refer tosections2.4.6.1 and 2.4.6.2 for a full description of ARD and ML management from waste rock and dry stack tailings piles, respectively).

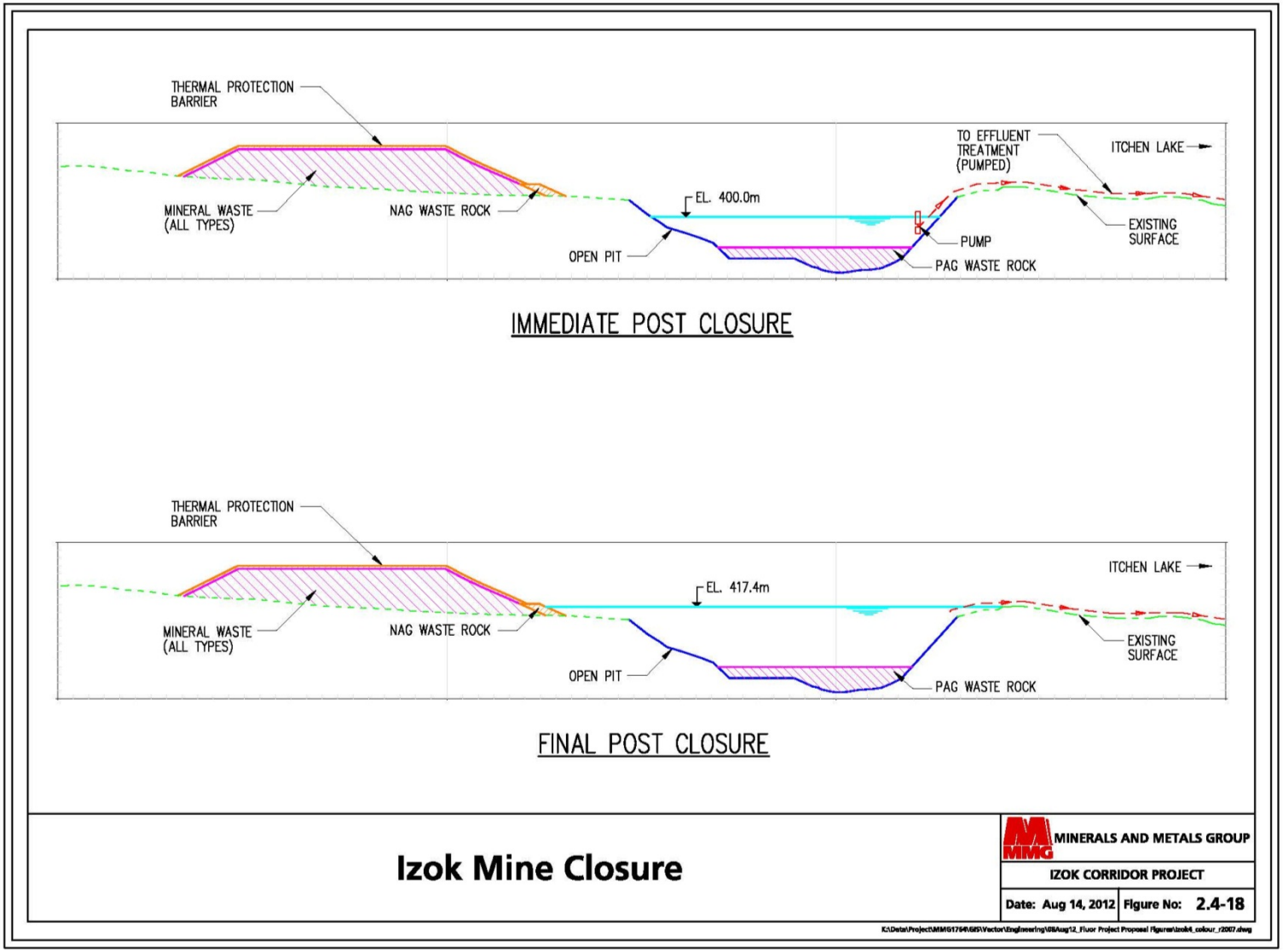


Figure 2.4-18 Izok Mine - Closure

Once production of ARD and ML has effectively ceased, eliminating the need to pump and treat water from the flooded pit and nearby area, the effluent treatment plant and associated infrastructure will be decommissioned and removed. Other water control structures such as the water holding pond and non-contact water diversion ditch system will also be decommissioned.

2.4.7.5 Groundwater Management Plan

Groundwater management measures implemented during mine operation will control, collect and treat groundwater inflows into the pits and from other mine site areas.

As described in section 2.4.4.3, the Izok Mine is situated within a talik in a region of continuous permafrost. Permafrost in the area extends to a depth of more than 300 m. Within continuous permafrost regions, groundwater flow may occur beneath the permafrost, within taliks (unfrozen ground beneath lakes and rivers within areas of continuous permafrost),in localized pockets within the permafrost zone, and in the seasonal shallow "active layer" (the surface layer above the permafrost that freezes and thaws seasonally). Shallow groundwater flows occur only in summer months within the "active layer", which typically varies in thickness between one and five metres depending primarily on soil conditions. Bedrock geology, permafrost, and taliks are key factors that define the deep groundwater flow system.

During mine operation, groundwater that flows into the Izok Mine open pit and underground operation from the Izok Lake talik will be collected in sumps, and pumped to a water holding pond. From there, the groundwater will be pumped to a water treatment facility for treatment and re-cycled as process plant make-up water or released to Itchen Lake when discharge criteria have been met.

Inflow rates will tend to increase with depth of excavation, but decrease with time as the talik becomes dewatered and permafrost aggradation of the talik occurs. These effects will be modelled in subsequent phases of Project design and mine planning.

Groundwater flowing through the seasonal, shallow "active layer" within the disturbed Izok Lake catchment area will naturally flow towards and into the open pits. Shallow groundwater flows will intersect the pit walls and drain down to a mine sump. From there, it will be pumped to a water holding pond. The volume of this shallow groundwater is expected to be relatively small due to shallow overburden layers in the mine site area.

Seasonal shallow groundwater flows coming from the banks of the diversion channel (Iznogoudh to Itchen Lake) will be of good quality and will flow untreated into the diversion channel and through to Itchen Lake.

2.4.7.6 Groundwater Management Alternatives

Drilling a ring of large diameter perimeter dewatering wells around the pit limits is being considered during the feasibility study as an alternative to free inflow, collection in sumps and pumping of groundwater. By this means, pumps lowered into the perimeter holes could remove groundwater before it can reach the pit walls.

2.4.7.7 Groundwater Management – Mitigation by Design

No mitigation by design options have yet been identified that might eliminate or reduce groundwater flows into the mine openings.

2.4.7.8 Groundwater Management Closure Plan

At closure, once water quality has returned to acceptable levels, the new water body created by flooding the pit and surrounding area will be allowed to refill to its natural level (most likely the same level as the former Izok Lake) from inflows of precipitation, surface run-off, and groundwater inflows. Groundwater inflows post closure will cease when a natural water elevation has been reached.

2.4.8 Preliminary Izok Mine Water Requirements

Fresh water will be sourced from Itchen Lake. The location of the water inlet is shown in Izok Mine site plan (refer to **Figure 2.4-17**).

Fresh water intakes will either be submerged on the lake bed or on a barge. The inlet structure will be designed in accordance with DFO's Fresh Water Intake End-of-Pipe Fish Screen Guideline (1995).

2.4.8.1 Process Water

Process water is the term for water used in the mineral processing plant, and can be described in two ways; the circulating water within the plant, and the amount of water that needs to be continuously added to the process (i.e. makeup water) to balance water leaving the process in the form of moisture in the concentrate produced and other sources of loss.

Typically, two tonnes of process water (2 m^3) will be used for every tonne of ore processed. Process water will be predominantly composed of recycled water and supplemented with makeup water, which will be predominantly from water collected on other parts of the mine site (e.g. mine groundwater inflows and surface run-off water).

2.4.8.2 Potable Water

A potable water treatment unit will serve the plant complex and camp and will comprise self-contained, pre-assembled modules. In addition to meeting drinking water requirements for the plant complex, the treated potable water will also be used for safety showers and eye wash stations.

2.4.8.3 Fire-fighting Water

The fire-fighting water systems for the industrial complex and camp at Izok Mine will consist of a combined fire-fighting water and process water make-up tank with the lower portion holding fire-fighting water. Fire-fighting water distribution pumps (including a stand-by diesel powered pump for use during a power outage) and a distribution system of steel pipes will be installed within buildings and utilidors, and hydrants and fire hoses will be located throughout the plant site. In the camp, a dual-purpose fire-fighting water and fresh water tank will be installed, with the lower portion storing the fire-fighting water.

The fire-fighting water tanks will be carbon steel field-erected tanks provided with immersion heaters. Tanks will be designed to supply the fire-fighting system for two hours of operation.

2.4.8.4 Water Balance

A preliminary site-wide water balance has been developed for the Izok Mine, which includes the mill and effluent treatment plant.

2.4.8.5 Water Requirements Alternatives Considered

Sourcing fresh water from Iznogoudh Lake was considered and rejected, as this potential source is substantially further from the plant and camp than Itchen Lake, and associated costs of piping, pumping, and electrical lines are higher.

2.4.8.6 Water Requirements Mitigation by Design

The following processes have been incorporated into the mine design to mitigate effects on surface water quantity.

- Recycling contact water for re-use in the process plant and the mine
- Treating contact water in a effluent treatment plant
- Re-using treated water within the minesite rather than releasing itto Itchen Lake

2.4.8.7 Water Requirements Closure Plan

Water systems at Izok Mine will be decommissioned, dismantled and removed at closure.

2.4.9 Izok Mine Waste and Other Wastes

2.4.9.1 Process Water Treatment and Discharge

There will be times when the water balance will be in deficit and there will be a need for fresh make-up water, and times when the water balance will be in surplus and excess process water will need to be treated prior to release.

Excess process water will be directed to an effluent treatment plant installed inside the process plant. The effluent treatment plant will have the capacity to treat 1,000 m^3/hr of water, and will be fed with water from the concentrate and tailings thickener overflows. The treatment plant will precipitate oxidized metals, which will be removed by a high-density sludge system. The process will involve two tanks: one to receive input water and to inject air, and the other for lime addition to raise the pH to precipitate dissolved metals. Treated water will be pumped to sedimentation ponds for solid-liquid separation prior to release to Itchen Lake.

Water discharged to the environment will meet the water quality permit limits under the Metal Mining Effluent Regulations (MMER). Suitable sampling and flow measuring instruments will be installed to sample the quality of the effluent discharge. A range of values for water quality parameters will be established to ensure that the water treatment has been effective. The discharge will be regularly

monitored to ensure conformity with environmental standards. Release of non-compliant water will be prevented by returning the water to the effluent treatment plant for re-treatment. Treated effluent meeting discharge criteria will be discharged under the surface of Itchen Lake.

Sludge generated in the effluent treatment plant and sediments from the sediment ponds or clarifiers will be pumped to the tailings filtration plant for co-disposal with the tailings.

2.4.9.2 Sewage Treatment and Discharge

Sewage from the camp, process plant and maintenance facilities will be conveyed in heat traced insulated pipes to a sewage treatment plant located either inside the process plant or close by it. A rotating biological contactor sewage treatment systems or similar will be used. During construction, sewage plant effluent meeting discharge criteria will be discharged to Itchen Lake. During the operational phase, sewage plant effluent will be re-cycled into the process plant as make-up water or used for other non-potable water uses such as dust suppression. If not re-used, it will be discharged into Itchen Lake.

Sludge from the sewage treatment plant will be disposed of with process plant tailings.

2.4.9.3 Grey Water Treatment and Discharge

Grey water will be pumped either to the process plant as make-up water, or treated to meet discharge criteria and either discharged to Itchen Lake, re-used in the process plant, or directed untreated to a land farm.

2.4.9.4 Solid Waste Treatment and Discharge

Combustible solid waste and non-combustible solid waste, including bulky items and scrap metal, will be collected and disposed of in a landfill within the Izok Lake catchment area. A site for the land fill will be selected during future studies.

Combustible solid wastes will be regularly collected and removed from source locations to areas where fire will not pose a hazard. Combustible solid waste may be incinerated.

Landfills will be engineered facilities to deal with leachate concerns and to ensure that only non-hazardous waste will be disposed. Domestic garbage will be collected on a daily basis, incinerated and the ash buried in a landfill. Transfer containers for solid waste collection will be located throughout the mine site; these will be kept closed with animal resistant lids to reduce scavenging. Incinerators will be located within an electric-fenced area to prevent access by wildlife.

Non-combustible materials may be placed into the waste rock piles.

2.4.9.5 Other Liquid Wastes Treatment and Discharge

Oils will be collected and incinerated or mixed with diesel to fuel the diesel generators.

Contaminated snow will be deposited in the water holding pond, where it will be pumped to the water treatment plan.

Empty barrels and fuel drums will be drained, cleaned and placed in a landfill.

2.4.9.6 Hazardous Waste Treatment and Discharge

Hazardous waste will be stored, handled and transported according to the Hazardous Waste Management Plan, which will be developed for the Izok Mine site. Hazardous materials will be placed in sealed metal containers, typical 40 gallon oil drums, and shipped off site to a hazardous material treatment facility.

2.4.9.7 Waste Water and Other Wastes Alternatives

The use of a clarifier for solid-liquid separation instead of sediment ponds and sand filters has been chosen as it will reduce the size of the sand filters and allow the underflow to be continuously recirculated until it becomes thick enough to be sent to the tailings filters.

2.4.9.8 Waste Water and Other Wastes Mitigation by Design

Designs that mitigate the effect of water treatment and discharge at Izok Mine include:

- Maximizing re-use of treated effluent within the process plant, which reduces the amount of fresh make-up water and effluent to be released to the environment
- To the extent possible, locating all point sources of waste water and other wastes within the former Izok Lake catchment, thus limiting the potential area affected by spills

2.4.9.9 Waste Water and Other Wastes Closure Plan

At closure, all water treatment and discharge infrastructure not required for the post-closure phase treatment of water will be decommissioned and removed.

Infrastructure required for water treatment during the post-closure phase will be decommissioned and removed once water quality meets discharge criteria without treatment.

Landfills will be totally enclosed with an armoured soil cover.

A conceptual water flow diagram at closure is presented in **Figure 2.4-19**.

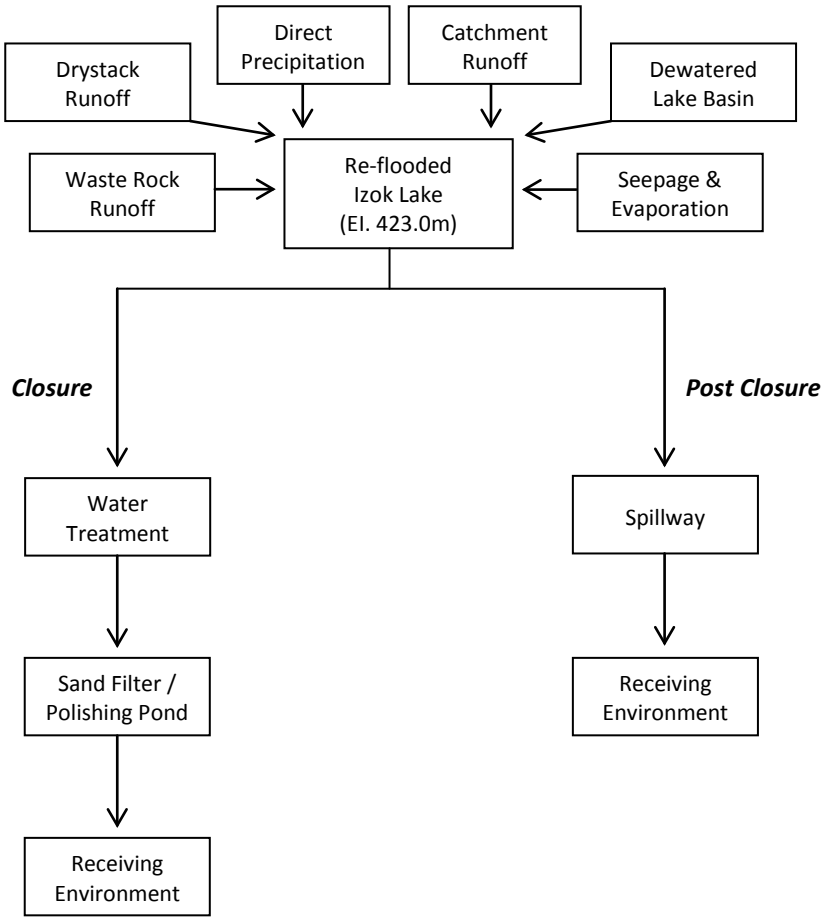


Figure 2.4-19 Conceptual Water Flows at Izok Mine at Closure

2.4.10 Izok Mine Facilities and Infrastructure

2.4.10.1 Infrastructure Elements

Permanent facilities and infrastructure at the Izok Mine will comprise the following main elements.

- Camp
- Offices
- Roads
- Surface water management structures
- Process plant
- Plant site services

- A truck shop for mobile equipment
- A warehouse
- A covered cold storage area and an open cold storage area
- Explosives storage facilities
- Process plant workshops
- Assay Laboratory
- Hazardous materials handling and storage facilities
- Container yard
- Diesel-electric generators
- Tank farm
- Power distribution system
- Airport
- Potable water treatment plant
- Sewage treatment plant
- Effluent treatment plant
- Concentrate storage building
- First aid services
- Emergency response services
- Landfill
- Land farm

The mine complex and plant site was selected for its proximity to the ore body and suitability for Project infrastructure foundations. The site is located approximately 600 m east of the pit on a ridge of exposed bedrock with thin overburden soils.

Figure 2.4-20shows the layout of the Izok Mine plant site and associated infrastructure.

2.4.10.2 Roads

Mine site roads will connect all parts of the mine, and will be constructed of quarried NAG rock and NAG waste rock and surfaced with screened gravel.

2.4.10.3 Mineral Processing Plant

The mineral processing plant (“mill building”) will be a steel-framed metal clad building thatwill house grinding mills, flotation sections, tailings filtration units, effluent treatment plant, reagent mixing units, concentrate and tailings filters. The mill building will be connected to the main buildings via utilidor.

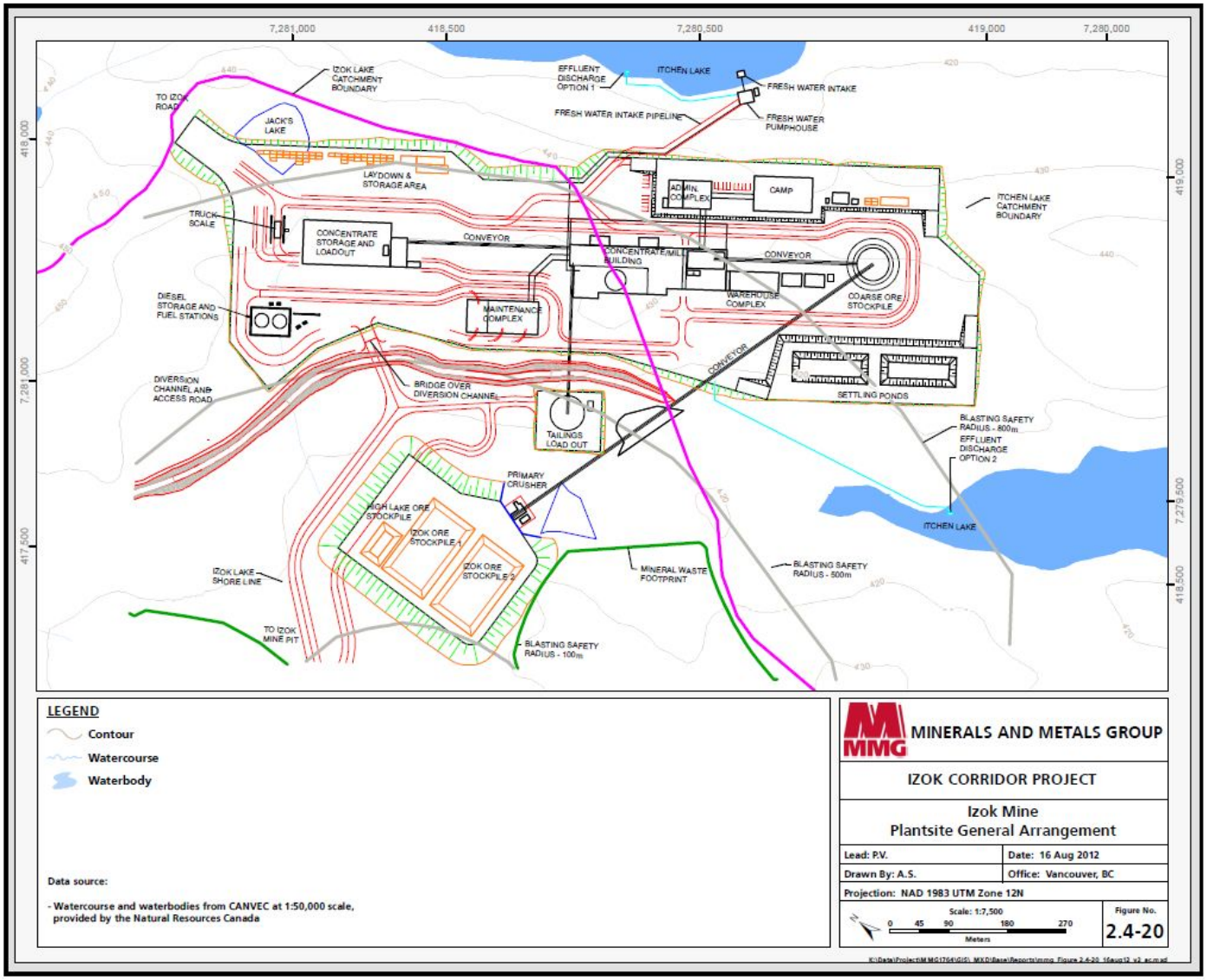


Figure 2.4-20 Izok Mine Plant Site General Arrangement

2.4.10.4 Concentrate Storage Building

Concentrate will be transferred from the mill building to the concentrate storage building by an enclosed conveyor system. The concentrate storage building will be located to the north of the process plant. It will be a stand-alone, enclosed building and will have a capacity between 50,000 tonnes and 200,000 tonnes of concentrate, or between one and four month's production to allow for road closures resulting from inclement weather conditions, seasonal closures during the caribou migration periods, and scheduled road maintenance. The ongoing feasibility study and particularly the development of the Traffic Management Plan will help to confirm on-site storage needs.

2.4.10.5 Electric Power Generation

Electric power for the mine will be provided by diesel electrical generating units located in the main power house located within the concentrator building. Power generation capability will be approximately 15 to 20 MW, including standby and back-up units. Diesel generators will be located adjacent to the camp complex for use in the event of a failure of the main system. Engine and exhaust heat will be recovered from the diesel generators for heating buildings.

2.4.10.6 Electric Power Distribution

Power will be distributed within the mine complex through insulated cable within utilidors. Power will be distributed outside the mine complex through insulated cable laid in shallow open ditches.MMG will follow best standard practice, as used at other mining developments in cold climates.

2.4.10.7 Fuel Systems

Approximately 35 Ml of low sulphur diesel will be required annually for operations at the Izok Mine. This is a preliminary number and may change as the feasibility study progresses. Diesel will be used for power generation and mobile equipment operation. Diesel will be supplied from diesel storage tanks located near the service building and the diesel generators. The fuel system will include at least two diesel storage tanks plus required containers of gasoline and lubricants, which will all be located within a bermed area as per Nunavut regulations.

Diesel will be transported by tanker trucks to the mine site from the bulk fuel storage at Grays Bay Port.

Facilities will be provided for metered delivery to vehicles through regular filling hoses. The dispensing station will have a 50,000 litre day tank in accordance with requirements of National Fire Code of Canada. Re-fuelling of vehicles will be conducted within a bermed area to contain any potential spills.

Diesel will be piped from the tank farm to a day tank at the power generation equipment, which will be located in a power house within the process plant building.

Other fuel types will include aviation fuel for helicopters. This will be stored in 45 gallon steel barrels. The annual consumption is estimated at 100,000 litres. Aviation fuel will be stored in a lined bermed area at the tank farm and moved on pallets as needed to a lined bermed area at the helicopter pad.

All fuel handling equipment, installations and procedures will comply with Environment Canada's fuel storage system regulations (Storage Tank System for Petroleum and Allied Petroleum Products).

2.4.10.8 Airport

The existing Ham Lake Airstrip is located about 11 km to the north west of Izok Mine. This is a 900 m all-weather gravel airstrip, which has been used for a number of years for exploration activities.

Two potential airstrips are being considered west of Izok Mine (**Figure 2.4-21).** Final selection of the airstrip location will be made during feasibility planning.

2.4.10.9 Accommodation

The camp at Izok Mine will be sized for the peak manpower loading, which will occur during construction of the diversion channel, sedimentation pond, cut-off dam and plant site rough grading activities. Camp capacity requirements will peak again when the concentrator plant is completed and commissioning takes place.

Temporary mobile camps of limited size (between 100 and 200 person capacity) will be installed for the initial part of the construction phase, and will be replaced by the permanent camp buildings when these are constructed.

The personnel accommodation complex (or permanent camp) will be located south east of the process plant, and will house approximately 700 to 800 workers during the construction phase and between 300 -500workers during the operations. These numbers are preliminary and will be improved by the time the Draft Environmental Impact Statement (DEIS) is delivered.

Permanent camp buildings will be pre-constructed modules that are assembled and erected on site. The permanent camp will include kitchen, laundry and recreation facilities. The camp will be installed early in the Project as part of the pre-construction schedule and will be of modular design to allow for expansion as the Project progresses through the various construction phases. The proposed location of the camp takes into account potential sources of noise and dust emissions, distance from blasting in the mine, and the predominant wind direction.

The permanent camp will include fitness and recreational facilities to attract and retain employees and to promote their health and well-being. There will be areas dedicated to training, computer access, and other dedicated spaces. MMG will be consulting with other operators and with communities on how to design camps that will maintain a healthy and balanced lifestyle while away from home, and provide opportunities for hobbies, training and learning while on site. MMG is also looking at room configuration and size, as well as other amenities currently provided by other operators to inform the planning process.

2.4.10.10 Communications

MMG is investigating a variety of options to provide secure and reliable communication on site. At this time, the pre-feasibility studies suggest that communications between Izok Mine and external locations will be via satellite. Communication within the Izok site will be by radio and a local phone system will be used within the mine complex.

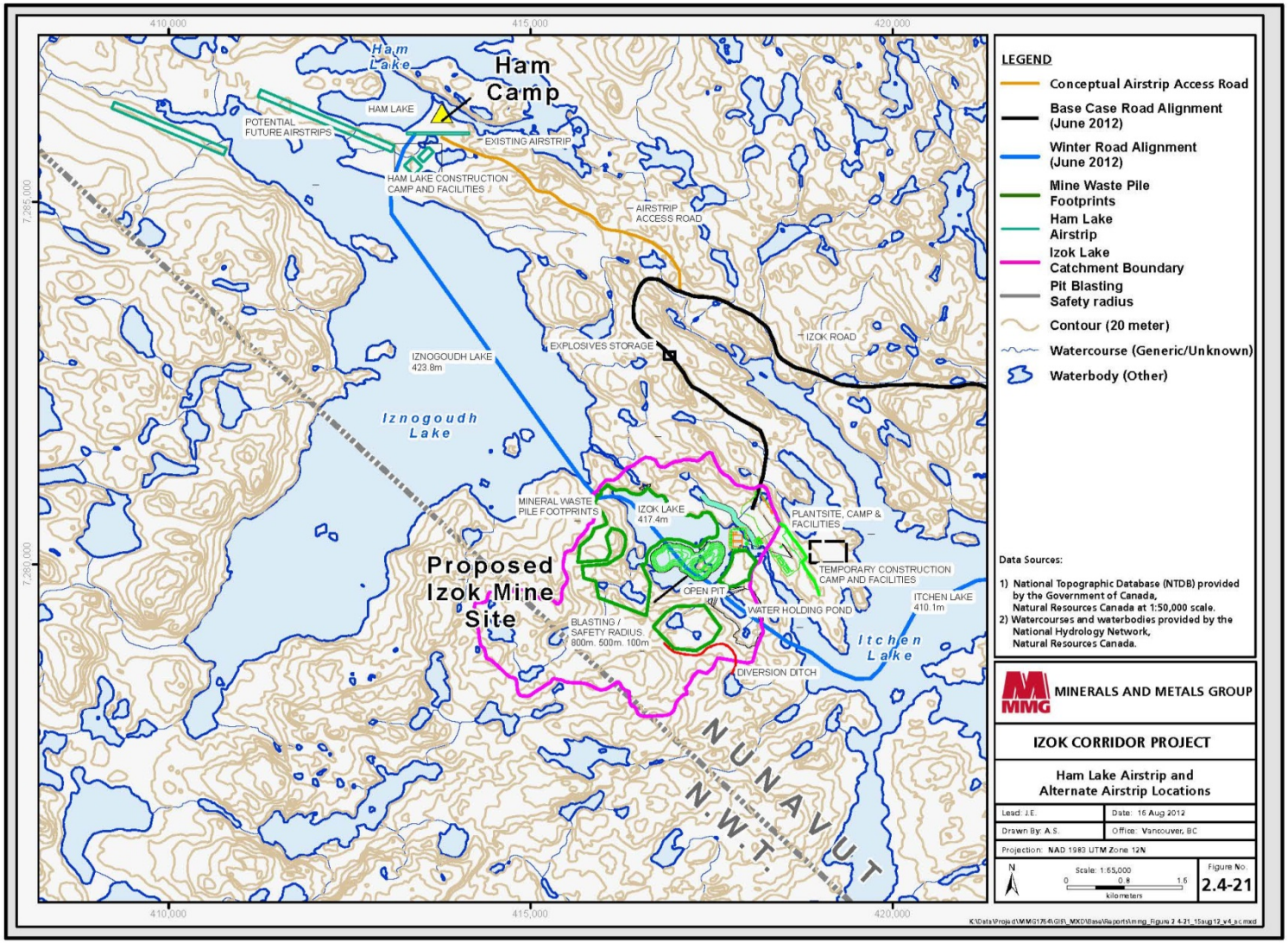


Figure 2.4-21 Ham Lake Airstrip and Alternate Airstrip Locations

2.4.10.11 Explosives Storage and Handling

Explosives and blasting agents will be transported to Izok Mine by road from the main storage depot and manufacturing facility at High Lake. Transportation, storage and handling of explosives will comply with all relevant regulations and Acts (i.e., federal *Explosives Act* and the *Explosive Use Act of Nunavut)*.

Exact quantities and descriptions of explosives and components of explosives are being currently being developed.

Explosives magazines at Izok Mine will consist of a fenced area sized to handle standard 6 m containers and 80,000 kg silos containing emulsion. Blasting accessories are classed as an explosive and bullet proof magazines will be installed and located approximately 1 km from buildings or roads; the exact distance determined by regulation and dependent on the amount and type of explosive being stored.

Based on the experience of operating mines in the Northwest Territories and Nunavut, a high percentage of the blast holes will be wet. In these cases, an emulsion based explosive mixed with ANFO (ammonium nitrate and fuel oil) will be used.

Emulsion consists of ammonium nitrate prills, water and emulsifiers. Ammonium nitrate will be handled in specially constructed containers of 20 t capacity.

2.4.10.12 Hazardous Materials

The Izok Mine and processing plant will use a variety of chemicals and reagents that are classified as hazardous but are standard in the mineral processing industry.

A full description of types, quantities, method of storage and containment, secondary containment measures, method of chemical transfer, and description of spill control measures for hazardous materials will be developed during the next stage of Project planning.

Hazardous materials will be packaged in drums or bulk bags and shipped to mine in sea containers via barge or ocean bulk-carrier ships. All hazardous materials will be stored within the shipping container and will be placed adjacent to the process plant, allowing ready access and just-in-time removal of hazardous materials from safe storage in containers.

2.4.10.13 Infrastructure Alternatives Considered

Alternative Airstrip Locations

An alternate airstrip location west of Izok Mine is considered potentially viable(refer to **Figure 2.4-21**). It will be further investigated during the 2012 field season. This location would eliminate the need to construct approximately 5 km of road to access the Ham Lake airstrip, but will likely incur higher construction costs as the ground is exposed rock, whereas Ham Lake airstrip is located on lake and river sediment material.

2.4.10.14 Infrastructure – Mitigation by Design

With exception of the Ham Lake airstrip and a small portion of the mine complex, all infrastructure elements will be located within the Izok Lake catchment to avoid downstream environmental effects in

the event of an accidental release of contact water or spilled material, or a catastrophic failure of a water retaining structure.

In addition, the general arrangement and juxtaposition of infrastructure elements will minimize the disturbed area.

2.4.10.15 Infrastructure Closure Plan

At closure, all infrastructure elements will be decommissioned and removed.

2.5 High Lake Mine

2.5.1 High Lake Site Geology

The central part of the High Lake property is underlain by north-trending Archean aged (2.69-2.60 Ga) basaltic to rhyolitic flows and fragmental volcanics (**Figure 2.5-1**). A large mass of Late Archean plutonic rocks intrudes the supracrustal units in the western part of the property. Several prominent northwest and north-south trending brittle faults, including the regional High Lake fault, variably displace granitoid and volcanic units before the emplacement of the diabase dikes.

The High Lake VMS deposits are within the felsic volcanic sequence with the B and D zones at or near the contact with granodiorite intrusion. Past drilling has focused on the areas of mineralization. These comprise the recent West zone discovery and the previously outlined AB and D zones. The largest zone (West_100 zone) is about 275 m long, extends about 900 m down dip and is up to 40 m thick.

The D zone is about 560 m south of the AB zone. It is a banded polymetallic massive sulphide comprising four separate lenses of mineralization. The largest is about 150 m long, dips down 320 m and is up to 35 m thick. The deposit strikes about 30 degrees and dips steeply to the west-northwest and faces northwest. Copper rich stringer mineralization occurs to the east. The north end of the deposit may be truncated by the High Lake Fault, while the southern portion appears to be cut off by the diorite/granodiorite complex.

The A zone is larger and made of stringer type sulphide mineralization stratigraphically below the more massive sulphide B zone mineralization. The A zone is also discordant with the host felsic lapilli tuffs interbedded with ash tuffs and crystal tuffs. The alteration assembly consists of chlorite, sericite, cordierite, anthophyllite and silicification, with minor amounts of biotite, talc and amphibole. Copper rich areas are associated with massive sulphide lenses in the core of the zone.

The B zone is stratigraphically above the A zone. The deposit is in altered ash and crystal tuffs. The zone is bounded on the east by the A zone and the southern end appears to be cut off by the diorite/granodiorite complex. Mineralization consists of pyrite, magnetite, pyrrhotite, chalcopyrite, sphalerite and galena, and occurs as bands and pods.

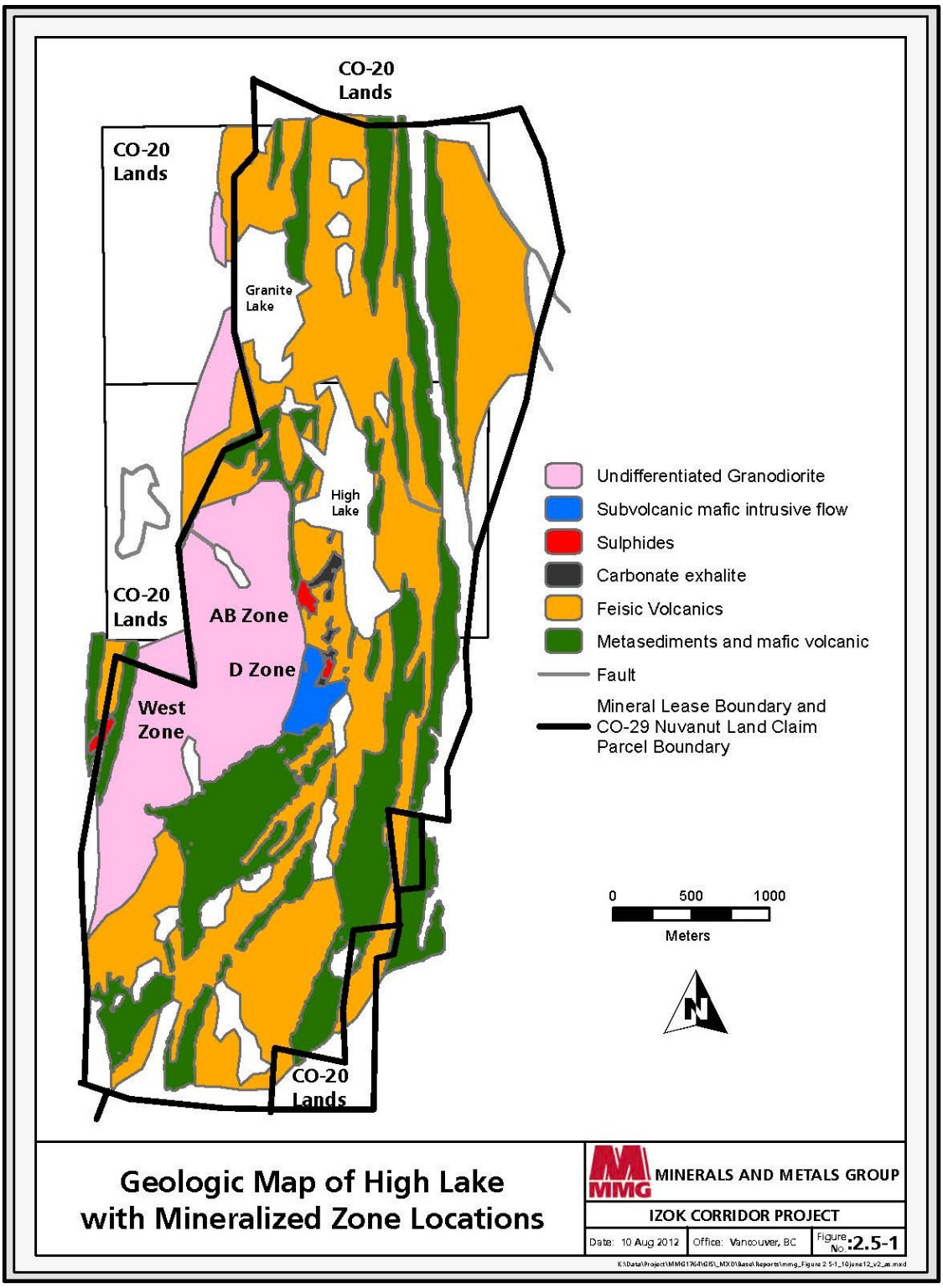


Figure 2.5-1 Geological Map of High Lake with Mineralized Zone Locations

2.5.2 High Lake Mineral Resources and Reserves

Mineral resource estimates for the High Lake deposits are outlined in **Table 2.5-1**.

Table 2.5-1 Preliminary High Lake Mineral Resources as of 30 June 2010

High Lake Mineral Resources									
2% Cu equivalent cut-off grade	Tonnes (Mt)	Zinc grade (% Zn)	Copper grade (% Cu)	Lead grade (% Pb)	Silver grade (g/tAg)	Gold grade (g/tAu)	Contained Metal		
							Zinc (*000 t)	Copper (*000 t)	Lead (*000 t)
Measured	-	-	-	-	-	-	-	-	-
Indicated	17.2	3.4	2.3	0.3	70	1.0	576.2	387.0	53.3
Inferred	0.0	2.4	0.5	0.4	122	0.2	1.0	0.2	0.2
Total Resources	17.2	3.3	2.2	0.3	70	0.9	577.2	387.2	53.5

2.5.3 High Lake Site Overview

The High Lake Mine site is located approximately 300 km north of the Izok Mine and approximately 1,500 m west of the Kennarctic River. High Lake is approximately 0.7 km^2, with a water volume of approximately 7.3 Mm^3 and an average mean depth of 10.25 m. There are mineral deposits on the land adjacent to High Lake that are exposed at surface, and any surface run-off over these areas becomes highly acidic, containing high levels of dissolved minerals. As a consequence, High Lake does not support aquatic life.

Some hydrogeological test hole drilling has been carried out at High Lake. The depth of permafrost in the area of the High Lake deposits has been measured at 440 m. As such, mining excavations above this horizon are not expected to encounter groundwater inflows. Based on the current mine design, maximum mining depths for the High Lake deposits, where open pit mining will occur, are well above this horizon. In the West Zone (underground), the maximum mining depth will extend to approximately 540 m below surface; however, the lowermost economic limit has not been confirmed. At this depth, the lowermost 100 m of mining excavations might be exposed to contact with potential aquifers.

2.5.3.1 Mine Geotechnical Conditions

Geological and geotechnical models will be prepared for the AB, D and West Zone deposits in 2012.In lieu of structural and geological models, the current geotechnical model is based upon general knowledge of the distribution of the lithologies at the AB, D and West zones, instead of individual geotechnical domains.

Geotechnical Mine Design Criteria

Work carried out to date provides elementary design criteria for open pits such as bench height, bench width, and slope angles, and underground stopes. More detailed design criteria will be developed based on the new geological and geotechnical models being produced.

Mining Optimization and Inventory

Optimization exercises performed during the pre-feasibility study resulted in an estimated mining inventory of material in all zones that could be mined economically (**Table 2.5-2**).

Table 2.5-2 Preliminary High Lake Mining Inventory

	Tonnes (Mt)	Zinc grade (% Zn)	Copper grade (% Cu)	Lead grade (% Pb)	Silver grade (g/t Ag)	Gold grade (gt/ Au)	Zinc ('000 t)	Copper ('000 t)	Lead ('000 t)	Silver (M oz)
Open Pit	2.7	1.3	3.6	0.1	33	0.6	35	96	3	3.1
Underground	4.2	3.8	2.7	0.4	104	1.4	160	113	17	15.4
Total	6.9	2.8	3.0	0.3	76	1.1	195	210	20	18.6

Mining at High Lake will commence with the two relatively small and short-lived open pits, and continue to the end of mine life by underground methods at the High Lake West zone. The underground mining operation will be developed through access from a ramp driven in the footwall with cross-cuts accessing the ore. During the final stage of mine life, the small and lower grade D pit will be mined.

The open pits (AB and D) and underground mining (West Zone) at High Lake are shown in **Figure 2.5-2**.Current parameters of the open pit and underground mine are summarized in **Table 2.5-3**.

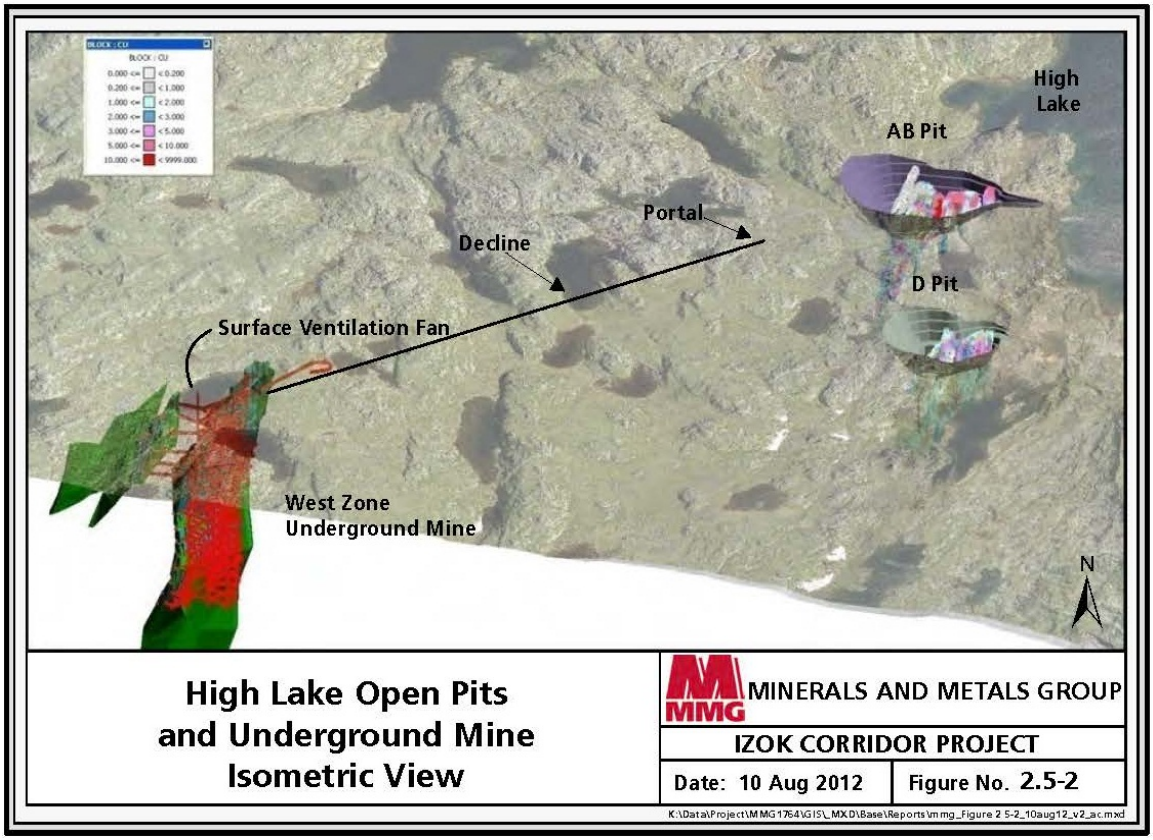


Figure 2.5-2 High Lake Open Pits and Underground Mine Isometric View

Table 2.5-3 Preliminary Mine Design Parameters for the High Lake Mine Deposits

Parameter	AB Pit	D Pit	West Zone
Excavated Volume	4.9M m^3	1.1 Mm^3	2.1 Mm^3
Maximum Depth (m)	155 m	90 m	540 m
Maximum Width (m)	290 m	165 m	70 m
Maximum Length (m)	400 m	260 m	210 m

2.5.3.2 Mining Infrastructure and Processes

Underground Ventilation

In the early years of mine operation, the West Zone underground mine will be in permafrost and as such the mine intake air will not be heated. This will preserve ground stability by maintaining frozen ground conditions. During later years, the mine may extend beneath the permafrost and groundwater will seep into the mine. During this period, the mine intake air may need to be heated to prevent inflowing water from freezing.

Mine Backfill

Wasterock will likely be used to backfill mined out stope excavations. It has yet to be decided if cement will be added to consolidate the backfill material. In this eventuality, the waste rock may have to be warmed to above freezing.

Dewatering

The High Lake open pits and the uppermost 440 to 450 m of the West Zone underground mining are expected to be in permafrost conditions and no groundwater inflows are anticipated. In the open pits, water from precipitation and spring snow melt will be pumped to a central waste water handling facility for the High Lake site. In the underground mine, the brine solution used for drilling and dust suppression will be collected and re-circulated after use. Much of this solution will be removed from the mine as moisture adhering to the broken ore and waste, which will require additional solution to replenish this loss. Minimal amounts of mine water due to spring runoff inflows will be pumped to surface and piped to the central site waste water handling facility.

Power Supply and Distribution

At High Lake, power will be fed from the main site generation and distribution system to a transformer and load centres located at the mine, from there it will be distributed to surface and underground workings.

Fuel Supply

Fuel for mining equipment will be delivered to satellite fuel depots located at the open pits or directly to the mining equipment in fuel trucks. At the underground mine, fuel storage will likely be located underground, protected from the weather. All storage areas on surface and underground will be enclosed or bermed.

Automation and Communication

Automation in the High Lake Mine is expected to be confined to systems on board the mining equipment. A dispatch system will be used in the open pit to assist in prioritizing the deployment of equipment to working areas or for scheduled maintenance, and to collect operational data from onboard diagnostics systems.

The main communications systems will consist of one system for equipment and operating data collection and another for voice communications by radio sets carried by all personnel and equipment. In the underground mine, signals for communications will be carried by a leaky-feeder cable system that is run into all headings. Other systems will be used for ground movement and micro-seismic monitoring.GPS will be installed on most equipment that will operate on surface.

All MMG sites will be connected either by satellite or other means.

Services Buildings

The following central services and other buildings will be constructed at the High Lake Mine.

- Accommodations
- Security
- Office & Dry Facility
- Waste Water Treatment Facility
- Maintenance Buildings
- Warehousing & Storage

Explosives Handling and Storage

Handling and storage of explosives will adhere to both the federal *Explosives Act* and the *Explosive Use Act* of Nunavut. Explosive accessories such as blasting caps, high explosive boosters and detonation cord will be transported to a central storage facility at the mine. Blasting agent materials such as ammonium nitrate, fuel oil and emulsion ingredients will be transported to a central on-site facility for the manufacture of ANFO and emulsion at High Lake. These will be further blended and loaded into blastholes in proportions appropriate to the wetness and temperature of the holes. Explosives and blasting agents will be transported to the work sites using purpose built mobile equipment.

Drill and Blast

All underground production drilling in permafrost will be done with 89 mm ITH units, and ANFO based explosives will be used for all production blasting. If mining extends beneath the permafrost, a wet hole product of 70%Emulsion/30%ANFO blend will be used.

In the open pits, 152 mm blast holes will be drilled in ore and 225 mm diameter blast holes will be drilled in waste. ANFO based explosives will be used for all production blasting.

Materials Handling

Two 200-tonne diesel-powered hydraulic excavators will be used to handle ore and waste. The excavators have been matched to load 91-tonne trucks. The difference in bucket capacity is an adjustment of minable material in-situ density to the lifting capacity of the excavator; ore being 3.96 t/m³ and the three waste components averaging 2.63 t/m³. The average estimated maximum productivity is 1,106 tonnes per operating hour.

An 800 hp front-end loader with a 10.3 m³ bucket will work at the ore stockpile to blend ore and tram feed to a jaw crusher. The crusher loader will back-up the excavators for in-pit waste removal.

Ore will be hauled from the open pits in 90 to 100 tonne trucks. Ore will be hauled from underground in 40 - 60 tonne trucks.

2.5.3.3 Open Pit Mine Equipment

Preliminary specifications for open pit mining equipment at the High Lake site are listed in **Table 2.5-4**.These specifications may change during development of the feasibility study. The list includes the primary equipment for drilling, blasting, loading and haulage, as well as ancillary mine equipment for maintaining pit floors and roadways, moving equipment with limited mobility, equipment servicing, personnel transport and secondary ore and waste handling.

Table 2.5-4 Preliminary High Lake Open Pit Equipment

Open Pit Equipment		
Function	**Equipment Type**	**Estimated Quantity**
DRILLING	225-mm Drill	1
	152-mm Drill	1
BLASTING	Bulk Powder Delivery Truck	1
	Explosive Accessories Delivery Truck	1
LOADING	200 t Hydraulic Excavator – 8m³	1
	200 t Hydraulic Excavator – 12m³	1
HAULING	Mechanical Drive Haul Trucks – 91t	3
CRUSHER FEEDER	Frontend Loader – 800 hp	1
SUPPORT EQUIPMENT	Crawler Dozer – 400 hp	2
	Motor Grader – 300 hp	1
MINE GENERAL	General Purpose Excavators – 350 hp	1
	Picker Truck (Large)	1
	Tractor/Lowboy (100+ tonne)	1
	Fuel Truck	1
	Fuel/Lube Truck	1
	Light Tower	4

Open Pit Equipment		
Function	**Equipment Type**	**Estimated Quantity**
ANCILLARY EQUIPMENT	Hydraulic Crane – 75 t	1
	Tire Manipulator	1
	Integrated Tool Carriers	1
	Mechanic/Welder Truck	1
	Vacuum Truck	1
	Tandem Truck	TBD
	F550 Flatdeck	2
	Crewcab	4
	Bus	2
	Suburban/Van/Ambulance	1

2.5.3.4 Underground Mining Equipment

Current specifications for underground mining equipment at the High Lake Mine are listed in **Table 2.5-5**.These specifications may change during preparation of the feasibility study. The list includes the primary equipment for drilling, blasting, loading, ground support and haulage, as well as ancillary mine equipment for equipment servicing, mine services and personnel transport.

Table 2.5-5 Preliminary High Lake Underground Mine Equipment

Underground Mine Equipment		
Function	Equipment Type	Estimated Quantity
LOADING	R2900 LHD	4
DRILLING	Development Jumbo	3
HAULAGE	AD55 Truck	3
GROUND SUPPORT	Bolter	3
ANCILLARY	Light Vehicles	8
	Service Vehicles	4
	Agitator Truck	3

2.5.3.5 Production Schedule

The overall preliminary production schedule is based on a nominal 2 Mtpa. Approximately 600 ktpa of this will come from the High Lake Mine. First ore will be produced from the AB Pit. Simultaneously, portal excavation and construction will commence at the West Zone deposit, which will be mined using underground methods, with first ore to be produced in late 2019.The low-grade, low-tonnage D Pit will be developed and mined at the end of the mine life. The preliminary production schedule for the High Lake Mine is shown in **Table 2.5-6**.

Table 2.5-6 Preliminary High Lake Production Schedule

AB Open Pit	Waste Tonnes Mined	Ore Tonnes Mined	Cu grade (%)	Pb grade (%)	Zn grade (%)	Au grade (g/t)	Ag grade (g/t)
2017	3,751,552	54,702	2.37%	0.10%	1.03%	0.80	20.72
2018	4,119,191	595,209	4.08%	0.10%	0.74%	0.65	24.19
2019	2,021,579	597,654	4.23%	0.10%	0.47%	0.66	28.76
2020	1,290,486	450,457	3.65%	0.10%	0.19%	0.56	25.25
2021	738,421	302,306	3.80%	0.10%	0.18%	0.53	28.15
2022	264,185	185,695	3.23%	0.10%	0.91%	0.54	31.02
TOTAL	**12,185,413**	**2,186,023**	**3.88%**	**0.10%**	**0.50%**	**0.61**	**26.70**
D Open Pit	**Waste Tonnes Mined**	**Ore Tonnes Mined**	**Cu grade (%)**	**Pb grade (%)**	**Zn grade (%)**	**Au grade (g/t)**	**Ag grade (g/t)**
2028	2,833,487	486,308	2.17%	0.10%	5.05%	0.39	63.41
TOTAL	**2,833,487**	**486,308**	**2.17%**	**0.10%**	**5.05%**	**0.39**	**63.41**
West Zone Underground	**Waste Tonnes Mined**	**Ore Tonnes Mined**	**Cu grade (%)**	**Pb grade (%)**	**Zn grade (%)**	**Au grade (g/t)**	**Ag grade (g/t)**
2018	251,550						
2019	467,550	720	2.11%	0.22%	2.96%	1.62	89.32
2020	456,075	134,337	3.18%	0.49%	4.10%	1.40	102.00
2021	508,800	294,478	2.90%	0.47%	3.35%	1.30	98.76
2022	328,650	443,253	2.65%	0.34%	3.39%	1.21	96.44
2023	137,625	600,000	2.66%	0.33%	3.59%	1.52	115.98
2024	103,875	600,000	2.57%	0.38%	4.09%	1.49	108.40
2025	89,325	600,000	2.61%	0.38%	4.07%	1.44	103.50
2026	64,350	750,000	2.71%	0.36%	3.79%	1.37	99.85
2027	55,426	732,726	2.82%	0.34%	3.62%	1.42	101.23
TOTAL	**2,463,226**	**4,155,514**	**2.71%**	**0.37%**	**3.75%**	**1.41**	**103.81**
HIGH LAKE TOTALS	**Waste Tonnes Mined**	**Ore Tonnes Mined**	**Cu grade (%)**	**Pb grade (%)**	**Zn grade (%)**	**Au grade (g/t)**	**Ag grade (g/t)**
2017	3,751,552	54,702	2.37%	0.10%	1.03%	0.80	20.72
2018	4,370,741	595,209	4.08%	0.10%	0.74%	0.65	24.19
2019	2,489,129	598,374	4.23%	0.10%	0.47%	0.66	28.83
2020	1,746,561	584,793	3.54%	0.19%	1.09%	0.75	42.88
2021	1,247,221	596,784	3.36%	0.28%	1.74%	0.91	62.99
2022	592,835	628,947	2.82%	0.27%	2.65%	1.01	77.13
2023	137,625	600,000	2.66%	0.33%	3.59%	1.52	115.98
2024	103,875	600,000	2.57%	0.38%	4.09%	1.49	108.40
2025	89,325	600,000	2.61%	0.38%	4.07%	1.44	103.50
2026	64,350	750,000	2.71%	0.36%	3.79%	1.37	99.85
2027	55,426	732,726	2.82%	0.34%	3.62%	1.42	101.23
2028	2,833,487	486,308	2.17%	0.10%	5.05%	0.39	63.41
TOTAL	**17,482,126**	**6,827,845**	**3.05%**	**0.26%**	**2.80%**	**1.08**	**76.24**

2.5.4 High Lake Mine Waste Rock Management

2.5.4.1 Waste Rock Quantities

Accessing ore at High Lake Mine will require excavating 25 Mt of waste rock, approximately 60% of which is predicted to be potentially acid generating (PAG).Approximately 2 Mt of waste rock might be placed underground as backfill in the underground mine in the West Zone, leaving 23 Mt of waste rock to be deposited on surface.

2.5.4.2 Waste Rock Characterization

A comprehensive geochemical testing program was completed in 2007 to characterize the potential for ARD/ML from the waste rock at High Lake. Additional testing is in currently in progress to supplement this dataset. The objectives of the characterization program were essentially the same as the ones described for the Izok Mine (section 2.4.6.1). Some preliminary conclusions from this program are:

- The sulphur content ranges from very low (0.1%) to high (10%), with the majority of samples containing less than 1% sulphur. Samples with higher amounts of sulphide are typically found in close proximity to the ore zones and in the footwall of the deposit.
- The neutralization potential (NP) ranges from low (<10 kg $CaCO_3$eq/t) to moderate (40 kg $CaCO_3$eq/t), with a few rock units having NP values greater than 100 kg $CaCO_3$eq/t. Carbonate NP values are slightly lower than NP values but unlike waste rock from Izok, carbonates were present in most of the samples. All samples had neutral to alkaline paste pH values.
- Based on ARD classification using the more conservative carbonate NP data, 60% of the waste rock from the AB and D zone pits at High Lake has been classified as PAG. Kinetic testing has demonstrated that the silicate-NP is capable of maintaining neutral pH conditions. Therefore, it is possible that the proportion of PAG rock will reduce as further interpretation of the data progresses.
- The neutralizing potential present in most samples is expected to result in a substantial delay (up to 4 years longer) to the onset of ARD. Kinetic test results on the PAG samples were run for 40 weeks. Results indicate that the sulphides oxidize quite slowly in comparison to tests from other sites with comparable amounts of sulphide. Acidic conditions did not develop in any of these samples over the 10 month test period.
- Under field conditions with much lower temperatures, reaction rates could be up to 5 times slower, suggesting that there could be a delay of at least 4 years before acidic conditions could develop in the field. Additionally, given the slower than expected oxidation rates, it is possible that buffering by silicate minerals could prevent ARD from developing over the longer term in some of these materials. This may substantially reduce the amounts of PAG that will require special management strategies.

Geochemical testing is ongoing to more closely characterize waste rock and associated leachate water, providing the inputs necessary for further geochemical and water quality modelling.

2.5.4.3 Waste Rock Design Approach

As described for the Izok Mine (section 2.4.6.1), the majority of PAG mine wastes from High Lake will be sub-aerially deposited. While sub-aerial deposition will be more complex and costly during the operational phase, it has clear advantages over subaqueous deposition, as it does not require that a water cover and dam be maintained in perpetuity.

During operations at High Lake, the production and release of ARD/ML will be managed by ensuring that freezing of the PAG waste rock occurs during or shortly after deposition, and that this material remains frozen year round in perpetuity. This objective will be achieved by selecting appropriate deposition schedules and techniques as described for waste rock management at the Izok Mine site (refer to section 2.4.6.1).

2.5.4.4 Waste Rock Management Plan

The proposed mining schedule at High Lake Mine is as follows.

- Years 1 to 6 – open pits (AB Zone)
- Years 2 to 11 – underground mine (West Zone)
- Year 12- open pit (D Zone)

Approximately 2 Mt of PAG waste rock will be used for backfill of the underground mine and therefore will not require special consideration at closure.

The remaining 23 Mt of waste rock will be sub-aerially placed on sloping ground immediately to the west of High Lake. The foundation is anticipated to be relatively thin overburden located over bedrock that is frost shattered to some near-surface depth. Permafrost is expected to a depth of 400 m in this region.

The main elements of the High Lake Mine Waste Rock Management Plan will be the same as those described earlier for the Izok Mine (section 2.4.4.6).

2.5.4.5 Waste Rock Alternatives

An alternative Waste Rock Management Plan that was considered involved submerging PAG waste rock in High Lake. This alternative was rejected, as it might require water to be fed into High Lake to maintain water cover over the submerged rock during low precipitation years, management of overflowing water quality during normal precipitation years, and possibly maintenance of one or more dams; all in perpetuity.

2.5.4.6 Waste Rock Mitigation by Design

Sub-aerial deposition of waste rock offers considerable advantages over the typical sub-aqueous approach, particularly after closure. The following studies will be performed to confirm design assumptions.

- Site investigations to more closely characterize subsurface conditions, geothermal regimes, and their effects on mine waste rock pile design

- Diamond drilling and block model review to more closely define NAG and PAG waste rock quantities
- Modelling of seepage and runoff rates and water quality from the PAG waste rock piles
- Modelling of shallow groundwater flows
- Modelling and laboratory testing at sub-zero temperatures to predict the geochemical and metal leaching characteristics of waste rock at the temperatures that will be encountered at High Lake Mine
- Collection of field data during the early operational phase to confirm the performance of thermal protection covers

2.5.4.7 Waste Rock Closure Plan

The waste rock closure plan for the High Lake Mine involves depositing the majority of PAG waste rock sub-aerially. A small amount may be placed underground. This approach was selected because it most closely meets the minimum maintenance closure concept. Key elements of the closure plan are the same as that described earlier for Izok Mine waste rock.

2.5.4.8 Air Emissions

Mining operations at the High Lake Mine will result in atmospheric emissions of gases and diesel particulate matter from combustion of diesel fuel, and fugitive dust emissions from material handling and transport. Short-term dust emissions will occur during blasting, and overburden and waste rock piles will also be a source of dust particles at certain times of the year.

Features that have been incorporated into Project design to minimize air quality effects due to combustion of fossil fuels include:

- Use of low sulphur grade diesel
- Regular maintenance of all equipment (vehicles and power plant) to ensure efficient operation

Primary measures that will be implemented to manage fugitive dust emissions and minimize potential effects on air quality include:

- Reduced speed limits for vehicular traffic on roads.
- Application of dust suppressants to roads and all open surfaces and/or stockpile surfaces
- Regular application of dust suppression watering to control dust emissions during dry periods

Mitigation measures will be implemented during the operational phase of the Project as emission or nuisance dust sources are identified.

2.5.4.9 Noise Emissions

The major sources of noise at the High Lake Mine will be blasting and mine diesel-powered equipment. Other sources of noise will be operation of pumps, compressors, generators, front end loaders and service vehicles. Measures that will be implemented to mitigate noise pollution will follow applicable occupational health and safety standards and will include the following.

- Schedule noisy construction activities during normal working hours, as practicable
- Conduct regular maintenance of construction and operations vehicles and equipment to minimize noise emissions
- Install air inlet silencers and exhaust silencers on all combustion engines
- Construct noise baffles or enclosures for particularly noisy equipment

2.5.5 High Lake Surface and Groundwater Management

2.5.5.1 Surface Water Management Plan

The three key components of the water management system at High Lake include:

- surface water diversion system, including surface water diversion berms/ditches, and divider berms
- water holding pond
- water treatment plant

Best practices for the control of sedimentation in run-off water will be implemented during construction, including silt traps, silt fences, settling ponds and sumps, grease traps, and monitoring and pumping systems.

Non-Contact Water

Contact water will be minimized by intercepting surface runoff water before it enters the mine site. This will be achieved through strategically located cut-off ditches and berms. Non-contact water will be diverted around the mine site area and discharged directly to the downstream receiving environment.

Contact Water

Surface run-off that comes in contact with operations (contact water) will be collected in sumps, ponds, and ditches and transferred to a water holding pond to settle out suspended solids, particulate/colloidal-phase contaminants, and oil and grease. The holding pond will have sufficient storage capacity to accommodate seasonal variations in surface water as well as groundwater inflows to the mine excavation.

All contact water will be tested for contaminants prior to treatment and/or release. The quantity and quality of runoff will be monitored to ensure it complies with applicable direct discharge limits. Best management practices such as silt fences, sediment traps, and regular monitoring will be implemented to minimize erosion where construction, mining, and closure activities take place.

MMG is still investigating the potential discharge location and management plans options as well as environmental effects for a discharge point in either the Kennarctic River or High Lake. Any water will be treated before discharge.

2.5.5.2 Surface Water Management Alternatives

No alternatives to the proposed Surface Water Management Plan have been identified as it conforms to the highest industry standard best practices and regulations for managing surface water.

2.5.5.3 Surface Water Management Mitigation by Design

The Surface Water Management Plan will mitigate the risk of uncontrolled release of contact water to the receiving environment by intercepting, collecting, and treating such water by means of well-designed water control and containment structures (refer to section 12).

2.5.5.4 Surface Water Management Closure Plan

Post-closure water management at the High Lake Mine will commence immediately following closure and will involve collecting all contact water that flows from waste rock piles, both in the form of surface run-off and surface and shallow seepages. Contact water will be pumped to a holding pond where it will be treated in an effluent treatment plant and released to the receiving environment once it meets discharge criteria.

Once ARD/ML has ceased, the effluent treatment plant and associated infrastructure will be decommissioned and removed. Other structures such as the water holding pond, contact water collection ditch and sump system, and non-contact water diversion ditch system will also be decommissioned and removed.

2.5.5.5 Groundwater Management Plan

Groundwater management during mine operation will control, collect and treat groundwater inflows into the pits and underground workings and from other mine site areas.

The High Lake Mine is situated within a region of continuous permafrost, generally more than 400 m thick. Within continuous permafrost regions, groundwater flows may occur beneath the permafrost, within taliks (unfrozen ground beneath lakes and rivers within areas of continuous permafrost), in localized pockets within the permafrost zone, and in the seasonal shallow “active layer” (the surface layer above the permafrost that freezes and thaws seasonally). Shallow groundwater flows only occur in summer months within the “active layer”, which typically varies in thickness between 0.5 m to 4 m depending primarily on ground conditions. Localized groundwater pockets within the permafrost zone will tend to contain a small amount of water, and to drain out quickly and not to re-charge. Bedrock geology, permafrost, and taliks play a critical role in defining the deep groundwater flow systems.

Open pit mining at High Lake will be within permafrost and therefore only negligible groundwater flows into the excavation are anticipated.

The upper part of the underground mine at High Lake will be in permafrost, with no substantive inflow of groundwater expected to occur. Below 400 m, permafrost conditions do not exist and groundwater inflows are anticipated. Inflow quantity is likely to increase with depth of excavation, and decrease with time as local dewatering occurs. These effects will be modelled in subsequent phases of design and mine planning.

Based on experience from other northern sub-permafrost mining operations, groundwater quality is expected to be saline below sea level and to contain various dissolved metals.

Groundwater that flows into the open pits during mine operation will be collected in mine sumps, pumped to a water holding pond, and then pumped to a water treatment facility for treatment and release to the Kennarctic River or High Lake when discharge criteria are met.

Water pumped from the underground mine will be directed to a holding pond and then the effluent treatment plant. All discharge from the effluent treatment plant will meet discharge criteria prior to release to the receiving environment.

2.5.5.6 Groundwater Management Alternatives

No alternatives are known for managing groundwater at High Lake Mine.

2.5.5.7 Groundwater – Mitigation by Design

No mitigation by design has been identified that might eliminate or reduce groundwater flows into the mine openings.

2.5.5.8 Mine Groundwater Closure Plan

At closure, pumping and collection of inflowing groundwater to the underground mine will cease. Localized groundwater pockets will be depleted in advance of closure. Shallow groundwater inflows into the open pit from the active layer will be minimal and will tend to freeze quickly and are expected to remain frozen permanently.

2.5.6 High Lake Mine Water Requirements

Fresh water will be sourced from Lakes 4, 5 and 15 at High Lake Mine. Fresh water will be pumped through HDPE insulated and heat traced pipelines. Water will be received into a steel tank located inside a building at the mine complex. The upper half of the tank will supply potable and general mine water needs, while the lower half will contain fire-fighting water.

2.5.6.1 Potable Water

Potable water will be generated by treating fresh water in a potable water treatment system. The effluent treatment plant will consist of self-contained, pre-assembled modules.

2.5.6.2 Water Requirements Alternatives

No alternatives have been identified to meet water requirements at the High Lake Mine.

2.5.6.3 Water Requirements Mitigation by Design

The following features have been incorporated into the design of the Project to mitigate effects on surface water quantity:

- Recycling contact water for re-use in the crushing and screening plant and other operations at the mine
- Treating contact water in an effluent treatment plant and re-using treated water within the mine site rather than release to the Kennarctic River or High Lake

2.5.6.4 Water Requirements Closure Plan

Water management systems at the High Lake Mine will be decommissioned, dismantled and removed at closure.

2.5.7 High Lake Mine Waste Water and Other Wastes

2.5.7.1 Contact Water Treatment and Discharge

Contact water will be directed toan effluent treatment plant, which will precipitate oxidized metals and remove them by means of a high-density sludge system. The process will involve two tanks: one to receive input water and inject air, and the other for lime addition to raise the pH to precipitate dissolved metals. Treated water will be pumped to sedimentation ponds for solid-liquid separation prior to release to the receiving environment. As mentioned earlier, both High Lake and the Kennarctic River are considered a potential discharge point.

2.5.7.2 Sewage Treatment and Discharge

Sewage from the camps and maintenance facilities will be conveyed in heat traced insulated pipes to a pre-packaged sewage treatment plant. A rotating biological contactor sewage treatment system or similar system will be used.

During construction, treated effluent will be discharged to the Kennarctic River.

During the operational phase, treated effluent will be re-cycled within the mine operations for dust suppression and other non-potable uses or discharged to receiving waters. Sludge from the sewage treatment plant will be dewatered and either incinerated at High Lake mine or transported to Izok Mine and co-disposed with the dry stack tailings.

2.5.7.3 Grey Water Treatment and Discharge

Grey water will be directed either to an effluent treatment plant where it will be treated for re-use in the process plant as make-up water or treated and discharged to the receiving environment.

2.5.7.4 Solid Waste Treatment and Discharge

Domestic garbage will be collected on a daily basis, incinerated and buried in a landfill. Transfer containers for solid waste collection will be located throughout the mine site; these will be kept closed with animal resistant lids to reduce scavenging. Incinerators will be located within an electric-fenced area to prevent access by wildlife. A Waste Management plan will be prepared for the mine site.

Non-combustible solid waste including bulky items and scrap metal will be collected and disposed of in the waste rock pile or an engineered landfill within the High Lake catchment area. A site for the landfill will be selected during future studies.

2.5.7.5 Other Liquid Wastes Treatment and Discharge

Waste oil will be collected and incinerated or mixed with diesel that will fuel the diesel generators. Any contaminated snow will be transported to the water holding pond and then pumped to the water treatment plant. Empty barrels and fuel drums will be drained, cleaned and placed in a landfill.

2.5.7.6 Hazardous Waste Treatment and Discharge

Hazardous waste will be stored, handled and transported according to the Hazardous Waste Management Plan (refer to section 12). Hazardous materials will be placed in sealed metal 40 gallon oil drums, and shipped off site to a hazardous material treatment facility.

2.5.7.7 Water Treatment and Other Wastes Alternatives

No alternatives have been identified for water treatment or management of other wastes.

2.5.7.8 Water Treatment and Other Wastes Mitigation by Design

Design elements that mitigate the effects of water treatment and discharge at High Lake Mine include:

- Re-use of sewage treatment plant effluent, which will reduce make-up water requirements

2.5.7.9 Water Treatment and Other Wastes Closure Plan

At closure, all water treatment and discharge infrastructure not required for the post-closure water treatment will be decommissioned and removed. Infrastructure required for continued treatment of contact water during the post-closure phase will be decommissioned and removed once water quality meets discharge criteria without treatment.

2.5.8 High Lake Mine Facilities and Infrastructure

2.5.8.1 Infrastructure Elements

Permanent facilities and infrastructure at the High Lake Mine will consist of the following:

- Camp
- Offices
- Site Access Roads
- Surface water management structures
- Plant site services
- A truck shop for mobile equipment
- A warehouse
- A covered cold storage area and an open cold storage area
- An explosives storage and manufacturing plant
- Hazardous materials handling and storage facilities
- Container yard
- Diesel-electric generators
- Tank farm
- Power distribution system
- Airport
- Potable water treatment plant
- Sewage treatment plant
- First aid facility
- Emergency response facility

The mine complex was selected for its proximity to the ore body and suitability for Project infrastructure foundations. The site is approximately 600 m west of the open pits on a ridge of exposed bedrock with thin overburden soils.

Figure 2.5-3shows the layout of the High Lake Mine site and associated infrastructure.

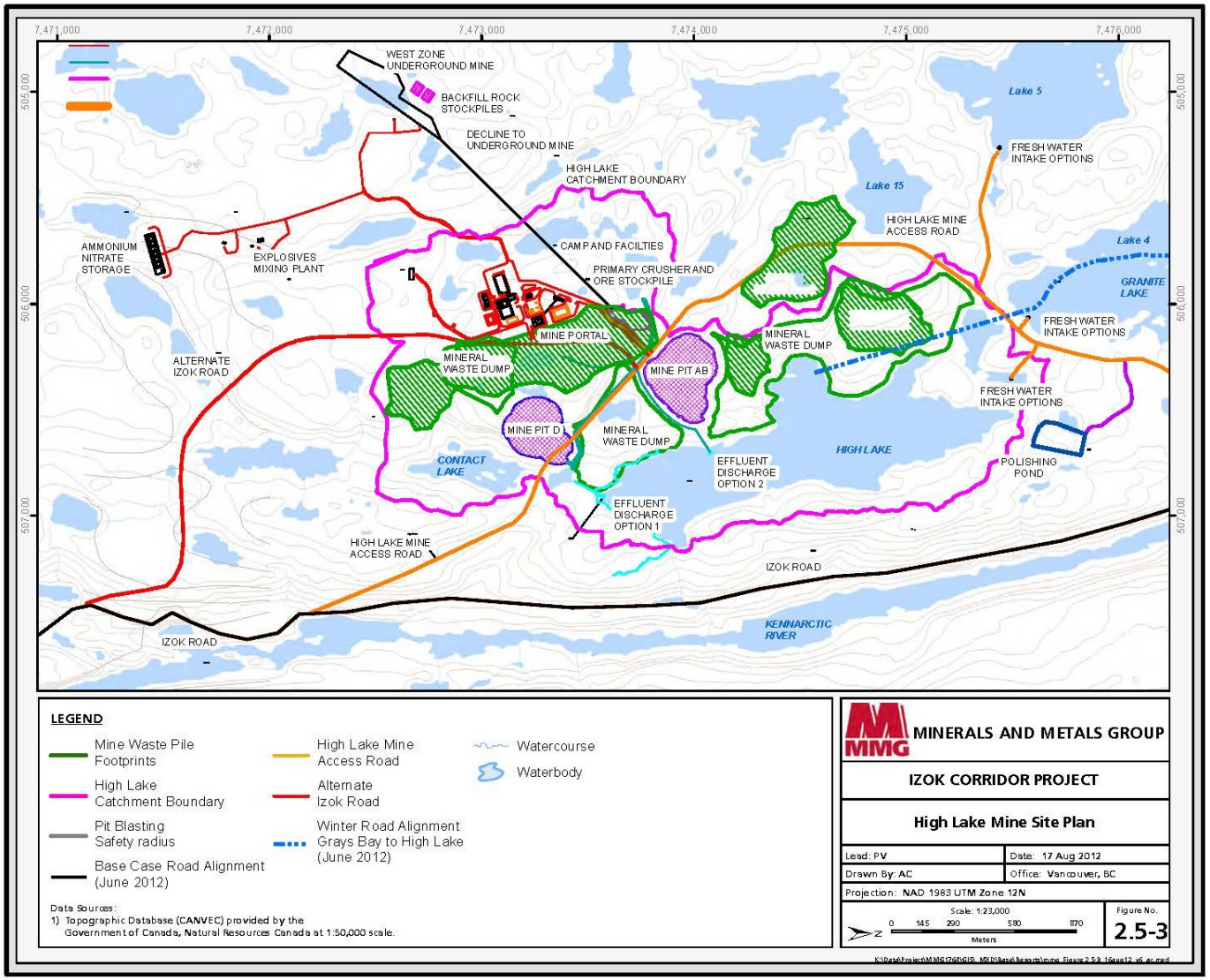


Figure 2.5-3 High Lake Mine Site Plan

2.5.8.2 Roads

Mine site roads connect all parts of the mine, and will be constructed of waste rock and surfaced with screened gravel.

2.5.8.3 Electric Power Generation

Electric power for the mine will be provided by diesel electrical generating units located in a power house at the mine complex. Power generation capability will be approximately 5 MW, including standby units with generation capability of 1 MW, which will be located adjacent to the camp complex for use in the event of a failure of the main system. Engine and exhaust heat will be recovered from the diesel generators for heating buildings.

2.5.8.4 Electric Power Distribution

Power distribution will be similar to the system described for the Izok Mine site (refer to section 2.4.10.6).

2.5.8.5 Mine Services

Services within the mine complex will be run within utilidors.

2.5.8.6 Fuel Systems

Approximately 7 ML of low sulphur diesel will be required annually for operations at the High Lake Mine. Diesel will be transported by truck to the mine site from the bulk fuel storage at Grays Bay port, and used for power generation and mobile equipment operation.

Diesel will be supplied from diesel storage tanks located near the service building and the diesel generators. The fuel system will comprise two diesel storage tanks plus required containers of gasoline and lubricants, which will all be located within a bermed area. Facilities will be provided for metering at the mine site tank farm.

Facilities will be provided for metered delivery to vehicles through a dispensing station with a 50,000 litre day tank in accordance with requirements of National Fire Code of Canada. Re-fuelling of vehicles will be conducted within a bermed area to contain any potential spills.

Diesel will be piped from the tank farm to a day tank at the diesel power generation equipment, which will be located in a power house within the mine complex area.

Other fuel types will include aviation fuel for helicopters. Helicopter fuel will be stored in 45 gallon steel barrels and annual consumption is estimated at 50,000 litres. It will be stored in a lined bermed area at the tank farm and moved on pallets as needed to a lined bermed area at the helicopter pad.

All fuel handling equipment, installations, and procedures will comply with Environment Canada's fuel storage system regulations (Storage Tank System for Petroleum and Allied Petroleum Products).

2.5.8.7 Airport

The High Lake Mine Airport may be located at Sand Lake, which is about 10 km due north of the mine in the Kennarctic River valley. It is a flat area with good visibility all around the site, is well drained and is the option located closest to the site. There is currently a modest airstrip at this site.

MMG is investigating other potential sites and will present a final selection with the DEIS. Potential locations for the airport are shown on **Figure 2.5-4**.

Infrastructure at the airstrip will include a building for waiting personnel, a small power generator set and air traffic navigation and guidance systems defined by the aircraft operator.

2.5.8.8 Accommodation

The accommodation complex (or permanent camp) will be located to the west of the open pits and will house 200 to 250workers during the construction phase and 100 to 200persons during the operations. It will include kitchen, laundry and recreation and training facilities. The camp will be installed early in the Project as part of the pre-construction activities, and will be of modular design to allow for expansion as the Project progresses. The proposed location of the camp takes into account potential sources of noise and dust emissions, distance from blasting in the mine, and the predominant wind direction. The camp facilities will include options for fitness and recreational facilities to attract and retain employees and to promote their health.

2.5.8.9 Communications

Communications between High Lake Mine and external locations will be by satellite. Communication within High Lake Mine will be by radio and a local phone system within the mine complex.

2.5.8.10 Explosives

Explosives and material for their manufacture will be transported to the High Lake Mine from the Grays Bay Port. Explosives will be packaged appropriately for transport and storage by the manufacturer and transported in sea containers. From the lay-down area at Grays Bay, containers of explosives will be progressively moved by truck to the High Lake Mine to be stored in magazines there until required for use. Transportation, storage and handling of explosives will comply with all relevant regulatory requirements (i.e., federal *Explosives Act* and the *Explosive Use Act* of Nunavut).

Explosives magazines at the High Lake Mine will consist of a fenced area sized to handle standard 6 m containers and 210 litre drums containing material for the manufacture of explosives. Blasting accessories are classed as explosives and bullet proof magazines will be installed and located approximately 1 km from buildings or roads.

A small emulsion manufacturing plant will be constructed at the mine site to prepare the emulsion-based explosive on an as-required basis.

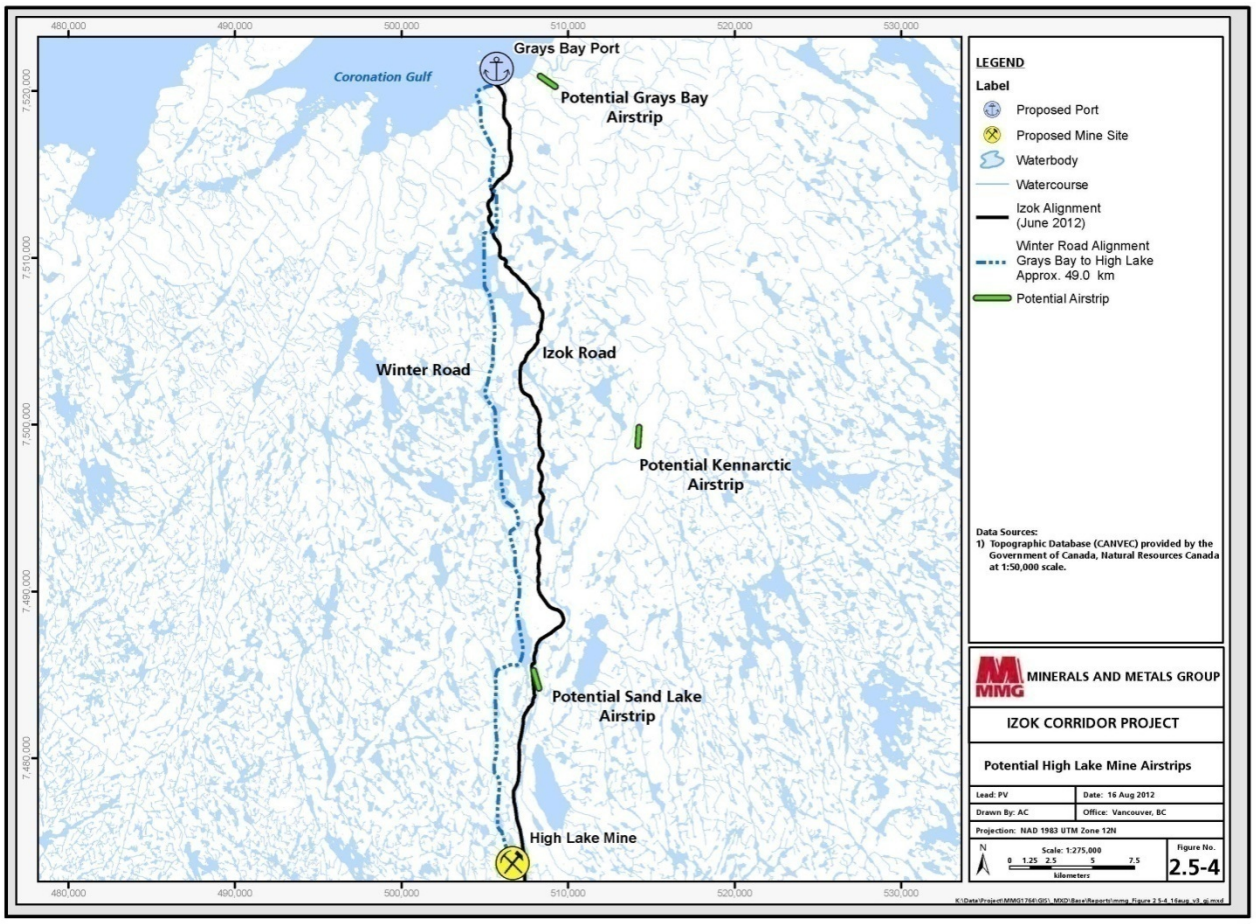


Figure 2.5-4 Potential High Lake Mine Airstrips

Emulsion consists of ammonium nitrate (AN) prills, water and emulsifiers. Ammonium nitrate will be handled in specially constructed containers of 20-tonne capacity. Emulsifiers will be shipped in steel drums. These products are not classified as explosives, but are classified as oxidizers and will be shipped and handled in compliance with regulations for such products and will be stored in a fenced outdoor area.

2.5.8.11 Hazardous Materials

The High Lake Mine and infrastructure will use a variety of chemicals and reagents classified as hazardous materials. Hazardous materials will be packaged in drums or bulk bags and shipped to mine in sea containers via barge or ocean bulk-carrier ships to Grays Bay port, or by air either to Izok Mine or High Lake Mine airstrip.

All hazardous material will be stored within original packaging and typically within the original shipping container and will be placed adjacent to the point of use, allowing for safe storage and ready access. A

full description of types, quantities, method of storage and containment, secondary containment measures, method of chemical transfer, and description of spill control measures for hazardous materials will be developed as part of the feasibility study.

2.5.8.12 Mine Infrastructure Alternatives

No alternatives to the currently planned mine infrastructure have been identified.

2.5.8.13 Mine Infrastructure - Mitigation by Design

By constructing only one processing plant at the Izok Mine site to process ore from both the Izok and High Lake mine sites, overall surface disturbance from the plant and associated tailings deposition will be minimized. Further, this will also reduce discharge from treated effluent from the High lake Mine and potential water quality issues.

With the exception of the Sand Lake airstrip, most of the infrastructure elements will be located within the High Lake catchment to avoid downstream environmental effects in the event of an accidental release of contact water or spilled material.

The general arrangement and juxtaposition of infrastructure elements in the Project design, minimizes the disturbed area.

2.5.8.14 Mine Infrastructure Closure Plan

At closure, all infrastructure at the High Lake Mine will be decommissioned, dismantled and removed.

2.6 Road Transportation

Road transportation for the Project will include a ~350 km all season access road linking Izok and High Lake mines with the port at Grays Bay ('Izok Road'), two temporary winter roads for construction of the mines (Izok to Contwoyto and High Lake to Grays Bay) and several lesser access roads between Project facilities.

Please note that MMG is undertaking additional studies in 2012 to refine and improve the all-season road route, including consideration of alternative alignments for some segments, and that changes might result from this additional work.

2.6.1 Winter Roads

2.6.1.1 Izok-Contwoyto Winter Road

Materials and equipment required for construction of the Izok Mine will be transported from Yellowknife to site via the Tibbit-to-Contwoyto Winter Road (TCWR), requiring re-establishment of a winter road segment linking the Izok Mine site and Contwoyto Lake (**Figure 2.6-1**) for a few years. The TCWR is operated from February to April by a Joint Venture of the diamond mines in the Lac de Gras region of the Northwest Territories. The junction of the TCWR and the Project winter road will be located either near the Lupin Mine or the Jericho Mine.

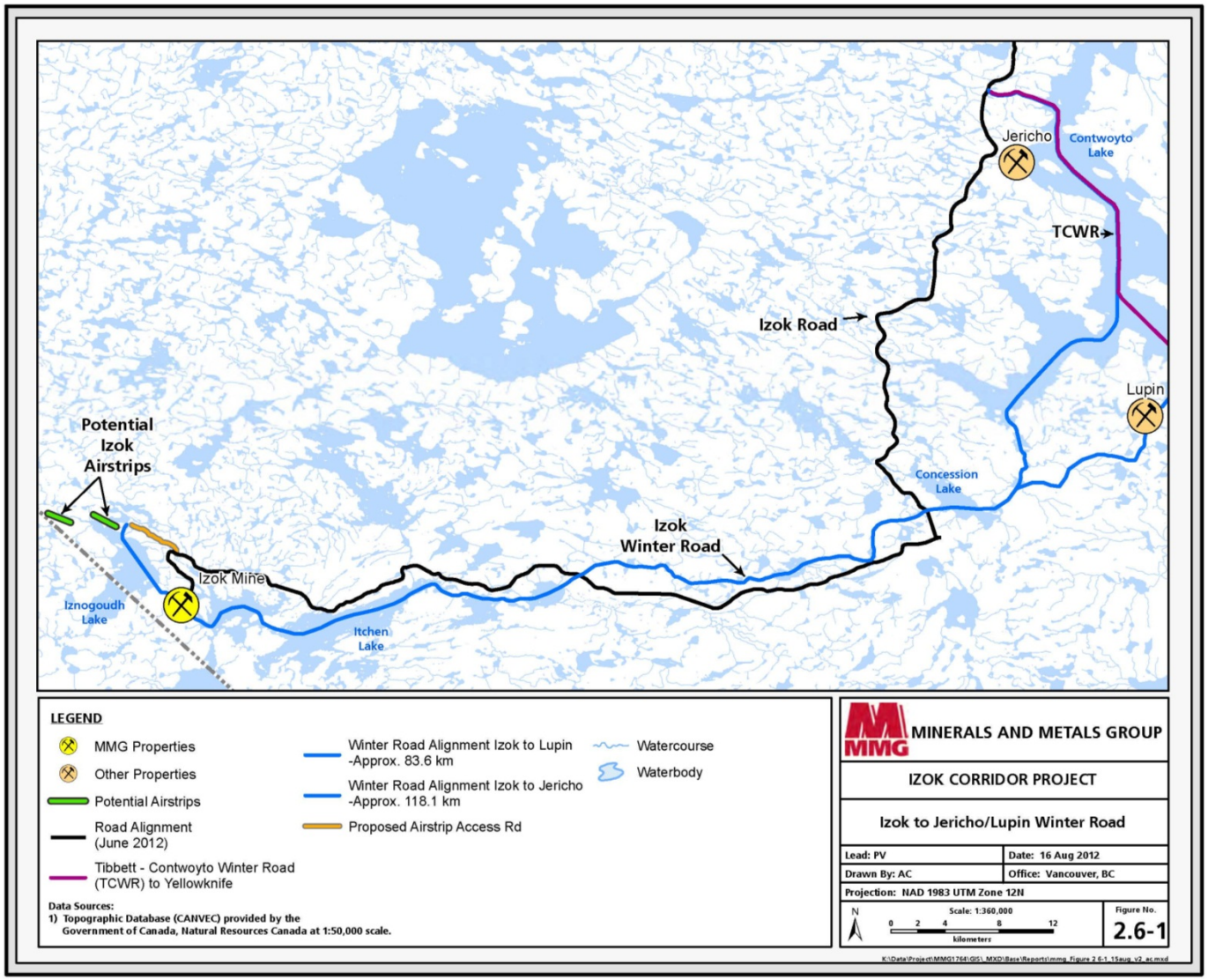


Figure 2.6-1 Izok to Jericho/Lupin Winter Road

Note that a winter road linking Lupin Mine and Izok Lake was constructed and used in previous years (it has been used previously to support MMG exploration programs). The winter road into the Izok Mine will be operated each winter for several years prior to completion of Izok Road. Winter road construction and management of road operations and traffic patterns will be consistent with best management practices in place for the TCWR.

The alignment of the Izok-Contwoyto Winter Road will be selected by personnel experienced in winter-road construction and operation. The route will follow frozen lakes and watercourses to the extent practical to minimize the length of on-land segments. Where these waterbodies are fish-bearing, road construction and management will be undertaken in accordance with DFO guidelines to avoid disturbance of fish habitat.

2.6.1.2 Grays Bay to High Lake Winter Road

A winter road from Grays Bay to High Lake Mine will be developed and operated annually during the construction phase of the Project to transport equipment and materials required for constructing the High Lake Mine, and to facilitate construction of Izok Road (**Figure 2.6-2**)

2.6.1.3 Water Management and Use

During winter road operation, it may be necessary to add water to the roadway to maintain or increase the thickness of the snow/ice embankment. Water will be drawn from previously selected waterbodies situated along the proposed road alignment following best management practices and within allowable water withdrawal limits. Where these lakes are fish-bearing, water withdrawal will be consistent with DFO guidelines. Water will be spread on the road using best practices and low ground pressure equipment.

Winter road alignments will not follow creek channels but will cross them occasionally. Where streams are crossed, particular attention will be given to ensuring that natural flow patterns during spring freshet are not hindered.

2.6.2 Izok Road (All-Season Road)

2.6.2.1 Overview

A ~350 km all-season access road ('Izok Road') will be constructed between the Izok Mine and Grays Bay Port to transport concentrate from the processing plant at the Izok Mine to the port and to backhaul ore from the High Lake Mine to the processing plant (Figure 2.6-3). Izok Road will also be used to transport personnel, fuel, cement, explosives and other mine supplies from the port to the mines. Although the majority of resupply materials to the Izok Mine will be via the port and Izok Road, there may be occasions when some re-supply is required from the south via the TCWR during winter. More information will be provided in the DEIS.

The exact length of the road may change slightly as studies are ongoing in 2012 to optimize the route. MMG is using 350km as an approximate length of the road but efforts to reduce this are ongoing.

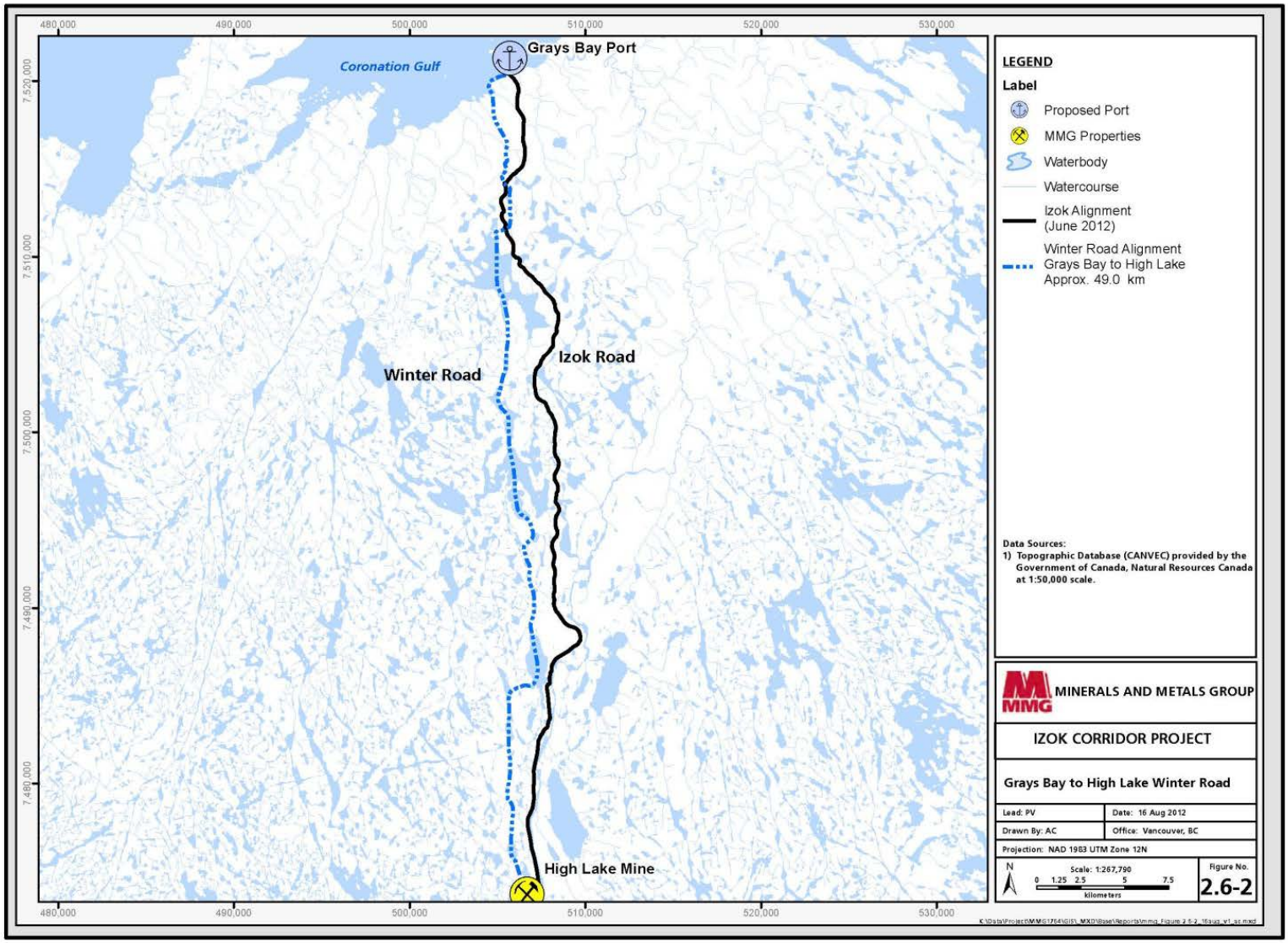


Figure 2.6-2 Grays Bay to High Lake Winter Road

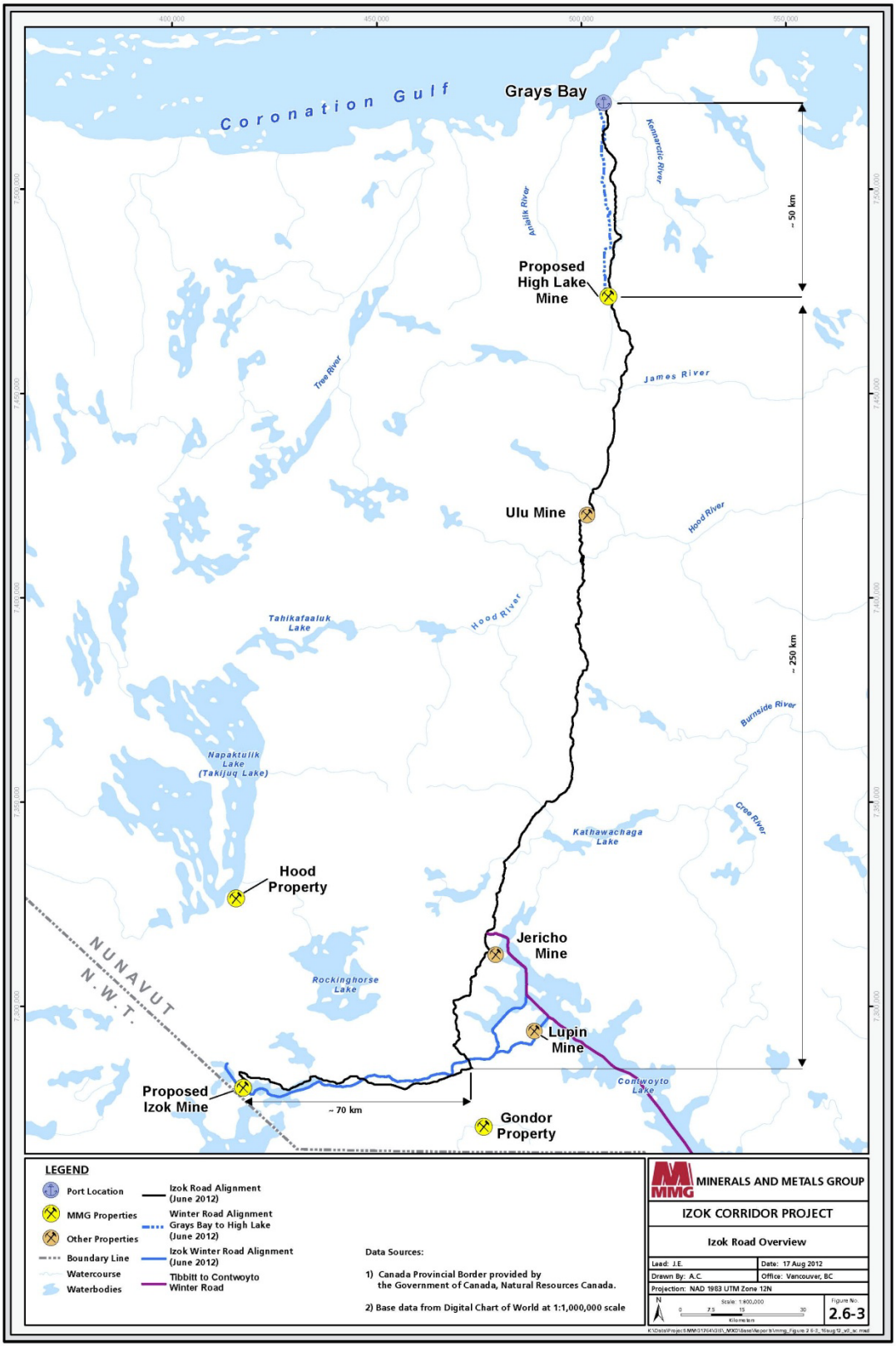


Figure 2.6-3 Izok Road Overview

2.6.2.2 Route Selection

The proposed route of Izok Road is based on available topographic information and preliminary route reconnaissance completed in 2007, 2008 and 2012. Environmental and archaeological studies have also been undertaken, as well as preliminary identification of potential sources of granular fill and rock quarries.

The ongoing feasibility study will include more detailed road design work and changes to the current alignment will be made to optimize the route. Key road design considerations will include minimizing the length and number of stream crossings, optimizing the use of road building material sources and avoiding disturbance of ground ice and permafrost.

As noted earlier, MMG is considering alternate route alignments for two segments of Izok Road based on information gathered during the feasibility study. The alternate segments are as follows.

- South Rockinghorse Segment: Izok Mine – south of Rockinghorse Lake – connecting to the base case route north of the Jericho Mine (77 km)
- Grays Bay Access Segment: High Lake – Grays Bay running east of the base case road alignment (36 km)

These alternative route alignments (**Figure 2.6-4**) are being considered due to MMG's interest in reducing haul distances, minimizing the number and lengths of streams crossings, avoiding challenging terrain features, reducing the potential for wildlife interactions, and increasing road user safety.

Conceptual design work and environmental baseline investigations are planned for the summer of 2012. These alternative route alignments will be further considered during the feasibility planning process and may be carried forward into the DEIS. However, MMG's objective is to have a final route selected by Q1 2013 and presented in the DEIS.

2.6.2.3 Izok Road Design Basis

The design basis for Izok Road includes a variety of engineering and environmental considerations and a particular focus on addressing the challenges of constructing, operating and decommissioning an all-season road in the arctic. Wind, snow, ice, drainage, fog, permafrost, light conditions and of course safety are all considerations when designing a road in the north.

Key Design Considerations

The following are key design considerations for Izok Road.

- Health and safety
- Minimize disturbance of ice lenses and permafrost
- Identify the optimum route for constructability and operation, including snow and ice management
- Design water crossings to minimize stream crossings and their effect on fish passage and habitat

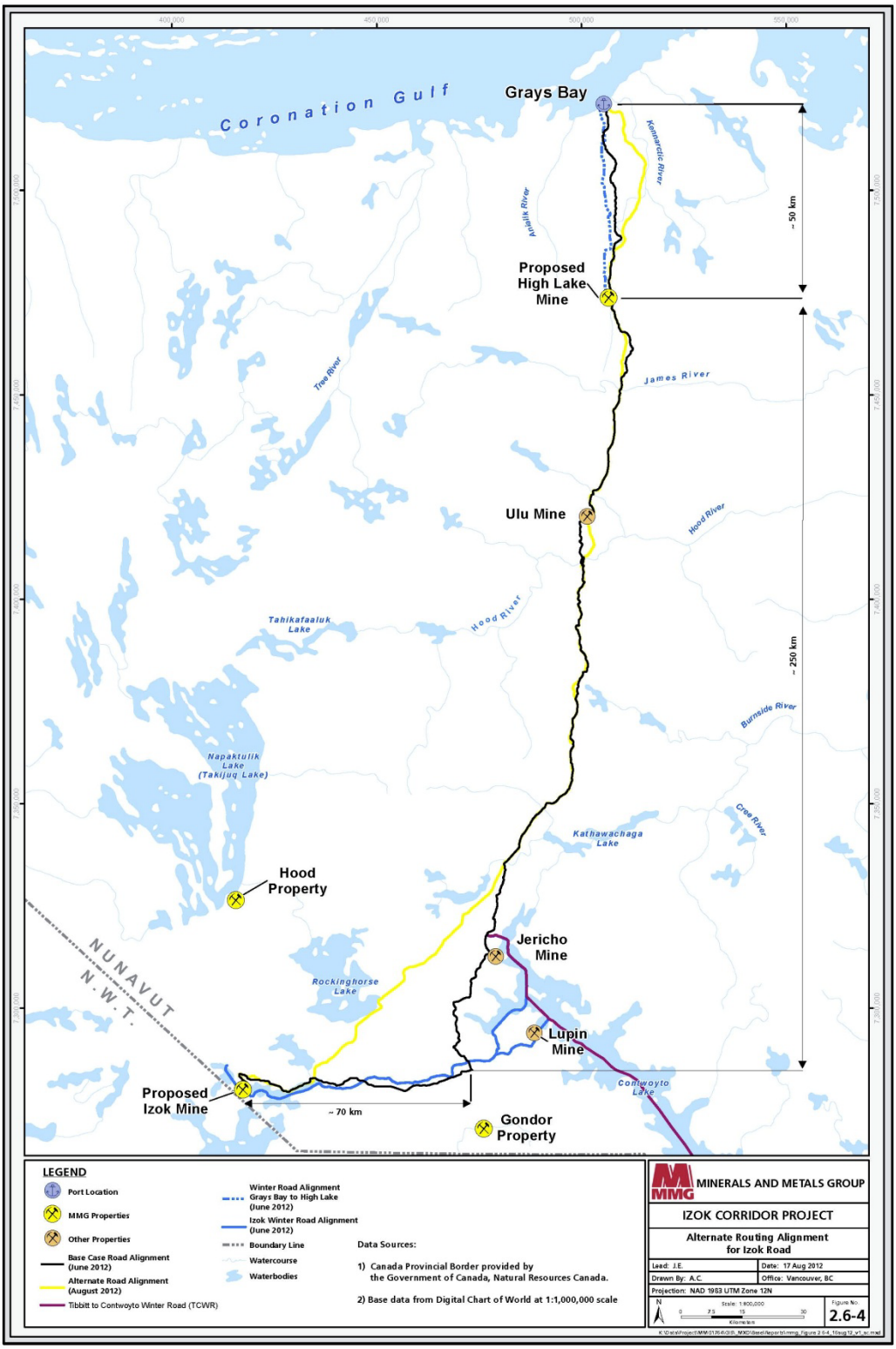


Figure 2.6-4 Alternate Routing Alignment for Izok Road

- Site borrow areas and quarries to minimize adverse effects on environmental and cultural values
- Identify suitable locations for wildlife crossing structures (e.g., caribou and other ungulates movement)
- Design road embankment heights to prevent visual obstructions and ease of caribou crossing
- Use of adequate materials on road surface and slopes to create a good travel surface for caribou crossing

Road Alignment

Ground conditions along Izok Road alignment are typically moraine (tills) with a bouldery surface and exposed frost-shattered bedrock. Some glaciofluvial outwash and esker complexes are also present. Marine and glacio-marine sediments are crossed as the route approaches the coast. Permafrost is continuous along the entire route with ground ice contents varying depending on terrain. Taliks of different sizes are expected under the numerous water bodies.

Between the Izok Mine and approximately 70 km to the east, the alignment generally follows smooth ground moraine, with gentler slopes. From there, the north-south section of the road alignment is quite rugged, with rock outcrops, substantial microtopography, and many stream crossings. The alignment has been adjusted to avoid difficult terrain and topography wherever possible.

The road alignment crosses many minor diffuse drainage paths that are dry for much of the year. Where it can be demonstrated that fish will not be affected, crossings of these diffuse drainages will be constructed with open-graded rock fill that is porous and will not interrupt overland flows. Crossings of other watercourses will be constructed using current best practices and in accordance with DFO's operational policy guidance for crossing structures for fish bearing watercourses. River crossings will be single or multiple-span bridges.

2.6.2.4 Key Geometric Parameters

The following is a summary of the preliminary geometric parameters for Izok Road.

- Road width of either 7 m (single lane) or 9 m (dual lane)
- Minimum horizontal curve radius of 170 m (super elevation of 4%)
- Desirable maximum vertical grades of 8%
- Single-lane bridges, approximately 5 m to 6 m wide and possibly 9 m wide in difficult conditions

2.6.2.5 Embankment Height and Side Slopes

Surficial soil, permafrost conditions and topography are controlling factors in determining the embankment height for design purposes. Terrain conditions along the road corridor are generally considered to be rugged with a high degree of variability. Surficial soil conditions will be interpreted based on field observations, mapping and photographs and used to determine appropriate design for embankment height.

Side slopes will be designed based on ground ice and surface water conditions. Modifications will be made at segments selected for caribou crossings. **Figure 2.6-5**shows a typical road cross section.

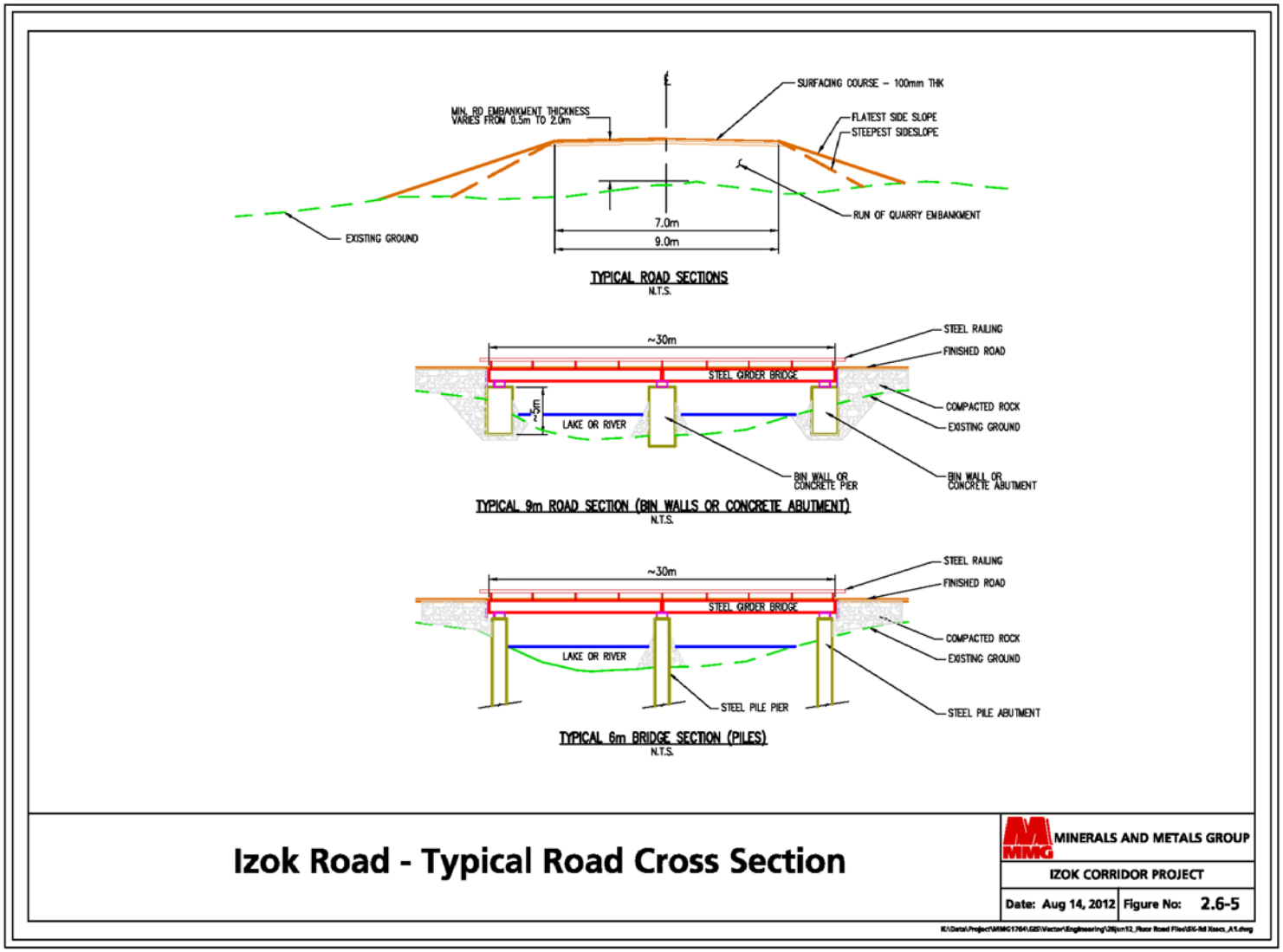


Figure 2.6-5 Izok Road - Typical Road Cross Section

2.6.2.6 Caribou Crossing Considerations

The Bathurst Caribou Herd moves through the Project area in concentrated groups each spring en route to calving grounds north of Contwoyto Lake, resulting in large numbers of caribou crossing the proposed alignment of Izok Road (refer to section 5.3.7.2 for additional details). Caribou crossing structures will be incorporated in the road design in areas of preferred habitat and at known crossing locations in order to facilitate continued caribou movement. The portion of Izok Road from the Jericho Mine to the Ulu Mine has historically been the area that has experienced the largest caribou movements in the past, and is expected to require multiple crossing. The need for crossings may be minimized at locations where topography and road design allow for relatively minimal grade on side slopes.

Road design considerations to facilitate continued caribou movement include:

- Embankments designed within minimal side slopes wherever possible
- Slope surface should be a relatively smooth and compacted
- Road width should be similar to that elsewhere on the road system
- The length of crossings may be variable; longer or more frequently situated crossings will be required in high-movement areas

2.6.2.7 Stream Crossings

For fish-bearing streams, crossings will be clear span structures consistent with DFO's operational policy guidance (i.e., bridges constructed entirely outside the upper water level or a culvert with footings situated outside the high water level of the channel). For non-fish bearing watercourses, wet lowlands and seasonally moist areas, a rock fill approach (placement of large rock material directly on the existing ground at the base of a road and embankment) may be used which will allow free drainage and maintain hydraulic function.

Current plans for Izok Road specify approximately 60 single-span bridges ranging from 10 m to 40 m in length, 10 multi-span bridge structures, and 80 major culvert and rock fill locations. Several additional culverts and rock fills will be installed along the road to ensure proper drainage through the embankment during freshet and other high flow events. Further information will be provided in the DEIS.

Figure 2.6-6 through **Figure 2.6-9** are conceptual illustrations of water crossings along the proposed Izok Road alignment. Crossing specifications and locations will be confirmed as road design continues during the feasibility study.

Appropriate erosion and sediment control measures (silt fences, flow checks in ditches, erosion control blankets and or seeding and mulch on exposed earth slopes) will be utilized to prevent adverse effects on watercourses and aquatic life during construction and operation of the roadway. All in-stream works will be conducted during acceptable time windows to avoid or reduce potential effects on fish (and raptors and other biological activities as relevant or related to road construction).

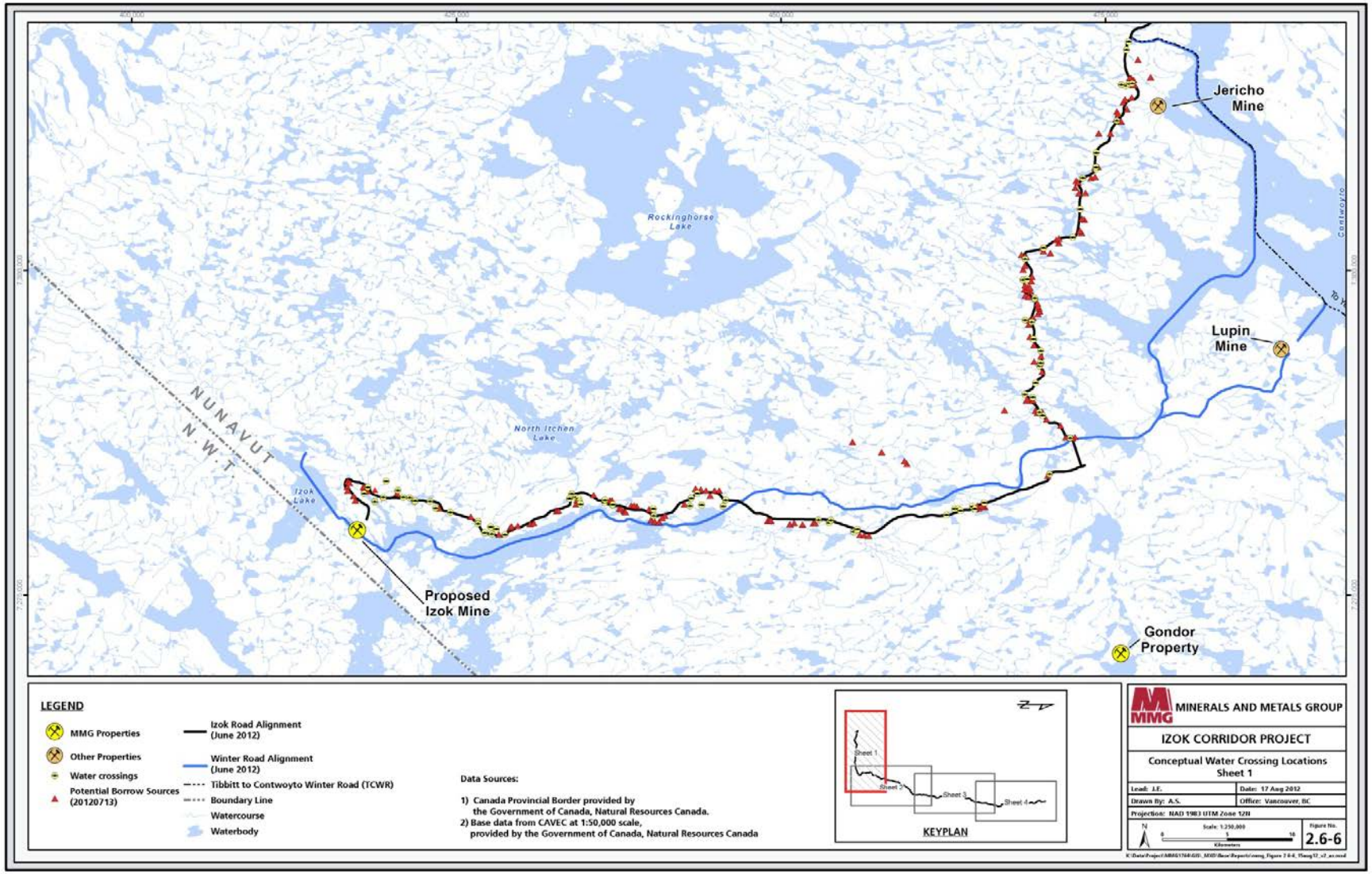


Figure 2.6-6 Conceptual Water Crossing Locations – Sheet 1

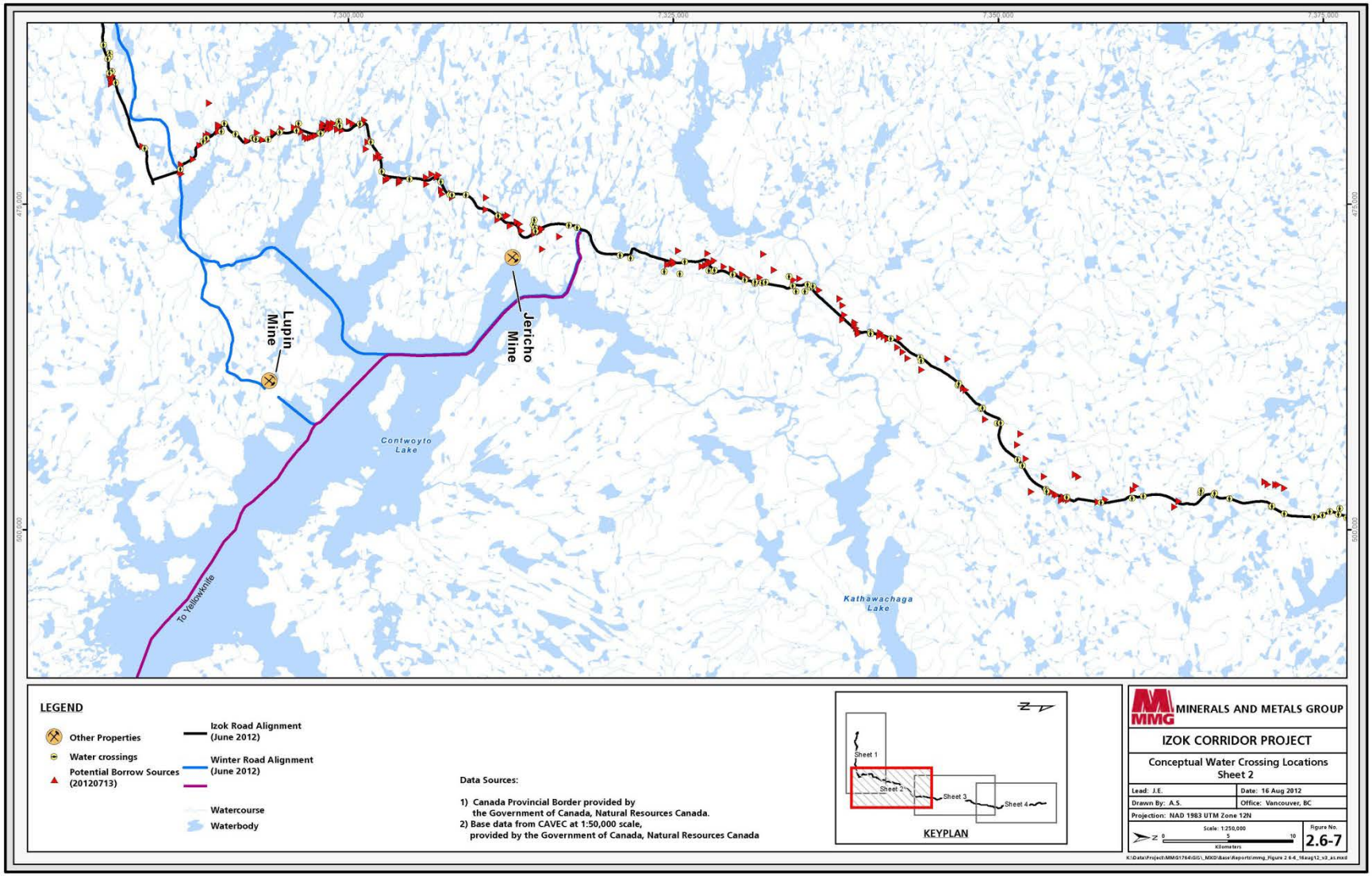


Figure 2.6-7 Conceptual Water Crossing Locations – Sheet 2

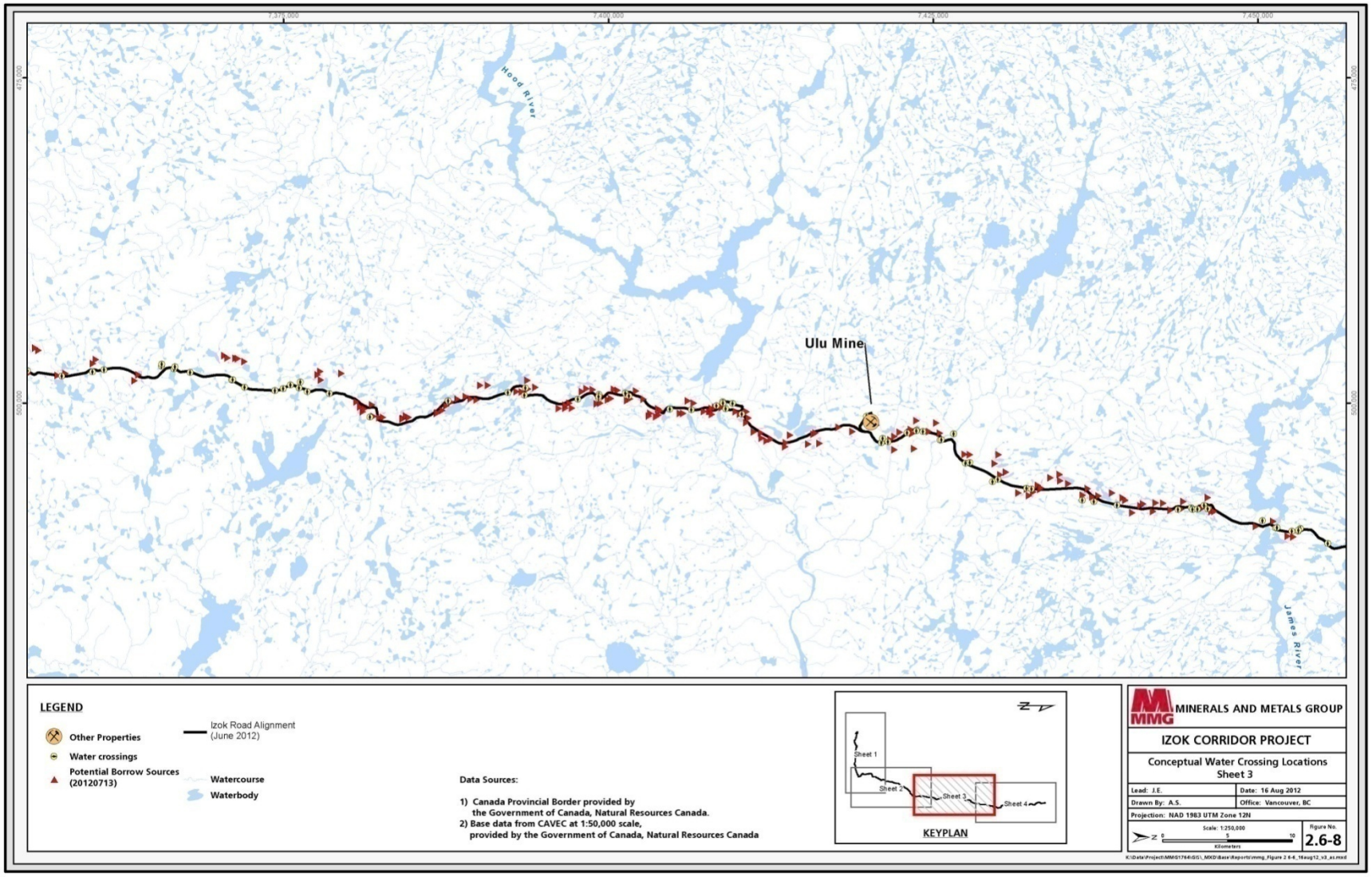


Figure 2.6-8 Conceptual Water Crossing Locations – Sheet 3

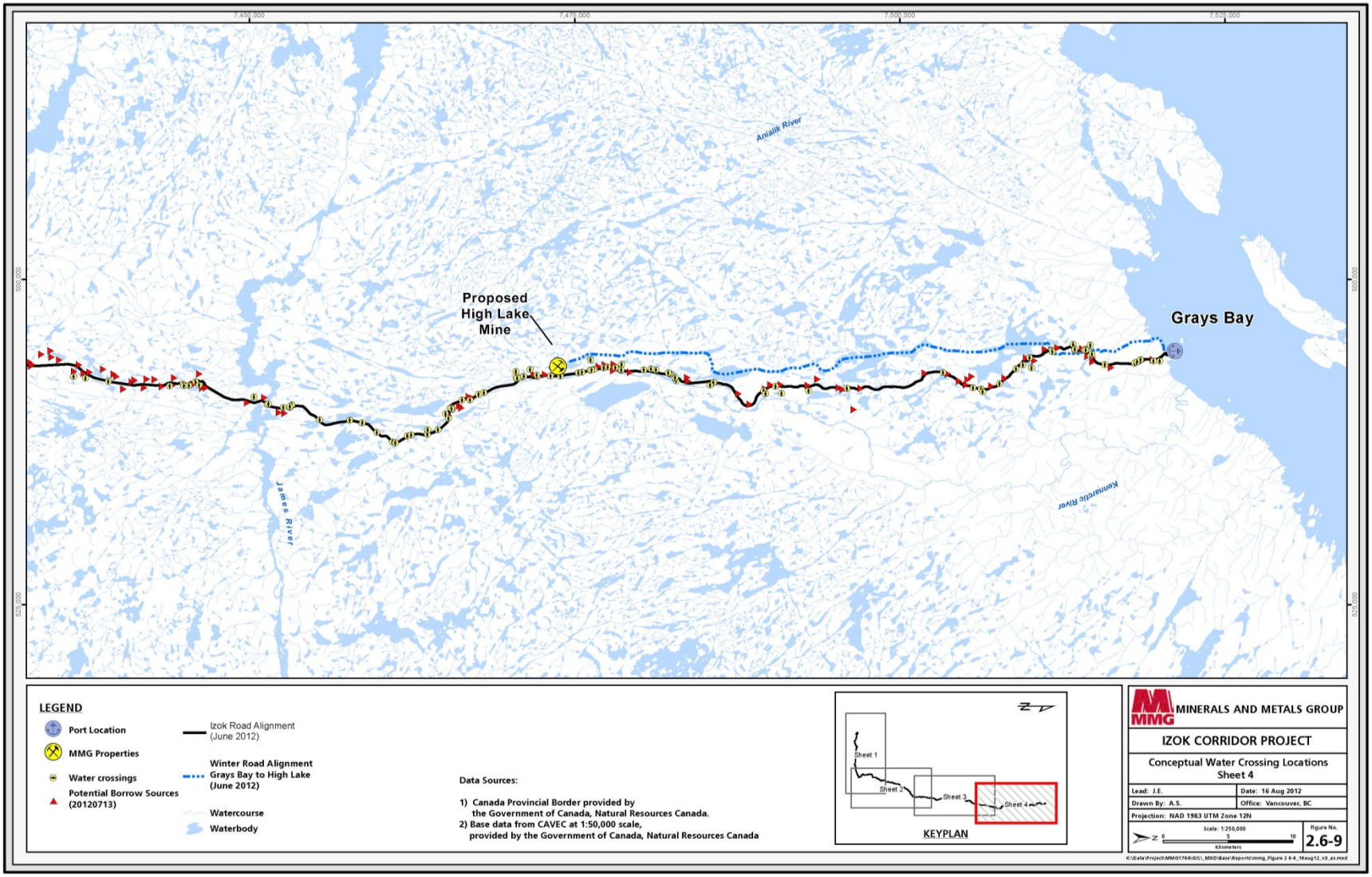


Figure 2.6-9 Conceptual Water Crossing Locations – Sheet 4

2.6.3 Road Construction

Construction of Izok Road will likely require two to three years depending on the level of effort and the construction staging plan to be developed as the engineering program proceeds. This schedule will also be affected by the issuance of permits for pre-construction activity and MMG's ability to mobilize material and equipment in 2014 and 2015.

At this time, MMG plans to initiate the construction concurrently from three to four strategically located starting points (or headings) along the length of the proposed road alignment. These headings will be areas that can be used to stage equipment and supplies in advance of construction. Existing facilities such as the Ulu project, Lupin or Jericho mines, or nearby sites, that can be supplied via winter road are good potential candidates, as is the proposed port location at Grays Bay that could be supplied via sealift during the summer open water season. MMG will discuss such arrangements with the owners of those sites, or find alternate sites, as planning progresses. Some of these facilities have adjacent airstrips that can also be used as necessary.

Construction activities will continue year round, with the possible exception of December and January when there is extreme weather and limited daylight or if concentrations of caribou are passing through one of the construction areas. There may also be changes to work contemplated near caribou crossings and calving activity, or any other sensitive biological activity. Wildlife and traffic management plans will be prepared for the construction phase of the Project.

Wherever possible, construction activities, quarries and borrow sources will be confined to the proposed road alignment to limit the area of disturbance and related effects on wildlife and habitat. Quarry and borrow sources will typically be located at 5 to 10 km intervals along the alignment and the locations of these sites and characteristics of materials will be confirmed during the road design process. Rock fill and granular material will be used for embankment construction. Cuts through ice rich soils will be avoided to maintain ground stability.

Rock and aggregate material will be sourced from quarries and approved sand or gravel deposits. During summer months, access trails to these material sources will be constructed with embankment material to minimize effects on the tundra. This technique will also be used to build pioneer roads within the final road alignment to access the bridge sites.

Culverts and bridge structures will be prefabricated and shipped to the nearest mobilization point and then transported along the newly constructed road or pioneer road to the crossing location. Bin wall (or similar type) abutments for bridge structures will be assembled on site. Small span bridges can be transported and launched as a complete unit (decking may be added on site). Larger or multi-span bridges will be transported in segments, assembled on site and launched. Major bridge structures may require more substantial abutment foundations (piles) or in the case of a multi-span structure, in-stream pier construction.

2.6.3.1 Construction Materials

The majority of Izok Road will be constructed with blast rock sub-base topped with aggregate granular base. Sources of road construction materials will be obtained from widening road cuts, glaciofluvial deposits, selected esker sands and gravels (wildlife habitat and archaeological issues will be considered),

and quarried rock. Sources of granular fill will be pre-screened through site investigations to avoid the use of potentially acid generating (PAG) materials in the road base. Dust suppression measures will be applied during construction and during placement and compaction of granular materials.

Borrow sources and quarries will be located as close as possible to where the material is required and portable rock crushers will be utilized during construction to minimize haul distances for gravel and rock. Figures 2.5-6 to 2.6-9 show the potential locations of quarry and borrow sources.

During rock and aggregate production, site operations will adhere to legislation and best practices applicable to migratory birds, protected wildlife, endangered species and species at risk.

A rehabilitation plan will be prepared and approved prior to operations at each pit or quarry.

2.6.4 Road Operation

2.6.4.1 Haul Trucks

Industrial haul trucks with sealed covers will be used to transport concentrate from the processing plant at the Izok Mine to the Grays Bay Port and will also be used to backhaul ore from the High Lake Mine to the processing plant (**Figure 2.6-10**). The general area is quite windy and this measure is needed to prevent loss of concentrate and minimize the risk of concentrate dust affecting vegetation, wildlife, soils and water.

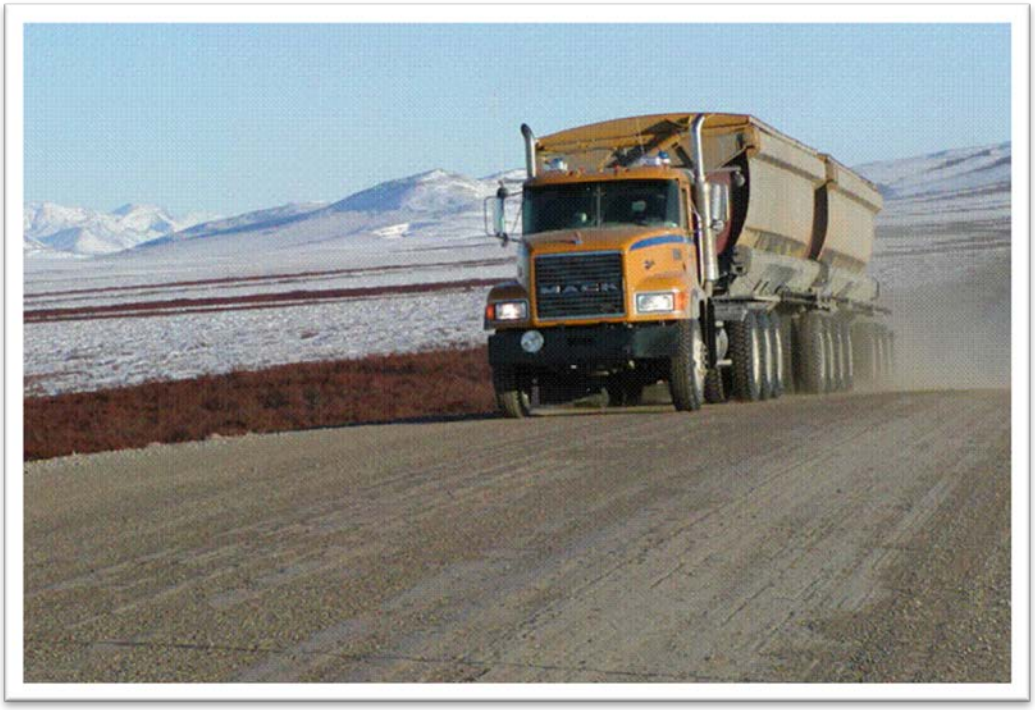


Figure 2.6-10 Example of a Haul Truck

Speed limits and traffic management procedures will be established to allow for efficient movement of concentrate, ore, fuel and supplies while ensuring safe operations for all weather and road conditions and minimizing the potential for collisions with wildlife, particularly caribou. A Traffic Management Plan and a Wildlife Management Plan will be prepared in consultation with HTOs and other stakeholders to ensure that mitigation and management measures appropriate for the local conditions are identified and implemented.

2.6.4.2 Vehicle Usage and Traffic Volumes

It is anticipated that Izok Road will operate 330 days per year, providing an allowance for up to five weeks of road closure or traffic limitations due to inclement weather, road repairs or to avoid/mitigate potential effects on wildlife, particularly calving related movement of the Bathurst Herd across Izok Road and Dolphin and Union Herd movements near the Grays Bay Port.

A total of approximately 6 million "wet" tonnes of concentrate will be hauled from the Izok Mine site to the port, or an average of 500,000 tonnes per annum (tpa) over the 12-year production phase. "Wet" tonnes refer to concentrate with the appropriate moisture content, not a saturated product.

Approximately 570,000 tpa of ore will be back hauled from the High Lake Mine to the processing plant at the Izok Mine site. This ore backhaul process will require an average of 15 round trips per operating day by haul trucks moving concentrate north from the Izok Mine site to the Port and then returning empty to the High Lake Mine site, taking on a load of ore and returning to the Izok Mine. At a speed of 80 km per hour, it would take one truck 6 hours to travel from Izok to Grays Bay. Obviously, this may change based on weather, visibility, road surface conditions and other speed consideration related to safe operation or wildlife and traffic management plans.

As well, road traffic of any kind will be affected by road closure: if for example, if the road is closed for a period of two to three weeks, traffic will need to be increased at other times to make up for the lost concentrate transportation. MMG will be preparing more accurate and more detailed traffic plans in conjunction with maintenance schedule, Wildlife Management Plan and in consultation with other operators in arctic conditions to establish thresholds for safe road use (fog, wind and temperature for example).

The Project's fuel and non-fuel cargo will be hauled to the Izok Mine and the High Lake Mine from the Grays Bay Port in road tankers and on container trucks. In addition, a small number of passenger and service/maintenance vehicles will use Izok Road. The total traffic volume on Izok Road is expected to be approximately 25 round trips per operating day.

2.6.4.3 Road Maintenance

Periodic maintenance of roadway surfaces and embankments will be required to repair defects and maintain the road surface. These maintenance activities will be conducted using conventional construction equipment, including graders, bulldozers, haul trucks and loaders. It is anticipated that road maintenance facilities will be established at the Izok Mine and at the Port. Road maintenance camps may also be established at High Lake and/or another intermediate location.

Culverts and bridges will be regularly inspected, particularly preceding and during spring thaw and freshet. Road dust will be managed using water from nearby sources, but suppressants such as calcium chloride may be considered during operation of the roadway when required.

2.6.4.4 Road Access

Road access, including potential use of the road by the public or other industrial users will be addressed in a Traffic Management Plan to be developed for the Project (see section 12).

At this time, MMG is planning to build, operate and maintain the all-season access road using its own resources and solely for Project use. Accordingly, MMG will assume full responsibility for construction, operation, maintenance and eventual closure and reclamation of this road. In the future, MMG may consider entering into agreements with other parties regarding shared use of the road, assuming that road-related safety risks can be managed effectively and any business risks related to road capacity and schedule can be addressed in manner that does not hinder the economic viability of the Project.

2.6.4.5 Emergency Management

Safety and preparedness for potential vehicle collisions and spills will be paramount and addressed in MMG's Spill Prevention and Emergency Response Plan. Implementation will occur prior to the start of construction, including training of staff and contractors and deployment of spill response equipment and supplies. In the event of a spill, a Spill Response Team will attend the site with appropriate containment and collection facilities. Any contaminated soil will be collected and disposed of in an appropriate manner.

Procedures will also be established for monitoring vehicles in transit and controlling traffic during inclement weather or when wildlife migrations necessitate vehicle movement restrictions. These and other traffic management measures will be detailed in MMG's Traffic Management Plan.

2.6.4.6 Road Safety

Izok Road and the mine access roads will be cleared of snow as required to maintain trafficable conditions. Road clearing operations will be carried out in manner that avoids obstruction of major watercourses and maintains identified caribou crossings. Major consideration for road safety will include:

- Snow clearing/stockpiling
- Freshet and hydrological conditions at crossings
- Pullouts for snow storms, vehicle breakdowns and bridges
- Monitoring vehicles for bad weather and wildlife movements
- Radio communications, signage, speed limits
- Additional procedures will be developed in 2012 and 2013 after consulting with operators in arctic environment

2.6.5 Alternatives Considered

Previous studies have considered several options for developing the Izok and High Lake deposits and transporting concentrate to processing facilities in Europe, Asia or North America. The only option that was financially viable was to develop the two deposits concurrently, process ore at a single facility and link them by road to a port on the Coronation Gulf.

Other options, including a road from the Izok deposit to a port site east of Kugluktuk and a road linking the Izok deposit to a proposed port at Bathurst Inlet were ruled out because they do not allow for efficient development and transportation of the mineral resources at High Lake.

In addition, the Bathurst Inlet Port and Road (BIPR) is a longer overall hauling distance and requires a crossing of Contwoyto Lake, by ice road in the winter and barge in the summer and would require concentrate haulage to cease during spring thaw and winter freeze up.

Other transportation options considered included truck hauling on winter road to railhead in the Northwest Territories and a slurry pipeline to a port at Grays Bay. These were also eliminated due to the costs of such options.

2.6.6 Road Reclamation

Upon closure, Izok Road between Grays Bay and the Izok Mine will be decommissioned and reclaimed in accordance with Nunavut guidelines. All bridges and culverts will be removed. Appropriate erosion and sediment control measures will be utilized during the removal of these structures. The road will be restored to stable conditions and pre-existing natural drainage patterns will be restored.

2.7 Grays Bay Port

2.7.1 Port Infrastructure

The port and related infrastructure will be located in Grays Bay (**Figure 2.7-1**) in the Coronation Gulf, approximately 330km northeast from the Izok Mine site, and 50 km north of the High Lake Satellite Mine site. It is located 179 km east of Kugluktuk and about 2.5 km west of the mouth of the Kennarctic River.

The port will consist of two main components:

1. Land-based infrastructure such as the concentrate storage building, fuel storage and laydown area, camp and administration office
2. The dock itself, which will have a footprint in the marine environment

While land-based activities at the port such as transport of fuel, concentrate and supplies will be year round, marine activities will be limited to the ice-free months in Coronation Gulf (roughly from mid July to mid October) when fuel and supplies for the Project will be delivered and the concentrate will be loaded and transported by bulk-carrier ships. This may also involve barge traffic.

At this time, MMG does not plan to break continuous land fast ice. Ice floes will be moved or broken by an ice breaker as needed during the months of July to October (refer to section 2.7.3 for more information).

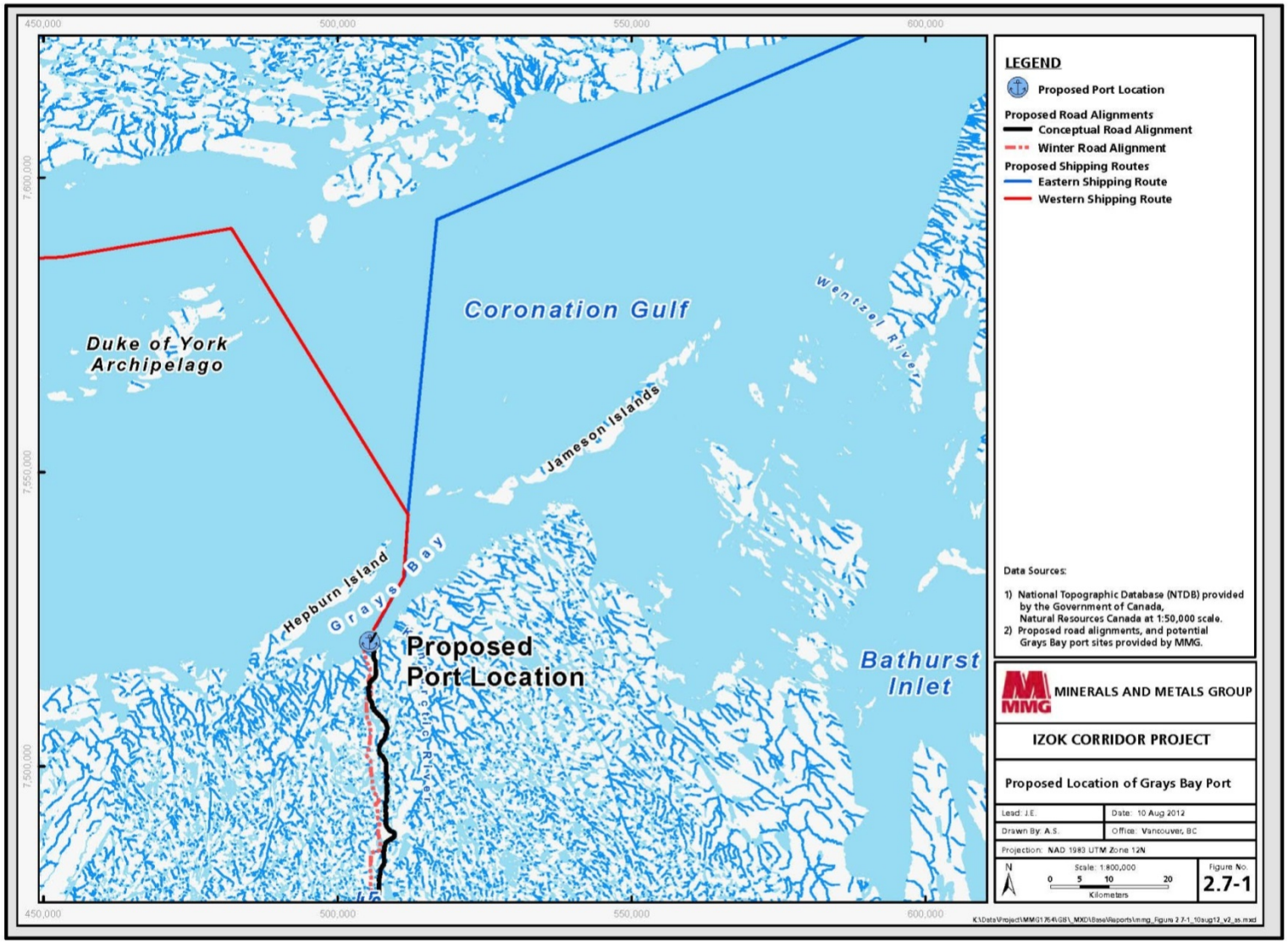


Figure 2.7-1 Proposed Location of Grays Bay Port

The selected location for the port is a rocky promontory which meets the needs for a deep-water approach for shipping, a steeply dipping shore for bringing ships close to land, and suitable land area for constructing the land-based facilities (**Figure 2.7-2**). There is also a gently sloping shoreline on the west site of the rocky promontory appropriate for barge landing. The chosen port site is the shortest distance from the High Lake Mine site, and a connection with deep-water shipping routes via Grays Bay.



Figure 2.7-2 Photograph of the Grays Bay Port Site

The layout of the port infrastructure is shown below in **Figure 2.7-3**. This figure does not include all facilities. Further work is taking place in 2012 to complete the port site design.

The permanent land-based facilities that will be established at Grays Bay may include:

- Concentrate shed with capacity to store 10 months of concentrate production
- 50 million litres diesel storage – steel tanks within bunds
- Dock and ship loader facility to accommodate 50,000 DWT bulk-carrier ships
- Diesel power generators and electricity distribution
- Water supply and desalination plant
- Refuse disposal and sewage treatment
- Port operation and administration offices
- Warehouse and lay-down areas for supplies and sea containers

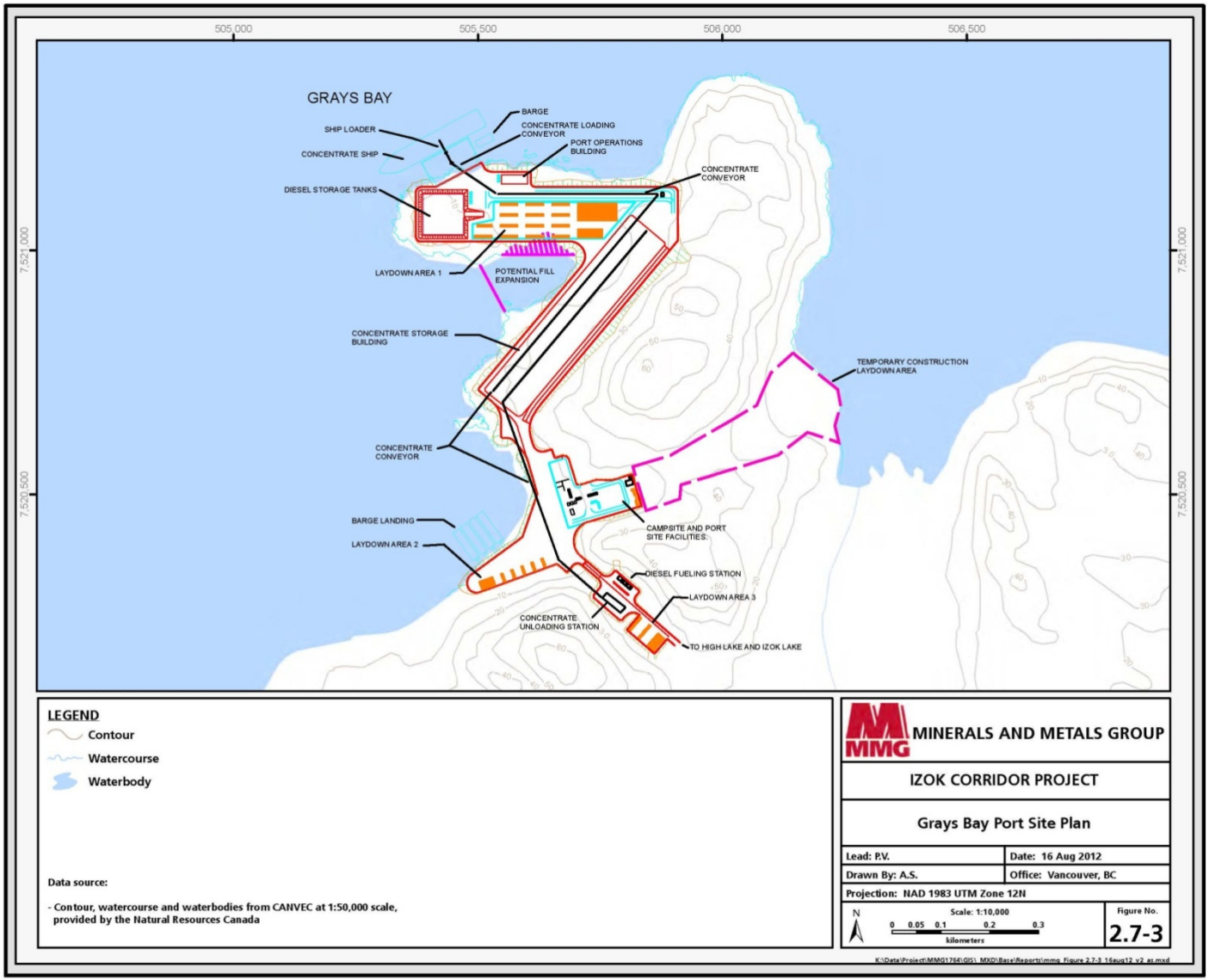


Figure 2.7-3 Grays Bay Port Site Plan

- Permanent camp
- Communication system
- Security
- Barge landing site
- Roads linking these facilities

2.7.2 Port Construction

2.7.2.1 Construction of Land-based Infrastructure

The land-based infrastructure will be built on level ground. Surface drainage ditches will be built around the site to collect any contaminated water and treated before release. Roadways and access areas around buildings will be designed to the same criteria as Izok Road.

Ground conditions are characterized by surface bedrock with minor quantities of till and thin glacio-marine sediments found in depressions. The site will first be graded to provide a stable and level surface for construction of the site facilities and roadways. Permafrost is present at the site but will not affect the stability of structures sitting on bedrock as building foundations will be built on competent bedrock.

Infilling of a small bay on the west side of the rocky promontory may be required for development of infrastructure. This will be determined based on further feasibility studies (refer to section 2.5-3).

In unheated structures such as the concentrate storage building, a floor space will be built. Any unconsolidated material will be excavated to a maximum depth of 2 m and will be replaced with well-graded, free-draining structural fill. The fill will be capped with crushed granular surfacing or with a concrete slab as building requirements dictate. Heated buildings and structures including the permanent camp will either be constructed with foundations elevated above the existing ground to preserve the permafrost or will sit directly on structural fill and which will act as a thermal barrier.

A permanent diesel storage facility will be built with berms. Fuel tanks will be constructed per the guidelines and permit terms and conditions.

Roads, power lines, communication lines, and piping will be constructed throughout the dock area as required.

2.7.2.2 Dock Description and Construction

A dock to accommodate 50,000 DWT ships will be built on the deep-water side of the rock peninsula (north facing shoreline). The ships will require a minimum of 12 m draft.

The berth will be a steel sheet pile structure backfilled with rock fill. This type of structure was selected because it offers good ice resistance, and has a high deck-load capacity. This has proven to be reliable dock structure for northern mining projects and other docking facilities across the Arctic.

The berth face will be at least 100 m. Floating mooring buoys or pile dolphins at each end of the wharf will secure the ship and be used to move it along the dock. Mooring buoys will be anchored by chain to concrete blocks on the seabed; the buoys will be removed at the end of each shipping season.

Details on dock construction will be provided as the feasibility study progresses. However, it is anticipated that dredging of marine sediments and blasted rock will likely be required. MMG will work with the Department of Fisheries and Oceans and other groups to plan construction, schedule, mitigations of impacts as well as a plan for No Net Loss of fish habitat within the dock footprint (refer to section 12).

2.7.3 Port Operation

The land-based, year round activity at the port will consist of trucks delivering the concentrate to the concentrate storage building, trucks picking up diesel, sea-containers and supplies to bring to the mine sites. The diesel station, power generation and camp will operate year–round. A robust Traffic Management Plan will be developed to minimize stress to the Dolphin and Union Caribou Herd when the area is used by caribou to cross to Victoria Island. Refer to section 7 for more details.

Shipping activities and ship loading activities will take place during ice-free months. The port will be open to receive ships and barges from mid July to October as recommended in the Draft West Kitikmeot Land Use Plan (NPC 2005), but most likely from August to October. Ice conditions studies are ongoing to provide more clarity on the most likely shipping window during those months

No shore-based ship's power, water, or services will be provided. Crews from foreign flagged vessels will not be allowed on shore.

2.7.3.1 Ships, Ship Loading and Unloading

Concentrate will be shipped offshore in 50,000 DWT ice-strengthened bulk-carriers, one of which will be specially designed to carry either diesel fuel or concentrates. This ship, called an Oil Bulk Ore Carrier (OBO) will deliver fuel to the port on the first trip it makes every year. Each ship will have five hatches into which the concentrate will be transferred using a ship-loader.

The preliminary ship specifications are summarized below:

- Type 50,000 DWT bulk-carrier
- Length 195 m
- Beam 32.5 m
- Draft 12.0 m
- Required water depth 13.5 m

Five ships will likely be required in the peak production years and will likely be constructed specifically for this Project. Economics and Fednav's Arctic experience suggest Polar Class 6 or equivalent ships with ice breaker support.MMG is assessing how and when ships will be commissioned, completed and operated.

Vessels will berth without tug assistance. Onshore accommodation will not be provided for ships' crews. Ships will likely be at the dock for 4 to 5 days.

The ship loader will be a fixed radial type capable of loading vessels up to 50,000 DWT at a design rate between 1,500 to 2,500 tph. Examples of ship loaders are shown in **Figure 2.7-4**.

The shiploader will be designed to avoid concentrate loss, dust and spillage, with dust collection equipment, a telescopic spout, washdown systems, and enclosed holds. To maintain minimal contamination, brushes and scrapers will be installed at the end of each conveyor line to clean the conveyor belt. An enclosed conveyor will transport the concentrate to the shiploader. The telescopic spout will extend from the upper level of the ship loader into the cargo holds.

The average loading rate for concentrate, inclusive of delays such weather, equipment delays, and other stoppages, will be about 1,200 tonnes per hour. At this rate, it will take slightly less than two days to load a 50,000 DWT vessel. Based on three trips for each ship, and allowing for 20% of delays due to weather, ships would be at Grays Bay dock for approximately 36 days per year.

Heavy-duty ship unloading equipment, probably 30 tonnes ship cranes, will be used to unload the bulk materials and containers from the ship at the dock. Once materials and equipment are off the ship, they will be transported by forklift and truck to laydown area. Supplies, diesel and sea containers will be transported to the mine site year-round.

2.7.3.2 Shipping Requirements

On average, the outbound traffic from Grays Bay Port will be between 450,000 and 650,000 DMT per year of zinc, copper and lead concentrates.

For the first trip of each year, ships will arrive at Grays Bay Port loaded with supplies. Total inbound tonnage of supplies and materials is estimated to be 25,000 tpa. 50 ML of diesel will be delivered either by barge or as backhaul on a concentrate export vessel. Up to 1,800 sea containers per year will be needed to provide dry foodstuffs, reagents, cement, ammonium nitrate, milling grinding media, spare parts, tires, explosives, and other supplies.

Supply barges may also deliver supplies. Barges will be similar to those that travel in arctic waters now supplying communities along the coast (**Figure 2.7-5**).

2.7.4 Barge Dock and Landing

A beach landing for barges will be constructed for construction materials and equipment, and may be used during the operational phase. At this time, MMG is also considering a more permanent landing and docking facility for barges. More details will be provided as the feasibility study progresses.

2.7.5 Electric Power Generation and Distribution

Power requirements during the operation phase are expected to be between 0.5 and 1.5 MW. Power will be provided by diesel generators and distributed through on-surface protected cabling.

2.7.6 Services

Water supply will be either desalinated sea water or trucked from the High Lake Mine. Any discharged water will meet the Nunavut Water Board's Guideline for Discharge for Domestic Wastewater in Nunavut (NWB 2000).



Figure 2.7-4 Example of Typical Shiploaders



Figure 2.7-5 Example of Typical Barge

Waste and surface water will be managed at the port site during the summer. This includes rainfall, snowmelt, and wash down water. Drainage paths will be developed for surface water runoff to flow into collection ditches. Collection ditches will direct water to a settling pond where solids will settle out and oil or diesel fuel will be retained by an invert weir trap. The solids will be disposed of as per a Waste Management Plan.

The port site will be capable of handling waste through proper processes and waste disposal management practices. An incineration plant and sewer system will be constructed on site simultaneously with the camp. Combustible garbage and construction waste materials will be transported to the incineration plant for disposal.

All water and sewage lines will be on surface and will be enclosed, heat-traced, insulated, and protected from traffic and winter conditions.

2.7.7 Fuel Systems

During the construction phase, temporary portable diesel tanks may be used prior to the construction of the tank farm.

After the grading of the site has been completed, a permanent fuel storage facility will be built for servicing the Izok project. This facility will consist of a bermed tank farm with two to four diesel storage tanks. The tanks will be filled from a ship with marine hoses, using the ship's pumps, connected to the permanent delivery piping network.

An impermeable membrane (arctic liner) will be embedded in the floor and dike walls. Tank foundations will be on structural fill over bedrock to avoid any permafrost and settlement issues.

Jet fuel for helicopters and aircraft as well as gasoline for small equipment will be shipped in drums or ISO tank containers. Propane and other industrial gases will be brought in bottles, and lubricants will be brought in plastic cubes.

2.7.8 Air Transportation

An airstrip may be constructed near the Grays Bay Port to meet access needs during construction. This airstrip will likely not be used during the operational phase given that an airstrip 40 km south at Sand Lake will be available. Personnel will likely travel to the Sand Lake Airport and then be transported by truck to the Grays Bay Port site. Final selection of the airstrip location will be based on further feasibility studies.

2.7.9 Accommodation

A temporary construction camp will be located at the port site, capable of housing between 100 and 250 people.

A camp for25 to 40 people will be built to meet the operational needs of the port. This number may change once traffic plans have been finalized as it is very likely that drivers will need to overnight at the camp, and shift schedule may affect the number of rooms required.

The facility will include a kitchen, first aid room, common dining room, mud rooms, and a recreation room. The operations office will be located at the same complex.

2.7.10 Communications

External communication will be either by satellite or microwave. MMG is still researching and costing the best way to provide reliable communication for all sites.

2.7.11 Explosives Handling

Ammonium nitrate will be shipped in specially constructed containers with a payload of 20 tonnes. Emulsifiers will be transported and stored in steel drums inside a 20 ft sea container. As these products are not classified as explosives, they do not require heated buildings and can be stored in an open fenced area.

Blasting accessories are classified as explosives, and specialized, bullet-proof magazines will be constructed in a separate area located at an appropriate distance from buildings and roads as per the *Explosives Act* requirements.

2.7.12 Hazardous Materials

There will be limited quantities of hazardous materials (e.g., chemical reagents required for the mineral processing plant) that will move through Grays Bay Port in containers destined for High Lake Mine and Izok Mine. Containers will remain un-opened at the Grays Bay Port, and hazardous materials will not be removed from their packaging. They will be stored in bermed and lined areas.

Hazardous wastes will be canned and shipped off site. A management plan will be prepared for hazardous waste disposal.

2.7.12.1 Air Emissions and Dust

The major sources of air emissions will be gases from combustion of diesel fuel and dust emissions. Low sulphur grade diesel will be used for power generation and mobile vehicle operation. Concentrate will be contained within covered buildings and conveyor galleries from unloading of concentrate trucks to unloading to the ships hold.

Operating equipment, vehicles, and the power plant have the potential to affect air quality. Examples of mitigation measures include:

- Efficient operation of all equipment (vehicles and power plant)
- Speed limits to reduce dust
- Application of dust suppressants to open ground where dust can originate
- Regular application of water to reduce dust emissions during the summer
- Installation of dust collectors at concentrate transfer points
- Enclosed handling of concentrate from delivery to the storage shed to the ship hatches.

The Project is fossil fuel intensive as alternative energy sources do not exist in the area. The combustion of fossil fuels (e.g., diesel) produces greenhouse gases (GHG) such as carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). Emission factors will be used to calculate GHG emissions from the quantity of fuel consumed for a given fuel type and combustion source.

2.7.12.2 Noise Emissions

The major sources of noise will be from diesel-powered vehicles and, diesel-powered generation equipment. The highest continuous noise levels at Grays Bay port will be generated by the concentrate trucks. Other sources of noise will be from the operation of pumps, compressors, generators, front end loaders and service vehicles.

Mitigation measures to reduce noise pollution will include:

- Conducting regular maintenance of construction and operations vehicles and equipment
- Installing air inlet silencers and exhaust silencers on all combustion engines
- Constructing noise baffles or enclosures for particularly noisy equipment
- Developing a noise monitoring and reduction program as part of the company's Health and Safety Policy

2.7.13 Security

Security and customs control for international shipping will be managed by MMG and will comply with Canadian law. Ship's personnel will remain on ship while at Grays Bay Port.

2.7.14 Port Alternatives Considered

2.7.14.1 Alternative Port Locations

Several alternative locations have been considered for the location of the port (**Figure 2.7-6**). Several engineering reports, bathymetric studies, archaeological studies, the economics of the Project and the distance to High Lake provided good background information to guide the final selection of the port. MMG's long-term plan for its presence in Nunavut has also influenced site selection.

Three adjacent sites were considered and rejected as being less accessible by either ships or by road. Further afield, a potential port location east of Kugluktuk, some 100 km west of the selected site, was assessed and rejected as being too far from High Lake Mine and being an option only if Izok was the only proposed mine.

A potential port location in Bathurst Inlet was assessed and rejected as providing access to Izok Mine but not to High Lake Mine. In addition, the Bathurst Inlet Road would require the crossing of a 69 km lake (on ice road in winter and/or by barge during ice-free months) with consequent loss of transportation for several months during the shoulder season. It would still not connect the High Lake Mine to the Izok Mine.

Both options were deemed uneconomic, as revenues from both Izok and High Lake concentrate must be part of the business plan to make the Project economically viable.

2.7.14.2 Alternative Dock Types

Various types of docks have been considered and rejected in favour of a gravity-based sheet pile structure. Risk involved with a sheet pile structure is considered low for this application as there are numerous successful examples of these structures in the north.

A prefabricated caisson structure that would be shipped to the dock location and sunk onto a prepared foundation was considered and rejected as having no perceivable advantage and having a higher cost than a sheet pile structure.

A floating dock and a pipe pile dock were both considered but rejected as being too vulnerable to forces imposed by ice.

2.7.14.3 Alternative Concentrate Storage Building Construction Material

A lighter steel frame building with fabric cladding was considered and rejected as having no clear advantage.

2.7.15 Mitigation by Design

The environmental effects of Grays Bay Port have been mitigated through minimizing the disturbed area. The location selected for Grays Bay Port allows all necessary infrastructure components to be constructed within a small footprint.

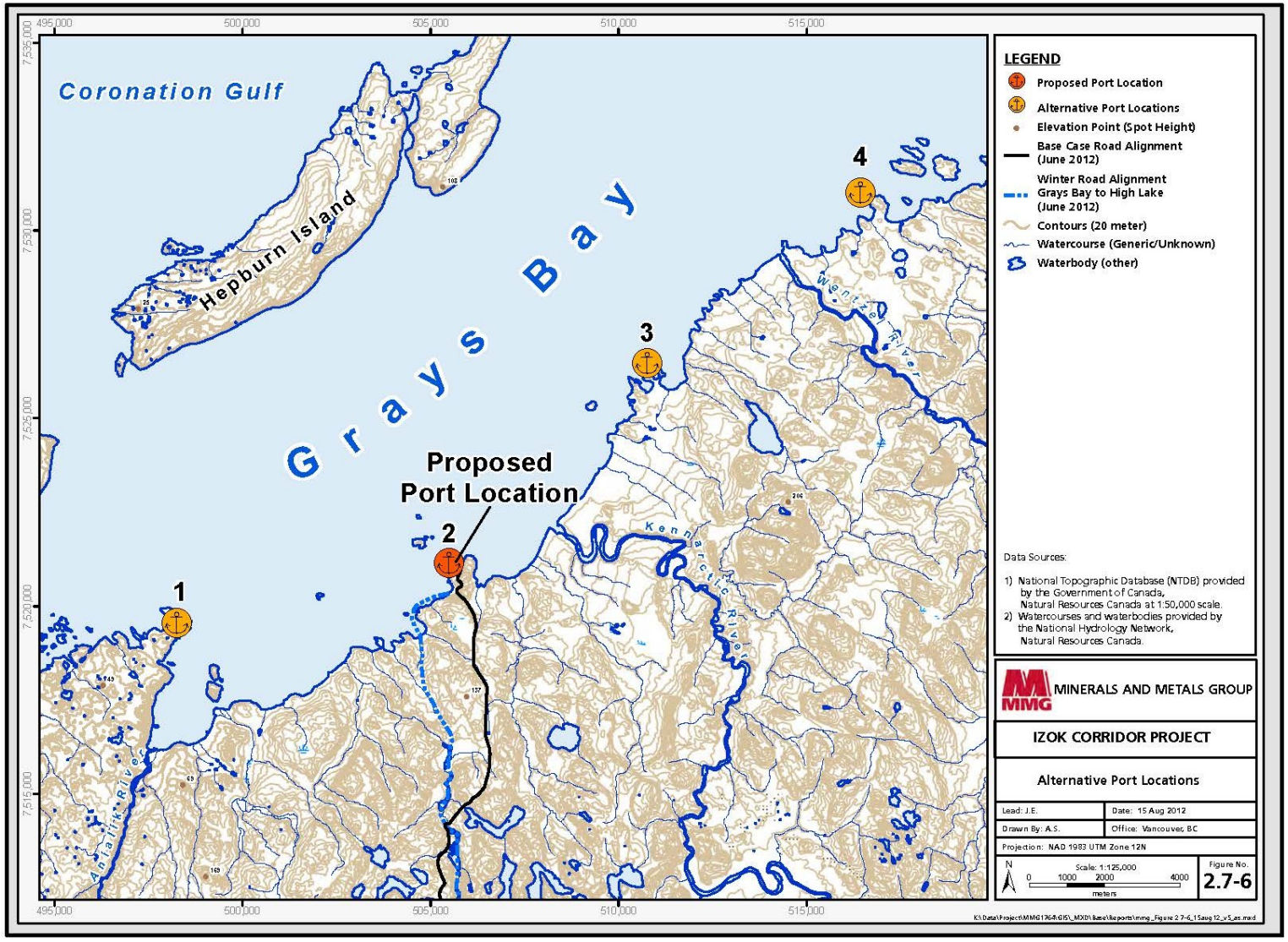


Figure 2.7-6 Alternative Port Locations in Grays Bay

2.7.16 Closure Plan

All infrastructures at Grays Bay Port will be decommissioned, dismantled, and removed at closure.

2.7.17 Port Surface Water Management

Best practices for the control of sedimentation in run-off water will be implemented during construction and operation, including silt traps, silt fences, settling ponds and sumps, grease traps, and monitoring and pumping systems.

To the extent practical, non-contact runoff water from undisturbed areas will be segregated and, if found to satisfy discharge water quality standards, discharged to the receiving environment without treatment.

Contact water will be collected and diverted to a water holding pond, which will have sufficient storage capacity to accommodate seasonal variations in surface water.

All contact water will be tested for contaminants prior to treatment and/or release. Where necessary, diversion ditches will be used to route contact water to collection ponds or sumps for transfer to a water holding pond.

Management plans for disposal of sludge from the water holding pond will be developed.

No alternatives to the proposed Surface Water Management Plan have been identified as it conforms to the highest industry standard best practices and regulations for managing surface water.

The Surface Water Management Plan (see section 12) will mitigate the risk of uncontrolled release of contact water to the environment by intercepting, collecting, and treating such water by means of well-designed water control and containment structures.

All water retaining structures for managing contact water will be designed to handle the volumes of water resulting from exceptional weather events to ensure there is no possibility of uncontrolled release of contact water.

Water flow amounts used in design of water management systems are based on conservative assessments of global warming trends.

The volume of contact water generated will be minimized by intercepting and diverting around disturbed areas the greatest amount of non-contact surface water as the topography permits.

Where ground conditions indicate it necessary, liners will be installed in water retaining structures to eliminate seepage of contact water into groundwater regimes.

2.7.18 Port Water Treatment

Sewage generated at Grays Bay will be treated in a rotating biological contactor sewage treatment system or similar. Effluent will meet discharge criteria prior to release to the marine environment.

Sludge from sewage treatment will be discharged to a land farm or incinerated.

Grey water will be directed either to a water treatment plant where it will be treated for re-use, treated to meet discharge criteria and discharged in the sea, or directed to a land farm.

No alternatives have been identified for water treatment and discharge at Grays Bay.

At closure, all water treatment and discharge infrastructure not required for the first post-closure phase treatment of water in Grays Bay will be decommissioned and removed.

2.8 Marine Transportation

Between 450,000 and 650,000 DMT of mineral concentrates will be shipped from Grays Bay through Coronation Gulf to ports in Europe and Asia en route to smelters and refineries. An estimated 50 ML diesel oil and 25,000 t resupply cargo will be transported into Grays Bayevery year to re-supply port and mine site operations.

Coronation Gulf is ice free for three to four months each year. Shipping access through the Coronation Gulf must, however, pass through parts of the Arctic Ocean that have narrower ice-free periods. While the length of the shipping season will depend on vessel design (ice classification) and ice conditions, the maximum length of the shipping season will in many cases be limited to 100 to 120 days to be consistent with the draft Kitikmeot Regional Land Use Plan (NPC 2005).

Vessel speeds will average 14 knots in open water and will reduce to an average of 6 knots in areas of the Northwest Passage such as between Resolute and Grays Bay. In accordance with the North Baffin Region Land Use Plan (NPC 2000), all ships will remain at least 10 km from coastlines in the Northwest Passage and 20 to 25 km from the coast of Lancaster Sound, unless approaching or leaving port, to avoid direct contact with concentrations of marine wildlife, whenever safe and practical to do so.

MMG will consult with several boards and agencies to prepare marine transportation plans to mitigate marine transport effects on marine mammals and birds.

MMG is in the process of completing transportation, logistics and scheduling for marine transport. Details will be provided as this work progresses. MMG will also be looking into lessons learned from other projects currently in the NIRB review process for guidance and recommendations.

2.8.1 Shipping Activity

Ships will follow existing surveyed routes through the Northwest Passage (**Figure 2.8-1**). From the west, the ships will travel through the Bering Strait, Beaufort Sea and Amundsen Gulf to the Coronation Gulf (**Figure 2.8-2**). From the east, the ships will travel through Davis Strait and Baffin Bay through Lancaster Sound to Peel Sound then Victoria Strait to the Coronation Gulf (**Figure 2.8-3**). Considerations in route selection will include market locations for the concentrates, locations for concentrate transfer to other vessels or trans-shipment terminals and the most suitable location for the loading of operating supplies and diesel. Both Asian and European markets are considered for as destination for delivery of the concentrates.

Preliminary findings indicate that ships with a light ice class using the western Bering Strait route would have a berth operating window ranging from less than 30 days to more than 70 days operating without ice breakers. Ships with a heavier ice class could access the port up to the full period of approximately 100 days between caribou migrations. In conformity with Requirement 6.2 of the draft West Kitikmeot

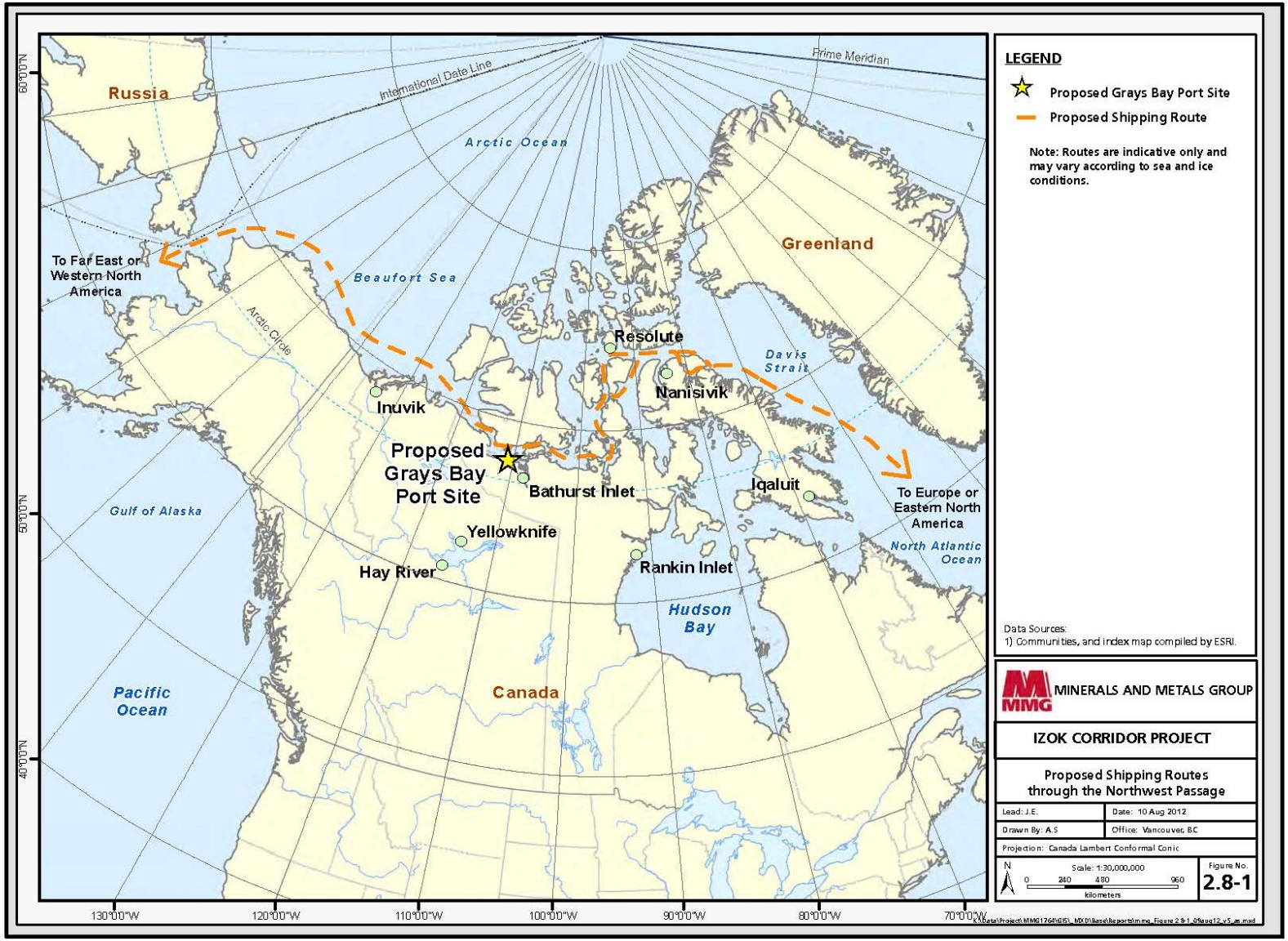


Figure 2.8-1 Proposed Shipping Routes through the Northwest Passage



Figure 2.8-2 Proposed Western Shipping Route



Figure 2.8-3 Proposed Eastern Shipping Route

Regional Land Use Plan (NPC 2005), shipping and ice breaking shall not take place during caribou migration periods outside the normal open water season between 01 July and 15 October, or between 15 October and 30 October if there is no ice breaking.

The eastern Davis Strait route is expected to have a shorter ice-free shipping period than the western route, and is closer to eastern markets for the Izok Corridor Project concentrates. Shipping related to the Project will take into account sensitive coastal and offshore areas, wildlife migration timing and shipping considerations outlined in the North Baffin Regional Land Use Plan (NPC 2000).

At this time, 16 round trips will be needed during the peak year of production. Only one ship at a time will be alongside the dock for loading or discharging. Ships may have to anchor in the vicinity to wait for space at the dock.

Ships will travel south from the surveyed Northwest Passage shipping route through the Coronation Gulf to reach Grays Bay. On leaving the dock, the ships will follow a route northeast from the dock across Grays Bay to the channel to the immediate east of Hepburn Island, then north across Coronation Gulf and onwards to Europe or the Far East to join the surveyed east/west route.A bathymetric survey of the north/south route through the Coronation Gulf was conducted in 2004 and the route was determined to be navigable. The Grays Bay dock location was selected based in part on a bathymetric survey of Grays Bay.

2.8.2 Waste and Water Management

Section 12 provides a list of Waste and Water Management plans. Ballast water, bilge water, waste oil, solid waste, deck drainage, Grey and Black Water Management plans will be developed for the Project.

2.8.3 Mitigation by Design

Ocean bulk-carriers built for the Project will incorporate updated environmental protection systems, including:

- Self-contained hold wash water tanks
- Bilge water cleaned and released per Canadian regulation
- Oil carrier will be double-hulled
- Fuel burned by ships will be low sulphur arctic fuel per regulation
- Avoidance of breaking land fast ice
- Limiting shipping activity to open-water season to avoid disturbance to caribou crossings and Inuit harvesting activities

In the DEIS, MMG will provide a description of waste produced or carried onboard, including quantities, storage, treatment, handling and disposal methods for ballast water, bilge water, waste oil, solid waste, deck drainage, grey and blackwater and hazardous or toxic waste.

MMG will provide a list of all applicable regulations concerning management of waste and discharges into the marine environment.

2.8.4 Alternatives Considered

Consideration has been given to the following alternatives to ocean carriage of concentrates and re-supply.

- Road transport via winter or all-weather road constructed southwards to Yellowknife was considered, studied and modelled but rejected due to high capital and operating cost. Once in Yellowknife, the concentrate would still need to be transported to either to a smelter in Trail, BC, or to a port in BC (Stewart or Vancouver). This is not a feasible option. Neither road, railroad or slurry pipeline are economic options for a southern land based route option. A recent study completed by MMG in 2010 and 2011 confirmed that shipping is the most viable option for the shipping of concentrate.
- Re-supply on barges out of Hay River, NWT which navigate the Mackenzie River is being considered for the Project. This option will be further evaluated as an alternative to shipping re-supply containers and break-bulk on the hatches of the bulk-carriers. It is likely that this would be an alternative for only part of the Project needs.

2.9 Employment and Procurement

2.9.1 Project Management and Administration

MMG already operates several mines in Australia, Asia and Africa. MMG will bring this experience and knowledge to the Canadian Project and make adjustments and changes as required by the Canadian and Nunavut context.

The main administration for Canadian operations will be in Vancouver, BC. MMG will also maintain a Project office in Kugluktuk. MMG will consider the possibility of another northern office.

There will also be an on-site management mine manager to oversee daily operations, with support from MMG's Vancouver office.

2.9.2 Human Resource Management

MMG has extensive Human Resource policies governing its global operations. Some of the key policies include:

- Equal Opportunity, Promoting Diversity & Fair Treatment
- Education Assistance
- Flexible Workplace Arrangements
- Group Personal Accident
- New Employee Guideline
- Parental Leave Policy
- Performance Improvement Policy

- Recognition, Spot Bonus, Merit Adjustment & Higher Duties Allowances
- Medical and other Insurances

2.9.3 Construction Workforce

There are no existing permanent communities in the vicinity of the Project construction sites with facilities that could accommodate construction workers. The construction crews will likely originate from western and northern Canada and possibly other locations, and camp accommodations will be required as early as 2015.

The three base camps at High Lake Mine, Izok Mine, and Grays Bay Port and the three mobile road construction camps will be used during the construction of the roads, the port and the mine site facilities. Other sites may be considered and will be discussed later as the feasibility study progresses. It is anticipated that the construction base camps at the Grays Bay Port, and High Lake and Izok Mine sites will eventually be used by operations personnel as permanent camps. Before construction of the Izok Mine camp and associated water and sewage treatment facilities are completed, it is anticipated that workers will be flown in from the Izok or other camps daily.

The average on-site work force is expected to be approximately 670. The total workforce will be approximately double that at 1140 workers based on a fly-in fly-out (FIFO) rotation. These numbers are preliminary and may change as the feasibility study progresses.

2.9.4 Operations Workforce

During the operational phase of the Project, the total work force will be approximately 710 people, with 400 people on the mine site at any particular time due to shift cycles and rotation of personnel. This includes a total of approximately 45 people at the Port site during summer shipping operations, and 20 during the non-shipping months. These numbers are preliminary and may change as the feasibility study progresses.

2.9.5 Closure and Reclamation Workforce

Progressive reclamation will occur throughout the life of the Project, and some closure work will begin in the last year of the operating phase. Final site reclamation is estimated to take two to three years, starting in 2029, followed by a post-closure monitoring phase of approximately seven years. The workforce required during reclamation and post-closure monitoring has yet to be determined.

2.9.6 Mobilization

The Izok Corridor Project will be a FIFO operation.MMG has well established mine management and administration systems for FIFO operations. These systems will be adapted and applied to its operations in Nunavut.

MMG is considering mobilization options from the Kitikmeot communities, as well as other points in Canada. These studies are part of the feasibility evaluation currently taking place.

2.9.7 On-site Services and Facilities for Workers

MMG will offer on-site services and facilities for its workers consistent with other northern operations. Employees may expect fitness, cultural and spiritual facilities, healthy meals including country foods and the ability for staff to store their own country foods, educational labs and opportunities/facilities for training.

2.9.8 Contracting and Procurement

MMG will contract and procure from firms in Nunavut as possible. Terms, conditions, criteria and requirements will be clearly identified in a timely manner. As part of the feasibility evaluation, MMG will be examining other opportunities for local contracting and procurement.

2.9.9 Inuit Impact and Benefit Agreement

MMG will negotiate a draft Inuit Impact and Benefit Agreement (IIBA) prior to the submission of the Final Environmental Impact Statement. MMG has already initiated early discussions with the KIA.

2.9.10 Inuit Contracting and Business Support

The extent to which Inuit firms will meet MMG's business support needs awaits the results of the ongoing planning and assessment, and will be informed through negotiations between MMG and the KIA. The percentage of the workforce that will be Inuit is one of the factors that are being examined as part of the labour force evaluation, and also will be part of future discussions between MMG and the KIA.

2.9.11 Community Outreach

Currently, community outreach has included sponsorship of a variety of community-based initiatives. MMG is providing active support to community-based "stay in school" initiatives and opportunities. A training program is planned, which will facilitate apprenticeships in skills that will mesh with Project employment opportunities. As the Project proceeds through the regulatory process, MMG will be expanding its community outreach program.

2.10 Summary of Mitigation by Project Design

Various mitigation measures have been incorporated into the design of the Project to eliminate or reduce potential environmental effects. These preliminary measures are summarized below in **Table 2.10-1**. Additional measures will be adopted in the next years, based on consultation with stakeholders.

Table 2.10-1 Preliminary Summary of Mitigation by Design

Project Activity	Potential Effect	Mitigation Designed into Project	Effect of Mitigation
Izok Mine Site			
Construction of mineral processing plant	Surface disturbance Reduced water quality	Construct only one processing plant to process ore from both Izok Mine and High Lake Mine at Izok Lake	Reduced footprint at High Lake by not constructing a processing plant at site. Reduced discharge of treated effluent from High Lake Mine
Dewatering Izok Lake	Loss of fish passage between Iznogoudh and Itchen lakes	Diversion channel connecting Iznogoudh Lake to Itchen Lake will be designed to be a fish passage	Fish passage between Iznogoudh Lake and Itchen Lake will be uninterrupted
Dewatering Izok Lake	Loss of fish habitat in Izok Lake	Diversion channel connecting Iznogoudh Lake and Itchen Lake will be designed to be fish habitat by placing boulder and gravel piles along channel bottom to provide fish rearing and resting habitat, and creating rough channel walls and bottom in rock cuts	Fish habitat will be created in the diversion channel
Tailings Disposal	Reduced surface water quality, fish habitat quality	Tailings will be dry stacked	Elimination of ARD and ML from tailings pile
Construction of mineral waste piles	Reduced quality and quantity of terrestrial habitats	Deposit mineral wastes largely within the outline of the drained Izok Lake	Izok Lake lakebed will necessarily become a disturbed area to access ore, thus placing wastes there will minimize overall amount of disturbance
	Reduced water quality due to ARD and ML seepage from mineral waste piles	Mineral wastes piles will be designed to freeze, and once frozen will be capped with thermal protection rock covers which will prevent the formation and release of ARD and ML	Elimination of ARD and ML seepage from mineral waste piles
	Reduced water quality due to surface run-off water and precipitation contacting reactive mineral wastes	Mineral wastes piles will be designed to freeze, and once frozen will be capped with thermal protection rock covers which will prevent precipitation contacting reactive mineral wastes	Minimization or elimination of surface run-off water and precipitation contacting reactive mineral wastes which will prevent water quality reduction

Project Activity	Potential Effect	Mitigation Designed into Project	Effect of Mitigation
Construction of mineral waste piles (cont'd.)		Surface run-off will be diverted away from and around reactive mineral waste piles	
	Reduced air quality due to airborne dust from mineral waste piles	A portion of mineral wastes will be submerged in the bottom of the worked out pit Dust creation will be minimized by designing mineral waste piles such that final rock covers may be installed as early as possible Exposed surfaces of fine mineral wastes (tailings) will be designed to allow rolling with a smooth roller	By leaving mineral wastes in the bottom of the worked-out pit, diesel consumption will be reduced with resulting improvement in air quality By submerging mineral wastes, airborne dust creation is eliminated Installing rock covers early will reduce the possibility of airborne dust creation Rolling fine mineral waste surfaces reduces the possibility of airborne dust creation
Conversion of surface run-off from non-contact water to contact water	Reduced surface run-off water quality	Design a surface water management systems that will divert non-contact surface run-off water from entering the Izok Lake basin	Minimizing the amount of surface run-off water that enters the Izok Lake basin to becoming contact water requiring treatment before release
		Design water control structures such as berms, ditches, ponds, and dams handling contact water to have impervious liners	Elimination of seepage of contact water into groundwater regimes
Process Water Supply	Effects on water quantity of Itchen or IznogoudhLake by sourcing fresh water	Re-cycling process plant water, open pit water, and settled runoff for primary water supply	Reduce amount of fresh water drawn from Itchen and Iznogoudh Lakes
Ore Crushing and Screening	Airborne dust emission	Design the ore crushing and screening plant to be enclosed in a building	Reduced airborne dust emission
Crushed ore storage	Airborne dust emission of concentrate	Design the crushed ore storage to be enclosed in a building	Reduced airborne dust emission of concentrate

Project Activity	Potential Effect	Mitigation Designed into Project	Effect of Mitigation
Concentrate storage and loading	Airborne dust emission of concentrate	Design concentrate storage and loading facilities to be enclosed in a building	Reduced airborne dust of concentrate mission
	Precipitation causing run-off and erosion of concentrate	Design concentrate storage and loading facilities to be enclosed in a building	Reduced run-off and erosion of concentrate
Connecting site buildings	Safety of personnel during bad weather	Design of major buildings to be connected by utilidors	Increased safety of personnel in bad weather
	Frost and vehicle damage to services, which might result in a spill	Design of services to be routed in arctic corridors	Decreased possibility of damage to services
Inert solid waste	Contamination of environment; land disturbance from landfill	Design inert solid waste management system to enclose inert solid waste in waste rock dumps	Reduced footprint by eliminating a landfill
Fuel	Effect on air quality from burning diesel	Design project to operate exclusively on low sulphur diesel	Reduced effect on air quality
Process plant thickener	Effect on Iznogoudh and Itchenlakes from withdrawal of fresh water	Process plant designed to recycle water by installing a thickener	Reduced amount of water drawn from surrounding lakes
Temporary winter road	Lake drawdown caused by water withdrawal	Minimize water use from small lakes where water withdrawal will affect water levels	Reduced effect on fish habitat
	Destruction or disturbance of vegetation	Design the road alignment to be over water where possible to minimize disturbance to frozen or vegetation sensitive ground. Employ effective use of snow and ice pads to protect underlying vegetation and tundra.	Reduced disturbance to vegetation
	Vehicle collisions	Design road to maximize clear lines of sight	Reduced potential for accidents
Air strip	Contamination of surface water and groundwater due to de-icing fluids	De-icing area lined to prevent release of de-icing fluids	Removed possibility of de-icing fluids entering groundwater or surface water
Mineral wastes at closure	Airborne and water-borne pollution from reactive mineral wastes	Crushed rockcapping progressively installed during operational phase and completed at closure	Release of airborne and water-borne pollution reduced or eliminated
High Lake Mine Site			
Deposition of mineral waste	Potential for airborne and water-borne pollution emanating from mineral waste	Mine design to maximize use of PAG waste rock for underground mine backfill	Reduced release of airborne or water-borne pollution after closure

Project Activity	Potential Effect	Mitigation Designed into Project	Effect of Mitigation
	piles	Design such that mineral waste piles will freeze and remain frozen in perpetuity	Reduced or eliminated release of airborne or water-borne pollution after closure
Fresh Water supply	Effect on water quantity of fresh water source lake(s)	Design water management system to recycle pit water and surface runoff	Reduce amount of freshwater drawn from fresh water source lakes
Creation of waste water	Contamination of surface waters	Design minesite such that all point sources of waste water and other wastes are located within High Lake catchment	Possibility of waste water affecting areas outside of High Lake catchment eliminated
Conversion of surface run-off from non-contact water to contact water	Reduced surface run-off water quality	Design a surface water management systems that will divert non-contact surface run-off water from entering the High Lake basin	Minimizing the amount of surface run-off water that enters the High Lake basin becoming contact water requiring treatment before release
Mine infrastructure	Contamination and loss of fish habitat	Containment of substantially all disturbance inside High Lake catchment	Minimized downstream effects in event of accidental release of contact water or spilled material
Connecting site buildings	Safety of personnel during bad weather	Design of major buildings to be connected by utilidors	Increased safety of personnel in bad weather
	Frost and vehicle damage to services, which might result in a spill	Design of services to be routed in arctic corridors	Decreased possibility of damage to services
Inert solid waste	Contamination of environment; land disturbance from landfill	Design inert solid waste management system to enclose inert solid waste in waste rock dumps	Reduced footprint by eliminating a landfill
Deposition of mineral waste	Potential for airborne and water-borne pollution emanating from mineral waste piles	Mine design to maximize use of PAG waste rock for underground mine backfill	Reduced release of airborne or water-borne pollution after closure
Fuel	Effect on air quality from burning of diesel	Design project to operate exclusively on low sulphur diesel	Reduced effect on air quality
Izok Road			
Road embankment	Disturbance or loss	Minimize construction of road alignment along the tops of eskers to minimize disturbance footprint	Avoidance or mitigation prior to construction
	Barrier to wildlife movements	Provide smooth, compacted slope surface	Reduced effect on wildlife movements
		Suitable design for wildlife crossings; crossings to be located in areas of preferred	

Project Activity	Potential Effect	Mitigation Designed into Project	Effect of Mitigation
		habitats	
	Ice thaw	Minimize cuts through ice rich soils	Reduce adverse effects on permafrost
Borrow and quarry sources	Destruction or disturbance of landforms	Selected use of eskers and glaciofluvial deposits; select sources near or on final road alignment	Avoidance or mitigation prior to construction; minimize footprint of road
Concentrate transport	Dust release and contamination	Hard covered trucks	Reduced contamination and loss of product
Grays Bay Port			
Surface water management	Reduced water quality	Design systems and practices to intercept, collect, and treat as necessary to meet discharge criteriacontact water before release	Reduced risk of uncontrolled release of contact water
		Design diversion system to divert non-contact water to greatest extent possible	Reduced amount of contact water
		Design of water management systems based on conservative global warming trends	
Site foundations	Thawing and ice heaving	Design foundations so as not to disturb sensitive permafrost ground	Permafrost preservation
Concentrate storage and loading	Airborne dust emission of concentrate	Design concentrate storage and loading facilities to be enclosed in a building	Reduced airborne dust of concentrate mission
Temporary winter road	Lake drawdown caused by water withdrawal	Minimize water use from small lakes where water withdrawal will affect water levels	Reduced effect on fish habitat
	Destruction or disturbance of vegetation	Design the road alignment to be over water where possible to minimize disturbance to frozen or vegetation sensitive ground. Employ effective use of snow and ice pads to protect underlying vegetation and tundra.	Reduced disturbance to vegetation
	Vehicle collisions	Design road to maximize clear lines of sight	Reduced potential for accidents
Marine Shipping			
Shipping route	Disturbance to marine wildlife	Whenever safe and practical to do so, all ships shall remain at least 10 km from all coastlines in the region, unless	

Project Activity	Potential Effect	Mitigation Designed into Project	Effect of Mitigation
		approaching or leaving port	
		Whenever safe or practical to do so, all ships shall remain at least 20 to 25 km from the coasts of Lancaster Sound, unless approaching or leaving port, to avoid direct contact with concentrations of marine wildlife	
Marine shipping	Reduced air quality due to ships' engines exhaust	Design ships and operating protocols to use low sulphur fuel	Reduce sulphur dioxide emissions
Ice breaking	Effects on marine mammals and harvesting activities by premature breakup of land-fast ice	Ships and shipping systems and protocols will be such that no ice breaking will occur within continuous landfast ice outside the permitted open water season between July 1st and October 15th	Reduced risk of disturbances to marine mammals and harvesting activities

Izok Corridor Project Proposal

SECTION 3

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3 PUBLIC ENGAGEMENT

3.1 Overview of Engagement Plan

Since 2004, there has been continuous engagement with Kitikmeot residents, leaders, government departments and Inuit organizations regarding proposed development of the High Lake and Izok Lake deposits. Previous owners (Wolfden, Zinifex and OZ Minerals) completed engagement programs as part of preparation of the High Lake Draft Environmental Impact Statement (DEIS), which was submitted to the Nunavut Impact Review Board (NIRB) in 2006, and again in anticipation of a review of the proposed Izok Lake Project in 2007/2008.

Recently, MMG announced that it would be discontinuing the review of the High Lake Project, and advancing the Izok Corridor Project. With that announcement, MMG initiated a new engagement and consultation program that, to date has included:

- Early information meetings to update several agencies and boards
- A Resource Development Advisory Group (RDAG) meeting
- Community visits and open houses
- Preliminary issue scoping discussions with communities and agencies
- Announcement of the development of community advisory committees
- Distribution of information sheets, newsletters, etc.

In addition, MMG has maintained an office in Kugluktuk with a full-time Community Liaison Officer and a part-time employee to support consultation activities.

3.2 History of Engagement

Wolfden and Zinifex undertook an engagement program for the proposed High Lake Mine[1] Project between 2004 and 2007. This previously proposed project included a port at Grays Bay and an all-season road connecting the proposed High Lake Mine to a proposed port.

OZ Minerals held a series of consultation and engagement activities in 2007 and 2008 to introduce the Izok Lake Project. **Table 3.2-1** summarizes engagement activities that took place with various Kitikmeot communities between 2004 and 2005 in relation to the proposed High Lake Project. Some community meetings listed below (e.g., with Hamlet Council and/or staff and Hunter and Trapper Organizations) were conducted as part of the socio-economic program.

[1] See NIRB ftp website for details. ftp://ftp.nirb.ca/02-REVIEWS/ACTIVE%20REVIEWS/06MN082-MMG%20HIGH%20LAKE/1-SCREENING/01-APPLICATION/

Table 3.2-1 Community Visits, 2004-2005

Community	Organization	Date(s)
Cambridge Bay	Community open house	• April 7, 2004 • May 30, 2005
	Hamlet Council and/or Staff	• April 7, 2004 • February 22, 2005 • May 30, 2005
	Hunters and Trappers Organization	• May 30, 2005[1]
	Local businesses: Kitnuna Corporation, Kitikmeot Supplies, Kitikmeot Foods, Inukshuk Enterprises and Kalvik Enterprises[2]	• May 30, 2005
Gjoa Haven	Community open house	• June 1, 2005
	Hamlet Council and/or Staff	• April 6, 2004 • April 28, 2005 • June 1, 2005 • August 4, 2005
	Local business: KAP Enterprises/ Central Arctic Services Ltd	• June 1, 2005
Kugaaruk	Hamlet Council and/or Staff	• August 3, 2005
Kugluktuk	Community open house	• February 9, 2004 • May 31, 2005
	Hamlet Council and/or Staff Hunters and Trappers Organization[3]and Regional Hunters and Trappers Association[4]	• February 9, 2004 • February 12, 2004 • May 31, 2005 • May 30, 2006 • February 24, 2005 • May 31, 2005 • May 31, 2006
	Local businesses: JMS Supplies, Mulco Ltd and Kikiak Contractors	
Taloyoak	Community Open House	• June 2, 2005
	Hamlet Council and/or Staff	• April 26, 2005 • June 2, 2005
	Hunters and Trappers Organization	• April 26, 2005 • June 2, 2005

1 Invited but did not attend
2 Invited but did not attend
3 Invited but did not attend May 31, 2005 meeting
4 Invited but did not attend May 31, 2005 meeting

In 2007 and 2008, OZ Minerals hosted several site visits. Elders and other representatives from the Kitikmeot communities and Tlicho (NWT) representatives visited the Izok Project site during August and September 2008.

Between 2008 and 2011, MMG's Community Liaison Officer in Kugluktuk continued with low-key activities such as sponsorship programs, updates to the Kitikmeot Inuit Association, and facilitating short-term employment opportunities.

Table 3.2-2 presents a summary of consultation activities that occurred with the regulators between 2004 and 2006. Some meetings took place in the communities as part of the community visits and/or the socio-economic program (e.g., Kitikmeot Inuit Association, Nunavut Tunngavik Inc., Government of Nunavut departments).

Table 3.2-2 Inuit Organizations and Regulatory Agency Consultation, 2004-2006

Organization	Location	Date
Cordilleran Mineral Exploration Round-up - Kitikmeot Inuit Association	Vancouver, BC	January 2004
	Vancouver, BC	January 2005
Canadian Environmental Assessment Agency[1]	Iqaluit, NU	May 27, 2005
Environment Canada	Iqaluit, NU	June 18, 2004
	Iqaluit, NU	May 27, 2005
Fisheries and Oceans Canada	Iqaluit, NU	June 18, 2004
	Iqaluit, NU	May 27, 2005
	Vancouver, BC	June 27, 2006
Government of the Northwest Territories (GNWT) - Resources, Wildlife and Economic Development	Yellowknife, NT	May 7, 2004
GN, Department of Economic Development & Transportation	Iqaluit, NU	June 18, 2004
	Iqaluit, NU	May 27, 2005
GN, Department of Environment	Iqaluit, NU	June 18, 2004
	Iqaluit, NU	May 27, 2005
GN, Department of Health & Social Services	Iqaluit, NU	June 18, 2004
Health Canada	Iqaluit, NU	June 18, 2004
Human Resources Skills and Development Canada	Iqaluit, NU	May 27, 2005
Indian and Northern Affairs Canada	Iqaluit, NU	June 18, 2004
	Iqaluit, NU	May 27, 2005
Kitikmeot Inuit Association	Kugluktuk	February 10, 2004
	Gjoa Haven	April 6, 2004
	Kugluktuk	February 24, 2005
	Kugluktuk	June 1, 2005
	Gjoa Haven	June 1, 2005
	Taloyoak	June 2, 2005
	Kugluktuk	March 30, 2006
	Calgary	April 19-20, 2006
Minerals Development Advisory Group (MDAG) - KIA, NIRB, NPC, GN, INAC and EC representatives	Kugluktuk	February 10-11, 2004
Natural Resources Canada[2]	Iqaluit, NU	May 27, 2005

Organization	Location	Date
Nunavut Impact Review Board	Cambridge Bay Calgary, AB Calgary, AB	April 8, 2004 September 2, 2005 June 2006
Nunavut Tunngavik Incorporated	Cambridge Bay Cambridge Bay Iqaluit, NU Cambridge Bay	April 8, 2004 February 21, 2005 May 27, 2005 May 30, 2005
Nunavut Water Board	Gjoa Haven Yellowknife	April 6, 2004 June 3, 2005
Prospectors and Developers Association of Canada (PDAC) - Indian and Northern Affairs Canada, Kitikmeot Inuit Association and Nunavut Impact Review Board	Toronto, ON Toronto, ON	March 8-9, 2004 March 7-8, 2005 March 7-9, 2006

1 Contacted by teleconference
2 Contacted by teleconference

3.3 Community Liaison Officer and Kugluktuk Office

Since 2009, MMG has maintained an office in Kugluktuk. Currently, the office is staffed by one full-time Community Liaison Officer, Donald Havioyak, and one part-time employee who supports the planning of community events.

The Community Liaison Officer provides direct support to MMG in hiring seasonal staff for the exploration and environmental programs, and provides local knowledge and insight to the planning and design of field programs, development and delivery of the consultation strategy and overall advice to the MMG team. Through ongoing communication with residents and agencies, MMG was able to initiate planning and design of the Project with a relatively inclusive list of concerns and issues and insight from the perspective of local residents.

The Community Liaison Officer also assists with implementation of the MMG community sponsorship program by working closely with the mayors of Kugluktuk and Cambridge Bay in the selection of applicants for funding. MMG is also learning about its neighbours' interest and priorities through these programs. **Table 3.3-1** provides a list of community programs funded by MMG to date.

Table 3.3-1 MMG Sponsorship Programs

Organization	Community	Purpose	Sponsorship Amount
Kitikmeot Heritage Society	Cambridge Bay	Cultural Camp	$10,000
Nunavut Literacy Council	Cambridge Bay & Kugluktuk	Inuinnaqtun Family Literacy Resources	$11,000
Kugluktuk Recreation	Kugluktuk	Soccer skills clinic	$500
Cambridge Bay Childcare Society	Cambridge Bay	Fundraiser	$3,000
Hamlet of Kugluktuk	Kugluktuk	Women's Shelter	$3,000
Kitikmeot Heritage Society	Cambridge Bay	Piecing Our Culture Together: The Kiilinik High School Mosaic Project	$10,000
Hamlet of Kugluktuk	Kugluktuk	Community Feast	$1,500

Organization	Community	Purpose	Sponsorship Amount
Hamlet of Kugluktuk	Kugluktuk	Scoreboard	$8,400
Hamlet of Kugluktuk	Kugluktuk	Food hamper fundraiser	$500
Hamlet of Cambridge Bay	Cambridge Bay	Food hamper fundraiser	$500
Women In Action, Steps of Hope	Cambridge Bay	Cancer fund-raising	$2,000
Kugluktuk Recreation	Kugluktuk	Canada Day and Nunavut Day BBQ	$2,000
Kugluktuk Recreation	Kugluktuk	Hockey Tournament	$500
Kugluktuk Hunters & Trappers Organization	Kugluktuk	Arctic Char Community Stewardship and Restoration Project	$5,000
Northern Youth Abroad		Northern Youth Aboard Program	$1,000
Gjoa Haven Hunters & Trappers Association	Gjoa Haven	Annual Seal Derby	$1,000
Nunavut Table Tennis Association		Table Tennis Camp in Ottawa with Cultural Programs	$2,000
NWT & Nunavut Construction Association	Gjoa Haven	Construction Boot Camp	$6,000
Kugluktuk Recreation	Kugluktuk	Kugluktuk Summer Games	$5000
KIA employment	Cambridge Bay	Women Building Futures	$5000

3.4 Early Information Meetings

In recognition of the heavy workloads of agencies, departments and boards and the need to plan ahead, MMG has conducted early information sessions with Nunavut regulators since January 2012. The purpose of these meetings was to provide updates on the Izok Corridor Project and MMG's long-term plan for its presence in Nunavut, and to seek preliminary feedback on issues and concerns that will need to be considered in the design of the Project. MMG will be establishing a website that will provide up to date information on the project.

During the Vancouver Cordilleran Round Up conference in January 2012, MMG held early information meetings with representatives of several agencies including the NIRB, the Kitikmeot Inuit Association (KIA), the Nunavut Resources Council (NRC), Minister Taptuna and several members of his team, representatives of the Northern Project Management Office and others. These meetings involved presentations on MMG and the Izok Corridor Project and, in some cases, visits to the Vancouver MMG office and introduction to staff.

On March 5, 2012, MMG organized information meetings with the KIA, Nunavut Tunngavik Inc. (NTI), Aboriginal Affairs and Northern Development Canada (AANDC), Minister Agglukaq, Senator Patterson and the NRC during the Prospector and Developers Association of Canada (PDAC) symposium held in Toronto. Mr. Andrew Michelmore, CEO of MMG, attended PDAC and was introduced to the KIA, NTI and several others. MMG delivered a presentation on the Izok Corridor Project at a lunch organized annually with the NTI.

The first major planned information event was a presentation on the Project to the Resource Development Advisory Group (RDAG) in Iqaluit in April 2012 prior to the Nunavut Mining Symposium.

The meeting took place over 1.5 days during which MMG presented the Project and its key elements, as well as key issues and potential effects of the proposed development. The following provides a list of agencies that attended this event (**Table 3.4-1**). During the Nunavut Mining Symposium, MMG also met with KIA, the Nunavut Water Board, AANDC, the Nunavut/NWT Chamber of Mines, business representatives, NG and others.

Table 3.4-1 Participants of the Resource Development Advisory Group Meeting, April 2012

Name	Organization
Sarah Holzman	Government of Nunavut (GN) – Department of Environment
Karen Costello	AANDC – Acting Director - Operations, Nunavut Regional Office (NRO)
Murray Ball	AANDC – Manager of Water Resources, NRO
Margaux Brisco	AANDC – Manager, Environment
Allison Dunn	Environment Canada – Sr. Environmental Assessment Coordinator
Eva Paul	AANDC – Water Resources Officer, Kitikmeot Region
Tracey McCaie	AANDC – Acting Manager Land Administration
Sophia Granchinho	Nunavut Impact Review Board (NIRB) – Technical Advisor
Amanda Hanson	NIRB – Director of Technical Services
Marc Noreau	GN – Department of Justice
Gordon MacKay	GN – Economic Development and Transportation – ADM
Paul Budkewitsch	AANDC – District Geologist, Mineral Resources
Matt Senkow	AANDC – District Geologist, Mineral Resources
Leslie Payette	AANDC – Senior Advisor, Executive Services
Andrea Cull	AANDC – Water Resources
Jeff G. Mercer	AANDC - Manager, Lands Administration
Rosanne D'Orazio	AANDC – Environmental Assessment Specialist, Environment
Tamara Fast	AANDC – Regional Socio-Economic Analysis
Gustavo Oliveiro	GN – Economic Development and Transportation – Regional Socio-ec Coordinator
Grant Hipfner	GN – Finance
Dianne Lapierre	GN - Economic Development and Transportation Manager, Environmental Assessment and Regulation
John Cowan	Transport Canada – Environmental Officer
Geoffrey Clark	Kitikmeot Inuit Association (KIA) – Director, Lands and Environment
Rob Johnstone	Natural Resources Canada (NRCAN) – Deputy Director, Sustainable Mining and Materials Policy Division
Derrick Moggey	Department of Fisheries and Oceans (DFO)
Keith Morrison	Nunavut Tunngavik Inc. (NTI) – Senior Advisor, Dept of Lands and Resources
Mitch Bloom	CanNor – Northern Project Management Office (NPMO) – Vice President
Johann Pelage	CanNor – Northern Project Management Office (NPMO) – Project Manager
Paula Smith	Environment Canada (EC)
David Hohnstein	Nunavut Water Board (NWB) – Director of Technical Services
Pauloosie Suvega	GN – Dept. of Executive and Intergovernmental Affairs (EIA) – Assistant Deputy Minister, Sustainable Development
Jean Daniel Blouin	GN – Dept. of the Environment

MMG is also building relationships with other mining proponents (such as Elgin Mining, Sabina, XStrata, Agnico Eagle) that are active in Nunavut, and is planning to seek opportunities for resource sharing, lessons learned and potential efficiencies in delivery of environmental and socio-economic programs.

In May 2012, MMG also met with the Wekeezii Land and Water Board, the Mackenzie Valley Land and Water Board, Environment Canada, Canadian Northern Economic Development Agency (CanNor) and the Kwe Beh Working Group in Yellowknife.

3.4.1 Community Visits

In July 2011, MMG's Approval Manager and Human Resources Manager traveled to Kugluktuk to introduce themselves, as new MMG staff. Along with MMG's Community Liaison Officer, they met with the Mayor and Councilors of the Hamlet, the Economic Development officer, the High School Principal and the Social Services team, and visited the Elders center, the Recreational Center, the KIA and the Kugluktuk Hunters and Trappers Organization (KHTO) offices to provide an update on the Project and an overview of MMG's objectives. A similar visit was planned for Cambridge Bay but was cancelled due to poor weather.

The Community Liaison Officer continued to work with residents and agencies to provide information, seek feedback and liaise between the larger MMG team and residents.

Since April 2012, MMG has visited each community within the Kitikmeot and met with parties that might have an interest in the Project (**Table 3.4-2**). The purpose of these meetings was to inform communities about the Izok Corridor Project and seek preliminary feedback on issues and concerns that will need to be considered in the design of the Project, and to introduce MMG to the Nunavut.

During the community visits, MMG held open houses and smaller one-on-one meetings with agencies. At the request of and with the support of KIA, MMG delivered a full-day version of the RDAG material to the Hamlet, KIA staff and HTO and several others in Kugluktuk during the week of the open house. More activities are planned for 2012 and 2013.

Table 3.4-2 Recent Community Visits

Organization	Location	Date
Mayor and Council Secondary School Hunters and Trappers Organization Elders Center Social Services Economic Development Officer	Kugluktuk	July 2011
Mayor and Council, Kugluktuk Hamlet	Vancouver	January 2012
Community Open House Mayor and Council Hunters and Trappers Secondary School	Gjoa Haven, NU	April 16-17, 2012
Community Open House Mayor and Council Hunters and Trappers	Kugaaruk, NU	April 18-19, 2012

Organization	Location	Date
Secondary School		
Community Open House Mayor and Council Hunters and Trappers Secondary School	Taloyoak, NU	April 19-20, 2012
Community Open House Mayor and Council Hunters and Trappers Secondary School Nunavut Tunngavik Inc. Kitikmeot Inuit Association Nunavut Impact Review Board Arctic College	Cambridge Bay, NU	April 24–27, 2012
Community Open House Mayor and Council Hunters and Trappers Secondary School Kitikmeot Inuit Association RCMP	Kugluktuk, NU	April 30-May 3, 2012
Wekeezii Land and Water Board, the Mackenzie Valley Land and Water Board, Environment Canada, CanNor and the Kwe Beh Working Group	Yellowknife, NT	May 29-30, 2012

3.4.2 Summary of Issues and Concerns

Consultation undertaken in April and May 2012 with residents of the Kitikmeot, regulatory agencies for Nunavut and the NWT, and the Tlicho revealed the following thoughts, issues and concerns related to the Project.

Employment

The primary interest by all the groups was the possibility of employment. With the impending changes to the Newmont operations in the Kitikmeot, the possibility of having employment with MMG was high on everyone's mind.

Training

The second area of interest was opportunities for training to improve employment opportunities and when these might be made available to Kitikmeot residents.

Business opportunities

The Kitikmeot businesses asked about contracting opportunities, and when these opportunities would be available.

Shipping

Residents of Gjoa Haven and Taloyoak expressed concerns related to Project shipping. In particular, polar bear and walrus were discussed.

Caribou

Comments were provided from each community regarding the Bathurst and Dolphin and Union (DU) caribou herds. Community members welcomed MMG's efforts to avoid interference with calving cows from the Bathurst herd. They also provided information on timing of when caribou from the DU herd gather along the coastline. They expressed a great interest in participating in the development of management and monitoring plans. MMG is following up with site visits and workshops in summer and fall 2012.

Fish

The Kugluktuk HTO wanted to discuss fish in Izok Lake and what species reside in the lake. MMG is following up with a site visit in August 2012.

Water quality

Interest was expressed about MMG's plans for tailings, waste and water management.

3.5 Future Engagement

The next phases of the engagement program will focus on clarifying Project-related issues, and seeking input to the assessment of Project alternatives and the development of mitigation strategies and management plans for the Project. Sessions will be conducted with regulators, community advisory committees, HTOs, mayors and councils, and the broader Kitikmeot public. MMG will continue to keep the Tlicho in NWT informed, and will arrange a meeting with the Inuvialuit Game Council to advise them of Project-related marine shipping proposed along the western route. MMG will also arrange for site visits during the summer of 2012.

MMG will prepare regular newsletters and fact sheets, and develop an Izok Corridor Project specific website to keep community members, organization and regulators apprised of progress being made on the Project.

Immediate engagement plans include a workshop on caribou-related concerns in Kugluktuk in September 2012, a site visit by the HTOs, biologists, DFO and KIA in August 2012, open houses and information/update sessions and other meetings in September 2012. Discussions related to potential alternatives for routing of the all-season road, traffic management and potential conflicts with caribou will be a high priority with all groups. MMG has also initiated discussions with Nunavut Government biologists.

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SECTION 4

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4 TRADITIONAL KNOWLEDGE

4.1 Introduction

MMG is building on the traditional knowledge studies initiated by Wolfden Resources Ltd. for the High Lake Project[1]. This previous work included the collection and compilation of traditional knowledge from elders, hunters and trappers, and several site visits. MMG will continue to build on its understanding of the environment as seen, perceived and valued by Inuit in support of the Draft Environmental Impact Statement (DEIS) for the Izok Corridor Project.

4.2 Approach and Methods

MMG will undertake a multi-part traditional knowledge program for the Izok Corridor Project. The program will include:

- Continued collection of documented knowledge for the entire Project area, including the commissioning of reports from the Naonayaotit Traditional Knowledge Program (NTKP) database managed by the Kitikmeot Inuit Association (KIA)
- Recording of Inuit Qaujimajatuqangit from Inuit in the Project area (elders, Hunters and Trappers Organization (HTO)) and Tlicho interests around Izok
- Incorporating issue-specific advice from community knowledge holders

While gathering knowledge is a core part of the work, MMG's primary interest is the application of this knowledge. In particular, MMG is interested in the contribution traditional knowledge can make to the design of the Project and aspects of the environmental assessment, including identification of issues, effects analysis, identification of potential mitigation measures, determination of effects significance and follow-up and monitoring programs.

Finally, traditional knowledge will be a crucial part of management plans developed for this Project. For example, the Kugluktuk HTO communicated their knowledge of the use of the Grays Bay area by the Dolphin and Union caribou herd before these animals migrate across the Coronation Gulf to Victoria Island in the spring.

4.2.1 Study Area

The study area for the collection of traditional knowledge includes the proposed eastern and western shipping routes and the region of the Kitikmeot west of Bathurst Inlet, south of Coronation Gulf, north of the NWT border and east of Rockinghorse Lake.

4.2.2 Applying Existing Traditional Knowledge

Existing traditional knowledge will be collated in a manner that supports information exchange and integration into work being carried out for the Project by the MMG environment and engineering teams. Traditional knowledge has already been incorporated in the mine design process, initial development of

[1] http://ftp.nirb.ca/02-REVIEWS/ACTIVE%20REVIEWS/06MN082-MMG%20HIGH%20LAKE/

environmental management plans and operational planning. For example, temporary road closures are being planned during the operational phase of the Project to facilitate caribou movements to calving areas in the vicinity of the proposed Izok Road. In addition, existing traditional knowledge, as reflected in the Draft West Kitikmeot Land Use Plan (NPC 2005), provides appropriate timing windows for marine shipping activities to minimize potential disturbances during the annual migration of the Dolphin and Union Caribou Herd between the mainland and Victoria Island.

4.2.3 Documenting Issue-Specific Traditional Knowledge

MMG plans to seek guidance in preparation of the DEIS from traditional knowledge documented during workshops. These workshops will focus on key issues and concerns articulated by communities for the region south of High Lake and for the proposed shipping routes. Workshops are expected to be held in Kugluktuk and Gjoa Haven. MMG is also arranging with the KIA to obtain a traditional knowledge report for the entire Project area.

MMG has been in contact with the Kwe Beh Working Group of the Tlicho Government, and will be gathering knowledge (e.g., existing literature, workshop) for their area of interest within Nunavut.

4.2.4 Integrating Traditional Knowledge

MMG understands the importance of incorporating traditional knowledge with popular science in all aspects of the Project, and the need for a balanced presentation of issues and conclusions in the DEIS. Accordingly, MMG has adopted an approach that seeks to integrate traditional knowledge into all Project phases including design, operations, closure and post closure. Recognizing that traditional knowledge is both a process and product, MMG will look towards traditional knowledge to contribute baseline information for the Project area, to support the assessment of effects and contribute to the understanding of issues and concerns of the Project and to plan for the mitigation of those effects. Traditional knowledge collection will involve discussions about how local residents view the Project and the acceptability of its potential effects on the environment and its people within the context of local knowledge. Specific issues and concerns regarding the Project will be considered and will form an integral part of the issues scoping process.

Izok Corridor Project Proposal

SECTION 5

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5 EXISTING BIOPHYSICAL ENVIRONMENT

5.1 Potential Valued Ecosystem Components

Based on regulatory and community engagement conducted in relation to the High Lake Project Draft Environmental Impact Statement (DEIS) and other Part 5 reviews for mining projects in Nunavut, MMG has developed a preliminary list of potential Valued Ecosystem Components (VECs) for the Izok Corridor Project. It is anticipated that this list of VECs will be further refined through the regulatory scoping process and ongoing public engagement. This will include selection of Key Indicator species, species groups or ecosystem functions that represent components of the broader Valued Components, which for practical reasons will be used to focus the assessment of potential residual Project environmental effects and cumulative effects in the DEIS.

Atmospheric Environment

- Air Quality
- Climate
- Noise and Vibration

Terrestrial Environment

- Landforms and Soils
- Vegetation
- Terrestrial Wildlife and Wildlife Habitat
- Terrestrial Birds

Aquatic Environment

- Hydrogeology
- Surface Hydrology
- Water and Sediment Quality
- Aquatic Organisms, Fish and Habitat

Marine Environment

- Water and Sediment Quality
- Aquatic Organisms and Habitat
- Marine Mammals and Habitat
- Marine Birds and Habitat

The following sections summarize existing information for each VEC within the Project area. Baseline conditions are described for both local and regional study areas (LSA, RSA) as defined for each VEC.

In most cases, descriptions of the existing environment are based on field data collected in 2004 and 2005 for the High Lake project DEIS, and more recently in 2007 and 2008 for the High Lake project proposal. Additional data are currently being obtained through ongoing (2012) field studies (including associated traditional knowledge) to support preparation of the Izok Corridor Project DEIS and provide baseline for future long-term monitoring programs that will be implemented during the Project.

5.2 Areas of Ecological Interest

There are several terrestrial and marine areas that are recognized for their wildlife and habitat values within the Kitikmeot and North Baffin Land Use Planning regions of Nunavut, and the Inuvialuit Settlement region of the Northwest Territories (NWT). These include National Parks, Territorial Parks, Migratory Bird Sanctuaries (federal protection) and Wetlands of International Importance (Ramsar Sites). These areas are protected through various federal and territorial legislation including the *Nunavut Wildlife Act, NWT Wildlife Act, Canadian Wildlife Act, Migratory Birds Convention Act* and the Ramsar treaty. There are also a number of other sites of importance in the region of the Project, including International Biological Program (IBP) sites, Canadian Heritage Rivers, key marine and terrestrial habitat sites and wildlife areas of special interest and importance. These areas are recognized as conservation areas under Article 9 of the Nunavut Land Claims Agreement (NLCA) but are currently not legally protected.

The footprint of the Izok Corridor Project does not overlap with the boundaries of any protected areas. There are portions of the proposed eastern and western shipping routes that will be in proximity to some marine conservation areas and polar bear areas of importance; however, ship passage will be limited to the ice-free season to limit any potential impacts on wildlife.

5.2.1 Protected Areas

Table 5.2-1 provides a summary of protected areas within the Kitikmeot and North Baffin regions and in the NWT along the proposed shipping routes. The locations of these areas are shown in **Figure 5.2-1**.

Table 5.2-1 Protected Areas within the Region of the Project

Area Name	Ecological Value	Protected Status
Anderson River Delta	Important bird breeding, moulting and staging habitat, including threatened species	Migratory Bird Sanctuary
Cape Parry	Globally significant waterfowl concentrations	Migratory Bird Sanctuary
Banks Island	Home to both the endangered Peary caribou and to the highest density of muskoxen in the world	Banks Island Migratory Bird Sanctuary 1 and 2, Aulavik National Park
Tuktut Nogait	Core calving and post-calving grounds of the Bluenose West caribou herd; major breeding and nesting ground for migratory birds	National Park
Kugluk/Bloody Falls	National historic site	Territorial Park
Ovayok (Mount Pelly)	Archaeological sites; important wildlife habitat	Territorial Park
Queen Maud Gulf	Major waterfowl nesting area	Migratory Bird Sanctuary, Ramsar Site
Thelon River	Unique flora, musk ox habitat, Important Bird Area (IBA); Canadian Heritage River	Game Sanctuary
Rasmussen lowlands	Nesting shorebirds and waterfowl; nesting Peregrine falcons	Ramsar site
Erebus Bay, King William Island	National historic site	Territorial Park
Seymour Island	Supports a population of the nationally vulnerable Ivory Gull	Migratory Bird Sanctuary
North Bathurst Island	Calving ground for Peary Caribou, archaeological sites	Proposed National Park
Port Refuge, Devon Island	National historic site	Territorial Park
Beechy Island	National historic site	Territorial Park
Prince Leopold Island	Major seabird colony	Migratory Bird Sanctuary
Bylot Island	Seabirds, polar bear denning	Bylot Island Migratory Bird Sanctuary, Sirmilik National Park

5.2.2 Conservation Zones

The Draft West Kitikmeot Regional Land Use Plan (NPC 2005) and North Baffin Land Use Plan (NPC 2000) identify a number of conservation zones in the region of the Project (**Figure 5.2-2**). These include key marine and terrestrial habitat sites, and wildlife areas of special interest. The eastern shipping route passes near the Jenny Lind Island key migratory bird habitat site, Creswell Bay Important Bird Area, and polar bear denning locations in Victoria Strait and Larsen Sound. The western shipping route passes near the Lambert Channel Polynya, which is an important ecological habitat feature during the winter months.

None of these areas lie within the Project Development Area.

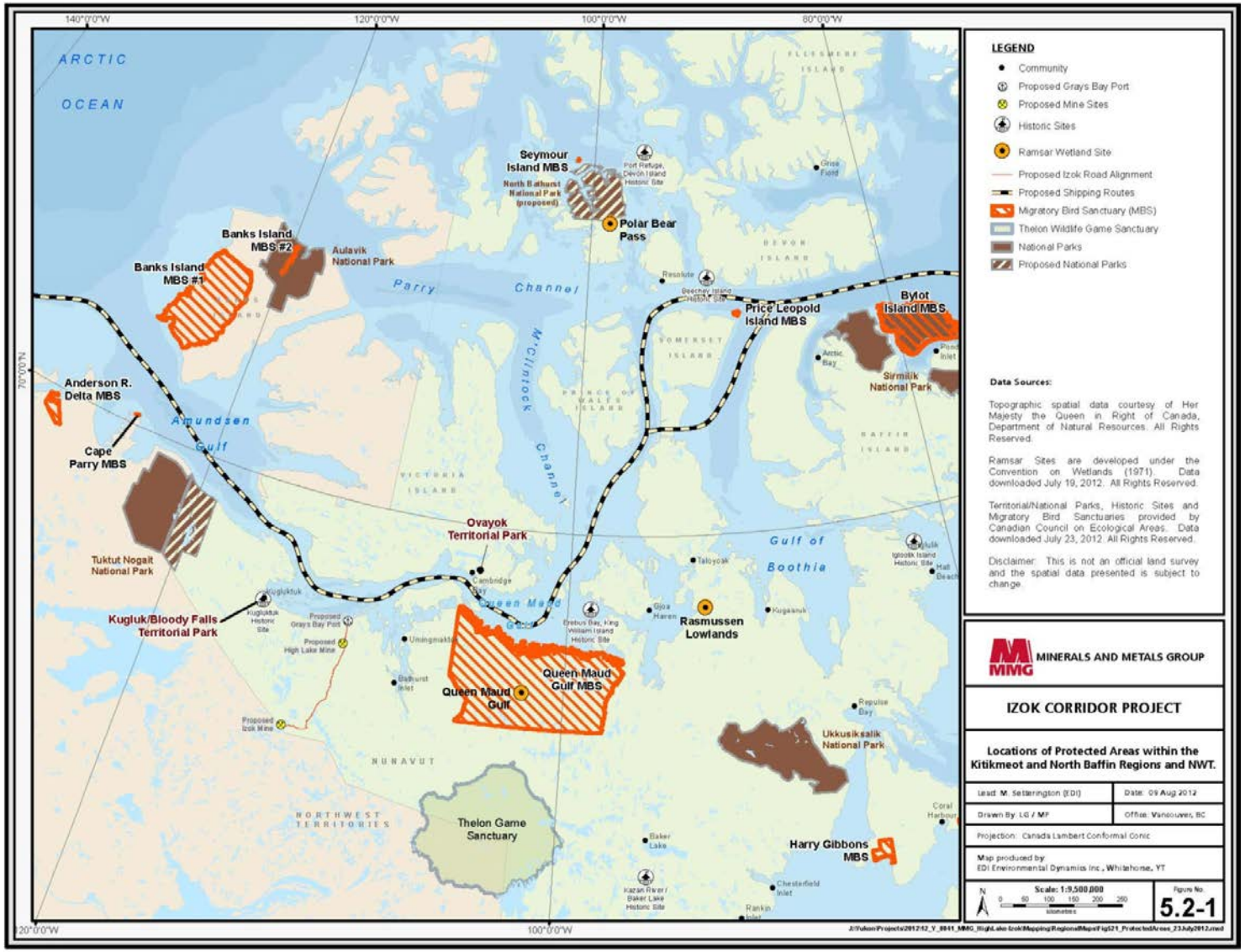


Figure 5.2-1 Protected Areas within the Kitikmeot and North Baffin Regions and NWT

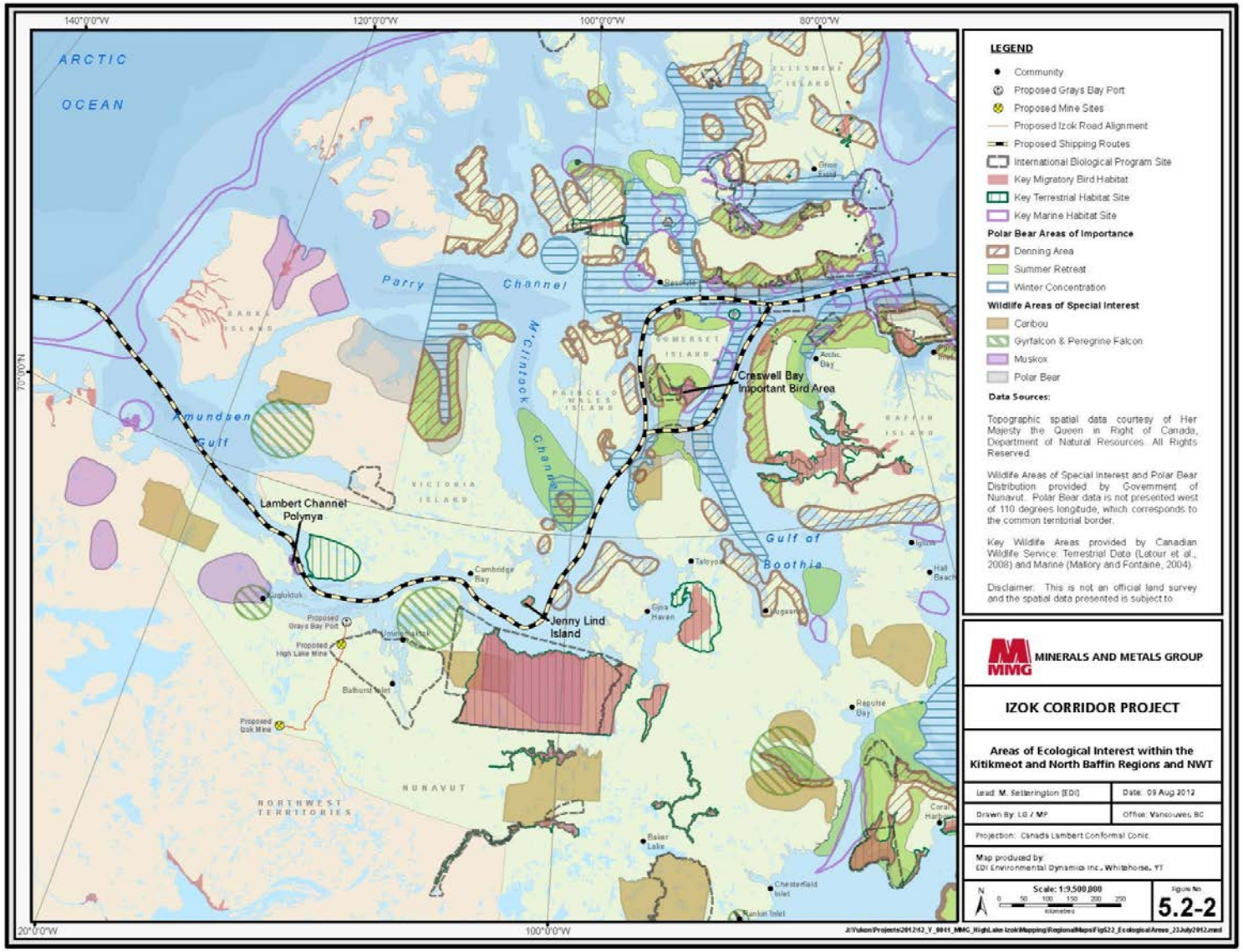


Figure 5.2-2 Areas of Ecological Interest within the Kitikmeot and North Baffin Regions and NWT

5.3 Air Quality

Given the remoteness of the Project, baseline air quality in the vicinity of the Project is essentially unaffected by local industrial, residential and transportation activities. However, ambient air quality in the Arctic, including the Kitikmeot region, is influenced by long-range transport of air contaminants from industrial sources located on other continents.

The Project will result in fugitive sources of dust, as well as atmospheric emissions from diesel combustion during mine operation, haul fleets, processing of ore and operation of the port facility. While carbon dioxide (CO_2) and water vapour (H_2O) are the primary products of combustion, trace amounts of oxides of nitrogen (NO_X), particulate matter with diameter less than 2.5 µm ($PM_{2.5}$), particulate matter less than 10 µm (PM_{10}), and suspended particulates (TSP) will also be produced. A portion of the particulates produced from combustion of diesel is comprised of metals.

Trace amounts of SO_2, carbon monoxide (CO) and polycyclic aromatic hydrocarbons (PAH) emissions will also be emitted from combustion sources and fugitive emissions of volatile organic compounds (VOCs) may occur.

5.3.1 Study Areas

Local Study Areas

Local Study Areas (LSAs) were defined for each of the main components of the Project (Grays Bay Port, High Lake Mine site, and Izok Mine site) to support assessment of Project effects on air quality. Each LSA is approximately 30 km x 30 km centred on the activity of interest, and includes a portion of Izok Road to consider the effect of haul traffic on air quality. The LSA for the Grays Bay Port also includes a portion of the shipping route. The boundaries of the LSAs were defined based on the area within which predicted concentrations will be 10% or less of maximum predicted concentrations in the LSA.

Air quality modelling will be based on model grid points within each LSA that are graduated with distance from the centre of the activity, approximately as follows.

- 20-m receptor spacing in the general area of the property boundary
- 50-m receptor spacing within 0.5 km from the source
- 250-m receptor spacing within 2 km from the sources of interest
- 500-m spacing within 5 km from the sources of interest
- 1000-m spacing beyond 5 km

Regional Study Area

The Regional Study Area (RSA) encompasses the three LSAs, and is defined as the area within which meteorology will be modelled, as one of the inputs to the dispersion models run within each of the LSAs. Emissions from major current or planned projects will be included in the RSA; however, the effects of these projects will only be modelled within the LSAs where they may interact with Project plumes.

5.3.2 Description of Existing Environment

Measurements of air quality in the RSA are sparse, widely separated, and span various time periods.

A primary source of air quality information is a particulate monitoring program conducted by an MMG predecessor at Izok Lake in September 2008. This information is supplemented by longer term monitoring data from Environment Canada monitoring stations in Yellowknife, Fort Liard, Norman Wells and Inuvik, which provide measurements of criteria gases, and Environment Canada particulate observations at Daring Lake NWT, 2002-2006. These data are expected to be indicative of air quality conditions in the Project Development area.

All available meteorology and climate data for the Project area were collected by MMG or its predecessors. This includes data collected at High Lake (February 2004 – August 2011), Izok Lake (September 2008 – August 2011), and Grays Bay (February 2010 – August 2011).

5.3.2.1 Air Quality Measurements

Criteria Gases

Air quality in the NWT is monitored by Environment Canada, and annual reports are readily available for the 2000 to 2006 period. Continuous ambient air quality monitoring is conducted at stations located in Yellowknife, Fort Liard, Norman Wells and Inuvik.

SO_2 is measured continuously at Yellowknife, Fort Liard, Norman Wells and Inuvik. Recent measurements indicate that background maximum 1-h SO_2 concentrations have ranged from 11 µg/m^3 to 16 µg/m^3. Similarly, the annual average SO_2 concentrations range from 1 µg/m^3 to 5 µg/m^3. Expected background concentrations on site are likely to be lower.

NO_2 is measured continuously at Yellowknife and Inuvik. Maximum 1-h NO_2 concentrations measured at the two sites were 50 µg/m^3 and 89 µg/m^3, respectively. Corresponding annual average concentrations ranged from 5 µg/m^3 to 12 µg/m^3, respectively. These levels, however, are likely attributable to combustion sources near the monitoring stations (e.g., vehicles, residential heating).

CO is measured continuously at Yellowknife. The maximum measured 1-h CO concentration was 2,000 µg/m^3. Most of the hourly concentrations are less than 200 µg/m^3.

Particulate Matter

Izok Lake

Measurements of hourly $PM_{2.5}$ were conducted at Izok Lake from 9 to 28 September 2008, resulting in 336 h of valid data. Measurement statistics indicate that most reported concentrations were less than 1 µg/m^3 (the median value was zero and the 90th percentile value was 1 µg/m^3. Based on very limited data, maximum values were measured before midnight.

Daring Lake

The Environment Canada Daring Lake air quality station is located about 100 km south of Izok Lake. Particulate concentration data collected during the summers of 2002 to 2006 (**Table 5.3-1**) indicated the following.

- The highest measured $PM_{2.5}$ concentration was approximately 42 $\mu g/m^3$, which occurred in late July 2004 and was attributed to smoke from forest fires burning south of Great Slave Lake.
- The median $PM_{2.5}$ concentration was 2 $\mu g/m^3$, and the 90th percentile ranged from 2.8 to 14 $\mu g/m^3$ over the years 2002 to 2006.
- Maximum concentrations of $PM_{2.5}$ and PM_{10} were measured during the month of July; median concentrations tended to decrease over the summer months.

With the possible except of 2004 data, Daring Lake data are expected to be representative of PM_{10} and $PM_{2.5}$ concentrations in the Project area.

Table 5.3-1 Daring Lake 24-Hour Particulate Concentration Statistics ($\mu g/m^3$), 2002 to 2006

Sample Date	PM_{10} 2002	$PM_{2.5}$ 2003	$PM_{2.5}$ 2004	$PM_{2.5}$ 2005	$PM_{2.5}$ 2006
Minimum	0.0	0.14	0.97	0.00	0.31
Median	1.7	1.9	4.7	1.2	1.3
Average	1.6	2.4	7.1	1.5	1.8
90th Percentile	2.8	5.2	14	3.2	3.8
Maximum	3.3	6.8	41.5	3.8	5.4

5.3.2.2 Meteorology and Climatology Measurements

Wind Speed and Direction

Available wind data for the Project area suggests that:

- Predominant winds at Grays Bay are from the north-northwest. Winds blow along the shoreline relatively infrequently. The strongest winds blow from the north-northwest.
- Predominant winds at High Lake are from the south and about 5% of winds were calm. The frequency of calms is more than 5.1 %. There is little seasonal variation in wind direction frequency.
- Predominant winds at Izok Lake are from the northeast. Winds are calm 7% of the time. There is little seasonal variation in wind direction frequency.

Temperature

Based on hourly average temperatures measured at Grays Bay, High Lake and Izok Lake for their respective periods of record (see above), there was a clear seasonal variation in median and maximum hourly average temperature for the three stations. Further, there was also a slight diurnal variation in median and maximum average temperatures.

Precipitation

Available data on daily total precipitation at Grays Bay (2010-2011), and daily total rainfall at High Lake (2006-2011) and Izok Lake (2008-2011) indicate that the coastal station had the highest daily values. At Grays Bay, monthly total precipitation reached 70 mm and the maximum occurred in July. At High Lake, monthly total rainfall reached 45 mm and the maximum occurred in September. At Izok Lake, monthly total rainfall reached 55 mm and the maximum also occurred in September.

5.3.3 Ongoing and Future Studies

Atmospheric conditions are being monitored continuously in 2012 at the Izok and High Lake Mine sites. These measurements will be compared with data from the Environment Canada monitoring stations to update existing baseline information for the Project. A meteorological model for the Project with be developed using this baseline information.

5.4 Noise and Vibration

Noise is generally defined as an unwanted portion of sound and is one of the unavoidable effects of industrial development. Activities associated with construction, operation, and closure of the Izok Corridor Project will introduce noise into the local environment. Since noise travels through air and water, any increase is treated as a potential effect on organisms living in atmospheric and aquatic environments, including humans, wildlife and fish.

5.4.1 Study Areas

Local Study Areas

The LSA for atmospheric noise is defined as a 3 km radius around the footprints of the major Project components, including the Izok and High Lake Mine sites and associated infrastructure, Izok Road and Grays Bay Port.

For the marine environment, the LSA is based on the extent of possible underwater noise-related effects on marine mammals. This area extends 5 km from the dock site at Grays Bay and 5 km on either side of the shipping routes.

Regional Study Areas

The RSA extends beyond the LSA to encompass Project effects that may interact with similar effects from other projects and activities in the region. This area is defined by a 20 km buffer area extending beyond the LSA for the mine sites and Izok Road.

For the marine environment, the RSA encompasses the coastal areas along the western and eastern shipping routes.

5.4.2 Description of Existing Environment

The Project is located in a pristine, natural area that is remote from established human settlement. The closest community is Kugluktuk, which is located approximately 179 km west of the Grays Bay Port site. There is neither industrial nor resource extraction development within the vicinity of the Project Development area. The closest development project is Lupin Mine, 80 km east of Izok camp, which is currently on care and maintenance. With the exception of exploration activities at the High Lake and Izok sites, the only noise in the area is generated by natural source such as wind and precipitation.

There is no available information to establish baseline vibration within the Project area. With the exception of some limited exploration activities, there are no substantial sources of vibration at the Izok or High Lake Mine sites.

Terrestrial RSA

Background atmospheric noise levels in remote areas are typically low, ranging from about 25 to 40 dBA. Baseline noise surveys conducted for two remote northern mining projects (Diavik and Snap Lake) reported background noise levels ranging from 25 to 40 dBA (Diavik 1998) and 23 to 40 dBA (De Beers 2002). The average hourly noise level reported at the Snap Lake site was 35 dBA (De Beers 2002). These levels were also reviewed and accepted as characteristic of background levels in the Doris North Gold Project (Miramar 2005).

Marine RSA

Limited information is available on noise levels in the marine environment. Measured ambient levels in the open ocean, remote from any anthropogenic noise sources range from 74 to 100 dB (Heathershaw 2001). No measurements of ambient marine noise levels are available for the Canadian Arctic. However, noise levels associated with active ice-breaking activities in the Beaufort Sea have been reported to range from 192 dB (bubbler associated noise) to 205 dB (associated with propeller cavitation) (Erbe and Farmer 2001).

There is no regular ship traffic within the Project area and background marine noise levels are expected to be associated with natural sources (e.g., marine life, wave action) and within the range identified for the open ocean (74 to 100 dB). Sound levels in marine environments are referenced to a base pressure of 1 μPa and are not perceived at the same level as dBA reported for atmospheric noise.

5.4.3 Future Studies

No further field work is planned to collect ambient noise data for the Project Development area. A terrestrial noise model will be prepared for the terrestrial assessment using publically available regional information.

A marine noise model will also be developed for the marine assessment using publically available data for the region. Ambient noise levels will be measured prior to construction of the port site and these data will be used as input into the model to management local noise effects. Mitigation measures will be designed to meet all regulatory thresholds.

5.5 Hydrogeology

The proposed Project lies within a continuous permafrost region of western Nunavut. Within continuous permafrost regions, groundwater flow occurs beneath the permafrost, within taliks (unfrozen ground beneath lakes), and in the shallow active layer above the permafrost. Bedrock geology, permafrost and lake taliks play a critical role in defining the deep groundwater flow system.

5.5.1 Study Areas

Local Study Areas

A Local Study Area (LSA) was identified for both the Izok Mine and the High Lake Mine based on the maximum possible area that may be susceptible to changes in groundwater quality and quantity.

The depth of the LSA is also important to define because of the underground mining component of the Project. The open pit at the Izok Mine is anticipated to be on the order of 180 m deep, and the Inukshuk underground mine will be on the order of 280 m deep. The AB and D open pits at the High Lake Mine are anticipated to be on the order of 155 m and 90 m deep, respectively. The maximum depth of the West Zone underground mine at High Lake is anticipated to be 540 m below ground surface (bgs). A maximum LSA depth of 800 m bgs at the Izok Mine and 1300 m bgs at the High Lake Mine is thought to be adequate because it is the expected maximum depth to which potential effects on groundwater flow patterns and groundwater quality are possible.

Within the Izok Mine LSA, there is approximately 95 m of variation in surface water elevations. Ground surface elevations range from approximately 410 m above seas level (asl) to 500 m asl. Izok Lake has a surface elevation of approximately 417.4 m asl. Iznogoudh Lake, located upstream of Izok Lake, has a surface elevation of 424 m asl. Itchen Lake, located downstream of Izok Lake, has a surface elevation of 411 m asl.

Within the High Lake Mine LSA, there is approximately 150 m elevation change in surface water elevations. The ground surface elevation is approximately 365 m asl near the West Zone, and at 200 m asl at the shore of the Kennarctic River. High Lake has a water surface elevation of 283 m above mean sea level (amsl).

Regional Study Area

Because the deep groundwater system at both the Izok Mine and High Lake Mine is anticipated to move very slowly as a result of permafrost and low conductivities of the rock mass, there is no need to define a Regional Study Area (RSA) for the hydrogeological component of the Izok Corridor Project.

5.5.2 Description of Existing Environment

Field investigations have been conducted at the Izok and High Lake Mine sites to determine pre-mining hydraulic heads, groundwater flow directions, groundwater temperatures and groundwater quality. For the High Lake Mine site, pre-mining hydraulic heads, groundwater flow directions, and groundwater velocities have also been estimated using a numerical groundwater model.

Three supporting documents describe in detail, the field work and numerical groundwater modelling work undertaken at both the Izok Mine and the High Lake Mine.

- Izok Lake Project - Draft Hydrogeological Technical Report (2011)
- Hydrogeological Modelling of the Proposed High Lake Mine (2006)
- Hydrogeology Field Reports, High Lake (2005 and 2006)

5.5.2.1 Surficial Geology

Izok Mine LSA

The surficial geology of the Izok Mine area was mapped in 1996 (Dredge et al. 1996). The area was last glaciated approximately 10,000 years ago during the late Wisconsinan glaciation. Glaciers eroded the upper layers of highly weathered bedrock and covered them with till deposits up to 10 m thick. Composition of the till is highly variable and contains large boulders and a fine grained-ice rich matrix. Less abundant surficial deposits include sand and gravel deposits from glaciofluvial processes and organic (peat and mud) deposits.

High Lake Mine LSA

Rees (1994) and Rampton and Thomas (1993) describe the general recent geological history of the High Lake Mine area. Surficial geology of the High Lake Mine area was previously described by Gartner Lee Limited (GLL) (2005a, 2006a) and BGC Engineering (2006a). The High Lake area was glaciated by the Keewatin section of the Wisconsin Laurentide Ice Sheet. Ice advanced in the area from the east to the northwest, scouring the rocky surface and depressing the ground surface due to the weight of the Ice. As the ice started to retreat from the area, thick marine sediments were deposited near the coast and in low areas connected to the sea. It is estimated that the sea level during deglaciation was 210 m higher than present. The removal of the ice allowed the ground to rebound, stranding the marine sediments in the lower areas such as in the Kennarctic River valley, downstream of High Lake and a few other areas near the coast. Streams are now eroding many of these areas of thick marine silt and clay.

Melting glacial ice resulted in the deposition of an unsorted, boulder rich diamicton that forms thin morainal deposits over most of the area surrounding High Lake. Morainal deposits in the High Lake area are usually thin veneers, blankets and felsenmeers (boulder fields) that cover most of the surface of the study area. Meltwater channels associated with deglaciation are filled with glaciofluvial material, comprising a mixture of boulders, cobbles, gravel and sand. In some areas, the till surface has been washed by post-glacial melt water, leaving a granular veneer.

5.5.2.2 Bedrock Geology

Izok Mine LSA

The Izok deposit is situated within the Slave Structural Province of the Canadian Precambrian Shield. The Slave Structural Province is composed of Archean volcano-sedimentary rocks, which have been grouped into two formations; the Contwoyto and the Lower Point Lake. The Point Lake Formation is comprised of felsic to mafic tuffs and metasediments, whereas the Contwoyto Formation is composed of equivalently

metamorphosed greywackes and mudstones (turbidites). These formations were later intruded by late Archean bodies and crosscut by the Helikian-aged diabase dykes called the Mackenzie Swarm.

The Izok Lake volcanogenic massive sulphide (VMS) deposit is hosted within or near the top of the Point Lake Formation. It is comprised predominantly within felsic volcanic (rhyolitic) rocks with lesser intermediate (dacite) and mafic (gabbro) volcanic rock and metasedimentary rock. Exposed bedrock outcrops around Izok Lake consist of granitic rock (north and west), volcanic rock (south) and metasediments (east).

The target ore bodies, referred to as the Izok and Inukshuk deposits, are situated directly underneath and just east of Izok Lake. The VMS deposits contain commercial quantities of zinc, copper and lead and to a lesser extent silver. Structural geology reports have described the mineralized gossan zones as intensely deformed by folding and faulting making delineation of the deposit complicated.

A detailed structural report based on surficial bedrock measurements and drill core suggests four different structural domains within the Project area on the basis of the orientation of the dominant foliation and degree of refolding (SRK 2010). Subsequent detailed bedrock mapping was conducted over a small area east of Izok Lake by Stibley (2011). MMG's borehole database and available geologic mapping have since been synthesized into a geologic model of the Izok deposit (AMC 2012) that illustrated two primary discontinuities in the vicinity of the open pit and underground mine: one trending north-south, and the second trending northwest-southeast.

High Lake Mine LSA

The High Lake West Zone, AB Zone and D Zone deposits are hosted within the High Lake greenstone belt, which is located in the northern part of the Slave Structural Province. It is broadly located within the Archean Slave Province consisting of a basement gneiss overlain by thick successions of greywacke, turbidites and basalt. The general bedrock geology units are felsic to ultramafic metavolcanic rock (country rock) and intrusive hornblende/biotite granodiorite and diabase dykes. The belt is greenschist facies (chlorite) with amphibolites facies (andalusite) rocks occurring to both the north and south. The bedding planes of the volcanic country rock are near vertical and trend north to south. Intrusive granodiorite and diabase dyke are hosted within the volcanic country rock. The High Lake deposit is located near the eastern margin of the western domain of the greenstone belt, and within the Rush Lake Sequence. This sequence consists of felsic-intermediate flows and tuffs that have been hydrothermally altered in places. The sequence consists mainly of intermediate and felsic volcanic and non-bedded volcaniclastic rocks. It is marked by a horizon of chemical sedimentary rocks including a banded iron formation and marble. Rocks in the Western domain are of greenschist grade and characterized by an abundance of gossans and syn-volcanic base metal occurrences. Several massive sulphide deposits contain substantial gold. A more detailed bedrock geology description can be found in Henderson et al. (2000).

5.5.2.3 Permafrost

Both mine sites are located within the continuous permafrost zone, with open taliks (unfrozen zones beneath lakes) providing the only connection between surface water and the deep (sub-permafrost) groundwater flow system. Permafrost is highly variable and depends on the surficial soil thickness and type, the depth and proximity of surface water bodies and slope aspect. Frozen ground is considered

relatively impermeable to groundwater flow, with permafrost reducing the hydraulic conductivity of the rock by at least one to two orders of magnitude (Burt and Williams 1976).

Izok Mine LSA

Several thermistor strings were installed as part of the 1993 geotechnical investigation (EBA 1994) and the 2008 hydrogeological investigation (AECOM 2011). In 2008, a number of thermistor strings outfitted with dataloggers were installed to continuously monitor ground temperatures over time both within Izok Lake and surrounding it. Available ground temperature data from thermistor strings installed within and surrounding Izok Lake suggest a through talik exists underneath Izok Lake. The base of permafrost surrounding Izok Lake is estimated to be 251 m to 300 m bgs. Preliminary thermistor data suggests that the active layer may be up to 8 m thick. Ongoing data collection and analysis is focused on characterizing the seasonal and spatial variability in ground temperatures surrounding the mine site to support engineering studies.

High Lake Mine LSA

A number of thermistor strings were installed as part of geotechnical investigations in 2004, 2005 and 2006 (BGC 2006a) and hydrogeological investigations conducted in 2005 and 2006 (GLL 2005a, 2006a). Thermistors indicate that, in the vicinity of the West Zone at the High Lake Mine, the base of the permafrost is at 440 m bgs. This is equivalent to about 75 m below mean sea level. Thermal modelling indicates that through taliks connecting surface water and the underlying groundwater system exist below lakes where the surface water depth is greater than 2 to 2.5 m. Below smaller lakes where the talik is surrounded by permafrost, closed taliks are present and permafrost occurs at a depth below the talik. Below larger lakes, where the talik extends to the base of the permafrost, through taliks are present. Elongated lakes with a width greater than 240 m that do not freeze to the bottom in winter have a through talik. Round lakes that do not freeze to the bottom in winter with a diameter greater than 470 m also have a through talik. As a result, a through talik exists below High Lake and a number of other lakes in the LSA.

Beneath the Kennarctic River, near High Lake, permafrost conditions are near freezing. Thermal modeling and thermistor data beneath the edge of the Kennarctic River indicate that the ground temperature is marginally below freezing. These results indicate there may be pockets of unfrozen ground that permit groundwater exchange between the shallow surface water system and the deep groundwater flow system underlying the Kennarctic River. The working assumption is that a through talik exists underneath the Kennarctic River in the wider sections of the riverbed. There are two sections that are adjacent to High Lake and Lake L34 where a through talik is expected to exist because of the proximity to the larger lakes and the wider width of the Kennarctic River.

5.5.2.4 Permeability Testing

Hydrogeological field investigations were conducted at the High Lake Mine in 2005 and 2006 (GLL 2005a, 2006b). A separate investigation was conducted at the Izok Mine in 2008. Ongoing investigations are focused on collecting additional hydraulic conductivity information, monitoring groundwater elevations, characterizing permafrost and determining baseline groundwater quality at both the Izok and High Lake Mines.

Izok Mine LSA

A total of 21 packer tests were conducted by AECOM during the advancement of six NQ sized (76 mm) diamond drill exploration boreholes in 2008. Two slug tests were conducted to characterize the hydraulic conductivity of the overburden. Boreholes tested were up to 647 m deep in the vicinity of the proposed open pit and underground mines at the Izok Mine.

Two falling head slug tests were conducted on overburden soils as part of the hydrogeological investigations, with hydraulic conductivity values ranging from 2.5 x 10^{-4} m/s to 3.0 x 10^{-4} m/s. The geometric mean hydraulic conductivity for overburden is 2.7 x 10^{-4} m/s, which is equivalent to a silty or clean sand unit (Freeze and Cherry 1979).

Two packer tests were conducted over an interval where the dominant geological unit was weathered bedrock. Weathered bedrock hydraulic conductivity values ranged from 1.1 x 10^{-7} m/s to 2.0 x 10^{-7} m/s with a geometric mean of 1.5 x 10^{-7} m/s, which is within the range of literature reported hydraulic conductivity values for fractured igneous and metamorphic bedrock (Freeze and Cherry 1979).

A total of 19 packer tests were conducted on relatively unweathered (fresh) bedrock units. Fresh bedrock hydraulic conductivity values ranged from 2.8 x 10^{-10} m/s to 5.0 x 10^{-7} m/s with a geometric mean for all bedrock units of 1.8 x 10^{-7} m/s. This value is within the range of literature reported hydraulic conductivity values for unfractured and fractured igneous and metamorphic bedrock (Freeze and Cherry 1979).

High Lake Mine LSA

Hydraulic conductivity testing was completed in lake taliks underlying High Lake and L12, and in deep exploration boreholes extending up to 900 m and below the base of permafrost near the West Zone underground mine.

Packer testing was conducted in the following locations: two boreholes in the talik below High Lake, one borehole in lake talik near the West Zone (below Lake L12), and two deep boreholes near the West Zone (beneath the permafrost). The hydraulic conductivities measured in shallow volcanic country rock ranged from about 1 x 10^{-6} m/s to 3 x 10^{-9} m/s, with a most representative value (geometric mean) of 5 x10^{-8} m/s. The hydraulic conductivities measured in deep volcanic country rock ranged from about 10^{-9} m/s to 10^{-11} m/s, with a most representative value (geometric mean) of 5 x10^{-10} m/s.

5.5.2.5 Shallow Groundwater Flow Regime

Shallow groundwater flow is expected within the seasonally active layer above the permafrost from June to September. When temperatures are above freezing, the active layer becomes thawed (typically late spring to late summer). Shallow groundwater is anticipated to flow from topographic highs to topographic lows along the top of permafrost within the active layer, and eventually discharge to surface creeks or lakes. Permafrost is inferred to restrict recharge and encourage surface runoff wherever it is present. The active layer has no direct hydraulic connection with the deep groundwater flow system.

Izok Mine LSA

Preliminary data collected from thermistor strings and shallow groundwater monitoring wells installed during September 2008 suggests that the active layer ranges in thickness from 0 m to 8 m at the Izok Mine. The active layer consists predominantly of overburden material with lesser amounts of weathered bedrock. Relatively high overburden permeability and porosity values may permit groundwater to flow easily through this unit during the unfrozen months.

There is potential for substantial groundwater flux from adjacent lakes to enter the proposed pit shell through unfrozen taliks underlying both the inlet and outlet of Izok Lake. Additional ongoing investigation will help understand permafrost and groundwater flow beneath the inlet and outlet channels of Izok Lake.

High Lake Mine LSA

At the High Lake Mine, the depth of the active layer is estimated to be 5 m for exposed bedrock and 2 m for overburden such as till. The shallow groundwater flow has little to no hydraulic connection with the deep groundwater flow system below the permafrost at High Lake. However, deep groundwater flow can occur beneath lakes via taliks, connecting surface water to the deeper, regional groundwater flow system. Shallow groundwater flow in the active layer from one lake to another is expected to occur in areas where containing topography is at a lower elevation than the active layer depth.

5.5.2.6 Deep Groundwater Flow Regime

The deep groundwater flow system is the flow system beneath permafrost. It interacts with surface water bodies through open taliks beneath large lakes and rivers. During unfrozen months, shallow groundwater will flow rapidly through overburden along the top of bedrock (or permafrost). Permafrost acts as an impermeable unit creating semi-confining conditions within the deep system. Groundwater within the generally low permeability deep system travels primarily through a series of connected rubble zones and fractured rock zones. It appears that hydraulic conductivity decreases with depth although additional factors (bedrock type, weathering etc.) appear to affect hydraulic conductivity on the local scale. The weathering potential decreases with depth and overburden pressures increase. As a result, the quantity of fractures and the fracture aperture may decrease, resulting in lower porosity and hydraulic conductivity with depth. Several vibrating wire piezometers have been installed to monitor seasonal fluctuations in groundwater levels and temperatures at both the Izok Mine and High Lake Mine and establish both vertical and horizontal groundwater flow gradients.

Izok Mine LSA

Four hydrostratigraphic units have been identified in the vicinity of the Izok Mine including overburden, weathered bedrock, fresh bedrock and faults.

Bedrock hydraulic conductivity values vary over four orders of magnitude but are within the range of literature reported hydraulic conductivity values for unfractured and fractured igneous and metamorphic bedrock (Freeze and Cherry 1979). Higher hydraulic conductivity values were observed in testing intervals that exhibited a greater degree of fracturing, while lower hydraulic conductivity values were observed in areas of competent, unfractured and silicified rock.

Groundwater heads indicate downwards groundwater flow from the lake to the deep groundwater system. They also indicate a relatively low horizontal groundwater flow gradient of 0.001 from beneath Izok Lake towards Itchen Lake. Based on measured hydraulic heads the deep groundwater flow system is assumed to be completely saturated with regional flow from Izok Lake towards the south east. The deep groundwater elevation beneath Izok Lake is similar to that of Itchen Lake, which may indicate a hydraulic connection between the two lakes.

High Lake Mine LSA

Three hydrostratigraphic units have been identified in the vicinity of the Izok Mine including overburden, weathered bedrock and fresh bedrock. Although faults have been identified based on geologic mapping, they have not been tested or included in the conceptual groundwater model.

Thermal modelling identified the following lakes within the LSA as those that were likely to have a through talik connecting the lake to the deep groundwater flow system: L16 (High Lake), L4 (Granite Lake), L5, Duck Lake, L34, and L718. In addition, thermal modelling indicates a through talik could exist beneath sections of the Kennarctic River. The pre-mining groundwater elevation (hydraulic head) beneath the permafrost was determined using three-dimensional groundwater modelling. Groundwater flow surrounding the High Lake Mine is generally to the northeast and toward the Kennarctic River through a very low permeability bedrock system. All groundwater that recharges through taliks, must travel approximately 440 m vertically downward before entering the deep groundwater flow system and travelling horizontally toward the point of groundwater discharge (e.g., Kennarctic River or lake).

5.5.2.7 Groundwater Quality

Izok Mine LSA

Multiple shallow groundwater samples were collected from monitoring wells installed in the active layer (GLL08-1 and GLL08-2) in 2008. GLL08-1 is located southwest Izok Lake and the ore body. Highly elevated concentrations of physical parameters, anions and dissolved metals exist within shallow groundwater and are attributed to calcium chloride brine drilling fluids. GLL08-2 is located east of Izok Lake and ore body. Analytical results for major anions (bicarbonate, chloride and sulphate) and major cations (calcium, magnesium, sodium) indicate that groundwater is a dilute calcium-magnesium-bicarbonate groundwater. These concentrations are presumed to be representative of background concentrations within the active layer. Ongoing studies will attempt to characterize the quality of groundwater within the Izok Lake talik and the active layer surrounding Izok Lake to support development of a site-wide water balance.

High Lake Mine LSA

During the 2006 hydrogeology field program, a water quality sample was collected from the talik boreholes drilled below High Lake in the volcanic country rock. Groundwater quality was measured in the High Lake talik in early 2006 at a depth of about 25 m below the top of the bedrock and compared to surface water quality. Groundwater within the High Lake talik exhibited a pH of 7.4, conductivity of 132 μS/cm, and a hardness as $CaCO_3$ of 53 mg/L. Median High Lake surface water pH was 6.95,

conductivity was 89.4 μS/cm, and hardness as $CaCO_3$ was 34.6 mg/L. Dissolved concentrations are reported for metals in groundwater and surface water.

In terms of major ions, groundwater in the High Lake talik is geochemically similar to High Lake surface water. In contrast, trace metals including cadmium, copper and zinc are considerably lower in the talik groundwater than High Lake surface water. This reduction suggests an attenuation mechanism exits within the High Lake talik, as groundwater flow is downward. However, molybdenum is considerably higher in the talik groundwater than the surface water. The measured talik groundwater quality exceeds the CCME water quality guideline (protection of Aquatic Life) for cadmium and copper. The remaining trace metal constituents measured in the talik groundwater are below CCME water quality guidelines.

Deep groundwater quality has not been sampled in or near the LSA for High Lake. As a result, the best source of information available is published values for deep underground mines in the Canadian Shield. It is well known that groundwater quality deteriorates with increasing depth in the Canadian Shield (Frape and Fritz, 1987). At a depth of about 1,000 m, groundwater is often saline, with calcium-sodium-chloride dominating. The proposed West Zone underground mine will extend to almost 900 m below ground surface (bgs), while the base of the permafrost is expected to be 440 m bgs.

The main literature source available for the estimation of deep groundwater quality is Frape and Fritz (1987). Additional information was obtained from the Lupin mine project (Ruskeeniemi et al. 2002, Ruskeeniemi et al. (2004), and personal communication with T. Ruskeeniemi). Estimates of deep groundwater quality were made based on available literature data and indicate that baseline concentrations of some parameters including cadmium, lead, copper, aluminum, nickel, iron and zinc may exceed CCME guidelines and exhibit total dissolved solids concentrations between 5,000 and 50,000 mg/L. As part of ongoing work, information available from other new mines will be included in the interpretation of deep groundwater quality at the High Lake Mine.

5.5.3 Ongoing Studies

The 2012 hydrogeology field program includes:

- A baseline hydrotechnical surface water field program to characterize the hydrological baseline conditions of the Project area
- A snow pack survey and stream flows during freshet and the early, mid and late summer periods
- Surveys of large streams at Izok and High Lake Mine sites that are likely to flow throughout the year

5.6 Freshwater Environment

5.6.1 Surface Hydrology

An understanding of the hydrology of the Project area requires knowledge of the climate, including precipitation and evaporation/evapotranspiration, as well as stream flows. Factors such as topography, soils, permafrost, ground cover and vegetation greatly influence the paths of water taken as part of the hydrologic cycle, including surface flow and groundwater inflow. Stream flow is a key parameter used to understand the hydrology of a particular area, as it is the only part of the hydrologic cycle in which surface water is so confined as to permit reasonably accurate measurements of quantities involved. For

the Izok Corridor Project, the design, construction and operation of the various components of the mine plan will involve consideration of surface water quantities with respect to the design of dams, tailings impoundments, settling ponds, culverts, bridges, water treatment facilities, potable water demands and storm water management systems. As such, any potential changes to the long-term annual and seasonal spatial and temporal characteristics of existing surface water regimes created by these Project components need to be identified and quantified to the degree possible to allow for development of appropriate mitigation.

5.6.1.1 Study Areas

Local Study Areas

LSAs for the Izok Mine site, High Lake Mine site and Izok Road were based on the maximum possible spatial extent of Projects effects on surface water flow.

The LSA for the Izok Mine lies within the Nunavut territory and includes:

- Izok Lake and its watershed
- Iznogoudh Lake
- Itchen Lake
- Ham Lake

The LSA for the High Lake Mine encompasses three primary drainages.

- High Lake, its basin area plus its outlet to the Kennarctic River
- Granite Lake, its basin area plus its outlet to the Kennarctic River
- The Kennarctic River above and below the High Lake outlet, as well as the Kennarctic River below the Granite Creek outlet
- All water courses within the Project footprint extending to the upstream extent of their catchments

The Izok Road LSA encompasses an area three times the channel width upstream and downstream of each stream crossing, or 100 m, whichever is greater.

Regional Study Area

The RSA is bounded by the maximum spatial extent of potential Project effects on surface water regimes, which could extend beyond the LSA boundaries and act cumulatively with effects of other projects in the region. The RSAs for the three major Project components are defined as follows.

- Izok Mine - The Itchen Lake watershed including upstream surface runoff contributions from Izok Lake, Iznogoudh Lake and Ham Lake, and downstream to its outflow to Point Lake
- High Lake Mine - The Kennarctic River from its confluence with High Lake outflow, downstream to its outlet at Grays Bay at the Arctic Ocean
- Izok Road - Water bodies up to 1 km on either side of the road alignment centerline

5.6.1.2 Description of Existing Environment

Izok Mine - Based on a gap analysis of surface water information for the Izok Project area (GLL 2008a), it was concluded that almost no information existed within the study area to characterize its hydrology sufficiently so as to relate it to distant long-term stations. Within the Izok area, some short-term baseline hydrology and climate data exist for the years 1993-1994 and 2001-2002, with some additional data and analysis available from the Lupin and Jericho mine projects. To address these data gaps, additional baseline data were collected in 2008, including seven snow courses prior to the 2008 runoff period, and installation of 11 stream water level loggers and two lake level loggers (included in this total was re-activation of a WSC station 10PB002 on Izok Lake inflow) followed by measurement of stream discharges.

High Lake Mine - Baseline hydrology information was collected over three summer seasons (2004 to 2006) as part of the High Lake project. Five snow courses were completed in 2004: three at the High Lake Mine site, and two in the Ulu area. Sixteen snow courses completed in 2005: five were at the High Lake site, and four in the Ulu area. No snow course measurements were conducted in 2006.

In 2004, water level recorders were installed at three locations at the High Lake site and two locations at Ulu. In 2005, seven water level recorders were installed at High Lake and two at Ulu. In 2006, eight water level recorders were installed at the High Lake site.

In addition to recorded water levels, channel cross sections were surveyed and discharge measurements were made, where it was safe to do so.

Izok Road - Baseline hydrology information was collected along the road route in 2004 to 2006 in support of the High Lake project DEIS. This involved the completion of snow courses, as well as installation of water level recorders and discharge measurements at various road stream crossing sites. Seven snow courses were completed in 2005. In 2004 and 2005, three water level recorders were installed at three stream crossing sites, and a discharge measurement was made at 15 stream crossings. In 2006, only one water level recorder was installed at a road crossing.

Izok Mine LSA

Iznogoudh Lake

Outflow from Iznogoudh Lake is conveyed via a short channel into Izok Lake. The lake drainage area is 338 km^2. A Water Survey of Canada (WSC) gauge No. 10PB002, which operated at the outlet in 1993, 1994 and 2008, shows outflow beginning during the period 22 May to 01 June when daily mean temperatures rise and stay above zero; the peak occurred two to three weeks later and the base-length of the snowmelt component of the hydrograph was about 10 weeks. Later hydrograph peaks occurred in September and October due to rainfall. Depths of runoff from the basin were in the range of 100 mm to 200 mm. It appears that the volume and perhaps the duration of snowmelt runoff are controlled by the initial availability of snow on the ground plus minor amounts of rainfall in late May and early June. The timing and magnitude of the peak, however, may be greatly affected by temperatures in the first week or two of freshet runoff.

Izok Lake

Izok Lake has a local drainage area of 8.6 km^2, of which 2.7 km^2 is lake area. Average and dry year precipitation is tentatively estimated to be 393 and 218 mm; corresponding lake evaporation depths are 285 and 350 mm. The dry year values suggest a deficit condition. Given the small local basin area and the current plan to divert Iznogoudh Lake outflows around Izok Lake, it will be important to determine the time required for Izok Lake to refill after mine closure.

Given the relatively small size of Izok Lake and its small local drainage area, it is likely that outflow from the lake is largely unaffected by storage effects so that inflows to Itchen Lake are essentially represented by outflows from Iznogoudh Lake.

Ham Lake

As Ham Lake outflows into Iznogoudh Lake, hydrologic parameters generated for this lake will also be applicable to Ham Lake.

High Lake Mine LSA

High Lake

The High Lake drainage is typical of drainages in the region, consisting of steep terrain and short streams connecting many small lakes. These channels typically experience substantial flows during the freshet season and dry up by mid July. The drainage basin area upstream of the High Lake outlet is 3.35 km^2 and is dominated by High Lake, which flows into the Kennarctic River. The majority of the mine development area and associated infrastructure will be contained within this basin, although the West Zone underground mine will be located within an adjacent drainage system immediately north of the High Lake basin. Approximately 26.2 % of the High Lake basin area is made up of lakes. Based in part on hydrometric and climate data collected within the LSA during the period 2004 to 2007, it was determined that:

- estimated runoff coefficients (depth of runoff as a ratio of total precipitation over a 12-month period) were in the range of 0.42 to 0.77
- the average distribution of runoff per month as a percentage of the summer runoff period was 47% in June; 29% in July; 14% in August; 8% in September and 4% in October
- spring freshet begins in late May to the end of June
- stream flows typically began receding by the end of June
- mean annual precipitation is 280 mm, with 53 % being rainfall and 47 % snowfall (394 mm and 164 mm in extreme wet and dry years)
- mean annual evaporation is 235 mm

The baseline hydrology data were sufficient to enable extrapolation to existing regional hydrometric station data.

Granite Lake

The Granite Lake basin, a tributary of the Kennarctic River, is located immediately north of and contiguous with the High Lake basin. It drains 48.4 km^2, of which 23.8 % is made up of lake area. Topographic features and drainage characteristics are similar to those described for High Lake. The timing and temporal distribution of surface runoff is similar to High Lake. Maximum discharge measured during 2004 and 2005 summer seasons was in the order of 5 cms, with corresponding depths of up to 0.4 m.

Kennarctic River

The Kennarctic River basin area is 330 km^2 upstream of the High Lake outlet, 400 km^2 downstream of the Granite Lake inflow confluence and 1380 km^2 at its mouth. It flows into Grays Bay 3 km east of the Grays Bay dock site. The river is relatively straight with much of its shoreline confined by steep cliffs and hills. The channel typically consists of a sequence of boulder bed deposits that create slope controls that create rapids, followed immediately downstream by deeply scoured beds. Peak discharges measured upstream of the High Lake confluence during the 2005 and 2006 field seasons were about 65 and 28 cms, respectively. In both years, discharge diminished to less than 1 cms by the end of September.

Izok Road LSA

Existing Information under the current (base case) route alignment, Izok Road is expected to cross 25 substantial water crossings between Izok and Lupin plus an additional 115 water crossings along the Lupin to High Lake segment and 14 crossings along the High Lake to Grays Dock segment (refer to **Figures 2.6-5** to **2.6-8**). Typically, channels at crossings consist of wide boulder beds, with flows persisting through the summer months only for the larger streams.

Two streams situated north of the High Lake Mine site were included in the 2005 and 2006 hydrology program. The data indicated that runoff coefficients were in the range of 0.45 and 0.57; average runoff as a percentage of 12-month runoff was the same as for the High Lake site.

Six streams at road crossings in the Lupin to High Lake segment were included in the 2008 hydrometric program. **Table 5.6-1** summarizes flow velocities measured at the road crossing sites.

Table 5.6-1 Flow Velocities at Road Crossing Sites along the Lupin to High Lake Section, 2008

Stream Name	Date	Surface Velocity (m/s)
Frayed Knots	12/06/2008	2.7
Hood River	14/09/2008	1.2
Un-named Creek (Site 4)	12/06/2008	1.8
Un-named Creek (Site 5)	11/09/2008	1.1
Un-named Creek (Site 12)	14/06/2008	0.9
Un-named Creek (Site 13)	14/06/2008	2.4

5.6.1.3 Ongoing Studies

Izok Mine LSA

Although information from baseline studies conducted in 2007 and 2008 was not complete enough to estimate runoff volumes during these years, the data collected will be used to establish stream flow rating curves for those gauging sites that will be maintained during future baseline programs.

The 2012 field program involves re-establishing a baseline collection network within the Izok Mine LSA. This includes:

- conducting seven snow courses in the Izok Mine LSA to obtain a second year of baseline data (a repeat of the 2008 program)
- establishing 11 water level recorders (seven stream and four lake level stations), which will include measurement of stream flows and survey of channel cross sections
- re-activation of the WSC station that records flow out of Iznogoudh Lake into Izok Lake

In addition, a detailed bathymetrical and ground survey of the proposed Diversion Channel inlet and outlet between Iznogoudh Lake and Itchen Lake will be conducted.

High Lake Mine LSA

The 2012 field program also involves conducting seven snow courses in the High Lake Mine LSA to obtain a second year of baseline data (a repeat of the 2008 program), and establishing 11 water level recorders (seven stream and four lake level stations), which will include measurement of stream discharge where possible and/or surface velocity measurements.

Izok Road LSA

During the 2012 field program, six level loggers will be installed along the road route, and discharge measurements and channel surveys will be conducted. In addition, all substantial stream crossings along the road route were observed during the spring runoff period via helicopter. Photographs are being collected to observe high water conditions and determine where ice might be an influence at crossings.

As with previous field programs at these sites, the fisheries and water quality studies will be coordinated with the hydrology program. For example, stream gauging sites will be coordinated with water quality sample sites.

5.6.2 Surface Water Quality and Sediment Quality

Water and sediment are important components of aquatic habitat, and changes in their quality may affect the health of aquatic organisms, including fish, the quality of habitat for wildlife (e.g., waterfowl, drinking sources), the quality of drinking water for human use, and the quality of water for cultural uses. Baseline water quality and sediment quality are influenced by geology, climate, landscape topography, landscape cover, watershed disturbance and runoff within the catchment. These factors can influence yearly, seasonal and spatial variability in water quality and spatial variability in sediment quality.

The proposed Izok Corridor Project has the potential to affect freshwater quality and sediment quality, particularly as it relates to the protection of aquatic life, wildlife, drinking water sources, and cultural uses. Works and activities related to the Project must be carried out in a manner such that the integrity of the aquatic system is maintained, and effects on freshwater and sediment quality are minimized.

5.6.2.1 Study Areas

Local Study Area

The main components of the Izok Corridor Project that are relevant to assessing effects on freshwater and sediment quality include the Izok Mine, High Lake Mine, and Izok Road corridor. The Grays Bay Port site is not included within the study area for this discipline, as it is addressed within the marine component of the environment (section 5.8.2).

The LSA is defined as the area within which there is the potential for the Project to directly affect the aquatic ecosystem. It encompasses the direct Project footprint, the spatial extent of effects from effluent discharge, upstream areas that contribute surface water to the Project area, and areas of direct dust deposition.

The LSA for the Izok Mine is within the Nunavut territory and includes the following.

- Izok Lake watershed
- Iznogoudh Lake
- Ham Lake
- Itchen Lake (eastern portion down to the territorial border)
- Other small lakes and tributaries within the zone of aerial deposition

The LSA for the High Lake Mine includes three main drainage areas (High Lake, Granite Lake, Kennarctic River) and the reference lakes. Specifically, this includes:

- All watercourses within the Project footprint extending to the upstream extent of their catchments
- High Lake and the outlet of High Lake to the Kennarctic River to a point 1 km downstream of the outflow (to account for complete mixing of High Lake and any mine discharge with the Kennarctic River)
- Other small lakes and tributaries within the zone of aerial deposition

The Izok Road LSA includes the portion of watercourses within 100 m of either side of the centreline of the road alignment.

Regional Study Area

The RSA includes waterbodies that may be affected beyond the LSA boundary, and areas that could be affected by residual effects of the Izok Corridor Project in combination with effects of other projects in the area. Freshwater quality and sediment quality effects are generally limited in distribution to watershed boundaries, but aerial deposition of dust could extend beyond watershed boundaries. The RSAs for the three Project components are defined as follows.

- Izok Mine - the Itchen Lake watershed including upstream contributing sources (Izok Lake, Iznogoudh Lake, and Ham Lake) and downstream to its outflow to Point Lake, and extending to the outflow of Point Lake to the Coppermine River
- High Lake Mine - the Kennarctic River watershed including upstream contributing sources (High Lake and Granite Lake) to the outlet of the Kennarctic River at Grays Bay
- Izok Road - water bodies 1 km to either side of the centreline of the road alignment

5.6.2.2 Description of Existing Environment

Izok Mine - Many aquatic studies have been completed in the vicinity of the Izok Mine since the 1970s. These are summarized in the Izok Project Gap Analysis (GLL 2008a), as well as various other reports (GLL 2006b, 2006c, 2006d). The gap analysis was used to inform the study design for 2007 and subsequent field surveys. Some of the earlier data can only be used in a descriptive manner because there is either insufficient detail about the collection and analysis methods or the analytical detection limits are too high for the data to be useful in an environmental assessment. Additional field programs are being undertaken in 2012 to complete the baseline description.

High Lake Mine - The aquatic environment in the High Lake Mine study area was summarized in the High Lake DEIS (GLL 2006d). It was based on an environmental inventory of the High Lake area (Rees 1994), preliminary investigations completed in 2003, and detailed field programs completed in 2004 and 2005. Some additional data were collected in 2006 and 2007 to address gaps identified during review of the DEIS. Limited additional field programs are being undertaken in 2012 to complete the baseline description.

Izok Road – Izok Road will be studied in three sections: Izok to Lupin, Lupin to High Lake, and High Lake to the port. Watercourses along the portion of the road between Izok and Lupin were sampled as part of the Bathurst Inlet Port and Access Road (BIPAR) project (Rescan 2002). A reconnaissance survey of a proposed all-season road corridor alignment was completed in September 2006 (GLL 2006b), and field water quality data were collected. Watercourses along the portion of the road between High Lake and Grays Bay were sampled for water quality in 2005 as part of baseline studies for the High Lake project (GLL 2006c). Until 2007, there was little information on watercourses along the portion of the road between Lupin and High Lake except for smaller areas corresponding to proposed mining projects such as Ulu (EBM 1997) and Jericho (Tahera 2003). Watercourses along the road alignment were sampled for water quality in the fall of 2007 (GLL 2008c) and spring of 2008 (Golder 2011).

Izok Mine LSA

Surface water quality in the Izok Mine LSA typically has low conductivity, neutral pH, soft water, and high sensitivity to acid deposition. The waters are well oxygenated during open-water periods but, in some of the lakes, oxygen concentrations can drop below values considered necessary to support aquatic life during the ice-covered period. Nutrients are very low, such that waterbodies are classified as oligotrophic.

Metal concentrations in surface water are low, although there were exceedances of Canadian Water Quality Guidelines (CWQG; CCME 2011a) for a few metal parameters in some of the waterbodies (GLL 2008c; Golder 2011). Metal concentrations in lakes within the study did not exceed CWQG; however,

aluminum, cadmium, copper and zinc levels exceeded guidelines in some samples collected from tributaries within the study area.

Sediments in the lakes are predominantly silty-clay. Metal concentrations vary within and between lakes. While arsenic was above Canadian Sediment Quality Guidelines (CSQG; CCME 2011b) in all samples, cadmium, chromium, lead and zinc levels were found to exceed CSQG in sediments from only some waterbodies.

High Lake Mine LSA

The High Lake Mine area drains to the north, and the small lakes in the LSA flow to the Kennarctic River. The river comprises a series of wide, deep pools linked together by more shallow, fast moving reaches.

The water quality observed in the study area is in keeping with the geology of the region. Generally, the lakes and rivers have very soft water (low in dissolved solids), are very low in nutrients, and are circumneutral but sensitive to acidic inputs. The lakes typically have very low metal concentrations, but the High Lake area also reflects the mineralized geology with slightly elevated chloride, sodium, copper and zinc concentrations compared to the rest of the Slave Province (Puznicki 1996, 1997).

During the open-water season, the lakes are well mixed, well oxygenated, of a generally homogenous thermal nature and relatively clear with Secchi depths of at least 6 m. During under-ice conditions, the lakes are relatively well oxygenated although dissolved oxygen falls below the CCME guideline of 6.5 mg/L at the bottom in some lakes. Under-ice concentrations of some parameters are also observed at higher concentrations than during the open-water season: such “cryo-concentration” of solutes under ice-cover is a common observation in Arctic lakes.

Streams and lakes within the High Lake Mine LSA are similar to those with the Izok LSA. The exception is High Lake itself, and one stream and two seeps that flow to High Lake.

- Water quality in Seep 1 is indicative of acidic drainage from an oxidized, sulphide rich, mineralized region, with low pH, elevated levels of hardness ions and sulphate and metals concentrations in the mg/L range.
- Water quality in Seep 2 is very soft, with near neutral pH, a high acid sensitivity and metals concentrations that exceed CCME guidelines but which are lower than those in Seep 1.
- Water quality in Stream S35 is in keeping with water that flows through a highly mineralized zone, showing elevated concentrations of sulphate and hardness, circumneutral pH, and metals concentrations consistently above CCME guidelines.
- High Lake itself is highly enriched by trace metals. Copper, cadmium and zinc in the lake water exceed CCME Guidelines by 50 to 100 times such that it is acutely toxic to fish. Rainbow trout died within the first 24 hours of a standard toxicity test. Water quality in the High Lake outflow is consistent with that of High Lake: soft, sensitive to acidic inputs, and nutrient poor with elevated concentrations of cadmium, copper and zinc.

Sediments in the lakes are predominantly silty-clay with arsenic, zinc, cadmium, chromium, lead, zinc and, occasionally, mercury concentrations above CSQG.

Water quality in the Kennarctic River is circumneutral, soft, oligotrophic and sensitive to acid inputs. Metals are present at detectable levels upstream of High Lake and increase downstream of High Lake such that Cu occasionally exceeds the CCME guideline. Sediment metal concentrations indicate the influence of the metal-rich discharge from High Lake, with concentrations below the High Lake outflow being higher than those upstream. Arsenic, zinc, cadmium, copper and lead are generally present in Kennarctic River sediment at concentrations above the guideline values.

Izok Road LSA

Surface waters within the Izok Road LSA have low conductivity, neutral pH, soft water, and high sensitivity to acid deposition. The waters are well oxygenated during the open-water period; data for the ice-covered period are not available. Nutrients are very low, and waterbodies are oligotrophic.

Metal concentrations in surface water are low, and aluminum and copper exceeded CWQG in some of the tributaries (GLL 2008c; Golder 2011). In most samples, the metal was present primarily in the dissolved form as opposed to the particulate form.

5.6.2.3 Ongoing Studies

Izok Mine LSA

Additional field studies being conducted in the Izok Lake LSA in 2012 are focusing on waterbodies within the direct footprint of Izok Mine, downstream of the proposed diversion channel between Iznogoudh and Itchen lakes, and downstream of the proposed treated effluent discharge point in Itchen Lake. These include:

- Collection of water samples for field chemistry and lab analysis from main tributaries within the Iznogoudh, Izok and Itchen Lake basins
- Conduct of water column profiles for temperature, pH, dissolved oxygen and conductivity from various locations within Ham, Iznogoudh, Izok, Itchen and a reference lake
- Collection of surface and bottom water column samples for lab analysis of water quality (e.g., alkalinity, hardness, nutrients, and metals)
- Collection of water samples from various locations within Ham, Iznogoudh, Izok, Itchen and a reference lake for analysis of chlorophyll *a* concentration, phytoplankton, zooplankton and benthic invertebrates
- Collection of surface sediment samples from various locations within Iznogoudh, Izok, Itchen and a reference lake for analysis of sediment chemistry (e.g., grain size and metals) and diatom composition
- Collection of sediment cores from various locations with Iznogoudh, Itchen and a reference lake for analysis of long-term changes in diatom community composition and interpretation of long-term changes and variance in water quality

High Lake Mine LSA

The baseline water quality program for the High Lake Mine LSA is considered to be almost complete. Additional field work in 2012 includes:

- Measurements of water quality (particularly dissolved oxygen) under ice in the pools of the Kennarctic River
- Sampling of water quality in the two seeps, Stream S35 and High Lake to determine whether acid and metals conditions have changed since 2006
- Collection of sediment cores from High Lake and a reference lake for analysis of long-term changes in diatom community composition and interpretation of long-term changes and variance in water quality

Izok Road LSA

The baseline water quality program within the Izok Road LSA is considered to be almost complete as data have been collected from a subset of watercourses during two different field programs (fall 2007 and spring 2008). Additional field studies being conducted in 2012 involve collecting samples for water quality, sediment quality and benthic invertebrates at 10 selected water crossing locations.

Collection and paleolimnological analysis of cores from Itchen Lake, High Lake and a reference lake will allow comparison of variance in water quality over the past 200 years to short-term (2004-2012) variance to provide a clear documentation of baseline conditions and any trends due to climate change or other regional factors that may influence subsequent interpretations. Further sampling of water quality will be required during the pre-construction phase to refine the project baseline, address any specific potential effects that are identified, and inform the EEM (Environmental Effects Monitoring) program and Aquatic Effects Monitoring Program (AEMP) study designs.

The water quality studies will be coordinated with the fisheries and hydrology programs. For example, stream and benthic sampling sites will be coordinated with sediment sampling and sample sites.

5.6.3 Freshwater Aquatic Organisms and Habitat

Fish species present in Nunavut lakes and rivers typically include Arctic grayling (*Thymallus arcticus*), Arctic char (*Salvelinus alpinus*), lake trout (*Salvelinus namaycush*), round whitefish (*Prosopium cylindraceum*), slimy sculpin (*Cottus cognatus*), burbot (*Lota lota*), lake cisco (*Coregonus artedii*) and stickleback (*Pungitius sp.*). Fish habitat usage varies depending on seasonal flow regimes, watercourse depth and ice thickness. Typically, rivers and streams provide migratory habitat during freshet flows, as well as spawning and rearing habitat during the open-water season. Lakes provide spawning, nursery, rearing and foraging habitat, and in waterbodies with sufficient depth, overwintering habitat.

5.6.3.1 Study Areas

Local Study Areas

Three LSAs have been defined for freshwater aquatic organisms and habitat; the Izok and High Lake Mine sites and the Izok Road footprint. The Grays Bay Port site is not included as this is being addressed in the marine component of the study.

The Izok Mine LSA includes watercourses and waterbodies within the mine footprint, as well as the potential receiving environment: Ham Lake, "Izok Bay" of Iznogoudh Lake, Iznogoudh Creek, Izok Lake, Izok Creek, and "Izok Bay" of Itchen Lake.

The High Lake Mine LSA encompasses the immediate west side of the Kennarctic River, approximately 50 km inland of Grays Bay.

The Izok Road LSA is generally defined by a 2 km wide corridor along the road alignment from the Izok Mine site to the proposed dock facility at Grays Bay. It extends up to 4 km in areas where the routing of the two temporary winter roads (Grays Bay to High Lake, and Lupin to Izok) crosses lakes that are larger than 2 km in width.

Regional Study Area

The RSA provides the regional context for assessing incremental changes in fish abundance and distribution as a result of the Project in combination with effects of other projects and activities. It includes:

- Aquatic fish habitats in the vicinity of waters affected by the Project, including upstream and downstream waters that fish may use for migration and meeting life history requirements.
- The spatial extent of a population unit within the LSA, which for species such as Arctic grayling and lake trout, will extend beyond waterbodies and watercourse where fish may be either directly affected by the Project footprint or indirectly affected by upstream Project-related activities.

The RSA includes watersheds underlying the Izok mine footprint, including Izok, Itchen, Iznogoudh, Ham lakes, and the waters draining into these waterbodies; the Kennarctic River watershed; and watercourses that intersect the road corridor from Izok Mine to the Grays Bay Port site.

5.6.3.2 Description of Existing Environment

Izok Mine - Existing information on freshwater aquatic organisms and habitat within the Izok Mine LSA includes previous baseline field programs in support of the High Lake project and Izok project (RL&L 1992, 1993; Golder 2003a, 2003b; GLL 2008c; RC BioSolutions Ltd. 2011).

High Lake Mine - Available information on freshwater aquatic organisms and habitat within the High Lake Mine LSA includes that summarized in Rees (1994) and Scott and Crossman (1998), as well as data collected during baseline programs conducted between 2004 and 2006 (GLL 2006e).

Izok Road - Aerial reconnaissance surveys of the road corridor were completed at various times over the period 2001 to 2008. The Grays Bay to High Lake segment was completed in 2005 (GLL 2005b), while the

High Lake to Lupin segment was completed in the fall of 2007 and in 2008 (RC BioSolutions 2011). The section from Lupin to Izok Lake was completed in 2001 and 2002 (Rescan 2003).

Izok Mine LSA

Studies of the four lakes within the LSA (Iznogoudh, Izok, Itchen and Ham lakes) reported the presence of Arctic grayling, lake trout, round whitefish, longnose sucker, burbot, ninespine stickleback, lake cisco and slimy sculpin. Among the fish species captured, round whitefish and lake trout were numerically the most abundant species in the LSA (RL&L 1993; Golder 2003a, b). Mark-recapture sampling in Izok Lake in 2003 enumerated a population of about 544 lake trout (for fish greater than 350 mm) (RL&L 1993). Captured lake trout ranged in length from 115 to 710 mm, and in age from 2 to 15 years old (GLL 2008b). Captured round whitefish ranged in length from 107 to 443 mm, and in age from 1 to 17 years old (GLL 2008c). Arctic grayling were relatively low in abundance throughout the LSA (GLL 2008c; Golder 2003a, b; RL&L 1993), and those sampled ranged in length from 365 to 450 mm (GLL 2008c).

Potential forage fish habitat was identified in all the lakes surveyed, and potential large-bodied fish habitat was identified in seven of the small lakes in the Izok Lake sub-drainage (GLL 2008b). Most streams assessed had poor to no habitat potential for fish due to seasonal intermittent flow, poorly defined channels, steep gradients and/or lack of connectivity to other watercourses. None of the sub-drainages appeared to provide satisfactory passage for fish moving upstream from Izok Lake. However, Arctic grayling movements have been recorded from Izok Lake to Iznogoudh Lake and from Izok Lake to Itchen Lake (Golder 2003a). It is thought that Arctic grayling prefer stream habitat for summer feeding/holding over lake habitats in the LSA. Iznogoudh Creek does not appear to be an important spawning area for Arctic grayling, nor do the tributaries draining into Izok Lake (RL&L 1993).

Although dated (mostly 20 years old), there is an adequate database for describing metal concentrations in tissues of lake trout from the Izok Mine LSA. For other species, the database may be less than adequate for describing baseline metal conditions. The most recent baseline report indicates that metal levels in lake trout and round whitefish tissue samples can exceed United States Environmental Protection Agency (USEPA) thresholds for the protection of fish for aluminum, cadmium, copper, nickel, and selenium (GLL 2008c). GLL (2008b) reported that selenium concentrations in liver of lake trout can exceed the British Columbia Water Quality Criteria (1.0 mg/Wkg in tissue, BC MOE 2001); however, the levels did not exceed the USEPA draft criterion for aquatic life (7.91 mg/Dkg, USEPA 2000).

High Lake Mine LSA

Fish community composition and life history data have been collected from the High Lake Mine LSA, including one control lake in the region. Scott and Crossman (1973) indicate that the following fish species are potentially present in the LSA: broad whitefish (*Coregonus nasus*), anadromous and resident Arctic char (*Salvelinus alpinus*), lake trout (*Salvelinus namaycush*), Arctic grayling (*Thymallus arcticus*), round whitefish (*Prosopium cyclindraceum*) and northern pike (*Esox lucius*).

Only Arctic char, lake trout, slimy sculpin (*Cottus cognatus*) and ninespine stickleback (*Pungitius pungitius*) were captured during previous sampling programs. Despite extensive sampling efforts in High Lake (Lake L16) in 2004 and 2005 involving both standard scientific collection methods and traditional Inuit fishing methods, no fish were captured. There is compelling evidence that High Lake does not support local fish populations.

Lake structure and substrates throughout the LSA are generally similar. Littoral areas have predominantly boulder substrates, with intermittent bedrock and cobble areas. The boulders change grade to cobbles and fines with an increase in depth and gradient. Based on local observations, the boulder/cobble zone in deeper lakes (>5 m depth) generally ends abruptly at an average depth of 4.5 m.

The nearby Kennarctic River supports populations of lake trout and slimy sculpin, as well as both anadromous and land-locked Arctic char. The river is characterized by a gradient of less than 5% with boulders generally dominating the substrate.

Analysis of metal levels in fish tissues indicate that some metals tissue loads can exceed guidelines primarily for fish from the High Lake drainage. Results of metals analysis of fish livers and tissues tended to be generally similar between the two lakes that support fish in this sub drainage, while maximum copper levels sampled in Lake L18 lake trout liver were higher than those found throughout the LSA (GLL 2006e).

Izok Road LSA

Watercourse crossings span six major drainage basins. All six drainages enter the Arctic Ocean at various locations. The Coppermine River enters the Arctic Ocean near Kugluktuk; the Burnside, Hood and James rivers enter Bathurst Inlet; and the Kennarctic River and an unnamed river drainage enter near Grays Bay.

Many streams along the road route were determined to be ephemeral, having no defined bed or banks and contained flow only during spring freshet. All crossings that were determined to have potentially defined bed and banks were also assessed from the ground.

Potentially sensitive areas such as spawning, migration, and rearing were identified using the fish habitat data and relating it to physical habitat requirements of the fish VECs. Most of the watercourses with adequate flow and absence of physical barriers along the road route typically provide habitat for migration movements and seasonal rearing. Use of these habitats is generally low and of short and/or seasonal duration. Arctic char, Arctic grayling, lake trout, ninespine stickleback, round whitefish, and slimy sculpin use some of the watercourses in the study area during the ice-free season. Arctic grayling were not observed or captured in any drainages north of the Burnside River drainage. This is important to note because they are the only spring spawning fish VEC in the LSA.

5.6.3.3 Ongoing Studies

Izok Mine LSA

The following field studies are currently ongoing within the Izok Mine LSA.

- Detailed assessment of habitat and Arctic grayling use of streams that are likely to be directly affected by the Project within the Izok Lake basin, including Izok and Iznogoudh creeks
- Hydroacoustic population survey of Izok Lake and standard index gill netting (i.e., broad-scale fish community monitoring) of Izok Lake, upper bays of Itchen Lake, portions of Iznogoudh Lake and a reference lake

- Bathymetry and fish habitat (i.e., substrate) inventory of lakes in the Izok Lake sub-drainages, including Izok Lake, portions (or specific bays) of Itchen Lake, portions (or specific bays) of Iznogoudh Lake and a reference lake
- Fish composition surveys of several lakes and streams within sub-basins of Izok Lake where baseline data is incomplete
- Opportunistic fish tissue sample collection from Itchen Lake and a reference lake for metals analysis
- Collection of benthic invertebrate samples

High Lake Mine LSA

Field studies are currently ongoing to confirm fish presence in various watercourses and waterbodies in the High Lake LSA, including the South sub drainage.

Izok Road LSA

Several changes to the road corridor occurred in 2007 and 2008, which resulted in new watercourse crossing options that require assessment. All watercourse crossings that have not been assessed to date are being assessed during the 2012 field season. This includes summer fisheries surveys at all stream crossing locations along the alternate road alignment.

The 2012 field program include fish sampling and habitat mapping for watercourse crossings in and around the Izok Lake LSA that were not previously sampled in any detail. Lake bathymetry data will also be collected from the small lakes along the proposed temporary winter road routes

5.7 Terrestrial Environment

5.7.1 Soils and Landforms

Soils and landforms are important components of the terrestrial environment in the area, and changes in their quantity and quality may affect the health of the ecosystem, including the quality of vegetation and wildlife habitat.

5.7.1.1 Study Areas

Local Study Area

The LSA encompasses the area within which all direct effects and indirect effects of Project activities on the landforms and soils are likely to occur. The LSA includes a 5 km radius surrounding the proposed Izok Mine site and facilities, a 5 km radius surrounding the proposed High Lake Mine site and facilities, a 1 km wide buffer on either side of the centreline of the proposed all-season road and winter road corridors, and a 1 km wide buffer around the Grays Bay Port site (Kestrel Research Inc. 2011).

Regional Study Area

The RSA is the area within which indirect effects of the Project are likely to occur. It is defined as a 30 km wide buffer around Project facilities, infrastructure and road corridors, which is considered sufficiently

broad to encompass the maximum spatial extent of possible changes in soil quality from the deposition of airborne contaminants.

5.7.1.2 Description of Existing Environment

Common Landforms and Soils

Field surveys of soils and landforms within the Project area were initiated in 2005 and continued in 2008 (GLL 2007, 2008b). The field assessments evaluated key features of the landscape including topography, parent material, slope, aspect, drainage, depth of water table, moisture regime, site position, stoniness, erosion and vegetative cover. Important or abnormal occurrences encountered at the site such as permafrost features, erosion, compaction or ground cover were recorded. Other information collected included surface stoniness and depth to permafrost, bedrock and water table. Soil pits were dug (approximately 1 m deep or to depth of permafrost or rock) within or next to each vegetation survey plot (Kestrel Research Inc. 2011). Soil profile descriptions included horizon depth, colour, mottles (abundance) texture, structure, root abundance and size, and percent and size of coarse fragments. These soils and landscapes were described in accordance with 'The Canadian System of Soil Classification' - Third Edition (Soil Classification Working Group 1998).

Vegetation information is available in the 2008 Vegetation Field Report (Kestrel Research Inc. 2011), and contaminant information exists in the Field Report for High Lake Project Contaminant Sampling (GLL 2007).

Regional Study Area

The Izok Corridor Project is situated in the treeless southern arctic tundra. The granitic bedrock underlying the region is part of the northern edge of the Bear Slave Upland on the Canadian Shield. The upland surface is incised by two major valleys, namely the north-trending Kennarctic River valley to the east, and the east-trending James River valley. Glaciation by the Wisconsinan Laurentide Ice Sheet was the major influence in forming the characteristic rugged terrain typical of well-glaciated shield topography.

The majority of the RSA contains undulating to rolling bedrock overlain by thin covers of till, felsenmeer and colluvium. Till deposits are mainly stony, sandy to silty loams and either less than 1 m deep (veneers) or 1 to 2 m deep (blankets, depressional). Frost churning and permafrost influence soil development, resulting in the formation of Brunisolic and Turbic Cryosolic soils in uplands. Gleysolic and Histic Cryosols occupy depressions and toe slopes where water is seasonally perched.

Within 13 km of the Arctic coast, sediments of marine origin occur on lower slopes and valley floors. These fine-grained silt and clay rich sediments were originally deposited in a marine environment and are now exposed due to an uplift of the surface once glaciers retreated. Ice content of these sediments is estimated at 40%. The most common soils are Brunisolic Turbic Cryosols and Orthic Regosols.

A large, east-west-oriented esker complex crosses the area just north of Ham Camp. It is composed of gravelly sand with locally high coarse fragment content. Smaller eskers and glacial complexes occur elsewhere, including the Izok Mine area and along Izok Road. Deflation is widespread on these deposits, resulting in Orthic Regosolic and Regosolic Static Cryosolic soils.

Minor occurrences of fluvial deposits of cobbles and boulders exist along water courses occurring in shallow drainage pathways between lakes. Riparian soils are mainly RegoGleysols.

There is variation in landforms (percent of area and associated soils) among the four LSAs. This is described below.

Izok Mine LSA

Deposits within the Izok Lake Mine LSA are dominantly till veneers, depressions, and blankets (61%). Bedrock (6%) and glaciofluvial material (3%) occur in localized areas. Approximately 25% of the area is covered by water. The surficial materials in the Izok Lake Mine site suggest a low to moderate sensitivity to permafrost. Wet areas contain Gleysolic and Histic Cryosols covering 97 ha of the area (12.9%).

Turbic Cryosols are commonly associated with both till and glaciofluvial materials. Brunisolic Eutric and Dystric Static Cryosols are also common with glaciofluvial deposits. Eskers account for some of the glaciofluvial deposits observed in the Izok Lake Mine site.

High Lake Mine LSA

The High Lake Mine site is located on glaciated till veneer or till blanket (59%) and to a lesser extent colluvium (7%) and bedrock (5%). Water occupies 28% of the area. Material is mostly coarse grained or bouldery and therefore not highly sensitive to permafrost. Only 1% of the area is considered poorly drained and very little evidence of permafrost activities was observed.

Soils associated with till blanket and till veneer are most likely to be Gleysolic, Brunisolic Eutric, Brunisolic Dystric, Orthic Dystric, Orthic Eutric, and Regosolic Turbic Cryosols. These soils are all affected by cryoturbation.

Wetlands contain Gleysolic and Histic Cryosols covering 3.2 ha of the area (1.9%).

Izok Road LSA

Grays Bay to High Lake - Landforms occurring within the Grays Bay to High Lake section of Izok Road include, in order of decreasing extent, marine (25%) > bedrock 19%) > colluvium (16%) > water (14%) > glaciofluvial (12%) > till (11%).

Near Grays Bay, ice-rich fine grained, well sorted marine clays and silt are present, often located on long, gentle slopes where solifluction and soil creep related to permafrost are present. Ice content in the marine sediments has been estimated at 30% (Kerr et al. 2005). Thicker till and ice rich fine grained marine sediments are present north of the High Lake area. The most common upland soils are Orthic and Brunisolic Eutric Turbic Cryosols.

Wet soils, namely Gleysolic and Histic Cryosols, make up 16 ha of the area (4.9%).

High Lake to Ulu - Along the High Lake to Ulu section of the road, the major landforms are till (61%) > bedrock (10%) and water (10%) > glaciolacustrine (9%). Till veneer (<1 m thick) and blankets (1 to 2 m thick) exhibit permafrost features, being more pronounced in the latter. Bedrock is often frost shattered. Surface boulders are common on the till and bedrock. Solifluction stripes are widespread on the silty to fine sandy lacustrine materials blanketing the underlying till north of Ulu. The most common upland soils are Brunisolic Turbic Cryosols and Orthic Regosols. Poorly drained areas containing Gleysolic and Histic Cryosols cover 19ha (0.9% of the area).

Ulu to Izok Lake - This area resembles the High Lake to Ulu section but has more glaciofluvial deposits. Landforms consist of till (69%) > bedrock (12%) > glaciofluvial (9%) > water (7%). Associated upland soils include Brunisolic Turbic Cryosols and Orthic Regosols. Poorly drained areas with Gleysolic and Histic Cryosols cover 173 ha (11.6%).

Grays Bay Port LSA

The land-based port infrastructure will be predominantly located on bedrock exposures or thin ice-rich marine sediments, a mixture of clay, silt, sand and boulders. Marine deposits make up most of the genetic material (34%), and 40% of the marine deposits are classified as fine-grained and therefore permafrost sensitive (Dredge et al. 1996). Bedrock makes up 15%, and the rest is water (51%). Soils commonly associated with marine deposits include Orthic Eutric Turbic Cryosols, which tend to be highly affected by cryoturbation, and Gleysolic Turbic Cryosols, which develop on poorly drained areas. Bedrock deposits are often associated with little to no soil; however, soil types observed on bedrock include Brunisolic Eutric Turbic Cryosols and Orthic Regosols. Wetlands are characterized by Gleysolic and Histic Cryosols making up 6.2 ha of the area (18.4%).

Uncommon or Valuable Landforms

Uncommon or valuable landforms have been assigned a high value in terms of habitat potential in the LSA. Rare plant species and animal habitats are often associated with an uncommon landform, and concerns about these landforms have been expressed during the consultation process. Three types of landforms (steep bedrock cliffs, fluvial floodplains and eskers) have been identified as particularly valuable.

Steep bedrock cliffs are identified as valuable landforms by Project biologists as preferred nesting sites for several species of raptors such as peregrine falcon, golden eagle, gyraflacon, rough-legged hawks, and for ravens. Steep bedrock cliffs have been identified on 9.2 ha of the LSA (0.3%).

Fluvial floodplains located along rivers are considered valuable because they are uncommon in the LSA and have high habitat value. River corridors are known to have high value to animals and humans as migration corridors, they provide access to fishing opportunities, are in close proximity to fish habitat and may sustain unusual plants and plant communities. Undifferentiated landforms (a bouldery surface acting as channel for intermittent, diffuse, flow between waterbodies) are also included in this section because of the stream like behavior and important effects they have on the hydrology of the water bodies they connect. Fluvial floodplains and undifferentiated channels cover about 51 ha of the LSA (1.7%).

Eskers have been identified as a valuable landform during consultations with local communities, elders, regulators and Project scientists. Eskers are identified as uncommon landforms or landforms of value separately from other glaciofluvial features. They are often associated with archaeological resources, denning sites for small and large mammals (such as wolves and grizzly bears), rare or unusual plant communities or plant species, and are generally valued as an aesthetic landmark. They are also commonly used as migration routes for caribou (Traynor 2001). Eskers cover 17 ha of the LSA (0.5% of LSA).

5.7.1.3 Ongoing Studies

The objective of the 2012 field program is to delineate and characterize the landforms and associated soils in the LSAs in order to assess potential Project effects on their abundance, diversity and stability and determine appropriate mitigation measures. The following work is being undertaken as part of the field program.

- Determine permafrost conditions (relate processes and active layer, surface water bodies and topography)
- Locate special sensitive or unique landform features
- Develop soils and landforms associations to support the completion of ecosystem mapping and description
- Relate/check mapped soils and landforms units and associations delineated during preliminary air photo interpretation with field soil and landform descriptions data
- Link soil descriptions with vegetation communities to establish soil vegetation relationships in terms of reclamation targets
- Detect evidence for potential for ground and rock instability
- Determine the suitability of topsoil and overburden for use in the re-vegetation of surface-disturbed areas
- Determine bedrock lithology, morphology, geomorphology and soils at proposed borrow and quarry sites, and other areas where earthworks are proposed
- Determine potential for acid rock drainage and evaluate possible mitigation techniques
- Sample soils to determine characteristics for vegetation growth and sensitivity to potentially acidifying inputs
- Investigate the quantity and quality of soils and deposited sediments in lakes to prepare for actions needed once water bodies are drained. Reclamation suitability must be assessed and plans to vegetate the areas might need to be considered to avoid erosion
- Examine reclamation at other projects for techniques and success rates
- Mapping and sampling in areas not previously/adequately covered by earlier field programs
- Describe soils at all vegetation plots and collect soil samples (about 25 sites with analysis of 2 horizons per site) for physical and chemical analyses

5.7.2 Vegetation

The diversity and distribution of vegetation plays a key role in ecosystem function. Vegetation patterns on the land are influenced by climate, substrate, terrain and water patterns. Characteristic groupings of vegetation occur at the landscape scale and at smaller scales. Different vegetation associations provide a variety of habitats used by wildlife. Wildlife and people can influence vegetation abundance and diversity, and industrial development in particular has the potential to affect vegetation ecosystem health.

The objective of the vegetation program is to develop descriptions of common ecological units on the landscape, including their component landforms, vegetation associations and soils. Maps are developed to identify the baseline cover and diversity of ecological units and vegetation associations at a local scale and land cover at a regional scale. This information will provide the basis for predicting Project-related effects and developing mitigation measures for construction, operations and closure-related activities. It will also be used to assist with planning of environment monitoring programs during the closure phase.

5.7.2.1 Study Areas

Local Study Area

The LSA is defined as the area within which direct and indirect effects of the Project on vegetation are predicted to occur. The LSA includes a 5 km radius surrounding the Izok Mine site and facilities, a 5 km radius surrounding the High Lake Mine site and facilities, a 1 km wide buffer on either side of the centreline of the proposed Izok Road and winter road corridors, and a 1 km wide buffer surrounding the Grays Bay Port site.

Regional Study Area

The RSA represents vegetation diversity at a landscape scale and includes the area within which any regional effects of Project activities are predicted to occur. The RSA includes a 30 km wide buffer around all Project facilities, infrastructure and road corridors.

5.7.2.2 Description of Existing Environment

Regional Study Area

The Izok Corridor Project is located in the Takijua Lake Upland Ecoregion of the Southern Arctic Ecozone. This ecoregion is located in the eastern half of the Bear-Slave Upland south of Coronation Gulf. Vegetation in the area is characterized by shrub tundra that consists of dwarf birch, willow, northern Labrador tea, *Dryas* spp. and *Vaccinium* spp. Depressional sites are dominated by willow, sphagnum moss and sedge tussocks and spruce stands occur scattered along the southern boundary of the ecoregion (Environment Canada 2005).

A land cover classification has been developed for the northern portion of the RSA but not for the southern portion. The landscape around the High Lake Mine and the road to Grays Bay is strongly influenced by the underlying bedrock systems. Glacial till and boulders form a thin cover on and between bedrock outcrops. The most common vegetation classes in the northern area of the RSA are heath bedrock/boulder and bedrock/boulders. Fresh water lakes, streams and rivers cover 15% of the area. Within about 13 km of the arctic coast, fine sediments of marine origin occur in valleys. Relatively well-drained areas of marine sediment or glacial till support heath tundra. In areas of flowing water on or below the ground surface, a riparian tall shrub class occurs. Shallow water along the edges of streams, lakes and perched ponds support a non-tussock sedge class. Lichen veneer forms on relatively level, dry, well-drained substrates including glacio-fluvial outwash terraces, raised beaches and thin dry soils associated with bedrock outcrops.

Local Study Area

Ecological Land Classifications

LSA mapping is based on 1:20,000 scale, high resolution aerial photography. Ecological Land Classification (ELC) field surveys are being conducted to confirm and complete the vegetation mapping for the LSA. ELC standards are based on the British Columbia's Resource Inventory Committee (RIC) (1998) mapping standards (where appropriate).

Data collected during field programs completed in 2004, 2005 and 2008 have been used to characterize and map vegetation associations in the LSA. Twenty-four (24) vegetation association units were mapped within the area). The characterization of several units is incomplete based on the number of full plots completed to date.

Rare Plants The potential for occurrences of rare and at risk plant species, rare ecological communities are investigated based on SARA Public Registry searches, existing records (Canadian Museum of Nature 2005) and the General Status Rankings of Vascular Plants in Nunavut (Government of Nunavut, 2010) list of elements by ecozone. Reconnaissance rare plant surveys are undertaken to assess the baseline distribution and associated habitat of "at risk", "may be at risk" and "sensitive" plant species within the Izok Corridor Local Study Area and the project footprint.

Observations of seven "may be at risk" plant species and 27 "sensitive" plant species (GN 2005) were made during field surveys of the general area of the Project in 2004, 2005 and 2008 (**Table 5.7-1**). Observations of four plant species not currently recorded for Nunavut were made as well. No "at risk" species were observed.

Table 5.7-1 Records for Sensitive and May Be at Risk Plants from the Izok Corridor Project LSA

Scientific Name	Common Name	Nunavut 2005 Status Rank	Habitat	Habitat or Vegetation Association	# of Records
Arnica frigida	Snow arnica	May be at Risk	Snowbank and riparian area blow snowbank	HS	2
Carex canescens	Silvery sedge	Maybe at risk	River meadows, lake shores and wet places		7
Carex podocarpa	Graceful mountain sedge	Maybe at risk	Snowbank communities and riparian areas	HS, BF, BR, HR	28
Cerastium cerastoides	Mountain chickweed	Maybe at risk	Moist tundra		2
Gentianella propinqua	Four-part gentian	May be at Risk	Marine backshore on sand/silt	Coastal Communities	3
Pyrola minor	Snowline wintergreen	Maybe at risk	Moist lake shores		7
Subularia aquatica	Water awlwort	Maybe at risk	sandy bottom of shallow, clear standing water		1
Viola species		Maybe at risk to Sensitive	Tall Riparian shrub vegetation communities and gravelly lakeshores		12

Scientific Name	Common Name	Nunavut 2005 Status Rank	Habitat	Habitat or Vegetation Association	# of Records
Argentina egedii	Egede Cinquefoil	Sensitive	Marine backshore tidal flats on clay	Coastal Communities	1
Agrostis mertensii	Northern bent grass	Sensitive	Sand and fluvial rock as well as at the base of eskers	HB, OD	16
Betula occidentalis	Water birch	Sensitive	Low wet areas and sedge associations		2
Bromus pumpellianus	Pumpelly's Brome	Sensitive	Sandy and gravelly river banks and islands, Avens association on old Inuit camp	Coastal Communities	5
Callitriche palustris	Marsh water-starwort	Sensitive	Aquatic along sheltered sandy lakeshores within 30 cm of water		3
Carex capitata	Capitate Sedge	Sensitive	At the base of eskers and in low wet places	HB, OD	3
Carex gynocrates	Northern bog sedge	Sensitive	Within boulder field growing on limited substrate between boulders		
Carex tenuiflora	Sparse-flowered sedge	Sensitive	Along rocky and sandy lakeshores	ST	13
Dasiphora fruticosa	Shrubby cinquefoil	Sensitive	Open tundra, riparian areas and snowbank associations	BF, HS	12
Festuca saximontana	Rocky mountain fescue	Sensitive	Dry grassy and rocky places		1
Galium trifidum	Small bedstraw	Sensitive	Along peat moss dominated shore		6
Isoetes echinospora	Spiny-spored Quillwort	Sensitive	Sandy lake shores within shallow water		3
Juncus filiformis	Thread rush	Sensitive	Moist, sandy lake shores		2
Lathyrus japonicus	Beach pea	Sensitive	Marine beach and backshore on fine gravels and sand	Coastal Communities, GC	4
Luzula spicata	Spiked woodrush	Sensitive	Sandy tall riparian shrub areas		1
Lycopodium clavatum	Running clubmoss	Sensitive	Sandy lakeshores	BS, Coastal Communities	9
Oxytropis deflexa	Pendant-pod point-vetch	Sensitive	Lichen veneer and avens communities on exposed thin soils (silt, sand and gravel)	HS, OH, GE, GC, BL, HT, HR, ML	10
Pinguicula	Hairy butterwort	Sensitive	Sphagnum Hummocks	BR	32

Scientific Name	Common Name	Nunavut 2005 Status Rank	Habitat	Habitat or Vegetation Association	# of Records
villosa			and Riparian associations with hummocks.		
Rubus arcticus	Arctic raspberry	Sensitive	Tussock sedge association and Riparian areas	BF, ST	4
Rumex arcticus	Arctic dock	Sensitive	Tussocks sedge and riparian associations	Coastal Communities, MT, ST, SN	6
Salix pulchra	Tea-leaved willow	Sensitive	Low shrub communities on areas of sub-surface water movement, hummocky ground	BF, ST, HT	11
Saxifraga nelsoniana	Heart-leaved saxifrage	Sensitive	Snowbank associations	HS, UE, RB, BF, Coastal Communities, OD	26
Sibbaldia procumbens	Creeping Sibbaldia	Sensitive	Snowbank association in sandy soils on glacio-fluvial complex	HS, OD	5
Sparganium natans	Small burreed	Sensitive	Rocky shoreline		2
Vaccinium oxycoccos	Small cranberry	Sensitive	Sphagnum Hummocks	OD, OH	25
Viola macloskeyi	Smooth White violet	Sensitive	Tall riparian shrub vegetation	BF	1
Galium tinctorium	Stiff marsh bedstraw	Not listed	Tall riparian shrub areas	BF	
Lycopodium alpinum	Alpine clubmoss	Not listed	Snow bank communities and sandy lakeshores	HS	1
Phegopteris connectilis	Long beech-fern	Not listed	Tall shrub areas		1
Sagina caespitosa	Tufted pearlwort	Not listed	Gravely places		1

5.7.2.3 Ongoing Studies

Regional Study Area

Regional Study Area mapping will be developed based on regional scale Land Cover Classification (LCC) mapping for Landsat scenes covering the Izok Corridor Project RSA. The image classification will be a supervised classification based on field data collected in 2005, 2006 and 2008 and the existing LCC mapping for the northern portion of the Izok Corridor Project. The resolution of the mapping will be a 30-m cell size. Additional field data will be collected to improve the accuracy of the draft LCC.

Local Study Area

The footprints of some Project components are different from that proposed for the High Lake (2004-2005) and Izok (2008-2009) projects. Where extensions of the 1 km wide buffer area around currently proposed roads, quarries, infrastructure and the 5 km area around mines is necessary, LSA mapping will be expanded. This includes Izok Road and winter road alignments, quarry and granular sources, and mine infrastructure.

Ecological Land Classification (ELC) surveys are being conducted in 2012 to:

- Verify the accuracy of new 1:20,000 scale ecosystem mapping
- Increase the number of full ELC plots to improve the characterization of several under-sampled ecosystem units (MT, ML, MH, HS, BS, RB, UE)

ELC standards are based on the British Columbia's RIC (1998) mapping standards (where appropriate)

The current footprints of the proposed all-season and winter road alignments, borrow sources and mine infrastructure have also changed from that proposed for the previous High Lake and Izok projects. Limited reconnaissance level rare plant surveys are being conducted in 2012 to:

- Assess the associated habitat of "may be at risk" and "sensitive" plant species within the borrow pits identified in 2008
- Survey vegetation associations along new sections of the proposed Project footprint
- Determine the extent of rare plant populations affected by the footprint once the footprint is finalized

During the 2012 field program, existing industry disturbance in the area will be monitored to:

- Characterize the effects of permafrost degradation on vegetation community composition and structure in sensitive, ice rich marine silt landforms
- Gather information on the characteristics and suitability of soils for revegetation
- Identify colonizing and early successional plant species and processes of natural revegetation

5.7.3 Wildlife and Wildlife Habitat

5.7.3.1 Study Areas

Local Study Area

The LSA for terrestrial wildlife studies was selected to describe the habitat immediately adjacent to the Project footprint that may be subject to direct effects. This area includes a 1 km buffer around the footprint of all project facilities, infrastructure and road corridors.

Regional Study Area

The RSA includes a 30 km buffer surrounding major Project components (the Izok Mine site, the High Lake Mine site, and the Grays Bay Port site), and a 20 km buffer on either side of the Izok Road corridor.

It was designed particularly to address issues relating to caribou, while ensuring that the area was sufficiently large to address other species inhabiting the area.

The current RSA is relatively unchanged from that used during the 2008 and 2010 studies, other than some minor alterations due to road re-alignments, and the exclusion of a previous road alignment option from Izok to east of Kugluktuk.

5.7.3.2 Description of Existing Environment

Wildlife habitat within the Izok Corridor Project area consists of a variety of tundra plant communities, varying from bare rock to large expanses of heath tundra, to less common riparian-shrub systems (Gould et al. 2003). Abiotic features such as cliffs and eskers also provide unique wildlife habitats and contribute to biodiversity in the area. Many species of wildlife are migratory and, as such, their abundance varies seasonally. The terrestrial wildlife species found within this region are largely representative of the entire species assemblage found in the central Low Arctic. Species guilds include ungulates, large- and medium-sized carnivores, small mammals, raptors, waterfowl and shorebirds, and upland birds and songbirds. Caribou (*Rangifer tarandus*), muskoxen (*Ovibos moschatus*), grizzly bears (*Ursus arctos*), wolves (*Canis lupus*) and wolverines (*Gulo gulo*) are among the more common large mammals present in the area.

A number of western science studies have occurred in the West Kitikmeot region. Along with Inuit Qaujimajatuqangit (IQ), these provide background information on the ecology of wildlife and the diversity of habitats in the region. To supplement this regional knowledge, field studies for the previous High Lake (2004) project and Izok (2007) project were conducted periodically between 2004 and 2010, and are being undertaken in 2012 for the Izok Corridor Project.

Species at Risk

Table 5.7-2 lists Species at Risk that potentially occur within the Izok Corridor RSA. These species are described in more detail below.

Table 5.7-2 Terrestrial Mammal Species at Risk in the Izok Corridor RSA

Species	Scientific Name	Species Status		
		Nunavut[1]	SARA Schedule[2]	COSEWIC[3]
Barren-ground Caribou (Dolphin and Union caribou)*	*Rangifer tarandus groenlandicus*	Secure	Schedule 1	Special Concern
Grizzly Bear	*Ursus arctos*	Sensitive	Not currently scheduled	Special Concern
Wolverine	*Gulo gulo*	Secure	Not currently scheduled	Special Concern

* The SARA and COSEWIC listings for barren-ground caribou only apply to the Dolphin and Union caribou; other caribou herds present within the RSA have not been assessed by COSEWIC and are not currently scheduled under SARA.
1 CESCC (2011)
2 Environment Canada (2011)
3 COSEWIC (2011)

Ungulates

There are three ungulate species present within the Izok Corridor RSA: caribou, muskoxen and moose (*Alces alces*).

Caribou play a pivotal role in the lives of Aboriginal people and other residents of the north. They continue to be central to the culture, identity and diet of the West Kitikmeot, and local Inuit have hunted these animals for millennia (Thorpe et al. 2001). Caribou within the region also play a key role in food chain dynamics, particularly as a prey source for carnivorous and omnivorous animals. Caribou are numerous and widespread throughout the Arctic regions; however, their current status is a concern as several herds have undergone dramatic declines in recent years (Adamczewski et al. 2009).

Caribou from three herds are known to occur within the Izok Corridor RSA on a seasonal basis including the Dolphin and Union herd, Bathurst herd, and Bluenose-East herd. These caribou are highly migratory and often winter great distances from calving and summer grounds. In general, they migrate to their calving grounds in April and May, and calve during the first two weeks of June. Following calving, the animals disperse throughout their summer ranges and gradually begin moving back to their wintering grounds. The rut occurs in October, generally during fall migration. For all caribou herds, the timing of movements and main movement paths vary annually.

Dolphin and Union caribou (*R. t. groenlandicus x pearyi*) calve and summer on Victoria Island and cross the Coronation Gulf and Dease Strait to winter on the mainland on both sides of Bathurst Inlet (Nishi and Gunn 2004, Poole et al. 2010). They can be found in the Izok Corridor RSA from late October to early June; during that time they are found from the James River and Ulu areas north to the mainland coast. In general, Dolphin and Union caribou are widely distributed during winter, although they tend to congregate closer to the coast in late winter (April-May). The herd appears roughly stable or slightly declining in numbers (~22,000 animals [estimate within the survey zone from 2007 census]; M. Dumond, GN DoE, pers. comm.). The herd is experiencing greater harvest pressure, perhaps due to lower numbers of mainland caribou, and is being affected by later freezing of the straits between Victoria Island and the mainland (Poole et al. 2010).

Bathurst caribou (*R. t. groenlandicus*) winter south of the treeline within a broad area from northern Saskatchewan to south of Great Bear Lake before migrating north in spring to calve along the Hood and Burnside rivers west of Bathurst Inlet (Gunn et al. 2001, Nishi et al. 2010). The Izok Corridor RSA overlaps portions of the migration route, post-calving, summer, and early fall range for this herd, as well as the western edge of recent calving grounds. The 2009 estimate for the Bathurst herd (~32,000 ± 5,300 [SE] caribou; Nishi et al. 2010) represents a >90% decline from surveys from the mid 1980s. There are indications from recent reconnaissance calving ground surveys that Bathurst numbers may have stabilized, and a census will be conducted in June 2012 (B. Croft, GNWT ENR, pers. comm., May 2012.).

The Bluenose-East caribou herd is generally found west of the Izok Corridor RSA, but may occur in the southwestern sections of the RSA during summer and fall (Nagy et al. 2005; GNWT ENR, unpubl. data). However, the western portions of the study area are likely at the eastern limit of the Bluenose-East caribou range, and occurrence will be variable among years. Previous project surveys documented probable Bluenose-East caribou in the study area in August 2010.The 2010 survey of the Bluenose-East caribou herd indicated a population of 98,650 ± 7,125 (post-calving photo survey; J. Adamczewski, GNWT ENR, pers. comm.), an increase since 2006 (66,800 ± 5,200; Nagy and Tracz 2006).

Muskoxen are an important source of local food and meat for commercial export, and are increasingly used for guided sport hunts as well as a resource for tourism and wildlife viewing. Muskoxen occur within the general area throughout the year. Comparison with a 2005 muskox survey by Nunavut Government biologists that covered from Kugluktuk to Bathurst Inlet and from Jericho north to the coast indicates that the Izok Corridor RSA occurs within a low density area, which held an estimated 365 ± 209 muskoxen and only 4% calves (Dumond 2007). More recently, project-related aerial surveys in 2008 have observed up to 167 muskoxen within the RSA at a time.

Moose densities on the tundra are typically low. The presence of moose in the Izok Corridor RSA has been confirmed by project surveys throughout the years, but the species has been observed in very limited numbers, and nearly all of the observations have been within 30 km of the coast, associated with shrub habitats in low-elevation valleys. No population estimates are available for the region.

Carnivores

Several species of large- and medium-sized carnivores are present in the Izok Corridor RSA, including grizzly bears, wolverines, wolves (*Canis lupus*), Arctic fox (*Alopex lagopus*) and red fox (*Vulpes vulpes*). These animals are typical of the Low Arctic and generally occur at low densities throughout the Kitikmeot region. Many of them are harvested by Inuit hunters, and represent a source of income for local people. Additionally, grizzly bears and wolverine are high-profile species of local and national interest and conservation concern. Ermine (*Mustela ermine*), and least weasel (*M.nivalis*) may also be present within the RSA.

Grizzly bears are found throughout the mainland of the Kitikmeot region, with increasing sightings on Victoria Island. They are adapted to preying on caribou and muskoxen, but also feed on vegetation and roots and will hunt small mammals such as Arctic ground squirrels (*Spermophilus parryii*; Gau et al. 2002). Grizzly bears in this area use habitats such as eskers in spring for early season vegetation and berries, and heath tundra and shrub habitats in summer for foraging (McLoughlin et al. 2002a). Denning areas for bears are typically in well-drained, steep-sloped heath tundra, heath-boulder habitats, or esker habitats, often under tall shrubs that help to support the ceiling, and on all but north exposures (McLoughlin et al. 2002b). Project surveys have observed grizzly bears throughout the RSA and have documented local denning. Bears may concentrate closer to calving Bathurst caribou and along the coast during spring, but overall, the animals appear to be widely distributed. Densities in this region are unknown; however, grizzly bear DNA studies are currently underway at several projects within and adjacent to the Kitikmeot region, including the grizzly bear hair snare program planned for the Izok RSA during the summer of 2012.

Wolves are the predominant predators of both caribou (Kuyt 1972, Williams 1990) and muskoxen (Heard 1992, Gunn and Adamczewski 2003). Wolves also will forage on small mammals such as lemmings, voles, and Arctic ground squirrels, and they play a pivotal role in all levels of the food web within the Arctic ecosystem. While most carnivores are territorial, wolves that depend largely on barren-ground caribou do not maintain regular territories. With the exception of the denning period, these wolves will migrate with caribou to maintain a year-round food source. Recent estimates of wolf numbers associated with the Bathurst herd are unknown, but annual wolf den surveys suggest that wolf numbers and productivity have fallen rapidly in recent years as the caribou herds have declined (Adamczewski et al. 2009). Wolf denning in the tundra tends to occur closer to treeline, likely a strategy

to optimize timing and access to caribou for rearing pups (Heard and Williams 1992, Cluff et al. 2002), and is predominantly in eskers and other glacial formations (Cluff et al. 2002, McLoughlin et al. 2004). Previous surveys have observed wolves throughout the study area, associated with both the Bathurst and Dolphin and Union herds. Two active wolf dens have been documented within the RSA.

Wolverines are wide-ranging carnivores that inhabit all portions of the Canadian Arctic in low densities. They have large home ranges and depend primarily on carrion, in particular caribou, as their major food source (Mulders 2000). Wolverines are an important cultural and economic resource for the people of the NWT and Nunavut, and are hunted for their valued pelts for parka trim (owing to the frost-resistant fur) and for sale to auction houses. Regulators have raised concerns about the health of wolverine populations in the Arctic (Mulders et al. 2007). In past decades, a number of mining developments have proven to be detrimental to local wolverine populations (e.g., DDMI 2003, BHP Billiton 2006). In 2008, a wolverine DNA inventory program was successfully conducted in the High Lake area, resulting in 29 unique captures of wolverines within a 3,000 km² study area. A similar study is being completed in the Izok area in 2012.

Arctic foxes and red foxes are both found within the Kitikmeot region. Both species are trapped for their pelts (Thorpe et al. 2001), with Bathurst Inlet residents taking roughly equal numbers of red foxes and Arctic foxes and residents of other West Kitikmeot communities taking more Arctic fox (Priest and Usher 2004). Foxes in Arctic environments fluctuate widely in number, following the three to five year cycle in vole and lemming populations, their primary food source (MacPherson 1969, Garrott and Eberhardt 1987, Voigt 1987). They also feed on ground squirrels, Arctic hares (*Lepus arcticus*), birds, eggs, berries, and most other prey available, and scavenge ungulate meat from kills made by larger predators (MacPherson 1969, Thorpe et al. 2001, Cypher 2003). They typically den in sandy soils near riverbanks and on eskers. Previous work in the Izok Corridor RSA has found evidence of both species within the study area; however, observations indicate that red fox are more numerous than Arctic fox in this area.

Small Mammals

Small mammals, including lemmings, voles and ground squirrels, are found throughout the study area, and are a recognized part of the food chain in supporting larger wildlife species. Arctic hare, while not usually considered among small mammals, are also ubiquitous throughout the study area. Carnivores such as weasels, foxes, wolves, wolverines, grizzly bears, and raptors depend on these animals as prey species throughout the year. Some small mammal populations, lemmings and voles in particular, undergo synchronous population fluctuations (Krebs et al. 2002) and form the basis for much of the terrestrial trophic dynamics in the Canadian Arctic (Krebs et al. 2003). Such population cycles may peak every three to four years, and may be influenced by weather patterns (Leslie 1959), predation (Myrbeget 1973, Ydenberg 1987) and/or dispersal events of juveniles.

Small mammal trapping and other surveys previously completed for the project have documented Arctic hare, Arctic ground squirrels, northern red-backed voles, meadow voles, masked shrew and lemming species within the RSA. Northern red-backed vole and Arctic ground squirrel appear to be some of the more abundant species.

5.7.3.3 Ongoing Studies

The following ungulate and carnivore surveys are being conducted in 2012.

- A series of aerial ungulate (caribou, muskox, moose) distribution surveys in March through September
- Aerial ungulate track and trail surveys in March, April and July
- Expanded aerial transect surveys for ungulates (caribou and muskox) along the alternate route alignment
- Grizzly bear and wolverine DNA inventories using hair-snare sampling
- Aerial surveys to inventory carnivore (grizzly bear, wolf, fox) den sites along the proposed road alignment

No further studies related specifically to terrestrial species at risk are planned.

Although no small mammal studies are being conducted in 2012, small mammals will be documented whenever they are encountered during other wildlife field work.

5.7.4 Birds and Habitat

5.7.4.1 Study Areas

The study areas used for terrestrial bird studies for the Izok Corridor Project are the same as for the terrestrial wildlife studies (refer to section 5.7.3.1).

5.7.4.2 Description of Existing Environment

Terrestrial birds within the Kitikmeot region consist of both migratory and resident species, and include a diverse array of species and species guilds. Longer periods of daylight and seasonally abundant food supply from May through August generally support the breeding and rearing periods for most species. Relatively few species are present outside of the breeding period because long, cold winters and limited food availability limit populations. Those species that remain include gyrfalcons (*Falco rusticolus*), ptarmigan (*Lagopus sp.*), and common ravens (*Corvus corax*). Migrant species occupy wintering areas extending from the Canadian boreal forest to the southern extent of South America. Because of the vast distances covered by many species between summer and winter habitats, factors and effects occurring far beyond the breeding range often affect populations. However, environmental factors within the breeding range are undoubtedly important to the survival of all species breeding within the region. Birds are prominent in Inuit culture, and several species (e.g., including ducks, geese, and ptarmigan) are regularly hunted for food (Priest and Usher 2004).

Prior to baseline studies for proposed mines in this region, information detailing species distribution and presence within the mainland area was often based on limited field data. However, baseline studies previously conducted for the High Lake and Izok projects, as well as other projects in the area, have provided much better information for local bird populations.

Species at Risk

Table 5.7-3 lists bird Species at Risk that are potentially present within the Izok Corridor RSA. Of these, only the Eskimo curlew is currently listed under Schedule 1 of SARA. COSEWIC and SARA have

designated the Eskimo curlew as Endangered, and the GN lists this species as At Risk. However, nesting of this species has not been confirmed for over a century, and the RSA is east of the historic probable breeding area of the species (COSEWIC 2009). Two other species are listed under Schedule 3 of SARA: peregrine falcon, which is designated as Secure by the Government of Nunavut (GN), and as a Species of Special Concern by COSEWIC, and short-eared owl, which is considered Sensitive by the GN and as Special Concern by COSEWIC. Both of these species were documented within the RSA in previous studies. Peregrine falcon is a ubiquitous breeder in suitable habitat throughout the region. Additionally, barn swallow, while not currently scheduled under SARA, is under consideration for addition to Schedule 1 (Environment Canada 2011) and has been listed as Threatened by COSEWIC. A single barn swallow was observed during previous surveys within the RSA.

The remaining bird species listed in **Table 5.7-3** are not currently scheduled under SARA and have either not been assessed or are considered Not at Risk by COSEWIC. All are designated as Sensitive by the GN, and in most cases, this designation is likely because of perceived small populations on the periphery of distribution ranges.

Table 5.7-3 Bird Species at Risk within the Izok Corridor RSA

Species	Scientific Name	Species Status		
		Nunavut[1]	SARA Schedule[2]	COSEWIC[3]
Common Eider	*Somateria mollissima*	Sensitive	Not currently scheduled	Not assessed
King Eider	*Somateria spectabilis*	Sensitive	Not currently scheduled	Not assessed
Long-tailed Duck	*Clangula hyemalis*	Sensitive	Not currently scheduled	Not assessed
Golden Eagle	*Aquila chrysaetos*	Sensitive	Not currently scheduled	Not at Risk
Rough-legged Hawk	*Buteo lagopus*	Sensitive	Not currently scheduled	Not at Risk
Gyrfalcon	*Falco rusticolus*	Sensitive	Not currently scheduled	Not at Risk
Peregrine Falcon (tundra)	*Falco peregrinus tundrius*	Secure	Schedule 3	Special Concern
American Golden-plover	*Pluvialis dominica*	Sensitive	Not currently scheduled	Not assessed
Black-bellied Plover*	*Pluvialis squatarola*	Sensitive	Not currently scheduled	Not assessed
Eskimo Curlew	*Numenius borealis*	At Risk	Schedule 1	Endangered
Ruddy Turnstone*	*Arenaria interpres*	Sensitive	Not currently scheduled	Not assessed
Sanderling	*Calidris alba*	Sensitive	Not currently scheduled	Not assessed
Semipalmated Sandpiper	*Calidris pusilla*	Sensitive	Not currently scheduled	Not assessed
Least Sandpiper	*Calidris minutilla*	Sensitive	Not currently scheduled	Not assessed
Buff-breasted Sandpiper*	*Tryngites subruficollis*	Sensitive	Not currently scheduled	Not assessed
Red Phalarope*	*Phalaropus fulicarius*	Sensitive	Not currently scheduled	Not assessed
Red-necked Phalarope	*Phalaropus lobatus*	Sensitive	Not currently scheduled	Not assessed
Glaucous Gull	*Larus hyperboreus*	Sensitive	Not currently scheduled	Not assessed
Thayer's Gull	*Larus thayeri*	Sensitive	Not currently scheduled	Not assessed
Arctic Tern	*Sterna paradisaea*	Sensitive	Not currently scheduled	Not assessed
Short-eared Owl	*Asio flammeus*	Sensitive	Schedule 3	Special Concern

Species	Scientific Name	Species Status		
		Nunavut[1]	SARA Schedule[2]	COSEWIC[3]
Barn Swallow	*Hirundo rustica*		Not currently scheduled	Threatened
Northern Wheatear*	*Oenanthe oenanthe*	Sensitive	Not currently scheduled	Not assessed
American Pipit	*Anthus rubescens*	Sensitive	Not currently scheduled	Not assessed
American Tree Sparrow	*Spizella arborea*	Sensitive	Not currently scheduled	Not assessed
Harris's Sparrow	*Zonotrichia querula*	Sensitive	Not currently scheduled	Not assessed
White-crowned Sparrow	*Zonotrichia leucophrys*	Sensitive	Not currently scheduled	Not assessed
Snow Bunting	*Plectrophenax nivalis*	Sensitive	Not currently scheduled	Not assessed
Hoary Redpoll	*Acanthis hornemanni*	Sensitive	Not currently scheduled	Not assessed

* The Izok Corridor RSA is outside of the main range for these species
1 CESCC (2011)
2 Environment Canada (2011)
3 COSEWIC (2011)

Raptors

There are nine species of raptors potentially present in the RSA including ravens, which although true passerines, are considered "functional raptors" (Poole and Bromley 1988) because they nest on cliffs where they interact with raptors for nesting territories and build stick nests that can be used by raptors for nesting. Three of these species can be considered ground-nesting raptors (short-eared owl, snowy owl (*Nyctea scandiaca*), and northern harrier (*Circus cyaneus*)). The remaining species (golden eagle, bald eagle (*Haliaeetus leucocephalus*), gyrfalcon, peregrine falcon, rough-legged hawk, and common raven) breed and occupy nests on cliffs in the region. Of these species, the bald eagle is at the edge of its established range, and would be expected to occur as accidental or vagrant only.

The Izok Corridor RSA has an abundance of rocky outcrops that form ridges, mesas and canyons. Many of these have steep faces providing suitable nesting sites for cliff-nesting raptors, and previous surveys have found that nesting raptors are comparatively abundant wherever cliffs are present. In particular, high numbers of peregrine falcons and gyrfalcons have been found in the RSA. Common raven, rough-legged hawk, and golden eagle are also common, with breeding numbers of rough-legged hawks following the three to four-year small mammal cycles (Poole and Bromley 1988). In comparison, ground-nesting raptors appear to be less common throughout the RSA; no ground-nesting sites have been documented during surveys.

Waterfowl

Waterfowl (ducks, loons, geese, and swans) are migratory species and, as such, are protected under the federal Migratory Birds Convention Act. The Arctic is known to provide critically important areas for waterfowl, which use Arctic habitats for migration and staging, breeding, and moulting. Large congregations of waterfowl can occur in certain locations for any of these three purposes. These congregation areas are important since there may be periods when a large proportion of a local

population is present, making them potentially vulnerable to predators, human activities, or severe weather events.

Based on known species ranges and previous field surveys in the Izok Corridor RSA, over 20 species of waterfowl have the potential to inhabit that RSA. Although the RSA contains many small inland lakes and ponds with potential breeding and feeding sites for waterfowl, survey results have indicated that bird densities are relatively low. To date, no large congregations of waterfowl have been found within the terrestrial RSA. The most common species documented in the region during previous surveys include yellow-billed loon (*Gavia adamsii*), red-throated loon (*Gavia stellate*), common merganser (*Mergus merganser*), long-tailed duck (*Clangula hyemalis*) and greater white-fronted goose (*Anser albifrons*).

Tundra Breeding Birds

Tundra breeding birds refers to migratory birds that are not raptors, waterfowl or sea ducks. Songbirds (i.e., passerines) are typical of this category, but shorebirds (e.g., plovers and sandpipers), gulls and terns and upland game birds (ptarmigan) are also included in this group. With the exception of some ptarmigan, birds in this group are seasonal migrants and, similar to waterfowl populations, are protected under the federal Migratory Birds Convention Act. Collectively, tundra breeding birds are an important prey for raptors (Poole and Bromley 1988) and land mammals such as foxes.

Previous work conducted for the Izok and High Lake projects, as well as the Jericho (Hubert and Associates Ltd. 2002) and the Ulu (Echo Bay Mines Ltd. 1997) properties, has documented almost 40 species of upland breeding birds in the region. Some of the most common species appear to be lapland longspur (*Calcarius lapponicus*), savannah sparrow (*Passerculus sandwichensis*), American tree sparrow (*Spizella arborea*), horned lark (*Eremophila alpestris*), and hoary redpoll (*Carduelis hornemanni*). Wet tundra habitats such as sedge and riparian tall shrub are among the most productive habitats for upland breeding birds within this region.

5.7.4.3 Ongoing Studies

Aerial raptor surveys are being conducted in 2012 to document distribution and baseline productivity of raptor species in the study area (i.e. peregrine falcon, gyrfalcon, golden eagle, rough-legged hawk and common raven). The program will involve an aerial survey in early June to document nest site occupancy, and a survey in late July or early August to document site productivity. A single aerial survey is also being conducted in 2012 to document the abundance and breeding distribution of loons and other waterfowl along interior habitats within the Project area. These surveys have been expanded to include the alternate road alignment.

Tundra breeding bird surveys are being conducted to document species composition, distribution and density of passerines, shorebirds and other breeding birds inhabiting terrestrial habitats within the proposed Izok Corridor Project. Surveys will include methods such as the rapid PRISM (Program for Regional and International Shorebird Monitoring) method developed by CWS.

No further studies specifically related to bird species at risk are planned for 2012.

5.8 Marine Environment

5.8.1 Physical Processes and Ice Climate

5.8.1.1 Study Areas

Local Study Area

The LSA for marine physical processes is limited to the footprint of the Grays Bay dock.

Regional Study Area

As there is no potential for the Project to affect marine physical processes beyond the LSA, no RSA has been defined.

5.8.1.2 Description of Existing Environment

Grays Bay is sheltered from Coronation Gulf by Hepburn Island, which is located about 10 km north of the mainland. The high cliffs of the island form an effective wind break for winds blowing out of the north into Grays Bay, and limit the fetch distance for wind-generated waves as compared to conditions out in the gulf.

The Canadian Hydrographic Service publishes tide tables for Kugluktuk and Cambridge Bay, which provide an indication of the potential tidal range at Grays Bay. The 2012 tidal range at Kugluktuk is 0.2-0.5 m, and at Cambridge Bay is 0.2-1.0 m (Canadian Hydrographic Service Tide Tables). Actual measurements will be made at the Grays Bay dock site as part of ongoing engineering work at the port.

Grays Bay is usually ice covered, except for a brief period between mid July and early November. The actual shipping season is much shorter, however, due to ice conditions elsewhere in the Arctic. This is particularly true at the western and eastern ends of Coronation Gulf where ships are forced to navigate into higher latitudes in order to traverse the Northwest Passage. The Annual Ice Atlas (Canadian Ice Service) reported that ice melted completely in Coronation Gulf in July 2011. Ice began forming along the shores of Coronation Gulf during the second week of November, and freeze-up progressed quickly. The Western Arctic was completely ice covered by the third week of November, which was three weeks later than normally reported. Landfast ice began to retreat from shore at Grays Bay in early June 2012, while ice thickness was >1 m within 50 m of shore.

Ice thickness is measured by the Canadian Ice Service at Cambridge Bay. Since 2000, maximum ice thickness at Cambridge Bay has been slightly greater than 2 m. This is considered to be a good approximation of expected ice thickness at Grays Bay.

A preliminary bathymetric survey was undertaken in Grays Bay in 2004 (Challenger Geomatics Ltd. 2004). The survey included the approaches to Grays Bay from Coronation Gulf, as well as Grays Bay itself to confirm a viable shipping channel. The survey was conducted across the site based on a 20 m by 20 m grid. It was determined that water in excess of 20 m deep was present at a distance of less than 100 m from shore, confirming that the site provided the minimum water depth required for ship berthing. Further site investigations were undertaken in 2005 (BGC Engineering Inc. 2006b) to obtain greater detail on bathymetry. Results of the 2005 survey indicated that the bedrock sub-bottom contours

parallel the shoreline shape of the peninsula, dropping to 45 m approximately 100 m offshore (average slope of 24°). In the proposed dock site area, the bedrock slope averages about 20° from the shoreline to a water depth of approximately 15 m, then steepens to about 30° below 15 m.

5.8.1.3 Ongoing Studies

The tidal range at the Grays Bay dock site will be measured as part of ongoing engineering work at the port site. Currents and waves in the LSA around Grays Bay are also under investigation. Instruments (bottom mounted acoustic Doppler current meters) to measure currents and waves near the proposed dock site were deployed in the summer of 2008. The data from those deployments are being processed. A second deployment is planned for the ice-free period of 2012.

5.8.2 Marine Water and Sediment Quality

The study of marine water and sediment quality includes a spatial and temporal characterization of baseline conditions. Water and sediment quality are important components of the marine habitat and changes in their quality may affect the health of marine organisms, and the quality of habitat.

5.8.2.1 Study Areas

Local Study Area

The LSA for water and sediment quality is defined as a 500 m radius from the dock site. This area encompasses the expected maximum extent of direct effects of the Project on marine water and sediment quality.

Regional Study Area

The RSA is arbitrarily set at 2 km from the dock site. Cumulative effects are not expected given the remoteness of the area, and distance from any existing anthropogenic disturbances. Any indirect Project effects are anticipated to be undetectable beyond 2 km from shore.

5.8.2.2 Description of Existing Environment

Water quality in Grays Bay was sampled in August 2005 and August 2008 in support of the High Lake and Izok projects. The 2005 data was presented in the High Lake DEIS (GLL 2006b). The 2008 data was collected as part of baseline investigations conducted by OZ Minerals and has not been previously reported.

Grays Bay is located hundreds of kilometers from any anthropogenic point sources of contamination. The largest influences on water quality are the formation and melting of ice, and inputs of freshwater from the Kennarctic River and smaller streams.

The Kennarctic River carries a relatively high suspended sediment load that produces a plume of turbid water in the ocean. The low salinity and warmer temperature of the river water produce a low density surface layer that overrides the high density oceanic water. The plume location is affected by wind and tide. At times, the turbid water plume extends to the potential dock site location. At other times, the plume is carried to the northeast away from the dock site, and clear water is present at the dock site.

During the August 2008 water quality sampling program, water at the dock site was clear, with a Secchi depth of 8-10 m.

Ice formation and melting mainly affects surface water salinity. During ice formation, salt is excluded from the ice and a high salinity surface layer is formed that is denser than the sub-surface water, which causes it to sink and readily mix with sub-surface water. During ice melt, a low salinity surface layer forms and persists because it is less dense than the sub-surface layer, and requires wind mixing to erode the vertical salinity gradient.

Total metal concentrations in water at Grays Bay are highly dependent on the level of suspended sediments, since sediments typically have elevated metals levels compared to background dissolved metal levels. With a few exceptions, water quality in Grays Bay is reported to be below CCME (2007) marine water quality guidelines for the protection of aquatic life (GLL 2006b). Some samples collected in 2005 had mercury levels greater than the CCME marine guideline of 16 ng/L inorganic Hg. Results of analyses carried out on the 2008 samples indicated that mercury levels were less than the detection limit of 0.5 ng/L. Levels of all other metals analyzed were below guidelines. Dissolved metal levels were in the range that is typical of open ocean water, and lower than CCME guidelines for total metals (**Table 5.8-1**).

Table 5.8-1 Comparison of Metal Concentrations in 2008 samples with Regulatory Guidelines

Element	Concentration (µg/L)		
	2008 range	Typical Seawater Composition[1]	CCME Marine Guideline
Arsenic	0.54 - 1.23	2.6	12.5
Cadmium	<0.02 - 0.035	0.11	0.12
Copper	0.31 - 0.598	0.9	
Iron	<10	3.4	
Lead	<0.050	0.03	
Mercury	<0.010	0.15	0.016[2]
Molybdenum	6 - 9.6	10	
Nickel	0.057 - 0.558	6.6	
Zinc	<0.5 - 1.08	5	

1 Turekian (1968)
2 Inorganic mercury

Sediments within Grays Bay were sampled in 2004, 2005 and 2008 as part of baseline studies for High Lake and Izok Lake projects. The particle size distribution of samples collected in 2008 indicated that surface sediment is composed primarily of fine sand and silt. Sediment quality analyses found that arsenic, copper and chromium were above the Interim Sediment Quality Guidelines (CCME 2002) at some sites in Grays Bay and the mouth of the Kennarctic River. However, all metal concentrations measured were below Probable Effects Level (PEL).

Water and sediment quality results from sites sampled beyond the LSA were similar to that found within the Grays Bay LSA.

5.8.2.3 Ongoing Studies

Baseline water quality sampling in the Grays Bay Port LSA is being conducted in June and September 2012. Samples will be collected from near surface and near bottom waters. Baseline sediment quality sampling is planned for September 2012 and will coincide with benthic invertebrate sampling. The 2012 data will increase the robustness of the baseline dataset, and permit an inter-annual comparison of results.

5.8.3 Marine Aquatic Organisms and Habitat

5.8.3.1 Study Area

Local Study Area

For marine habitat, the Project Development Area (PDA) is the project footprint under the dock and any other areas where marine habitat will be potentially lost. For marine fauna, the PDA is considered to be part of, and indistinguishable from the Local Study Area (LSA), which is defined as that area where immediate direct and indirect effects of the Project could potentially occur. The boundaries of the area are based on expected dispersal of sediments from Project activities, particularly concentrate, around the dock site in Grays Bay, a distance expected to be a few km from the dock site.

Regional Study Area

The Regional Study Area (RSA) for marine fauna is defined as Grays Bay, as Project effects are not expected to occur beyond the immediate area of the dock site).

5.8.3.2 Description of Existing Environment

The description of marine fauna and habitat within the RSA is based largely on studies conducted in other arctic marine locations.

- A study of test fisheries of the Coppermine River (Gillman and Kristofferson 1984)
- A study conducted during the summer and fall in Coronation Gulf near Kugluktuk (KCC 1993)
- A study conducted during the summer in Melville Sound (RL&L and Golder 2003)
- A study of the status of Cambridge Bay anadromous arctic char stocks conducted for the Canadian Science Advisory Secretariat (Day and de March 2004)

Other field work was conducted in 2002 and 2003 for the Bathurst Inlet Port and Road Project EIS; however, these studies are not publicly available.

Information on the LSA was collected as part of the High Lake Project DEIS, and included reconnaissance-level field sampling at four potential dock sites in summer 2004 and at the preferred dock site in summer 2005 (GLL 2006e).

Regional Study Area

Zooplankton

Zooplankton is responsible for much of the secondary production that occurs in arctic marine waters because most groups and species are herbivores that form a direct link between phytoplankton and higher vertebrate consumers (e.g., fish, birds and marine mammals). Some zooplankton groups contain species that are carnivores, and they compete directly for the secondary production with higher vertebrates.

Zooplankton species composition is generally homogeneous through the Canadian Arctic (Grainger 1965), although it is broadly related to water depth, temperature and salinity (Griffiths et al. 1987; Griffiths and Thomson 2002). Grainger (1965) described two major groups of zooplankton in Beaufort Sea waters <100 m deep based on horizontal and vertical distribution patterns and physical measurements. One characterizes the upper 100 m of arctic surface waters, and has a widespread offshore and inshore distribution. Included are the hydrozoans *Aglantha digitale* and *Aeginopsis laurentii*, the ctenophore *Beroe cucumis*, and several species of copepods: *Calanus hyperboreus*, *C. glacialis*, *Pseudocalanus minutus*, *Metridia longa*, and *Oithona similis*. The second, characteristic of shallow, inshore brackish waters, includes the hydrozoans *Euphysa flammea*, *Halitholus cirratus*, and *Sarsia princeps*; the ctenophore *Obelia* spp.; and the copepods *Limnocalanus macrurus*, *Acartia clausi*, *Eurytemora herdmani*, and *Derjuginia tolli*.

Copepods dominate the zooplankton in the Beaufort Sea and elsewhere in the Arctic (e.g., in Lancaster Sound and Baffin Bay, Buchanan and Sekerak 1982; off the Mackenzie Delta and Herschel Island, Grainger and Grohe 1975; along the Yukon coast, Bradstreet and Fissel 1986, Bradstreet et al. 1987).

Benthic Fauna

Benthic fauna are divided into two main groups based on the habitat that they occupy: epifauna and infauna (Thorson 1957). Epifauna (or epibenthos) inhabit the upper surface of the substrate, and are separated into sessile forms (e.g., sea anemones) and mobile forms (e.g., mysids and some amphipods). Infauna (e.g., bivalves and polychaetes) are found in the bottom sediments, and are usually sedentary.

Sessile epifauna are restricted, for the most part, to hard surfaces, which are rare in the western Arctic. Mobile epifauna are often abundant in inshore areas of the Beaufort Sea during the open-water period (Griffiths and Dillinger 1981; Griffiths and Buchanan 1982; Bradstreet and Fissel 1986). Certain localized habitats in the Beaufort region appear to be very productive, particularly in protected areas on the outer islands of the Mackenzie Delta (e.g., Slaney 1973; Wacasey 1975). Epifauna of the shallow inshore zone of the Beaufort Sea are important ecologically because they comprise major components of the diets of fish, birds, and marine mammals (Divoky 1978; Lowry et al. 1978; Craig et al. 1984).

In the Beaufort Sea, infaunal species diversity and biomass generally increase with depth and distance from shore, from at least beyond the 20-m depth contour to the edge of the continental shelf (Wacasey 1975). Minimum numbers occur at depths of 15–20 m, which correspond closely to the shear zone, the boundary between landfast ice and the moving ice pack. Low densities also occur in depths <2 m, primarily because the landfast ice freezes to the bottom.

Marine Fish

Most arctic marine fish have a predominantly offshore, marine distribution year round. However, there are three species that migrate near shore during summer and inhabit brackish water environments in large numbers. They are the fourhorn sculpin, arctic flounder, and saffron cod. The arctic cod is abundant throughout the Arctic Ocean and can be quite abundant in nearshore areas.

Arctic Cod (Boreogadus saida) - The arctic cod has a circumpolar distribution and is ubiquitous in marine waters of arctic Canada and Alaska (e.g., Bradstreet et al. 1986; Welch et al. 1993; Hop et al. 1997). In nearshore coastal waters, arctic cod abundance during summer is highest where salinities are highest, and lowest where conditions are more brackish. Schooling likely affects local abundance. Arctic cod are often observed in large age-segregated schools (e.g., Welch et al. 1993) that may form under ice to feed (e.g., Moulton and Tarbox 1987), or as protection against predators (e.g., Hop et al. 1997). The movement of the large schools into coastal areas can be either short lived (Craig and Haldorson 1981) or sustained (Glass et al. 1990).

The arctic cod is an important food item in the diets of marine mammals, birds and fish, and is considered to be a primary component of the arctic marine food chain (Bradstreet et al. 1986; Hobson and Welch 1992). Arctic cod feed on planktonic and epibenthic fauna; dominant prey items are mysids, amphipods, and copepods (e.g., Craig and Haldorson 1981; Coyle et al. 1997).

Arctic cod was the fourth most numerous harvested fish recorded in Kitikmeot (Priest and Usher 2004). Average annual catches recorded for Kugluktuk and Cambridge Bay between 1996–1997 and 2001–2002 were 768 and 56, respectively.

Fourhorn Sculpin (Myoxochephalus quadricornis) - The fourhorn sculpin is a demersal species that has a circumpolar nearshore distribution in brackish and moderately saline waters (Scott and Crossman 1973; Morrow 1980). This species migrates onshore into brackish coastal habitats during summer to feed, and can travel considerable distances up rivers. Fourhorn sculpins live permanently near the coast and do not undergo extensive migrations. They rarely occur deeper than 15–20 m (Andriyashev 1954).

The fourhorn sculpin was taken in relatively high numbers near Kugluktuk (KCC 1993) and in relatively low numbers in Melville Sound (RL&L and Golder 2003). Although they have no commercial or subsistence use, they serve as forage for fish and birds (Griffiths et al. 1975; Kendel et al. 1975; Craig and Haldorson 1981).

Flounder (Pleuronectes glacialis) - The arctic flounder is a bottom-dwelling circumpolar marine species, typically found in shallow coastal waters during summer when it commonly enters low-salinity habitats (e.g., Morrow 1980). It is uncommon east of Cape Bathurst (Stewart et al. 1993).

Arctic flounder were taken in relatively low numbers near Kugluktuk (KCC 1993) and in Melville Sound (RL&L and Golder 2003). The starry flounder *Platichthys stellatus* ranges east to the Coronation Gulf, Melville Sound, and Bathurst Inlet (Stewart et al. 1993). Off the Coppermine River, Gillman and Kristofferson (1984) found starry flounder but not arctic flounder. Starry flounder were taken in relatively low numbers near Kugluktuk (KCC 1993) but not in Melville Sound (RL&L and Golder 2003).

Saffron Cod (Eleginus gracilis) - The saffron cod is found in brackish and marine waters of the Beaufort Sea east to Bathurst Inlet (Walters 1955). It frequently enters rivers and can go considerable distances upstream (Morrow 1980). Saffron cod can be found both nearshore and offshore during summer (e.g.,

Byers and Kishino 1980). It is the least abundant of the "onshore" marine species. Off the Coppermine River, Gillman and Kristofferson (1984) found small numbers of saffron cod. They were taken in relatively high numbers near Kugluktuk (KCC 1993) and in Melville Sound (RL&L and Golder 2003).

Bering Wolffish (Anarhichas orientalis) - The only Canadian records of the Bering wolffish were three individuals recorded in Bathurst Inlet (Houston and McAllister 1990). For that reason, the species was considered a threatened species by COSEWIC in 2001, although its status has since been downgraded because of a lack of data (NPC 2004). Because of its highly specialized and localized habitat, the NPC has recommended that the species deserves special management consideration (NPC 2004). A probable Bering wolfish (specimen photographed, but not retained) was caught near Kugluktuk in summer 2004 (T. Gordanier, DFO, in litt. 2005). The Bering wolffish is usually found in shallower water than other wolfish, and it prefers algae-covered rocky bottoms. It moves into deeper waters when ice forms.

Offshore Marine Species (excluding arctic cod) - There have been only a few offshore surveys of demersal fish in the western Arctic, and these have been focused on the Beaufort Sea. Surveys of demersal fish in the offshore waters (>50 km offshore) of the western and central Beaufort Sea have identified 17 species of marine fish (Frost and Lowry 1983). Incidental takes from nearshore studies have identified an additional dozen or so "deepwater species". They include 10 species of sculpin, 2 poachers, 4 snailfish, 10 eelpouts, 5 pricklebacks, 2 wolffishes, and 1 species of gunnel. They reflect a numerically low, yet geographically extensive, marine faunal assemblage throughout arctic marine waters. McAllister (1962) suggested that this "Innuit" faunal assemblage extends continuously from the central Canadian Arctic westward through the Beaufort, Chukchi, East Siberian, Laptev, Kara, and Barents seas.

Anadromous Fish

Anadromous fishes are hatched and initially reared in freshwater river systems before migrating to sea, where they spend most of their lives before returning to their natal streams as adults to spawn.

Arctic Cisco (Coregonus autumnalis) - Arctic cisco remains associated with drainages that are extensive enough to provide sufficient habitat during winter. In the eastern Beaufort Sea, only the Mackenzie River appears large enough to support substantial stocks of sub-adult and adult fish as well as juveniles and fry (Bond 1982). Arctic cisco was the second and fifth most abundant fish found near Kugluktuk (KCC 1993) and off the Coppermine River (Gillman and Kristofferson 1984), respectively. It is rarely reported in Kitikmeot in the Nunavut Wildlife Harvest Study (Priest and Usher 2004).

Rainbow Smelt (Osmerus mordax) - Most coastal fish surveys report taking small to moderate numbers of rainbow smelt, but catch rates are typically the lowest of the anadromous and amphidromous species. Rainbow smelt was the sixth most abundant fish found near Kugluktuk (KCC 1993), but was not found off the Coppermine River (Gillman and Kristofferson 1984) or in Melville Sound (RL&L and Golder 2003). It is not reported in the Nunavut Wildlife Harvest Study (Priest and Usher 2004).

Amphidromous Fish

Amphidromous fish cycle annually between freshwater and coastal marine environments. Amphidromous fish spawn and overwinter in rivers and streams but migrate out into coastal waters for several months each summer to feed.

Arctic char (Salvelinus alpinus) and Dolly Varden (Salvelinus malma) - Arctic char is the most northerly-distributed freshwater fish in Nunavut, and has a circumpolar presence in marine waters, lakes, and

rivers. Arctic char can exist as landlocked and anadromous forms, with the latter moving to salt water in the spring and returning to spawn in the summer to early fall. The Dolly Varden is common along much of the Beaufort Sea coast during summer (Fechhelm et al. 2000), but abundance drops markedly east of Phillips Bay on the Yukon coast (Kendel et al. 1975).

Arctic char was the fourth most abundant fish taken near Kugluktuk (KCC 1993), and the third most abundant fish taken in Melville Sound (RL&L and Golder 2003). Arctic char was the most numerous harvested fish recorded in Kitikmeot (Priest and Usher 2004). Average annual catches recorded for Kugluktuk and Cambridge Bay between 1996-1997 and 2001–2002 were 8518 and 6461, respectively. The commercial char fishery in Cambridge Bay, carried out at the mouths of various rivers in the area, averaged 41,000 kg round weight per year during 1960–2003 (Day and de March 2004). The Draft West Kitikmeot Regional Land Use Plan highlighted the need for special management of the species and its habitat in areas located near communities and those used by the commercial fishery (NPC 2005).

Least Cisco (Coregonus sardinella) - Amphidromous least cisco have a discontinuous distribution in the Beaufort Sea (Craig and McCart 1975; Craig 1984, 1989); eastern populations are associated primarily with the Mackenzie River watershed. Eastward of the Mackenzie Delta, fry, juveniles, and adults are found along the Tuktoyaktuk Peninsula, and have been reported to be quite abundant beyond Cape Dalhousie at Wood Bay (Bond and Erickson 1993). Least ciscos were found in small numbers off the Coppermine River (Gillman and Kristofferson 1984). They were rarely reported in Kitikmeot (except for Goa Haven) in the Nunavut Wildlife Harvest Study (Priest and Usher 2004).

Whitefish (Coregonus clupeaformis complex) - Humpback whitefish have a discontinuous distribution in the river systems of the Beaufort Sea. Eastern populations are associated with the Mackenzie River and several smaller rivers of western arctic Canada (Craig 1984). They are intolerant of high salinity conditions and remain in brackish nearshore waters and river deltas during summer. The only whitefish reported in the Nunavut Wildlife Harvest Study was lake whitefish, and it was the second most numerous fish recorded in Kitikmeot (Priest and Usher 2004). Lake whitefish was the fifth most abundant fish found near Kugluktuk (KCC 1993) and the fifth most abundant fish found off the Coppermine River (Gillman and Kristofferson 1984).

Inconnu (Stenodus leucicthys) - Amphidromous inconnu are present in most of the Mackenzie River drainage and east to the Anderson River (Morrow 1980). They were rarely reported in Kitikmeot in the Nunavut Wildlife Harvest Study, and according to hunters from Kugluktuk, inconnu are not found near there (Priest and Usher 2004).

Freshwater Fish

Many freshwater fish can tolerate low levels of salt water such as are commonly found in brackish water estuaries or where large rivers may enter the sea. Several species of freshwater aquatic organisms are occasionally found in shallow coastal habitats of Coronation Gulf, including lake trout and arctic grayling.

Local Study Area

During August/September 2004 and July 2005, plankton, benthos, intertidal, water quality, bottom trawls, gill net surveys were conducted in the vicinity of proposed dock facilities in Grays Bay. Sampling effort in 2004 extended from Dock Site 1 to Dock Site 4 and included zooplankton, benthic and sediment sampling, intertidal surveys, and fishing with gill nets. In 2005, sampling activities focused at Dock Site 2,

the proposed location of the Izok Corridor Project dock, and included benthic sampling, diver-operated underwater video, temperature-salinity profiles, and fishing with gill nets and a bottom trawl.

Temperature, Salinity, and Oxygen

In July 2005, water temperature decreased and salinity increased with depth. There was evidence of a thermocline and a halocline at various depths and times. Water temperatures ranged from 4.2 to 6.7°C at the surface to 0.5°C at 15 m. Salinity was relatively low and variable at the surface (15.6–20.4 ppt), but more constant at depths of 5 to 10 m depths. The highest salinity was recorded at 15 m. Dissolved oxygen content was high (12.5–13.6 mg/L) and increased slightly with depth, likely because oxygen is more soluble in cold water. At all depths and locations, the water was supersaturated (110–117%) with oxygen.

Zooplankton

The zooplankton collected in Grays Bay had a similar species composition to zooplankton described earlier by Grainger (1965) as characteristic of the upper 100 m of arctic surface waters, with a widespread offshore and inshore distribution. Density and biomass were similar to those reported in other arctic locations (e.g., Buchanan and Sekerak 1982).

Copepods dominated zooplankton numbers (90.5%) and biomass (44.9%). Larvaceans (mostly *Fritillaria borealis*) ranked second in terms of numbers (6.0%) but contributed little to biomass (1.2%) because of their small size. Other larger but less numerous taxa contributed to the rest of zooplankton biomass. Echinoderm larvae and barnacle larvae contributed very little to biomass and numbers.

Benthos

Samples of infaunal benthos collected in 2004 and 2005 were similar in terms of biomass, densities, and group and species composition. Somewhat lower densities and biomasses were reported in 2004, which is likely attributable to the deeper depths sampled in that year; the minimum density and biomass in 2004 were from the deepest depth sampled (30 m).

The group and species composition of infauna collected in Grays Bay were generally similar to those collected in other arctic locations (e.g., Thomson 1982). Biomasses were also similar, but densities were higher than those found at similar depths in other arctic locations (e.g., Cross and Thomson 1981, 1987; Thomson 1982).

Epibenthos

The bottom trawl used to capture demersal fish also sampled larger epibenthic invertebrate species, which included starfish (*Urasterias lincki*) and sea urchins *Strongylocentrotus* spp.).

Observations of substrate and biota were made in 12 intertidal sample areas. Substrate varied from fine sand to bedrock, with the following observed: biota none (five samples), encrusting green algae (six samples), brown filamentous algae (four samples), and small numbers of amphipods (three samples).

Marine Habitat

Based on underwater video recordings, substrates in deep (>10 m) water were found to be composed a silt with widely scattered small rocks on the surface. Numerous siphon holes of infaunal bivalves were evident. At depths of 10–20 m, sea urchins were numerous, large starfish were less numerous but

common, and crabs were seen in low numbers on most transects. In some areas, there were patches of anemones. At >20 m depths, brittle stars and large bivalve siphons were abundant and there appeared to be a mat of filamentous algae on the sediment surface.

As water depth decreased, there were increasing amounts of gravel and rock with generally the same fauna. Farther inshore (<5 m depth), rocks and boulders covered the bottom completely, with patches of seaweed (*Fucus* sp.) and filamentous algae attached to them, in some places widely scattered and in others very dense. In very shallow water (<2 m), the substrate consisted of bedrock or large boulders, and the only visible biota were filamentous algae.

Based on analysis of the underwater video, areas of low-, medium-, and high-quality marine habitat within the PDA were 70.8 ha (88% of total area), 2.8 ha (3.4%), and 6.9% (8.6%), respectively. Ratings were assigned according to bottom features, which were in turn related to water depth. Habitat was of low quality at 0–2 m (bedrock or large boulder) and >10 m deep (few biota, sediment with occasional rocks); high quality at 2–5 m deep (some biota, mixed large rock substrate); and 50% low and 50% medium quality at 5–10 m deep (gravel of small rocks on sediment with gravel patches).

Fish

During the 2004 surveys, a total of 53 arctic char, 20 arctic cisco, 2 unidentified cod, and 1 lake trout were captured in 27 gillnet sets. During the July 2005 surveys, 6 arctic char, 2 arctic cisco, 1 saffron cod, and 1 least cisco were captured during 4 gillnet sets at the preferred dock site. Only 2 fish were captured in 8 bottom trawls. Both specimens were the spatulate sculpin (*Icelus spatula*).

Two other studies conducted near Grays Bays had similar levels of gillnetting effort as the 2004/2005 surveys (KCC 1993; RL&L and Golder 2003). Overall standardized catch rate in Grays Bay (33.9) was intermediate between those observed near Kugluktuk (187) and in Melville Sound (8.6). The standardized catch rates for arctic char in Grays Bay (23 in each of 2004 and 2005) were similar to that near Kugluktuk (23), but much higher than in Melville Sound (<1). However, fish species diversity at Grays Bay was 42% and 71% of that observed at Kugluktuk and Melville Sound, respectively. Lake whitefish, arctic grayling, pacific herring, rainbow smelt, fourhorn sculpin, arctic flounder, starry flounder, longhead dab, and Greenland cod were absent in catches from Grays Bay.

Traditional knowledge and harvest studies have indicated that Grays Bay is not an important location for subsistence or commercial harvest of arctic char. This lack of use may be attributable to the remote location of Grays Bay from communities in West Kitikmeot.

5.8.3.3 Ongoing Studies

The 2012 field program includes sampling within Grays Bay to characterize the infaunal benthos and demersal fish and macroinvertebrates in and near the proposed dock footprint, and establish a baseline for a future infaunal benthos monitoring program off the proposed dock site and at a nearby control site.

5.8.4 Marine Mammals and Habitat

5.8.4.1 Study Area

Local Study Area

The Project Development Area (i.e., the project footprint) is considered to be part of, and indistinguishable from, the LSA which encompasses that area where immediate direct and indirect effects of the Project could potentially occur based on modelled pressure level thresholds of underwater sound produced by Project activities. The LSA for marine mammals is defined as distances, expected to be on the order of tens of kilometers, around the dock site in Grays Bay and on either side of the shipping route from Grays Bay to the boundaries of Nunavut in Amundsen Gulf and Lancaster Sound.

Regional Study Area

The RSA for marine mammals is defined as the marine waterways from shore to shore and coastal areas west along the existing shipping route in Coronation Gulf through Dolphin and Union Strait to the boundary of Nunavut in Amundsen Gulf, and east from the existing shipping route in Coronation Gulf through Peel Sound to Lancaster Sound.

For most of the year, virtually all of the RSA is icebound. The proposed shipping period is during the open-water period. However, even during that period, the entire RSA is rarely ice free. Heavy ice cover typically remains in the central Arctic Archipelago (e.g., Larsen Sound). The distribution and abundance of marine mammals in the LSA and RSA are highly dependent on the extent and nature of the ice cover.

5.8.4.2 Description of Existing Environment

There is little existing information on marine mammals in Coronation Gulf. There is only one previous publication (Stewart and Burt 1994), which reported extralimital occurrences of beluga and walrus. In addition, the High Lake Kitikmeot Inuit Qaujimajatuqangit (IQ) study (GLL 2006f) contains some information on marine mammals. Indirect evidence of their presence is found in the Nunavut Wildlife Harvest Study (Priest and Usher 2004). Reports of belugas and narwhals in Coronation Gulf in 2011 appeared in the northern newspaper Nunatsiaq.

Field studies were conducted in Coronation Gulf in spring and summer 2004 in support of the High Lake Project DEIS (GLL 2006g). This included aerial seal surveys in Grays Bay and adjacent ice-covered water, covering an area of 608 km^2 at longitudes 110.3–111.4ºW and an east-west distance of 46 km from the mainland coast to about 35 km offshore.

Information on marine mammals in the RSA includes existing literature reviews (e.g., CCG 1990; Thomson et al. 1992; CAC 1993; Thomson et al. 1995), as well as research publications. There are considerable data from earlier studies on the distribution and abundance of marine mammals from western Amundsen Gulf and westward, and from Peel Sound eastward. However, those studies covered primarily areas of the eastern and western High Arctic. The most substantial data gap is the area from eastern Amundsen Gulf through Coronation Gulf and Queen Maud Gulf north into Larsen Sound.

Field studies were conducted along the proposed shipping routes in spring and summer 2004 in support of the High Lake Project DEIS (GLL 2006g). These included aerial surveys to gather reconnaissance-level

information on the occurrence of marine mammals in the west-central High Arctic, where relatively few surveys of marine mammals had been conducted. The surveyed area included both the LSA and the RSA. Survey coverage extended from Amundsen Gulf east to southwestern Devon Island and Somerset Island.

Regional Study Area

Baseline conditions for key marine mammal species within the RSA are described below. **Table 5.8-2** summarizes the status of all species in the RSA under the *Species at Risk Act* (SARA) (Government of Canada 2003), the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), and the Government of the Northwest Territories (GNWT).

Table 5.8-2 Conservation Status of Marine Mammals that occur in the RSA

Species	Population	Status		
		SARA[1]	COSEWIC[2]	GNWT[3]
Ringed seal (*Pusa hispida*)	Arctic Ocean	NL	NAR	NL
Bearded seal (*Erignathus barbatus*)	Arctic Ocean	NL	DD	NL
Harp seal (*Phoca groenlandica*)	Canada	NL	NL	NL
Walrus (*Odobenus rosmarus*)	Atlantic	NL	SC	NL
Beluga whale (*Delphinapterus leucas*)	E Beaufort Sea	NL	NAR	NL
	E High Arctic-Baffin Bay	S3: SC[4]	SC	NA
Bowhead whale (*Balaena mysticetus*)	Eastern Arctic	S2: EN	NA	NA
	E Canada-W Greenland	NA	SC	NA
	Bering-Chukchi-Beaufort	S1: SC	SC	SC
Narwhal (*Monodon monoceros*)	Arctic Ocean	NL	SC	NL
Polar Bear (*Ursus maritimus*)	Canada	S1: SC	SC	SC

NA = Not applicable
1 Species at Risk Act: S1=Schedule 1, S2=Schedule 2, S#=Schedule 3, NL=Not listed, SC=Special Concern, EN=Endangered
2 COSEWIC (2011): NL=Not Listed; NAR=Not at Risk; SC=Special Concern; DD = Data Deficient
3 GNWT (2012): NL=Not Listed, NA=Not Applicable, SC=Special Concern
4 Under consideration for addition to Schedule 1

Ringed Seal

The ringed seal has a continuous circumpolar distribution and is the most abundant marine mammal in the Canadian Arctic. The numbers of seals hauled out on the ice in spring have been estimated, but the estimates may substantially underestimate the actual population sizes: at least 40,000 in the Canadian Beaufort Sea (Stirling et al. 1981a); 50,000 in northern Amundsen Gulf (Kingsley 1990); and 90,000 in the Canadian High Arctic (Kingsley 1985, 1990). There can be large natural variations in their numbers in an area over short periods (Stirling et al. 1977, Smith and Stirling 1978, Harwood and Stirling 1992).

Ringed seals are year-round residents in the Arctic and are highly adapted for living in arctic conditions. Ice conditions influence ringed seal distribution and abundance (Smith and Stirling 1975, 1978; Moulton et al. 2002) as they haul out on sea ice to moult and rest. They maintain breathing holes in landfast sea ice through the ice-covered period, and give birth to young on the ice in subnivean lairs in April. Newborn pups rely on their white fur, high metabolic rates, and the birth lair for protection from the cold. Newborn pups enter the water to escape predation, however, they must return to the birth lair to prevent hypothermia (Smith et al. 1991). Ringed seals also breed in the pack ice (Finley et al. 1983; Kelly 1988).

During the spring moulting season, ringed seals are dispersed at low densities on top of the ice, and seem to prefer areas with high ice cover and water depths of 50–75 m (Stirling et al. 1982). During summer, they are dispersed throughout open-water areas. Ringed seals are capable of moving distances of 1,000 km or more during summer, although they tend to show site fidelity (Teilmann et al. 1999).

Ringed seals feed primarily on fish (especially arctic cod) and large crustacean zooplankton such as amphipods, euphausiids, epibenthic mysids, and decapods (Lowry et al. 1980; Bradstreet et al. 1986; Smith 1987).

During the 2004 field surveys, there were 47 sightings of 59 ringed seals. Nine sightings of 10 bearded seals were also observed throughout the survey area. One harp seal was tentatively identified, along the coast of the Boothia Peninsula. These results must be interpreted with caution, as seals are difficult to detect in the open water from a fast-moving aircraft flying at an altitude of 500 feet; most individuals were probably not detected.

Beluga Whale

The beluga has a circumpolar distribution, with two populations that summer in the RSA: the Eastern Beaufort Sea (EBS) and Eastern High Arctic–Baffin Bay (EHA-BB) stocks (COSEWIC 2011). The former stock summers in the Canadian Beaufort Sea and Amundsen Gulf, and winters in the Bering and Chukchi seas (Finley et al. 1987). The latter stock summers in the Canadian High Arctic and winters in Baffin Bay.

The EBS stock occurs along the proposed shipping route from Grays Bay to the west. The most recent population estimate for the EBS Stock, based on surveys in 1992 (Harwood et al. 1996) corrected for animals below the water surface, is 39,258 (Allen and Angliss 2011). The spring migration from the Bering Sea occurs primarily in April/May through leads off northern Alaska and the Yukon. The belugas arrive off Banks Island and Cape Bathurst in late spring (Fraker 1977, 1979), and move back along the seaward edge of the landfast ice off the Tuktoyaktuk Peninsula toward the Mackenzie River estuary (Fraker and Fraker 1982; Norton and Harwood 1986). Typically, they begin arriving in late June to early July (FJMC 2001) and concentrate in the generally ice-free waters in greatest numbers during late June to mid July. By late July and early August, relatively few whales are present in the estuary. The autumn migration from the Canadian Beaufort Sea begins during late August–early September, with the majority of autumn migrants traveling through offshore waters, near and within the pack-ice edge (Davis and Evans 1982; Frost et al. 1988; Hazard 1988; Clarke et al. 1993; FJMC 2001).

The summer range of the EHA-BB stock overlaps in part with the proposed eastern shipping route. Innes et al. (2002) provided an abundance estimate of 21,213. Belugas typically do not occur in the central Arctic Archipelago but there are extralimital records of beluga whales in Coronation Gulf at Kugluktuk, Cambridge Bay, and Bathurst Inlet, and at Taloyoak.

The EHA-BB stock winters in loose pack ice along the west coast of Greenland (e.g., McLaren and Davis 1983), and in the North Water polynya in northern Baffin Bay (e.g., Richard et al. 1998, 2001; Heide-Jørgensen et al. 2003a). They enter Lancaster Sound between late April and early May (Finley and Renaud 1980) and late June/July (Davis and Finley 1979; Koski et al. 2002). The core summering range is in offshore and coastal waters around Somerset Island: in Prince Regent Inlet, Barrow Strait, and Peel Sound. During mid July to mid August, belugas concentrate in large groups of up to several thousand in a few shallow estuaries on Somerset Island (e.g., Smith et al. 1985; Koski et al. 2002).

Most belugas leave the estuaries by mid August, and a large proportion shifts to Peel Sound and Franklin Strait (Richard et al. 2001; Koski et al. 2002), using several bays on Prince of Wales Island and the Boothia Peninsula and making daily trips to the Franklin Trench, frequently diving to the seabed (Smith and Martin 1994; Richard et al. 2001; Heide-Jørgensen et al. 2003a). They migrating out of the central High Arctic in mid to late September mostly within 400 m of the south coast of Devon Island (Davis and Finley 1979; Koski and Davis 1979, 1980; Heide-Jørgensen et al. 2003a). Most pass through Lancaster Sound in less than a week (Koski et al. 2002).

During the 2004 field surveys, belugas were observed at either end of the survey area, in eastern Amundsen Gulf and Dolphin and Union Strait, and in Peel Sound and Radstock Bay, southwestern Devon Island. No belugas were seen between Dolphin and Union Strait and southern Peel Sound.

To the west, 56 belugas were observed in eastern Amundsen Gulf, including adults, calves and possibly subadults. Four belugas were sighted in Dolphin and Union Strait. To the east, belugas were observed along the southeastern coast of Prince of Wales Island, in Peel Sound, and in Radstock Bay, Devon Island. No belugas were seen in Peel Sound south of Coningham Bay, in Prince Regent Inlet from Creswell Bay to Lancaster Sound, or in Barrow Strait. Along the southeastern coast of Prince of Wales Island, a large group estimated at about 120 individuals was sighted along the coast between Willis Bay and Coningham Bay. Between Willis Bay and Cape Brodie, 52 belugas were sighted along the coast. North from Cape Brodie, there were 12 sightings of 21 belugas along the centre line of Peel Sound, including single animals, adult-young pairs, and groups of 3 or 4. In Radstock Bay, about 270 belugas were sighted, including adults and calves.

Narwhal

The narwhal inhabits deep marine waters of the eastern Canadian Arctic from northern Hudson Bay and Davis Strait west to the central Arctic Archipelago (Reeves et al. 2002). It does not traditionally occur in the Beaufort Sea or elsewhere in the western Canadian Arctic, although it was seen off Cambridge Bay in August 2011. Those that summer in the Canadian High Arctic winter in Baffin Bay.

Innes et al. (2002) estimated that 45,358 narwhals summer around Somerset Island. Up to 10,000 can summer in Admiralty Inlet, 3000 in Eclipse Sound, and 10,000 in Prince Regent Inlet. About 2000 narwhal summer in Peel Sound and 1000 in Barrow Strait. Numbers in each area vary from year to year (Fallis et al. 1983; Smith et al. 1985; Koski and Davis 1994; Richard et al. 1994).

Narwhals winter in very heavy pack ice in northern Davis Strait and southern Baffin Bay (McLaren and Davis 1982). In spring, they move north through the loosening pack ice and appear near and in Lancaster Sound in April, entering Pond Inlet and Lancaster Sound in late June/July after breakup of the ice edge, with the peak movement westward into the central High Arctic occurring in late June and July. In summer, they do not frequent shallow waters or estuaries (as do many belugas) but prefer deep-water fiords, inlets and channels (Born et al. 1994; Dietz et al. 1994; Kingsley et al. 1994; Richard et al. 1994; Heide-Jørgensen et al. 2003b). Most narwhals summer in the fiords of northern Baffin Island and others summer in Prince Regent Inlet and the Gulf of Boothia, with smaller numbers in Barrow Strait and Peel Sound (Fallis et al. 1983; Smith et al. 1985; Koski and Davis 1994; Richard et al. 1994; Heide-Jørgensen et al. 2003b). During summer, narwhals do not move great distances (Heide-Jørgensen et al. 2003b).

Narwhals return to Baffin Bay via Lancaster Sound at a much slower pace than do belugas (Finley and Johnston 1977). Initially, they are dispersed in open water and remain there as long as open water

permits, mostly in offshore waters of the passages among the central Arctic islands. By mid to late September, most have moved into Lancaster Sound near the north and south coasts during at least the first part of the migration (Koski and Davis 1980; Heide-Jørgensen et al. 2003b). The pace of outbound migration then becomes very rapid, and most have left by mid October (Heide-Jørgensen et al. 2003b).

During the 2004 field surveys, narwhals were recorded only on 17 September, when one group of about 12 was observed north of Prince Leopold Island in western Lancaster Sound, and another 25 were seen in Radstock Bay.

Bowhead Whale

The bowhead whale is a large, slow-moving arctic baleen whale that is well adapted for living in ice-covered waters. Two stocks are found in the RAA: the Bering-Chukchi-Beaufort Sea (BCB) Stock and the Davis Strait-Baffin Bay (DS-BB) Stock (Davis and Koski 1980; Finley 2001). The most recent abundance estimate for the BCB Stock is 10,545 (Allen and Angliss 2011). This population has been increasing in recent decades (George et al. 2004). The DS-BB Stock has increased in size from the early 1980s (Koski et al. 2006; Heide-Jørgensen et al. 2007) to the present; the currently accepted estimate is 6344 (IWC 2009), but that estimate could be negatively biased.

Bowhead whales of the BCB stock winter in the central and western Bering Sea, and most of the stock summers in the Canadian Beaufort Sea and Amundsen Gulf (Moore and Reeves 1993). The spring migration across the western Beaufort Sea occurs through offshore ice leads, generally during mid April to mid June (Braham et al. 1984; Moore and Reeves 1993). Most whales remain in offshore waters (>200 m deep) among the pack ice in the central and eastern Beaufort Sea until they begin to move toward coastal and nearshore areas during late July to mid August (Davis et al. 1982). There, they feed in dense patches of zooplankton (Bradstreet et al. 1987) that are associated with fronts and discontinuities in the ocean (Thomson et al. 1986). Fall migration out of the Canadian Beaufort Sea to the Bering Sea typically occurs from early September to late October. The Inupiat people of northern Alaska hunt bowhead whales during the spring and fall migrations.

Bowheads from the DS-BB Stock apparently winter primarily in Hudson Strait, and in smaller numbers in Baffin Bay (Koski et al. 2006). They summer in northern Hudson Bay-Foxe Basin and in the central High Arctic. Migration into the eastern and central High Arctic occurs through Lancaster Sound from early/mid May to early August, with a peak in late June (Davis and Koski 1980). About half of the existing DS-BB Stock summer in the bays and passages of the central and eastern High Arctic islands during August and September (Davis and Koski 1980; Koski and Davis 1980), especially Isabella Bay (eastern Baffin Island), Eclipse Sound (northern Baffin Island), Milne Inlet, Admiralty Inlet, and Prince Regent Inlet, with the latter area considered to be a major nursery area (Lubbock 1937). A few bowheads occur in the Peel Sound/Franklin Strait area and in Barrow Strait (Davis and Koski 1980; Davis et al. 1980). Fall migration out of the eastern Arctic Archipelago occurs during late August/October. In late August/September, whales that summer in Prince Regent Inlet and areas to the west migrate to the north coast of Baffin Island, and those that summer in Eclipse Sound move north through Navy Board Inlet then east along Bylot Island (Koski and Davis 1980) and the east coast of Baffin Island (Finley 1990, 2001). The migration is within 1.5 km of the coast and rapid, averaging 5 km/h (Koski and Davis 1980).

During the 2004 field surveys, only one group of two bowhead whales (a large individual and a smaller animal (adult and young)) was sighted in Radstock Bay, southwestern Devon Island.

Polar Bear

The polar bear is distributed throughout the circumpolar Arctic in a number of relatively discrete populations (Stirling et al. 1984), four of which occur along the proposed shipping routes: the Lancaster Sound (population size 1700) and M'Clintock Channel (240) populations to the east, and the Northern Beaufort Sea (1200) and Southern Beaufort Sea (1800) populations to the west (Lunn et al. 2002).

The local distribution and abundance of polar bears vary through the year, and are strongly influenced by those of their principal prey, the ringed seal, and by the presence or absence, distribution and quality of sea ice. During winter and spring, most polar bears are found on the sea ice (Amstrup 2000). They tend to concentrate along pressure ice that parallels the coasts and near floe edges, where they are able to hunt seals most effectively (Stirling et al. 1984). In summer, when the pack ice retreats offshore, polar bears are found along the edge of the pack ice (DeMaster and Stirling 1981; Amstrup 1995). During years with little or no pack ice near the coast, polar bears are often found along the coastline and on barrier islands (Stirling 1974).

In December, females give birth in snow dens in coastal areas or on the ice. Polar bear dens are concentrated in some areas, but throughout the central Arctic, denning occurs at low densities along most coastlines that have been investigated (Stirling et al. 1979, 1981b; Schweinsburg et al. 1981). In the Beaufort Sea, most denning occurs on heavy pack ice (Lentfer 1975, Amstrup and Gardner 1989). In late March to early April, females with cubs return to the sea ice to hunt seals, usually concentrating in places where ringed seals are pupping (Davis et al. 1980).

During the 2004 field surveys, there were two sightings of polar bears on 18–19 September, one a single individual pulling itself out of the water onto an ice pan off the western coast of the Boothia Peninsula south of Weld Harbour, and an adult and two cubs feeding on a seal northwest of Gateshead Island in southern M'Clintock Channel. Both sightings were in areas of heavy ice cover (95–99%). In addition, five kill sites (presumably by polar bears) were seen in eastern Larsen Sound and southern Franklin Strait (two kills) and in the vicinity of Gateshead Island (three kills) during surveys on 17–19 September. Polar bear tracks were seen in two locations: north of Prince Leopold Island in western Lancaster Sound, and off the western coast of the Boothia Peninsula very near the first bear sighting. All the kill sites and one set of tracks were in areas of heavy ice cover (>90%). The tracks in Lancaster Sound were in <20% ice cover.

Local Study Area

Ringed Seal

During the 2004 field surveys, ringed seals were widely distributed throughout the LSA. A total of 1936 ringed seals were seen on transect, many undoubtedly the same individuals seen on other days. The surveys covered 2802 km^2 of fast ice habitat. The observed overall uncorrected density of seals was 0.69/km^2 for the combined survey replicates. This density is well within the normal range of densities for ringed seals seen during studies in other landfast-ice areas in the Canadian and U.S. Arctic. Ringed seals were observed in most parts of the study area, but there was an obvious tendency for lower densities in the shallowest parts of the bay and along the shoreline.

During the period from 1996 to 2001, ringed seal harvests were reported for all four communities on Coronation Gulf (Priest and Usher 2004). A low number of seals harvested from Bathurst Inlet and

Umingmaktok. Kugluktuk recorded the highest harvest, with an average of ~280 per year, most (76%) of which were harvested in August and September with smaller numbers harvested in every other month. The harvest in Cambridge Bay increased from 38 in 1996/1997 to 277 in 2000/2001, with an average of about 96 per year. These were harvested mostly in July to September and May and June), with small numbers taken in November, December, March and April. The peninsula immediately southeast of Hepburn Island was identified as an area where seals are hunted in spring or summer (GLL 2006g).

Bearded Seal

During the 2004 field surveys, there were a total of 33 sightings of bearded seals (35), some possibly re-sightings of the same individuals on different days. Sightings appeared to be well dispersed within the LSA.

Bearded seal harvests were reported for all communities on Coronation Gulf except Cambridge Bay during 1996–2001 (Priest and Usher 2004). The numbers of seals harvested were low in all communities. Kugluktuk recorded the highest harvest, with an average of two bearded seals per year. Bearded seals were taken from May to September, with the majority harvested in July.

Beluga Whale

Belugas usually do not penetrate the area between Dolphin and Union Strait and Victoria Strait (Stewart and Burt 1994). However, in some years, probably because of favourable ice conditions, they have been observed or harvested. Stewart and Burt (1994) noted that only one beluga was harvested at Kugluktuk during 1962–1971, none were taken during 1988–1993, and one was sighted at Cambridge Bay in 1977. In late July 1989, two were sighted in Bathurst Inlet. Over the period from 1996 to 2001, belugas were only harvested in Coronation Gulf from Kugluktuk in 1996. In 1999, belugas were sighted just north of Hepburn Island, and three were harvested. On 6 August 2011, hundreds were seen near Kugluktuk, and 13 of these were harvested (NNSO 2011).

Narwhal

Narwhals generally do not occur west of the central High Arctic. However, numerous groups of narwhals were seen off Cambridge Bay in August 2011. Groups were seen until about 29 August, and several were harvested (NO 2011).

5.8.4.3 Ongoing Studies

A considerable amount of information is available on the distribution of marine mammals (e.g. belugas, narwhal, bowheads, ringed seal, bearded seal, walrus, and harp seals) along parts of the shipping routes, from the Beaufort Sea to the west and Barrow Straight, Lancaster Sound, and Baffin Bay to the east. Little or no information is available for the parts of the shipping route in between. Aerial transect surveys in Grays Bay and in the area of the shipping lanes into Grays Bay will be undertaken in 2012 to characterize summer use by marine mammals.

5.8.5 Marine Birds and Habitat

5.8.5.1 Study Areas

Project ships will travel along existing surveyed routes through the Northwest Passage. From the west, ships will travel through the Bering Strait, Beaufort Sea and Amundsen Gulf to the Coronation Gulf. From the east, ships will travel through Davis Strait and Baffin Bay through Lancaster Sound to Peel Sound then Victoria Strait to the Coronation Gulf. Study areas for marine birds will extend along the shipping routes to the extent of the Nunavut Territorial waters.

Local Study Area

The LSA for marine birds includes a 1 km buffer on either side of the Project footprint of all port facilities and the eastern and western shipping routes.

Regional Study Area

The RSA for the marine bird studies consists of a 50 km buffer on either side of the Project footprint.

5.8.5.2 Description of Existing Environment

Marine birds are birds that occupy saltwater environments during large portions of their annual cycle; these may include pelagic birds (i.e., those characteristic of offshore waters), seaducks (i.e., ducks that live primarily at sea when not on their breeding grounds) and other waterfowl, and larids (jaegars, gulls, terns, etc.). Although not generally considered marine birds, shorebirds (e.g., plovers and sandpipers) are also considered in this section.

A diversity of birds relies on marine habitats for migration and staging, breeding, moulting, and some for over-wintering. Nearly 100 species of marine birds, waterfowl, waterbirds and shorebirds can be found along Canada's marine coastline and offshore habitats, and approximately 10 million pairs of breeding marine birds use marine habitats in Nunavut and the Northwest Territories (Mallory and Fontaine 2004).

Marine Birds

Marine habitats within the Izok Corridor region (i.e., eastern Amundsen Gulf, Dolphin and Union Strait, Coronation Gulf, Bathurst Inlet, Dease Strait, Queen Maud Gulf) support a variety of waterfowl and seabird species. Common species in this region include several species of geese, tundra swan (*Cygnus columbianus*), king eider (*Somateria spectabilis*), common eider (*Somateria mollissima*), surf scoter (*Melanitta perspicillata*) white-winged scoter (*Melanitta fusca*), long-tailed duck (*Clangula hyemalis*), northern pintail (*Anas acuta*), red-breasted merganser (*Mergus serrator*), several species of loons (*Gaviasp*.), glaucous gulls (*Larus hyperboreus*), and Arctic terns (*Sterna paradisaea*; e.g., Dickson and Gilchrist 2002, Mallory and Fontaine 2004, Raven and Dickson 2006, Latour et al. 2008, Groves and Mallek 2011). Pelagic seabird populations appear to be limited in this region (e.g., Dickson and Gilchrist 2002). An aerial survey of marine birds along the southern shoreline of the Coronation Gulf conducted by the Canadian Wildlife Service (CWS) in June 1995 (L. Dickson, CWS, pers. comm., April 2006) found that numbers were generally low in this area, but that Grays Bay harboured a greater concentration than elsewhere (mainly common eider, long-tailed duck, and red-breasted merganser) likely due to

open water appearing earlier in the spring between Hepburn Island and the mainland compared to elsewhere (L. Dickson, CWS, pers. comm., April 2006).

The common eider has become a concern in the central and western Arctic over the last decades due to declines in the breeding population (more than 50% between 1976 and 1996; Dickson et al. 2003). In June 1995, a survey of the southern shoreline of the Coronation Gulf indicated that up to 25% of the Canadian breeding population of common eider occurs within the Bathurst Inlet area (including the Grays Bay area, Raven and Dickson 2006). Surveys conducted in the area from 2006 to 2008 detected a substantial decline in the number of common eiders breeding in this area (Raven and Dickson 2006).

Species at Risk

Table 5.8-3 lists Species at Risk that could potentially occur within the RSA and interact with Project shipping. Most of the species listed are designated as Sensitive by the GN, but are not currently scheduled under SARA and have not been assessed by COSEWIC. In many cases, the Sensitive designation by the GN is likely due to the presence of perceived small populations on the periphery of natural ranges. Three species or subspecies, however, are currently listed under Schedule 1 of SARA, and are designated as Endangered or Threatened by COSEWIC. These three species are the red knot, ivory gull, and Ross's gull.

Table 5.8-3 Marine Bird Species at Risk Potentially Occurring within Project Shipping Corridors

Species	*Scientific Name*	Species Status		
		Nunavut[1]	SARA Schedule[2]	COSEWIC[3]
Common Eider	*Somateria mollissima*	Sensitive	Not currently scheduled	Not assessed
King Eider	*Somateria spectabilis*	Sensitive	Not currently scheduled	Not assessed
Long-tailed Duck	*Clangula hyemalis*	Sensitive	Not currently scheduled	Not assessed
American Golden-plover	*Pluvialis dominica*	Sensitive	Not currently scheduled	Not assessed
Black-bellied Plover	*Pluvialis squatarola*	Sensitive	Not currently scheduled	Not assessed
Whimbrel	*Numenius phaeopus*	Sensitive	Not currently scheduled	Not assessed
Ruddy Turnstone	*Arenaria interpres*	Sensitive	Not currently scheduled	Not assessed
Sanderling	*Calidris alba*	Sensitive	Not currently scheduled	Not assessed
Red Knot	*Calidris canutus*	At Risk	Roselaari ssp – Schedule 1, Rufa&Islandica ssp - Not currently scheduled	Roselaari ssp – Threatened Rufa ssp - Endangered Islandica ssp – Special Concern
Dunlin	*Calidris alpina*	Sensitive	Not currently scheduled	Not assessed
Semipalmated Sandpiper	*Calidris pusilla*	Sensitive	Not currently scheduled	Not assessed
Least Sandpiper	*Calidris minutilla*	Sensitive	Not currently scheduled	Not assessed
Buff-breasted Sandpiper	*Tryngites subruficollis*	Sensitive	Not currently scheduled	Not assessed
Red Phalarope	*Phalaropus fulicarius*	Sensitive	Not currently scheduled	Not assessed
Red-necked Phalarope	*Phalaropus lobatus*	Sensitive	Not currently scheduled	Not assessed

Species	*Scientific Name*	Species Status		
		Nunavut[1]	SARA Schedule[2]	COSEWIC[3]
Glaucous Gull	*Larus hyperboreus*	Sensitive	Not currently scheduled	Not assessed
Thayer's Gull	*Larus thayeri*	Sensitive	Not currently scheduled	Not assessed
Ivory Gull	*Pagophila eburnea*	At Risk	Schedule 1	Endangered
Ross's Gull	*Rhodostethia rosea*	At Risk	Schedule 1	Threatened
Arctic Tern	*Sterna paradisaea*	Sensitive	Not currently scheduled	Not assessed
Northern Fulmar	*Fulmarus glacialis*	Sensitive	Not currently scheduled	Not assessed

1 CESCC (2011)
2 Environment Canada (2011)
3 COSEWIC (2011)

Important Marine Bird Habitats

There are several marine and near shore areas within the Izok Corridor Project area that are designated as Important Bird Areas, Key Marine Habitats, or Key Migratory Bird Habitats (see section 5.2). These areas are known to seasonally support large concentrations of marine birds such as common eider, king eider, several species of geese, tundra swan and others. Among others, they include the Amundsen Gulf and Cape Bathurst Polynya along the south and western coast of the Amundsen Gulf, Lambert Channel located between the Dolphin and Union Strait and the Coronation Gulf, southwestern Victoria Island, the Queen Maud Gulf Bird Sanctuary, and Jenny Lind Island in the Queen Maud Gulf (Mallory and Fontaine 2004, Latour et al 2008, Important Bird Areas Canada 2010).

5.8.5.3 Ongoing Studies

Seabird surveys associated with the proposed port site at Grays Bay will be undertaken in 2012 focusing on the ground-based surveys of the shoreline adjacent to the port site and one or more control areas, and aerial transect surveys in Grays Bay and the Coronation Gulf. The ground-based work will be conducted will take place as a part of concurrent terrestrial songbird and shorebird surveys in the area. The aerial transect surveys will be performed in conjunction with the marine mammal aerial transect surveys.

Izok Corridor Project Proposal

SECTION 6

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6 EXISTING HUMAN ENVIRONMENT

6.1 Introduction

The framework for the socio-economic impact assessment will be inclusive of the concepts of community well-being and quality of life; individual, family and community wellness; community capacity and the concept of the competent community (Annis 2005, Ribova 2000, Bowles 1981, Lotz 1977) with a focus on the Kitikmeot communities and, at higher level, the broader region. The Valued Socio-economic Components (VSECs) of the general "community assets" framework are summarized below.

The ***Human Assets*** of the socio-economic environment considers the skills and knowledge inherent in the community, the opportunities for growth and learning, access to skills and knowledge, and access to essential services that are fundamental in maintaining individual, family and community wellness. Baseline conditions related to this category include:

- Governance and Leadership
- Population Demographics
- Education and Skills Training
- Health, Safety and Social Services

The ***Economic Assets*** category considers the opportunities available to people for employment and participation in the economic life of the community and region, including the monetary or financial resources that people and governments use to achieve their economic objectives. Economic assets are key determinants of economic vitality. Baseline conditions associated with this category include:

- Economic Development
- Labour Force and Employment
- Wage Income and Income Support
- Non-Wage or Traditional Economy
- Contracting, Business Activity and Opportunities
- Non-Traditional Land Use and Tourism
- Financial Capacity

The ***Physical Assets*** category considers the basic infrastructure that allows a community to function effectively. The availability and quality of such physical assets serve to attract and retain people and investment in a community; they influence personal, family and community wellness. Baseline conditions associated with this category include:

- Housing
- Community Infrastructure and Services
- Transportation Infrastructure and Services

The ***Social Assets*** category considers the traditional and community activities in which people participate and the facilities or amenities that they draw upon to access them. It includes:

- Cultural, Archaeological and Paleontological Resources
- Traditional Activity and Knowledge
- Community Recreational Facilities and Programs

The ***Natural Assets*** category considers the biophysical environment upon which community well-being also depends. The natural assets are described in section 5.0 of this Project Proposal, and include the air, land, waters and wildlife.

In addition to these assets, three broad VSECs are considered not necessarily as assets, but desired **Community Well-Being Outcomes**. These are:

- Individual and Family Wellness
- Community Wellness
- Personal Security, including Financial and Food Security

6.2 Study Area

The Izok Corridor Project is situated in the Territory of Nunavut, within the Kitikmeot region (the Region), which is the most western of the three administrative regions within the Territory. The Region includes the three main population centres of Cambridge Bay, Kugluktuk and Gjoa Haven (**Figure 6.2-1**).

- Cambridge Bay is located 960 km northeast of Yellowknife and 1,600 km west of Iqaluit. Cambridge Bay is the largest community in the Kitikmeot region and home to the regional government.
- Kugluktuk is near the mouth of the Coppermine River. It is approximately 600 km north of Yellowknife and 450 km southwest of Cambridge Bay. It is the second largest community in the region.
- Gjoa Haven is located on southeastern shore of King William Island, 1,056 km northeast of Yellowknife.

The Region also hosts smaller communities of Kugaaruk and Taloyoak, with Bathurst and Umingmaktok, being used seasonally.

- Bathurst Inlet is a deep inlet located on the northern coast of Canada's mainland, which drains the Burnside and Western rivers. It is seasonally used by several residents of Cambridge Bay.
- Kugaaruk is located on the shore of Pelly Bay, just off the Gulf of Boothia in the Simpson Peninsula. Access is by air or by annual supply sealift.
- Taloyoak is located on a narrow inlet on the western side of the Boothia Peninsula. Prior to 1992, the community was known as Spence Bay. It is the most northerly mainland community, best accessed by air from Yellowknife or Cambridge Bay or by barge.
- Umingmaktok is located on Bay Chimo harbour. The camp was established around an abandoned Hudson's Bay Company post. It is primarily a seasonal hunting and fishing camp.

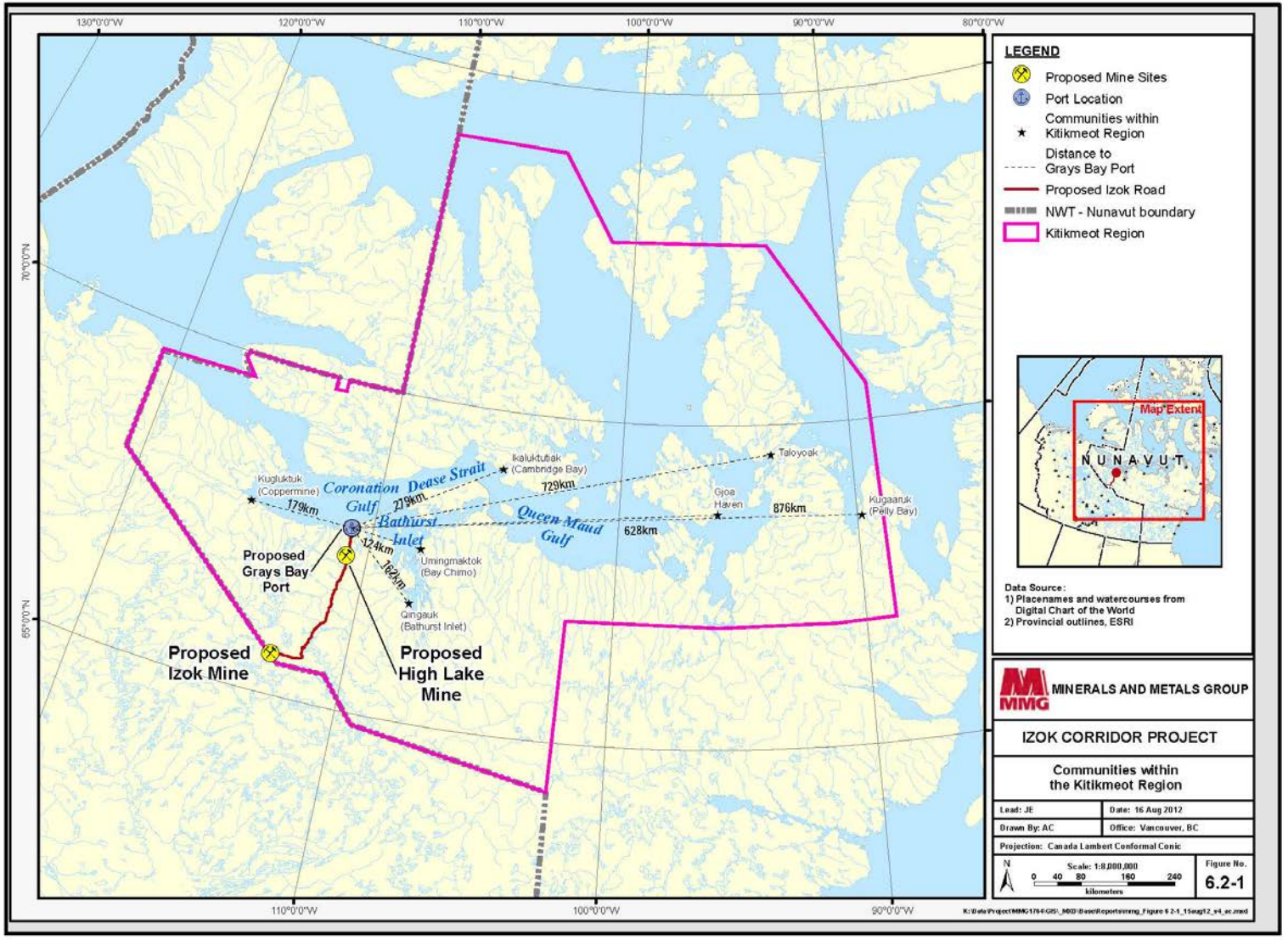


Figure 6.2-1 Communities within the Kitikmeot Region

6.3 Human Assets

This section provides an overview of governance and leadership, population demographics, education and skills training, health and safety and social services in the study area.

6.3.1 Governance and Leadership

The Territory of Nunavut was created in 1999, via the *Nunavut Act*[1] and the Nunavut Land Claim Agreement (NLCA). Nunavut has a public government with its legislative assembly located in Iqaluit, the territory's capital. There are no political parties in Nunavut, and the territory operates by consensus government. The Government of Nunavut (GN) has developed an action plan that demonstrates its leadership and responsibilities to all Nunavumiut. The action plan aims to pursue the government's mandated priorities set out in *"Tamapta: Building Our Future Together"* (Government of Nunavut 2009). The action plan focuses on improving education, reducing poverty and making the territorial civil service more efficient.

Hamlets across Nunavut are core-funded by the GN, under a formula based on population, need and other variables, and the Hamlets are mandated to deliver key services to the community. An elected Hamlet Council makes the decisions on community needs, and the Senior Administrative Officer and staff administer to those needs. Transfer payments to the communities are reflected in the GN budget.

Most of Nunavut's 1,994,000 km^2 is owned and managed by the federal government. Inuit owned lands comprise 18% of that area; 16% of which involves surface rights and the remaining 2% involve sub-surface mineral rights. In the Kitikmeot, the surface rights are vested with the Kitikmeot Inuit Association (KIA). Subsurface rights are held by Nunavut Tunngavik Incorporated (NTI). The federal department of Aboriginal Affairs and Northern Development Canada (AANDC) manages those lands and subsurface minerals on lands that were retained by Canada, as well as subsurface rights on 16% of Inuit owned lands. The Lands Department of NTI, located in Cambridge Bay, has responsibility for the management of Inuit owned lands, the environment, minerals, oil and gas and the marine environment. NTI has developed policies that guide the fulfillment of its responsibilities with respect to land management, including a Mining Policy, Water Policy, Mine Reclamation Policy and guidelines, a Uranium Policy and an Environment Policy.

The KIA also plays a role in land management through its responsibilities for management of surface rights on Inuit owned lands, and through its NLCA Article 39 obligations with respect the establishment of conservation areas and the negotiation and development of Inuit Impact Benefit Agreements (IIBA). The Kitikmeot Hunters and Trappers Organization (HTO) manage wildlife harvesting. All of the Inuit communities in the study area have a local HTO. Government funding to HTOs depends on the number of general hunting licenses within the community, fur returns and HTO work plans (Rescan 2008).

6.3.2 Population Demographics

Nunavut's population continues to grow rapidly. Since 1981, the population of the territory and the Kitikmeot region has almost doubled. As shown in **Table 6.3-1**, the Nunavut Bureau of Statistics reported the 2011 population of the Kitikmeot region at 6,012 persons. This represents approximately 19% of Nunavut's population and an increase of approximately 651 persons (12%) since 2006. The communities

with the largest populations are Cambridge Bay (1,608 persons), Kugluktuk (1,450 persons) and Gjoa Haven (1,279 persons). Each of these communities has also experienced growth since 2006, with Gjoa Haven growing by approximately 20%. The three smaller communities and unorganized areas of the Region have a combined population of approximately 1,675 persons.

Table 6.3-1 Population in Nunavut and the Kitikmeot Region 1981 – 2011

	1981	1986	1991	1996	2001	2006	2011
Nunavut	15,572	18,408	21,244	24,730	26,745	29,474	31,906
Kitikmeot	2,945	3,447	4,025	4,644	4,816	5,361	6,012
Bathurst Inlet	20	16	18	18	5	0	0
Cambridge Bay	815	1,002	1,116	1,351	1,309	1,477	1,608
Gjoa Haven	523	650	783	879	960	1,064	1,279
Kitikmeot Unorganized[1]	30	45	7	0	0	21	0
Kugaaruk	257	297	409	496	605	688	771
Kugluktuk	809	888	1,059	1,201	1,212	1,302	1,450
Taloyoak	431	488	580	648	720	809	899
Umingmaktok	60	61	53	51	5	0	5

Source: Nunavut Bureau of Statistics (2011b)

In terms of demographics, there is roughly an equal proportion of males and females in the population. A large segment of the population, nearly 50% in some communities, is youth. As such, the number of females of child-bearing age is expected to remain high. The populations of Kitikmeot communities have the potential to grow for years to come unless the young population chooses to leave the Region to other regions of Nunavut or Canada. To this end, migration has long been a part of Inuit traditional culture and continues today for more economic than subsistence reasons.

6.3.3 Education and Skills Training

In Nunavut, the task of providing education falls within the mandate of the GN Department of Education. The department provides education programs from kindergarten through to post-secondary schooling.

Graduation rates in the Kitikmeot are rising, but the total numbers of graduates are still low. Furthermore, young Inuit attending primary schools are showing increased rates of poor attendance and in some cases, dropping out from school prior to completing their graduation. Experience has shown that teenage students around the age of 16 are the most likely to drop out, specifically young males.

Schools in the Kitikmeot from kindergarten through to Grade 12 follow Inuuqatigiit, which is a culture-based curriculum from the Inuit perspective. Inuuqatigiit was developed by Inuit educators and grounded in the belief of the Elders that education must be community based. This curriculum is intended to develop pride of identity and language in the students. Since 1995, Health Canada has assisted the GN through the Aboriginal Head Start Program (AHS), a special pre-school education program for young children. The AHS is currently being offered in Kugluktuk, Gjoa Haven and Taloyoak.

Nunavut Arctic College (NAC) plays a key role in furthering education in Nunavut, and thereby furthering both the GN's Adult Learning Strategy and the NTI's employment objective under Article 23 of the NLCA. As the primary provider of post-secondary education, training and skills, NAC has developed a series of key programs that attempt to develop skills to address both the needs of Nunavummiut seeking employment and the skill sets required by industry.

The NAC offers a range of educational programs for adult learners in three campus locations in Nunavut: Cambridge Bay (Kitikmeot Campus), Rankin Inlet (Rankin Campus), and Iqaluit (Nunatta Campus). The Kitikmeot Campus includes classrooms, administration facilities and student residences. The NAC also has 24 Community Learning Centres (CLCs) across Nunavut. The Kitikmeot CLCs are located in Kugluktuk, Gjoa Haven, Kugaaruk and Taloyoak. The Kitikmeot Campus of NAC course offerings are delivered both on-campus and throughout the region through CLC. While many of the courses focus on academic upgrading in advance of further training, the college does offer single and multi-year certificate and diploma programs. Some university courses and other special programming are delivered in partnership with university and college institutions from outside of Nunavut.

6.3.4 Health, Safety and Social Services

A variety of health, safety and social services are shared among Kitikmeot communities, with Cambridge Bay being the regional service centre. These services are provided by various GN government departments and agencies (i.e., Community and Government Services, Health and Social Services) as well as Hamlet governments. Hamlets also seek independent funding from developers, trusts, foundations, and federal programs, so as to support other initiatives they wish to undertake. **Table 6.3-2** provides a summary of the health, safety and social services available to Kitikmeot residents.

Table 6.3-2 Health, Safety and Social Services in the Kitikmeot

	Type	Service	Community	Beneficiaries
Health Service	Regional Health Centre	• 24 Hours Emergency • Short Term Health Care • Physician on Staff • Palliative and Birthing Care • Audiology • Trauma care	• Cambridge Bay	• All residents of the Kitikmeot (limited access)
	Community Health Centre	• Primary Care • Tele-health service • Nursing Station • No Physician	• Kugluktuk, Gjoa Haven, Taloyoak, Kugaaruk	• All residents (limited access)
	Med-flight Air Ambulance	• Emergency Medical Service	• Kugaaruk	• All residents (limited direct services)

	Type	Service	Community	Beneficiaries
Wellness Services	Community Wellness Centre	• Child Protection Services • Initiating alcohol and drug counselling • Hot-Line Service • Drug and Alcohol Programs • Gambling Addiction • Family Violence • Elders Centre and Program • Counselling	• Cambridge Bay, Kugluktuk • Cambridge Bay	• All residents (limited access) • Cambridge Bay Residents
Safety	Royal Canadian Mounted Police	• Policing • Crime Prevention • Traffic Safety	• Cambridge Bay, Kugluktuk, Gjoa Haven, Taloyoak, Kugaaruk	• All residents (limited service)
	Fire Department	• Firefighting • Emergency response • Fire prevention	• Cambridge Bay, Kugluktuk, Gjoa Haven, Taloyoak, Kugaaruk	• All residents
Social Service	Daycare	• Child care 18 months and over	• Cambridge Bay, Kugluktuk, Gjoa Haven, Taloyoak, Kugaaruk	• All residents,(limited access)
	Housing	• Subsidized Housing	• Cambridge Bay, Kugluktuk, Gjoa Haven, Taloyoak, Kugaaruk	• All residents (limited access)
	Women's Shelter	• Psychiatric Nurse • Shelter and Food	• Cambridge Bay, Kugluktuk	• All residents (limited access)

6.4 Economic Assets

This section provides an overview of Nunavut's economy, components of Gross Domestic Product (GDP), and future economic opportunities (i.e., Non-Traditional Land Use and Tourism) and issues that affect Nunavut's economic development overall. This overview is followed by a summary of data related to Nunavut's labour force and employment characteristics; personal income (i.e., employment income) and income support; and the non-wage economy.

6.4.1 Overview of Nunavut's Economy and State of Economic Development

Nunavut's wage-based economy is sustained largely by the activities of the public sector (Statistics Canada 2011a). This includes spending on program delivery, grants and contributions, transfers to individuals, businesses and communities, and health, education and defense. The influence of the public sector on the economy expands further when considering the indirect and induced effects from this spending. Most public sector activities come from GN spending, while most of its revenues are collected through transfers from the federal government. The GN receives approximately 90% of its total revenues via federal government transfers determined by the Territorial Formula Financing (TFF) agreement (Government of Nunavut 2012a).

The dependence on the government can have a stabilizing effect on the economy. For example, the 2008-2009 economic recession was not as evident in Nunavut as in other parts of the country. There was a noticeable halt to many resource-based and private-sector-led initiatives but government activities continued. These were spurred on by the Canadian Economic Action Plan that contributed to additional infrastructure spending. However, it must be noted that lack of consistent funding from the government can also have a destabilizing effect on the economy. Changes in budget allocations can affect the delivery of government programs that rely on those funds.

The largest private sector within the economy is the mineral exploration and mining sector. This sector holds the most potential for future expansion of GDP, employment and financial wealth. Currently, the Meadowbank Gold Mine owned and operated by the Canadian miner Agnico-Eagle Mines is the only active mine in Nunavut. It is located in the Kivalliq region northwest of Baker Lake. Production began in 2010 and is expected to continue until 2016. As of August 2011, there were 1,235 people working directly for the project, of which 289 were Inuit beneficiaries (Kivalliq SMEC 2011).

There are other potential mining projects in the Kitikmeot region. Several base metal, gold, silver, and diamond deposits in the region are in various stages of exploration and development. There are also other important economic sectors within Nunavut's economy that contribute to its diversification and job opportunities for labour. The Northwest Company is Nunavut's largest single private-sector employer through its chain of retail and grocery stores. Most of this sector's activities are directly or indirectly associated with government residential or non-residential investments and the mining sector.

Other sectors include tourism, fishing, food processing, and the arts sector and cultural industries. These are all currently small contributors to the wage-based economy relative to the public sector or mining sector but are still developing. Food processing is a small, but important element within the Kitikmeot regional economy. It processes specialty foods from char and muskox that are harvested locally. Tourism in the Kitikmeot provides for small economic opportunities. The main non-business tourist destinations in the Kitikmeot region are Bathurst Inlet, centred on the Bathurst Inlet Lodge (Rescan 2008) and Cambridge Bay, which offers three hotels (Rescan 2008). The community of Kugluktuk also hosts a range of tourism and cultural businesses, including an 18-hole golf course and the Northwest Passage Interpretive Centre and Historical Park.

6.4.2 Labour Force and Employment

Most jobs found in Nunavut are located in the territorial capital of Iqaluit. This is where most public administration jobs (territorial and federal) are located, along with the territorial hospital, several schools and Inuit organizations. The presence of these government and Inuit jobs has given rise to an expanding service industry in Iqaluit, which is attracting more migration of Nunavummiut from other Nunavut communities.

For those communities that do not have a decentralized GN department and are otherwise untouched by any resource development, few jobs exist beyond those required for Hamlet administration and maintenance and the public sector, and few new jobs are ever created.

Communities that have some GN presence because of the decentralization of departments serve as regional centres and have better-developed economies in areas such as fishing, arts or tourism. There are 10 communities where the GN has decentralized its operations, of which three of these located in

the Kitikmeot region. These include Cambridge Bay, Kugluktuk and Gjoa Haven, along with Igloolik, Rankin Inlet, Cape Dorset, Arviat, Pangnirtung, Baker Lake and Pond Inlet.

Table 6.4-1 provides labour market statistics for Nunavut. In 2011, 66.8% of the source population participated in the labour market, meaning they held jobs or were unemployed but were actively seeking work. The unemployment rate, which is calculated from the labour force rather than the source population, was 16.5% versus a national rate of 7.3% (Statistics Canada 2012). **Table 6.4-2** presents labour market data specifically for the Kitikmeot communities.

Table 6.4-1 Labour Force and Employment Characteristics for People Aged 15 and Over, Nunavut, 2010 to 2011 (Annual Averages)

	2010	2011
Total Population Aged 15 and Over	**20,900**	**21,100**
Labour Force	13,700	14,100
Employment	11,700	11,800
Unemployment[1]	2,100	2,300
Participation Rate (%)	65.5	66.8
Employment Rate (%)	55.7	55.8
Unemployment Rate[1] (%)	15	16.5
Inuit Population Aged 15 and Over	**16,300**	**16,400**
Labour Force	9,400	9,800
Employment	7,600	7,500
Unemployment[1]	1,900	2,200
Participation Rate (%)	57.9	59.6
Employment Rate (%)	46	46.2
Unemployment Rate[1] (%)	20.5	22.5
Non-Inuit Population Aged 15 and Over[2]	**4,600**	**4,700**
Labour Force	4,300	4,300
Employment	4,200	4,200
Participation Rate (%)	92.3	91.9
Employment Rate (%)	89.5	89.2

Note(s): The data in this report have been adjusted to reflect the 2006 Census population estimates. All LFS data have been revised back to 1996, except the data for Nunavut which have been revised back to 2004.

1 Use the unemployment estimates with caution as they tend to have a higher variability than employment estimates

2 Unemployment estimates for non-Inuit are suppressed due to their small numbers

Source: Nunavut Bureau of Statistics (2011b)

Table 6.4-2 Labour Force and Employment Activity for the Total Population 15 Years and Over, for Nunavut, Kitikmeot Region and Communities, 2006 Census

	Total – Population 15 years and over	In the Labour Force	Employed	Unemployed	Not in the Labour Force
Nunavut	19,340	12,635	10,670	1,965	6,705
Kitikmeot region	3,490	2,205	1,760	440	1,295
Cambridge Bay	1,020	720	650	70	300
Gjoa Haven	660	410	290	120	255
Kugaaruk	400	230	185	50	170
Kugluktuk	895	545	425	120	350
Taloyoak	495	285	200	80	215

Notes:

1 Data may not add up to totals due to random rounding.
2 Nunavut totals include data for settlements and unorganized areas.
3 See the last worksheet for definitions.

Source: Nunavut Bureau of Statistics (2008)

Labour force data reveal some discrepancies between Inuit and non-Inuit labour. Geography and education are contributing factors in this discrepancy. Most non-Inuit live in Iqaluit where the majority of employment opportunities are located. The majority of non-Inuit also have at least a high school education. Inuit represent the large majority of communities outside Iqaluit and, according to the *2006 Census*, 69% of that population aged 15 and older did not have a high school certificate (Statistics Canada 2008).

Table 6.4-3 presents community labour market data from the *2006 Census* (2011 census data is not yet available). As these data are five years out of date, some caution should be used in its interpretation. In general, the Kitikmeot labour market is weaker than the other two regions, with a lower percentage of employment. The community data reveal the discrepancy between Cambridge Bay where the unemployment rate is below 10% but above 20% everywhere else.

Table 6.4-3 Labour Force and Employment Activity for the Total Population 15 Years and Over for Nunavut, Kitikmeot Region and Communities, 2006 Census

	Participation Rate (%)	Employment Rate (%)	Unemployment Rate (%)
Nunavut	65.3	55.2	15.6
Kitikmeot region	63.2	50.4	20.0
Cambridge Bay	70.6	63.7	9.7
Gjoa Haven	62.1	43.9	29.3
Kugaaruk	57.5	46.2	21.7
Kugluktuk	60.9	47.5	22.0
Taloyoak	57.6	40.4	28.1

Notes:

1 Data may not add up to totals due to random rounding.
2 Nunavut totals include data for settlements and unorganized areas.
3 See the last worksheet for definitions.

Source: Statistics Canada (2008)

6.4.3 Wage Income and Income Support

Income levels throughout Nunavut and the Kitikmeot region closely mirror the employment data. Average personal income in Nunavut is close to the rest of the country, but only for the population of income earners (**Table 6.4-4**). In the Kitikmeot region, the median after-tax income level is approximately $6,000 higher than the remaining four communities (**Table 6.4-5**).

Table 6.4-4 Average and Median Income Levels for those with a Source of Income

	Nunavut	Canada
Median 2005 After-Tax Income $	20,042	23,307
Average 2005 After-Tax Income $	28,781	29,214

Source: Statistics Canada (2007a)

Table 6.4-5 Median Income, Persons 15 Years and Older

	Before Tax	After Tax
Cambridge Bay	26,061	24,016
Gjoa Haven	16,606	16,192
Kugaaruk	18,304	16,512
Kugluktuk	18,336	17,259
Taloyoak	15,744	15,360

Source: Statistics Canada (2007b)

The high cost of living in Nunavut reduces the purchasing power of this income. Nunavut's median income is low when compared to the national average, which indicates that a larger percentage of the population live close to or below the poverty line[1]. In 2008-2009, nearly half the population received some form of income support (**Table 6.4-6**). A similar percentage of the population reside in social housing, where rent for most tenants is $60 per month (Nunavut Housing Corporation 2011).

Table 6.4-6 Nunavummiut Receiving Income Support, 2008-2009

	# of People
Social Assistance	15,523
Senior Citizen's Supplementary Benefits	679
Nunavut Child Benefits	5,815

Source: Government of Nunavut, Department of Education, Social Support Statistics (estimates)
Non-wage or Traditional Economy

The "non-wage" or "traditional" economy, which includes subsistence hunting, trapping, domestic fishing and gathering plants, has always been regarded as being of utmost importance to the Nunavut economy. As elsewhere in Nunavut, this remains true in the Kitikmeot. However, anecdotal evidence suggests that the role of traditional hunting and gathering is continuing to shift from one that sustains the economy to one that sustains the culture. Ultimately, traditional Inuit sharing patterns are made possible by the work related wages. In addition to the wage economy contributing to cultural activities,

[1]Note that Nunavut does not have an official poverty line. Instead, one can look at the penetration of the GN's income support program to understand the extent of financial poverty.

the subsistence non-wage economy is also a growing industry. The GN (2007) noted that this sector generated an estimated $30 million in sales in 2003, and sales were expected to grow to $50 million by the year 2013. Government support for traditional activities includes a guaranteed prime fur price schedule, which is reviewed annually. Subsidies are available for fur vendors. The Community Harvesters Assistance Program also provides financial assistance to hunters and trappers (Rescan 2008).

6.4.4 Financial Capacity

The GN receives more than 90% of its revenues from federal government transfers. The majority of these transfers are through an agreement called the Territorial Formula Financing Agreement (TFF*).*

Other federal transfers include the Health and Social Transfer, which is a transfer that all provinces and territories receive and is based strictly on population.

Table 6.4-7 provides estimates of the GN's revenue sources for 2012-2013.

Table 6.4-7 Government of Nunavut Revenue Sources, 2012-2013

	Revenue Sources	Estimates 2012-2013 ($000)
Federal Transfers	Formula Financing Arrangement	1,273,498
	Other Federal Transfers	82,600
	Total Federal Transfers	**1,356,098**
Own Source Revenues	Personal Income Tax	18,400
	Corporate Income Tax	8,400
	Fuel Tax	4,200
	Property Tax and School Levies Tobacco Tax	2,700
	Tobacco Tax	14,600
	Payroll Tax	22,300
	Insurance Taxes	700
	Liquor Commission, net cost of goods sold	5,265
	Petroleum Products Division, net cost of goods sold	13,261
	Rental Recovery – Staff Housing	15,500
	Other Revenues	14,900
	Recovery of Prior Years' Expenditures	-
	Total Own Source Revenues	**120,226**
Total Revenues		**1,476,324**

Source: Government of Nunavut (2012a)

The GN's main estimates for the 2011-2012 Operations and Maintenance Budget for the Kitikmeot region is $150,958,000. Along with these Operations and Maintenance monies, the Region shares an annual territorial capital budget that in 2011-2012 totalled $122,476,000.

6.5 Physical Assets

This section provides an overview of Nunavut's housing, community infrastructure and services and transportation infrastructure and services, with a focus on the Kitikmeot region.

6.5.1 Housing

Public housing in Nunavut is managed by the Nunavut Housing Corporation (NHC). The NHC undertakes a regular Nunavut Housing Needs Survey (NHNS) to collect data on the housing needs of Nunavummiut to assist them in planning and providing housing. **Table 6.5-1** provides the number of housing units in the Kitikmeot in 2001 and 2011. The data show that, over the past decade, the number of rented and owned dwellings has increased. Most of the housing occupied by residents of the Kitikmeot region is classified as public housing, which made up slightly less than two-thirds of all occupied dwellings. The second most common type of housing was owner-occupied dwellings, representing about 1 dwelling out of 4. The remaining occupied dwellings were staff housing and other types of rented housing. Despite the increase in housing stock, there remains a lengthy waiting list for available housing.

Table 6.5-1 Housing Stock in the Kitikmeot Region, 2001 and 2011*

Year	Overall Kitikmeot region	Cambridge Bay	Kugluktuk	Gjoa Haven	Taloyoak	Kugaaruk
2001	1,060	315	310	160	140	135
2011	1,600	540	430	230	220	170
Percent Change	51%	71%	39%	44%	57%	26%

Source: Nunavut Bureau of Statistics (2012) and Statistics Canada (2001c)

* No information was available for the communities of Bathurst Inlet and Umingmatoq

According to the National Occupancy Standard (NOS) crowding measure, the proportion of unsuitable dwellings in Nunavut was 35%. The Kitikmeot communities of Gjoa Haven, Arctic Bay, Taloyoak and Kugaaruk had above-average prevalence of unsuitable dwellings of 57, 45%, 56% and 50%, respectively.

6.5.2 Community Infrastructure and Services

Hamlets in Nunavut are responsible for providing community infrastructure and services. For the most part, water is distributed to individual households via a daily truck run or by ordering water through a designated local company provider. Sewage is pumped out from individual homes. Each of the communities operates a landfill facility.

6.5.3 Transportation Infrastructure and Services

Nunavut's road infrastructure has been driven by the need to access non-renewable resources. The Kitikmeot region has no all-season roads only seasonal ice roads. At present, interest in expanding road infrastructure in Nunavut in general and the Kitikmeot in particular is linked to mining operations and meeting their supply needs (Nunavut Resources Corporation 2011; Nunatsiaq Online 2010).

Aircraft are the primary means of transportation within Nunavut. Nunavummiut fly more often than any other people in Canada. Most communities in Nunavut are served by a Transport Canada certified or registered airport. There are also several special purpose or private airstrips developed to serve the resource industry.

The Kitikmeot region has airports in Cambridge Bay, Kugaaruk, Kugluktuk, Kugaaruk and Taloyoak. The main airline carriers in the region are First Air, Canadian North and Kenn Borek Air (Nunavut Handbook 2004).

Efforts are underway to expand transportation arrangements in Nunavut. In December 2010, Kitikmeot Inuit Association (KIA) and First Air announced a transportation agreement for beneficiaries in Nunavut. The agreement includes reduced costs to KIA beneficiaries and special cargo rates to facilitate the shipment of such cargo as snowmobiles and ATVs. In addition, First Air will be providing employment and training opportunities (KIA 2010).

Deep-water ports are limited in Nunavut; there are none in the Kitikmeot. Surveys of potential locations for deep-water ports have taken place over the past 30 years. Deep-water ports are considered important for commercial fishing, tourism and business opportunities such as mining, which requires this type of infrastructure. Within the Kitikmeot, each of the communities have small craft dock systems or barge landings to receive annual resupply shipments and allow use of small boats. The major shipping operation within the region is Western Arctic Re-supply, which originates in Hay River, Northwest Territories and serves all of the communities in the Kitikmeot, except Kugaaruk.

6.6 Social Assets

6.6.1 Cultural, Archaeological and Paleontological Resources

This section provides an overview of cultural and archaeological resources, traditional activity and knowledge, and community recreational facilities and programs. Cultural, archaeological and paleontological resources are critical for understanding the history of Nunavut and are valued by Kitikmeot community members. Archaeological resources are important sources of historical knowledge and Inuit cultural heritage and identity. Local communities, regional Inuit organizations, including the KIA, the Inuit Heritage Trust (IHT) and the GN all consider archaeological sites to be a valuable asset. Archaeological sites in Nunavut are protected by Articles 33 and 34 of the NLCA, the GN's *Historical Resources Act* and the Nunavut Archaeological and Paleontological Site Regulations. Protection of paleontological resources in Nunavut is governed by the GN under the Nunavut *Archaeological and Paleontological Sites Regulations*.

The Izok Corridor Project spans two very different regions, archaeologically and culturally. The majority of the area is within the Central Inuit region, but the southern section encompasses the northern portion of Dene Athapaskan Indian range. There is evidence that people have occupied the central Arctic mainland region for at least 3,500 years when the first sites of the Arctic Small Tool Tradition have been dated. It is apparent that primary focal points for past people in this region were the coast between Bathurst Inlet and the Coppermine River, the entire Coppermine drainage system, major river valleys particularly the Hood and the James, and Contwoyto and Itchen lakes.

Paleontological resources (e.g., fossils) are direct and integral part of the bedrock geology of an area. They are not man-made but natural and integral part of an ancient rock. The geology of the area does not show fossil bearing rock formation. There are no fossils or other paleontological resources found or recorded in the Project area to date.

6.6.1.1 Introduction

The following sections describe existing information on archaeological resources within the study area of the Izok Corridor Project, as a baseline from which potential direct and indirect effects of the Project can be identified and evaluated. Archaeological resources are non-renewable, finite resources. They are often not readily identifiable by the untrained eye, and can be directly disturbed by any activity that causes ground disturbance.

Article 33.4.3 of the NLCA specifies the responsibilities of the Inuit Heritage Trust to support, encourage and facilitate the conservation, maintenance, restoration and display of archaeological sites and specimens in the Nunavut Settlement Area. This protection is further clarified under the Nunavut *Archaeological and Palaeontological Sites Regulations* (NAPSR), which are administered by the Government of Nunavut (GN). The GN Department of Culture, Language, Elders and Youth (CLEY 2003) reviews reports and approves final recommendations regarding site mitigation. In addition to NASPR, the federal *Territorial Land Use Regulations*, administered by the Department of Aboriginal Affairs and Northern Development Canada, prohibits activity within 30 m of a known or suspected archaeological site or burial ground located on federal Crown land.

Important elements related to archaeological resources include the characteristics of the site assemblage and the integrity of archaeological resources within the site. There are different types of sites, and each site is unique. All archaeological sites form an assemblage that provides cultural information concerning past people who have used the area. Various types of sites provide different information about people's temporal and spatial ranges and the types of activities that occurred. The maintenance of some representation of these different types of sites on a regional basis is important. For example, if a particular type of site is found frequently in the region, there is a lower need to try to preserve each example as long as a representative sample can be maintained. However, in the case of comparatively unique sites, particularly sites of high importance, efforts must be made to avoid disturbance or loss.

Rock features provide cultural information by construction attributes of the features and their internal site relationships. The context of artifacts is a crucial aspect of the information content and that information is lost through the displacement or removal of artifacts. Much can be learned about past activities from an artifact's location and its relationships to other artifacts and features. Additional information can be obtained from studying the artifact's attributes, for example, style, shape, manner of construction and evidence of use or breakage patterns. It is important that artifacts be studied in their original place and that no part of the artifact assemblage is lost without prior study.

Burial sites and very large, intensively used or exceedingly rare sites are exceptions. However, most archaeological sites do not fall into those categories.

6.6.1.2 Study Areas

Local Study Area

The Project footprint is the land area directly disturbed by construction, operation and closure activities associated with each of the key Project components, including the High Lake Mine site and the Izok Mine site, which includes mining activities and associated infrastructure; the Grays Bay Port including

the docking and storage areas; and Izok Road and winter access roads linking the Izok and High Lake mines to Grays Bay. The Local Study Areas (LSA) encompasses the footprints of these Project components plus a 1 km buffer (0.5 km on each side).

The LSA comprises the zone within which direct and indirect effects of the Project are most likely to occur. Effects on archaeological sites are location specific and direct effects are not expected to occur outside of the LSA.

Regional Study Area

To provide the appropriate spatial and temporal context, the Regional Study Area (RSA) encompasses the area traditionally used by the Copper Inuit (as defined by early ethnographers), as well as the northern portion of the Yellowknives and Tlicho ranges. Consequently, the RSA extends from just west of Kugluktuk, north to encompass the southern portion of Victoria Island, east to include Kent Peninsula and Bathurst Inlet, southeast to Contwoyto Lake, and southwest to just east of Great Bear Lake, encompassing the northern portion of the Coppermine drainage system.

6.6.1.3 Existing Archaeological Baseline

The majority of the Izok Corridor Project area is within the Central Inuit region, but the southern section encompasses the northern portion of Dene Athapaskan Indian range. This means that two different historical cultural sequences need to be considered.

A large ice sheet covered this region until approximately 9,000 years ago and movements of the glacier sculpted the landscape. As the ice sheet receded, large lakes formed, boulders and gravels were deposited, and the ground rose and various levels of ocean beach ridges were formed. These landscape features determine where people will go.

There is evidence that people have occupied the central Arctic mainland region for at least 3,500 years when the first sites of the Arctic Small Tool Tradition have been dated. The Thule people appeared about 1,000 years ago, and the Copper Inuit about 400 years ago (McGhee 1978). From documentary sources, it is apparent that primary focal points for past people in this region were the coast between Bathurst Inlet and the Coppermine River, the entire Coppermine drainage system, major river valleys particularly the Hood and the James, and Contwoyto and Itchen lakes. The main river valleys and long, continuous sections of eskers provided important routes for people to travel inland from coastal areas or from the south. During the spring, summer and fall, the region was used primarily for caribou hunting, although other animals such as muskox and fox were hunted, and other resources may have been gathered as necessary. Seals were hunted along the coast and fish were captured at river mouths and in lakes.

The vicinities of Itchen and Contwoyto lakes were also used by Athapaskan Dene from the central Barrenlands, specifically the Yellowknives and the Tlicho in late prehistoric and early historic times. The culture history of the central Barrenlands extends back as long as 7,500 years ago. Various cultural traditions have been identified to the south of the present study area, all thought to result from human movements due to climatic changes. Northern Plano tradition represents the earliest recognized occupation of the central Barrenlands, thought to date around 6,000 to 7,500 years ago. Barrenland Arctic Small Tool tradition (ASTt), or Canadian Tundra tradition (Gordon 1977), is thought to represent a

southward migration of Arctic coastal hunters and dates roughly 3,500 to 2,700 years ago. The ASTt was replaced in the Barrenlands by what is known as the Taltheilei tradition, suggested to have moved in from the southeast between approximately 2,500 years ago to A.D. 1800. This tradition is considered by some researchers (e.g., Noble 1981) as a major ancestral Athapaskan tradition and is widespread across much of the historic Yellowknife people's homeland.

In general, survival for people living on the Barrenlands was largely dependent on the barren-ground caribou; consequently, their travels were governed by the movements of the caribou. All Dene inhabitants of this region followed a similar nomadic lifestyle moving with the caribou, north onto the Barrenlands in the summer and south into the forest fringes in the winter. Fish also formed an important component of the diet and were taken throughout the year, by nets in summer and ice fishing in winter. Within this region, people gravitated to major caribou grazing areas and the large lakes and rivers.

Izok Mine Local Study Area (LSA)

Prior to a study conducted in 2008 in relation to the Izok project (Prager 2009), four previous archaeological studies Damkjar 1994, Fedirchuk 2001, Tischer 2002) examined parts of the Izok Mine area and associated road alternatives to Lupin/Contwoyto Lake area. These studies resulted in the recording of over 100 archaeological sites, many around Ham and Iznogoudh lakes and along the north Itchen Lake shore. In 2008, the locations of those sites were compared to the mine and road plans at that time and those sites that appeared to be close were revisited (Prager 2009). Specific areas proposed for siting of infrastructure around Izok Lake were surveyed by ground traverses.

Four sites were recorded to the east (LjPc-11, 12, 13, 31), and two sites were found to the west (LjPc-28, 29) along the narrows. Five sites are known along the shore of Iznogoudh Lake (LjPc-10, 19, 27, 30, LkPc-5) heading toward the airstrip and exploration camp at Ham Lake. In the Ham Lake area, there are numerous sites recorded on the long esker north of the camp and airstrip, and five sites are recorded in the immediate area of the camp and airstrip (LkPc-1, 10, 14, 15, 20).

The proposed mine site layout will be compared to that examined previously to ensure that currently proposed infrastructure locations have been covered by the inventory surveys. All revised sections of the mine footprint, in particular the plant site, revised access road and diversion channel, will be subject to intensive ground reconnaissance to complete the inventory and identify all archaeological resources that may be affected by the Project. Locations of all recorded sites will be compared to the latest mine infrastructure plans. Any sites that are identified to be close, that were not visited in 2008, will be revisited to ascertain their status, both in terms of site condition and position relative to possible effects.

High Lake Mine LSA

The High Lake Mine footprint as proposed in 2004-2006 was thoroughly examined by pedestrian traverses (Bussey 2005; Prager 2006, 2007). One archaeological site (MiNu-1) was recorded on the east side of High Lake (Bussey 2005). This site, a single open cache, was assigned low archaeological site significance and was mitigated by detailed mapping in 2006 (Prager 2007).

Under the current plan for the High Lake Mine site, the footprint will likely be smaller than that proposed in 2006. Consequently, additional ground reconnaissance is not required. However, a comparison between the current footprint and the previous proposed footprint will be made to confirm that the area has been fully inventoried and no additional archaeological sites are at risk of disturbance due to the Project.

Izok Road LSA

Previous studies related to the High Lake project (in 2004, 2005, 2006), the Izok Mine project and the Bathurst Inlet Port and Road project (in 1993, 2001, 2002) resulted in the recording of over 100 archaeological sites along potential road routes. Revisits were conducted in 2008 of all the sites (approximately 50) judged to be in close proximity to the proposed road route (Prager 2009). In addition, ground reconnaissance conducted in 2008 recorded an additional 46 archaeological sites, all within or adjacent to the roads as proposed at that time. It must be noted that the route had not been finalized at the time of the 2008 archaeological field work.

The only portion of road that has received intensive archaeological investigations to date was the section extending 12 km north of High Lake Mine site to the Sand Lake airstrip (Prager 2007). That assessment involved ground reconnaissance of most of the road and associated borrow sources, as well as detailed assessment or systematic data recovery at seven sites (MiNu-5, MiNu-6, MiNu-7, MiNu-8, MiNu-10, MiNu-11, MiNu-12).

All revised sections of the road alignment will be examined by air and on ground. All associated construction facilities, particularly proposed borrow sources and camps, will be assessed by low and slow helicopter overflight and selected sections examined by ground traverses. Locations of all recorded archaeological sites will be compared to the final Izok Road and winter road alignments. Sites that are identified to be close but were not assessed in 2008 will be revisited to ascertain their status, both in terms of site condition and position relative to possible effects.

Grays Bay Port LSA

At the Grays Bay Port site, the entire peninsula was extensively covered by pedestrian traverses in 2004 (Bussey 2005), 2005 (Prager 2006) and 2006 (Prager 2007). Two large sites, MkNu-2, MkNu-4, are situated in the lower northwestern portion of this landform. Four sites (MkNu-4, 5, 6, 10, 12) were recorded in the pass. Two sites (MkNu-3, MkNu-8) are located in the high, central part of the headland, and one (MkNh-7) is situated on the lower rocky west side. All nine sites are located within or in close proximity to the current proposed port footprint.

The archaeological sites at Grays Bay range from small to large in size, all contain stone features, and two also contain stone artifacts indicating considerable age. The two biggest sites (MkNu-2 and MkNu-4) contain a large quantity and wide variety of stone alignments and stone clusters. The suggested functions include tent rings, skin drying circles, caches, and support rocks for drying racks or kayaks. Various artifacts of wood, bone, antler and possibly ivory are present. The differences in the feature locations, shapes and sizes and construction methods suggest occupation at different periods of time, although seasonal use or different functions may also account for some of the variety. In general, the use of this section of coastline appears most intensive during the Copper Inuit historic period, but evidence of use as early as 3,500 years ago was found on the higher portion of the landform.

At the port site, one final series of closely spaced transects to cover the entire landform will complete the inventory survey. Additional work will first comprise detailed mapping to scale at those sites for which this is not yet complete. An intensive and extensive subsurface testing program will be necessary at those sites that have some soil, vegetation cover, and/or potential for obscured remains (i.e., MkNu-2, 4, 5, 6, 12).

6.6.1.4 Existing Archaeological Conditions Summary

There are approximately 150 recorded archaeological sites that potentially exist within the Izok Corridor Project LSA. While some of these sites are scattered through the study area, many are concentrated in specific areas around Grays Bay, Itchen Lake, Iznogoudh Lake, Ham Lake, Hood River, and James River.

Once the Project footprint is finalized, low-level helicopter flights and on foot transects will complete the inventory of all archaeological resources. Each site will be evaluated in terms of its potential to be affected by the development and possibilities for avoidance. At each site where effects are considered likely, more detailed assessment will be conducted to determine site boundaries, content and scientific significance. Cultural significance will also be incorporated where possible. This information will be used to prepare a site-specific mitigation plan, which may comprise avoidance, protection or data recovery. These mitigation plans must be approved by the GN and then implemented prior to initiation of disturbance activities.

6.6.2 Traditional Activities and Knowledge

Traditional land and resource use continues to support the subsistence economy. Hunting, fishing and gathering plants and berries contribute healthy and nutritious food to the diet of Nunavummiut families. Trapping provides pelts for sale, personal use and crafts. The contribution of country foods to a Kitikmeot family's diet varies from 10% to 29%. Caribou, Arctic char, ringed seal, and musk ox, trout and whitefish are the most frequently consumed, depending on the season (Wolfden 2006).

Information on the extent to which Nunavummiut in the Kitikmeot engage in subsistence harvest are becoming dated. However, anecdotal evidence suggests that, while traditional land use may have declined since the early part of the past decade, a substantial proportion of the Kitikmeot population still harvest food. The Nunavut Wildlife Harvest Study noted that the percentage of active hunters is 21-22%, whereas the percentage of intensive hunters is 4% of the total hunters interviewed with most hunters being occasional harvesters.

The 2001 Aboriginal People's Survey (Rescan 2008) reported that approximately 50-60% of residents (aged 15 years and older) in Kugluktuk, Cambridge Bay and Gjoa Haven engaged in hunting activity in the 12 months prior to the surveys; 70- 76% of residents were involved in fishing. Gathering activities showed the greatest variation, from 15% of residents in Cambridge Bay to 63% in Kugluktuk.

The Conference Board of Canada (2001) noted the importance of traditional activities for the lifestyle and diet of many residents. Nearly a third (31%) of residents report eating caribou meat daily or almost daily, while only 16% report eating it rarely or never. Other country foods include fish, seal, ptarmigan and muskox. The West Kitikmeot Draft Land Use Plan (WKRLUP 2005) estimated that 1,000-1,500 kg of hunting products, including meat and fish, are harvested by each hunter every year, with an estimated replacement value of $10,000-15,000 per hunter annually.

6.6.3 Community Recreational Facilities and Programs

Municipalities are responsible for the provision of recreation facilities and programs within their respective communities. Depending on each community, recreation facilities and programming vary. Within the Kitikmeot, there are numerous existing and proposed parks and conservation areas (refer to section 5.2). Federal Parks and conservation areas include: the Tuktut Nogait National Park, the Queen Maud Gulf Migratory Bird Sanctuaries, Queen Maude Gulf/Lambert Channel Polynya. National historic sites include the Coppermine River (Kugluktuk), O'Reilly Island (Gjoa Haven) and Utkuhiksalik (Gjoa Haven).

Territorial Parks and conservation areas include: Ovayok Territorial Community Park (Cambridge Bay), Kugluk/Bloody Falls Territorial Community Park (Kugluktuk), Kugaaruk Park (Kugaaruk), Rasmussen Lowlands (Taloyoak), Wilberforce Falls (Bathurst Inlet), Hiukitak River (Umingmaktok). Territorial historic sites include the Northwest Passage Territorial Historic Park (Gjoa Haven), Wilmot Island, Perry Island and Reid Island, and Wall Bay.

6.7 Individual and Community Wellness

It is hypothesized that community well-being is enhanced when individuals, families and their communities experience few adverse effects and more positive effects on people's daily lives.

6.7.1 Individual and Family Wellness

There are many determinants of wellness for both individuals and families. However, three key indicators in Nunavut are the prevalence of alcohol and substance abuse, family violence and abuse, and teen pregnancy.

Alcohol and substance abuse is common across Nunavut. In the Kitikmeot, communities are considered non-restricted or open, restricted or "dry" with respect to the possession of alcohol Cambridge Bay and Talaoyak are open, Gjoa Haven and Kugaaruk are dry communities, and Kugluktuk residents have restricted access.

The number of people using controlled substances such as marijuana, hashish, crystal methamphetamine and cocaine appears to be growing. No statistics are available at this time regarding the extent to which people in the region use these drugs. Inhalant abuse, another serious issue in Inuit communities, is often considered an under recognized form of substance abuse. Individuals who have an addiction problem have limited access to treatment (Korhonen 2005).

Family violence and abuse can include many forms of mistreatment, neglect and abuse, both physical and mental, between family members, relatives or dependent relationships. This can involve physical violence, sexual abuse, rape, exploitation, neglect of children, and emotional and verbal abuse. Family violence is complex and there is no single cause, yet it can be linked to individual issues relating to power and culture loss and other external contributing factors such as poverty, poor housing conditions, unemployment, and alcohol abuse (Pauktuutit Inuit Women of Canada 2006).

It is estimated that there is a higher incidence of family violence and abuse in Nunavut as compared to the rest of Canada. Statistics Canada reported that Aboriginal peoples (First Nations, Métis and Inuit) were three times more likely to be victims of spousal violence than non-Aboriginal peoples. The extent

of family violence is not known, as there are many cases that go unreported and often remain hidden. Per capita rates of shelter use are much higher in the territories than in the provinces. There are seven shelters in all of Nunavut, of which two are located within the Kitikmeot.

In the recent past, Nunavut has been faced with a growing number of teenage pregnancies. In 2004, Nunavut had an estimated teenage pregnancy rate 18 times higher than the rest of Canada (Archibald 2004).

Overall, individuals and families living Kitikmeot communities face the same challenges as residents of other Nunavut communities in terms of alcohol and substance abuse, family violence and abuse, and teen pregnancy.

6.7.2 Community Wellness

There are many determinants of community wellness. In Nunavut, two key indicators of the state of community wellness are the prevalence of suicide and crime. Community wellness is also a function of people's sense of belonging and purpose that reflect the cohesiveness of a community and the individuals in the communities. It reflects the willingness of individuals to co-operate and work together. Indicators include sharing and volunteering or helping out.

Suicide is among the 10 leading causes of death in Canada. According to Health Canada, Inuit suicide rates are more than 11 times higher than the Canadian rate, and 83% of these involved people under 30 years of age (Inuit Tapiriit Kanatami). From just a few self-inflicted deaths throughout the 1960s and 1970s, an average of 28 Nunavummiut have died by suicide each year from 2000 to 2010 (The Canadian Press 2011). The suicide rate of Inuit women in Nunavut is lower than Inuit men but is far higher than that of women in the rest of Canada (Government of Nunavut 2010).

Rates of suicide attempts and suicidal ideation (thoughts of committing suicide) also appear to be high in Nunavut. In 2009 alone, the RCMP responded to 983 "occurrences where persons are reported to be threatening or attempting suicide" in Nunavut. Kitikmeot communities face the same challenges as other Nunavut communities with respect to suicide prevention.

In 2011, the GN released a 3-year Nunavut Suicide Prevention Action Plan that is geared towards provision of more mental health services and suicide intervention training (Nunatsiaq Online 2011).

Crime is also a broad indicator of community wellness. **Table 6.7-1** and **Table 6.7-2** provide crime data from 2002 to 2009 for the Kitikmeot region. These data indicate increased numbers of violations in all categories and increased numbers of violations in most Kitikmeot communities.

Table 6.7-1 Reported Crime Data in the Kitikmeot Region, 2002-2009

Category	2002	2003	2004	2005	2006	2007	2008	2009
Total Violations	1,899	2,458	2,505	2,208	2,591	2,315	2,338	2,565
Crime Including Traffic	1,860	2,417	2,450	2,157	2,542	2,265	2,270	2,490
Police Reported Criminal Code Violations	358	451	455	395	455	399	399	434
Police Reported Federal statues Violations	39	41	55	51	49	50	68	75
Police-reported Violent Crime	598	777	763	671	631	548	647	705

Police reported non-violent crime	171	203	213	175	217	187	178	214
Police reported criminal code traffic violations	46	81	76	67	96	99	73	70

Sources: Nunavut Bureau of Statistics (2011a)

Table 6.7-2 Reported Actual Violations for Kitikmeot Region and Communities, 2002-2009

	2002	2003	2004	2005	2006	2007	2008	2009
Kitikmeot region	1,899	2,458	2,505	2,208	2,591	2,315	2,338	2,565
Cambridge Bay[2]	752	934	841	883	1,238	1,150	1,259	1,239
Gjoa Haven	173	261	216	240	143	230	295	482
Kugaaruk[7]	73	140	146	50	47	74	62	38
Kugluktuk	730	953	1,058	695	921	731	533	629
Taloyoak	171	170	244	340	242	130	189	177

Source: Nunavut Bureau of Statistics (2011a)

Sharing involves the recognition of relationships in a family, between families and in the larger community. Sharing of harvests provides for strong social and cultural connections. Sharing of food has continued despite involvement in the wage economy. In fact, the wage economy makes it possible to participate in harvests and hunts (e.g., purchase of guns, bullets, snow machines). Without the wage economy, subsistence harvests would diminish and social and cultural connections might be altered (Wenzel 2009, 1989, 1981; Lonner 1980, Fienup-Riordan 1986). Based on a 2007 survey of 9,000 individuals from Nunavut's 10 largest communities (66% of the population over 15), volunteers contributed an average of 186 hours per year to their communities. The percentage of the population volunteering was 43% in 2007 - below the national average of 46% (Statistics Canada 2009).

The vitality of a community's culture and people's use of traditional languages are also important indicators of community wellness. The Nunavut government lists four official languages. These are: Inuktitut, Inuinnaqtun, English and French for the Territory. Up until the 19th century and early 20th century, the Inuktitut language was an oral language with a variety of dialects, of which one is Inuinnaqtun. Today, Inuktitut and Inuinnaqtun are also written, using syllabics and Roman orthography respectively. English has become the dominant language in Nunavut.

The use pattern of Inuit languages in the Kitikmeot is consistent with the overall pattern for Inuktitut speakers across Nunavut. The proportion of Kitikmeot residents that spoke Inuktitut or Inuinnaqtun first and continue to speak it preferentially has been dropping steadily since 1996. This is likely a reflection of the aging population and the passing of elders.

The communities of Kugluktuk and Cambridge Bay may be the exception. Although the Kitikmeot population is losing Inuktitut and Inuinnaqtun mother tongue speakers, there is some evidence that these languages are being learned as a second language. Inuktitut language training is available to children in pre-school programs from Kindergarten to Grade 5. From Grade 6 to 12, English is the predominant language of instruction and the Inuktitut language is a subject.

In Cambridge Bay and Kugluktuk, the Kindergarten to Grade 12 curriculum is all in English. In communities where Inuinnaqtun is spoken, English is the only language of educational instruction.

The GN has made the revitalization of the Inuit language a priority. As part of their revitalization strategy, the GN passed the *Inuit Language Protection Act* in 2008. The objective of the legislation is to increase the population of Inuit who can speak and read their language fluently. It seeks to ensure that Inuit Language remains at the centre of education, work and daily life throughout the territory. With the passage of this Act the GN has also committed to provide services and communications to the public that are effective and culturally appropriate in the official language of their choice.

6.7.3 Personal Security

Two key issues that relate to personal security are people's financial security and their access to a sufficient amount of nutritious food (i.e., food security).

Financial security is about achieving material well-being and having adequate income to meet basic needs such as housing, food, and clothing, and being able to take advantage of opportunities and lead a rewarding life. The GDP per capita is often used as a measure of the standard of living. An increase in GDP is associated with greater material well-being, and thus with a higher standard of living.

In 2010, the national nominal GDP per capita was $47,606, while that in Nunavut was slightly higher at $53,452. Nevertheless, the high cost of living in Nunavut reduces the purchasing power of people's earned income. Nunavut's median income is low when compared to the national average, which indicates that a larger percentage of the population live close to or below the poverty line.

Inuit in Nunavut rely on both traditional and store bought food to meet their subsistence needs. Food security remains a serious issue for many individuals and families in Nunavut particularly among those on social assistance. A 2006 study reported that participants in six Nunavut communities indicated that many people had difficulty obtaining enough food every month (Chan et al. 2006).

In 2011, the federal government introduced the Nutrition North Canada (NNC) program, which seeks to improve access to perishable healthy food in isolated northern communities. This program is based on a market-driven model, whereby the food subsidy is transferred to retailers and suppliers that apply and are selected to register with the program (Nutrition North Canada 2012).

The GN's Department of Health and Social Services established the "Developing Healthy Communities" strategy for Nunavut 2008-2013. The GN's goals are to increase the number of children eating country foods; to improve food security for all families through increased access to nutritious and acceptable food; and to increase knowledge and skills regarding healthy foods, menu options and budgeting (Government of Nunavut 2012b).

Izok Corridor Project Proposal

SECTION 7

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7 POTENTIAL PROJECT ENVIRONMENTAL EFFECTS

The Izok Corridor Project has the potential to affect the biophysical and human environments through activities and infrastructure development associated with all phases of the Project (construction, operation, closure and decommissioning, and post closure). The following provides a preliminary identification of potential biophysical effects that could occur as a result of routine Project activities and facilities. These are summarized in Appendix B, as contained within NIRB's Project Specific Information Requirements (Part 2 Form). Possible mitigation measures and monitoring for these potential effects are also described below.

A detailed assessment of the environmental effects of the Project and development of appropriate mitigation will be conducted as part of the feasibility study and environmental assessment (EA) phase of the Project and will be presented in the Draft Environmental Impact Statement (DEIS). The DEIS will focus on Project effects that have the potential to result in substantive changes to the selected Valued Components (VCs), and will include determinations of significance for changes in environmental receptors as a result of these changes.

The DEIS will include a description of possible accidents and malfunctions that could occur during the life of the Project, and a detailed evaluation of potential risks and consequences of these incidents on the environment and human health and safety (refer to section 11).

7.1 Identification of Potential Project Environmental Effects

Preliminary identification of potential environmental effects is based on an initial scoping exercise that considered the full scope of the Project based on pre-feasibility design.

The current base case route for the Izok Road has been used as the basis for identifying key environmental issues related to ground transportation. The alternative route alignment currently being studied would involve some additional footprint, and different topography, terrestrial habitats and stream crossing locations, which could influence the extent to which construction and operational activities affect the biophysical environment. However, the nature of the interactions is not expected to differ substantively. Final selection of the road alignment will be made as part of the ongoing feasibility study and assessed in detail in the DEIS.

7.1.1 Issues Scoping

Key elements of the scoping process included:

- Consideration of all Project-related issues identified to date through engagement with regulatory agencies and communities
- Identification of potential interactions between the Project and selected Valued Ecosystem Components (VECs)
- Ranking of Project-environment interactions as a means of identifying those interactions that have the potential to result in an adverse effect on a VEC despite planned mitigation (e.g., Best Management Practices, mitigation by Project design) and require a detailed assessment in the DEIS

Rankings of potential interactions between the Project and the environment are based on the predicted nature of the resulting effect, prior to the implementation of any mitigation. It is not intended to describe the predicted magnitude or extent of possible residual effects of the Project. Interactions have been prioritized based on the following definitions.

- Rank = 0 If there is no interaction or no potential for substantive interaction between a Project activity and the VC to cause a potential environmental effect, an assessment of that environmental effect is not required. These interactions are categorized as 0, and are not considered further in the EA.
- Rank = 1 If there is likely to be a potential interaction between a Project activity and a VEC but not likely to be substantive in light of planned mitigation, the interaction is categorized as 1. Such interactions are well understood, and can be mitigated with a high degree of certainty with proven technology and practices. These interactions are subject to a less detailed assessment and are rated as not significant.
- Rank = 2 If a potential interaction between a Project activity and a VEC could result in more substantive environmental effects despite the planned mitigation, if there is less certainty regarding the effectiveness of mitigation, or if there is high degree of concern from regulatory agencies, Inuit or stakeholders, the interaction is categorized as 2. These potential interactions are subject to a more detailed analysis in the environmental assessment.

In assigning rankings to each potential Project-environment interaction, consideration was given to the following criteria as a means of ensuring that a precautionary approach was taken early in the issues scoping.

- Relevant policies stated in legislation, regulations and policy statements that need to be considered
- The extent to which an environment component or system is likely to change as a result of Project actions
- The societal values placed on certain environmental features and qualities
- Whether there is or is likely to be controversy surrounding an issue
- Whether there is a meaningful degree of uncertainty with respect to the environmental effect or the effectiveness of planned mitigation

The issue scoping was based on available information regarding the VC (field baseline studies, and published and unpublished information sources), the effects literature, experience with similar northern mining projects, and best professional judgment to identify where potential interactions could occur based on likely spatial and temporal overlap with each Project activity.

7.2 Atmospheric Environment

7.2.1 Potential Changes to Air Quality

The Project will result in emissions to the atmosphere from fossil fuel combustion sources, and fugitive dust emissions from processing equipment, material handling and vehicle traffic. At sufficiently high

concentrations, these air emissions could have direct and indirect effects on human health, water and soil quality, vegetation quality and wildlife habitat.

7.2.1.1 Potential Effects

Key Project activities that may cause a change in air quality include those that involve emissions of chemicals of potential concern (COPCs). Potential changes in air quality include:

- Increases in ambient air concentrations of COPCs
- Emissions that contribute to the anthropogenic component of climate change

7.2.1.2 Effects Mechanisms and Linkages

During each phase of the Project, various activities have the potential to increase ambient air concentrations of COPCs within the local and regional study areas, including dust (TSP, PM_{10}, $PM_{2.5}$), metals, gaseous compounds (SO_2, NO_x, CO), and volatile organic compounds (VOCs). Sources of these emissions will include:

- Construction: Land clearing, blasting, grading, hauling, excavating, material handling, quarrying and aggregate crushing, fuel combustion, incineration of waste
- Operations: Drilling and blasting, ore and mine waste rock handling, stockpile and road maintenance, wind erosion of stockpiles, vehicle traffic, fuel combustion, milling operations and incineration of waste
- Closure: Decommissioning and removal of site pads, airstrips and roads, backfilling, contouring

Project activities that are likely to have the greatest effect on air quality include mining activities (i.e., blasting, loading and hauling), stockpiling and milling activities (ore handling, crushing and grinding and transport). Although emissions from ventilation of the underground mines are expected to be a source of fugitive dust, this is expected to be much lower than that associated with open pit mining activities.

Most waste management activities are expected to have little effect on air quality; however, incineration of wastes and odours from discharge of effluents and sewage sludge from VOCs or reduced sulphur could affect air quality.

Power generation and vehicle emissions associated with operation of service vehicle fleets will be a source of emissions. These will be accounted for as part of the overall fleet fuel consumption, and will be explicitly modelled as part of the detailed assessment.

In general, transportation-related activities will represent a key source of emissions from combustion of diesel. This will include emissions from general surface transportation, haul trucks, marine ship emissions, and ship loading/unloading. Emissions from air transportation are expected to be intermittent, and effects at the surface will likely be short lived and therefore negligible relative to other transportation-related emissions.

Project activities will have the potential to generate greenhouse gas (GHG) emissions that could affect climate change. These include fuel combustion from power generation, operation of heavy equipment and vehicles, and marine shipping.

7.2.1.3 Potential Mitigation

The Izok Project is fossil fuel intensive, as alternative energy sources do not exist in the area. The combustion of diesel will produce greenhouse gases (GHG) such as carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). Features that have been incorporated into Project design to minimize air quality effects due to combustion of fossil fuels include:

- Low sulphur diesel will be used to reduce emissions of SO_2 and the formation of secondary sulphate particles in the $PM_{2.5}$ size range
- Vehicles and power generation facilities will be regularly maintained to promote efficient operation
- Equipment and vehicle travel patterns will be optimized to minimize fuel consumption and GHG emissions

Several design and operational features have been incorporated into the current Project plans to manage fugitive dust emissions at the mine sites, port and along Izok Road, including:

- Rock coverings (non-acid generating; NAG) will be applied on top of tailings
- Vehicle speed limits will be established and enforced on Project roads
- Hard covers will be installed on concentrate trucks to avoid concentrate loss during transport
- Concentrate will be stored in enclosed facilities at the Izok Mine and the Grays Bay Port
- A covered conveyor with an elephant hose loading chute will be used for loading ships

In addition to these specific design and management features, a Road Management Program (including dust mitigation measures) and an Air Quality Management Plan will be developed for the Project (refer to section 12).

7.2.1.4 Potential Monitoring

The Air Quality Management Plan will detail measures to minimize GHG emissions from Project activities and infrastructure and will outline the air quality monitoring program, including:

- A source monitoring program
- An ambient air quality monitoring program
- Climate monitoring programs at the port and the mine sites, including wind speed and direction

7.2.2 Potential Changes to Noise and Vibration

7.2.2.1 Potential Effects

Project activities during the construction, operations and decommissioning phases have the potential to increase noise and vibration levels in nearby areas. Increased noise and vibration could potentially result in human health effects (i.e., annoyance, sleep disturbance) and/or wildlife effects (disturbance and displacement). Given that the closest permanent community (Kugluktuk) is located approximately 176 km from the Project Development area, any potential noise and vibration effects on humans are expected to be limited to seasonal use of the area.

Underwater noise effects are discussed in relation to marine wildlife (section 7.6).

7.2.2.2 Effects Mechanisms and Linkages

Increases in ambient noise levels and ground vibrations could result in disturbance to both humans and wildlife. The main source of noise and vibrations will likely include:

- Construction: Operation of heavy equipment during site preparation, quarry operations, blasting, construction of Project infrastructure, air traffic and ground transportation
- Operations: Operation of heavy equipment associated with open pit and underground mining, mill operations, loading/offloading of ore, truck traffic related to ore, overburden and waste rock, air traffic, marine vessel use
- Closure: Operation of heavy equipment during removal of infrastructure and reclamation activities

Airborne and ground-based noise and vibration levels will be modelled in relation to any sensitive receptors within the Local Study Area and Regional Study Area, and compared to International and provincial noise and vibration guidelines. The modelling results will also be used to assess potential effects on terrestrial wildlife within the study area.

Construction Phase

Ambient noise levels within the LSA will increase as a result of construction of infrastructure at the Izok and High Lake Mine sites and Grays Bay Port site, as well as road construction and movement of materials between sites. Activities will include, intermittent blasting associated with port, road and mine site preparation, and heavy equipment operation. These are expected to be intermittent and transient sources of noise.

Construction at the port site will involve in-water activities including drilling, blasting, excavation, setting sheet pile and placing of rock fill. These activities will generate short-term increases in noise levels.

Operations Phase

Noise associated with Project operations are expected to be greatest at the Izok and High Lake mines during the early stages of open pit mining. The mill will be fully operational, and all ore processing will be in progress. All major surface mining, milling and ancillary equipment will be housed within buildings. This includes the crushers, rod and ball mills, power generators and ore processing equipment. Attenuation of sound levels will be achieved through prudent equipment selection and building design. The noise characteristics of these sources will be reviewed during the detailed design stage and appropriate noise abatement measures will be implemented, where required.

Operation of service vehicle fleets will be a source of intermittent noise during the operations phases. Transportation of ore and concentrate will introduce a linear noise source along transportation routes between the mine sites and the dock facility.

Marine vessel generated noise will occur along the shipping routes, but this will be infrequent and restricted to two to three months per year during the open-water shipping season.

7.2.2.3 Potential Mitigation

A Noise Abatement Management Plan will be developed for the Project to reduce noise emissions generated by Project facilities and activities (refer to section 12). Mitigation measures that have been incorporated into Project design to reduce construction and operation-related noise include:

- Housing major stationary equipment (e.g., crushers, power generators) in insulated buildings
- Outfitting mobile equipment with appropriate muffler systems
- Following standard operating procedures and regular maintenance schedules for equipment and machinery

7.2.2.4 Potential Monitoring

The Noise Abatement Management Plan will outline a monitoring program that will be implemented throughout the life of the Project to monitor and manage effects of noise emissions (refer to section 12). These programs could include:

- Environmental noise monitoring at the Project sites
- Ambient noise surveys conducted at a distance from sources to determine the need for further noise mitigation

7.3 Hydrogeology

7.3.1 Potential Changes to Hydrogeology

The Izok Corridor Project is located within a continuous permafrost region, where permafrost extends to a depth of more than 300 m at the Izok Mine and to 440 m at the High Lake Mine. Groundwater flow occurs in the seasonal shallow active layer above the permafrost, within taliks and beneath the permafrost. Shallow groundwater flow only occurs in the summer months within the thawed active layer, which typically varies in thickness between 1 and 8 m. Bedrock geology, permafrost and lake taliks play a critical role in defining the deep groundwater flow system.

Project activities at the Izok Mine and High Lake Mine have the potential to result in changes to groundwater flow and groundwater quality.

7.3.1.1 Potential Effects

Key issues related to groundwater include:

- Changes in groundwater levels and groundwater flow patterns from dewatering and subsequent flooding of Izok Lake, open pits and underground mines
- Changes in shallow and deep groundwater quality from discharge of waters from the open pit and underground mines during post closure
- Changes in shallow and deep groundwater quality from discharge of waters affected by acid rock drainage (ARD) and metal leaching (ML) from waste rock and tailings to the shallow and deep groundwater system

- Changes in shallow groundwater and surface water quality from discharge of treated groundwater to surface waterbodies

Potential effects of spills of fuels, waste oil, reagents, concentrate, lime/cement and blasting reagents/residues on shallow groundwater quality can be mitigated through the use of best management practices or engineering designs that have been well developed and tested at similar sites.

Landfills and landfarms have been designed, constructed and monitored in northern environments for many years. The potential for these to affect groundwater is primarily through effects on shallow groundwater quality as a result of leachate migration. Any landfills constructed to manage solid waste or landfarms to manage contaminated soils will utilize proven designs and management plans to minimize the potential for Project-related effects on soil and groundwater.

7.3.1.2 Effects Mechanisms and Linkages

Mine Dewatering

Because groundwater levels and surface water levels are linked through lake taliks, dewatering of the open pits and underground mine workings and dewatering of Izok Lake has the potential to reduce groundwater and surface water levels and affect groundwater flow patterns during the construction, operation and post-closure phases of the Project.

As mining at the Izok Mine will not be in permafrost due to the deposits lying within the talik beneath the existing lake, groundwater inflows into the open pit and underground mine are expected to occur. At High Lake, the AB and D open pit mines will be largely developed in permafrost, and only negligible groundwater inflows are anticipated. Although no substantive inflow of groundwater is expected to occur in the upper part of the West Zone underground mine, inflows are expected to occur below 400 m.

Following closure, it is anticipated that groundwater and surface water levels will return to pre-mining levels and pre-mining groundwater flow patterns will largely be restored. This will be confirmed using a three-dimensional digital groundwater flow model for both the Izok and High Lake mines.

Mine inflow water quality may be affected by ARD reactions on the mine walls, blasting residuals, sediment and possibly minor hydrocarbons from mining equipment. These groundwater inflows will be captured in the open pit and underground mine sumps, and will be pumped to the water treatment facility (along with any surface water inflows) for treatment prior to discharge or reuse.

Discharge of Waters from Flooded Mine Workings

During the post-closure period, the Izok Lake basin including the open pits and Inukshuk underground mining operation will be flooded by groundwater and surface water inflows. Over time, pit lakes are expected to develop in the AB and D pits, but they will not be connected to the deep groundwater system because a through talik is not expected to develop. After groundwater and surface water levels have returned to pre-mining levels, groundwater flow directions will reverse from inward to outward and there is a potential for contaminant movement in the groundwater flow system to receiving water bodies (where there is sufficient permeability/hydraulic connection and no permafrost).

It is possible that water quality will be adversely affected as a result of the interaction between groundwater/surface water and the walls of both the open pit and underground mine workings. During the post-closure and closure phases of the Project, discharge of untreated waters from the open pit and underground mines has the potential to affect shallow and deep groundwater quality.

Future field work and groundwater modelling will attempt to define any potential groundwater pathways for contaminant migration, and provide estimates of potential contaminant loadings and travel times from the tailings facility to surface water resources. The overall effect on the environment as a result of Project activities will be quantified through the development of a site-wide water balance and water quality model.

Discharge of Waters from Tailings and Waste Rock

Waste rock and tailings will be generated during construction and operation of the mines. Waste rock and tailings geochemistry suggests that there is the potential for acid rock drainage and metal leaching (ARD/ML) to affect groundwater and surface water quality in the vicinity of the Izok Mine (tailings and waste rock) and High Lake Mine (waste rock only). Infiltration of precipitation through the waste rock piles and tailings dry stack will produce leachate that will report to both the shallow groundwater system underlying the waste rock piles and the lake talik beneath Izok Lake.

Environmental effects of the discharge of ARD/ML affected waters could begin during construction and extend to the closure phase of the Project if left unmitigated. During construction and operations, the majority of seepage from waste rock piles and the tailings dry stack will report to the open pits at the Izok Mine, or will be collected at the base of waste rock piles at the High Lake Mine. All seepage will be collected and treated to meet discharge standards prior to release to the downgradient receiving environment (Itchen Lake, High Lake or the Kennarctic River). During the post-closure phase of the Project, water levels within the Izok Lake basin are anticipated to recover to pre-mining levels. Lake levels in Izok Lake are anticipated to fluctuate within the NAG waste rock underlying the tailings dry stack. All water within the Izok Lake catchment will be treated until discharge standards are met prior to release to Itchen Lake.

A site-wide water balance and water quality model will be used to assess the potential for any effects on surface and groundwater quality as a result of the Project.

Discharge of Treated Water to Surface Water Bodies

Discharge of treated groundwater to surface water bodies has the potential to affect shallow groundwater and surface water quality. There is the potential that highly saline groundwater will be encountered during development of the Inukshuk underground mine at the Izok Mine. Depending on the lowermost economic mining horizon, groundwater may also be encountered at the West Zone underground mine at High Lake.

Existing literature describing the quality of deep groundwater quality beneath permafrost suggests that the quality of water could be quite variable and highly saline, with substantial concentrations of trace metals. Because deep groundwater from both the Inukshuk and West Zone underground mine is anticipated to be brackish to saline, treatment of these waters will be required prior to discharge to the environment. Treatment of saline groundwater is technically challenging, and will likely produce a large

volume of residual, highly concentrated brine that will also need to be managed. The treatability of large volumes of highly saline groundwater from underground mine workings is poorly understood and will be further investigated as part of the environmental assessment.

7.3.1.3 Potential Mitigation

A Groundwater Management Plan will be developed for the Izok Mine and the High Lake Mine, which will outline adaptive strategies for controlling, collecting and treating groundwater inflows (refer to section 12). Possible mitigation to address potential effects to groundwater is discussed below.

Mine Dewatering

- Where the shallow and deep groundwater systems are connected (lake taliks), the potential for effects on nearby surface water bodies can be minimized through grouting or ground freezing to control any large persistent inflows to the mines. This will be particularly important in areas where any high permeability structures intersect both open pits and adjacent lakes. Ongoing monitoring of permafrost, groundwater levels, lake levels and mine inflows will assist in determining the most effective method of mitigating any large inflows.

Discharge of Waters from Flooded Mine Workings

- By minimizing the volume of waste rock and ore left in the mine workings and implementing measures to minimize the potential for ARD and ML processes, effects on groundwater quality can be mitigated. Groundwater flowing through the bedrock system is anticipated to flow at a very slow rate, and there may be the potential for attenuation of metals and other mine-related compounds along groundwater flow pathways. Travel times from the mine workings along the groundwater flow path to any downgradient receptors are anticipated to be long. Discharge through the surface water pathway will be treated to meet discharge criteria until such time as it is no longer required. Travel times, the potential for attenuation and the potential for effects on environmental receptors will be assessed using geochemical models, groundwater models, a site-wide water balance and water quality model.

Discharge of Waters from Tailings and Waste Rock Facilities

- A progressive closure plan will be implemented for the tailings dry stack and waste rock piles (refer to section 12). This will involve installation of temporary and/or permanent covers to minimize the volume of water that interacts with waste rock or tailings. Permafrost aggradation into the waste rock piles and tailings will also help to minimize infiltration over time. It is anticipated that the final cover will be designed as a thermal cover to minimize infiltration through the tailings mass. By minimizing infiltration, the volume of leachate reporting to the underlying groundwater flow system will also be minimized. Unsaturated groundwater flow will dominate within the tailings dry stack, and infiltrations rates through the tailings are anticipated to be lower than if the tailings mass was maintained at saturation in a flooded state. The tailings dry stack will be constructed on top of a waste rock base at an elevation well above measured levels in Izok Lake to avoid contact between tailings and surface water upon flooding of Izok Lake at closure. Additional mitigation may involve treatment of runoff and seepage from the tailings and waste rock piles, or installation of an

engineered liner or groundwater extraction wells. The need for mitigation measures will be evaluated based on the results of predictive geochemical and groundwater modelling and ongoing monitoring during operations, closure and post closure. The results of monitoring will be incorporated into the adaptive management plan.

Discharge of Treated Water to Surface Water Bodies

- If large volumes of water require treatment to meet discharge limits, a large volume of sludge will be generated, which will require management. Additional investigation is required to confirm the feasibility of treating highly saline groundwater and managing sludge. Prior to developing any mine workings below the base of permafrost, groundwater quality samples will be collected using boreholes drilled from the underground mine workings to verify the quality of any groundwater that may be encountered. Additional permeability testing will also be conducted to help estimate the volume of groundwater that may report to the mine.

7.3.1.4 Potential Monitoring

Monitoring of groundwater levels will be required to determine the potential for effects on nearby lakes and rivers with underlying through taliks, and determine the effectiveness of mine dewatering.

Groundwater quality will be monitored throughout the life of the mine and during the post-closure period to determine effects on the surrounding environment and guide adaptive management. Groundwater quality samples will be collected from the sub-permafrost aquifers prior to mine development to permit characterization of groundwater quality and design of mine water treatment plants as required. Water quality in the pit lakes and underground mines will also be monitored during operations and while flooding during the post-closure period. This information will be used to update the site-wide water balance and water quality model as mine development continues.

Based on the results of the monitoring program, adaptive management strategies will be developed to address any groundwater flow or groundwater quality concerns.

7.4 Freshwater Aquatic Environment

7.4.1 Potential Changes to Surface Hydrology

7.4.1.1 Potential Effects

The Izok Corridor Project has the potential to interact with surface hydrology and affect its spatial and/or temporal distribution. The main Project components or activities that may affect surface water quantity and distribution include:

- Izok Lake dewatering and diversion
- Runoff from waste rock piles or ore stockpiles
- Interception and containment of surface runoff
- Project infrastructure development

- Stream crossings along Izok Road
- Freshwater requirements

7.4.1.2 Effects Mechanisms and Linkages

Izok Lake Dewatering and Diversion

Draining of Izok Lake is necessary to mine the ore beneath the lakebed. This water will be pumped to the water management pond for treatment before being released to Itchen Lake. This represents a one-time change in the fate of Izok Lake water and flow pattern within the Izok Lake outflow channel.

Construction of the Izok diversion channel and diversion dam will affect the spatial distribution of surface water by directing outflow from Iznogoudh Lake into Itchen Lake at a different location, and possibly changing the integrity of the channel as a result of potential exposure of permafrost. Other possible effects include the need to temporarily block inflow to the channel during the operations phase if repair work becomes necessary to maintain/adjust fish passage structures or repair/install erosion protection works, and blockage of inflow due to snow and ice accumulations at the channel entrance.

Surface runoff not contained by the diversion channel will continue to flow into the lake area and will be diverted to facilitate open pit mining within the lake footprint. Non-contact water will be segregated and, when found to satisfy water quality standards, will be conveyed directly to Itchen Lake. Contact water will be diverted to holding ponds, where it will be treated and then released into Itchen Lake. Removal of Izok Lake from the system will likely cause the rates of inflow to Itchen Lake to change. A water balance model will confirm the extent to which changes in surface water flows will occur.

Runoff from Waste Rock Piles and Ore Stockpiles

Runoff from waste rock piles at the High Lake Mine site and waste rock and ore stockpiles at the Izok Mine site will be collected and directed to temporary holding ponds for treatment before release to the receiving environment (High Lake or Kennarctic River, Itchen Lake). A portion of this water will be lost from the system due to wetting of the material surface and freezing within the piles. A model that estimates runoff rates has been developed for High Lake and will also be used for estimating runoff from the Izok Lake storage piles.

Surface Water Management

Interception, collection and conveyance of surface water along road ditches and around mine infrastructure will be required to minimize effects on water quality. As water is held and treated in the sedimentation ponds, there is the potential for the temporal distribution of surface water to be altered, thus affecting water levels, volumes and flow rates. Water management is also likely to change surface flow patterns from the natural surface drainage system. The key risk associated with this is possible erosion of ditches and sediment loading in response to high flows, snow accumulation in ditches or undersized culverts.

Project Infrastructure Development

Site clearing and construction activities at the Izok Mine and High Lake Mine sites will require the dewatering of small ponds and standing water, which can affect surface hydrology. The amount of ponded water that will require dewatering will be estimated to assess potential effects on water volumes and flow rates both locally on site and downstream.

Stream Crossings along Izok Road

Bridge and culvert crossings along Izok Road have the potential to interfere with the conveyance of water through the crossing section. This could have implications for fish passage, particularly at culvert crossings.

Freshwater Requirements

Fresh water will be required for potable water, fire-fighting water, dust suppression and general water needs at the Project sites. Water will be sourced from local waterbodies, which may reduce water levels, volumes and flow rates in the lakes and downstream environment. The maximum rate of diversion and total volume of diversion will be determined for each site to assess potential effects on surface hydrology of the source lakes.

Water withdrawal will also be required for flooding of the winter roads and airstrips. Although use of lake water to flood ice for enhanced thickening will not likely result in substantial changes to lake levels, water diverted to construct ice roads could have an effect on the source streams and lakes.

7.4.1.3 Potential Mitigation

Izok Lake Diversion

Effects of the Izok diversion channel on surface hydrology will be primarily mitigated through engineering design for the Probable Maximum Flood (PMF) event and to minimize potential issues with ice and snow accumulation or permafrost. Adaptive management measures will be implemented as required to maintain diversion channel performance during and after operations.

Surface Water Management

Drainage facilities will be designed (sized) for the 100-year flood event to minimize potential effects on surface hydrology. This will help to minimize risks associated with potential erosion of ditches and sediment loading from high flows or snow accumulation in ditches.

Stream Crossings along Izok Road

Potential effects of bridges and culverts on surface hydrology will be mitigated by adopting the 100-year flood peak for sizing of the openings and designing crossings based on natural flow conditions at each of the road crossings.

Freshwater Requirements

The following features have been incorporated into the design of the Project to reduce the amount of fresh water that will be withdrawn from the source lakes for use at the Izok Mine site (Itchen or Iznogoudh lakes) and High Lake Mine site (lakes 4, 5 and 15; refer to Figure 2.5-3).

- The process plant at Izok will recycle water and makeup water will be predominantly from other parts of the mine site (e.g., open pit water, mine groundwater inflows and settled surface runoff).
- Contact water will be recycled for use in the crushing and screening plant and other operations at the Izok and High Lake mines.
- Contact water will be treated in an effluent treatment plant at the High Lake Mine site and re-used at the site.
- Winter road construction will conform to DFO's protocol for winter water withdrawal such that no more than 10% of the under-ice volume will be withdrawn from a source lake during one ice-covered season.

7.4.1.4 Potential Monitoring

Potential monitoring of surface hydrology at the Project sites could include the following.

- Continued operation of selected baseline hydrometric stations
- Installation of water level recorders at prescribed locations within the water management system at the Izok Mine site
- Maintenance of the climate stations at the High Lake and Izok mines

7.4.2 Potential Changes to Water Quality and Sediment Quality

7.4.2.1 Potential Effects

The Project has the potential to affect water quality and sediment quality through release of contaminated water, transport and deposition of dust, alteration of the natural hydrologic cycle, and alteration of watersheds through land use disturbance. Changes in water quality and sediment quality may affect the ability of the receiving environment to protect aquatic life and to provide a source of safe and secure drinking water.

7.4.2.2 Effects Mechanisms and Linkages

Linkages through which Project activities could affect water quality and sediment quality include:

- Site clearing, snow clearing, contouring for site drainage, and erosion and sedimentation control
- Installation and commissioning of hazardous materials areas including fuel tanks and explosives
- Installation and commissioning of power generation facilities, water intakes and outfalls
- Generation of air emissions including particulate matter, metals and potential acid inputs (PAI)

- Construction and operation of Izok Road including watercourse crossings, borrow sources and site drainage
- Open pit mining operations including dewatering of Izok Lake and mine pits, blasting, stockpiling of waste rock, ore and tailings and alteration of groundwater flows
- Construction of the Izok diversion channel including quality of material within the channel (i.e., potential acid generation and metal leaching), erosion and sedimentation, and rerouting of flows into another basin
- Collection, treatment and release of process and mine water
- Treatment and release of non-mineral waste (domestic wastewater)
- Decommissioning of in-water structures

Mechanisms linking Project activities to water quality and sediment quality are transport of Contaminants of Potential Concern (COPC) through runoff of surface water, seepage to surface water, direct discharge to surface water, and atmospheric deposition.

- Runoff of Surface Water – ground disturbance, dewatering activities, site alteration and spills can result in the mobilization or deposition of trace metals, hydrocarbons and suspended solids to the surface of the ground or to snow. Subsequent rainfall or snowmelt may carry these materials to surface waters.
- Seepage to Surface Water – precipitation falling on waste rock piles or ore stockpiles may mobilize solids, metals or acids, and carry them to surface water through seeps.
- Direct Discharge to Surface Water – Water that comes into contact with Project activities, including domestic sewage and mine site water, at the Izok and High Lake Mine sites will be collected, treated and discharged to surface water. This water may contain trace metals, blasting residues, nutrients, solids, highly saline groundwater and compounds, which consume high amounts of oxygen. These contaminants will be treated to reduce concentrations to levels considered safe to discharge under the terms of the Project Water Licence.
- Atmospheric Deposition – Traffic, blasting and site disturbance will generate dust that may be deposited to fresh water, or to areas that run off to fresh water and carry suspended solids and trace metals into the aquatic environment. Combustion of diesel fuel for power generation and incineration of waste will generate particulate matter, and acid emissions to the atmosphere that could subsequently be deposited to land or surface water.

7.4.2.3 Potential Mitigation

A number of mitigation measures have been incorporated into design of the Project to reduce potential effects on water quality and sediment quality.

- Development of an Izok Lake Dewatering Plan (refer to section 12) that will minimize total suspended solids in surface waters
- Recycling of process and mine water to minimize freshwater requirements and the volume of treated effluent discharged to receiving environments

- Use of holding ponds to collect contact runoff water and allow for suspended sediments to settle before release to the receiving environment
- Dust suppression measures in the Roads Management Program and the Air Quality Management Plan (refer to section 12)
- Enclosed conveyance systems and processing facilities to reduce emission of particulate matter, metals and PAI
- Secondary containment and minimum set-back of tanks, hazardous materials, chemicals, and explosive storage areas from surface water
- Management of potential acid generating (PAG) and non-acid generating (NAG) rock and collection of drainage from waste rock areas
- Use of NAG material at all road watercourse crossings
- Management, placement and collection of runoff from tailings

7.4.2.4 Potential Monitoring

Various monitoring and adaptive management programs may be developed to inform management decisions around mine operations, implement changes in operations as required, and ensure compliance with operational permits (refer to section 12). Possible monitoring programs for surface water and sediment quality could include:

- Monitoring of turbidity in Itchen Lake during release of water from Izok Lake
- Monitoring of the quality of source and treated drinking water supplies for the mine operations
- Regular sampling and analysis of treated effluent prior to release to the receiving environment
- Monitoring of disposition of NAG and PAG rock, stability and thermal status of waste rock piles and runoff and seepage to reduce and manage the potential for ML/ARD
- Development and implementation of an Aquatic Effects Monitoring Program for water, sediments, aquatic life and fish

7.4.3 Potential Changes to Aquatic Organisms and Habitat

The Izok Corridor Project has the potential to cause changes to fish habitat, fish abundance and distribution, and fish health. The assessment will focus on species of interest, including lake trout, Arctic grayling, and Arctic char, as well as changes to fish habitat.

7.4.3.1 Key Effects

Key potential effects of the Project on freshwater fish include:

- Physical habitat loss or alteration from mine footprints, dewatering, road crossing footprint, and sedimentation
- Fish passage alteration or disruption from mine footprints, stream crossing structures, dewatering, and diversion channels

- Reduced habitat quality due to increased sedimentation from mine and road construction, operation and closure, effluent discharge and site runoff
- Reduction in fish health from changes in water quality and sediment quality

7.4.3.2 Effects Mechanisms and Linkages

The primary sources of potential disturbance or effects on freshwater fish and fish habitat are the winter roads, Izok Road and the Izok and High Lake Mine sites. The following highlights potential mechanisms by which construction, operational or closure activities associated with these Project components could result in effects on the selected Key Indicators (KIs).

- Winter Road
  - Winter habitat alteration from water withdrawal from small lakes for road construction
  - Riparian habitat alteration at access points for lakes and river from both road construction and operation
  - Flow and passage alteration in small streams during spring freshet due to ice build-up
- Izok Road
  - Habitat loss from watercourse crossing footprint
  - Fish passage alteration or disruption from watercourse crossing design
  - Change in habitat quality from sedimentation during stream crossing construction, operation and removal
- Izok and High Lake Mine sites
  - Loss of fish habitat from dewatering of Izok Lake and mine-related infrastructure footprint
  - Habitat fragmentation from watercourse diversions and alterations of fish passage at Izok
  - Sedimentation and changes to habitat quality from mine construction, footprint, reclamation and removal
  - Habitat loss from the water intake and effluent diffuser footprints
  - Habitat loss and alteration from water withdrawals and use at the mine sites
  - Changes in habitat quality and fish health from camp and mine effluent discharge, mine site runoff and dust deposition (e.g., sedimentation, increased metal concentrations, increased nutrient concentrations)

7.4.3.3 Potential Mitigation

The following includes some of the possible mitigation measures that could be employed to reduce or eliminate Project-related effects on freshwater fish and fish habitat.

- Winter Road
  - Follow DFO guidelines regarding water withdrawal from small lakes for winter road construction
  - Notch the ice crossing on small streams to encourage faster melting of ice build-up during early spring

- Izok Road
  - Minimize the number of stream crossings
  - Design crossings to allow for fish passage
  - Implement sediment and erosion control measures during construction
- High Lake Mine
  - Manage, capture and treat mine site runoff and mine-related effluent as required to achieve regulatory standards before release to the receiving environment
  - Implement the dust control measures in the Roads Management Plan and the Air Quality Management Plan (refer to section 12)
- Izok Mine
  - Design the Izok channel diversion such that fish passage is maintained and spawning habitat and rearing habitat is provided
  - In accordance with DFO's Fresh Water Intake End-of-Pipe Fish Screen Guideline (DFO 1995), design freshwater intakes and fit with appropriately sized fish screens to prevent potential losses of fish due to entrainment and impingement
  - Develop fish habitat compensation in consultation with local Inuit communities, DFO, and other regulatory agencies for loss of fish habitat in Izok Lake
  - Plan and implement pre-development fish salvage from Izok Lake in consultation with DFO and local Inuit communities

7.4.3.4 Potential Monitoring

An Aquatic Effects Monitoring Program will be developed to guide construction, operation and closure of the Project, and will outline study design, monitoring schedules, methods and reporting procedures (see section 12).

7.5 Terrestrial Environment

7.5.1 Potential Changes to Terrain

7.5.1.1 Potential Effects

The Izok Corridor Project has the potential to affect terrain through changes in permafrost conditions and terrain stability due to vegetation clearing, changes in slope and changes in surface and subsurface flow.

Construction of Project components and infrastructure could also cause a change in terrain and landforms due to disturbance of permafrost sensitive landforms and uncommon landforms (e.g., eskers), which may support valuable terrestrial ecosystems and contribute to biodiversity.

7.5.1.2 Effects Mechanisms and Linkages

Change in Permafrost and Terrain Stability

Site preparation, excavation, contouring and construction of both on-land structures (i.e., buildings, airstrips and roads) and in-water and shoreline structures (i.e., freshwater diversions, dykes, berms, collection ponds, water crossings, effluent pipelines and dock site) could induce changes in the permafrost regime and affect terrain stability. These effects could in turn cause slope instability, shoreline erosion, slides, rock falls and slumping in surficial deposits and bedrock.

During closure of the Project, removal of site pads and infrastructure, freshwater diversions and surface drainage containment could affect terrain and the permafrost regime, as a new shallow permafrost regime and terrain slope may be re-established at these locations. Shallow permafrost condition and the stability of terrain could also be affected due to disturbances during closure of the Project.

Change in Landforms

Construction of infrastructure, including roads, airstrips and foundations, as well as borrow source quarrying will result in ground surface disturbance, which could lead to the loss of landforms.

Construction and operational activities will also cause changes in surface and subsurface water systems and the shallow thermal regime, which could result in changes in permafrost conditions and loss of permafrost sensitive landforms.

7.5.1.3 Potential Mitigations

The following mitigation measures could be implemented to reduce potential effects of the Project on the permafrost regime and terrain stability.

- Use coarser materials for road construction to minimize frost effects
- Manage drainage around infrastructure to reduce deep pools of water at the surface
- Insulate infrastructure, where feasible
- Minimize surface disturbance in high ground-ice areas to reduce potential for deepening the thaw depth and associated thaw settlement
- Place culverts or other drainage structures where the road crosses surface drainages
- Undertake construction activities in sensitive areas during winter whenever feasible
- Monitor the Izok Road to ensure that signs of permafrost degradation, erosion or mass movement are quickly identified and mitigated by appropriate surface cover, drainage and erosion control measures

Potential Project effects on permafrost sensitive and uncommon landforms may be mitigated through Project design as well as specialized measures, including:

- Consider local and regional climatic conditions, and the presence and expected changes to permafrost terrain in Project design

- Avoid uncommon landforms (eskers, wetlands and shoreline areas) and steep terrain where possible
- Minimize cut width or disturbance through eskers, wetlands and shoreline areas
- Reduce the use of glaciofluvial landforms during mine infrastructure construction

7.5.1.4 Potential Monitoring

Monitoring of terrain stability and landforms could include establishment of a Thaw-Depth Monitoring System including routine field inspection to monitor landform changes.

7.5.2 Potential Changes to Soils

Soil quality, measured in terms of nutrient and elemental composition, could be altered by deposition of dust or runoff. Soil quantity (i.e., extent and depth of soils) could be altered by removal, disturbance, replacement or burial of soils.

7.5.2.1 Potential Effects

Soil quality could be adversely affected by potential acid inputs (PAI) from air emissions, stockpile runoff and fugitive dust deposition (e.g., metals) during all phases of the Project. Potential changes in soil quality could also occur due to compaction, admixing and erosion during construction and operational activities.

Potential changes in soil quantity could occur due to topsoil stripping, surface soil erosion, soil movement and burial during construction activities.

Reduced soil quality and quantity could affect reclamation activities associated with soil placement and vegetation occurrence at closure.

7.5.2.2 Effects Mechanisms and Linkages

Soil Quality

Air emissions from the combustion of fossil fuels could introduce acidifying compounds (i.e., sulphur dioxide [SO_2] and nitrogen dioxide [NO_2]) to soils, which could lead to soil acidification or contamination. The largest sources of PAI would be power generation from diesel generators, use of industrial machinery and equipment and the milling process. Soil acidification resulting from long-term deposition of acidifying substances could result in lower soil pH, a decrease in base saturation and increase in aluminum bioavailability. Such changes in soil chemical properties have been shown to adversely affect nutrient cycling and decomposition processes by changing microbial community populations and soil function.

Exposure of waste rock and tailings to air and precipitation runoff could also result in the generation of ARD and/or increased release of metals into the surrounding environment, which could lead to deterioration of soil quality.

On-land construction, mining, milling, transportation and on-land decommissioning will generate dust, which could potentially change the pH and nutrient regime of soils. Fugitive dust from storing, handling or transporting the concentrate could introduce metals in the form of particulates into the air, which could be deposited on soils and vegetation away from their source.

Soil admixing and erosion could occur during excavation and construction, stockpiling and decommissioning of Project infrastructure. Admixing of the soil layers could affect soil quality by causing changes in soil texture and structure, as well as diluting organic matter and organic carbon, which could adversely influence microbiological activities. Soils stored in overburden piles will be susceptible to erosion due to exposure to climatic events. Erosion of soils could also occur along roadways, stream crossings and facility footprints if areas are denuded of vegetation. A loss of soil from erosion events could affect revegetation efforts following replacement of soils from the stockpile over disturbed areas.

Soil compaction could also occur due to movement of heavy equipment or repeated movement of lighter equipment, as well as placement of heavy materials on top of the soils. Soil compaction influences structure, drainage, porosity, and susceptibility to erosion, which could reduce the ability of vegetation to become established.

Soil Quantity

Loss of soil could occur as a result of site preparation for on-land, in-water and shoreline structures (i.e., freshwater diversions, dykes, berms, collection ponds, water crossings, effluent pipelines and dock site), which requires soil salvage and storage. Soils disturbed during construction of Project infrastructure and quarry sites, as well as waste and overburden stockpiles will be susceptible to erosion due to their exposure to climatic events such as wind, precipitation, or water flow over a surface.

7.5.2.3 Potential Mitigations

A number of mitigation measures have been incorporated into design of the Project that will reduce Project-related effects on soil quality and quantity.

- Industrial machinery and equipment and diesel-powered generators will meet federal air emission standards
- NAG waste rock will be used for construction
- Low sulphur diesel will be used to reduce SO_2 fumigation
- Dust suppressants will be used to control of dust dispersion at the mine sites and along Project roadways
- Speed limits will be imposed on Project roads to reduce airborne dust from vehicles and equipment
- Rock covers will be installed on mineral waste piles as early as possible to minimize dust generation
- Conveyance systems and processing facilities will be enclosed to reduce emission of particulate matter, metals and PAI
- Disruption and compaction of soil will be minimized by limiting the area of land disturbance
- Use of frozen lake surfaces along the winter road route will be maximized

- Soil erosion will be prevented by constructing freshwater diversions to divert surface drainage around the mine site
- Soil transport will be minimized by selecting location for stockpiles that will reduce haul distances

7.5.2.4 Potential Monitoring

Monitoring for potential changes in soil quality and soil quantity could include conducting regular checks of overburden piles for signs of soil erosion.

7.5.3 Potential Changes to Vegetation

7.5.3.1 Potential Effects

The Izok Corridor Project has the potential to cause changes in the cover, composition, distribution and diversity of vegetation on the landscape, and the health of vegetation.

7.5.3.2 Effects Mechanisms and Linkages

Key Project activities and mechanisms by which effects on vegetation could occur include:

- Vegetation clearing, surface disturbance, flooding, burial and compaction, which could cause a direct loss of vegetation
- Changes in substrate composition, moisture and temperature, which could indirectly affect vegetation
- Alteration of local hydrology, which could result in changes to upstream and downstream plant communities
- Air emissions and dust deposition, which could affect plant health and the composition of vegetation communities
- Introduction of invasive plants through vehicles and materials being brought into the Project area

The potential for changes in vegetation would be greatest during the construction phase of the Project when plant cover will be removed and disturbed due to building of infrastructure.

7.5.3.3 Potential Mitigation

In addition to the Project design features outlined for soil (refer to section 7.5.2.3), the following measures could also be implemented to minimize direct effects on vegetation.

- Restricting winter road use to frozen ground conditions
- Ensuring all equipment is cleaned and weed free prior to transportation to the Project to reduce potential for introducing exotic invasive plants to the region

7.5.3.4 Potential Monitoring

Possible vegetation monitoring includes monitoring of Project reclamation and revegetation progress and implementing adaptive management to address problem areas.

7.5.4 Potential Changes to Wildlife and Wildlife Habitat

7.5.4.1 Key Effects

Key potential Project effects on wildlife and wildlife habitat include change in habitat availability, change in injury or mortality risk, and disruption of movement patterns and distribution.

7.5.4.2 Effects Mechanisms and Linkages

Animals may interact with the mine during normal movements within their home ranges, or through attractants such as food, waste and shelter. Human-wildlife interactions may lead to a wildlife incident resulting in injury or death (an incident is defined as any wildlife interaction that requires a response by mine personnel, such as deterrent or avoidance action). Injury or death may occur as a result of vehicle wildlife collisions, destruction of dens, nests and/or burrows, interactions with development infrastructure, lethal control of problem wildlife, and from contaminants.

Development can affect habitat directly where the habitat is no longer available or accessible to wildlife or indirectly where the habitat is still accessible but altered such that its use by wildlife is affected. Direct habitat loss is most effectively evaluated as potential Project effects on vegetation (wildlife forage) and landforms (e.g., eskers as den site habitat). Potential Project-related sources of habitat loss are the same as described for terrain (section 7.5.1.2) and vegetation (section 7.5.3.2). A reduction in functional habitat may result from Project-related activities that displace wildlife from an area, thus reducing its overall effectiveness as suitable habitat. This may include activities such as blasting, vehicle and aircraft noise, and human presence near key habitat areas (e.g., calving areas).

Corridor placement (e.g., haul routes and airstrips), mine and facility placement, and noise emissions may disrupt movement patterns and result in changes in wildlife distribution. Project-specific sources that may affect wildlife movement include vehicle and air traffic, Project infrastructure (roads, port site, camps, airstrips, equipment storage and stockpiling areas), and Project surface disturbance (open pit mine). Both daily and seasonal movements may be affected. Indicators for examining the permeability of the proposed roads will include the distribution and crossing rate of caribou tracks encountering the roads.

7.5.4.3 Potential Mitigation

A Wildlife Mitigation and Monitoring Plan will be developed for the Project based on lessons learned from other Arctic projects, and will incorporate traditional knowledge and input from other stakeholders (refer to section 12.2.2.11). The plan will present mitigation and management policies, and effects monitoring study designs and procedures to reduce potential Project-related effects on wildlife and wildlife habitat.

Since Project-related effects mechanisms and linkages are similar for most wildlife species and habitat within the RSA, the following mitigation measures are generally applicable to addressing effects to a number of species. Some possible species-specific mitigation measures are outlined below.

Wildlife Habitat

- Restrict the mine surface footprint to the smallest area necessary, and limit habitat change with a compact design
- Restrict the road to the shortest possible route, and maximize the use of frozen lake surfaces along the winter road route
- Assign designated areas for storing materials that avoid sites such as vegetated areas or water bodies
- Limit disturbance near riparian areas and lakeshores, and avoid sensitive and unique wildlife habitat, where practicable
- Remove infrastructure and reclaim roads and airstrips upon closure to minimize duration of potential wildlife effects

Wildlife Incidents and Mortality

- Provide wildlife awareness and sensitivity training (especially bear awareness training) for all on-site personnel to familiarize them with an ecologically responsible code of ethics regarding wildlife and wildlife habitat
- Report all wildlife incidents immediately
- Where appropriate, use an electric or non-electric fence in selected areas to exclude wildlife
- Inspect the airstrip for wildlife prior to take-off and landing of all aircrafts
- Design buildings to discourage their use by animals for shelter
- Use signs and radios to warn drivers when wildlife, especially caribou, is present in an area
- Enforce speed limits on Izok Road and winter roads
- Vehicle operators to yield to wildlife crossing on roads, be vigilant in watching for wildlife near roads, and take all reasonable measures to avoid vehicle-wildlife incidences
- Install wildlife crossing signs at high frequency wildlife crossing areas or in areas where animals are found to reside near roads
- Implement and enforce a Waste Management Plan to minimize the presence of attractants such as garbage and waste food (refer to section 12)
- Immediately report problem wildlife, any dens or nests, or substantial mine-related wildlife incidents immediately to the appropriate authorities

Wildlife Movements and Distribution

- Reduce noise by use of muffled exhaust systems and meet emission guidelines
- Adhere to prescribed airflight corridors and altitudes near known concentrations of wildlife
- Restrict vehicles to designated roads and prepared work areas only

Caribou

The following mitigation measures are specific to reducing potential collisions and subsequent caribou mortalities along transportation infrastructure and within Project facilities, and minimizing sensory disturbance and restrictions to movement of caribou and other ungulates within the RSA. Many of the general mitigation measures outlined above pertain to caribou and other ungulates.

- Establish a caribou (ungulate) alert system to immediately warn personnel of the number and location of ungulates
- If a group of caribou is observed in the vicinity of construction or operation activity, implement and monitor traffic activity controls
- Deter caribou from hazardous areas

Grizzly Bear and Wolverine

Wildlife mitigation, waste management, and mine personnel education will be proposed to minimize effects of the Project on grizzly bears and wolverine, and to reduce the possibility of bear-human interactions.

7.5.4.4 Potential Monitoring

Wildlife Habitat

A discussion of possible programs for monitoring direct and indirect habitat loss is provided in the following sections for selected species.

Caribou

The broad objectives of caribou monitoring would be to determine whether the Project is adversely affecting the abundance, distribution and behaviour of caribou, and harvest of caribou within the RSA. To address these objectives, monitoring could include:

- Regular aerial surveys to document caribou numbers, distribution, and group composition in the RSA
- Ground-based surveys of caribou snow tracks along Izok Road and winter roads
- Scanning observations of caribou from the ground to document caribou behaviour and group composition in the RSA
- Documentation of caribou sightings and interactions by Project personnel in a wildlife log for the Project
- Conduct interviews and surveys in Kugluktuk, Umingmaktok and Bathurst Inlet or with GN DOE wildlife staff to document hunter activity in the RSA

Grizzly Bear and Wolverine

Monitoring will be undertaken to determine whether the Project is affecting the abundance and distribution of grizzly bears and wolverine within the RSA. This could include the following.

- Continued hair-snagging, DNA monitoring Conduct aerial transect surveys to document grizzly bear and wolverine sightings incidental to ungulate monitoring in the RSA
- Conduct observations of grizzly bear and wolverine interactions with development infrastructure within the LSA

7.5.5 Potential Changes to Birds and Bird Habitat

7.5.5.1 Potential Effects

Project activities during construction, operation and closure have the potential to adversely affect the distribution, abundance and health of bird populations in the RSA. Potential effects include:

- Sensory and auditory disturbance from mining activities and road traffic to nesting and breeding birds, potentially leading to nest abandonment
- Increased risk of injury or mortality of birds as a result of attraction with lighting on mine facilities and collisions with infrastructure
- Direct habitat loss from site clearing for Project roads and infrastructure

7.5.5.2 Effects Mechanisms and Linkages

Raptors

Raptors are susceptible to disturbance during the breeding season, especially early in the season prior to the initiation of nesting and early in the brooding period (typically May and June, depending upon the species). Construction and operational activities (including road traffic) could cause sensory disturbance of incubating or brooding adults at nest sites close to these activities, which could result in reduced nest productivity.

Waterfowl

The Project has the potential to cause both direct and indirect effects on waterfowl. Construction activities could result in the direct habitat loss, while disturbance from construction and operational activities could cause disturbance to waterfowl in the vicinity of the mine sites and affect waterfowl breeding success and energetics.

Upland breeding birds

Although the zone of influence of Project disturbances will likely be limited to less than 300 m to 400 m (Smith et al. 2005), some disturbance (primarily from direct loss of habitat) could occur on and near the Project disturbance footprint.

7.5.5.3 Potential Mitigation

Raptors

In addition to the general mitigation measures outlined in section 7.5.4.3, the following measures could be implemented to minimize disturbance to peregrine falcons and other cliff-nesting raptors.

- Develop a nest-specific management plan for active raptor nests identified within 1.6 km of the footprint
- Avoid disturbance to nests during the early part of the nesting cycle (late May through to early July, depending on the species) to minimize the risk of nest site abandonment
- Discourage nesting of raptors on artificial structures, pit walls, or other facilities

Waterfowl

Although waterfowl are not common on inland lakes and rivers in the Izok Corridor Project area, they are susceptible to displacement from high levels of human disturbance. Specific measures for waterfowl could include the following.

- Avoid known habitats of waterfowl in development areas, wherever and whenever possible
- Conduct land clearing in potential waterfowl habitat outside of the waterfowl breeding season unless a systematic nest survey by a qualified wildlife biologist has determined that no waterfowl nests are present
- Avoid activities and disturbances within occupied waterfowl nesting areas
- Prevent waterfowl and loons from landing or nesting on mine infrastructure and man-made ponds (e.g., tailings and reclamation), and use aversion tactics if necessary
- Develop a nest-specific management plan for all active waterfowl nests found within 200 m of development activities or in areas slated for clearing during the breeding season

Upland breeding birds

In addition to the above general measures and those outlined in section 7.5.4.3, the following mitigation measures also apply to upland breeding birds.

- If windows, transmission lines, or other structures or components of buildings result in bird collisions and death, implement deterrent measures such as placement of streamers on wires
- Make efforts to prevent upland birds from nesting on mine infrastructure

7.5.5.4 Potential Monitoring

Raptors

Raptor monitoring could be used to determine whether the Project is affecting the distribution, occupancy rate, or productivity of raptors. Although the territories of all raptors would be monitored

during such surveys, the peregrine falcon would be the focal species because it is most numerous and is a listed species.

Waterfowl

Waterfowl monitoring may be implemented to determine if the Project is adversely affecting the abundance and distribution of waterfowl and nesting habitat through early summer nesting surveys around wetlands and waterbodies.

Upland breeding birds

Breeding bird monitoring may be implemented to determine if the Project is adversely affecting the density, diversity and species richness of upland breeding birds through stratified breeding bird surveys using an area-search, plot-based (PRISM) protocol.

7.6 Marine Environment

7.6.1 Potential Changes to Marine Water and Sediment Quality

The Izok Corridor Project has the potential to affect marine water quality and sediment quality at the proposed Grays Bay Port and, in turn, the health of marine organisms.

7.6.1.1 Potential Effects

Key Project activities or mechanisms through which effects on marine water and sediment quality could occur include:

- Fugitive dust from blasting, dredging and land clearing during construction
- Fugitive dust from handling and loading of the concentrate into ships during operations
- Discharge of contact water from the port site
- Discharge of brine from the desalination plant
- Accidental spills of concentrate, petroleum or other hazardous materials

7.6.1.2 Effects Mechanisms and Linkages

Construction Activities

Construction of the Grays Bay Port will entail periods of blasting and dredging of rock, which could result in an increase in turbidity and sedimentation of marine habitat. In addition, clearing of land during construction of the port has the potential to increase suspended sediment concentrations in the marine environment through site runoff.

Although the marine environment of Grays Bay often experiences elevated levels of suspended sediments from silt-laden plumes from large river systems, increases attributable to construction activities could at times exceed natural levels.

Increased suspended sediment levels from construction activities could also result in elevated total metal levels within the water column for a period of time before the sediments settle out.

Atmospheric Deposition

Traffic, blasting, site disturbance and handling of concentrate at the port will generate fugitive dust that may be deposited in the marine environment and could potentially cause elevated metal levels in water and sediment within Grays Bay.

Discharge of Brine from Desalination Plant

Potable water at the Grays Bay port will be produced in a water desalination treatment plant using sea water as feed. Salts removed during the desalination process will be discharged back to the marine environment as a high salinity brine.

Discharge of Contact Water

Water that comes into contact with Project facilities and activities may contain trace metals, blasting residues and other contaminants.

7.6.1.3 Potential Mitigation

The following mitigation has been incorporated into Project design to reduce potential effects on water quality and sediment quality in Grays Bay.

- Sediment and erosion control measures will be implemented during construction and operation, including diversion ditches, silt traps, silt fences and settling ponds
- water collected in the settling pond, will be tested for contaminants prior to treatment and/or release to the marine environment
- Use of an enclosed concentrate storage shed with dust filters
- Use of enclosed conveyors for movement of concentrate from the storage shed to ship loaders
- Development of a spill contingency and emergency response plan for potential spills at the port (refer to section 12)

Other possible measures to mitigate Project effects on the marine environment in Grays Bay might include:

- Use of silt curtains or other means during blasting and dredging
- Use of a diffuser for discharge of desalination brine

7.6.1.4 Potential Monitoring

Water and sediment quality monitoring programs might include:

- Turbidity monitoring in Grays Bay during construction
- Water and sediment quality monitoring in the immediate vicinity of the port

- Effluent monitoring during construction and operations to assess discharge water quality

7.6.2 Potential Changes to Marine Aquatic Organisms and Habitat

7.6.2.1 Potential Effects

Key potential effects of the Project on marine fish include:

- harmful alteration, disruption or destruction (HADD) of fish habitat
- change in health, distribution or size of arctic char populations
- increased risk of fish mortality

The primary sources of disturbance to marine fish and fish habitat will be underwater blasting and dredging during construction, possible infilling of part of the shallow bay between the dock and the concentrate storage shed, presence of the dock, and accidental spills of concentrate, petroleum or other hazardous materials. Arctic char has been selected for assessing these potential effects due to the importance of this species for subsistence harvesting.

7.6.2.2 Effect Mechanisms and Linkages

Direct loss of fish habitat will occur within the dock footprint and any filled portion of the shallow bay. Alteration or disruption of fish habitat (including substrate and sessile organisms) could occur around the dock site as a result of turbidity and sedimentation from blasting and dredging, and potential accidental spills of concentrate, petroleum or other hazardous materials. These disturbances could also result in changes in the health, distribution or size of arctic char populations in the Grays Bay area. Construction noise caused by underwater blasting could also result in direct mortality of fish.

7.6.2.3 Potential Mitigation

All blasting operations will be carried out in accordance with applicable guidelines and regulations, and the details will be agreed with DFO at the *Fisheries Act* authorization application stage. Authorization for harmful alteration, disruption, or destruction (HADD) of fish habitat will be obtained from the Minister of Fisheries, and a No Net Loss Plan will be prepared and implemented. Habitat enhancement will be applied to achieve no net loss (refer to section 12).

Other possible mitigation measures include:

- Use of rock fill for the dock that is free of fine materials to minimize increases in turbidity and sedimentation
- Use of a bubble curtain system around the blasting area to minimize injury or mortality to fish
- Use of lined fuel tank farms to minimize the risk of an accidental diesel release

7.6.2.4 Potential Monitoring

An environmental effects monitoring (EEM) program will be developed to monitor the marine receiving environment and determine whether project discharges have any effects on infaunal benthos.

7.6.3 Potential Changes to Marine Mammals

7.6.3.1 Potential Effects

Key potential effects of the Project on marine mammals include:

- Change in behaviour and distribution
- Increase in hearing impairment
- Increased risk of injury or mortality

The primary sources of disturbance will likely be underwater noise created by construction activities (underwater blasting, dredging, and pile driving) in Grays Bay, and underwater noise generated by Project vessels along the shipping routes. The presence of the large vessels travelling at speed is also expected to be a source of disturbance to some marine mammals.

Key indicator species selected for assessing potential Project effects in Grays Bay include ringed seals and beluga whales. Beluga whale, narwhal, bowhead whale, polar bear and possibly other species will be the focus of the effects assessment for the marine shipping component of the Project.

7.6.3.2 Effect Mechanisms and Linkages

In-water construction activities at Grays Bay (blasting, dredging) will generate underwater noise that could result in avoidance of the area by ringed seals in spring and/or summer and by belugas in summer. Avoidance would likely be temporary, during and shortly after the construction activities. If ringed seals or belugas were sufficiently close to the sound sources, hearing impairment could potentially occur. Noise or other disturbances during ringed seal pupping in early spring could startle pups to the extent that they enter the water and suffer hypothermia. Underwater blasting could also cause injury or mortality of ringed seals (in spring or summer) or belugas (in summer) if they are in close proximity to the dock site when blasting is taking place.

Underwater sound generated by marine vessels along the shipping routes could result in changes in distribution of marine mammals due to avoidance behaviour. Also, a collision between a bulk carrier moving at speed and a marine mammal could result in serious injury or direct mortality. Large, slow-moving whales such as the bowhead whale are particularly susceptible to collisions, especially while socializing.

7.6.3.3 Potential Mitigation

All blasting operations will be carried out in accordance with applicable guidelines and regulations (e.g., DFO's "*Guidelines for the Use of Explosives in or near Canadian Fisheries Waters*"), and subject to discussion with DFO.

An Environmental Monitor will be on site during all construction activities. Before commencing with underwater blasting or dredging, the Environmental Monitor will assess the area for marine mammal presence. If a marine mammal enters the area during underwater blasting, dredging or pile driving, the activity will be suspended until the animal has left the area.

Other possible mitigation measures include:

- Use of either a long-stick backhoe or a clamshell dredge, which produce less noise than suction or cutter suction dredges
- Use of a bubble curtain system around the blasting area to minimize sounds produced during underwater blasting

Mitigation measures will be employed to reduce the risk of Project-related vessel-mammal strikes. Possible measures include speed restrictions in sensitive areas, maintenance of a constant course, and use of onboard marine mammal observers (MMOs). In general, all Project vessels would steer a straight course, maintain constant speed, and avoid sudden changes in speed or direction whenever possible.

7.6.3.4 Potential Monitoring

Onboard monitors would record marine mammal and other wildlife sightings, ice conditions and wildlife behaviour, including near-misses and incidents of vessel strikes with marine mammals.

7.6.4 Potential Changes to Marine Birds

7.6.4.1 Potential Effects

Key issues related to potential effects of the Project on marine birds and marine bird habitat include changes in distribution, abundance, and health. Responses to disturbance vary from behaviours of alertness and vocalizations, temporary cessation of incubating or brooding, to nest site abandonment (K. Poole, AWR, personal observations).

7.6.4.2 Effects Mechanisms and Linkages

The Project could cause both direct and indirect effects on marine birds. Construction of the dock facilities could result in direct habitat loss. Disturbance from shipping traffic could result in changes in distribution and use of foraging and nesting habitat. Wake activity from passing ships could also change shoreline nesting and foraging habitat.

Indirect effects of the Project on seabirds could result from human activity during both the construction and operational phases, which could have an adverse effect on breeding success and energetics.

7.6.4.3 Potential Mitigation

Marine birds occur in moderate numbers along the coast near Grays Bay and the proposed dock site. Marine birds are susceptible to displacement from high levels of human disturbance. Specific measures to mitigate Project-related effects could include the following.

- Avoid known habitats of seabirds in development areas, wherever and whenever possible
- Develop a nest-specific management plan for all active seabird nests found within 200 m of development activities or in areas slated for clearing during the breeding season
- Establish flight corridors and minimum aircraft cruising altitudes to avoid known concentrations of seabirds

7.6.4.4 Potential Monitoring

Seabird monitoring may be undertaken to determine whether the Project is adversely affecting the abundance and/or distribution of seabirds in important habitat areas along the coastal portion of the RSA.

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SECTION 8

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8 POTENTIAL PROJECT SOCIO-ECONOMIC AND CULTURAL EFFECTS

8.1 Socio-economic Environment

8.1.1 Key Issues and Concerns

Community consultation undertaken in April and May of 2012 (refer to section 3) revealed that residents of the Kitikmeot and the regulatory agencies in Nunavut had a number of issues and concerns and positive comments about the proposed Project. Key interests focused on possible opportunities for employment, training and contracting. Residents of Gjoa Haven and Taloyoak were also interested in the shipping aspect of the Project.

8.1.2 Identification of Potential Project Effects

As discussed in section 7.1, preliminary identification of potential Project effects is based on an initial scoping exercise that considered pre-feasibility design for the Project. A detailed assessment of potential socio-economic and cultural effects of the Project and development of appropriate mitigation will be conducted as part of the feasibility study and environmental assessment (EA) phase of the Project and will be presented in the Draft Environmental Impact Statement (DEIS).

Key elements of the initial scoping process include consideration of all Project-related issues identified to date through engagement with regulatory agencies and communities, and identification of potential interactions between the Project and selected Valued Socio-economic Components (VSECs). These are summarized in Appendix B, as contained within NIRB's Project Specific Information Requirements (Part 2 Form). Possible mitigation measures and monitoring for these potential effects are also described below.

8.1.3 Potential Project Effects and Mitigation

Potential direct effects of the Project on the socio-economic environment are largely determined by:

- Employment directly with MMG, or with a contractor
- Payment of royalties, taxes and other forms of compensation
- Changes to the biophysical environment in relation to human activities or perception

The direct socio-economic effects of the Project can be largely and effectively mitigated through measures aimed at managing human resources, protecting public and workers safety, enhancing business development, and protecting traditional land use.

Indirect and induced effects may be related to the response of individuals, families and communities, and governments and other organizations (i.e., Regional Inuit Organizations, Nunavut Tunngavik Inc. (NTI) etc.) to direct Project effects on the socio-economic effects, on the natural environment, and from the Project as a whole.

The interaction between the various effects of the Project will result in various outcomes on community well-being in terms of individual and family wellness, community wellness, and personal security. The manner in which they are managed will determine whether these outcomes are beneficial or adverse.

To this end, the indirect socio-economic effects of the Project can be effectively managed through adaptive approaches and collaborative problem solving such that the desired outcome is achieved. The following section discusses the key potential effects of the Project on the socio-economic environment, and MMG's proposed approach to managing these effects. The section is organized according to the five core assets that collectively form individual and community wellness, which is a reflection of cumulative effects.

Potential effects of the Project on natural assets such as wildlife are not addressed in this section. A discussion of potential effects of the biophysical environment is presented in section 7.

8.1.3.1 Human Assets

Human Assets encompass the skills and knowledge inherent in the community, opportunities for growth and learning, access to skills and knowledge, and access to essential services that are fundamental to maintaining individual, family and community wellness.

The total construction workforce will be approximately 1,140 workers, including management, trades people and labourers taking into consideration shifts and rotation. During the operations phase, the total workforce is estimated to be in the order of 710 people. Given the demand for labour with the Izok Corridor Project, Kitikmeot residents can expect opportunities for employment and chances for developing skills and knowledge.

The Project may indirectly increase the population in some communities and possibly induce increased demands for health, safety, and social services as people may relocate to access jobs. As this will be a fly-in and fly-out (FIFO) operation, major population moves from inside the Kitikmeot region are not expected to occur, but individuals and families from points not part of the pick-up communities may relocate to take advantage of jobs. Decisions to migrate into the region are considered more likely to occur during the early years of operations, as people adjust to opportunities offered by the Project.

The Project demand for labour, particularly trades people, may be a catalyst for more proactive and sustained initiatives by government, other employers, labour groups and educational institutions aimed at establishing a stable, qualified workforce. This may result in the creation of new apprenticeship opportunities that will generate a number of new certified trades people available for the Project itself and/or Nunavut's general labour market and in the communities.

The Project will contribute to the expansion of the skills base over the long term. As such, the Project may also be a catalyst for increased enrollment in post-secondary educational programs that provide degrees or certificates and other training programs that support certification in a skilled trade. MMG is already engaged in a stay-in-school initiative.

8.1.3.2 Economic Assets

The Economic Assets considers opportunities for employment and participation in the economic life of the community and region, including the monetary or financial resources that people and governments use to achieve their economic objectives. It also includes the payment of royalties and other fees that MMG will make to the federal and territorial governments, NTI and the Kitikmeot Inuit Association (KIA). Economic assets are key determinants of economic vitality.

Overall, the Izok Corridor Project is likely to improve the economic assets of various parties across Nunavut and beyond. MMG is planning for local hires and local contractors. This will create new employment and business opportunities in Nunavut.

As a result of these opportunities, community economies may grow. Further, with increasing job experience, education and training, and contracting over time, the Project will enhance the capacity of the labour force overall. MMG's influence will be a sustained demand on the existing labour force and result in increased competition for skilled workers, particularly trades people.

The Project may be a catalyst for increased local and regional economic development during construction, operation and decommissioning, and may attract investment and/or new business operations to the Kitikmeot and Nunavut in general as a result of spending of new disposable income and from MMG's expenditures in the communities.

The benefits of economic opportunities to Nunavummiut and Kitikmeot residents in particular are expected to gain momentum with time. As a result, it is expected that total household income in the Kitikmeot will increase over time and result in lower requirements for income support.

Increased income has potential to cause both beneficial and adverse effects on individual and community well-being. Increased incomes will improve people's financial security and ability to spend. Indirectly, this same increase in ability to spend may reduce the need and interest to participate in traditional non-wage economy. This may have a longer term effect on the transfer of cultural knowledge to family members. This might be countered by community-based programs where they exist.

The financial capacity of various governments and organizations will likely improve as a result of the Project. For example, the Government of Nunavut (GN) is anticipated to benefit from increased personal, corporate and fuel tax revenue generated directly and indirectly by the Project. In addition to the increase in the GN's financial capacity, the NTI will gain royalties from the Project, and KIA will likely benefit from the financial provisions of an Inuit Impact and Benefit Agreement (IIBA) and fees paid for leases related to surface access rights. All together, the implementation of an IIBA and possibly a Development Partnership Agreement (DPA) with the GN could be used to off-set potential Project-related operating costs incurred by communities and the GN.

8.1.3.3 Physical Assets

The Physical Assets consider the basic infrastructure that allows a community to function effectively, through the availability and quality of assets that attract and retain people and investments within a community.

Mining projects have been known to place demands on housing stock and transportation infrastructure. As the Project is located 180 km from the nearest community, Kugluktuk, communities will likely not become hubs for transportation of supplies, goods and equipment. The demand on transport will be to move local workers to the Izok Mine site or the High Lake site. Since the Izok Corridor Project will operate on a FIFO rotational system, it will not likely have a direct measureable effect on housing or transportation infrastructure. Rather, the FIFO system is the primary mitigation to avoid such effects.

8.1.3.4 Social Assets

The Social Assets include traditional and other community activities in which people participate, and the facilities or amenities that they draw upon in pursuit of their personal and community objectives. The cultural, archaeological and paleontological resources of the Inuit people, the traditional activities undertaken on the land and recreational facilities that serve the community help maintain traditional Inuit knowledge, networks within the community and among communities, increase connectivity among people, and generate relationships across generations.

The most direct effects of the Project on social assets may be the loss of access to lands and waters and the physical disturbance to cultural, archaeological and paleontological resources present within or in the vicinity of the mines, road and port facility. The Project may also affect traditional activities through the direct loss of fish and wildlife (Refer to sections 5 and 8.2 for a detailed discussion of potential Project effects on the natural environment and archaeological resources, respectively).

Indirect effects of the Project may also occur as a result of the creation of employment and business opportunities, which may affect traditional activities, as more people participate in the wage-based economy. While increased wage income and rotational work can provide the financial resources and maintain opportunities for harvesting for those who choose to continue their traditional activities; the corollary is that for some individuals there may be less time or desire to practice these activities.

The growing support and commitment among governments, Inuit organizations and others toward the maintenance of traditional culture is expected be a positive influence on the retention of traditional skills, language, values and knowledge over the long term. As a worst case, the Project may reduce traditional activities and knowledge, but will certainly not result in a loss of these social assets. Nevertheless, any erosion of traditional culture can have negative effects on some individuals' sense of well-being, particularly on women and family elders.

Finally, the manner in which the roads, mine sites and related infrastructure are decommissioned and restored during the post-closure phase of the Project has the potential to directly affect traditional activities and the perceptions of environmental quality.

8.1.3.5 Individual and Community Wellness

Individual and community wellness sits at the intersection of the assets. It is the summation of the assets combined and a reflection of cumulative contributions. For example, a reduction of harvesting or sharing of harvest has potential to adversely affect food security. To the extent possible, the synergistic effects that result from direct Project effects will be considered under individual and community wellness.

8.1.4 Socio-economic Effects Management and Benefits Enhancement

The overall goal of socio-economic effects management is to ensure that workers, communities and government organizations adversely affected by the Project have the capacity to cope with change and that MMG's effects management and benefits enhancement facilitate the ability to cope.

MMG will be designing the Izok Corridor Project consistent with its corporate standards (refer to sections 1 and 12 for more details). Relevant to the Izok Corridor Project are its draft standards for local

employment, local procurement, community development, cultural awareness, and heritage and social impact management. These draft guidelines are to be approved before the end of 2012. Extracted from these draft guidelines are the following principles that apply to socio-economic effects management and benefits enhancement measures. These principles include:

1) MMG and all other parties involved in Project implementation will ensure that the safety of the environment and protection of human health are paramount in all decision making.

2) Effects management measures that avoid or reduce the severity of direct adverse socio-economic effects will be the primary focus of MMG commitments. Adaptive management and collaborative problem solving will be the primary approaches for addressing indirect socio-economic effects, be they adverse or positive in nature.

3) Those potentially affected by the Izok Corridor Project will be afforded the opportunity to participate in the design and delivery of the socio-economic effects management measures and participate in collaborative problem solving.

4) MMG shall take reasonable actions to ensure that the services and programs offered by various governments and organizations operating in the Kitikmeot region are not undermined by actions or events directly related to the Project and within the control of MMG.

5) Monitoring and surveillance activities shall be undertaken to assist in continual improvement and adaptive management.

6) Ongoing communications are valuable and important activities. Project-related communications will be open, accurate and timely. Communications will be designed to suit the needs of all Nunavummiut.

7) All mechanisms designed for the delivery of socio-economic effects management will be as accessible, user-friendly, culturally appropriate and non-bureaucratic as possible.

To manage the direct socio-economic effects of the Project, MMG will develop management plans in collaboration with various stakeholders, including a Human Resources Management Plan that is aimed at ensuring compliance with applicable human resources legislation and mining industry standards regarding employment, compensation and benefits.

MMG is also considering adaptive management plans for addressing indirect socio-economic effects. Possible plans that may be developed, depending on the outcome of the effects analysis, include:

- An Employee Well-Being Enhancement Plan: MMG shall develop a plan for providing its employees with access to services that are aimed at enhancing their personal security and family wellness.
- A Community Capacity and Well-Being Enhancement Plan: MMG shall develop a plan for its support of various government and Inuit Organization's initiatives aimed at addressing community capacity and wellness priorities. This plan will include the consideration of a Development Partnership Agreement (DPA) with the GN and related measures.
- Closure Transition Plan: MMG is considering the development of a plan aimed at managing the socio-economic effects likely to be felt towards the end of mine operations and post closure.

8.1.5 Socio-economic Monitoring

The management plans will include provisions for monitoring and surveillance, continual improvement and reporting of results to communities, Inuit organizations, the KIA, Institutions of Public Government, and other interests.

8.2 Archaeological Resources

8.2.1 Potential Project Effects

Ground-disturbing activities associated with Project construction, operation and closure will have direct effects on archaeological resources. Construction and operational-related activities that could have direct effects on archaeological sites include: site clearing, vehicular movements, construction of surface facilities, development and maintenance of all site infrastructure including winter and all-season roads, port (blasting, trenching, grading, backfilling, installation of foundations and supports for surface structures and utilities, drainage alteration) utilities, airstrip, stockpiles, quarries and borrow pits, vehicular movement and excavations related to accidents (spill containment).

Key effects on archaeological resources could be expected to occur primarily during the construction phase. However, ongoing activities associated with the operations phase such as road maintenance, stockpiling, activities at borrow and quarry sites and activities associated with closure also have the potential to affect archaeological resources. Winter roads are generally constructed over low lying level ground and frozen water bodies, and their construction and operation are less likely to affect areas of good archaeological potential. The exception to this is at river crossings and some lake entry and exit points. Borrow sites are generally located on ground moraine and esker deposits, which often have good potential for archaeological sites. Quarries are usually located on bedrock outcrops, which can also have archaeological features, particularly at lakeshores or along water courses. Excavations at these types of locations could damage archaeological resources.

During operations, mining is unlikely to further affect archaeological resources, as long as no additional surface disturbance is planned. Any future additional land requirements must be located with full consideration of archaeological sites.

Archaeological inventories will be conducted at all Project locations that entail ground disturbance, including quarries and borrow sites. They will also be conducted on additional land that would be required for closure activities prior to finalization of the closure plans. Once all proposed development areas have been inventoried, the total site population will be known and those that may be affected can be identified. For each site, factors considered in the assessment are proximity of the archaeological site to development activities, the type of effect expected and proportion of the site to be affected. Using these factors in combination with results of detailed site assessments, mitigation measures will be determined on a site-specific basis.

Indirect effects on archaeological sites could also occur during construction, operation, closure and post closure due to increased numbers of Project personnel engaged in non-project related activities, such as recreation. In addition, improved access to the region from construction of a port at Grays Bay and winter and all-season roads between the Izok and High Lake mines and Grays Bay could also cause an

increase in non-Project related people in the area. Indirect effects could occur close to or at a distance from the development locations and roads.

Improved access and increased use of the area could increase the potential for damage to archaeological sites through increased use of snow machines, all-terrain-vehicles and people walking in the area. This could also lead to a people finding archaeological sites and gathering artifacts. Both of these actions could cause a loss of a site's contextual information.

Effects from Project-related sources would be expected to occur during the construction, operation and closure phases, whereas effects from non-Project related activities would be expected to occur once the transportation infrastructure has been constructed and continue through to the closure phase when the facilities are removed or decommissioned.

8.2.2 Potential Mitigation

Mitigation refers to measures (project design changes, use of best management practices or other measures) that are incorporated into the Project to eliminate or reduce potential effects. There are two types of mitigation measures: mitigation by design and discipline-specific mitigation.

8.2.2.1 Mitigation by Design

The primary mitigation by design measure relating to archaeology is avoidance of archaeological sites or archaeologically sensitive areas by project realignment or redesign. Typically, only minor changes are required due to the limited size and location-specific nature of archaeological sites. This approach eliminates the need for detailed impact assessment and subsequent mitigation actions, as it constitutes adequate mitigation of potential impacts.

An additional mitigation strategy that can be incorporated into the Project design is to minimize the use of eskers. These landscape features typically have high potential for archaeological resources; therefore, this strategy reduces the potential to impact sites.

8.2.2.2 Discipline-Specific Mitigation

As noted above, the first choice for mitigation of project effects on archaeological sites is to avoid the site. Where avoidance of project effects on an archaeological site is not possible, two other strategies can be considered: site protection (either temporary or permanent), or site documentation and data collection, generally called systematic data recovery.

Site protection is used where project activities are temporary or intermittent at a reasonable distance so as to make direct effects unlikely. Construction and maintenance personnel will be made aware of the locations of archaeological resources close to Project infrastructure or activities and the importance of not disturbing them. Forms of site protection can include the creation of a sufficiently large buffer zone within which development will not occur, the erection of physical barriers, or monitoring by a qualified archaeologist. Protective barriers may be temporary (i.e., for the specific period of a limited term project activity), or may be in place over the long term, as in the case of a site close to a road right-of-way.

If neither avoidance nor site protection are possible, then a suite of actions referred to as systematic data recovery will be implemented. These actions include surface collection, detailed mapping, and

subsurface testing to evaluate site deposits and/or excavation of a selected sample of the total site area. The site will be thoroughly documented and a sufficient sample of the cultural information contained in the archaeological site will be collected. As full-scale mitigative excavations destroy heritage resources, they are more appropriately referred to as compensation rather than mitigation. Systematic data recovery is reserved for situations where site disturbance due to development is unavoidable, or when the expected cultural information is considered of sufficient value such that the excavation disturbance is warranted. Very important or sensitive sites, such as burials or unique types or important gathering locales, may need to be preserved, together with representative examples of all other site types. Such decisions are made on a site-specific basis and require consultation with the GN.

The ongoing potential for direct and indirect effects can be minimized by application of access limitations, monitoring and/or surveillance procedures, restricted availability of archaeological site location information and through implementation of an effective education program for all Project personnel.

8.2.3 Potential Monitoring

Follow-up baseline data collection is required for the revised mine and port footprints, and the winter and all-season road alignments. This is most appropriately completed after the road alignments are finalized, but must be completed before construction begins.

Following completion of the baseline data collection, a Heritage Resource Management Plan (refer to section 12.2) will be prepared that will detail the status of all recorded archaeological resources within the LSA, recommend site-specific mitigation or compensation strategies, recommend monitoring programs and outline contingency procedures in the event of unexpected archaeological discoveries during the life of the Project.

Monitoring of sites close to development areas will be undertaken. This will entail periodic inspections of sites by a qualified archaeologist to assess the potential for indirect effects and monitoring of any Project activities close to recorded archaeological resources to ensure successful avoidance. These sites would be within the zone of possible indirect effects. Where potential for Project effects is evident, follow-up will consist of establishing protective barriers or some form of data recovery where appropriate.

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SECTION 9

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9 HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENT

9.1 Introduction

Human Health and Ecological Risk Assessment (HHERA) is a framework used to determine how much contact (exposure) people, animals and plants could have with specific chemicals, and estimates the likelihood of adverse effects from that exposure.

An HHERA will be conducted for the Izok Corridor Project to evaluate the potential for health effects on local people and off-work staff, and wildlife resources in the study area. The assessment will comprise two major components: 1) a human health risk assessment (HHRA) to evaluate the potential effects of suspended particulates and standard pollutants at specific receptor locations; and 2) an ecological risk assessment (ERA) to evaluate potential effects on the atmospheric and aquatic environments and key wildlife species.

9.2 Potential Project Effects

The Project has the potential to affect human health through exposure from air, soil, vegetation and aquatic pathways, including:

- Degradation of ambient air quality leading to potential inhalation-based health effects on local people and staff during off-work hours
- Deposition of contaminant-laden dust into the terrestrial environment, leading to potential uptake by humans if local plants and animals are eaten
- Discharge of mine-affected waters, effluents and accidental release of such waters through seepage and leakage into the surrounding groundwater and surface waters, leading to potential human health effects from drinking local waters

The Project has the potential to affect ecological receptors through exposure from air, soil, vegetation and water, including:

- Deposition of contaminant-laden dust leading to uptake by local vegetation and animals, potentially resulting in adverse health effects in plant and animal populations
- Discharge of mine-affected waters, effluents and accidental release of such waters through seepage and leakage into the surrounding groundwater and surface waters, leading to potential health effects on fish and fish-eating wildlife

9.3 Approach

The HHERA for the Project will follow a tiered approach, initiated as a screening-level risk assessment. Depending on the results of the screening, it may be necessary to progress to a greater level of detail and modelling rigor. The next step will focus on specific chemicals of concern and exposure pathways identified during the screening process. The HHERA will evaluate both short-term and long-term exposure scenarios and resulting potential for health effects. The assessment will be based primarily on results of the air quality, airborne deposition, and water quality modelling and associated terrestrial and

aquatic effects assessments. The HHERA assessment may also include consideration of potential contaminant-related health concerns identified during the consultation process.

The HHERA will focus on potential human health and ecological health effects at the Izok Mine site. The reasons for this approach are two-fold. The HHERA conducted for the High Lake Project DEIS concluded that there would be no significant adverse health effects to humans or ecological receptors associated with the development of the High Lake Mine. This conclusion was based on baseline studies conducted from 2005 to 2006, which involved comprehensive sampling programs for:

- water quality
- soil and sediment chemistry
- tissue metals concentrations in vegetation (i.e., rock sedge, water sedge, crowberry stems and berries, Labrador tea leaves, snow lichen)
- fish (i.e., Lake trout, Arctic char; muscle and liver samples)
- small mammals (i.e., northern redbacked vole)

Because current Project plans involve locating the processing facility at Izok, the overall footprint and air emissions from construction and operation of the High Lake Mine will be smaller than previously proposed and assessed. Results of the 2008 HHERA are therefore considered applicable and conservatively protective.

Further, the current Project design incorporates several mitigation measures to minimize the generation of fugitive dust from the handling, storage and transportation of concentrate. As discussed in section 2, haul truck containers and storage and loading facilities at Grays Bay Port will be enclosed to minimize airborne dust emissions of concentrate and potential deposition of metals along Izok Road and at the port site. Consequently, potential effects on air quality and the terrestrial/marine environments are no longer considered to be a substantial concern. Pre-construction baseline studies along the road and at the port site will be used to develop a comprehensive database for use during operational monitoring and the reclamation phase.

9.4 Field Program

In 2008, baseline studies were conducted at 25 sites proximate to the Izok Mine. These baseline studies provide valuable chemical data for water, soil, sediment, fish tissues (i.e., lake trout, round whitefish), forage and browse vegetation, and plants consumed by humans (i.e., tea leaves, berries). However, data gaps were identified in relation to baseline soil, vegetation, and small mammal data for the Izok Mine area.

To fulfill data requirements for the HHERA, a spatial grid will be established around the Izok Mine area, compatible with both the air quality and risk assessments. This will allow evaluation of risk to human and ecological receptors in a spatially explicit manner based on background soil quality conditions and expected deposition of chemicals of concern (i.e., metals) over the construction and operations phases of the mine. The spatially explicit aspect of the HHERA is important because the geographic magnitude of environmental effects is a key factor for reliably establishing the significance of adverse environmental effects.

The HHERA program will incorporate available traditional knowledge (TK) and land use information to identify human and key ecological receptor locations, develop site-specific exposure scenarios in relation to air, soil, water and foods, and obtain information on the terrestrial environment (soil, plants, invertebrates, wildlife) and aquatic environment (water and sediment quality, invertebrates, fish) in the air quality dispersion model.

The 2012 fish baseline program will provide fish tissue data for large-bodied species (i.e., muscle filets consumed by people and whole body carcasses consumed by wildlife) and small-bodied species (i.e., forage fish that are prey to piscivorous fish species). Lake trout, Arctic grayling and round whitefish will likely be the species sampled, depending on local fish distributions in Itchen Lake and at reference sites. Similarly, the 2012 soils baseline program will provide soil chemistry data for the study area. The 2012 HHERA field program will involve further sampling and analysis of surface soil chemistry to spatially characterize trace metal concentrations within the air quality sampling grid. At a subset of these new sites, co-located vegetation samples (i.e., berries, lichen, sedge, shrubs, tea leaves) and small mammal samples will be collected, as available. The field program will be undertaken in August to coincide with developed vegetative growth, berry-ripening, and higher levels of nocturnal mammal activity. These data are critical site-specific inputs to the multi-media food chain model used to estimate health risks.

9.5 HHERA Analytical Methods

The HHERA uses a generalized risk assessment framework (**Figure 9.5-1**). The assessment will identify contaminants of concern, potential human and ecological receptors and potential exposure pathways (during the problem formulation stage) and potential toxic effects.

9.5.1 Overview

A quantitative HHERA comprises:

- Problem formulation (descriptions of the contaminants of concern, potential human and ecological receptors, potential exposure pathways)
- Estimation of exposure concentrations from field samples and/or modelled concentrations
- Selection of toxicological reference values (TRVs) as per federal guidance
- Comparison of exposure estimates to TRVs and determination of potential risk
- Description and rationale for all assumptions and uncertainties

Risk management or mitigation strategies will be proposed in cases where potential health risks are predicted to occur.

In cases where contaminants of concern, receptors or potential exposure pathways do not exist, potential health effects can be assessed qualitatively. The difference between a qualitative and quantitative assessment is that qualitative assessments are generally descriptive or categorical in nature; whereas, quantitative assessments are based on predictive calculations of chemical exposure.

A quantitative HHERA is planned for the Izok Mine area. This will focus on the potential for contaminant transfer and resultant health effects due primarily to fugitive dust associated with mining activities, vehicular emissions, and effluent and seepage waters. Project design, mitigation and management plans will be incorporated into the risk assessment. Toxicity information on each chemical of concern will be combined with the results of the exposure assessment to characterize potential health risks.

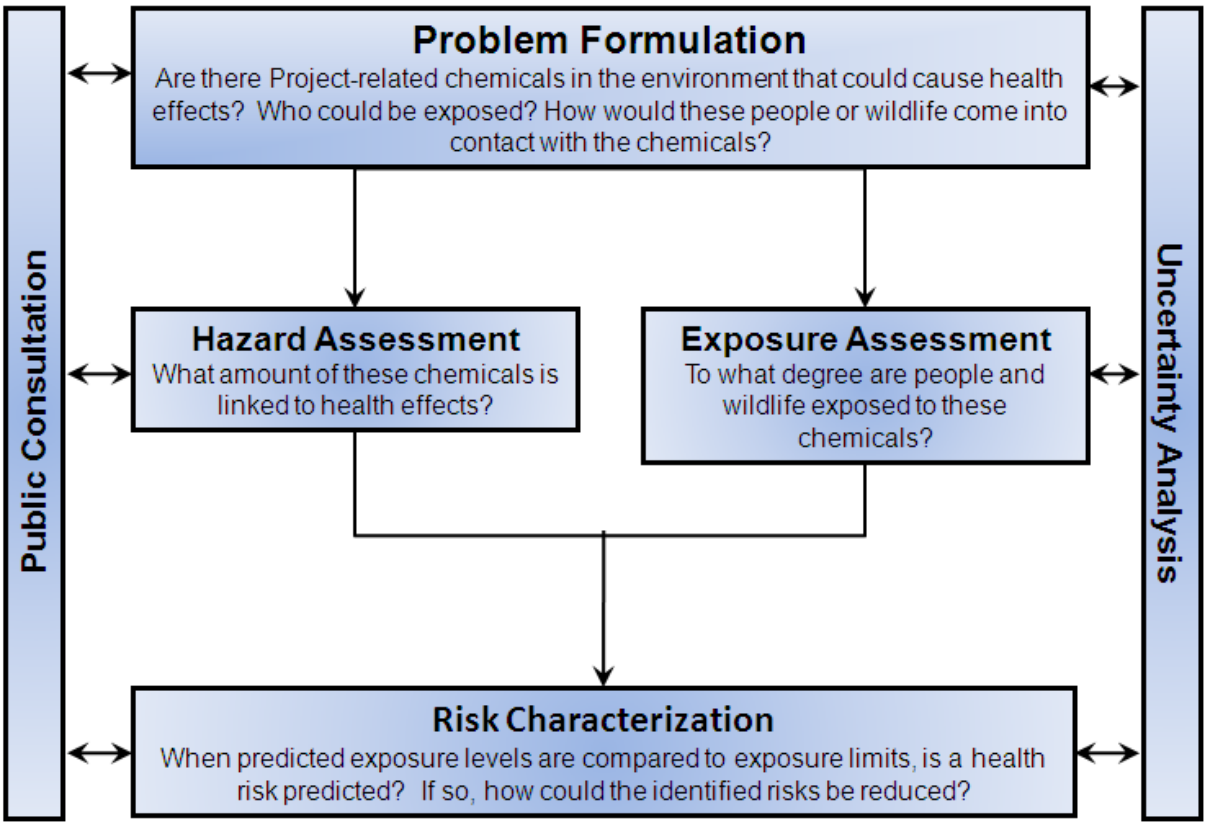


Figure 9.5-1 Risk Assessment Framework

9.5.2 Hazard and Exposure Assessments

For the HHRA, the ratio of predicted dose to tolerable dose provides the hazard quotient (HQ) to evaluate soil and food ingestion. The ratio of exposure concentration to a health-based TRV provides a concentration ratio (CR) used to evaluate air and water exposures. The HQ and CR are effects benchmarks for non-carcinogenic chemicals to identify potential health risks. For carcinogenic chemicals, the incremental lifetime cancer risk (ILCR) is calculated and evaluated based Health Canada's recommended level of acceptable cancer risk level of 1 in 100,000 individuals.

Toxicity information for the ERA will be focused on ingestion of soil, water and food. Chronic TRV indicating effects to each ecological species (or laboratory surrogate), based on environmental concentrations, will be used. Toxicological benchmarks for the HHRA and ERA will be based on government sources including Health Canada and the United States Environmental Protection Agency (Risk Assessment Information System, and Oak Ridge National Laboratory).

Historical and current baseline data will be compiled together with predicted soil and water concentrations, based on aerial deposition and water quality models. These data will be inputs to the HHRA and ERA models for evaluating health risks for each Project phase. Human health will be assessed for local Inuit and non-aboriginal people who use, or could potentially use the area, and for workers who may be exposed during off-work hours at camp. Ecological health will be evaluated for both terrestrial

and aquatic wildlife and bird populations using representative species for each major ecological niche. These will be selected based on wildlife baseline studies, and will integrate TK and communications with local residents. Fish tissue chemistry will also be used in the HHRA and ERA models based on the consumption of fish species by people or by specific wildlife receptors of interest. However, the evaluation of effects to fish species and other aquatic biota will be addressed in the aquatics effects assessment in the DEIS.

9.5.3 Risk Characterization

The risk characterization phase of the HHERA will determine whether the planned development is anticipated to have any adverse effects on human health or the health of selected ecological receptor species. Each contaminant will be assessed for the potential to cause adverse effects to each receptor of concern based on the resultant HQ or ILCR produced. A HQ or CR greater than the acceptability benchmark (sum for all pathways of 1) indicates that potential exposures may be a source of non-carcinogenic health effects, and that some form of mitigation may be required to prevent unacceptable exposures.

Similarly, an ILCR greater than 1 x 10-05 indicates that potential exposures are above the accepted threshold of carcinogenic health risk and warrant further assessment. These potential health concerns are evaluated in consideration of statistical confidence in the result, uncertainty in exposure modelling and toxicity data. It is also important to have a clear understanding of naturally elevated background levels and the relative change in baseline or background conditions that the planned operations would have and its effect on overall cancer risk.

The potential cumulative effects on human or ecological health will be assessed based on the results of the respective cumulative effects assessments (i.e., evaluating potential interactions with other projects in the area) from the air quality, soil quality, and water quality assessments.

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SECTION 10

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10 CUMULATIVE AND TRANSBOUNDARY EFFECTS

10.1 Cumulative Effects Assessment

10.1.1 Approach

The potential contribution of the Izok Corridor Project to regional cumulative effects will be assessed in accordance with NIRB requirements. This assessment will follow the latest guidance and precedence of best practice for such assessments in various administrative jurisdictions in Canada.

The cumulative effects assessment will consider the most likely cause-effect pathways through which residual Project effects could interact with other past, existing and reasonably foreseeable projects and activities both in time and space. Given the remoteness of the Project Development area, likely means by which cumulative effects could occur include:

- Long-range transport of a residual Project effect on a Valued Ecosystem Component (VEC) (e.g., air or water pathways)
- Residual Project effects on a broad ranging VEC (e.g., wildlife species)
- Synergistic effects of the Project that could result in a disturbance on a natural feature within a larger region under land and resource management

Where the Project is predicted to result in a measureable or detectable residual effect on a VEC, the effect will be screened to determine if there is the potential for it to interact with similar effects of other projects or activities. If a cumulative effect could occur, the effect will be assessed in detail and its significance on the VEC determined.

The assessment will be spatially bound within regional study areas (RSAs) defined for each VEC, and temporally bound to consider the base case (i.e., existing cumulative effects prior to the Project), Project case (i.e., cumulative effects over and above the base case due to the Project), and future case (i.e., cumulative effects due to the Project in combination with all reasonably foreseeable future project and actions). For this assessment, a potential far future development scenario will also be considered to address the potential for additional resources to be discovered during the life of the Project. Given the lack of information regarding specific details of potential future developments, the assessment of a far future case will be, by definition, qualitative.

The cumulative effects assessment will be based on a description of the current status of regional cumulative effects of all past and present projects and activities in the RSA to establish the context for assessing the incremental contribution of the Project.

Applicable government plans (e.g., regional land use plans), programs and other initiatives will be identified and discussed in relation to contribution to mitigation and monitoring of cumulative effects.

10.1.2 Potential Biophysical Cumulative Effects

A list of candidate actions (e.g., exploratory mining, production mines, infrastructure and natural resource harvesting) will be prepared to assist in assessing possible cumulative effects on the terrestrial and marine environments in the Draft Environmental Impact Statement (DEIS). This will include past, present and reasonably foreseeable projects, activities and actions with residual environmental effects that could overlap spatially and temporally with residual Project effects. Separate project inclusion lists will be developed for the terrestrial and marine assessments based on the RSAs selected for marine mammals and vegetation, as they encompass the geographically broadest areas within which residual Project effects could occur.

The following sections identify potential pathways through which Project effects could overlap with effects of other projects and activities to cause more regional cumulative effects. A more detailed assessment of possible cumulative effects will be undertaken as part of the DEIS based on a more comprehensive review of each regional project or activity.

Air Quality

Changes to air quality from airborne dust and combustion emissions during construction and operation of the Izok and High Lake Mine sites, Izok Road and Grays Bay Port could be, under certain climatic conditions, sufficiently broad to interact with emissions from other existing and future projects and activities in the region. This includes air emissions from operations of equipment and vehicles, as well as emissions from marine transportation.

Noise and Vibration

Noise and vibration from Project facilities and activities could cause sensory disturbance to wildlife, which may act cumulatively with that of existing and future projects in the region. This applies to potential effects of equipment operation and vehicular traffic on terrestrial wildlife species, as well as marine vessel operations on marine wildlife.

Surface Water and Groundwater

There are no other past, existing or reasonably foreseeable future projects located within the local watersheds of the Izok Corridor Project. As such, the potential for cumulative effects on surface water and groundwater quality and quantity is expected to be unlikely. The exception may be induced developments that could occur in the region as a result of the building of the Project all-season road and port facilities.

Freshwater Aquatic Organisms, Fish and Fish Habitat

As with surface water and groundwater, there is no potential for Project effects on aquatic organisms, fish and fish habitat to interact cumulatively with effects of other regional projects or activities. Given that there has been limited historical use of the Project Development area for traditional fishing activities, it is unlikely that any residual effect of the Project would interact with these activities to cause a detectable or measurable regional effect on fish populations.

Landforms

Future development projects in the region would likely require the use of existing borrow and quarry sources (including eskers) for construction materials, which could act cumulatively to deplete these resources over the long term.

Soils and Vegetation

The Izok Corridor Project has the potential to affect soils and vegetation through direct loss associated with building of infrastructure, as well as through deposition of trace elements from air emissions. Although there are no other past, existing or foreseeable future projects that could act cumulatively with these effects, there is the possibility that future induced developments and activities that use the Project all-season road could lead to increased emissions, and greater effects on soils and vegetation.

Wildlife and Wildlife Habitat

Effects on wildlife and wildlife habitat could be cumulative if the Project and other actions physically remove or modify habitat, change movement patterns or cause direct mortality within the regional wildlife study area. Potential effects on caribou, grizzly bear, muskox and wolverine will be assessed in the DEIS.

Caribou are at greatest risk of being affected by regional cumulative effects due to their large seasonal migration patterns. Two herds (the Bathurst and Dolphin and Union herds) have the potential to be affected by the Project as a result of construction and operation activities. These effects have the potential to act cumulatively in parts of their ranges with similar effects from other human activity in the region.

Birds and Habitat

Effects on birds and bird habitat may be cumulative if the Project and other actions cause a change in habitat availability through direct loss of the habitat or sensory disturbance within the regional study area. While migratory birds have the greatest potential to be affected by multiple project and activities effects due to their large ranges, potential cumulative effects of raptors and upland breeding birds will also be assessed in the DEIS.

Marine Environment

Project effects on marine water and sediment quality and marine fish are likely to be spatially limited (e.g., vicinity of Grays Bay Port) and therefore the potential to interact cumulatively with other past, existing or future projects is expected to be minimal. However, these effects will be addressed in detail in the DEIS.

Marine shipping activities could cause increased risk of injury or mortality and a change in behaviour of some marine wildlife species (e.g., marine mammals and colonial nesting birds), which could act cumulatively with effects of other marine transportation activities in the region. However, the potential contribution of the Project to cumulative effects is anticipated to be relatively small given the projected number of vessel transits each year (16 return trips), use of established shipping lanes, and use of the open-water season to meet marine transportation requirements.

10.1.3 Potential Socio-economic Cumulative Effects

Cumulative effects on the socio-economic environment are anticipated to be both adverse and beneficial with overall positive outcomes on individual, family and community well-being. Any cumulative effects that occur will be the result of a complex interaction between the various effects of the Project with those of other developments, and their collective contributions to the social, cultural and economic changes or shifts occurring across Nunavut. This Project will be a strong driver for change in the Kitikmeot region.

Human Assets

The Izok Corridor Project will be another fly-in/fly-out mining operation in Nunavut that will require qualified management personnel, trades people and general labourers. One anticipated cumulative effect is competition for labour with the other mining operations in Nunavut. The demand for labour will likely result in sustained efforts to establish a stable, qualified workforce. One possible outcome of this could be increased enrolment in post-secondary educational programs. The response of Nunavummiut could be a desire to relocate to take advantage of educational and employment opportunities. Larger communities in the Kitikmeot region are anticipated to have the competitive advantage over smaller ones in attracting and/or retaining people.

Economic Assets

The Project, in combination with other developments across Nunavut, will create a greater number and a more diverse range of employment and business opportunities for all Nunavummiut. Multiple projects will act as a catalyst for increased local and regional economic development, resulting in new investment in the mining service industry across Nunavut. Total household income will increase and, over time, is expected to result in lower requirements for income support, and improve people's financial security. The financial capacity of various governments and organizations will also likely improve over time as revenue sources increase. Overall, this could manifest itself in a further shift from an economy based on traditional activity and government transfers to one that is more wage-based, competitive and entrepreneurial.

Given the vast geography of the Kitikmeot region, increased access to the land through the development of a road could make hunting and trapping further afield from communities more attractive, thereby maintaining the non-wage economy to some extent.

Physical Assets

Any cumulative effects on community infrastructure and services will depend on migration into the region and net changes in the population. Communities that experience population growth will experience increased demand for housing stock, community services and transportation infrastructure.

Social Assets

Cumulative effects on social assets could include potential loss of traditional harvesting areas, and physical disturbance to cultural, archaeological and paleontological resources. In the absence of effective and sustained initiatives by governments, Inuit organizations and others to maintain traditional

culture, the shift towards a wage economy and greater use of English will further affect Inuit traditional activities and knowledge over time. Any reduction of harvesting or sharing of harvest would represent an erosion of traditional culture as it is presently viewed by many Inuit. The corollary to this is that employment also provides the finances to allow participation in cultural activities.

In addition to changes in culture, the Project also has the potential to create divisions within the communities and a situation of haves and have-nots among community members. Development projects such as this have also been identified as causing family breakdowns when families are not adequately prepared.

MMG is committed to collaborating with stakeholders in developing and implementing mitigation measures through Project design, environmental protection plans, and adaptive management to limit any potential contribution of the Project to regional cumulative effects on the biophysical and socio-economic environments.

10.2 Transboundary Effects Assessment

10.2.1 Approach

Potential transboundary effects will be assessed in accordance with NIRB requirements. This assessment will identify those potential residual Project effects that could extend across or occur outside of the geographic boundaries of Nunavut. This includes cumulative effects that may spatially overlap other administrative jurisdictions, as well as Project effects that occur within other jurisdictions such as those associated with marine shipping along the western shipping route.

The assessment will also identify any existing or pending land and resource use management initiatives by other jurisdictions that may contribute to Nunavut or Project-based mitigation and monitoring of those effects.

10.2.2 Potential Biophysical Transboundary Effects

While most residual Project effects on the biophysical environment are expected to be localized (i.e., within close proximity to the Project footprint) and therefore within Nunavut boundaries, there is the potential for some effects to be transboundary in nature.

- Changes to air quality as a result of fugitive dust and atmospheric emissions from diesel combustion during mining and milling operations, air and ground transportation and marine transportation, which could extend into the NWT and contribute to global GHG emissions
- Effects on surface water and freshwater aquatic organisms from construction and operation of the Izok Mine, which is in close proximity to the Nunavut-NWT border
- Effects on wide-ranging wildlife species such as the Bathurst and Dolphin and Union caribou herds, grizzly bear, wolverine and several species of migratory birds
- Effects on marine mammals along the western shipping route in the NWT, such as the Eastern Beaufort Sea beluga whale population, bowhead whales of the Bering-Chukchi-Beaufort Sea stock, the Northern Beaufort Sea and Southern Beaufort Sea populations of polar bears, and ringed seals in Amundsen Gulf and the Beaufort Sea

10.2.2 Potential Socio-economic Transboundary Effects

The Izok Corridor Project has the potential to result in transboundary effects on traditional use of lands and waters for wildlife harvesting. This is due, in part, to the proximity of the Izok Mine site to the NWT border and the harvesting access afforded to Tlicho residents by the Tlicho Land Claim Agreement. Further, the western shipping route through the Northwest Passage could also affect the use of waterways by the Inuvialuit for their traditional activities. The Project also has the potential to result in transboundary effects by generating economic opportunities outside of Nunavut through purchases of goods and services from across Canada, use of Yellowknife as a point of hire, increased marine shipping of goods, and the potential for increased use of the Tibbitt to Contwoyto Winter Road.

MMG is committed to collaborating with stakeholders in developing and implementing mitigation measures through Project design, environmental protection plans, and adaptive management to limit any potential transboundary effects on the biophysical and socio-economic environments.

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11 ACCIDENTS AND MALFUNCTIONS

11.1 Overview

Under the NIRB review process, the Draft Environmental Impact Statement (DEIS) is to present a discussion of possible accidents and malfunctions that could occur during each phase of a project, with a focus on those scenarios that have a reasonable probability of occurring. This is to include an evaluation of the probability of occurrence, as well as an assessment of the potential consequences of these incidents on the environment and human health and safety. Specifically, the assessment is to demonstrate that the conventional malfunctions and accidents are unlikely to cause long-term or residual effects both to persons and the environment, taking into account the proposed mitigation measures including preventive measures and emergency response capability should an incident occur.

As part of the DEIS for the Izok Corridor Project, the Accidents and Malfunctions assessment will identify and qualitatively assess the risks associated with each of the key Project components during the construction, operation and closure phases.

11.2 Approach

The Accidents and Malfunctions assessment will involve a Project-wide risk assessment, as well as more detailed assessments of potential transportation risks.

The Project-wide risk assessment will focus on potential accidents and malfunctions associated with each of the primary physical components of the Izok Corridor Project at a screening level, and evaluate the likely effects of such incidents on human health and safety and the environment. For each component, the potential failure scenario(s) will be identified along with the proposed key mitigation concepts to manage the identified risk. The risks associated with each failure scenario will be evaluated (assuming that the proposed mitigation concepts are fully in place) in terms of estimated frequency of occurrence, the type of consequence anticipated and the estimated magnitude of the consequence.

For this assessment, the primary physical components of the Projects will be grouped into the following broad categories.

- Izok and High Lake mines
- Izok Mill and associated facilities
- Izok Road
- Grays Bay Port
- Marine shipping

The risk assessment will be based on MMG's experience with the construction, operation and decommissioning of mining projects, review of previous accidents and malfunctions associated with projects in the North, review of community and regulatory agency concerns, and knowledge of the Project and proposed activities.

More detailed risk assessments will be conducted to address the risk of transporting concentrate, fuel and reagents through the various transportation modes (i.e., via haul truck on Izok Road, via ocean-

going vessels along the eastern and western shipping routes) to workers, the public and the environment. The assessment will focus on those accidents and malfunction scenarios that would result in the most severe potential consequences to conservatively bound the assessment. These bounding scenarios will be selected based on the following considerations.

- Frequency of occurrence based on available statistics for transportation-related accidents
- Quantity of any hazardous substances that might be involved in the potential incident
- Duration and potential spatial extent of the releases into the environment
- Magnitude of the effect on the environment

The assessment will consider the likely consequences of the accident and malfunction scenarios on key receptors (aquatic, terrestrial and human) of the environment based on calculations of chemical concentrations in the various environmental media, exposure pathways modelling for the various receptors, and risk characterization based on selected benchmarks.

The assessment will provide a detailed breakdown of the various tasks related to transportation, the hazards associated with each task, the types of preventive and mitigative measures that will be in place, and any additional mitigation that may be required to reduce the consequence of such incidents.

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SECTION 12

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12 ENVIRONMENT MANAGEMENT SYSTEM

This section provides an overview of the MMG's proposed Environmental Management System for the Izok Corridor Project, including key programs and management plans to support operational goals. MMG has considerable management and organizational experience from its operational mines, and will be adapting this experience to arctic conditions of Nunavut for operation of the Project.

Detailed management plans will be prepared during the Project licensing and permitting stage based on the feasibility study, further environmental studies, and consultation with federal and territorial agencies and other stakeholders.

12.1 Organizational Management and Operational Approach

12.1.1 Organization Management

Project management and administration will be based at MMG's Vancouver BC office, with on-site management located at the Izok and High Lake Mine sites. On-site management and administration will be the responsibility of each Mine Manager along with the following staff.

- Personnel officers
- Community liaison officer
- Security, health and safety and training staff
- Procurement and general administrative staff
- Off-site logistics and clerical staff

Mine managers will report directly to the Izok Corridor Project Manager, who will report to the Chief Operating Officer (COO) of MMG.

A community liaison office has been established in Kugluktuk for the purpose of communicating with local residents about the Project. For the construction and operation phases of the Project, MMG is considering a local office in Cambridge Bay and possibly a small office in Yellowknife. This will be determined in the next year based on the feasibility study.

12.1.2 Operating Policies

MMG is committed to the standards set by the International Council of Mining and Metals (ICMM), particularly in relation to biodiversity and sustainable development. Seven components of this framework are essential to the successful construction and operation of the Izok Corridor Project.

- Commitment to best practices in:
  - Corporate governance
  - Production standards
  - Health and safety
  - Operational excellence
  - Environmental protection
- Commitment to local economies and communities to support social licence to operate
- Economic viability of the Project

MMG is committed to applying these standards to the full cycle of mine life by requiring all employees and contractors to comply with corporate policies and directives, and all applicable environmental laws, regulations, and licence and permit conditions. Programs for each key area also will be implemented and evaluated for their efficiency in achieving set goals while ensuring individual safety and improving operations and environmental protection.

12.2 Key Environmental Management Programs

MMG aims to minimize the environmental footprint of all its projects by equipping its people with environmental standards to effectively manage the environmental aspects of mining operations. These standards are part of MMG's risk management practice that sets the internal benchmark for operations. Key environmental priorities include:

- Land and biodiversity management
- Water management
- Energy, greenhouse gas emissions and climate change
- Mineral waste management
- Closure planning

MMG is developing an integrated Safety, Health, Environment and Community (SHEC) Management System that incorporates ISO14001 environmental management system requirements. The system will include the formal, risk-based identification of environmental policies, standards and supporting assurance program to measure the operational performance against the environmental performance standards. MMG is working to ensure all operations maintain or receive ISO14001 certification and achieve zero non-compliance with operational licence and other legal requirements.

MMG will prepare Environmental Management Programs in accordance with its SHEC Management System for all phases of the Project (site preparation, construction, operation, maintenance, closure and post closure). These programs will be integrated into procedure documents for use by site management staff, occupational health, safety and environmental compliance staff, and government departments and agencies tasked with environmental and regulatory compliance monitoring. The following Environmental Management Programs will be developed for the Project. They will present specific monitoring and evaluations strategies to be implemented throughout the life of the Project, in accordance with requirements of the Nunavut Impact Review Board (NIRB) and applicable federal and

territorial regulatory acts and policies. Inuit organizations, federal and territorial regulatory agencies and communities will be consulted during development of these plans.

- Waste Management Program
  - Mineral Waste Management Plan
  - Non-Mineral Waste Management Plan
  - Landfill Management Plan
  - Hazardous Materials Management Plan
  - Incineration Management Plan
- Site Water Management Program
  - Surface Water Management Plan
  - Groundwater Management Plan
  - Waste Water Management Plan
- Risk Management Program
  - Risk Management and Emergency Response Plan
  - Spill Contingency Plan
- Shipping Management Program
- Roads Management Program
- Borrow Pit and Quarry Management Plan
- Explosives Management Plan
- Air Quality Monitoring and Management Plan
- Noise Abatement Plan
- Aquatic Effects Monitoring and Management Program
- Wildlife Mitigation and Monitoring Program
- No Net Loss Plan
- Closure Reclamation Plan

Adaptive strategies will be integrated into these programs to assess the effectiveness of mitigation and management, and enable improvements to be made throughout the life of the Project. This will include identification of thresholds/criteria and indicators that will be used to trigger management actions based on data collection and review of analytical results, and feedback from government, public and other stakeholders.

As per MMG's SHEC Management Framework, regular reviews of its Environmental Management Plans will be conducted to ensure that monitoring results are integrated and the necessary adjustments are implemented as required. These reviews also provide a formal mechanism to assess effectiveness of management in achieving company objectives and maintaining ongoing compliance with Project permits and authorizations.

12.2.1 Waste Management Program

Waste management is a major concern for most mining operations globally. MMG is committed to preventing and reducing the effects mineral and non-mineral wastes over the life of the Izok Corridor Project, and to minimizing post-mining rehabilitation and closure liability.

Mineral Waste Management Plan

Towards meeting the above objectives, MMG will develop a Mineral Waste Management Plan for the Izok and High Lake mines that will comprise standards for managing all mining and process waste generated at the Project, including waste rock, overburden and tailings. The plan will cover all stages of waste management from generation to final use and/or disposal. This will include:

- Predicted volumes/tonnage of waste rock, physical and chemical characteristics of the waste, and segregation criteria
- Analyses implemented in development of proposed pile design and runoff management plans
- Stockpile methods and procedures, including plans for mitigating the chemical and physical hazards of the waste
- Potential for rock heave phenomena and any resulting implications to ground stability
- Plans for accommodating projected volumes of materials at waste rock facilities, including contingency plans for situations in which the designed facility may not be adequate to accommodate waste
- Details regarding process for selecting preferred options for management of waste rock, including a discussion of alternative options
- Ongoing monitoring of waste disposal structures
- Regular monitoring of the geochemical properties of the waste piles

Non-Mineral Waste Management Plan

A management plan will also be developed to address all non-mineral wastes generated by operational activities at the Izok and High Lake Mine sites and at the Grays Bay Port. The plan will cover all wastes that are not residues directly derived from the mining or processing of rock, such as used oil, greases, batteries, solvents, spent reagents, contaminated soils and sewage residues. Key elements of the plan will comprise the following.

- Predicted quantities, characteristics, environmental hazards and risk associated with non-mineral wastes
- Operation of various waste management facilities including storage and disposal of domestic, industrial, or chemically contaminated wastes and hazardous substances
- Sorting of solid and liquid wastes into appropriate categories and storage sites
- Management of effluent treatment, recycling options, and discharge
- Discharge sites and water quality requirements

Landfill Management Plan

Pursuant to requirements for water licence application for the Project, a management plan will be developed for landfill facilities that will be constructed at the Izok and High Lake Mine sites and Grays Bay Port. The plan will describe the design of the landfills required for storage of non-hazardous wastes that cannot be recycled. This will include an inventory of the types and volumes of non-combustible, non-hazardous industrial wastes generated and land filled over the life of Project. The plan will detail operation of the landfills, as well as final reclamation.

Hazardous Materials Management Plan

A Hazardous Materials Management Plan will be prepared for the Izok and High Lake mines and the Grays Bay Port that will outline strategies specific to each particular waste generated at the Project. This plan will outline the information and protocols necessary for the safe handling, storage and transportation of hazardous materials that will be used at the Project based on best management practices. The plan will include:

- Waste and material inventories, including types and volumes of hazardous wastes generated by the Project
- Characterization of potential environmental hazards of these materials, and management of these hazards through the EMS
- Identification of storage and disposal methods
- Contingency and emergency response plans
- Type and delivery of training for those responsible for handling potentially hazardous materials
- Procedures for maintenance and review of records of hazardous material consumption and incidents
- Procedures to track and manage wastes generated through use of hazardous materials
- Responsibilities for managing hazardous materials

Incineration Management Plan

The Incineration Management Plan will describe the technologies, facilities and equipment that will be used to meet emission standards for incinerator operations. This will include plans for personnel training in incinerator management and operation, as well as procedures for collection and reporting of operational data and maintenance records.

12.2.2 Site Water Management Program

The efficient use of water and management of waste water discharges are important aspects of MMG's operations. MMG is developing a Water Management Strategy and detailed Water Management Plan for that will apply to all Project components. As part of its commitment to water, MMG is working towards having a functional Water Balance Model completed for all its operations. This will be a key aspect of designing the Izok Corridor Project.

Surface Water Management Plan

A Surface Water Management Plan will be developed to describe the overall strategies that will be applied at each Project site to intercept, collect, treat and monitor contact and non-contact water. This will include:

- Surface runoff, snowmelt and rainwater that might come in contact with contaminated areas
- Runoff from overburden stockpiles, waste rock stockpile areas and quarry sites, in particular stockpiles with ARD and ML potential
- Runoff from lined fuel tank farms, fuel transfer stations and landfill facilities
- Stormwater/freshet from roads, borrow areas and airstrips

The plan will describe the water management structures, wastewater treatment technologies and facilities, including estimated volumes and treatment targets of effluent, and applicable discharge standards. Further, it will describe the methods for any water conservation and recycling to maximize water reuse and minimize use of freshwater sources, and discuss how climate change has been considered in its design.

Specific to the Izok Mine site, the management plan will discuss plans for draining of Izok Lake and the design of the water diversion system to maintain hydraulic connectivity between Iznogoudh Lake to Itchen Lake, including the diversion channel, berm/ditch systems, and dams. This will include plans for closure and post-closure water quality monitoring and water treatment.

Groundwater Management Plan

A Groundwater Management Plan will be developed for the Izok and High Lake mines to provide strategies for controlling and collecting groundwater inflows into the open pit and underground mines, and methods for treatment, recycling and use of groundwater at the mine facilities or discharge to the receiving environments.

Waste Water Management Plan

A sewage and grey water management plan will be developed for the Project. This will include a description of the proposed treatment technologies and facilities, and estimated volumes and treatment targets of effluent, as well as applicable discharge standards. The plan will cover management of waste water generated during the full cycle of mine life, including treatment/disposal methods, options for sewage sludge, and contingency measures for sewage plant malfunction and/or disturbances, and associated spill response measures.

12.2.3 Risk Management Program

Risk Management and Emergency Response Plan

A Risk Management and Emergency Response Plan will be developed to assess and manage potential natural hazards associated with the Project, including the marine shipping routes. This will include an analysis of the potential for malfunctions and accidents associated with project facilities and activities, occurring independent of, or associated with natural hazards, as well as a sensitivity analysis.

The plan will include:

- Notification and reporting procedures, and associated responsible organizations and personnel
- Contingency procedures for each risk, and associated security systems and prevention measures
- Options for medical transport of injured staff or persons both within and beyond the project area
- Constraints resulting from logistics and time frames for prompt response
- Description of how relevant government agencies, Inuit organizations and local communities will be involved in development of plans
- Any other contemplated loss prevention practices

Spill Contingency Plan

MMG will develop Spill Contingency plans to deal with unforeseen petroleum and chemical accidents that may occur during construction and operation of the Izok Corridor Project. These will include a land-based spill contingency plan, oil handling facility contingency plan, and shipboard oil pollution emergency plan.

A preliminary land-based spill contingency plan has been prepared for the Izok Corridor Project, and is included as part of the KIA Inuit Land Use License Application (Appendix D of this document).

The final spill contingency plans will identify the lines of authority and responsibility, describe reporting and communication procedures, and describe the action plan that will be implemented in the event of a spill. The plan will include all information necessary to effectively control and cleanup a spill, reflecting current state-of-the art containment and cleanup procedures. Specifically, the plans will include:

- Measures for prevention of hazardous material spills
- Monitoring protocols
- Spill response and reporting procedures
  - Spill notification
  - Event criteria and trans-boundary considerations
  - Incident management team and roles
  - Contacts for government agencies, industry, and international organizations
  - Response escalation response support
  - Containment and clean up protocols for handling large and small spills
- Mandatory spill response equipment
- Employee and contractor spill training program

12.2.4 Shipping Management Program

A management program will be developed for the marine transportation component of the Project to ensure that MMG's shipping contractor meet or exceed environmental legislation, regulations and guidelines for barging and shipping operations. The plan will incorporate lessons learned from other

marine operations in the region into safety measures and operating procedures for all marine equipment. This will include

- A hazard identification analysis and a preliminary risk analysis for the western and eastern shipping routes, including measures to mitigate marine transportation risks
- Onboard waste management policies and guidelines for handling solid waste, sewage and other domestic waste generated by the ships
- Ballast Water Management Plan
- Proposed measures to reduce the risk of introduction of invasive aquatic and non-aquatic species
- Marine wildlife mitigation plan
- Procedures for managing and reporting potential accidents and malfunctions
- Smuggling prevention measures
- Identified third party liabilities
- Mitigation for potential socio-economic effects of shipping
- Ice Management Plan

12.2.5 Roads Management Program

The Izok Corridor Project will involve the development of a road network comprising service roads around the Izok and High Lake mine facilities and the Grays Bay Port, temporary winter roads, and the all-season access road linking the mine sites and port. MMG will develop a roads management plan that will be in effect throughout the duration of the Project to minimize effects of road construction and operation on air quality, waterbodies, wildlife interactions, and sensitive landforms.

The roads management program will outline road use policies (such as speed limits, closure, use of monitor and convoys), procedures for daily operation and maintenance, communication systems and protocols, emergency shelters, safety procedures, emergency reporting and procedures for fuel/chemical spills and other emergency events, and site reclamation plans.

A primary consideration in developing the roads management program will be safety of road users, as reduced visibility due to light conditions and weather could pose a serious safety issue. Protection of the environment will also be a key component of this program. As such, it will include:

- Traffic Management Plans
- Dust Management Plans
- Sediment and Erosion Control Plans
- Caribou Management Plans

The Caribou Management Plans will specifically address potential conflicts with the Bathurst and Dolphin and Union caribou herds during the migration, calving and post-calving periods.

12.2.6 Borrow Pit and Quarry Management Plan

Aggregate requirements for Project development works will be supplied by quarry and borrow sites located at the Izok and High Lake Mine sites, near the port, and along the Izok Road corridor. MMG will prepare a management plan that will guide site preparation, development and closure of these sites to mitigate potential environment effects associated with their use. This will include aggregate extraction and quarry methods, transportation and storage, including proposed methods for handling ice and managing water released by thawing of permafrost and ground ice. The plan will also outline mitigation measures to reduce ARD and ML potential for quarried materials and management strategies for dealing with drainage and erosion control, air quality and fish and wildlife issues. Project monitoring will evaluate consistency with the plan and operational compliance with regulations, leases and permits.

A detailed reclamation plan will be developed as required by the land use permit. Reclamation objectives will be developed in accordance with regulatory authorities.

12.2.7 Explosives Management Plan

The Izok Corridor Project will require ammonium nitrate and fuel oil (ANFO) and emulsion explosives for controlled blasting during mining of the Izok and High Mine deposits. In advance of mine construction, an Explosives Management Plan will be developed to manage the manufacture, transport, storage, handling and use of explosives for the Project. This plan will describe best management practices and safe handling procedures to minimize the loss of ammonia to mine rock and ore, and control leaching and runoff from explosive storage areas as per existing federal and territorial regulations relating to explosives manufacture, storage and use. The plan will also include spill containment prevention methods, personnel training and security measures.

12.2.8 Air Quality Monitoring and Management Plan

An Air Quality Monitoring and Management Plan will be developed to ensure compliance with applicable guidelines and regulations during construction and operation of the Project. The purpose of the plan will be to monitor and mitigate exhaust and fugitive dust emissions generated by Project facilities and activities to manage air quality effects on human health, the terrestrial environment and aquatic/marine environments. Specifically, the plan will include strategies to reduce and control air emissions, methods for air quality monitoring and related adaptive management measures, and procedures for management plan auditing and reporting of monitoring results.

As part of the Air Quality Management Plan, plans will be developed for minimizing greenhouse gas emissions from Project activities and infrastructure. An Energy Management Program will be key part of the Project, and energy efficiency targets will be a part of mine planning.

12.2.9 Noise Abatement Plan

MMG will develop a Noise Abatement Management Plan to mitigate potential noise emissions generated by Project facilities and activities at the port, mine sites and marine transportation routes. The plan will outline noise control methods, noise reduction through Project design, and occupational noise management and monitoring programs, including procedures for management plan auditing and reporting of monitoring results.

12.2.10 Aquatic Effects Monitoring and Management Program

As per requirements for water licence application for the Project, MMG will develop an Aquatic Effects Monitoring and Management Program. The objectives of this program will be to determine the short- and long-term effects of the Project on the aquatic environment, evaluate the accuracy of effect predictions, assess the effectiveness of the planned mitigation measures, and identify any additional measures that are required to reduce these effects. Key to this program will be the inclusion of adaptive strategies to trigger management actions based on monitoring results and feedback from regulators and other stakeholders. The program will outline the study design in terms of spatial and temporal sampling plan, and the monitoring schedule and methods. It will also describe the procedures for reporting of program results.

12.2.11 Wildlife Mitigation and Monitoring Program

A Wildlife Mitigation and Monitoring Program will be developed for the Izok Corridor Project, which will provide internal work procedures and best management practices for all activities at site to reduce Project-related effects on wildlife and wildlife habitat. The program will comprise the following.

- Selection criteria and rationale for wildlife species selected for monitoring and mitigation programs
- A description of how TK has been integrated into the development of mitigation and monitoring programs
- Details regarding plans for involvement of local hunters in wildlife monitoring program design and implementation
- Plans for coordinating wildlife studies/monitoring activities with other organizations, institutions, government departments and/or individual researchers conducting wildlife studies
- Discussion of how terrestrial wildlife surveys and monitoring protocols will be designed
- Description of monitoring study design and field methods
- Description of how indicators, sampling design, methodology and analysis will be appropriate and adequate to detect spatial and temporal project-related effects on wildlife
- Measures to avoid or reduce disturbance, harassment, injury or mortality of terrestrial and marine wildlife due to the Project
- Description of data analysis methods, including triggers/thresholds for adaptive management
- Mechanism for evaluation of mitigation effectiveness and adaptive management
- Quality assurance and quality control measures
- Procedures for reporting and plan updates
- Awareness training and education

12.2.12 No Net Loss Plan

MMG will develop a No Net Loss Plan that will describe potential Project effects on fish habitat, and a compensation plan to achieve “No Net Loss” of fish habitat productive capacity as it relates to the DFO

policy for the management of fish habitat. The plan will provide estimates of total fish habitat loss, and describe procedures and structures that will be designed to compensate for potential residual effects of the Project on fish and fish habitat. The no net loss plan will apply to fish habitat losses associated with draining of Izok Lake, road construction and any fish habitat losses associated with development of Grays Bay Port and associated infrastructure.

12.2.13 Closure and Reclamation Plan

MMG is currently developing guidance material for integrated closure planning across its operations, including a tool to formally quantify closure risks, closure costs and assess the quality of closure plans.

Closure is a foremost consideration in the planning of the Izok Corridor Project to ensure that environmental issues are taken into consideration early in mine design. A comprehensive Closure and Reclamation Plan will be developed for the Project to ensure minimal post-closure environmental effects, and public health and safety. The plan will outline how the various Project components (including the mines, port and all-season road) will be decommissioned, reclaimed and closed following mine closure. The plan will include a description of progressive reclamation measures and closure reclamation objectives and proposed monitoring that will be conducted during the closure and post-closure phases. Reclamation will be consistent with the Mine Site Reclamation Policy for Nunavut (AANDC 2002), and reclamation of IOL portions of the Project will follow the NTI reclamation policy. End land use objectives that guide these reclamation plans will be defined based on consultation with government agencies and local communities.

12.3 Key Socio-Economic Effects Management Program

MMG plans to take the necessary steps to properly manage socio-economic changes that might result from the Izok Corridor Project. The overall goal of Socio-economic Effects Management Program is to ensure that workers, community members and government organizations adversely affected by the Project have the capacity to cope with change and that MMG's effects management and benefits enhancement facilitate the ability to cope.

To manage the direct socio-economic effects of the Project, MMG will develop management plans in collaboration with various stakeholders. These plans will be grounded in MMG's corporate standards, the lessons learned elsewhere in Nunavut and northern Canada, positive precedents set in Inuit Impact and Benefits Agreements (IIBAs), Development Partnership Agreements and the results of consultation and collaboration with stakeholders. The following outlines some of the plans that MMG is considering. For each plan, MMG also expects to monitor and report on the implementation of these plans and programs.

12.3.1 Occupational Health and Safety Plan

Employee safety is one of MMG's four core values. Its SHEC Management System is used to drive a consistent approach across the company by providing overall strategies, policies and standards, performance management support, and building capability of employees. MMG's Injury Prevention Principles help to guide thoughts, behaviours and decisions relating to health and safety amongst its employees.

MMG will develop an Occupational Health and Safety Plan for the Izok Corridor Project in accordance with its SHEC Management System that will focus on accident prevention and risk management. The plan will cover such topics as:

- Best safety practices and safety awareness programs
- Employee training programs
- Procedures for emergency incidence reporting and action

12.3.2 Local Employment Plan

MMG is committed to identifying local skills and capabilities, and identifying opportunities for Project employment, and available benefits. MMG expects to work with Inuit organizations, affected communities and Government of Nunavut to develop strategic plans and programs that deliver on local employment commitments. This information is generally consolidated into a Human Resources Management Plan. These plans describe among other things:

- Fly-in fly-out arrangements
- Recruitment
- Education and skills opportunities
- Skills and accepted skill equivalency
- Counseling and support arrangements on site
- Banking and financial arrangements and training
- Employee benefits package
- On-site opportunities for recreation, sports and learning

12.3.3 Education and Skill Development Plan

Education and skill development will be a core part of MMG's local employment initiatives. This plan provides MMG's intentions for providing its workforce and others education and skill development opportunities. The plan may include:

- Apprenticeship programs
- Scholarship and funding programs for employees as well as community members
- Employee training and advancement
- Support job-related skills development in collaboration with Nunavut educational institutions

12.3.4 Local Procurement Plan

MMG will prepare a plan for promoting local contracting opportunities at the earliest possible stage of the Project. The Business Development Plan will include:

- Company policies and targets towards supporting local business procurement and development
- Specific arrangements for local businesses such as advanced notification, contract splitting to accommodate capacity of local businesses, etc.
- Terms and conditions for basic contract and service providers

12.3.5 Cultural Awareness and Heritage Resource Management Plan

MMG will develop a Cultural Awareness and Heritage Resource Management Plan that will describe general and site-specific measures to protect cultural and heritage resources and promote cultural awareness through training (e.g., cross cultural training). A core part of the plan will be a process for identifying, managing and responding to complaints and grievances in relation to any issues, including cultural heritage, and for recording and investigating incidents and disturbances.

MMG will prepare the Cultural Awareness and Heritage Resource Management Plan as per the legislative requirements of the Government of Nunavut.

Izok Corridor Project Proposal

SECTION 13

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