Volume 3:
Project Description and Alternatives

PHASE 2 OF THE HOPE BAY PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT

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PHASE 2
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Glossary and Abbreviations

Terminology used in this document is defined where it is first used. The following list will assist readers who may choose to review only portions of the document.

Framework Agreement	Mineral Exploration Agreement between TMAC and the KIA
ARD	Acid rock drainage
AWR	All-weather road
Belt, the	Hope Bay Greenstone Belt
BHP Billiton Inc., or BHP	BHP Minerals Canada Ltd.
Cambiex	Cambiex Exploration Inc.
CAPEX	Capital Expenditures
Commercial Lease, the	Commercial Lease no. KTCL313D001
Company, the	TMAC Resources Inc.
Construction	The phase of the project during which the Project is constructed.
CRF	Cemented rock fill
CWP	Contact water ponds
CWP 1	Contact Water Pond No. 1
CWP 2	Contact Water Pond No. 2
CWP 3	Contact Water Pond No. 3
DEFZ	Deformation Zone
DFO	Fisheries and Oceans Canada
Direct Impact	Employment, income, GDP and tax revenue generated directly by the Project, including the resulting employment, income, GDP and tax revenue generated by industries directly contracted to supply the on-site goods and services used by the Project.
Economic impact	The result or effect that the mine development has on the economy of a particular region. Often described in terms of employment, personal income, GDP, and government tax revenue effects.
EFAP	Employee and Family Assistance Program
EIS	Environmental Impact Statement
ERM	ERM Consultants Canada Ltd.
ERT	Emergency response team
FOS	Factors of safety

G&A	General and Administrative
GCL	Geosynthetic Clay liner
GDP	Gross Domestic Product. The value-added by economic activity, principally composed of personal income and corporate profits.
GN	Government of Nunavut
HBML	Hope Bay Mining Ltd.
HBVB	Hope Bay Volcanic Belt
HDPE	High density polyethylene
Hope Bay Gold	Hope Bay Gold Corporation Inc.
HP	High pressure
HWM	High water mark
ICRP	Interim Mine Closure and Reclamation Plan
IIBA	Inuit Impact and Benefit Agreement
INAC	Indigenous and Northern Affairs Canada
Indirect Impact	Employment, income, GDP and tax revenue associated with all industries that are ultimately supplying the goods and services used by the industries directly supplying the Project, and include all transactions to the beginning of the supply chain excluding direct on-site suppliers to the Project and the Project itself.
Induced Impact	Employment, income, GDP and tax revenue associated with economic activity because of workers spending their incomes on goods and services, including those directly and indirectly employed because of the Project.
IOL	Inuit-Owned Lands
IPJ	Inline pressure jig
IPO	Initial public offering
IQ	Inuit Qaujimajatuqangit
KIA	Kitikmeot Inuit Association
LH	Long-hole
LOM	Life of mine
LP	Low pressure
MEAs	Mineral Exploration Agreements
MHBL	Miramar Hope Bay Limited
mill	Process plant
Miramar	Miramar Mining Corporation

ML	Metal leaching
MMER	Metal Mining Effluent Regulations
MOMB	Marine outfall mixing box
NIRB	Nunavut Impact Review Board
NPC	Nunavut Planning Commission
NRCan	Natural Resources Canada
NSR	Net Smelter Return
NTI	Nunavut Tunngavik Inc.
NWB	Nunavut Water Board
OGV	Ocean going vessels
OPEP	Oil Pollution Emergency Plan
Operation	The phase of the project during which the mine is producing.
OPEX	Operating expenditures
PAX	Potassium amyl xanthate
PCP	Pollution control ponds
PDA	Potential Development Area
PFS	Pre-Feasibility Study
PL	Production leases
Project, the	Phase 2
Property, the	The Hope Bay Property is TMAC's prime holding in the Canadian Artic, with 80 mineral claims and leases and one Inuit Mineral Exploration Agreement that comprise approximately 20 × 80 km^2 of the Hope Bay Greenstone Belt.
Proponent, the	TMAC Resources Inc.
Q2	2^{nd} quarter
ROQ	Run-of-quarry
RRSP	Registered retirement savings plan
STOL	Short take-off and landing
TIA	Tailings impoundment area
TMAC	TMAC Resources Inc.
TSX	Toronto Stock Exchange
Type A Water Licence	Doris Project Type A Water Licence 2AM-DOH1323
UCF	Unconsolidated fill

VEC	Valued Environmental Component
VoIP	voice over IP
VSEC	Valued Socio-Economic Component
VSI	Vertical shaft impactor
WRP	Waste rock piles
WRR	Winter road route
WTP	Water treatment plant
WWCA	Water and Wildlife Compensation Agreement

Units of Measurement

°C	degree Celsius	**km^2**	square kilometre
a	annum	**km/h**	kilometre per hour
BTU	British thermal units	**kt**	Kiloton
cfm	cubic feet per minute	**kVA**	kilovolt-amperes
cm	centimetre	**kW**	Kilowatt
DWT	Deadweight tonnage	**m**	Metre
ha	hectare	**m^2**	square metre
h	hour	**mm**	Millimeter
k	kilo (thousand)	**MW**	Megawatt
kg	kilogram	**tpd**	metric tonne per day
km	kilometre	**V**	Volt

1. Introduction

The Hope Bay Greenstone Belt (“the Property”) is TMAC Resources Inc.’s (“TMAC”, “the Proponent”) prime holding and is its sole focus for exploration, development and mining. TMAC holds mineral claims, leases and one Inuit Mineral Exploration Agreement that comprise an approximately 20 × 80 km property. These mineral holdings comprise the Hope Bay Greenstone Belt, on which the primary gold deposits Doris, Madrid North, Madrid South and Boston are located. The Hope Bay Belt is host to numerous other prospective areas which suggest that economic reserves will continue to be delineated, permitted and developed, creating a multigenerational operation.

Phase 2 Project (“the Project”) focuses on mining of the Madrid North, Madrid South and Boston deposits by utilizing and expanding upon the Doris Project infrastructure for the integrated development of the Hope Bay Belt (Figure 1-1). The Project represents a timely opportunity to develop the well-established Hope Bay gold deposits into a long-term mining operation in Canadian Arctic that provides sustained economic stability and benefits for the Kitikmeot region. The development plan minimizes capital investment and builds on the existing assets to generate cash flow that can sustain continuing exploration and expansion.

The Phase 2 Project will be operated in an environmentally sound manner and will provide direct, sustained benefits to Nunavummiut, Inuit-owned businesses, and local communities. The Project represents a predictable and stable economic platform that can provide benefits that are best recognized over the long-term. Once established, the long-life mining operation will provide a platform enabling the identification, permitting, and mining of additional mineral reserves on the Hope Bay Belt. The presence of substantial physical infrastructure (i.e., airstrips, roads, camps, cargo dock) may also create opportunities for ongoing use by others after the mine closes. The benefits of Phase 2 Project include:

- Support to future infrastructure initiatives, such as regional transportation networks. Phase 2 will require the ongoing utilization of Northern marine shipping routes. Regular and predictable marine transport of bulk supplies by ship or barge will complement the efficiency initiatives for regional shipments to Kitikmeot communities.
- Providing substantial trades, technical, and management training and employment for Nunavummiut. These programs can be targeted towards desired long-term skills that will carry forward and create future opportunities for Nunavummiut.
- Providing sustained and predictable payment of production royalties to the Kitikmeot Inuit Association (KIA), Nunavut Tunngavik Inc. (NTI), and Government of Canada.
- Enhancing Canadian presence in Canada’s North during the current period of increasing international use of the Northwest Passage connecting the Atlantic, Arctic, and Pacific Oceans.

Looking forward, TMAC intends to pursue development of the Hope Bay Belt with the mining of additional as yet undiscovered deposits. Exploration of the Belt will continue in much the same way it has been undertaken for the past several years consisting of mapping and drilling programs aimed at discovering mineralized zones in the Belt, and better defining the known deposits at Doris, Madrid, Boston and numerous other locations on the belt.

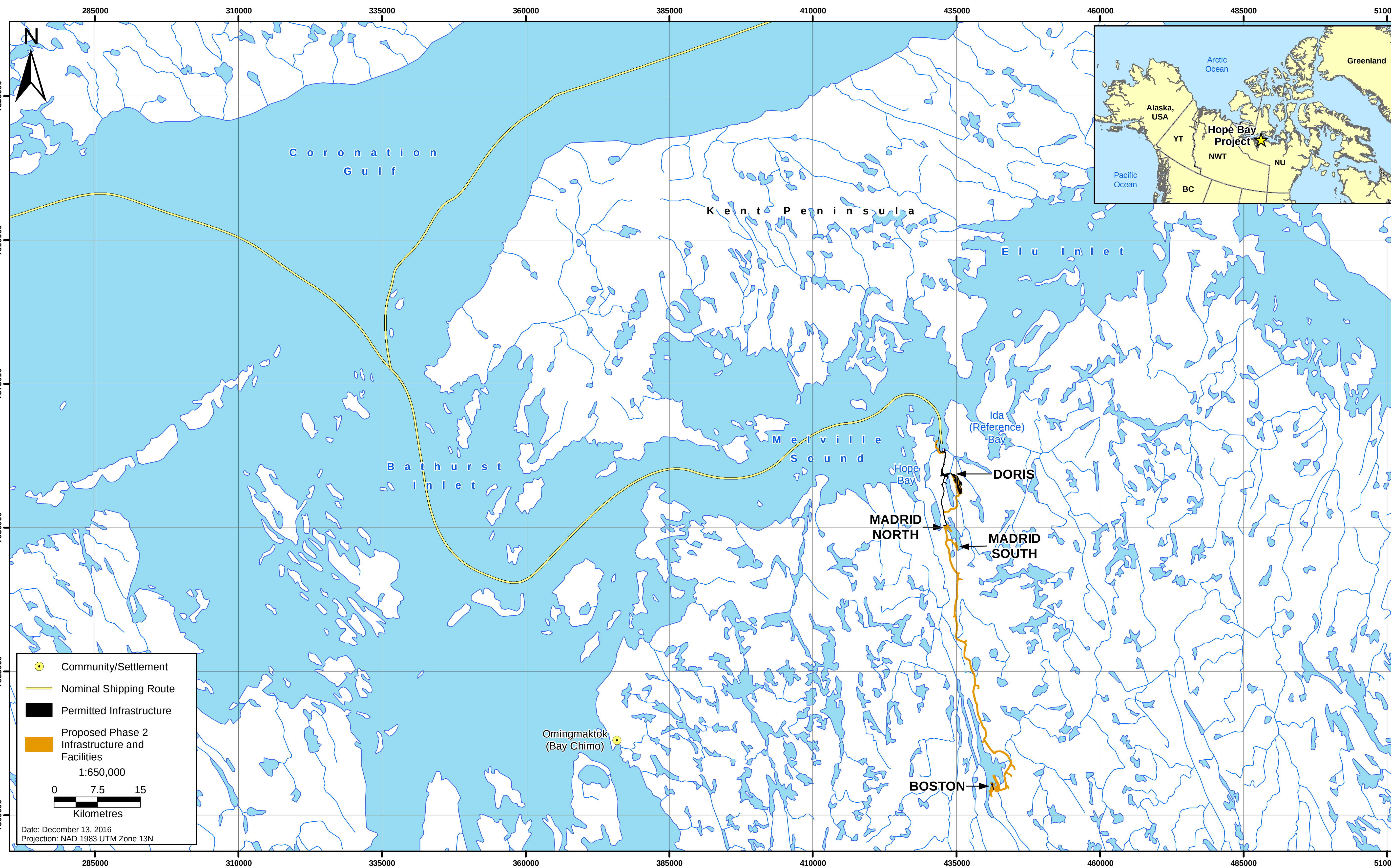
Mining operations and benefits may be extended should additional mineral deposits become economical to develop. Should additional deposits be identified that are beyond the scope of the authorizations and approvals held, TMAC will enter into the appropriate permitting processes. The presence of existing infrastructure will be of environmental and economic value to future projects, just as it is for the Phase 2 Project.

Any project of the scale and importance of the development of the Hope Bay Belt cannot be done in isolation. Many partnerships are required and TMAC has been supported in its development goals by meaningful partnerships with two major Inuit organizations, Nunavut Tunngavik Inc. (NTI) and The Kitikmeot Inuit Association (KIA). The NTI is the partner organization that coordinates and manages Inuit responsibilities set out in the Nunavut Agreement. NTI holds the surface title and mineral rights to Inuit-Owned Lands (IOL) in Nunavut, including the surface rights over the entire Hope Bay Property and mineral rights over selected portions of the Property. The KIA administers the surface rights and the Inuit Impact and Benefits Agreement (IIBA) associated with TMAC's activities at the Property. The Kitikmeot Inuit Association (KIA) and TMAC will continue to share in existing and future benefits through partnerships and agreements already in place including the Framework Agreement, the Inuit Impact Benefits Agreement (IIBA) and the Commercial Lease. Both organizations fill important roles on behalf of Inuit and they ensure, along with TMAC, that the existing Framework Agreement and other, future agreements as required, will provide continued social and economic benefits for Nunavummiut, Nunavut, and, Canada while effective stewardship to the land is maintained.

TMAC's Phase 2 Project is the result of a continual evaluation of the proposal put forward in 2011 by Hope Bay Mining Limited (HBML 2011). In May 2012, the proposal was referred to the NIRB for public review pursuant to Part 5 of Article 12 of the Nunavut Agreement. Guidelines for the Preparation of the EIS were issued by the Nunavut Impact Review Board (NIRB) in December 2012 (NIRB 2012a). The NIRB's current review of this Environmental Impact Statement for Phase 2 as defined by TMAC is a resumption of the review initiated in May 2012.

This Environmental Impact Statement is provided to the Nunavut Impact Review Board (NIRB) by TMAC Resources Inc. in support of TMAC's applications for Phase 2 development of the Hope Bay Property ("Phase 2").

Figure 1-1
Project Location



2. Project Design Considerations

Avoiding and mitigating potential effects from the Hope Bay Project has guided TMAC's design decisions. Project design considerations included health and safety, the biophysical environment, archaeological and cultural heritage, and socio-economic information from baseline data and other available data sources. TMAC has taken a precautionary approach in the absence of information or lack of certainty about Project effects to the environment to ensure that serious harm or damage is avoided by Project components and activities. The following sections describe TMAC's approach to Project development and design that ensures the successful development of the Project and avoidance or mitigation of potential Project effects.

2.1 PRECAUTIONARY PRINCIPLE

TMAC is committed to acting in a socially and environmentally responsible manner, reducing environmental damage and harm, where possible. To meet this goal, TMAC has used the Precautionary Principle in designing the Project. The approach considers all available baseline information to help design the Project to avoid significant adverse effects to environmental and social values. The applications of this approach and changes to Project design were part of the assessment of alternatives described in Section 7.

To support TMAC's approach to limiting serious harm or damage, TMAC has conducted extensive research to establish data on baseline and existing conditions. TMAC also has extensive knowledge and experience based on current operations that have guided Project design and the development of management plans and mitigation measures that reduce negative environmental and social-economic effects.

To ensure consideration of potential environmental effects, the Precautionary Principle guides the selection of valued components, study areas, and potential Project effects used in the assessment chapters. Where uncertainty exists about the extent of damage that could derive from Project components and activities, this was identified in the assessments and resulted in changes to Project components and activities and/or the establishment of mitigation measures. The Project has developed procedures, mitigation measures, and management practices to reduce effects and to ensure protection of health and safety, the biophysical environment, archaeological and cultural heritage, and socio-economic values. The effectiveness of these procedures, mitigation measures, and management practices guides the characterization of residual effects.

The Precautionary Principle will guide implementation of the Project in the form of monitoring and an adaptive management approach that is flexible and responsive to changing conditions and new scientific information. TMAC has worked closely with local stakeholders to incorporate local knowledge, TK, and IQ to ensure that effects to social and cultural values and considerations for the health of the local population are incorporated in the Project design and planning. The Project will provide ongoing economic benefits to Nunavut and employment opportunities for residents of Nunavut.

2.2 HEALTH AND SAFETY

The commitment to occupational health and safety on the part of the TMAC is based on the principle of controlling risk to provide a proactive and positive safety culture and an incident-free workplace. The objectives in implementing this policy are:

- to have all personnel appropriately trained, responsible, and accountable for safety management;
- to incorporate industry best practices for health and safety standards in the engineering, design, and processes implemented at all workplaces;
- to comply with all relevant standards, codes of practice, and regulatory requirements; and
- to provide effective training, efficient communication, and continuous review of occupational health and safety practices.

Design considerations in relation to accidents and malfunctions are discussed in Volume 7, Section 1.

2.3 CLIMATE CHANGE

The design of Project infrastructure considers potential implications of climate change. TMAC has conducted an analysis of climate change for integration into Project design (Appendix V3-2A). The analysis provides the climate change projections for key climatic and hydrologic design parameters for use in Project designs. The existing climatic data and hydrological parameters used in the project are described and provided (Appendix V3-2B).

Project design also considered vulnerabilities of mining infrastructure components including roads, airstrips, and tailings management facilities to climate change. TMAC has included a discussion of climate change and the potential effects of the environment on the Project in Volume 7, Section 2.

Climate change was considered in thermal and hydrologic modelling for the Project through the application of climate change factors. These factors allowed for changes in climatic conditions in the models. Examples where a climate change factor was used include the following:

- the design of contact water ponds (CWP; Appendix V3-2C);
- hydrologic modelling conducted as part of the mine water and load balance predictions (Appendix V3-2D);
- thermal modelling of the required thickness of rock pads over permafrost (Appendix V3-2E, Appendix C);
- thermal modelling of the North, South, and West Dams at the Doris tailings impoundment area (TIA; Appendix V3-3F, Appendices E and F); and
- thermal modelling of the Boston TIA (Appendix V3-2F, Appendix C).

2.4 BIOPHYSICAL

The Project design considered comprehensive baseline studies of biophysical components in the Project including atmospheric and hydrological conditions, terrain and soils, vegetation, aquatic, fisheries, and wildlife. The potential effects of the Project on biophysical features include:

- loss of biophysical features due to Project components and activities such as clearing and grubbing for infrastructure footprints; and

- alteration of biophysical features or processes due to Project activities such as dust or noise.

The Project design incorporates design, operational safeguards, and contingency plans to mitigate potential effects. Highlights of the mitigation measures incorporated into Project design have included consideration for:

- setbacks from streams and waterways;
- buffer zone from known rare plants;
- buffer zone from known archeological sites;
- minimize project footprint to reduce habitat loss and alteration;
- important bird nesting areas; and
- develop site-specific mitigations where minimum buffers cannot be achieved.

The following sections review Project design considerations that address the above effects.

2.4.1 Ecosystems, Vegetation, and Landforms

Terrestrial ecosystems and vegetation are included in the application because of their importance to Inuit, sustaining habitat, and forage they provide for wildlife species, and potentially at-risk plant and lichens.

Environmental sensitivity maps were developed using information on baseline and existing conditions to inform Project design and reduce potential effects to ecosystem and vegetation Valued Ecosystem Components (VECs). Terrestrial ecosystem surveys and mapping, vegetation surveys, terrain and soil mapping, and rare plant surveys were used to identify ecosystems and vegetation that are often considered rare or sensitive, due to their scarcity on the landscape, special habitat features they provide, and/or cultural importance (Table 2.4-1). Baseline information is included in Volume 4.

Table 2.4-1. Features included in Environmental Sensitivity Mapping to Inform Project Design

Feature Type	Rationale for Inclusion
Riparian ecosystems and floodplains	Deciduous shrubs are an important food source for ungulates; provide nesting and cover habitat for various wildlife species (e.g., breeding birds); and are used by Inuit for tools, fuel, and hunting.
Esker complexes	Esker-related ecosystems provide important denning habitat for mammals such as foxes, wolves, wolverine, and ground squirrels, and travel corridors for many wildlife species; used as travel routes by Inuit peoples.
Fragile or rare wetlands, shallow open water, ponds, and marsh ecosystems	These ecosystems provide important habitat to grizzly bears and caribou in the spring. Furthermore, the ecosystems provide food and other materials for Inuit traditional uses.
Bedrock cliff	Steep, exposed bedrock cliffs provide bird nesting habitat and habitat for rare plant species.
Bedrock-lichen veneer ecosystems	Dry, windswept areas support a continuous mat of lichens, an important food source for caribou.
Beaches, marine intertidal areas, and marine backshores	These marine associated areas provide habitat for rare plant species and are travel and foraging areas for a variety of wildlife.
Rare plants and lichens	Rare plant species are important to biodiversity and may be federally protected.

Reducing potential effects by avoidance is, where practicable, the most effective mitigation measure to reduce the potential for serious damage or harm. Hence, the locations of these features were identified and Project infrastructure was relocated, where required and feasible, to avoid effects to these features.

Other design considerations used in the Project that reduce effects to terrestrial ecosystems include:

- speed limits are applied to vehicles travelling on roads, which has the added benefit of reducing dust adjacent to roadways;
- reduced effects to riparian and wetland habitat by routing roads, as far as is practical, from streams, channel crossings, and wet, boggy areas where fish habitat may be disturbed;
- avoid disturbance of the tundra vegetation, permafrost, or soils outside of Project footprints; and
- use of dust suppression where required for safety and operational needs.

2.4.2 Terrestrial Wildlife and Wildlife Habitat

Baseline studies focused on wildlife populations identified by Inuit to be culturally important, and included studies to characterize important wildlife features and habitats. Baseline conditions are included in Volume 4.

Wildlife baseline information was used to develop environmental sensitivity maps to inform Project design and reduce potential effects to wildlife and wildlife habitat features (Table 2.4-1). Ecosystems of traditional and cultural importance due to their value as wildlife habitat, including eskers, various wetland types, marine shores, and riparian ecosystems were included in the sensitivity mapping. Nesting sites, based on 9 years of surveys, for cliff-nesting raptors and mammal den sites were included on the environmental sensitivity maps to inform Project design.

Reducing potential effects by avoidance is, where practicable, the most effective mitigation measure to reduce the potential for serious damage or harm. The location of each feature was identified and Project infrastructure was relocated, where feasible, to avoid potential effects.

2.5 FISH AND FISH HABITAT

Numerous lakes, rivers, streams, ponds, and marine estuaries provide fish habitat within the Project area. Baseline studies focused on fish species and related fish habitat protected by the *Fisheries Act* or identified by Inuit to be culturally important, and included studies to document fish species and habitat. Baseline conditions are included in Volume 5, Sections 7 and 11.

Fisheries sensitive areas were assessed based on baseline survey data indicating fish presence. These known sites were included in the environmental sensitivity mapping and Project design was adjusted to avoid these areas wherever possible. In addition, water features were identified and setbacks of 31 or 51 m were applied to avoid affecting riparian functions.

Additional Project design features include:

- stream crossings confirmed not to be fish habitat will be spanned using culverts if the peak flow is sufficiently low;

- to the extent practicable, high flow fish-bearing streams will be spanned using clear span structures. Fish-bearing streams of very low flow will be spanned using culverts sized for fish passage provided the required conditions necessary to sustain fish habitat can be achieved; and
- routing roads, as far as is practical, to avoid streams, channel crossings and wet, boggy areas where fish habitat may be disturbed.

2.6 PERMAFROST

Permafrost has been characterized for Project component areas (Volume 4, Section 6) and geotechnical design principles that relate to permafrost have been developed (Appendix V3-2E).

The Project site is located in a zone of continuous permafrost. The permafrost at the Project site is estimated to be approximately 570 m thick, with permafrost 500 m thick in the Doris mining area, 570 m thick in the Madrid mining area, and 565 m thick in the Boston mining area. The geothermal gradient is estimated to be 0.021°C/m. The active layer in overburden soils ranges between 0.5 and 1.4 m, with an average depth of 0.9 m.

Climate change and the predicted increase in air temperatures at the Project are expected to affect permafrost characteristics. While the Project itself is predicted to stay in the zone of continuous permafrost, the region is predicted to be thermally sensitive to climate change. Climate change, specifically warmer summer temperatures, are expected to increase the active layer thickness. By 2100, the active layer of clay overburden is estimated to increase by 0.93 m (see Appendix V3-2A).

Project design reduced potential effects to permafrost. Design elements include:

- thermal modelling (Appendix V3-2C, Appendix C) to determine fill requirements over tundra to ensure preservation of permafrost for infrastructure construction;
- wherever possible, airstrips, roads and other infrastructure pads will be constructed in the winter to ensure the integrity of the permafrost using sufficient cover material to insulate it; and
- contact water ponds (CWP) will be designed to minimize effect to permafrost and ensure pond structural stability.

2.7 LAND USE

Project design consideration for land use activities and practices include those specifically targeted to benefit land users as well as those developed to reduce the effects of the Project on wildlife and aquatic mammals. Two types of land users may access areas near to the Project: commercial land and resource users (e.g., sport hunters, licenced outfitters, tourism operators) and local Inuit land users participating in land use activities (e.g., hunting, trapping, gathering). Baseline conditions are included in Volume 6, Section 5.

The potential effects of the Project on land users for which Project design considerations either reduce effects or enhance the practice of the activity include:

- changes in access to land and resources;
- changes to the experience of the natural environment; and
- changes to harvesting practices and/or success.

A number of design elements are beneficial for and reduce or eliminate effects for commercial and local land users. The following is a review of Project design considerations that either address the above effects or contribute to the maintenance of the practice in other ways.

2.7.1 Change in Access to Lands and Resources

Project design considerations that address land access include:

- ship only during open water months (therefore not disturbing travel over the Coronation Gulf by people and wildlife);
- incorporate best practices in site reclamation following Project Closure, that aim to re-open access to areas formerly used by the Project to people and wildlife; and
- allow land users to use Project transportation infrastructure to access KIA IOL outside of the land covered by a TMAC Advanced Exploration Agreement and Commercial Lease[1]. This will facilitate the continued use of areas outside of the Project site for typical land use activates.

TMAC has adopted a number of additional Project design considerations to facilitate continued land and resource use through other means:

- providing for air travel to the Project site from each of the Kitikmeot communities, which enables Kitikmeot residents to return home between shifts and eliminates potential additional time travel south; and
- a work rotation (two weeks on/two weeks off) that aims to increase the ability of traditional land users who become Project employees to continue to conduct traditional land use by providing extended periods of time off in their home communities.

2.7.2 Changes to the Experience of the Natural Environment

Project design considerations that address potential changes to the experience of the natural environment reduce and limit changes to sensory disturbance such as air quality, noise, vibration, and visual and aesthetic resources. The Project designs include a number of specifications and site/operating policies that reduce this effect:

- helicopters will operate at a minimum height over land and will not fly close to caribou herds, subject to flight safety considerations.;
- a Noise Abatement Plan provides procedures to limit and monitor Project noise (Volume 8, Annex 20). and
- air quality specifications (e.g., dust management) consider the presence of the land users in the area and the need to limit Project emissions. This measure further reduces any change to the land user experience.

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[1] Under terms and conditions reasonably required to ensure safety and unhindered site operations and commercially reasonable user pay fees at TMACs discretion (HBB IIBA 2015).

2.7.3 Changes to Harvesting Practices and/or Success

Project design considerations that address potential changes to harvesting practices and/or success are those focused on facilitating land use, as well as those focused on reducing or eliminating potential effects to land users. Design measures focused on facilitating continued land use include:

- allow Inuit land users to cross Project transportation infrastructure to access KIA IOL outside of the land covered by the TMAC Advanced Exploration Agreement and Commercial Lease. This will facilitate the continued use of areas outside of the Project site for typical activates;
- ship only during open water months (therefore not disturbing travel over Coronation Gulf by people and wildlife);
- construct roads without continuous berms to allow for the easy passage of people and wildlife; and
- as described in the Wildlife Mitigation and Monitoring Plan (Volume 8, Annex 22), adopt a number of design measures to maintain environment and wildlife habitat to reduce or eliminate changes to wildlife in the area.

2.8 INUIT QAUJIMAJATUQANGIT

The Project has considered the recommendations of industry experts that have reviewed Inuit Qaujimajatuqangit (IQ) in relation to their area of expertise and informed TMAC of adjustments to Project design based on the content provided in IQ documentation (Volume 2, Section 2).

IQ content has been considered in relation to each topic of focus; examples include the following:

- IQ describes the historical travel routes that inform current land use activities, indicating where Inuit cross Coronation Gulf as they travel south to the mainland to hunt, trap, and gather. In this instance, IQ provided information on the importance of using only open water shipping as there are numerous travel routes between Cambridge Bay and the mainland.
- IQ informs wildlife experts of past trends, which speak to current trends in wildlife migration and specific mitigation and enhancement measures. Open water shipping removes any disruption of caribou movement from the mainland to Victoria Island. Targeted workshops have been had with local representatives to understand and discuss how other Project infrastructure such as roads can be built and operated in a way that minimizes potential impacts to wildlife.

2.9 ARCHAEOLOGICAL AND HERITAGE RESOURCES

TMAC respects archaeological sites that have or may be discovered.

Archaeological sites are identified and mitigated when it is clear that they will be impacted.

TMAC compares exploration programs and proposed developments to recorded site locations, and additional survey or mitigation is applied as necessary. TMAC has incorporated archaeological programs as part of the ongoing baseline data collection and implemented a Standard Operating Procedure for all employees, contractors, and visitors. Upon discovery of an archaeological site, the site is not to be removed or disturbed and the location will be reported to the appropriate regulatory bodies.

2.10 SOCIO-ECONOMICS

Project design consideration for socio-economics include those targeted to benefit Kitikmeot residents, as well as those developed to more broadly provide benefits of the Project. The benefits of the Project will offset or reduce potential adverse socio-economic effects. For example, potential adverse effects to community well-being may be offset by the provision of the Employee and Family Assistance Program (EFAP).

The Project design considerations for socio-economics are focused on the policies and procedures TMAC has adopted to guide the operation of the Project for employees. The Valued Socio-economic Components (VSECs) for which Project design considerations reduce effects, provide a benefit to offset an adverse effect, or enhance a value related to the effect, include the following.

<u>Business Opportunities</u>

- Support to local business growth.

<u>Employment</u>

- Increases of employment opportunities and income.
- Development of labour force capacity.

<u>Education and Training</u>

- Increase to the demand for education and training programs.
- Change in perception of education and employment.

<u>Migration, Housing, and Infrastructure and Services</u>

- In-migration to the Kitikmeot Region.
- Increase to the demand for housing.
- Increase to the demand for local services.

<u>Community Health and Well-being</u>

- Increase to family stability.
- Increase in family spending.
- Increase in food security and cost of living.

2.10.1 Business Opportunities

The Project enhances the potential positive effects for local businesses through the development of an IIBA that includes specifications and preference for local businesses (i.e., Kitikmeot Qualified Businesses). The Project business model establishes a hiring preference for local businesses to enhance the potential benefits to the Kitikmeot Region.

2.10.2 Employment

Through the IIBA, the Project enhances the potential positive effects for employment and income which includes a commitment for the preferential hiring of Kitikmeot Inuit, followed by other Inuit and residents of Nunavut.

2.10.3 Education and Training

The Project addresses the potential for increased demand for education and training, and facilitates changes to perceptions about education and employment. TMAC will provide a number of capacity-building on-the-job programs and has further committed to engaging the Government of Nunavut, and local education and training providers, on Project workforce needs. Additionally, TMAC participates in information sessions at local high schools potentially influencing local perceptions of the link between education and employment.

2.10.4 Migration, Housing, and Infrastructure and Services

A number of Project design elements are anticipated to reduce the potential for adverse effects to migration (or population influx), housing, and infrastructure and services. These include the fly-in/out operation of the Project, the two-week-work and two-week-off rotation schedule, and the development of worker accommodations at site. The Project design adopts each of these measures to negate incentives for relocation and mitigates potential effects on migration, housing, and infrastructure, and services to the Kitikmeot Region.

2.10.5 Community Health and Well-being

The Project addresses potential effects to community health and well-being through a number of measures. These include various assistance options for workers and families through the EFAP, the work rotation schedule, and the provision of a country foods kitchen at the site. Each of these serves to reduce potentially adverse effects and promote the enhancement of Project benefits to community health and well-being.

2.11 PUBLIC ENGAGEMENT

The Project includes ongoing engagement through community meetings, career workshops and presentations, a TMAC office in Cambridge Bay, and online feedback mechanisms. Engagement provides a means for the public to continually influence the Project Construction, Operation, Reclamation and Closure, and Post-closure phases.

As described in the description of the evaluation of alternatives (Volume 3, Section 7), community acceptability or preference refers to the expressions of approval or preference in local communities described in the Socio-economics chapter (Volume 6, Section 3). Project alternatives have been presented and feedback has been received through a number of consultation methods. The Traditional Knowledge chapter (Volume 2, Section 2), and Public Consultation and Engagement chapter (Volume 2, Section 3) give details on the methods and results of community engagement.

2.12 FUTURE DEVELOPMENT

Consideration of potential future development is an integral part of the Project development. The Project itself is part of a staged approach to development of the Belt that may facilitate the identification, permitting and development of additional mining activities. The presence of existing infrastructure constructed or maintained for this Project would be of value to future projects.

The potential for future development is described in Section 8 of this document. The role that this Project potentially plays in facilitating future development.

3. Construction Phase

3.1 OVERVIEW

3.1.1 Project Schedule

The Project is scheduled to achieve continuous mine operations in the Hope Bay Greenstone Belt through mining at Doris, a bulk sample followed by commercial mining at Madrid North and South, and mining of the Boston deposit. The Project schedule (Figure 3.1-1) illustrates TMAC's staged approach to conducting the Project Permitting, Construction, Operation, Reclamation and Closure, and Post-closure phases at Madrid and Boston deposits.

3.1.2 Use of Existing Infrastructure

Existing site infrastructure and/or approved infrastructure that may be used for Project construction activities include:

- all-weather airstrip at the Boston exploration area and helicopter pad;
- seasonal construction and/or operation of winter ice strip on Aimaokatalok Lake;
- Boston Site with capacity for up to 65 people during construction;
- Quarry D Camp with capacity for up to 100 people;
- seasonal construction/operation of Doris to Boston winter road route (WRR); and
- three existing quarry sites along the Doris to Windy all-weather road (AWR).

Existing site infrastructure and/or approved infrastructure that will be in use for other operating/exploration projects and that may also be used to support Project construction activities includes:

- Doris Site with capacity for up to 280 people;
- Doris airstrip, winter ice strip, and helicopter pad;
- Roberts Bay offloading facility and road to Doris; and
- Madrid North and Madrid South sites and access roads.

Figure 3.1-2 shows approved infrastructure footprints for Doris and Roberts Bay and the proposed infrastructure for Phase 2, including the expanded TIA.

3.1.3 Scope of the Madrid Advanced Exploration Program

This assessment assumes that construction of the Madrid North and Madrid South pads, roads, facilities, and underground workings will occur under the authorizations and approvals under TMAC's Madrid Advanced Exploration Program (TMAC 2014). TMAC has submitted an application to the NWB for a Type B Water Licence for the Madrid Advanced Exploration Program which includes components related to undertaking continued exploration and the bulk sample program located on IOL over a 10-year period.

The application is under review and entails the incremental expansion of the existing exploration infrastructure at Madrid North and Madrid South to accommodate production mining.

Figure 3.1-1
Project Schedule

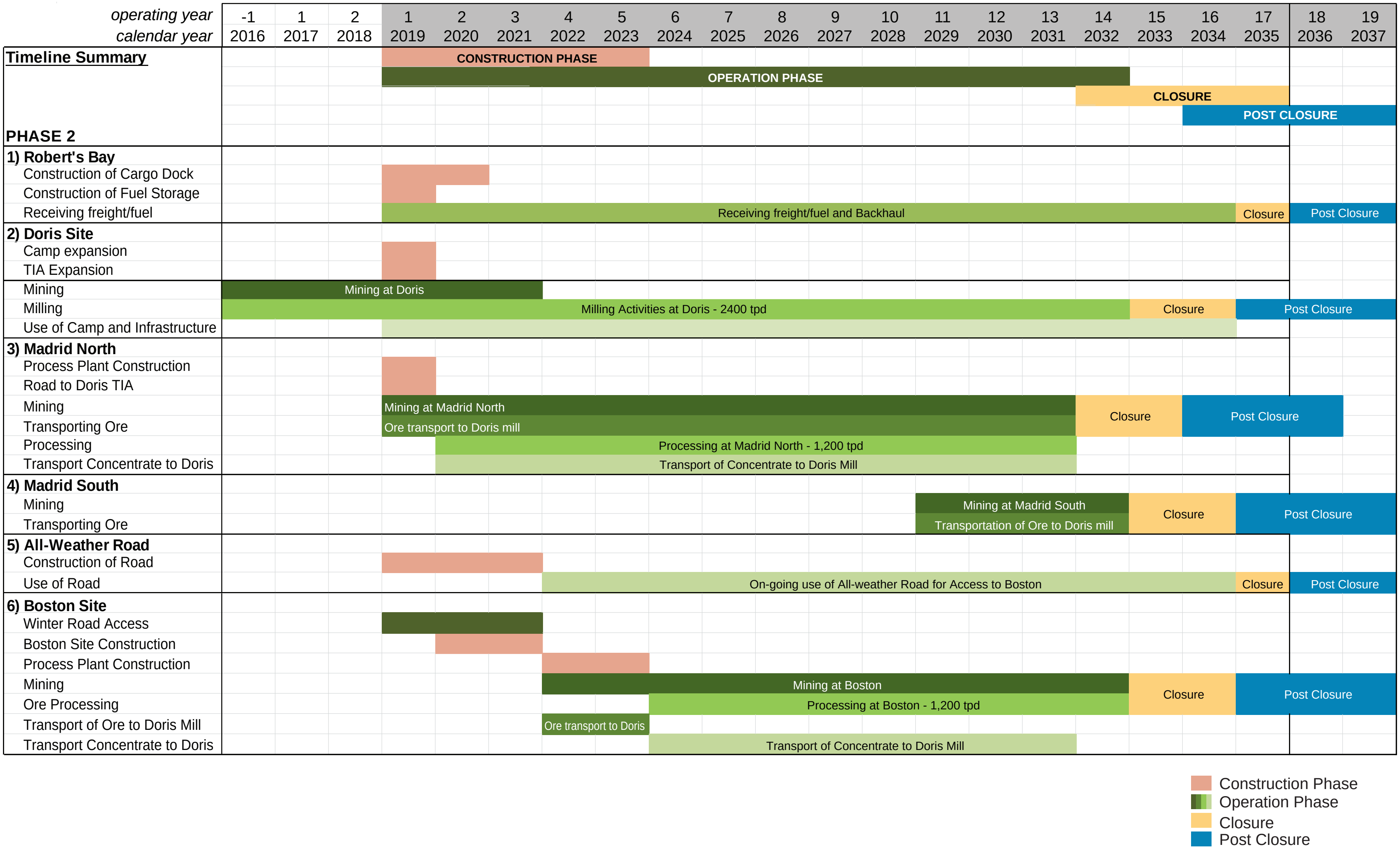
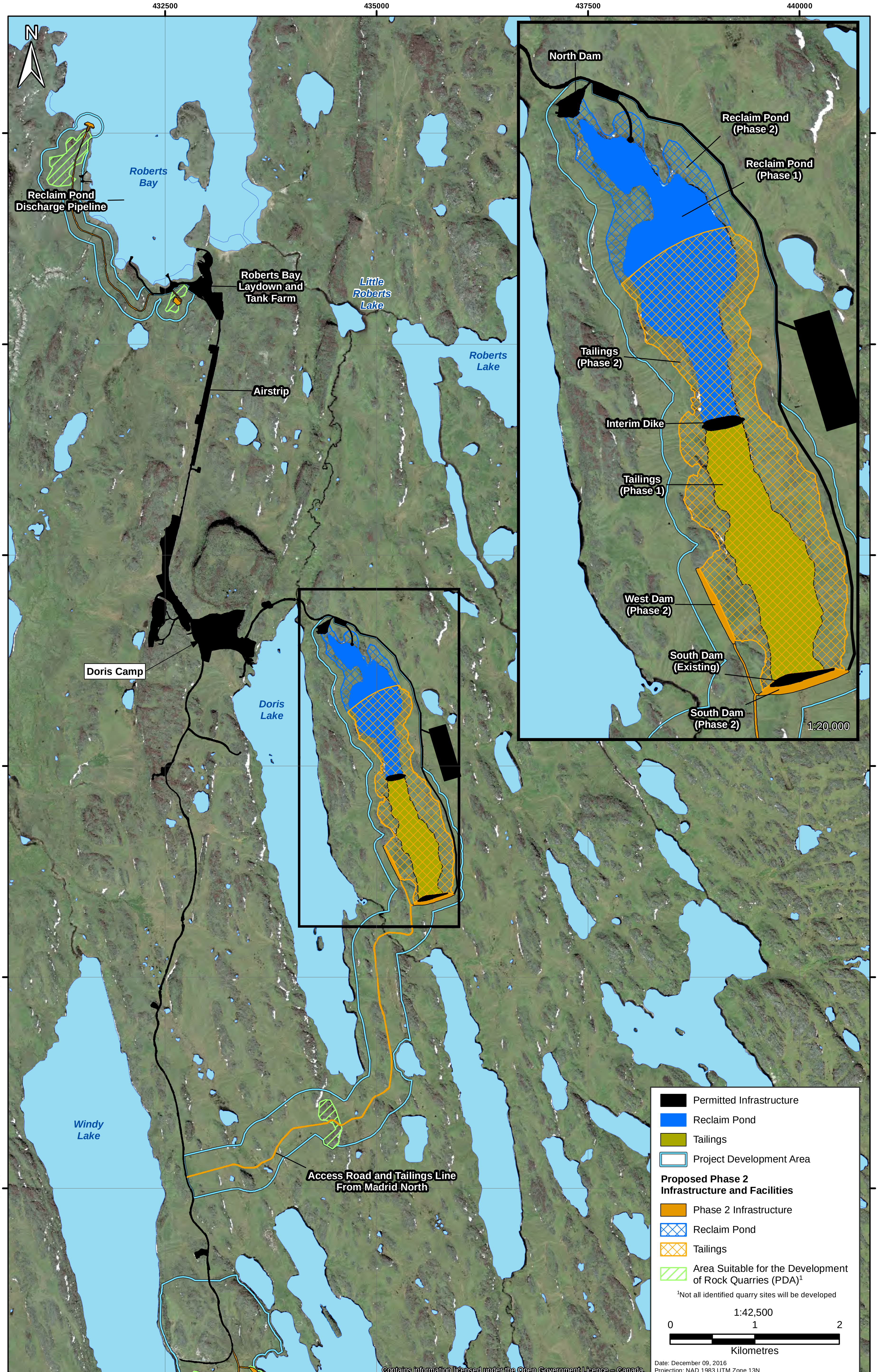


Figure 3.1-2

Doris Approved and Proposed Phase 2 Footprints



The Phase 2 Project schedule is presented in Figure 3.1-1. While construction will overlap with operation of the Doris facilities, it is expected that the construction of the Madrid North facilities will be completed within a year of Project approval. Ore mined at Madrid North will be trucked to the Doris mill for processing until the Madrid processing plant is operational.

Construction of the Boston facilities will begin once of the all-weather access road is completed. The plan is to truck ore mined at Boston to the Doris mill for the initial two years of mining operation while the Boston processing plant is constructed. Once the Boston processing plant is operational, the concentrate produced at Boston will be trucked to the Doris mill for gold recovery.

The Madrid North and South bulk samples are expected to yield resource information on the mineral deposits in those areas. Exploration activities at each site will consist of four components: diamond drilling, underground development, test stoping, and bulk sampling of the ore.

The Madrid Advanced Exploration Program includes the following components and activities.

- Utilization of existing infrastructure associated with the Doris Project:
  - camp facilities to support up to 70 personnel as required to undertake the advanced exploration activities;
  - mill to process ore;
  - Tailings Impoundment Area (TIA);
  - landfill and hazardous waste areas, particularly if closure and remediation becomes required for the Madrid Advanced Exploration Program infrastructure;
  - fuel tank farms; and
  - Doris airstrip and Roberts Bay facility for transport of personnel and supplies.
- Utilization of existing infrastructure at the Madrid and Boston areas:
  - borrow and rock quarry facilities: existing Quarries A, B, and D along the Doris-Windy AWR;
  - AWR between Doris and Windy Lake for transportation of personnel, ore, waste, fuel, and supplies; and
  - future mobilization of existing exploration site infrastructure, should it become necessary.
- Construction of additional facilities at Madrid North and South:
  - access portals and ramps for underground operations at Madrid North and at Madrid South;
  - 4.7 km extension of the existing AWR originating from the Doris to the Windy exploration area (Madrid North) to the Madrid South deposit, with associated access road turn-offs;
  - development of a WRR from Madrid North to access Madrid South until AWR has been constructed;
  - all weather access road and tailings line from Madrid North to the south end of the TIA;
  - borrow and rock quarry facilities; two quarries referenced as Quarries G and H;
  - waste and ore stockpiles; and
  - water and waste management structures.
- Undertaking of advanced exploration access to aforementioned deposits through:
  - continue field mapping and sampling, as well as airborne/ground/downhole geophysics;
  - diamond drilling from the surface and underground; and

- bulk sampling through underground mining methods and mine development.

3.1.4 Scope of Project Construction

The proximity of the Madrid area to the Doris Site, process plant, and TIA provides the opportunity for the Project to utilize existing infrastructure at Doris as an integral part of the Phase 2 Project. It is anticipated that this will reduce costs, minimize the footprint and minimize the time required to complete the development, and production at the Madrid deposits, and to facilitate transition to development and production at the Boston deposit. The permitted infrastructure and facilities at Roberts Bay and Doris (Project Certificate No 003 and Type A Water Licence 2AM-DOH1323) have sufficient capacity to support Project construction for Phase 2.

The Project Construction will include:

- expansion of the Doris TIA (raising of south dam and construction of west dam);
- construction of an off-loading cargo dock and additional fuel storage at Roberts Bay;
- complete development of the Madrid North and Madrid South underground workings;
- incremental expansion of infrastructure at Madrid North and Madrid South to accommodate production mining;
- construction of a 1,200 tpd concentrator and a power plant at Madrid North;
- all weather access road and tailings line from Madrid North to the south end of the TIA;
- all-weather road (AWR) linking Madrid to Boston;
- all-weather airstrip at Boston;
- all infrastructure necessary to support mining and milling activities at Madrid and Boston including construction of a new accommodation facility at Boston and associated support facilities, additional fuel storage, ore pad, waste rock pad, concentrator, and dry-stack tailings management area (TMA) at Boston; and
- infrastructure necessary to support ongoing exploration activities at both Madrid and Boston.

3.1.5 Construction Workforce

The construction activities will begin in Year 1 (2019) and carry through Year 5. TMAC expects that the construction workforce will peak up to 200 individuals (on shift at any one time) and that construction workers will be housed at both the expanded Doris Site (400 beds) and the new Boston Site (200 beds).

At Boston, priority will be placed on construction of the proposed 200 bed camp. The camp modules will be shipped to Roberts Bay during the summer of Year 1 and later transported to the Boston Site over the winter road (winter of Year 2). This camp is expected to be operational by the summer of Year 2 and will house the construction crews working on the Boston Site development and the southern portion of the all-weather road. Construction activities at Boston are expected to last for up to three years.

As construction activities winds down at Boston (by Year 3 and 4 of the Project), the development of the mine (Year 4) and the operation of the processing plant will begin (Year 5). During these transition years, the Boston Site will house both construction and operation crews. Once mine production and processing plant operation ramp up to full capacity, the 200 beds camp will be used to accommodate the operation crews.

It is expected that the total workforce at the Hope Bay belt (construction and operation crews) will likely peak up to 600 individuals.

3.2 QUARRYING

The development and ongoing maintenance of Project facilities and infrastructure will require the development of quarries for aggregate sourcing. The Project design has identified all potential quarry sites and the quarry material is geochemically stable (Appendix V3-3A). Total quarried material requirements for Project Construction are expected to be 5 million tonnes.

Quarry outcrops vary in height and will be drilled and blasted in benches. Where the rock mass is competent, the conventional hard rock bench design parameters are for 3 to 5 m high benches with 80° wall slopes. Bench setbacks will be between 3 and 5 m. Based on observed rock quality, these parameters will be adjusted throughout quarry development.

Figure 3.7-1 identifies the location of quarries for the AWR. Of the quarries identified four are likely to be used. The decision on which quarry will be accessed will depend upon the progression of the AWR and the haul distance to the next section of the AWR. Due to the cost of moving and operating crushers, most quarries will only be accessed once or twice during the LOM. Sufficient crush will be processed to supply that area of the Project for the LOM. Quarries associated with Madrid North (Quarry H), Madrid South (Quarry H), Boston (Quarry AD), and Madrid South AWR (Quarry G) will be developed during the Construction phase.

Surface runoff (rain and snowmelt) management will consist of an upstream quarry berm to prevent runoff from outside of the quarry footprint from entering the area, as well as a downstream berm to contain surface runoff within the quarry footprint. The rock will be mined near to grade, but not to a level below grade to avoid creating permanent ponds at closure. The quarry base will have a low spot or sump where this water can collect without affecting quarry operations. The sump will be large enough to contain water until it meets standards acceptable for discharge to the environment. The development and operation of each quarry site Annex 17).

3.3 ROBERTS BAY

Roberts Bay is located approximately 5 km from the Doris Site and is the port entry point for the Belt. The port has a jetty for offloading cargo and fuel, and a fuel storage facilities. In order to provide for the economic supply of material and equipment into the Belt, an annual sealift is required. This sealift generally occurs in the open water period of August through October, when ships and barges can access Roberts Bay.

3.3.1 Cargo Dock

To support the safe and efficient offloading of fuel, equipment and supplies a cargo dock (Appendix V3-3B), and access road (Appendix V3-3C) to the dock and fuel pipeline along the access road will be constructed at Roberts Bay (Figure 3.3-1). In addition to the construction of the dock, an additional 10 ML tank farm consisting of two 5 ML tanks will be constructed at Roberts Bay (Appendix V3-3D).

Preliminary design criteria for the dock facilities include geometry and load capacity required to support the design vessel(s) and estimated equipment loads. Design environmental criteria include site geotechnical characteristics and loads associated with ice, surge and wave interaction

Along with the marine cargo dock other components required to support a cargo dock that unloads fuel include:

- **Mooring Points -** Upland mooring points (if required) to assist the tanker in positioning and holding in place while offloading the fuel. Additional points will be established on shore with rock anchors or large blocks, to fix the temporary containment boom to shore.
- **Beach Landing and Gravel Pad** - A natural beach landing sufficient to land a 5 to 8 m work boat is required. This can be a natural beach area or ROQ (greater than 1 m) placed in shallow water to create an artificial work boat landing site. Adjacent to the beach landing will be a gravel pad (approximately 30 × 30 m) for vehicle turn-around and spill container storage.
- **Shore Manifold** - Reel with enough floating hose and manifold for connecting from the tanker to the pipeline.

3.3.2 Shipping Activities during Construction

Roberts Bay receives all fuel, equipment and material required for Project construction. During the Construction phase, TMAC expects to receive fuel shipment during each open water season. Fuel will be delivered by double-hull fuel tankers and unloaded by lightering a barge or floating hose. TMAC has a functional Oil Pollution Emergency Plan (OPEP) for its fuel depot at Robert Bay (Volume 8, Annex 3). Transport Canada reviews the OPEP on an annual basis. This OPEP will be revised as required to address any changes to fuel offloading.

From the Roberts Bay main tank farm, tanker trucks will distribute fuel to designated storage areas and tank farms at Doris, Madrid, and Boston, as required.

Sealifts for construction material, equipment, freight, and resupply will occur during the open water season. Expected shipping volumes are presented in Table 3.3-1.

Table 3.3-1. Expected Shipping Volumes for Construction and Operation Phases

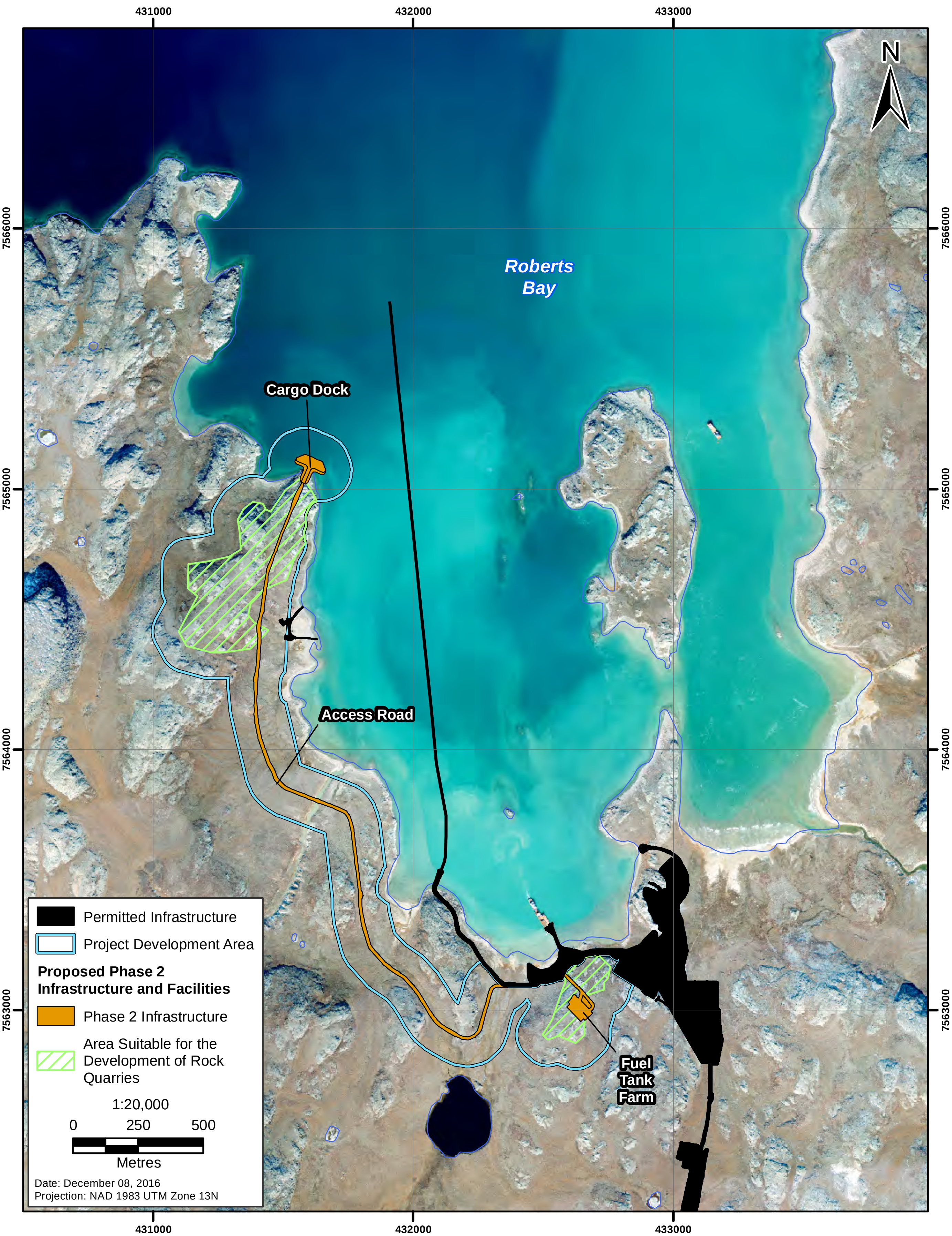
	Construction Phase		Operation Phase	
	Quantity per Year	No. of Vessels per Year	Quantity per Year	No. of Vessels per Year
Freight/Resupply	12,000 to 14,000 tonnes	4	10,000 tonnes	4
Fuel	30 ML	2	40 ML	2 to 3
Shipping season: August to October annually				

The site is set up to receive the material using the existing laydown areas at Roberts Bay via direct shipment on barge or via lightering barge transfer from freighters moored in the Bay.

TMAC plans and books the logistics surrounding the sealift in 2nd quarter (Q2) of each year to maximize supply of material, equipment, etc., during the short shipping season.

All shipping and ship providers will follow Canadian and Arctic shipping legislation, including the *Canada Shipping Act* (2001) and the *Arctic Waters Pollution Prevention Act* (1985) and regulations therein that outlines overall shipping safety, training, roles and responsibilities of captains and crews, and environmental protection.

Figure 3.3-1
Roberts Bay Infrastructure



3.4 DORIS SITE

The Project construction activities include expansion of the TIA (storage of 18 Mt of tailings), the expansion of the camp to accommodate up to 400 persons, and, increase in water supply. An additional 100 beds may be required for the peak construction period. No other facilities or infrastructures require modification beyond existing authorizations to support Project construction and operating activities.

The Project requires expansion of the Doris TIA, which will include:

- construction of a new perimeter road around sections of the expanded TIA;
- raising the south dam by 8 m;
- constructing a 5 m high west dam; and
- quarrying, crushing, and screening of aggregate for the construction.

The design for the Doris TIA specifies a subaerial deposition of about 2.5 million tonnes (Mt) of tailings. The TIA is a former lake (Tail Lake), delisted in accordance with Schedule II of the Metal Mining Effluent Regulations (MMER). Project construction will expand the TIA capacity to accommodate the entire volume of flotation tailings scheduled from mining at the Madrid North, Madrid South, and a portion of the Boston underground workings. The scheduled total tailings storage requirement for the Doris TIA is 18.0 Mt (14 million m^3). There will be no changes to the water discharge system of the TIA. A marine outfall discharges the final effluent directly to Roberts Bay as authorized under the Doris Project Type A Water Licence 2AM-DOH1323 (the Type A Water Licence).

Tailings will be permanently contained within three dams: the North, South, and West dams. The North Dam will function as a water-retaining dam, while the South and West dams will have tailings deposited against the upstream face, pushing the reclaim pond away from these structures. The North Dam is a water-retaining frozen core dam and was constructed in 2012, while the South and West dams are planned as frozen foundation rock fill dams incorporating a geosynthetic clay liner (GCL). Tailings will be spigotted from a number of points along the eastern perimeter of the TIA and from the South Dam, creating a landscape that drains towards the North Dam at an average slope of about 1%. The details of the TIA expansion are presented in *Hope Bay Project – Doris Tailings Impoundment Area – Phase 2 Design* (Appendix V3-3F).

Approximately 8% of the process plant tailings are comprised of detoxified cyanide tailings, and this tailings stream will be sent underground where it will be mixed with underground waste rock for use as structural mine backfill. The volume of detoxified tailings is expected to be less than 10% of the ore processed. Storage requirement planning conservatively considered the overall total tailings volume to be stored in the TIA without subtracting the detoxified tailings.

3.5 MADRID NORTH

The final production-level design of Madrid North is described in *Hope Bay Project – Madrid North Surface Infrastructure* Preliminary Design (Appendix V3-3G). The construction activities for the Project are those required to modify the site from its configuration for the Madrid Advanced Exploration Program. The Project construction activities required to modify the site include:

- expansion of the site pad, primarily to accommodate a larger waste rock stockpile;
- construction of a tailings pipeline and service road to Doris TIA;

- expansion of the Contact Water Pond (CWP) to accommodate the larger pad area;
- use of a local quarry to produce construction bulk rock fill and aggregate;
- construction of a 1,200 tpd capacity process plant;
- construction of a 3.6 MW capacity power plant;
- construction of a 4.5 ML fuel storage facility; and
- construction of three vent raise pads and associated access roads.

The final design of the Madrid North site is illustrated in Figure 3.5-1. Detailed reference drawings for the Madrid North site are listed in Appendix V3-3G, Attachment 1.

3.5.1 Fuel Storage at Madrid North

3.5.1.1 Design Criteria

Design criteria are:

- fuel storage tanks and transfer station are within a lined facility to provide secondary containment, should leaks occur;
- the design vehicles for the facility are crew cab trucks and Super B train fuel trucks (60,000 L capacity);
- the secondary containment facility is designed to contain 110% of the fuel tank volume, 10% of the fuel transport truck volume, all the rainfall from the 1:100 year, 24-hour storm runoff, and the average maximum daily snowmelt; and
- the containment area has a minimum slope of 1% towards a sump.

In addition, the fuel facility meets the following codes and guidelines:

- NFPA (2014) 30, Flammable and Combustible Liquids Code, 2015 Edition;
- Environmental Code of Practice for Aboveground and Underground Storage Tank Systems Containing Petroleum and Allied Petroleum Products (CCME 2015); and
- ORD-C58.9-1997, Secondary Containment Liners for Underground or Aboveground Tanks.

3.5.1.2 Design

The fuel tanks will be located in a row in the center of the facility, a minimum of 3.0 m from the base of the containment area berms, and 9.8 m between tanks to allow access. The containment berms will be constructed of transition material overlain by the geomembrane and bedding layers. To reduce the amount of construction material required and the height of the containment berms, the base of the fuel facility will be cut into bedrock. The berms will have interior slopes of 2H:1V to allow for geomembrane placement and will have exterior slopes of 1.5H:1V. The secondary containment facility will have a surface area of approximately 6,800 m^2 and a minimum containment capacity of approximately 5,500 m^3.

There will be a 6 m wide ramp allowing vehicles to drive through the fuel facility. Ramps sloping at 5 to 6% enter and exit the facility. A flat area within the facility is where the fuel transfer module will be set up and where refueling will occur.

3.5.2 Madrid North Process Plant

TMAC proposes to carry out crushing, milling and concentration of ore at Madrid North. The concentrate will correspond to less than 10% of the ore milled, and will be transported to the Doris mill for gold extraction. Hence, the Madrid North concentrator does not require the use of cyanide in the extraction process. Tailings from the concentrator will be directed to the existing TIA via an access road to be constructed north of Patch Lake (Figure 3.5-1). This route is the shortest routing to the TIA and therefore minimizes pumping requirements, maintenance of the line and minimizes spill potential due to a shorter length of pipe.

Site preparation and construction of the foundation for the concentrator will aim to begin in the spring. Site preparation consists of leveling the site by benching into the bedrock outcrops. Concrete pads for the building and crushing/concentrator equipment will be built during the summer months. A concrete batch plant will be transported to Madrid North prior to commencing construction. To the extent practicable, the mill building will be prefabricated in modular sections, transported to site, and assembled on the prepared foundation pads. Crushing and milling equipment will be shipped to Roberts Bay during the open water season, transported to the Madrid North site on the AWR, and placed on the prepared foundations within the mill building.

Construction of the concentrator building is expected to be completed within one year.

3.6 MADRID SOUTH

The design of the Madrid South is described in *Hope Bay Project* – Madrid South Surface Preliminary Infrastructure Design (Appendix V3-3H). The construction activities for the Project are those required to modify the site from its configuration for the Madrid Advanced Exploration Program. The Project construction activities required to modify the site includes:

- expansion of the site pad, primarily to accommodate a larger waste rock stockpile;
- vent raise and access road;
- expansion of the primary CWP to accommodate the larger pad area; and
- use of a local quarry to produce construction bulk rock fill and aggregate.

The design of the Madrid South site is illustrated on Figure 3.6-1. Detailed reference drawings for the Madrid South site are included in Appendix V3-3H Attachment 1.

3.7 MADRID-BOSTON ALL-WEATHER ROAD

The design of the Madrid-Boston AWR (Figure 3.7-1) is described in *Hope Bay Project – All Weather Road Preliminary Design* (Appendix V3-3I). The AWR will be constructed for the Project and, therefore, its construction is attributable to the Project. The Project construction activities include:

- development and use of quarries to produce construction bulk rock fill and aggregate;
- construction of the AWR per design;
- installation of culverts and bridges at water crossings; and
- use of the established Madrid-Boston winter road route or other short localized winter routes as required to enable efficient construction of the all-weather road.

Figure 3.5-1
Madrid North Layout

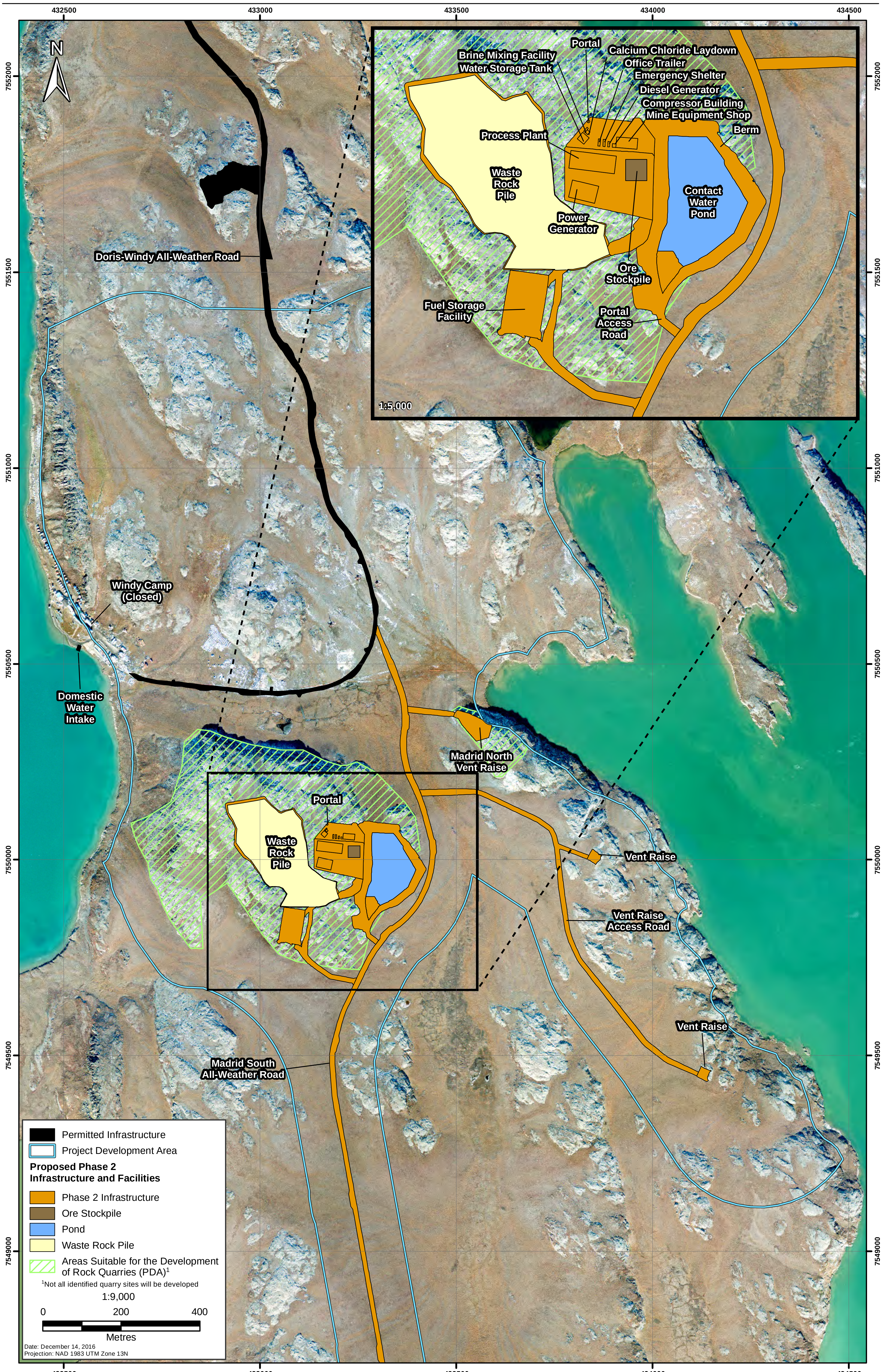


Figure 3.6-1
Madrid South Layout

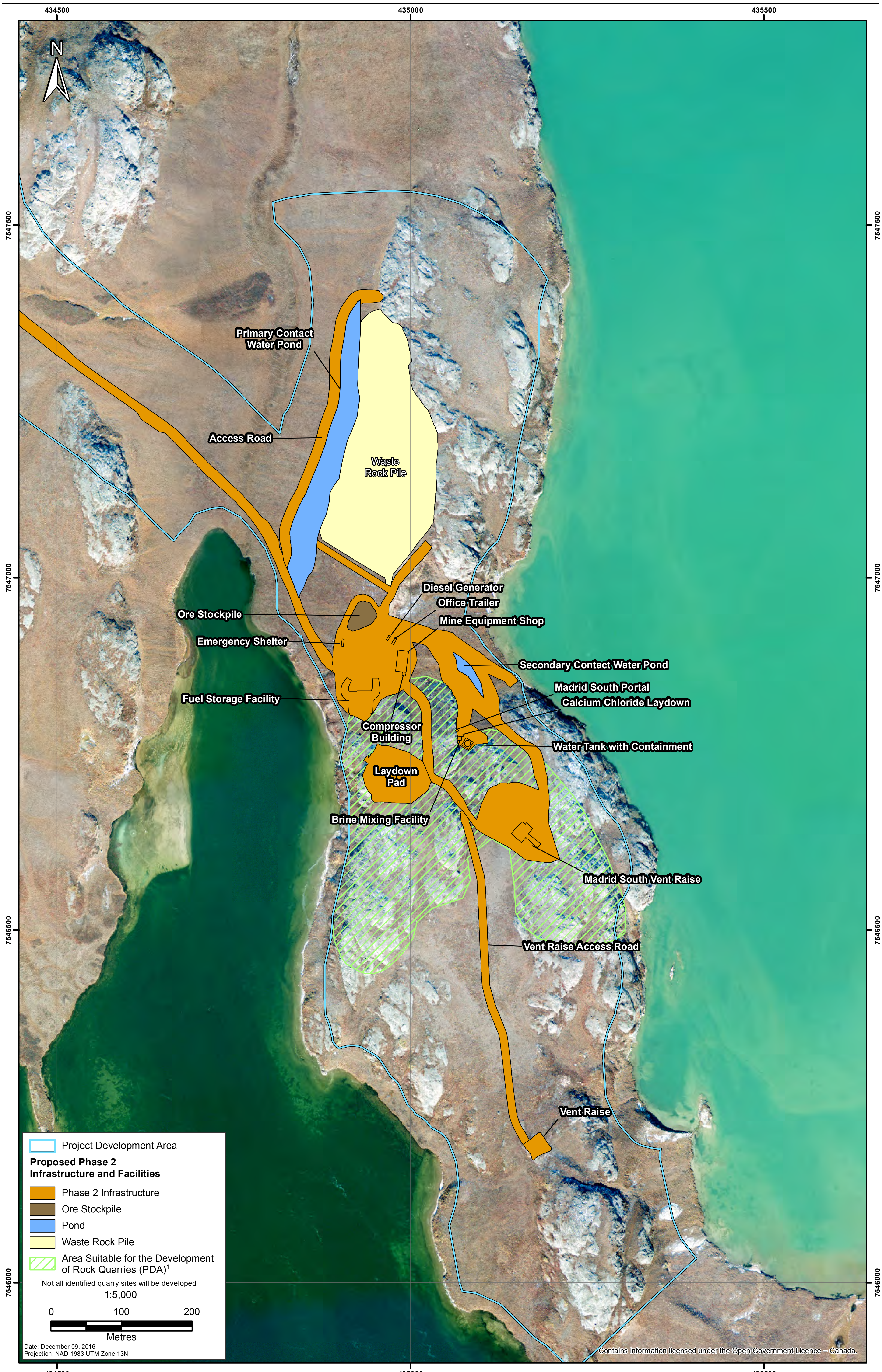
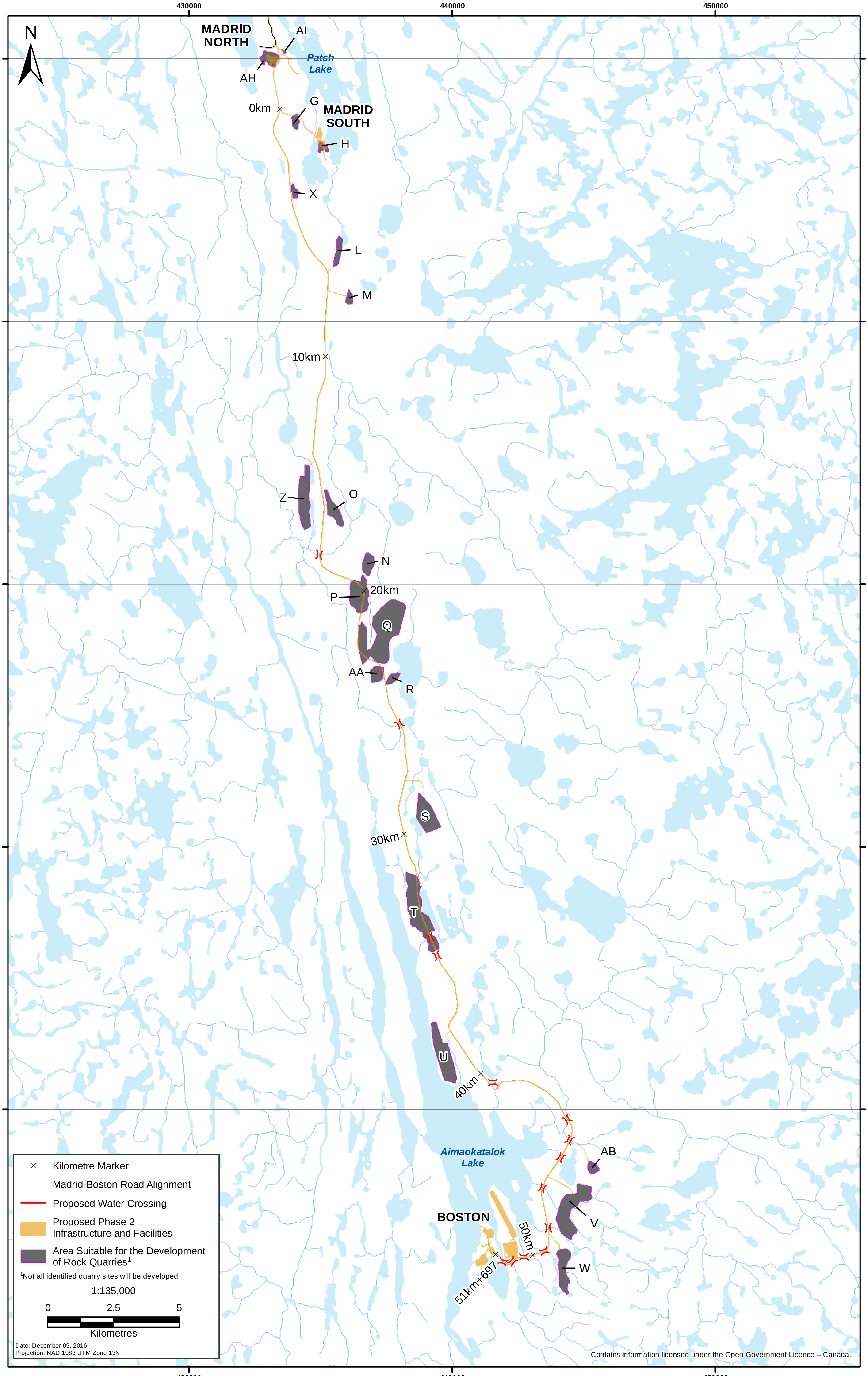


Figure 3.7-1
Madrid–Boston All-Weather Road and Potential Quarry Locations



The design of the Madrid-Boston AWR and all potential quarry locations are illustrated on Figure 3.7-1. Not all of the potential quarry locations are planned to be utilized, pending final designs. Detailed reference drawings for the proposed AWR corridor are included in Appendix V3-3I. Geochemical characterization of potential quarry locations for construction of the AWR is provided in Appendix V3-3A.

3.7.1 All-weather Road Design Objectives

The objectives for the AWR connecting the Madrid and Boston Mining areas are:

- provide year-round access between the three mining areas (Doris, Boston, and Madrid);
- enable the initial haulage of ore and gold concentrate from Boston and Madrid to Doris;
- improve drill support efficiency and reduce operating costs;
- limit tundra damage on existing WRR and avoid new WRRs being created; and
- improve site safety at Boston and Madrid by ensuring year round medical evacuation ability through the other camps and airstrips.

3.7.2 All-weather Road Foundation Conditions

Permafrost in the Project area extends to depths of 570 m. The ground temperature near the depth of zero annual amplitude ranges from −9.8 to −5.6°C, with an average of −7.6°C. Active layer depth based on ground temperatures measured in overburden soil averages 1.0 m with a range from 0.5 to 1.7 m. The average geothermal gradient is 0.021°C/m.

Permafrost soils are comprised mainly of marine clays, silty clay and clayey silt, with pockets of moraine till underlying these deposits. The most prevalent rock type on site with surface exposure is mafic volcanics, predominantly basalt. The marine silts and clays contain ground ice on average ranging from 10 to 30% by volume, but occasionally as high as 50%. The till contain typically contains low to moderate ice contents ranging from 5 to 25%.

3.7.3 Design Criteria

The road is designed to be a single lane road with turnouts to allow for passing. Haul trucks will be used to construct the road and will travel the road and during operations, the road will support the haulage of ore; therefore, the haul road standards set out in the Consolidated Nunavut Mine Health and Safety Regulations are applied to this road. The road design criteria are as follows:

- the design vehicles will be crew cab trucks, personnel transfer busses, Super B-Fuel Trucks and Super B-Trucks, and Lowbed Truck. In addition, construction equipment will periodically travel the road, which is expected to include: CAT 988 loaders, CAT 325 excavators, CAT D10 dozers, and CAT B-300 and CAT 773 haul trucks. CAT 773 haul trucks can only traverse stream crossings while empty;
- the maximum design speed for any vehicle will be 50 km/h;
- thermal analysis indicates that road fill should be a minimum of 1.5 m thick to ensure the permafrost foundations remain frozen; however, observations of existing infrastructure indicate that a 1.0 m minimum fill thickness should be sufficient;
- minimum road thickness over bedrock is 0.3 m;

- the minimum crest road width will be 8 m for single lane traffic and 11 m for dual lane traffic. Where the road shoulder is more than 3 m above the ground, the road will be widened by 1 m and a safety barrier will be constructed at least 1 m high;
- the maximum grade is 10%; however, wherever possible grades less than 4% will be targeted;
- stream crossings confirmed not to be fish habitat will be spanned using culverts if the peak flow is sufficiently low. High flow fish-bearing streams will be spanned using bridge structures. Fish-bearing streams of lower flow will be spanned using culverts sized for fish passage provided the required conditions necessary to sustain fish habitat can be achieved;
- the routing as far as is practical will avoid stream, channel crossings and wet, boggy areas where fish habitat may be disturbed;
- winter snow clearing of this road will require significant effort; therefore, routing of the road should consider areas where the natural topography would assist in minimizing snow drifting; and
- to prevent snow accumulation on the roadway, in areas where the road fill is greater than 3 m, selected portion of the road side slopes may be flattened to 5H:1V to prevent the need for barriers.

3.7.4 Road Design

The selected road alignment extends south from the Madrid South AWR and roughly follows the east side of Aimaokatalok Lake before terminating in the Boston mining area. The road alignment is presented on Figure 3.7-1. This alignment considered cultural and environmentally sensitive areas and reduces the bridge spans at stream crossings.

3.7.4.1 Typical Cross Section

Thermal modelling was completed to determine fill thickness required to preserve permafrost under infrastructure such as the AWR. Thermal modelling details can be found in the *Infrastructure (Pad/Roads) Thermal Modelling Report* (SRK 2016b). Four typical fill thicknesses (Bedrock Zone, Zone 1, Zone 2, and Zone 3) ranging from 0.3 to 2.0 m were identified based on the thermal modelling and observed performance of roads previously constructed on site. Fill zones are assigned based on site specific ground conditions, identified through air photo interpretation:

- Bedrock Zone is exposed bedrock outcrop that may be blasted if necessary and has a minimum fill thickness of 0.3 m;
- Zone 1 is even, un-patterned ground and has a minimum fill thickness of 1 m;
- Zone 2 is transitional, un-patterned ground with indications of drainage areas, but no frost polygons. This zone has a minimum fill thickness of 1.5 m; and
- Zone 3 is patterned ground with observable frost polygons or wet areas and has a minimum fill thickness of 2 m.

Roads will consist of approximately 0.15 m of surfacing material overlying a layer of run-of-quarry (ROQ) material of varying thickness depending on the zone classification. Dual lane roads will occur in areas of Madrid and Boston Site areas where transport of ore, waste rock and other higher traffic areas exist.

Road turnouts matching the fill zone thickness of the road and measuring 4 m wide and 30 m long will be constructed at a minimum frequency of 1 km along longer sections of road such as the Madrid to Boston all weather road.

3.7.4.2 Animal Crossings

It is expected that animals will be able to move freely across the majority of the all-weather road. During design of the road, community members will be consulted as to locations along the road where road bank could be modified with a more gradual slope to ensure easier passage (if required). These crossing locations will likely consist of 10 m wide sections of the roadway where the shoulders are flattened to 5H:1V and topped with surfacing material.

3.7.4.3 Stream Crossings

For the purpose of this EIS, TMAC has defined a stream as preferential flow paths for surface freshet melt water and rainfall such that it may contain water seasonally or permanently, and frequently links permanent water bodies. Crossings locations and features are based on air photo interpretation, topography, available hydrology data, and photos and descriptions from previous studies. Four crossing types have been identified as culverts, fish-bearing culverts, bridges with pile foundations, and bridges with frozen abutment foundations. Table 3.7-1 provides details on the 16 stream crossings on the proposed AWR.

Table 3.7-1. Stream Crossing Details

Crossing ID	Crossing Type	Minimum Span Length* (m)	Comments
C-MBR-7	End bearing pile bridge	15 m	Fish presence confirmed (Arctic Grayling)
C-MBR-8	End bearing pile bridge	14 m	Fish presence confirmed (species not confirmed)
C-MBR-9	End bearing pile bridge	20 m	Assumed fish-bearing
C-MBR-10	Culvert	N/A	Generally wet area; preferential flow path not identified; investigate for presence of fish
C-MBR-11	Fish-bearing Culvert	N/A	Generally wet area; preferential flow path not identified; fish presence confirmed (Ninespine Stickleback)
C-MBR-12	End bearing pile bridge	20 m	Fish presence confirmed (Arctic Grayling and Ninespine Stickleback)
C-MBR-13	Fish-bearing culvert	N/A	Very small stream; fish investigate for presence of fish
C-MBR-14	Fish-bearing culvert	N/A	Very small stream; investigate for presence of fish
C-MBR-15	End bearing pile bridge	10 m	Fish presence confirmed (Ninespine Stickleback)
C-MBR-16	End bearing pile bridge	12 m	End bearing pile span would reduce the required width. Fish presence confirmed (Arctic Grayling and Ninespine Stickleback)
C-MBR-17	Culvert	N/A	Very small stream; investigate for presence of fish
C-MBR-18	Culvert	N/A	Generally wet area; preferential flow path not identified; investigate for presence of fish
C-MBR-19	End bearing pile bridge	12 m	Fish presence confirmed (Lake Trout, Arctic Grayling, Burbot, Slimy Sculpin and Ninespine Stickleback)
C-MBR-20	Frozen abutment bridge	N/A	Very small stream; fish presence confirmed (Ninespine Stickleback and Slimy Sculpin)

**Typical supplier bridge span lengths will be used where possible to avoid custom manufacturing.*

Culvert Crossings (Non-fish-bearing)

Stream crossings confirmed not to be fish habitat will be spanned using 1 m diameter culverts.

Culvert Crossing (Fish-bearing)

For fish-bearing streams with minimal flow, culverts sized to allow fish passage will be used. A typical fish-bearing culvert will have a minimum diameter of 1 m and riprap will be placed inside the culvert to dampen the flow velocity to allow the passage of fish. Culvert diameter and rip-rap size will vary depending on the catchment area reporting to the crossing and the type of fish expected. A frozen abutment clear span crossing will be used in cases where detailed analysis indicates that conditions to sustain fish cannot be achieved using a fish-bearing culvert crossing.

Bridge Crossings

A crossing structure will be constructed at all stream crossings that are fish-bearing and free flowing. The bridge structure will be above the ordinary high water mark (HWM).

Silt fences will be installed along the toe of the roadway to ensure that sediments do not enter the streams. The silt fences will start a minimum of 3 m before the abutment of the clear-span structure.

3.7.5 Road Development

3.7.5.1 Fill Classification

Two different fill materials are preferred for the construction of the proposed road. These materials are summarized below in Table 3.7-2.

Table 3.7-2. Classification of Fill Materials

Fill Material	Classification
Run-of-Quarry	1 m maximum, well graded
Surfacing Material	32 mm minus crush

3.7.5.2 Fill Source

All fill required for the proposed road will be produced from geochemically suitable rock quarried on-site. Coarse-grained esker material will be avoided for road construction. Details on the geochemical characterization of the potential quarries are provided in Appendix V3-3A.

Twenty-one potential quarries have been identified along the Madrid-Boston AWR, based on air photo interpretation and geological maps of the area. Geochemical testing has been performed on 15 of the identified quarries. The remaining quarries are typically located within well-studied rock types, which are expected to be suitable for construction.

Identified quarries have been ranked and classified as preferred and non-preferred based on environmental and social sensitivities and rock type (Appendix V3-3I, Appendix B). The potential quarry locations are shown on Figure 3.7-1.

3.7.6 Construction

3.7.6.1 Construction Schedule

Wherever possible, winter construction of pads and roads will ensure foundation materials remain frozen. Nonetheless, construction during the summer may be required to meet construction schedules. Winter and summer construction techniques will be identical; however, summer construction will require more construction material as greater imbedding of material into the active zone will occur. It is recognized that summer construction will require careful screening of the site for nesting birds and it may be necessary to modify construction schedules to avoid the disturbance of nesting populations.

3.7.6.2 Construction Method

Construction of the road will consist of:

- clearing of the snow and ice off the road alignment immediately prior to fill placement;
- construction fill will be placed by end-dumping along an advancing road surface. After end dumping, the fill will be levelled with a bulldozer;
- surfacing material will not be placed until the ROQ layer has been completed to the design grade and level, and a topographic survey has been performed;
- temporary rock fill turnouts will be constructed to facilitate construction and meet safe pullouts for emergencies;
- road turnouts and animal crossings will be constructed using the same methodology as that used for the road construction; and
- where necessary rock drains will be installed at topographic lows to ensure no standing water is created on or near the road.

3.7.6.3 Construction Equipment

Based on previous road construction on site it is assumed that the construction fleet will consist of CAT 730 haul truck, CAT 773 haul truck, CAT D8 dozer, and a crusher. Truck traffic during construction should provide sufficient compaction that the use of a compactor is not required. However, if a compactor is required it is assumed that the CAT CS563 will be used.

3.7.6.4 Construction Camp

To facilitate construction of the AWR, TMAC may erect temporary construction camps at one or two locations along the proposed alignment. The camps will be self-contained with water and catering provided from the Doris or Boston facilities. Sewage and solid waste will be transported to the Doris or Boston Site for treatment and disposal. The camp will be equipped with a diesel fired heating system. Diesel fuel will be stored in potable double-wall storage facilities. The will be no discharges to the receiving environment.

3.7.7 Logistics

The existing and planned infrastructure at Boston, Madrid, and Doris sites will greatly facilitate the construction needs of the AWR. In addition to construction camps along the AWR, construction crews can be accommodated at the Doris and Boston sites.

The fuel required for construction of the AWR will be stored in existing fuel tank farms at Doris, Madrid or Boston. Re-fuelling of construction equipment will be done using a dedicated fuel truck. Regular maintenance of the construction fleet will take place in existing facilities or long-term facilities planned for Doris, Madrid and Boston.

3.8 BOSTON

The design of the Boston Site infrastructure, excluding the Boston TIA, is described in Hope Bay Project: Boston Surface Infrastructure Preliminary Design (Appendix V3-3J). A complete description of the design of the Boston TMA is provided in Appendix V3-2F. The Project construction reconfigures and expands the existing exploration camp at the Boston Site such that all construction activities are attributed to the Project. The Project construction activities include:

- construction of an expanded site pad and all infrastructure necessary to conduct exploration activities, production-level underground mining, ore processing and tailings deposition;
- expansion of accommodations capacity; and
- use of the established Madrid-Boston WRR until the AWR is operable.

The design of the Boston Site is illustrated on Figure 3.8-1.

Detailed reference drawings for the Boston Site infrastructure are listed in Appendix V3-3J, Attachment A.

3.8.1 Design Concept

The Boston mine site is a self-contained facility, and thus contains all infrastructures required to support the mining operations. The design concept for the Boston pads and roads applies the same principles as used in the Doris and Madrid mine sites. All facilities will be located on either bedrock or rock fill pads at least 1 m thick. Site layouts are designed to minimize the overall footprint, and minimize the volume of contact water. Ponds capture and contain contact water is in for appropriate disposal.

TMAC administers and controls site access roads as private roads (Volume 8, Section 4.11 Road Management Plan in this EIS). Although the use and classification of these access roads are not as mine haul roads, TMAC has designed all site roads to meet or exceed minimum haul road requirements set out in the Consolidation of the Mine Health and Safety Regulations.

3.8.2 Infrastructure Components

The infrastructure associated with the mining activities at Boston include: accommodations, processing plant, power plant, fuel facility, waste rock pile, ore stockpile pads, landfarm, laydown area, and core storage. The components are grouped into zones that must be in proximity to each other for practical use. In the case of the mine and mill zones, buildings must be located near contact water containment.

Boston Site accommodations have an existing capacity of 65 persons, which will be utilized for the Construction phase and replaced with a 200 person accommodations facility for the Operation phase.

Details on the surface footprint for each component and limitations on their location are summarized in Table 3.8-1.

3.8.3 Environmental Setbacks

Environmental setbacks for infrastructure are listed in Section 2.4.