Volume 1 Annex V1-7 Type A Water Licence Applications

Package P4-17

Hope Bay Project Quarry Management and Monitoring Plan

MAC RESOURCES

HOPE BAY PROJECT QUARRY MANAGEMENT PLAN

HOPE BAY, NUNAVUT

DECEMBER 2017

Hope Bay Project Quarry Management Plan

Plain Language Overview:

This Plan describes the management and monitoring requirements for quarries at the Hope Bay Project. Construction of many of the facilities at the Hope Bay Project site require rock for fill material. This rock is to be sourced from various approved quarry sites. Quarry material that will be used for construction is considered to have a low potential for acid rock drainage and metal leaching. Any quarry rock that is unsuitable for use as construction material will be placed as backfill in an underground mine. After waste rock has been exhausted as a source of mine backfill, quarry rock will be required for structural support underground and will be used as a source of mine backfill. The quarrying, infrastructure and road construction activities consist of drilling, blasting, mucking crushing, haulage to usage locations (e.g., the advancing road limit), end dump and levelling. Each activity is to be conducted in accordance with this Plan and the various water licenses for the specific sites.

Hope Bay, Nunavut

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Revisions

Revision #	Date	Section	Changes Summary	Author	Approver
1	April 2010	Throughout		SRK	HBML
2	December 2014	Throughout	Inclusion of Quarries 2, 3 and 4. Update to license requirements. TMAC as current licensee for the Hope Bay region.	SRK	TMAC
3	February 2017	Throughout	Changes to document structure for operational suitability and efficiency	TMAC with contributions from SRK	TMAC
4	November 2017	Throughout	Transfer to new template. Inclusion of Phase 2 quarries, quarry rock use as mine backfill and identification of quarries not suitable for use as construction (and to be used as mine backfill at Madrid North or Boston).	TMAC with contributions from SRK	

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Glossary

Term	Definition
AN	ammonium nitrate
ANFO	ammonium nitrate + fuel oil
ARD	acid rock drainage
ESR	Environmental and Social Responsibility
ICP-MS	Inductively coupled plasma mass spectrometry
INAC	Indigenous and Northern Affairs Canada
KIA	Kitikmeot Inuit Association
ML	metal leaching
NIRB	Nunavut Impact Review Board
NP/AP	Neutralizing potential to acid generating potential
NWB	Nunavut Water Board
PAG	Potentially acid generating
QA/QC	Quality Assurance and Quality Control
SNP	Surveillance network program
TDS	Total dissolved solids
TIA	Tailings Impoundment Area
TMAC	TMAC Resources Inc.
WSCC	Workers Safety and Compensation Committee

1 Introduction

The Hope Bay Project (the Project) is a gold mining and milling undertaking of TMAC Resources Inc (TMAC). The Project is located 705 km northeast of Yellowknife and 153 km southwest of Cambridge Bay in Nunavut Territory, and is situated east of Bathurst Inlet. The Project comprises of three distinct areas of known mineralization plus extensive exploration potential and targets. The three areas that host mineral resources are Doris, Madrid, and Boston.

The Project consists of two phases: Phase 1 (Doris project), which is currently being carried out under an existing Water Licence, and Phase 2 (Madrid-Boston Project) which is in the environmental assessment and water licencing stage. Phase 1 includes mining and infrastructure at Doris only, while Phase 2 includes mining and infrastructure associated with Madrid and Boston located approximately 10 and 60 km due south from Doris, respectively.

This Hope Bay Project Quarry Management Plan (the Plan) has been prepared by TMAC as part of the water licencing stage of Phase 2 of the Project and in accordance with various existing water licences and the Kitikmeot Inuit Association (KIA) Framework Agreement held by TMAC associated with developments throughout the Hope Bay region.

The Plan is intended primarily for use by TMAC and its contractors to ensure that best practices are followed for minimizing potential environmental impacts and environmental liabilities with respect to *quarry rock*, and that the conditions of water licences and KIA agreement are met.

This Plan is structured in a manner such that one document pertaining to *quarries* is approved and implemented across all TMAC's Hope Bay Project sites, while still addressing site and licence-specific needs. The main document outlines TMAC's approach to *quarr*ies as it pertains to all of TMAC's Hope Bay developments. Subsequent updates will be included if new quarries are proposed with specific management requirements. This is intended for consistency and efficiency across operations and compliance management.

1.1 Objectives

Quarry rock for the Hope Bay Project will be used for the construction of infrastructure and roads, and also as structural backfill in selected underground mines. The scope of this Plan includes 35 quarries, of which 11 are approved quarry sites and 24 are proposed quarries as part of Madrid-Boston Project.

The construction of many of the facilities at the Hope Bay Project site require rock for fill material. Material from quarries considered to have a low potential for acid rock drainage (ARD) generation and low sulphur content is suitable to be used as construction material. Quarries will also be developed for use as as structural backfill at Madrid North and Boston once all mine rock has been exhausted. Quarry rock that is unsuitable for use as construction material will only be used as mine backfill.

The quarrying, infrastructure and road construction activities consist of drilling, blasting, mucking crushing, haulage to usage locations (e.g., the advancing road limit, to the waste rock stockpile), end dump and levelling. The objective of this Plan is to outline how these activities will be managed and monitored. Furthermore, this Plan documents if rock from each quarry is geochemically suitable for use as construction material or as mine backfill. Management and material handling of quarry rock to be used as backfill is described in the Madrid-Boston Project, Waste Rock, Ore and Mine Backfill Management Plan. In brief, quarry rock that will be placed as backfill will be placed on the waste rock stockpile pad before being transferred underground. The monitoring of all quarry rock used as mine backfill is docmentered in this Plan.

1.2 Quarry Locations

The quarries currently approved for use as construction material are listed and briefly described in Table 1.1. Table 1.2 lists the proposed Madrid-Boston Project quarries and summarizes the geochemical suitability of each location for construction. Maps presenting all quarry locations are presented in Attachment 1. Approved quarry locations are outlined in Figures A-1 to A-6 in solid blue line.

Table 1.2 also notes which quarries require additional test work prior to development (discussed further in Section 2.1.1).

Table 1.1: Location and Status of Approved Hope Bay Quarries[1]

Quarry	Description
1	Site is currently used for the Fuel Tank Farm.
2	Located west of the Doris Camp.
3	Located east of Tail Lake. Material will be required for construction of the South Dam.
4	Doris Camp is located on the former quarry site.
5	Located at the south apron of the Doris North Airstrip Expansion.
A	Located at the northern end of the Doris Windy Road. Site is currently used for storage of explosives.
B	Located on the Doris Windy Road. Site has been proposed for storage of explosives.
D	Site has been approved for construction of a new camp.
G	Located on the proposed Madrid South All-weather Road.
H	Located on the proposed Madrid South All-weather Road at the Madrid South Portal.
I	Located at Proposed Doris Central Vent Raise.

Table 1.1.2: Location and Status of Proposed Madrid-Boston Project Quarries (SRK 2017b)

Quarry ID	Quarry Rock Suitable for Construction?	Confirmatory Test Work Required Prior to Use as Construction Material	Description
s	✓		Located east of Patch Lake
L	✓		Along Madrid-Boston all-weather road
M	✓		Along Madrid-Boston all-weather road
N	✓		Along Madrid-Boston all-weather road
O	✓	✓	Along Madrid-Boston all-weather road
P	✓		Along Madrid-Boston all-weather road
Q	✓	✓	Along Madrid-Boston all-weather road
R	✓		Along Madrid-Boston all-weather road
S	✓	✓	Along Madrid-Boston all-weather road
T	✓	✓	Along Madrid-Boston all-weather road
U	✓	✓	Along Madrid-Boston all-weather road
V	✓	✓	Along Madrid-Boston all-weather road
W	Suitable as mine backfill. Silicate mineralogical characterization recommended to assess suitability for construction.*	✓	Along Madrid-Boston all-weather road
X	✓	✓	Along Madrid-Boston all-weather road
Z	Possible*	✓	Along Madrid-Boston all-weather road
AA	✓	✓	Along Madrid-Boston all-weather road
AB	✓	✓	Along Madrid-Boston all-weather road
AD	Suitable as mine backfill only		Located on the proposed Boston processing plant pad
AE	✓	✓	Located on the proposed Roberts Bay cargo dock
AF	✓	✓	Located on the proposed Roberts Bay tank farm
AG	✓	✓	Along all-weather road between Madrid and Tailings Impoundment Area (TIA) South Dam
AH	✓	✓	Located on the proposed Madrid North portal
AI	✓	✓	Located on the proposed Madrid North vent raise
AJ	✓	✓	Along Madrid-Boston all-weather road

Notes:
(1) ✓ confirms column heading.
(2) *Additional geochemical testwork required to demonstrate suitability as construction rock

1.3 Relevant Legislation and Guidance

Worker health and safety, and operational components of the Plan are part of TMAC's mine plan and come under the jurisdiction of the Nunavut Mines Inspector. Environmental elements of the Plan come under the jurisdiction of the Nunavut Water Board (NWB), the Nunavut Impact Review Board (NIRB) and other regulatory agencies.

Implementation of the Plan in part should be considered alongside the relevant legislation listed in Table 1.3.

Table 1.3: List of federal and territorial regulations governing the Hope Bay Project Quarry Management Plan

Regulation	Year	Governing Body	Relevance
Workers Safety and Compensation Commission (WSCC) Chief Mines Inspector as per Mine Health and Safety Act, and its associated Regulations	1995	Government of Nunavut	Includes underground disposal management

1.4 Related Documents

Table 1.4: List of documents related to the Hope Bay Project Quarry Management Plan

Document Title	Year	Relevance
Hope Bay Project Groundwater Management Plan (SRK 2016)	2016a	Includes underground disposal management
Hope Bay Project Waste Rock, Ore and Mine Backfill Management Plan (TMAC 2017a)	2017	Includes monitoring of waste rock, ore and mine backfill, including quarry rock backfill management. Geochemical characterization program for using waste rock for construction is outlined.
Quality Assurance and Quality Control Plan (TMAC 2017b)	2017	Detailed QA/QC procedures
Hope Bay Project Doris-Madrid Interim Closure and Reclamation Plan, November 2017 (SRK 2017a) Hope Bay Project Boston Conceptual Closure and Reclamation Plan, November 2017 (SRK 2017b)	2017	Includes closure activities

1.5 Plan Management

Revisions to the Plan can be triggered by activities such as changes in the mine plan, operational performance, personnel or organizational structure, mine ownership, regulatory or social considerations, and life cycle or design philosophy. The Plan is reviewed annually and is revised or updated as necessary in accordance with changing circumstances.

Overall responsibility for the Plan implementation lies with the Surface Manager. The functional site-based lead for assigning and applying appropriate resources to execute the Plan rests with the Surface Superintendent. The Environmental Manager and Coordinator are responsible for day-to-day execution of activities associated with the Plan.

1.6 Roles and Responsibilities

Table 1.5 shows the roles and responsibilities for the Hope Bay Project Quarry Management Plan.

Table 1.5: Roles and Responsibilities

Role	Responsibilities
Mine General Manager	• Responsible for the management and operations of the quarries and for providing the necessary resources to manage the quarries.
Surface Manager	• Implementing the Plan; • Providing onsite resources to operate the quarries; • Providing onsite resources to conduct geological/geochemical inspections; • Conducting and documenting regular inspections; • Ensuring that water treatment and discharge activities take place as requested by Environment and Social Responsibility (ESR) and logs of discharge quantities and locations are provided to ESR; and • Providing input on the modifications in the design and the operation of the quarries.
Environmental Manager	• Updating the Plan; • Providing the necessary resources for completing the water sampling programs; • Liaise with Indigenous and Northern Affairs Canada (INAC) inspector prior to water discharge; • Coordinate: - Construction Monitoring Report; - Waste Rock and Quarry Monitoring Report; - Construction Summary Report; - Monthly Monitoring Report; and - Annual Geotechnical Inspection Report
Environmental Coordinator	• Ensuring water sampling programs are completed as needed; • Ensuring internal records are kept of the quantities of rock excavated from the quarries; • Weekly visual inspections; • Conduct or facilitate seep and operational quarry sampling programs; • Keeping records of onsite analysis, observations, photographs, water discharge activities and laboratory analysis; and • Conducting monthly and annual regulatory reporting as required
Geologist	• Weekly visual inspections of the quarry face; andKeeping records of inspection data sheets and photographs.

2 Management Issues

2.1 Pre-Development

2.1.1 Quarry Material Characterization

Geochemical characterization studies of all approved quarry sites for the Hope Bay Project (Table 1.1) have been presented in AMEC (2005), and SRK (2007, 2008, 2010, 2011, 2014 and 2017c). Based on these geochemical characterization programs, the material from the approved quarries (Table 1.1) is considered to have a low potential for ARD generation based on NP/AP ratios and low sulphur content. Accordingly, material from these quarries is suitable to be used as construction material.

The geochemical assessment of the proposed Madrid-Boston Project quarries (Table 1.2) was based on results of the 2011 quarry geochemical characterization program and/or a comparison to the existing quarry rock data set in the context of regional belt-wide geology. The results of the assessment are presented in Table 1.2 and are summarized as follows:

- Six quarries (Quarry J, L, M, N, P, and R) are considered to have a low potential for ARD generation based on NP/AP ratios and low sulphur content. Accordingly, material from these quarries is suitable to be used as construction material. In Attachment 1, the boundaries of these quarries are presented as green dashed lines.
- Fifteen quarries (Quarry O, Q, S, T, U, V, X, AA, AB, AE, AF, AG, AH, AI, and AJ) are considered to have a low potential for ARD based on the regional geology of the quarry rock in comparison to the belt-wide quarry rock geochemical database. These quarries are suitable for use as construction rock but a confirmatory sampling program is required prior to development. The boundaries of these quarries are presented as purple dashed lines in Attachment 1.
- Based on the existing data, two quarries (Quarry W and Z) are currently suitable as mine backfill material only, however additional test work may demonstrate that the quarry rock is suitable for construction. The boundaries of these quarries are presented as pink dashed lines in Attachment 1.
- Quarry AD (denoted by red dashed lines in Attachment 1) contains material that is not suitable for construction due to high risk of ARD and has been designated for use as mine backfill only. The management of quarry rock not suitable for use as construction material is discussed in Section 2.2.1.

2.1.2 Archaeology Survey

Archaeological surveys of the quarries and the all-weather road routes were conducted. Based on the results of the survey, buffers were established to ensure that the development of quarries and all-weather roads do not impact any archaeological sites.

Management Action

TMAC provides training on “chance-find” procedures to relevant field staff to ensure that any archaeological sites that were not identified during pre-development surveys are recognized and treated in an appropriate manner i.e., in accordance with the Heritage Resources Protection Plan (TMAC 2016).

2.1.3 Setback Distance Requirements

Shock waves from blasting in close proximity to fish bearing water have the potential to cause detrimental shock wave effects on fish. Guidelines for the use of explosives in or near Canadian fisheries waters (Wright and Hopky 1998) provide specific methods for calculating the setback distance required to stay below this threshold based on different amounts of explosive and the type of substrate.

Management Action

To ensure that there are no detrimental effects on fish from quarry activities, these guidelines will be used to establish final setback distances for each of the quarries.

2.2 Operations

2.2.1 Quarries Classified as High Risk for ARD

The construction of mine infrastructure may necessitate the development of quarries with quarry rock that is unsuitable for use as construction material. Table 2-1 lists all quarries that are currently designated as not geochemically suitable as construction material. Material from quarries listed in Table 2.1 is to be managed as mine backfill, which entails placing the rock on the designated waste rock stockpile at either Madrid North or Boston. For Quarry W and Z, these quarries can potentially be used for construction, subject to further geochemical characterizaiton as outlined in SRK (2017c). Monitoring of quarry rock that would be used as structural backfill is outlined in Section 3.1 and is support of the objectives of the mine backfill monitoring program (TMAC 2017a).

Table 2.1: Quarries designated for use as mine backfill

Quarry	Description	Potential for Use as Construction Material
AD	In proposed location of the Boston processing plant; located in mineralized area	None
W	Along Madrid-Boston all-weather road	Could potentially be used as construction material, subject to additional characterization. Silicate mineralogical characterization recommended.
Z	Along Madrid-Boston all-weather road	Could potentially be used as construction material, subject to additional characterization.

2.2.2 Residual Explosives

The majority of the rock fill will be blasted using an Ammonium Nitrate (AN) and fuel oil mixture blasting product (ANFO).

The potential for wet-holes in the quarries is considered to be low due to the land-based nature of the quarry sites and the presence of permafrost below the outcrops. The potential for wet holes will be assessed at the time of drilling and again at the time of loading each blast hole.

Management Action

The blaster responsible for loading and firing the drilled pattern begins the loading process by walking the entire pattern and checking the actual drilled depth of each hole versus the plan and noting any conditions such as water in each hole. This information is recorded on the blast pattern record sheet required by regulation to determine the amount and type of explosive and delay detonators required in each hole.

The presence of water in any drill hole requires one of several approaches to be taken to ensure proper and complete explosive detonation. ANFO designed for proper detonation in wet holes is available and can be used. Alternatively, dewatering the hole using a down hole dewatering pump and truck so that a poly borehole liner can be lowered into the hole and ANFO poured inside the bag is another approach which can be implemented.

In the event that an incomplete detonation of the product occurs, it is likely that an orange colour smoke plume would be observed rising from the affected area. The blaster is required by the regulations to inspect the blasted area, make note of blast holes that may have experienced incomplete detonation and mark those locations with flagging.

Information from the blaster's inspection will be noted in the blast pattern log and the daily operations shift log communicated to all field supervision personnel. The flagged off area will remain until the excavation equipment advances to within half the hole spacing distance at which time the suspect material would be more closely inspected for the presence of ANFO.

2.2.3 Blast Management

The quarry sites have been deemed suitable for use provided that the archaeological site buffer zone is kept intact; therefore, due care will be taken in order to maintain the integrity of these sites.

Management Action

The blasts will be designed to shoot away from the potentially impacted archaeological sites. Prior to any blast, the rock face will be cleaned to minimize the potential of fly rock.

Single hole delays will also be used for maximum shot placement away from any identified archaeological sites and row timing will be increased to prevent back break and ensure all rock is moving in a forward motion away from the archaeological sites.

As an additional precaution, the blast limits will be set 60 m from the recommended 30 m buffers zones located in the quarries. This extra buffer will offer further protection from any possible disturbance to archaeological sites.

2.2.4 Precipitation/ Snow Melt Water Management

The development of each quarry will proceed in a manner that, to the extent possible, ensures that all water entering the quarry as a result of precipitation or snow melt is retained within the quarry boundaries. Generally, this will be accomplished by ensuring that the quarry floors are sloped toward a natural low area of the quarry and, if required, the creation of a quarry sump to collect the waters and settle out suspended solids.

In the event that the quarry sump requires pumping, a sample of the ponded water will be collected, preserved in the appropriate manner, and submitted to an accredited laboratory for the analysis of specified parameters. These parameters are outlined in the relevant Water Licences. Table 2-2 presents the quarry effluent quality limits as stated in Part D Item 18 of Water Licence 2BE-HOP1222.

Additionally, notification will be provided to the Inspector, at least ten (10) days prior to the planned pumping (as per Part D, Item 16 of 2BE-HOP1222). The notification will include the volume proposed for discharge and the discharge location.

Management Action

Following receipt of the laboratory results, water meeting the discharge requirements (Table 2-2) will be discharged. Section 5.1.5 describes the management action if water does not meet the discharge limits.

Care will be taken not to disturb settled solids in the bottom of the sump and pumping of the sump will only take place when conditions are suitable. Care will also be taken to ensure that discharged water does not enter fish bearing waters and that the pump discharge is positioned in a manner that minimizes erosion and siltation of the area downstream of the discharge.

Table 2.2: Quarry Effluent Quality Limits (Part D Item 18 of Water Licence 2BE-HOP1222)

Parameter	Maximum Average Concentration	Maximum Concentration in Any Grab Sample
pH	6.0 to 9.0	9.0
Electrical Conductivity	500 µS/cm	500 µS/cm
Total Ammonia	2 mg/L	4 mg/L
Total Suspended Solids	15 mg/L	30 mg/L
Oil and Grease	5 mg/L and no visible sheen	10 mg/L and no visible sheen
Total Aluminum	1.0 mg/L	2.0 mg/L
Total Arsenic	0.05 mg/L	0.10 mg/L
Total Copper	0.02 mg/L	0.04 mg/L
Total Iron	0.30 mg/L	0.60 mg/L
Total Lead	0.01 mg/L	0.02 mg/L
Total Nickel	0.05 mg/L	0.10 mg/L
Total Zinc	0.01 mg/L	0.02 mg/L

2.2.5 Dust Management

The major source of dust generation during the operations of the quarries will be in the vicinity of the crusher while it is operating.

Management Action

Dust suppression, where required, will consist of using water as permitted by the relevant Water Licence. A record of the volume of water used for this purpose will be maintained.

2.2.6 Equipment Re-fuelling

Re-fuelling of equipment operating in one of the active quarries will be conducted in a manner that will ensure that any spill of fuel or lubricants is effectively contained within the quarry area and clean-up is easily accomplished. During this activity, all re-fuelling equipment will be equipped with a Spill Kit suitable for the materials being handled and a functioning fire extinguisher suitable for the materials being transferred.

Management Action

In the unlikely event that a spill does occur during re-fuelling activities, clean-up of the spilled material will be initiated immediately and all activities within the quarry suspended until the clean-up is complete. The material will be disposed of in an appropriate manner as per the requirements specified in the Hope Bay Project Spill Contingency Plan TMAC (2017c).

2.3 Quarry Closure

The quarries will be decommissioned at mine closure upon full utilization of the available materials, when the quarry is deemed no longer required or re-purposed for a different land use by TMAC. The quarries will be decommissioned and reclaimed. All vertical faces in the quarries will be scaled. Safety berms will be left in place. The area of each quarry will be inspected by a qualified inspector, to ensure no loaded holes are remaining

Details of the closure activities are available in the relevant Closure and Reclamation Plans.

3 Monitoring and Evaluation

The monitoring and evaluation programs outlined below applies to all quarries and quarry rock regardless of intended use or geochemical characteristics, and includes quarry rock used for construction or mine backfill. The rationale for monitoring of quarry rock that will be used as backfill is presented in the Hope Bay Project, Waste Rock, Ore and Mine Backfill Management Plan TMAC (2017a).

3.1 Quarry Operations

3.1.1 Quarry Visual Inspection

During quarrying operations, a visual inspection of the quarry face to verify the geological characteristics of the rock will be conducted by a qualified field geologist or geochemist at least once per week. The purpose of the inspection will be to confirm the presence of the expected rock types and that disseminated sulphides only (e.g., not veins) are being exposed and therefore used in construction. A secondary objective of the inspection will be to confirm the absence of any fibrous forms of actinolite in the quarry material.

Prior to the inspection, site personnel will ensure that it is safe to work within the quarry and will inform any vehicle operators as to the location and timing of the inspection work.

The inspector will walk from one side of the quarry around to the other side examining both the surface and the exposed bedding material along the side of the quarry for any anomalous rock types or significant amounts of sulphide. If present, these materials will be examined, described, and located on a map. In addition, at regular 100 metre intervals, the inspector will stop and complete a close inspection of the rocks, breaking open several rock clasts and describing what they see. The results of each inspection will be recorded on data sheets, and reported in the Construction Monitoring Report submitted by March 31 of the year following construction.

3.1.2 Quarry Material Tracking

For each quarry, volumes of material and the intended purpose (construction or backfill) will be recorded. If the quarry rock is used as backfill, the waste rock stockpile on which it was placed will also be recorded.

3.1.3 Quarry Rock Sampling

During quarrying activities, blast material from each active quarry will be collected at two different stages of quarry development per year. During each collection event, a whole rock sample and a sample of the same material sieved to pass a less than 2 mm screen will be submitted to an accredited external lab for sulphur analysis. This sampling method and frequency will result in up to four samples from each active quarry per year. The sample locations will be pre-determined to ensure that they reflect a random selection of the rock fill material used in road construction. In the event that the results return a sulphur value of greater than (>) 0.1 % sulphur, the samples will be subjected to ABA[1] and other confirmatory test work including shake flask extraction tests[2] on a representative subset of sieved samples (-2 mm).

The objective of this program will be to confirm previous rock characterization results and to assess the ARD potential of the fine fraction, which tends to concentrate sulphide minerals. In the case of quarries that will be developed as mine backfill material, a secondary objective is to confirm the geochemical characteristics of the mine backfill.

The results of the analysis will be reported in the Waste Rock and Quarry Monitoring Report (which is referenced in the Construction Monitoring Report) and submitted by March 31 of the year following construction. The report will include a discussion and interpretation of the geochemical data collected.

3.1.4 Quarry Sump Monitoring

After significant precipitation events, the quarry area will be inspected and the water level in the quarry sump assessed. In the event that the quarry sump requires pumping, the procedures or contingencies outlined in Sections 2.2.4 and 5.1.5 of this plan will be followed.

3.1.5 Blast Vibration Monitoring

Guidelines for the use of explosives in or near Canadian fisheries waters (Wright and Hopky 1998) indicate that "*no explosive shall be detonated in or near fish habitat that produces, or is likely to produce, an instantaneous pressure change (i.e., overpressure) greater than 100 kPa (14.5 psi) in the swimbladder of a fish*". Blast vibration monitoring will be undertaken to avoid potential effects when detonation distances approach the recommended setbacks to ensure appropriate vibration thresholds that are protective of fish and vulnerable life stages of fish are maintained.

[1] Paste pH, sulphate by HCl leach, total inorganic carbon, Modified NP and elemental content by aqua regia digestion followed by ICP finish.
[2] MEND (2009) method. Leachate analysis to include pH, EC, SO_4, acidity, alkalinity, chloride, ammonia, and low level dissolved metals.

3.2 Construction

3.2.1 Infrastructure and All-Weather Roads

Visual Inspections

During all construction activities, a visual inspection by site personnel will be conducted of the quarries, equipment storage and re-fuelling areas, construction areas and the advancing area of road construction activity at least once per week. The inspection will focus on identification and removal of foreign and/or spilled materials, assessing the extent of erosion and sedimentation resulting from rock placement (particularly during periods of precipitation), the extent of dusting and the transport of dust onto the surrounding tundra.

In addition, an inspection of each watercourse crossing along the all-weather roads throughout the annual ice-free period will be conducted in order to confirm structural integrity, confirm soil and permafrost stability in the immediate area and to confirm that the crossings have been located adequately with respect to the watercourses.

A record of the date, place and results of each inspection will be maintained as will a photographic record of “items of interest” (i.e., dusting, wildlife encounters, spilled material, etc.) identified during the inspection.

3.3 Post-Construction Inspections and Monitoring

3.3.1 Quarry

Visual Inspection

A visual inspection of each mined-out quarry will be completed at least once per year in order to ensure that the site remains safe and no environmental or public health and safety concerns have developed. In the event that potentially acid generating waste rock has been placed in one or more of the mined-out quarries, the area will be inspected to ensure that the 2 meter cover remains intact and that seeps from the material are not in evidence.

In the event that the inspection identifies ponded water within the mined-out quarry in sufficient volume to require pumping, the procedures or contingencies outlined in Section 2.2.3of this Plan will be followed.

Records of the inspections and findings of each will be maintained and reported in the appropriate manner.

3.3.2 Infrastructure and All-Weather Roads

Following completion of the construction of the road and pad areas, an inspection will be conducted by a qualified field geologist or geochemist in order to characterize the rock used in construction and to identify and sample ephemeral seeps occurring through the road construction material. The objective of this program will be to confirm that an environmentally-significant level of metal leaching (ML) is not occurring from the road materials.

In the event that quarry rock from any of the quarries is used in the construction of additional infrastructure, the area in which the rock is used will be incorporated in the ongoing seep and rock sampling program. The monitoring and sampling will be completed in order to ensure that the highest regulated requirement for the management of construction rock is uniformly applied throughout the Hope Bay Belt.

Seep Survey and Sampling

Seep surveys will be conducted during the spring freshet in the year following completion of construction using quarry rock. Details of seep survey monitoring following completion of construction using waste rock are outlined in TMAC (2017a).

Seeps will be located by walking along the downstream side of the roads and infrastructure, looking, and listening for signs of flowing water. In low-lying areas where the direction of surface water flow is not evident, both sides of the structure will be inspected. Where surface flows are identified, the upstream side will be inspected to determine whether the flow originates from the upstream side or whether it is likely to originate from within the rock fill material. Most samples will target the latter, more ideal type of seep. However, a selected number (maximum of one location for every 2 km of road) will be collected at locations where there is moderate upstream flow component. In these cases, samples will be collected from both upstream and downstream of the roads.

At a minimum, a water sample will be collected from 10% of the identified ephemeral seeps (regardless of the field measurement values) appropriately preserved and submitted for laboratory analysis.

All the samples collected will be preserved in an appropriate manner, labelled and submitted to an accredited laboratory for analysis of pH, total dissolved solids (TDS), acidity and/or alkalinity, sulphate, total ammonia, nitrate, and a full suite of dissolved metals by inductively coupled plasma mass spectrometry (ICP-MS). The results of the seep survey will be reported in the Waste Rock and Quarry Monitoring Report (which is referenced in the Construction Monitoring Report) and submitted by March 31 of the year following construction. The report will include a discussion of the interpretation of the geochemical data collected.

Infrastructure Inspection and Material Sampling

Rock characterization and sampling will be conducted once construction of the road and pad areas is completed by a qualified field geologist or geochemist to characterize the rock used in construction. The objective of this program is to confirm the geology and geochemistry of the quarry rock, and assess the ARD potential of the fine fraction, which tends to concentrate sulphide minerals.

All infrastructure areas will be visually examined to confirm the geology of the construction material, with an emphasis on rock type and sulphide content. Samples of in situ rock fill will be collected from pre-determined points of the infrastructure (approximately 1 sample per 0.5 kilometres of road, and five samples from each of the pad areas). At each sample location, a rock sample (<1” fraction) will be collected as well as a -2 mm sieved sample when available. The sample locations will be pre-determined to ensure that the samples reflect a random selection of a representative material of the *in situ* rock fill from each quarry used for construction.

All the samples will be submitted to an accredited external lab for sulphur analysis. In the event that the results return a sulphur value of greater than (>) 0.1 % sulphur, the samples will be subject to ABA and shake flask extraction tests on a representative subset of samples, as described in Section 3.1.3. Testing will be completed on both the fines and the bulk sample.

The results will be reported in the Waste Rock and Quarry Monitoring Report (which is referenced in the Construction Monitoring Report) and will include a discussion and interpretation of the geochemical data collected.

3.4 QA/QC Procedures for Water Sampling

Quality assurance and quality control (QA/QC) is a set of operating principles that, if strictly followed during sample collection and analysis, will produce data of known and legally defensible quality.

Sampling procedures include:

- Using clean sampling gloves for each composite sample;
- Cleaning sampling equipment between each composite sample;
- Collecting samples using bottles and jars provided by the laboratory following the instructions provided by the laboratory for each parameter type;
- Labelling sample containers clearly with the sample station, date, time, and analysis requested;
- Keeping samples cool and dark during storage and shipment to the laboratory; and
- Checking field notes for accuracy and completeness at the end of each sampling session.

Detailed QA/QC procedures are available in the Quality Assurance and Quality Control Plan TMAC (2017b).

4 Documentation and Reporting

The following reports will be prepared in accordance with the relevant water licences and the KIA Framework Agreement:

- Annual Construction Monitoring Report;
- Annual Waste Rock, Quarry and Mine Backfill Monitoring Report;
- Construction Summary Reports;
- Monthly Monitoring Report; and
- Annual Geotechnical Inspection Report.

All the aforementioned reports are to be submitted no later than March 31 of the year following construction, with the exception of the Monthly Monitoring Report, which is submitting on a monthly basis.

5 Contingencies

5.1.1 Identification of Inappropriate Quarry Rock

In the unlikely event that the visual inspection identifies potentially acid generation (PAG) rock in a quarry with material designated as suitable for construction, the geologist will “tag” the material for avoidance or removal. If the material is excavated, it will be transported to a waste rock storage area for disposal underground. If this is not possible at the time, the PAG rock will be buried in an active or previously mined-out quarry. If the PAG material is buried, it will be covered with a minimum of 2 metres of rock material that is approved for construction and will be clearly marked as inappropriate for use as construction material. In the quarry stored rock, permafrost is expected to slowly aggrade into the rock fill, slowing the rates of sulphide oxidation substantially, and eventually shutting off seepage pathways. The clean rock cover would act as a thermal blanket to keep the active freeze/thaw zone away from the more reactive rock.

In the unlikely event that the visual inspection identifies fibrous actinolite, the geologist will “tag” the material for avoidance or removal. If the material is excavated, it will be transported to a waste rock storage area for disposal underground. If this is not possible at the time, the material will be buried in one of the previously mined-out quarries and covered with a 1.0 m layer of benign rock and a record of the location maintained.

5.1.2 Inappropriate Construction Material Identified

In the unlikely event that the results of the seep monitoring/sampling program or the road material sampling program indicate the presence of potential ML or ARD further investigations will be undertaken to define the extent and assess the potential impacts of the material. If warranted, and after discussion with the appropriate regulatory agencies, the material will be excavated and hauled to a waste rock storage area or temporarily stored in one of the previously mined-out quarries prior to eventual disposal underground. The quarry stored rock fill will be placed within the quarry and covered with a minimum of 2 m of rock material that is approved for construction and will be clearly marked as inappropriate for use as construction material. Permafrost is expected to slowly aggrade into the rock fill, slowing the rates of sulphide oxidation substantially, and eventually shutting off seepage pathways. The clean rock cover will also act as a thermal blanket to keep the active freeze/thaw zone away from the more reactive rock.

5.1.3 Identification of Un-detonated or High ANFO Residue Areas

Material considered un-detonated or high in ANFO residue, which will contain potentially elevated levels of nutrients (primarily ammonia) will be selectively excavated and hauled to an established waste rock management area with any runoff from the area reporting to Pollution Control Ponds for ultimate disposal in the Tailings Impoundment Area (TIA).

5.1.4 Spill of ANFO

In the unlikely event that a spill of the ANFO occurs during the charging of the holes for blasting, all activities within the quarry will be suspended until the clean-up is complete in accordance with the Hope Bay Spill Contingency Plan (TMAC 2017c). The clean-up of the spilled material will be initiated immediately and the material disposed of in accordance with the Explosives Management Plan.

5.1.5 Sump Water Requires Special Handling

In the event that the quarry water does not meet the discharge criteria, an inquiry of the cause of the noted exceedance will be conducted, and appropriate mitigation developed. Any non-compliant water that needs to be discharged would be transported to Contact Water Ponds for management and/or transported directly to the Doris North TIA for disposal or the Boston surge pond.

All compliant and non-compliant monitoring results are summarized in the monthly SNP reports to the NWB and a copy is provided to the Inspector. This monthly report would include details of the disposal of any non-complaint water.

6 References

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HOPE BAY PROJECT QUARRY MANAGEMENT PLAN

HOPE BAY, NUNAVUT

Attachment 1: Maps

419700
429700
439700
449700
459700
7560000
7550000
7540000
7530000
7520000
7510000
7500000

See Drawing 1-2
See Drawing 1-3
See Drawing 1-4
See Drawing 1-5
See Drawing 1-6

Quarry AE
Quarry 1
Quarry AF
Quarry 5
Quarry 4
Doris Portal
Quarry 2
Quarry I
Quarry 3
Quarry A
Quarry B
Quarry AG
Quarry D
Quarry J
Quarry AH
Quarry AI
Madrid North Portal
Madrid South Portal
Quarry G
Quarry H
Quarry X
Quarry L
Quarry M
Quarry Z
Quarry O
Quarry N
Quarry P
Quarry Q
Quarry AA
Quarry R
Quarry S
Quarry T
Quarry U
Quarry AB
Quarry V
Boston Portal
Quarry W
Quarry AD
Quarry AJ

Melville Sound
Roberts Lake
Hope Bay
Doris Lake
Ogama Lake
Windy Lake
Patch Lake
Aimaokatalok Lake

N

Legend

- Underground Mine Portal
- Existing Infrastructure
- Future Infrastructure
- Approved Quarries
- Phase 2 Quarry - Geochemically suitable for construction
- Phase 2 Quarry - Further geochemical test work required to confirm suitability for construction
- Phase 2 Quarry - Potentially not suitable for contruction*. Further geochemical test work required
- Phase 2 Quarry - Not suitable for construction. Use as mine backfill only

0 2 4 6 8 10
Kilometers

Notes:
1. *Refer to Table 1-2 in the Quarry Management Plan
2. Coordinate System: NAD 1983 UTM Zone 13N
3. Base Topo Data: CanVec, Natural Resources Canada

srk consulting

Project No: 1CT022.013
Filename: 1CT022.013_Figure_01_FEISQuarries_rev6

TMAC RESOURCES

HOPE BAY PROJECT

Proposed FEIS and Approved Quarry Locations, Hope Bay Project

Date: Dec 2017
Approved: LB/MCN
Figure: A-1

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429700
432200
434700
437200
7565000
7562500
7560000
7557500
7555000

Quarry AE
Quarry 1
Quarry AF
Quarry 5
Quarry 2
Quarry 4
Doris Portal
Quarry I
Quarry 3
Quarry A
Quarry B
Quarry AG

Roberts Lake
TIA
Doris Lake

N

Legend

- Underground Mine Portal
- Existing Infrastructure
- Future Infrastructure
- Stream
- Contour (10m Interval)
- Approved Quarries
- Phase 2 Quarry - Geochemically suitable for construction
- Phase 2 Quarry - Further geochemical test work required to confirm suitability for construction
- Phase 2 Quarry - Potentially not suitable for contruction*. Further geochemical test work required
- Phase 2 Quarry - Not suitable for construction. Use as mine backfill only

0 250 500 750 1,000 1,250
Meters

Notes:
1. *Refer to Table 1-2 in the Quarry Management Plan
2. Coordinate System: NAD 1983 UTM Zone 13N
3. Base Topo Data: CanVec, Natural Resources Canada

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Project No: 1CT022.013
Filename: 1CT022.013_Figure_02_FEISQuarries_rev6

TMAC RESOURCES

HOPE BAY PROJECT

Proposed FEIS and Approved Quarry Locations, Hope Bay Project

Date:	Approved:	Drawing:
Dec 2017	LB/MCN	A-2

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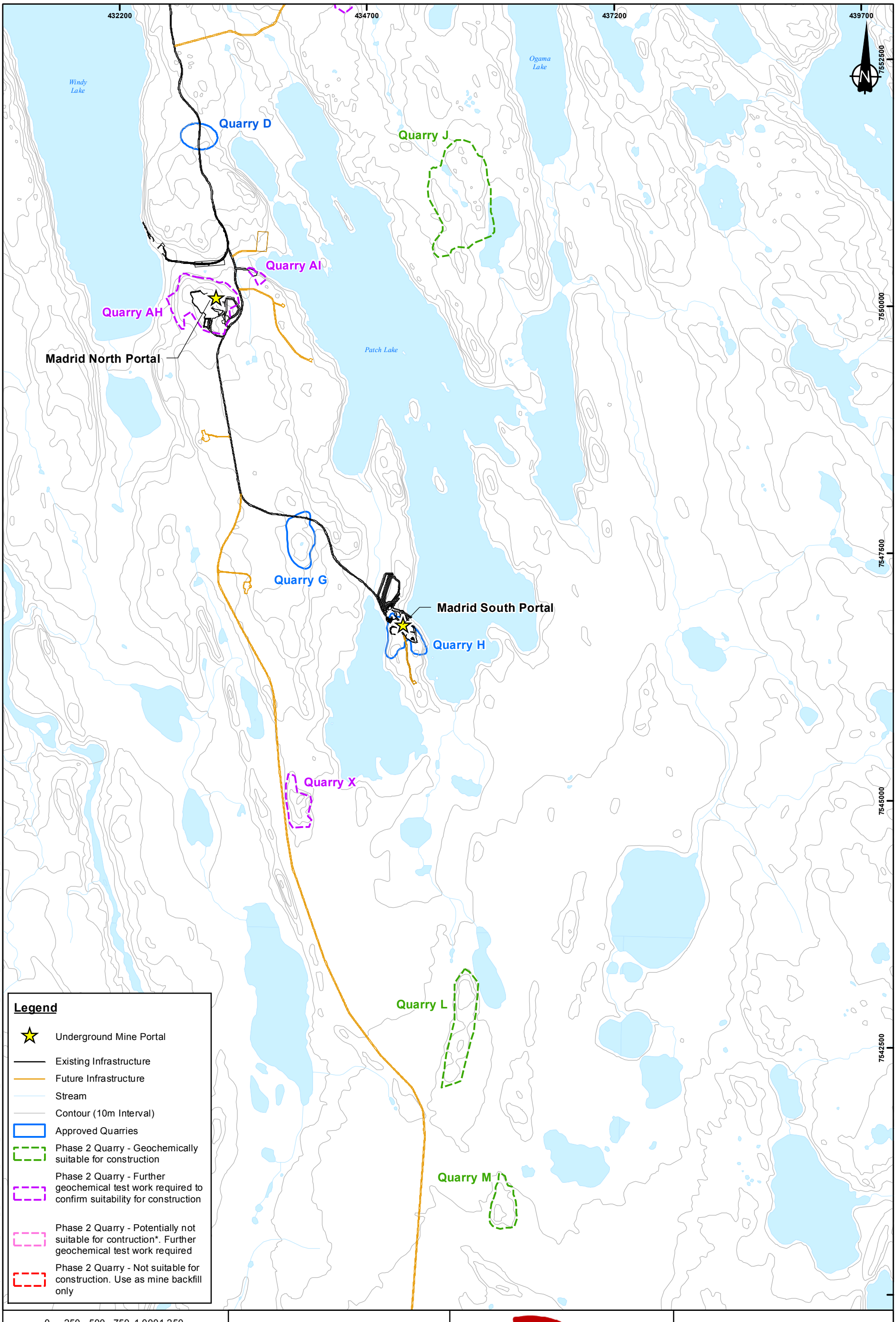
432200
434700
437200
439700
7552500
7550000
7547500
7545000
7542500
Windy Lake
Ogama Lake
Patch Lake
Quarry D
Quarry J
Quarry AI
Quarry AH
Madrid North Portal
Quarry G
Madrid South Portal
Quarry H
Quarry X
Quarry L
Quarry M
Legend
Underground Mine Portal
Existing Infrastructure
Future Infrastructure
Stream
Contour (10m Interval)
Approved Quarries
Phase 2 Quarry - Geochemically suitable for construction
Phase 2 Quarry - Further geochemical test work required to confirm suitability for construction
Phase 2 Quarry - Potentially not suitable for contruction*. Further geochemical test work required
Phase 2 Quarry - Not suitable for construction. Use as mine backfill only
0 250 500 750 1,000 1,250
Meters
Notes:
1. *Refer to Table 1-2 in the Quarry Management Plan
2. Coordinate System: NAD 1983 UTM Zone 13N
3. Base Topo Data: CanVec, Natural Resources Canada
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TMAC RESOURCES
Project No: 1CT022.013
Filename: 1CT022.013_Figure_03_FEISQuarries_rev3
HOPE BAY PROJECT
Proposed FEIS and Approved Quarry Locations, Hope Bay Project
Date: Dec 2017
Approved: LB/MCN
Drawing: A-3
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434700
437200
439700
7535000
7532500
7530000
7527500
7525000

Quarry Z
Quarry O
Quarry N
Quarry P
Quarry Q
Quarry R
Quarry AA

Legend

- Existing Infrastructure
- Future Infrastructure
- Stream
- Contour (10m Interval)
- Approved Quarries
- Phase 2 Quarry - Geochemically suitable for construction
- Phase 2 Quarry - Further geochemical test work required to confirm suitability for construction
- Phase 2 Quarry - Potentially not suitable for contruction*. Further geochemical test work required
- Phase 2 Quarry - Not suitable for construction. Use as mine backfill only

0 250 500 750 1,000 1,250
Meters

Notes:
1. *Refer to Table 1-2 in the Quarry Management Plan
2. Coordinate System: NAD 1983 UTM Zone 13N
3. Base Topo Data: CanVec, Natural Resources Canada

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Project No: 1CT022.013

Filename: 1CT022.013_Figure_04_FEISQuarries_rev3

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HOPE BAY PROJECT

Proposed FEIS and Approved Quarry Locations, Hope Bay Project

Date: Dec 2017
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Drawing: A-4

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437200
439700
442200
7522500
7520000
7517500
7515000
7512500
7510000

Quarry S

Quarry T

Quarry U

Legend

- Existing Infrastructure
- Future Infrastructure
- Stream
- Contour (10m Interval)
- Approved Quarries
- Phase 2 Quarry - Geochemically suitable for construction
- Phase 2 Quarry - Further geochemical test work required to confirm suitability for construction
- Phase 2 Quarry - Potentially not suitable for contruction*. Further geochemical test work required
- Phase 2 Quarry - Not suitable for construction. Use as mine backfill only

0 250 500 750 1,000 1,250
Meters

Notes:
1. *Refer to Table 1-2 in the Quarry Management Plan
2. Coordinate System: NAD 1983 UTM Zone 13N
3. Base Topo Data: CanVec, Natural Resources Canada

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Project No: 1CT022.013

Filename: 1CT022.013_Figure_05_FEISQuarries_rev3

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HOPE BAY PROJECT

Proposed FEIS and Approved Quarry Locations, Hope Bay Project

Date:	Approved:	Drawing:
Dec 2017	LB/MCN	A-5

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439700
442200
444700
447200
7510000
7507500
7505000
7502500
7500000

Aimaokatalok Lake

Quarry AB

Quarry V

Boston Portal

Quarry AD

Quarry AJ

Quarry W

Legend

- Underground Mine Portal
- Existing Infrastructure
- Future Infrastructure
- Stream
- Contour (10m Interval)
- Approved Quarries
- Phase 2 Quarry - Geochemically suitable for construction
- Phase 2 Quarry - Further geochemical test work required to confirm suitability for construction
- Phase 2 Quarry - Potentially not suitable for contruction*. Further geochemical test work required
- Phase 2 Quarry - Not suitable for construction. Use as mine backfill only

0 250 500 750 1,000 1,250
Meters

Notes:
1. *Refer to Table 1-2 in the Quarry Management Plan
2. Coordinate System: NAD 1983 UTM Zone 13N
3. Base Topo Data: CanVec, Natural Resources Canada

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Project No: 1CT022.013

Filename: 1CT022.013_Figure_06_FEISQuarries_rev4

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HOPE BAY PROJECT

Proposed FEIS and Approved Quarry Locations, Hope Bay Project

Date:	Approved:	Drawing:
Dec 2017	LB/MCN	A-6

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