

MADRID-BOSTON PROJECT
FINAL ENVIRONMENTAL IMPACT STATEMENT

Volume 1 Annex V1-7 Type A Water Licence Applications

Package P5-27

Boston Tailings Disposal Alternatives Assessment,
Hope Bay Project





Boston Tailings Disposal Alternatives Assessment, Hope Bay Project

Prepared for

TMAC Resources Inc.



Prepared by

 **srk** consulting

The logo for SRK Consulting. It features a stylized orange 'V' or checkmark shape to the left of the word 'srk' in a bold, orange, sans-serif font. To the right of 'srk', the word 'consulting' is written in a smaller, gray, sans-serif font.

SRK Consulting (Canada) Inc.
1CT022.013
November 2017

Boston Tailings Disposal Alternatives Assessment, Hope Bay Project

November 2017

Prepared for

TMAC Resources Inc.
PO Box 44
Suite 1010-95 Wellington St. W
Toronto, ON M5J 2N7
Canada

Tel: +1 867 873 4767
Web: www.tmacresources.com

Prepared by

SRK Consulting (Canada) Inc.
2200-1066 West Hastings Street
Vancouver, BC V6E 3X2
Canada

Tel: +1 604 681 4196
Web: www.srk.com

Project No: 1CT022.013

File Name: Boston_TailingsAltAssmt_Report_1CT022.013_20171123_KNK_IM_EMR.docx

Copyright © SRK Consulting (Canada) Inc., 2017

 **srk** consulting

Table of Contents

1	Introduction	1
2	Multiple Accounts Analysis Process	2
3	Selecting Alternatives	3
3.1	Tailings Technologies	3
3.1.1	General3	
3.1.2	Tailings Management Technologies	3
3.1.3	Tailings Technologies Assessment.....	6
3.2	Containment Dam Technologies	8
3.2.1	General8	
3.2.2	Containment Technologies	8
3.2.3	Containment Dam Technology Assessment.....	10
3.3	Tailings Disposal Sites.....	10
4	Step 1: Accounts and Subaccounts.....	12
4.1	Accounts	12
4.2	Subaccounts	12
5	Step 2: Pre-Screening Assessment	14
5.1	Primary Pre-Screening Criteria.....	14
5.2	Secondary Pre-Screening Criteria.....	14
6	Analysis, Scoring, and Weighting	16
6.1	Step 3: Detailed Analysis.....	16
6.2	Step 4: Scoring	16
6.3	Step 5: Weighting.....	16
7	Step 6: Sensitivity Analysis	18
8	Discussion and Conclusion.....	19
9	References.....	21

List of Tables

Table 1: Details of Tailings Technology Assessment	7
Table 2: Summary of Accounts and Subaccounts	12
Table 3: Alternatives Ranking	17
Table 4: Sensitivity Analysis Results	18

Change Log

The following table provides an overview of material changes to this report from the previous version issued as Appendix V3-2F as part of the DEIS for Phase 2 of the Hope Bay Project dated December 2016.

Changes by Section

Information Request, Technical Comment, or Other Change	Section	Comments
No material changes		

1 Introduction

The Hope Bay Project (the Project) is a gold mining and milling undertaking of TMAC Resources Inc. 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 regulatory stage. Phase 1 includes mining and infrastructure at Doris, while Phase 2 includes mining and infrastructure at Madrid and Boston located approximately 10 and 60 km due south from Doris, respectively.

The Madrid Mine will be operated as satellite facilities to Doris, with the majority of Madrid ore being trucked to the Doris mill, safe for a small concentrate plant at Madrid North. However, all of the Madrid tailings will be deposited in the Doris Tailings Impoundment Area (TIA). Boston; however, is sufficiently far from Doris that deposition of Boston tailings at the Doris TIA is impractical. Therefore, Boston is to be a self-sufficient mining complex that will include a processing facility and a new tailings management area (TMA).

This report presents a comprehensive tailings disposal alternatives assessment for the Boston deposit in the form of a multiple accounts analysis (MAA). It was prepared in accordance with the Environment Canada guideline for disposal of mine waste (EC 2011). This assessment takes into consideration technical, operational, environmental, socio-economic, and project economic factors. It also considers tailings disposal technologies, containment dam technologies, and tailings disposal sites.

2 Multiple Accounts Analysis Process

MAA is a tool for performing detailed analyses that allows the direct comparison of various alternatives on an objective basis. The MAA, as defined by EC (2011) for mine waste facilities, is a seven-step process where the first six steps pertain to the analysis, while the seventh step is documenting the analysis and reporting the findings, i.e. this report.

Step 1: Accounts and Subaccounts (Section 4). This step entails documenting a comprehensive list of subaccounts (or criteria) organized by accounts (or general categories) pertinent to the evaluation of each alternative. The four accounts are technical/operational, environmental, project economics, and socio-economic. Using these accounts and the subaccounts, the alternatives are presented in the form of concise summary tables to allow direct comparison.

Step 2: Pre-screening Assessment (Section 5). This assessment typically uses a subset of conditional evaluation criteria that allows any alternatives identified as potentially “fatally flawed” to be rejected from further detailed assessment. The reasons for removal of any of the alternatives are clearly identified as part of this step.

Step 3: Detailed Analysis (Section 6.1). This step comprises a detailed evaluation of the alternatives that remain after the pre-screening assessment. Each alternative is evaluated based on all accounts and the complete set of subaccounts. Data to support each sub-account is collected, processed, and summarized, complete with engineering evaluations as required.

Step 4: Scoring (Section 6.2). Each subaccount receives a score in this step. The scores are tallied and the alternatives are ranked on the total score basis, with the highest score usually becoming the preferred alternatives.

Step 5: Weighting (Section 6.3). Apply a weight to the accounts. Each account is given a relative weight based on its level of importance compared to the other accounts. These weights create a fixed-value bias that should reflect site specific factors and stakeholder input. EC (2011) recommends assigning the following weights to each of the accounts: Technical/Operational (3), Environmental (6), Project Economics (1.5), and Socio-Economics (3).

Step 6: Sensitivity Analysis (Section 7). Assigning of weighting factors to the various accounts provides the greatest opportunity for imposing user bias into the analysis (such as the weighting imposed by EC (2011)). Therefore, the MAA must be accompanied by a rigorous sensitivity analysis to ensure that the bias of the assessor is not impacting the outcome.

These six steps of the analysis are documented within this report, followed by discussions and conclusions (Section 8).

3 Selecting Alternatives

3.1 Tailings Technologies

3.1.1 General

Technologies commonly used for tailings management and deposition include conventional low solids content slurry tailings, thickened tailings, paste tailings, and filtered (i.e. dry-stack) tailings. The primary differences between these technologies relate to the amount of water that is associated with the tailings deposition. Different definitions exist for different tailings technologies depending on the literature cited. The sections below provide descriptions of each of these technologies in the context of this Project, complete with a discussion of their advantages and disadvantages.

There are also technologies where tailings and waste rock are managed as a combined stream (i.e. co-disposal and co-mixing). Underground mining at the Project requires the use of structural backfill; therefore, all waste rock will be hauled back underground for use as backfill over the life of the Project. As a result, combined tailings and waste rock technologies were not considered in this alternatives assessment.

3.1.2 Tailings Management Technologies

Conventional Low Solids Content Slurry Tailings

Conventional low solids content slurry tailings are the most widely used tailings technology throughout the world including the Canadian arctic. It is the technology used for Doris and Madrid within the Doris TIA. Other examples of its use in an arctic climate setting include the closed Lupin and Nanisivik mines, as well as the operating mines of Meadowbank, Diavik, and Ekati to name just a few.

The technology consists of pumping a slurry with a solids content of typically between 30 and 50%. The solids content is sufficiently low that conventional centrifugal pumps can be used, making it a very economical disposal technology. Tailings are deposited using spigots and depending on the deposition plan, there could be any number of active spigots operating at any time. Once the slurry exits the spigot, material segregation takes place. The larger (i.e. coarser) and heavier (i.e. sulfate minerals) particles settle out first, and the smallest and lightest particles settle out last with significant free water liberated in this process typically collected in a reclaim pond. The result is that a tailings beach is developed, which for gold tailings is typically about 1% in grade from the discharge location to the reclaim pond. The upper part of the beach is more permeable and contains much of the sulfate bearing minerals (if present), while the lower part of the beach is less permeable as it contains most of the fines (also known as slimes).

This technology is naturally associated with a large volume of free water (which can be recycled to the processing facility), and therefore requires environmental containment in the form of containment dams. Due to the low solids content, the settled dry density of the tailings is typically quite low, in the range of 1.3 tonnes per m³. As a result, this is a less efficient storage technology compared to other tailings technologies and requires the largest containment structures (and

typically overall footprint). This storage efficiency is often further reduced in an arctic climate where a significant proportion (approximately 20%) of the storage capacity can be lost to ice entrainment; however, the ice entrainment can be managed if careful winter tailings deposition strategies are adopted. The low settled dry density and large volume of free water being retained also presents the highest operational (and subsequent environmental and economic) risk of any of the technologies due to unforeseen events such as a dam breach.

The capital costs associated with containment dams can be high, but this is often mitigated by constructing the dams in stages over the life of the Project. The operational costs of this technology are typically the lowest of all the technologies, as it is limited to predominantly tailings discharge and reclaim water pumping, which even at increased distances from the processing plant is relatively economical.

Two primary deposition strategies for conventional low solids content slurry are typically considered: subaqueous deposition and subaerial deposition. Subaqueous deposition entails complete submergence of the tailings stream, which is considered to be the best long-term closure strategy for acid generating tailings and also mitigates against tailings dust and excess ice entrainment during the operational period. If a permanent water cover can be maintained at closure, with appropriate depth taking into consideration wave action and ice scour, the material would not oxidize, and therefore the ultimate long-term environmental containment could be provided. However, if this water cover requires permanent water retaining containment dams, it cannot be a walk-away closure strategy.

Subaerial tailings means the tailings beaches are not covered by water and the closure strategy would entail some form of engineered dry cover. This offers the advantage of allowing for decommissioning of the containment dams and facilitates a walk-away closure strategy. Dust management is however a concern that requires management over the life of the Project. Cover placement over the often very soft tailings can be challenging; however, this is to some extent mitigated by the ability to construct covers in the winter and early spring when the tailings are sufficiently frozen to provide a trafficable surface.

Thickened Tailings

Thickened tailings in the context of this discussion is simply a higher solids content slurry, typically higher than 50% for gold tailings. However, what makes this technology different is that the thickening is done to specifically preclude tailings segregation once discharged, which means that the tailings beach is a more uniform product. This is done by using high rate thickeners (and chemical flocculants as required) that alter the rheological properties of the tailings stream. However, the viscosity of the thickened tailings must remain low enough to allow pumping using conventional centrifugal pumps.

The resultant tailings beach has an increased slope, typically between 1 and 4%, and the settled dry density of the tailings is slightly higher than that of conventional low solids content slurry. This deposition strategy still results in liberation of a fair amount of free water, and therefore containment dams are still required, but relative to the low solids content slurry technology the dams are smaller and the overall footprint required is reduced. At higher beach angles, thickened

tailings can be deposited from a single central raised discharge structure to develop a self-draining cone shaped tailings facility.

The bulk of water can be recycled at the thickener, which provides opportunities for water circuit optimizations and ultimately a lower fresh make-up water draw for the processing plant. Since considerable effort and expense is undertaken to dewater the tailings, it typically does not make sense to do subaqueous placement of thickened tailings.

The capital cost of this technology can be significantly greater than conventional low solids content slurry due to the need for a thickening plant. The need for slightly smaller containment dams could however offset those costs. Increased thickening and pumping costs do result in increased overall operating costs. Closure costs may be lower compared to the low solids content slurry method due to the slightly smaller surface area and possibly improved tailings access from a trafficability perspective.

Thickened tailings are commonly preferred in arid parts of the world where maximizing recycled water close to the processing facility is of great value. There are no known thickened tailings facilities in the Canadian arctic, but the Kidd Creek Mine in Ontario does use this technology successfully under typical Canadian winter conditions.

Paste Tailings

Paste tailings are like thickened tailings, but a greater degree of thickening is targeted using specialized deep cone or paste thickeners to get the tailings consistency to that of toothpaste. The goal is to produce a non-segregating pumpable tailings (albeit with costly positive displacement pumps) with a very small amount of free water liberated after deposition. This technology was initially developed to use tailings as an underground structural backfill material by adding binders, predominantly cement, to the thickened paste.

When applied as a primary surface tailings disposal technology, cement binders are not added because they are not required and doing so would be cost prohibitive. Paste tailings have steeper beach angles than thickened tailings, typically upwards of 6%, and have even greater settled dry density than thickened tailings. In addition, since there is very little free water liberated, the containment dams and overall footprint required for this tailings technology is markedly smaller than the previous two technologies. In addition, the tailings surface is trafficable very soon after placement.

Like thickened tailings, it does not make sense to go through the expense of paste thickening if the disposal strategy is subaqueous, due to the fact that mixing of the tailings with the water in the pond will add back much of the water that was previously removed at great expense. Therefore, this technology is only applied subaerially. Dust management and cover placement is however comparatively easier due to the increased trafficability.

Capital and operating costs associated with paste production and pumping is very high compared to thickened tailings, but substantially reduced containment dams and water management costs do offset those costs to some degree.

Although paste tailings technology is common for mine backfill purposes, including the Canadian arctic, its use as full scale surface tailings disposal technology is limited worldwide and there are no Canadian arctic case studies.

Filtered Tailings

Filtered tailings are on the opposite end of the tailings dewatering spectrum compared to low solids content tailings slurry. The technology entails dewatering the tailings by mechanical means through either filter presses (lower production rates) or belt filters (higher production rates). The dewatered tailings, which typically have a gravimetric moisture content of about 10 to 15% after filtration, can then be transported to the deposition site by either conventional truck-and-shovel methods or by belt conveyors and stackers. At the deposition site, relatively thin lifts of tailings are “stacked” and in most cases (but not always) compacted using conventional earthworks techniques. This technology is therefore often referred to as dry-stack tailings.

Since there is no free water liberated from these tailings and the tailings are considered a structural component if properly compacted, no containment dams are required. It is however best practice to construct downstream water containment structures to retain any surface water runoff that does come into contact with the filtered tailings.

The tailings grind needs to be sufficiently coarse for this technology to be cost effective, but typical gold tailings, such as planned for at Boston, would be suitable.

Compared to the other tailings technologies, filtered tailings typically have the highest equipment capital and operating costs. This is due to the very high capital cost of the filter plant, which may not necessarily be offset by the savings of not requiring containment dams. The operating cost is high because of the energy demands for filtering, and the placement cost of using earthmoving equipment as opposed to hydraulic placement by pumps.

Once again, filtered tailings are only placed sub-aerially as it would be counterproductive to go through the expense of dewatering the tailings only to submerge it afterwards. Closure cover placement and dust management is however simple compared to the other technologies as the material is completely trafficable and the facility can be shaped to accommodate any required landform.

Filtered tailings are routinely used worldwide and are rapidly becoming the preferred technology due to the belief that it is best practice in tailings management available. This technology has been used in the Canadian arctic at the Raglan Mine. Other examples of filtered tailings used in very cold climates include the Minto Mine in Yukon, as well as Red Dog and Pogo mines in Alaska.

3.1.3 Tailings Technologies Assessment

A qualitative assessment of the tailings technologies described above was completed, considering the advantages and disadvantages in the context of the proposed Boston Mine project (Table 1).

Table 1: Details of Tailings Technology Assessment

Technology	Advantages	Disadvantages	Conclusion
Conventional Low Solids Content Slurry Tailings	<ul style="list-style-type: none"> Most commonly used technology, including in cold climates; Simple technology, well understood by operators; Most operationally flexible technology under upset or changing conditions; and Generally lowest operating cost. 	<ul style="list-style-type: none"> Lowest storage efficiency due to low settled dry density, high water content and ice entrainment; Typically requires largest footprint; Potentially highest up-front and sustaining capital for containment dams; Requires management of the largest volumes of supernatant water; Perceived to be the highest risk tailings technology; Lowest trafficability makes dust management and closure cover construction most challenging; Least efficient use of water; and Tailings segregation makes closure more challenging. 	<ul style="list-style-type: none"> Although there are considerable disadvantages, the technology was considered for Boston since it is a well understood and proven technology in cold climates, and is the preferred strategy for the Doris TIA.
Thickened Tailings	<ul style="list-style-type: none"> Non segregating tailings; Slightly reduced footprint compared to low solids content slurry tailings due to slightly greater settled dry density, steeper beach angle and lower water content; Lower water use than for low solids content slurry tailings; and Improved tailings trafficability allowing for possible year-round tailings access for dust management and construction of closure covers. 	<ul style="list-style-type: none"> Increased capital cost for thickening plant (may be offset by savings offered by requirement for smaller containment dams); Large containment dams still necessary (albeit smaller than for low solids content slurry tailings); Limited flexibility to handle upset or changing conditions; and Less commonly used in cold regions. 	<ul style="list-style-type: none"> This technology has definite advantages over low solids content slurry tailings; however, the benefits would be hard to accurately quantify at a conceptual design level. Therefore low solids content slurry was deemed a conservative bookend for the alternatives assessment and thickened tailings technology was not assessed further.
Paste Tailings	<ul style="list-style-type: none"> Non-segregating tailings; Slightly reduced footprint compared to thickened tailings due to slightly greater settled dry density, steeper beach angle and lower water content; Markedly smaller containment dams due to minimal water management requirements; Lower water use than for thickened tailings; and Vastly improved tailings trafficability allowing for year-round tailings access for dust management and construction of closure covers. 	<ul style="list-style-type: none"> Vastly increased capital cost for paste plant and positive displacement pumps compared to thickened tailings; High operating cost; Minimal flexibility to handle upset or changing conditions; Highly complex operation; and No precedent in cold regions. 	<ul style="list-style-type: none"> There are no documented case studies of full scale paste tailings technology in an arctic setting, and therefore it is deemed an unproven technology and was not considered further.

Technology	Advantages	Disadvantages	Conclusion
Filtered Tailings	<ul style="list-style-type: none">• Proven technology in cold climates;• Most efficient use of water as all water is recycled in the processing plant;• No need for containment dams;• Smallest footprint;• Perceived to be best practice and the safest tailings technology.	<ul style="list-style-type: none">• Sensitive to upset conditions, requiring provisions for temporary tailings storage in a separate facility;• Tight quality control of the deposition sequence is required;• Very high capital and operating cost.	<ul style="list-style-type: none">• Notwithstanding the fact that this technology is considered best practice, the clear operational and environmental advantages offered by this technology makes it worthy of further consideration. It also offers the opposite bookend of available tailings technologies to consider.

3.2 Containment Dam Technologies

3.2.1 General

For low solids content slurry tailings containment dams are required. Foundation conditions at Boston are described in SRK (2017), and can be summarized as moderately thick, often ice rich permafrost soils. The soils range from sandy gravels to silty clays, and the active layer is typically about 1 m thick. Construction borrow materials are limited to geochemically suitable quarry rock crushed and screened to the required size fractions.

3.2.2 Containment Technologies

Containment dam technologies that were considered for the Project including cyclone tailings dams, conventional low permeability core dams, frozen core dams, conventional (unfrozen) upstream geosynthetic lined dams, and frozen foundation dams with upstream geosynthetic liner. The sections below provide a more detailed discussion of these technologies.

Cyclone Tailings Dam

A cost-effective tailings containment dam technology that is commonly used worldwide is to construct dams with cyclone tailings. The tailings slurry is passed through cyclones and the coarser underflow consisting predominantly of sand is used to construct the walls using conventional earthmoving equipment. The finer overflow tailings are deposited upstream of the cycloned sand walls together with the supernatant water.

Although there are examples of this technology being used in areas that experience seasonally cold conditions such as in interior British Columbia, there are no arctic case studies of this technology in use. The primary reason is due to the operational challenges of managing cyclones under freezing conditions and the strict quality control required for constructing the sand walls. Ice entrainment would be extremely detrimental to the stability of the structure and precluding that from occurring in an arctic setting would be challenging. As a result, the use of this technology is not considered appropriate for the Project.

Low Permeability Core Dam

Conventional low permeability core dams rely on a low permeability material, typically a material of moderate to high clay content, to provide the necessary water retention ability of the structure. The core material must be carefully placed using strict quality control procedures and needs to be keyed into bedrock or other suitable low permeability foundation materials.

Low permeability cores cannot be constructed under winter conditions (i.e. frozen) as the appropriate material moisture conditioning and compaction cannot be done. Also, all construction material needs to be completely thawed. There is no suitable low permeability borrow sources available at the Project site and, should any be found, the material would be completely frozen. Therefore, the use of this containment dam technology is not considered viable for the Project.

Frozen Core Dam

A frozen core dam consists of an engineered saturated frozen core, completely bonded to the underlying permafrost foundation. This technology was used to construct the North Dam at the Doris TIA (SRK 2012) and has been demonstrated to work very effectively at the Project site. Construction of a frozen core dam is complex, time consuming and expensive. Very strict quality control is required to ensure suitable core material is produced, while construction of the core requires rigorous production, placement and testing procedures. In addition, a frozen core dam can only be constructed in the winter when air temperatures are colder than -15°C .

If water retention is required for prolonged periods of time, this dam construction technology would undoubtedly be the most viable technology for the Project site. However, if the tailings deposition plan was designed to progressively develop tailings beaches against the dams and thereby move the pond away from the wall, then a less complex technology such as the frozen foundation dam (see sub-section below) would be more suitable.

Unfrozen Upstream Geosynthetic Lined Dam

If suitable low permeability core material is not available or if site conditions do not allow for construction with low permeability material (e.g. at the Project site), a viable alternative would be to construct a rockfill dam with an upstream liner providing the water retention layer. The liner; however, needs to be tied into suitable low permeability foundation soils or bedrock.

Even though this dam construction technology is often used in arctic settings, it is not a viable technology for this Project. Although permafrost conditions ensure that foundation soils are currently frozen, if the dam foundation is not engineered to remain frozen it would eventually thaw and the soils are seldom of sufficiently low permeability when unfrozen. Tying the liner into intact bedrock is not viable either because foundation soils at the Project site are typically too thick making excavation of the key trench to bedrock impractical.

Frozen Foundation Dams with Upstream Geosynthetic Liner

The frozen foundation dam combines the frozen core and unfrozen upstream geosynthetic dam concepts. The primary water retention component is an upstream geomembrane liner; however,

the liner is keyed into the permafrost and the dam is engineered to ensure that the liner remains tied into permafrost for its design life. This is achieved by providing appropriate thermal insulation in critical areas. If this dam is subject to prolonged water ponding, it has a limited practical design life; however, if the pond is progressively moved away from the dam by beaching tailings adjacent to the dam, this containment structure becomes part of the permafrost landscape and is considered a very effective containment technology.

3.2.3 Containment Dam Technology Assessment

Based on the summaries of containment dam technologies in the preceding section, it can readily be concluded that cyclone tailings dams, conventional low permeability core dams, and conventional unfrozen upstream geosynthetic lined dams are not suitable technologies for the Project site, and therefore were not further evaluated in this alternatives assessment.

Frozen core and frozen foundation dams are viable and appropriate containment dam technologies for the Project site; however, frozen core dams are complex and expensive structures, and that degree of rigour is only warranted if long-term water retention is required. It is preferable from an overall environmental risk perspective to minimize the load on containment dams; therefore, as far as practical, tailings beaches will be developed upstream of all containment dams which makes frozen foundation dams the preferred containment dam technology for the Project site. In this alternatives assessment, all containment dams are therefore considered to be frozen foundation dams with upstream geosynthetic liners.

3.3 Tailings Disposal Sites

Taking into consideration the tailings and containment dam technologies suitable for the Project site, several tailings disposal sites were considered for evaluation in the alternatives assessment. As an initial starting point the following siting rationale was selected for finding candidate sites:

- Slurry tailings sites had to have sufficient storage capacity for at least 5.1 million tonnes of tailings at an assumed settled dry density of 1.3 t/m³, for a minimum storage volume of 3.9 million m³ plus a 1 million m³ allowance for reclaim water and freeboard. Initially the tailings quantity considered was 4.5 million tonnes (3.5 million m³), but as the project planning progressed, the ore reserves included in this study were increased to 5.1 Mt, resulting in an increase in required storage capacity. Storage capacity evaluation was based on the available regional topographical data (5 m contour intervals).
- Dry stack tailings sites had to have sufficient storage capacity for storage for 2.8 million m³ of tailings, i.e. 5.1 million tonnes at 1.8 t/m³ density. No allowance for water storage is required. As in the case of the slurry tailings sites, the initial storage requirement was lower (2.3 million m³) and had to be increased as the project planning progressed, and larger ore quantities were included.
- A maximum straight line distance of 15 km as measured from the existing Boston portal.
- No locations west of Aimaokatalok Lake.

- Use of water bodies, possibly requiring listing on Schedule 2 of the Metal Mining Effluent Regulations (MMER 2015) was not specifically excluded.
- As far as practical, sites with natural containment offered by topographical features such as valleys or gently sloping terrain are preferred over large man-made containment.

A total of 35 tailings disposal alternatives were identified and are illustrated in Figure 2. Two of these locations are different tailings disposal technologies (conventional low solids content slurry, #08 (B3a), and filtered tailings, #09 (B3b), at the same site. Three alternatives were evaluated only for filtered tailings technology (Alt. #03 (A3a), Alt. #04 (A3b), and Alt. #10 (B4)) and the remaining sites only considered conventional low solids slurry tailings.

Table A-1 (Appendix A) contains a comprehensive summary describing each of the 35 tailings disposal sites. Each site is identified by an alternative number and a site descriptor. Table A-1 also references figures associated with each alternative. For each alternative, Table A-1 provides a concise description of the site location, the tailings deposition method, the tailings deposition type, the straight-line distance from the Boston portal, the tailings management area footprint, the proposed containment dam and/or dry-stack height, the maximum tailings storage volume, the containment dam type (dam descriptor), and whether or not the proposed tailings management area are within the proposed project development area (PDA) or not.

4 Step 1: Accounts and Subaccounts

4.1 Accounts

In accordance with the MAA guideline published by EC (2011) for disposal of mine waste, the four accounts assessed includes technical/operational, project economic, environmental, and socio-economic criteria (Table 2).

4.2 Subaccounts

Subaccounts selected for the MAA are listed in Table 2. The subaccounts follow the recommended list in the MAA guideline published by EC (2011) for disposal of mine waste, but were modified slightly considering site specific conditions. Specifically, environmental and socio-economic subaccounts are based on the identified valued ecosystem components (VECs), valued socio-economic components (VSECs), and subjects of note for the Project.

Care was taken to avoid “double counting” of criteria. For example, although distance from the mill site can be a subaccount for the environmental (land disturbance) and engineering categories (fill quantity), it was evaluated under the technical/operational account only.

Table 2: Summary of Accounts and Subaccounts

Account	Subaccount
Technical/Operational	Deposition Method
	Distance from Mill
	Dam Volume
	Total Dam Fill
	Engineering Complexity
	Storage Factor
	Pumping Distance
	Head Difference
	Flexibility with Respect to Deposition Method
	Height/Footprint Trade-off
	Opportunity for Progressive Reclamation
	Favourable Topography
	Dam Height (qualitative)
	Volume of Water Stored
	Consequence of Dam/Dry Stack Failure
	Water Management Add-on
Project Economic	Total Cost
	Economic Risks
	Construction Risks

Account	Subaccount
Environmental	Air Quality
	Surface Water Quantity and Quality
	Fish and Fish Habitat
	Terrestrial Ecology, Vegetation and Landforms
	Caribou
	Wolverine
	Grizzly Bear
	Migratory Birds
	Raptors
Socio-Economic	Archaeological Sites
	Inuit Employment and Training
	Inuit Economic Opportunities
	Traditional Land Use
	Community Response
	Regulatory Response

5 Step 2: Pre-Screening Assessment

5.1 Primary Pre-Screening Criteria

The first step of the MAA is to conduct a pre-screening assessment. The objective of this step is to conduct a high level “fatal flaw” analysis of all the tailings disposal alternatives identified in Table A-1 (Appendix A) to develop a more practical and reasonable short list from which to conduct the more rigorous quantitative MAA. The primary pre-screening criteria selected for the Boston tailings alternatives assessment were as follows:

- **Location relative to the potential development area (PDA) boundary.** Considerable project baseline data has been collected within an extensive PDA and any tailings alternative within that area would allow for seamless transitioning into the environmental assessment phase. However, alternatives outside of the PDA may require up to two years of additional baseline data collection which would result in unacceptable project delays.
- **Practical distance from mill.** Transport of tailings must be within 10 km (road distance) from the Boston processing plant. The tailings volume is low requiring a small diameter pipeline. The friction and heat loss through such a pipeline is significant and pumping further than 10 km is not deemed economically feasible. Likewise trucking filtered tailings that distance will result in tailing freezing in the truck, which would make dry stack construction impossible.

These disposal criteria were applied sequentially. The first criterion above was applied to the whole of 35 alternatives, resulting in 18 alternatives being eliminated. Preliminary road alignments were then created for the remaining 17 alternatives. The second criterion was subsequently applied resulting in an additional 3 alternatives being eliminated, leaving 14 alternatives worthy of further consideration (Table A-2, Appendix A).

5.2 Secondary Pre-Screening Criteria

Due to the large number of alternatives that had not been screened out as part of the primary pre-screening process, a decision was made to subject those alternatives to a secondary pre-screening phase. The rationale behind selection of these criteria was to eliminate alternatives that might have very material environmental impacts associated with them, which when evaluated by stakeholders could constitute “fatal flaws”. The secondary pre-screening criteria selected for the Boston tailings alternatives assessment were as follows:

- **Major Stream Diversion.** Construction, operation, and maintenance of major stream diversions in an arctic setting is technically challenging and can have significant long-term environmental effects associated with permafrost degradation and habitat loss. As a result, alternatives that would require this feature were not carried forward in the assessment.
- **Complex Contact Water Management.** Contact water needs to be effectively managed during construction, operations and closure. A failure of the contact water collection and management system could lead to significant environmental effects if an uncontrolled discharge were to occur to streams and/or lakes. Alternatives that require very complex contact water management strategies were therefore not preferred.

- **Listing on Schedule 2 of MMER.** Discharge of a deleterious substance (including tailings) into a water body that would impact fish habitat requires delisting under Schedule 2 of the MMER (MMER 2015). This process is onerous and could have material impacts on timelines for regulatory approvals. As a result, alternatives where this may be a requirement were not carried forward in the assessment.
- **Capacity for Expansion.** The alternatives were compared based on conceptual engineering that considered storage capacity as described in Section 3.3. However, this is an early development stage of the Project and the selected disposal site must allow for increases in ore reserves.

Just as for the primary pre-screening criteria, these secondary pre-screening criteria were also applied sequentially. A further ten alternatives were eliminated, leaving four alternatives for detailed evaluation in the MAA (Table A-2, Appendix A). Complete details of the four shortlisted alternatives are provided in Table A-3 (Appendix A). Figures 4 through 7 provide general arrangements for each of these alternatives.

6 Analysis, Scoring, and Weighting

6.1 Step 3: Detailed Analysis

Comprehensive conceptual designs of each of the four shortlisted alternatives described in Table A-3 (Appendix A) were developed. The designs were carried out using 3-D modelling software Muck3D (MineBridge 2015), and the resultant design layouts are presented in Figures 4 through 7. Tables A-4 through A-7 (Appendix A) provide complete details of these shortlisted alternatives in the context of the accounts and subaccounts selected for the Project (i.e. technical/operational, economic, environmental, and socio-economic), with each table representing one of the accounts above.

6.2 Step 4: Scoring

The scoring criteria for each of the subaccounts selected for the Project are summarized in Table A-8 through A-11 (Appendix A). All scoring was based on a point scale from 0 to 5. In cases where a binary rating was required (yes/no type of questions) the full range was not applied, but a score of 4 or 5 was assigned to differentiate between alternatives.

Two of the socio-economic subaccounts (community response and regulatory response) could not be used in the ranking process because community consultation was still in progress at time of writing and, as a result, factual data was not yet available.

Table A-12 (Appendix A) provides the compiled accounts ledger for the alternatives. This ledger documents the score assigned to each alternative for each subaccount. No weighting is assigned to any of the scores in Table A-12, i.e., all subaccounts are considered equal.

6.3 Step 5: Weighting

Weighting of the accounts for the base case analysis was done in accordance with the MAA guideline published by EC (2011) for disposal of mine waste. The guideline recommends a weight of 3 for technical/operational, 1.5 for project economics, 6 for environmental, and 3 for socio-economic. This assessment has considered various weightings as part of the Step 6: Sensitivity Analysis.

The base case MAA results are presented

Table 3. The account merit rating is calculated by scoring each of the subaccounts as presented in Table A12 (accounts ledger). The total merit score of each account is the sum of all the subaccount scores.

For any given subaccount in the table, the maximum merit rating (and merit score in this case) that an alternative can achieve is five, which implies the alternative is considered to have the best performance in that given subaccount. The merit scores for each subaccount are then added to determine the total merit score of the account.

To avoid unintentionally increasing the importance of an account with many subaccounts relative to an account with few subaccounts, each account merit score is normalized by the number of subaccounts it contains. For example, the technical/operational account has 15 subaccounts while the project economics account only has 3 subaccounts. Without the normalization, the maximum merit score that can be achieved by an alternative is the product of five times the number of subaccounts within that account. The technical/operational account could receive a maximum merit score of 75, while the economic account could only receive a maximum merit score of 15. To avoid this bias, the account merit scores are normalized by dividing by the sum of the subaccounts of 15 and 3, respectively. This normalized account merit score is called the account merit rating.

Finally, the total overall score of an alternative consists of the sum of the four proportionate account scores. The highest proportionate number in any given account implies the most desirable alternative with respect to that account. The tailings alternative that has the largest overall merit rating is considered to be the best overall alternative.

Each account was given the weight as recommended by the EC (2011) guidelines. The effect of assigning weights to the accounts was determined by conducting a sensitivity analysis as discussed in the next section. Figure 9 displays the account merit scores in radar charts. The best alternative would have the largest area.

Table 3: Alternatives Ranking

		Weight	Alternatives				
			B3a	B3b	B4	G1	
Account Merit Rating	Technical / Operational	3	2.93	3.93	3.87	2.33	
	Project Economics	1.5	3.00	3.67	3.67	2.67	
	Environmental	6	2.22	2.78	3.44	2.78	
	Socio-Economics	3	1.83	1.67	1.83	1.67	
Account Merit Score (Account Merit Rating x Weight)	Technical / Operational		8.80	11.80	11.60	7.00	
	Project Economics		4.50	5.50	5.50	4.00	
	Environmental		13.33	16.67	20.67	16.67	
	Socio-Economics		5.50	5.00	5.50	5.00	
Alternative Merit Score			32.13	38.97	43.27	32.67	
Alternative Merit Rating			2.38	2.89	3.20	2.42	
Account Rank	Technical / Operational	3	1	2	4		
	Project Economics	3	1	1	4		
	Environmental	4	2	1	2		
	Socio-Economics	1	3	1	3		
Overall Alternative Rank			4	2	1	3	

Source: \\van-svr0\Projects\01_SITES\Hope.Bay\1CT022.004_Phase 2 DEIS - Engineering Support\Task 620_Tailings Boston\BostonTIA_MAA_SummarySheets_1CT022.004_Rev11_IM_KK_EMR.xlsx

7 Step 6: Sensitivity Analysis

A sensitivity analysis was conducted by assigning different weightings to the accounts and the results are summarized in Table 4. Weighting of zero was assigned to the accounts one-by-one while maintaining the other account unchanged (scenarios 1 through 4), followed by assigning zero weighting to all but one account (scenarios 5 through 8). An equal weighting of 1 was also tested (scenario 9), followed by assigning a weighting of zero to the account one-by-one while all other accounts had a weighting of 1 (scenarios 10 through 13).

It was found that Alternative B4 remained the preferred option in all but one of the weighting scenarios. The overall ranking was largely maintained, with filtered tailings (B3b and B4) ranking consistently higher than slurry tailing alternatives (B3a and G1).

Table 4: Sensitivity Analysis Results

Scenario	Account Weights				Overall Ranking			
	Technical/ Operational	Project Economics	Environmental	Socio- economic	B3a	B3b	B4	G1
Base	3	1.5	6	3	4	2	1	3
1	0	1.5	6	3	4	2	1	3
2	3	0	6	3	4	2	1	3
3	3	1.5	0	3	3	2	1	4
4	3	1.5	6	0	4	2	1	3
5	3	0	0	0	3	1	2	4
6	0	1.5	0	0	3	1	1	4
7	0	0	6	0	4	2	1	2
8	0	0	0	3	1	3	1	3
9	1	1	1	1	3	2	1	4
10	0	1	1	1	4	2	1	3
11	1	0	1	1	3	2	1	4
12	1	1	0	1	3	2	1	4
13	1	1	1	0	3	2	1	4

Source: \\van-svr0\Projects\01_SITES\Hope.Bay\1CT022.004_Phase 2 DEIS - Engineering Support\Task 620_Tailings Boston\BostonTIA_MAA_SummarySheets_1CT022.004_Rev10_IM_KK_EMR.xlsx

8 Discussion and Conclusion

An MAA, in accordance with the EC (2011) guidelines for MAA for mine waste disposal, was completed to determine which of 35 tailings disposal alternatives would be the preferred option for the Boston TMA. Following a two-stage pre-screening evaluation, four sites were shortlisted for detailed evaluation. Comprehensive conceptual designs of each of the shortlisted options were developed and subsequently scored in terms of technical/operational, project economic, environmental and socio-economic criteria (accounts). Each account was further broken down into subaccounts (33 in total).

The base case analysis assumed weighting in accordance with the EC (2011) guideline, and a series of sensitivity analysis was completed to test for any bias in the analysis.

The analysis concluded that the preferred tailings management system at Boston would be to place filtered tailings into a free-standing dry stack facility in close proximity to the proposed processing facility on favourable ground. B4 was the only site to meet this criteria; therefore, it was ranked at the top as the most viable alternative.

This report, Hope Bay Project Boston Tailings Disposal Alternatives Assessment, was prepared by SRK Consulting (Canada) Inc.

Kaitlyn Kooy
This signature was scanned with the
author's approval for exclusive use in this
document; any other use is not authorized.

Kaitlyn Kooy, EIT
Staff Consultant

Maritz Rykaart
This signature was scanned with the
author's approval for exclusive use in this
document; any other use is not authorized.

Iozsef Miskolczi, PEng
Senior Consultant

and reviewed by

Maritz Rykaart
This signature was scanned with the
author's approval for exclusive use in this
document; any other use is not authorized.

Maritz Rykaart, PhD, PEng
Practice Leader

All data used as source material plus the text, tables, figures, and attachments of this document have been reviewed and prepared in accordance with generally accepted professional engineering and environmental practices.

Disclaimer—SRK Consulting (Canada) Inc. has prepared this document for TMAC Resources Inc.. Any use or decisions by which a third party makes of this document are the responsibility of such third parties. In no circumstance does SRK accept any consequential liability arising from commercial decisions or actions resulting from the use of this report by a third party.

The opinions expressed in this report have been based on the information available to SRK at the time of preparation. SRK has exercised all due care in reviewing information supplied by others for use on this project. Whilst SRK has compared key supplied data with expected values, the accuracy of the results and conclusions from the review are entirely reliant on the accuracy and completeness of the supplied data. SRK does not accept responsibility for any errors or omissions in the supplied information, except to the extent that SRK was hired to verify the data.

9 References

[EC] Environment Canada. 2011 Guidelines for the Assessment of Alternatives for Mine Waste Disposal. (<http://ec.gc.ca/pollution/default.asp?lang=En&n=125349F7-1>), accessed on Feb. 19, 2016.

Metal Mining Effluent Regulations, (2015). Tailings Impoundment Areas - Schedule 2. Last amended May 6, 2016. <http://laws-lois.justice.gc.ca/eng/regulations/SOR-2002-222/>. Accessed June 2016.

MineBridge Software Inc. 2015. Muck3D User Manual, v.3.1.0, Issue date: 11/05/2015.

SRK Consulting (Canada) Inc. 2012. Hope Bay Project, North Dam As-Built Report. Report Prepared for Hope Bay Mining Limited. Project Number: 1CH008.058. October 2012.

SRK Consulting (Canada) Inc., 2017. Geotechnical Design Parameters and Overburden Summary Report, Hope Bay Project. Report Prepared for TMAC Resources Inc. 1CT022.013. November 2017.

Figures



 **srk** consulting

SRK JOB NO.: 1CT022.013

FILE NAME: 1CT022.013_AltAss FIGURES_20171123.pdf

MAC
RESOURCES

HOPE BAY PROJECT

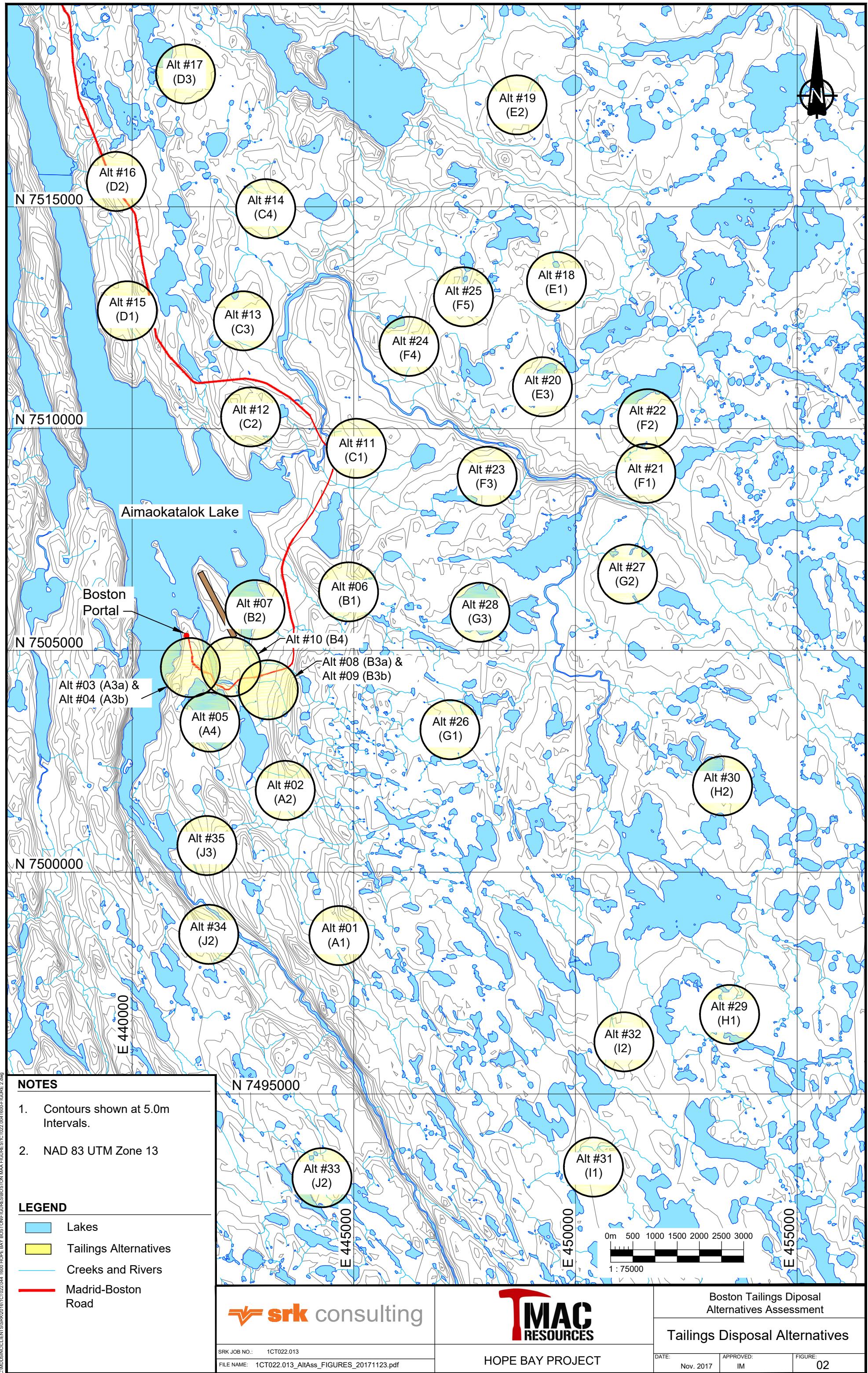
Boston Tailings Disposal
Alternatives Assessment

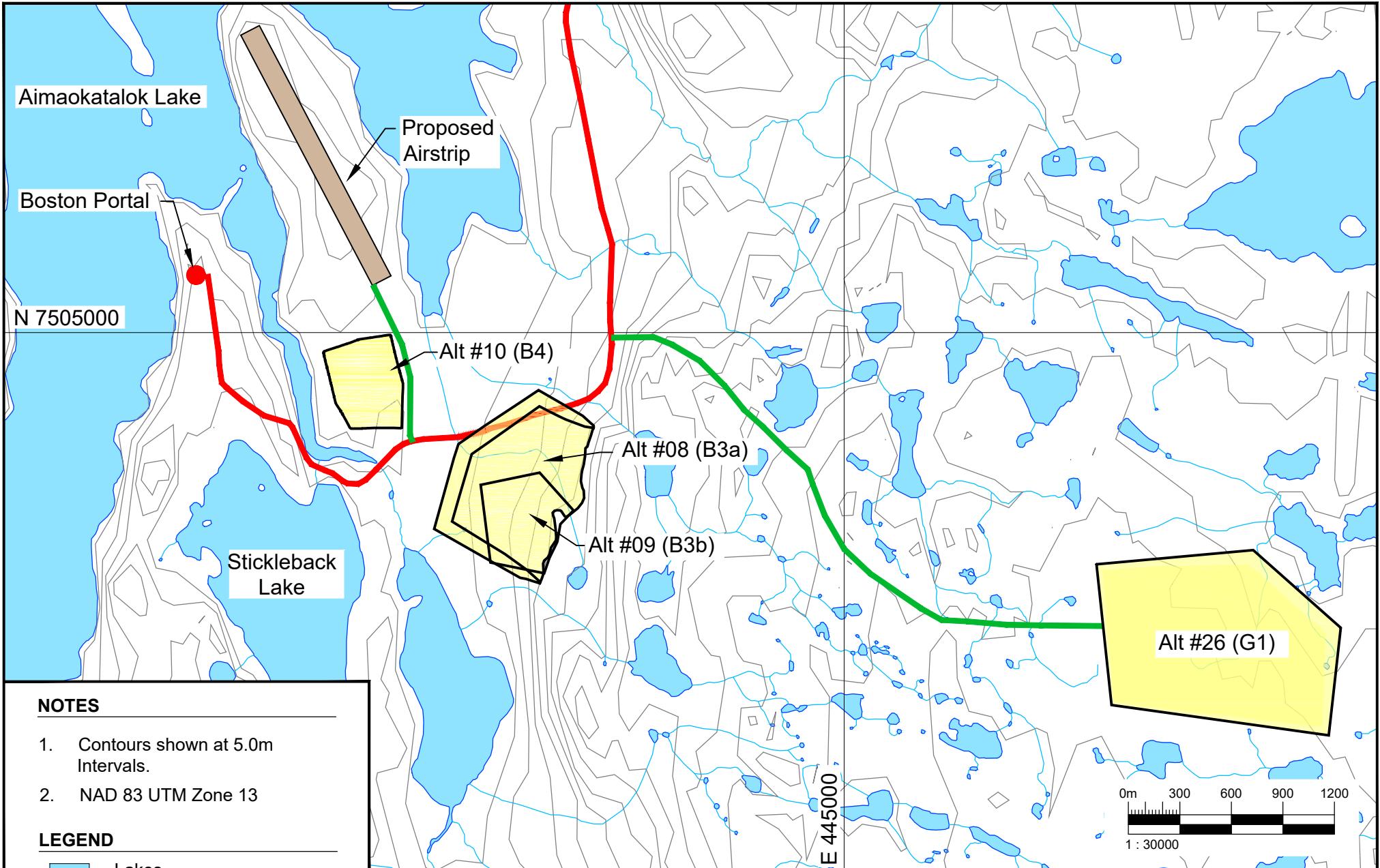
Site Location Plan

DATE:
Nov. 2017

APPROVED:
IM

FIGURE:
01





NOTES

1. Contours shown at 5.0m Intervals.
2. NAD 83 UTM Zone 13

LEGEND

- Lakes
- Tailings Alternatives
- Creeks and Rivers
- Proposed Access Road
- Madrid-Boston Road

 **srk** consulting

SRK JOB NO.: 1CT022.013
FILE NAME: 1CT022.013_AltAss FIGURES_20171123.pdf

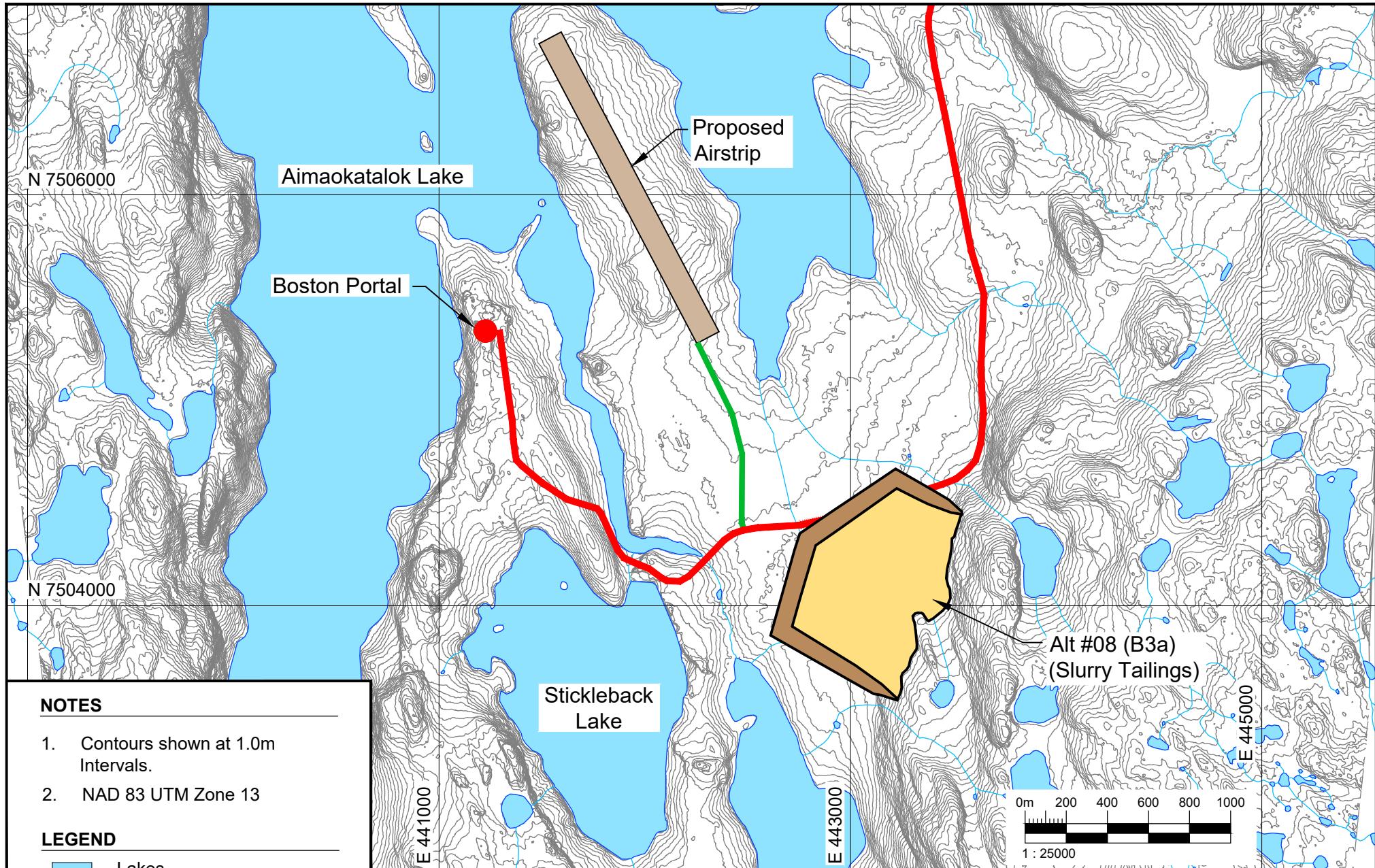

T MAC
RESOURCES

HOPE BAY PROJECT

Boston Tailings Disposal
Alternatives Assessment

Shortlisted Tailings Disposal
Alternatives

DATE: Nov. 2017 APPROVED: IM FIGURE: 03



 **srk** consulting

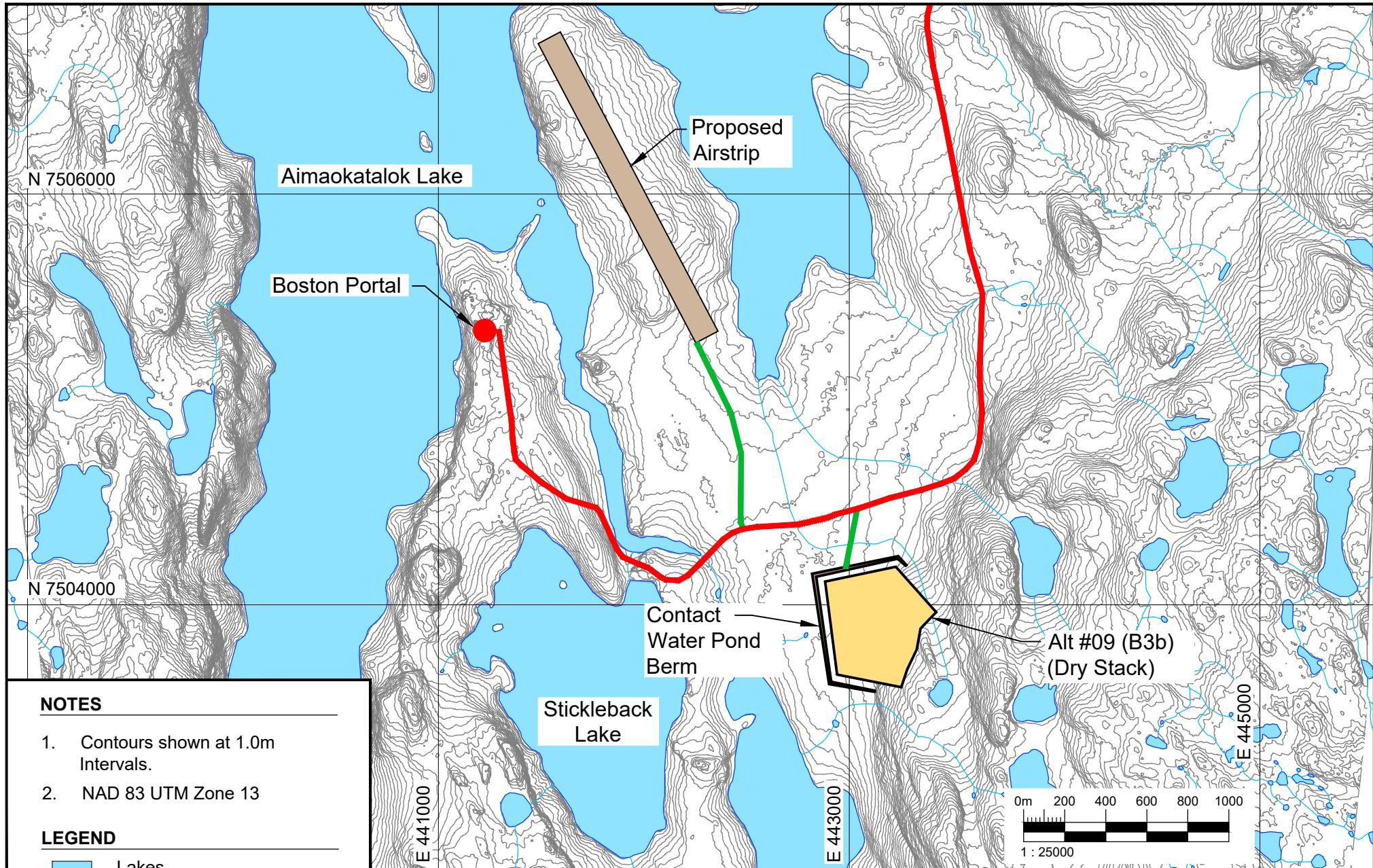
SRK JOB NO.: 1CT022.013
FILE NAME: 1CT022.013_AltAss FIGURES_20171123.pdf

TMAC
RESOURCES

HOPE BAY PROJECT

Boston Tailings Disposal
Alternatives Assessment
Alternative #08 (B3a)
(Slurry Tailings)

DATE: Nov. 2017 APPROVED: IM FIGURE: 04



NOTES

1. Contours shown at 1.0m Intervals.
2. NAD 83 UTM Zone 13

LEGEND

- Lakes
- Tailings Area
- Creeks and Rivers
- Proposed Access Road
- Madrid-Boston Road

 **srk** consulting

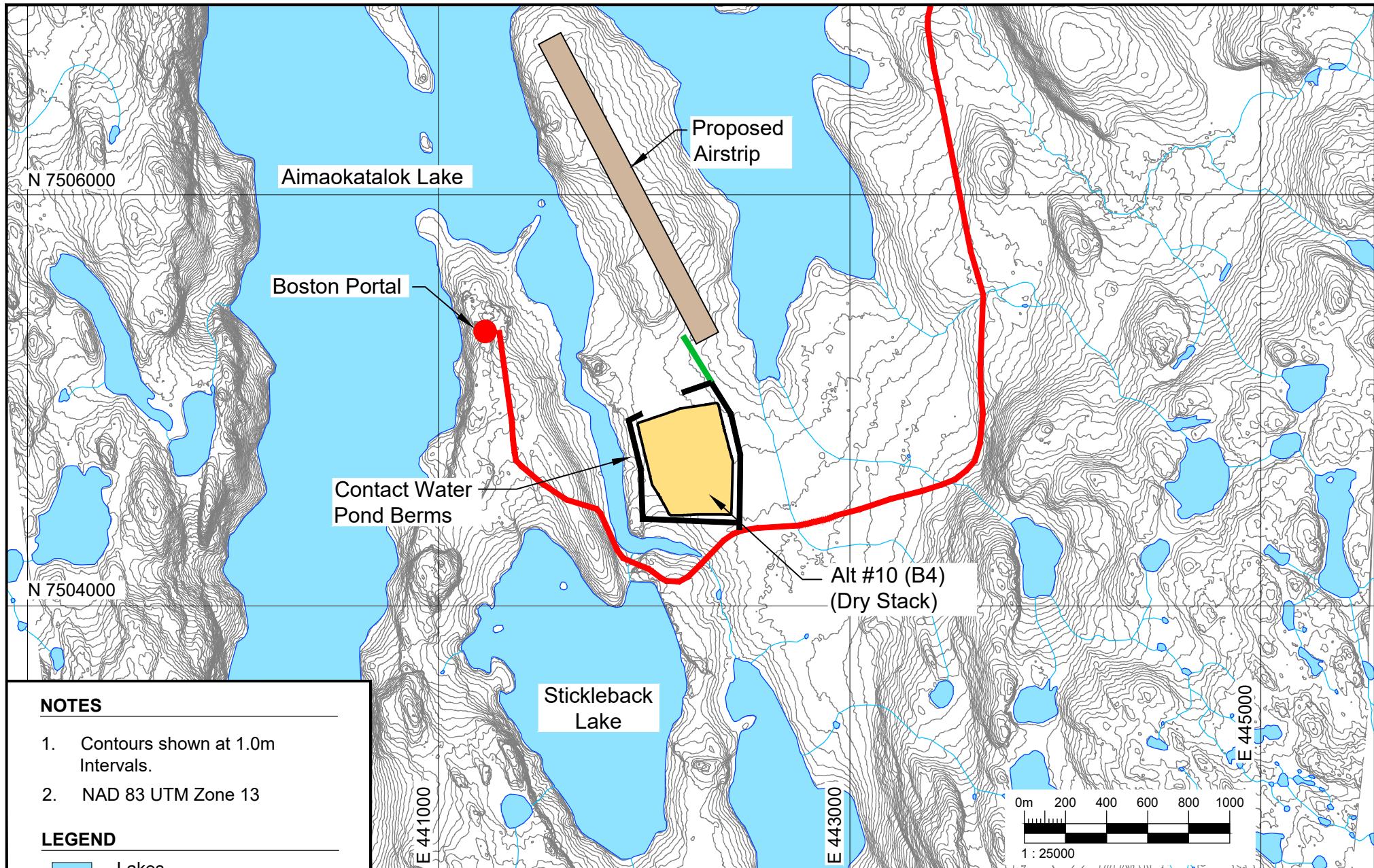
SRK JOB NO.: 1CT022.013
FILE NAME: 1CT022.013_AltAss FIGURES_20171123.pdf

TMAC
RESOURCES

HOPE BAY PROJECT

Boston Tailings Disposal
Alternatives Assessment
Alternative #09 (B3b)
(Dry Stack)

DATE: Nov. 2017 APPROVED: IM FIGURE: 05



 **srk** consulting

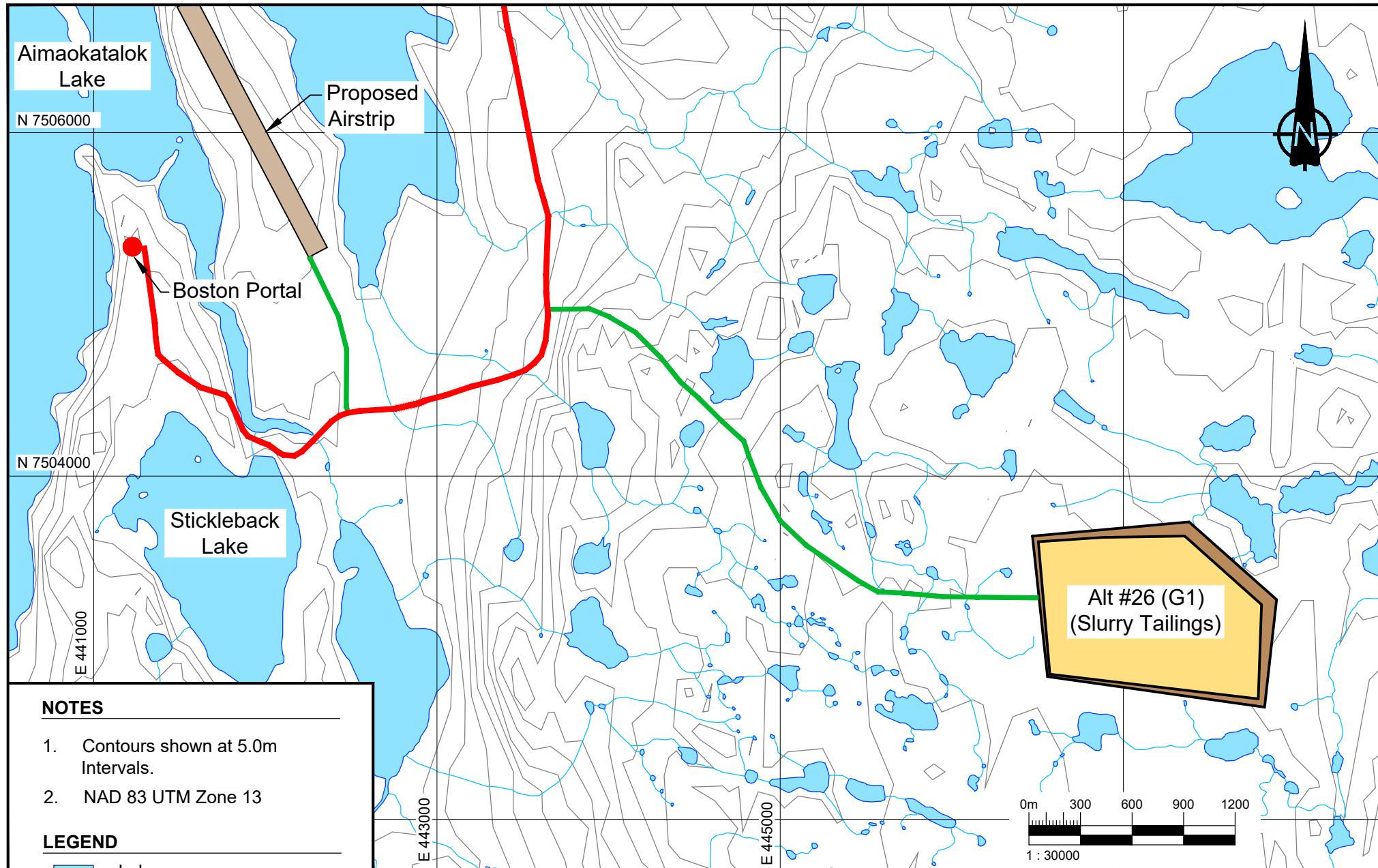
SRK JOB NO.: 1CT022.013
FILE NAME: 1CT022.013_AltAss FIGURES_20171123.pdf

TMAC
RESOURCES

HOPE BAY PROJECT

Boston Tailings Disposal
Alternatives Assessment
Alternative #10 (B4)
(Dry Stack)

DATE: Nov. 2017 APPROVED: IM FIGURE: 06



NOTES

1. Contours shown at 5.0m Intervals.
2. NAD 83 UTM Zone 13

LEGEND

- Lakes
- Tailings Area
- Creeks and Rivers
- Proposed Access Road
- Madrid-Boston Road

 **srk** consulting

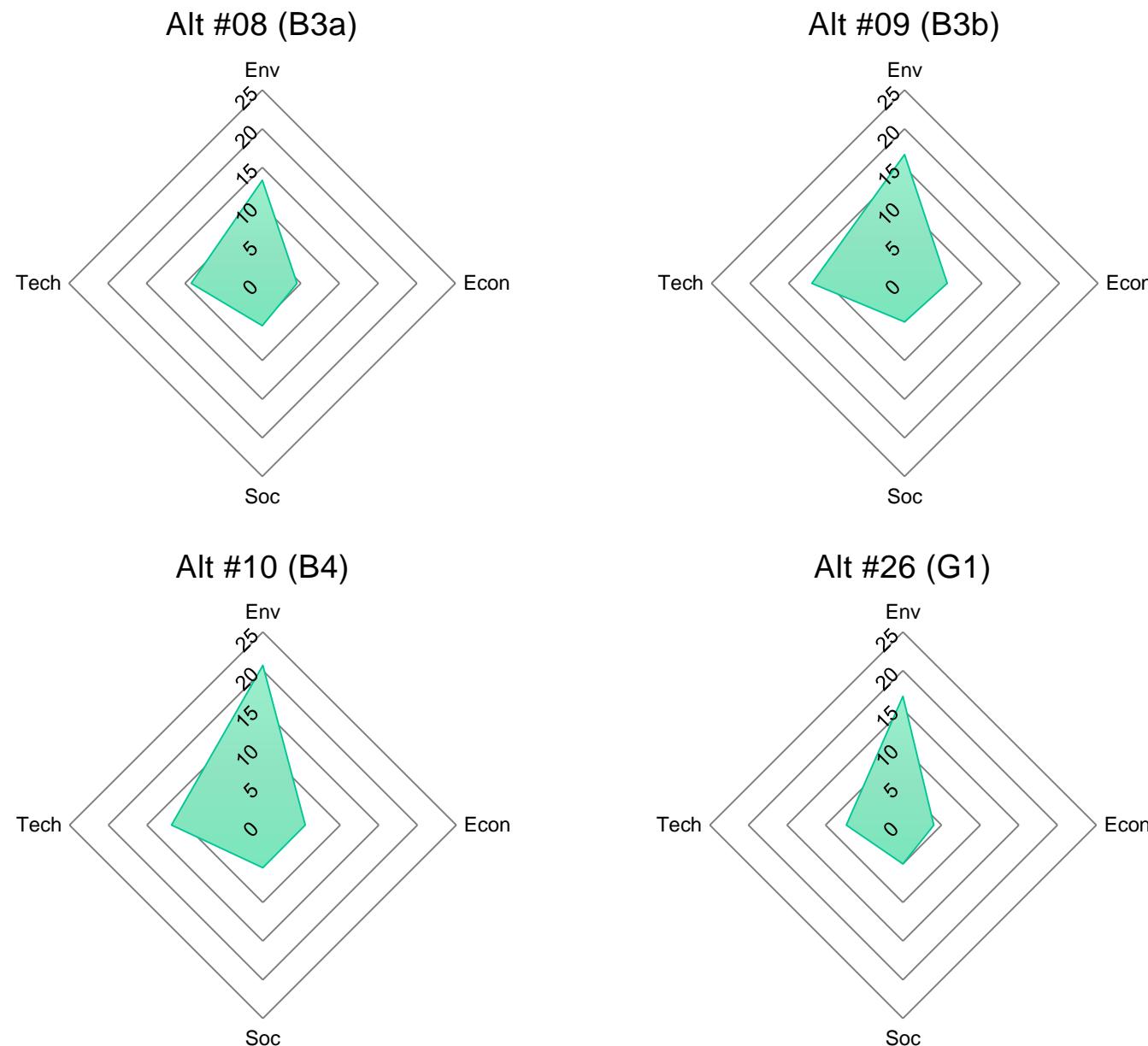
SRK JOB NO.: 1CT022.013
FILE NAME: 1CT022.013_AltAss FIGURES_20171123.pdf

TMAC
RESOURCES

HOPE BAY PROJECT

Boston Tailings Disposal
Alternatives Assessment
Alternative #26 (G1)
(Slurry Tailings)

DATE: Nov. 2017 APPROVED: IM FIGURE: 07



 Job No: 1CT022.013	 HOPE BAY PROJECT	Boston Tailings Disposal Alternatives Assessment		
		Alternative Account Merit Scores as Radar Charts		
Filename: 1CT022.013_AltAss FIGURES_20171123.pdf	Date: Nov 2017	Approved: MMM	Figure: 8	

Attachment A – MAA Summary Tables

Table A-1: Summary of Tailings Disposal Alternatives

Site Number	Site #01	Site #02	Site #03	Site #04	Site #05	Site #06	Site #07	Site #08	Site #09	Site #10	Site #11	Site #12	Site #13	Site #14	Site #15	Site #16	Site #17	Site #18
Site Descriptor	A1	A2	A3a	A3b	A4	B1	B2	B3a	B3b	B4	C1	C2	C3	C4	D1	D2	D3	E1
Figure #	02	02	02,03,04	02	02	02	02	02,03,05	02,03,06	02,03,07	02	02	02	02	02	02	02	02
Site Location	SSE of Mill	SSE of Mill	S of Mill	S of Mill	S of Mill	ENE of Mill	NE of Mill	ESE of Mill	ESE of Mill	ESE of Mill	NE of Mill	NNE of Mill	NNE of Mill	NNW of Mill	NNW of Mill	N of Mill	NE of Mill	
Tailings Deposition Method	Slurry	Slurry	Filtered	Filtered	Slurry	Slurry	Slurry	Slurry	Slurry	Filtered	Slurry	Slurry	Slurry	Slurry	Slurry	Slurry	Slurry	Slurry
Deposition Type	Sub-AE	Sub-AE	Sub-AE	Sub-AE	Sub-AQ	Sub-AE	Sub-AQ	Sub-AE	Sub-AE	Sub-AE	Sub-AE	Sub-AE	Sub-AE	Sub-AE	Sub-AE	Sub-AE	Sub-AE	Sub-AE
Straight Line Distance from Mill (km)	6.82	3.94	1.28	1.28	1.30	3.56	2.39	2.24	2.12	1.68	5.89	5.36	7.44	10.01	7.66	10.58	12.89	11.73
Footprint (ha)	84	71	18	30	118	90	100	54	21	15	88	47	123	114	109	81	97	138
Dam/Dry Stack Height (m)	12	14	23	12	6	13	8	10	25	26	17	25	12	10	19	22	8	9
Maximum Storage Volume (Mm ³)	4.4	4.8	2.3	2.3	4.9	4.8	5.4	4.9	2.3	2.3	5.2	4.6	5.6	5.5	5.5	5.0	4.5	5.4
Dam Descriptor	Ring Dam	Ring Dam	CWP Berm	Water Retaining Dam	Water Retaining Dam	Ring Dam	Water Retaining Dam	Sidehill Dam	CWP Berm	CWP Berm	Ring Dam	Ring Dam	Ring Dam	Ring Dam	Ring Dam	Ring Dam	Ring Dam	Ring Dam
Within PDA	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	no	no	yes	yes	no

Notes:

PDA = Potential Development Area

CWP Berm = Contact Water Pond Berm

Sub-AE = Sub-aerial

Sub-AQ = Sub-Aqueous

Table A-1: Summary of Tailings Disposal Alternatives (continued)

Site Number	Site #19	Site #20	Site #21	Site #22	Site #23	Site #24	Site #25	Site #26	Site #27	Site #28	Site #29	Site #30	Site #31	Site #32	Site #33	Site #34	Site #35
Site Descriptor	E2	E3	F1	F2	F3	F4	F5	G1	G2	G3	H1	H2	I1	I2	J1	J2	J3
Figure #	02	02	02	02	02	02	02	02,03,08	02	02	02	02	02	02	02	02	02
Site Location	NNE of Mill	ENE of Mill	ENE of Mill	ENE of Mill	ENE of Mill	NNE of Mill	NNE of Mill	ESE of Mill	ENE of Mill	E of Mill	ESE of Mill	ESE of Mill	SSE of Mill	SE of Mill	SSE of Mill	S of Mill	S of Mill
Tailings Deposition Method	Slurry	Slurry	Slurry	Slurry	Slurry	Slurry	Slurry	Slurry	Slurry								
Deposition Type	Sub-AE	Sub-AE	Sub-AE	Sub-AE	Sub-AE	Sub-AE	Sub-AE	Sub-AE	Sub-AE								
Straight Line Distance from Mill (km)	14.31	9.27	11.09	11.62	6.81	8.43	10.04	5.27	10.11	6.07	14.82	12.52	14.93	13.32	12.38	6.53	3.89
Footprint (ha)	125	117	135	135	91	89	134	120	138	136	138	138	131	135	137	61	62
Dam/Dry Stack Height (m)	9	6	15	6	15	13	11	15	6	4	5	9	7	7	7	15	15
Maximum Storage Volume (Mm ³)	4.6	5.5	5.3	5.0	5.0	5.3	4.8	5.1	5.1	5.1	4.6	5.5	5.4	4.9	5.1	4.9	4.7
Dam Descriptor	Ring Dam	Ring Dam	Ring Dam	Ring Dam	Ring Dam	Ring Dam	Ring Dam	Ring Dam	Sidehill Dam								
Within PDA	no	yes	no	yes	no	no	no	no	no	no	yes						

Notes:

PDA = Potential Development Area

CWP Berm = Contact Water Pond Berm

Sub-AE = Sub-aerial

Sub-AQ = Sub-Aqueous

Table A-2: Pre-Screening (Primary and Secondary) of Tailings Disposal Alternatives

Criteria	Rationale	Site #01	Site #02	Site #03	Site #04	Site #05	Site #06	Site #07	Site #08	Site #09	Site #10	Site #11	Site #12	Site #13	Site #14	Site #15	Site #16	Site #17
		A1	A2	A3a	A3b	A4	B1	B2	B3a	B3b	B4	C1	C2	C3	C4	D1	D2	D3
Pre-screening: Fatal Flaw Criteria																		
Within PDA	The alternative must be within the PDA to be included in further assessment	yes	no	no	yes	yes	no											
Practical distance from process plant	The alternative must be within a practical distance (less than 10 km) to the Boston Process Plant. Alternatives located further away than 10 km were excluded from further assessment	yes	no	no	no	no	no											
Passing fatal flaw criteria		YES	NO	NO	NO	NO	NO	NO										
Prescreening: Refinement																		
No major stream diversions required	The alternative must not be in the path of any major streams that would require diversion. Alternatives in the path of major streams were excluded from further assessment	no	no	yes	yes	yes	no	no	yes	yes	yes	yes						
Allow for adequate management of runoff	The alternative must have the ability to capture any contact runoff water	yes	yes	yes	yes	yes	yes	no	yes	yes	yes	yes	no					
Does not require lake listing on Schedule 2 of the MMER	Alternatives that require a lake to be delisted under Schedule 2 of the MMER were excluded from further assessment	yes	no	yes	no	no	yes	no	yes	yes	yes	yes	no					
Potential for increased tailings deposition capacity	Alternatives that cannot be expanded beyond the currently assessed capacity were excluded from further assessment	yes	yes	no	yes													
Alternative carried forward to detailed analysis		NO	YES	YES	YES	YES	NO	NO	NO	NO	NO	NO						

Notes:

PDA = Potential Development Area

Table A-2: Pre-Screening (Primary and Secondary) of Tailings Disposal Alternatives (continued)

Criteria	Rationale	Site #18	Site #19	Site #20	Site #21	Site #22	Site #23	Site #24	Site #25	Site #26	Site #27	Site #28	Site #29	Site #30	Site #31	Site #32	Site #33	Site #34	Site #35
		E1	E2	E3	F1	F2	F3	F4	F5	G1	G2	G3	H1	H2	I1	I2	J1	J2	J3
Pre-screening: Fatal Flaw Criteria																			
Within PDA	The alternative must be within the PDA to be included in further assessment	no	yes	no	yes	no	no	no	no	no	no	yes							
Practical distance from process plant	The alternative must be within a practical distance (less than 10 km) to the Boston Process Plant. Alternatives located further away than 10 km were excluded from further assessment	no	yes	no	yes	no	no	no	no	no	no	yes							
Passing fatal flaw criteria		NO	YES	NO	YES	NO	NO	NO	NO	NO	NO	YES							
Prescreening: Refinement																			
No major stream diversions required	The alternative must not be in the path of any major streams that would require diversion. Alternatives in the path of major streams were excluded from further assessment									yes		yes							yes
Allow for adequate management of runoff	The alternative must have the ability to capture any contact runoff water									yes		yes							no
Does not require lake listing on Schedule 2 of the MMER	Alternatives that require a lake to be delisted under Schedule 2 of the MMER were excluded from further assessment									yes		no							no
Potential for increased tailings deposition capacity	Alternatives that cannot be expanded beyond the currently assessed capacity were excluded from further assessment									yes		yes							yes
Alternative carried forward to detailed analysis		NO	YES	NO															

Notes:

PDA = Potential Development Area

Table A-3: Detailed Description of Shortlisted Alternatives

Site Number	Site #08	Site #09	Site #10	Site #26
Site Descriptor	B3a	B3b	B4	G1
Site Location	ESE of Mill	ESE of Mill	ESE of Mill	ESE of Mill
Tailings Deposition Method	Slurry	Filtered	Filtered	Slurry
Straight Distance from Mill (km)	2.2	2.1	1.7	5.3
Footprint (ha)	54	21	15	120
Dam or Drystack Maximum Height (m)	10	25	26	15
Maximum Tailings Storage (Mm ³)	4.9	2.3	2.3	5.1
Estimated Dam Fill Volume (Mm ³)	1.80	0.25	0.19	2.28
Storage Efficiency	4	N/A	N/A	5
Access Road Length (km)	0.6	0.3	0.1	3.8
Description	This alternative would be located southeast of the mill abutting a bedrock outcrop directly adjacent to the proposed Madrid Boston Road. The containment dam would surround the south, west, and north sides of the facility, with the east portion being contained by natural topography. The total length would be approximately 1.9 km. The dam would be constructed in successive raises with a maximum final height of 10 m. The TIA would have a footprint of 56 ha. The outflow of a small pond with a footprint of 1 ha would be diverted into the TIA or around the facility. No major lakes or streams would be directly affected.	This facility would occupy a smaller footprint in the same location as Alternative B3a. No tailings containment structures would be required as the tailings would be filtered and deposited as a dry stack on the facility's 21 ha footprint.	This is a drystack facility located north of the Madrid Boston Road. The height is about 26 m and the footprint is 20 ha.	This alternative is a conventional slurry facility, located on high ground about 6.5 kilometers southeast of the mill. The dam height would be 10 meters, and the footprint 119 hectares. Freshwater diversion and runoff water collection are provided.
Dam Details	One large dam surrounding the north, west, and south sides. Dam length = 1.9 km; max dam height = 10 m.	One large contact water berm surrounding the north, west, and south sides. Berm length = 1.2 km; max berm height = 4 m	One large contact water berm on the east and south sides, proposed Boston Airstrip access road acting as a contact water berm on the east, one small berm to the north. Berm length (excluding airstrip access road) = 1 km; max berm height = 4 m.	One large dam surrounding the facility on all sides. Dam length = 4.2 km; max dam height = 15 m.
Synopsis of Operation	Slurry tailings would be pumped from the process plant and deposited sub-aerially through spigots located on the perimeter of the TIA. Reclaim water would be pumped back to the process plant from a reclaim barge.	Filtered tailings will be trucked from the filter plant and compacted in 5 m benches with 3H:1V slopes to a maximum height of 25 m. Any water collected in the contact water ponds will be pumped to the water treatment facility or discharged to the environment as appropriate.	Filtered tailings will be trucked from the filter plant and compacted in 5 m benches with 3H:1V slopes to a maximum height of 26 m. Any water collected in the contact water ponds will be pumped to the water treatment facility or discharged to the environment as appropriate.	Slurry tailings will be pumped directly from the mill and deposited sub-aerially into the tailings containment. Supernatant water will be pumped back to the mill as process water.
Synopsis of Closure	At closure, a dry cover consisting of 1 m of not potentially acid generating (NPAG) waste rock or other clean rock incorporating a geomembrane would be constructed. The dam would be breached to the elevation of the cover to prevent the impoundment of any water.	Dry stack will be covered with a minimum 1 m dry cover, incorporating a low permeability geomembrane. Contact water berms will be breached to prevent impounding any water.	Dry stack will be covered with a minimum 1 m dry cover, incorporating a low permeability geomembrane. Contact water berms will be breached to prevent impounding any water.	Tailings will be covered with a 1 m dry cover, incorporating a low permeability geomembrane. The dam will be breached to the elevation of the cover to prevent impounding any water.

Table A-4: Detailed Analysis per the Technical/Operational Criteria (Subaccounts)

Criteria	Rationale/Issues/Concerns	Site #08	Site #09	Site #10	Site #26
		B3a	B3b	B4	G1
Deposition Method	Slurry or Filtered Tailings	Slurry	Filtered	Filtered	Slurry
Road Distance from Mill (km)	Longer distance requires more capital and operational cost, presents operational challenges such as risk of pipeline freezing, risk of spill, and results in greater footprint, i.e. more habitat impact.	2.4	2.7	2.6	6.5
Maximum Height of the Facility (m)	Increased height of a facility compared to the surrounding topography will have greater visual impact as well as increase exposure to wind-born dust emissions.	10	25	26	15
Quarry volume requirements for dam, access road, and closure cover construction (Mm ³)	Larger rock fill volumes require larger quarries, i.e. greater land disturbance and habitat loss; Larger quarry development results in higher dust emissions due to crusher dust.	1.80	0.25	0.19	2.28
Foundation Conditions Ratio	Poor foundation conditions present engineering and construction challenges. Bedrock is the most preferable foundation, whereas frost polygons pose the most challenges. Higher ratios are preferable.	1.6 16% bedrock, 41% flat unpatterned ground, and 43% frost polygons.	3.2 40% bedrock and 60% flat unpatterned ground	2.0 100% flat unpatterned ground	3.4 58% bedrock, 22% flat unpatterned ground, and 20% frost polygons
Storage Factor	The storage factor is the ratio of slurry tailings storage volume to the dam fill volume. A higher storage factor indicates greater storage efficiency. Arbitrarily set to 100 for Dry Stacks due to no containment structures being required.	4	150	150	5
Elevation Difference (m)	More energy is required to pump slurry tailings or truck filtered tailings to a facility at a higher elevation than the mill. A negative value indicates that the TIA is lower than the mill.	1.0	26.0	17.0	62.2
Flexibility with regard to technical, operational, and environmental uncertainties	Mill upsets can result in substantially different supernatant water chemistry, which places high demands on a water treatment plant; Mill upsets can result in variable supernatant volumes, which is difficult to handle in a water treatment plant; Severe climatic conditions can result in excessive ice entrainment in tailings, which will affect the impoundment storage volume; Extreme hydrological events can result in extreme drought or flood conditions affecting the system water balance and potential capacity.	Moderately flexible. System will require increased dam heights to create additional storage	System highly flexible. Excess storage capacity available.	System highly flexible. Excess storage capacity available.	Moderately flexible. System will require increased dam heights to create additional storage
Footprint (Ha)	Sites that permanently change large areas of habitat are less desirable.	54	21	15	120
Footprint / Height Trade-off	Sites where the footprint cannot be reduced by increasing the height of the dam or dry stack are less desirable.	Footprint can be reduced by increasing the height of the facility.	Footprint can be reduced by increasing the height of the facility.	Height of facility cannot be increased due to interference with proposed new Boston Airstrip, therefore footprint cannot be reduced	Footprint can be reduced by increasing the height of the facility.
Progressive reclamation	Ideal tailings disposal alternatives will allow the pre-mining land use to return and allow for the facility to be reclaimed progressively. Climate does not allow for a rapid re-growth of vegetation.	No	Yes	Yes	No
Favorable topography	Ideal tailings disposal alternatives will utilize the natural topography as much as possible to reduce dam fill requirements.	Yes	Yes	No	No
Minimum contact water stored (m ³)	Alternatives that store large volumes of water are less desirable.	39,085	0	0	87,381
Consequence of Dam/Dry Stack Failure	The consequence of dam or dry stack failure is higher when there are environmentally sensitive areas downstream of the facility and/or the tailings have very high mobility i.e. Slurry tailings.	High	Low	Low	High
Water Management Add-on	Alternatives that require water to be managed outside of the TIA are less desirable.	Internal Reclaim Pond	External to facility, inside the Mill; no Reclaim Pond	External to facility, inside the Mill; no Reclaim Pond	Internal Reclaim Pond

Table A-5: Detailed Analysis per the Project Economic Criteria (Subaccounts)

Criteria	Rationale/Issues/Concerns	Site #08	Site #09	Site #10	Site #26
		B3a	B3b	B4	G1
Capital costs (excluding taxes and royalties)	This includes the cost of primary infrastructure (i.e. dams, water treatment plant, etc.), tailings service road and support systems, tailings feed pipeline, secondary geotechnical structures (i.e. shoreline protection, stream diversions etc.), contractor mobilization, engineering and construction supervision.	\$11,564,000	\$7,304,000	\$7,243,000	\$15,329,000
Operational costs (excluding taxes and royalties)	This includes actual tailings deposition costs (excluding mill costs to deliver tailings) for the two-year operational life. This includes annual inspections, monitoring, water treatment, construction associated with adaptive management etc.	\$627,000	\$14,997,000	\$14,997,000	\$627,000
Closure costs (excluding taxes and royalties)	This includes dam deconstruction (if required), dry cover placement (if required), contractor mobilization, engineering and construction supervision.	\$13,195,000	\$5,229,000	\$3,664,000	\$29,497,000
Post closure costs (excluding taxes and royalties)	This allows for inspection and monitoring for a period of up to 100 years.	\$690,000	\$690,000	\$690,000	\$690,000
Total costs (sum of all of the above, excluding taxes and royalties)	Sum total of capital, operations, closure, and fish compensation and monitoring costs listed above.	\$26,076,000	\$28,220,000	\$26,594,000	\$46,143,000
Economic risks (Very low; Low; Low to Medium; Medium to High; High; Very high)	Economic risks include commodity prices; a drop in price may render any of these alternatives uneconomical; Unforeseen technical difficulties in terms of foundation complexities for dams etc., may increase the cost burden; Royalty, and other compensation payments may increase; Predicted performances may not realize requiring more funding; Regulatory permit requirements may pose require additional funding.	Medium to High. Regulatory uncertainty (MMER Sched. II). Perpetual care required.	Low to Medium. Perpetual care required.	Low to Medium. Perpetual care required.	Medium to High. Regulatory uncertainty (MMER Sched. II). Perpetual care required.
Construction risks (Very low; Low; Low to Medium; Medium to High; High; Very high)	Complex structures may be delayed due to harsh climatic conditions; Mobilization and demobilization may be delayed due to sea-ice conditions; Unforeseen geotechnical conditions may require design modifications	Low to Medium. Dam is small and can be completed in one season or successive raises. Foundation conditions are uncertain.	Low to Medium. Foundation conditions uncertain.	Low to Medium. Foundation conditions uncertain.	Medium to High. Dam can be completed in one season or successive raises. Subsurface conditions unknown. Unforeseen foundation conditions may result in construction delays.

Table A-6: Detailed Analysis per the Environmental Criteria (Subaccounts)

Criteria	Rationale/Issues/Concerns	Site #08	Site #09	Site #10	Site #26
		B3a	B3b	B4	G1
Air Quality	Fugitive dust and emissions through construction, operation and closure may differ meaningfully between alternatives. A VEC.	Ongoing mitigation required during operations; reclamation work required	Ongoing mitigation required during operations; reclamation work required	Ongoing mitigation required during operations; reclamation work required	Ongoing mitigation required during operations; reclamation work required
Surface Water Quantity and Quality	Streamflows may be diverted or otherwise affected and effluent discharges may differ meaningfully between alternatives. A VEC.	Treatment of runoff water required for a finite time post-closure; natural hydrometric levels can be re-established post-closure	Treatment of runoff water or complex discharge strategy required during operations; hydrometric levels may require active mitigation through operations	Treatment of runoff water or complex discharge strategy required during operations; hydrometric levels may require active mitigation through operations	Treatment of runoff water required for a finite time post-closure; natural hydrometric levels can be re-established post-closure
Fish and Fish Habitat	Effects to fish and fish habitat through construction, operation and closure as well as complexity of regulatory permitting may differ meaningfully between alternatives. A VEC.	Effects to fish and fish habitat at a level that necessitate Fisheries Act Authorization and offsetting, including listing under Schedule 2 of the Metal Mining Effluent Regulations	Minor effects to fish and fish habitat; Fisheries Act Authorization and offsetting not required	Minor effects to fish and fish habitat; Fisheries Act Authorization and offsetting not required	Effects to fish and fish habitat at a level that necessitate Fisheries Act Authorization and offsetting, including listing under Schedule 2 of the Metal Mining Effluent Regulations
Terrestrial Ecology, Vegetation and Landforms	Effects to rare or unique aspects of terrestrial ecology, vegetation and landforms may differ meaningfully between alternatives. A VEC.	Minor, mitigable effects to unique, rare or culturally special landscape features or surface ecology; reclamation goals can be achieved through established methods	Minor, mitigable effects to unique, rare or culturally special landscape features or surface ecology; reclamation goals can be achieved through established methods	No unique, rare or culturally special landscape features or surface ecology affected; small terrestrial footprint compared to other alternatives; reclamation goals can be achieved through established methods	No unique, rare or culturally special landscape features or surface ecology affected; larger terrestrial footprint compared to other alternatives; reclamation goals can be achieved through established methods
Caribou	Ranges of three caribou herds overlap the Project area, one of which (Dolphin-Union herd) is a federally-listed population. Effects to caribou health, safety, habitat or movement may differ meaningfully between alternatives. A VEC.	Potential effects and risks of the alternative require specific mitigation; no effects on special habitat or disruption of primary migration trails; reclamation goals can be achieved through established methods	Potential effects and risks of the alternative require specific mitigation; no effects on special habitat or disruption of primary migration trails; reclamation goals can be achieved through established methods	Minor incremental effects of the alternative; the alternative does not introduce acute health or safety risks to caribou; no effects on special habitat or disruption of migration trails; reclamation goals can be achieved through established methods	Minor incremental effects of the alternative; the alternative does not introduce acute health or safety risks to caribou; no effects on special habitat or disruption of migration trails; reclamation goals can be achieved through established methods
Wolverine	Federally-listed species; importance of wolverine to Inuit was raised in the IQ workshop. Effects to wolverine health, safety, habitat or movement may differ meaningfully between alternatives. A VEC.	No measureable incremental effects of the alternative; the alternative does not introduce acute health or safety risks to wolverine; no effects on special habitat; reclamation goals can be achieved through established methods	No measureable incremental effects of the alternative; the alternative does not introduce acute health or safety risks to wolverine; no effects on special habitat; reclamation goals can be achieved through established methods	No measureable incremental effects of the alternative; the alternative does not introduce acute health or safety risks to wolverine; no effects on special habitat; reclamation goals can be achieved through established methods	No measureable incremental effects of the alternative; the alternative does not introduce acute health or safety risks to wolverine; no effects on special habitat; reclamation goals can be achieved through established methods
Grizzly Bear	Federally-listed species. Effects to grizzly bear health, safety, habitat or movement may differ meaningfully between alternatives. A VEC.	Minor, mitigable effects or risks during operations; no effects on special habitat; reclamation goals can be achieved through established methods	Minor, mitigable effects or risks during operations; no effects on special habitat; reclamation goals can be achieved through established methods	No measureable incremental effects of the alternative; the alternative does not introduce acute health or safety risks to grizzly bear; no effects on special habitat; reclamation goals can be achieved through established methods	No measureable incremental effects of the alternative; the alternative does not introduce acute health or safety risks to grizzly bear; no effects on special habitat; reclamation goals can be achieved through established methods
Migratory Birds	Regulated under the Migratory Birds Convention Act. Effects to migratory bird's health, safety, habitat or movement may differ meaningfully between alternatives. A VEC.	Minor, mitigable effects and risks during operations; no effects on special habitat or disruption of primary migration trails; reclamation goals can be achieved through established methods	No measureable incremental effects of the alternative; the alternative does not introduce acute health or safety risks to migratory birds; no effects on special habitat or disruption of migration paths	No measureable incremental effects of the alternative; the alternative does not introduce acute health or safety risks to migratory birds; no effects on special habitat or disruption of migration paths	Minor, mitigable effects and risks during operations; no effects on special habitat or disruption of primary migration trails; reclamation goals can be achieved through established methods
Raptors	Includes federally-listed species such as the peregrine falcon. Effects to raptor health, safety, habitat or movement may differ meaningfully between alternatives. A VEC.	No measureable incremental effects of the alternative; the alternative does not introduce acute health or safety risks to raptors; no effects on special habitat	No measureable incremental effects of the alternative; the alternative does not introduce acute health or safety risks to raptors; no effects on special habitat	No measureable incremental effects of the alternative; the alternative does not introduce acute health or safety risks to raptors; no effects on special habitat	No measureable incremental effects of the alternative; the alternative does not introduce acute health or safety risks to raptors; no effects on special habitat

Table A-7: Detailed Analysis According to Socio-Economic Criteria (Subaccounts)

Criteria	Rationale/Issues/Concerns	Site #08	Site #09	Site #10	Site #26
		B3a	B3b	B4	G1
Archaeological Sites	Effects to archaeological sites may differ meaningfully between alternatives. A VEC.	Sites may be present because this area has not been fully surveyed	Sites may be present because this area has not been fully surveyed	Previous survey conducted; no known sites present that require mitigation	Sites are likely to be present since area has not been surveyed and has moderate-high archaeological potential
Inuit Employment and Training	Effects to Inuit employment and training may differ meaningfully between alternatives. A VEC.	Alternative expected to provide proportionally greater Inuit employment and training compared to the Project as a whole	Alternative expected to provide proportionally similar Inuit employment and training compared to the Project as a whole	Alternative expected to provide proportionally similar Inuit employment and training compared to the Project as a whole	Alternative expected to provide proportionally greater Inuit employment and training compared to the Project as a whole
Inuit Economic Opportunities	Effects to Inuit economic opportunities may differ meaningfully between alternatives. A VEC.	Alternative expected to provide proportionally similar Inuit economic opportunities compared to the Project as a whole	Alternative expected to provide proportionally less Inuit economic opportunities compared to the Project as a whole	Alternative expected to provide proportionally less Inuit economic opportunities compared to the Project as a whole	Alternative expected to provide proportionally similar Inuit economic opportunities compared to the Project as a whole
Traditional Land Use	Effects to traditional land use may differ meaningfully between alternatives. A VEC.	Minor incremental effect during operations that does not affect locations of traditional significance; post-closure goals for traditional land use for the Project as a whole are not compromised; relatively larger footprint compared to other alternatives	Minor incremental effect during operations that does not affect locations of traditional significance; post-closure goals for traditional land use for the Project as a whole are not compromised; relatively smaller footprint than other alternatives	Minor incremental effect during operations that does not affect locations of traditional significance; post-closure goals for traditional land use for the Project as a whole are not compromised; relatively smaller footprint than other alternatives	Minor incremental effect during operations that does not affect locations of traditional significance; post-closure goals for traditional land use for the Project as a whole are not compromised; relatively larger footprint compared to other alternatives
Community Response	Feedback on the proposed tailings management alternatives received through the community engagement program.	No data available. Public consultation still in progress at the time this assessment was completed.	No data available. Public consultation still in progress at the time this assessment was completed.	No data available. Public consultation still in progress at the time this assessment was completed.	No data available. Public consultation still in progress at the time this assessment was completed.
Regulatory Response	Feedback on the proposed tailings management alternatives received through the regulatory engagement program.	No data available. Public consultation still in progress at the time this assessment was completed.	No data available. Public consultation still in progress at the time this assessment was completed.	No data available. Public consultation still in progress at the time this assessment was completed.	No data available. Public consultation still in progress at the time this assessment was completed.

Table A-8: Technical/Operational Criteria (Subaccounts) Scoring Matrix

Points	Deposition Method	Road Distance from Mill (km)	Maximum Height of the Facility (m)	Total Dam Fill (Mm ³)	Foundation Conditions Ratio	Storage Factor	Elevation Difference (m)	Flexibility with Regard to Technical, Operational, and Environmental Uncertainties
5	Filtered	Less than 1 km	Less than 5 m	Less than 0.1 Mm ³	More than 4	More than 50	Less than 0 m (i.e. downhill)	yes
4	Slurry	Between 1 and 2 km	Between 5 and 10 m	Between 0.1 and 0.2 Mm ³	Between 3.5 and 4	Between 40 and 50	Between 0 and 10 m	no
3	Not used	Between 1 and 3 km	Between 10 and 15 m	Between 0.2 and 0.5 Mm ³	Between 3 and 3.5	Between 30 and 40	Between 10 and 20 m	Not used
2		Between 3 and 4 km	Between 15 and 20 m	Between 0.5 and 1.0 Mm ³	Between 2.5 and 3	Between 20 and 30	Between 20 and 30 m	
1		Between 4 and 5 km	Between 20 and 25 m	Between 1.0 and 2.0 Mm ³	Between 2 and 2.5	Between 10 and 20	Between 30 and 40 m	
0		More than 5 km	More than 25 m	More than 2.0 Mm ³	Less than 2	Less than 10	More than 40 m	

Table A-8: Technical/Operational Criteria (Subaccounts) Scoring Matrix (Continued)

Points	Footprint (Ha)	Footprint / Height Trade-off	Progressive reclamation	Favorable topography	Capacity for expansion	Minimum contact water stored (m ³)	Consequence of Dam/Drystack Failure	Water Management Add-on
5	Less than 15 Ha	Yes	Yes	Yes	Yes	None	Low	Internal
4	Between 15 and 20	No	No	No	No	Less than 0.01 Mm ³	Not used	External
3	Between 20 and 25	Not used	Not used	Not used	Not used	Between 0.01 and 0.03 Mm ³		Not used
2	Between 25 and 50					Between 0.03 and 0.06 Mm ³	Moderate	
1	Between 50 and 100					Between 0.06 and 1.0 Mm ³	Not used	
0	More than 100					More than 1.0 Mm ³	High	

Table A-9: Project Economic Criteria (Subaccounts) Scoring Matrix

Points	Total costs	Economic risks	Construction risks
5	Less than \$30M	Very Low	Very Low
4	Between \$30M and \$45M	Low	Low
3	Between \$45M and \$60M	Low to Medium	Low to Medium
2	Between \$60M and \$75M	Medium to High	Medium to High
1	Between \$75M and \$90M	High	High
0	More than \$90M	Very High	Very High

Table A-10: Environmental Criteria (Subaccounts) Scoring Matrix

Points	Air Quality	Surface Water Quantity and Quality	Fish and Fish Habitat	Terrestrial Ecology, Vegetation and Landforms	Caribou	Wolverine	Grizzly Bear	Migratory Birds	Raptors
5	Negligible - no measurable effects on air quality	Negligible - no measurable effects on water quality; no measurable changes to hydrometric levels	Negligible - no measurable effects on fish and fish habitat; Fisheries Act authorization and offsetting not required	Negligible - no incremental effect due to the alternative	Negligible - no incremental effect due to the alternative	Negligible - no incremental effect due to the alternative	Negligible - no incremental effect due to the alternative	Negligible - no incremental effect due to the alternative	Negligible - no incremental effect due to the alternative
4	Low - acceptable air quality without mitigation	Low - acceptable water quality without mitigation; acceptable changes to hydrometric levels without mitigation	Low - minor effects to fish and fish habitat; Fisheries Act Authorization and offsetting not required	Low - no unique, rare or culturally special landscape features or surface ecology affected; small terrestrial footprint compared to other alternatives; reclamation goals can be achieved through established methods	Low - minor incremental effects of the alternative; the alternative does not introduce acute health or safety risks to caribou; no effects on special habitat or disruption of migration trails; reclamation goals can be achieved through established methods	Low - no measurable incremental effects of the alternative; the alternative does not introduce acute health or safety risks to wolverine; no effects on special habitat; reclamation goals can be achieved through established methods	Low - no measurable incremental effects of the alternative; the alternative does not introduce acute health or safety risks to grizzly bear; no effects on special habitat; reclamation goals can be achieved through established methods	Low - no measurable incremental effects of the alternative; the alternative does not introduce acute health or safety risks to migratory birds; no effects on special habitat or disruption of migration paths	Low - no measurable incremental effects of the alternative; the alternative does not introduce acute health or safety risks to raptors; no effects on special habitat
3	Low to medium - occasional ad hoc mitigation required on specific areas	Low to medium - occasional treatment of runoff water may be required on a contingency basis; acceptable changes to hydrometric levels without mitigation	Low to Medium - effects to fish and fish habitat at a level that necessitates Fisheries Act Authorization and offsetting	Low to Medium - no unique, rare or culturally special landscape features or surface ecology affected; larger terrestrial footprint compared to other alternatives; reclamation goals can be achieved through established methods	Not used	Not used	Not used	Not used	Not used
2	Medium to high - ongoing mitigation required during operations	Medium to high - treatment of runoff water or complex discharge strategy required during operations; hydrometric levels may require active mitigation through operations	Medium to High - effects to fish and fish habitat at a level that necessitates Fisheries Act Authorization and offsetting, including listing under Schedule 2 of the Metal Mining Effluent Regulations	Medium to High - minor, mitigable effects to unique, rare or culturally special landscape features or surface ecology; reclamation goals can be achieved through established methods	Medium to High - potential effects and risks of the alternative require specific mitigation; no effects on special habitat or disruption of primary migration trails; reclamation goals can be achieved through established methods	Medium to High - minor, mitigable effects or risks during operations; no effects on special habitat; reclamation goals can be achieved through established methods	Medium to High - minor, mitigable effects or risks during operations; no effects on special habitat; reclamation goals can be achieved through established methods	Medium to High - minor, mitigable effects and risks during operations; no effects on special habitat or disruption of primary migration trails; reclamation goals can be achieved through established methods	Medium to High - minor, mitigable effects during operations; no effects on special habitat; reclamation goals can be achieved through established methods
1	High - ongoing mitigation required during operations; reclamation work required	High - treatment of runoff water required for a finite time post-closure; natural hydrometric levels can be re-established post-closure	High - long-term effects on fish, fish habitat and Aboriginal fishery; complex remedial work required that results in permanently altered local habitat; complex Fisheries Act Authorization required including complex offsetting works and listing under Schedule 2 of the Metal Mining Effluent Regulations	Not used	Not used	Not used	Not used	Not used	Not used
0	Very high - required level of mitigation during operations or closure is unavailable or not practicable	Very high - perpetual treatment of runoff water required; hydrometric levels changed permanently and negatively	Very high - permanent loss of fish habitat that permanently changes local fish populations and Aboriginal fishery; Fisheries Act authorizations may not be possible; no identified offsetting concepts of sufficient magnitude	Very high - permanent loss or negative alteration of unique, rare or culturally special landscape features or surface ecology; required level of mitigation during operations or closure is unavailable or not practicable	Very high - permanent loss or negative alteration of special habitat areas or primary migration trails; required level of mitigation during operations or closure is unavailable or not practicable	Very high - permanent loss or negative alteration of special habitat areas; required level of mitigation during operations or closure is unavailable or not practicable	Very high - permanent loss or negative alteration of special habitat areas; required level of mitigation during operations or closure is unavailable or not practicable	Very high - permanent loss or negative alteration of special habitat areas or primary migration trails; required level of mitigation during operations or closure is unavailable or not practicable; contravenes Migratory Birds Convention Act	Very high - permanent loss or negative alteration of special habitat areas; required level of mitigation during operations or closure is unavailable or not practicable

Table A-11: Socio-economic Criteria (Subaccounts) Scoring Matrix

Points	Archaeological Sites	Inuit Employment and Training	Inuit Economic Opportunities	Traditional Land Use	Community Response	Regulatory Response
5	Negligible - verified no sites present	Very high (positive effect) - alternative expected to provide proportionally greater Inuit employment and training compared to the Project as a whole and greater than other alternatives	Very high (positive effect) - alternative expected to provide proportionally greater Inuit economic opportunities compared to the Project as a whole and greater than other alternatives	Negligible - no incremental effect due to the alternative	Preferred - perceived as beneficial for Inuit, local communities and Nunavut; perceived as environmentally safe	Preferred - allowable under applicable Acts and Regulations; industry-leading environmental and social responsibility plans
4	Low - no sites present	High - alternative expected to provide proportionally greater Inuit employment and training compared to the Project as a whole	High - alternative expected to provide proportionally greater Inuit economic opportunities compared to the Project as a whole	Low - minor incremental effect during operations that does not affect locations of traditional significance; reclaimed alternative achieves post-closure goals for traditional land use	Not used	Not used
3	Low to medium - no sites present that require mitigation	Medium to high (positive effect) - alternative expected to provide proportionally similar Inuit employment and training compared to the Project as a whole	Medium to high (positive effect) - alternative expected to provide proportionally similar Inuit economic opportunities compared to the Project as a whole	Low to medium - minor incremental effect during operations that does not affect locations of traditional significance; post-closure goals for traditional land use for the Project as a whole are not compromised; relatively smaller footprint than other alternatives	Acceptable - perceived as beneficial or neutral for Inuit, local communities and Nunavut; environmental concerns require mitigation and close monitoring	Acceptable - allowable under applicable Acts and Regulations; follows industry best management approaches to environmental and social responsibility
2	Medium to high - sites are present that require mitigation through project design	Low to medium - alternative expected to provide proportionally less Inuit employment and training compared to the Project as a whole	Low to medium - alternative expected to provide proportionally less Inuit economic opportunities compared to the Project as a whole	Medium to high - minor incremental effect during operations that does not affect locations of traditional significance; post-closure goals for traditional land use for the Project as a whole are not compromised; relatively larger footprint compared to other alternatives	Not used	Not used
1	High - sites are present that require mitigation through retrieval	Low (positive effect) - alternative expected to provide proportionally less Inuit employment and training compared to the Project as a whole and lower than other alternatives	Low (positive effect) - alternative expected to provide proportionally less Inuit economic opportunities compared to the Project as a whole and lower than other alternatives	High - potential effects to areas of traditional significance require mitigation; post-closure goals for traditional land use for the Project as a whole are not compromised	Not Preferred - perceived as neutral for Inuit, local communities and Nunavut; high uncertainty that environmental concerns can be satisfactorily mitigated	Not Preferred - allowable under applicable Acts and Regulations; does not follow industry best management approaches to environmental and social responsibility
0	Very high - sites of special cultural significance are present where mitigation is not practicable	Negligible - alternative expected to provide no Inuit employment and training	Negligible - alternative expected to provide no Inuit economic opportunities	Very high - permanent loss of areas of traditional significance; post-closure goals for traditional land use for the Project as a whole are compromised	Not acceptable - perceived as detrimental to Inuit, local communities and Nunavut; environmental issues cannot be satisfactorily mitigated	Not acceptable - not allowable under applicable Acts and Regulations

Table A-12: Overall Accounts Ledger

Account	Sub-account	Notes	Counter	Total Score	84	105	111	78
				Ranking	3	2	1	4
Technical/Operational	Deposition Method	Slurry or Filtered Tailings	1	4	5	5	4	
	Road Distance from Mill (km)	Longer distance requires more capital and operational cost, presents operational challenges such as risk of pipeline freezing, risk of spill, and results in greater footprint, i.e. more habitat impact.	2	4	3	3	0	
	Maximum Height of the Facility (m)	Increased height of a facility compared to the surrounding topography will have greater visual impact as well as increase exposure to wind-born dust emissions.	3	3	0	0	0	2
	Quarry volume requirements for dam, access road, and closure cover construction (Mm ³)	Larger rock fill volumes require larger quarries, i.e. greater land disturbance and habitat loss; Larger quarry development results in higher dust emissions due to crusher dust.	4	1	5	5	1	
	Foundation Conditions Ratio	Poor foundation conditions present engineering and construction challenges. Bedrock is the most preferable foundation, whereas frost polygons pose the most challenges. Higher ratios are preferable.	5	0	3	1	3	
	Storage Factor	The storage factor is the ratio of slurry tailings storage volume to the dam fill volume. A higher storage factor indicates greater storage efficiency. Arbitrarily set to 100 for Dry Stacks due to no containment structures being required.	6	0	5	5	0	
	Elevation Difference (m)	More energy is required to pump slurry tailings or truck filtered tailings to a facility at a higher elevation than the mill. A negative value indicates that the TIA is lower than the mill.	7	4	2	3	0	
	Flexibility with regard to technical, operational, and environmental uncertainties	Mill upsets can result in substantially different supernatant water chemistry, which places high demands on a water treatment plant; Mill upsets can result in variable supernatant volumes, which is difficult to handle in a water treatment plant; Severe climatic conditions can result in excessive ice entrainment in tailings, which will affect the impoundment storage volume; Extreme hydrological events can result in extreme drought or flood conditions affecting the system water balance and potential capacity.	8	5	4	4	5	
	Footprint (Ha)	Sites that permanently change large areas of habitat are less desirable.	9	1	3	5	0	
	Footprint / Height Trade-off	Sites where the footprint cannot be reduced by increasing the height of the dam or dry stack are less desirable.	10	5	5	4	5	
	Progressive reclamation	Ideal tailings disposal alternatives will allow the pre-mining land use to return and allow for the facility to be reclaimed progressively. Climate does not allow for a rapid re-growth of vegetation.	11	4	5	5	4	
	Favorable topography	Ideal tailings disposal alternatives will utilize the natural topography as much as possible to reduce dam fill requirements.	12	5	5	4	4	
	Minimum contact water stored (m ³)	Alternatives that store large volumes of water are less desirable.	13	3	5	5	2	
	Consequence of Dam/Dry Stack Failure	The consequence of dam or dry stack failure is higher when there are environmentally sensitive areas downstream of the facility and/or the tailings have very high mobility i.e. Slurry tailings.	14	0	5	5	0	
	Water Management Add-on	Alternatives that require water to be managed outside of the TIA are less desirable.	15	5	4	4	5	
Project Economics	Total costs (sum of all of the above, excluding taxes and royalties)	The total cost of the alternative (capital, operational, closure, post-closure and fish compensation) is vitally important to the proponent to ensure that the project remain economically viable.	1	4	5	5	3	
	Economic risks (Very low; Low; Low to Medium; Medium to High; High; Very high)	Risks and uncertainties associated with the cost estimates are of the utmost importance to the proponent, since large cost variances could jeopardize the economic viability of the Project.	2	2	3	3	2	
	Construction risks (Very low; Low; Low to Medium; Medium to High; High; Very high)	Complex structures may be delayed due to harsh climatic conditions; Mobilization and demobilization may be delayed due to sea-ice conditions; Unforeseen geotechnical conditions may require design modifications	3	3	3	3	3	
Environmental	Air Quality	Fugitive dust and emissions through construction, operation and closure may differ meaningfully between alternatives. A VEC.	1	1	1	1	1	
	Surface Water Quantity and Quality	Stream flows may be diverted or otherwise affected and effluent discharges may differ meaningfully between alternatives. A VEC.	2	1	2	2	1	
	Fish and Fish Habitat	Effects to fish and fish habitat through construction, operation and closure and complexity of regulatory permitting may differ meaningfully between alternatives. A VEC.	3	2	4	4	2	
	Terrestrial Ecology, Vegetation and Landforms	Effects to rare or unique aspects of terrestrial ecology, vegetation and landforms may differ meaningfully between alternatives. A VEC.	4	2	2	4	3	
	Caribou	Ranges of three caribou herds overlap the Project area, one of which (Dolphin-Union herd) is a federally-listed population. Effects to caribou health, safety, habitat or movement may differ meaningfully between alternatives. A VEC.	5	2	2	4	4	
	Wolverine	Importance of wolverine to Inuit was raised in the IQ workshop; federally-listed species. Effects to wolverine health, safety, habitat or movement may differ meaningfully between alternatives. A VEC.	6	4	4	4	4	
	Grizzly Bear	Federally-listed species. Effects to grizzly bear health, safety, habitat or movement may differ meaningfully between alternatives. A VEC.	7	2	2	4	4	
	Migratory Birds	Regulated under the Migratory Birds Convention Act. Effects to migratory bird's health, safety, habitat or movement may differ meaningfully between alternatives. A VEC.	8	2	4	4	2	
Socio-Economics	Raptors	Includes federally-listed species such as the peregrine falcon. Effects to raptor health, safety, habitat or movement may differ meaningfully between alternatives. A VEC.	9	4	4	4	4	
	Archaeological Sites	Effects to archaeological sites may differ meaningfully between alternatives. A VEC.	1	2	2	3	1	
	Inuit Employment and Training	Effects to traditional land use may differ meaningfully between alternatives. A VEC.	2	4	3	3	4	
	Inuit Economic Opportunities	Effects to Inuit economic opportunities may differ meaningfully between alternatives. A VEC.	3	3	2	2	3	
	Traditional Land Use	Effects to traditional land use may differ meaningfully between alternatives. A VEC.	4	2	3	3	2	
	Community Response	Feedback on the proposed tailings management alternatives received through the community engagement program.	5	n/a	n/a	n/a	n/a	
	Regulatory Response	Feedback on the proposed tailings management alternatives received through the regulatory engagement program.	6	n/a	n/a	n/a	n/a	