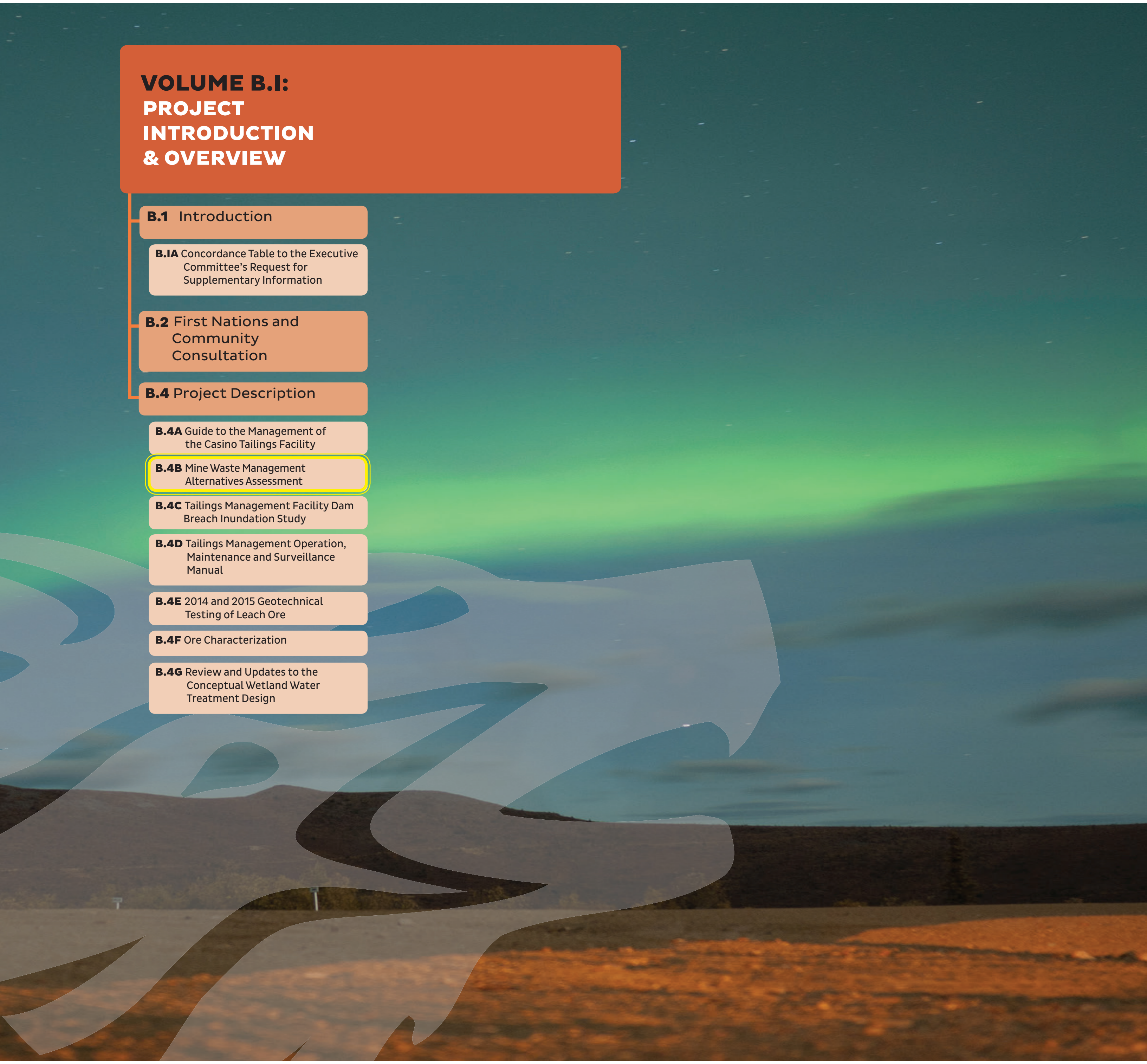
APPENDIX B.4B: Mine Waste Management Alternatives Assessment



VOLUME B.I: PROJECT INTRODUCTION & OVERVIEW

CASINO

CASINO PROJECT

MINE WASTE MANAGEMENT ALTERNATIVES ASSESSMENT

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Executive Summary

The Casino Project is a proposed copper-gold open pit mine located 150 km northwest of Carmacks and 300 km from Whitehorse. The Project is designed to process approximately 120,000 t/d of copper and gold ore over a 22 year mine life. Processing of the sulphide ore will occur via conventional flotation to produce copper and molybdenum mineral concentrates. Processing of oxide ore is via heap leaching and carbon adsorption technology that will produce gold and silver doré bars.

Mine waste generated at the Project consists of mining waste rock and tailings generated from the flotation process. Mine waste volumes are derived from a feasibility study conducted in 2013, the geochemical characterization of which indicates that of the 956 million tonnes of tailings, approximately 80% is geochemically innocuous non-acid generating (NAG) material, and the remaining 20% is potentially reactive. Additionally, the 658 million tonnes of waste rock and overburden material has also been characterized as potentially reactive.

The assessment of mine waste management for the Casino Project was initiated in 2008, and refinement of the mine waste management strategy has continued through to completion of the Feasibility Study in 2013. This report summarizes the alternatives assessment for mine waste management conducted for the Casino Project, with information derived from a number of previous reports.

The approach used for this alternatives assessment is based on the guidance provided by Environment Canada (2011) for Multiple Accounts Analysis (MAA). The guidance was used as a tool to evaluate a set of options for the management of waste rock and tailings at the Casino Project. The assessment presents all tailings alternatives that have been assessed to date, with an evaluation in accordance with screening criteria applicable to the Casino Project.

The alternatives assessment has two parts: the analysis and selection of the preferred method for managing mine waste; and the analysis and selection of the preferred location for mine waste storage. Both parts of the alternatives assessment evaluate the mine water management options based on technical, environmental, economic, and socio-economic criteria.

The findings of the comparative assessment indicate that the use of cyclone sand for embankment construction is the preferred option. It provides low operational complexity and controllable geotechnical conditions given the project’s location and water conditions, with the least environmental disturbance.

The preferred option for location is upper Casino Creek, as it had the highest combined score, when considering technical, environmental, socio-economic and economic factors. The upper Casino Creek option also had the highest score in the environmental and socio-economic accounts and was identified by all sensitivity analyses.

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1 INTRODUCTION

The Casino Project is a proposed copper-gold open pit mine located 150 km northwest of Carmacks and 300 km from Whitehorse. The Project is designed to process approximately 120,000 t/d of copper and gold ore over a 22 year mine life. Processing of the sulphide ore will occur via conventional flotation to produce copper and molybdenum mineral concentrates. Processing of oxide ore is via heap leaching and carbon adsorption technology that will produce gold and silver doré bars. Supplemental freshwater for processing and camp activities will be provided by a pipeline from the Yukon River. Access to the Project is via the 200 km Freegold Road from Carmacks, of which 80 km is a public use highway maintained by the Yukon Government, and the remaining 120 km extension will be a private access road.

Mine waste generated at the Project consists of mining waste rock and tailings generated from the flotation process. Mine waste volumes are derived from a feasibility study conducted in 2013, the geochemical characterization of which indicates that of the 956 million tonnes of tailings, approximately 80% is geochemically innocuous non-acid generating (NAG) material, and the remaining 20% is potentially reactive (PAG). Additionally, the 658 million tonnes of waste rock and overburden material has also been characterized as potentially reactive.

The assessment of mine waste management for the Casino Project was initiated in 2008, and refinement of the mine waste management strategy has continued through to completion of the Feasibility Study in 2013 (M3, 2013). This report summarizes the alternatives assessment for mine waste management conducted for the Casino Project, with information derived from the following documents:

- Knight Piesold Consulting (KP), Casino Copper-Gold Project, Mine Waste Management Assessment, January 18, 2008.
- KP, Casino Copper-Gold Project, Tailings Management Facility Construction Material Alternatives, June 15, 2010.
- KP, Casino Copper-Gold Project, Tailings Management Facility Alternative Assessment, July 20, 2010.
- KP, Casino Copper-Gold Project, Report on Feasibility Design of the Tailings Management Facility, December 20, 2012.
- Lorax Environmental, Casino Waste Rock and Ore Geochemical Static Test Assessment, December 3, 2013.
- Lorax Environmental, Casino Geochemical Source Term Development, December 4, 2013.
- Lorax Environmental, Casino Kinetic Testwork 2014 Update for Ore, Waste Rock and Tailings, December 15, 2014.
- Tailings Management Facility Risk Assessment, provided in Supplementary Information Report to ARR-2, YESAB Project #2014-0002, Section B.4, response to R2-4, December 2015.

The alternatives assessment has two parts: the analysis and selection of the preferred method for managing mine waste; and the analysis and selection of the preferred location for mine waste storage. Both analyses follow the same general framework to arrive at the preferred option, as follows:

- Define criteria used to evaluate options;
- Describe all available options;
- Identify the advantages and disadvantages of each option with respect to key engineering, environmental, socio-economic and economic considerations;
- Conduct a ranking, scaling and weighting evaluation in order to compare the cumulative advantages and disadvantages of each option; and
- Provide a conclusion as to preferred option based on transparent rationale.

The approach for the analysis and selection of the preferred location is based on the guidance provided by Environment Canada (2011) for Multiple Accounts Analysis (MAA), which is used as a tool to evaluate a set of options for the management of waste rock and tailings at the Casino Project. The assessment presents all tailings alternatives that have been assessed to date, with an evaluation in accordance with screening criteria applicable to the Casino Project.

The conclusions and recommendations in the documents listed above were used to direct the further design of the TMF, as provided in the Report on Feasibility Design of the Tailings Management Facility (KP, 2012), which provides site-specific details of the cyclone sand dam option, using updated mine planning and site investigation results. As such, the process design details provided herein should be considered as preliminary details, which were generated for alternatives assessment purposes, and have been superseded by the details in the Report on Feasibility Design of the Tailings Management Facility (KP, 2012).

2 CASINO MINE WASTE

2.1 WASTE PRODUCTION

The proposed components of the project facilities include an open pit up to 600 metres deep containing a mineable reserve of approximately 965 million tonnes (Mt) of mill ore. The deposit will be mined using open pit methods with a nominal mill throughput of approximately 120,000 tonnes/day (tpd) of ore over a 22 year operating life. Approximately 157.5 Mt of additional mined ore will be processed at a Heap Leach Facility (HLF) located south of the open pit. Mine waste includes approximately 956 Mt of tailings and up to 658 Mt potentially reactive waste rock and overburden materials. The waste production and milling schedule is summarized in Table 2-1.

Table 2-1: Casino Mine Waste and Ore Production Schedule

Year of Operations	Mill Ore (kt)	Gold Leach Ore (kt)	Overburden (kt)	All Waste (kt)
-3		5,030	187	2,151
-2		12,676	542	3,644
-1		18,517	959	6,127
1	32,850	16,601	4,087	23,522
2	43,800	14,877	2,230	27,592
3	43,801	11,824	646	32,239
4	43,800	2,087	882	43,368
5	43,799	96	1,188	38,249
6	43,800	8	53	32,749
7	43,800	3,201	408	42,736
8	43,800	7,777	306	46,722
9	43,800	9,407	372	51,153
10	43,799	5,209	180	48,062
11	43,800	11,141	1,537	52,200
12	43,800	387	373	47,913
13	43,800	591	947	48,345
14	43,800	425	593	48,399
15	43,800	79	56	46,962
16	43,800			34,214
17	43,800			30,457
18	43,800			20,758
19	43,800			19,143
20	43,800			14,186
21	43,800			
22	43,800			
23	23,139			
TOTAL	**975,788**	**119,933**	**15,546**	**760,891**

The pre-feasibility assessment (KP, 2008) assumed a total tailings storage of 974 million tonnes with an unquantified volume of potentially reactive waste rock, therefore, an initial assessment was conducted assuming co-disposal of one-third (282 Mt) and two thirds (564 Mt) of produced waste. Subsequent analysis identified that the entire waste rock volume (658 Mt) is potentially reactive. Specifically, the large majority of the NAG waste rock was found to be metal (copper) leaching, and therefore is not suitable for construction material and is required to be disposed of sub-aqueously.

2.2 MINE ROCK GEOCHEMICAL PROPERTIES

Lorax Environmental has conducted an extensive geochemical characterization program which has contributed to the development of waste rock and tailings management planning for the Casino Project. Techniques used to assess metal leaching/acid rock drainage (ML/ARD) potential include static tests which examine the intrinsic ML/ARD potential of a sample, and kinetic tests which expose the material to various weathering conditions. Data gathered as part of the static and kinetic testwork program are presented in:

- Casino Geochemical Static Test Assessment (Lorax, 2013a);
- Kinetic Testwork Update in Support of Casino ML/ARD Assessment (Lorax, 2013b); and
- Casino Kinetic Testwork 2014 Update for Ore, Waste Rock and Tailings (Lorax, 2014).

The Lorax (2013a) study concluded that ML/ARD characteristics varied within the Casino deposit primarily by mineralization zone and to a lesser extent lithologic unit. Trends were not identified based on the alteration zones of the Casino Intrusive Complex. Therefore, the Casino kinetic test program was primarily focused on geochemical characteristics of the mineralization zones (Lorax, 2013b). An overview of ML/ARD properties of the three mineralization zones is provided below. The neutralization potential ratio (NPR) values sited below are defined by the ratio of neutralization potential (calculated from carbonate content) and acid potential (calculated from non-sulphate S content).

Oxide Leach CAP Zone

- The CAP samples (ore and waste) have acidic median paste pH values of 4.7, indicating that the majority of the CAP waste rock will be immediately acid generating when excavated.
- Secondary water soluble sulphate and oxide minerals, rather than sulphide minerals, are the major source of acidity and metal leaching from CAP samples.

Supergene (SUP) Zone (includes Supergene Oxide (SOX) and Supergene Sulphide (SUS))

- The majority of the SUP samples have a NPR < 2.0 (88% SOX and 97% SUS), which implies that waste rock and ore from this mineralization zone is potentially acid generating (PAG).
- Unlike the CAP sample set, some SUP samples still contain carbonate minerals capable of buffering pH; however, the samples also contain sulphide minerals in sufficient quantities to deplete the buffering capacity over time and provide an additional source of metal leaching.

- Similar to the CAP sample set, SUP samples contain oxide minerals as a source of acidity and metal leaching. The SUP samples (ore and waste) have a median paste pH of 6.1.

Hypogene (HYP) Zone

- The majority of the HYP samples (87% ore and 92% waste rock) have been identified as having a NPR < 2, which implies that under advanced weathering conditions waste rock and ore from the HYP zone will produce acidic drainage.
- Ore and waste rock samples from the HYP zone have the highest median carbonate neutralization potential (27 kg CaCO3/t), and highest median paste pH (8.1) of the mineralization zones in the Casino deposit.

Due to the nature of the mineralization at the Casino Project, Lorax recommends that tailings and waste rock produced at the Casino mine be subaqueously disposed of in a tailings management facility (Lorax, 2013c). Sub-aqueous disposal will prevent sulphide oxidation in mine waste and is considered geochemically favorable compared to disposal in an unsaturated environment. Further, Lorax suggests that PAG tailings and pyrite concentrate from the de-sulphidization circuit be deposited into the centre of the impoundment and covered with a layer of depyritized (NAG) tailings at the end of mine life, which will result in saturated source terms for both the PAG and NAG which are predicted to be pH-neutral with relatively low metal concentrations due to the stability of sulphide minerals under saturated conditions (Lorax, 2013c).

These geochemical considerations form the basis of the mine waste management alternatives assessment, discussed further in subsequent sections.

3 ALTERNATIVES ASSESSMENT METHODOLOGY

This report addresses the alternative assessment for mine waste management at the Casino Project through the evaluation of two criteria:

1. The method for managing mine waste through various tailings disposal options; and
2. The identification of a preferred location for the option chosen in 1. above.

The methodology for ranking and weighting the options for 1. and 2. above vary slightly, in that the options for managing mine waste are mainly constrained by the technical considerations available for the specific conditions and disposal criteria (i.e., high throughput milling and mining and high geochemical risk), whereas the options for location are more flexible, and can be considered in the context of environmental, socio-economic and economic factors.

Therefore, a relative ranking of 1 through 4 was given to the mine waste disposal alternatives (Section 4), whereas a 6-point ranking scale is provided for the location alternatives assessments. The location alternatives are further weighted, based on a tiered system of weighting, whereby the main considerations (i.e. technical, environmental, socio-economic, and economic), and the sub-accounts, were weighted relative to one another. This is described further in Sections 3.2 and 3.3.

The collective evaluation is described in Section 5.5, by consideration. The combined numerical evaluation is provided in Appendix A, and sensitivity analysis provided in Section 5.7.

3.1 PARTICIPANTS

The evaluation of mine waste management options was conducted by Knight Piesold (KP), in consultation with Casino Mining Corporation, and the results presented in the following documents:

- Knight Piesold Consulting (KP), Casino Copper-Gold Project, Mine Waste Management Assessment, January 18, 2008.
- KP, Casino Copper-Gold Project, Tailings Management Facility Construction Material Alternatives, June 15, 2010.
- KP, Casino Copper-Gold Project, Tailings Management Facility Alternative Assessment, July 20, 2010.

These documents were summarized and adapted to the alternatives assessment framework, with the results presented in Section 4, below.

The evaluation of location options was conducted largely based on the guidelines provided by Environment Canada (EC - 2011) and includes a relative assessment of positive and negative effects of these options with respect to technical, environmental, socio-economic and project economic accounts. The evaluation was completed by a group of technical experts in May 2013, given existing baseline information and professional judgment of expectations during and after mining. Participant groups included:

- Casino Mining Corporation (CMC);

- Knight Piesold (KP);
- Palmer Environmental Consulting Group Ltd. (PECG);
- Lorax Environmental Services Inc. (Lorax);
- Marsland Environmental Associates (MEA); and
- Brodie Consulting Ltd. (BCL).

Following the guidelines provided by EC, within each of the main considerations (i.e., technical, environmental, socio-economic and economic), the group defined a series of sub-accounts selected as issues that were considered to be of key importance and or of a material effect (positive or negative). Each sub-account was described on the basis of an indicator or a series of indicators. The numerical evaluation was conducted via a ranking-scaling and weighting assessment with both scalars and weights assigned on the basis of a 6-point scale. In this manner, a scale of 6 was applied to the best option for each indicator individually with other options scaled comparatively. Weights were applied to indicators, sub-accounts and accounts such that most important were given a weight of 6 and others weighted by comparison of relative importance.

3.2 RANKING

For the mine waste management options, a relative ranking of 1 through 4 was given, as the options were strongly driven by comparison to each other. For the locations alternatives, ranking involved an assessment of comparing the relative expectations of characteristics of alternatives for each of the issues defined in the assessment. In this manner, the location alternatives were first ranked from best, or most favored, to worst or least favored for that aspect being considered. In order to convey the evaluators' judgment of how much better or how much worse any one alternative was expected to be from the others, a scale was applied. As in the EC guidelines, a 6-point scale was used and modified to be meaningful for each indicator independently. The best alternative was assigned a value of 6 and all others scaled relative to that. It should be noted that while a value of 6 was always applied to the best alternative, there does not need to be a corresponding value of 1, in fact in many cases, alternatives were deemed equal and all assigned values of 6. It should also be noted that a value of 6 for one indicator is unique to that indicator and not necessarily equal in a numerical sense to a value of 6 in any of the other indicators. Ranking and scaling compares alternatives on an indicator by indicator basis. This is distinct from the comparison of indicators to one another which was accomplished via weighting.

Additionally, the sub-accounts within any one main account were weighted relative to one another and the indicators within any one sub-account were weighted relative to one another. The higher the weight of any one indicator, the higher the deemed relative importance of that indicator compared to others in its sub-account. A scale of 1 to 6 was used in this evaluation whereby a value of 6 reflects the view by the evaluators that it was an issue of greatest importance within the evaluation.

3.3 WEIGHTING

The exercise of applying weights to accounts, sub-accounts and indicators instills a level of importance to the issues being considered relative to one another. Just as ranking and scaling was distinctly independent of indicators beyond the immediate one in any single scaling, the process of weighting is distinctly separate from any comparison of one alternative to another.

A tiered system of weighting was conducted whereby the main accounts were weighted relative to one another, the sub-accounts within any one main account were weighted relative to one another and the indicators within any one sub-account were weighted relative to one another. The higher the weight of any one indicator, the higher the deemed relative importance of that indicator compared to others in its sub-account. A scale of 1 to 6 was used in this evaluation whereby a value of 6 reflects the view by the evaluators that it was an issue of greatest importance within the evaluation.

The weights applied to the main accounts were as recommended in the EC guidelines whereby the weight for the technical account was a value of 3, that for the environment account was a 6, that for the socio-economic account was a 3 and the project economic account was a 1.5.

Within each main account, the sub-accounts were weighted relative to one another and within each sub-account the indicators were weighted relative to one another. The resultant weights are summarized in the set of tables below for each main account as assigned by the group of participants.

3.3.1 Technical Account Weights

In review of the weights for the sub-accounts within the technical account, the highest weights and therefore the issues of greatest importance were considered to be the operational management, structural stability and presence of permafrost (Table 3-1). Compared to these issues, dam design details, construction and capacity were deemed of lower importance. This weighting reflects the evaluators' emphasis on the degree of complexity related to the operational management of disposing of tailings and waste rock in the manner proposed, the resultant stability of the facility which in part is influenced by the presence or lack of permafrost in the area. Other issues, while important design considerations were deemed to be less critical to the technical considerations of the TMF facilities.

Though of somewhat lesser weight, the dam characteristics were refined by a number of indicators, more than many of the sub-accounts. Within that sub-account, the issues of dam size and configuration, the total number of dams and the total embankment volume were considered of equal and important weight.

Other sub-accounts were described by only a few indicators. Operational management was described further by the footprint area and the operational ease of managing the tailings and waste rock. Of these, it was considered that the operational management of waste rock given that this involved identifying rock types as PAG or otherwise on an operational scale, scheduling trucks with PAG waste to haul to the TMF facility and sub-aqueous placement of the PAG rock, was considered more important than the disposal of tailings via conventional slurry pipeline.

The construction sub-account considered both geotechnical complexity and scheduling of construction rock as unique indicators. Of these, the geotechnical complexity was deemed of higher importance.

Table 3-1: Technical Account Sub-Account and Indicator Weights

Sub-account	Sub-account Weight	Indicator	Indicator Weight
Dam Design	4	Impoundment storage volume	2
		Dam size and configuration	6
		Number of large dams required	6
		Total embankment volume	6
Operational Management	6	Impoundment footprint	4
		operational ease – tailings	5
		operational ease - waste rock	6
Construction	4	Geotechnical complexity	6
		scheduling (construction)	4
Structural Stability	6	stability considerations operations and long term	6
Permafrost	6	permafrost sensitivity	6
Capacity	3	expansion potential	6

3.3.2 Environmental Account Weights

The sub-account and indicator weights within the environmental account are summarized in Table 3-2.

Within the environmental sub-accounts, those considered to be of highest importance related to the environmental consequence of a dam failure, water management and water quality. These sub-accounts were weighted with values of 6. Compared to those issues, other environmental sub-accounts were given lower values, with fish habitat and closure measures given values of 4, wildlife habitat and flora given values of 3, groundwater effects given a value of 2 and air quality given a value of 1. These sub-account weights reflect the expectations that the project is located in an area where there is not anticipated to be substantial effect on fish habitat, wildlife, flora, groundwater or air quality. Closure, while notably a very important consideration, was in this evaluation uncoupled from the effects on water quality in the closure phase of the mine life. It was considered that the potential long term effects on water quality were one of, if not the most important aspect of closure for this project and therefore weighted at a value below that of water quality.

Indicator weights within those sub-accounts that were described with more than one indicator are relatively straightforward. Within the water management indicators, the catchment area and amount of seepage expected were considered more important indicators than were the complexity of water management systems or the long term requirements related to the management structures in part due to the expectations that water management infrastructure would not be any more complex or onerous than is typical for a mine of this type.

Table 3-2: Environmental Account Sub-Account and Indicator Weights

Sub-account	Sub-account Weight	Indicator	Indicator Weight
Consequence of Dam Failure	6	Potential environmental effect as a consequence of dam failure	6
Water Management (storage & seepage)	6	Catchment area	6
		Degree of TMF seepage expected	6
		Operational water management complexity	4
		Long term maintenance requirements	4
Water Quality	6	Operational water quality (assumes 10% bypass) with respect to MMER at the toe of the dam (ratio of Cu seepage/Cu MMER)	6
		Operational water quality (assumes 10% bypass + discharge if required) with respect to CCME immediately below first tributary (assumed first occurrence of fish) d/s of dam (ratio of Cu seepage/Cu CCME)	6
		Operational water quality (assumes 10% bypass + discharge if required) with respect to CCME 10 km d/s of dam (ratio of Cu seepage/Cu CCME)	4
		Closure water quality (assumes 100% bypass) with respect to CCME at the toe of the dam (ratio of Cu seepage/Cu CCME)	4
		Closure water quality (assumes 100% bypass) with respect to CCME at first tributary (assumed first occurrence of fish) d/s of dam (ratio of Cu seepage/Cu CCME)	6
		Closure water quality (assumes 100% bypass + discharge if required) with respect to CCME 10 km d/s of dam (ratio of Cu seepage/Cu CCME)	6
		Operational water quality at point of spillway discharge (ratio of Cu /Cu CCME)	6
		Closure water quality at point of spillway discharge (ratio of Cu /Cu CCME)	6
Groundwater	2	Potential reduction in groundwater contributions downgradient	3
		Potential impacts to GW quality downgradient	6
Fish Habitat	4	Quality of fish habitat under the footprint of the TMF	2
		Quality of fish habitat at first tributary d/s of the dam during operations	4
		Quality of fish habitat 10 km d/s of the dam during operations	6
		Reduction of flow (Operations to early closure)	3
		Removal of fish habitat by footprint	6
Wildlife Habitat	3	Effect on wildlife habitat in footprint area	6
Flora	3	Effect on flora in footprint area	6
Air Quality	1	Potential for fugitive dust emissions	6
Closure Measures	4	Duration of long term liability	6
		Extent of measures to implement closure	6
		Long term level/intensity of site activity	6

The water quality sub-account was delineated by mining stage (operational and closure stage) and by location of potential effect (toe of the dam, first tributary and 10 km downstream as well as in the TMF pond itself). Within these indicators, all but two were considered to be of high importance and given a weight of 6. The two that were weighted lower (both values of 4) included the operational term at a location 10 km downstream, as during operations the potential effect that far from the facilities was considered to be of a very low probability, and the indicator representing toe seepage on closure, which was expected to be still within the area that would be controlled by closure measures with negligible if any release to the environment if of poor quality.

The indicators representing groundwater were for a reduction in flow (quantity) and potential effects on groundwater quality. Comparing these two indicators, the evaluators' assessed the issue of quality to be of higher importance than quantity in part because there are no immediate users of groundwater in the project area.

Fish habitat was described by a number of indicators that reflect the effects on fish habitat at various locations in a manner similar to what was done for water quality. Specifically this was the area affected by the TMF footprint, at the first tributary downstream and at a location 10 km downstream. In addition the potential for flow reduction and any resulting effect on fish habitat was included. Comparing these indicators against one another, the quality of habitat 10 km downstream of the TMF options was considered the most important indicator, as this is the location where there is likely to be good fish habitat. The other points of reference were assessed as having lower weights. Similarly flow reductions, particularly further downgradient were perceived to be of lesser concern than potential effects on quality.

The sub-account representing closure measures was the only other sub-account within the environmental account that was represented by more than one indicator as in the table above. All three of these indicators were considered equal in weight and high in value and given weights of 6.

3.3.3 Socio-Economic Account Weights

The weights applied to the socio-economic sub-accounts and indicators are summarized in Table 3-3.

The evaluators assigned weights of 6, or those sub-accounts considered to be of highest importance with respect to socio-economic considerations, to issues such as traditional land use, long term care and maintenance, permitting, archaeology, safety, community perception and the future burden on society. By comparison, the issues of noise and aesthetics given the remote location of the project were given values of 1. Similarly issues related to tax contribution and job opportunities, while very important considerations for the project as a whole were considered of lesser importance to the evaluation of TMF alternatives and were also given values of 1.

Only a few of the sub-accounts were described by more than one indicator. Long term care and maintenance for example was defined as considering both winter operating requirements and total effort separately because the project is located in the north and winter can pose challenges that are not present at other times of the year it was given special consideration. Both indicators however were considered of equal, and high importance.

Table 3-3: Socio-Economic Account Sub-Account and Indicator Weights

Sub-account	Sub-account Weight	Indicator	Indicator Weight
Traditional Land Use	6	In immediate area	6
Long Term Care and Maintenance	6	Winter operating requirements	6
		Total effort	6
Permitting	6	Overall project complexity from permitting point of view	6
		Requirement for schedule 2 amendment	6
Archaeology	6	Sites of importance in immediate area	6
Safety	6	Consequence of dam breach (socio-economic impacts)	6
Noise	1	Degree of noise pollution	6
Aesthetics	1	Visibility from frequented areas	6
Tax contribution	1	Anticipated taxes	6
Job opportunities	1	Job/contracting potential	6
		Training/experience opportunities	6
Community perception	6	Community perception	6
Future Burden on Society	6	Future burden on society	6

Permitting was also divided into two indicators; the overall complexity from a permitting perspective as well as the expectations for a Schedule 2 amendment requirement. Again, both indicators were considered to be of equal and high importance and both given weighted values of 6.

Job opportunities were described as both the direct potential for jobs as well as the opportunities for training and experience that otherwise wouldn't be available to people in the area. These indicators, as with the others, were considered to be of high importance and both given values of 6.

3.3.4 Project Economic Account Weights

Weight values for the project economic account were as summarized in Table 3-4.

Table 3-4: Project Economic Account Sub-Account and Indicator Weights

Sub-account	Sub-account Weight	Indicator	Indicator Weight
Government Costs	6	Supporting infrastructure costs	6
Project Costs	6	Initial capital cost (waste and water management costs only)	6
		Sustaining and operating costs	5
		Fish habitat compensation	2
		Closure costs	2
		Post closure costs	2

Both the government costs and the project costs were considered of high importance and given weights of 6. Within the project costs, indicators were developed for different time periods as well as for fish habitat compensation costs. Of these, the initial capital costs were considered the most important indicator followed by the sustaining and operating costs. All other costs; fish habitat compensation, closure and post closure costs, were considered of lower importance in large part because they are typically amounts far less than the capital and sustaining costs. These were all given values of 2 as compared to other project costs.

4 MINE WASTE MANAGEMENT ALTERNATIVES ASSESSMENT

4.1 OBJECTIVES AND ASSUMPTIONS

The objectives of the mine waste and water management strategy at the Casino Project are:

1. Permanent and secure storage of tailings and mine waste
2. Selective placement of waste materials to:
    a. Ensure long term geotechnical stability, incorporating settlement and the minimization of seepage; and
    b. Maximize water quality through the minimization of acid generation potential and metal leaching waste.

A number of assumptions or design bases are defined for assessment of the options associated with the project. Assumptions are typically developed on the basis of the deposit type and size, expected production rates and anticipated environmental management requirements for wastes associated with the deposit. The assumptions used for the development of options for the Casino Project are:

- 157.5 Mt of oxide ore will be processed in a heap leach facility, south of the open pit. The location and operation of the heap leach facility is distinct from the storage of tailings and waste rock and is therefore outside the scope of this evaluation.
- Underground mining methods are not feasible. Mining will be via open pit mining methods. As with the heap leach facility, the open pit was considered outside the scope of the evaluation of waste storage alternatives.
- The candidate waste management facility locations need to be able to store 956 Mt of tailings and 658 Mt of waste rock.
- Geochemical characterization work indicates a large proportion of the waste will be potentially acid generating (PAG). The current assumption is that to align with the industry's best management practices for management of PAG waste this waste will be managed and stored sub-aqueously within a management facility.

4.2 TAILINGS AND MINE WASTE DISPOSAL METHODS

Tailings can be disposed of in a variety of ways, dependent on the geotechnical and chemical properties of the tailings after final processing (Journeaux Assoc., 2012). Typical tailings generated through milled flotation processes may be deposited in one of four ways: as conventional/slurry tailings, thickened tailings, paste tailings or filtered tailings, which have characteristics outlined in Table 4-1 and increase in solids concentration, as shown in Figure 4-1.

Table 4-1: Characteristics of Tailings Deposition Methods (from Taguchi, 2014 and Journeaux Assoc., 2012)

Tailings	Solids Content	Conveyance System	Beach Slope	Disposal Option
Slurry	<45%	Centrifugal pump	0.5% - 2%	Sub-aqueous
				Open Pit
				Natural terrain – dam and dikes built to form perimeter barrier
Thickened	45% - 65%	Centrifugal pump	2% - 6%	Sub-aqueous
				Open Pit
				Natural terrain – dam and dikes built to form perimeter barrier
Paste	65% - 70%	Positive displacement pump	2% - 10%	Sub-aqueous
				Open Pit
				Natural terrain – dam and dikes built to form perimeter barrier
Filtered	80% - 85%	Non-pumpable. Trucked or conveyed	No beaches	Open Pit
				Natural terrain – "dry" stacking and freezing

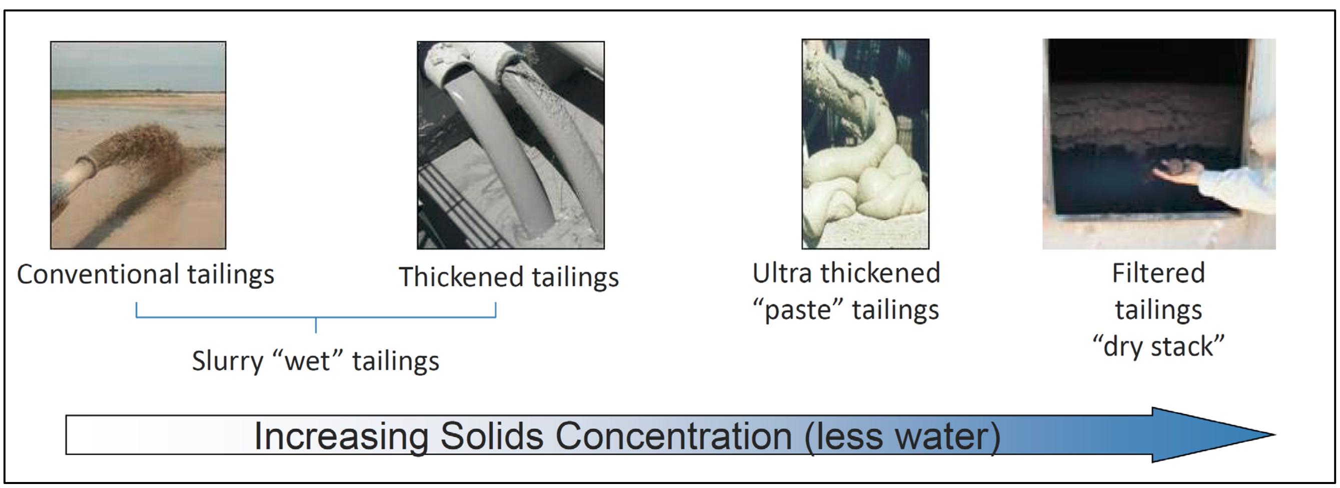


Figure 4-1: Solids Concentration of Typical Tailings Disposal Processes

Tailings slurries and thickened tailings are typically contained in facilities made of dams and dikes placed at points in the natural terrain that constrain the tailings and restrict seepage from the facility (i.e., tailings management facilities (TMFs)). Tailings slurries are best suited to operations where:

- Geochemical issues may arise through oxidation of the tailings and/or waste rock;
- Climatic conditions are extremely wet/seasonally wet; and/or

- Operations are at a larger scale (from Davies, 2015).

Globally, conventional slurry tailings make up the majority of existing TMFs, with approximately the same number of thickened plus surface paste tailings and filtered tailings facilities (Davies, 2011).

Filtered or "dry" tailings are best suited to projects that have one or more of the following attributes (from Davies, 2011):

- Reside in arid regions, where water conservation is crucial (e.g. Western Australia, Southwest United States, much of Africa, many regions of South America, arctic regions of Canada and Russia).
- Have flow sheets where economic recovery (commodity or process agent(s)) is enhanced by tailings filtration.
- Reside in areas where very high seismicity contraindicates some forms of conventional tailings impoundments.
- Reside in cold regions, where water handling is very difficult in winter.
- Have topographic considerations that exclude conventional dam construction and/or viable storage to dam material volume ratios.
- The operating and/or closure liability of a conventional tailings impoundment are in excess of the incremental increase to develop a dry stack.
- Milling rate is generally less than 10,000 tonnes per day.

Waste rock is typically disposed of in either surface dumps (which require soil covers to manage acid rock drainage and metal leaching potential), placement back in an open pit or underground mine, or co-disposed together with tailings in a co-disposal facility. Co-disposal of tailings and waste rock in one integrated disposal facility is used to improve disposal methods in cold regions, and can reduce acid mine drainage, metal leaching, storage facility footprints, increase compaction and facilitate progressive closure (Journeaux Assoc., 2012).

4.3 MANAGEMENT ALTERNATIVES

The selection of alternatives available for mine waste management at the Casino Project must take into consideration the objectives, assumptions, and criteria listed above. Four options for dam construction and/or tailings disposal and management are evaluated:

1. Use of local borrow materials to replace mine waste rock for construction of the tailings embankment;
2. Cyclone sand construction of the tailings embankment;
3. Thickened/paste tailings; and
4. Development of a dewatered tailings (dry stack) facility.

The general advantages and disadvantages to the various disposal options are outlined in Figure 4-2, and assessment of the four options detailed below.

At the wetter end of the density spectrum, tailings slurries are likely the lowest operating costs, but are the least efficient water conservation option, and require containment dams where seepage may be an issue, depending on the impoundment type. Tailings slurries have relatively complex water management. Conversely, at the other end of the density spectrum “dry” stack tailings have the most efficient water conservation, have low seepage losses from the stack, have the potential to be progressively covered and reclaimed, should be a geotechnically stable tailings mass, have minimal containment requirements and have relatively simple water management. However, “dry” stack tailings is limited by the scale of filtration technology (i.e., <10,000 tonnes per day) and has much higher operating costs.

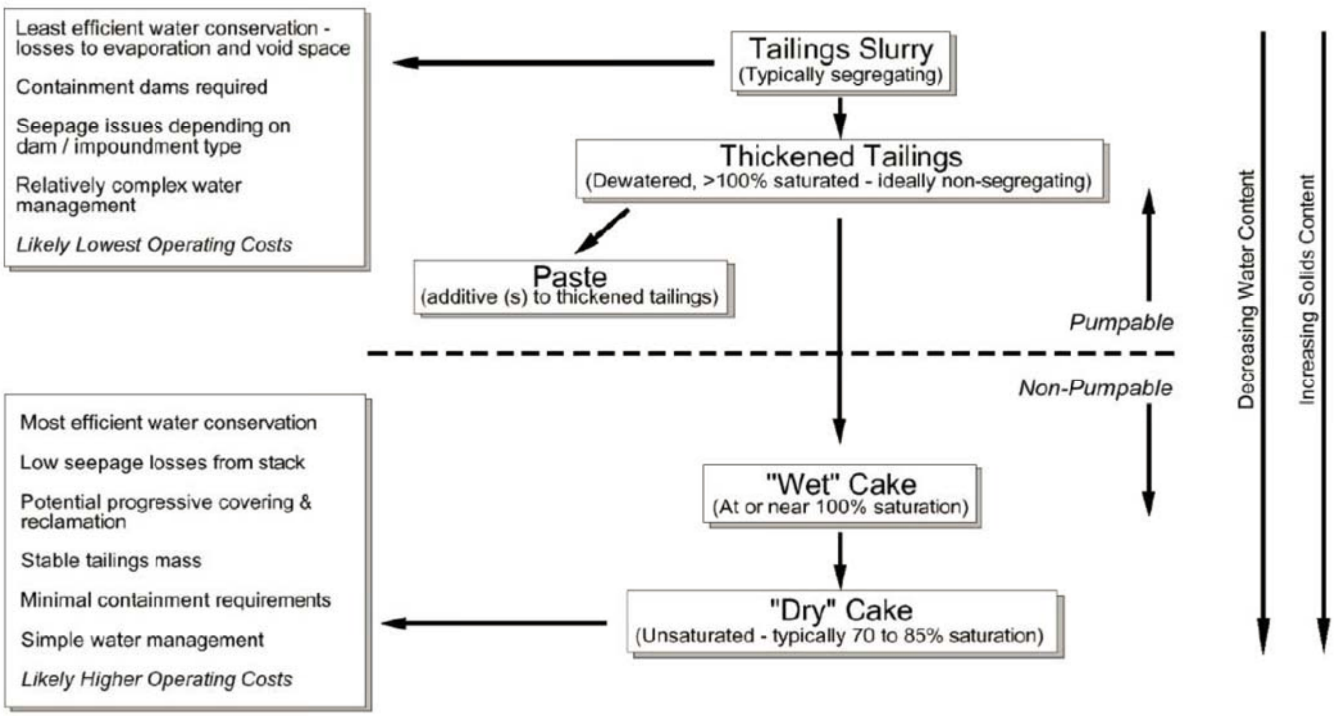


Figure 4-2: Tailings Disposal Options Advantages and Disadvantages (from Davies, 2011)

4.3.1 Local Borrow Materials

The local borrow material option incorporates the construction of a valley-fill dam made from primarily rockfill, with the co-disposal of slurried tailings and waste rock in the resulting impoundment. A schematic arrangement of the TMF for this option is illustrated on Figure 4-3. Suitable waste rock from the Open Pit is assumed to be available to construct the Stage I (starter) dam using NAG material from the oxide cap. Embankment construction to facilitate staged expansion of the TMF will be carried out using suitable rockfill materials sourced from local quarrying.

The embankments will be constructed as water-retaining zoned structures with a low permeability core zone and appropriate filter and transition zones to prevent downstream migration of fines. The core zone will include a seepage cut-off keyed into competent rock in the foundation. Information from previous geotechnical investigations at the site indicates that residual soils in the area may provide suitable low permeability borrow fill for use in construction of the embankment core zone and seepage cut-off.

The embankments are designed as full section embankments, with 2H:1V upstream and downstream slopes. Staged expansions of the embankments will utilize the centreline method of construction. A typical section through the Main Embankment is shown on Figure 4-4. An embankment height of approximately 303 m (elevation 1,008 m) is required at the deepest section for storage of 974.4 million tonnes of tailings (including approximately 49 million tonnes of pyritic tailings) and 837.6 million tonnes of PAG and ML waste rock. The depth-area-capacity (storage) relationship for this facility is given on Figure 4-5.

Tailings slurry will be discharged from the mill circuits at about 55% solids by total mass of slurry. It is assumed that approximately 80% of the tailings will be delivered to the TMF as geochemically innocuous material following pyrite separation. The remaining 20% of the total tailings comprises potentially reactive pyritic tailings discharged by a separate pipeline into a cell contained within the northern end of the TMF, remote from the embankment. Given the elevation difference between the mill and the TMF, the tailings will flow by gravity through a single pipeline, with provision for energy dissipation as required. The slurry is typically discharged through one or several off-takes, from header pipes situated around the periphery of the TMF and its confining embankments. The tailings solids settle out of the slurry and released water accumulates in a surface water (supernatant pond). Clear water from this pond is pumped back to the mill for re-use in the process.

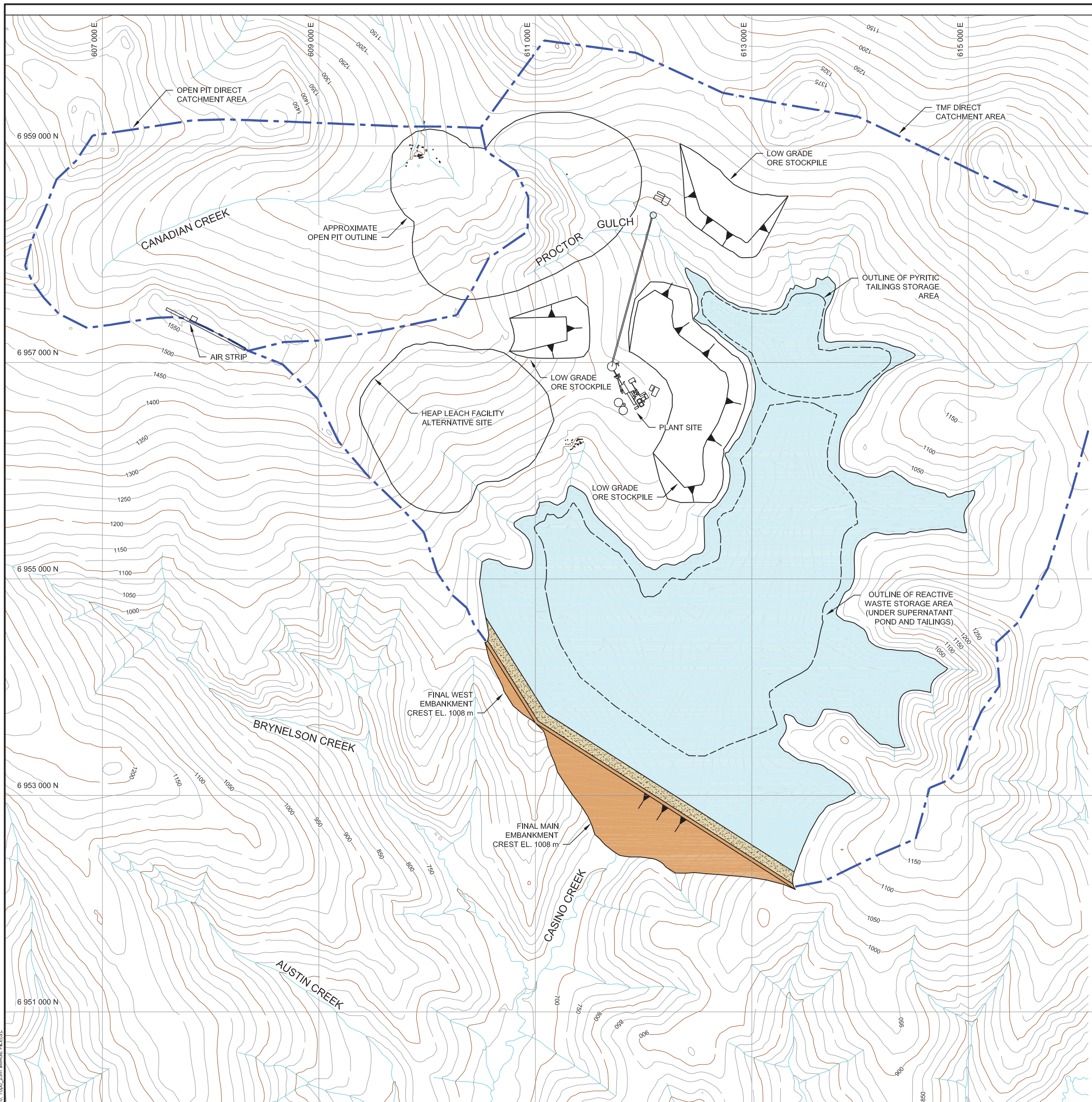
Specific overall features of this TMF option include:

- Two earth-rockfill, zoned embankments, referred to as the Main and West Embankments;
- Tailings distribution system;
- Reclaim water system;
- PAG/ML waste storage area;
- Pyritic tailings storage area;
- Supernatant (surface water) pond, and
- Seepage collection ditches and ponds/sumps.

Key design considerations for the evaluation of use of local borrow materials for dam construction include:

- Availability of borrow materials. The quantity of shell zone material required for the Main and West Embankments (excluding the Stage I dam) is approximately 105 million m^3. For this study, this material is assumed to be sourced from a quarry operation within 5 km of the Main Embankment.

- The geochemical characteristics of rockfill borrow materials would need to be assessed to confirm that they are not potentially acid generating or have metal leaching potential.
- Site investigations and testing will be required to characterize the availability and suitability of potential rockfill quarry locations.
- Any NAG waste rock material determined to have no metal leaching potential can be used to supplement local borrow materials in embankment construction. The unit cost for mine waste rock will likely be less than that associated with rockfill sourced by local quarrying.
- Placement of a buttress against the downstream shell of the Main Embankment may be required to ensure long-term stability and integrity of the TMF due to the height of the final dam (exceeding 300 m). Embankment stability analyses will need to consider the condition of underlying foundation soils and the impact of high confining stresses on the shear strength of the rockfill materials (with consideration of rock type, distribution of rockfill particle sizes, density and durability).



NOTES:

1. COORDINATE GRID IS UTM (WGS84/NAD83) ZONE 7 (m).
2. CONTOUR INTERVAL IS 25 METRES.
3. DIMENSIONS ARE IN METRES UNLESS NOTED.
4. PLANT SITE AND CRUSHER LAYOUT PROVIDED BY M3ENGINEERING AND TECHNOLOGY CORPORATION (APRIL 9, 2008).

SCALE A: 400 200 0 400 800 1200 1600 2000 m

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	CHK'D	APP'D
0	16APR'10	ISSUED WITH REPORT	AG	SC	GRG	KJB

WESTERN COPPER CORPORATION

CASINO COPPER-GOLD PROJECT

LOCAL BORROW MATERIALS OPTION GENERAL ARRANGEMENT

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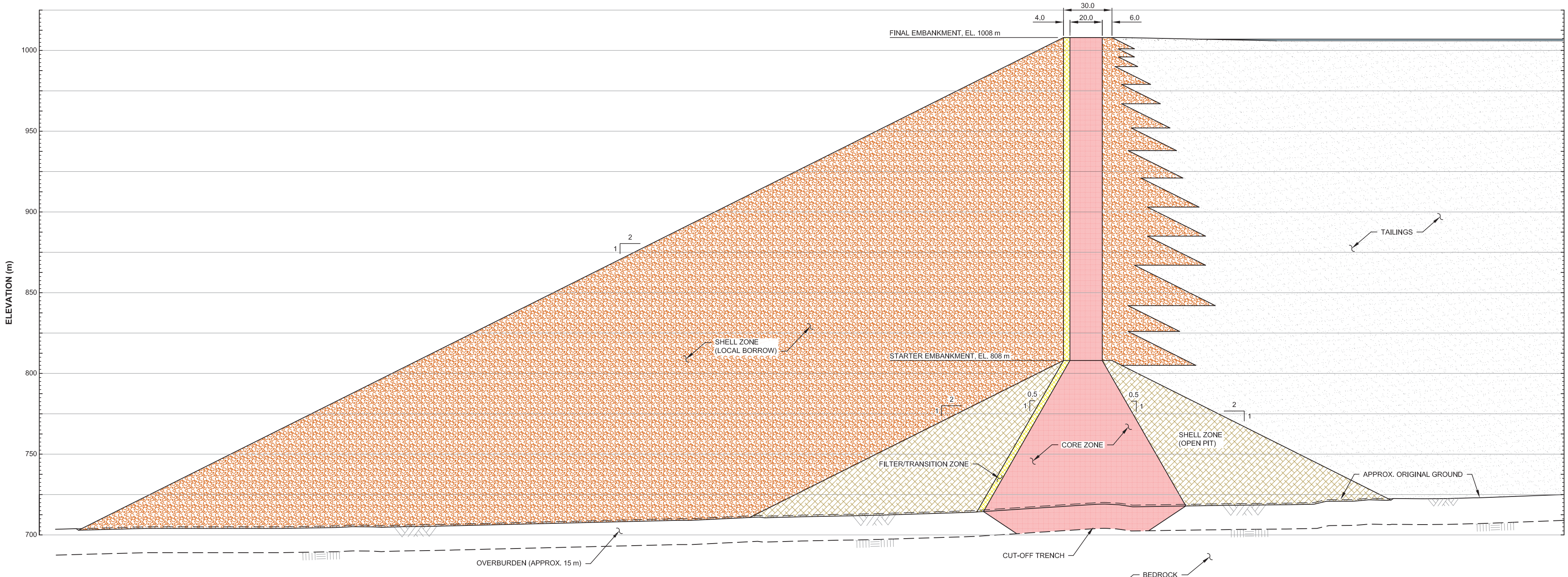
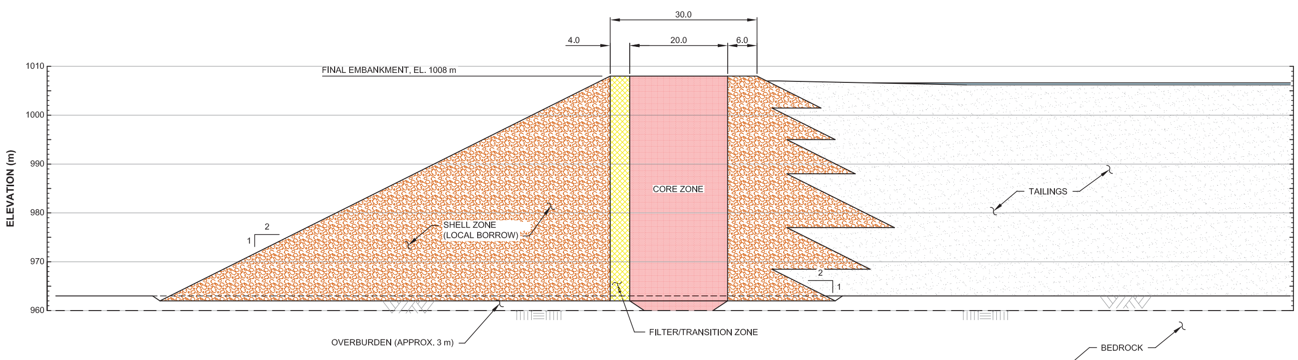
P/A NO. VA101-325/3 | REF NO. 2

Figure 4-3 | REV 0



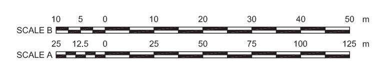
MAIN EMBANKMENT CROSS SECTION

SCALE A



WEST EMBANKMENT CROSS SECTION

SCALE B



0	16APR'10	ISSUED WITH REPORT	AG	SC	GRG	KJB
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WESTERN COPPER CORPORATION

CASINO COPPER-GOLD PROJECT

LOCAL BORROW MATERIALS OPTION
TYPICAL EMBANKMENT SECTIONS

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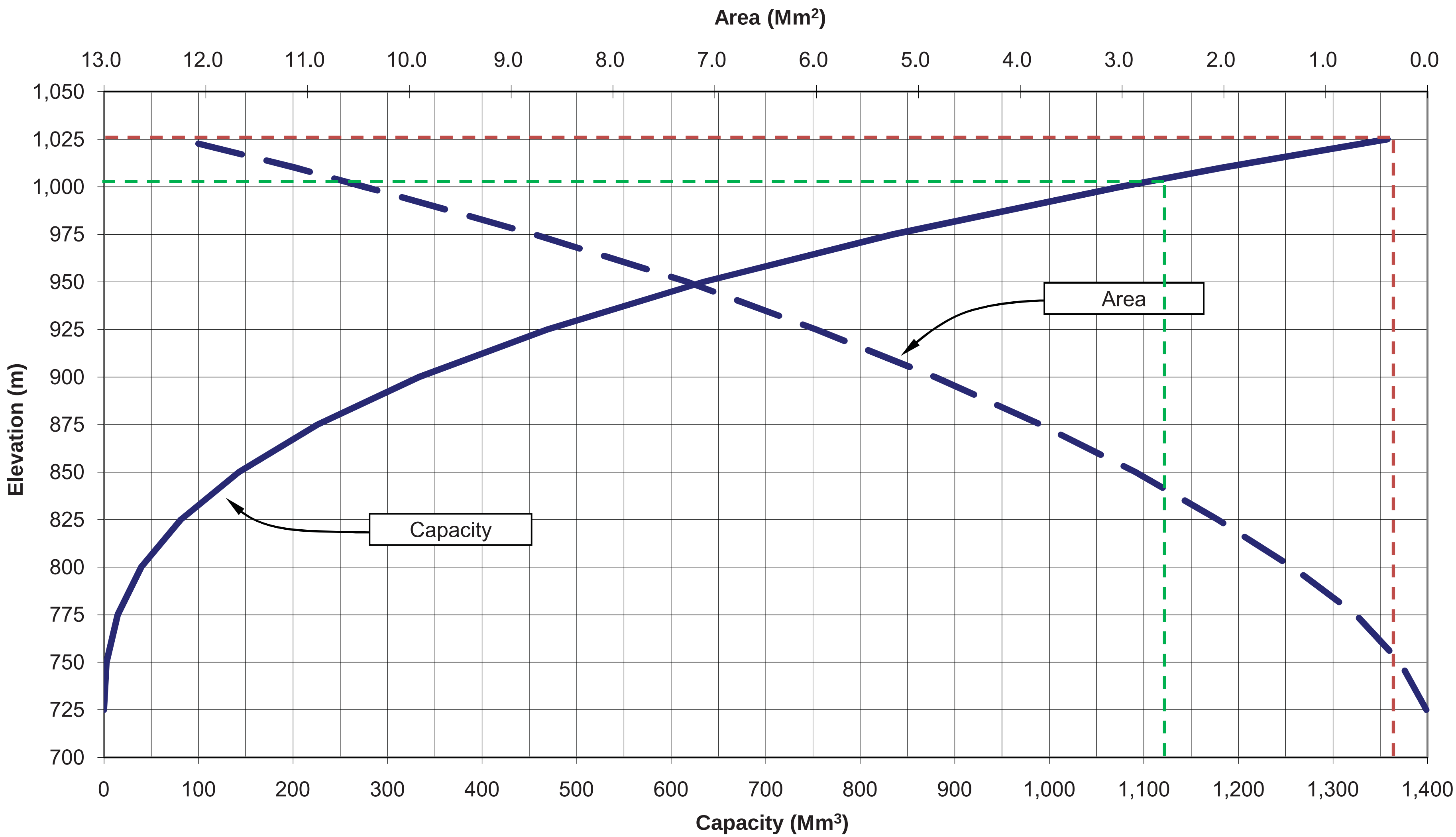
P/A NO.	REF NO.
VA101-325/3	2

Figure 4-4

REV 0



NOTES:
1. TAILINGS PLUS PAG AND ML WASTE MATERIAL STORAGE VOLUME = 1,119 Mm^3.
2. EXPANDED CASE: TAILINGS PLUS PAG AND ML WASTE MATERIAL STORAGE VOLUME = 1,369.9 Mm^3.

WESTERN COPPER CORPORATION

CASINO COPPER-GOLD PROJECT

LOCAL BORROW MATERIALS OPTION
DEPTH-AREA-CAPACITY RELATIONSHIP

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PROJECT / ASSIGNMENT NO.	REF NO.
VA101-325/3	2

Figure 4-5 REV. 0

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	03MAY'10	ISSUED WITH REPORT	AG	GRG	KJB

4.3.2 Cyclone Sand Embankment

This option also requires the construction of a valley-fill dam with an impoundment to store slurried tailings and waste, subaqueously. Embankment construction for this option is assumed to be primarily from cyclone sand material. The sand fraction of the bulk tailings is extracted by cycloning the tailings slurry. The resulting sandy underflow product can be used as a construction material provided that it can be placed, drained and compacted sufficiently to ensure embankment stability and preclude potential for liquefaction during seismic shaking. Suitable waste rock from the Open Pit is assumed to be available to construct the Stage I (starter) dam using NAG material from the oxide cap. Embankment construction to facilitate staged expansion of the TMF will be carried out primarily using cyclone sand material. A general arrangement of the TMF for this design option is illustrated on Figure 4-6.

The particle size distribution of the Casino mill tailings is a key consideration for determining the suitability of the bulk tailings to provide cyclone sand fill material of suitable quality and sufficient quantity. Coarser tailings are preferred, as a higher sand fraction or ‘split’ can be realized. A low percentage of fines is also preferred, in order to promote rapid drainage and to facilitate compaction. Two stage cycloning will be required to achieve the desired sand product (low fines content).

Similar to the TMF option utilizing only local borrow materials, the embankments will be constructed as water-retaining zoned structures with a low permeability core zone, appropriate filter and transition zones to prevent downstream migration of fines, and a seepage cut-off keyed into competent rock in the foundation. Information from previous geotechnical investigations at the site indicates that residual soils in the area may provide suitable low permeability borrow fill for use in construction of the embankment core zone and seepage cut-off. Staged expansions of the embankments will utilize the centreline method of construction with a minimum downstream slope of 3H:1V. A typical section through the Main Embankment is shown on Figure 4-7. An embankment height of approximately 286 metres is required at the deepest section for storage of 956 million tonnes of tailings and 658 million tonnes of potentially reactive waste rock.

Approximately 221 million tonnes of the stored tailings will be utilized as cyclone sand fill for embankment construction. The depth-area-capacity (storage) relationship for this facility is given on Figure 4-8.

Cell construction using narrow sand deposition panels will be required for raising the downstream shell of the embankments. The panel method involves the construction and maintenance of long, narrow cells along the face of the embankment. A schematic of the panel construction sequence is shown on Figure 4-9.

It is estimated that 50% of the NAG tailings can be recovered as cyclone sand when the cyclone station is operating. This amounts to approximately 7.2 to 7.5 million m^3 of cyclone sand fill material produced annually. Any shortfall of embankment fill material would need to be made up with rockfill from Open Pit stripping (if available and geochemically innocuous) and/or suitable fill material from local borrow sources or quarries. Approximately 50% of NAG tailings solids assumed to be produced by cyclone plant as sand fill is suitable for embankment construction (based on expected tailings particle size distribution). Cyclone sand production is assume for average 9 months per year. Cyclone sand production begins at start of Year 1 and plant availability is 90%.

It is assumed that approximately 80% of the tailings will be geochemically innocuous material following pyrite separation. The remaining 20% of the total tailings comprises potentially reactive pyritic tailings discharged by a separate pipeline into a cell contained within the northern end of the TMF, remote from the embankment.

Significant features of the cyclone sand design concept required for the TMF include the following:

- A two stage cyclone sand plant.
- The cyclone sand plant will be located at an elevation such that discharge of sand and combined cyclone overflow can be achieved by gravity. Relocation of the cyclone plant may be required later in the project life.
- The cyclone sand plant will be fed directly from the mill using off-take connections from and to the existing bulk tailings pipelines. This arrangement will maintain the operational ability to bypass the cyclone plant and continue to deposit bulk tailings directly into the TMF when required.
- An additional water inflow of approximately 5,000 m^3/hr is required at the cyclone sand plant during operations. This will be used to reduce the solids content of the primary and secondary cyclone feeds and to fluidize the sand to enhance gravity transport, reduce pipeline pressures and minimize sand pumping costs. Supply of the additional water will come from a dedicated floating reclaim pump-station located within the TMF. A single dedicated pipeline will connect this floating pumpstation to the cyclone sand plant.
- The cyclone underflow (sand fraction) will be pumped as required and discharged by gravity from the cyclone sand plant as a slurry of approximately 55% solids by weight, through one of several steel pipelines laid from the cyclone station. These lines will be laid across a downstream bench below the crest of the TMF confining embankment and extended at intervals down the downstream face for deposition of sand into confining “cells” for use as construction material. The provision of several lines enables the relocation of discharge points, on-going pipeline maintenance and the continuous placement of sand, allowing zones of previously deposited sand material to drain and be compacted by earthmoving equipment.
- The fine cyclone overflow material (fine tailings) will be returned back into the existing bulk tailings discharge pipelines, immediately downstream of the cyclone sand plant, and discharged directly into the TMF from existing off-takes in pipelines laid along the upstream embankment crest and around the periphery of the TMF. Additional pumping will be provided as required.
- Additional solids collection and water recovery measures will be required at the downstream embankment toe. These include sediment collection ponds, drainage recovery pumping and pipeworks systems, plus a seepage recovery pond and pump-back system. These components are required to collect fine sediments and water recovered from the draining sand fill. The sediments will need to be removed by dredging or excavation on at least an annual basis and all

water will be pumped back into the TMF through dedicated pipelines. Back-up pumping and power will be required.

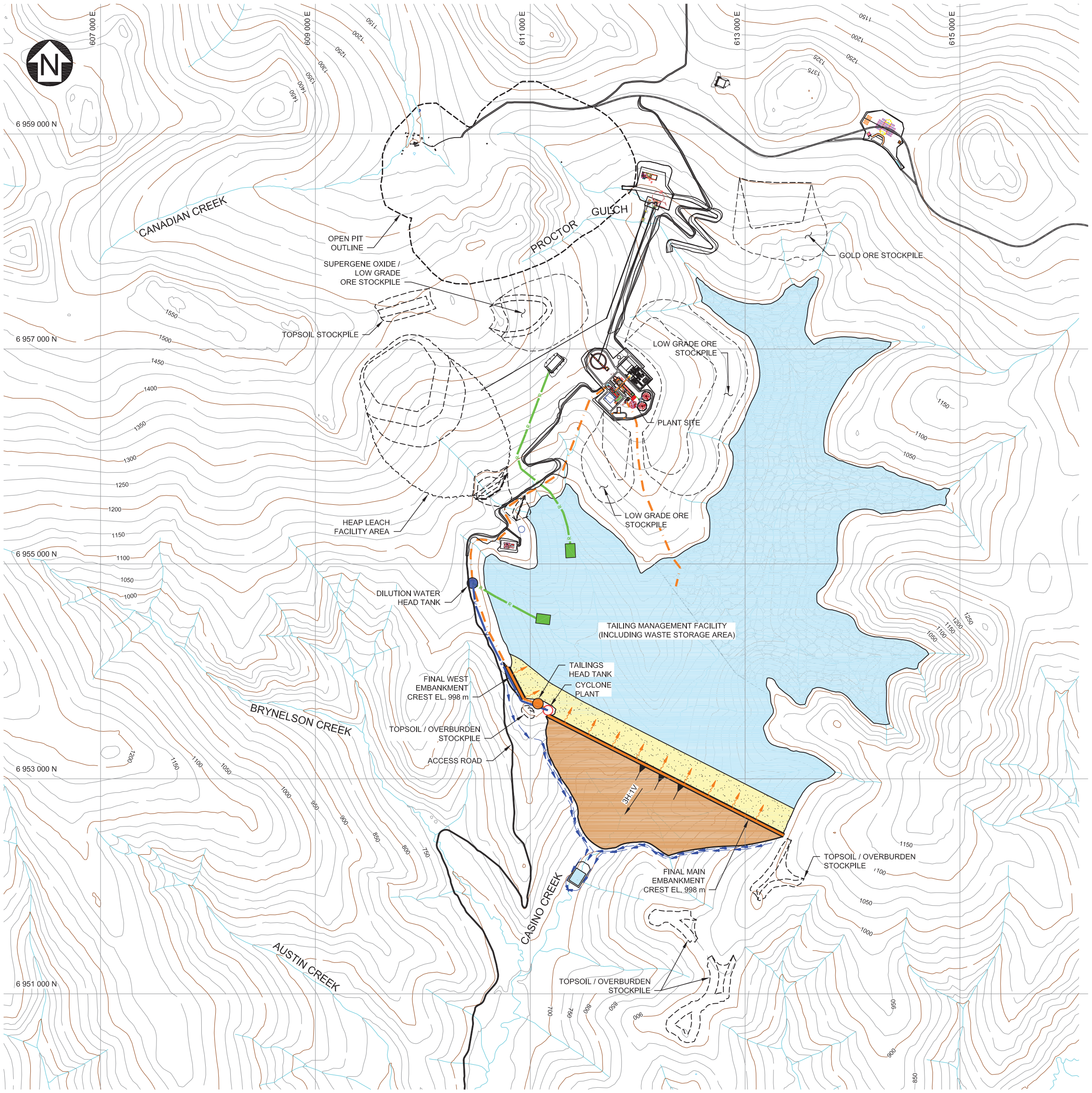
- During the winter months and at other times when the cyclone sand plant is not operating, bulk tailings discharge will be rotated sequentially into the TMF from offtakes in the bulk tailings pipelines.

Key design and operating considerations that need to be included in the evaluation of cyclone sand material for embankment construction include the following:

- Embankment height, stability and seismic resistance. This limits the sand placement options and would likely necessitate construction using sand cells, where additional vibratory compaction would be required to ensure a sufficiently dense, high strength and liquefaction resistant material.
- Cold winter conditions that will reduce the construction period, partly due to the potential for freezing and ice entrainment in the sand fill and partly because of snow drifting in the sand cells.
- Tailings particle size distribution. The tailings grind is fundamental in determining the 'split' that can be achieved by cycloning (i.e. the percentage of the tailings stream that can be separated and used as sand fill for construction). Clean sand, with a low fines content, will be required for placement in the sand cells, in order to facilitate rapid drainage and subsequent compaction. It is anticipated that the fines content (% passing a #200 sieve) of the cyclone sand will need to be less than 15%, in order to maximize fill placement rates and to ensure adequate compaction and drainage.
- The availability of cyclone sand needs to be matched with the filling schedule for the TMF, to ensure adequate embankment heights are provided well in advance of the rising tailings surface. The Stage 1 (starter) embankment must be high enough to allow sufficient quantities of sand to be produced and placed to facilitate subsequent embankment raises. A hybrid approach (combination of rockfill and cyclone sand) may be necessary to offset any shortfall of cyclone sand available for construction during the operating life of the TMF. The sequencing of sand cell construction in relation to the requirements for embankment crest raising and the associated rockfill placement schedules will need to be carefully evaluated in subsequent design studies. Similarly, the timing, logistics and operating requirements for pipeline management and relocations will also need to be evaluated for future design studies.
- If a combination of cyclone sand and rockfill is utilised for embankment construction, additional filter and drainage layers will be required at the base of sand zones to prevent the migration of tailings sand into underlying rockfill and to provide drainage for the transport of water released from the sand.
- The possibility of windy conditions at the site must be considered. The problem can be exacerbated during cold winter conditions as a 'freeze drying' process tends to destroy capillary tensions in partially saturated sand, making it more susceptible to dusting. This will be a significant environmental consideration. Appropriate provisions will need to be incorporated to

prevent windblown dusting. This will most likely mean that the cyclone sand material will have to be capped with erosion resistant fill material, particularly during the cold winter months, when it may be impractical and/or impossible to continue with active sand placement.

- Only clean (geochemically innocuous) bulk tailings can be cycloned to produce sand fill material for embankment construction. No potentially acid generating or metal leaching materials can be used for embankment construction. Management of the potentially reactive pyritic tailings stream during system maintenance or breakdown needs to be coordinated to ensure that total tailings that include the pyrite stream are not directed to the cyclone sand plant.
- Water management is a major consideration, as protection of downstream fisheries resources is a fundamental requirement. Downstream cyclone water recovery systems will need to include appropriate provisions for containment of fines washed out of the cyclone sand fill, along with additional water collection ponds and water recovery systems. The provision of back-up pumps and a standby power supply must be considered for pump-back systems. The water management aspects of the cyclone sand systems will be major environmental considerations. These will need to be carefully considered to ensure appropriate levels of environmental protection are maintained, both during operations and after closure.
- The requirement for a very large embankment may warrant the installation of multiple or movable sand plants, particularly if the use of cyclone sand as a construction material is to be maximized.
- To accommodate cyclone sand plant maintenance or downtime (primarily during the winter months), valves and pipeworks will need to allow bulk tailings to be delivered directly to the TMF for discharge.
- Placement of a buttress against the downstream shell of the Main Embankment, or an overall flattening of the slope, may be required to ensure long-term stability and integrity of the TMF due to the height of the final dam (280+ metres). Embankment stability analyses will need to consider the condition of underlying foundation soils and the impact of high confining stresses on the shear strength of the cyclone sand material.



LEGEND:

- TAILINGS
- EMBANKMENT (CYCLONE SAND)
- EMBANKMENT (ROCKFILL)
- POND
- TAILINGS PIPELINES
- RECLAIM PIPELINES
- WATER PIPELINES
- TAILINGS HEAD TANK
- DILUTION WATER HEAD TANK
- CYCLONE PLANT
- DIVERSION DITCHES

NOTES:

1. COORDINATE GRID IS UTM (WGS84/NAD83) ZONE 7 (m).
2. CONTOUR INTERVAL IS 25 METRES.
3. DIMENSIONS ARE IN METRES UNLESS NOTED.
4. OPEN PIT AT ITS FINAL OUTLINE AS PROVIDED BY CASINO MINING CORPORATION (NOVEMBER 2012).
5. PLANT SITE AND CRUSHER LAYOUT PROVIDED BY M3 ENGINEERING AND TECHNOLOGY CORPORATION (OCTOBER 4, 2012).
6. ORE AND TOPSOIL STOCKPILES ARE SHOWN AT THEIR MAXIMUM SIZE DURING OPERATIONS.

SCALE A 400 200 0 400 800 1200 1600 2000 m

CASINO MINING CORPORATION

CASINO COPPER-GOLD PROJECT

Cyclone Sand Embankment Option
General Arrangement

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA101-325/8	10

Figure 4-6

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REV	DATE	DESCRIPTION	DESIGNED	DRAWN	CHK'D	APP'D
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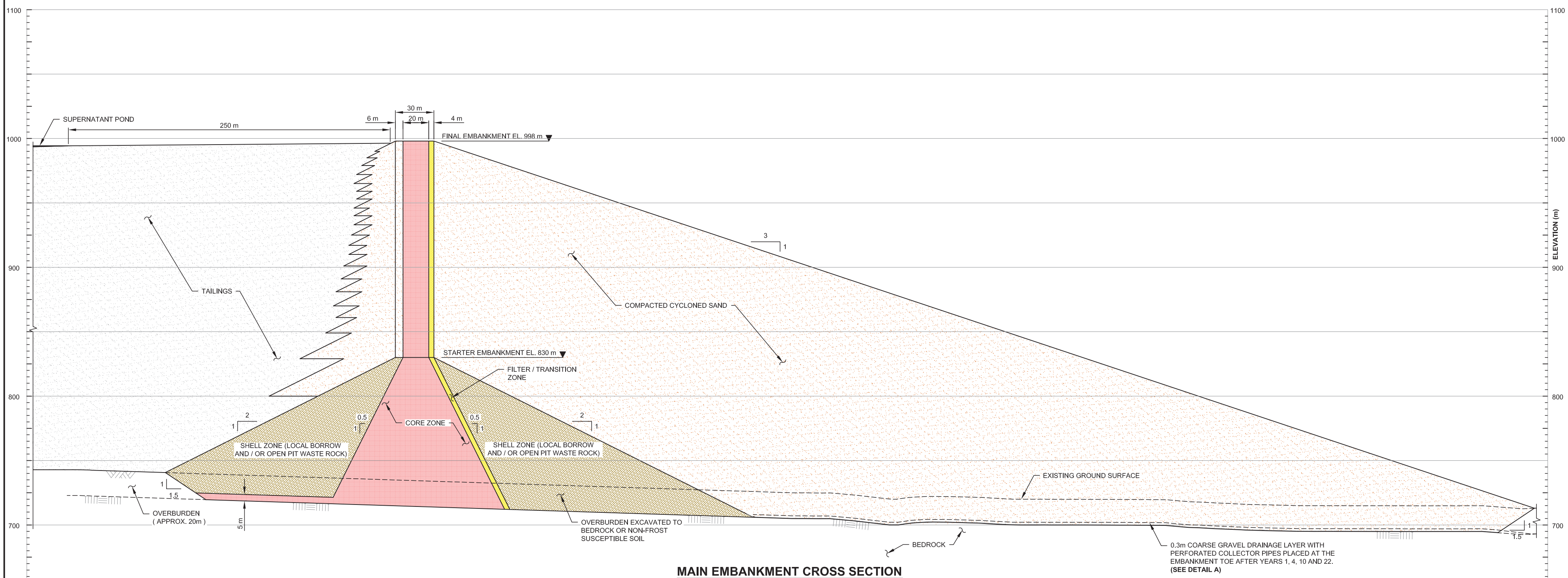
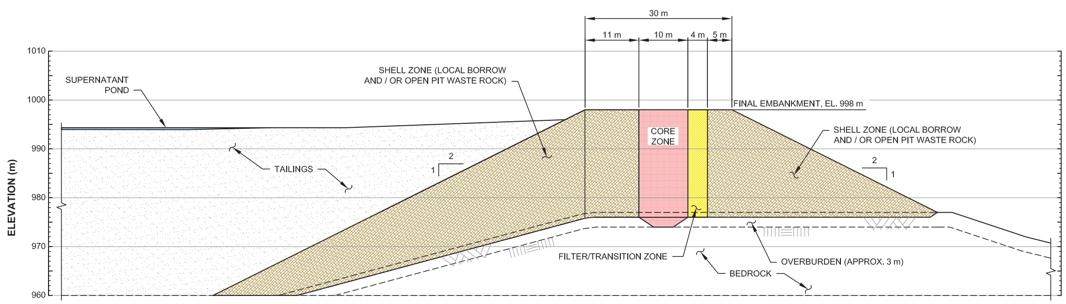


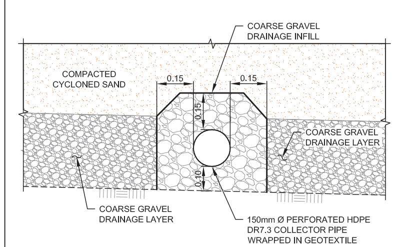
MAIN EMBANKMENT CROSS SECTION

SCALE A



WEST EMBANKMENT CROSS SECTION

SCALE B



A
-
DETAIL
EMBANKMENT DRAINAGE SYSTEM
SCALE C

NOTES:

1. COORDINATE GRID IS UTM (WGS84/NAD83) ZONE 7 (m).
2. DIMENSIONS AND ELEVATIONS ARE IN METRES UNLESS NOTED.
3. GENERALIZED TOPOGRAPHY SHOWN.

SCALE C: 0.2 0.1 0 0.2 0.4 0.6 0.8 1 m
SCALE B: 10 5 0 10 20 30 40 50 m
SCALE A: 30 15 0 50 100 150 m

CASINO MINING CORPORATION

CASINO COPPER-GOLD PROJECT

Cyclone Sand Embankment Option
Typical Embankment Sections

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CONSULTING

P/A NO.	REF NO.
VA101-325/8	10

Figure 4-7

REV 0

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	CHK'D	APP'D
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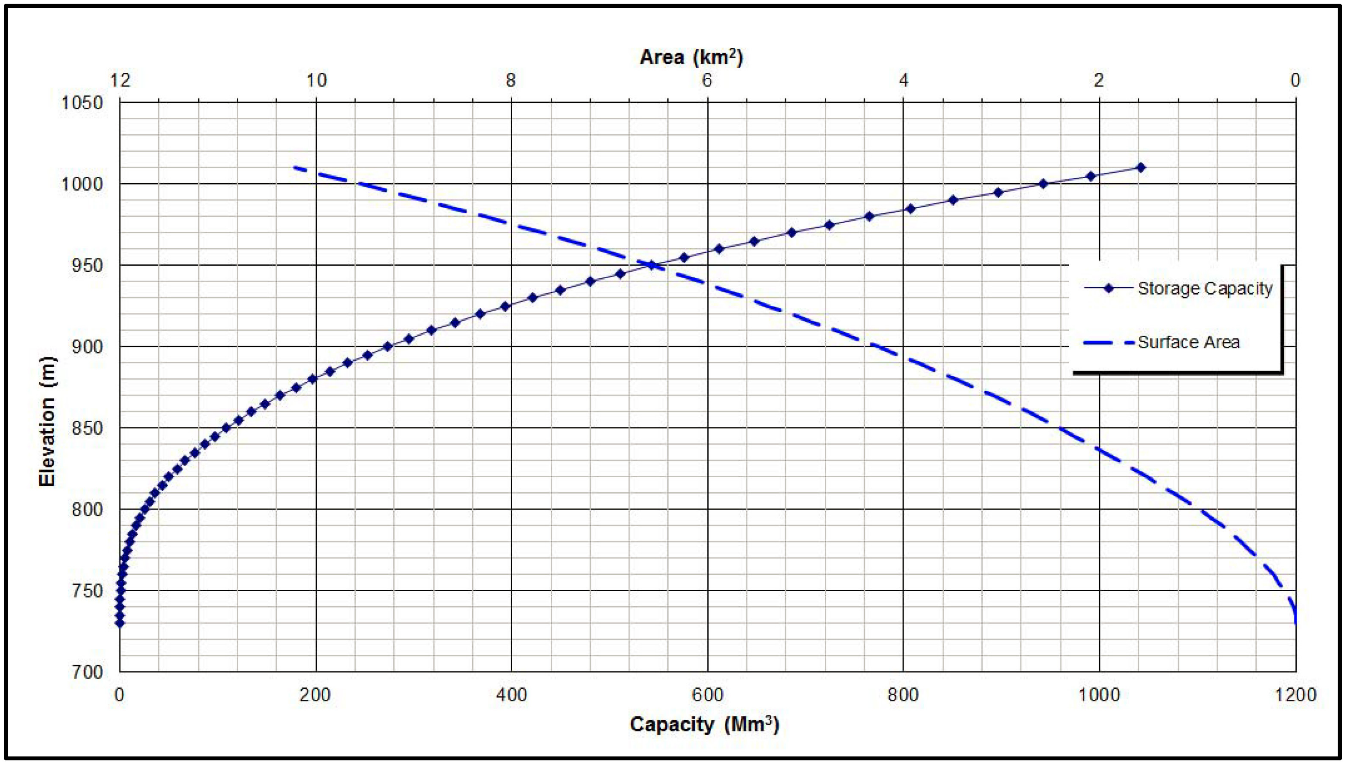

Figure 4-8: Cyclone Sand Embankment Option Depth-Area-Capacity Relationship

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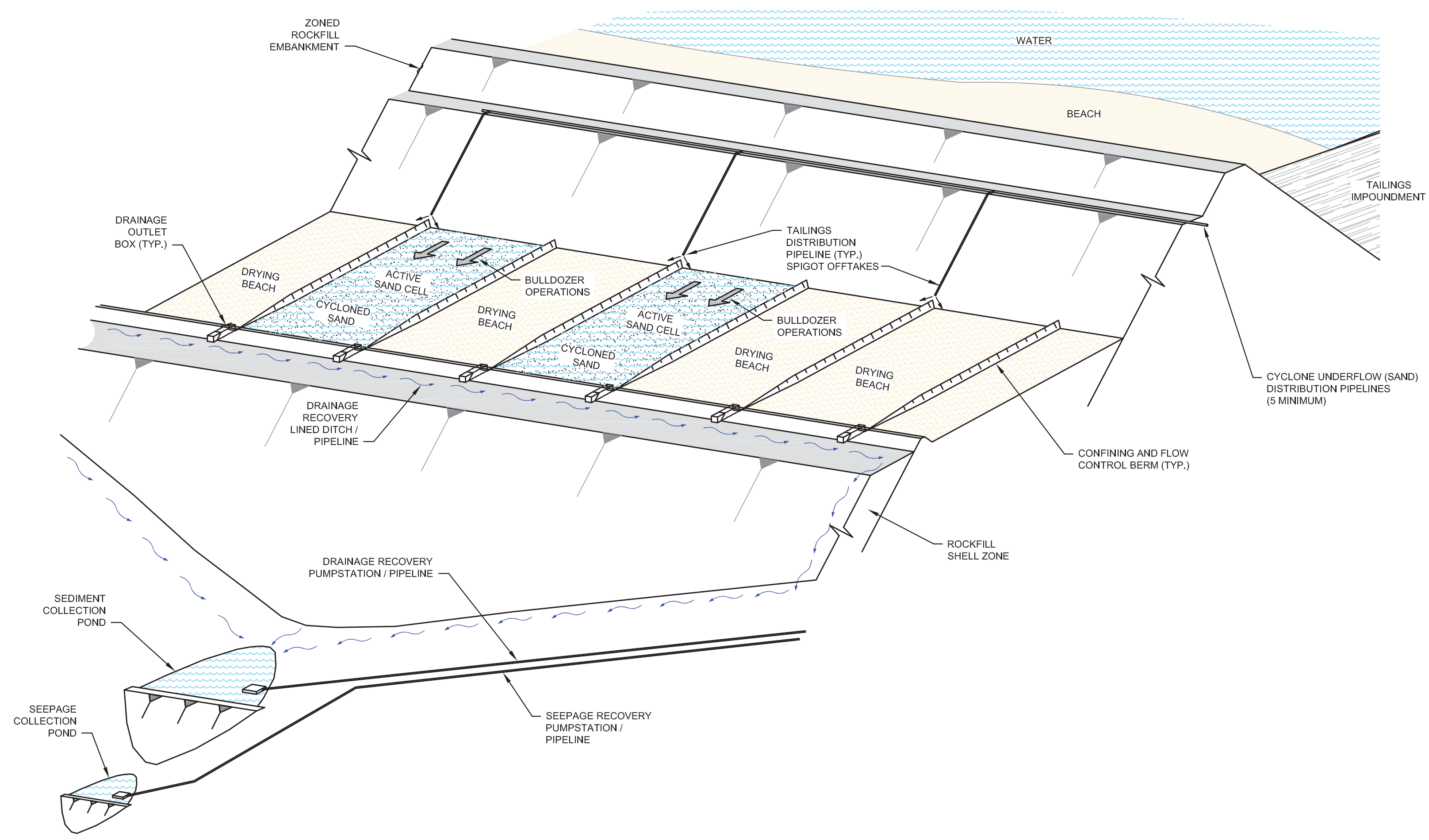

NOTES:

1. SAND CELL PLACEMENT OPERATIONS OCCUR SIMULATANEOUSLY IN TWO OR THREE CELLS.

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REV	DATE	DESCRIPTION	DESIGNED	DRAWN	CHK'D	APP'D

WESTERN COPPER CORPORATION

CASINO COPPER -GOLD PROJECT

CYCLONE SAND DEPOSITION SCHEMATIC

Knight Piésold CONSULTING

P/A NO.	REF NO.	
VA101-325/3	2	
Figure 4-9		REV 0

4.3.3 Thickened/Paste Tailings

Thickened and paste tailings production uses settling, thickening and filtration processes to increase the tailings solids content. The tailings behaviour (rheology) changes with increases in density and viscosity. Commonly cited advantages for surface disposal of tailings as a thickened slurry or paste compared to conventional slurried tailings disposal include the following:

- Decreases the time required for a tailings deposit to achieve its final density and volume;
- Minimizes seepage from the tailings;
- Ease of operations and reduced water storage requirements;
- Reduced storage requirements and dam construction requirements;
- Reduces disturbance areas (facility footprint);
- Improved environmental performance; and
- Ease of reclamation at closure.

The tailings system complexity and working area increases with the need for mechanical equipment and flocculent addition. Paste tailings require positive displacement pumps and high pressure pipelines to deliver tailings to the TMF. An advantage may be the reduced power cost for pumping smaller tailings flows to the TMF and smaller reclaim water volumes from the TMF. However, potential capital cost advantages with smaller diameter tailings and reclaim pipelines may be offset by costs for processing equipment such as thickeners and re-circulation pumps, the need for earlier installation of booster pumps (due to increased tailings viscosity) and the added risk to operations from process upsets or equipment malfunction. Reduced power costs for pumping may be significantly offset by dewatering (e.g. flocculent) costs and higher operating and maintenance costs.

A consistent finding of dewatered tailings studies is that for most operations the production and delivery of thickened, and particularly paste tailings, is a high cost, high maintenance operation. Experience with thickened slurry and paste tailings has demonstrated the importance of a consistent feed and the technical and maintenance problems associated with production and delivery of a consistent tailings product. The demand for dewatering can result in major conflicts with the milling process, while the tailings distribution system can be adversely affected if it is not suitably designed for the specific characteristics and variations of the dewatered tailings stream.

The implementation of a dewatered tailings process, the production, delivery and deposition requirements, and the revised water management systems typically combine to increase operational complexity. The likelihood of periodic upset conditions increases, especially during the commissioning period. With more complex tailings handling and disposal systems, cold weather and darkness, the potential for mill shutdown or spillage may be significantly greater than for conventional slurry tailings disposal.

Thickened and paste tailings still retain considerable moisture after dewatering and deposition. The in situ strength characteristics of these materials are typically very similar to those associated with conventional slurried tailings deposits. Consequently, it often remains necessary to provide a substantial confining embankment to maintain appropriate stability under static and seismic loading conditions. The addition of cement can increase the strength characteristics of paste tailings, but can be very costly.

The use of dewatered tailings is unlikely to change the general design requirements for the TMF at the Casino project. The facility would still need to provide a confining embankment, storage for water management (surplus), accommodate storm water flows, as well as maintaining an appropriate water cover over potentially reactive mine waste materials (to inhibit oxidation) placed into the TMF for co-disposal.

A preliminary assessment has been carried out to examine the impact of dewatered tailings on TMF embankment height and impoundment footprint area, due to the potential increase in average dry density of the stored tailings and the corresponding reduction in stored volume. Information from existing mine operations indicates that an average tailings dry density of approximately 1.6 t/m^3 to 1.8 t/m^3 may be achievable, depending on the physical characteristics of the tailings, the level of dewatering employed (thickened slurry or paste) and site-specific conditions (including placement strategy and climate conditions). The potential decrease in the starter and final embankment heights is only about 6 and 16 metres respectively. The corresponding reduction in the final impoundment footprint size is also minor (less than 10%). This assumes a high average dry density of about 1.8 t/m^3 is achieved and maintained. The potential decrease in embankment height and footprint size will be even smaller if the average dry density is lower.

4.3.4 Dewatered Tailings 'Dry Stack'

This option considers the use of dewatered (filtered) tailings for storage within a "dry stack" facility. A dry stack facility can be used to store the majority of the tailings and would require significantly less material for the confining embankments, compared to disposal by conventional tailings slurry discharge. However, a separate facility is still required to provide subaqueous storage and confinement of potentially reactive waste rock (PAG and ML) and pyritic tailings, and to provide a facility for water management (including recovery to the mill) and contingency storage for those periods when the dry stack facility or dewatering plant is not operational.

Filtered tailings are produced using pressure or vacuum forces in presses, drums or belt filtration units. The tailings are typically dewatered to a moist, cake-like consistency, with water contents sufficiently low to achieve an unsaturated tailings material. The dewatered tailings are transported by conveyors or trucks to a 'dry stack' where they can be compacted in lifts to improve density and stability and enable the ability for machinery to work on the impoundment surface to facilitate on-going expansion.

Pyritic tailings (assumed to be approximately 20% of the total tailings) and all PAG and ML waste rock will be deposited within a Potentially Reactive (PR) waste facility located in the Casino Creek valley south-east from the Open Pit. The dry stack facility accommodating all non-reactive tailings will be located immediately downstream of this impoundment.

A general arrangement of the dry stack facility and adjacent PR waste facility is shown on Figure 4-10.

Specific features of the mine waste facilities are listed below:

- One earth-rockfill, zoned embankment;
- Non-reactive tailings distribution system;
- Pyritic tailings distribution system;
- Dewatered tailings distribution system;
- Reclaim water system;
- Reactive waste storage area;
- Pyritic tailings storage area;
- Supernatant (surface water) pond; and
- Seepage collection ditches and ponds/sumps.

It is assumed that the dry stack tailings facility will accommodate approximately 80% of the total tailings stream. The dewatered tailings will be placed and compacted in conjunction with a perimeter berm constructed from NAG waste rock and/or local borrow materials. Filtered tailings will be produced at a dewatering plant, likely established in the area west of the dry stack facility, where the proposed plant site is currently situated. It is assumed that the dewatered tailings will be delivered to the dry stack either by truck or by conveyor. A typical section through the dry stack facility is shown on Figure 4-11. The depth-capacity (storage) relationship for the dry stack tailings facility is given on Figure 4-12. The final height of the dry stack facility required for storage of 487.2 million m^3 (876.9 million tonnes) of dewatered tailings is approximately 226 metres (Elevation 991 m). This is based on an assumed in situ average tailings dry density of 1.8 tonnes/m^3. It is likely that an underdrain system will be required to ensure drainage and maintain unsaturated conditions within the filtered tailings pile.

The PR waste facility is required for storage of all pyritic tailings (assumed to be 20% of the total tailings stream) and all mine waste rock identified as Potentially Acid Generating (PAG) or with Metal Leaching (ML) potential. Additionally, it is assumed that approximately 5% of the non-reactive tailings will be discharged into this facility. This will be required during periods when the tailings dewatering plant is not operating (e.g. due to maintenance or unscheduled shutdown) or due to unfavourable weather conditions inhibiting tailings placement in the dry stack facility. The confining embankment for the PR waste facility will have a similar design concept to that described for the local borrow embankment option. The facility has been designed to permanently store 97.4 million tonnes of pyritic and bulk tailings (69.6 million m^3 at an assumed average dry density of 1.4 t/m^3) and approximately 658 million tonnes of PAG and ML waste rock which will be stored in the Reactive Waste Storage Area contained within the PR waste facility. The final embankment height is approximately 280 m (Elevation 1,025 m). The depth-area-capacity relationship for the PR waste facility is shown on Figure 4-13.

The overall configuration of the dry stack tailings facility and adjacent PR waste facility has been developed to minimize disturbed area (impoundment footprint), minimize the contributing catchment area (to simplify water management requirements), and to enable the non-reactive tailings dry stack to provide an additional seepage barrier between the PR waste facility and downstream receiving waters.

Embankment slope revegetation and reclamation could occur incrementally during staged expansion of the dry stack facility. Reclamation at closure would consist of revegetating the final surface of the impoundment. Decommissioning of ancillary facilities such as the tailings filtering and dewatering plant would occur at the time other project facilities were dismantled.

Tailings physical characteristics, such as particle size distribution (percent fines), strongly influence the ability to dewater the tailings solids sufficiently for them to be handled and placed in a compacted dry stack. The presence of excessive fines in the tailings may make it impractical to achieve a workable “dry” tailings product.

The storage of dry tailings can be beneficial, but it is not a method that can be applied in all circumstances. Operational problems may occur as a result of filtering equipment breakdown or a failure of filters to achieve performance requirements, resulting in a variable product. The filtering and transport of dry tailings to the storage area can be very costly in comparison to conventional pumping of tailings slurry, particularly if the slurry can flow under gravity, without pumping. Handling and placement of dewatered tailings in the dry stack facility will add to labour and equipment costs. In an environment with a potential water surplus, such as Casino, water management and water balance requirements may be challenging with a dry stack facility.

In the event of a planned (maintenance) or unplanned halt to operations at the dewatering plant or delivery system, it will be necessary to provide an alternative method for tailings discharge to avoid mill shut-down. This can be achieved by installing a backup pipeline system to the PR waste facility.

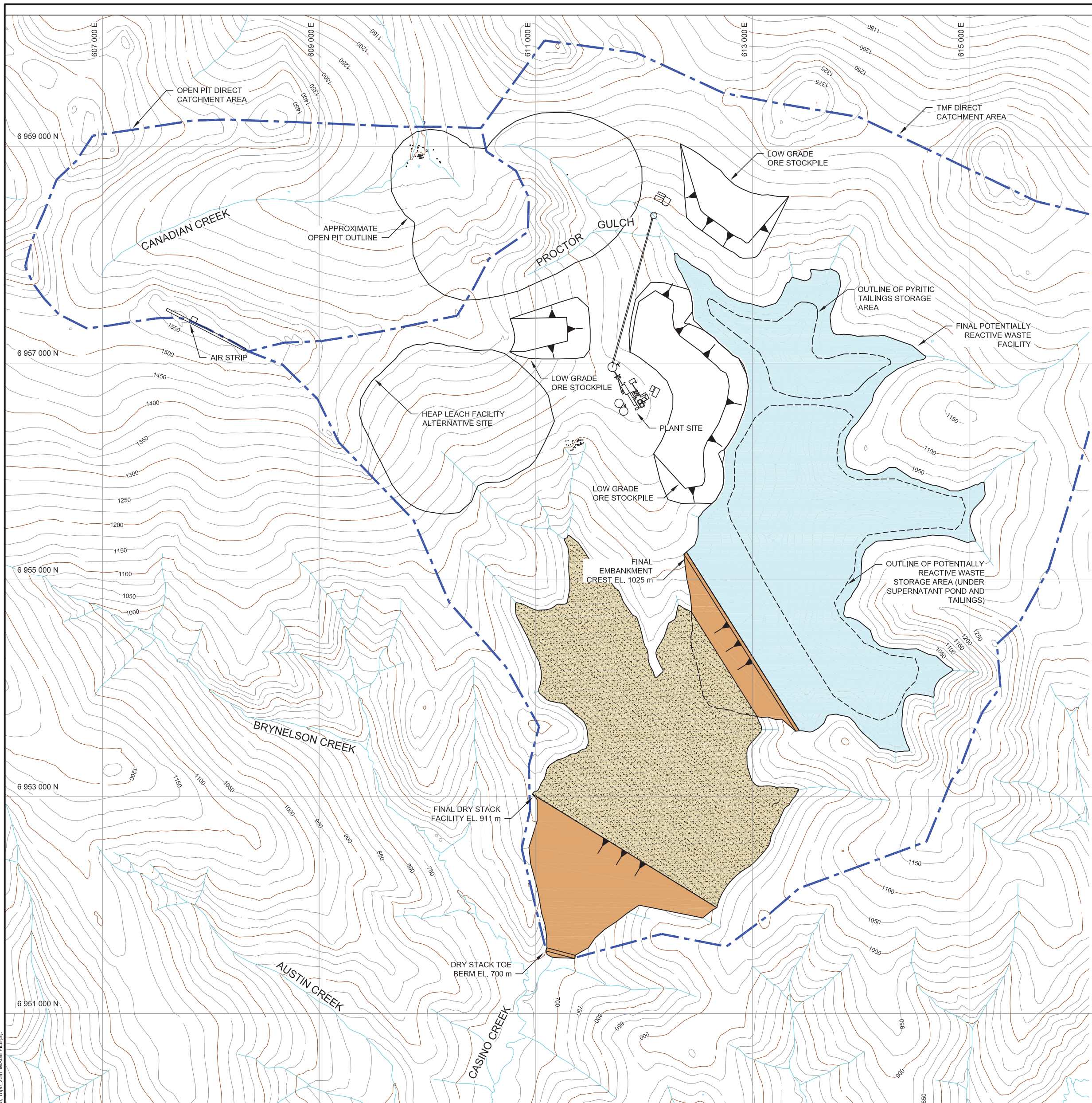
Dry stack tailings facilities by nature are expected to have little seepage, but this may not be the experience in practice. Seepage controls have been required at La Coipa Mine in Chile, the Mineral Hill Mine in Montana and the Raglan Mine in Quebec. At Greens Creek Mine in Alaska, a continuous addition of organic carbon to the tailings is required to assure their long-term chemical stability in order to meet water quality requirements.

The cold climate at the Casino site will present challenges during winter operations, including the need to prevent snow or ice accumulations on the tailings dry stack. Dust emissions from the dewatered tailings surface will be difficult to manage during dry spells, particularly if there is strong wind exposure. Windblown dusting can worsen in winter months, as freeze-drying and other frost processes can loosen the tailings surface. The moderately wet climate may cause problems during the summer months, as excessive moisture addition can result in rapid degradation of trafficability and prevent adequate compaction.

The filtered tailings stack would be susceptible to instability, due to any residual ice lenses or localized liquefaction, if the pile becomes saturated due to rainfall, snow entrainment or percolation from runoff. The risk of embankment stability issues is also high for the PR waste facility due to the need to provide subaqueous storage for the entire impoundment surface, resulting in a water pond immediately upstream of the embankment (no tailings beach).

The above issues will be exacerbated by the need to produce a consistent dewatered tailings product that satisfies performance requirements for a large tonnage, high production rate (100,000 tpd) operation.

The dewatered tailings option incorporates filtered tailings production technologies and delivery systems that are without precedent for the scale of operation anticipated for the Casino project, particularly for the cold winter conditions experienced at the site. Therefore, there are inherent risks in proceeding with this technology for the Casino project, unless appropriate contingency measures are incorporated in the mine waste management plan.



NOTES:

1. COORDINATE GRID IS UTM (WGS84/NAD83) ZONE 7 (m).
2. CONTOUR INTERVAL IS 25 METRES.
3. DIMENSIONS ARE IN METRES UNLESS NOTED.
4. PLANT SITE AND CRUSHER LAYOUT PROVIDED BY M3ENGINEERING AND TECHNOLOGY CORPORATION (APRIL 9, 2008).

SCALE A: 400 200 0 400 800 1200 1600 2000 m

WESTERN COPPER CORPORATION

CASINO COPPER-GOLD PROJECT

DEWATERED TAILINGS OPTION GENERAL ARRANGEMENT

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA101-325/3	2

Figure 4-10 — REV 0

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	CHK'D	APP'D
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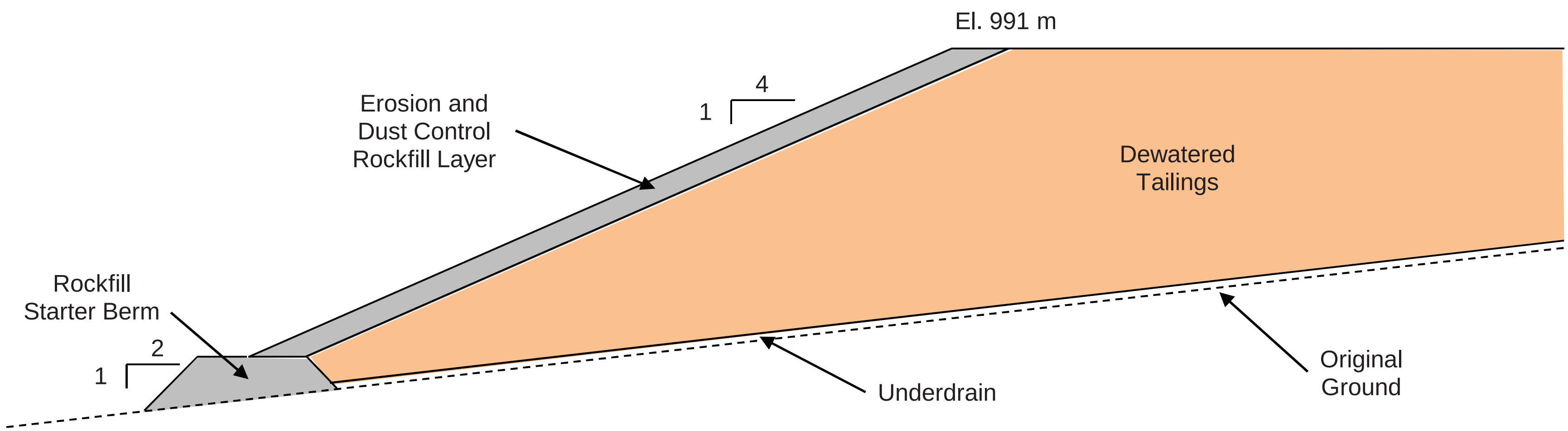

WESTERN COPPER CORPORATION

CASINO COPPER-GOLD PROJECT

DEWATERED TAILINGS OPTION
DRY STACK FACILITY
TYPICAL SECTION

Knight Piésold CONSULTING

P/A NO. VA101-325/3

REF. NO. 2

Figure 4-11

REV 0

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
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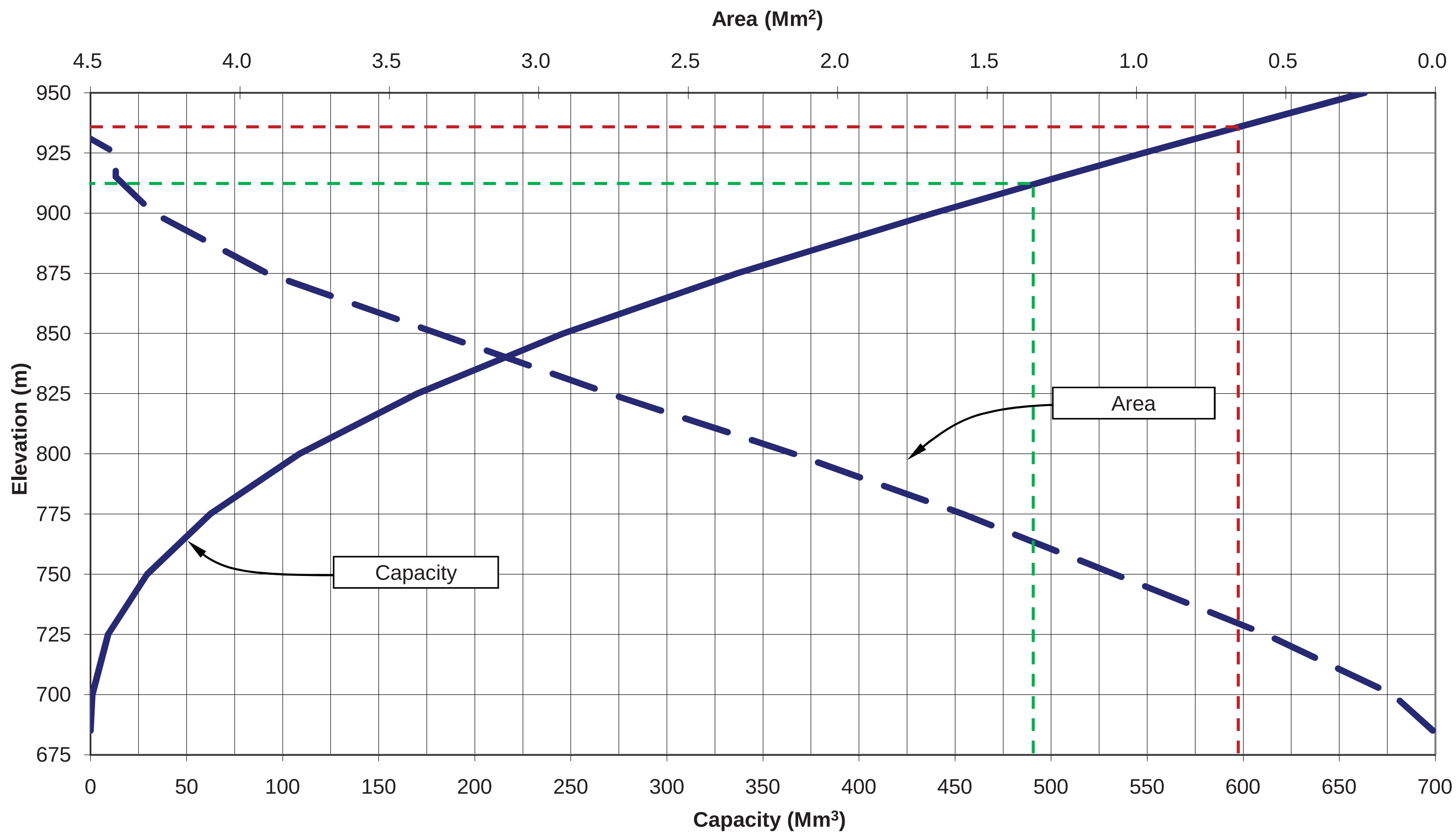


NOTES:

1. TAILINGS STORAGE VOLUME = 487.2 Mm^3.
2. EXPANDED CASE: TAILINGS STORAGE VOLUME = 596.4 Mm^3.

0	03MAY'10	ISSUED WITH REPORT	AG	GRG	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

WESTERN COPPER CORPORATION

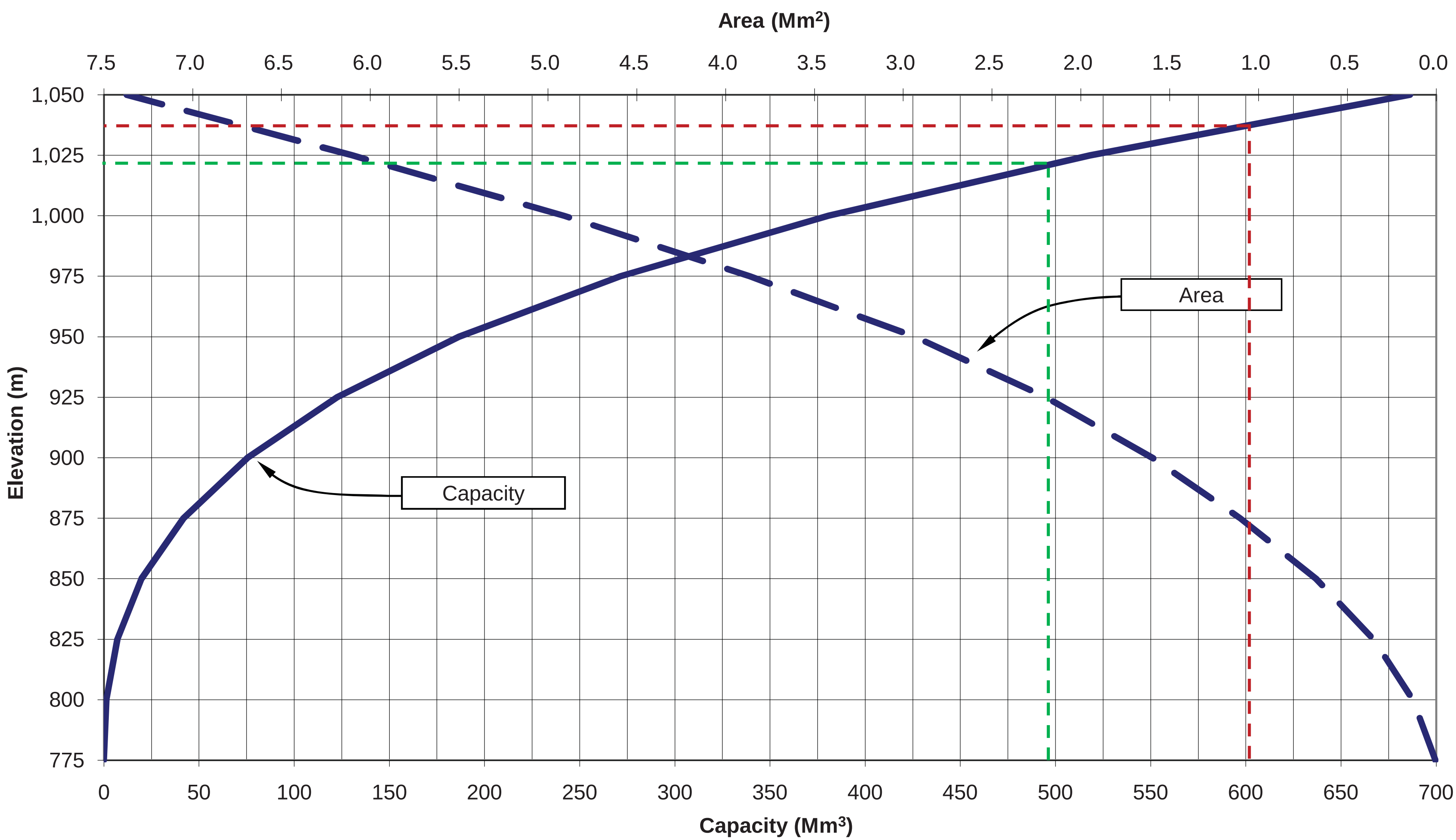
CASINO COPPER-GOLD PROJECT

DEWATERED TAILINGS OPTION
DRY STACK FACILITY
DEPTH-AREA-CAPACITY RELATIONSHIP

Knight Piésold CONSULTING

PROJECT / ASSIGNMENT NO.	REF NO.
VA101-325/3	2

Figure 4-12 REV. 0



NOTES:

1. TAILINGS PLUS PAG AND ML WASTE MATERIAL STORAGE VOLUME = 492.7 Mm^3.
2. EXPANDED CASE: TAILINGS PLUS PAG AND ML WASTE MATERIAL STORAGE VOLUME = 603.9 Mm^3.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	19MAY'10	ISSUED WITH REPORT	AG	GRG	KJB

WESTERN COPPER CORPORATION

CASINO COPPER-GOLD PROJECT

DEWATERED TAILINGS OPTION
POTENTIALLY REACTIVE WASTE FACILITY
DEPTH-AREA-CAPACITY RELATIONSHIP

Knight Piésold CONSULTING

PROJECT / ASSIGNMENT NO. VA101-325/3

REF NO. 2

Figure 4-13

REV. 0

4.4 MANAGEMENT ALTERNATIVES ASSESSMENT

A comparative scoping level evaluation has been carried out for the four TMF options described above. The potential advantages and short-comings of each TMF option have been examined, including consideration of construction and operating factors for a large scale mine waste management plan in cold climate conditions. The preferred TMF option will be that which is best suited to the site-specific circumstances and requirements. No “one size fits all” solution is available to address every particular and unique environmental, design and operational issue. The chosen option will aim to apply the best available and most appropriate technology, with a commitment to best management practices and cost effectiveness.

Primary design and operating, environmental, and economic considerations for the TMF options are discussed below.

4.4.1 Technical Considerations

Design and operating considerations include adapting to inevitable changes and variability in the mill throughput (production rate and material composition); embankment stability requirements, construction material availability and suitability, TMF seepage control, tailings handling and delivery, pipeline and pumping systems reliability, flexibility and redundancy, tailings deposition and reclaim water management, water management, and closure requirements.

4.4.1.1 Operational Complexity

The water management system for the cycloned sand and dry stack options will be more complex than that required for a conventional tailings management system as utilised for the option using local borrow materials for embankment construction. Two reclaim water systems are required to provide mill process water and feed water for the cycloned sand plant. Also, two mine waste facilities (dry stack and PR waste facility) with very different design and operating requirements are required for the dewatered tailings option.

A TMF that utilises local borrow materials for embankment construction will require a significant quantity of suitable rock/earthfill material that is characterised as non-potentially acid generating and does not exhibit metal leaching potential. Potential locations to source this material are currently not defined.

Placement of embankment fill during the winter months using local borrow (rockfill) materials will be less challenging compared to the other two TMF options. Embankment construction using local borrow materials can be performed year round, although the efficiency of construction operations will likely be less during the winter months. Cyclone sand production and placement may be limited to about 9 months of the year, due to the cold winter climate at the Casino site. Bulk tailings discharge into the TMF will be required during any cessation in cyclone sand production. The availability of cyclone sand for embankment construction is dependent on a number of factors and may not meet embankment construction material requirements at certain times during operations. However, shortfalls in sand production can be balanced with suitable (geochemically innocuous) rockfill from open pit stripping and/or from local borrow sources or quarry.

However, it may be necessary to utilize earth/rockfill materials in the initial years of operations to accommodate any shortfall of cyclone sand availability for construction of staged embankment expansions. Embankment staging, sand cell construction sequencing and integration with rockfill placement schedules (if required) will need to be examined in more detail for future design studies. Suitable earth/rockfill materials may also be required to provide erosion protection and minimise dusting for the cyclone sand embankment, and to satisfy embankment stability requirements. Use of cyclone sand as embankment fill reduces the amount of solids that are stored within the TMF by a volume roughly equivalent to the volume of sand used for construction. This allows for either additional storage capacity or a reduced embankment height.

The potential benefits of thickened tailings (such as smaller tailings facility footprint, lower embankment dam) would be minor, and would likely be outweighed by the higher capital, operating and maintenance costs and increased operational complexity likely to be associated with a dewatered tailings system at this project site.

The dewatered tailings option requires two individually managed facilities, both of which will have their own operating requirements and challenges. The need to operate two facilities will only add to the complexity of the mine waste management plan. All of the design and operating issues identified with the use of local borrow materials for embankment construction will also apply to the PR waste facility.

4.4.1.2 Geotechnical Stability

The static and seismic stability of the confining embankments is an important consideration for each of the TMF options, due to the large dam heights required. The TMF option that utilises local borrow for embankment construction requires a final embankment exceeding 300 m in height. A final embankment height of 286 m is required for the cyclone sand option. Although the dewatered tailings option requires a lower final embankment height (about 280 m), the stability and integrity of the dry stack and PR waste facilities will likely have a higher risk of potential issues associated with embankment stability and integrity.

The use of cyclone sand fill in embankment construction provides a corresponding reduction in impoundment storage requirements, resulting in a reduced embankment height. The final embankment for the cyclone sand option is approximately 18 metres lower than the TMF option using only local borrow (rockfill) materials. This is relatively minor given the large quantity of sand tailings that will be utilised in embankment construction, but is due to the storage characteristics of the TMF in the later years of operations (large storage capacity increase for a small increase in TMF height).

4.4.1.3 Geochemical Characteristics

Tailings and waste rock produced at the Casino mine must be subaqueously disposed of in a tailings management facility. Sub-aqueous disposal will prevent sulphide oxidation in mine waste and is considered geochemically favorable compared to disposal in an unsaturated environment. All four disposal options would require long-term subaqueous disposal of the PAG tailings and waste rock behind a geotechnically sound dam. The cyclone sand option would require a smaller dam as the NAG tailings could be used in the construction of the dam itself, thereby reducing the volume of material required to be stored in the impoundment.

The use of dewatered tailings is unlikely to change the general design requirements for the TMF at the Casino project. The facility would still need to provide a confining embankment, storage for water management (surplus), accommodate storm water flows, as well as maintaining an appropriate water cover over potentially reactive mine waste materials (to inhibit oxidation) placed into the TMF for co-disposal.

A dry stack facility could store the majority of the NAG tailings and would require significantly less material for the confining embankments, compared to disposal by conventional tailings slurry discharge. However, a separate facility is still required to provide subaqueous storage and confinement of potentially reactive waste rock (PAG and ML) and pyritic tailings, and to provide a facility for water management (including recovery to the mill) and contingency storage for those periods when the dry stack facility or dewatering plant is not operational. Pyritic tailings (assumed to be approximately 20% of the total tailings) and all PAG and ML waste rock will be deposited within a Potentially Reactive (PR) waste facility located in the Casino Creek valley south-east from the Open Pit.

4.4.2 Environmental Considerations

Selection of a preferred mine waste management option requires consideration of several environmental factors, including (from Journeaux Assoc., 2012):

- Sub-catchment area;
- Footprint area;
- Potential for generating dust;
- Potential for acid rock drainage and metal leaching;
- Potential for seepage to impact groundwater;
- Potential for geotechnical hazards (includes consideration of foundation conditions, impact of seismicity and height of structure);
- Aquatic habitat loss;
- Visual impact;
- Terrestrial wildlife habitat loss (song birds, water fowl and terrestrial mammals);
- Aquatic wildlife habitat loss (water fowl); and
- Impact on fish and fish habitat.

For the mine waste management options presented in this study, the cyclone sand option has the smallest footprint within the Casino Creek valley. The TMF embankment constructed of local borrow materials will create an impoundment only slightly larger than the cyclone sand option. However, it will also include a large disturbance area outside of the TMF associated with the large borrow area(s) required to provide sufficient rockfill material. The dewatered tailings dry stack facility and adjacent PR waste facility will create the largest disturbance area. The dry stack option also has the largest direct catchment area and will likely have the largest impact on water resources.

Impacts to air quality related to dusting due to construction traffic and windblown sand from the tailings embankments will be higher for the cyclone sand and tailings dry stack facilities. Appropriate provisions to manage dusting will be required for these two options.

4.4.3 Socio-Economic Considerations

Many of the environmental considerations noted above are also socio-economic considerations. Potential environmental effects have a direct impact on local communities and on the lives of those who live in those communities. For example, the TMF footprint area affects use and enjoyment of land during and after operations. Also, the potential for loss of aquatic and terrestrial wildlife affects the way of life for people in local communities.

4.4.4 Economic Considerations

Preliminary order of magnitude initial capital, sustaining capital and operating costs, including costs for material preparation, transport and placement, have been prepared to facilitate a comparative economic assessment of the three TMF options (economic evaluation not conducted for the thickened tailings option). The economic evaluation considers capital and operating costs associated with storage of tailings and waste rock for the full mine life. A summary of the estimated capital and operating costs for the three TMF options is provided in Table 4-2.

Table 4-2: Summary of Initial Capital, Sustaining Capital and Operating Costs (in Million $CAD)

TMF Option	Initial Capital Cost	Sustaining Capital Cost	Operating Cost	Total Cost
Local Borrow	82	1,009	139	1,230
Cyclone Sand	101	597	263	961
Dewatered Tailings	265	1,822	902	2,988

The cycloned sand and dewatered tailings (dry stack) options have larger initial capital costs compared to the option using only local borrow material for embankment construction. The initial capital cost for the cyclone sand option is approximately $20 million more than the local borrow materials option. This is primarily due to the high initial capital costs associated with construction of a cyclone sand plant and associated infrastructure. The initial capital cost for the dewatered tailings option is approximately three times greater than the local borrow materials option and cyclone sand option. High initial capital costs for the dewatered tailings option are associated with the tailings dewatering (filtration) plant, tailings transportation (conveyor/truck delivery system) and provision of a PR waste facility to accommodate subaqueous disposal of PAG and ML waste material and pyritic tailings.

The local borrow materials and dewatered tailings options have significantly larger sustaining capital costs compared to the cyclone sand option. The sustaining capital cost for the cyclone sand option is approximately $410 million less than the local borrow materials option and approximately $1,225 million less than the dry stack option. This is primarily due to the lower unit rate of fill material used for embankment construction. The local borrow materials option has the smallest operating cost of the three options due to lower power requirements.

The use of cyclone sand for TMF embankment construction has the potential to utilize approximately 220 million tonnes of tailings sand which will displace 275 million tonnes of rockfill from within the embankments. The total savings associated with the use of cyclone sand over locally quarried rockfill is in the order of $270 million over the operating life of the facility.

Closure Costs

The local borrow material and cyclone sand dam options would be comparable in terms of closure costs to sustain the water cover in the impoundment, and to provide long-term monitoring and maintenance of the dam. However, the local borrow material would require a larger dam (303 m vs. 286 m) and would require upwards of 105 million m^3 of borrow material. This borrow excavation would require substantial reclamation, thereby increasing the closure costs of the borrow material dam option well above those of the cyclone sand dam option.

The dewatered tailings option would require two dams: one for storage of potentially reactive material 280 m high, and the other for containment of the dry stack tailings, 226 m high. Therefore, the closure costs of the dewatered tailings option would be equal those for the cyclone sand dam option *plus* the costs for closure of the dry stack tailings.

Therefore, the cyclone sand dam option has significantly lower costs for closure than the local borrow material or the dewatered tailings disposal options.

4.5 SELECTION OF MANAGEMENT OPTION

Based on the discussion above, the four options have been ranked with values of 1 through 4, to determine the most appropriate selection. Where there is no difference in the option used, a “-“ symbol is used to signify “equal”.

Option	**Slurried Tailings Borrow Material Dam**	**Slurried Tailings Cyclone Sand Dam**	**Paste Tailings**	**Filtered Tailings (Dry Stack)**
Consideration	**Weighting**			
Technical				
Operational Complexity	4	3	1	1
Geotechnical Stability	4	4	4	1
Geochemical	4	4	4	3

characteristics				
Environmental				
Potential for seepage	2	2	3	3
Area of disturbance	3	4	3	1
Air Quality	4	2	4	2
Visual impact	-	-	-	-
Terrestrial wildlife habitat loss	-	-	-	-
Impact on fish and fish habitat.	-	-	-	-
Economic	2	4	n/a	1
TOTAL	***19***	***23***	***19***	***12***

The dewatered tailings option incorporates filtered tailings production technologies and delivery systems that are without precedent for the scale of operation anticipated for the Casino project, particularly for the cold winter conditions experienced at the site. Therefore, there are inherent risks in proceeding with this technology for the Casino project, unless appropriate contingency measures are incorporated in the mine waste management plan.

The paste tailings option has increased operational complexity, with increased likelihood of periodic upset conditions increases, and more complex tailings handling and disposal systems, the potential for mill shutdown or spillage may be significantly greater than for conventional slurry tailings disposal. Also, the use of dewatered tailings is unlikely to change the general design requirements for the TMF. The facility would still need to provide a confining embankment, storage for water management (surplus), accommodate storm water flows, as well as maintaining an appropriate water cover over potentially reactive mine waste materials (to inhibit oxidation) placed into the TMF for co-disposal.

The option for constructing a dam from local borrow material was ranked equally to the paste tailings options, however, is technically comparable to the cyclone sand dam option. However, preliminary evaluation of borrow availability indicates that to acquire borrow in sufficient quantities to build the embankment entirely of borrow would require excessive disturbance and movement of materials.

Therefore, the comparative assessment indicates that the use of cyclone sand for embankment construction is the preferred option. It provides low operational complexity and controllable geotechnical conditions given the project's location and water conditions, while incurring the least disturbance to the environment.

5 WASTE MANAGEMENT STORAGE SITES

5.1 OBJECTIVES AND ASSUMPTIONS

Following the above determination of preferred mine waste management strategy, a number of TMF locations were evaluated. The evaluation consists of a screening level screening and a detailed evaluation level assessment, detailed below. The development of options initially considered for the project encompasses a larger number of potential waste storage locations than that included the formal evaluation. These locations are termed *potential storage sites* rather than *options*. Those sites that were not excluded at the screening level were developed in greater detailed and termed waste management location options. Both screening level and detailed evaluation results are described herein as:

1. Scoping level identification and screening of potential storage sites; and
2. Detailed development and assessment of selected waste management location options.

5.2 SCOPING LEVEL SCREENING

All potential storage sites are shown on Figure 5-1 and summarized in Table 5-1. The threshold criteria used to scope these sites included the following:

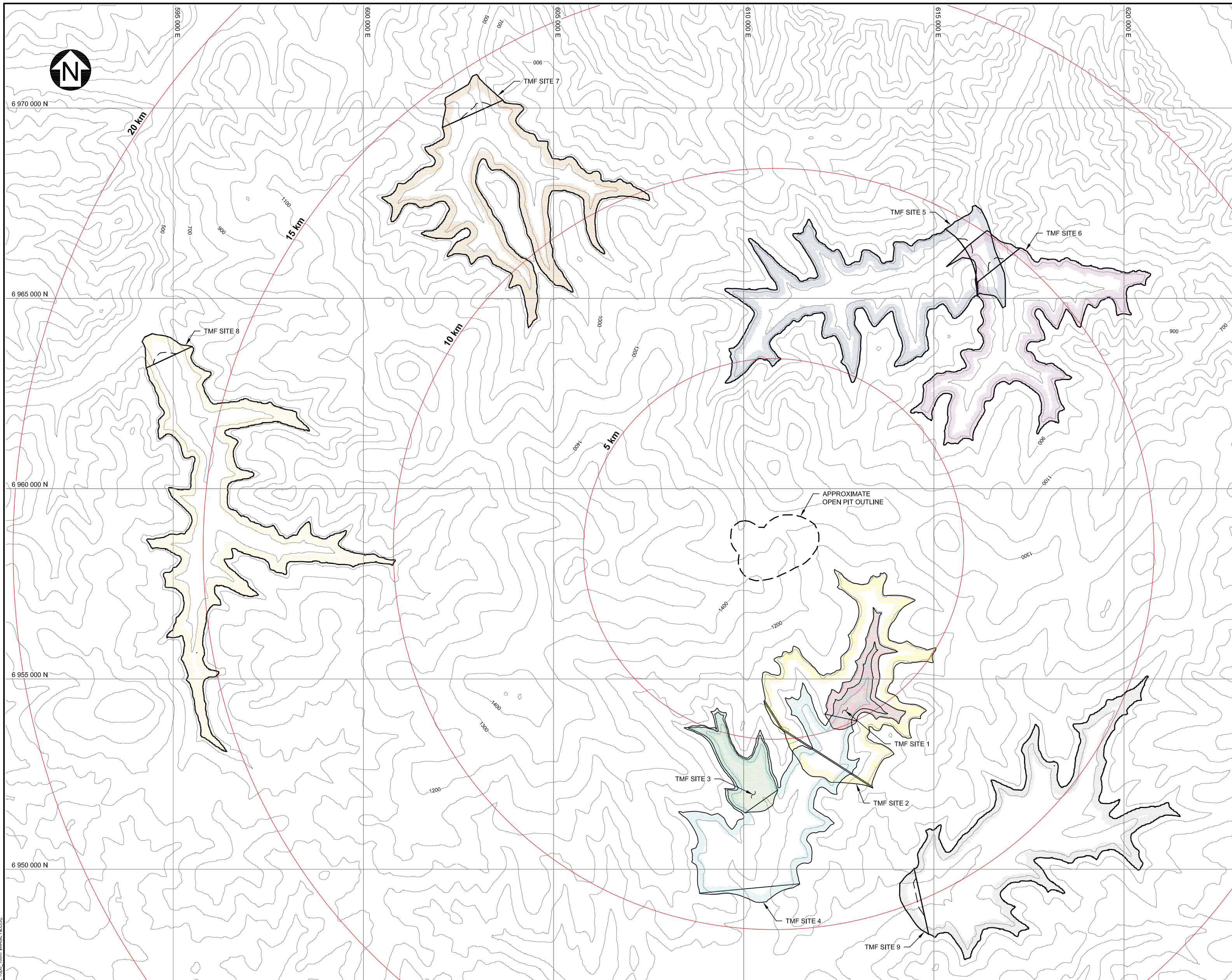
- Sites were within 20 km radial distance from the deposit area;
- Sites would have sufficient capacity (956 Mt of tailings and up to 685 Mt of waste rock); and
- Only considered conventional tailings slurry deposition as anticipated production rates are in excess of what could be managed via dry stack alternatives (as per Section 4 above).

Pre-screening of these potential storage sites was done via a set of specific questions including as summarized in Table 5-2 below.

Table 5-1: Summary of Scoping Level TMF Sites

<table>
<tr><th>Site</th><th>Construction Approach</th><th>Operational Approach</th><th>Closure Approach</th></tr>
<tr><td>Site 1</td><td>Construction of starter dam, diversions around facility for clean run-off. Insufficient capacity as TMF, possibly useful for scenario with multiple sites</td><td>Sub-aqueous deposition of PAG tailings, raises constructed of cyclone sand, overflow to beach, water deficit, so no discharge, capacity insufficient for waste rock storage.</td><td>Water cover over PAG tailings, dry cover on beach, waste rock storage elsewhere would require appropriate closure measures.</td></tr>
<tr><td>Site 2</td><td>Construction of starter dam, diversions around facility for clean run-off.</td><td>Sub-aqueous deposition of PAG tailings, raises constructed of cyclone sand, overflow to beach, sub-aqueous deposition of waste rock, water deficit anticipated, so make-up water likely required.</td><td>Dry cover over beach area, water cover over PAG tailings and waste rock.</td></tr>
<tr><td>Site 3</td><td colspan="3">Insufficient capacity as TMF but potential water supply dam or as scenario with multiple dams.</td></tr>
<tr><td>Site 4</td><td>Construction of starter dam, may include significant foundation prep work, diversions around facility for clean run-off.</td><td rowspan="6">Sub-aqueous deposition of PAG tailings and waste rock, dam raises use cyclone sand with NAG overflow to beach, water surplus anticipated, so discharge likely required.</td><td rowspan="6">Dry cover over beach area, water cover over PAG tailings and waste rock.</td></tr>
<tr><td>Site 5</td><td rowspan="5">Construction of starter dam, diversions around facility for clean run-off.</td></tr>
<tr><td>Site 6</td></tr>
<tr><td>Site 7</td></tr>
<tr><td>Site 8</td></tr>
<tr><td>Site 9</td></tr>
<tr><td>Multiple Sites[1]</td><td>Construction of 3 starter dams in the upper reaches of Casino Creek, Austin Creek and Brynelson Creek with associated water diversions</td><td>Storage of tailings in one facility and waste rock in 2 other facilities. Only the tailings facility would have raises constructed by cyclone sand, the other facilities would require rockfill or borrow material</td><td>A combination of water and dry covers on 3 facilities.</td></tr>
</table>

1. The alternative for more than one facility is included to allow for waste storage in the upper reaches of watersheds to clearly avoid areas frequented by fish, 3 facilities would be required to meet capacity needs.



REV	DATE	DESCRIPTION	DESIGNED	DRAWN	CHK'D	APP'D
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NOTES:

1. COORDINATE GRID IS UTM (WGS84/NAD83) ZONE 7 (m).
2. CONTOUR INTERVAL IS 100 METRES.
3. DIMENSIONS AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.

SCALE A 1 0.5 0 1 2 3 4 5 km

WESTERN COPPER CORPORATION

CASINO COPPER-GOLD PROJECT

ALTERNATIVE TAILINGS MANAGEMENT FACILITY SITES

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA101-325/3	VA10-01163

Figure 5-1

REV 0

Table 5-2: Pre-Screening Assessment

Criteria	Rationale	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Multiple Sites
Would the TMF have sufficient capacity?	It is preferable to have one TMF location except for specific rationale as in the case of our Multiple Sites option	NO	YES	NO	YES	YES	YES	YES	YES	YES	YES
Would the TMF have expansion potential?	In the case of project expansion important to understand if another facility would be required?	NO	YES	NO	YES	YES	YES	YES	YES	YES	NO
Would the TMF avoid sensitive fish habitat?	It is preferable to the extent possible to avoid sensitive fish habitat.	YES	YES	YES	YES	YES	NO	NO	NO	NO	YES
If greater than ~10 km from the deposit, would the TMF provide advantages that do not exist at sites closer to the deposit?	Sites located within 10 km of the deposit are preferable to those at greater distances unless there is a particular advantage with greater distance	-	-	-	-	-	NO	NO	NO	NO	-
Should the site be excluded from further assessment?		YES	NO	YES	NO	NO	YES	YES	YES	YES	NO

5.3 DEVELOPMENT AND ASSESSMENT OF POTENTIAL OPTIONS

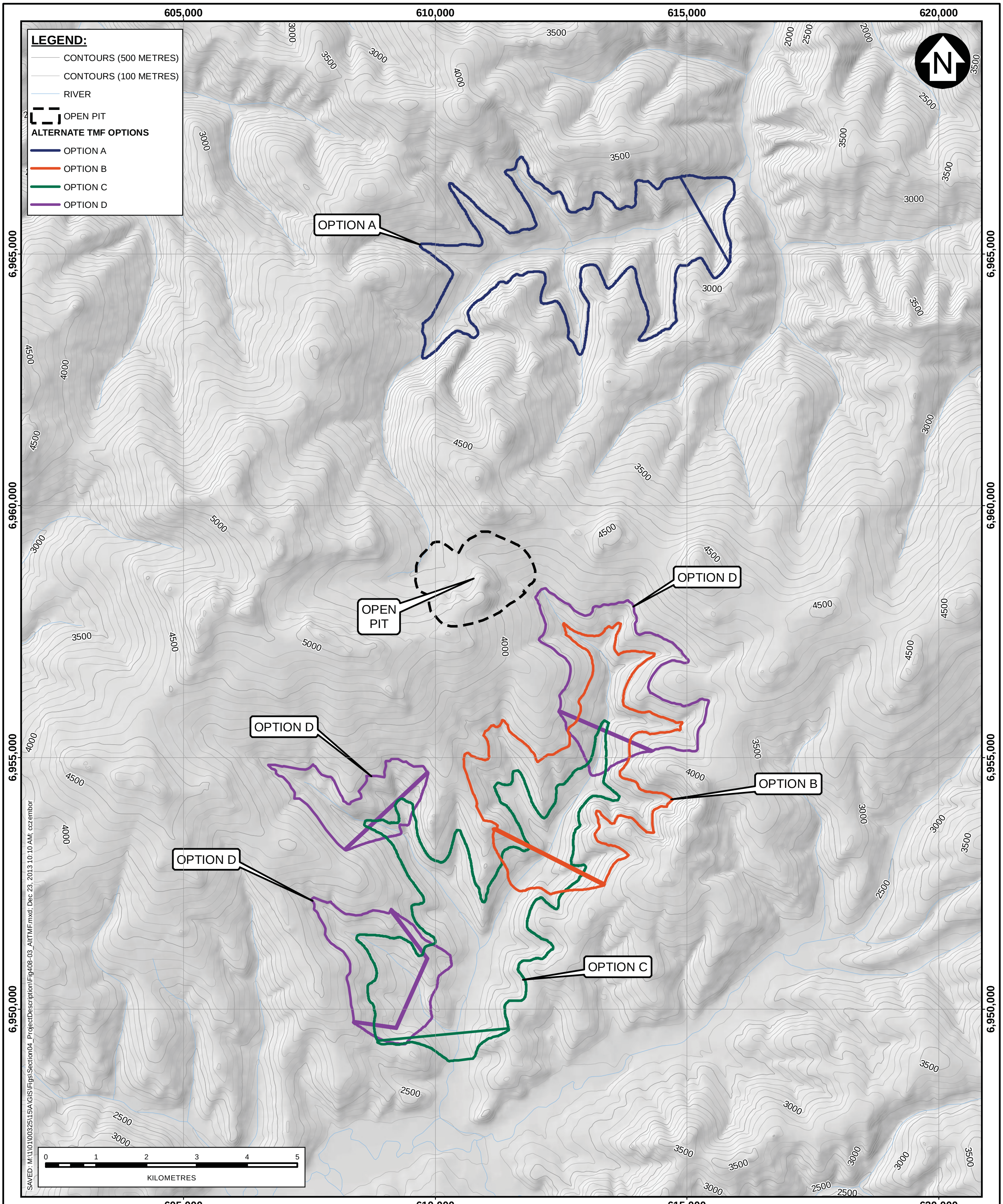
Those sites that were not fatally flawed in the pre-screening evaluation were carried forward into a more detailed assessment. These sites have been structured into the potential Options shown on Figure 2. Potential Options have been given a letter designation so as to differentiate them from the numbered sites from scoping and pre-screening. Labeling starts with the northern-most location and goes southward and include:

- Option A: Canadian Creek location (pre-screening site #5), shown in Figure 5-3. Option A includes a TMF dam located within Canadian Creek just above the confluence with Britannia Creek which drains to the Yukon River located approximately 7 km from the toe of the dam. The facility has capacity to place all tailings and waste rock in a subaqueous environment.

- Option B: Upper Casino Creek (pre-screening site #2) as shown in Figure 5-4. Option B represents the most compact footprint for the overall project. Capacity is sufficient to store all the tailings with underwater disposal of waste rock. Other facilities such as the heap leach facility would drain towards the TMF facility.

- Option C: Lower Casino Creek (pre-screening site #4) shown in Figure 5-5. Option C is located approximately 5 km further downstream from the Option B configuration. This option would provide for sufficient capacity for all tailings and subaqueous disposal of waste rock. As in the Option B configuration, the other facilities such as the heap leach facility would drain towards the Option C impoundment.
- Option D: Option D (pre-screening site “Multiple Sites”) combines a number of sites with the objective of keeping all waste well above any areas frequented by fish. Because of topographic challenges with this approach, three locations are required to provide for the needed capacity (Figure 5-6) located in Upper Casino, Upper Brynelson and Upper Meloy drainages. Option D was developed to clearly avoid areas frequented by fish. In order to accomplish this objective, multiple sites would be required, each located in the upper reaches of three watersheds, namely Casino Creek, Meloy Creek and Brynelson Creek. The non-acid generating tailings would be stored in the Casino Creek facility while waste rock and the potentially acid generating tailings would be stored in the other two facilities.

Table 5-3 provides for some of the engineering characteristics of these potential options.



PREPARED BY:

Knight Piésold
CONSULTING

DESIGNED	CC
DRAWN	CC
CHK'D	CAH
APP'D	KJB
REV	0
DATE	16DEC'13

NOTES:
1. BASE MAP: YUKON GOVERNMENT SHADED RELIEF, EAGLE MAPPING.
2. PROJECTION: NAD 1983 UTM ZONE 7N
3. COORDINATE GRID: METRES

CASINO

Potential TMF Option Locations

CASINO PROJECT

Figure 5-2

REF 1

P/A VA101-325/15

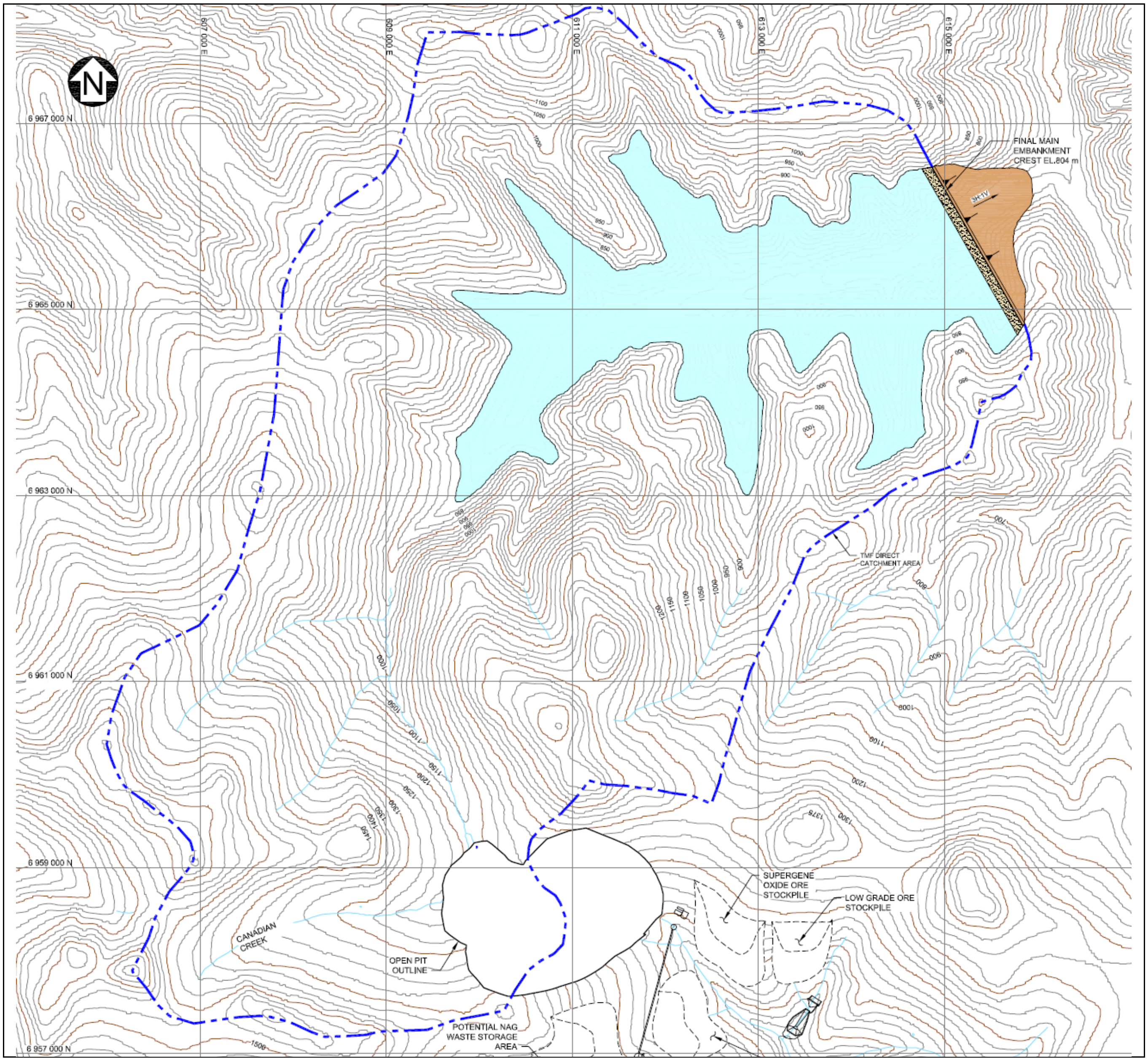


Figure 5-3: Option A: Canadian Creek (Site #5)

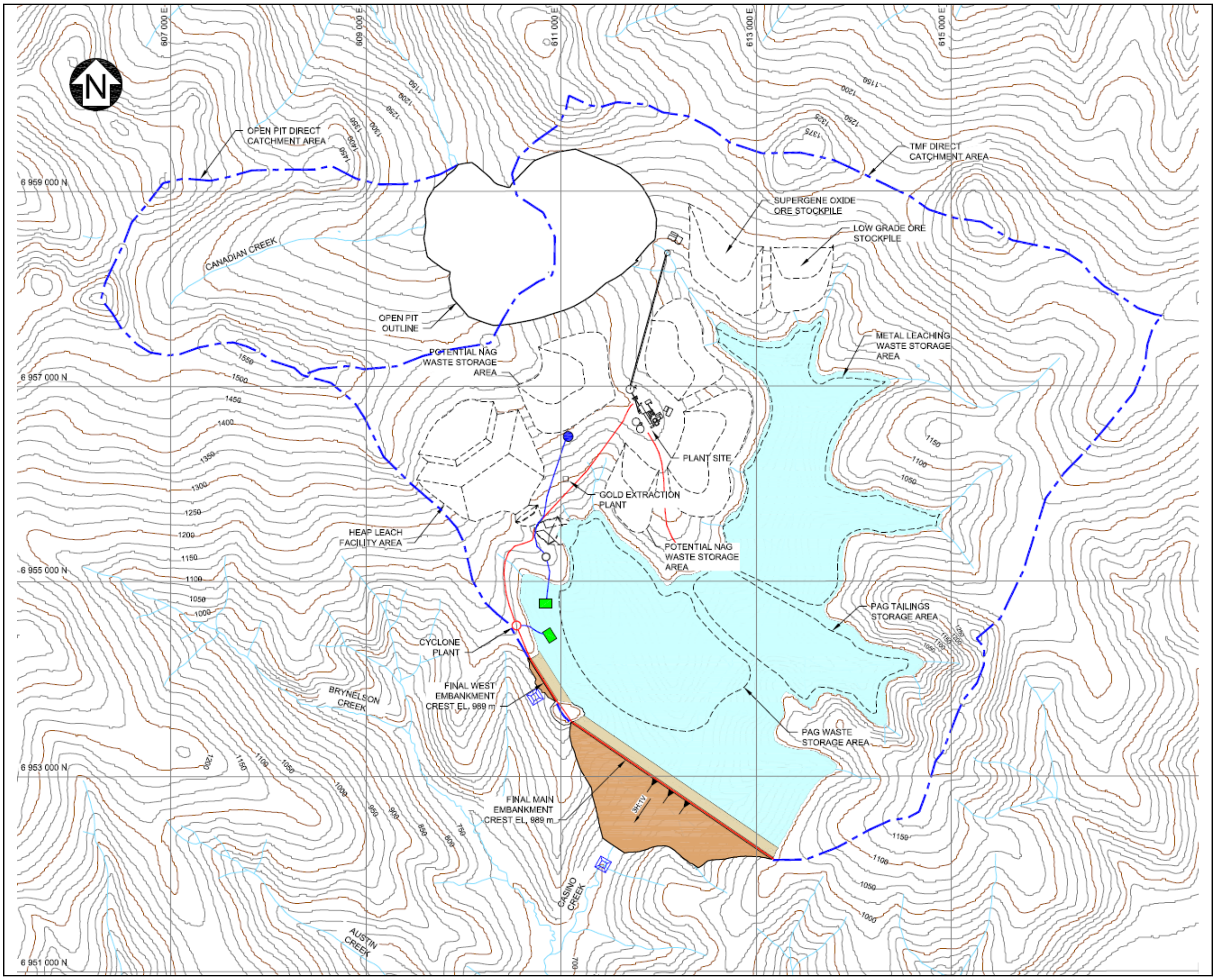


Figure 5-4: Option B: Upper Casino Creek (Site #2)

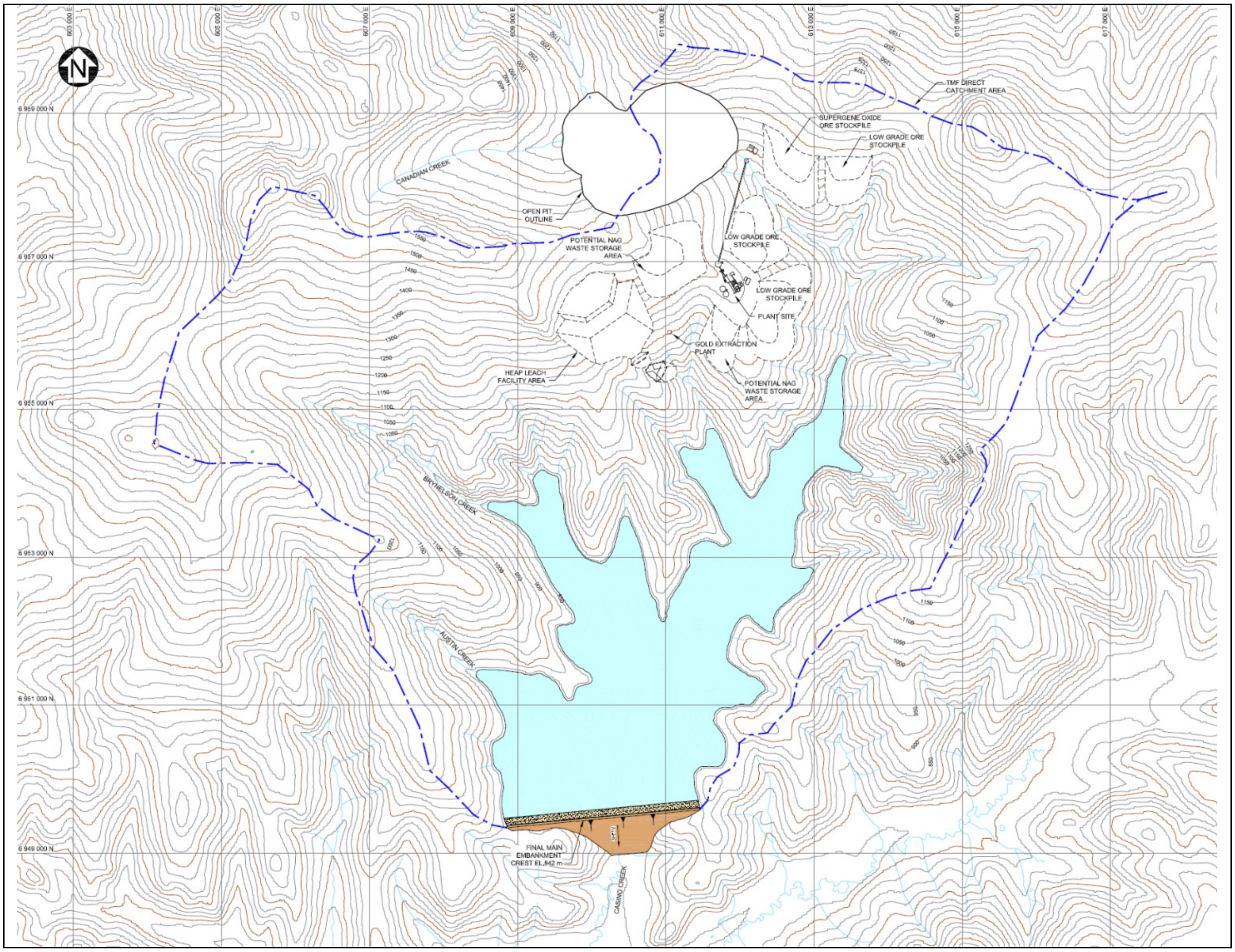


Figure 5-5: Option C: Lower Casino Creek (Site #4)

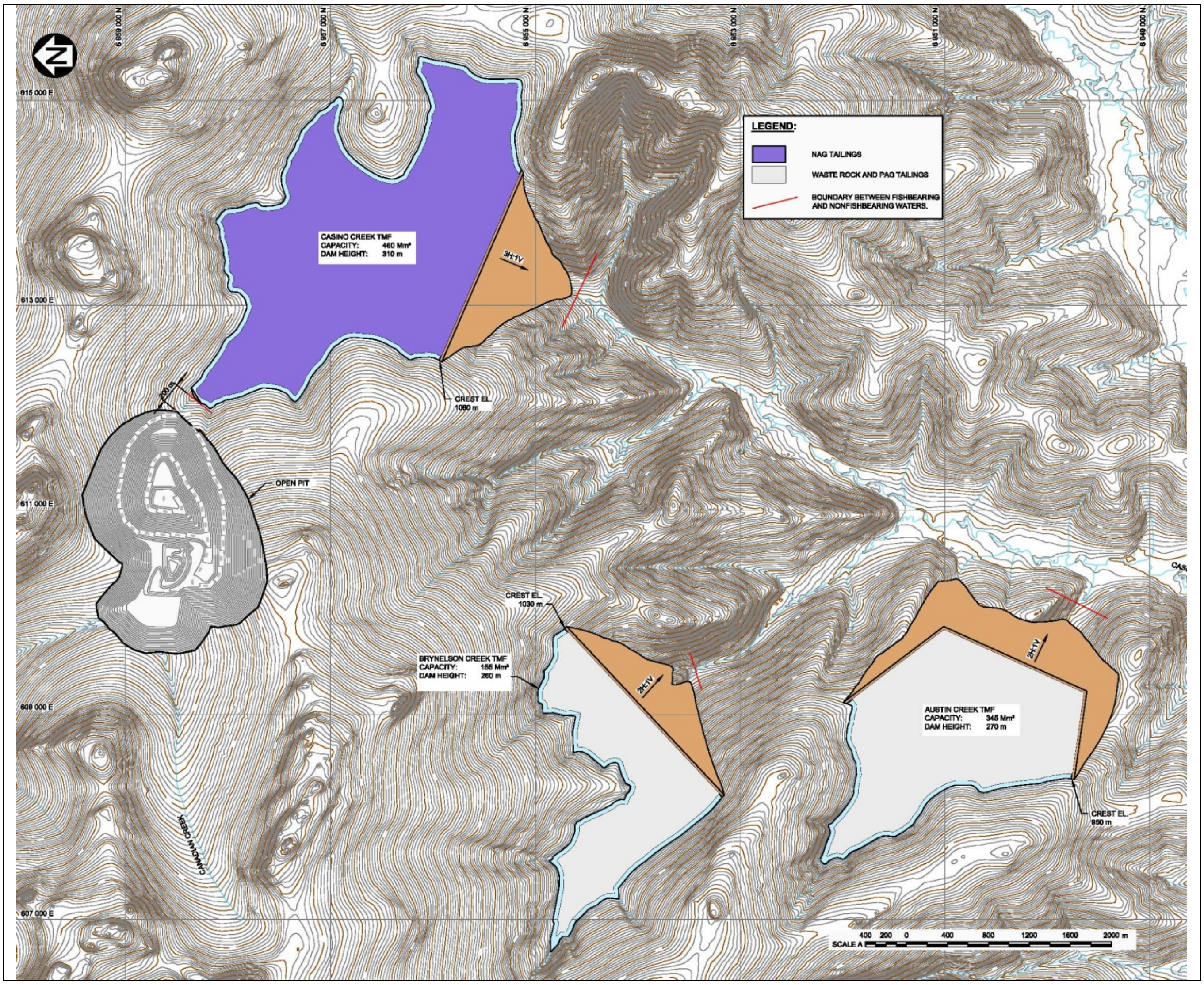


Figure 5-6: Option D: Upper Casino, Brynelson and Meloy Creeks (Site "Multiple Sites")

Table 5-3: Characteristics of Potential Options

Characterization Criteria	Rationale	Option A	Option B	Option C	Option D[1]
Maximum dam height (m)	In general higher dams may be slightly more complex, but all would be designed to meet guidelines provided by the Canadian Dam Association	284	286	192	300/270/260
Embankment volume (Mm^3)	Need to have sufficient cyclone sand for dam raises or borrow source	87	136	48	87/112/57 (256)
Embankment footprint (km^2)	An indication of the size of the facility	0.9	1.4	0.8	0.8/1.0/0.6 (2)
Impoundment storage volume (Mm^3)	An indication of the storage capacity and facility size	939.4	939.4	939.4	460/345/155 (960)
Impoundment footprint (km^2)	A measure of the facility size	10.2	9.8	13.0	5.8/3.1/2.2 (11)
Dam foundation conditions	An indication of potential complexity for foundation preparation work	Moderate to poor	Moderate to poor	Moderate to poor	Moderate to poor
Distance for road/pipeline alignment to dam (km)	Reflection of piping distance, access roads etc.	10	7	13	4.6/5.4/8.8 (18.8)
Catchment area (km^2)	Indication of water management issues	62	37	77	18.3/7.1/17.0 (42)
Total number of watersheds effected	There is a benefit to having all facilities in one single watershed	2	1	1	1
Operational water balance	An indication of whether discharge during operations is anticipated	Water surplus	Water deficit	Water surplus	Water surplus at times
Topography	The general topography consists of well-rounded ridges and hills with deeply incised drainages	Located in the upper reaches of the Britannia drainage, topography generally steep	Located in the upper reaches of Casino drainage, topography generally steep	Located in lower reaches of Casino drainage where valley flattens out.	Located in the upper reaches of three drainages, topography generally steep

Characterization Criteria	Rationale	Option A	Option B	Option C	Option D[1]
Climate	No significant differences in climate are expected for the options being considered other than potentially permafrost expectations (see below)	The climate in the Dawson Range is subarctic. Permafrost is widespread on north-facing slopes, and discontinuous on south-facing slopes. Annual precipitation is 500 mm with average temperatures of -2.7°C			
Permafrost	The area has discontinuous permafrost, in general northern slopes may have greater permafrost	Drainage faces northeast, permafrost on the northern slopes could be greater	Drains to the south, no significant northern slope component	Drains to the south, no significant northern slope component	Three separate facilities, but generally drain to the south
Atmospheric issues	Fugitive dust can be an issue with TMF facilities, since all options consider conventional slurry the effects are considered minimal	No significant dust effects expected other than potentially minor dust from tailings beaches.			
Geochemistry	Waste is expected to be substantially PAG in nature with some NAG or low PAG oxide rock that could have ML issues; rougher tailings expected to be NAG, cleaner tailings expected to be PAG	Waste management includes sub-aqueous disposal of all PAG waste rock and tailings			
Water quality	The ability to meet water quality objectives for any option is a key consideration	Good baseline water quality, significant dilution available downstream	Baseline water quality is poor, little dilution until lower Casino and Dip Creek	Baseline water quality is good, some dilution at Dip Creek	Baseline water quality is mixed, very little dilution until lower Casino and Dip Creek
Vegetation	Vegetation consists of black & white spruce forests with aspen and some lodgepole pine. Black spruce & paper birch on permafrost slopes. Scrub birch and willow form extensive stands in subalpine sections from valley bottoms to well above the tree line	No substantive differences between options expected			
Aquatic life and habitat	The ability to remain protective of aquatic life and habitat is a key consideration for all options	Frequented by fish	Possibly frequented by fish	Frequented by fish	Non-fish bearing

Characterization Criteria	Rationale	Option A	Option B	Option C	Option D[1]
Terrestrial and bird life and habitat	No significant differences expected for the options considered	Characteristic wildlife in the region includes caribou, grizzly and black bear, dall sheep, moose,beaver, fox, wolf, hare, raven, rock and willow ptarmigan, and golden eagle			
Archaeology	Record of archaeological sites considered within the evaluation	None	None	None	None
Mineral/commercial tenures					
First Nations issues		Located within the Selkirk First Nation Traditional Territory			
Perception	The anticipated over-arching perceptions about the options could influence decisions	Concerns about potential effect on the Yukon River	No concerns	Concerns about potential effects on fish	Concerns related to three large dam structures
Previous and existing land use	Will the option have an undue effect on existing or previous land uses in the immediate area	Placer mining activities in the area, exploration activities	Exploration activities, others?		
Aesthetics	Visibility of the site will be limited for any of the options	No aesthetic effect anticipated			
Human safety	Safety always held as paramount concern by mining companies, none of the options are considered ‘unsafe’	Dam designed as an extreme classification	Dam designed as an extreme classification	Dam designed as an extreme classification	Three dams designed as having extreme classifications

1. Values provided for Option D are for three individual dams Casino Creek/Meloy Creek/Brynelson Creek respectively with the sum of the three in brackets where appropriate

5.4 EVALUATION OF SELECTED OPTIONS

5.4.1 Technical Considerations

The technical account encompassed those aspects that are commonly included in the engineering assessments completed to select tailings facility locations. The sub-accounts and indicators were selected therefore in an effort to differentiate between the fundamental engineering considerations for the various options (e.g. capacity of the facility) and the geotechnical considerations that may be option-specific (e.g. foundation conditions). Many of the indicators of technical aspects of each option were quantifiable and are described individually in the sections to follow. A summary of the ranking results are provided in Table 5-4, and the ranking and weighting results are provided in Appendix A.

Table 5-4: Technical Considerations Ranking Results

Sub-Accounts	Indicators	Option A	Option B	Option C	Option D
		TIA+WR in Canadian Creek	TIA+WR in Casino Creek (Upper)	TIA+WR in Casino Creek (Lower)	TIA+WR avoiding areas frequented by fish
Dam Design	Impoundment storage volume	6	6	6	6
	Dam size and configuration	4	4	6	1
	Number of large dams required	6	6	6	4
	Total embankment volume	5	4	6	1
Operational Management	Impoundment footprint	5	6	2	4
	Operational ease - tailings	5	6	5	4
	Operational ease - waste rock	4	6	4	3
Construction	Geotechnical complexity	5	6	5	2
	Scheduling (construction)	5	4	6	1
Structural Stability	Stability considerations operations and long term	4	5	6	2
Permafrost	Permafrost sensitivity	6	6	6	6
Capacity	Expansion potential	4	4	6	2

5.4.1.1 Dam Design

The dam design sub-account was evaluated using indicators or measures of the physical nature of the tailings dams associated with each option as described below.

Impoundment storage volume

One of the design aspects for the potential options identified for the project was that each option would be able to store all the tailings and reactive waste rock. While all potential options meet this minimum requirement, there is benefit of having additional volume to accommodate potentially extended mine life, changed volume of waste rock resulting from changing metal prices and cut-off grades etc. Options A, B and C were all designed to have the same storage volume of ~940 Mm^3, while Option D would have a slightly higher cumulative storage volume of 960 Mm^3. This differential however was considered to be inconsequential and all options were considered to be equally ranked (i.e. the same) and given a scalar value of 6, i.e. all options would have the volume to meet the design basis for volume.

Dam size and configuration

The indicator selected to represent the dam size and configuration was dam height. In general, the higher the dam the slightly more complex the design; however dam design for all options would be conducted to meet the guidelines provided by the Canadian Dam Association (CDA) regardless of height. Options A and B which would both be located relatively high in their respective watersheds in tight valleys would have similar dam heights (284 and 287 m respectively). For the same volume, Option C which would be located lower in Casino Valley would be a lower, though longer dam (192 m) while Option D with three dams located high in three of the valleys would require a combined height of 960 m (460, 345 and 155m combined).

Number of large dams required

Typically the number of large dams considered for any one project is limited to the main tailings dam structure, i.e. does not include structures for seepage collection ponds etc. With the increased size of mining operations and the more common management practice of sub-aqueous disposal of waste rock the number of dams considered in feasible options is increasing. However, it remains more desirable not only on a cost basis, but on a technical basis to have only one large engineered structure that will require careful construction and on-going monitoring and maintenance well beyond the mine life. Options A, B and C require only one large dam, while Option D requires 3 large dams to be constructed.

Total embankment volume

The final indicator that used to describe dam characteristics was total embankment volume. This considered the amount of material required to construct the dam(s) in each option. This would consist of rock fill for the starter embankments and cyclone tailings sand for raises of the main dams. In the case of Option D, sufficient cyclone sand would only be available for the main tailings facility dam, and additional rock fill or borrow material would be required for the other two dams. The embankment volumes that would be required for Option A would be 87 Mm^3, for Option B would be 136 Mm^3, for Option C would be 48 Mm^3 and the cumulative volume required for Option D would be 256 Mm^3.

5.4.1.2 Operational Management

The operational management of each facility included in the evaluation was assessed using three indicators; the impoundment footprint, and the operational ease with which tailings and waste rock could be managed.

Impoundment footprint

The footprint of the entire facility each option was quantified by KP in their assessment of options. It was considered that the smaller the footprint of each facility, the better the option with the understanding that minimizing disturbed footprint is generally considered a best management practice in the industry. The areal footprint of the options in consideration did not vary significantly. Option A was calculated to have a footprint size of 10.2 km^2, Option B was 9.8 km^2, Option C was 13.0 km^2, and the combined footprint of the three facilities comprising Option D was 11.1 km^2.

Operational ease (tailings)

One of the fundamental considerations given to waste storage designs, though a difficult one to quantify, is the ease with which the facility can be operated. This encompasses a number of considerations including the distance from the open pit and mill to the waste storage facility, the anticipation of winter conditions, grade (slope) of the pipeline and number of drainages that need to be crossed. In all options considered and with focus on the tailings component of the facility (both storage and construction needs), a few assumptions were made as common to all options including the operation of the mill such that the process will be a flotation process with de-sulphidation and cyclone sand operation for dam construction.

With these aspects considered, Option B which has the smaller dam and would be within the Upper Casino drainage basin was considered the best of the options. Though Option A would be in a different drainage basin, it would not pose significantly greater disturbance along the route from the operations to the storage facility though it would involve some upslope pumping along portions of the line and it would have a slightly higher dam. It was therefore considered to be a scale of 5 by comparison. Option C, with a generally similar location to Option B, but a dam height similar to that in Option A was also given a value of 5. The option with the greater differences would be Option D; however with respect to tailings specifically, the dam that would be constructed of tailings would not differ significantly from the other options. It would however be anticipated to have a higher rate of rise being higher in the watershed and was therefore given a value of 4.

Operational ease (PAG waste rock)

Because the waste management for Casino would integrate both the tailings and the PAG waste rock, the operational ease of management of the waste rock within the TMF options was also considered and done so as a separate indicator. As with the assessment for the tailings operational management, the distance from the pit to the storage facility was a consideration for waste rock management. Another indicator considered was the operational expectations of each option during winter conditions. These considerations are potentially more pertinent to waste rock management than to that of the tailings as the waste rock will be hauled by truck and therefore involve human participation whereas the tailings will be transported by pipeline. Because of this, distance from the pit to the waste storage facility was given significant consideration. Options B and D would be located closest to the pit, while Option A in Canadian Creek and Option C in lower Casino Creek would be further from the pit (by about 8 and 5 km respectively).

In addition to distance for Option D, the fact that 2 of the 3 dams included in this option would be rockfill dams which was considered an added complexity. Waste rock and or borrow material would be required for their construction which would likely pose additional difficulty in order to keep PAG waste rock submerged underwater. The scalar used was again the qualitative range as used for tailings above.

5.4.1.3 Construction

When considering the construction aspects of the options, the main aspect is that of the dam construction itself. This sub-account has been defined further into two main indicators; geotechnical complexity and scheduling of construction materials.

Geotechnical complexity

The geotechnical complexity was evaluated qualitatively and encompassed the considerations of the foundation conditions and placement of the dam within valleys. Unfavorable foundation conditions may include pervious and/or liquefiable soils, presence of permafrost (potentially on northern slopes), highly fractured bedrock etc. and placement of the dam in the headwaters or side valleys were considered more likely to be of higher complexity than at locations in lower reaches of a valley.

While the foundation conditions at all of the locations where dams would be located in the various options considered are not known to the same degree, a professional judgment was made using geological information, aspect (to assess permafrost) and location within the valley. On that basis, Option B was considered to have the most favorable conditions and be the least complex amongst the options. It would drain to the south and therefore would not be anticipated to have permafrost. Options A and C had less information available on which to base an assessment, but have the potential for some permafrost on northern slopes (Option A in particular) and unconsolidated soils (both Options A and C). Option D which would involve 3 dams for consideration, 2 that have relatively little information available related to foundation conditions but all of which would be located in fairly steep valleys.

Scheduling (construction)

Scheduling for construction needs was considered another important indicator of the construction sub-account. Because all options would include demands for rock (starter dam for all options and on-going rock fill for 2 of the 3 dams in Option D) and demands for cyclone sand for the dam raises, this indicator encompassed both tailings and rock needs and the scheduling expectations of those. The success of any of the options in this regard reflected the expectations of how susceptible each of the options would be to scheduling changes. Both the ability to deliver the cyclone sand and rock/quarry material when needed is critical to the design and was assessed on the basis of the size of the dams, fill requirements, and expected rate of rise of the facility.

Based on that perspective, Option C, with the smallest dam and volume needs was considered the best option, Options A and B located at higher elevations in the valley were slightly less desirable with higher volume needs and higher required rates of rise. Option D was considered to be the least favorable option by this measure with a very large volume demand and 3 structures with the expectation that 2 of them would be constructed concurrently.

5.4.1.4 Structural Stability

The stability of the main facilities was another critical sub-account within the technical considerations. Given all the options would be within a very similar area with respect to topography, climate and seismic zones and would all be designed to the appropriate guidelines provided by the Canadian Dam Association, all options would be built to be structurally stable (i.e. there are no stability fatal flaws identified). To differentiate the options in this aspect therefore, a qualitative description of the stability considerations used in design of each of the options was developed.

Stability considerations (operational and long term)

Considerations of structure stability both during operational phase and afterwards was assessed on the basis of the number of dams, the terrain and abutment conditions, expectations of the colluvial aprons and permafrost conditions, dam height and anticipated tailings beach width.

With these considerations in mind, Options A, B and C with only one main dam were assessed to be preferable over Option D with 3 large structures. Further, the lower dam in Option C with the wider tailings beach was considered to be favored over Options A and B, and ground conditions in Option B would be expected to be slightly better than that for Option A. The scalar developed to communicate these considerations was defined in terms of stability concerns that would need to be designed around in each of the options.

5.4.1.5 Permafrost

Permafrost can cause technical challenges in the design of waste storage structures in the north. The Casino project is in an area of discontinuous permafrost and in general the northern slopes are expected to have a greater degree of permafrost. The permafrost sensitivity for each option was evaluated to reflect this aspect of the design of each option considered.

Permafrost sensitivity

Because the northern slopes in the area are expected to have a greater potential for permafrost, aspect was the key consideration in the assessment of permafrost sensitivity. Options B, C and D generally all drain towards the south with very few northern slopes in the design; though with three separate facilities in Option D there is a greater anticipation of sensitivity to permafrost. Option A does include some degree of northern slope exposure, though not to a significant degree within the dam footprint. Given the level of understanding and generally similar nature of each of the options considered, all options were considered equal in terms of permafrost sensitivity and therefore all given a value of 6.

Capacity

The last technical consideration included in the evaluation was that related to capacity of each option and was measured qualitatively on the basis of expansion potential.

Expansion potential

The ability of each option to handle potential expansion was included not only to assess the potential effects of increased production from the project, but also the potential effects of increased volumes of

PAG rock, should it occur. The expansion potential was evaluated qualitatively and considered to be largely dictated by the expected size of the option, the location in which it would be sited and the ability to increase the size of the dam(s) if required.

With the most favorable volume to height relationship, Option C in the Lower Casino location would have the greatest expansion potential, Options A and B would have similar and lower expansion potential by comparison with less favorable volume to height relationships and Option D with three facilities in the upper reaches of 3 drainages would have the least favorable conditions for expansion potential.

5.4.2 Environmental Account

The environmental account encompassed those aspects that are commonly included in the impact assessments completed to support project proposals. The sub-accounts and indicators were selected to differentiate between the potential effects of each option to issues such as water management and quality, fish and wildlife habitat, effects on flora and air quality and closure considerations. A summary of the ranking results are provided in Table 5-5, and the ranking and weighting results are provided in Appendix A.

Table 5-5: Environmental Considerations Ranking Results

Sub-accounts	Indicators	Option A	Option B	Option C	Option D
		TIA+WR in Canadian Creek	TIA+WR in Casino Creek (Upper)	TIA+WR in Casino Creek (Lower)	TIA+WR avoiding areas frequented by fish
Consequence of Dam Failure	Potential environmental effect as a consequence of dam failure	2	6	6	6
Water Management (storage & seepage)	Catchment area	3	6	2	5
	Degree of TIA seepage expected	3	5	6	2
	Operational water management complexity	5	6	4	3
	Long term maintenance requirements	6	6	5	3
Water Quality	Operational water quality at the toe of the dam	6	6	6	2
	Operational water quality immediately below first tributary	4	4	6	2
	Operational water quality 10 km d/s of dam	6	5	4	2
	Closure water quality at the toe of the dam	6	6	6	2
	Closure water quality (assumes 100% bypass) with at first tributary	5	4	6	2

Sub-accounts	Indicators	Option A TIA+WR in Canadian Creek	Option B TIA+WR in Casino Creek (Upper)	Option C TIA+WR in Casino Creek (Lower)	Option D TIA+WR avoiding areas frequented by fish
	Closure water quality 10 km d/s of dam	6	3	3	2
	Operational water quality at point of spillway discharge	5	6	5	6
	Closure water quality at point of spillway discharge	6	3	5	2
Groundwater	Potential reduction in groundwater contributions downgradient	6	6	6	4
	Potential impacts to GW quality downgradient	5	6	6	3
Fish Habitat	Quality of fish habitat under the footrpint of the TIA	4	6	3	6
	Quality of fish habitat at first tributary d/s of the dam during operations	4	6	3	6
	Quality of fish habitat 10 km d/s of the dam during operations	1	6	6	6
	Reduction of flow (Operations to early closure)	5	4	6	4
	Removal of fish habitat by footprint	4	6	3	6
Wildlife Habitat	Effect on wildlife habitat in footprint area	6	6	6	6
Flora	Effect on flora in footprint area	6	6	6	6
Air Quality	Potential for fugitive dust emissions	6	6	6	6
Closure Measures	duration of long term liability	6	6	6	6
	extent of measures to implement closure	4	6	5	4
	long term level/intensity of site activity	6	4	4	4

5.4.2.1 Consequence of Dam Failure

Given the remoteness of the area there was no perceived consequences to humans in the event of a dam failure and as such only environmental consequences were considered, and in particular that related to the fish and wildlife resources down gradient of the dam in each of the options considered.

Potential environmental effect as a consequence of dam failure

The CDA dam classification guidelines include consideration of the receiving environment in the event of a dam failure and were used as a means of evaluating this indicator. Work by Eagen and Greenaway (2011) outlines the criteria considered in the classification of dams as including aspects such as the extent or presence of identified species, habitat use, intensity/degree of change if a failure were to occur, restoration feasibility, duration of impact, and species status in the expected inundation zone that could result in the event of a dam failure. These factors were used to develop a matrix that can be referenced in the classification of a dam (i.e. assignment of a dam class as low, significant, high, very high or extreme) in parallel to geotechnical aspects of dam classification (Eagen and Greenaway, 2011).

The evaluators used that Dam Class matrix to assess the options for Casino and in so doing assigned a Dam Class of “Very High” to the Option A alternative, based on the presence of Arctic grayling downstream in Canadian and Britannia Creeks, and Chinook spawning habitat and Golden Eagle presence on the Yukon River near the mouth of Britannia Creek, approximately 9 km downstream. A Dam Class of “High” was assigned to Options B, C, and each of the TIAs for option D based on the presence of Arctic Grayling in the watersheds associated with Casino Creek.

The Dam Class system uses a 5-point scale and does not require that the ‘best’ option in the evaluation be given a scalar value of 6 as is done in this alternative assessment. Therefore the Dam Class system was used as a basis of evaluation, but re-cast into the scalar system used here as shown below. In short, Options B, C and D were considered equal and more favorable than Option A.

5.4.2.2 Water Management (storage & seepage)

Water management considerations included in the environmental account were represented by four indicators reflecting the physical nature of water management. Water quality related aspects are evaluated separately in subsequent sub-accounts.

Catchment area

The first indicator selected to represent water management was the catchment area which reflects the amount of water that would need to be managed via diversions or captured.

Catchment areas were estimated in units of km^2 and were quantified for the four options. Option A would have a catchment area of 62 km^2, Option B would have a catchment area of 37 km^2, Option C would be 77 km^2 and the combined catchment area of the Option D dams would be 42 km^2.

Degree of TMF seepage expected

Water management of seepage from the TMF is a critical factor in the design and assessment of impacts related to each option. Estimates of the degree of seepage expected from each option were made and considered aspects such as the expected foundation conditions, potential for permafrost and fractures and dam height.

Because Option C would be the lowest dam and would not be expected to have unfavorable foundation conditions, it was considered to be the best option with respect to the degree of expected seepage. Option B which would be located in the upper Casino Creek drainage would be higher than Option C, but is expected to have good foundation conditions. Option A in Canadian Creek would be of similar height to that in Option B, but based on geology was assessed to have less favorable foundation conditions with the expectation of higher amount of seepage likely. Option D, with three dams and points of seepage was considered the least favorable option.

Operational water management complexity

During operations, the management of water in large part depends on whether there will be a water surplus (and therefore discharge) or water deficit (and therefore make-up requirements). An option with a water surplus in this evaluation was considered less attractive from an environmental impact perspective as it implies discharge requirements and more onerous management of diversions etc.

All options considered for Casino are expected to have water surplus situations with the exception of Option B in the Upper Casino location. Option B has assumed a make-up water supply from the Yukon River but would operate as a zero discharge scenario. Option B therefore was considered the best option when considering this indicator. The remaining options were differentiated further based on the expected complexity of diverting excess water, capture of seepage etc. Option A was considered the next most favored option as it is located high in the Canadian Creek watershed and would have less water to manage around the facility than Option C for example located lower in the Casino valley. Option D despite being high in the valleys would require diversion structures and capture facilities associated with all three structures and was considered the least favorable of the options.

Long term maintenance requirements

The previous indicator focused on the operational phase of the project, water management in the closure phase has been evaluated as the long term maintenance requirements of water management structures. This indicator was assessed on the expectations of the degree of maintenance and oversight that would be expected for the water management structures that would be required for each of the options. This considers the frequency of inspections for the dams, the maintenance and number of pumps and ponds that were included in the option and the size of the spillways.

Options A and B in the upper reaches of Canadian and Casino Creeks were evaluated to have a typical degree of maintenance and oversight required for water management structures associated with these facilities. Option C would have a slightly larger spillway and diversion structures to accommodate a higher volume of water being lower in the valley and Option D with three large structures and water management features would be the least favorable of the options with respect to long term maintenance.

5.4.2.3 Water Quality

Water quality was another key sub-account included in the environmental account evaluation. Because processing related activities create a very different water quality than do the long term weathering processes that influence closure, both time frames were considered (i.e. operational and closure) as distinct indicators. In addition, there were four points of reference evaluated; that at the toe of the dam, at the first tributary downstream of the TMF dam, at a location 10 km downstream from the TMF dam and at the spillway in each option.

Water quality predictions to quantify the expectations of concentrations of copper, chosen as an indicator parameter for potential effects from the project, were provided by Marsland Environmental Associates.

Operational water quality (assumes 10% bypass) with respect to MMER at the toe of the dam

Predictions of water quality at the toe of the facility at each of the options assumed 10% bypass in each case and seepage quality represented by 0.54 mg/L copper. The effect therefore was a reflection of the water quality or assimilative capacity of the area immediately below the toe of each facility. The evaluation also considered that for Options A through C would have only one facility while Option D would have three facilities which would all have a seepage contribution. Another difference with Option D as opposed to the others, is that those facilities in which waste rock would be stored without the tailings, there would be no additional alkalinity added through process waters discharged with the tailings. As such, water quality in seepage from the waste rock stored facilities could differ and potentially be higher than for that associated with the tailings. A comparative estimate was made for Option D on a qualitative basis and comparison with predictions for the other options.

Operational water quality (assumes 10% bypass + discharge if required) with respect to CCME immediately below first tributary (assumed first occurrence of fish) downstream of dam

As was done for the above indicator predicting water quality at the toe of the dam, the same exercise was completed for each option at the first tributary below each location; specifically Britannia Creek for Option A, Brynelson Creek for Option B and Dip Creek for Options C and D. A similar scalar to differentiate the options was developed based on predictions provided in Appendix A; specifically that water quality at the first tributary downstream from Option A was predicted to be 0.011 mg/L, for Option B was predicted to be 0.012 mg/L, for Option C was predicted to be 0.0033 mg/L and for Option D was qualitatively evaluated assuming three distinct loads from three facilities, two of which may have worse seepage quality than the main tailings facility.

Operational water quality (assumes 10% bypass + discharge if required) with respect to CCME 10 km downstream of dam

To expand the comparison further, another assessment at a reference point 10 km downstream from each option was also provided. Resultant predictions for Option A, B and C were 0.00089 mg/L, 0.0019 mg/L and 0.0026 mg/L copper respectively. Option D was again only qualitatively assessed and assumed to be the least favored option. The primary difference in these predicted values was in the dilutive capacity of the Yukon River (for Option A) compared to Dip Creek (for Options B, C and D).

Operational water quality at point of spillway discharge

While the previous water quality indicators were intended to assess effects of seepage, the water quality of any surface discharge from the spillway during operations was also assessed. This considered whether or not there would be an anticipated discharge during operations and if so what that water quality would be expected to be. Both Options B and D assumed no discharge during operations and therefore would be the most favored options in this regard. For Option A, the receiving environment would be to the Yukon River with significant dilution and for Option C discharge would be to Dip Creek, with less dilution capacity; however predictions suggest water quality of the ponded water to be well below CCME guidelines. The scalar developed to reflect these differences is below.

Closure water quality (assumes 100% bypass) with respect to CCME at the toe of the dam

As for the operational stage of the operation, predictions were also made at closure at the toe of the dam for each of the options (see Appendix A). For Options A, B and C, the expected concentration of seepage at the toe of the dam is considered to be the same, as the tailings and waste rock management is similar for all these options. Option D, with three dams, two of which would store primarily waste rock was estimated to be less favorable than the other options in which all waste would be stored in one facility.

Closure water quality (assumes 100% bypass) with respect to CCME at first tributary (assumed first occurrence of fish) downstream of dam

On closure at the first tributary downstream of the toe of the dam for each option predicted water quality for Option A was 0.038 mg/L Cu, for Option B was 0.056 mg/L Cu and for Option C was 0.015 mg/L. Option D was qualitatively assessed to be 3 times less favorable to the best option to reflect the three facilities required in this option.

Closure water quality (assumes 100% bypass + discharge if required) with respect to CCME 10 km downstream of dam

At 10 km downstream, predictions were 0.00091, 0.015 and 0.012 mg/L Cu for Options A, B and C. Option D was considered least favorable. Option A is significantly better than Options B, C and D in this indicator due to the dilution capacity in the Yukon River compared to Dip Creek.

Closure water quality at point of spillway discharge

Predictions of water quality on closure in the pond at the point of spillway for each option were prepared as provided in Appendix A. Expectations were that Options A, B and C would produce the copper concentrations of 0.0023, 0.016 and 0.0065 mg/L, while Option D would have three separate facilities that could all discharge a load to the surface water environment and was considered less favorable.

5.4.2.4 Groundwater

The effects on groundwater were assessed and described with respect to an indicator for quantity and an indicator for quality as below.

Potential reduction in groundwater contributions down gradient

The potential reduction in groundwater down gradient of the TMF facility in each option was assessed qualitatively and considered the anticipated permeability and size of each facility. Options A through C were considered equal as there was no reason to assume that Canadian Creek and Casino Creek would have substantially different groundwater regimes. Option D was considered to be less favored as it would have an effect on three drainages.

Potential impacts to GW quality down gradient

The assessment of impacts to groundwater quality was for that potential effect of seepage that does not get captured by the capture systems designed for each facility on the groundwater. It considered the gradient, the higher the gradient the potential for increased seepage and the anticipated bedrock permeability conditions. For this assessment, it was assumed that Canadian Creek may have slightly higher permeability than Casino Creek based on the bedrock geology of schist in the area of Option A. It also considered that the three dams in Option D would all be expected to have higher gradients and therefore possibly higher seepage than those facilities located further down their respective drainages. It was also noted that the waste rock only facilities may have different seepage quality than those that are co-disposed tailings (with process water) and waste rock.

5.4.2.5 Fish Habitat

Fish habitat is another key sub-account within the environmental account. A description of the fish species and stream classification is summarized in Table 5-6. Indicators were developed in a manner that was similar to that for the water quality indicators in the previous sub-section. Specifically this included an assessment of the potential effect to fish habitat quality within the TMF footprint, at the first tributary downstream and at a location 10 km distal. Also considered was an indicator for the reduction of flow and the removal of fish habitat within the footprint of the TMF. Each of these are discussed further below.

Table 5-6: Fish Species and Stream Classification

Option	Creek	Fish Species Downstream (Mapster)	Placer Stream Classification Model (YESAB Geolocator)
A	Canadian Creek	Arctic grayling in Canadian Creek, Britannia Creek, and Chinook salmon in Yukon River, located ~ 8 km downstream	Canadian Creek - salmon proximity 8.9 km; No salmon spawning Britannia Creek - No salmon spawning but Section 2 but salmon proximity (Chinook) ~2.6 km Yukon River - Chinook Salmon spawning
B	Upper Casino Creek	Arctic grayling	Casino Creek - no salmon spawning Dip Creek - No salmon spawning
C	Lower Casino Creek	Arctic grayling	Casino Creek - no salmon spawning Dip Creek - No salmon spawning
D	Casino, Austin & Brynelson Creeks	Non fish bearing Casino headwaters and Austin & Brynelson creeks but Arctic grayling downstream	Casino, Austin & Brynelson Creeks - no salmon spawning Dip Creek - No salmon spawning

Quality of fish habitat under the footprint of the TMF

A qualitative assessment of the quality of the existing fish habitat under the proposed footprint of the TMF in each of the options was also included. The most favorable option in this context would be that with the least favored fish habitat within the footprint area. Options B and D were considered equal in this regard. Option A was given a value of 4 with somewhat higher quality and/or more fish as compared to other options and Option C further downstream in Casino Creek was considered to have the best fish quality.

Quality of fish habitat at first tributary downstream of the dam during operations

Similarly, the quality or number of fish expected at the first tributary downstream of the facility for each option was assessed. The first tributary downstream of Option A is the Britannia Creek, for Option B it would be Brynelson Creek and for Options C and D it would be Dip Creek.

Quality of fish habitat 10 km downstream of the dam during operations

At a location 10 km downstream from the facilities, the comparison was that between the Yukon River (Option A) and Dip Creek (Options B, C and D) and an assessment of the existing quality of fish habitat and number of fish in each respectively. This assessment considered that the quality of fish habitat in the Yukon River far exceeds that of Dip Creek and the scalar values below were developed to reflect that difference.

Reduction of flow (operations to early closure)

A reduction in flow would be expected to potentially have an effect on fish and fish habitat. This was assessed as a specific indicator here and considered the existing flow in receiving environments and the potential to cut off flow. Flow in Britannia and lower reaches of Casino is higher than in Upper Casino, Upper Meloy and Upper Brynelson. Because of these existing respective flows, the reduction in flow for Option A and C would likely have a lesser influence than for Options B and D.

Removal of fish habitat by footprint

The removal of fish habitat as different from the quality of fish habitat affected was assessed on the basis of footprint area. The smallest footprint would be associated with Options B and D followed by Options A and then C.

5.4.2.6 Wildlife Habitat

The assessment of wildlife in part considered the area that would be disturbed and the wildlife use in that area. This has been evaluated in a combined manner via an indicator defined as the effect on wildlife habitat in the footprint area.

Wildlife use in the area of the project includes caribou, grizzly and black bear, dall sheep, moose, beaver, fox, wolf, hare, raven, rock and willow ptarmigan and golden eagle. None of the options would be expected to have a negative effect on any of the species and while the footprint of each would vary slightly, the resultant effect on wildlife was considered to be the same between options and negligible in all cases. All options were therefore given a value of 6.

5.4.2.7 Flora

As with wildlife, the potential effect on flora for the options considered was included as an environmental indicator in the evaluation.

The area around Casino includes vegetation consisting of black and white spruce forest with aspen and some lodgepole pine. Black spruce and paper birch are generally seen on the permafrost slopes. Scrub birch and willow form an extensive stand in subalpine sections from the valley bottoms to well above the tree line. Given all options being considered would be within the same general area, no differences are expected between the options, and as with the wildlife assessment, all options were given a value of 6.

5.4.2.8 Air Quality

Air quality can be a concern at mining operations, particularly with consideration to dust management and was included in the environmental account as a potential for fugitive dust emissions.

Blasting rock and management of tailings include small particulates which can lead to dust emissions that require control. Because all of the options for tailings and waste rock management would include a conventional slurry management of tailings and construction of dam raises by cyclone sand, all options were considered to have a similar potential for dust creation and given a scalar value of 6.

5.4.2.9 Closure Measures

Consideration of closure measures was considered here to be primarily related to long term protection of the environment and therefore included in the environmental account. This evaluation included three indicators in the assessment related to closure; specifically, the duration of the long term liability anticipated, the extent of the measures required to implement closure and the long term level or intensity of activity anticipated to maintain environmental protection through closure. These are discussed individually below.

Duration of long term liability

Closure planning in mining almost universally includes the objective to minimize or limit the duration post closure for which there is a liability to the proponent, regulators and other stakeholders. In practical terms however, there was no significant difference identified in the options being considered with respect to the duration of the long term liability associated with each. Each option will have at least one large dam structure, water diversion infrastructure etc and therefore liabilities associated with these structures for decades post mining. All options therefore were considered to have the same anticipated duration of on-going liability associated with them. All options were given an equal value of 6.

Extent of measures to implement closure

The extent of anticipated measures required for each option in order to successfully implement a protective closure plan was also considered. This included an assessment of the expected complexity of closure and long term management of water for each option. This indicator differs slightly from most others considered in that it in part must consider the closure scenario for the open pit with is integrated into the closure landscape of the TIAs once it has flooded (i.e. drains through the TIAs). For Option A, closure measures would be required to create a drainage system from the open pit into the TMF with drainage routing to Canadian Creek while Options B and C would have an easier spill point from the pit into their respective TMF facilities. As with Option A, Option D with 3 facilities placed high in the valley headwaters would pose difficulty in integrating pit overflow into the TMF system. Because of the integration of pit waters with the TIAs, Options B and C would be preferable to Options A and D. Differentiating Options B and C from one another, Option C has a larger footprint and would require greater water management structures than Option B. Therefore Option B was considered slightly more favorable than Option D.

Long term level/intensity of site activity

The intensity or level of site activity expected through the closure and post closure phase considered the expectations for water collection, pumping requirements and treatment associated with each option. Because all options would include sub-aqueous disposal of PAG rock, the on-going water management and treatment associated with each option is similar. The primary difference anticipated is in the expected receiving environment. In this assessment, Option A was assumed to include a discharge of site waters by gravity to a diffuser in the Yukon River with significant assimilative and dilutive capacity. The remaining Options B, C and D would all include discharge eventually into the Dip Creek system with a lower assimilative and dilutive capacity as compared to the Yukon River and would be expected to have higher number of pumping requirements than the primarily gravity system associated with Option A. A higher degree and intensity of management of the closure water management would therefore be expected.

5.4.3 Socio-economic Account

The third main account included the socio-economic aspects. This included issues that were often more difficult to quantify and dealt with issues such as other land uses, permitting, care and maintenance, perception, safety, job opportunities etc. Each of these are discussed uniquely below and in many cases were not discriminating. A summary of the ranking results are provided in Table 5-7, and the ranking and weighting results are provided in Appendix A.

Table 5-7: Socio-Economic Considerations Ranking Results

Sub-accounts	Indicators	Option A	Option B	Option C	Option D
		TIA+WR in Canadian Creek	TIA+WR in Casino Creek (Upper)	TIA+WR in Casino Creek (Lower)	TIA+WR avoiding areas frequented by fish
Traditional land use	In immediate area	3	6	6	6
Long term care and maintenance	Winter operating requirements	5	6	5	6
	Total effort	6	6	6	6
Permitting	Overall project complexity from permitting point of view	2	6	6	1
	Requirement for schedule 2 amendment	1	6	1	6
Archaeology	Sites of importance in immediate area	6	6	6	6
Safety	Consequence of dam breach (socio-economic impacts)	2	6	6	6
Noise	Degree of noise pollution	6	6	6	6
Aesthetics	Visibility from frequented areas	6	6	6	6
Tax contribution	Anticipated taxes	6	6	6	6
Job opportunities	Job/contracting potential	6	6	6	6
	Training/experience opportunities	6	6	6	6
Community perception	Community perception	2	6	4	1
Future burden on society	Future burden on society	6	6	6	6

5.4.3.1 Traditional Land Use

Traditional land use in this context was meant to consider activities in the immediate area of each of the options related to hunting, gathering, fishing or religious activities.

The evaluation of these options considered differences in land use in the Canadian Creek and Britannia Creek system versus the Casino Drainage. It was assessed that the traditional land usage in the area was limited to the presence of an old fishing village in Britannia and a few artifacts identified in Canadian Creek. Nothing was identified in Casino Creek drainage. Option A was therefore less favorable with respect to this indicator than were Options B, C and D.

5.4.3.2 Long Term Care and Maintenance

The long term care and maintenance sub-account was selected to reflect anticipated closure activities that normally become the burden in part to regulators and other stakeholders distinct from those of an operating mining company. This was assessed in terms of seasonal complexities (winter operating requirements) and total effort.

Winter operating requirements

Winter can pose difficulty with respect to long term care of mine sites with respect to access, ice build-up (glaciation), and equipment operations. The winter operating requirements assessed here reflect the difficulty of options that include a pump back during the winter as opposed to those that do not. Specifically, it was assumed that Options A and C would require winter pump back components which would involve a greater involvement and degree of oversight, maintenance and monitoring than those that do not (Options B and D). Scalar values did not vary significantly however.

Total effort

The assessment of total or overall effort was also included in this sub-account. This considers the expected degree of long term management anticipated with the site in the given options considered and assumed that all options would have a similar degree of long term care and maintenance required and therefore all were given a scalar value equal to 6.

5.4.3.3 Permitting

Two aspects related to permitting were considered in this sub-account. The first was the overall project complexity and the group's expectations related to permitting based on their collective experience elsewhere. The second was the expected requirement for a Schedule 2 Amendment with any of the options considered which was perceived to add a level of difficulty and impact on the project scheduling as a result.

Overall project complexity from a permitting point of view

The overall project complexity from a permitting perspective considered the size of the dams related to each option, the geochemical and geotechnical complexity of each, and the expectations for negative perceptions, if any, related to the receiving environment. In the case of Option A, while the size of the dam and complexity of the system was not significantly different from any of the other options, there was an expectation of negative perception related to the Yukon River being the point of discharge for this option. Options B and C were considered relatively similar with respect to dam precedents and receiving environment. Option D, because it includes 3 large dams was considered less favorable than B or C despite being within the same receiving environment.

Requirement for Schedule 2 amendment

Based on conversations with regulators, it was the understanding of the group completing this evaluation that a Schedule 2 Amendment would be required in areas frequented by fish but could be lifted in areas with poor fish value. As such, Options B and D were considered to have no fish and/or poor fish value and were given a value of 6. Options A and C were considered to have fish of good value and would be subject to a Schedule 2 Amendment. The scalar in this case was simplified whereby Options B and D were given a value of 6 (no amendment required) and Options A and C were given a value of 1 (amendment required).

5.4.3.4 Archaeology

While detailed archaeology in all locations was not completed, an assessment was made based on the existing information and was defined as the presence of sites of importance in the immediate area.

No sites of importance were identified in the Casino Creek drainage and as a result Options B, C and D were all given a value of 6. Some sites of importance however were identified within the Canadian Creek/Britannia Creek system and by comparison Option A was therefore given a value of 2.

5.4.3.5 Safety

Safety on mine sites is always a topic given very high level of scrutiny and attention. Based on feedback from stakeholders, the key safety issue from a socio-economic perspective was the consequence of a dam breach. While the probability of that occurring in any option is considered very low, the consequences could differ option to option.

The consequence was evaluated on the basis of the potential of people, fish, wildlife etc. to exist down gradient of the facility in the drainages considered and the value of habitat that could be affected. This differentiated Option A located in Canadian Creek which eventually feeds into the Yukon River from Options B, C and D located in Casino Creek drainage which feeds into Dip Creek. It was assumed that in this regard, Option A would have a significantly higher consequence than Options B, C or D.

5.4.3.6 Noise

The degree of noise pollution associated with any mining project is a typical aspect of concern and was therefore included in the evaluation.

Given the remoteness of the project and the relative closeness of all options to the open pit, the options considered were all evaluated as equal with respect to degree of noise pollution and were therefore all given a scalar value of 6.

5.4.3.7 Aesthetics

Similarly, aesthetics is an aspect that is considered when developing potential options for waste storage and was included here.

Aesthetics was assessed on the basis of the visibility of each option from areas that were deemed to be frequented by people. Option A situated in the upper reaches of Canadian Creek was not expected to be visible, nor were Options B, C and D located within Casino Creek. As a result, all options were considered equal and given scalar values of 6.

5.4.3.8 Tax Contribution

Tax contribution was another sub-account deemed to be worthy of consideration in the evaluation of options and included in the assessment.

The tax contribution was evaluated on the basis of anticipated taxes, none of the options considered for waste management storage were significantly different with respect to anticipated taxes and therefore all were given a value of 6.

5.4.3.9 Job Opportunities

Job opportunities were considered on the basis of potential for direct jobs but also on the basis of potential training or experience opportunities.

All options were considered to have the same potential for job creation and given values of 6.

All options were considered to have the same expectations for skills required and therefore training and experience opportunities. All options were given a value of 6.

5.4.3.10 Community Perception

Community perception was included in the evaluation and considered as the perception of people in the general vicinity of the project and directly affected by the mine.

Expectations of perception considered the proximity and palatability of discharge locations (e.g. Yukon River versus Dip Creek), the height and number of dams and the potential influence of the option on areas frequented by fish. Based on these considerations, Option B was evaluated as likely being the most favorable of options, followed by Option C and then by Options A and D equally.

5.4.3.11 Future Burden on Society

The future burden on society was included to reflect the expected challenges on closure that would conceivably fall on the local community and society in general.

Anticipated future burden therefore considered differences amongst options such as if any one option would require higher degree of site interaction, be more susceptible to fluctuations in climate, economic or political conditions etc. than the others. Given all options would be located fairly close to the deposit and represent generally similar means of waste handling, storage and closure conditions, the future burden associated with each was considered relatively similar amongst the options and all were given values of 6.

5.4.4 Economic Account

The last main account included was the economic account. It included two sub-accounts, one representing costs that may be attributed to government input and the other relates to the project costs posed to the proponent. A summary of the ranking results are provided in Table 5-8, and the ranking and weighting results are provided in Appendix A.

Table 5-8: Economic Considerations Ranking Results

Sub-accounts	Indicators	Option A	Option B	Option C	Option D
		TIA+WR in Canadian Creek	TIA+WR in Casino Creek (Upper)	TIA+WR in Casino Creek (Lower)	TIA+WR avoiding areas frequented by fish
Government Costs	Supporting infrastructure costs	6	6	6	6
Project Costs	Initial capital cost (waste and water management costs only)	6	4	6	1
	Sustaining and operating costs	4	6	6	1
	Fish habitat compensation	6	6	6	6
	Closure costs	6	6	4	3
	Post closure costs	6	5	4	2

5.4.4.1 Government Costs

Potential government costs considered only those that may relate to development of supporting infrastructure (e.g. roads, power, rail).

Since all options are would be located close to the deposit and require similar infrastructure, all options were considered equal and given a value of 6.

5.4.4.2 Project Costs

Proponent costs have been included to represent itemized costs for construction, operations and closure related timeframes. These are more easily estimated on a quantitative basis and are described in the following sub-sections.

Initial capital cost (waste and water management costs only)

The initial capital costs related to waste and water management were estimated by Knight Piesold with Option A estimated to cost ~$93 million, Option B estimated at $162 million, Option C estimated at $91 million and Option D estimated to be in excess of $300 million. Costs in this indicator were largely related to the construction of the starter dam(s) in each option.

Sustaining and operating costs

Sustaining and operating costs include estimates for the dam raises, disposal of tailings and waste rock, water management etc. These were also estimated by Knight Piesold with Options A through D having estimated amounts of $2.98, $2.77, $2.72 and in excess of $4.00 billion dollars respectively. The scalar range developed to reflect these differences was as follows.

Fish habitat compensation

Fish habitat compensation costs for all options were expected to be similar and on the order of half a million dollars. All options were given a scalar value of 6 to reflect this assessment.

Closure costs

Closure costs for each option were also estimated. These were done on the basis of comparison to the closure cost estimates provided in the pre-feasibility study (PFS) for the project which was a value of approximately $100 million. The scalar developed and relative option value assigned was as below. In the assessment, Options A and B were considered to have closure costs similar to that estimated in the PFS. Because of the positive water balance in Option C there would be additional costs to provide for water diversions through closure and it was therefore evaluated at a higher cost. For Option D, with three large dams, additional costs associated with seepage and water management were also assumed.

Post closure costs

Post closure costs were included to consider the longer term costs for on-going site maintenance and monitoring. Estimates were qualitative and considered the need or potential need for water capture and potentially treatment. As such, it largely reflects anticipated effects of water quality. With discharge assumed to the Yukon River for Option A, this was the favored option in this regard as the high dilution in the Yukon would negate the need for water collection and treatment. Option B was slightly less favored, followed by Option C with a higher amount of water to manage and Options D with three dams and potentially worse seepage quality associated with the two of these being used to store waste rock.

5.5 SELECTION OF PREFERRED LOCATION

The assigned scalar values and weights as described in the preceding sections were used to calculate scores for each indicator, sub-account and account separately and in a combined or overall manner. To accomplish this, the scalar values used to compare alternatives in every indicator were multiplied by the weight for that indicator. The weighted scalar values were then summed within a given sub-account to provide a sub-account score [$=\Sigma S \times W$] and normalized to the original 6-point scale by dividing by the sum of the indicator weights to provide a sub-account merit rating [$=\Sigma S \times W / \Sigma W$]. The result is a normalized value between 1 and 6 for each alternative that provides a comparative measure, i.e. the alternative with the highest value is the most favorable option with respect to the sub-account considered, and the alternative with the lowest value is the least favorable. A similar process of weighting, summation and normalizing is applied to the sub-accounts to obtain account scores and merit ratings for each account considered in the analysis. Finally, the process is repeated again with the accounts to obtain final overall scores and merit ratings for each of the alternatives.

For the Casino project evaluation, the resultant scores were as shown in Table 5-9. The completed ledger is provided in Appendix A.

Table 5-9: TMF Option Combined Ratings

	Option A	Option B	Option C	Option D
	TMF+WR in Canadian Creek	**TMF+WR in Casino Creek (Upper)**	**TMF+WR in Casino Creek (Lower)**	**TMF+WR avoiding areas frequented by fish**
Technical	4.8	5.3	5.5	3.2
Environmental	4.5	5.6	5.2	4.6
Socio-economics	3.8	5.5	4.7	5.4
Project Economics	5.7	5.6	5.8	4.0
Combined Evaluation	4.5	5.5	5.2	4.4

As with the evaluation process itself, these merit ratings are meant to illustrate a relative difference of the options to one another. The yellow highlights indicate the highest scoring option in each of the main accounts as well as the combined evaluation provided in the last row. On review, the preferred or most favored option is Option B which had the highest combined score, as well as the highest score in the environmental and socio-economic account. Option C was given the highest technical rating as well as highest with respect to project economics. These merit ratings are also shown graphically in Figure 5-7.

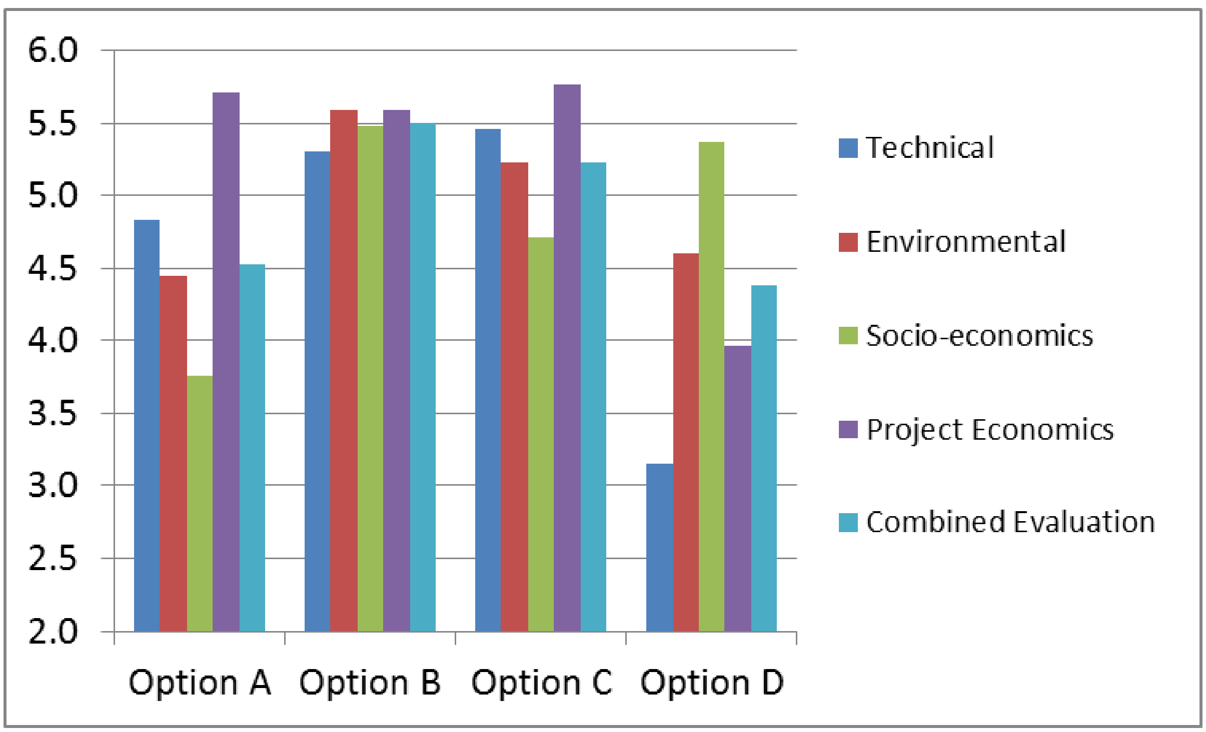


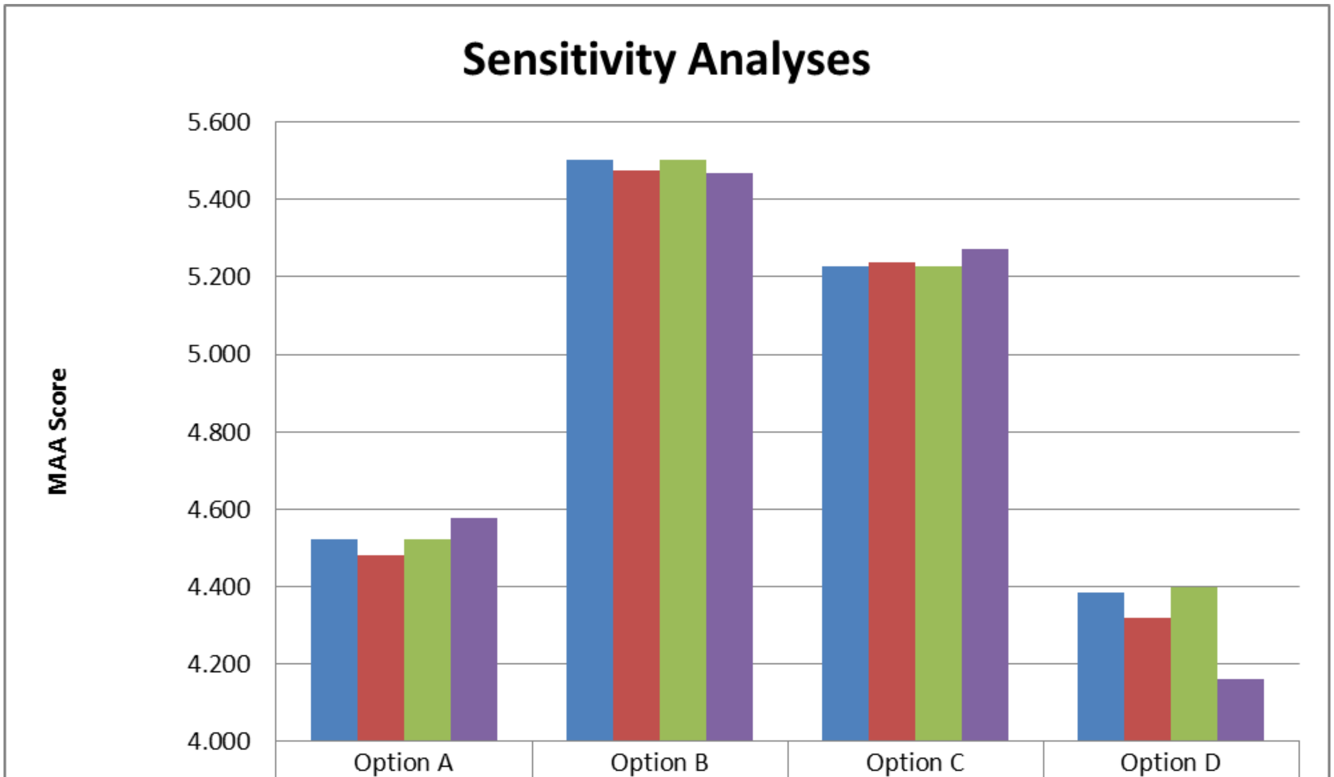
Figure 5-7: Main Account and Combined Evaluation Merit Ratings

5.6 SENSITIVITY ANALYSIS

In addition to the evaluation described above, a set of sensitivity analyses were completed. Three sensitivity analyses were completed as described below:

1. Exclusion of indicators that are non-discriminatory. Those indicators that discriminate amongst alternatives, or provide a mathematical differentiation have a greater influence on the resultant relative merit ratings. Those that are non-discriminating tend to equalize the scores. The evaluation completed here defined an indicator as discriminating if the difference between the weighted scalar (S x W) for the best and worst option in any indicator was more than 30%. Those indicators that were less than 30% different from best to worst were applied a weight of 0.001 and effectively excluded from the numerical calculation.
2. Sensitivity around ‘perception’ indicators. Based on feedback in presentations on the alternative evaluation process with stakeholders in Whitehorse, it was decided to complete a sensitivity analysis around the indicators related to the complexity of the option from a permitting perspective and the assessment of community perception. During the base case evaluation, the evaluators had assessed the permitting and community perception of three large dams associated with Option D to be negative and given that option a scalar value of 1 in both cases. The feedback at the Whitehorse meetings was that this was perhaps too harsh an assessment and that a sensitivity using a scalar value of 4 for those indicators may be better appropriate. This change is shown as sensitivity run 2.
3. The last sensitivity was to assign a weight to the technical account of higher value, specifically a 6 equal to that of the environmental account.

The results of these sensitivities are shown on Figure 5-8. In every case, Option B resulted in the highest merit rating compared to the other options.



	Option A	Option B	Option C	Option D
Base Case	4.522	5.503	5.228	4.384
Sensitivity Run 1	4.479	5.475	5.236	4.318
Sensitivity Run 2	4.522	5.503	5.228	4.399
Sensitivity Run 3	4.577	5.468	5.271	4.161

Figure 5-8: Results of the Sensitivity Analysis Compared to the Base Case Merit Ratings

6 CONCLUSIONS

The objectives of the mine waste and water management strategy at the Casino Project are to ensure permanent and secure storage of tailings and mine waste and to selectively place waste materials to maximize water quality through the minimization of acid generation potential and metal leaching waste.

Due to the nature of the mineralization at the Casino Project, best available management dictates that potentially reactive tailings and waste rock be subaqueously disposed of in a tailings management facility. Sub-aqueous disposal will prevent sulphide oxidation in mine waste and is considered geochemically favorable compared to disposal in an unsaturated environment. These geochemical considerations form the basis of the mine waste management alternatives assessment.

Four methods of tailings disposal was considered: slurried tailings in a local borrow material constructed valley-fill dam; slurried tailings in a cyclone sand constructed valley-fill dam; thickened tailings and paste tailings, which would also require a storage dam; or “dry” stack, or filtered tailings for disposal of NAG tailings, and an embankment dam for the PAG tailings and waste rock.

The comparative assessment indicates that the use of cyclone sand for embankment construction is the preferred option. It provides low operational complexity and controllable geotechnical conditions given the project’s location and water conditions, while incurring the least disturbance to the environment.

A subsequent analysis of various locations for the cyclone sand embankment and impoundment was conducted following Environment Canada Multiple Accounts Analysis guidelines (EC, 2011). A scoping level screening assessment considered 10 location options, and excluded 6 options from further analysis as they did not meet the basic requirements for the waste management facility. Of the four remaining options, an evaluation by a group of technical experts was conducted in May 2013 incorporating thorough consideration of technical, environmental, socio-economic and economic considerations. A further sensitivity analysis was conducted to verify the results.

The location alternatives assessment indicated that the preferred or most favored option is the Upper Casino Creek option (Option B) which had the highest combined score, as well as the highest score in the environmental and socio-economic account. The sensitivity analysis indicated that in every case, that option (Option B) resulted in the highest merit rating compared to the other options.

Therefore, the mine waste management disposal option selected is slurried tailings co-disposed with waste rock in an impoundment formed by a cyclone sand dam in upper Casino Creek.

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APPENDIX A ALTERNATIVES ANALYSIS RANKING AND WEIGHTING RESULTS

LOCATION ALTERNATIVE ASSESSMENT LEDGER

ACCOUNTS	W	SUB-ACCOUNTS	W	INDICATORS	W	Option A	Option B	Option C	Option D	Discrimination Values (based on a difference of 30%)	
						TIA+WR in Canadian Creek	TIA+WR in Casino Creek (Upper)	TIA+WR in Casino Creek (Lower)	TIA+WR avoiding areas frequented by fish		
Technical	3	Dam Design	4	Impoundment storage volume	2	6	6	6	6	0	ND
				Dam size and configuration	6	4	4	6	1	30	D
				Number of large dams required	6	6	6	6	4	12	D
				Total embankment volume	6	5	4	6	1	30	D
				Sub-account merit score (Σ{SxW})		102	96	120	48		
				Sub-account merit rating (Σ{SxW}/ΣW)		5.1	4.8	6.0	2.4		
		Operational Management	6	Impoundment footprint	4	5	6	2	4	16	D
				operational ease - tailings	5	5	6	5	4	10	D
				operational ease - waste rock	6	4	6	4	3	18	D
				Sub-account merit score (Σ{SxW})		69	90	57	54		
				Sub-account merit rating (Σ{SxW}/ΣW)		4.6	6.0	3.8	3.6		
		Construction	4	Geotechnical complexity	6	5	6	5	2	24	D
				scheduling (construction)	4	5	4	6	1	20	D
				Sub-account merit score (Σ{SxW})		50	52	54	16		
				Sub-account merit rating (Σ{SxW}/ΣW)		5.0	5.2	5.4	1.6		
		Structural Stability	6	stability considerations operations and long term	6	4	5	6	2	24	D
				Sub-account merit score (Σ{SxW})		24	30	36	12		
				Sub-account merit rating (Σ{SxW}/ΣW)		4.0	5.0	6.0	2.0		

LOCATION ALTERNATIVE ASSESSMENT LEDGER

ACCOUNTS	W	SUB-ACCOUNTS	W	INDICATORS	W	Option A	Option B	Option C	Option D	Discrimination Values (based on a difference of 30%)	
		Permafrost	6	permafrost sensitivity	6	6	6	6	6	0	ND
				Sub-account merit score (Σ{SxW})		36	36	36	36		
				Sub-account merit rating (Σ{SxW}/ΣW)		6.0	6.0	6.0	6.0		
		Capacity	3	expansion potential	6	4	4	6	2	24	D
				Sub-account merit score (Σ{SxW})		24	24	36	12		
				Sub-account merit rating (Σ{SxW}/ΣW)		4.0	4.0	6.0	2.0		
		Account merit score (Σ{SxW})				140	154	158	92		
		Account merit rating (Σ{SxW}/ΣW)				4.8	5.3	5.5	3.2		

LOCATION ALTERNATIVE ASSESSMENT LEDGER

ACCOUNTS	W	SUB-ACCOUNTS	W	INDICATORS	W	Option A	Option B	Option C	Option D	Discrimination Values (based on a difference of 30%)	
Environmental	6	Consequence of Dam Failure	6	Potential environmental effect as a consequence of dam failure	6	2	6	6	6	24	D
				Sub-account merit score (Σ{SxW})		12	36	36	36		
				Sub-account merit rating (Σ{SxW}/ΣW)		2.0	6.0	6.0	6.0		
		Water Management (storage & seepage)	6	Catchment area	6	3	6	2	5	24	D
				Degree of TIA seepage expected	6	3	5	6	2	24	D
				Operational water management complexity	4	5	6	4	3	12	D
				Long term maintenance requirements	4	6	6	5	3	12	D
				Sub-account merit score (Σ{SxW})		80	114	84	66		
				Sub-account merit rating (Σ{SxW}/ΣW)		4.0	5.7	4.2	3.3		
		Water Quality	6	Operational water quality (assumes 10% bypass) with respect to MMER at the toe of the dam (ratio of Cu seepage/Cu MMER)	6	6	6	6	2	24	D
				Operational water quality (assumes 10% bypass + discharge if required) with respect to CCME immediately below first	6	4	4	6	2	24	D
				Operational water quality (assumes 10% bypass + discharge if required) with respect to CCME 10 km d/s of dam (ratio	4	6	5	4	2	16	D
				Closure water quality (assumes 100% bypass) with respect to CCME at the toe of the dam (ratio of Cu seepage/Cu CCME)	4	6	6	6	2	16	D
				Closure water quality (assumes 100% bypass) with respect to CCME at first tributary (assumed first occurrence of fish)	6	5	4	6	2	24	D
				Closure water quality (assumes 100% bypass + discharge if required) with respect to CCME 10 km d/s of dam (ratio	6	6	3	3	2	24	D
				Operational water quality at point of spillway discharge (ratio of Cu /Cu CCME)	6	5	6	5	6	6	ND
				Closure water quality at point of spillway discharge (ratio of Cu /Cu CCME)	6	6	3	5	2	24	D
				Sub-account merit score (Σ{SxW})		240	200	226	112		
				Sub-account merit rating (Σ{SxW}/ΣW)		5.5	4.5	5.1	2.5		

LOCATION ALTERNATIVE ASSESSMENT LEDGER

ACCOUNTS	W	SUB-ACCOUNTS	W	INDICATORS	W	Option A	Option B	Option C	Option D	Discrimination Values (based on a difference of 30%)	
		Groundwater	2	Potential reduction in groundwater contributions downgradient	3	6	6	6	4	6	ND
				Potential impacts to GW quality downgradient	6	5	6	6	3	18	D
				Sub-account merit score (Σ{SxW})		48	54	54	30		
				Sub-account merit rating (Σ{SxW}/ΣW)		5.3	6.0	6.0	3.3		
		Fish Habitat	4	Quality of fish habitat under the footrpint of the TIA	2	4	6	3	6	6	ND
				Quality of fish habitat at first tributary d/s of the dam during operations	4	4	6	3	6	12	D
				Quality of fish habitat 10 km d/s of the dam during operations	6	1	6	6	6	30	D
				Reduction of flow (Operations to early closure)	3	5	4	6	4	6	ND
				Removal of fish habitat by footprint	6	4	6	3	6	18	D
				Sub-account merit score (Σ{SxW})		69	120	90	120		
				Sub-account merit rating (Σ{SxW}/ΣW)		3.3	5.7	4.3	5.7		
		Wildlife Habitat	3	Effect on wildlife habitat in footprint area	6	6	6	6	6	0	ND
				Sub-account merit score (Σ{SxW})		36	36	36	36		
				Sub-account merit rating (Σ{SxW}/ΣW)		6.0	6.0	6.0	6.0		
		Flora	3	Effect on flora in footprint area	6	6	6	6	6	0	ND
				Sub-account merit score (Σ{SxW})		36	36	36	36		
				Sub-account merit rating (Σ{SxW}/ΣW)		6.0	6.0	6.0	6.0		
		Air Quality	1	Potential for fugitive dust emissions	6	6	6	6	6	0	ND

LOCATION ALTERNATIVE ASSESSMENT LEDGER

ACCOUNTS	W	SUB-ACCOUNTS	W	INDICATORS	W	Option A	Option B	Option C	Option D	Discrimination Values (based on a difference of 30%)	
				Sub-account merit score (Σ{SxW})		36	36	36	36		
				Sub-account merit rating (Σ{SxW}/ΣW)		6.0	6.0	6.0	6.0		
		Closure Measures	4	duration of long term liability	6	6	6	6	6	0	ND
				extent of measures to implement closure	6	4	6	5	4	12	D
				long term level/intensity of site activity	6	6	4	4	4	12	D
				Sub-account merit score (Σ{SxW})		96	96	90	84		
				Sub-account merit rating (Σ{SxW}/ΣW)		5.3	5.3	5.0	4.7		
		Account merit score (Σ{SxW})				156	196	183	161		
		Account merit rating (Σ{SxW}/ΣW)				4.5	5.6	5.2	4.6		

LOCATION ALTERNATIVE ASSESSMENT LEDGER

ACCOUNTS	W	SUB-ACCOUNTS	W	INDICATORS	W	Option A	Option B	Option C	Option D	Discrimination Values (based on a difference of 30%)	
Socio-economics	3	Traditional Land Use	6	in immediate area	6	3	6	6	6	18	D
				Sub-account merit score (Σ{SxW})		18	36	36	36		
				Sub-account merit rating (Σ{SxW}/ΣW)		3.0	6.0	6.0	6.0		
		Long Term Care and Maintenance	6	winter operating requirements	6	5	6	5	6	6	ND
				total effort	6	6	6	6	6	0	ND
				Sub-account merit score (Σ{SxW})		66	72	66	72		
				Sub-account merit rating (Σ{SxW}/ΣW)		5.5	6.0	5.5	6.0		
		Permitting	6	Overall project complexity from permitting point of view	6	2	6	6	1	30	D
				Requirement for schedule 2 amendment	6	1	6	1	6	30	D
				Sub-account merit score (Σ{SxW})		6	36	6	36		
				Sub-account merit rating (Σ{SxW}/ΣW)		1.0	6.0	1.0	6.0		
		Archaeology	6	sites of importance in immediate area	6	6	6	6	6	0	ND
				Sub-account merit score (Σ{SxW})		36	36	36	36		
				Sub-account merit rating (Σ{SxW}/ΣW)		6.0	6.0	6.0	6.0		
		Safety	6	Consequence of dam breach (socio-economic impacts)	6	2	6	6	6	24	D
				Sub-account merit score (Σ{SxW})		12	36	36	36		
				Sub-account merit rating (Σ{SxW}/ΣW)		2.0	6.0	6.0	6.0		
		Noise	1	Degree of noise pollution	6	6	6	6	6	0	ND
				Sub-account merit score (Σ{SxW})		36	36	36	36		
				Sub-account merit rating (Σ{SxW}/ΣW)		6.0	6.0	6.0	6.0		

LOCATION ALTERNATIVE ASSESSMENT LEDGER

ACCOUNTS	W	SUB-ACCOUNTS	W	INDICATORS	W	Option A	Option B	Option C	Option D	Discrimination Values (based on a difference of 30%)	
		Aesthetics	1	Visibility from frequented areas	6	6	6	6	6	0	ND
				Sub-account merit score (Σ{SxW})		36	36	36	36		
				Sub-account merit rating (Σ{SxW}/ΣW)		6.0	6.0	6.0	6.0		
		Tax contribution	1	Anticipated taxes	6	6	6	6	6	0	ND
				Sub-account merit score (Σ{SxW})		36	36	36	36		
				Sub-account merit rating (Σ{SxW}/ΣW)		6.0	6.0	6.0	6.0		
		Job opportunities	1	Job/contracting potential	6	6	6	6	6	0	ND
				Training/experience opportunities	6	6	6	6	6	0	ND
				Sub-account merit score (Σ{SxW})		72	72	72	72		
				Sub-account merit rating (Σ{SxW}/ΣW)		6.0	6.0	6.0	6.0		
		Community perception	6	Community perception	6	2	6	4	1	30	D
				Sub-account merit score (Σ{SxW})		12	36	24	6		
				Sub-account merit rating (Σ{SxW}/ΣW)		2.0	6.0	4.0	1.0		
		Future Burden on Society	6	Future burden on society	6	6	6	6	6	0	ND
				Sub-account merit score (Σ{SxW})		36	36	36	36		
				Sub-account merit rating (Σ{SxW}/ΣW)		6.0	6.0	6.0	6.0		
		Account merit score (Σ{SxW})				173	252	217	247		
		Account merit rating (Σ{SxW}/ΣW)				3.8	5.5	4.7	5.4		

LOCATION ALTERNATIVE ASSESSMENT LEDGER

ACCOUNTS	W	SUB-ACCOUNTS	W	INDICATORS	W	Option A	Option B	Option C	Option D	Discrimination Values (based on a difference of 30%)	
Project Economics	1.5	Government Costs	6	Supporting infrastructure costs	6	6	6	6	6	0	ND
				Sub-account merit score (Σ{SxW})		36	36	36	36		
				Sub-account merit rating (Σ{SxW}/ΣW)		6.0	6.0	6.0	6.0		
		Project Costs	6	Initial capital cost (waste and water management costs only)	6	6	4	6	1	30	D
				Sustaining and operating costs	5	4	6	6	1	25	D
				Fish habitat compensation	2	6	6	6	6	0	ND
				Closure costs	2	6	6	4	3	6	ND
				Post closure costs	2	6	5	4	2	8	ND
				Sub-account merit score (Σ{SxW})		92	88	94	33		
				Sub-account merit rating (Σ{SxW}/ΣW)		5.4	5.2	5.5	1.9		
		Account merit score (Σ{SxW})				68	67	69	48		
		Account merit rating (Σ{SxW}/ΣW)				5.7	5.6	5.8	4.0		
Combined Evaluation		Overall merit score (Σ{SxW})				61	74	71	59		
Combined Evaluation		Overall merit rating (Σ{SxW}/ΣW)				4.5	5.5	5.2	4.4		