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March 20, 2015

Doug Caul
Associate Deputy Minister and Executive Director
Environmental Assessment Office
PO Box 9426 Stn Prov Govt
Victoria BC V8W 9V1
Doug.Caul@gov.bc.ca

Dear Mr. Caul:

Reference: Your letter dated February 20, 2015

Thank you for the opportunity to provide comments on the Mount Polley Investigation Report in relation to the Morrison project. Our technical response is contained in the enclosed report prepared by Harvey McLeod of Klohn Crippen Berger Ltd. (KCB).

Pacific Booker Minerals (PBM) recognizes the important work done by the review panel and supports all the recommendations. The lessons learned from the review will be integrated into the design of the Morrison tailings facility.

PBM is a member of the Mining Association of Canada and supports the Towards Sustainable Mining initiative.

KCB believes that the Morrison Project design is protective of the environment and that it does not have a risk of any significant adverse effects.

PBM looks forward to working with the BC Government and First Nations to bring the mine into production, providing employment and training opportunities for residents of north-western BC while successfully implementing the numerous mitigation measures that the company is committed to. PBM trusts that this report will provide you with the information required to assist the EAO in making an informed positive recommendation on the Project.

Yours truly,

E. Tornquist

Erik Tornquist
Executive VP & COO
Pacific Booker Minerals Inc.

continues on next page...

cc: Honourable Bill Bennett, Minister of Energy and Mines

Honourable Mary Polak, Minister of Environment

Lisa Walls, Regional Director, Pacific and Yukon Region, Canadian Environmental Assessment Agency

Klohn Crippen Berger

Pacific Booker Minerals

Morrison Copper / Gold Project

Environmental Assessment Application –

Response on Mount Polley Panel Recommendations

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March 2015

Klohn Crippen Berger

March 19, 2015

Pacific Booker Minerals
1166 Alberni Street
Suite 1103
Vancouver, British Columbia
V6E 3Z3

Mr. Erik Tornquist
Executive VP and COO

Dear Mr. Tornquist:

Morrison Copper/Gold Project
Environmental Assessment Application - Response on Mount Polley Panel Recommendations

As requested by the Environmental Assessment Office, please find enclosed the attached report which provides Klohn Crippen Berger's (KCB's) response and clarifications of the new items that were raised in response to the Mount Polly Independent Technical Review Board (IGRB) Panel Report and First Nations comments regarding the Mount Polley Failure.

The document continues to support our opinion that the Project has been designed using Best Available Practices and can be safely constructed, operated, and closed to protect the environment.

Yours truly,

KLOHN CRIPPEN BERGER LTD.

Harvey McLeod, P.Eng.
Principal

JS/HM:jcp

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Pacific Booker Minerals

Morrison Copper / Gold Project

Environmental Assessment Application –

Response on Mount Polley Panel Recommendations

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1 INTRODUCTION

General

This letter is in response to the letter from Mr. Doug Caul, Associate Deputy Minister from the Environmental Assessment Office, dated February 20, 2015. The letter outlines two objectives, as follows:

1) Extend the opportunity for Pacific Booker Minerals (PBM) to provide any comments on the investigation and report prepared by the Mount Polley Independent Technical Review Board (ITRB) report (Panel Report).

2) The First Nations have been invited to provide their comments on the Mount Polley failure and the Panel Report in relation to Morrison.

Pacific Booker has been given the opportunity to respond to the First Nation letters.

Report Outline

This report has been prepared to provide comments on the Morrison Tailings Storage Facility (TSF) in view of the Panel Report and in consideration of comments received from First Nations. The report is structured to provide the following:

Section 2: Overview of Mount Polley Failure and the Morrison TSF: Discussion of First Nation comments and a summation of the Mount Polley Failure and Panel Report. Summary of Morrison TSF and comparison between Morrison TSF and Mount Polley tailings facility.

Section 3: Mount Polley Independent Panel Observations: Summary of the important observations and recommendations derived from the Panel Report.

Section 4: Best Applicable Practices: what are they and how these are considered by PBM, and lessons learned from Mount Polley?

Section 5: Best Available Technology (BAT): what are they and how do the Panels BAT recommendations apply to Morrison TSF?

Section 6: Strengthen Current Regulatory Operations: response to the Ministry of Energy and Mines requirements for operating mines, and how these would apply to Morrison TSF.

2 OVERVIEW THE MOUNT POLLEY FAILURE AND THE MORRISON TSF

2.1 Discussion on First Nations Comments on the Mount Polley Failure

Comments have been received from the First Nation communities that have an interest in the Morrison Project and these are documented in the following letters:

- Lake Babine Nation, letter dated February 13, 2015, which includes a Technical Memorandum from Source Environmental Associates, dated February 12, 2015.
- Gitanyow Hereditary Chiefs, dated October 6, 2014, regarding Suspension of Morrison Mine Reconsiderations.
- Gitxsan Chiefs'Office, dated October 2, 2014, regarding Suspension of Morrison Mine Reconsiderations.
- Lake Babine Nation, letter dated September 8, 2014 regarding Suspension of Morrison Mine Reconsiderations.

Many of the observations made by the First Nations reflect previous comments on the project and as requested by the letter from Mr. Doug Caul, "It is not necessary to reiterate the submissions made previously regarding Morrison.

The First Nations collectively are alarmed with the Mount Polley failure and have a strong concern that failure of the Morrison TSF would cause irreparable harm to Morrison Lake and the salmon. First Nation concerns and the Panel Report recommendations for improved State of Practice are critically important and are part of the ongoing dialogue to design, construct and close the TSF as a safe and environmentally sustainable condition. Key technical aspects related to the TSF safety are addressed in this report.

The Lake Babine Nation provided some technical observations related to Mount Polley vs Morrison TSF's and these include:

- "*storage of some tailings that are more reactive than Mt. Polley*". KCB recognize this concern and have management plans to contain the reactive tailings away from the dams. Nonetheless, the release of reactive tailings onto the ground surface could result in oxidation and acid rock drainage if it is not cleaned up. Reactive tailings reporting to Morrison Lake would be submerged and would not become acidic.
- "stockpile dangerous PAG rock beside Morrison Lake for the operating life of the Mine, then store it, permanently less than 100 m from Morrison Lake". It appears that LBN agree with the recommendation from MEM to store the PAG rock in the TSF. The Mount Polley failure, however, highlights the increased risk that would result from the placement of PAG rock in the TSF. This increase in the TSF risk would be due to: 1) higher dam; 2) potential to release PAG rock in the event of a failure; and, 3) the increased complexity of constructing and

operating the TSF. Klohn Crippen Berger believe that storage of PAG rock back into the open pit on closure is the lowest risk alternative.

- *"on the lack of comprehensive geotechnical assessment:* Geotechnical investigations were carried out for the Feasibility Study. Additional investigations will be carried out for the Detailed Design stage. This is further discussed in Section 6.2 of this report.

2.2 ITRB Panel Report

The Mount Polley tailings dam failed in the early morning of August 4, 2014 and resulted in a release of approximately 20 Mm^3 of water and tailings. An independent panel was subsequently established by the Government of British Columbia, with the mandate to assess the cause of failure and make recommendations for reducing the risk and moving towards the concept of zero failures. The Panel's "Report on Mount Polley Tailings Storage Facility Dam Breach" was issued January 30, 2015. The report assessed the root cause of the failure and provided recommendations for reducing the risk of tailings dam failure.

> The cause of failure was raising the dam and the use of a steep downstream slope, which stressed the foundation soil and led to failure. The dam failed on a weak clay layer that had not been identified, nor had the strength response of the clay been correctly accounted for in the design. The dam slumped and the water pond eroded the dam and led to release of water and tailings. "The Panel concluded that the dominant contribution to the failure resides in the design."

The findings of the Panel Report are being used as a guide for the Ministry of Energy and Mines (MEM) to improve the "State of Practice" for design, management, operation and closure of tailing facilities in British Columbia.

2.3 Morrison Tailings Storage Facility (TSF) Summary

The PBM project is in the advanced stages of the Environmental Assessment (EA) process and comprises a proposed 30,000 tpd open pit mine located near Morrison Lake, approximately 65 km northeast of Smithers, British Columbia. The open pit and process plant is located near the eastern shore of Morrison Lake and the TSF is located approximately 3.5 km northeast of the mine, within a watershed catchment area that drains primarily westward into Morrison Lake. Mine waste rock is placed uphill of the open pit, 800 m east of the lake shore.

The TSF is formed with two main dams (Main and North dams) and a smaller saddle dam (West dam) and abuts against the natural hillsides. The footprint area is approximately 500 ha, and the dams will be constructed in stages over the approximately 20 year mine life. The TSF will be lined with an impermeable geomembrane and the dams will be constructed of compacted desulphurized cyclone sand. Seepage will be collected and recycled to the TSF and surplus tailings water will be recycled back to the process plant. The TSF pond will attenuate seasonal flows, but will not accumulate water on an annual basis. Surplus water from wet years will be treated and discharged via a diffuser in

Morrison Lake. On closure, the TSF will be reclaimed with a small pond/wetland area and vegetated dry beach surfaces.

2.4 Comparison of Mount Polley TSF with Morrison TSF

There are number of important differences between the proposed Morrison TSF compared to the failed Mount Polly TSF. A comparison of these is summarised below in Table 2.1

Table 2.1 Comparison of the Proposed Morrison TSF and Mount Polley TSF

Design Aspect	Proposed Morrison TSF	Mount Polly TSF
Dam Type	Centreline, Cycloned Sand Tailings with till core and geomembrane liner	Modified Upstream transitioning to centerline; Earth/Rockfill dam
Dam Dimensions	Main Dam – 2,500 m long, max. 90 m North Dam – 1,700 m long, 40 m high West Dam – 1,200 m long, 35 m high	Main Embankment – 52 m high Perimeter Embankment – 42 m high South Embankment – 32 m high
Dam Slopes	3H:1V	1.3H:1V, without proposed buttresses
Upstream core support	Spigotted tailings beach	Sand cells and rockfill
Impoundment Liner	60 mil LLDPE geomembrane over native low permeability till	Till soil
Delivery Method	Pumped	Pumped
Dam Components	Till core (10m wide), secondary cycloned sand dam with finger drains	Till core (min. 4.3m wide), processed filter and rockfill
Percent Solids	33% when pumped to the TSF cyclone station, cycloned to 70% solids and 18% fines content	35% solids
Dam Filters	Sand and gravel blanket drain and finger drains. Cyclone sand against till core	Chimney Drain using processed mine rock
Dam Foundation (Simplified Geology)	Homogeneous glacial till overlying rock	Interlayered glaciolacustrine clays with tills and glaciofluvial soils, overlying altered bedrock
Operational Ponded Water Volume	< 2 Mm^3	10 Mm^3 (Approximately at time of failure)
PAG Cleaner Tailings management	Kept submerged below ponded water during operations. Capped in the last two years of mining with neutral tailings	N/A
Water Management Operating Conditions Annual water surplus	Neutral water balance – no annual surplus	> 1 Mm^3
Closure cover option	Dry cover with wetland/pond	Not specified
Closure water pond volume	< 300,000 m^3	Not specified

3 MT. POLLEY INDEPENDENT PANEL OBSERVATIONS

A summary of the key Panel observations, along with a brief summary of their consideration with respect to the Morrison TSF is provided in Table 3.1, and additional discussion on the key aspects are presented in the referenced section of this report.

Table 3.1 Mt. Polley ITRB Observations and Recommendations

Panel Report Page Reference	ITRB Observation/Comment/Recommendation	Observations to Morrison TSF	This Report Section
119	Tailings dams are complex systems that require "consistently flawless execution...."	The Morrison cyclone sand dam is a "simple" structure that is relatively insensitive to human error. The geomembrane liner provides additional redundancy and resilience to both environmental seepage loss and dam safety.	5.2
120	The path to zero failure "leads to best practices, then continues to best technologies".	Noted and discussed.	4 & 5
121	Best Available Technology Principals: Eliminate surface water from the impoundment Promote unsaturated conditions in the tailings with drainage provisions Achieve dilatant conditions throughout the tailings deposit by compaction.	Noted and discussed.	5
122	Filtered tailings is considered a Best Available Technology. Tailings need to be dewatered and compacted.	Compaction of filtered tailings in winter and high rainfall/snowfall conditions is impractical. PAG cleaner tailings requires saturated conditions to prevent acid generation.	5.3
122	Greens Creek filtered tailings is presented as an example of BAT.	Morrison is 40 times larger than Greens Creek and does not have an underground mine to place the tailings into when there is an "upset" condition (i.e. too wet).	5.3
122	Additional dewatering enhancements may include cycloning. Dewatering at high rates are being progressed by Rosemount Copper, Arizona with 68,000 tpd filter press operation.	Morrison cyclones for the dam. Dry climate increases ability to compact and to carry out operations year round.	5.3
123	Cost comparisons between slurry tailings and filtered tailings storage do not include risk cost and it is difficult to include costs that relate to "externalities "	Noted and discussed.	5.3.3
124	Chemical stability depends on physical stability first. Filtered tailings can slow down geochemical reactions and seepage gradients. Covers can be used to further mitigate ARD/ML and allow for progressive reclamation.	Noted and discussed.	5.3.2
125	BAT should be actively encouraged for new tailings facilities. Safety should be evaluated and cost should not be the determining factor.	Noted and discussed.	5
125	BAT should be applied to closure to allow progressive removal of TSF inventories. Where applicable, alternatives to water cover should be aggressively pursued.	BAT has been applied to closure.	5.2

Panel Report Page Reference	ITRB Observation/Comment/Recommendation	Observations to Morrison TSF	This Report Section
126	Best available practices (BAP). "It is important that safety be enhanced by providing for robust outcomes in dam design, construction and operation."	Centerline cyclone sand dams are robust and simple to construct and operate.	5.2
126	Corporate governance should follow Mining Association of Canada Guidelines, including "Towards Sustainable Mining.	Noted and discussed.	4.1
127	Corporate TSF Design Responsibilities should include: Risk assessments, Quantitative Performance Objectives (QPA's) and Feasibility studies and Permitting should include environmental assessment of BAT and" they should not be excluded if they are advanced far enough to warrant implementation in practice".	Noted and discussed.	4.2, 5.3, 6.5
128	A bankable feasibility study should include: A detailed evaluation of all potential failure modes Detailed cost analysis of BAT tailings and closure options. A detailed declaration of QPA's.	Noted and discussed.	4.2, 5.3.3
129	An independent technical review board (ITRB) should be used to provide third-party advice on the design, construction, operation and closure has become increasingly common and is recognized to provide value.	PBM has committed to independent third party review.	4.1
131	MEM should evaluate TSF's for: Undrained shear failure for dams with silt and clay foundations Water balance adequacy Filter adequacy.	Morrison TSF has assessed undrained shear failure in the foundation till. The EA Application included numerous scenarios to assess water balance adequacy Cyclone sand is a natural filter for the till core. The geomembrane liner will significantly reduce or eliminate seepage pressures in the dam.	6

4 BEST APPLICABLE PRACTICES

4.1 Corporate Governance and Independent Review Boards

The panel's recommendation states that corporations proposing to operate a Tailings Storage Facility (TSF) should be required to be a member of the Mining Association of Canada (MAC) or be obliged to commit to an equivalent program for tailings management, including the audit function. PBM is a member of MAC and as the project proceeds would implement the Towards Sustainable Mining (TSM) systems that MAC has developed.

As part of the EA Application, PBM had committed to independent third party review of the groundwater aspects of the project. PBM supports the panel recommendation and also commits to developing a Technical Review Board (TRB).

4.2 Expand Corporate Design Commitments

General

The panel's recommendation states that *"future permit applications for a new TSF should be based on a bankable feasibility that would have considered all technical, environmental, social and economic aspects of the project in sufficient detail to support an investment decision, which might have an accuracy of +/- 10-15%". More explicitly it should contain the following:*

1. *A detailed declaration of Quantitative Performance Objectives (QPOs).*
2. *A detailed evaluation of all potential failure modes and a management scheme for all residual risk.*
3. *Detailed cost/benefit analyses of BAT tailings and closure options so that economic effects can be understood, recognizing that the results of the cost/benefit analyses should not supersede BAT safety considerations."*

A discussion of QPO's for the Morrison TSF is presented in Section 6.5 of this report.

A discussion on the cost/benefit of the filtered tailings (BAT) is presented in Section 5 of this report.

Risk Assessment

A Failure Mode Effects Assessment (FMEA) is part of the Mining Association of Canada (MAC) Towards Sustainable Mining (TSM) Guidance. The FMEA is a valuable tool to assist in identifying potential risks and to assist in developing risk management plans to reduce the risk. A comprehensive FMEA for the TSF has not yet been carried out for the Morrison EA Application, although the "Accidents and Malfunctions" chapter of the EA did address some of the risks. The Adaptive Management Section of the Review Response Report – Rev.2 provides management plans for environmental components of the TSF.

In consideration of the Panel's recommendation outlined above, a preliminary FMEA was carried out for the TSF and is included in Appendix I. The purpose of this FMEA is to illustrate the methodology and communicate the framework for the risk assessment. As the project moves forward into the next stage of design and Permitting, a comprehensive FMEA would be carried out with technical experts and with First Nation, Regulatory and Stakeholder involvement.

5 BEST AVAILABLE TECHNOLOGIES (BAT)

5.1 Introduction

The Panel has identified Filtered Tailings (FT) as the Best Available Technology (BAT) for tailings storage and it is appropriate to acknowledge that FT facilities present the lowest risk of a catastrophic failure. As discussed in Section 5.3 of this report, FT technology may have significant challenges with the engineering, environment, and cost components for under certain conditions. Therefore it is also important to distinguish BAT that are appropriate for the site conditions, and to recognize that other best available technologies can and should also be used.

BAT is influenced by the site conditions and other factors and, therefore, it is important to recognize and to apply best available technologies to the design, operation, and closure of the TSF to reduce the risk. Modern TSF design has evolved over the last 60 years in parallel with the continued development of soil mechanics and conventional water dam engineering. Additionally, there are special features of tailings dams that can be applied to reduce the risk of a tailings dam, as opposed to a water dam.

This section of the report outlines the BAT that have been applied to the TSF and, also presents a conceptual review of the application of FT technology.

5.2 BAT Used for Morrison TSF

The design of the Morrison TSF uses BAT's that are appropriate for the site conditions, and these are summarized in the following sections:

Cyclone Sand Dam

The technology for construction of cyclone sand dams started in the mid-1960's with Klohn Crippen Berger's (then Ripley Klohn Leonoff) design of the Brenda tailings dam in south central British Columbia. The dam was designed for the maximum credible earthquake and still meets design standards today despite continual seismic zone updating. The Brenda TSF has been closed for a number of years and has been reclaimed as a landform with minimal water storage and a reclaimed surface of grassland vegetation. Some of the important components of a cyclone sand dam, that reinforce its robustness include:

- The dam does not rely on the low permeability core zone for stability. A number of cyclone sand dams are constructed without a low permeability core (e.g. Brenda and Gibraltar copper mines).
- Cyclone sand is a natural filter for a glacial till core zone, which means that the entire downstream shell of the dam is acting as a robust filter. This contrasts with a rockfill dam that requires properly graded processed filters to transition from the till core to the rockfill. As demonstrated at Mount Polley, the QA/QC of the filter production and placement requires continual vigilance and, if not carried out comprehensively, presents a risk.

- Placement of cyclone sand takes place during the spring-fall construction season and requires control and management of the operations to produce and place the sand as specified. However, during the remaining winter operations, tailings can be spigotted from several areas with little management. This reduces risks associated with complex operations in the winter, as would be required for a filtered tailings facility.

Geomembrane Liner

The use of a geomembrane liner for the TSF is a BAT for reducing the risk associated with seepage (note that it is also likely that a geomembrane liner would be required for a filtered tailings facility). The liner, however, also significantly reduces the risk of the TSF by:

- The combination of low permeability tailings overlying a geomembrane liner dramatically reduces the ability for water (seepage) to flow through the liner. This results in negligible seepage pressures within the dam due to the stored tailings and, therefore, reduces the risk of piping.
- Elimination of a pervious drain on top of the liner, which is Best Available Technology in several States in the USA, significantly reduces the risk of seepage. The drains actually increase the risk of seepage by providing a flow path for water.

Water Balance

The accumulation of water was identified by the Panel as an important factor in the consequence of the Mount Polley failure. The Morrison TSF will be operated with a minimal water pond, as required to attenuate seasonal inflows. During a dam break, the operating water pond typical washes away an equal volume of tailings, which are transported as a slurry/water flow down the streambeds. The remaining tailings then slump to their natural residual slope angle. Therefore, limiting the volume of water stored is important to reduce the risk, particularly on closure.

Long beaches in front of the dams will be developed for the TSF and helps prevent the release of water in the event of slope movement.

Closure Plan

The Morrison TSF has a number BAT's that have been applied to closure and these include:

- Minimal water pond: On closure the TSF water pond will be pumped to the open pit and co-placed with the PAG mine rock. This results in a small water pond/wetland. For sizing purposes a volume of 300,000 m^3 has been assumed. The actual volume will be as small as possible.
- Two spillways will be constructed, to the North and to the South. This provides redundancy in the event of a spillway blockage.
- The upstream crest of the dams are widened to ensure that if slumping of the dam occurs, the water pond would not be close enough to erode the dam, as was the case for Mount Polley.

- The Main Dam would be constructed higher than the other two dams, which would significantly reduce the risk of overtopping the Main Dam.

5.3 Filtered Tailings Review

5.3.1 Overview

Filtered tailings (FT) technology has been used over the last 30 years on a number of projects worldwide and is typically one of the alternatives that is assessed in the tailings alternative assessments for new projects. The process involves the use of pressure or vacuum filters that squeeze or suck the water from the tailings resulting in tailings with less water than conventionally stored tailings. Achieving a water content near the optimum moisture content is required to allow compaction of the tailings to the required density.

A summary of potential benefits and challenges with FT technology is summarized in Table 5.1, and discussed in the following sections.

Table 5.1 Potential Benefits and Drawbacks of Filtered Tailings

Potential Benefits	Potential Drawbacks and Design Issues
▪ Achieves Objective: Reduced tailings loss in unlikely event of TSF failure (if constructed properly). ▪ Increases range of potential closure land use (no ponds).	▪ Climate (difficult to compact during winter / rain / snow / ice). ▪ In wet, northern climate typically need to operate two zones – outer retention zones compacted during good weather, inner zone reserved for placement in poor weather with less than optimum compaction. ▪ Difficulties in scaling up from largest existing practice for northern filtered operations (~ 750[1] tpd (Greens Creek)) to 30,000 tpd (operational and capital cost aspects). ▪ Operating costs very much higher per tonne. ▪ High power costs and higher CO_2 emissions from truck and equipment. ▪ Not recommended for cleaner tailings (due to Acid Generating Potential, Closure ARD / Water Treatment). ▪ May require large dam and pond for runoff water management (to store design floods). ▪ Significant Total Suspended Solids (TSS) in runoff requires ponds with long retention time before discharge or reclaim. ▪ Applicability to site – not clear if there are any advantages given not all of the filtered tailings can be compacted due to weather, creating need for compacted retention dam structure.

Note: The Greens Creek plant is sized for a larger tonnage, however the average throughput is 750 tpd as the remaining tailings are placed underground.

The cost of FT is normally higher that conventional tailings storage, and have historically been driven by site specific factors that may include, for example:

- Requirement to maximize reclaim of water, which is a common driver in desert environments (projects in Mexico, Australia, Chile and Arizona).
- Potential to freeze the tailings and not manage a water pond in arctic environments (Raglan, Quebec).
- Requirement to minimize footprint and potential environmental perception (Greens Creek, Alaska).

The application of FT has typically been adopted for projects with the following profile:

- Warm dry climates, which allow for placement and compaction of the tailings year round.
- Smaller tonnage operations where compaction of the tailings is not carried out as the slopes are very flat and the pile is not very high.
- Gold mines, where the value of a tonne of ore/tailings is on the order of $250/t, as opposed to large copper mines where the ore/tailings values are on the order of $20/t. This allows for higher tailings costs for gold mines.
- Flat areas where tailings can be stacked without “damming” a stream and runoff water can be managed.
- Underground mines where tailings can be placed underground during periods of poor weather (rain, snow, cold) and placed on surface the rest of the year.

The Panel identified the Rosemount copper mine in Arizona which is proposing a 68,000 tpd filtered tailings facility in Arizona. This project includes the following components:

- Pressure filter technology with conveyors to transport the tailings to the TSF.
- Tailings is to be spread and compacted and placed in a three sided pile against a hillside.
- Climate is warm and dry and the plant will operate 365 days a year.
- The facility is not lined and surface water is collected and managed with ditches and ponds.
- Regulators have concluded that groundwater effects are acceptable. The tailings are not potentially acid generating.
- Water conservation is an important component.

The Rosemont project represents a major increase in the scale of filtered tailings operations, previously the largest one was on the order of 18,000 tpd in Chile. However, this mine has not been constructed and no operational experience at these high tonnages has been developed to confirm feasibility.

5.3.2 Conceptual Design

A conceptual scoping level assessment of applying the filtered tailings technology to the Morrison TSF was carried out to identify the potential technical benefits and challenges, and the potential costs. The assessment was based on a design life of 22 years to store 224 Mt of tailings. The tailings would be filtered in two streams: a) rougher NAG tailings – 85%); and b) sulphide cleaner PAG tailings -15%. The filter plants would be placed near the proposed plantsite and filtered tailings would be trucked to the TSF, which would be located within the eastern side of the currently proposed TSF.

The main components include:

- Filter plants which use pressure filters systems comprising automated pressure plates driven with hydraulic rams. Separate plants would be used for the rougher and cleaner tailing streams.
- The TSF area would be stripped and proof-rolled for placement of the geomembrane liner.
- Clean water diversion ditches would divert surface runoff water around the TSF.
- Collection ditches would be installed along the perimeter, leading to gravity flow into a storage attenuation pond. The pond would be on the order of 1,000 m by 100 m in plan area, and approximately 10 m deep, and would be sized to store the 200 year runoff from the TSF and to attenuate seasonal runoff flows to allow contact water to be recycled back to the process plant. The pond would also be used to store surplus groundwater and surface water inflows into the open pit and in the process plant area.
- Filtered tailings storage and loadout area adjacent to the filter plant. Tailings would be delivered to the TSF with mine haul trucks. The average one way haul distance to the TSF for placement of the tailings is approximately 6 km and a 40 m wide mine haul road would be constructed with a maximum grade of 10%.
- Tailings would be dumped and spread into 300 mm thick lifts and compacted with large 10 tonne smooth drum rollers.
- Sulphide cleaner tailings would be placed in the interior of the pile to reduce the risk of acid drainage.
- Non PAG rougher tailings would be placed in the remainder of the pile. During summer months, filtered tailings would be placed in the outer zone of the pile to ensure that the tailings can be compacted. During winter months and in periods of heavy rain, tailings would be placed in the interior of the pile.
- The outer slope of the pile would be progressively reclaimed as the pile is raised.

A plan view of this conceptual layout is shown on Figure 5.1.

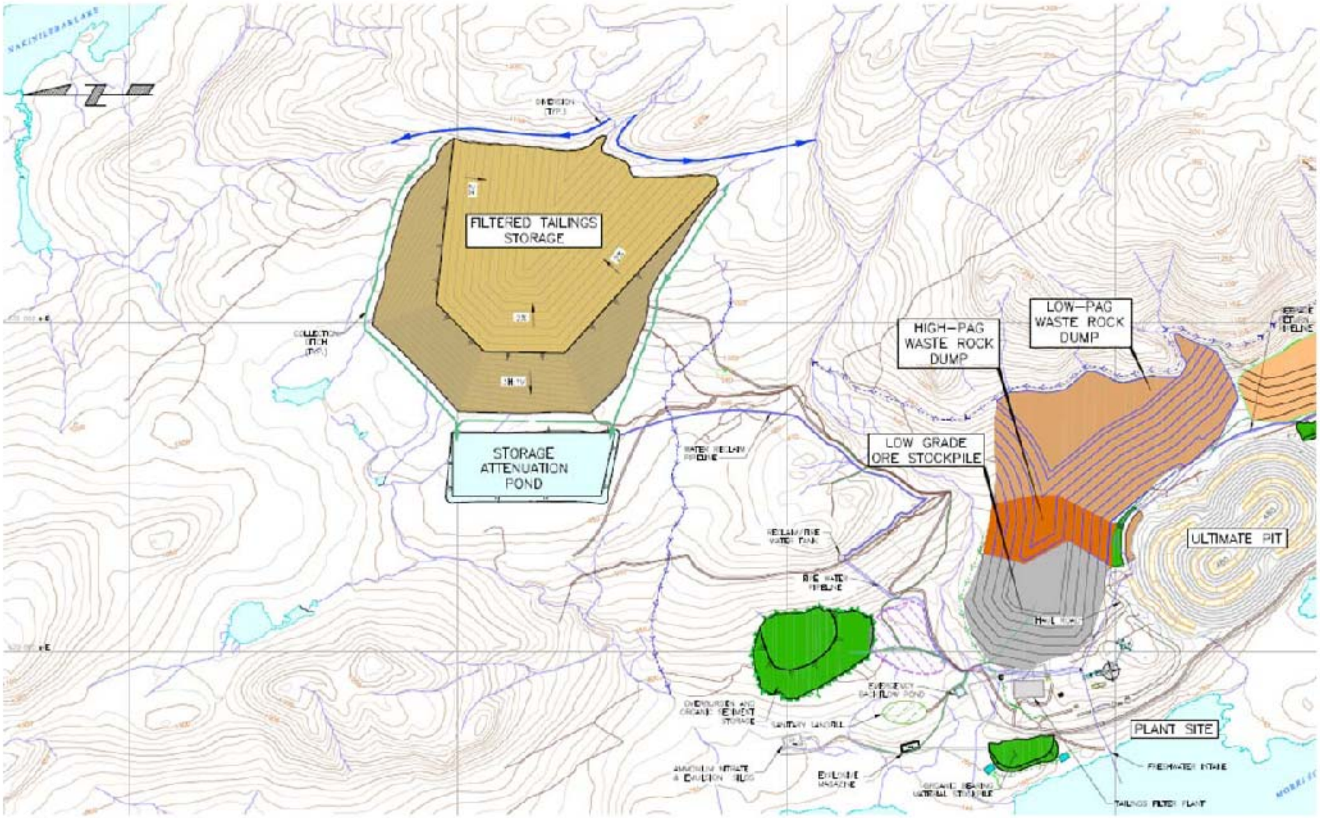

Figure 5.1 Filtered Tailings Facility – Plan

5.3.3 Conceptual Design - Cost Estimate

An order of magnitude cost estimate was prepared to identify the main cost items and provide an indication of the potential cost of the FT facility, and this is summarized in Table 5.2. The estimate assumes that the basic design presented in the previous section could be technically feasible and environmentally acceptable.

Table 5.2 Filtered Tailings Conceptual Cost Estimate

WBS Code	Area, Item Description	Measure Qty	Measure Unit	Unit Cost	CAPEX Total	OPEX Total (over 20 years operation)
1	**Tailings Filter Plant**				**$ 102,000,000**	**$ 220,000,000**
1.1	Earthworks and site prep	1	LS	$ 2,000,000	$ 2,000,000	$ -
1.2	Filter press equipment - 2 plants	1	LS	$ 50,000,000	$ 50,000,000	$ -
	Building & support plant	1		$ 50,000,000	$ 50,000,000	
1.3	Operate (power etc)	220,000,000	tonne	$ 0.50	$ -	$ 110,000,000
1.4	Maintenance	22	year	$ 5,000,000	$ -	$ 110,000,000
2	**Filtered Tailings Storage Area**				**$ 14,660,000**	**$ 498,000,000**
2.1	Clear and Grub	240	ha	$ 6,000	$ 1,440,000	$ -
2.2	Strip and Stockpile Organic Bearing Material	80,000	m3	$ 9	$ 720,000	$ -
2.3	Proof Roll Footprint and place liner	2,400,000	m2	$ 20	$ 12,000,000	$ 36,000,000
2.4	Sediment Control, and Drainage	1	LS	$ 500,000	$ 500,000	$ -
2.5	Load, Haul and Place Filtered Tailings	1,320,000,000	tonne/km	$ 0.25	$ -	$ 330,000,000
2.6	Spread Tailings with Dozers	220,000,000	tonnes	$ 0.30	$ -	$ 66,000,000
2.7	Compact Tailings in 1 foot lifts	220,000,000	tonnes	$ 0.30	$ -	$ 66,000,000
3	**Water Management Infrastructure**				**$ 29,212,000**	**$ 4,000,000**
3.1	Clear and Grub	112	ha	$ 6,000	$ 672,000	$ -
3.2	Diversion Ditch - Excavation	3,000	m	$ 100	$ 300,000	$ -
3.3	Diversion Ditch - Liner	12,000	m2	$ 20	$ 240,000	$ -
3.4	Water Retention and Reclaim Pond - Dam	1	LS	$ 6,000,000	$ 6,000,000	$ -
3.5	Water Retention and Reclaim Pond - Liner	1,000,000	m2	$ 20	$ 20,000,000	$ -
3.6	Erosion Protection	100,000	m3	$ 20	$ 2,000,000	$ -
3.7	Operate/Maintain	20	year	$ 200,000	$ -	$ 4,000,000
4	**Closure**				**$ 9,151,200**	**$ 2,903,200**
4.1	Soil Cover Over Tailings Stockpile	480,000	m3	$ 12	$ 5,760,000	$ 1,152,000
4.3	Erosion Protection	60,000	m3	$ 20	$ 1,200,000	$ 240,000
4.4	Reclamation/Restoration Costing	300	Ha	$ 7,000.00	$ 2,100,000	$ 420,000
4.5	Decommission Water Collection Pond	1	LS	$ 1,000,000.00		$ 1,000,000
4.6	Decommission Diversion Ditches	3,800	m	$ 24	$ 91,200	$ 91,200
5	**Anxillary Infrastructure**				**$ 4,800,000**	**$ 1,567,500**
5.1	40 m wide haul road	6	km	$ 800,000	$ 4,800,000	$ 1,567,500
6	**Water Monitoring**				**$ 400,000**	**$ 1,000,000**
6.1	Instrumentation and monitoring	1	LS	$ 400,000	$ 400,000	$ 1,000,000
				Total	**$ 160,223,200**	**$ 727,470,700**
7	**Contingency**					
7.1	Recommended Contingency			40%	**$ 64,089,280**	**$ 290,988,280**
				Total + Contingency	**$ 224,312,480**	**$ 1,018,458,980**
				Million $	**$ 224**	**$ 1,018**

The cost of the FT is on the order of $5.50/t or about 25% of the value of the ore. Total costs over the life of mine are on the order of $1.25 billion, however the level of accuracy of this cost estimate is low and the potential cost range could be significantly more than indicated. The cost of the proposed tailings storage is on the order of $1.00/t, which is significantly less than the cost of FT.

The Panel Report suggested that the risk cost of the TSF be considered in comparison with the risk cost of the FT alternative. While this can be considered in a qualitative sense, it is very challenging to be able to quantify the risk cost of the two alternatives. This concept also recycles back to the risk assessment and risk management plan for the TSF. Robust and comprehensive risk assessment and risk management plans are strong tools to use in reducing the risk cost.

5.3.4 Challenges for Filtered Tailings for Morrison

The preceding sections have presented a conceptual design for a FT storage alternative and an order of magnitude estimate of what it could cost, assuming that it is technically feasible. However, the application of FT technology for Morrison has a number of site specific challenges that would need to be addressed in more detail, and these include:

- Freezing temperatures and snowfall occur from November to March, or approximately 50% of the time. This places challenges in scheduling and managing materials to allow construction of a stable outer slope.
- Freezing temperatures can result in layers of ice and snow within the pile, which introduces layers of weakness and a reduction in compaction efficiency.
- Acid rock drainage from the sulphide tailings may occur during placement, and may introduce long term concerns if saturation cannot be assured/attained.
- Management of surface runoff water, as well as open pit groundwater, need to be collected and managed in a secure facility, while meeting requirements for dam design and water release.
- There is no precedent in the World for FT applied at this scale and in a similar climate and, consequently, the mine financing and feasibility is subject to the risk perception of the technology.

The required water collection dam is a significant structure and would be designed to meet standards as failure of the dam would result in release of mine process water into Morrison Lake.

6 STRENGTHEN CURRENT REGULATORY OPERATIONS

6.1 General

In response to the Panel Report, MEM has requested operating mines in British Columbia to assess if the conditions at other operating mines could be similar to Mount Polley. The areas of potential concern include:

- geological conditions and the potential for undrained shear failure for dams with silt and clay foundations;
- water balance adequacy, including provisions and contingencies for wet years; and
- filter adequacy.

In addition, the Panel recommended that quantitative performance objectives (QPO's) be established to clarify the application and enforcement of dam safety performance objectives.

6.2 Geotechnical Conditions

One of the important observations from the Mt. Polley Failure was that there was inadequate site characterization of the dam foundation soils. The main components of this included:

- Inadequate number of drill holes in the dam, for example there were only three deep sampled drill holes (all near the downstream toe of the dam) over the 2,000 m length of the Perimeter Embankment where the dam was breached.
- Lack of understanding of the undrained shear strength behaviour of the glaciolacustrine clay layer.
- Lack of understanding of the complexity of the geological environment and, hence, the potential influence on underestimating the number of drill holes and testing required.

The foundation soils for the Mount Polley TSF comprise glaciolacustrine clays and silts interlayered with a number of glacial till units and glaciofluvial layers. The deposits were laid down during several glacial events which result in deposits that vary from extremely dense (due to ancient glaciation) to moderately dense (recent glaciation). Glaciolacustrine layers develop in lakes, typically during the glacial retreat. These deposits can be clay rich and low strength. The dam failure occurred in one of these layers, located approximately 10 m below the natural ground surface.

The presence of weak clay layers can be accommodated with appropriate selection of soils strength and flattening of the dam slopes to ensure stability. The key element, however, is to understand the glacial history and have sufficient site investigations to characterize the soils.

Morrison TSF – Geological Setting and Site Investigations

Site investigations were carried out for the Feasibility Study of the TSF which included:

- geophysical surveys along the centerline of the dam alignments and 2 upstream and downstream sections for the Main Dam;
- geologic mapping and terrain mapping; and
- 9 sampled drill holes on the Main Dam (2.5 km long); and 4 sampled drill holes on the North Dam (2 km long).

The main observations of the site investigation concluded:

- The dam foundation comprise mainly medium dense to very dense glacial till that is moderately overconsolidated. The till is low plastic and has a low permeability. The till is fairly uniform around the site and the liquidity index (which is an indicator the glacial loading) is reasonably consistently around -0.2. Laboratory triaxial testing of the till indicates that it is dilative when sheared and has an effective friction angle of 37°.
- A possible glaciolacustrine soil was noted in one drill hole for the North Dam, on the soil/bedrock contact (the soil sample had a higher moisture content than the other till samples). Glaciolacustrine units were not identified in any of the other drillholes.

Stability Analysis

Both effective and undrained stability analyses were carried out for the Starter Dam. The effective strength analysis used a pore pressure response parameter obtained from laboratory testing and empirical relationships. Piezometers will be installed under the dam and monitored to confirm the predicted pore pressures and stability. Stability analyses were carried out using both undrained shear strength analysis and effective stress analysis of the glacial till foundation.

Future Studies

The site characterization studies carried out to date are appropriate for the Feasibility and EA Stage of the project. Additional drilling, laboratory testing, analysis and studies will be carried out for the Detailed Design Stage and for preparation of construction drawings and specifications. The stability analysis indicates that the pore pressure response in the glacial till is an important design and monitoring parameter and, hence, will require additional testing and comprehensive monitoring.

6.3 Water Balance Adequacy

The water balance adequacy has undergone a significant amount of scrutiny during the EA process, particularly with respect to potential increases in flow due to groundwater inflows into the open pit and to wet climatic conditions. The water balance will continue to be an area of comprehensive monitoring and management. The EA Application includes water treatment and discharge to allow the TSF to be managed with a minimum water volume.

6.4 Filter Adequacy

As discussed in Section 5.2 of this report, the cyclone sand that forms the main body of the dam is a natural filter for the till core.

6.5 Quantitative Performance Objectives

Quantitative performance objectives (QPOs) have not been developed for the Morrison TSF and will be developed in the Permitting stage. At this time we envisage that the QPOs may include, for example, the following:

- minimum core zone support width and associated minimum beach width; and
- water balance response requirements, e.g. pumping or emergency spillway if pond level exceeds design limits for flood management; and
- monitoring of foundation below the dam.

7 CLOSING

This report is an instrument of service of Klohn Crippen Berger Ltd. The report has been prepared for the exclusive use of Pacific Booker Minerals Inc. (Client) for the specific application to the Morrison Copper/Gold Project. The report's contents may not be relied upon by any other party without the express written permission of Klohn Crippen Berger. In this report, Klohn Crippen Berger has endeavoured to comply with generally-accepted professional practice common to the local area. Klohn Crippen Berger makes no warranty, express or implied.

Yours truly,
KLOHN CRIPPEN BERGER LTD.

19 March 2015

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Principle

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APPENDIX I

Failure Mode Effects Assessment (FMEA)

Morrison TSF - Risk Assessment
Failure Modes Effects Assment

LEGEND

PROJECT STAGE

C	CONSTRUCTION
O	OPERATION
CL	CLOSURE
P	POST CLOSURE

LIKELIHOOD

A	ALWAYS CERTAIN (annual)
B	LIKELY (10 to 100 year return period)
C	POSSIBLE (100 to 1,000 year return period)
D	RARE (1,000 to 10,000) year return period)
E	CONCEIVABLE BUT IMPROBABLE (> 10,000 year return period)

CONSEQUENCE

5	CATASTROPHIC
4	MAJOR (Significant and irreversible impacts)
3	MODERATE (Significant and reversible impacts, consistent exceedence)
2	MINOR (Temporary exceedence, reversible impact)
1	INSIGNIFICANT (Negligible impact)

CONFIDENCE

H	HIGH
M	MODERATE
L	LOW

Water Quality: Water quality, aquatic toxicity, groundwater & surface water.
Biophysical: Area of disturbance, release of tailings or waste, fauna & flora.
Community/Social: Economic costs of communities, land use and potential for loss of life and people affected
Cost: Public image and community relations, and economic cost for the project.

RISK LEVELS

1	Risk with a likelihood of "always certain" and "catastrophic" consequences (A-5), and are classified as "fatal flaws". Level 1 risks are unacceptable and mean that a new design is needed or the project should not go ahead.
2	Risk of "likely" likelihood and "catastrophic" consequences (B-5); and risk with "always certain" likelihood and "major" consequences (A-4). Level 2 risks are of concern to senior management, shareholders, and the potentially affected public. They require a high level of scrutiny and detailed risk management and contingency plans.
3	Risk with "possible" likelihood and "catastrophic" consequences (C-5); risk with "likely" likelihood and "major" consequences (B-4); and risks with "always certain" likelihood and "moderate" consequences (A-3). Level 3 risks are of concern of senior management, engineering design and operating staff. They require a risk management plan and contingency plan.
4	Risk with "unlikely" likelihood and "catastrophic" consequences (D-5); risk with "possible" likelihood and "major" consequences (C-4); risks with "likely" likelihood and "moderate" consequences (B-3); and, risks with "always certain" likelihood and "minor" consequences (A-2). Level 4 risks are of concern to the Engineering design and operations staff and require operating procedures and risk management plans to manage the risks.
5	Risk with "conceivable but improbable" likelihood and "catastrophic" consequences (E-5); risk with "unlikely" likelihood and "major" consequences (D-4); risks with "possible" likelihood and "moderate" consequences (C-3); risks with "likely" likelihood and "minor" consequences (B-2); and, risk with "always certain" likelihood and "insignificant" consequences (A-1). Level 5 risks are of concern to the Engineering design and operations staff and require operating procedures and risk management plans to manage the risks.
>5	Risks which range from "conceivable but improbable" likelihood and "major" consequences to "likely" likelihood and "insignificant" consequences (B-1, C-1, C-2, D-1, D-2, D-3, E-1, E-2, E-3, E-4) are considered to be inconsequential; however, they are presented in the risk tables because but they were discussed in the risk assessment work shop.

MORRISON PROJECT TAILINGS STORAGE FACILITY - RISK REVIEW
March 19, 2015

Morrison Project TSF							CONSEQUENCES				CONFIDENCE				
COMPONENT/SUB-COMPONENT	I. D. No.	CLASS OF FAILURE MECHANISM	FAILURE MODE AND CAUSE (WHAT IF?)	EFFECTS	PROJECT STAGE	LIKELIHOOD	WATER QUALITY	BIOPHYSICAL	COMMUNITY/ SOCIAL	COST	LEVEL OF CONFIDENCE	ADJUSTED LIKELIHOOD	COMPENSATING FACTORS AND RISK MANAGEMENT COMPONENTS	RISK LEVEL (ADJUSTED FOR LEVEL OF CONFIDENCE)	RISK LEVEL
100 SERIES: DAM SAFETY MAIN DAM															
FILTERS, DRAINS, FILL, FOUNDATION	100.1	FOUNDATION	PORE PRESSURES IN TILL FOUNDATION SOILS ARE HIGHER THAN PREDICTED	REDUCTION IN STABILITY REQUIRING SLOPE FLATTENING	C/O	C	1	1	1	3	M	C	STABILITY MODELLING SUPPORTED BY SITE INVESTIGATION DATA, PIEZOMETERS TO MEASURE PRESSURES, RISK REDUCES WITH TIME AS FOUNDATION MATERIAL CONSOLIDATES	C, 3	5
	100.2	FOUNDATION	PRESENCE OF UNDETECTED WEAK GLACIOLACUSTRINE LAYER	C/P	C/O	C	5	5	5	5	H	D	SITE INVESTIGATION SHOWS MINOR GLACIOLUCUSTRINE CLAYS PRESENT AT THE NORTH DAM FOUNDATION. ADDITIONAL DRILLING TO BE CONDUCTED DURING DETAILED DESIGN	D, 5	4
	100.3	FOUNDATION	DAM UNDERDRAINS FAIL TO PERFORM DUE TO SEDIMENTATION OR DETERIORATION OF DRAIN MATERIAL	RISE IN WATER TABLE IN THE CYCLONE SAND FILL, SMALL REDUCTION IN FACTOR OF SAFETY	O/P	C	1	1	2	2	M	C	HIGH FACTOR OF SAFETY IN DRAIN CAPACITY. PIEZOMETERS MONITOR PORE PRESSURES IN DAM	C, 2	>5
	100.4	PIPING AND CRACKING	CRACKING OF THE TILL CORE DUE TO DIFFERENTIAL SETTLEMENT	TAILINGS PIPE THROUGH THE CRACK AND INTO THE DAM FILL, LEADING TO EROSION AND RELEASE OF TAILINGS	O/P	D	3	3	3	2	L	C	GEOMEMBRANE LINER WILL RETARD PIPING. CYCLONE SAND FILL IS A NATURAL FILTER FOR BOTH THE TILL AND THE UPSTREAM TAILINGS	C, 3	5
	100.5	HUMAN INTERVENTION	INADEQUATE QUANTITY OF CYCLONE SAND	REQUIRE BORROW MATERIAL, HIGHER COST	O	C	1	1	1	2	M	C	INCREASE CYCLONE PLANT RECOVERY, TESTING WITH QUALITY VS RECOVERY FOR DOWNSTREAM; EXPAND PLANT FOR NEW TONNAGE	C, 2	>5
	100.6	PIPING AND CRACKING	INTERNAL EROSION (PIPING) OF DAM	DEGRADATION IN STRUCTURAL PROPERTIES RESULTING IN DAM FAILURE	O/P	D	5	5	5	2	M	D	GEOMEMBRANE LINER AND CYCLONE SAND PRESENT A CONSERVATIVE DESIGN, QA/QC DURING CONSTRUCTION, DAM SAFETY MONITORING,	D, 5	4
	100.7	HUMAN INTERVENTION	SURFACE EROSION OF DAM	LOCALISED FAILURE AND REPAIRS REQUIRED	O/P	D	3	4	4	3	M	D	MAINTENANCE OF THE SLOPE AND RECLAMATION ON CLOSURE	D, 4	5
	100.8	FOUNDATION	EARTHQUAKE LEADING TO SLOPE FAILURE	DAM DEFORMATION WHICH IS LESS THAN CORE THICKNESS WITH NO TAILINGS RELEASE	O/P	D	4	4	5	4	M	D	CONSERVATIVE DESIGN, DAM SAFETY MONITORING,	D, 5	4
200 SERIES: IMPOUNDMENT & WATER QUALITY - OPERATIONS															
TAILINGS BEACH, RESERVOIR SLOPE, RECLAIM, SEEPAGE POND, TAILS STORAGE/ POND LEVEL	200.1	IMPOUNDMENT FOUNDATION	SPRINGS IN IMPOUNDMENT AREA "LIFT" THE GEOMEMBRANE LINER BEFORE TAILINGS ARE AVAILABLE TO LOAD THE LINER.	ADDITIONAL COSTS FOR UNDERDRAINS TO TEMPORARILY RELIEVE THE PRESSURE	C	B	1	1	1	2	M	B	INSTALL UNDERAINS IN AREAS OF SPRINGS	B, 2	5
	200.2	IMPOUNDMENT FOUNDATION	BEDDING SURFACE FOR GEOMEMBRANE LINER IS ROUGH, RESULTING IN HOLES IN THE LINER.	INCREASE IN SEEPAGE THROUGH THE LINER, POTENTIAL GROUNDWATER EFFECTS	P	C	2	1	2	2	M	C	QA/QC OF LINER BEDDING PREPARATION. TAILINGS/LINER SYSTEMS ARE VERY ROBUST AND CAN ACCOMMODATE HOLES IN THE LINER WITHOUT A MEASUREABLE INCREASE IN SEEPAGE. NATURAL TILL FOUNDATION FURTHER LIMITS SEEPAGE	C, 2	>5
	200.3	IMPOUNDMENT FOUNDATION	HOLES IN GEOMEMBRANE LINER WITHIN AN AREA OF THE IMPOUNDMENT WHERE "FREE WATER" IS PRESENT.	INCREASE IN SEEPAGE THROUGH THE LINER, POTENTIAL GROUNDWATER EFFECTS	O/P	C	2	1	2	2	M	C	TEMPORARY CONDITION UNTIL TAILINGS BLANKET THE AREA. QA/QC OF LINER BEDDING PREPARATION. NATURAL TILL FOUNDATION FURTHER LIMITS SEEPAGE	C, 2	>5
	200.4	IMPOUNDMENT FOUNDATION	PERMEABILITY OF POND SEDIMENTS IN THE UNLINED AREAS IS HIGHER THAN PREDICTED	INCREASE IN CONTAMINANT LOADING TO FOUNDATION GROUNDWATER.	C/0	C	2	1	2	2	M	C	SITE INVESTIGATIONS TO QUANTIFY PERMEABILITY. PLACE LINER IF REQUIRED.	C, 2	>5
	200.5	IMPOUNDMENT FOUNDATION	STEEP ROCK SLOPE REQUIRES GEOMEMBRANE LINER TO BE PLACED WITHOUT A TILL BEDDING	INCREASE IN CONTAMINANT LOADING TO FOUNDATION GROUNDWATER.	C/O/P	C	1	1	1	2	L	B	TAILINGS/LINER SYSTEMS ARE VERY ROBUST AND CAN ACCOMMODATE HOLES IN THE LINER WITHOUT A MEASUREABLE INCREASE IN SEEPAGE. PREFERENTIAL SPIGOTTING OF FINE TAILINGS OVER THESE AREAS. RESLOPE OF ROCK SURFACES TO ALLOW PLACEMENT OF BEDDING TILL	B, 2	5
	200.6	HUMAN INTERVENTION	TAILINGS DEPOSITION IS NOT MANAGED TO MAINTAIN BEACHES TO SUPPORT THE DAM CORE ZONE	REQUIRES ADDITIONAL FILL TO SUPPORT THE CORE. INCREASES PRESSURES ON THE DAM	O/CL	B	2	2	2	2	M	B	DETAILED DEPOSITION PLANNING AND MONITORING.	B, 2	5
	200.7	OVERTOPPING	CUMULATIVE WET YEARS RESULT IN LARGE VOLUME OF WATER THAT MUST BE RELEASED.	REQUIRES CONSTRUCTION OF ADDITIONAL TREATMENT CAPACITY OR OPERATION AT A REDUCEC ED EFFICIENCY. WATER QUALITY EFFECTS ON MORRISON LAKE.	O/CL	C	4	1	4	3	M	C	DETAILED WATER BALANCE. MONITORING AND MODELING OF MORRISON LAKE. POTENTIAL DISCHARGE OF TREATED WATER TO BABINE LAKE	C, 4	4
	200.8	OVERTOPPING	LANDSLIDE IN TSF FOOTPRINT CAUSING DISPLACEMENT OF PONDED WATER AND/OR TAILINGS	WATER WAVE POTENTIALLY OVERTOPS DAM	O/CL	D	4	3	3	3	H	D	GEOHAZARD MAPPING, CONSERVATIVE DESIGN, CAPACITY, MAINTENANCE	D, 4	5
	200.9	HUMAN INTERVENTION	CLEANER TAILINGS BECOMES UNSATURATED DURING OPERATIONS CREATING ACID MINE DRAINAGE	DEGRADATION OF WATER QUALITY, POSSIBLY REQUIRING TREATMENT	O/CL	C	2	1	2	2	M	C	QA OF SPIGOTTING SYSTEM AND MONITORING OF POND WATER LEVELS	C, 2	>5

MORRISON PROJECT TAILINGS STORAGE FACILITY - RISK REVIEW
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Morrison Project TSF							CONSEQUENCES				CONFIDENCE				
COMPONENT/SUB-COMPONENT	I.D. No.	CLASS OF FAILURE MECHANISM	FAILURE MODE AND CAUSE (WHAT IF?)	EFFECTS	PROJECT STAGE	LIKELIHOOD	WATER QUALITY	BIOPHYSICAL	COMMUNITY/SOCIAL	COST	LEVEL OF CONFIDENCE	ADJUSTED LIKELIHOOD	COMPENSATING FACTORS AND RISK MANAGEMENT COMPONENTS	RISK LEVEL (ADJUSTED FOR LEVEL OF CONFIDENCE)	RISK LEVEL
300 SERIES: TAILINGS AND SURFACE WATER MANAGEMENT STRUCTURES															
PUMP BARGES, PUMPBACK SYSTEMS, PUMPING, DIVERSION CHANNEL, TAILINGS PIPELINE, CYCLONE STATIONS, THICKENERS	300.1	HUMAN INTERVENTION	TAILINGS PIPELINE BREAK	UNCONTAINED SPILL OF TAILINGS SLURRY	O	B	2	2	2	2	M	B	PRESSURE SENSORS FOR AUTOMATIC SHUTDOWN, LINED DITCH, EMERGENCY STORAGE AT LOW POINTS	B, 2	5
	300.2	HUMAN INTERVENTION	WATER RECLAIM PIPELINE BREAK	UNCONTAINED SPILL OF PROCESS WATER	O	B	2	1	2	1	M	B	PRESSURE SENSORS FOR AUTOMATIC SHUTDOWN, LINED DITCH, EMERGENCY STORAGE AT LOW POINTS	B, 2	5
	300.3	OVERTOPPING	PUMP BARGE BREAKDOWN FOR EXTENDED TIME COMBINED WITH RAINFALL	INCREASES POND LEVEL	O	B	1	1	1	1	M	B	BACKUP PUMPS, MONITORING AND ADAPTIVE MANAGEMENT	B, 1	>5
	300.4	HUMAN INTERVENTION	SHUTDOWN OF THICKENER FOR EXTENDED TIME	INCREASE IN WATER DELIVERED TO IMPOUNDMENT AND TO BE PUMPED BACK	O	B	1	1	1	1	M	B	RECLAIM WATER CAPACITY IN IMPOUNDMENT IS AVAILABLE TO MANAGE INFLOW	B, 1	>5
	300.5	HUMAN INTERVENTION	SEEPAGE COLLECTION SYSTEM BREAKDOWN FOR EXTENDED TIME	EXCEEDS STORAGE CAPACITY OF FACILITY AND REQUIRES DISCHARGE	O	B	3	1	3	2	M	B	BACKUP PUMPS FOR CONTINGENCIES	B, 3	4
	300.6				O/CL	D	4	3	3	3	H	D		D, 4	5
400: SERIES CLOSURE															
COVERS, CLOSURE SPILLWAY, WATER TREATMENT PLANT, FINAL DAM	400.1	OVERTOPPING	SPILLWAYS PLUG AND DAM OVERTOPS	OVERTOPPING LEADS TO EROSION OF THE DAM AND RELEASE OF TAILINGS AND WATER	CL/P	D	5	2	2	2	M	D	TWO SPILLWAYS ARE PROVIDED FOR REDUNDANCY. DAM CREST WIDENED TO INCREASE RESILIENCE TO OVERTOPPING. LONG TERM MONITORING OF SPILLWAYS. NORTH DAM CONSTRUCTED LOWER THAT THE OTHER DAMS SO THAT FAILURE IS INTO NAKINILERAK LAKE, NOT MORRISON LAKE	D, 5	4
	400.2	HUMAN INTERVENTION	TAILINGS TOO SOFT TO RECLAIM	INCREASE COST TO RECLAIM	CL	B	1	2	1	2	M	B	USE GEOTEXTILES & CYCLONED SAND MAT	B, 2	5
	400.3	HUMAN INTERVENTION	EARLY OR TEMPORARY CLOSURE DUE LOWER METAL PRICES	SURPLUS WATER TREATED AND STORED IN THE OPEN PIT	O/CL	C	3	1	3	3	L	B	TREATMENT PLANT TO CONTINUE DURING TEMPORARY CLOSURE	B, 3	4
	400.4	HUMAN INTERVENTION	EROSION OF DAM SLOPES	WASHOUT OF SLOPE AND EVENTUAL DEGRADATION OF THE DAM, REQUIRING MAINATENANCE	CL/P	B	2	2	2	2	L	A	EROSION RESISTANCE COVER ON THE DAM. ONGOING MONITORING AND MAINTENANCE	A, 2	4
	400.5	HUMAN INTERVENTION	END LAND USE OBJECTIVES NOT MET	ADDITIONAL COSTS	CL	C	1	3	1	2	M	C	TEST PLOTS BEFORE CLOSURE	C, 3	5
	400.6	PIPING AND CRACKING	CRACKING OF THE TILL CORE AND/OR PIPING OF TAILINGS THROUGH THE CORE AND LINER	PIPING OF TAILINGS AND INTERNAL EROSION OF THE DAM LEADING TO REPAIRS	CL/P	D	2	2	2	2	L	C	GEOMEMBRANE LINER AND CYCLONE SAND ARE RESISTANT TO PIPING. HYDRAULIC GRADIENTS WILL DECREASE ON CLOSURE WITH THE LIMITED WATER POND	C, 2	>5
	400.7	HUMAN INTERVENTION	NEUTRAL LEACHING DUE TO SULPHATES IN THE CYCLONE SAND OR RUNOFF FROM THE TSF BEACH SLOPES	DEGRADATION OF WATER QUALITY REQUIRING LONGER TERM TREATMENT AND PUMPBACK FROM THE SEEPAGE PONDS	CL	B	2	2	2	2	M	B	MONITORING OF WATER QUALITY UNTIL THE SYSTEM STABILIZES	B, 2	5
	400.8	FOUNDATION	LONG TERM DEGRADATION OF THE GEOMEMBRANE LINER	INCREASE IN CONTAMINANT LOADING TO FOUNDATION GROUNDWATER	P	D	2	1	2	2	L	C	TAILINGS GEOMBRANE LINER SYSTEMS CAN ACCOMMODATE CRACKING WITHOUT SIGNIFICANT INCREASES IN SEEPAGE. LONG TERM CONSOLIDATION OF TAILINGS REDUCES TAILINGS PERMEABILITY	C, 2	>5
	400.9	FOUNDATION	ARD FROM TAILINGS	DEGRADATION OF WATER QUALITY, POSSIBLY REQUIRING TREATMENT	P	D	3	1	1	2	M	D	DETAILED MATERIAL CHARACTERISATION AND CONSERVATIVE PREDICTIVE MODELLING	D, 3	>5

Project Stage	Likelihood		Consequences		CONFIDENCE	
C - Construction	A	H - High (annual)	5	E- Extreme (catastrophic failure)	H	High
O - Operation	B	M- Moderate (10 to 100 year return period)	4	H - Significant and irreversible impacts	M	Moderate
C1- Closure	C	L - Low (100 to 1,000 year return period0	3	M - Significant and reversible impacts, consistent	L	Low
P - Post Closure	D	VL - Very low (1,000 to 10,000) year return period)	2	L - Low impact, temporary exceedance, reversible		
	E	N- Negligibly (>10,000 year return period)	1	N - Negligible impact		

MORRISON PROJECT (PROPOSED DESIGN)

(Sheet: TSF - PROPOSED DESIGN)

RISK REVIEW CHART

CONSEQUENCE	LIKELIHOOD: E - CONCEIVABLE BUT IMPROBABLE	D - UNLIKELY	C - POSSIBLE	B - LIKELY	A - ALWAYS CERTAIN
5 - CATASTROPHIC	RISK LEVEL 5 — E, 5	RISK LEVEL 4 — D, 5 100.2, 100.8, 400.1	RISK LEVEL 3 — C, 5	RISK LEVEL 2 — B, 5	RISK LEVEL 1 — A, 5
4 - MAJOR	RISK LEVEL >5 — E, 4	RISK LEVEL 5 — D, 4 200.8, 300.6	RISK LEVEL 4 — C, 4 200.7	RISK LEVEL 3 — B, 4	RISK LEVEL 2 — A, 4
3 - MODERATE	RISK LEVEL >5 — E, 3	RISK LEVEL >5 — D, 3 400.9	RISK LEVEL 5 — C, 3 100.1, 100.4, 400.5	RISK LEVEL 4 — B, 3 300.5, 400.3	RISK LEVEL 3 — A, 3
2 - MINOR	RISK LEVEL >5 — E, 2	RISK LEVEL >5 — D, 2	RISK LEVEL >5 — C, 2 100.3, 200.2, 200.3, 200.4, 200.9, 400.6, 400.8	RISK LEVEL 5 — B, 2 200.1, 200.5, 200.6, 300.1, 300.2, 400.2, 400.7	RISK LEVEL 4 — A, 2 400.4
1 - INSIGNIFICANT	RISK LEVEL >5 — E, 1	RISK LEVEL >5 — D, 1	RISK LEVEL >5 — C, 1	RISK LEVEL >5 — B, 1 300.3, 300.4	RISK LEVEL 5 — A, 1

WATER QUALITY		BIOPHYSICAL		SOCIO-ECONOMIC	COST
Surface Water	**Groundwater**	**Morrison Lake Habitat**	**Terrestrial and Wetland Habitat**		
No detectable changes relative to “background” conditions.	No detectable changes relative to “background” conditions.	No measurable changes	No measurable changes	No measurable changes	No measurable changes
Minor changes, occasional exceedance of water quality guidelines in Stream 7	Minor changes, occasional exceedance of water quality guidelines in monitoring wells	Area affected is limited to Stream 7	<5 Ha of terrestrial habitat lost. No critical wildlife habitat affected.	No negative effect in the socio-economics of local communities. Effects last less than 1 year. Affects < 10 people	Less than $1 million in costs. Local public relations concern.
Exceedance of water quality guidelines in Stream 7; Occasion exceedance of water quality guidelines in Morrison Lake. Sediment load between twice and 5 times baseline. Measurable effect on salmon.	Exceedance of water quality guidelines in monitoring wells on a regular basis;	Degradation of spawning habitat in Morrison Lake near the outlet of Stream 7	5 Ha to 20 ha of habitat loss. Migration route disrupted for yellow-listed species. Mitigation/compensation possible.	Reduction in the social and economic conditions of local communities. Effects lasting 1-5 years. Affects 10 to 100 people. Potential for 1 life lost.	$1 to 10 million in costs. Regional public relations concern.
Up to 10 times water quality guidelines for more than 7 days in Morrison Lake. Sediment loads greater than 5 times to 100 times baseline for more than a month. Significant effect on salmon.	Up to 10 times water quality guidelines for more than 7 days in monitoring wells	Degradation of spawning habitat around the perimeter of Morrison Lake	20 Ha to 100 Ha of habitat lost; Migration route for blue-listed species lost. Mitigation/compensation possible; Rare ecosystem affected and protection measures needed.	Reduction in the social and economic conditions of regional communities. Affects 100 to 1,000 people. Potential for <10 lives lost.	$10 to 100 million in costs. National public relations concern.
Over 100 times water quality guidelines in Morrison Lake. Sediment loads greater than 100 times baseline for more than a month. Very significant effect on salmon	Over 100 times water quality guidelines in monitoring wells	Degradation of spawning habit it Morrison River.	>100 Ha of habitat lost; Migration route for red-listed species lost. No mitigation possible.	Reduction in the social and economic conditions of national communities. Affects > 1,000 people. Potential for 10 or more lives lost.	>$100 million in costs. International public relations concern.