9. CLOSURE AND RECLAMATION

9.1 General

The closure plan for the Morrison Copper/Gold project has been revised from the EAC to include the major changes presented in this report, and described in this section. The closure plan provides for a more sustainable landscape and reduces the long term risks associated with acid rock drainage. The main visual features of the closure plan are shown on Figure 9.1 and the overall closure plan for the site is shown on Figure 9.1.

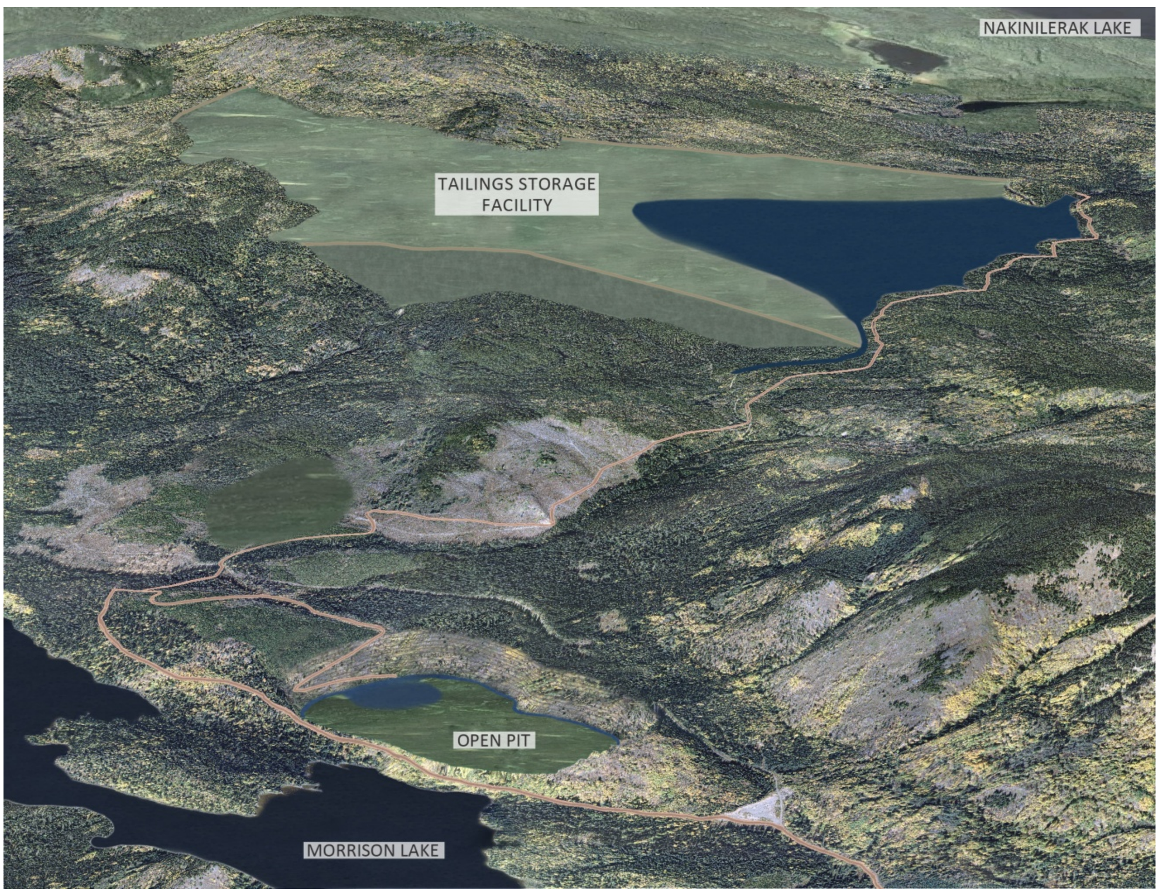


Figure 9.1 Morrison Copper/Gold Project - Post Closure

9.2 Tailings Storage Facility

9.2.1 General

The TSF will be closed as combination of "wet" and "dry" areas with a water pond occupying approximately 35% of the area. Wetlands will be constructed around the pond perimeter and the remaining area will be covered with a growth medium (glacial till and organics) and reforested. The dam slopes will be covered with erosion protection materials and re-vegetated.

Management of the water pond as a closed system will occur until it is assured that the water quality is suitable for release via a closure spillway located in the left (southeast) abutment of the Main Dam. Until water is suitable for release, mitigation measures may include that surplus will be treated prior to discharge.

9.2.2 Water Pond

The water balance of the TSF is described in Section 7 of this report and on completion of mining the process water volume in the TSF is estimated to be 300,000 m^3. On closure, the majority of the pond water will be pumped to the open pit, with approximately 10,000 m^3 remaining.

The closure objective is to minimize the volume of remaining residual process to allow natural dilution to attenuate the water quality as the pond size increases to the final pond level. The water quality of the pond on closure will be influenced by runoff from the tailings beaches, fresh water runoff inflows and the volume of residual process water. The water quality aspects are discussed in Section 8 of this report.

The TSF pond will subsequently fill with precipitation and runoff, over a period of approximately 2 years, to a final water volume of approximately 4 Mm^3. The final water pond will cover an area of up to 1.7 km^2 and be up to 7 m deep, with an average depth of 2.5 m. A closure spillway will be constructed from the pond around the left (southeast) abutment of the Main Dam.

9.2.3 Reclamation

Reclamation of the TSF beach areas (340 ha) will require stockpiling of sufficient soil during the life of the mine. The closure cover will consist of a growth medium comprising organics, topsoil and glacial till. The cover will be nominally 300 mm thick, with approximately 200 mm (650,000 m^3) of glacial till and 100 mm (350,000 m^3) of organic growth medium. Glacial till will be borrowed from:

a) The Overburden Stockpile (estimated stored volume is 550,000 m^3), however portions are required for reclamation of the plant-site area;

b) The foundation area of the waste rock dump, which has a thick glacial till unit. The glacial till soil will be tested for potential ARD contamination prior to being used; and

c) Glacial till borrowed from the TSF footprint.

The organic bearing stockpile will store organic material collected from the TSF impoundment area and is shown in plan on Figure 4.1. The material will be progressively stockpiled as the impoundment area increases, with a total volume of approximately 400,000 m^3.

The vegetation will consist of native species, including grasses, shrubs and trees.

Wetlands will be constructed along the perimeter of the impoundment, which has a total circumferential length of approximately 2.5 km. The width of the submergent wetlands (water depth <2 m) would be in the order of 200 m wide (50 ha), and the emergent wetland width would be in the order of 70 m (17.5 ha).

9.3 Mine Area

9.3.1 General

The closure plan is to place PAG waste rock into the open pit up to an elevation a few meters below the elevation of Morrison Lake. The pit area will be closed as a combination of shallow pond and wetland. Surplus PAG rock that cannot be accommodated in the open pit will be placed in the TSF as described in Section 4.4.3 of this report. The footprint of the waste rock dumps will be cleared of potentially contaminated soils and revegetated.

The process plant and most of the associated facilities will be decommissioned. The water treatment plant will occupy a portion of the existing building.

A detailed plan and section through the open pit after closure is shown on Figure 9.2 and the main design components are described in the following sections.

9.3.2 Reclamation of Open Pit Area

The open pit area will be reclaimed with three main zones, shown in plan and section on Figure 9.2 and summarized as follows:

<u>Pond Area:</u>

A pond area is required to seasonally store water to allow the water treatment plant to be operated year round. The pond will be approximately 10 ha in area and 3 m deep. PAG rock will be placed to elevation 729.5 m and capped with glacial till to elevation 730 m. The pond may develop a 1 m thick ice cover during the winter and the required storage volume below the ice is based on the water treatment rate of 55 m^3/hr over 4.5 winter months, which is approximately 180,000 m^3.

Non Pond Area:

The remaining area will be filled with PAG rock to elevation 729.5 m, and non-PAG rock to elevation 732.5 m and glacial till to elevation 733 m. This area will be subdivided into two zones, as follows:

1. Pit Wall Collection: A 1 m high berm of glacial till will be placed 20 m from the pit wall and the area will be sloped at 0.5% towards the water pond. The purpose of this zone is to, as far as practical, separate pit wall drainage from interior drainage, and provide a future opportunity to reduce the volume of water requiring treatment; and

2. Wetland: The interior of the bermed area will be reclaimed with a growth medium and wetland plants in the order of 68 ha. The purpose of this zone is to provide a future opportunity to reduce the volume of water requiring treatment and to provide habitat.

A pump station will be placed near the water pond area and water will be pumped to the water treatment plant. The water balance assumes that any surplus water from the wetland area will be included as treatment water, although there is a future opportunity to separately discharge this water, when it meets discharge water quality criteria.

9.4 Water Treatment and Morrison Lake Diffuser

The water treatment plant will be sized to treat all water that collects within the pit area (55 m^3/hr) with a 50% addition for a maximum plant capacity of 85 m^3/hr. Water will be pumped from the open pit pond to the water treatment plant. The open pit pond has storage capacity to attenuate seasonal flows. During extreme events, surplus water would be stored within the pond, pit wall collection bench, and potentially the wetland area. The water treatment plant would then be operated at a higher capacity to draw down the flood flow.

Sludge containment pads will be constructed adjacent to the water treatment plant. Typical methods used in returning alkaline treated water down to acceptable water quality pH (i.e., pH 6.5-8) include aeration or CO_2 bubbling before discharge.

9.4.1 Treatment Plant Discharge

Discharge of treated water will be pumped to a submerged diffuser in Morrison Lake. The pump system will be housed within the treatment plant, and consist of two centrifugal pumps. Each pump is designed to pump the base flow, with one pump operating at all times and one pump on standby. During surge periods, both pumps will be operated for discharge at up to 1.5 times the base flow.

Water will be conveyed to the diffuser through a 150 mm diameter HDPE pipeline routed across the pipeline crossing and along the former ammonium nitrate and emulsion silos access road to the shore of Morrison Lake. The remaining 2,000 m of pipeline will sit on the lake bottom weighted by concrete ballasts secured at 100 m intervals. The average Morrison Lake water elevation is 732 masl, representing a total vertical head of -93 m. The total pipeline length is approximately 4,300 m. Electrical power will be supplied by existing transmission and distribution infrastructure for the water treatment plant.

9.4.2 Sludge Management

Sludge produced from similar High Density Sludge plants in British Columbia are being both stored on-land (Teck Cominco – Kimberly) and underwater (Equity Silver). The sludge is chemically inert provided it is not leached with low pH solutions, which would re-mobilize the metals.

The Expected Case sludge disposal design will be an on-land storage facility adjacent to the water treatment plant (Figure 9.3). The preferred storage solution is to keep the pile drained and to minimize surface water infiltration with a low permeability soil cover.

9.4.3 Sludge Production

Quantity estimates are based on a sludge production rate of 4 kg per cubic metre of treated water (SGS-CEMI, 2011). The average annual flow of water from the pit lake to the treatment plant has been estimated as 55 m^3/hr. Table 9.1 summarizes the expected sludge production values based on the expected flow and sludge production rate.

Table 9.1 Sludge Production Rate

Design Case	Outflow from Pit to Treatment Plant	Sludge Production		
		(kg/m^3)	(kg/hr)	(kg/day)
Average Flow	55 m^3/hr	4	220	5,280

9.4.4 Storage Requirements

The key parameter required to estimate storage quantities is the in-situ density of the sludge after it is allowed to drain. Based on past experience SGS-CEMI predicts that the in-situ solids content of the sludge after it has drained could vary between 55% and 60% depending on the concentration of iron. Assuming a specific gravity for the sludge of 1.5 the in situ density of the sludge could range from 675 kg/m^3 to 750 kg/m^3. An average in situ dry density of 725 kg/m^3 was assumed for volume estimates.

Table 9.2 summarizes the storage requirements if the water treatment plant is operated for the base case 100 years, or an upper bound 500 years.

Table 9.2 Sludge Storage Requirements

In Situ Dry Density	Incremental Storage Volume	Total Storage Requirements	
		Base Case (100yr)	Upper Bound (500yr)
725 kg/m^3	2,660 m^3/yr	266,0000 m^3	1.3 M m^3

9.4.5 Sludge Handling

Sludge will be removed from the clarifier on a periodic basis. Sludge will be pumped to sludge holding cells located adjacent to the plant. The sludge is expected to settle up to a maximum density of 55% to 60% solids. The consolidation of the sludge may release up to 15 m^3/day (0.7 m^3/hr) at the base case sludge production rate. Surplus water from the settling will be recycled back to the treatment plant.

9.4.6 Sludge Storage Facility Design

<u>Layout</u>

The Sludge Storage Facility (SSF) will be laid out as a series of adjoining cells formed by a 4 m high containment berm. The containment berm will be constructed with 2H:1V slopes and a crest width of 4 m. Each cell will have an area of 10,000 m^2 (approximately 100 m x 100 m) and will provide storage for 20 years of water treatment and sludge disposal. When each cell is filled to capacity, the cell will be capped with a 0.7 m thick low permeability glacial till plus 0.3 m-thick organic soil cover to reduce infiltration. Sand and gravel drains along the inner berm surface and base will allow the sludge to drain and consolidate with time. Over the base case period of treatment (100 years), the sludge containment facility will grow to total size of approximately 70,000 m^2. Berm and cover construction will require approximately 100,000 m^3 of glacial till earthfill from the remaining Overburden Stockpile, and 10,000 m^3 of clean sand and gravel.

The Expected Case sludge disposal facility is shown on Figure 9.3. The upper bound disposal case (500 years) will be accommodated by adding additional cells laterally and increasing the height of existing cells. The ultimate facility height will be approximately 20 m for the upper bound storage case.

Water Management

The sludge will tend to release a small amount of water as the sludge consolidates. To allow the excess water to drain, containment berms will be constructed with a pervious sand and gravel drainage zone. As long as the sludge does not come into contact with low pH water, the consolidation water will have the same quality as the treated effluent. This consolidation water will run off the surface, mixing with natural runoff.

Flood water, consisting of precipitation over the cell footprint area, will be discharged through culverts or an armoured swale in the berm crest.

Drainage exiting the containment berms will require monitoring to verify the water quality. In the event that water quality of seepage does not meet discharge requirements, seepage can be collected with ditching and directed to the open pit.

Closure

On closure the SSF will be capped to reduce infiltration. The cover surface will be graded to prevent water from ponding on the surface. The surface will be reclaimed with a 0.3 m thickness of organic bearing material and re-vegetated similarly to the WRD.

9.4.7 Morrison Lake Diffuser

The treated wastewater will be discharged vertically from a diffuser located at the deepest point (~60 m) in the north-basin of Morrison Lake. An elongated elliptical plume will form above the diffuser. For a 100:1 dilution, the plume will extend 40 m vertical and have a maximum width of about 5 m.

9.5 Closure Cost Estimate

The preliminary cost estimate presented in the EAC has been updated to include the project changes presented in the revised closure plan. The main cost changes include the following:

- Placement of PAG rock back into the open pit: The loading and haulage cost for PAG rock movement on closure is estimated to be approximately \$0.35/t, for loading, haulage and placement. The placement cost is based on using the mine equipment and a combination of: (a) direct haulage to the base of the open pit for High PAG rock; and (b) short haulage to the pit rim and end dumping into the open pit

- The mixing of lime with the PAG rock will use several methods: (a) mixing of lime with a pump and circulation of water in the pit lake as it is being filled; and (b) placement of a lime slurry, via a lime mixing tank and an overhead "drive-through" bay for the haul trucks that would dose each truck load prior to placement;

- Hauling and placing soil materials and revegetation: The aerial extent of placement of soil materials and revegetation increases due the reclamation of the TSF and the open pit wetland. The additional area is approximately 420 ha.

- Hauling and placement of overburden materials: The area decreases as a result of not placing a soil cover over the waste rock dump and is replaced with a lower volume of material for the open pit closure cover.

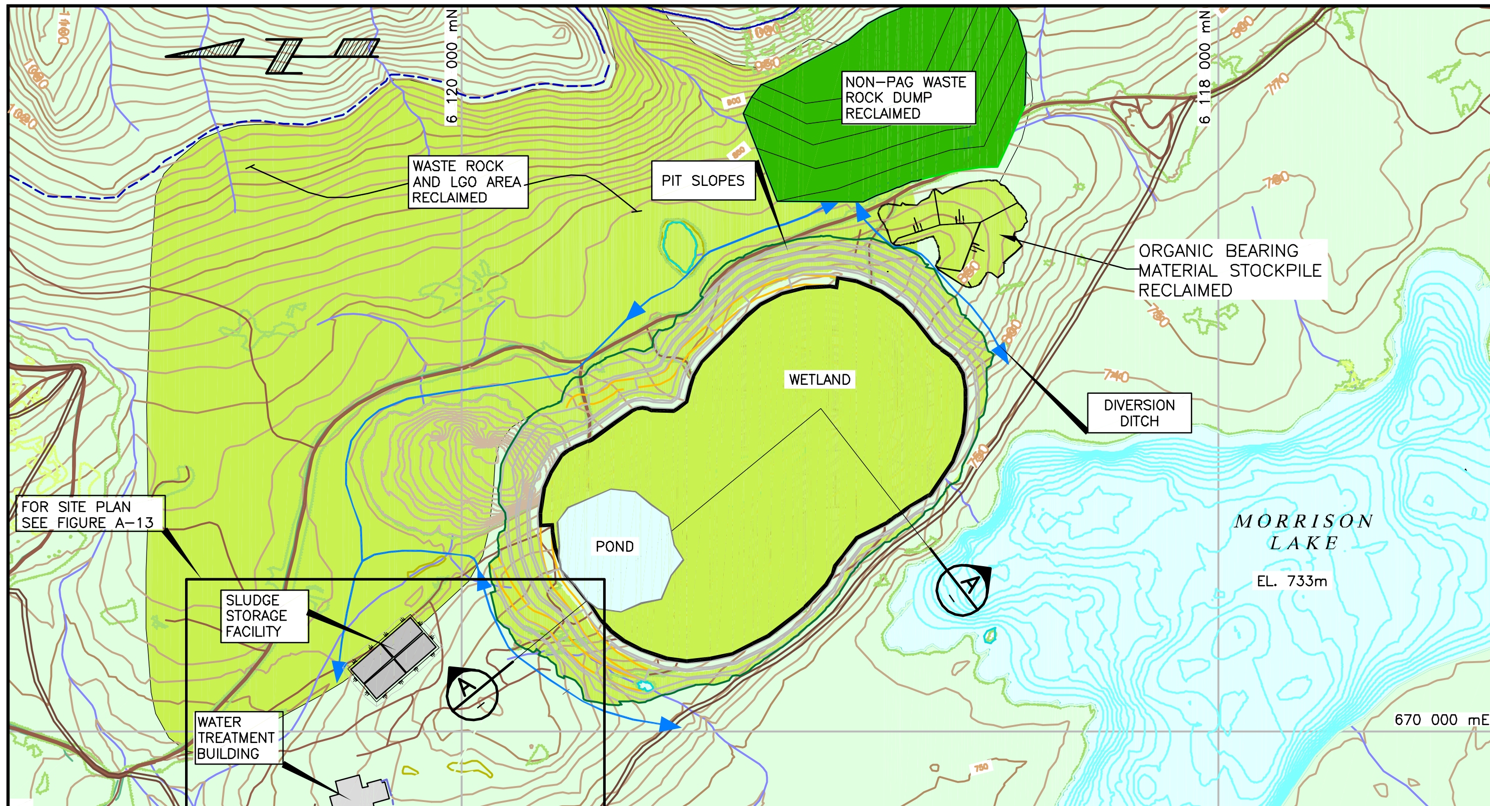
A summary of the revised preliminary cost estimate is provided in Table 9.3.

Table 9.3 Preliminary Closure, Post Closure and Reclamation Cost Estimate

Mine Activity Category and Description	Quantity	Unit	Cost	Total Cost
Closure Costs – Area Disturbance				
Load – haul – place PAG rock in pit	148,000,000	tonne	$51,800,000	
Lime treatment of PAG rock	7.5	years	$6,400,000	
Hauling and placing soil materials	613	ha	$12,800,000	
Hauling and placing non-PAG rock	4,000,000	tonne	$2,000,000	
Hauling and placing overburden materials	80	ha	$7,000,000	
Site road and general recontouring			$500,000	
Revegetation of site (seeing/planting/mulch)	613	ha	$4,600,000	
Subtotal				**$85,100,000**
Closure Costs – Lump Sum Items				
Mill building and foundation	LS		$500,000	
Structures in plantsite area (13)	LS		$1,750,000	
Structures outside of plantsite area (18)	LS		$300,000	
Landfill decommissioning	LS		$150,000	
Land farming hydrocarbons	LS		$250,000	
Stockpiles and collection ditches	LS		$200,000	
TSF closure spillway and earthworks	LS		$300,000	
Subtotal				**$3,450,000**
Post Closure Costs				
Local power line decommissioning	LS		$50,000	
Hauling and placing soil materials	129	ha	$2,710,000	
Revegetation of site (seeing/planting/mulch) – terrestrial (120 ha) and littoral (40ha)	160	ha	$1,000,000	
Seepage collection system decommissioning TSF	LS		$500,000	
Water treatment plant and diffuser	LS		$10,000,000	
Subtotal				**$14,260,000**
TOTAL				**$102,900,000**

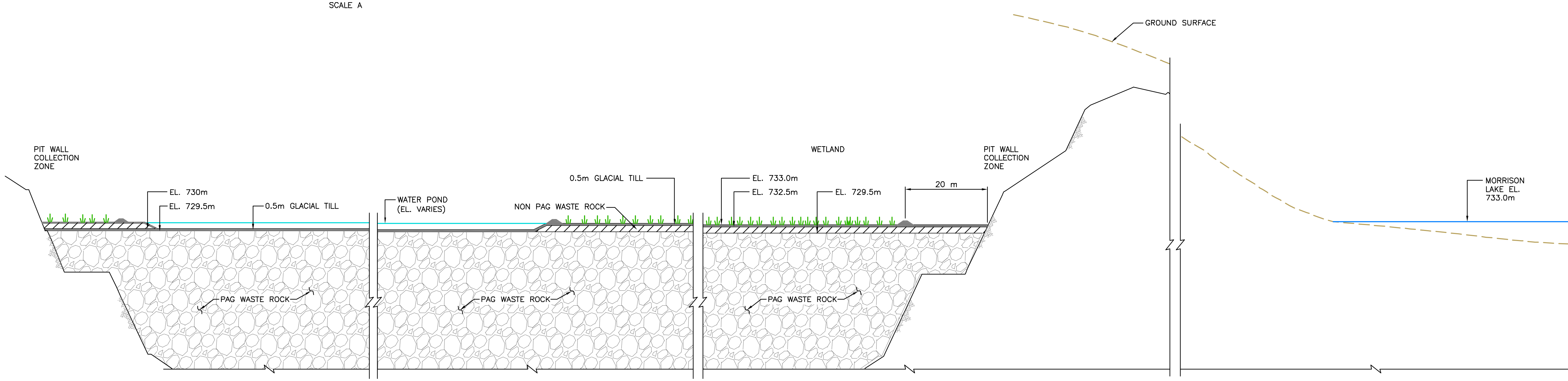
Post-closure monitoring will be required and is estimated to cost $0.62 million per year for the first five years and then decrease with time.

In addition, the annual operating cost of the water treatment plant is estimated to be in the order of $260,000 per year, plus sludge disposal costs of $10,000 per year and infrastructure support of $100,000 per year; total costs $370,000 per year.



PLAN

SCALE A



TYPICAL SECTION A

SCALE B

NOTES:

1. TOPOGRAPHY IS 10m CONTOUR INTERVAL, PRODUCED FROM AERIAL PHOTOGRAPHY FLOWN IN SEP, 2006 AND COMPILED BY EAGLE MAPPING LTD.
2. MORRISON LAKE BATHYMETRIC CONTOURS ARE 1m INTERVAL.
3. DATUM IN UTM NAD83, ZONE 9.

NOT FOR CONSTRUCTION

TO BE READ WITH KLOHN CRIPPEN BERGER REPORT DATED ________

SCALE B: 0 20m

SCALE A: 0 500m

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CLIENT: pbm

Klohn Crippen Berger

PROJECT: MORRISON COPPER/GOLD PROJECT

TITLE: CLOSURE PHASE PIT AREA PLAN AND SECTION

PROJECT No. M09382A04

FIG. No. 9.2

KCB-R-MLD

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Date: 5/12/2011
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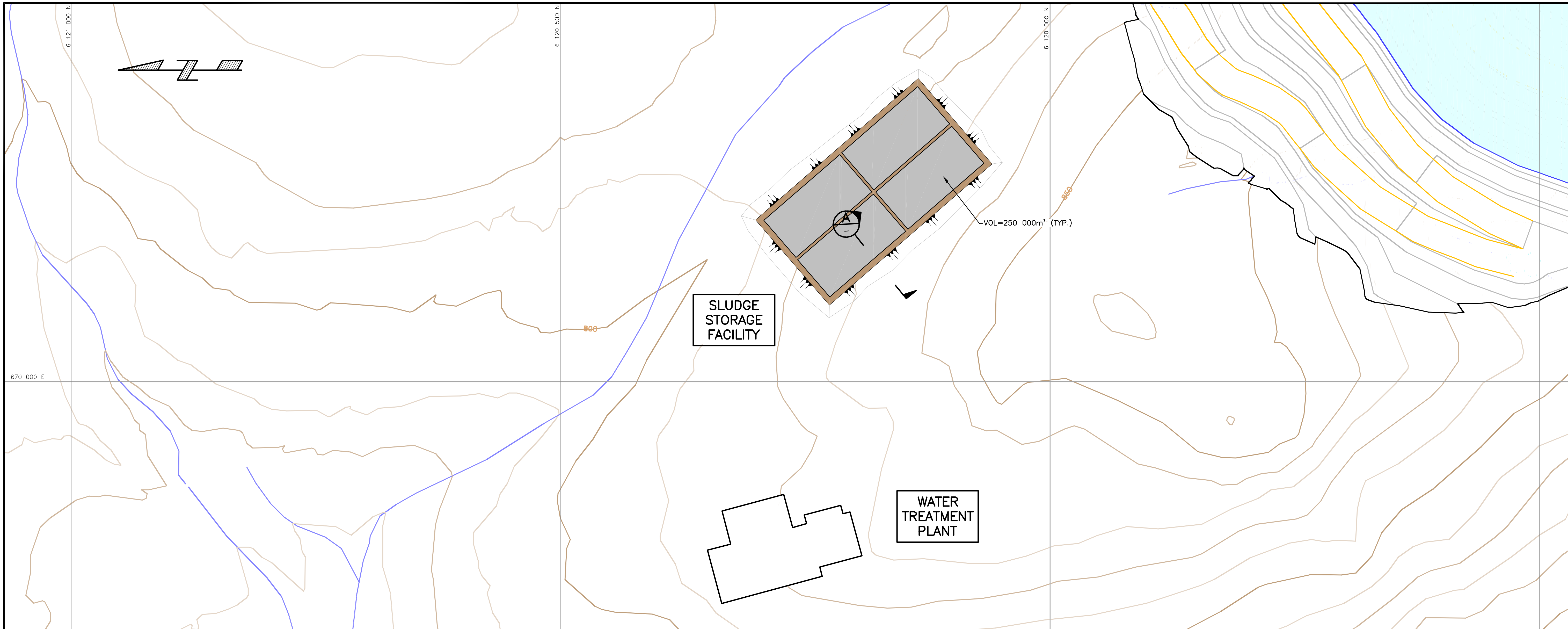
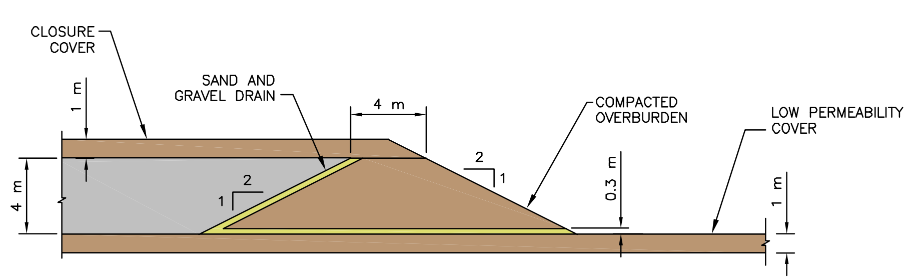
Xrefs: BM-Morrison Copper-Jan10



SITE PLAN



SECTION A
NTS

LEGEND

- EXISTING ROADS
- HAUL ROAD
- TREATEMENT PLANT SLUDGE
- COMPACTED OVERBURDEN

NOTES:

1. TOPOGRAPHY IS 2m CONTOUR INTERVAL, PRODUCED FROM AERIAL PHOTOGRAPHY FLOWN IN SEP, 2006 AND COMPILED BY EAGLE MAPPING LTD
2. DATUM IN UTM NAD83, ZONE 9.

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SCALE: 0 — 200 m

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CLIENT: pbm

Klohn Crippen Berger

PROJECT: MORRISON COPPER/GOLD PROJECT

TITLE: CLOSURE PHASE SLUDGE STORAGE FACILITY 100-YR STORAGE CAPACITY

PROJECT No.: M09382A04

FIG. No.: 9.3

KCB-R-MLB

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Date: 5/12/2011
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Xrefs: BM–Morrison Copper–Jan10

10. EFFECTS ASSESSMENT

10.1 Introduction

10.1.1 General

The effects assessment for the EAC Application has been revised for the water quality and water quantity (flow) effects on the receiving streams and Morrison Lake. The revisions are due to:

- Revisions to the changed project design for the TSF and Closure Plan;
- Revisions to water quality predictions;
- Revisions to site wide water balance;
- Revisions to hydrogeology assessment (seepage rates); and
- Maintenance of minimum 50% flow in Stream MCS7.

This section present the effects assessment on water quality and water quantity and other VEC's for the project, specifically as they relate to the main project modifications described in this report. An update of all of the effects identified in the EAC Application is included in Appendix IV. The update is presented with track changes to identify changes from the original EAC Application.

Water Management

The design of water management facilities for construction, operation and closure is documented in the EAC Addendum – Appendix AC – Water Management. The main changes to surface water flows occur with the TSF on Stream MCS7, and to a lesser degree, Stream MCS6 near the mine area. As discussed in the following section, a minimum flow of 50% will be maintained in Stream MCS7. The catchment area for Stream MCS6 is the second largest (13.25 km^2) in the Project area. The encroachment of the waste dump will reduce the catchment area by 3.5% (Figure 2.1), which is considered a negligible decrease in a watershed of this size and in a stream with channel widths of 5.0 m. Additionally, as stated in Addendum Appendix AX Geotechnical Feasibility Study Rev-1, Diversion Ditch A, located along the uphill side of the waste rock dump, will divert approximately 2.4 km^2 (18%) of additional catchment into Stream MCS6. The effects on Stream MCS6 of peak flows and siltation from the diversion ditch will be mitigated by appropriately sized sediment ponds.

Other VEC's

The effects assessment for the EAC Application has been revised for the changes in the closure plan for the TSF, waste rock dump and Mine Area for the changes in effect on wildlife, wetland habitat, terrain, ecosystems and vegetation, and fish and fish habitat. The revisions are primarily due to the changes in the ponded area of the TSF, which requires reclamation of 340 ha of tailings beaches, and the placement of waste rock back into the open pit.

10.1.2 Effects Assessment Methodology

General

The assessment of the residual effects of the project has been revised to reflect the changes in the waste management and closure plan for the facility. The assessment utilizes the methodology described in Section 5 of the EAC Application. The extent of and the effect are classified into 4 categories as summarized in Table 10.1. The residual effects rating descriptors used for the assessment are included in Table 10.2.

Table 10.1 Description of the Level of Significance Classification

Classification	Description
Negligible	Very slight change from the baseline conditions such that no discernable effect upon the local ecology/environment results. No change in ecological classification
Minor	Small but noticeable shift away from the baseline conditions. Changes in environmental quality, etc., are likely to be of a minor temporary nature such that ecology or environmental characteristics are slightly affected. Equivalent to minor but measurable change within a class.
Moderate	A significant and noticeable shift from the baseline conditions that may be long-term; or a high degree of change for a temporary period. Results in a change in ecological status.
Major	Major shift away from the baseline conditions, fundamental change to environmental conditions. May include a relatively high degree of change for a long-term period, or by a very high amount for a shorter episode. Ecology or environmental quality is greatly changed from the baseline.

Table 10.2 Residual Effects Rating Descriptors

Magnitude	Spatial Extent		Duration of Effect	Frequency	Reversibility of Effects	Resilience (context)	Level of Significance of Residual Effects		Likelihood of Effects	
	Biophysical	Socio-Economic					Adverse	Positive	Probability of Occurrence	Confidence Level
Negligible: no detectable change from baseline conditions	**Local:** Effect is limited to the immediate Project footprint or within a 100 m buffer.	**Individual / family:** Effects limited to individuals, families or households	**Short-term:** effect lasts < 2 years (i.e., duration of construction phase)	**One Time:** effect is confined to one discrete period in time during the life of the Project	**Reversible Short Term:** Effect can be reversed within the active life of the Project (i.e., during construction, operation and closure phases)	**High:** Feature has a high natural resilience to imposed stresses and could respond and adapt to additional effects	**Negligible:** May result in a slight decline in condition of the VEC for a very short temporal period, but the baseline conditions will be regained or maintained. The receiving environment / community will experience no significant hardship or change. Research, monitoring and/or recovery initiatives are not required.	**Negligible:** May result in a slight improvement in the condition of the VEC in the study area for a very short temporal period, but the VEC is likely to return to baseline conditions. The receiving environment / community will experience no significant benefit.	**Low:** an effect is unlikely but could occur	**High:** There is a good understanding of the cause effect relationship and all necessary data is available for the Project area. Low degree of uncertainty and variation from the predicted effect is expected to be low. > 80 % confidence
Low: differs from the average value for baseline conditions, but within the range of natural variation and well below a guideline or threshold value	**Landscape/ Watershed**: Effect is limited to a broader area than "local", but still remains tied to the Project footprint.	**Community:** effect on primary and/or secondary study community(ies)	**Medium-term:** effect lasts up to20 to 25 years (i.e. approximate duration of mine operations)	**Sporadic:** effect occurs rarely and at sporadic intervals	**Reversible Long Term:** Effect can be reversed within 100 years	**Neutral:** Feature has a neutral resilience to imposed stresses and may be able to respond and adapt to additional effects	**Minor:** May result in a slight decline in condition of the VEC during the life of the Project. The receiving environment / community may experience a low level of hardship or change. Research, monitoring and/or recovery initiatives would not normally be required.	**Minor:** May result in slight improvement in condition of the VEC during the life of the Project. The receiving environment / community may experience a low degree of benefit.	**Medium:** an effect is likely but may not occur	**Intermediate:** The cause effect relationships are not fully understood or data for the Project area is incomplete. Moderate degree of uncertainty; while results may vary, predictions are relatively confident. 40 to 80 % confidence
Medium: differs from the average value for baseline conditions and approaches the limits of natural variation, but below or equal to a guideline or threshold value	**Regional:** Effect extends across the broader region.	**Regional / First Nations:** Effect on the broader regional community / economy, or on a First Nations group	**Long-term:** Effect lasts between 25 and 50 years	**Regular:** Effect occurs on a regular basis and potentially beyond the life span of the Project	**Irreversible:** Effect cannot be reversed	**Low:** Feature has a low resilience to imposed stresses, due to past human activity or ecological/social fragility	**Moderate:** May result in a decline in condition of the VEC to stable, but outside-of-baseline, levels; which may persist beyond Project closure. The receiving environment / community may experience a noticeable level of hardship or change. Regional management actions such as research, monitoring and/or recovery initiatives are recommended.	**Moderate:** May result in an improvement in condition of the VEC, beyond baseline variation; which may persist beyond Project closure. The receiving environment / community may experience a moderate and noticeable degree of benefit.	**High:** an effect is highly likely to occur	**Low:** The cause-effect relationships are poorly understood and data for the Project area is incomplete. High degree of uncertainty and final results may vary considerably. < 40 % confidence
High: predicted to differ from baseline conditions or a guideline or threshold value so that there will be a detectable change beyond the range of natural variation (i.e., change of state from baseline conditions)	**Provincial / Trans-Boundary:** Effect extends across or beyond the province.	**Provincial / Trans-Boundary:** Effect extends across or beyond the province	**Far Future:** effect lasts more than 50 years	**Continuous:** effect occurs constantly during, and potentially beyond, the life of the Project			**Major:** May result in threats to the sustainability of the VEC and should be considered a management concern. The receiving environment / community is expected to experience a high level of hardship or change. Research, monitoring and/or recovery initiatives should be considered	**Major:** May result in significant and lasting improvement in condition of the VEC, well beyond baseline levels. The receiving environment / community is expected to experience a high degree of benefit		

Classification of Significance

The level of significance rating, summarizes the residual risk associated with each potential effect. However, the rating does not answer the key question: ***"Is the project likely to cause significant adverse residual environmental effects?"***

A supplementary classification, therefore, is included, therefore, that incorporates the Residual Effects Rating Factors to answer the basic question: are the effects significant or not significant? This approach provides EAO and CEAA a clear Yes or No answer as to whether or not the project will cause <u>significant adverse residual environmental effects.</u>

The supplemental Significance Classification is based on considering the assessment descriptors as contributing attributes to the significance of a residual effect. While recognizing the value of professional judgment, the following are criteria are applied in determining the Significance Rating for each effect:

Magnitude:

- If the magnitude of the effect is low, then the predicted impact is "not significant", recognizing that magnitude includes consideration of sensitive species, habitats or populations.

- If effects are measurable, such as air or water quality meeting applicable performance criteria, standards or guidelines then, irrespective of the magnitude, the effect is "not significant".

Duration

- If the duration of the impact is short-term (i.e., construction period only, for example), the effect prediction is "not significant".

Reversibility

- If the effect is reversible in the short term, the predicted effect is "not significant".

Extent

- If the geographic extent of the impact is Local, or at the Landscape Level, the predicted effect is "not significant".

- If the extent of a negative socio-economic effect is limited to individuals, the predicted effect impact is “not significant”.

Frequency

- If the effect has a one time or sporadic frequency, the predicted effect is “not significant”.

Reversibility

- If the effect is reversible short or long term, the predicted effect is “not significant”.

Resilience

- If the effect has a neutral to high resilience, the predicted effect is “not significant”.

All residual effects have been considered using these criteria such that in addition to a Level of Significance Category a Significance Rating has been assigned. PBM has reviewed the effects assessment and, on the basis of the above criteria as well as new data and analysis, and an updated Effects Table is included in Appendix IV. The resulting rating of residual effects is intended to aid EAO and CEAA in answering the question “Is the Project Likely to cause significant adverse residual effects?”

10.2 Effects on Water Quality and Water Quantity

10.2.1 TSF Effects on Stream Water Quantity

The TSF effects on flows in Stream MCS7 have been revised from the EAC Application to account for the modifications to the diversions during operations, the short closure period, and the revised groundwater seepage rates. The effects on stream flows in Stream MCS8 are negligible and the effect on stream flows in Stream MCS10 is the same as in EAC application, e.g. 22% reduction.

The surface areas for Stream MCS7, and the reductions at various stages of the mine life, are summarized in Table 10.3.

Table 10.3 Summary of Catchment Area Reductions for Stream 7 due to TSF

Component	Ha of Catchment for Time (Year of Operation)					
	Baseline	**0 - 5**	**5-10**	**10-15**	**15-25**	**Closure**
TSF	510	300	385	440	510	510
Seepage Ponds and Dams	205	205	205	205	205	205
TSF Diversion –primary	320	320	320	320	320	320
TSF Diversion – secondary		210	125	70	0	0
Downstream of TSF	315	315	315	315	315	315
Total area contributing	1350	950	755	700	630	1350
% of baseline flow	100	70	56	52	47	100

The % reduction in stream flow for Stream MCS7 due to the TSF has been assumed to be 50%, recognizing that the secondary diversions may not be fully implemented, depending on the actual water balance for the project. The reduction in surface water flow will be partially offset with an increase in seepage base flow due to the TSF. Nonetheless, the environmental effect of a 50% reduced flow has been used for the effects assessment on the aquatic habitat, as discussed in more detail in the Fish Habitat Compensation Plan.

The 50% flow reduction has also been used for the water quality effects assessment on Stream MCS7, which is discussed in the following section.

10.2.2 TSF Seepage Effects on Water Quality

The effects of TSF seepage on the environment have been revised to reflect the revised TSF pond and porewater quality, TSF seepage rates and updated baseline surface water and groundwater quality.

10.2.2.1 Water Quality Modelling

Seepage from the TSF will flow into the receiving streams (MCS7, 8 & 10) and into the deeper groundwater system and into Morrison Lake. Seepage will mix with the regional groundwater and the surface water. The seepage estimates for the TSF are discussed in Section 6.2.5 of this report. The Expected Case seepage rate for operations is 100 m^3/hr, with an Upper Bound of 150 m^3/hr. The expected case seepage rate for closure is 50 m^3/hr with an Upper Bound of 100 m^3/hr. There is a significant lag time for seepage to reach the receiving streams and Morrison Lake and, therefore, the Upper Bound seepage case for closure was used for the both the Expected and Upper Bound case for the assessment.

The % solute in the receiving streams have been revised using the revised TSF hydrogeology models and are summarized in Table 10.4 and model outputs are included in Appendix II. Allocation of the seepage to the receiving waters and the %solute in the receiving streams is summarized in Table 10.5.

Table 10.4 Predicted Relative Concentrations of Seepage in TSF Receiving Streams

Concentration Relative to TSF Source (%)	MCS-7 Downstream (m)	MCS-7i West Tributary (m)	MCS-7ii East Tributary (m)	MCS-8 (m)	MCS-10 (m)
0 to 20	704	0	2031	2752	1933
20 to 40	325	232	92	0	150
40 to 60	0	405	244	0	160
60 to 80	0	655	0	0	186
80 to 100	0	96	0	0	0
TOTAL STREAM LENGTH (m)	1029	1388	2367	2752	2429
Average % Solute	20%	58%	15%	10%	18%
Average % Solute in Stream 7	28%				

Table 10.5 TSF Seepage Allocation

Seepage Component	Seepage Allocation % of Total	Seepage Rate (m^3/hr)	% Solute
Total	100	100	
MCS7	13	35	28
MCS8	30	14	10
MCS10	7	1	18
Deep seepage reporting to Morrison Lake	50	50	

During winter base flow conditions it is assumed that there is no dilution of seepage water with surface water. During the remainder of the year, the base flow groundwater is diluted with the average surface water flow. The receiving groundwater quality is calculated using the %solute and adding the baseline groundwater load {% solute x TSF water quality + (1-% solute) x baseline groundwater quality)}.

The low flow and average flow and the seepage contributions are summarized in Table 10.6.

Table 10.6 Surface Flow Conditions and Seepage Contributions at MCS-7, MCS-8, and MCS-10

Stream	Flow Conditions	Surface Flow (L/s)	Groundwater Contribution (L/s)	Total Flow (L/s)
MCS 7 + I + II	Low Flow	0	3.6	3.6
	Average Flow	58	58	61.6
MCS-8	Low Flow	0	8.3	8.3
	Average Flow	32	8.3	40
MCS-10	Low Flow	0	1.9	2
	Average Flow	21	1.9	23

Note change of units from m^3/hr to L/s

The potential seepage effects on the receiving streams of MCS-7, MCS-8 and MCS-10 are shown in Table 10.7, Table 10.8 and Table 10.9, respectively.

Table 10.7 Surface Water Quality in MCS-7 Streams Downstream of the TSF at Low and Average Flow Conditions

Parameter (mg/L, except pH)	TSF Porewater		Baseline Water Quality		Expected Case Water Quality MCS-7		Upper Bound Water Quality MCS-7		BCWQG's Expected Case		BCWQGs Upper Bound	
	EC	UB	Groundwater	Surface	Low	Average	Low	Average	Low	Average	Low	Average
pH	8.2	7.9	8.3	8.0	8.0	8.0	8.0	8.0	6.5-9	6.5-9	6.5-9	6.5-9
Alkalinity	96	100	327	82	262	93	263	93	10	10	10	10
F	0.47	0.55	1.31	0.067	1.07	0.13	1.10	0.13	30	30	30	30
Cl	20	5.9	1.8	0.42	6.9	0.8	3.0	0.57	150	150	150	150
Sulphate	887	1700	65	9.9	295	27	523	40	100	100	100	100
Nitrite	0.03		0.002	0.00079	0.010	0.0013	0.0013	0.0008	0.069	0.020	0.030	0.020
Nitrate	0.33		0.016	0.13	0.10	0.13	0.011	0.12	13	13	13	13
Ammonia	0.096		0.073	0.0098	0.079	0.014	0.052	0.012	1.6	1.6	1.6	1.6
Mercury	0.000028	0.000005	0.000008	0.000022	0.000014	0.000021	0.000007	0.000021	0.000020	0.000020	0.000020	0.000020
Silver	0.000023	0.00001	0.00001	0.000017	0.00002	0.000017	0.00001	0.000017	0.0015	0.0015	0.0015	0.0015
Aluminum	0.22	0.39	0.06	0.047	0.10	0.050	0.15	0.05	0.050	0.050	0.050	0.050
Arsenic	0.015	0.018	0.0049	0.00027	0.008	0.0007	0.009	0.0008	0.0050	0.0050	0.0050	0.0050
Barium	0.35	0.58	0.10	0.029	0.17	0.037	0.24	0.041	1.0	1.0	1.0	1.0
Beryllium	0.000048	0.000076	0.00037	0.0011	0.00028	0.00102	0.00029	0.00102	No WQG			
Boron			0.13	0.013	0.093	0.018	0.093	0.018	1.2	1.2	1.2	1.2
Calcium	148	260	35	22	67	25	98	27	No direct WQO (part of Hardness)			
Cadmium	0.00088	0.0016	0.000068	0.00019	0.00030	0.00020	0.00050	0.00021	0.00009	0.000031	0.00014	0.000034
Cobalt	0.011	0.021	0.0018	0.000083	0.0044	0.0003	0.0072	0.0005	0.0040	0.0040	0.0040	0.0040
Chromium	0.00035	0.00044	0.00047	0.00039	0.00044	0.00039	0.00046	0.00039	0.0010	0.0010	0.0010	0.0010
Copper	0.032	0.0039	0.00067	0.0025	0.009	0.0029	0.0016	0.0024	13.5	3.6	21	4.1
Iron	0.037	0.053	0.7	0.046	0.5	0.07	0.5	0.07	1.0	1.0	1.0	1.0
Potassium	30	44	1.4	0.89	9	1.4	13	1.6	No WQG			
Lithium	0.022	0.042	0.069	0.0042	0.056	0.007	0.061	0.008	0.087	0.087	0.087	0.087
Magnesium	110	210	15	4.6	42	7	70	8	No direct WQO (part of Hardness)			
Manganese	0.76	1.5	0.73	0.011	0.73	0.05	0.9	0.07	2.1	1.0	2.9	1.1
Molybdenum	0.17	0.28	0.0068	0.000091	0.052	0.003	0.08	0.005	1.0	1.0	1.0	1.0
Sodium	26	21	101	6.0	80	10	79	10	No WQG			
Nickel	0.018	0.033	0.0025	0.00050	0.0068	0.0009	0.011	0.0011	0.15	0.15	0.15	0.15
Lead	0.0047	0.0092	0.00021	0.00021	0.0015	0.00029	0.0027	0.00036	0.018	0.0061	0.030	0.0066
Antimony	0.023	0.042	0.00021	0.000097	0.0066	0.0005	0.012	0.0008	0.020	0.020	0.020	0.020
Selenium	0.0098	0.019	0.00024	0.00050	0.0029	0.0006	0.0055	0.0008	0.0020	0.0020	0.0020	0.0020
Silicon	2.9	3.6	5.4	2.6	4.7	2.7	4.9	2.8	No WQO			
Strontium			0.41617	0.00013	0.29964	0.01763	0.29964	0.01763	No WQO			
Vanadium	0.0004	0.00029	0.0007	0.00052	0.0006	0.0005	0.0006	0.0005	No WQO			
Zinc	0.22	0.44	0.004	0.0044	0.065	0.008	0.13	0.012	0.19	0.008	0.34	0.017
Hardness	821	1500	150	76	338	91	528	102				

* BCWQG are calculated based on the hardness and pH of the receiving environment; Shading indicates exceedance.

Table 10.8 Surface Water Quality in Stream MCS-8 Downstream of the TSF at Low and Average Flow Conditions

Parameter (mg/L, except pH)	TSF Porewater		Baseline Water Quality		Expected Case Water Quality MCS-8		Upper Bound Water Quality MCS-8		BCWQG's Expected Case		BCWQGs Upper Bound	
	EC	UB	Groundwater	Surface	Low	Average	Low	Average	Low	Average	Low	Average
pH	8.2	7.9	8.3	7.96	8.0	8.0	8.0	8.0	6.5-9	6.5-9	6.5-9	6.5-9
Alkalinity	96	100	327	109.33	304	149	304	149	10	10	10	10
F	0.47	0.55	1.31	0.07	1.23	0.31	1.23	0.31	30	30	30	30
Cl	20	5.9	1.8	0.500	4	1.1	2.2	0.9	150	150	150	150
Sulphate	887	1700	65	12.52	148	40	229	57	100	100	100	100
Nitrite	0.03		0.002	0.001	0.005	0.0017	0.0016	0.0011	0.04	0.020	0.022	0.020
Nitrate	0.33		0.016	0.330	0.05	0.27	0.0141	0.26	13	13	13	13
Ammonia	0.096		0.073	0.0127	0.075	0.026	0.065	0.024	1.6	1.6	1.6	1.6
Mercury	0.000028	0.000005	0.000008	0.000023	0.000010	0.000021	0.0000077	0.000020	0.000020	0.000020	0.000020	0.000020
Silver	0.000023	0.00001	0.00001	0.000010	0.00001	0.000011	0.00001	0.000010	0.0015	0.0015	0.0015	0.0015
Aluminum	0.22	0.39	0.06	0.017	0.07	0.028	0.09	0.032	0.050	0.050	0.050	0.050
Arsenic	0.015	0.018	0.0049	0.00043	0.006	0.0016	0.006	0.0016	0.0050	0.0050	0.0050	0.0050
Barium	0.35	0.58	0.10	0.054	0.13	0.069	0.15	0.07	1.0	1.0	1.0	1.0
Beryllium	0.000048	0.000076	0.00037	0.00030	0.00034	0.00031	0.00034	0.00031	No WQG			
Boron			0.13	0.015	0.117	0.036	0.117	0.036	1.2	1.2	1.2	1.2
Calcium	148	260	35	34	47	37	58	39	No direct WQO (part of Hardness)			
Cadmium	0.00088	0.0016	0.000068	0.000028	0.00015	0.00005	0.00022	0.00007	0.00006	0.000042	0.00008	0.000046
Cobalt	0.011	0.021	0.0018	0.00010	0.0027	0.0006	0.004	0.0009	0.0040	0.0040	0.0040	0.0040
Chromium	0.00035	0.00044	0.00047	0.00049	0.00046	0.00048	0.00047	0.00048	0.0010	0.0010	0.0010	0.0010
Copper	0.032	0.0039	0.00067	0.00080	0.004	0.0014	0.0010	0.0008	9	5.3	11	5.9
Iron	0.037	0.053	0.7	0.078	0.7	0.20	0.7	0.20	1.0	1.0	1.0	1.0
Potassium	30	44	1.4	0.95	4	1.6	6	1.9	No WQG			
Lithium	0.022	0.042	0.069	0.0050	0.064	0.017	0.066	0.018	0.087	0.087	0.087	0.087
Magnesium	110	210	15	6.4	25	10	35	12	No direct WQO (part of Hardness)			
Manganese	0.76	1.5	0.73	0.057	0.73	0.20	0.8	0.21	1.6	1.2	1.9	1.3
Molybdenum	0.17	0.28	0.0068	0.00014	0.023	0.005	0.03	0.007	1.0	1.0	1.0	1.0
Sodium	26	21	101	5.7	94	24	93	24	No WQG			
Nickel	0.018	0.033	0.0025	0.00051	0.004	0.0012	0.006	0.0015	0.15	0.15	0.15	0.15
Lead	0.0047	0.0092	0.00021	0.000060	0.0007	0.00018	0.0011	0.0003	0.012	0.0079	0.015	0.009
Antimony	0.023	0.042	0.00021	0.000067	0.002	0.0006	0.004	0.0010	0.020	0.020	0.020	0.020
Selenium	0.0098	0.019	0.00024	0.00043	0.0012	0.0006	0.0021	0.0008	0.0020	0.0020	0.0020	0.0020
Silicon	2.9	3.6	5.4	4.0	5.1	4.3	5.2	4.3	No WQO			
Strontium			0.41617	0.00010	0.37455	0.07722	0.37455	0.07722	No WQO			
Vanadium	0.0004	0.00029	0.0007	0.00055	0.0007	0.0006	0.0007	0.0006	No WQO			
Zinc	0.22	0.44	0.004	0.0017	0.03	0.007	0.05	0.011	0.10	0.040	0.15	0.05
Hardness	821	1500	150	111	218	133	285	147				

* BCWQG are calculated based on the hardness and pH of the receiving environment; Shading indicates exceedance.

Table 10.9 Surface Water Quality in Stream MCS-10 Downstream of the TSF at Low and Average Flow Conditions

Parameter (mg/L, except pH)	TSF Porewater		Baseline Water Quality		Expected Case Water Quality MCS-10		Upper Bound Water Quality MCS-10		BCWQG's Expected Case		BCWQGs Upper Bound	
	EC	UB	Groundwater	Surface	Low	Average	Low	Average	Low	Average	Low	Average
pH	8.2	7.9	8.3	7.81	8.0	8.0	8.0	8.0	6.5-9	6.5-9	6.5-9	6.5-9
Alkalinity	96	100	327	47.4	285	67	286	67	10	10	10	10
F	0.47	0.55	1.31	0.047	0.58	0.13	0.59	0.14	30	30	30	30
Cl	20	5.9	1.8	0.5	2.6	0.81	1.3	0.67	150	150	150	150
Sulphate	887	1700	65	5.42	107	21	180	35	100	100	100	100
Nitrite	0.03		0.002	0.001	0.0034	0.0014	0.0007	0.0010	0.026	0.020	0.020	0.020
Nitrate	0.33		0.016	0.0313	0.036	0.032	0.0064	0.030	13	13	13	13
Ammonia	0.096		0.073	0.0272	0.038	0.029	0.030	0.030	1.6	1.6	1.6	1.6
Mercury	0.000028	0.000005	0.000008	0.000030	0.0000058	0.000026	0.0000037	0.000028	0.000020	0.000020	0.000020	0.000020
Silver	0.000023	0.00001	0.00001	0.000020	0.00001	0.000018	0.00001	0.000019	0.0015	0.0015	0.0015	0.0015
Aluminum	0.22	0.39	0.06	0.18	0.04	0.16	0.06	0.17	0.050	0.050	0.050	0.050
Arsenic	0.015	0.018	0.0049	0.00078	0.0034	0.0012	0.0036	0.0013	0.0050	0.0050	0.0050	0.0050
Barium	0.35	0.58	0.10	0.033	0.073	0.040	0.09	0.046	1.0	1.0	1.0	1.0
Beryllium	0.000048	0.000076	0.00037	0.00028	0.00016	0.00026	0.00016	0.00028	No WQG			
Boron			0.13	0.0078	0.053	0.015	0.053	0.016	1.2	1.2	1.2	1.2
Calcium	148	260	35	12	28	15	38	18	No direct WQO (part of Hardness)			
Cadmium	0.00088	0.0016	0.000068	0.00012	0.00011	0.00012	0.00017	0.00014	0.000043	0.000021	0.000059	0.000026
Cobalt	0.011	0.021	0.0018	0.00015	0.0017	0.00040	0.0026	0.00058	0.0040	0.0040	0.0040	0.0040
Chromium	0.00035	0.00044	0.00047	0.00042	0.00022	0.00039	0.00023	0.00042	0.0010	0.0010	0.0010	0.0010
Copper	0.032	0.0039	0.00067	0.0012	0.0032	0.0015	0.00062	0.00117	5.4	2.4	7.9	3.0
Iron	0.037	0.053	0.7	0.85	0.30	0.76	0.31	0.83	1.0	1.0	1.0	1.0
Potassium	30	44	1.4	0.29	3.3	0.7	4.5	1.0	No WQG			
Lithium	0.022	0.042	0.069	0.0050	0.030	0.009	0.032	0.010	0.087	0.087	0.087	0.087
Magnesium	110	210	15	3.1	16	5.1	25	7.0	No direct WQO (part of Hardness)			
Manganese	0.76	1.5	0.73	0.17	0.37	0.20	0.43	0.23	1.2	0.87	1.5	0.94
Molybdenum	0.17	0.28	0.0068	0.000086	0.018	0.0028	0.028	0.0047	1.0	1.0	1.0	1.0
Sodium	26	21	101	4.0	44	10	43	11	No WQG			
Nickel	0.018	0.033	0.0025	0.00056	0.0026	0.00087	0.0040	0.0012	0.15	0.15	0.15	0.15
Lead	0.0047	0.0092	0.00021	0.000080	0.00051	0.00015	0.0009	0.00022	0.0080	0.0050	0.011	0.0055
Antimony	0.023	0.042	0.00021	0.000063	0.0022	0.00038	0.0039	0.00070	0.020	0.020	0.020	0.020
Selenium	0.0098	0.019	0.00024	0.00038	0.00098	0.00047	0.0018	0.00064	0.0020	0.0020	0.0020	0.0020
Silicon	2.9	3.6	5.4	2.6	2.5	2.6	2.5	2.8	No WQO			
Strontium			0.41617	0.00012	0.17063	0.02625	0.17063	0.02843	No WQO			
Vanadium	0.0004	0.00029	0.0007	0.00061	0.0003	0.0006	0.0003	0.0006	No WQO			
Zinc	0.22	0.44	0.004	0.0027	0.022	0.0056	0.041	0.0093	0.042	0.0075	0.088	0.0075
Hardness	821	1500	150	46.5	136	60	197	75				

* BCWQG are calculated based on the hardness and pH of the receiving environment; Shading indicates exceedance.

10.2.2.2 Discussion of Results

All discharges are within the metal mining effluent regulations (MMER). The parameters which exceed BCWQG are sulphate, aluminum, arsenic, cadmium, cobalt and selenium. Exceedance concentrations are highest at low flow when there is reduced dilution from surface water and the stream flow is assumed to be solely groundwater base flow.

The following observations are derived from the table:

<u>Sulphate</u>

Sulphate concentrations are in the order of up to 295 mg/L for the Expected Case, low flow. Groundwater sulphate concentrations are 65 mg/L, which influence the results. The current maximum provincial guideline for sulphate for the protection of aquatic life is 100 mg/L based on LC_{50}'s and LC_0's for striped bass (*Morone saxitilus)*, LC_{50}'s and LC_o's for the amphiopod *Hyella* and toxicity values for the aquatic moss (*Fontinalis antipyretica)* (Singleton, 2000). Aquatic mosses appear to be the most sensitive freshwater organisms to sulphate. *Fontinalis antipyretica*, however, does not occur within the Morrison Project area as the elevations are too high and the species requires lower pH than what is observed in streams. Higher guidelines are obtained based on safety factor of 10 using mean acute and chronic values and a proposed water quality objective (PWQO) could be developed that would be protective of aquatic habitat and within the range of predicted concentrations.

<u>Aluminum</u>

Aluminum concentrations are up to 0.10 mg/L for the Expected Case, low flow, which is slightly over the BCWQG of 0.05 mg/L. However, aluminum concentrations in the baseline surface water are 0.047 which is near BCWQG, and, therefore, there is a low risk of an effect.

Arsenic

Arsenic concentrations are up to 0.008 mg/L for the Expected Case low flow, which is just over the BCWQG of 0.005 mg/L. However, baseline groundwater concentrations for arsenic are 0.0049 mg/L, is just under the BCWQG.

Cadmium

Cadmium concentrations are in the order of up to 0.00030 mg/L for the Expected Case low flow, which is up to 3 times the BCWQG guideline of 0.00010 mg/L. However, the cadmium concentrations in the baseline groundwater and surface water are 0.000068 mg/L and 0.00019 mg/L, respectively, with only surface water being over BCWQGs. Nonetheless, cadmium concentrations are within the safety factor built into the BCWQGs safety factor, which is at least 10% of the lowest observed effects level (LOEL), and a PWQO could be developed that would be protective of aquatic habitat and within the range of the predicted concentrations.

Cobalt

Cobalt concentrations are up to 0.0044 mg/L for the Expected Case low flow, which just over the BCWQG of 0.0040 mg/L.

Selenium

Selenium concentrations are in the order of up to 0.003 mg/L for the Expected Case low flow, which is over the BCWQG of 0.002 mg/L.

Summary

The predicted water quality effects are considered to be moderate and site specific water quality objectives can be developed that are protective of aquatic habitat and fish. Mitigating factors that influence the water quality predictions include the following:

- Concentrations are believed to be over-stated as metals will be absorbed on the clay particles as the TSF seepage passes through the clay till both beneath the TSF and as it resurfaces. Such absorption may continue in the far future before the absorption capacity of clay has been depleted, whereupon the TSF seepage water quality will likely have substantially improved due to improved water quality of the TSF pond on closure.

- Elevated concentrations of aluminum, arsenic and cadmium occur in the baseline groundwater. Concentrations of baseline groundwater may be overstated due to poor development of groundwater wells and limited database. Samples with high TSS have been discounted.

- Elevated concentrations of cadmium and aluminum occur in surface water.

- TSF seepage loads to the streams will take time to develop, as discussed in Section 10.2.4.3 of this report, and will increase up to a maximum in the order of Year 30 and then decrease with time.

- The Expected Case seepage rate for closure is 60 m^3/hr, which would reduce loads from the TSF by 40% after closure.

Nonetheless, PWQO’s will be required for: sulphate and cadmium; and potentially for aluminum, arsenic, cobalt and selenium, that are protective of the receiving environments in the streams. PBM commits to developing PWQO’s during the permitting stage.

10.2.3 Water Flow Effects on Morrison Lake

The main sources of potential water flow effects on Morrison Lake are discussed, as follows:

- Groundwater inflow from Morrison Lake into the Open Pit: The potential for groundwater inflow from the lake into the open pit is addressed in Section 6.3.2 of this report. Groundwater inflows from Morrison Lake to the open pit vary from 60 m^3/hr to 90 m^3/hr for the Expected Case and Upper Bound Case, respectively.

- Reduction in regional groundwater flow through the mine area: The regional groundwater flow through the mine area will be directed towards the open pit, as opposed to Morrison Lake. Consequently this could result in a flow reduction of 40 m^3/hr to 55 m^3/hr for the Expected Case and Upper Bound case, respectively.

- Reduction in surface water flows to Stream MCS7. The predicted reduction in surface flow to Stream MCS7 is 50%, which is equivalent to a flow reduction of 212 m^3/hr.

- Increase in groundwater recharge from the TSF. The predicted groundwater increase due to seepage varies from 100 m^3/hr, for the Expected Case, to 50 m^3/hr for the Upper Bound case.

The net potential flow effects on Morrison Lake, therefore, range from 212 m^3/hr to 307 m^3/hr for the Expected Case and Upper Bound case, respectively. The average annual flow, through Morrison Lake and into Morrison River, is approximately 16,550 m^3/hr and, therefore, the potential flow reduction is in the order of 1% to 2% of the flow that moves through Morrison Lake. This potential flow reduction is well within the natural variation in stream flow and would not have a measureable effect on Morrison Lake or Morrison River. Similarly the reduction in flow would not have a measureable effect on the level of water in Morrison Lake.

10.2.4 Water Quality Effects on Morrison Lake

10.2.4.1 General

The Morrison Lake effects assessment has been revised to incorporate the following changes in effects:

- Revised water quality predictions for the TSF porewater and revised seepage rates from the TSF; and

- Revised closure plan, which included placement of PAG rock back into the open pit, with the following revised effects:

- Reduced water treatment rates and revision of the treated water quality; and
- Additional effects from potential seepage of PAG porewater from the open pit into Morrison Lake and the water quality prediction for that water.

10.2.4.2 Loading Sources

TSF Seepage Loads:

The revised potential effect of seepage loads on Morrison Lake is based on the following:

- Assumption that 100% of the seepage load reports directly to Morrison Lake.
- The water quality of the seepage will be the EDCM pH=8 water quality for the Upper Bound case and an average of the lock cycle test and the EDCM pH=8 water quality for the Expected Case, as discussed in Section 8.2.1 of this report.
- Assumption that there is no adsorption, precipitation or ion exchange along the flow path that would reduce concentrations for a number of parameters.
- The loads will discharge with streams near the surface in Morrison Lake, in the epilimion (upper 12 m), and deeper groundwater flow into the hypolimion. The result of this assumption is that the mixing of seepage water in the Lake adds to the total steady state water quality condition.

Water Treatment Plant Discharge

The revised closure plan for the mine area results in a reduction in the volume of water to be treated, which is now limited to the collection of pit wall runoff water. The assessment of the effects on Morrison Lake is based on the following:

- The pit wall runoff will be segregated as far as practical, nonetheless the flow rate of 55 m^3/hr assumes that groundwater and surplus water from the wetland area are also collected and treated. The direct flow onto the pit wall is approximately 16 m^3/hr.

- The water quality fed into the water treatment plant will be the EDCM pH=3 water quality. The water treatment plant will treat water to pH=9.3, with additional controls (e.g. retention time) to ensure treatment objectives are met, particularly for sulphate and cadmium.

<u>PAG Rock Porewater Effects</u>

The PAG rock will be backfilled into the open pit and will mix with residual Cleaner tailings water, groundwater inflows and runoff. The water will be limed during the backfilling process to maintain pH=8. After backfilling, the PAG rock will be capped with a low permeability cover. There is a low risk that regional groundwater gradients will transport PAG porewater into Morrison Lake (as discussed in Section 6.3.2 of this report. The modeling of this potential effect is based on the following:

- The Expected Case porewater flow is 20 m^3/hr and the Upper Bound flow is 40 m^3/hr.

- The water quality will be the bench scale treated water quality, which started with a pH=3 EDCM water quality, as discussed in Section 8.3.3 of this report.

- The flow reports directly to Morrison Lake with no attenuation.

The contributing loads from each source are shown in Table 10.10 and Table 10.11, for the Expected Case and the Upper Bound Case for the main constituents of potential concern.

10.2.4.3 Temporal Effects of Loads on Morrison Lake

The loading rates and Morrison Lake water quality predictions presented in the previous section of this report assume that all loads will report at the same time to the lake. However, in addition to the adsorption and ion exchange effects on attenuating the loads, the loading rates are attenuated with temporal effects as discussed in the following sections:

TSF Loading

The seepage effects will vary with time: initially seepage rates are low and seepage water quality is good, near the end of mining seepage rates will be the highest and the water quality would be worse. After closure, seepage rates will decline with the smaller water pond and water quality will quickly improve. In addition, the lag time for seepage through the tailings and overburden is in the order of 10 years to 20 years. Consequently, the seepage effects may peak approximately Year 25 to Year 30 and then decrease with time to negligible values by Year 80.

PAG Porewater Loading

PAG porewater will be established in approximately Year 25, and then may take 5 years to develop a seepage load into Morrison Lake. At the predicted flow rate of 40 m^3/h, the porewater would be flushed out over a period of 50 years. Consequently the concentration could be expected to slowly build up to a peak in Year 30 and then decrease with time to be negligible by Year 80.

Water Treatment Plant

The water treatment plant will commence operations near the end of the mine life and will continue into the far-future. The rate, therefore, will be steady for a long period of time. Over the very far future the acidic loading from the pit walls will decrease and the site will eventually return to near baseline conditions.

An approximation of the potential loading sources over 100 years is shown in Figure 10.1, which indicates that the maximum load (shown as Total % of Potential) could be reached in Year 40 and would reduce with time.

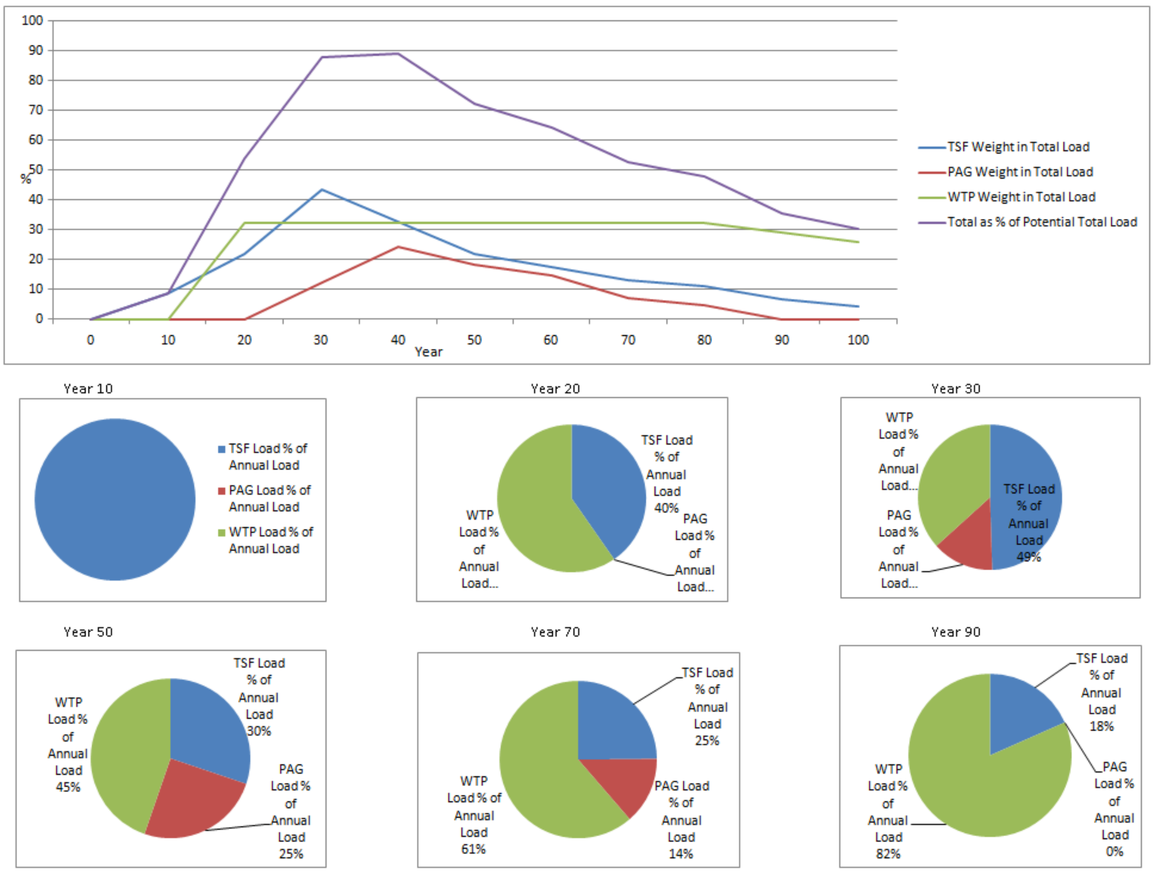

Figure 10.1 Temporal Distribution of Loading Sources to Morrison Lake

10.2.4.4 Morrison Lake Effects Modeling

The modeling of the diffuser/mixing plume and effects of loads from the TSF seepage and PAG porewater on the lake water quality has been carried out by Dr. Greg Lawrence of the University of British Columbia, and the general methodology is as discussed in EAC Addendum – Appendix AB -Lake Effects Assessment (Section 5). The effects on of the inflows to Morrison Lake occur spatially over a large area ranging from the TSF stream outflow/diffuser area to the mine area PAG groundwater loading. The loadings will mix with lake water throughout the year and, as such, are relatively insensitive to seasonal variations in baseline water quality. The loading sources are temporal, as discussed in the previous section. The modeling results presented assume all loads contribute to Morrison Lake at the maximum concentrations, at the same time.

The effects show both the steady state condition and the maximum (steady state with mixing near the diffuser). The steady state concentration, due to the diffuse loading, can take up to 30 years, or more, to develop as the diffuser water becomes mixed with the total lake water. The maximum diffuser concentration is based on mixing the diffuser effluent with the steady state concentration at a ratio of 100:1. The 100:1 mixing occurs within a vertical plume with a height of approximately 40 m and a maximum width of 5 m as described in Section 5.2 “Morrison Lake Diffuser Design” (EAC Addendum-Appendix AB).

The modeling of Morrison Lake quality is based on the available baseline data set for the lake water quality. Prior to June-2011, 39 samples were collected, and observations include:

- Two anomalous copper concentrations (40x’s average) were recorded in January 2011 for two deep samples. Inclusion of these two values would increase the average dissolved copper concentration from 0.00173 mg/L to 0.00393 mg/L.
- Dissolved selenium concentrations were observed above detection limits up to 2010 and for the last year have been running at detection limit.
- Cadmium concentrations for one round of sampling (9 samples) had a detection limit of 0.000017 mg/L and ½ detection was used for the average.

10.2.4.5 Discussion of Results

The results of the modeling are summarized in Table 10.10 and Table 10.11, for the Expected Case and the Upper Bound Case for the main constituents of potential concern.

Table 10.10 Concentrations of Key Parameters in Morrison Lake – Expected Case

Parameter (dissolved mg/L)	Treatment Plant Effluent	PAG Pore Water	TSF Seepage	Lake Background (Baseline)	Effluent only		Effluent + TSF		Effluent + TSF + PAG Porewater		BCWQG*	CCME	MMER
					Steady State-	Maximum (100:1 diff)	Steady State-	Maximum (100:1 diff)	Steady State-	Maximum (100:1 diff)			
Flow Rate – m^3/hr	55	20	50										
Nitrate	90	90	0.33	0.0377	0.44	1.3	0.45	1.34	0.5	1.4	13.3	13	
Sulphate	2000	4000	887	2.47	12	31	14.20	34.06	16	35	100	n/a	
Aluminum	0.46	0.41	0.22	0.0275	0.030	0.034	0.030	0.035	0.030	0.035	0.05	0.1	
Cadmium	0.0005	0.0042	0.00088	0.000011	0.000013	0.000018	0.000016	0.000021	0.000017	0.000022	0.000024		
Copper	0.007	0.032	0.032	0.00173	0.0018	0.0018	0.0019	0.0019	0.0019	0.0019	0.0036	0.004	0.3
Iron	0.02	0.02	0.037	0.0926	0.09	0.09	0.09	0.09	0.09	0.09	0.15	0.3	
Magnesium	210	210	110	1.9	2.9	4.9	3.2	5.3	3.3	5.3	n/a	n/a	
Selenium	0.0019	0.0023	0.000177	0.0002	0.00021	0.00023	0.00021	0.00023	0.00021	0.00023	0.002	0.001	
Zinc	0.064	0.064	0.22	0.00216	0.0024	0.0031	0.0031	0.0037	0.0031	0.0037	0.0075	0.0075	0.5

* 30 day average guideline based on a modified lake hardness of 90 mg/L (compared to baseline hardness of 29 mg/L)

Table 10.11 Concentrations of Key Parameters in Morrison Lake – Upper Bound

Parameter (dissolved mg/L)	Treatment Plant Effluent	PAG Pore Water	TSF Seepage	Lake Background (Baseline)	Effluent only		Effluent + TSF		Effluent + TSF + PAG Porewater		BCWQG*	CCME	MMER
					Steady State-	Maximum (100:1 diff)	Steady State-	Maximum (100:1 diff)	Steady State-	Maximum (100:1 diff)			
Flow Rate – m^3/hr	55	40	100										
Nitrate	90	90	1	0.0377	0.44	1.3	0.5	1.3	0.5	1.4	13.3	13	
Sulphate	2000	4000	1700	2.47	12	31	22	42	25	44	100	n/a	
Aluminum	0.46	0.41	0.39	0.0275	0.030	0.034	0.032	0.036	0.032	0.037	0.05	0.1	
Cadmium	0.0005	0.0042	0.0016	0.000011	0.000013	0.000018	0.000023	0.000028	0.000026	0.000031	0.000024		
Copper	0.007	0.032	0.06	0.00173	0.0018	0.0018	0.0021	0.0022	0.0021	0.0022	0.0036	0.004	0.3
Iron	0.02	0.02	0.053	0.0926	0.09	0.09	0.09	0.09	0.09	0.09	0.15	0.3	
Magnesium	210	210	210	1.9	2.9	4.9	4.1	6.2	4.3	6.3	n/a	n/a	
Selenium	0.0019	0.0023	0.019	0.0002	0.00021	0.00023	0.00032	0.00034	0.00033	0.00034	0.002	0.001	
Zinc	0.064	0.064	0.44	0.00216	0.0024	0.0031	0.0051	0.0057	0.0052	0.0057	0.0075	0.0075	0.5

* 30 day average guideline based on a modified lake hardness of 90 mg/L (compared to baseline hardness of 29 mg/L)
Shaded boxes indicate exceedance of guidelines.

The loading sources into Morrison Lake are within the MMER regulations for water discharge. The relative potential loading to Morrison Lake, from each of the loading sources, are summarized in Table 10.12 and Table 10.13 as increase over baseline for cadmium and sulphate, which are the two main constituents of potential concern.

Table 10.12 Incremental Concentration Increase for Morrison Lake – Expected Case

Parameter	Baseline (mg/L)	BCWQG	Diffuser		TSF Seepage	PAG Porewater	Total Increase	
			Steady State	Max. 100:1			Steady State	Max. 100:1
Cadmium (mg/L)	11	24	2	7	2.7	1.5	6.4	11.3
Sulphate (mg/L)	2.47	100	9	29	2.7	1.4	13	33

Note: Bold value exceeds BCWQG

Table 10.13 Incremental Concentration Increase for Morrison Lake – Upper Bound Case

Parameter	Baseline (mg/L)	BCWQG	Diffuser		TSF Seepage	PAG Porewater	Total Increase	
			Steady State	Max. 100:1			Steady State	Max. 100:1
Cadmium (mg/L)	11	24	2.3	7.1	9.7	3	**14.9**	**19.8**
Sulphate (mg/L)	2.47	100	9.1	29	10.3	2.9	24	45

Note: Bold value exceeds BCWQG

The predicted sulphate concentrations meet BCWQG. The changes in the sulphate concentrations in the lake are not significant enough to have any effect on the lake dynamics and stratification. (NB: Field work has been carried out in 2010 to confirm the physical behaviour of the lake – in particular temperature profiles have been taken to confirm the summer stratification and fall mixing of the hypolimion and epilimion. A potential concern was raised by one of the reviewers that the increase sulphate concentrations due to TSF loadings could affect the physical properties of the lake, in particular the annual turnover of the water. The increase in sulphate, however, is very small and the potential effect of the sulphate on the density of the water would be miniscule and would not affect the stratification of the lake, i.e. the lake would still be dimictic (Personal Communication: Dr. Greg Lawrence (UBC), Dr. Kevin Boland (Australia)).

The modeling indicates that the only parameter of potential concern is cadmium for the Upper Bound case. The mitigating factors for the Upper Bound case include:

- The modeling assumes no attenuation or absorption of cadmium as the TSF seepage water passes through the clay tills and other soils along the groundwater flow paths.
- The modeling assumes all loads report at the same time. As illustrated in Figure 10.1, total loading is estimated to peak in approximately Year 30 and decrease with time.
- The water treatment plant load assumes that all water within the open pit area will be collected and treated. However, there is a reasonable opportunity that the surplus water from the wetland area will not require treatment, which would reduce the water treatment plant loads by 25%.

Consequently there is a very low risk, even for the Upper Bound case, that cadmium concentrations in Morrison Lake will exceed BCWQGs and, therefore, development of a site specific water quality objective is not required.

10.2.5 Assessment of Residual Effects on Water Quality and Water Quantity

The residual effects assessment for the project has been revised for the TSF and Mine Area, with respect to changes in water flow and water quality due to the revised waste and water management plan for the project. The results of the assessment for the TSF are summarized in Table 10.14 and for the Mine Area in Table 10.15. The geographical extents of the majority of effects are within the project area. Components which could affect Morrison Lake are categorized as “Watershed” under the “Geographic Spatial Extent”.

The assessment concludes that there is only one Moderate magnitude effect, which is related to potential TSF seepage effects on Stream 7, and to a Minor extent on Streams 8 and 10. This potential effect will require a site specific water quality objective for cadmium and sulphate.

The potential residual effect on Morrison Lake is negligible to minor, with the main effect being an increase in sulphate concentration, particularly near the diffuser. Nonetheless, the concentrations are well below BCWQGs.

The remainder of the potential residual effects are classified as negligible to minor.

Using the significance rating discussed in Section 10.1.2 of this report, the potential effects are classified as “not a significant adverse effect”.

Table 10.14 Residual Effects Assessment Summary – TSF – Water Quantity and Quality

Description	Project Components	Project Phase(s)	Nature	Extent	Mitigation and Management	Potential for Residual Effects	Description	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Resilience (context)	Level of Significance	Significance Rating	Probability of Occurrence	Confidence Level
TSF seepage effects water quality effects on Streams 7, 8, 10	TSF	Operations and closure	Adverse	Moderate	Seepage mitigation in TSF. Seepage collection. Monitoring. Site specific water quality objectives.	Yes	Increased concentrations of metals and sulphate	Medium	Local/	Long term	Continuous	Reversible (long-term)	Neutral	Moderate	Not Significant	Medium	Intermediate
TSF water flow reduction in Stream 7	TSF	Operations	Adverse	Moderate	50% riparian baseflow maintained. Fish habitat compensation	Yes	Decrease flows by 50% loss of aquatic habitat (HADD)	Low	Local	Medium term	Continuous	Reversible (short-term)	High	Minor	Not Significant	High	High
TSF water flow reduction in Stream 10	TSF	Operations	Adverse	Minor	Fish habitat compensation	Yes	Decrease flows by 17%. Loss of aquatic habitat (HADD)	Low	Local	Medium term	Continuous	Reversible (short-term)	High	Negligible	Not Significant	High	High
TSF seepage effects on water quality Morrison Lake	TSF	Operations and closure	Adverse	Minor	Seepage mitigation in TSF.	Yes	Potential increase in cadmium concentration of 7 mg/L	Low	Watershed	Long term	Continuous	Reversible (long-term)	High	Negligible	Not Significant	Low	Intermediate
	TSF	Operations and closure	Adverse	Minor	Seepage mitigation in TSF	Yes	Potential increase in sulphate of 7 mg/L	Low	Watershed	Long term	Continuous	Reversible (long term)	High	Negligible	Not Significant	High	Intermediate
Discharge of water from TSF after closure	TSF	Closure	Adverse	Negligible to Minor	Dewater closure pond and dilute with surface water	Yes	Potential exceedance of some water quality parameters	Low	Local	Short term	Sporadic	Reversible (short-term)	High	Negligible to Minor	Not Significant	Low	Intermediate
Discharge of treated pit wall collection water to Morrison Lake	TSF	Operations	Adverse	Minor	Water management to reduce pond water accumulation. Land area discharge of groundwater from pit dewatering	Yes	Potential increase in cadmium and sulphate concentration in Morrison Lake 10% over baseline	Low	Watershed	Short term	Sporadic	Reversible (short-term)	High	Negligible	Not Significant	Low	Intermediate

Table 10.15 Residual Effects Assessment Summary – Mine Area – Water Quantity and Quality

Description	Project Components	Project Phase(s)	Nature	Extent	Mitigation and Management	Potential for Residual Effects	Description	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Resilience (context)	Significance Category	Significance Rating	Probability of Occurrence	Confidence Level
Water treatment plant discharge to Morrison Lake	Mine Area	Closure	Adverse	Minor	Placement of PAG rock back into the open pit and segregation of pit wall runoff water.	Yes	Increased cadmium concentrations in Morrison Lake: 2 mg/L steady state and 7 mg/L max.	Low	Watershed	Far Future	Continuous	Reversible (far future)	High	Minor	Not Significant	High	Intermediate
	Mine Area	Closure	Adverse	Minor	Placement of PAG rock back into the open pit and segregation of pit wall runoff water.	Yes	Increased sulphate concentrations in Morrison Lake: 10 mg/L steady state and 25 mg/L maximum	Low	Watershed	Far Future	Continuous	Reversible (far future)	High	Minor	Not Significant	High	Intermediate
PAG porewater transport to Morrison Lake	Mine Area	Closure	Adverse	Minor	Lime PAG porewater to pH=8	Yes	Increase concentrations of cadmium by 2 mg/L and sulphate 2 mg/L in Morrison Lake	Low	Watershed	Long term	Continuous	Reversible (long-term)	High	Minor	Not Significant	Low to moderate	Intermediate
Water flow reduction in Morrison Lake/Creek due to large pit water inflows	Mine Area	Operations	Adverse	Minor	Site investigations and potential grouting of major flow	Yes	Reduce annual flow through Morrison Lake/Creek by 1%.	Low	Watershed	Short to medium term	Sporadic to regular	Reversible (short term)	High	Negligible	Not Significant	Low	Intermediate

10.3 Effects Assessment – Other VECS

10.3.1 Climate and Meteorology

The revised closure plan was assessed for potential changes to the effects assessment on Climate and Meteorology. Table 8.2-5 in EAC Application, Vol. II, Section 8.2 states a residual Negligible adverse effect at closure. Placing the waste rock in the open pit will require additional diesel consumption and GHG emissions however land area reclaimed will increase by approximately 340 ha in the TSF and 68 ha of additional wetland area in the open pit. The resultant emissions of GHG may cause a slight decline in condition of the Climate VEC over a short temporal period but baseline conditions will be regained (Residual Effects Ratings Descriptors, EAC Application, Vol. I, Section 5, Table 5.2-8). These changes largely offset each other such that this residual effect will remain Negligible (Table 10.16).

10.3.2 Air Quality

The revised closure plan was assessed for potential changes to the effects assessment on Air Quality. Table 8.3-18 in EAC Application, Vol. II, Section 8.3 does not have any residual effect ratings for the closure phase based on the closure phase activities for closure and reclamation of the operation phase facilities. The revised closure plan involves 6 yrs of waste rock re-handling as well as reclamation of 340 ha of the TSF and is assessed below.

Construction and operations phase effects for gaseous and PM emissions (SO2, NO2, CO, PM2.5, PM 10) were assessed to have a negligible nature and extent and no level of significance and no potential adverse residual effect. Considering that the closure phase will involve less equipment and the net movement of material will be downhill rather than uphill this assessment is applicable to the closure phase as well.

The Construction and Operations phase assessment for significance of residual effects to ambient air quality outside the Project property boundary due to fugitive emissions are none and minor respectively considering emissions sources including:

- Vehicle operation;
- Open pit;
- Tailings pond;
- Waste rock dumps; and
- Access and haul roads.

Mitigation and management identified during operations include use of:

- Control equipment (i.e., scrubber);
- Regular maintenance; and
- Dust suppression mechanisms (road watering, vehicle speed regulations).

During closure, mitigation will include the above mitigation as well as several strategies, as required, which could include, for example, irrigation, wind fences or commercial dust suppressants. Therefore considering that, relative to operations there will be fewer fugitive emissions, there will be a Negligible residual effect to air quality from closure activities (Table 10.16).

10.3.3 Sediment Quality

The revised closure plan was assessed for potential changes to the effects assessment on Sediment Quality. The submersion of the waste rock in the open pit rather than remaining in the waste rock dump will contribute to reducing the quantity and improving the quality of sediment. Considerations are that the revised closure plan eliminates the waste rock dump and the requirement for the associated diversion while re-establishing the waste rock dump footprint.

Table 8.8-2 in EAC Application, Vol. II, Section 8.8 states a Negligible residual effect on sediment quality from surface runoff and siltation contaminant loading for the closure phase. Given the revised closure plan this residual effect is expected to remain Negligible (Table 10.16).

Table 8.8-2 states a Minor residual effect on sediment quality from metal leaching and acid rock drainage (ML/ARD) contamination. The revised closure plan potential for ML/ARD sediments post-closure is substantially reduced in both magnitude and duration. The residual effect is revised from Minor to Negligible (Table 10.16).

10.3.4 Aquatic Resources

The revised closure plan was assessed for potential changes to the effects assessment on Aquatic Resources. Notably the submersion of the waste rock in the open pit rather than remaining in the waste rock dump eliminates the requirement for the associated diversion while re-establishing the waste rock dump footprint as a forested area. These changes contribute to reducing the potential for ML/ARD as well as reducing the quantity while improving the quality of runoff and siltation.

Table 8.9-2 in EAC Application, Vol. II, Section 8.8 states a Negligible residual effect on aquatic resources from surface runoff and siltation and contaminant loading during the closure phase at the mine site. As the revised closure plan will reduce the quantity of siltation and the contaminant loading this residual effect is expected to remain Negligible (Table 10.16).

Table 8.9-2 states Minor residual effects to aquatic resources from ML-ARD contamination and from discharges and spills at the mine site during closure. The revised closure plan eliminates the waste rock dump and the requirement for the associated diversion thus contributing to a lower probability of occurrence of ML/ARD contamination and discharges. Therefore residual effects are expected to be reduced to Negligible (Table 10.16).

Table 8.9-2 states a Major residual effect to aquatic resources from draining the lake/pond in the pit area and pond/wetlands in the tailings facility footprint. Given the revised closure plan, this residual effect is rated as Moderate because the waste rock will be placed in the open pit allowing the pit to fill with water and will result in the restoration of wetlands and a ponded area. The TSF will be restored to forest, wetlands and a pond in the post-closure phase; thus aquatic resources will be replaced in both the pit and the TSF pond. Both the magnitude and duration of the effect are reduced (Table 10.16).

10.3.5 Fish and Fish Habitat

Section 8.10.4 in EAC Application Vol. II states there will be Moderate residual effects to fish and fish habitat as a result of direct habitat loss from the Project.

The revised closure plan for the TSF will provide reclaimed ponded areas of approximately 1.7 km^2, up to 7 m deep, with an average depth of 2.5 m. The water quality for the reclaimed TSF will be sufficient to release downstream and it is anticipated to replace productive capacity in the order of baseline conditions.

The fish habitat compensation plan (FHCP) for the Morrison Copper/Gold Project was reviewed in draft by DFO, who provided observations. Prior to, and during, the development of the FHCP, Pacific Booker Minerals has consulted with the Lake Babine

Nations with respect to potential concerns of effects to the aquatic environment and the potential options for fish habitat compensation. Details of the FHCP and LBN consultations are included in the Final FHCP Report.

The FHCP will offset the expected residual fish habitat losses, particularly in Streams 7, 10 and 5, which will be partly dewatered by Project infrastructure, and minor losses in Morrison Lake due to the footprints of the freshwater and treated effluent pipelines. The total fish-occupied area displaced by the Project will be approximately 0.12 ha (1,251 m^2), mainly in the above creeks. The lost habitat is primarily classified as "marginal" value, as defined by the Department of Fisheries and Oceans (DFO) and primarily consists of rearing habitat. The lost spawning habitat for the project is approximately 9 m^2. The fishless/ barren aquatic habitat displaced, mainly by the TSF, will total about 27.5 ha, which will be offset by increasing the productive capacity by improving fish access to ponds and streams.

Fish Bearing Habitat

The FHCP will include two newly created off-lake channels on the east side of the south basin in Morrison Lake. The channels will total 0.36 ha of aquatic habitat, which will replace the lost fish-occupied habitat at a replacement ratio of 3:1. The new channels will include spawning and rearing habitat for salmonids, including mainly rainbow trout (the main species affected by habitat losses), as well as sockeye and coho salmon; other salmonids may also use the new channels.

Given the revised water management plan, closure plan, and the Fish Habitat Compensation Plan, the residual effects on fish and fish habitat are reduced to Minor (Table 10.16).

Non-Fish Bearing Habitat

The compensation for fishless habitat lost to the Project is based on developing the equivalent productive capacity by improving access for fish in Stream 77300 to the "Olympic Lake" (00260 BABL) system. A measurement of productive habitat can be made on the basis of drift net sampling from Stream 7, which indicates a mass of nutrients available for productive fish habitat from the barren habitat. Compensation for this loss is based on developing equivalent productive capacity by improving fish access to the Olympic Lake system. This system includes: 17 ha in Olympic Lake and 0.24 ha of habitat improvement in Stream 77300. The improved access will offset the loss of barren habitat and provide for increased fish production. Once fish move into this creek/lake system and can more directly access food supplies, fish production in that system will increase and offset the barren habitat losses due to the Morrison Project.

With respect to non-fish bearing habitat, and the revised closure plan for the TSF and implementation of the Fish Habitat Compensation Plan the residual effects on productive capacity related to non-fish bearing habitat are Moderate (Table 10.16).

10.3.6 Navigable Waters

Section 8.11.4 in EAC Application Vol. II states there will be Negligible residual effects to navigable waters (Booker Lake) as a result of the Project. The revised closure plan includes extending the effluent pipeline to the deepest part of Morrison Lake. The effects on navigability are expected to remain Negligible (Table 10.16).

10.3.7 Wetlands

Section 8.12.6 in EAC Application Vol. II states there will be Major residual effects to wetlands as a result of the TSF and Moderate residual effects to wetlands as a result of the pit area.

The revised closure plan was assessed for any potential changes to the effect on wetland extent and function in the Project area. The baseline loss of wetland ecosystems in the TSF is 51.27 ha, the pit area 3.39 ha and the waste dumps 1.21 ha. There are opportunities to compensate for this loss from the construction of wetland habitat on the perimeter of the TSF. The revised closure plan includes the construction of wetlands along the perimeter of the TSF impoundment which has a total length of 2.5 km. The width of the submergent wetland area would be in the order of 200 m wide, for a total area of 50 ha. The emergent wetland width would be in the order of 70 m, for a total area of 17.5 ha. The revised closure plan also includes placing the waste rock back into the open pit with the creation of a wetland habitat in the interior of the bermed area in the order of 68 ha. These reclaimed wetland habitats in the TSF and open pit will replace the baseline loss of 55.87 ha with 125.5 ha.

A blue-listed bog (Wb01) will be inundated by the TSF and waste dumps (approximately 27 ha and 1.2 ha respectively). The direct compensation of this bog cannot occur as it can take decades for these communities to reach functional maturity, however, compensation of wetlands in the TSF and Mine Area will ensure functions carried out by wetlands in the Project will continue.

Given the revised closure plan for the TSF and open pit, the residual effects on wetlands are expected to be Moderate for the TSF and Minor for the open pit (Table 10.16).

10.3.8 Terrain, Surficial Materials, Overburden and Soils

The revised closure plan was assessed for potential changes to the effects assessment on Terrain, Surficial Materials, Overburden and Soils as presented in EAC Application, Vol. II, Section 8.13, Table 8.13-5. Residual effects from the open pit at closure were rated as Major due to steep unstable rock terrain in the closed, unfilled pit. However, the revised closure plan involves back filling the pit and includes the construction of wetlands and creation of a small pond. The residual effect is therefore revised to Minor (Table 10.16).

Residual effects from flooding the TSF at closure were previously rated as Major. However, the revised closure plan specifies a small pond in the closed TSF with wetlands and revegetation along the exposed beaches and on the dams and, therefore the residual effect is revised to Minor (Table 10.16).

Residual effects from the closure of the waste rock dump were rated as Minor in Table 8.13-5 in Vol. II of the EAC Application. The revised closure plan calls for re-handling the waste rock and placing it in the pit. The waste rock dump footprint will be reclaimed and therefore, there will be no residual effect associated with the waste rock dump upon closure.

10.3.9 Terrain Hazards

The revised closure plan was assessed for potential changes to the effects assessment on Terrain Hazards. Table 8.14-4 in EAC Application Vol. II, Section 8.14 states a Moderate residual effect with respect to soil slope failure (surface erosion, piping or saturation leading to slope failure) due to mine development. The revised closure plan includes the removal of the waste rock dump and the TSF will have a smaller water pond. As a result the water will be removed from the dam faces which will enhance the TSF’s stability; the residual effect of soil slope failure at closure is rated as Minor (Table 10.16).

Table 8.14-4 states a Minor residual effect with respect to rock slope failures (weathering and rock ravelling) in the open pit post-closure. In the revised closure plan, the back-filled pit will reduce the height of the exposed pit walls, thereby decreasing the likelihood of rock slope failure. The residual effect of rock slope failure in the pit remains Minor (Table 10.16).

The other effects assessments for Terrain Hazards remain the same as stated in the EAC Application, Vol. II, Section 8.14.

10.3.10 Ecosystems and Vegetation

Section 8.15.8 in EAC Application Vol. II states there will be Moderate residual effects to ecosystems that will be reclaimed at closure (lost-temporary).

The revised closure plan was assessed or any potential changes to vegetation loss and degradation. Vegetation loss will occur at the same baseline amount for the construction phase of the TSF, Mine Area and waste rock dump as described in Volume II (Section 8.15) of the EAC Application. The majority of the mine site will be decommissioned and reclaimed, with the objective of returning the area to the equivalent of its current (baseline) condition, and includes the reclamation of the TSF, Mine Area and waste rock dump areas. Vegetation will be lost permanently in the TSF and open pit area, and on reclamation it will either be replaced or replaced by another forested or shrub ecosystem. The mine site area, TSF and the waste rock dump contribute the largest vegetation loss for the Project (649 ha, 448 ha and 168 ha respectively). The revised closure plan of the TSF includes a combination of “wet” and “dry” areas with reclaimed terrestrial areas accounting for 65% of the TSF area. The reclaimed terrestrial areas will be covered with a growth medium (glacial till and organics) and reforested, and will provide additional opportunities for reclaiming lost vegetation than the previous closure plan. The vegetation will consist of local native species including grasses, shrubs and trees. The waste rock dump will also be reclaimed with local native species as this material will be placed back into the open pit on closure.

Given the revised closure plan for the TSF, open pit and waste rock dump, the residual effects on ecosystems and vegetation are expected to be Minor (Table 10.16).

10.3.11 Wildlife and Wildlife Habitat

Section 8.16.15 in EAC Application Vol. II states there will be Moderate (moose), Minor (grizzly bear, fisher, western toad, waterfowl) and Negligible (mule deer, American marten, forest birds, raptors) residual effects to wildlife from habitat loss from Project effects.

The revised closure plan was assessed for any potential changes to habitat loss or alteration in the context of wildlife. Habitat loss or alteration will occur at the same baseline amount for wildlife as described in the EAC. The revised closure plan will reclaim the TSF to consist of 65% terrestrial area with the remaining ponded area. This should, therefore, serve to replace habitat for many of the terrestrial and aquatic (e.g., waterfowl) species which formerly utilized the area.

The predicted water quality in the TSF during operations will not cause significant adverse effects to the transient wildlife populations that may consume the water periodically. Further, as the water quality in the TSF pond improves to dischargeable levels a few years after mining, the project impact on wildlife is reduced from that determined in the EAC Application.

The revised closure plan for the TSF, open pit and waste rock dump, and the associated increase in reclaimed terrestrial habitat the residual effects on wildlife are expected to remain Minor and Negligible (Table 10.16).

10.3.11.1 Archaeology

Section 8.17 of the EAC Application, Vol. II, Table 8.17-2 states a Negligible residual effect to as-yet unrecorded archaeological sites. This residual effect and other effects assessments on Archaeological resources will not change with the new closure plan.

10.3.12 Land Use

The effects assessments for land use described in Section 8.18 of Vol. II of the EAC Application will not change due to the revised closure plan.

10.3.13 Socio-economics

The effects assessments for socio-economics described in Section 8.19 of Vol. II in the EAC Application will not change due to the revised closure plan.

10.3.14 Visual Resources and Aesthetics

The revised closure plan was assessed for potential changes to the effects assessment on Visual Resources and Aesthetics as presented in EAC Application, Vol. II, Section 8.20, Table 8.20-10. The placement of the overburden stockpile 700 m from Morrison Lake, rather than on Morrison Point, will reduce the visual impact of the project. Additionally, the removal of the waste rock dump and construction of wetlands in the open pit will result in less long-term visual impact for the project. The visual effect of the pit post-closure is rated as Minor and this rating will not change with the new closure plan.

The visual effect of the waste rock dump post-closure was rated as Minor and this rating is downgraded to Negligible as a result of removal of waste rock from the dump (Table 10.16).

The visual effect of the TSF at closure was rated as Moderate and this rating is downgraded to Minor as a result of a smaller TSF pond and vegetation of the TSF dams and beaches (Table 10.16).

10.3.15 Noise

The revised closure plan was assessed for potential changes to the effects assessment on Noise as presented in EAC Application, Vol. II, Section 8.21, Table 8.21-7. There will be some additional truck noise on the mine site at closure, compared to the original closure plan, due to the re-handling of waste rock and backfilling of the open pit, but the residual effect of this is rated as Minor (Table 10.16).

10.3.16 Human Health

Health effects due to noise are presented in EAC Application, Vol. II, Section 8.22. There is expected to be an increase in noise levels at closure due to the re-handling of waste rock, which will lead to a Moderate effect on Tukii Hunting Camp (Table 10.16).

Health effects from changes in drinking water were assessed to be Negligible in the original effects assessment (Table 8.22-25); these ratings have not changed with respect to the revised closure plan.

Project effects on Country Foods were presented in the EAC Application, Vol. II, Section 8.22.5, and were rated as Negligible and Not Significant. These ratings have not changed with respect to the revised closure plan.

10.3.17 Summary of Key Residual Effects on Closure

The assessment of the residual effects of the project has been revised to reflect the changes in the closure plan for the facility in context with wetland habitat, ecosystems and vegetation, wildlife, terrain and fish and fish habitat.

The results of the assessment for the TSF, Mine Area and Waste Rock Dump are summarized in Table 10.16. The assessment concludes that there are four Moderate effect categories, which is related to the loss or change of aquatic resources (e.g., benthic invertebrates, phytoplankton), wetland habitat, non-fish bearing habitats (comparable with aquatic resources) and changes to increased noise on closure from backfilling the open pit with waste rock. This potential effect will be mitigated with the replacement of wetland habitat on closure in the TSF and open pit, although the blue listed bog (Wb01) will not be replaced. It is anticipated that over time, the reclaimed TSF will replace the loss to productive capacity back to baseline conditions.

Table 10.16 Residual Effects Assessment Summary – Terrestrial and Biological Environment

Description	Project Component	Project Phase(s)	Nature	Extent	Mitigation and Management	Potential for Residual Effects	Description	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Resilience (Context)	Significance Category	Significance Rating	Probability of Occurrence	Confidence Level
Direct GHG emissions from fossil fuel burning in internal combustion engines	Mine Area	Closure	Adverse	Negligible	Fuel and energy conservation	Yes	GHG will be released. Reclaiming larger area of TSF and areas of the open pit	Low	Local	Short to Medium Term	One Time	Reversible Short Term	Neutral	Negligible	Not Significant	High	Intermediate
Ambient Air Quality	Mine Area	Operations & Closure	Negligible	Negligible	Control equipment (i.e., scrubber), regular maintenance, dust suppression (e.g., road watering, vehicle speed restrictions)	Yes	Fugitive emissions	Low	Local	Short to Medium Term	One Time	Reversible Short Term	Neutral	Negligible	Not Significant	High	Intermediate
Surface runoff and siltation containment	Mine Area	Closure	Adverse	Negligible	Best management practices, environmental monitoring, erosion management plan	Yes	Submersion of waste rock in the open pit	Low	Local	Short Term	Sporadic	Reversible Short Term	High	Negligible	Not Significant	Low	High
Metal Leaching and Acid Rock Drainage (Sediment Quality)	Mine Area	Closure	Adverse	Low	Excavated materials to be placed back into open pit	Yes	Waste rock dump eliminated, placed back into open pit	Negligible	Local	Short Term	Sporadic	Reversible Long Term	Neutral	Negligible	Not Significant	Low	High
Surface Runoff and Siltation and Contaminant Loading (Aquatic Resources)	Mine Area	Closure	Adverse	Negligible	Silt fences, best management practices, environmental monitoring, erosion management plan	Yes	Waste rock dump eliminated, placed back into open pit.	Low	Local	Short Term	Sporadic	Reversible Short Term	High	Negligible	Not Significant	Low	High

Table 10.16 Residual Effects Assessment Summary – Terrestrial and Biological Environment (cont'd)

Description	Project Component	Project Phase(s)	Nature	Extent	Mitigation and Management	Potential for Residual Effects	Description	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Resilience (Context)	Significance	Significance Rating	Probability of Occurrence	Confidence Level
Metal Leaching and Acid Rock Drainage (Aquatic Resources)	Mine Area	Closure	Adverse	Major	Excavated materials to be placed back into open pit	Yes	ML/ARD resulting in mortality and sublethal effects to biota. Waste rock dump eliminated, placed back into open pit	Low	Local	Long Term	Sporadic	Reversible Long Term	Neutral	Negligible	Not Significant	Low	Low
Habitat loss from draining or burial with tailings (Aquatic Resources)	TSF, Mine Area	Closure	Adverse	Major	Reclamation of TSF and areas of the open pit	Yes	Reclamation of 350 ha of habitat in the TSF, including approximately 1.7 km^2 of ponded area, with 67.5 ha of wetland; and, 68 ha of wetland in the open pit	Medium	Local	Medium Term	One Time	Reversible Long Term	Low	Moderate	Not Significant	Low	High
Loss of fish bearing habitat	TSF, Mine Area	Closure	Adverse	Major	Reclaim TSF, implementation of FHCP	Yes	Rearing and spawning habitat created in off-lake channel habitat	Medium	Landscape / watershed	Long-term	One Time	Reversible Short Term	Neutral	Minor	Not Significant	Medium	High
Loss of non-fish Bearing habitat	TSF, Mine Area	Closure	Adverse	Major	Reclaim TSF, implementation of FHCP	Yes	Non-fish bearing habitat reclaimed in TSF.	Medium	Local	Long-term	One Time	Reversible Short Term	High	Moderate	Not Significant	High	High
Navigable Waters	Mine Area	Closure	Neutral	Negligible	Effluent pipe in deepest part of Morrison Lake. Loss of Booker Lake	Yes	N/A	Low	Landscape / watershed	Far Future	Continuous	Irreversible	High	Negligible	Not Significant	Medium	High
Loss of Wetland Extent and Function	TSF	Closure	Adverse	Major	Construct littoral marsh wetland communities around perimeter of the TSF	Yes	Loss of 26.65 ha blue listed Wb01. Compensated with the creation of 50 ha submergent wetland and 17.5 ha emergent wetland.	High	Landscape / watershed	Far Future	One Time	Reversible Long Term	Low	Moderate	Not Significant	Medium	Intermediate
Loss of Wetland Extent and Function	Waste Rock Dump	Closure	Adverse	Negligible	Placement of waste rock back into open pit, creation of additional wetland and open pond areas	No											

Table 10.16 Residual Effects Assessment Summary – Terrestrial and Biological Environment (cont'd)

Description	Project Component	Project Phase(s)	Nature	Extent	Mitigation and Management	Potential for Residual Effects	Description	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Resilience (Context)	Significance	Significance Rating	Probability of Occurrence	Confidence Level
Loss of Wetland Extent and Function	Mine Area	Closure	Adverse	Major	Areas lost included in non fish-bearing loss in Fish Habitat Compensation Plan	Yes	Loss of 0.4 ha Ws01 swamp in pit. Compensated with the creation of 68 ha of wetland habitat in open pit.	Medium	Local	Long-term	One Time	Reversible Short Term	Neutral	Minor	Not Significant	Medium	Intermediate
Terrain, Surficial Materials, Overburden & Soils	Open Pit	Closure	Adverse	Minor	r Backfilling pit with waste rock	Yes	Pit backfilled with waste rock and reclaimed with vegetation around perimeter, and wetlands established within berm	Medium	Local	Medium Term	Continuous	Reversible Short Term	Low	Minor	Not Significant	High	High
Terrain, Surficial Materials, Overburden & Soils	TSF	Closure	Adverse	Major	Flooding TSF	Yes	Smaller ponded area, reclaimed areas along exposed beaches and on dams	Medium	Local	Medium Term	Continuous	Reversible Short Term	Low	Minor	Not Significant	High	High
Soil Slope Failure (Terrain Hazard)	TSF	Closure	Adverse	Moderate	Flooding TSF	Yes	Smaller water pond, removing water from dam face	Medium	Local	Long Term	Sporadic	Reversible Short Term	Neutral	Minor	Not Significant	Low	High
Rock Slope Failure	Open pit	Closure	Neutral	Moderate	Pit backfilled with waste rock	Yes	Pit backfilled reduce height of exposed walls	Low	Local	Far Future	Sporadic	Irreversible	Low	Minor	Not Significant	High	Low
Habitat Loss or Alteration (Ecosystems & Vegetation)	TSF, Mine Area, Waste Rock Dump	Closure	Adverse	Major	Soil salvage, reclamation of TSF, waste rock dump & perimeter of open pit	Yes	TSF reclaimed with terrestrial areas (65% of TSF area)	Medium	Local	Long Term	One Time	Reversible Long Term	Neutral	Minor	Not Significant	High	High
Habitat Loss or Alteration of terrestrial ecosystems (for wildlife)	TSF, Mine Area, Waste Rock Dump	Closure	Adverse	Minor	Reclaim disturbed habitat to reflect pre-disturbance values after mine closure.	Yes	Habitat reclaimed in TSF, perimeter of open pit and waste rock dump.	Medium	Regional	Long-term	One Time	Reversible Long Term	Neutral	Minor/ Negligible	Not Significant	Medium	High

Table 10.16 Residual Effects Assessment Summary – Terrestrial and Biological Environment (cont'd)

Description	Project Component	Project Phase(s)	Nature	Extent	Mitigation and Management	Potential for Residual Effects	Description	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Resilience (Context)	Significance	Significance Rating	Probability of Occurrence	Confidence Level
Visual Effect	Waste Rock Dump	Closure	Adverse	Major	Overburden stockpile changed location; Waste Rock Dump removed	Yes	Overburden stockpile moved from Morrison Point to 700 m from Morrison Lake. Waste Rock Dump placed back into open pit	Negligible	Local	Far Future	Continuous	Reversible Short Term	Neutral	Negligible	Not Significant	High	High
Visual Effect	TSF	Closure	Adverse	Major	Reclamation of TSF with terrestrial and ponded areas	Yes	Smaller pond area, reclamation of terrestrial areas and wetlands	Medium	Local	Far Future	Continuous	Irreversible	Neutral	Minor	Not Significant	High	High
Noise	Mine Area	Closure	Adverse	Negligible	Site vehicles to comply with manufacturer noise limits; regular maintenance for all vehicles	Yes	Re-handling of waste rock and backfilling open pit	Medium	Landscape	Regular	Regular	Reversible Short Term	High	Minor	Not Significant	High	High
Noise (Human Health)	Mine Area	Closure	Adverse	Moderate	Site vehicles to comply with manufacturer noise limits; regular maintenance for all vehicles	Yes	Re-handling of waste rock and backfilling open pit and effect to Tukii Hunting Camp	Major	Local	Medium Term	Regular	Reversible Short Term	Low	Moderate	Not Significant	High	High

11. CUMULATIVE EFFECTS

The ratings of the cumulative effects of the Morrison Copper/Gold Project presented in Section 11, Volume III of the EAC remain unchanged. However, there is a significant reduction in the risk of cumulative effects and in the potential magnitude of cumulative effects associated with the revised operating and closure plan. The main areas of reduction of potential cumulative effects, and risks associated with them, include the following:

- The TSF is closed earlier and baseline conditions would, therefore, be restored earlier;
- The placement of Cleaner tailings near the reclaim pond and the capping of the TSF over the last 2.5 years of mine life with Rougher tailings mitigates the risk of ML/ARD;
- The TSF is closed with a smaller water pond, which reduces the risks associated with flood management and dam safety;
- The waste rock dump area is returned to baseline conditions sooner and does not have the ML/ARD risks;
- The submerged PAG waste rock in the open pit mitigates the potential for ML/ARD;
- The pit lake, and the commensurate potential water quality issues, is mitigated with the glacial till cap and small water pond;
- The groundwater conditions in the mine area are returned to near baseline conditions earlier with the accelerated closure of the open pit and the placement;
- The reclamation plan of the TSF is closer to baseline conditions, with forest, wetland and pond environments; and
- The volume of water requiring water treatment in the far future is reduced by 70%.

The revised closure plan reduces the long-term and far-future environmental liability associated with cumulative effects. The Expected Case presented in this report is considered the most likely scenario, but, as requested, an Upper Bound case has been developed. The Upper Bound case also results in a reduction in the potential for cumulative effects.

The cumulative effects of the water flow and water quality, particularly on Morrison River and Babine Lake, are negligible and not significant.

12. ADAPTIVE MANAGEMENT PLAN

12.1 General

The Project's Environmental Management System (EMS) includes Environmental Management Plans and Environmental Effects Monitoring Plans as described in the EAC Application Volume III Sections 13 and 14. The Environmental Management System will be part of PBM's overall Quality Management System, which is shown in Figure 12.1.

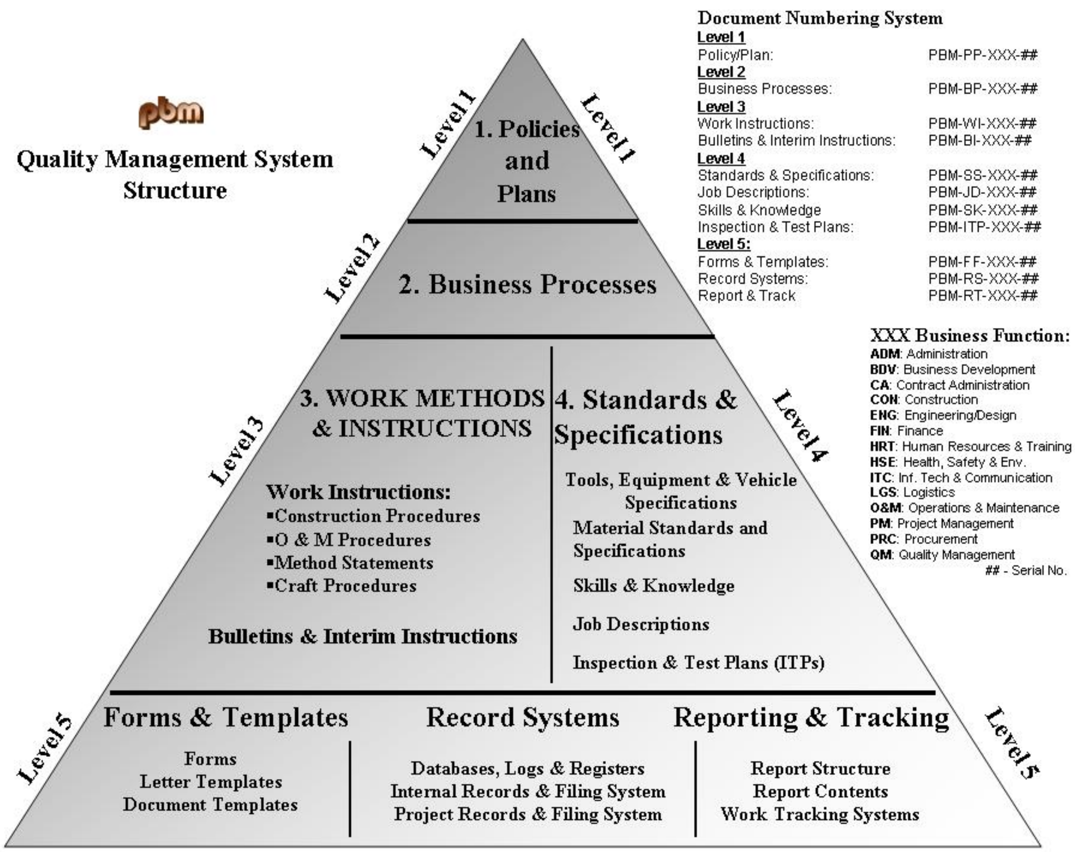

Figure 12.1 Schematic of Environmental Management System

PBM is committed to an adaptive management approach for the Project. Accordingly the EMS allows for continuous improvement with respect to environmental performance and includes an applied adaptive management approach that will address any necessary modifications and improvements to monitoring and mitigation The role of adaptive management within the framework of the Environmental Management System is shown in Figure 12.2.

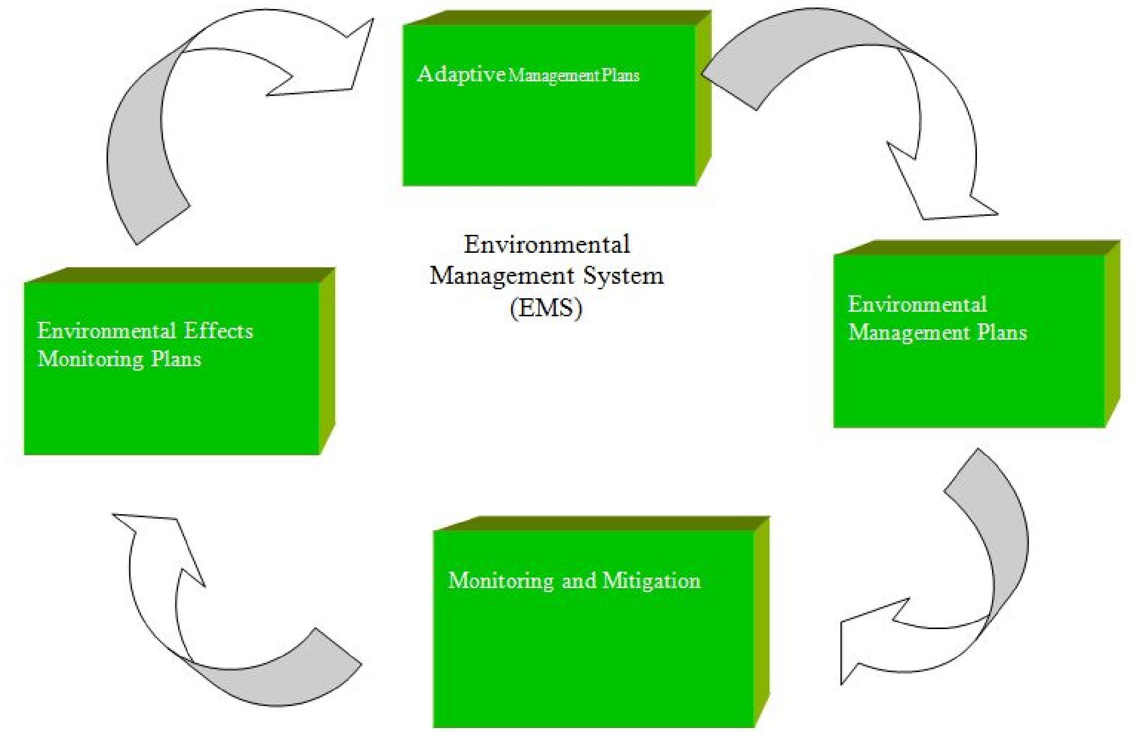

Figure 12.2 Schematic of Environmental Management Framework

Adaptive management plans are described below, however they will continue to be further defined during the project in response to actual site conditions. As the word "adaptive" suggests, plans will be adapted to the specific conditions and situations encountered. Operational and environmental effects monitoring may identify events or conditions that require solutions to ensure Project compliance with permits, licenses or authorizations. Once such events and conditions reach a threshold level adaptive management plans will be finalized and implemented.

Adaptive management plans will be maintained and updated at each phase of the Project. This process may be internal, but will include stakeholders in situations where outside input is desirable or mandated by government regulation or corporate policy. This process is continuous throughout all phases of the project with changes to management where required.

12.1.1 Supporting Adaptive Management Components

The adaptive management plan for the construction and operations of the project has been developed to address the key project uncertainties and areas of potential effects. The main TSF issues concern seepage from the impoundment and management of the project water balance. The main mine area components include the potential pit dewatering requirements and the potential influence of Morrison Lake on the pit dewatering.

The closure phase of the project includes key issues of de-commissioning and closing the TSF, such that it can be reclaimed as a pond, wetland, grassland, forested area and that the water quality is suitable for discharge. The open pit will be filled with PAG rock and key issues include storage capacity and the treatment and fate of PAG porewater associated with placement of the acidic PAG rock back into the open pit.

The Adaptive Management Plan s will be based, in part, on the various contingency plans developed for the main project components, which are described in the relevant sections of this report. The key Adaptive Management Components are summarized in Table 12.1.

Table 12.1 Adaptive Management Components

Component	Phase	Potential Outcome	Management Plan or Mitigation Strategies	Adaptive Management Threshold	Adaptive Management Plans
TSF	Operations	• Cyclone sand for dam construction does not meet non-PAG criteria.	• A quality assurance/quality control (QA/QC).	• SNPR values greater than 2.0.	• Additional sulphide separation, at the dam site using a pyrite removal cell.
		• Seepage rates from TSF increase over predicted values	• Groundwater monitoring wells; • Annual water balance reconciliation. • Site investigations and groundwater modeling to refine seepage predictions	• Groundwater and/or surface water monitoring indicates elevated concentrations in the receiving environment.	• Line portions of the impoundment with low hydraulic conductivity soils or geomembrane. • Selectively spigot tailings near areas of potential seepage. • Pump- back wells.
		• Site wide water balance results in surplus water to be stored in the TSF	• Annual water balance reconciliation and predictions. • Adjust dam raising schedule to reflect storage requirements.	• Storage of surplus water requires an increase in dam elevation.	• Increase cyclone sand production rate and raise dam.
	Pre-Closure	• Storage of surplus PAG rock or LGO is required.	• Monitor PAG and LGO volumes annually.	• Review in Year 10 if measured quantities will be able to be placed back into the open pit on closure.	• Place equivalent PAG rock into the TSF to ensure that the rock will be submerged prior to closure.
		• LGO ore is not milled pre-closure.	• Manage LGO stockpile to match pre-closure tailings management plan.	• Review in Year 1 to see if measured quantities of LGO match pre-closure milling.	• Sub-aqueous discharge of Cleaner tailings near the final TSF pond. • Potentially increase TSF water pond size for closure. • Potentially construct water treatment plant earlier to treat surplus water.
		• Rougher tailings for final beaches does not meet non-PAG criteria.	• A quality assurance/quality control (QA/QC).	• SNPR values greater than 2.0.	• Additional sulphide separation using a pyrite removal cell.
	Closure	• TSF pond water not suitable for discharge.	• Minimize pond size at closure and maximize natural dilution with runoff.	• Discharge criteria is not met.	• Increase final pond size. • Temporarily treat surplus water until it meets criteria for discharge.
Mine Area	Construction	• Booker Lake or Ore Pond sediments do not meet criteria for non-hazardous containment	• Sampling and testing program.	• Exceed storage criteria	• Store sediments in the TSF footprint.
		• Runoff from pre-stripping areas of the mine contains elevated metal concentrations.	• Sampling and monitoring	• Exceed discharge water quality criteria	• Store surplus water in the dewatered Booker Lake basin and pump to TSF at start of operations.
	Pre-closure	• Surplus PAG rock on closure	• Monitor volumes at Year 10	•	• Place surplus PAG rock in the TSF
		• Non-PAG rock has ARD/ML potential	• Monitor drainage from non-PAG dump	• Exceeds discharge criteria.	• Treat as PAG rock.
		• Non-PAG rock volume for closure is not sufficient for planned cap.	• Monitor volumes	• NA	• Treat as PAG rock and potentially treat additional geochemical load.
	Operations	• Excessive seepage from Morrison Lake into the Open Pit.	• Site investigations, mapping, and GW modeling. • Monitoring of flows and water levels.	• Surplus volumes of seepage upset water balance and potential affect Morrison Lake levels or Morrison Creek flows.	• Grouting of high hydraulic conductivity zones. • Discharge of large flows into a land area application
	Closure	• Higher groundwater inflows than predicted from “uphill” catchment.	• Monitor groundwater levels • Water balance reconciliation to confirm inflows.	• Surplus water requires increase in water treatment capacity.	• Treat surplus water. • Potentially segregate contact water with non contact water. • Install interceptor wells to collect “clean” groundwater inflows.
	Closure	• Residual pore water from PAG rock migrates into Morrison Lake	• Closure plan designed to minimize potential risk. • Monitor water quality between the pit and the lake.	• Elevated concentrations in receiving wells. • Measureable change in Morrison Lake water quality adjacent to the open pit.	• Install interceptor wells and treat water.
Site Wide Water Balance	Operations	• Water surplus accumulated during mine life.	• Maximize diversions. • Annual water balance reconciliation.	• Surplus water balance requires dam raising above normally required levels.	• Ensure efficiency of diversions and add interim diversions if possible • Discharge “clean” groundwater from dewatering wells to a land area application • Construct water treatment plant prior to closure to treat surplus water

13. SUMMARY

This revised Review Response Report for the Morrison Copper/Gold Project addresses the project changes which have been made to reduce the environmental effect of the Project as well as the long term environmental risk. The report includes the technical changes to the project as well as revised assessment of the significance of residual environmental effects.

The main Project changes revisions are summarized in Table 13.1and summarized as follows:

1. PBM commit to place all PAG waste rock and un-milled LGO back into the open pit on closure, where it will be flooded and covered. This reduces the total geochemical load coming from the mine area on closure and reduces the potential effects on Morrison Lake. In addition, the long term risk of the PAG rock is eliminated. The flows requiring water treatment are reduced to approximately 30% of the previous flows.

2. PBM commit to separating rougher and cleaner tailings for placement in the TSF. The non-sulphide rougher tailings will be placed around the TSF perimeter and the sulphide cleaner tailings will be placed near the central reclaim pond. On closure, the built up TSF water volume will be pumped to the open pit over a period of approximately 6 months and a TSF pond will form with natural runoff and precipitation. A closure pond of an approximate volume of 4 Mm^3 will form over 3 years, and will then discharge to Stream 7. The TSF will be closed as a combination of pond, wetland and forest and there will not be a major water pond against the dams.

3. The potential effects on Morrison Lake are reduced and the only parameter of potential concern which slightly exceeds BCWQGs is cadmium. The cadmium loadings are primarily from the TSF. It is important to note that the analysis conservatively assumes that the maximum cadmium concentration will report directly to Morrison Lake without any attenuation or absorption along the flow path. Accordingly, it is unlikely even with the maximum load, that there will be a measureable effect on Morrison Lake.

4. The overburden stockpile has also been relocated away from Morrison Point to a location approximately 700 m inland from the lake. This will allow Morrison Point to be retained for recreational and LBN use.

Table 13.1 Summary of Adopted Waste Management Modifications

Mine Component	Previous Proposal	Revised Proposal
Overburden Stockpile	Located on Morrison Point	Relocated to 700 m inland from Morrison Lake.
Booker Lake and Ore Pond Sediments	Store in Overburden and Organic Sediment Storage stockpile.	Geochemistry testing plan and Adaptive Management storage facility within the footprint of the TSF.
TSF	Mix cleaner and rougher tailings and discharge together.	Separate cleaner and rougher tailings and discharge cleaner tailings near reclaim pond. Place rougher tailings on the TSF beaches. Place cleaner tailings from milling of LGO into the open pit.
Low Grade Ore Stockpile	Milled or to remain in perpetuity	Milled or placed in open pit
Waste Rock	PAG rock not subdivided into units for management.	Waste rock to be segregated into high PAG and low PAG.
TSF	Discharge to open pit and then reclaim as lake or closed system	Pump all process water to the open pit and accelerate return of TSF pond water quality to BCWQGs. Close as combination pond, wetland and forest.
Water Treatment Plant	Design flow 214 m^3/hr for far future	Design flow 55 m^3/hr for far future
Morrison Lake Diffuser and Pipeline	Pipeline diameter 300 mm and 100:1 mixing plume width of 5.5 m, 25 m high.	Pipeline diameter 150 mm and 100:1 mixing plume width of 5 m, 40 m high.
Waste rock dump	On-land dump with soil cover to remain in far future	Submerge PAG waste rock in the open pit on closure and maintain pit area pond/wetland and water treatment.

The project changes result in a reduced volume of water stored in the TSF, improved water quality in the TSF years earlier and reduced the risk of ML/ARD from the waste rock. Based on the methodology in the EAC Application the significance of residual effects of the project are principally negligible to minor, with a few moderate effects to receiving streams. However, considering the Significance Rating introduced within this document none of the effects are significant. PBM believes this Significance Rating considered with the will aid EAO and CEAA to clearly address the question ***"Is the project likely to cause significant adverse residual environmental effects?"***

The ratings of the cumulative effects of the Morrison Copper/Gold Project presented in Section 11, Volume III of the EAC remain unchanged. However, there is a significant reduction in the risk of cumulative effects and in the potential magnitude of cumulative effects associated with the revised operating and closure plan.

Additionally PBM is committed to an adaptive management approach for the Project. The Project's Environmental Management System will include Environmental Management Plans and Environmental Effects Monitoring Plans. The EMS will allow for continuous improvement with respect to environmental performance and include an applied adaptive management approach that will address any necessary modifications and improvements to monitoring and mitigation or even result additional monitoring and mitigation measures being implemented. Adaptive Management Plans have been identified as having capacity for mitigation that is sufficient to respond to Upper Bound conditions.

During the EAC Review process, a number of commitments have been made by PBM with respect to various project and operational controls and monitoring. The key commitments, and associated general commitments, are tracked in Tables and will be submitted in a separate document. In addition, the Project Tracking Tables will be posted as a separate document.

The Morrison Copper/Gold Project EAC Application includes a large number of individual documents. Considering issues of professional conduct and practicality it is recognized that given the large number of documents, there may be ambiguities between documents as well as conflicting information and conclusions contained therein. In the case of conflict, the more recent document will take precedence over an earlier document with the order of precedence being: (i) Review Response Report, (ii) EAC Addendum, and (iii) EAC Application. More specific guidance is provided within the Application Information Key (AIK) with respect to sections of these documents and precedence. The AIK is submitted as a separate document.

PBM is committed to working throughout the detailed design and permitting process, and continuing into operations and closure, to plan, construct, operate and close the mine to minimize the environmental effects and enhance post-closure land use.

Yours truly,

KLOHN CRIPPEN BERGER LTD.

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