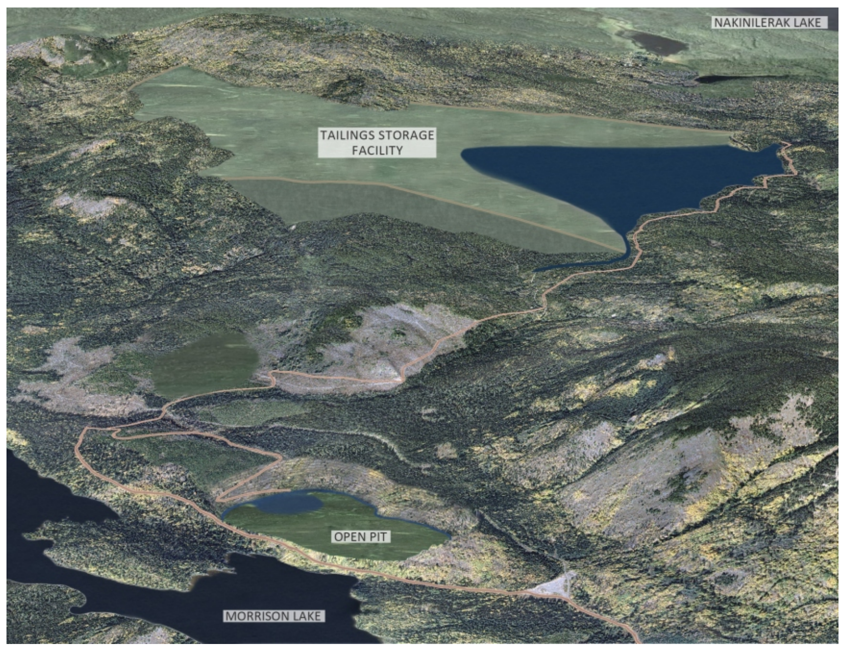
MORRISON COPPER/GOLD PROJECT

BC Environmental Assessment Certificate Application



Review Response Report - Rev.2

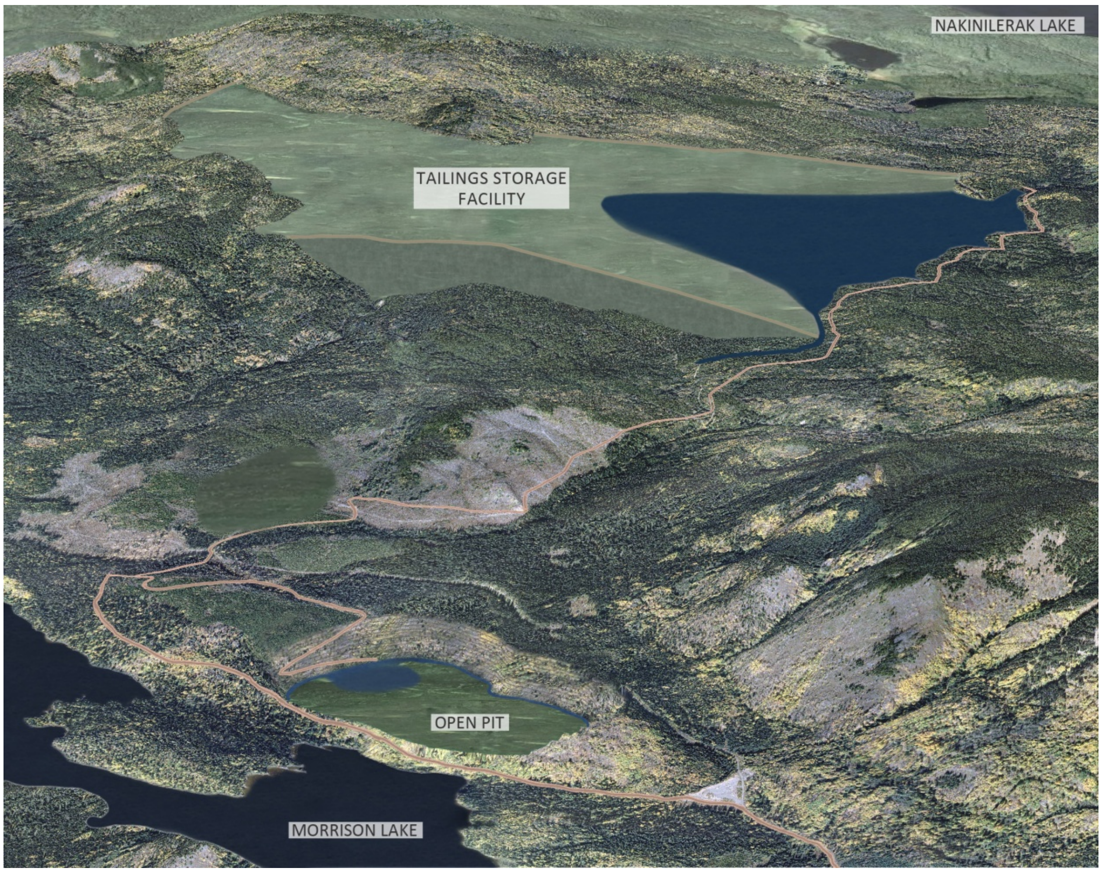
Klohn Crippen Berger

M09382A04

PACIFIC BOOKER MINERALS

MORRISON COPPER/GOLD PROJECT

BC Environmental Assessment Certificate Application



REVIEW RESPONSE REPORT – REV. 2

Klohn Crippen Berger

EXECUTIVE SUMMARY

General

Pacific Booker Minerals (PBM) submitted an Application for an Environmental Assessment Certificate (EAC) on September 29, 2009 for the Morrison Copper/Gold Project. In response to requests from the BC Environmental Assessment Office (EAO) and the Canadian Environmental Assessment Agency (CEAA), additional information and assessment was provided in the EAC Addendum, May 27, 2010. Subsequent to the EAC Addendum, PBM has received the review observations from the Provincial and Federal Agencies and the Lake Babine Nation (LBN) and has had a number of meetings with the Working Group. In addition to providing direct responses to review comments, via a tracking table, this Review Response Report provides additional clarification and details, particularly with respect to project modifications.

The Review Response Report - Rev.1 was issued in November 2010 for discussion with the Working Group. After its review by the Agencies and discussions with CEAA and EAO, PBM agreed to consider suggested changes in the Project, with the view of reducing the long term environmental risk. PBM arranged technical Working Group meetings in January and February 2011 focused on Hydrogeology/Hydrology, Water Quality and Aquatic Habitat to further clarify the technical concerns and to ensure that the significant technical issues are both understood and addressed.

The Review Response Report Rev.2 addresses the major Review comments and questions which primarily relate to water quality, water balance, and effects of the project on the receiving streams and Morrison Lake, and provides design details of the project changes. An updated Effects Assessment is included in this report, which addresses, with respect to project changes, the project effects on water quality, water quantity, aquatic environment, wildlife and terrestrial environment. The Effects Assessment also includes an additional rating methodology to screen effects as being “significant” or “not significant”. The report also addresses, in more detail, the Adaptive Management Plan for the major areas of potential concern.

The Review Response Report Rev.2 is to be considered supplemental to all other previously submitted documents. Hence PBM intends that all the EAC Application documents will co-exist and PBM will provide an Application Information Key (AIK) identifying the order of precedence guiding how the documents should be considered. Effectively the order of precedence addresses any potential ambiguities between documents, such as variations in results or assessments, by identifying that more current documents take precedence over prior documents.

Project Changes

The main project changes are modifications to management of tailings placed in the tailings storage facility and to the closure phase for the TSF and disposal of waste rock into the open pit. An image of the Project area post-closure is included at the end of the Executive Summary.

The management plan for the Tailings Storage Facility (TSF) has been revised to reduce the risk of sulphide tailings in the beaches by discharging higher sulphide Cleaner tailings separately from lower sulphide Rougher tailings. This revised management plan removes the requirement to maintain a large water pond over the tailings on closure. Consequently, the closure plan has been modified from a large water pond with perimeter wetlands to a combination of water pond, with wetlands and forest cover for the remainder of the impoundment area. Further details on the TSF are provided in Section 4 of this report.

The closure and reclamation plan for the Waste Rock has been revised to eliminate the above ground waste rock dump. On closure the waste rock, will be re-handled and place in the open pit so that the potentially acid generating (PAG) waste rock is submerged within the open pit.

In addition, changes have been made to the construction phase with relocation of the overburden stockpile (away from Morrison lakeshore) and waste management controls for potential contaminated soils and runoff during construction.

Closure and Reclamation Plan

During the last few years of mining the low grade ore (LGO) will be milled and water in-flows from the mine area and the cleaner tailings from the process plant will be discharged into the open pit. At this time haulage and placement of PAG waste rock into the open pit will also begin. At the end of processing, any residual water in the TSF will be pumped to the open pit. The PAG rock placed in the open pit will be saturated to mitigate acid rock drainage and capped with a low permeability soil layer. The open pit area will be reclaimed with an interior wetland zone and a pit wall collection/water treatment pond zone. The waste rock dump area, after removal of the waste rock and low grade ore stockpile, will be cleaned, graded and re-vegetated with forest and grasslands.

Within the open pit, collection of acidic runoff from the remaining pit wall slopes will be directed towards the open pit pond where it will be pumped to the water treatment plant. The treated water will be discharged in Morrison Lake at depth via a pipeline with a diffuser.

Water Balance and Hydrogeology

The Expected Case (EC) water management is that the Project will operate with "zero" surface water discharge during operations. PBM is confident this case will be achieved however, to provide increased confidence that higher volumes of water can be managed PBM has developed a water management plan for the Upper Bound (UB) case, as follows.

The groundwater models for the TSF were reviewed and adjusted to meet the above described changes to the operating and closure plan for the TSF. The predicted seepage rates were then considered to provide Lower Bound (LB), Expected Case (EC) and Upper Bound (UB) seepage rates.

The potential for groundwater inflow from Morrison Lake into the open pit during operations was re-assessed using a 2-D SEEPW groundwater model and analog data from Bell and Granisle mines, and other porphyry copper mines in British Columbia. The Bell and Granisle mines both have open pits which are adjacent to Babine Lake and pit water inflows have been measured at several stages of the pit infilling. The potential total pit inflows were also reassessed, with consideration of the regional groundwater recharge and analog data from other mines. Additionally, the potential for groundwater gradients to transport the porewater of waste rock that is placed back into the open pit into Morrison Lake was assessed for the long term closure stage of the project. The predicted pit inflows were then considered to provide Lower Bound (LB), Expected Case (EC) and Upper Bound (UB) inflow rates.

A summary of the revised seepage and pit water inflow rates is provided in Table 1.

Table 1 Summary of Seepage and Groundwater Flows

COMPONENT	OPERATIONS (m^3/hr)			CLOSURE (m^3/hr)		
	LB**	EC	UB	LB	EC	UB
TSF seepage	50	100	150	30	60	100
Morrison Lake inflows into pit		100	150			
Total pit dewatering		0* - 150	0* - 250			
Pit pond inflows					10	15
Pit PAG porewater to Morrison Lake					20	40

*Indicates the range of flows over time as the pit is developed.
**LB-Lower Bound, EC-Expected Case, UB-Upper Bound

The Upper Bound water management scenario is based on the accumulation of excess water that cannot be discharged. The Upper Bound water management case is thus based on:

- Lower Bound seepage rates from the TSF,
- Upper Bound pit dewatering flows,
- Upper Bound tailings density and diversion efficiency, and
- Storage of an additional 10 year return period wet year.

The site wide water balance program was expanded to include life of mine monthly calculations for the Expected Case and the Upper Bound water management cases as shown in Appendix iii. The water balance summary results are shown in Table 2.

Table 2 Summary of Site Water Balance Volumes

Year	Volume of TSF Pond Water (Mm^3)		
	Expected Case	Upper Bound	Upper Bound – Managed*
Maximum	10	19.3	10
End of Mine Life	0.3	4.5	0.3
Initial closure	0.01	0.01	0.01

The Upper Bound water management plan, using established mitigation measures, may result in an additional stored water volume of approximately 9 Mm^3. If required this volume of stored water can be stored by increasing the dam height of the TSF by approximately 2m. However, Adaptive Management options have been identified that can reduce the volume of stored water during the last ten years of mining. The Adaptive Management options include:

- Discharge of surplus groundwater from the pit dewatering into a land area application, provided the water quality is suitable for release;
- Construction of the water treatment plant earlier in the mine life and treatment of 70 m^3/hr to a maximum of 110 m^3/hr, with discharge via the diffuser in Morrison Lake.; and
- Seepage into the open pit from Morrison Lake could be mitigated with selective grouting of high hydraulic conductivity zones.

Water Quality

Water quality predictions for tailings process water, waste rock porewater, and pit wall drainage, have been made on the basis of empirical drainage chemistry models (EDCM) developed for the Bell and Granisle mines and with consideration of available humidity cell and field cube cell data from Morrison Mine. For prediction purposes, all three predictions methods were used and documented. For each parameter the highest predicted concentrations of the three methods was used as the Morrison prediction.

During operations, all contact water inflows from the mine area and open pit are directed via the process plant to the TSF and the tailings water will be limed to ensure pH=8 for processing. Initially water from the process plant will be that of the lock cycle tests. However over time some contaminants will accumulate and, therefore, tailings water degrades during operations; from the initial lock cycle test water quality to an EDCM pH=8 water quality at end of processing. The Expected Case TSF seepage water quality assumes the average of the two water qualities and the Upper Bound TSF seepage water quality assumes the EDCM pH=8 water quality.

On closure waste rock will be placed into the open pit. Approximately 50% of the potentially acid generating (PAG) waste rock may be acidic (pH=3) and will release metals, nutrients and oxyanions as it is submerged in the open pit. An assessment of the potential water quality was made with a bench scale test of Morrison water “spiked” to the EDCM pH=3 water quality, which was then limed to pH=8. The testing demonstrated that the predicted water quality can be achieved.

On closure, pit wall drainage will be collected and treated in a high density lime treatment plant. The design basis for the plant, assumed a starting water quality of pH=3. The treated water quality is discharged via a diffuser, at depth in Morrison Lake.

Effects Assessment

The revised effects assessment for the project considers: water quantity, water quality, aquatic habitat and terrestrial (wildlife and wetland) habitat.

Water Quantity Effects - Streams:

During operations non-contact water will be diverted around the mine facilities and contact water will be used in the process with some being stored in the voids of the tailings and waste rock. Reduction of approximately 50% of the flow, categorized as being of minor significance, occurs in Stream 7 which is the main stream in the TSF area. Other streams also have smaller flow changes categorized as being of negligible significance. The change in flow during operations results primarily in an effect on the aquatic habitat and this is addressed in the section describing aquatic habitat and with the Fish Habitat Compensation Plan. On closure, Stream 4, 6, 7 and 10 flows will be reinstated.

Water Quantity Effects – Morrison Lake:

The potential effect on Morrison Lake (e.g. due to accumulation of water in the TSF as pore and pond water and any losses such as evaporation) during operations will not be significant. Reductions in the volume of water reporting to Morrison Lake are predicted to be in the order of 1% to 2% of the average annual flow through Morrison Lake, which is well within the natural variability and should not have a measureable effect on flows or water levels in the lake.

Water Quality Effects - Streams:

The water quality of all seepage discharges meet MMER requirements for listed deleterious contaminants. Potential water quality exceedances are predicted for sulphate (3x's BC Water Quality Guidelines) and cadmium (3x's BC Water Quality Guidelines) are not deleterious. Other parameters, which are above the BC Water Quality Guidelines include: aluminum, arsenic, cobalt and selenium, however some of these elements are elevated due to the baseline groundwater and surface water quality. Further the predictions are conservative as the methodology used did not consider absorption, precipitation or ion exchange along the flow path, which would reduce concentrations for Al, As, Cd and Se. In addition, the seepage quantity and quality will vary with time:

- Initially seepage rates are low and seepage water quality is better,
- Near the end of mining seepage rates will be the highest and the water quality will likely be worse.
- After closure seepage rates will decline and water quality will improve.

An additional consideration is that the lag time for seepage through the tailings and overburden is in the order of 10 years to 20 years. Considering these variables the seepage effects may peak approximately Year 25 to 30 and then decrease with time.

Streams 7, 8 and 10 are predicted to be affected by seepage from the TSF, particularly during low flow periods. Site specific water quality objectives for cadmium and sulphate could be required for the receiving streams and will be developed during the permitting stage of the project.

Water Quality Effects - TSF Pond on Closure: The project changes result in a small pond of water remaining in the TSF a few months after closure. The TSF will then infill with precipitation and runoff water to establish a 17 ha permanent pond. At the same time the beach slopes inside the TSF will be covered with glacial till and a growth medium. The predicted water quality for the TSF pond filling has been computed using EDCM pH=8 water and loads that will derive from the beaches and the remaining water pond. The water quality prediction indicates that the discharge water quality will meet all guidelines after 3 years, with the exception of cadmium, which is approximately 4x's BC Water Quality Guidelines. The water quality will improve further as it is diluted over the years with runoff and precipitation.

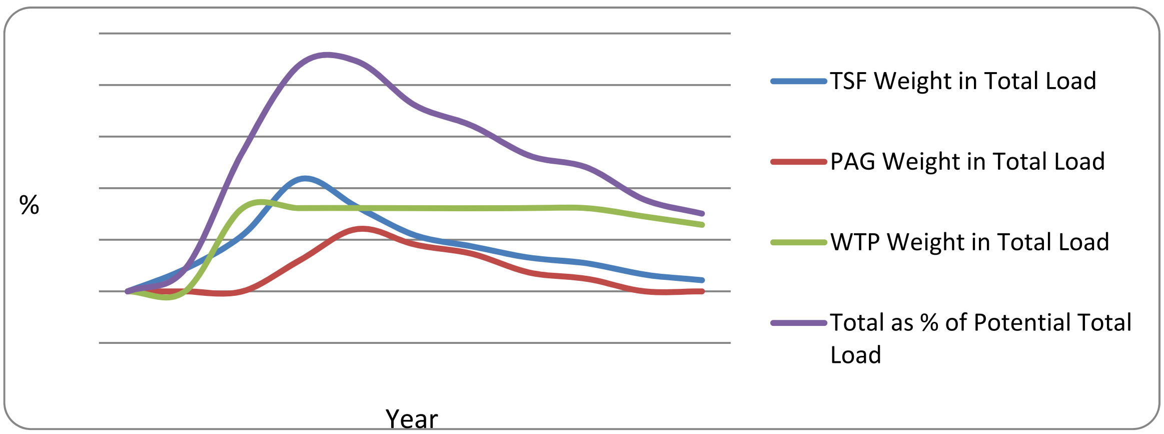
A site specific water quality objective could be required for the surface water discharge for the short period of time required before the cadmium concentration reduces to guideline levels.

Water Quality Effects- Morrison Lake:
Potential water quality effects on Morrison Lake could result from:

- TSF seepage;
- Water treatment plant discharges via the diffuser; and
- Seepage from the backfilled open pit.

Water quality modeling considering the three inflows has been carried out to determine potential changes in the water quality of the lake.

As discussed above, seepage quantity and quality from the TSF varies with time. In addition , the groundwater flow and quality from the open pit will vary with time and, over a period of approximately 50 years, the low quality water that will initially be present immediately after waste rock is placed into the open pit, will be flushed out would not contribute further to the effect on Morrison Lake. The result is that total contaminant loads in Morrison Lake will build up to a maximum in approximately Year 40, and then decrease with time. The following figure demonstrates the approximate temporal changes of the loads from TSF seepage, Open Pit Groundwater (PAG Waste Rock pore-water) and the water treatment plant.



Distribution of Loads from the TSF, Open Pit Groundwater (PAG Waste Rock Pore-water) and Water Treatment Plant to Morrison Lake with Time

The modeling indicates for the Expected Case, all parameters meet the guidelines. In the Upper Bound case cadmium is slightly elevated ((Steady State 2 nanograms and Maximum (100:1 diffuser) 7 nanograms over the BC Water Quality Guideline)). The load calculation also assumes no adsorption or ion exchanges of loads along the seepage flow paths. The water quality effects on Morrison Lake, therefore, are negligible and site specific water quality objectives are not required.

Aquatic Habitat Effects:

The Project effects on the aquatic habitat of the area occur through flow reductions in streams and the removal of barren pond and stream habitat (covered with the TSF and open pit). The effect on the aquatic habitat is documented in the Fish Habitat Compensation Plan. The fish bearing (i.e. HADD – harmful alteration, disruption or destruction) losses principally relate to the marginal fish habitat of Stream 7 and include:

- 1,242 m^2 of rearing habitat; and
- 9 m^2 of spawning habitat.

The non-fish bearing habitat loss is estimated to be equivalent to 12 million organisms per year. The fish bearing riparian losses are estimated to be 13,500 m^2.

To address the HADD's PBM has proposed a fish habitat compensation plan to DFO. The compensation plan includes construction of two "off-lake" channels, which will also provide compensation for loss of fish bearing riparian areas. The compensation plan for barren habitat includes upgrading of the Olympic Lake and Olympic Creek system, such that access to the estimated 50 million organisms/year could be made more available to fish and increase the productive capacity of the system.

Wetlands and Terrestrial Habitat Effects: The Project has an effect on wetlands and terrestrial habitat, principally within the TSF and the mine area. The project changes documented herein include a revised closure plan that allows for development of more wetland areas. This will include the shoreline and shallow waters of the TSF pond and wetlands within the closed open pit. Additionally, large areas of the TSF will be forested and the disturbed mine area will be reclaimed and forested.

Other Effects: The project changes result in revised water management and closure plans that either maintain or reduce the significance of adverse residual effects to sediment quality; aquatic resources; navigable waters; terrain, surficial materials, overburden and soils; terrain hazards; ecosystems and vegetation; wildlife and wildlife habitat; archaeology and heritage setting; land and resource use; socio-economic setting; visual resources and aesthetics; and human health.

In addition to considering the project changes the effects assessment methodology has been supplemented to include assessment descriptor criteria for determining Significance Ratings. All residual effects have been considered using these criteria such that in addition to a Significance Category a Significance Rating has been assigned for each residual effect. The resulting list of residual effects is intended to aid EAO and CEAA in answering the question "Is the Project Likely to cause significant adverse residual effects?"

Cumulative Effects: The revised water management and closure plan either maintains or reduces the cumulative effects on the project as described in the EAC.

Summary

The revised project design allows for early closure of the TSF and mine area and results in a significant reduction in the project effects, particularly on closure. The project has robust water management and waste management plans that are flexible to foreseeable variations in inputs and actual site conditions.

The residual effects of the project are principally negligible to minor, with a moderate effect to receiving streams.

Adaptive Management Plans have been identified as having capacity for more mitigation to respond to Upper Bound conditions.

PBM is committed, throughout the detailed design and permitting stages, and continuing into operations and closure, to plan, construct, operate and close the Morrison Copper/Gold Project to minimize the environmental effect and enhance post-closure land use.

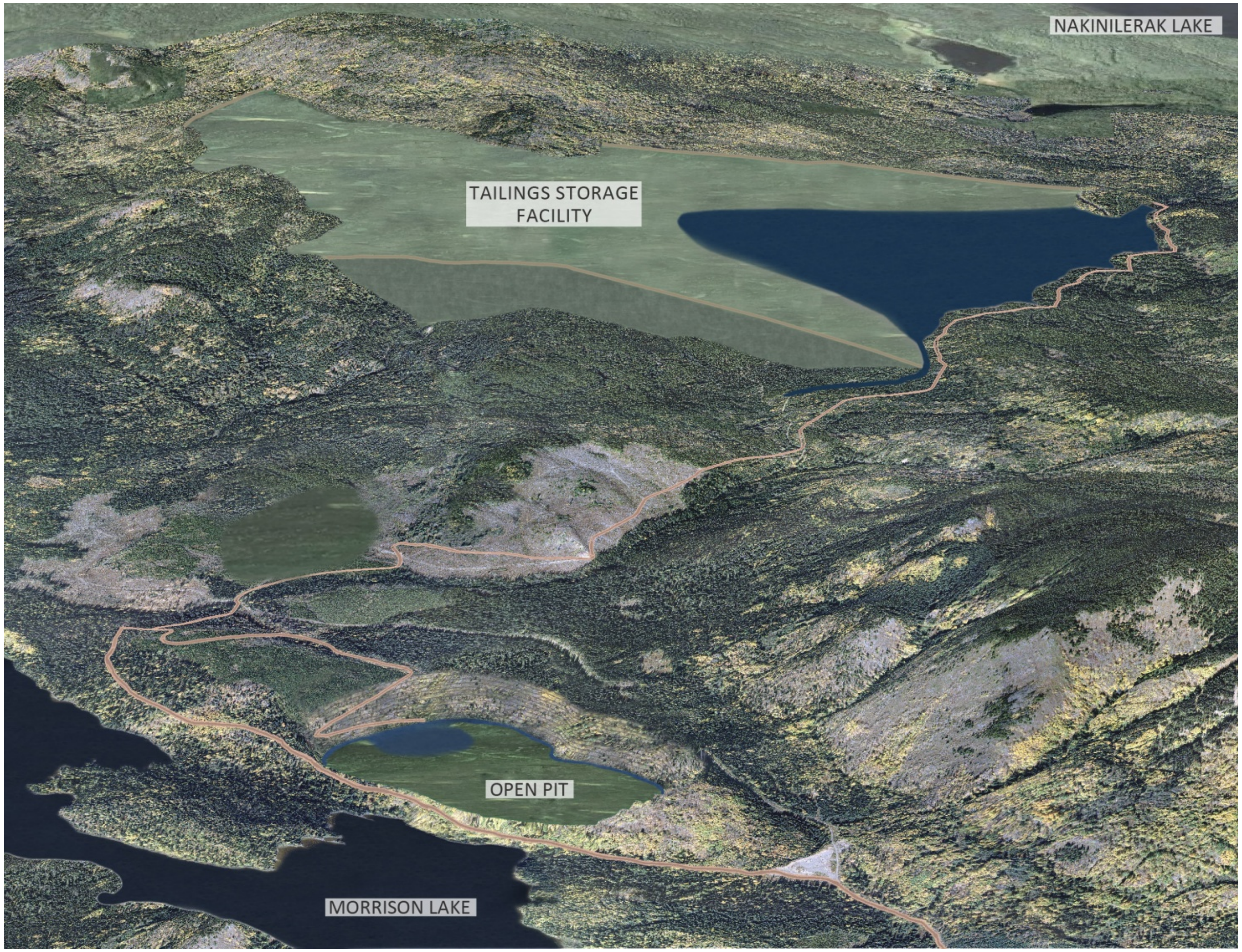


Figure 2 Morrison Copper/Gold Project - Post-Closure

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APPENDICES

1. INTRODUCTION

The Morrison Copper/Gold Project is a 30,000 tpd open pit mine located 65 km northeast of Smithers and adjacent to Morrison Lake as shown on Figure 1.1 and Figure 1.2. Pacific Booker Minerals (PBM) submitted an Environmental Assessment Application on September 29, 2009. In response to requests from the Environmental Assessment Office (EAO) additional information and assessment was provided in the EAC Addendum, May 27, 2010. Reviewers of the EAC Application and Addendum requested additional information. To provide this additional information PBM is providing this Review Response Report Rev-2, which is an updated version that supersedes the previous versions Rev-1, which was submitted in November, 2010.

The Review Response Report addresses the following:

- Inclusion of additional baseline data collected since submission of the EAC Application
- Modification to the management plans for overburden, waste rock and tailings to reduce the long term risks associated with closure of the mine and long term metal leaching and acid rock drainage (ARD/ML). The main modifications include:
    - Placement of all potentially acid generating (PAG) waste rock back into the open pit post closure, where it will be submerged and capped with a low permeability cover.
    - Separation of sulphide (Cleaner) tailings for a controlled disposal. The Cleaner and Rougher tailings will be sent to the TSF in separate pipelines. The Cleaner tailings will be discharged near the central operating decant pond. The Rougher tailings will be discharged around the perimeter and will form the majority of the beaches. On closure, the TSF pond water will be piped to the open pit and the TSF will be closed as a combination of pond, wetland and forest.

- Relocation of the overburden stockpile from Morrison Point, which is an important area to the LBN, to a location farther inland from Morrison Lake.
- Updating of the water management plan based on the revised waste management schedule, with the objective of minimizing the volume of water stored on closure.

The project changes result in modifications to the Effects Assessment related to improved water quality in Morrison Lake and ecosystem restoration on closure. The project changes result in reductions in both the volume of water discharged and geochemical loads from the mine area, as well as changes to the reclamation areas. In addition, closure of the TSF and mine area is accelerated. Also introduced is an effects significance rating that is applied to all project effects.

SITE LOCATION
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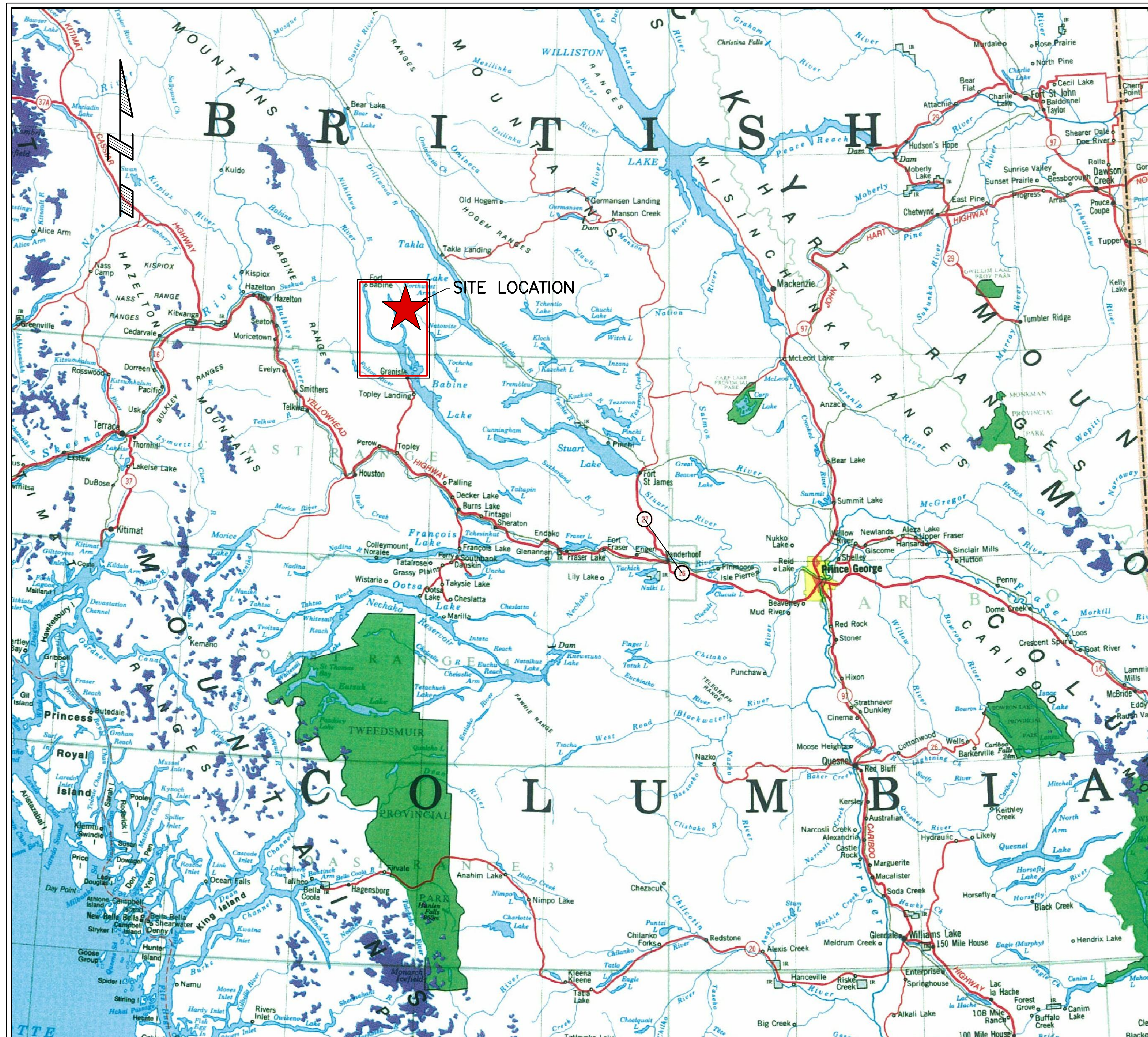

SITE LOCATION
N.T.S.

NOT FOR CONSTRUCTION

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SCALE A: 0 10 km

SCALE

NOTES:

1. TOPOGRAPHY COURTESY OF SOFTMAP.

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CLIENT

pbm

Klohn Crippen Berger

PROJECT

MORRISON COPPER/GOLD PROJECT

TITLE

SITE LOCATION PLAN

PROJECT No. M09382A04

FIG. No. 1.1

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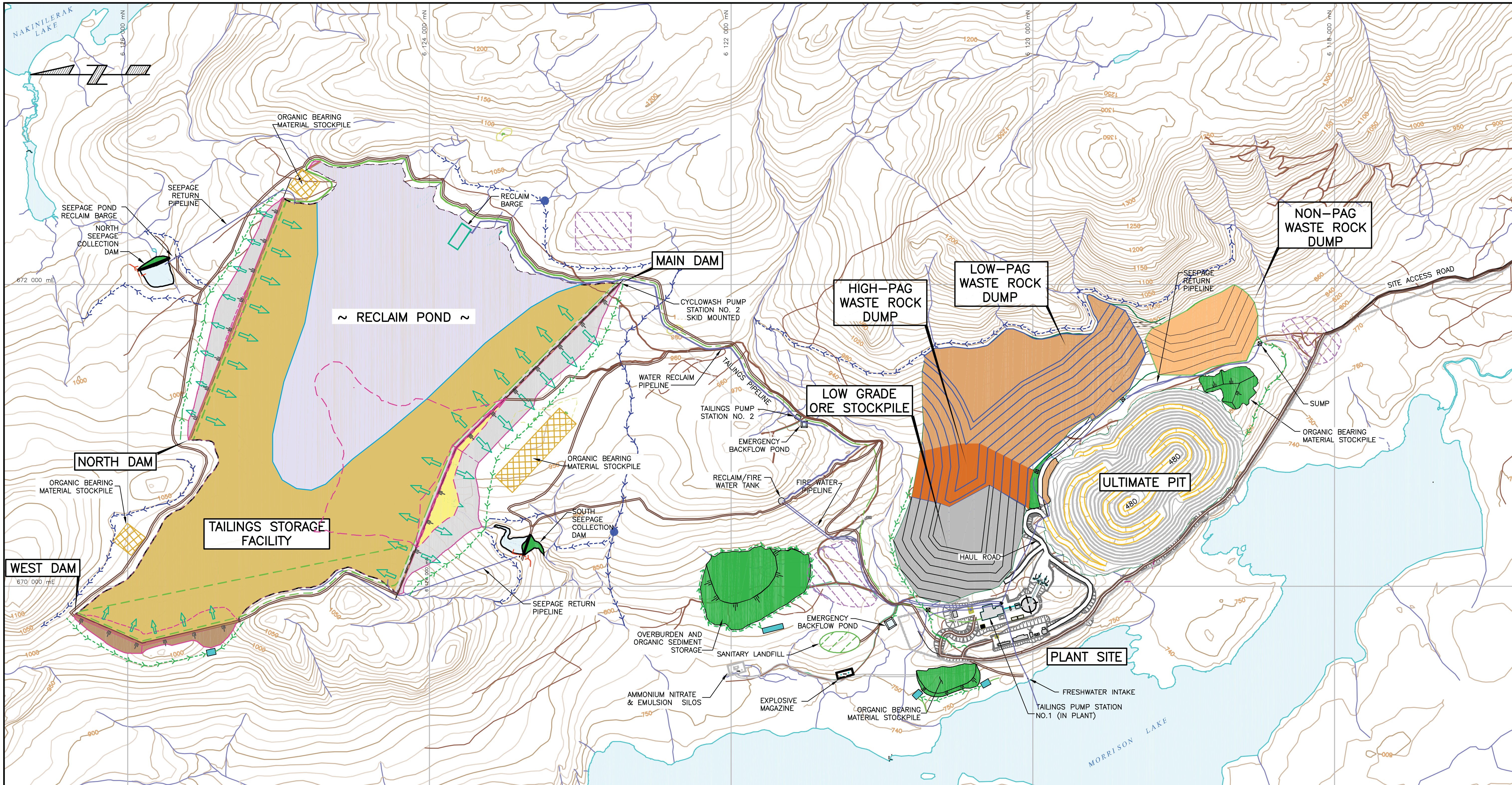

LEGEND

- TAILINGS LINE
- WATER PIPELINE
- SITE ACCESS ROAD
- HAUL ROAD
- EXISTING ROADS
- BORROW AREAS
- STOCKPILE AREAS
- SUMP
- DIVERSION CHANNEL
- SEEPAGE COLLECTION DITCH
- DAM SPILLWAY
- DIVERSION CONTROL STRUCTURE
- SEDIMENT CONTROL POND
- REVEGETATED SURFACE

NOTES:

1. TOPOGRAPHY IS 10 m CONTOUR INTERVAL, PRODUCED FROM AERIAL PHOTOGRAPHY FLOWN IN SEP, 2006 AND COMPILED BY EAGLE MAPPING LTD
2. DATUM IN UTM NAD83, ZONE 9.
3. PLANT SITE LAYOUT PROVIDED BY WARDROP (NOV. 4, 2008).

NOT FOR CONSTRUCTION

TO BE READ WITH KLOHN CRIPPEN BERGER REPORT DATED

SCALE 0 500 m

CLIENT: pbm

Klohn Crippen Berger

PROJECT: MORRISON COPPER/GOLD PROJECT

TITLE: GENERAL SITE ARRANGEMENT

PROJECT No. M09382A04

FIG. No. 1.2

KCB-R-MLB

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Xrefs: Instalaciones, BM-Morrison Copper-Jan08

2. REVISED PROJECT DESCRIPTION

2.1 Revised Project Components

2.1.1 Tailings Storage Facility

The changes to the Tailings Storage Facility (TSF) are summarized below and presented in Section 4 of this report.

Management of the TSF has been revised to reduce the risk of sulphide tailings in the beaches by discharging high sulphide Cleaner tailings separately from Rougher tailings. This management plan removes the requirement to maintain a large water pond over the tailings on closure. Consequently, the closure plan has been modified from a large water pond with perimeter wetlands to a combination of water pond with wetlands and forest cover for the remainder of the impoundment area.

2.1.2 Mine Area

The changes to the mine area project description are summarized below and details are presented in the Section 5 of this report.

Pre-Production Waste Management

A conceptual monitoring plan and geochemical criteria for the excavation of the lakebed sediments in Booker Lake and Ore Pond is described. A contingency storage facility within the TSF footprint is provided in the event that the sediments are not suitable for containment in the Overburden Stockpile.

Runoff from the open pit development work will be collected in the Booker Lake drained and excavated basin and, if the runoff is contaminated, it will be pumped to the TSF at mine start-up. Otherwise the water will be discharged to the environment as planned.

The main overburden stockpile has been relocated from Morrison Point to a location that is 700 m away from Morrison Lake.

Operations Segregation of Mine Waste Rock

Separating the non-PAG material was not financially justified when all the waste rock was to be placed permanently into the WRD. However in consideration of the increased disposal costs associated with placing the waste rock in the open pit upon closure during operations the waste rock will be segregated based on geochemical lag times and sulphide content. Non-PAG rock will be separately stockpiled and the two classes of PAG rock will be placed at opposite sides of the waste rock dump.

Closure and Reclamation Plan

The closure and reclamation plan for the PAG waste rock has been revised from an "on-land" storage facility, with a low permeability soil cover, to a facility where the PAG waste rock is re-handled and placed back into the open pit. The open pit, after placement of waste rock, would be closed as a combination of grassland and shallow pond.

During the last few years of mining the low grade ore (LGO) will be milled and water in-flows from the mine area and the cleaner tailings from the process plant will be discharged into the open pit. At this time haulage and placement of PAG waste rock into the pit will also begin. At the end of processing, excess residual water in the TSF will be pumped to the open pit.

The PAG rock will be saturated to mitigate acid rock drainage and capped with a low permeability soil layer.

Collection of acidic runoff from the remaining pit wall slopes (up to 100 m high) will be directed towards the open pit pond where it will be pumped to the water treatment plant. The treated water would be discharged in Morrison Lake at depth with a diffuser.

The ground surface area that was the footprint of the WRD, after removal of the waste rock dump and low grade ore stockpile, will be cleaned, graded and re-vegetated with forest and grasslands.

2.2 Revised Overall Project Description

2.2.1 Project History

The Morrison property was discovered and explored in the early 1960s during a rush of porphyry copper exploration in the Babine Lake region. Further delineation of the deposit took place between 1963 and 1973. Preliminary pit design and operating studies occurred between 1988 and 1990. PBM optioned the property in 1997 and carried out drilling between 1998 and 2007 for resource estimation, metallurgical analysis and geotechnical assessments. The geotechnical drilling conducted over multiple years provided data for the pit slope design and selection of the plant site and tailings storage facility.

2.2.2 Geology

The Morrison deposit is on the northern edge of the Skeena Arch within the Intermontane Belt of central BC and includes the Stikine volcanic arc terrain. The region is underlain by volcanic, clastic and epiclastic rocks ranging in age from the Lower Jurassic to Lower Cretaceous. The Morrison deposit is a calc-alkaline copper-gold porphyry. The deposit contains several zones of mineralization, primarily of chalcopyrite and minor bornite. Chalcopyrite is the primary copper-bearing mineral. Molybdenum is present in smaller and somewhat spatially restricted amounts, particularly in the southeast portion of the deposit.

2.2.3 Mining

The Morrison Copper/Gold Project will be an open pit mine with a tailings storage facility, waste rock dump, a plant site, warehouse, assay lab and other facilities, and a 25 km, 138 kV transmission line that will bring power to the site. The mine will produce approximately 224 Mt of ore and 169 Mt of waste rock. The ore will be processed at a rate of 30,000 t/d ore and an average 24,600 t/d of waste. The General Arrangement of the project is shown on Figure 1.2. The General Arrangement for the Construction Phase, Operation Phase and Closure Phase are shown on Figure 2.1, Figure 2.2 and Figure 2.3, respectively.

The open pit will be on the east side of Morrison Lake and will eventually be approximately 1,470 m long, 900 m wide, and to a maximum of 372 m deep. The open pit mine has been designed for four phases of open pit development. The overall life of mine strip ratio is relatively low at 0.82:1.0 waste to ore.

Mining will be performed top-down, in 12 m high bench-like steps. The slopes of the pit sides have been designed specifically for stability under local geological and managed groundwater conditions. Mining of the open pit will employ conventional truck and shovel methods over a 19-year period. A combination of shovels and trucks will be used for loading and hauling the ore and waste from the pit. Ore will be delivered to a primary crusher located near the pit limit while waste rock material will be hauled by truck to the dump located east of the open pit within the pit catchment. Uncrushed low grade ore will be placed in a stockpile north of the pit.

2.2.4 Low Grade Ore

The low grade ore will be used to provide an adequate supply of ore in each phase of the open pit development and for processing at the end of the mine life. During the mine life 51 Mt of low grade ore will pass through the stockpile with a maximum storage of 36 Mt about Year 11 and 26 Mt remaining in Year 19 when open pit mining ceases. Process plant operation will then be extended an additional 2.5 years to process 26 Mt of stockpiled low-grade ore.

2.2.5 Overburden

Suitable overburden and soils overlying the pit area as well as sufficient overburden from within the TSF will be salvaged and used to construct the tailings storage facility dams and for reclamation at closure. These materials will be stored in suitably design stockpiles until they are required for reclamation. Any stripped overburden not suitable for reclamation will be allocated to the waste rock dump.

2.2.6 Processing

The process plant with the assay lab, maintenance shops, warehouse, and other facilities will be in on the project site in the area north of the open pit. Ore will be processed at a rate of 30,000 tonnes/day through a conventional milling circuit consisting of a primary crusher, secondary cone crusher, High Pressure Grinding Rolls (HPGR), primary ball mills, and flotation circuit including regrind tower mills. The processing plant will operate 24 hours a day, 365 days of the year, with 92% availability in consideration of scheduled downtime for equipment maintenance.

Copper will be concentrated by flotation in large tank cells then cleaned and filtered to achieve acceptable shipping moistures without thermal drying. A molybdenum concentrate will be achieved by flotation in additional subsequent flotation.

The copper/gold concentrate transported by truck, via existing roads, a barge across Babine Lake, and paved road to the Port of Stewart for shipment to offshore smelters. Molybdenum concentrate will be trucked from the mine to a domestic refinery location.

2.2.7 Water Management

The project will be operated with zero surface discharge during operations using the diversions and the TSF to manage the water balance. The majority of the process water will re-circulate from the tailing storage area to minimize the quantity of makeup water required for process plant operation. The makeup water, primarily required to replace tailings pore-water as well as TSF seepage, is primarily provided by direct rainfall, runoff in the project site catchment and open pit dewatering. Generally fresh water intake is limited to a supply for use as potable, reagent mixing and valve gland water, however, the fresh/process water make-up system, consisting of a pump house and intake near the shore of Morrison Lake, has additional capacity for a-typical situations.

All water management and control structures are designed to mitigate erosion and to meet the appropriate hydraulic design criteria for safety, water balance, and sediment control.

2.2.8 Tailings Management

The tailings storage facility to contain 224 Mt of tailings will be approximately 5 km^2. Dam construction will use the coarse fraction of cycloned Rougher tailings over a till core. The tailings dams will be constructed with a till core using overburden stripped from the tailings storage facility area and from over the ore body. The tailings sand will be used to build the dam perimeter. The downstream slopes of the dams will be 3H:1V.

The tailings will be delivered to the tailings storage facility as water slurry via two pipelines discharging high sulphide Cleaner tailings separately from Rougher tailings. To reduce the risk of sulphide tailings in the beach areas only Rougher tailings will be used for dam construction.

Process water will be reclaimed from the tailings impoundment by pumps on a floating barge returned via a buried pipeline to the plant site such that in excess of 80% of the process water is re-cycled water.

Mining from the open pit will be completed approximately 2 years before the end of operations. During the ensuing 2 years the LGO is processed. The Cleaner tailings produced from processing the LGO will be placed within the open pit. This approach has major benefits as within the TSF only Rougher tailings will be deposited for the final 2 years of processing covering the previously deposited Cleaner tailings and it will result in a significant reduction in the pond size due to both the placement of cleaner tailings into the open pit and the cessation of pit dewatering and transfer of mine runoff to the TSF.

During operations a pond will be maintained adequate for providing the reclaim water and managing the water balance to achieve zero discharge. The closure plan will reduce to a smaller pond with wetland and forest cover for the remainder of the impoundment area.

2.2.9 Waste Rock Management

A waste rock dump will be located adjacent to and within the drainage catchment area of the open pit. The waste rock dump will be developed in benches. The overall slope will be 2.75H:1V with a flat bench on the top. The waste rock dump will extend up Hearne Hill to a height of 150 m. However, the maximum depth of the piled waste rock will be less due to the slope of both the waste rock dump and the underlying ground surface.

Segregation of PAG and non-PAG waste rock will be carried out with non-PAG rock placed in the south end of the waste rock dump. The waste rock dump will be engineered to a stable configuration and will remain uncovered during operations. Any ML/ARD runoff or seepage will captured and the water used for processing. Post closure the PAG waste rock will be placed in the open pit and submerged. After the waste rock is relocated to the open pit the 175 ha footprint area will be covered with a growth medium and re-vegetated.

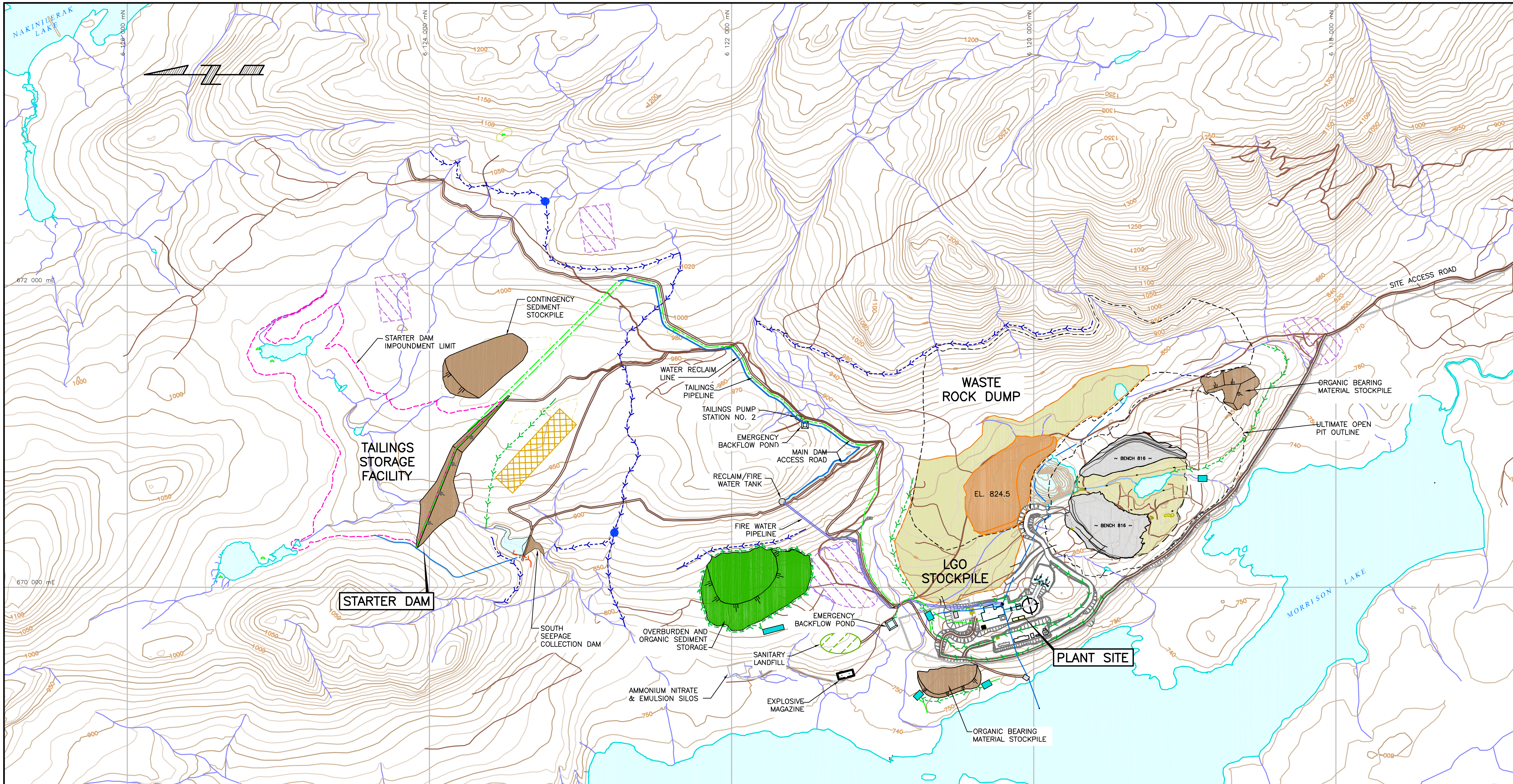
2.2.10 Infrastructure

Access to the site will use existing forestry roads. Concentrate trucks will travel south on the roads and cross Babine Lake by barge and then continue on existing roads to Stewart via Highway 16, 37 and 37a. PBM will assist in the maintenance of the existing forest service roads under the terms of agreements with BC Ministry of Forests and Range and other user groups.

Electrical power to the Morrison Copper/Gold Project will be supplied by BC Hydro from the Babine substation, on the west side of Babine Lake near the Village of Granisle, via existing and new transmission lines. PBM plans to extend the existing 138-kV line from the former Bell mine site to the mine site during the construction phase. The transmission line will extend along a newly constructed right-of-way corridor, approximately 25 km long and 31 m wide.

2.2.11 Project Schedule

Construction will take approximately 2.5 years. The pit will be mined for approximately 19 years with the low grade ore stockpile being processed for a further 2.5 years following the completion of mining thus resulting in a 21.5 year mine life. Closure and reclamation will take approximately 5 years.



LEGEND

- TAILINGS LINE
- WATER PIPELINE
- SITE ACCESS ROAD
- HAUL ROAD
- EXISTING ROADS
- WATER POND
- OPEN PIT
- SUMP
- DIVERSION CHANNEL
- SEEPAGE COLLECTION DITCH
- DAM SPILLWAY
- BORROW AREAS
- DIVERSION CONTROL STRUCTURE
- SEDIMENT CONTROL POND
- CLEARED AND GRUBBED AREA
- WASTE DUMP
- STOCK PILE AREAS

NOTES:

1. TOPOGRAPHY IS 10 m CONTOUR INTERVAL, PRODUCED FROM AERIAL PHOTOGRAPHY FLOWN IN SEP, 2006 AND COMPILED BY EAGLE MAPPING LTD
2. DATUM IN UTM NAD83, ZONE 9.
3. PLANT SITE LAYOUT PROVIDED BY WARDROP (NOV. 4, 2008).

NOT FOR CONSTRUCTION

TO BE READ WITH KLOHN CRIPPEN BERGER REPORT DATED ____________

SCALE: 0 — 500 m

CLIENT: pbm

Klohn Crippen Berger

PROJECT: MORRISON COPPER/GOLD PROJECT

TITLE: CONSTRUCTION PHASE GENERAL ARRANGEMENT

PROJECT No. M09382A04

FIG. No. 2.1

KCB-R-MLB

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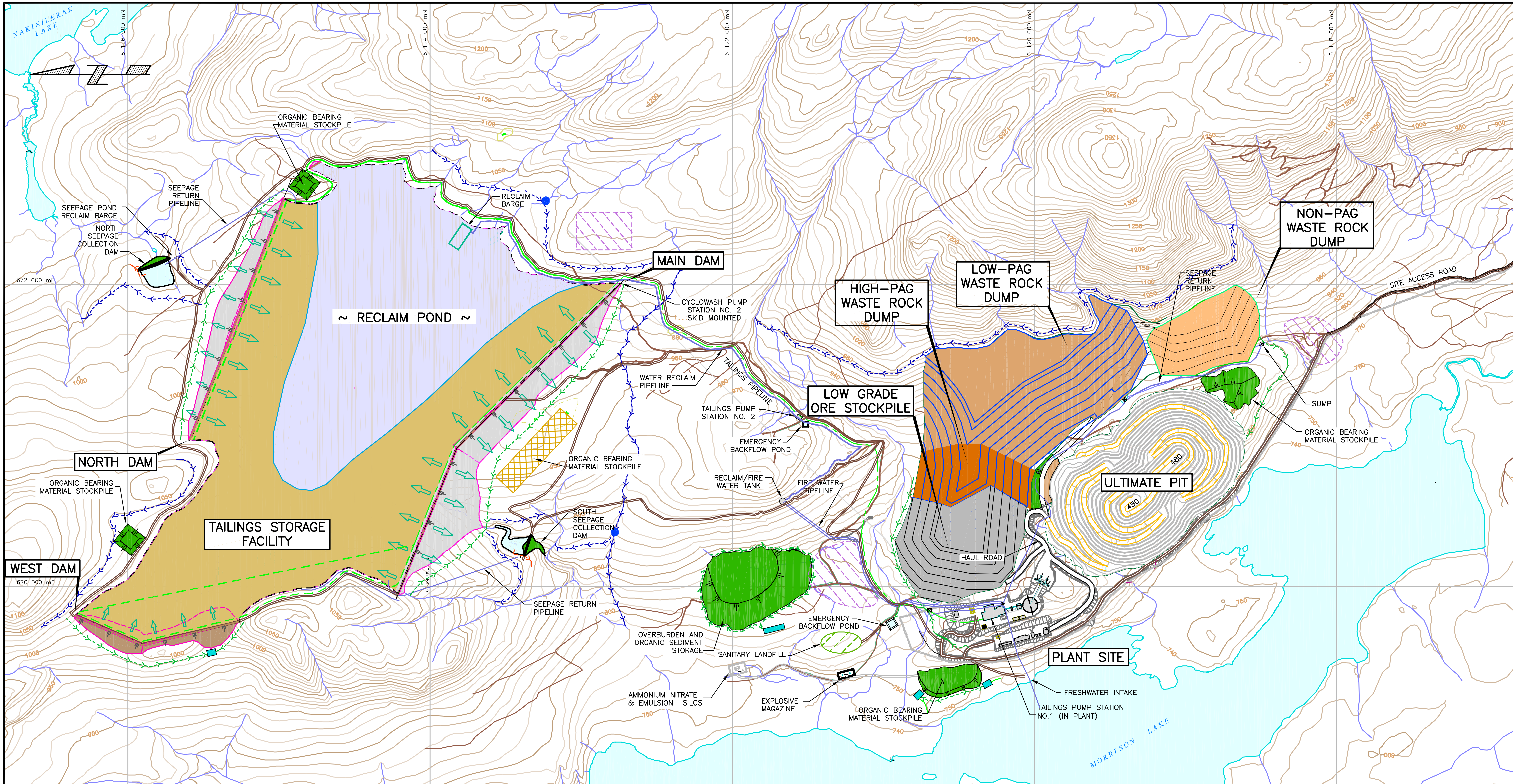
Xrefs: KCB-DESIGNS, BM-Morrison Copper-Jan10



LEGEND

- TAILINGS LINE
- WATER PIPELINE
- SITE ACCESS ROAD
- HAUL ROAD
- EXISTING ROADS
- BORROW AREAS
- STOCKPILE AREAS
- SUMP
- DIVERSION CHANNEL
- SEEPAGE COLLECTION DITCH
- DAM SPILLWAY
- DIVERSION CONTROL STRUCTURE
- SEDIMENT CONTROL POND
- REVEGETATED SURFACE

NOTES:

1. TOPOGRAPHY IS 10 m CONTOUR INTERVAL, PRODUCED FROM AERIAL PHOTOGRAPHY FLOWN IN SEP, 2006 AND COMPILED BY EAGLE MAPPING LTD
2. DATUM IN UTM NAD83, ZONE 9.
3. PLANT SITE LAYOUT PROVIDED BY WARDROP (NOV. 4, 2008).

NOT FOR CONSTRUCTION

TO BE READ WITH KLOHN CRIPPEN BERGER REPORT DATED

SCALE 0 500 m

CLIENT: pbm

Klohn Crippen Berger

PROJECT: MORRISON COPPER/GOLD PROJECT

TITLE: OPERATION PHASE GENERAL ARRANGEMENT

PROJECT No. M09382A04

FIG. No. 2.2

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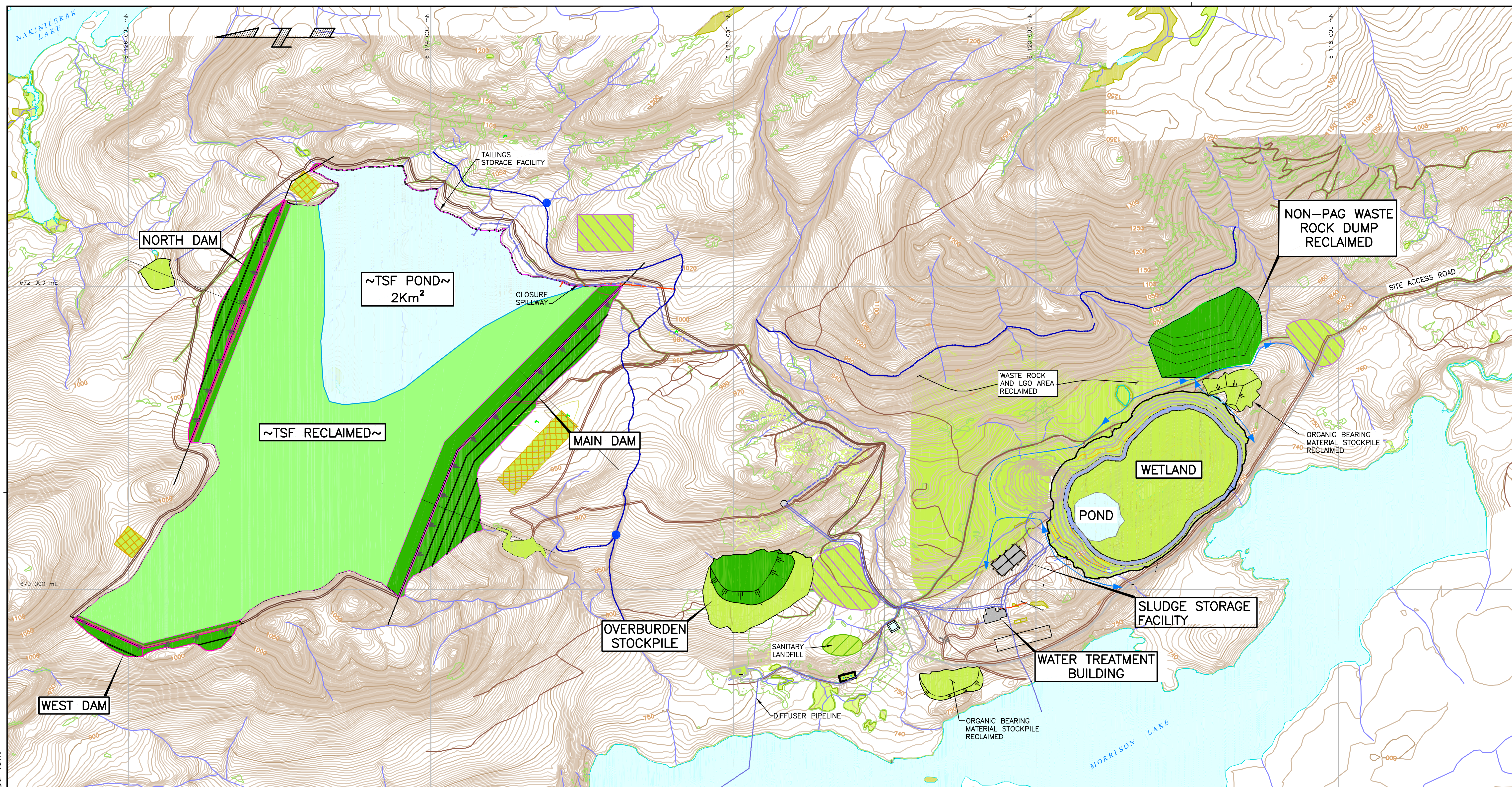

LEGEND

- WATER PIPELINE
- SITE ACCESS ROAD
- HAUL ROAD
- EXISTING ROADS
- BORROW AREAS
- STOCKPILE AREAS
- SUMP
- DIVERSION CHANNEL
- SEEPAGE COLLECTION DITCH
- DAM SPILLWAY
- DIVERSION CONTROL STRUCTURE
- SEDIMENT CONTROL POND
- RECLAIMED GROUND SURFACE
- CLOSURE COVER
- DITCHES

NOTES:

1. TOPOGRAPHY IS 2m 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.
4. PLANT SITE LAYOUT PROVIDED BY WARDROP (NOV. 4, 2008).

NOT FOR CONSTRUCTION

TO BE READ WITH KLOHN CRIPPEN BERGER REPORT DATED ________

SCALE 0 500 m

CLIENT: pbm

Klohn Crippen Berger

PROJECT: MORRISON COPPER/GOLD PROJECT

TITLE: CLOSURE PHASE GENERAL ARRANGEMENT

PROJECT No. M09382A04

FIG. No. 2.3

KCB-R-MLD

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Xrefs: Morrison-design-facilities, BM-Morrison Copper-Jan10

3. BASELINE DATA COLLECTION

3.1 General

To date PBM has collected a substantial volume of baseline data related to the Morrison Copper/Gold Project. Most data was collected prior to the submission of the EAC Application, however other data was subsequently collected to add to that data set including:

- Fish and fish habitat information from July 2009 (Rescan 2010), which included: habitat surveys, water quality; periphyton taxonomy, chlorophyll a and biomass; drift net sampling; and fish sampling, including for metals analysis;
- Meteorology, hydrology measurements and data logger information;
- Nakinilerak Baseline Study;
- Water quality sampling data for summer-fall 2009 and seasonally in 2010 and 2011 including freshet (Ice-Off) Baseline Data Gathering for Morrison Lake and Streams;
- Temperature profiles in Morrison Lake to confirm stratification characteristics;
- Water sampling included: surface water, groundwater and ARD/ML field cubes and barrels;
- Fish and habitat surveys in summer and fall 2010 to provide additional information for the Fish Habitat Compensation Plan. The surveys included mapping of the proposed fish habitat compensation sites, soil sampling, and aquatic habitat characterization;
- Moose and Mule Deer Survey.
- Spawning survey with LBN and flyover surveys of aquatic habitat compensation alternative with LBN; and
- Snowpack data for winter 2010/2011.

This baseline data has been used for the preparation of the EAC Application and also for use in support of concurrent and as well as for future non-concurrent permit applications. The data gathered to date is indicated within the spreadsheet (Appendix I) and is contained in a variety of reports, documents, spreadsheets and databases. Data collected since submission of the EAC Application and Addendum is included in Appendix I. It should also be noted that PBM is proceeding to compile all project data into a comprehensive database for future reference and analysis in conjunction with on-going environmental management and environmental effects monitoring.

Additionally, to support the non-concurrent permit application upon issuance of the EAC Application and in response to comments and guidance from various agencies PBM has committed to baseline data gathering prior to construction including:

- PBM must complete fish tissue sampling in a reference lake prior to construction.
- PBM must conduct dedicated surveys, by qualified and experienced environmental professionals, for invasive plants prior to the start of construction.
- PBM must complete baseline study of upper stream 7, stream 8 and stream 10 to the extent required by MoE.

3.2 Meteorology - Precipitation

The basis for the precipitation is presented in the EAC Application Section 7.2 Climate and Meteorology, as well as in EAC Addendum – Appendix AX Geotechnical Feasibility Study.

To further confirm calibration of site data to regional data, a recent comparison of data was made between the precipitation from the Morrison Site with the North Babine weather station and the results are presented in Table 3.1. The table indicates reasonable correlation of data. Accordingly there are no revisions made herein to the site precipitation and hydrology basis.

PBM will continue to collect precipitation and snow pack/depth data and continue to refine correlations between regional data and site data.

Table 3.1 Comparison of Precipitation Data – Morrison Site versus North Babine Weather Stations

YEAR	MONTH	SITE	BABINE	MONTHLY RATIO	PERIOD RATIO
2006	July	27.9	37	0.8	
	August (minus 2 days for site data)	11.9	13.6	0.9	
	July to Aug.	39.8	50.6		0.8
2007	June	83.8	83.6	1.0	
	July	71.9	113.2	0.6	
	Aug.	97.8	86.8	1.1	
	Sept.	22.6	29.2	0.8	
	Oct.	69.4	72.6	1.0	
	Nov.	49.5	52.6	0.9	
	Dec.*	51.3	3.6	14.3	
	June to Dec.	446.3	441.6		1.0
2008	January*	41.7	10.4	4.0	
	February*	45	34.2	1.3	
		86.7	44.6		1.9
2009	July	60.5	58.8	1.0	
	Aug.	25.9	20.8	1.2	
	Sept.	76.5	78	1.0	
		162.9	157.6		1.0

*Note: Winter snow data from Babine is not measured

3.3 Baseline Water Quality

A concern was raised within the Review Comments that the EAC baseline groundwater quality may not properly reflect the actual groundwater quality due to samples which had a very high turbidity. The high turbidity values could be due to insufficiently developed groundwater monitoring wells or due to a high extraction rate during sampling.

Accordingly, KCB has reviewed the groundwater quality database and developed a revised groundwater quality that excludes the high turbidity samples.

In addition, both the groundwater quality and surface water quality database used for the Effects Assessment presented in Section 10 of this report has been updated to include all data collected up until January 2011.

3.4 Morrison Lake Spring Survey

Morrison Lake was sampled in the spring (June) 2011 for water quality and depth profiling. The purpose of the sampling was to target ice-off and associated spring turnover, sampling was conducted between June 1 to June 8, 2011. A depth profile and water quality samples were collected at five sites on Morrison Lake (Sites A, B, C, D and E). The depth profiling was conducted at 1.5 m intervals and demonstrated that lake turnover had occurred with the hypolimnion recording the coolest temperatures (ranging 3.92°C to 4.92°C), the thermocline was recorded at approximately 9 m to 12 m with temperatures increasing up to 11.55°C in the epilimnion (Figure 3.1). Dissolved oxygen showed a decline at some sites at approximately 5 m with further declines at 10 m to 15 m, with further declines seen at 20 m at the deeper site (Site E) (Figure 3.2). Dissolved oxygen levels ranged from surface levels of 9.92 mg/L to 6.57 mg/L at deeper stations. pH values were slightly alkaline ranging from 7.31 to 8.16, with specific conductance ranging from 50 µs/cm to 89 µs/cm and total dissolved solids ranged from 32 mg/L to 58 mg/L. Water quality samples were collected from the surface and deeper layers with samples also collected from the thermocline at the proposed diffuser location (Site D).

Water quality samples were analyzed for general parameters, total and dissolved metals, nutrients, total organic carbon and cyanides. Transparency in Morrison Lake ranged from 1.70 m to 1.95 m and colouration was observed to be high in tannins. The measured concentrations of cadmium in Morrison Lake were below the detection level of 10 ng/L for all samples except one, which was 14 ng/L, compared to a baseline value of 11 ng/L. Similarly, the dissolved copper concentrations were within the range of measured baseline data. The June water quality data is consistent with the previous baseline water quality and, therefore, the effects assessment used in this report has not been modified to include the last data set.

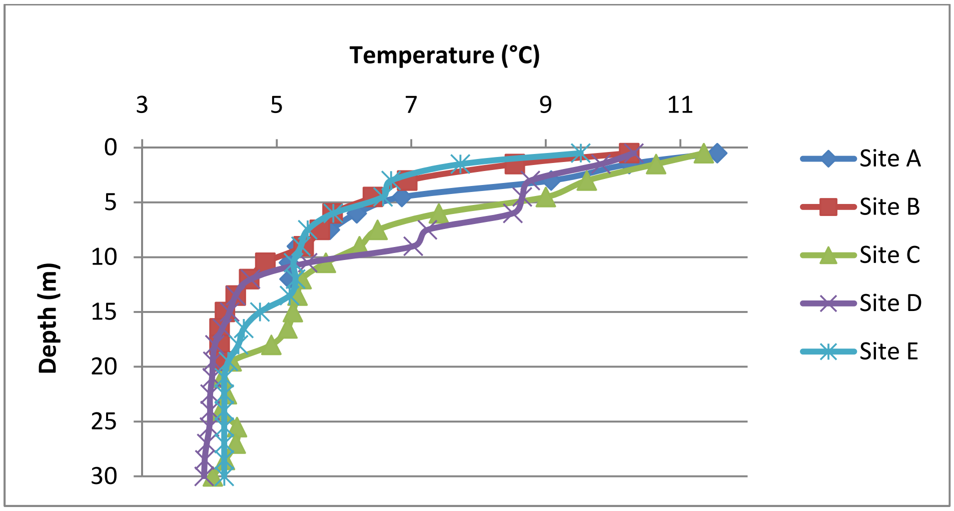


Figure 3.1 Temperature Profile Morrison Lake, June 2011

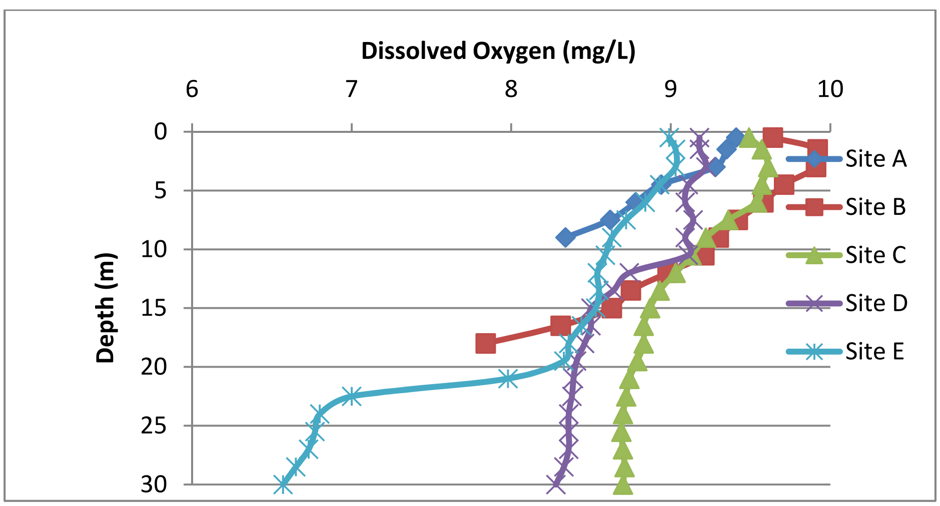


Figure 3.2 Dissolved Oxygen Profile Morrison Lake, June 2011

4. TAILINGS STORAGE FACILITY

4.1 Operations Tailings Management

The management of the Tailings Storage Facility (TSF) has been revised to reduce the risk of high sulphide tailings in the beaches, particularly on closure, with a modified disposal plan where the higher sulphide tailings are discharged separately from lower sulphide tailings. The higher sulphide tailings are then contained within a smaller area of the final impoundment and, in addition to being submerged, will be covered by a layer of lower sulphide tailings prior to mine closure.

The management plan is achievable as the processing of ore produces two streams of tailings:

- Cleaner Tailings: The Cleaner tailings are produced with sulphide/ore separation of the total tailings, which then goes on to additional milling and ore separation. The resulting tailings typically contain higher sulphides and a higher percentage of fines (silt sizes). The cleaner tailings typically represent approximately 10% of the total tailings.
- Rougher Tailings: Comprise approximately 90% of the tailings and typically contain lower concentrations of sulphides and fines.

Geochemistry data on the two types of tailings consists of ABA testing carried out during the feasibility study (EAC Addendum Appendix AX: Geotechnical Feasibility Study (KCB, 2009) Table 6.2) and reproduced here as Table 4.1.

Table 4.1 Summary of 2006 Tailings Static Geochemistry

Sample	Paste pH	% S	Available NP ($t\ CaCO_3/1000t$)	SNPR
F46 – Rougher/Scavenger Composite	8.2	0.19	35	8.0
F47 – Rougher/Scavenger Composite	7.7	1.07	73	2.33
F46 Bulk Rougher Tails Cycles 3+4+5	7.6	0.06	27.1	14.4
F47 Bulk Rougher Tails Cycles 3+4+5	8.0	0.13	47.4	11.7
F48 Bulk Rougher Tails Cycles 3+4+5	8.0	0.28	12.2	1.4
F51 Bulk Rougher Tails Cycles 3+4+5	8.2	0.10	31.2	10
F52 Bulk Rougher Tails Cycles 3+4+5	7.5	0.05	30.4	19
F46 Bulk Cleaner Tails Cycles 3+4+5	8.2	0.84	43.3	1.65
F47 Bulk Cleaner Tails Cycles 3+4+5	7.6	8.29	41.0	0.16
F48 Bulk Cleaner Tails Cycles 3+4+5	7.9	1.46	25.2	0.55
F51 Bulk Cleaner Tails Cycles 3+4+5	7.7	5.07	43.1	0.27
F52 Bulk Cleaner Tails Cycles 3+4+5	7.7	2.87	43.2	0.48

Note: NP - Neutralization Potential; SNPR – Sulphide Net Potential Ratio

The Cleaner tailings will be discharged, via a separate pipeline, as close as practical within the reclaim water pond. The Rougher tailings will be discharged around the perimeter of the impoundment and will be used to produce cyclone sand for construction of the dams.

In consideration of the closure configuration of the TSF pond, which has a closure spillway located in the left (southeast) abutment of the Main dam, the reclaim water pond will be located on the southeast side of the impoundment and tailings will be spigotted around the south, west and north to form the pond. The water reclaim pump barge and associated pipelines will also be relocated.

4.2 Pre-Closure Tailings Management

Mining from the open pit will be completed during Year 19 approximately 2.5 years before the end of operations. During the ensuing 2.5 years of operations milling will continue with processing of the LGO. The Cleaner tailings produced from processing the

LGO will be placed within the open pit. During placement of Cleaner tailings into the open pit it will be necessary to recycle water from the open pit back to the process plant. The estimated recycle rates are 150 m^3/hr for the Expected Case, and 250 m^3/hr for the Upper Bound case, as discussed in Section 7.5.2 of this report.

Overall this approach has some major benefits:

- The Rougher tailings will cover the Cleaner tailings that have been previously deposited near the reclaim pond, further reducing the risk of exposed sulphide tailings; and
- Accumulation of water in the open pit will result in a reduction of the amount of water stored in the TSF. This will result in a significant reduction in the TSF water pond on closure.

4.3 Environmental Management Plans –Mitigation Components

4.3.1 TSF Seepage

Seepage mitigation is discussed in Section 6.2.5 of this report. A plan of the TSF and a representative cross-section from Morrison Lake, through the TSF, and into Nakinilerak Lake is shown on Figure 4.2.

4.3.2 TSF Diversions

A main diversion will be constructed around the final TSF perimeter, which will allow for approximately 50% of riparian flow in Stream 7 to be maintained. In addition, perimeter diversions will be constructed at the Year 5, 10 and 15 TSF perimeters to further divert water during operations.

4.3.3 TSF Dust Control

Dust generation, during operations, may occur on tailings beaches and dam slopes An Environmental Management Plan is identified in the EAC Application Vol. 111, Section 13.2 Air Emissions and Fugitive Dust. During operations, the cyclone overflow fines and the spigotted tailings will be managed to maintain wetted beaches, as required to control dusting. Dust control on the dam faces may require irrigation during extended dry windy periods.

Within the TSF there will be larger areas of exposed and un-reclaimed beach during the final years of mining as the water pond is drawn down and then re-established. Temporary dust control may be required during this period until the cover is placed and vegetation established and, if required, will employ several strategies which could include, for example, irrigation, wind fences or commercial dust suppressants.

4.3.4 Rougher Tailings - ARD Control

The process plant design includes sulphide separation into the mill with the Cleaner and Rougher processing circuits. The Rougher tailings will be used to produce cyclone sand for construction of the dams and for discharge over the final beach slopes prior to closure.

A quality assurance/quality control (QA/QC) program will be carried out to ensure that cyclone sand used for construction of the dams will be non potentially acid generating (non PAG). This will include a geochemistry test program during operations. Any cyclone sand that does not meet the non-PAG specification will be placed in the impoundment and not used in the dam.

Similar controls will be placed on the pre-closure placement of Rougher tailings over the final closure beaches and pond areas.

4.4 Adaptive Management Components

4.4.1 Contingency for Raising the TSF Dam to Store Waste Rock and/or LGO or Water

The design basis for cyclone sand production exceeds dam fill requirements and there is sufficient cyclone sand and borrow materials to provide flexibility in raising the TSF dams to store additional volumes of waste rock or water, as/if, required. Based on the available data there is sufficient tailings sand for a 10 m raise in the dam elevation, which provides storage for approximately 50 Mm^3 (30% increase). This additional capacity may be allocated, as required, for surplus waste rock, surplus water or unprocessed low grade ore, and is sufficient for the various contingency plans described in the following sections.

4.4.2 Contingency for Storage of Surplus Water Balance

The TSF capacity increases as the dams are constructed and the completed TSF has a design capacity of approximately 160 Mm^3, (224 million tonnes of tailings). With respect to storage of surface water, the TSF, without raising the dam above the current design elevation, has the capacity to store up to approximately 12 Mm^3 of water below the crest elevation of the dam. The actual available volume of pond water depends on the stage of the TSF and the final beach slopes. For example, beach slopes of 0.5% and 0.75% result in 10 Mm^3 and 15 Mm^3, respectively, for the later stages of the TSF.

The potential volumes of water that may have to be stored in the TSF are summarized in Table 7.3 of this report, varies from up to 18.9 Mm^3 for the peak unmanaged Upper Bound to 10 Mm^3 for the peak managed Upper Bound (which is the same as the Expected Case). Given the time lag to reach the total volume of water for various water management scenarios, as well as the potential for further dam raises, the TSF has sufficient capacity for the Expected Case as well as the Upper Bound case.

4.4.3 Contingency for Disposal of PAG Waste Rock and/or LGO Prior to Closure

The management plan for the PAG waste rock on closure is to place the material within the mined out open pit and submerge it, as described in Section 5 of this report. However, the open pit has a defined storage volume and the current mine plan indicates a surplus of PAG rock (approximately 5 Mt) that could not be submerged.

Two alternatives were considered for storage of surplus PAG rock:

- Place in the TSF; or
- Raise the elevation of the PAG rock placement in the open pit and the level of submergence above the Morrison Lake elevation (733 masl).

Considering the potential risk of geochemical loads due to increased hydraulic gradient between the PAG rock and Morrison Lake, the surplus PAG waste rock will be placed in the TSF in Year 15.

Placing the waste rock in the TSF in advance of closure will ensure that the rock is placed below the final tailings elevation such that it remains permanently saturated to mitigate potential ARD. The rock to be placed in the TSF will consist of freshly mined PAG waste rock, of sufficient volume as to offset potential PAG rock. The PAG rock (sand, gravel, cobble, boulder sizes) would be placed near the perimeter of the tailings beach to a maximum elevation to ensure the PAG rock will eventually be flooded and covered with tailings prior to mine closure. The material would be placed with haul trucks and spread with dozers.

In addition, there was a Regulatory Review observation that there is the possibility that the stockpiled low grade ore (LGO) may not be processed, (approximately 26 Mt). Accordingly, the contingency plan is to place the equivalent amount of waste rock into the TSF between Year 10 and Year 15 of operations such that there is adequate capacity in the open pit for closure. The material should be placed in the TSF over this time period to ensure that the material will be covered with tailings and saturated, prior to closure. The TSF has surplus capacity available and storage of the remaining LGO rock into the TSF would require raising the final dam by approximately 3 m, which is readily accommodated.

4.4.4 Contingency Plan for TSF if LGO is not Processed

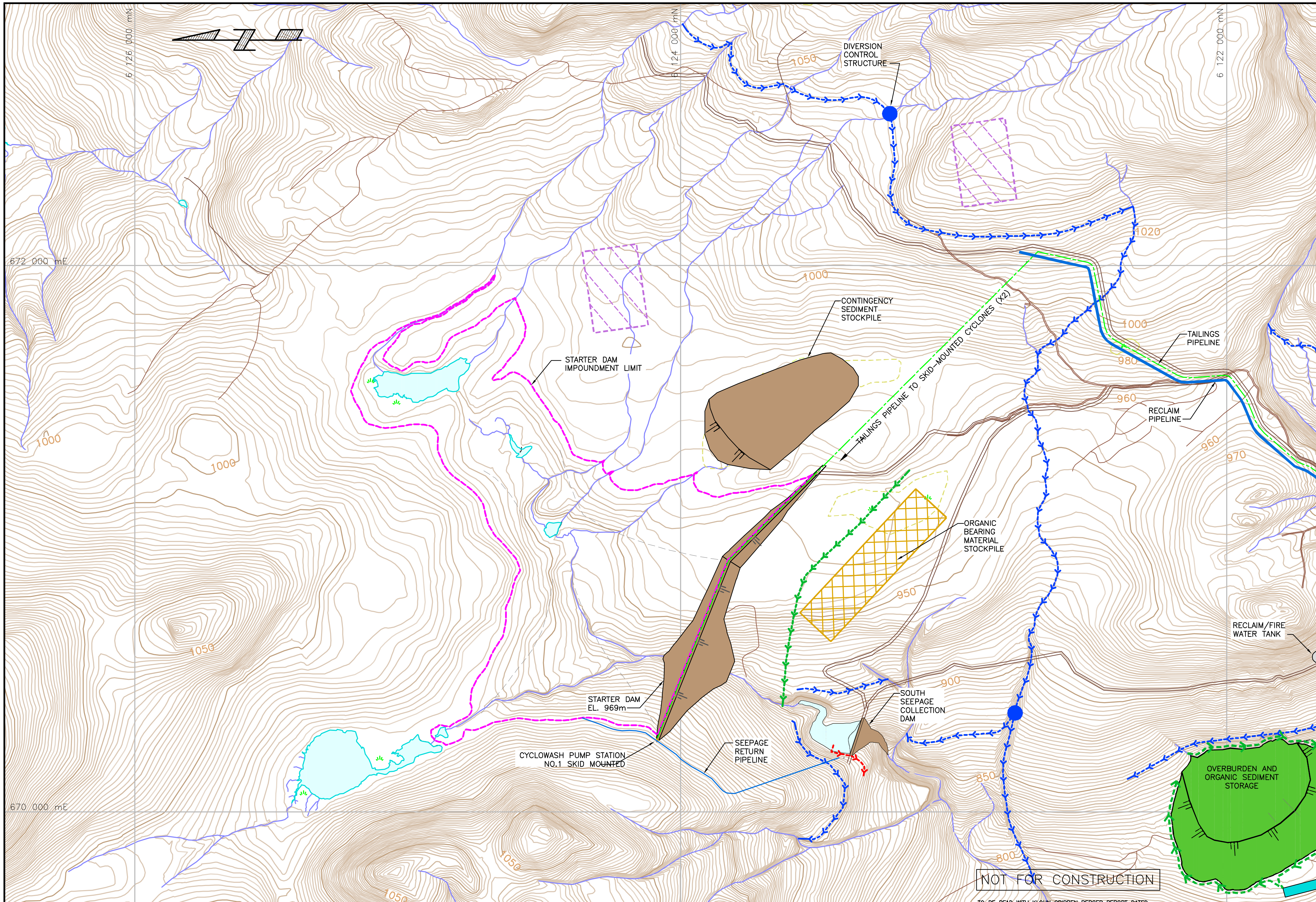
If the LGO is not milled, the Cleaner and Rougher tailings will continue to be co-disposed in the TSF until closure. The contingency management plan, for pre-closure and closure, includes the following:

- Additional measures will be taken to ensure that Cleaner tailings are preferentially placed in the deeper portion of the planned final TSF “lake” and will not be placed along the shoreline. This will require sub-aqueous placement with a floating pipeline;
- The final TSF “lake” will be sized to ensure that the Cleaner tailings are permanently saturated on closure; and
- At the end of mining the TSF pond water will be pumped to the open pit. The installed pumping capacity on the reclaim barge has the capacity to pump the entire water volume over a period of approximately 200 days. This water volume would not affect the open pit closure plan as it is currently based on the approximately equivalent volume placement of Cleaner tailings and inflow water.

There is a risk of potential water quality effects on the closure pond from the exposed Cleaner tailings during the period they are being flooded. The potential consequence of this is that the surplus TSF water may need to be directed to the open pit until it meets discharge requirements. The open pit could accommodate additional water volume with the displacement of placement of Cleaner tailings into the open pit (6 Mm^3) for several years.

4.4.5 Contingency Plan if Rougher Tailings has ARD Potential

The design includes sulphide separation in the process plant with the Cleaner and Rougher circuits. Bench scale processing tests indicate that the majority of the Rougher tailings will be non PAG. However there is a risk that additional processing could be required to ensure that the sulphides have been sufficiently removed. Consequently, the contingency plan for this case would be to install an additional sulphide separation circuit, either at the dam at the process plant. The additional sulphide separation would ensure that neutral (non-PAG). Rougher tailings can be produced for construction of the dam and for the final beach slopes.



LEGEND

- TAILINGS PIPELINE
- WATER PIPELINE
- SITE ACCESS ROAD
- HAUL ROAD
- EXISTING ROADS
- BORROW AREAS
- WATER POND
- DIVERSION CHANNEL
- SEEPAGE COLLECTION DITCH
- DAM SPILLWAY
- DIVERSION CONTROL STRUCTURE LOCATION

NOTES:

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

SCALE: 0 — 500 m

CLIENT: pbm

Klohn Crippen Berger

SCALE

PROJECT: MORRISON COPPER/GOLD PROJECT

TITLE: CONSTRUCTION PHASE TAILINGS STORAGE FACILITY – PLAN

PROJECT No. M09382A04

FIG. No. 4.1

KCB-R-MLB

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Date: 3/22/2011
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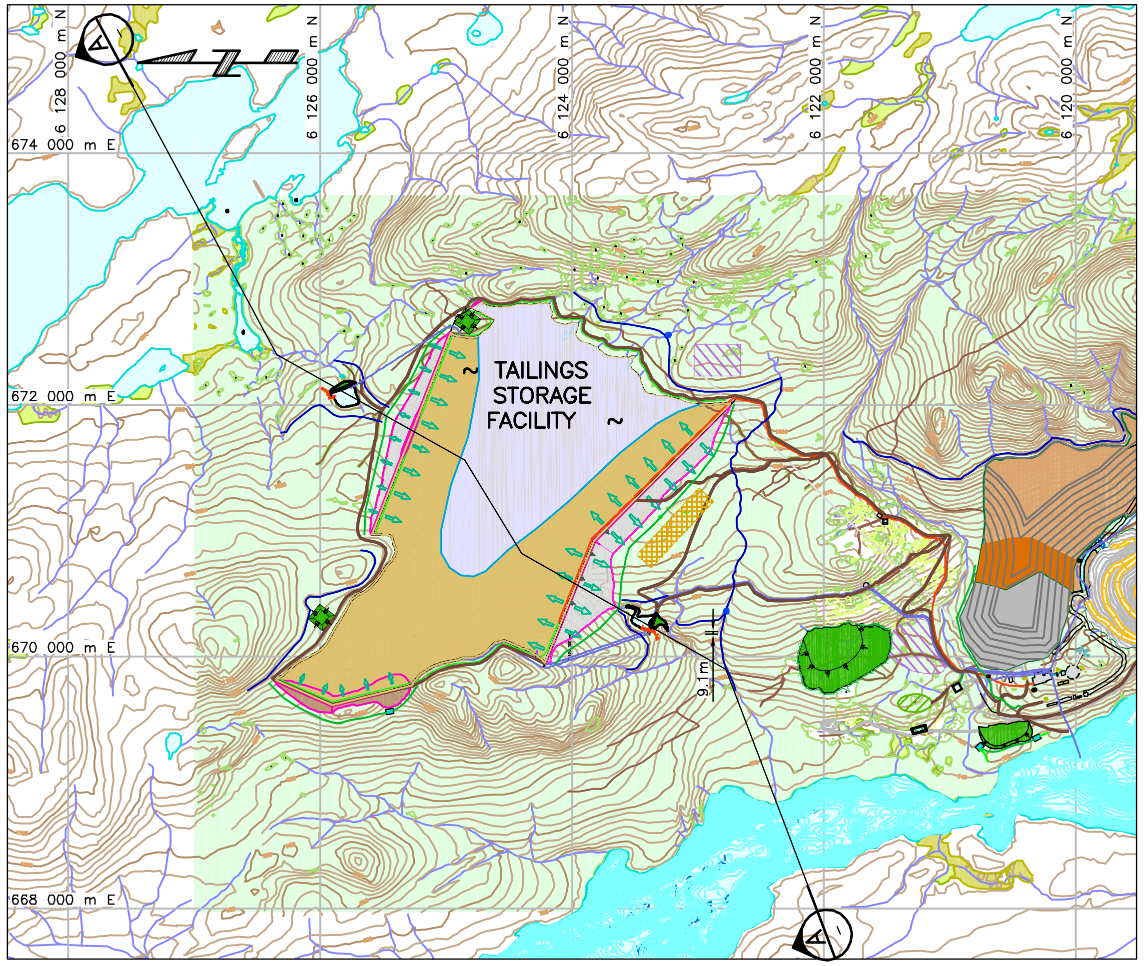
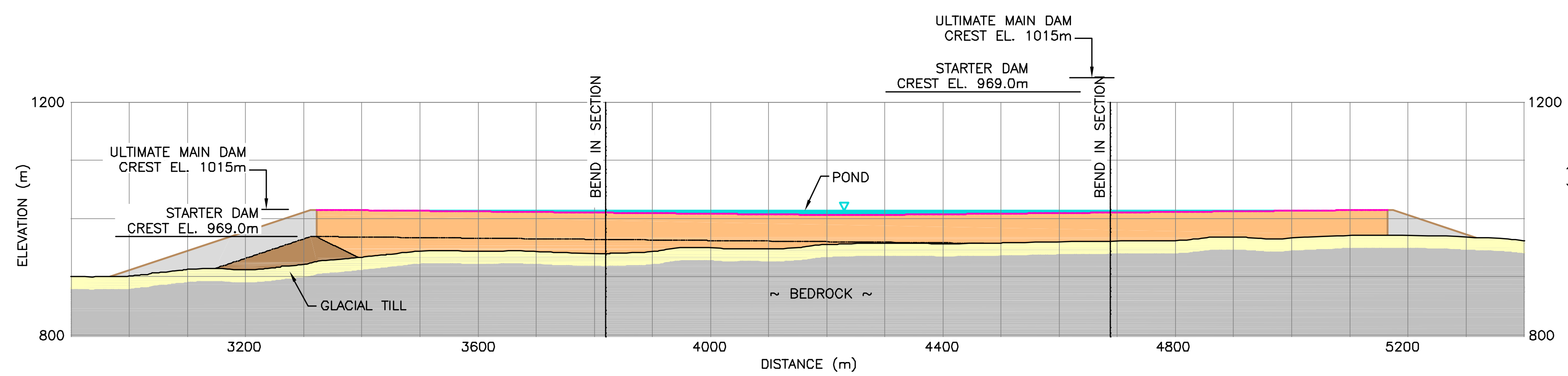
Xrefs: KCB-DESIGNS, BM-Morrison Copper-Jan10



LOCATION PLAN
SCALE A

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.
4. PLANT SITE LAYOUT PROVIDED BY WARDROP (NOV. 4, 2008).
5. DESIGN REFERENCED FROM KCB REPORT "GEOTECHNICAL FEASIBILTY STUDY – REV. 1" DATED JANUARY 9, 2009.



DETAIL 1
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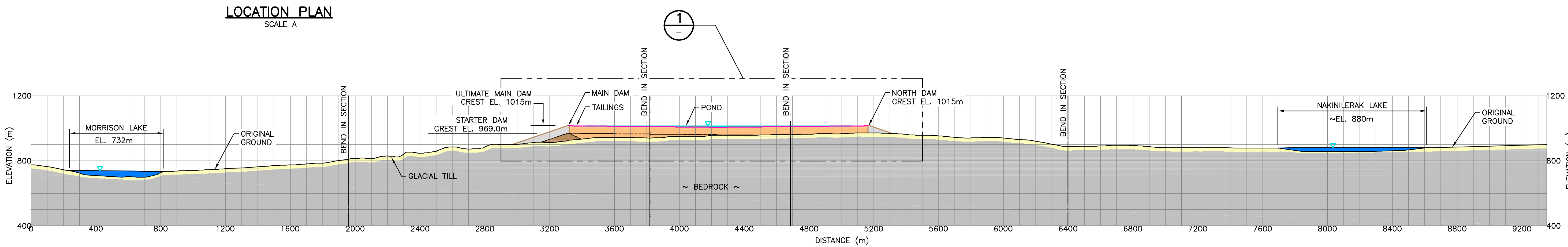

SECTION A
SCALE B

SCALE C: 0 — 400m
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SCALE

NOT FOR CONSTRUCTION

TO BE READ WITH KLOHN CRIPPEN BERGER REPORT DATED ____________

CLIENT: pbm

Klohn Crippen Berger

PROJECT: MORRISON COPPER/GOLD PROJECT

TITLE: OPERATION PHASE TAILINGS STORAGE FACILITY PLAN AND SECTION

PROJECT No. M09382A04

FIG. No. 4.2

KCB-R-MLD

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

5. MINE AREA

5.1 Pre-Production Phase (Construction) Waste Management

5.1.1 Booker Lake and Ore Pond

Two attributes of Booker Lake and Ore Pond were identified in the Review Comments as potential handling concerns in the draining and subsequent removal of overburden from the open pit footprint. These are the effects of anoxic water release during draining and the subsequent disposal of the excavated lake sediments

5.1.1.1 Anoxic Bottom Waters

The bottom waters of both Booker Lake and Ore Pond are likely anoxic. The direct release of these waters to the receiving environment may have deleterious effects on biota. These effects can be prevented by the simple expedient of oxygenating the waters prior to final release and design of the works will be carried out as part of detailed design and permitting.

Further evaluation to determine if anoxic conditions in Booker Lake will be undertaken prior to construction and design of oxygenating works, if required, will be carried out as part of detailed design and permitting.

5.1.1.2 Lake and Pond Sediments

The lake sediments from Booker Lake and Ore pond have a preliminary estimated volume of 650,000 m^3. The geochemistry was investigated in 2010 and is presented in the EAC Addendum - Appendix AM, “Updated Predictions of MLARD”.

The 2010 acid base accounting (ABA) testing of sediment samples from the bottom of Booker Lake and Ore Pond indicate that approximately 67% may be PAG. However, the PAG samples were primarily located near the upper sediment/water interface. This suggests that the deeper 33% of not-PAG sediment, nearer to the till/bedrock interface, may be segregated. Lakebed material disposed of in the overburden and organic sediment storage stockpile (OOSS) will be limited to material confirmed to be non-PAG. PAG sediment will be placed in the TSF.

When fully characterized, the sediments can be categorized according to environmental criteria. Some potential criteria are column III (Freshwater Sediment; Typical) of Schedule 9 of the contaminated sites regulation or the BC Ministry of Environment freshwater sediment guidelines (Table 5.1).

Table 5.1 Freshwater Sediment Environmental Criteria for Inorganic Components

Element	Schedule 9 (mg/g)	BCMENV-permissible exposure (mg/g)	BCMENV-threshold (mg/g)
As	0.020	0.017	0.0059
Cd	0.0042	0.0035	0.0006
Cr(T)	0.110	0.090	0.037
Cu	0.240	0.197	0.035
Fe	~	43.8	21.2
Pb	0.110	0.091	0.035
Hg	0.00058	0.000486	0.000170
Ni	~	0.075	0.016
Se	~	0.002	0.0002
Ag	~	0.0005	0.0005
Zn	0.380	0.315	0.123

Should the sediments exceed the environmental criteria, the sediments will be stored in the TSF; otherwise the sediments will be stockpiled separately for potential future use.

5.1.1.3 Conceptual Monitoring Program and Geochemical Criteria for Sediments

The following section presents a conceptual plan for characterizing the geochemistry of the sediments prior to placement in the Overburden and Sediment Stockpile. A contingency plan for storage of the sediment in the TSF is presented, in the event that the sediment is not suitable for storage in the overburden stockpile.

Booker Lake will be drained prior to winter freeze-up. As the surface of the sediments freeze it will be feasible to travel over the surface and core samples from the surface. Approximately 60 samples will be collected, from depths of 0.5 m, 1.2 m and 1.8 m from 20 sites. Testing of the samples will include: a) ABA analysis; b) leach tests; and c) geochemical analysis of metal concentrations.

Material which is potentially acid generating, or does not meet BC Ministry of Environment permissible exposure concentrations for metal concentrations, will be stored in the TSF sediment stockpile. It is likely that the segregation of the material, for practical purposes, will conservatively identify areas that are a potential concern for placement in the TSF. If major zones of inert material are identified they will be placed in the overburden and organic sediment stockpile.

The TSF sediment storage stockpile is shown on Figure 5.1 and Figure 5.2. The stockpile will be contained on the downhill side with a berm of competent soils from the development stage excavations for the open pit. The stockpile area could accommodate over 600,000 m^3 of sediment, over an area of up to 10 ha.

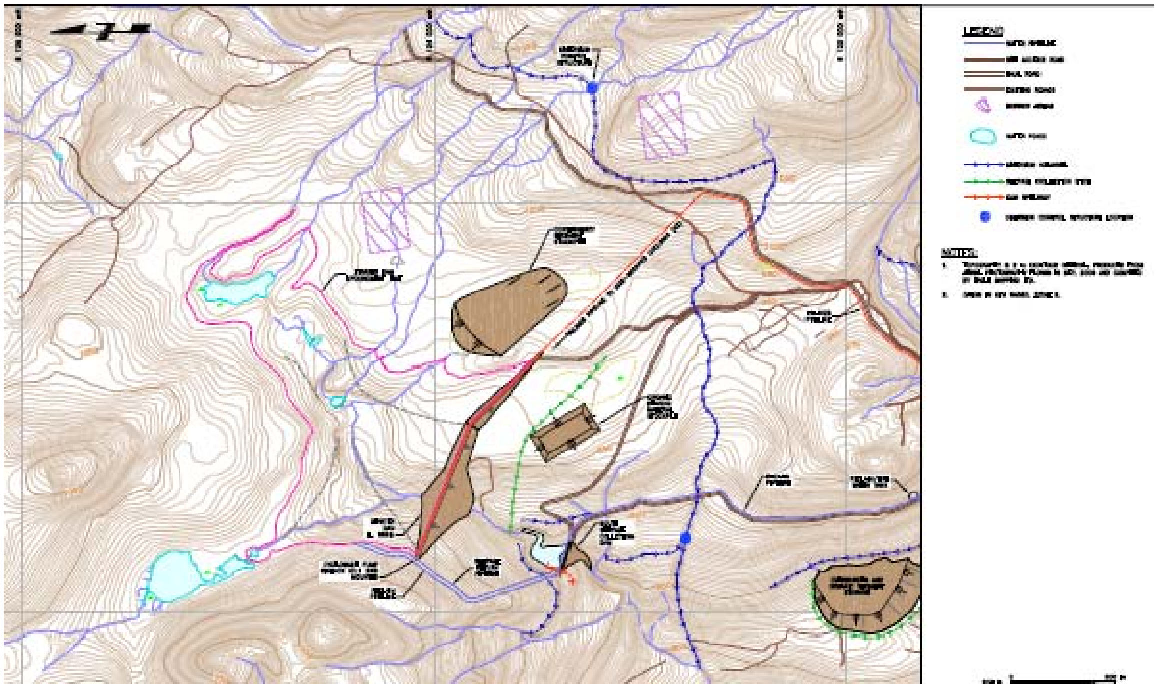


Figure 5.1 Location Plan – Contingency Sediment Stockpile

5.1.2 Management of PAG Runoff Water – Pre-Production

During the pre-production phase the open pit will be stripped of overburden and development of the initial benches for the open pit will begin. The waste materials from this will be a combination of PAG and non-PAG materials. All PAG materials will be stored in the waste rock dump footprint. Runoff from the PAG waste dump and the development rock benches will be collected and directed to the excavated Booker Lake for settling. If the water quality meets discharge guidelines it will be discharged, otherwise it will be stored until the TSF is operational and it can be used for process water. The storage volume in Booker Lake is approximately 1.5 million m^3, which is capable of storing at least several years of runoff, if required. Annual runoff from the construction areas is estimated to be up to 200,000 m^3/yr.

5.1.3 Overburden Stockpile

A preliminary design for relocation of the overburden stockpile has been carried out by PBM. The overburden stockpile was originally located on Morrison Point adjacent to Morrison Lake. The relocated overburden stockpile is shown in plan and section on Figure 5.2 and is approximately 700 m inland from Morrison Lake.

The overburden pile will be constructed in conjunction with the previously proposed overburden and organic sediment stockpile. The overburden typically consists of glacial till, which will provide additional structural support for storage of the weaker lakebed sediment.

The overburden stockpile will be used for closure to provide covers for the TSF dams, containment berms and other reclaim uses.

5.2 Operational Segregation of Mine Waste Rock

5.2.1 General

The open pit mine development plan consists of four pit development phases expanding to a single large open pit near Morrison Lake. A waste dump and a low grade stockpile will be located 100 m north and east of the open pit

The mine engineering group will be responsible for short, medium and long range planning as well as day to day grade control functions. Planning engineers will update mine plans at the short, intermediate and long range scale as required and determine stockpiling and milling cut-off grades to meet the mine plans as they evolve with time and improved updated databases. Geologists and grade control technicians will be responsible for blasthole sampling, assaying and grade control. Grade control will be focused on copper and gold. In addition, waste characterization will be a requirement for non-acid generating waste identification.

The mine will operate as a conventional and truck shovel operation. The typical production cycle will be drill, blast, grade control, load and haul. Ore and waste blocks will be identified in the pit by the grade control block model augmented by testing blast-hole samples. Ore will be drilled on a 12 m bench using a 6.3 m x 6.3 m pattern. Waste will be drilled at a 7.3 m x 7.3 m pattern. Sub-grade drilling will be 1.5 m to allow even breakage to the design bench elevation. Blasthole cuttings will be sampled and assayed for grade control.

Based on grade control, ore will be trucked to either the low grade ore stockpile or to a crusher near the mill, where the crushed product is temporarily stored in a crushed ore stockpile.

Waste from the open pit will be separated based on acid rock drainage/metal leaching potential (ARD/ML) into the following two categories:

- non-PAG waste rock with Adjusted Sulphide Net Potential Ratio (Adj. SNPR) at or greater than 2 (net neutralizing); and
- PAG waste rock Adj. SNPR values below 2 (net acid generating).

5.2.2 Criteria for Waste Rock Segregation

PAG and non-PAG Segregation

Adjusted SNPR will be the primary criteria for segregation of the non-PAG waste rock. All waste rock with an Adj. SNPR less than 2 will be assumed to be PAG. This includes high PAG and low PAG. Waste rock with an Adj. SNPR greater than 2 will be non-PAG.

During operations, a geochemical characterization program will be carried out and non-PAG rock will be preferentially placed towards the south side of the waste rock dump.

Segregation of waste rock will be accomplished on a 12 m x 20 m x 20 m basis using the block model. The block model results showed zones of non-PAG material that have the potential for segregation. A large cluster of blocks with estimated Adj. SNPR>2 waste rock is estimated in the north-eastern part of the pit. This mass accounts for 7.3 million tonnes or about 51% of the total Adj. SNPR>2 tonnes within the waste and most of the blocks exceed an Adj. SNPR value of 3. Another cluster of estimated Adj. SNPR>2 blocks located on the north-western periphery of the pit suggests that some net neutralizing material near surface may be separable in this area as well. Most of the remaining Adj. SNPR>2 blocks are widely scattered, have Adj. SNPR values between 2 and 3, and are not close to surface.

High PAG and Low PAG Segregation

As documented in the EAC Addendum Appendix S approximately 92% of the waste tonnes within the pit limits have estimated Adj. SNPR values below 2 and are considered PAG. Note that the Adj. SNPR is based on an Unavailable NP of 13 kg/t. Addendum Appendix AM Updated ML/ARD Predictions states "Normally, some portion of measured NP is "unavailable" for neutralization. As a result, the Unavailable Neutralization Potential should be subtracted from measured values before calculating net balances of acid-generating and acid-neutralizing capacities. The initial estimate of Unavailable NP for Morrison rock, based only on ABA, was 13 kg/t. However, kinetic testing has shown that the value for rock may be less than 13 kg/t………" Accordingly the Unavailable NP may be less than 13 hence, as documented in the Feasibility Study Volume 1 Section 4.2.4, 10% of the waste rock is assumed to be non-PAG. The Feasibility Study Mine Plan has identified 170 Mt of waste rock, of which approximately 153 Mt is PAG rock.

During operations the PAG waste rock will be classified into, as a minimum, two categories: "High" PAG and "Low" PAG where:

- High PAG waste rock (> 2%S and Adj. SNPR < 1)
- Low PAG waste rock (<2% S and Adj. SNPR < 2)

The basis for the High PAG definition is a combination of high sulphur, which can be the acid generating higher geochemical loads, and a lower neutralization potential, which indicates a shorter lag time to ARD. The NP consideration is included in the Adj. SNPR < 1, which theoretically excludes material that may have adequate NP to neutralize the sulphides or substantially delay the onset of ARD.

The High PAG rock has a higher risk of generating geochemical loadings during the mine life as it is expected to have the shortest lag time to acid production and could generate the worst water quality with the higher sulphide content. The potential volume of High PAG is on the order of <20% of the total waste rock. The selection criteria will be further developed during the mine planning and operations to ensure that the rock can be segregated on a mining scale, and, if practical, to also tie the selection criteria in with the copper grade, which may also allow future milling of the material. The justification for, and application of, Adjusted SNPR will continue to be assessed as more kinetic data is collected.

High PAG waste rock will be segregated towards the north end of the waste rock dump, as shown on Figure 2.2, and will be preferentially placed back in the base of the open pit on closure. Non-PAG will be placed in a separate stockpile at the south end of the waste rock dump as shown on Figure 2.2.

A summary of waste rock categories, segregation criteria and volumes is presented in Table 5.2.

Table 5.2 Waste Rock Segregation Summary

Waste Rock Unit	Segregation Criteria	% of Total Waste Rock	Million Tonnes
Non-PAG	Adj. SNPR > 2.0	10	17
High PAG	>2% S and Adj. SNPR < 1	20	34
Low PAG	<2% S and Adj. SNPR < 2	70	119

5.2.3 Methodology of Segregation

The block model will be used to guide the identification of potential PAG and non-PAG waste rock blocks. Additionally, this will be supplemented with geological interpretation and on-site laboratory geochemical testing. Individual bench plans will be prepared prior to the advance of mining. Pierce points for holes that have been tested previously for ABA will be plotted to verify the block model accuracy.

Blast-hole ABA data will be used to update the primary ABA database. These databases will be used, in conjunction with geologic mapping and modelling, as part of the grade control process. The grade control models used for planning will contain information regarding ore-waste contacts and material types for waste segregation.

ABA testing will be done on a composite of blast drill hole chips for waste materials (grid spacing of 7.3 m x 7.3 m). For example, considering the average mine stripping ratio of 0.8, 100,000 m^3 of mine material results in 44,000 m^3 of waste. This volume will hold 69 holes at the selected waste grid pattern and will yield 118,800 t assuming a density of 2.7 t/m^3. If one composite from each blast drill hole is tested, an average of approximately 5,200 ABA tests per year will be generated for the entire 170 Mt of waste rock scheduled for extraction. The actual testing frequency will likely be less than this due to the practical allowable resolution of operational mining, shovelling and hauling.

Therefore, a composite comprising of every three adjacent blast holes in waste rock will be considered for practical segregation for an average of 1,700 ABA analyses per year. Resulting materials characterization will be input to operational dig plans and clearly marked on muck piles for shovel-to-truck-to-waste dump transport.

There will be an assay laboratory in the processing plant building to process routine samples of intermediate and final products for quality control (mill feed and flotation products). Samples from the mine will also be analysed in this laboratory for grade control and mine planning. The major items of laboratory equipment will include:

- Laboratory jaw and cone crusher;
- Dust collection system;
- Laboratory ball mill;
- Atomic Absorption Spectrophotometer;
- Oven-style moisture determination equipment;
- Particle size analysis including Rotap sieving;
- Sedimentation devices and laser counting;
- Denver D12 rougher flotation machine with the necessary cells for test work;
- Laboratory cleaner flotation cells (2 L and 5 L);
- pH meters;
- Leco furnace;
- Titration equipment;
- Heating pads;

- Convection oven;
- Weighing devices; and
- Fume hoods with extraction fans.

The approximate number of samples to be tested using the on-site and external geochemical laboratories are summarized in Table 5.3. The number of samples may be increased during operations to assure capture of major sized blocks for segregation purposes.

Table 5.3 Summary of Waste Rock Segregation and Testing Plan

Waste Type	Approximate Number of Samples per Year	Analytical Segregation Method
NAG/PAG Waste Rock Adj. SNPR (SNPR = 2 criterion) High PAG (>2%S and Adj. SNPR<1 criteria)	1,700	Leco S, Sobek NP, Modified Sobek checks on every 50 samples.
	260 (external lab)	15% of site tested samples sent to an external lab for ABA check assays

Note that previous ARD/ML EA and Addendum reports indicates total sulphur can be used as a surrogate for sulphide sulphur while effective NP can only be estimated by the Sobek method, as inorganic carbon overestimates NP.

All data will be plotted on bench and daily dig plans and reviewed with the pit foreman and pit crews.

A GPS dispatch system will be installed in every piece of production equipment (e.g., shovels, haul trucks, track dozer, etc.) and used to manage block segregation and placement.

Bench plans will be transmitted to the shovel and track doze operators in real time. Plans with ore and waste characterization boundaries will be displayed on screens in the operators' cabs. The screens will also show the location of the piece of equipment relative to the bench plan in real time. The shovel and/or track dozer will segregate waste units according to the bench plan, once segregated the material will be loaded into haul trucks.

As haul trucks are load the dispatch system will transmit the nature of the material and the required dump location for each load to screens in the operators cab. Truck drivers will then follow instructions to ensure proper placement of materials.

Records will be kept of dispatch information so that proper segregation and management of waste units can be identified.

5.2.4 Elements of the Waste Rock Management Plan

The major elements of the waste rock management plan with respect to environmental protection are:

- Maintaining and further developing the block model;
- Periodically testing blast-hole samples to verify the accuracy of the block model and making adjustments as required;
- Implementing the segregation plan using geological and engineering controls and the dispatch system described above; and
- Maintaining and checking records to ensure that the management plan was followed as planned.

5.3 End of Mining and Open Pit Infilling

The closure plan, as described in Section 9.3 of this report, is to place the last two years of Cleaner tailings into the open pit and to infill the pit with PAG waste rock. The open pit, prior to closure, is shown in plan and section on Figure 5.3.

The available volume in the open pit, up to elevation 730 m (Morrison Lake is approximately El. 733 m), is approximately 76 Mm^3. The storage volume will be occupied with the Cleaner tailings (1.8 Mm^3) and PAG rock (74 Mm^3) and capped with a non-PAG rock and glacial till cover. Approximately 97% of the PAG rock can be stored in the open pit. PAG rock will be segregated during operations and “High” PAG will be preferentially placed in the base of the open pit.

The volume of pores (voids) within the PAG rock will be used to store the water from the Cleaner tailings decant, groundwater inflows and surface water inflows. The void ratio of the placed mine rock is estimated to be approximately 0.37, which is equivalent to approximately 20 Mm^3 of available pore space within the waste rock. A water and mass balance for the pit infilling is shown in Table 7.5, and is based on the following assumptions:

- Cleaner tailings will total approximately 2.3 Mt, which will be transported to the open pit at a density of 22.8% solids by weight and settle to a density of 72% solids by weight (1.3 t/m^3).
- Groundwater inflows into the open pit will vary over the infilling period, from a maximum of 150 m^3/hr reducing to 10 m^3/hr at completion of infilling (Expected Case), and from 250 m^3/hr to 15 m^3/hr for the Upper Bound case.
- Mine area runoff will reduce through the period as waste dump areas are reclaimed.

- Surface diversions will be constructed around the open pit to divert non-contact water away from the open pit.

5.4 Adaptive Management Components

The project design presented in this report has been developed on a base case estimate of waste rock types. Contingency plans are available to manage variations in the actual quantities produced during mining, and potential scenarios and management plans are discussed as follows:

Surplus PAG rock:

If it is not possible to segregate non-PAG waste rock there would be an additional 17 Mt of PAG rock requiring disposal. This material would need to be placed in the TSF as the base case condition already has the maximum amount placed in the open pit. The contingency plan would be the same as that described in Section 4.4.3 of this report. Storage of the additional 17 Mt would require raising the TSF by approximately 2 m, which is readily accommodated.

Non-PAG rock has neutral metal leaching concerns:

If the segregated non-PAG rock develops neutral ML concerns it will be treated as PAG, as discussed above.

Non PAG rock volume is low:

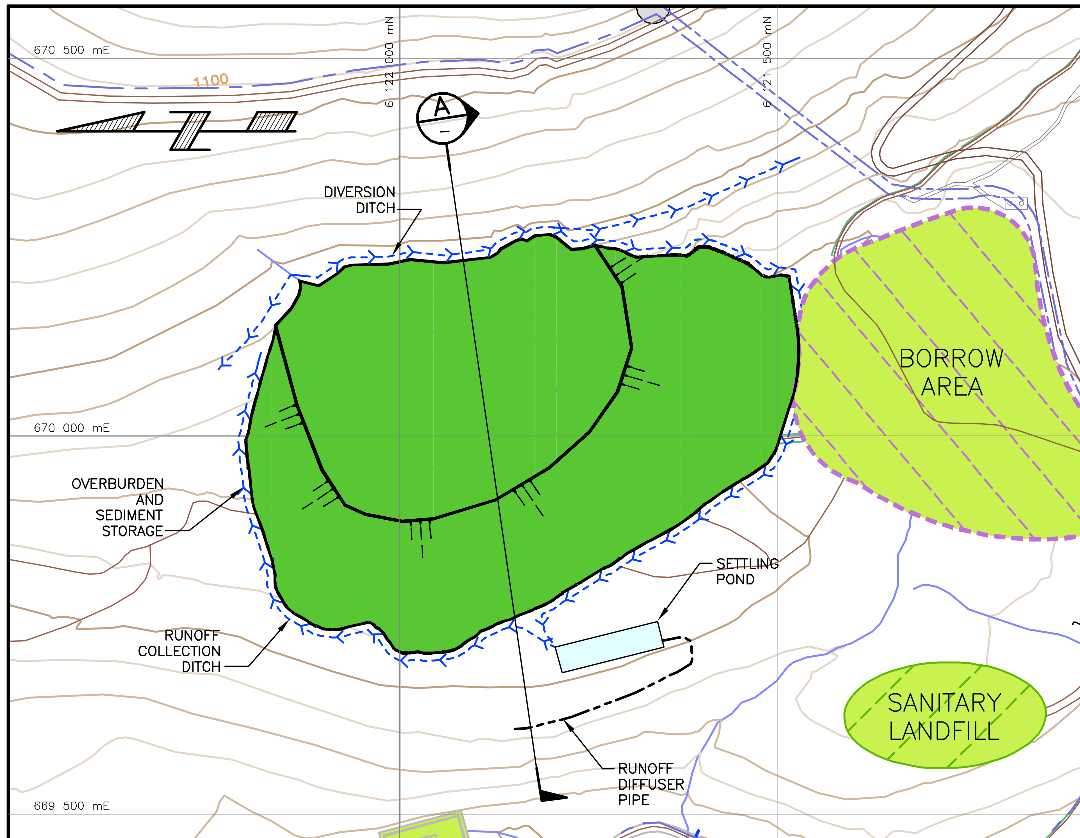
The closure plan for the open pit assumes approximately 4 Mt of non-PAG rock will be placed in the “wetland” area of the open pit. If this rock is not available, low PAG rock will be placed instead. The potential consequence of using low PAG rock will be to introduce additional geochemical loading to the water pond. However, the water quality predictions and water flows predictions for the effects assessment on closure conservatively assume all water has a low pH and will be treated.

Higher Quantities of high PAG rock:

The closure design conservatively assumes a lime requirement for treatment of 50% of the PAG rock placed back into the open pit. The consequence of have higher quantities of high PAG, would, therefore, not change the effects assessment. The main effect is the quantity of lime required for closure.

Uncertainty with the decision basis that triggers placement of PAG rock into the open pit:

The decision criteria will be based upon the mine plan as of Year 10. At this time the mine will have been operating for ten years and would have developed an improved basis for waste segregation, ore recovery and mine planning. Various mine plans would be run to assess the sensitivity of the plan to variations in metal prices and a risk based assessment would be developed for review by the Regulatory Agencies.



PLAN
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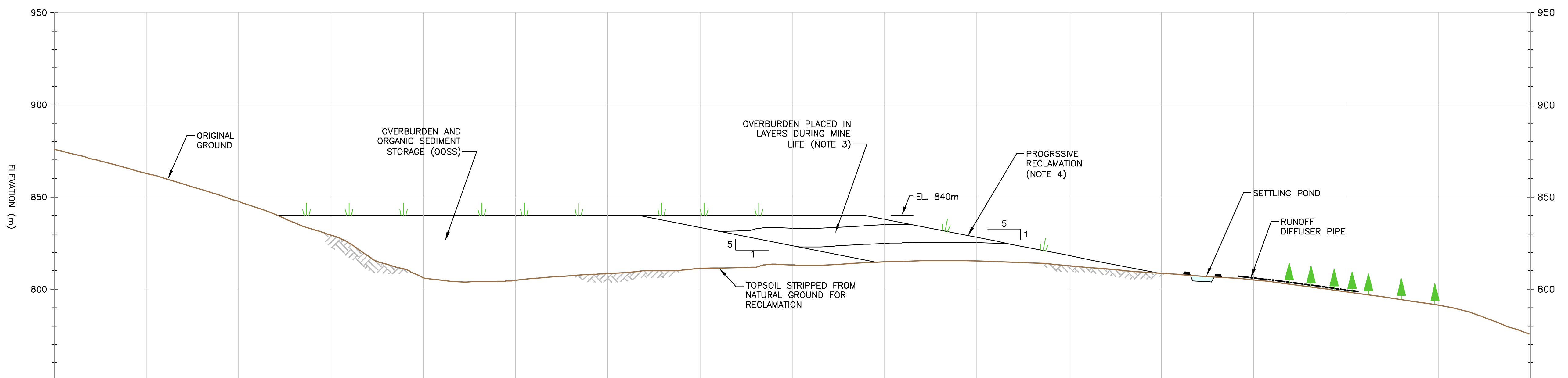

SECTION A
SCALE B

LEGEND

- DIVERSION CHANNEL
- EXISTING ROADS
- RECLAIMED SURFACE
- SETTLING POND
- RUNOFF DIFFUSER PIPE

NOTES:

1. TOPOGRAPHY IS 10 m CONTOUR INTERVAL, PRODUCED FROM AERIAL PHOTOGRAPHY FLOWN IN SEP, 2006 AND COMPILED BY EAGLE MAPPING LTD
2. DATUM IN UTM NAD83, ZONE 9.
3. OVERBURDEN WILL BE PLACED IN HORIZONTAL LAYERS WITH PERIMETER BERMS TO CONTAIN PRECIPITATION.
4. OVERBURDEN SLOPES WILL BE PROGRESSIVELY RECLAIMED WITH GRASS.

NOT FOR CONSTRUCTION

TO BE READ WITH KLOHN CRIPPEN BERGER REPORT DATED ____________

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CLIENT
pbm
Klohn Crippen Berger

PROJECT
MORRISON COPPER/GOLD PROJECT

TITLE
RELOCATED OVERBURDEN STOCKPILE
PLAN AND PROFILE

PROJECT No.	FIG. No.
M09382A04	5.2

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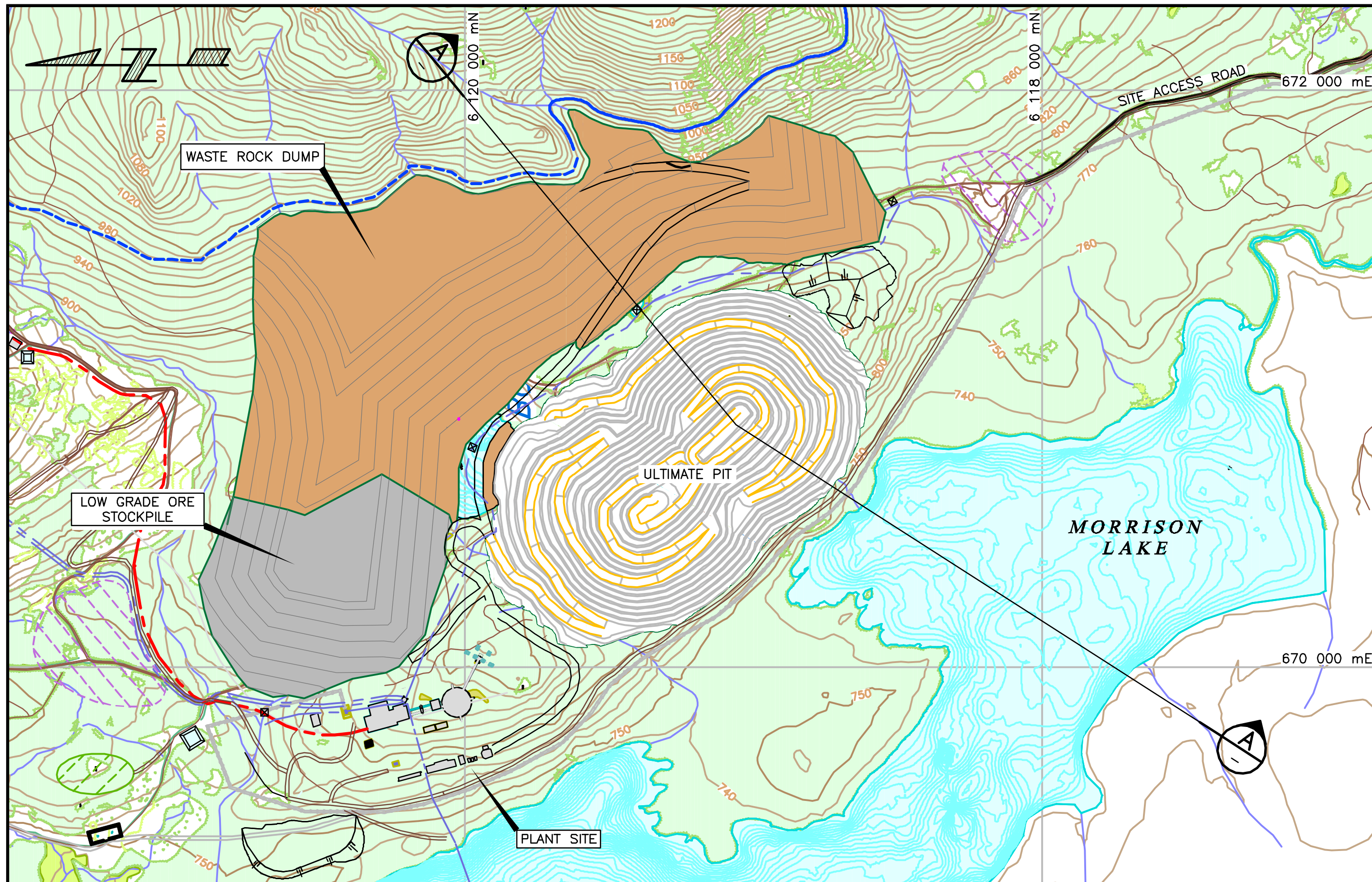
Xrefs: Morrison-design-facilities, BM-Morrison Copper-Jan10

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.
4. PLANT SITE LAYOUT PROVIDED BY WARDROP (NOV. 4, 2008).
5. DESIGN REFERENCED FROM KCB REPORT "GEOTECHNICAL FEASIBILTY STUDY – REV. 1" DATED JANUARY 9, 2009.



LOCATION PLAN
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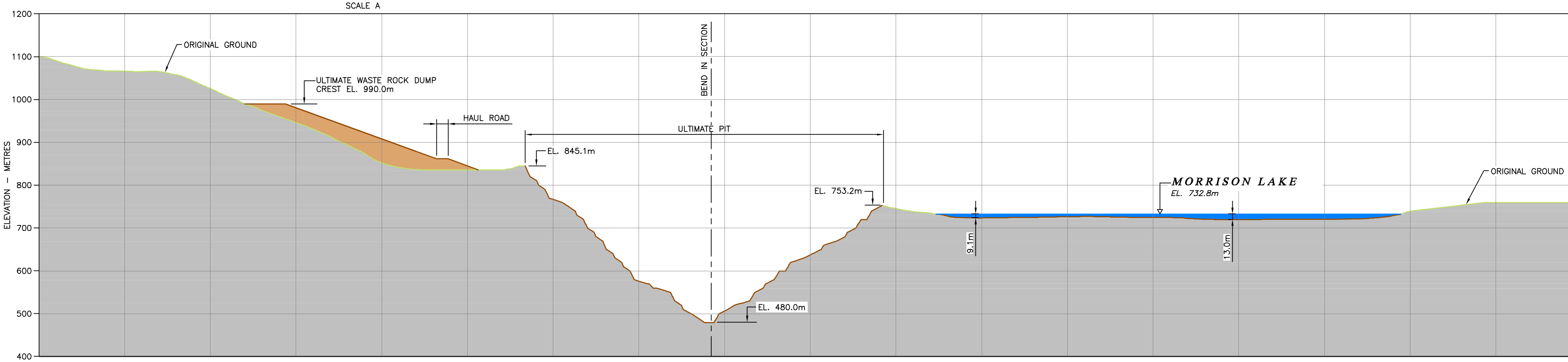

SECTION A
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NOT FOR CONSTRUCTION

TO BE READ WITH KLOHN CRIPPEN BERGER REPORT DATED ______

SCALE B: 0 250m

SCALE A: 0 500m

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CLIENT: pbm

Klohn Crippen Berger

PROJECT: MORRISON COPPER/GOLD PROJECT

TITLE: OPERATION PHASE WASTE DUMP AND OPEN PIT CROSS SECTION

PROJECT No.: M09382A04

FIG. No.: 5.3

KCB-R-MLD

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Xrefs: BM–Morrison Copper–Jan10

6. HYDROGEOLOGY

6.1 Revised Groundwater Models and Groundwater Flows

The EAC Application groundwater models and assessment of potential seepage rates from the TSF, pit dewatering flows, flows from Morrison Lake to the open pit and long term regional flows through the open pit have been revised. The revisions are based upon modifications to the EAC Application version of the MODFLOW groundwater model that includes an update of the hydro-geologic conditions and revised closure conditions. In addition 2-D SEEPW models and analogue pit inflow data from nearby Granisle and Bell mines, and other porphyry copper mines in British Columbia, has been used.

A representative hydrogeological cross section through the TSF is shown on Figure 6.7 and the section for the open pit is shown on Figure 6.8. The model output runs for the TSF seepage modeling are included in Appendix II. Groundwater flows influence the mine water balance and the effects assessment on Morrison Lake. The assessment identifies the Lower Bound (LB), Expected Case (EC) and Upper Bound case (UB).

6.2 TSF Area

6.2.1 Hydrogeology Database

The hydrogeology baseline and modeling reports included in the EAC Application form the basis for the update for this report. The groundwater assessment has been updated to include data that was not referenced in these initial reports.

Data that was not referenced in the EAC Application:

Addendum Appendix AX: Geotechnical Feasibility Study (KCB, 2009):

- 9.5 km of geophysical resistivity survey lines were carried out along the dam alignments and several upstream-downstream sections. The resistivity surveys are useful in quantifying the spatial distribution of glacial till as it is shown as a more conductive layer, as opposed to bedrock which is less conductive.

- A laboratory consolidation/permeability tests of a glacial till sample indicate a hydraulic conductivity of 1E-10 m/s. Laboratory soil classification tests have been carried out on over 100 samples, which indicate the glacial till to be a moderately plastic silt-sand-gravel mixture with some clay. Empirical correlations indicate hydraulic conductivities in the range of 1.0E-07 to 1.0E-10 m/s.

Addendum Appendix M - TSF Site Investigation Report, Knight Piesold (KP, 2007):

- Four hydraulic conductivity tests were carried out on 4 Shelby tube samples collected from the TSF area indicated hydraulic conductivities of: 1.7E-09, 1.4E-05, 2.4E-08, 5E-07, and 2E-10 m/s.

- Three hydraulic conductivity tests carried out on remoulded samples collected from the TSF area indicated hydraulic conductivities of 1.6E-07, 6.1E-09, and 1.5E-10.

- Drill hole DH06-10 indicated that hydraulic conductivity could not be measured for the test from 21.9 m to 53.6 m within the bedrock. The drill hole is located 250 m downstream of the centerline of the left (northwest) abutment of the North Dam. The test log does not indicate what the limit of the test equipment was – for example, on a recent KCB project the limit of the test equipment (pump capacity) limited test values to > 10^{-6} m/s. KCB has reviewed the drill core logs and photographs and no highly fractures zones were identified and it is uncertain why the test was not successful. Hydraulic conductivity tests carried out in 2007 by KCB in DH07-02, located 250 m upstream indicated bedrock hydraulic conductivity of 2.0E-07 m/s (26.0 to 35.0 m depth).

6.2.2 Influence of Faults

An important consideration is the potential for faults with high hydraulic conductivity within the TSF footprint and the influence that such faults may have on seepage from the

TSF. Geologic faults are included in geological interpretation of the TSF footprint geology and shown in Figure 6.1.

Geology of the project area is based upon the 1:100,000-scale regional geologic compilation map (MacIntyre 2001, BC GSB Open File 2001-3). This map compiles mapping efforts from many geologists over decades. In the vicinity of the Project site, terrain is heavily blanketed by till and other glacial deposits making direct observation of bedrock difficult. The fault on the map under the footprint of the TSF (Figure 6.1) is dashed, indicating its presence is inferred and may also reflect rock type changes. Geophysical surveys carried out along the dam alignments identified several potential anomalies which approximately correspond to potential faults.

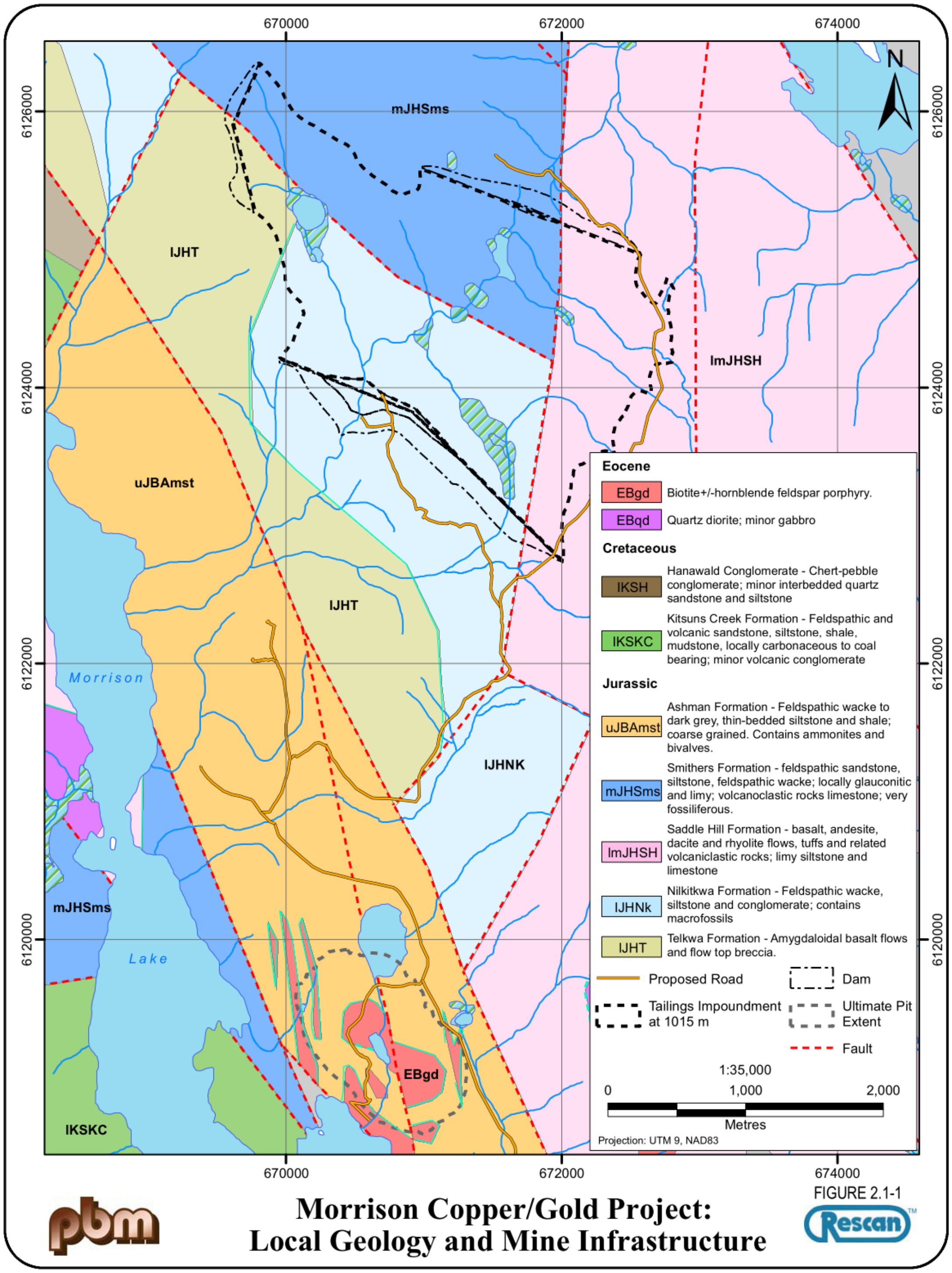


Figure 6.1 Bedrock geology in the Project area (from MacIntyre 2001; Figure reproduced from EAC Addendum AY, Fig. 2.1-1)

Fault hydraulic conductivity is controlled by the structural environment and whether the faults are in compression or tension. In general, it appears that the northwest trending structures may be in compression.

Finally, it is important to understand that the dominant controlling factors for seepage through the TSF foundations are the hydraulic conductivities of the tailings and the underlying glacial till. The potential for faults, even if present, to transmit significant quantities of water is very low because the inflow into the faults is controlled by the permeability of the glacial tills and the tailings – in effect the faults are inflow limited.

The presence of faults, however, will influence the flow path through bedrock, acting as a potential preferred flow path. This is, however, a conservative assumption, as the presence of gouge infill, local fault closure and splaying will limit hydraulic continuity, and may result in the fault acting locally as a barrier to groundwater flow. The presence of faults was included in the groundwater model and will continue to be assessed and incorporated into future detailed groundwater models.

6.2.3 Controlling Factors for Seepage from the TSF

The ultimate seepage rate out of the impoundment is controlled by the main factors summarized as follows:

1. Dam design: The design includes a low permeability core zone keyed into low permeability glacial till or rock foundations. The South Dam is the highest structure and will, therefore, have the highest hydraulic head and gradient.
2. Hydraulic conductivity of impoundment soils: The overburden soils act as a liner for the TSF and the distribution and hydraulic conductivity of the soils influence the seepage rates. The current modeling assumes 85% of the area is covered with glacial till and additional site characterization works will be carried out to confirm the actual conditions in more detail.

The results will be incorporated into a more detailed spatial model, which will be used to identify areas which will require placement of low permeability soil; or geomembrane liners in areas where soil placement is not practical.

3. Hydraulic conductivity of the tailings: The tailings hydraulic conductivity can vary significantly over the impoundment area due to segregation and separate disposal of the cleaner tailings. The design hydraulic conductivity used for the modeling assumes the upper range of potential hydraulic conductivity. In addition, the hydraulic conductivity of the tailings decreases with time as the tailings consolidate to a higher density under self weight. These factors should tend to decrease the seepage rates from those modeled.

4. The hydraulic conductivity of faults, both within the TSF footprint and along the potential flow path, will influence the direction of groundwater flow as they form preferential pathways. The influence of faults on the rate of seepage is limited because of the "inflow" constraints of the tailings and overburden.

6.2.4 Groundwater Modeling

The TSF 3-D; MODFLOW groundwater model has been re-run with the following inclusions/updates:

- The hydraulic conductivities for the bedrock and glacial till used in the model are appropriate.
- The EAC-Application model runs, however, assumed the case of no tailings and full water head up to the final dam height. The new model runs include the tailings.
- The hydraulic conductivity of the tailings has been adjusted to account for anisotropy with horizontal hydraulic conductivity of $1.5x10^{-7}$ m/s and a vertical hydraulic conductivity of $1.5x10^{-8}$ m/s.
- The size of the water pond has been modeled for several cases ranging from a full pond covering the entire TSF area to the predicted smaller pond on closure, as shown in Figure 6.2, Figure 6.3, and Figure 6.4.

- The groundwater model considers full saturation within the pond area and an infiltration rate of 77 mm/yr (14% of annual precipitation) over the tailings beach area.

The model outputs are included in Appendix II.

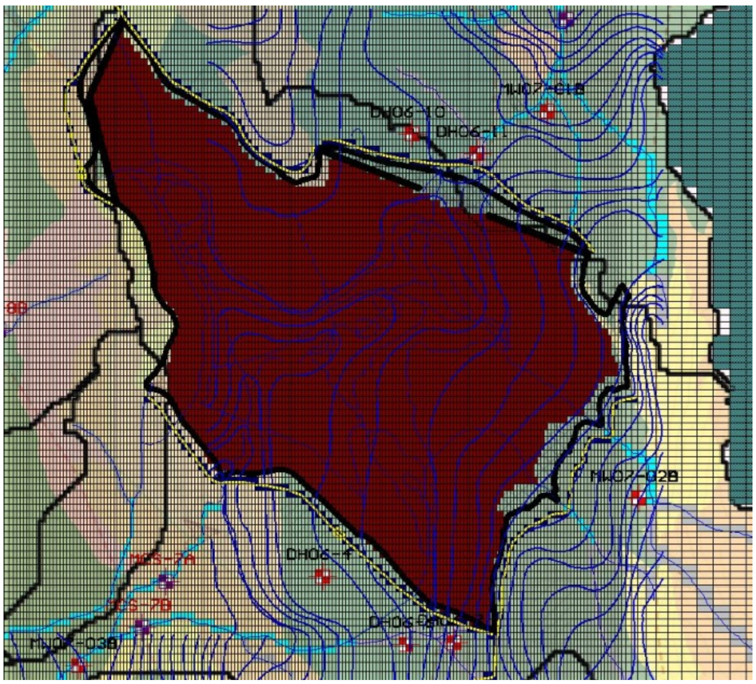


Figure 6.2 Plan of TSF for Full Pond Seepage Model

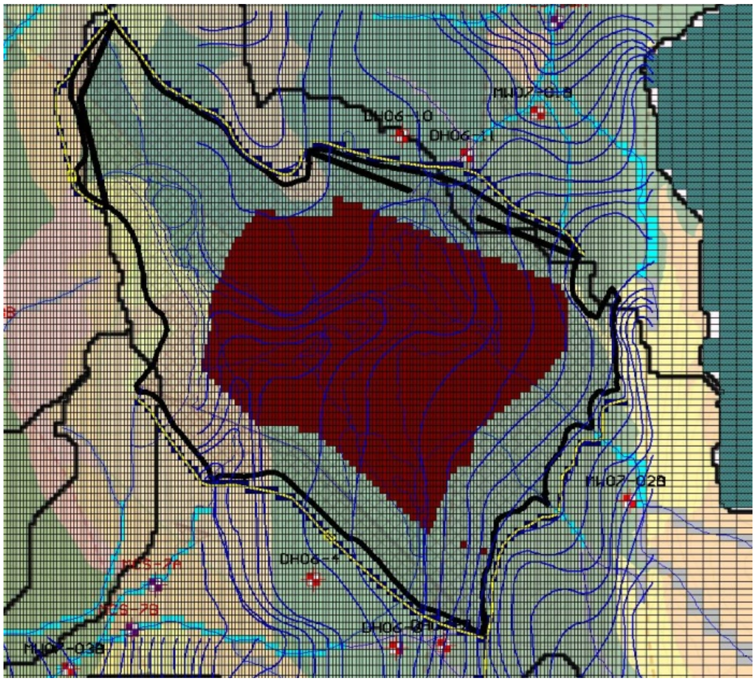


Figure 6.3 Plan of TSF with Mid Size Pond Level

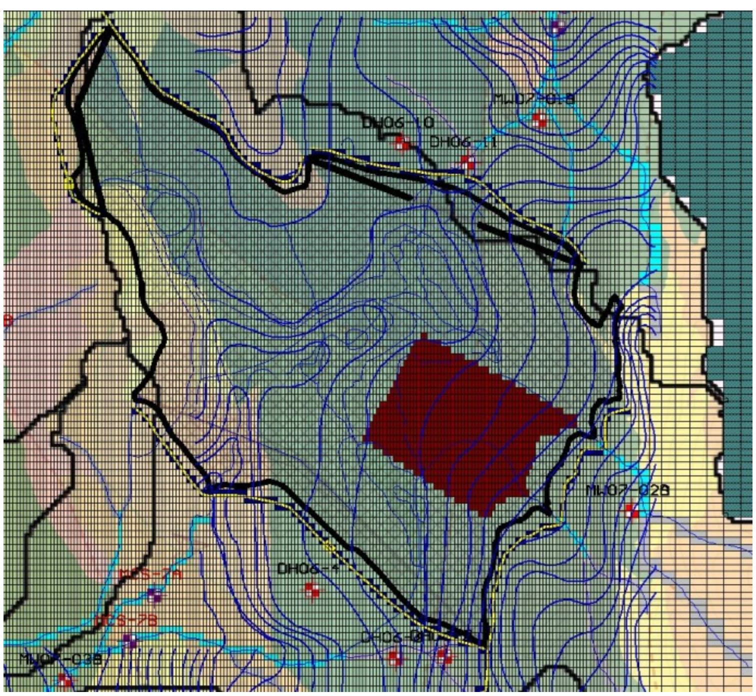


Figure 6.4 Plan of TSF with Closure Pond Level

6.2.5 TSF Seepage Estimates

Seepage estimates have developed for the final TSF impoundment for various water pond size and expanse. The cases include:

- The Expected Case seepage rate is based on a mid-sized water pond during operations and a small water pond on closure.
- The Upper Bound seepage rate is based on a large water pond during operations, where the entire TSF area could be either continually saturated or a free water pond. The Upper Bound seepage rate for closure assumes a mid-sized water pond.
- The Lower Bound seepage rates for operations and closure are assumed to be a half order of magnitude less than the Expected Case, which reflects the general order of accuracy of the seepage estimates.

The seepage estimates are summarized in Table 6.1.

Table 6.1 TSF Seepage Estimates – Expected and Upper Bound

Case	Seepage Rate (m^3/hr)	
	Operations	Closure
Lower Bound	50	30
Expected Case	100	60
Upper Bound	150	100

The Lower Bound seepage rates are used for water balance sensitivity (Upper Bound water balance) as discussed in Section 7.4 of this report. The Upper Bound seepage rates are used for environmental effects (Upper Bound seepage effects on receiving streams and Morrison Lake) as discussed in Section 8 of this report.

6.3 Mine Area

6.3.1 Open Pit Development

The open pit will be developed over 19 years in a number of stages: Phase I and II will be developed to 576masl, a depth of ~158 m below Morrison Lake (~734 masl); Phases III and IV will be developed to 480 masl, a depth of ~254 m below Morrison Lake:

- Phase I will be mined Year 1 to Year 7.
- Phase II will be mined Year 4 to Year 11.
- Phase III, an expansion of the Phase I pit will be mined Year 8 to Year 17 and
- Phase IV, an expansion of the Phase II pit will be mined Year 12 to Year 19.

The slow development of the open pit will allow time for assessment of actual conditions and implementation of adaptive management measures if and as required.

6.3.2 Hydrogeology Database

For this report two main sources of new data are incorporated into the assessment of potential pit inflows:

- Hydraulic conductivity data from drilling carried out in 2010 in the open pit (EAC Addendum Appendix) and
- Analog data from porphyry copper mines in British Columbia.

<u>Hydraulic Conductivity Data</u>

Hydraulic conductivity testing was carried out and presented in the EAC application – Hydrogeological Modeling Report and the EAC Application – 2010 Open Pit Site

Investigations. The 2010 testing that is included in the EAC Addendum targeted the hydraulic conductivity of the pit wall rock and, where possible, fault zones. The 2010 drill-holes and previous drill-holes between the open pit and Morrison Lake are shown in Figure 6.5 and the hydraulic conductivity data for the holes are summarized in Table 6.2. The measured data extends to approximately 150 m depth. The trend of the data does not suggest that anomalously high hydraulic conductivities should be expected below 150 m depth. A review of drill core at depth has not identified anomalous fracture density. In addition, the typical trend of hydraulic conductivity in bedrock is to reduce with depth as the confining pressure increase.

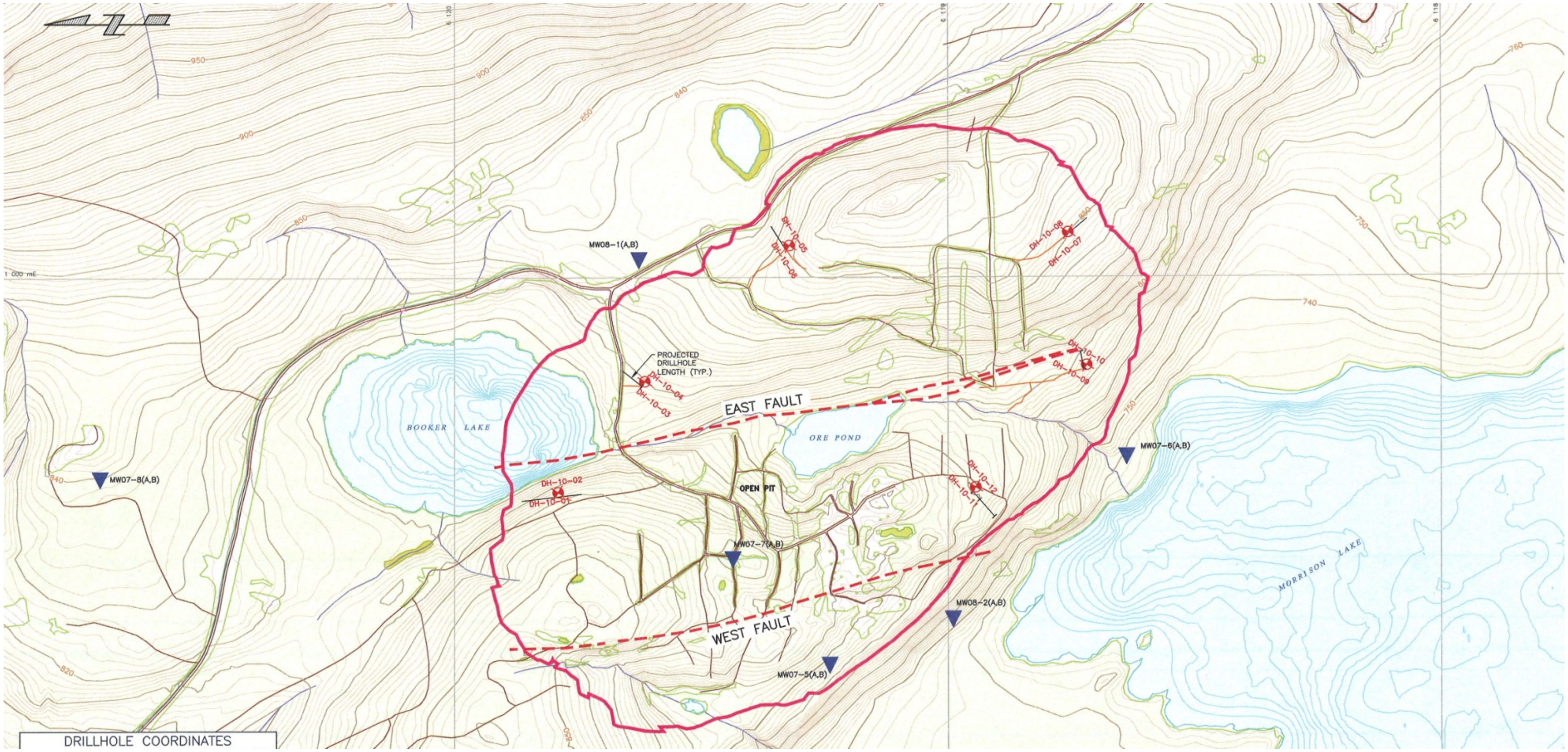


Figure 6.5 Plan of Pit Area Drill Locations and Faults

Table 6.2 Hydraulic Conductivity Data from Morrison Lake/Open Pit Area

Drill Hole	Material	Depth (m)	Hydraulic Conductivity (m/s)	Comments
DH-10-9	Small fault in sandstone	67.7 - 79.9	1.8E-06	The drill hole appears to be within fault/shear zones from 77 m to 98 m. East Zone Fault.
DH-10-10	Siltstone	67.0 - 92.5	1.8E-07	
	East Fault zone in sedimentary rock	140.2 - 146.9	3.8E-06	
	Sedimentary	0-160	1.1E-07	Falling head test carried out on total drill hole length.
DH-10-12	Porphyry	82.2 - 98.3	1.7E-06	
DH-07-05A	Porphyry	1.22-20.42	1.77E-07	
		21.33-28.04	2.23E-07	
		30.48-40.23	7.34E-07	
		35.81-40.23	6.49E-07	Slug tests
DH-07-05B	Glacial till	17.07-21.33	5.02E-07	Slug tests
DH-07-6A	Volcanics	10.82-16.31	9.08E-08	Slug tests
DH-07-6B	Glacial till	1.52-5.18	1.06E-06	Slug tests
DH-08-02A	Porphyry	42.98-49.07	5.5E-07	
		64.31-73.46	1.23E-05	
		82.6-91.7	5.9E-07	Recharge test
		105.46-113.08	1.36E-07	
		135.94-151.2	1.57E-06	

Discussion of Results

The geometric mean of the hydraulic conductivity of the bedrock between Morrison Lake and the open pit is approximately 5E-07 m/s and it varies from 1.6E-06 m/s to 9E-08 m/s. This range of variation is expected in a setting where hydraulic conductivity is controlled by discrete fractures in an otherwise competent rock mass. The hydraulic conductivity of the glacial till varies from 1.E-06 m/s near surface to 5E-07 m/s at depth. Hydraulic conductivity data is not available for the lakebed sediments, which has been estimated on the basis of empirical relationships with gradation.

The hydraulic conductivity of the East Fault appears to be in the order of 1.0E-06 m/s, although it likely contains zones of higher and lower hydraulic conductivities. DH-10-09 was drilled at an angle of 60° and intersected three shear zones (approximately 4 m wide each), which is interpreted to be the East Fault.

Analog Results for Pit Inflows

Groundwater inflow rates into the open pit are influenced by the presence of Morrison Lake and the uphill topography. Groundwater inflow rates from other closed, operating and planned porphyry copper mines in British Columbia have been reviewed and the results are summarized in this section and summarized in Table 6.3.

Table 6.3 Summary of Pit Groundwater Inflows –Analog Porphyry Copper Mines

Mine	Stage	Pit Depth	Flow (m^3/hr)	Comments
Granisle	closure	150 m	18 to < 47	Pit located adjacent to Babine Lake. Measured data.
Bell	closure	240 m	18 to < 67	Pit located adjacent to Babine Lake –Measured data.
Kemess South	Operations	225 m	30	Verbal communication – estimate of actual flows
Kemess North	Prediction		10 - 110	
Mt. Milligan	Prediction		70 - 130	
Red Chris	Prediction		85	

Granisle and Bell Mine Open Pits:

The Granisle and Bell mines were closed in late 1983 and allowed to infill with water until mid- 1986. During this period records were kept of the rate of pit infilling and volume of water accumulated. A detailed study was carried out (Klohn Leonoff Consultants Ltd., February 11, 1988 – Unpublished Client Report) to calibrate the rate of groundwater inflow and contributions from the catchment areas of each pit.

The Granisle open pit is located adjacent to Babine Lake (200 m to the northeast) and the tailings pond is located adjacent to the south side of the open pit. Groundwater inflows come from Babine Lake, the tailings impoundment and a limited area of local groundwater recharge and surface runoff. The open pit is approximately 150 m below the elevation of Babine Lake

The Bell Mine open pit is located on a peninsula in Babine Lake, approximately 300 m from the lake. The open pit collects drainage from the tailings impoundment and rock dump areas. The open pit diameter is approximately 1 km and the current pit lake is approximately 160 m deep, and the base of the pit is approximately 250 m below the elevation of Babine Lake.

The volume of water inflow over the approximately 1,000 days was approximately 675,000 m^3, which equates to an inflow rate of 27 m^3/hr. The estimated proportion of groundwater inflow was 18 m^3/hr. The estimates for both pits were similar.

A subsequent review of the Bell and Granisle pits was carried out in February 2003, by the Minesite Drainage Group (MDAG, 2003) as part of a geochemical survey for closure. The report indicated that the predicted inflow rate for the Granisle open pit was confirmed with field measurements over the period of 1984 to 2001. The back-calculated total inflow rate over this period was approximately 47m^3/hr, which was a combination of surface flows and groundwater inflows. Similarly the Bell open pit indicated a total inflow rate of 67m^3/hr over the same period. The higher rates reflect the influence of surface water inflows and actual groundwater inflows will be substantially less.

6.3.3 Groundwater Modeling and Flow Predictions

6.3.3.1 Pit Inflows during Operations

The pit dewatering flows are an important component of the overall water management and water balance of the project. The EAC Application groundwater model for the open pit assumed that dewatering wells would be used to draw down the water table in the perimeter rock to the base of the open pit. These dewatering wells would draw down the groundwater table in a cone. Using this model the dewatered area is excessive extending well beyond the extent of dewatering required for pit wall stability. This approach to simulating inflow into an open-mine pit is not industry standard. As the dewatered area of influence is large, regional hydraulic gradients are over-estimated and connectivity between groundwater and Morrison Lake are assumed to be "perfect", the model “over-predicts” dewatering flow rates required for the open pit. Over-prediction of groundwater levels in the pit area by the model will also result in pit inflow being over-conservative, as pumping is required to drawdown groundwater by up to 25 m more than would be required. The EAC groundwater model approach was based on a theoretical pumping system located within the pit area, which would draw the water table down to below pit level, and well beyond the pit walls. As such, the model gives a very approximate estimate of the order of magnitude of the inflow, which range from 50 m^3/hr to 291 m^3/hr.

The actual dewatering will consist of a combination of pit wall drainage holes, combined with some dewatering wells. The dewatered area around the open pit will be as required to meet pit wall stability. Thus a smaller dewatered area will be achieved resulting in a lower dewatering flow rate than was predicted in the initial EAC Application.

Pit dewatering inflows rates from similar porphyry copper open pits in similar geological settings gives an analog estimate of potential pit inflow, which varies from 18 m^3/hr to 130 m^3/hr. The Morrison open pit has similarities with the Granisle and Bell pits (adjacent to a lake), near hillside catchment areas (Kemess). The presence of major faults is common within porphyry copper deposits, although the central East Fault at Morrison could potentially be larger than major faults associated with other mines.

A simplified 2-D assessment of the open pit has been developed on the basis of the recharge area, assuming all groundwater inflow over an effective width of 1.2 km, would report directly to the open pit. Figure 6.8 shows the typical hydro-geologic section for the open pit. Assuming an uphill length of 42 km, an effective width of 1.2 km and an infiltration rate of 77mm/yr (14%) indicates approximately 40 m^3/hr. Assuming that the actual rate could be 2 times the rate due to inflow from Morrison Lake and depressurization works, would result in inflow rates in the order of 100 m^3/hr.

Accordingly, on the basis of analog data and simplified 2-D analysis, the open pit dewatering flows are estimated to be up to 150 m^3 for the Expected Case and up to 250 m^3/hr for the Upper Bound case, as summarized in Table 6.4.

Table 6.4 Expected Case and Upper Bound Pit Dewatering Flows

Pit Phase	**Pit Dewatering Flows (m^3/hr)**	
	Expected Case	**Upper Bound**
Year 1	10	10
I and II (150 m deep)	75	125
III and IV (250 m deep)	150	250

6.3.3.2 Flows from Morrison Lake

Hydro-geologic Model

Groundwater flow from Morrison Lake into the open pit has been modeled using a 2-D SeepW groundwater model and the typical section is shown in Figure 6.6. The open pit can be divided into a north and south section, each approximately 500 m long. The south section is adjacent to the lake with a relatively narrow width of approximately 150 m between the lake and the pit. The north section is separated by Morrison Point and the distance between the lake and the pit is in the order of 400 m to 800 m.

The soils and bedrock between the lake and the open pit are characterized as follows:

- *Lakebed Sediments:* Sediment samples were collected from Morrison Lake as part of the aquatic habitat baseline program. The sampling indicated that the lakebed sediments consist of loose fine silt, which is typical of most post glacial lakes. The hydraulic conductivity of the silt, using empirical correlations, is estimated to be in the order of 1.0E-08 m/s. The thickness of the lakebed sediments has not been determined, however are expected to be meters thick.

- *Glacial Till and Recent Soils:* Glacial till blankets most of the project area, however the till thickness and gradation can vary from a thick clay till to a thin granular till. The north section appears to have a thick low permeability glacial till (DH-07-05, see Table 6.2). The south section has a shallow till with a moderate permeability, which may also have been influenced by sediment outwash from the Stream 4, which drains Booker Lake.

- *Bedrock:* The hydraulic conductivity of the bedrock (see Table 6.2) varies from 1.6E-06 m/s to 9E-08 m/s, with a geometric mean of 5E-07 m/s.

The typical design section and expected case model run is shown in Figure 6.6. The model run assumes a lakebed hydraulic conductivity of 1E-08 m/s and a bedrock hydraulic conductivity of 5E-07 m/s.

PLACE HORIZONTAL

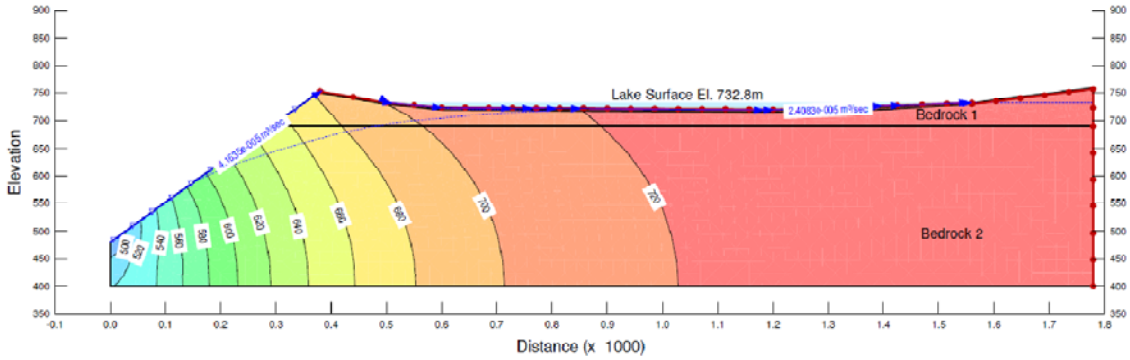


Figure 6.6 2-D SEEPW Model of Morrison Lake-Open Pit Section

Inflow Estimates from Morrison Lake at Maximum Pit Depth

The estimated inflow estimates for the south section, at the maximum pit depth, are 75 m^3/hr total, with approximately 45 m^3/hr coming from the lake, which is locally "perched" due to the low permeability lakebed sediments. This condition was not able to be replicated by the EAC MODFLOW model which was (conservatively) capable of simulating fully saturated conditions only. The lake inflows from the north section were not modeled but are expected to be similar to the general pit inflow rates and are assumed to be 35% of the south section due to the decreased hydraulic gradient.

Table 6.5 Estimated Morrison Lake Inflows to the Open Pit at Maximum Pit Depth

West Pit Wall Section	Morrison Lake Flows (m^3/hr)		Total Groundwater Flows (m^3/hr)	
	Expected Case	Upper Bound	Expected Case	Upper Bound
South	45	65	75	110
North	15	25	25	40
Total	60	90	100	150

Potential Influence of Faults

Two main faults have been identified, West and East faults, and these are shown on Figure 6.5. The faults run approximately parallel to Morrison Lake and, although they do not appear to provide a direct hydraulic connection, they may preferentially transport groundwater flow. Flow into the East Fault, which is a "significant" fault may receive groundwater flow from Morrison Lake and then preferentially direct the flow towards the open pit. Flow into the West Fault, which is considered to be a less significant fault may direct groundwater flow towards the northwest and within the pit wall crest. The assumption that faults will act as preferential pathways for groundwater flow is conservative as they may also act as aquitards and direct groundwater flow away from the open pit.

6.3.3.3 Closure Groundwater Flows

On closure, the PAG waste rock will be placed back into the open pit and the water level in the open pit will be similar to Morrison Lake. The groundwater system will return to a "similar" pre-mining baseline condition. An estimate of the regional groundwater flow into the open pit area on closure can be made on the basis of the hydro-geologic recharge area and the net annual infiltration rate of 77 mm/yr (14% of total precipitation goes into groundwater). The open pit is approximately 1.2 km long, and it is approximately 4.2 km to the groundwater divide, which then equates to a groundwater flow into the pit area of approximately 40 m^3/hr. The elevation of the pit lake area is the same as Morrison Lake and groundwater flow will: a) move into the pit lake; b) move through the PAG waste rock and into Morrison Lake; and/or c) move around or under the open pit or flow parallel to Morrison Lake and the regional groundwater system. The expected case and upper bound case for PAG groundwater flows are summarized in Table 6.6.

Table 6.6 Mine Area Groundwater Flows - Closure

Groundwater Component	Mine Area Groundwater Flows (m^3/hr)	
	Expected Case	**Upper Bound**
Groundwater into pit pond	10	15
Groundwater through PAG rock and into Morrison Lake	20	40
Groundwater that bypasses the PAG waste rock and open pit	10	0
TOTAL	**40**	**55**

The analytical approach for estimating groundwater inflow into mine pit lakes outlined in Marinelli and Niccoli (2000) was also applied to the mine pit under closure conditions. The assumed pit radius was 600 m, the bulk rock mass hydraulic conductivity was 5E-07 m/s and the recharge rate was 77 mm/yr. The final pit lake was assumed to be depressed by 2 m relative to surrounding groundwater to account for local evaporative effects. Estimated inflow into the final pit lake area from groundwater using, the Marinelli and Niccoli (2000) approach, was 25 m^3/hr, which is in the same order of magnitude as the potential flows presented in Table 6.6.

6.4 Adaptive Management Components

6.4.1 Contingency for Excessive Seepage Losses from the TSF

The TSF will develop over the life of the mine and hydrogeologic models and results from groundwater monitoring wells will be used to update, confirm, and refine predictions of potential seepage losses. The contingency plan for further mitigating the potential seepage losses from the TSF will include the following components:

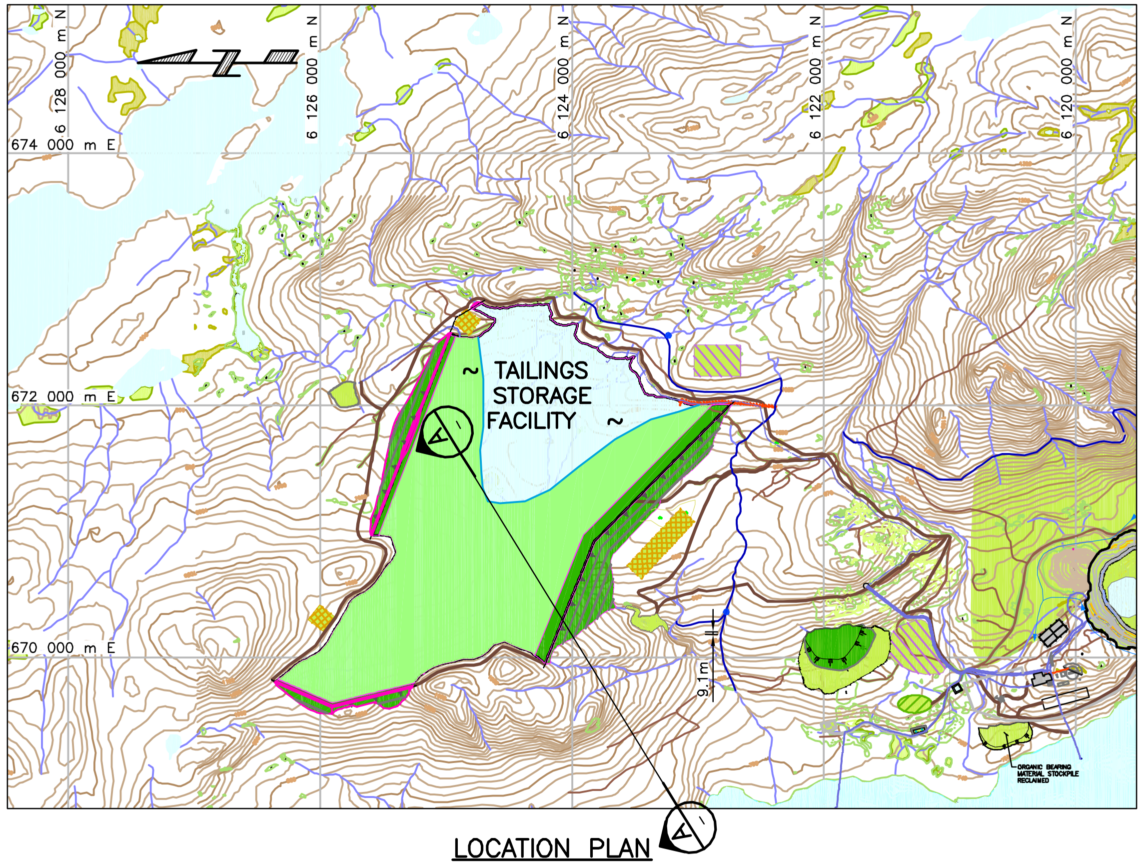
- Additional site investigations will include geophysics, test pits and drilling to provide broader spatial distribution; and
- Sections of the TSF will be lined, as and if required, with low hydraulic conductivity glacial till, or geomembrane liners.

6.4.2 Contingency for Excessive Seepage Inflows from Morrison Lake into the Open Pit

The open pit will be developed over the life of the mine and results from ongoing geological mapping, groundwater models and groundwater well monitoring will be used to update, confirm, and refine predictions of potential seepage flows from Morrison Lake to the Open Pit. In conjunction with the Adaptive Management plans for the Water Balance (see Section 7.6 of this report), the contingency plan for mitigation of the seepage flows will include a grouting program. The grouting, for example, could be carried out with a row of primary grout holes at 6 m centers, up to 100 m deep. Depending on the grout take secondary holes would be developed between the primary holes. Similar grouting programs are routinely carried out for large dam projects using standard technology.

6.4.3 Contingency for Groundwater Flows from PAG Porewater to Morrison Lake – Closure

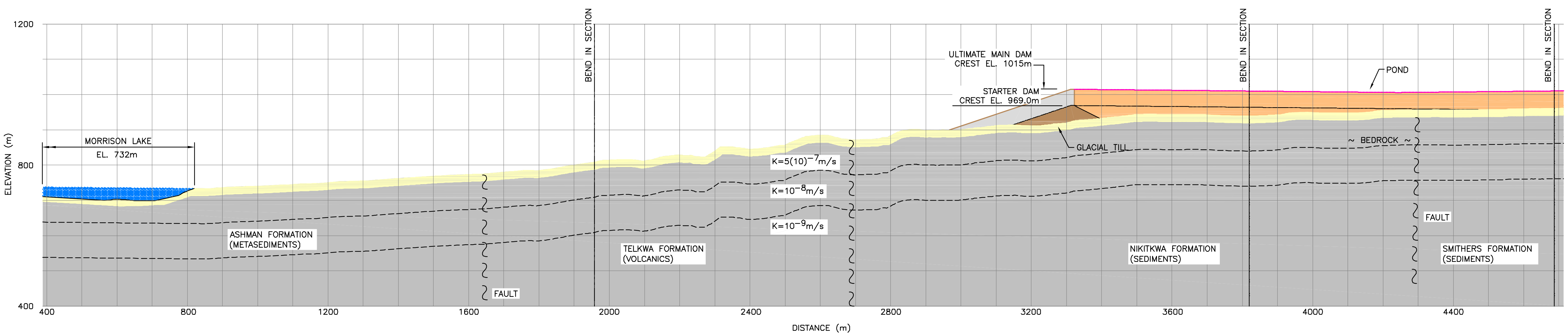
An improved understanding of the hydraulic connectivity between Morrison Lake and the Open Pit will be developed during operations. The refined groundwater models will be used to reassess the potential for groundwater movement of PAG porewater into Morrison Lake. The potential flow path is anticipated to be variable and consist of a component of shallow groundwater flow through the near surface bedrock and soils, as well as deeper flows through bedrock and the lakebed sediments. The groundwater quality will be monitored with groundwater wells and with sampling of the lake water quality. If adverse seepage effects are observed contingency plans will include interception of the groundwater, which would be recycled back to the open pit pond and sent to the water treatment plant.



LOCATION PLAN
SCALE A

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.
4. PLANT SITE LAYOUT PROVIDED BY WARDROP (NOV. 4, 2008).
5. DESIGN REFERENCED FROM KCB REPORT "GEOTECHNICAL FEASIBILTY STUDY – REV. 1" DATED JANUARY 9, 2009.



SECTION A
SCALE B

NOT FOR CONSTRUCTION

TO BE READ WITH KLOHN CRIPPEN BERGER REPORT DATED ______

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SCALE A: 0 — 1200m

CLIENT: pbm

Klohn Crippen Berger

PROJECT: MORRISON COPPER/GOLD PROJECT

TITLE: TAILINGS STORAGE FACILITY HYDROGEOLOGIC CROSS SECTION

PROJECT No. M09382A04

FIG. No. 6.7

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NOTES:

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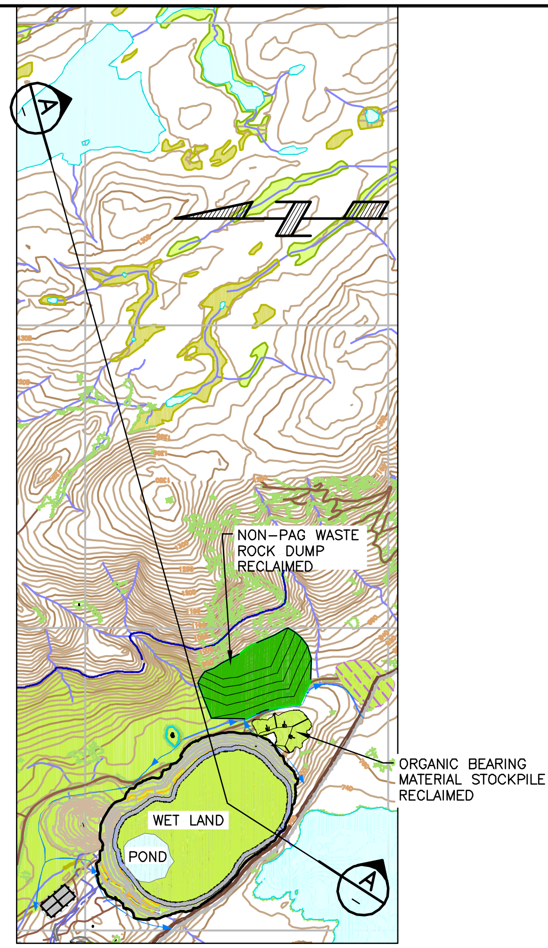
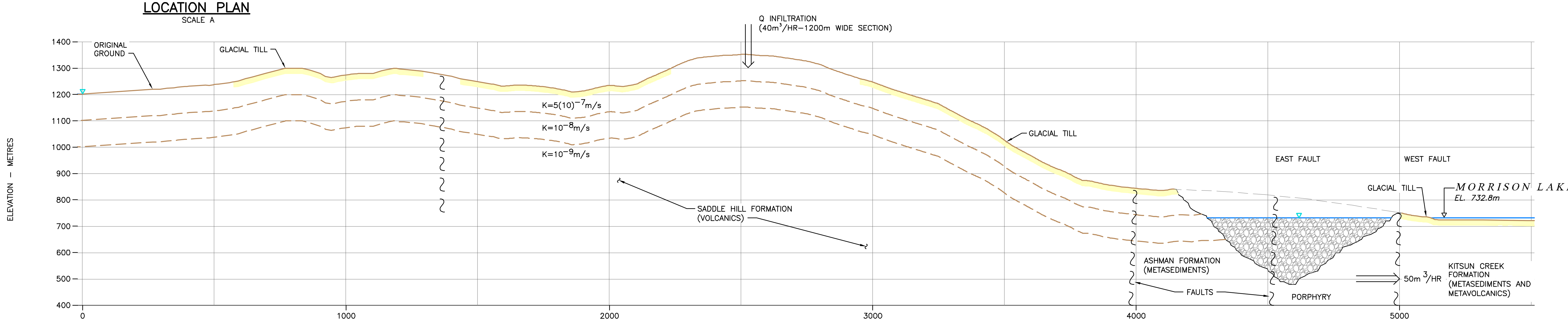
2. DATUM IN UTM NAD83, ZONE 9.
3. GROUNDWATER INFILTRATION RATE IS 77mm/YR. (14% OF PRECIPITATION).
4. DESIGN REFERENCED FROM KCB REPORT "GEOTECHNICAL FEASIBILTY STUDY – REV. 1" DATED JANUARY 9, 2009.



LOCATION PLAN
SCALE A



OPEN PIT – HYDROGELOGY SECTION

SECTION A
SCALE B

NOT FOR CONSTRUCTION

TO BE READ WITH KLOHN CRIPPEN BERGER REPORT DATED ________

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SCALE A: 0 500m

CLIENT: pbm

Klohn Crippen Berger

PROJECT: MORRISON COPPER/GOLD PROJECT

TITLE: OPEN PIT HYDROGEOLOGY CROSS SECTION

PROJECT No. M09382A04

FIG. No. 6.8

KCB-R-MLD

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Scale: 1=10(PS)
Drawing File: M:\VCR\M09382A04 – Morrison EAC Support\400 Drawings\MARCH PERMIT REPORT\FIG. 6.8(may92011).dwg (awong)
Xrefs: BM-Morrison Copper-Jan10

7. WATER BALANCE

7.1 General

The Expected Case project design is to operate as a "zero" discharge system while not accumulating a large volume of water stored in the TSF during operations. PBM is confident this case will be achieved. However the initial EAC Application water balance that indicated a large water surplus based on the assumption of only one diversion channel at the ultimate TSF impoundment elevation. The EAC Application did not incorporate the results of the (TSF) Geotechnical Feasibility Study (2007) that was based on progressive TSF diversions during the mine life.

However the EAC Application water balance that indicated a large water surplus was based on the assumption of only one diversion channel at the ultimate TSF impoundment elevation. The EAC Application did not incorporate the results of the (TSF) Geotechnical Feasibility Study (2007) that was based on progressive TSF diversions during the mine life.

The water balance for the project has, therefore, been revised to quantify the Expected Case and the Upper Bound case. The primary concern with the water balance is the ability to maintain a zero discharge facility during mine operations, as surplus water will either require water treatment or longer term containment until the water quality meets discharge criteria.

7.2 Methodology

Historical Development

A Goldsim hydrology model was developed for the EAC Application. An excel based monthly water balance was developed for the TSF for the Geotechnical Feasibility Study

(Klohn Crippen Berger, January, 2009) for the time steps of years 2, 10, 21 and closure and copies of the water balance are included in the Appendices to that report.

The excel spreadsheet water balance was updated for the EAC Addendum (May 2010) Appendix AB Lake Effects Assessment and Appendix AC Water Management Design reports. The assessment updated the excel based monthly water balance tables and included Years 2, 7, 11, 17, 19, early closure and late closure. The updated water balance used the TSF seepage rates and the Open Pit dewatering rates that were developed for the EAC Application.

NB: The water balance in the EAC Addendum was also based on the TSF diversion works scenario in which only one diversion was included at the final tailings elevation.

<u>Revised Water Balance Spreadsheets</u>

The water balance spreadsheet has been expanded for this report to include the full life of mine water balance for the Expected Case, the Upper Bound case, and the "managed" Upper Bound case and the results are included in Appendix IV. The water balance also considers the updated TSF seepage rates, pit dewatering rates and the TSF management plan for the last few years of mining when cleaner tailings will be placed in the open pit, along with all mine area runoff.

A general schematic of the site wide water balance is shown in Figure 7.1 and the water balance spreadsheet is set up to track the mine area components and the TSF area components.

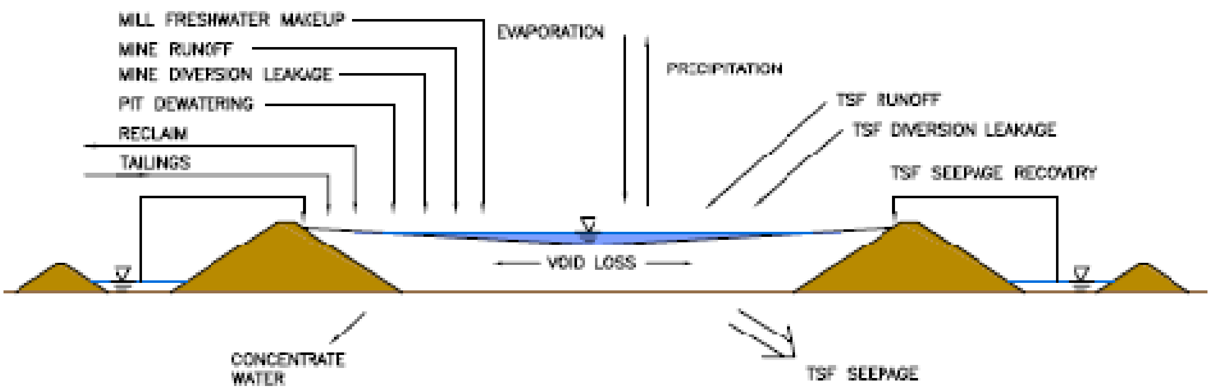


Figure 7.1 General Water Balance Schematic

<u>Clarification of water balance schematics:</u>

The water balance schematics for the different stages of mining have been revised to include the seepage from the TSF and modifications to the water management on closure and these are attached as Figure 7.2 to Figure 7.6.

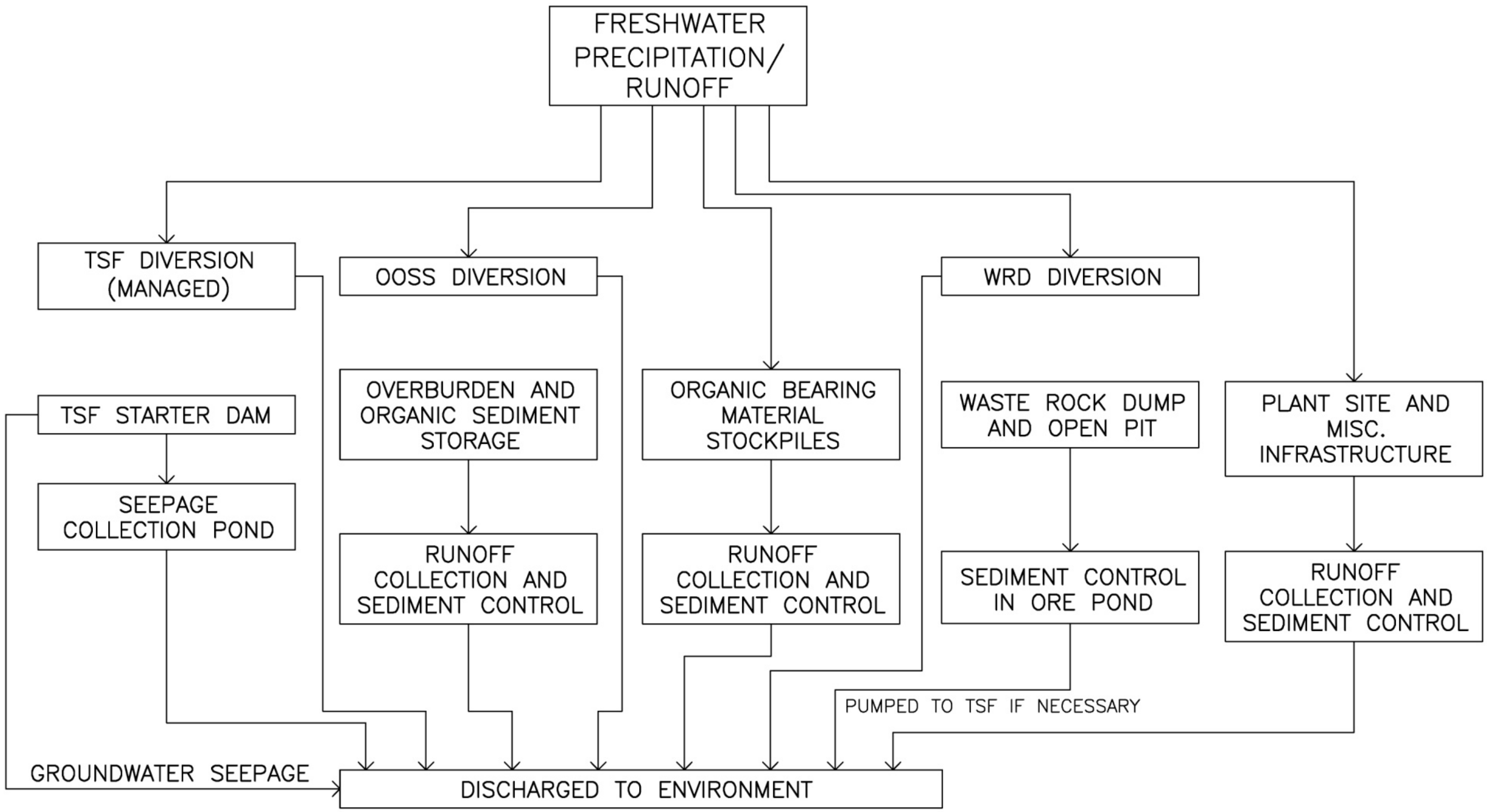


Figure 7.2 Water Management Schematic – Construction Phase

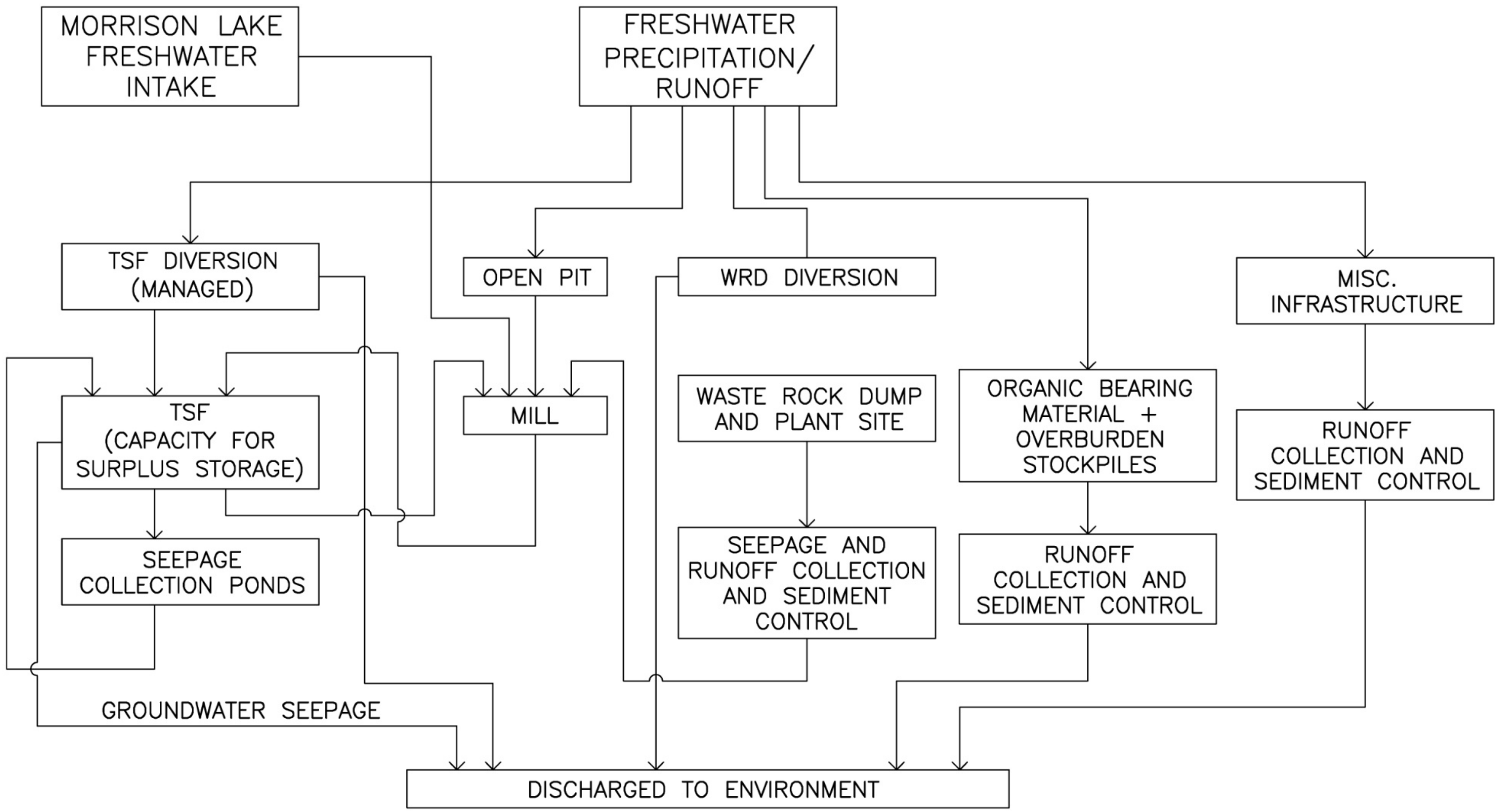


Figure 7.3 Water Management Schematic – Operation Phase

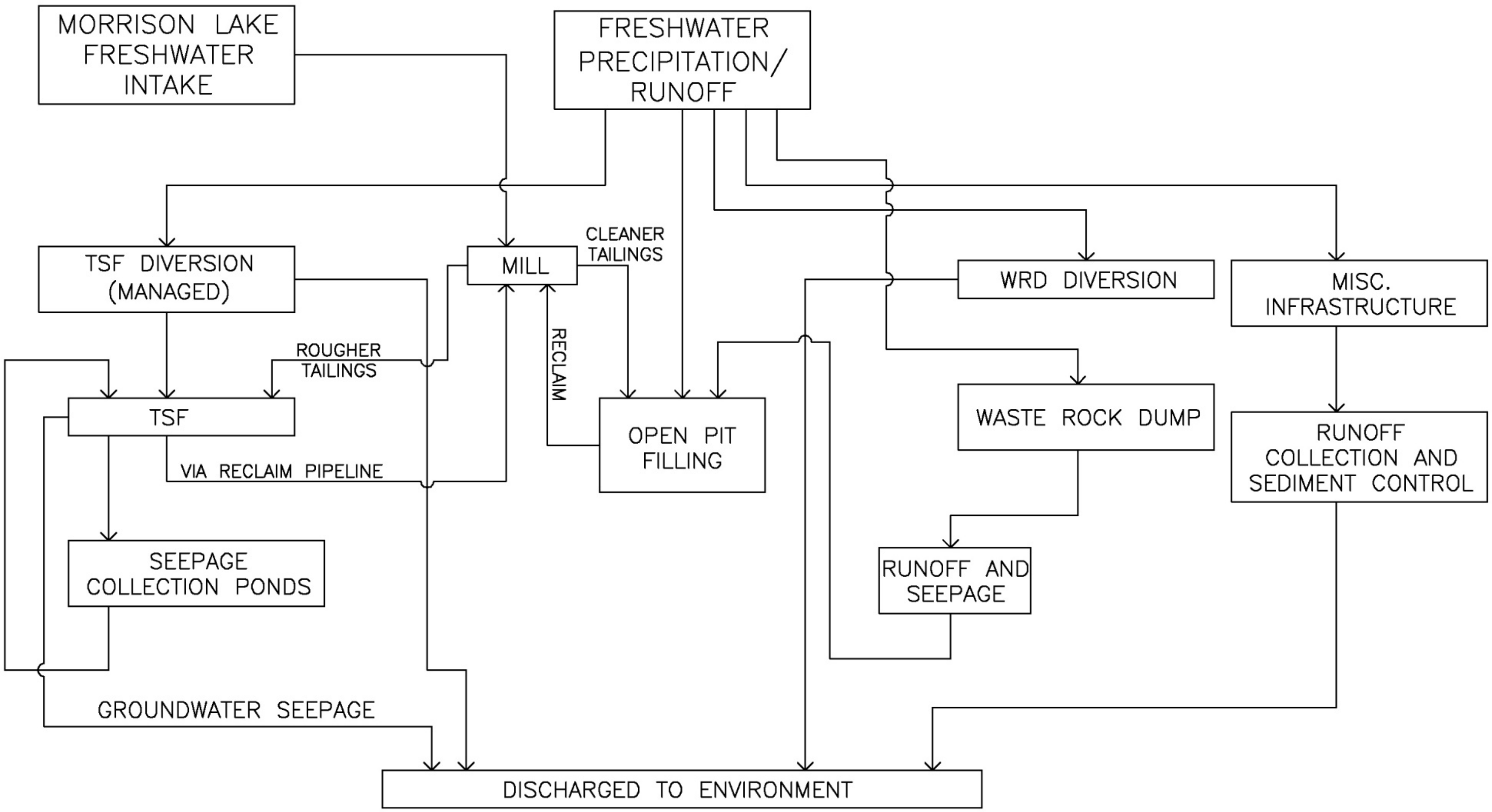


Figure 7.4 Water Management Schematic – Pre-closure Phase

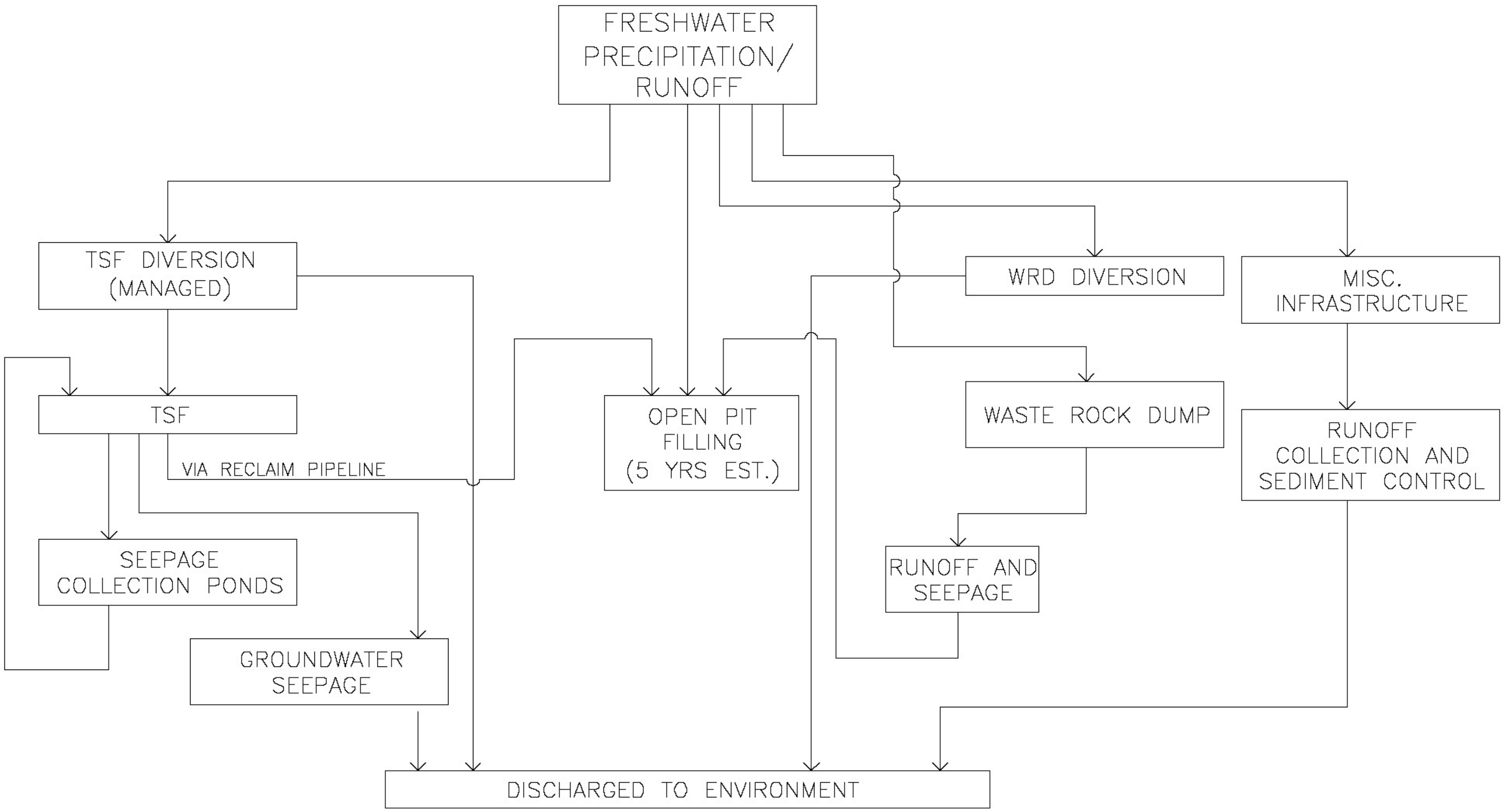


Figure 7.5 Water Management Schematic – Early Closure Phase

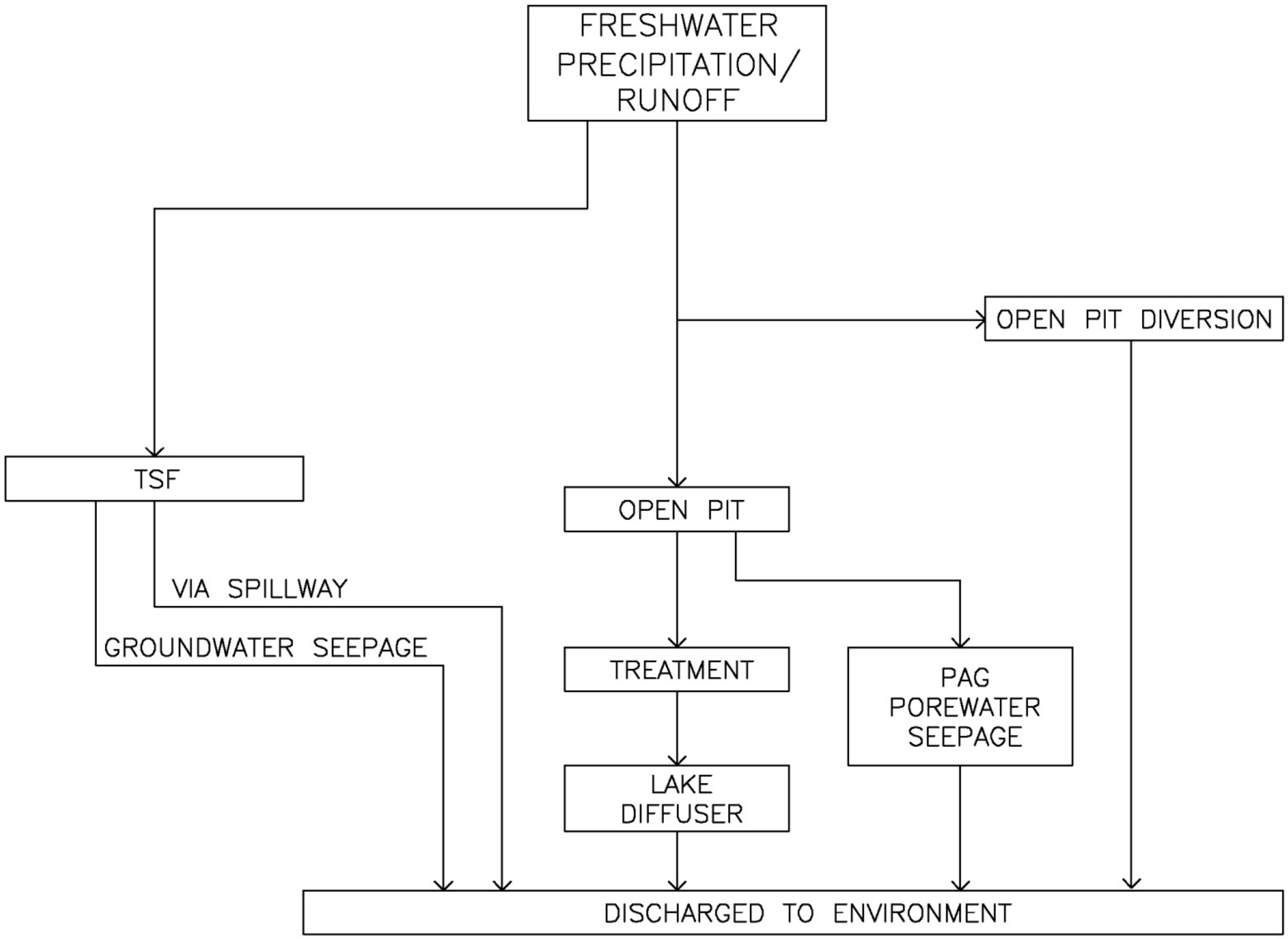


Figure 7.6 Water Management Schematic – Closure Phase

7.3 Key Water Balance Variables and Water Balance Results

7.3.1 Climate Change and Wet/Dry Years and Diversions

The tailings facility is managed on an average annual basis with seasonal storage of water. Accordingly, the sensitivity to wet and dry years is assessed based on the annual precipitation for wet and dry years and the results are shown in Table 7.1.

Table 7.1 TSF Water Balance Sensitivity Summary for Climate Conditions

Variable	Time Period	Volume Change (Mm^3)
100 year wet (Year 10)	Year	1.8
10 year wet (Year 10)	Year	1.2
10 year dry (Year 10)	Year	(0.96)
100 year dry (Year 10)	Year	(1.7)

For the 20 year mine life, the Expected Case water balance for climatic conditions will average wet and dry years. The Upper Bound case will include storage for a 10 year wet year return period, i.e. 1.2 Mm^3.

Surface water diversions are constructed in the mine area and around the TSF at various stages of operations. The expected case efficiency of the diversion ditches is 90% and the Upper Bound case assumes 80% efficiency.

7.3.2 Tailings Density Variability

The density of the tailings deposited in the impoundment influences the water balance – e.g. lower density tailings store more water. The Geotechnical Feasibility Study (KCB, 2009) assumed an in-situ density of 1.4 t/m^3. Subsequent review of the density, however, indicates that the density should be lower. The TSF has a significant portion of the year when cycloning is taking place; consequently the majority of tailings placed over the year will consist of cyclone fines and cleaner tailings (which are finer than rougher tailings).

Consequently, the expected density of the tailings is estimated to be 1.3 t/m^3 for the Expected Case and 1.35 t/m^3 for the Upper Bound case.

7.3.3 Fresh Water Makeup Requirements

Fresh water will be sourced from Morrison Lake. While there is some flexibility in using process water for mill cooling, it is desirable to have fresh water for gland water (for pumps), potable water and reagent mixing and this is treated as the Expected Case water balance.

7.3.4 Pit Dewatering

The Expected Case assumes that pit dewatering is occurring with horizontal drains and that separation of pit dewatering water from pit runoff will be difficult. For the Upper Bound case, the pit dewatering water is expected to come from dewatering wells which can pump directly to the fresh water tank for use as gland water, mill water and reagent mixing and only potable water will be sourced from Morrison Lake.

7.3.5 TSF Seepage and Open Pit Inflows Variability

The TSF seepage rates will vary over the life of the mine and these are described in Section 6.2.5 of this report. Similarly, the open pit inflows will vary over the life of mine and these are described in Section 6.3.3.1 of this report.

7.3.6 Summary of TSF Seepage Variables

The variables assessed for the TSF for the Expected Case and the Upper Bound cases are summarized in Table 7.2.

Table 7.2 Summary of TSF Water Balance Variables

Variable	Unit	Water Balance Conditions	
		Expected Case	Upper Bound
Climate – 10 year wet year	Mm^3	0	+1.2
Diversion efficiency	%	90	80
Tailings density	t/m^3	1.3	1.35
Fresh water makeup	m^3/hr	87	3
TSF seepage*	m^3/hr	5-100	5-50
Pit dewatering*	m^3/hr	5-150	5-250

*Flows vary over time as these facilities are developed

7.4 Water Balance Results

The TSF receives both Cleaner and Rougher tailings up until year 18, at which time the Cleaner tailings will be placed into the open pit. At this time the pit dewatering will stop and all pit groundwater inflows and runoff from the mine waste dumps and plant site areas will directed into the open pit. During placement of Cleaner tailings into the open pit it will be necessary to recycle water from the open pit back to the process plant. The estimated recycle rates are: 150 m^3/hr for the Expected Case; and 250 m^3/hr for the Upper Bound case.

The life of mine, monthly water balance results are included in Appendix III. The maximum water volume and the end of mine water volumes for the Expected and Upper Bound cases, summarized in Table 7.3.

Table 7.3 Water Balance Results for TSF Pond Water Volume

Year	Volume of TSF Pond Water (Mm^3)		
	Expected Case	Upper Bound	Upper Bound – Managed*
Maximum	10	19.3	10
End of Mine Life	0.3	4.5	0.3
Initial closure	0.01	0.01	0.01

*A surplus water management plan will be initiated midway through the mine life to reduce the volume of water.

The Expected Case uses a fresh water makeup rate of 45 m^3/hr to 87 m^3/hr over the life of mine to make-up any possible water shortage.

The Upper Bound case assumes storage for a 10 year wet year in Year 10.

The Upper Bound Managed case assumes management as described in Section 7.5.

Figure 7.7 shows a summary of the water balance inputs and outputs for Year 10 for the Expected Case, Upper Bound Case, and Upper Bound Managed Case. It can be seen that the in all cases the majority of the water input is from tailings transport water, with runoff from the TSF area and pit area comprising most of the remaining input. For the Upper Bound Case, runoff is increased because an allowance was made for greater diversion ditch leakage and the 10-year wet year (increased precipitation) was applied to the water balance in Year 10. Pit dewatering accounts for 3% - 4% of the water input. “Other” water inputs include seepage reclaim, freshwater drawn from Morrison Lake, and the water content of the mined ore before processing.

The majority of water “losses” comprise water recycled to the mill and water lost to the tailings voids. Evaporation accounts for 6% of the water loss, and seepage to the environment only 1% - 2%. “Other” water losses include potable water, dust suppression, and concentrate loadout (the water remaining in the ore concentrate). For Year 10, the Upper Bound and Upper Bound Managed cases are the same. In later years of mine life, excess water in the Upper Bound Condition may be treated and released to the environment as part of the Management strategy.

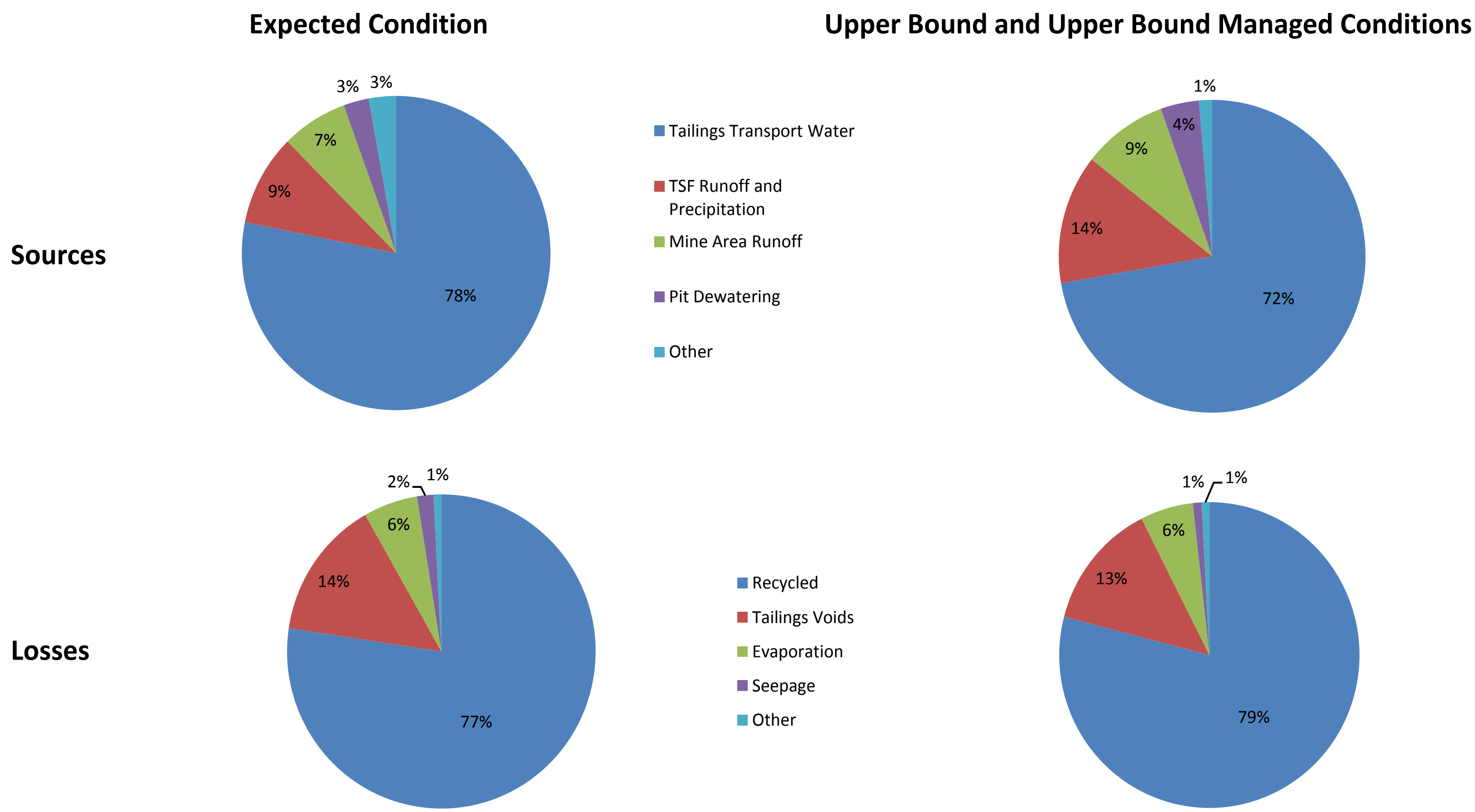


Figure 7.7 Summary of Water Balance Inputs and Losses for Year 10

7.5 Closure Water Balance

7.5.1 TSF

At the end of the mine life, the Expected Case and managed Upper Bound case water balance results in 300,000 m^3 of process water in the TSF pond. On initial closure the majority of this water will be pumped into the open pit, resulting in approximately 10,000 m^3 remaining in the TSF.

The TSF area will then be allowed to infill with surface runoff water and precipitation until a water pond of approximately 1.7 km^2 in area, with an average depth of 2.5 m would be developed. At this time the closure spillway release channel would be operational and would direct surplus water flow to Stream 7, provided the water quality was suitable for discharge.

A water balance for the closure condition is shown in Table 7.4, which is based on average precipitation (550 mm/yr), and evaporation (389 mm/yr) and the revised seepage estimates. The general arrangement of the TSF on closure is shown on Figure A-5. The uphill diverted catchment area of 3.82 km^2 will continue to be diverted around the TSF as the TSF is being infilled and, therefore, does not contribute to the pond filling. The remaining TSF area of 5.1 km^2 will be subdivided into pond area and beach area, with a final pond area of 1.7 km^2 and beach area of 3.4 km^2. During the initial filling, the pond area will be small and, therefore, an average pond area of 1 km^2 has been used for the evaporation losses and a beach area of 4.1 km^2 has been used for runoff. After pond infilling, which is predicted to take approximately 3 years, the diverted catchment will be directed into the TSF.

The final water balance will depend on the actual seepage from the TSF and the annual climate conditions at closure.

Table 7.4 TSF Water Balance on Initial and Full –Closure

INPUTS (GAINS)	INITIAL CLOSURE 0 TO 3 YEARS AFTER MINING			FULL CLOSURE 3 YEARS AFTER MINING		
	Area (km^2)	Runoff Coefficient	Flow (m^3/hr)	Area (km^2)	Runoff Coefficient	Flow (m^3/hr)
Runoff - diverted catchment	3.82	0.5	0	3.82	0.5	120
Precipitation - TSF pond	1	1	63	1.7	1	107
Runoff - TSF beaches	4.1	0.7	180	3.4	0.5	107
TSF beach sub-surface flow	4.1	0.1	26			
TSF Total Inputs			269			333
OUTPUTS (LOSSES)						
Evaporation - TSF pond	1	1	45	1.7	1	76
TSF - Seepage			50			50
TSF Total Losses			95			126
Net used for TSF pond building			174			
Net discharged to stream 7			120			207

7.5.2 Mine Area

The water balance for the open pit during the infilling period considers the following variables:

- Cleaner tailings inflow: delivered at 22.8% solids by weight and settles to 72% solids by weight.
- Water reclaim to process plant: included to allow balancing of the water balance and to minimize the potential requirement to treat water during the infilling period.
- TSF decant: at the completion of mining the TSF water pond will be pumped down from a volume of 300,000 m^3 to 10,000 m^3 and stored in the open pit.
- Groundwater inflows: groundwater inflow rates vary over the inflow period for the Expected and Upper Bound cases.
- Void volume: the available void volume in the PAG rock is based on a void ratio of 0.37.

The water and mass balance for the pit infilling is shown in Table 7.5 and Table 7.6 for the Expected Case and Upper Bound case, respectively.

The water balance for the infilling of the open pit indicates a surplus water balance of 7 m^3/hr to 25 m^3/hr, which will require treatment during the pit infilling stage.

Table 7.5 Water and Mass Balance for Pit Infilling – Expected Case

Year	Cleaner Tailings Solids		Cleaner Tailings Surplus Water[1]	Reclaim to Process Plant m^3/hr	Reclaim to Process Plant m^3	Decant of TSF to Open Pit[1]	Ground Water Inflow	Ground Water Volume	Cumulative Groundwater Volume	Mine Area Avg Runoff	Open Pit Evaporation	Mine Area Runoff	Volume of Waste Rock @ 2t/m^3	Cumulative Rock Tonnage	Total Annual Solids Volume	Cumulative Solids Volume	Total Water Inflow Volume	Cumulative Water Volume	Cumulative Volume of Voids	Water Treatment Rate	Cumulative Treated Volume	Net Pit Suplus Water
	tonnes	volume @1.3 t/m3	assume settle from 22.8% solids to 72% solids																			
-2.5	817,752	629,040	2,450,865	150	1,314,000		150	1,314,000	1,314,000	200	0	1,752,000	20,000,000	20,000,000	10,629,040	10,629,040	4,202,865	4,202,865	2,690,909	0	0	
-1.5	963,600	741,231	2,887,982	150	1,314,000		110	963,600	2,277,600	200	0	1,752,000	20,000,000	40,000,000	10,741,231	21,370,271	4,289,582	8,492,447	5,381,818	0	0	
-0.5	558,448	429,575	1,673,711	150	648,000		80	700,800	2,978,400	200	5	1,708,200	20,000,000	60,000,000	10,429,575	31,799,846	3,434,711	11,927,158	8,072,727	0	0	
0.5						290,000	65	569,400	3,547,800	200	10	1,664,400	20,000,000	80,000,000	10,000,000	41,799,846	2,233,800	14,160,958	10,763,636	0	0	
1.5							50	438,000	3,985,800	200	10	1,664,400	20,000,000	100,000,000	10,000,000	51,799,846	2,102,400	16,263,358	13,454,545	7	61,320	
2.5							40	350,400	4,336,200	150	10	1,226,400	20,000,000	120,000,000	10,000,000	61,799,846	1,576,800	17,840,158	16,145,455	7	122,640	
3.5							25	219,000	4,555,200	150	10	1,226,400	20,000,000	140,000,000	10,000,000	71,799,846	1,445,400	19,285,558	18,836,364	7	183,960	
4.5							10	87,600	4,642,800	100	10	788,400	8,000,000	148,000,000	4,000,000	75,799,846	876,000	20,161,558	19,912,727	7	245,280	3,551
Closure							10	87,600		33		289,080					376,680			48	420,480	-43,800

Table 7.6 Water and Mass Balance for Pit Infilling – Upper Bound Case

Year	Cleaner Tailings Solids		Cleaner Tailings Surplus Water[1]	Reclaim to Process Plant m^3/hr	Reclaim to Process Plant m^3	Decant of TSF to Open Pit[1]	Groundwater Inflow Rate	Groundwater Volume	Cumulative Groundwater Volume	Mine Area Avg Runoff	Open Pit Evaporation	Mine Area Runoff	Volume of Waste Rock @ 2t/m^3	Cumulative Rock Tonnage	Total Annual Solids Volume	Cumulative Solids Volume	Total Water Inflow Volume	Cumulative Water Volume	Cumulative Volume of Voids	Water Treatment Rate	Cumulative Treated Volume	Net Pit Surplus Water
	tonnes	volume @1.3 t/m3	assume settle from 22.8% solids to 72% solids																			
-2.5	817,752	629,040	2,450,865	250	2,190,000		250	2,190,000	2,190,000	200	0	1,752,000	20,000,000	20,000,000	10,629,040	10,629,040	4,202,865	4,202,865	2,690,909	0	0	
-1.5	963,600	741,231	2,887,982	250	2,190,000		200	1,752,000	3,942,000	200	0	1,752,000	20,000,000	40,000,000	10,741,231	21,370,271	4,201,982	8,404,847	5,381,818	0	0	
-0.5	558,448	429,575	1,673,711	250	1,080,000		150	1,314,000	5,256,000	200	5	1,708,200	20,000,000	60,000,000	10,429,575	31,799,846	3,615,911	12,020,758	8,072,727	0	0	
0.5						290,000	110	963,600	6,219,600	200	10	1,664,400	20,000,000	80,000,000	10,000,000	41,799,846	2,628,000	14,648,758	10,763,636	29	254,040	
1.5							80	700,800	6,920,400	200	10	1,664,400	20,000,000	100,000,000	10,000,000	51,799,846	2,365,200	17,013,958	13,454,545	29	508,080	
2.5							55	481,800	7,402,200	150	10	1,226,400	20,000,000	120,000,000	10,000,000	61,799,846	1,708,200	18,722,158	16,145,455	29	762,120	
3.5							35	306,600	7,708,800	150	10	1,226,400	20,000,000	140,000,000	10,000,000	71,799,846	1,533,000	20,255,158	18,836,364	29	1,016,160	
4.5							15	131,400	7,840,200	100	10	788,400	8,000,000	148,000,000	4,000,000	75,799,846	919,800	21,174,958	19,912,727	29	1,270,200	-7,969
Closure							10	87,600		33		289,080					376,680			48	420,480	-43,800

An average annual water balance has been carried out and is summarized in Table 7.7 and is based on the respective catchment areas and runoff coefficients shown in the table and the following annual climate basis:

- Precipitation 550 mm
- Evaporation 389 mm
- Wetland evapotranspiration 389 mm

Table 7.7 Water Balance for Pit Area on Full –Closure

Component	Surface Area (km^2)	Runoff Coefficient	Inflow (m^3/hr)	Outflow (m^3/hr)	Net Flow (m^3/hr)
Runoff from pit walls	0.29	0.9	16		
Runoff from un-diverted catchment	0.27	0.7	12		
Precipitation on pit pond area	0.12	1.0	7.5		
Precipitation on wetland area	0.7	1.0	44		
Groundwater inflow (allowance)			10		
Evaporation from pit pond area	0.12			5.3	
Evapotranspiration from wetland area.	0.68			30	
Net			**90**	**35**	**55**

The quantity of water that will require treatment and discharge into Morrison Lake is 55 m^3/hr.

7.6 Adaptive Management Components

7.6.1 Contingency Plan for Surplus Water Balance

The Upper Bound water balance case results in a surplus of TSF pond water, which will require measures to reduce the volume during the operating mine life. The water balance will be tracked over the mine life with annual reconciliation of all flows and calibration of the life of mine water balance to the actual conditions. If a trend of increasing net water balance flows is observed, the management plan will be implemented to mitigate the accumulation of water. The management plan will include components of the following, as required, and as appropriate:

1. Seepage into the open pit may be reduced with a grouting program.
2. Inflows to the open pit may be separately collected and discharged in a land area via surface irrigation system at a rate of 68 m^3/hr in Year 11, increasing to 110 m^3/hr for Year 12 to Year 20.5. This would be feasible if large water volumes are coming from the perimeter pit dewatering wells.
3. Water treatment of TSF water could be initiated earlier in the mine life. For example, if the water treatment plant was constructed in Year 10, it would be able to treat approximately 0.6 Mm^3/yr (at a rate of 70 m^3/hr), thereby reducing the pond volume by 7.7 Mm^3. The remaining 2.25 Mm^3 may be mitigated with the preceding options, or with a higher water treatment rate (110 m^3/hr).

8. GEOCHEMISTRY AND WATER QUALITY PREDICTIONS

8.1 Geochemistry Predictions

8.1.1 General

The open pit mine rocks contain a high percentage of potentially acid generating rocks and prediction of the water quality from the mine rock dumps, pit walls and processed tailings water are required. The Morrison deposit is similar in geology and geochemistry to the nearby Bell Mine and Granisle Mine, where EDCM (empirical drainage chemistry model) has been extensively developed. The models are based on an extensive database of samples at varying pH's and locations. The locations include direct drainage from rock dump seeps, open pit runoff and tailings pond water quality.

The general methodology for the Morrison Mine is to mainly control the pH of solutions, in particular the pH of the tailings process water will be maintained at pH=8 and the pH of the PAG rock porewater (which is placed in the open pit on closure) will be maintained at or above pH=8.

EDCM concentrations for a range of pH from 3 to 7.9, for both the Bell Mine and Granisle Mine and the final Morrison predictions are provided in Table 8.1.

Table 8.1 EDCM Concentrations for a Range of pH

Concentrations (mg/L unless noted)	Bell EDCM	Granisle EDCM	Final Morrison Prediction	Bell EDCM	Granisle EDCM	Final Morrison Prediction	Bell EDCM	Granisle EDCM	Final Morrison Prediction
pH	3.0	3.0	3.0	5.2	5.2	5.2	7.9	7.9	7.9
Acidity as $CaCO_3$	842	3,734	3,700	122	74	270	8.5	6.1	23
Alkalinity as $CaCO_3$	0	0	0	6.6	5.3	10	496	224	100
Sulphate	233	10,549	10,500	2,031	2,592	2,590	1,708	1,292	1,700
Conductivity (uS/cm)	3,058	11,713	12,000	2,768	4,086	4,100	2,450	2,423	2,500
Total Dissolved Solids	NA	13,549	14,000	NA	3,817	3,800	NA	2,036	2,000
Hardness	2,038	5,621	5,621	1,774	1,870	1,900	1,497	1,083	1,500
Bromide	NA	NA	NA	NA	NA	<1.0	NA	NA	<0.05
Fluoride	NA	2.7	2.7	NA	0.93	0.93	NA	0.55	0.55
Chloride	NA	27	27	NA	3.6	14	NA	3.6	5.9
Dissolved									
Aluminum	258	408	410	3.9	6.1	6.1	0.023	0.017	0.39
Antimony	<0.0001	0.0010	0.0010	<0.0001	0.00084	0.0026	<0.0001	0.00084	0.042
Arsenic	0.072	0.059	0.072	0.00082	0.0030	0.0083	0.00082	0.0030	0.018
Barium	0.010	0.0077	0.010	0.012	0.014	0.049	0.014	0.027	0.58
Beryllium	0.030	0.019	0.030	<0.005	0.00065	0.00065	<0.005	0.000076	0.000076
Bismuth	<0.001	0.74	0.74	<0.001	0.39	0.39	<0.001	0.26	0.26
Boron	<0.2	0.0041	0.0042	<0.2	0.035	0.035	<0.2	0.14	0.13
Cadmium	<0.0002	0.028	0.028	<0.0002	0.0014	0.0021	<0.0002	0.0012	0.0016
Calcium	335	376	380	299	249	300	260	203	260
Chromium	0.069	0.18	0.18	<0.001	<0.0005	0.0029	<0.001	<0.0005	<0.0005
Cobalt	1.5	7.0	7.0	0.22	0.025	0.60	0.021	0.0040	0.021
Copper	72	111	110	6.0	3.5	6.5	0.013	0.018	0.060
Iron	65	112	110	0.48	0.31	0.48	0.024	0.032	0.053
Lead	0.0092	0.34	0.34	0.0092	0.0070	0.0092	0.0092	0.00059	0.0092

Table 8.1 EDCM Concentrations for a Range of pH (cont'd)

Concentrations (mg/L unless noted)	Bell EDCM	Granisle EDCM	Final Morrison Prediction	Bell EDCM	Granisle EDCM	Final Morrison Prediction	Bell EDCM	Granisle EDCM	Final Morrison Prediction
pH	3.0	3.0	3.0	5.2	5.2	5.2	7.9	7.9	7.9
Lithium	<0.1	0.12	0.12	<0.1	0.012	0.044	<0.1	0.0060	0.0092
Magnesium	282	1,401	1,400	246	258	260	208	112	210
Manganese	21	27	27	4.9	3.3	4.9	0.81	0.085	1.5
Mercury	<0.0005	<0.00002	<0.00002	<0.0005	<0.00002	<0.00002	<0.0005	<0.00002	<0.00001
Molybdenum	0.064	0.067	0.067	0.064	0.067	0.066	0.064	0.067	0.28
Nickel	2.1	2.5	2.5	0.21	0.055	0.20	0.012	0.011	0.033
Phosphorus	7.9	21	21	0.095	0.24	0.24	0.095	0.24	0.36
Potassium	<75	1.9	1.9	<75	11	35	<75	15	44
Selenium	0.013	0.015	0.015	<0.0005	0.0033	0.018	<0.0005	0.0019	0.019
Silicon	21	19	21	5.1	6.6	6.6	3.2	2.2	3.6
Silver	<0.0001	<0.00002	<0.00002	<0.0001	<0.00002	<0.00002	<0.0001	<0.00002	<0.00002
Sodium	13	14	14	12	14	16	10	14	21
Strontium	2.5	4.2	4.1	2.0	2.7	2.7	1.6	2.2	3.9
Tellurium	<0.001	<0.0002	<0.0002	<0.001	<0.0002	<0.0002	<0.001	<0.0002	<0.0002
Thallium	<0.0001	<0.0002	<0.0002	<0.0001	<0.0002	0.0013	<0.0001	<0.0002	0.00024
Thorium	0.0047	0.020	0.020	<0.0005	<0.0001	<0.0001	<0.0005	<0.0001	<0.0001
Tin	<0.001	<0.0002	<0.0002	<0.001	<0.0002	<0.0002	<0.001	<0.0002	<0.0001
Titanium, maximum	0.048	<0.01	0.047	0.023	<0.01	0.023	0.0096	<0.01	0.016
Tungsten	NA	<0.2	<0.2	NA	<0.2	<0.2	NA	<0.2	<0.2
Uranium	0.0012	0.048	0.048	0.0010	0.0039	0.0039	0.00082	0.0011	0.0052
Vanadium	0.056	<0.004	0.056	<0.01	<0.004	<0.004	<0.01	<0.004	0.00029
Zinc	2.0	7.4	7.4	0.91	0.15	0.91	0.0091	0.018	0.44
Zirconium	0.032	<0.002	0.032	<0.001	<0.002	<0.001	<0.001	<0.002	<0.001

Notes:

1. Source EAC Addendum Appendix AM.

8.1.2 Comparison of Morrison Kinetic Data with Bell and Granisle EDCM

Kinetic data from the humidity cells currently being run for the Morrison project have been compared with the corresponding EDCM data for the same pH and the results are summarized in Table 8.2. The purpose of the review is to identify if there are any anomalous concentrations between Morrison data and Bell/Granisle data, although there is significant uncertainty in comparing a small scale kinetic test with the large scale equilibrium case. Nonetheless, the comparison does not appear to indicate any significant anomalies that would suggest that Morrison water quality would be significantly different that Granisle/Bell water quality.

Table 8.2 Comparison of Morrison Humidity Cell Data with Bell and Granisle EDCM's

Parameter (mg/L unless noted)	Morrison Humidity Cell (Coarse fraction)		Morrison Humidity Cell (Fine fraction)		Granisle EDCM		Bell EDCM	
	Average	Maximum	Average	Maximum				
pH (pH units)	7.8	8.2	7.0	7.9	7.8	7.0	7.8	7.0
Acidity as $CaCO_3$	1.0	1.0	1.1	8.0	6.7	14	9.6	24
Alkalinity as $CaCO_3$	48	71	10	53	195	64	423	117
TDS								
Sulphate	7.7	58	18	34	1325	1629	1719	1810
Fluoride					0.56	0.65	NA	NA
Chloride					3.6	3.6	NA	NA
Ammonia							<2.0	<2.0
Nitrite					<1.5	<1.5	<2.0	<2.0
Nitrate					<0.15	<0.15	<0.6	<0.6
Dissolved								
Aluminum	0.034	0.13	0.0050	0.030	0.021	0.12	0.027	0.13
Antimony	0.0014	0.0041	0.00040	0.0010	0.00084	0.00084	<0.00010	<0.00010
Arsenic	0.0010	0.0033	0.00024	0.00050	0.0030	0.0030	0.00082	0.00082
Barium	0.29	0.40	0.017	0.12	0.026	0.021	0.014	0.013
Beryllium	0.000014	0.000020	0.000013	0.000020	0.000082	0.00016	<0.0050	<0.0050
Bismuth	0.0000071	0.000020	0.0065	0.090	0.26	0.30	<0.0010	<0.0010
Cadmium	0.000013	0.000030	0.000012	0.000030	0.0012	0.0013	<0.00020	<0.00020
Calcium	14	24	4.9	7.4	308	312	261	272
Chromium	0.00023	0.00050	0.00026	0.00090	<0.00050	<0.00050	<0.0010	<0.0010
Cobalt	0.00025	0.0024	0.00019	0.0028	0.0042	0.0073	0.023	0.045
Copper	0.0012	0.0022	0.00056	0.0010	0.021	0.10	0.017	0.12
Iron	0.0050	0.0050	0.016	0.29	0.034	0.068	0.027	0.065
Lead	0.000032	0.00013	0.000027	0.00031	0.00065	0.0014	0.0092	0.0092
Lithium	0.0011	0.0030	0.0010	0.0010	0.0061	0.0076	<0.10	<0.1
Magnesium	4.5	6.6	2.6	3.8	115	148	209	220
Manganese	0.030	0.071	0.015	0.027	0.10	0.37	0.87	1.5

Table 8.2 Comparison of Morrison Humidity Cell Data with Bell and Granisle EDCM's (cont'd)

Parameter (mg/L unless noted)	Morrison Humidity Cell (Coarse fraction)		Morrison Humidity Cell (Fine fraction)		Granisle EDCM		Bell EDCM	
	Average	Maximum	Average	Maximum				
Mercury	0.000050	0.000050	0.000052	0.00010	<0.000020	<0.000020	<0.00050	<0.00050
Molybdenum	0.0035	0.021	0.0027	0.0041	0.066	0.066	0.064	0.064
Nickel	0.0010	0.0056	0.00048	0.0025	0.020	0.033	0.013	0.031
Potassium	4.3	11	1.7	2.7	14	13	<75	<75
Selenium	0.00056	0.0010	0.00050	0.00050	0.0019	0.0023	<0.00050	<0.00050
Silicon	0.64	1.4	0.15	0.63	2.3	3.2	3.2	3.7
Silver	0.000010	0.000030	0.000010	0.000050	<0.000020	<0.000020	<0.00010	<0.00010
Sodium	1.1	15	0.97	2.2	47	70	50	40
Tin	0.00018	0.0011	0.00019	0.0018	<0.00020	<0.00020	3.4	3.8
Titanium	0.000094	0.000040	0.000071	0.00010	<0.010	<0.010	0.0099	0.013
Vanadium	0.00028	0.00051	0.000070	0.00035	<0.0040	<0.0040	<0.010	<0.010
Zinc	0.0031	0.019	0.0023	0.0091	0.020	0.037	0.011	0.070

Notes:

- Humidity cell data includes 80 weeks of testing.

8.1.3 Tailings Porewater Quality

Assessment of Potential Oxyanion Release

A concern was raised regarding the potential release of oxyanions (i.e., As, Sb, Mo, Se) in pore-waters through the reductive dissolution of oxides. TSF oxyanion concentrations are predicted to be EDCM pH 8 concentrations, which are below BCWQGs. This prediction is supported by the alkaline process conditions, low concentrations in the solid-phase and lack of appreciable dissolved concentrations in humidity cell leachate data and 60 day ageing supernatant testing (Table 8.3). Due to the lack of an available oxyanion inventory in solution for initial sorption, the reductive dissolution of oxides is not expected to be a metal(loid) release mechanism.

Table 8.3 Tailings Solid-phase and Humidity Cell Summary Data

	2007 MDAG Phase 1				EAC Application						Granisle EDCM pH 8	BCWQGs
	Solid Phase		Humidity Cell Max		Solid Phase		Humidity Cell Max		Ageing Test			
	F46	F47	F46	F47	F25 Coarse	F26 Fine	F25 Coarse	F26 Fine	F25 Coarse	F26 Fine		
	ppm	ppm	mg/L	mg/	ppm	ppm	mg/L (Dissolved)	mg/L (Dissolved)	mg/L (Total)	mg/L (Total)	mg/L	mg/L
As	8.2	211	0.0046	0.0055	8.0	34	0.0033	0.00050	0.0028	0.0056	0.0030	0.005
Sb	1.1	9.2	0.0056	0.020	0.70	1.4	0.0040	0.00099	0.0053	0.0040	0.00084	0.02
Mo	14	11	0.057	0.022	13	22	0.021	0.0041	0.064	0.096	0.067	1
Se	2.0	3.0	0.015	0.032	1.0	2.0	0.0010	0.00050	0.001	0.002	0.0018	0.003

8.2 TSF Quality

8.2.1 Pond Water and Porewater Quality – Operations

The tailings process water quality will be modified over the life of the mine as it is influenced by the collected drainage from the open pit and waste rock dumps and the oxidation processes that may occur during processing and transporting of the tailings to the TSF. Initially, the process water quality can be expected to be similar to the pilot plant process water quality from the lock-cycle tests. Over the life of mine, and on initial closure, the water quality can be expected to be similar to the EDCM pH=8 water quality.

The tailings porewater will reflect the process water quality over the life of the mine and, therefore, will also vary in quality with time. For modeling purposes the expected case porewater quality is assumed to be the average water quality of the lock cycle tests and the EDCM pH=8 water quality. The upper bound water quality is assumed to be the EDCM pH=8 water quality.

A summary of the TSF predicted water qualities is presented in Table 8.4.

Table 8.4 Summary of TSF Pond Water Quality and Guidelines

Parameter (mg/L unless noted)	Average Tailings Aging Test (65% Coarse and 35% Fine)		Upper Bound Porewater (EDCM) Water Quality[1]	Expected Porewater Quality[2]	BCWQG Freshwater Aquatic (30-Day Average)	CCME Freshwater Aquatic	BC Wildlife (30-Day average)	Canadian Drinking Water	MMER (Maximum Monthly Mean)
pH (pH units)	8.4		7.9	8.2	6.5-9	6.5-9		6.5-8.5	
Acidity	1		23	12					
Alkalinity	91		100	96					
TDS	337		2000	1,169				500	
Sulphate	74		1700	887	100			500	
Fluoride	0.39		0.55	0.47	0.3		1	1.5	
Chloride	34		5.9	20	150		600	250	
Ammonia	0.096		NA	0.096	~1.5 (Assumes 0-10°C Temperature)	0.715-2.33			
Nitrite	0.030		NA	0.030	0.2	13	44.3	199	
Nitrate	0.33		NA	0.33	13	0.20	443	10.5	
	Total	**Dissolved**	**Dissolved**	**Dissolved**					
Aluminum	0.74	0.041	0.39	0.22	0.05	0.1	5	0.1	
Antimony	0.0038	0.0040	0.042	0.023	0.2			0.006	
Arsenic	0.0033	0.0021	0.018	0.015	0.005	0.005	0.025	0.01	0.50
Barium	0.19	0.12	0.58	0.35	1			1	
Beryllium	0.000027	0.000020	0.000076	0.000048	0.0053				
Bismuth	0.000023	0.000023	0.26	0.13					
Cadmium	0.00020	0.00016	0.0016	0.00088	0.00019	0.00019		0.005	
Calcium	39	36	260	148	4-8 (Moderately Sensitive Environment)				
Chromium	0.0030	0.00044	<0.0005	0.00035	0.001	0.001		0.05	
Cobalt	0.00063	0.00027	0.021	0.011	0.004				
Copper	0.018	0.0039	0.060	0.032	0.03	0.004	0.30	1	0.30
Iron	1.4	0.020	0.053	0.037	1	0.3		0.3	
Lead	0.00099	0.00021	0.0092	0.0047		0.007		0.01	0.20
Lithium	0.0010	0.0010	0.042	0.022	0.096				
Magnesium	11	10	210	110					

Table 8.4 Summary of TSF Pond Water Quality and Guidelines (cont'd)

Parameter (mg/L unless noted)	Average Tailings Aging Test (65% Coarse and 35% Fine)		Upper Bound Porewater (EDCM) Water Quality[1]	Expected Porewater Quality[2]	BCWQG Freshwater Aquatic (30-Day Average)	CCME Freshwater Aquatic	BC Wildlife (30-Day average)	Canadian Drinking Water	MMER (Maximum Monthly Mean)
Manganese	0.035	0.022	1.5	0.76	3.9			0.05	
Mercury	0.000050	0.000050	<0.00001	0.000028	0.00002	0.000026		0.001	
Molybdenum	0.064	0.059	0.28	0.17	1	0.073	0.05		
Nickel	0.014	0.0037	0.033	0.018	0.15	0.15			0.50
Potassium	15	15	44	30	196				
Selenium	0.00079	0.00058	0.019	0.0098	0.002	0.001	0.004	0.01	
Silicon	3.7	2.1	3.6	2.9					
Silver	0.000064	0.000035	<0.00002	0.000023	0.0015	0.0001			
Sodium	32	30	21	26				200	
Tin	0.0029	0.0024	<0.0001	0.0012					
Titanium	0.052	0.0011	0.016	0.0086	2				
Vanadium	0.0033	0.00051	0.00029	0.00040	0.006				
Zinc	0.0073	0.0029	0.44	0.22	0.50	0.03		5	0.50

Notes:

1. Source: Morrison EAC Addendum Appendix AM Table 5-3
2. Shaded value: expected porewater quality exceeds guideline.

Measured values less than the method detection limit were set at ½ the method detection limit for calculations purposes.

Water quality data from the operating Bell Mine tailings impoundment is also available for 1978 to 1986 and the results are summarized in Table 8.5. Water quality data for Granisle Mine tailings impoundment was only available for post operations (1986 to 1991) and the results are summarized in Table 8.5. The data set available for both operations only included the parameters shown. The data comparison demonstrates that the predicted TSF water quality at the end of mining operations is consistent with Bell and Granisle.

Table 8.5 Tailings Water Quality – Analogue Data from Bell and Granisle

Parameter	Granisle Mine (post-closure) (1986 – 1991)	Bell Mine (operating) 1978 to 1986 – (Tailings Pond Supernatant TPS1)
pH	7.8	8.4
Hardness – mg/L	1000	830
Sulphate – mg/L	1285	1420
Copper – dissolved – mg/L	0.0096	0.067
Iron – dissolved – mg/L	0.01	0.103
Zinc – dissolved - mg/L	0.0094	0.08

NB: The available water quality data is limited to pH, sulphate, copper, iron and zinc.

8.2.2 Pond Water Quality - Closure

Water Quality Inputs

The TSF pond water quality near the end of mining is predicted to be similar to Final Morrison predictions at pH 8. Baseline surface water quality upstream of the TSF is of good quality. There does not appear to be any significant neutral metal leaching concerns with respect to water quality (Table 8.6).

After closure, runoff from the tailings beaches may provide some load to the water pond. Tailings beach weathering reactivity is expected to contribute loadings as infiltrating contact water reports to the TSF pond. This beach loading is expected to decrease with time as the TSF pond increases in size and the exposed beach is progressively submerged. The closure water balance indicates that after 3 years, 89% of the 5.1 km^2 TSF catchment area will be submerged at a nominal 1 m deep pond.

Tailings beach infiltration, using a mass-balance-based approach, was done to determine whether the Morrison coarse tailings fraction could produce different water quality from the EDCM predictions at pH 8. The tailings beach infiltration was derived using the average and 95th percentile loading rates for coarse tailings humidity cell testing over 80 weeks as per the method below.

$$WQ_{ICT} = (L_{CT} * BD_{CT} * V_{AT} * F_1) / I$$

where: WQ_{ICT} = water quality of infiltrating tailings contact water with units mg/L;

L_{CT} = Coarse tailings loading with units mg/(kg * wk);

BD_{CT} = Coarse tailings bulk density assumed to be 1.4 t/m^3;

V_{AT} = Volume of tailings contributing to loadings assumed to be 0.5 m depth;

F_1 = Factor of 0.1 represents the fraction within the volume of tailings contributing to loadings; and

I = Infiltration reporting to pond according to closure water balance beach run-off of 206 m^3/hr and n infiltration coefficient of 1/8th *i.e., 25.8 m^3/hr).

Table 8.6 shows the resultant mass balance-based infiltrating contact water quality. Note that estimates for alkalinity and calcium are much too high and is reflective of the excess dissolution of carbonate NP during humidity cell testing. Otherwise, calculations for infiltrating contact water quality are similar to the Morrison Final predictions at pH 8. Therefore, the EDCM final Morrison pH 8 predictions are used for estimating infiltrating contact water quality reporting to the pond.

Table 8.6 TSF Closure Water Quality Inputs

Parameter (mg/L unless noted)	Final Morrison Prediction Water Quality for Initial TSF Pond	Tailings Infiltration Average Bound Water Quality Reporting to TSF Pond	Tailings Infiltration Upper Water Quality Reporting to TSF Pond	Baseline Surface Runoff Water Quality
pH (pH units)	7.9			7.9
Acidity (as $CaCO_3$)	23	58	58	2.2
Alkalinity (as $CaCO_3$)	100	2782	3368	72
TDS	2000			86
Sulphate	1700	443	697	8.8
Fluoride	0.55			0.064
Chloride	5.9			<0.25
Ammonia	NA			0.0044
Nitrite	NA			0.00057
Nitrate	NA			0.15
Dissolved				
Aluminum	0.39	2.0	2.8	0.036
Antimony	0.042	0.08	0.22	<0.000050
Arsenic	0.036	0.058	0.138	0.00026
Barium	0.58	17	20	0.025
Beryllium	0.000076	0.00080	0.0012	<0.00025
Bismuth	0.26	0.00041	0.00058	<0.00025
Cadmium	0.0016	0.0008	0.0017	<0.000010
Calcium	260	836	1,205	21
Chromium	<0.0005	0.0135	0.0145	<0.00025
Cobalt	0.021	0.014	0.030	<0.000050
Copper	0.060	0.070	0.091	0.00088
Iron	0.053	0.29	0.29	0.051
Lead	0.0092	0.0019	0.0064	0.000039
Lithium	0.042	0.063	0.058	<0.0025
Magnesium	210	260	344	4.0
Manganese	1.5	1.7	3.4	0.00060
Mercury	<0.00001	0	0	0.0000055
Molybdenum	0.28	0.20	0.65	0.000053
Nickel	0.033	0.06	0.24	0.00026
Potassium	44	252	542	0.29
Selenium	0.019	0.032	0.058	0.00030
Silicon	3.6	37	76	2.7
Silver	<0.00002	0.00059	0.00116	0.0000067
Sodium	21	63	235	5.2
Tin	<0.0001	0.010	0.053	0.000061
Titanium	0.016	0.0055	0.0116	<0.0050
Vanadium	0.00029	0.016	0.028	<0.00050
Zinc	0.44	0.18	0.52	0.00061

Post Closure Water Quality Predictions

The water quality of the reclaimed TSF water pond has been estimated on the assumption that a residual pond of approximately 10,000 m^3 remains after transfer of process water to the open pit. A simple dilution model, using runoff and precipitation has been carried out assuming that the final TSF pond will progressively infill to a final volume of approximately 4 Mm^3. The contribution of the tailings beaches has been based on the estimate that 1/8th of the runoff infiltration (e.g. 12.5% of 206 m^3/hr over 5.09 km^2 beach area at year 1), which is 26 m^3/hr, will move towards the pond.

The predicted water quality after mine closure is shown in Table 8.7 and the only parameter of potential concern at Year 3 is cadmium, which is above BCWQGs and is hardness dependent. This discharge concentration would be lower than the site specific water quality objective to be developed for Stream 7 and could, therefore, be discharged.

If the water quality is not suitable for discharge at the end of Year 3, the following mitigation measures would be adopted:

- Surplus water would be treated with a water treatment plant prior to release; and/or
- Interim diversion channels would be constructed over the covered tailings beach to achieve a neutral water balance.

Table 8.7 TSF Closure Pond Water Quality at TSF Pond Filling

Parameter (mg/L unless indicated)[1]	Year 0	Year 1	Year 2	Year 3[2]
Pond Volume (m3)	10,000	1,534,240	3,058,480	4,582,720
pH	7.9	6.12	6.11	6.07
Acidity (as CaCO3)	23	2.9	2.3	1.7
Alkalinity (as CaCO3)	100	11	8.4	5.9
Sulphate	1,700	185	136	92
TDS	2,000	217	160	108
Fluoride	0.55	0.069	0.053	0.039
Chloride	5.9	0.86	0.70	0.55
Dissolved				
Aluminum	0.39	0.043	0.032	0.021
Antimony	0.042	0.0046	0.0034	0.0023
Arsenic	0.036	0.0039	0.0029	0.0020
Barium	0.58	0.063	0.046	0.031
Beryllium	0.000076	0.00023	0.00024	0.00024
Bismuth	0.26	0.028	0.021	0.014
Boron	0.13	0.019	0.015	0.012
Cadmium	0.0016	0.00018	0.00014	0.00010
Calcium	260	29	22	15
Chromium	0.00025	0.00025	0.00025	0.00025
Cobalt	0.021	0.0023	0.0017	0.0012
Copper	0.060	0.0070	0.0052	0.0037
Iron	0.053	0.019	0.018	0.017
Lead	0.0092	0.0010	0.00076	0.00052
Lithium	0.0092	0.0032	0.0030	0.0029
Magnesium	210	23	17	12
Manganese	1.5	0.16	0.12	0.08
Mercury	0.0000050	0.0000050	0.0000050	0.0000050
Molybdenum	0.28	0.030	0.022	0.015
Nickel	0.033	0.0040	0.0031	0.0023
Potassium	44	4.8	3.5	2.4
Selenium	0.019	0.0025	0.0020	0.0015
Silicon	3.6	0.41	0.31	0.22
Silver	0.000010	0.0000055	0.0000054	0.0000053
Sodium	21	3.2	2.6	2.1
Tin	0.000050	0.000050	0.000050	0.000050
Titanium	0.016	0.0062	0.0059	0.0056
Vanadium	0.00029	0.00048	0.00048	0.00049
Zinc	0.44	0.049	0.036	0.025

Notes:

1. Green value: indicates ½ the method detection limit
2. Shaded value: exceeds BCWQG freshwater aquatic guidelines. No water will be discharged from the TSF pond until Year 3.

8.3 Mine Area Water Quality

8.3.1 LGO Stockpile – ML-ARD Effects

The LGO stockpile is currently envisioned to be an active pile that will supply mill feed during periods of open pit push backs and at the end of mining of the open pit. The potential for seepage effects from the LGO stockpile is as addressed in the EAC Addendum.

Although unlikely, there is a possibility that the LGO may not be milled (e.g. copper prices plunge and mine shuts down). There is also a possibility that oxidation of the sulphides may "upset" the process operation and that it may not be economical to process after the ore has been exposed for a long time. Accordingly, PBM commits that, in the event that is not milled, the LGO stockpile material will be placed back into the open pit.

8.3.2 Residual Water Quality of PAG Waste Rock on Closure

A portion of the PAG waste rock will become acidic over the life of the mine and residual precipitates will be present on the rock surfaces and will mix with the pit water during placement in the open pit. Acid base accounting and kinetic testing data indicates approximately 60% of net acid generating samples from the ML/ARD database are predicted to become acidic within 20 years after excavation (EAC Addendum Appendix AM, 2010). Accordingly, if the 60% is applied to the first 10 years of mining and a reduced rate of 30% is applied to the last 10 years of mining, the approximate percentage of PAG rock that has gone acidic would be less than 50%.

Estimates of the quality of water associated with the acidic rocks are assumed to be average ARD drainage predictions at pH 3 (EAC Addendum Appendix AM, 2010) shown in Table 8.8.

Table 8.8 Predicted PAG Porewater Quality

	EAC MDAG Addendum Appendix AM Average ARD
pH	3.0
Acidity	3,700
Alkalinity	0
Sulphate	10,500
F	2.7
Cl	27
Dissolved	
Al	410
Sb	0.0010
As	0.072
Ba	0.010
Be	0.030
B	0.0042
Cd	0.028
Ca	380
Cr	0.18
Co	7.0
Cu	110
Fe	110
Pb	0.34
Li	0.12
Mg	1,400
Mn	27
Hg	0.00010
Mo	0.067
Ni	2.5
P	21
K	1.9
Se	0.015
Si	21
Ag	0.000010
Na	14
Sr	4.1
Te	0.00010
Tl	0.00010
Th	0.020
Sn	0.00010
Ti	0.047
W	0.10
U	0.048
V	0.056
Zn	7.4

8.3.3 Treated Water Quality

Acid rock drainage will be treated via conventional liming methods. The potential average ARD has been predicted as per Table 8.8. Predicted water treatment concentrations were assessed with bench-scale treatment runs on leachate from the only Morrison humidity cell that is currently acidic, MO-00-19 83-83.4 m BFP / ArSe3+Si3 (199999). This leachate was chosen to represent, as best as possible, the expected water matrix at the project. In addition, elemental spikes were added to approximate the Final Morrison prediction concentrations at pH 3 (Table 8.9). Bench scale results indicate that in order to remove Zn from solution; a pH of at least 8 is required. Also note that a retention time of 670 minutes, compared to bench-scale testing of 40 minutes, will be required to decrease sulphate to 2,000 mg/L. Table 8.9 also shows the comparison of the Final Morrison EDCM predictions at pH 8. These predictions incorporate water quality data from Bell mine, where active lime treatment occurred in the TSF pond. For the Morrison project, the bench-scale results are used to estimate water quality of treated water.

Table 8.9 Bench-scale Lime Treatment of Estimated Final Morrison Average ARD pH 3

	Units	Morrison Final Predicted at pH 3	Bench Scale Testing				Morrison Final Prediction at pH 8
			Feed (Spiked)	pH 7.0	pH 8.0	pH 9.3	
Reaction Time (min)				**40**	**40**	**40**	
Aluminum (Al)	mg/L	410	239	0.093	0.41	0.464	0.39
Antimony (Sb)	mg/L	0.001	<0.002	<0.002	<0.002	<0.002	0.042
Arsenic (As)	mg/L	0.072	0.263	<0.0004	<0.0004	<0.0004	0.036
Barium (Ba)	mg/L	0.01	0.055	0.058	0.045	0.031	0.58
Beryllium (Be)	mg/L	0.03	<0.0004	<0.0004	<0.0004	<0.0004	0.000076
Bismuth (Bi)	mg/L		<0.004	<0.004	<0.004	<0.004	0.26
Boron (B)	mg/L	0.0042	0.0042	0.0042	0.0042	0.0042	0.13
Cadmium (Cd)	mg/L	0.028	0.063	0.017	0.00498	0.00032	0.0016

Table 8.9 Bench-scale Lime Treatment of Estimated Final Morrison Average ARD pH 3 (cont'd)

	Units	Morrison Final Predicted at pH 3	Bench Scale Testing				Morrison Final Prediction at pH 8
			Feed (Spiked)	pH 7.0	pH 8.0	pH 9.3	
Reaction Time (min)				**40**	**40**	**40**	
Calcium (Ca)	mg/L	380	7.2	483	463	535	260
Chromium (Cr)	mg/L	0.18	0.036	<0.004	<0.004	<0.004	<0.0005
Cobalt (Co)	mg/L	7	5.34	2.67	1.05	0.007	0.021
Copper (Cu)	mg/L	110	77.4	0.164	0.0321	0.0049	0.060
Iron (Fe)	mg/L	110	107	<0.02	<0.02	<0.02	0.053
Lead (Pb)	mg/L	0.34	1.4	<0.0008	<0.0008	<0.0008	0.0092
Magnesium (Mg)	mg/L	1400	2.8	1880	2030	1660	210
Manganese (Mn)	mg/L	27	18.1	15	12.7	0.243	1.5
Molybdenum (Mo)	mg/L	0.067	0.006	0.008	0.005	<0.004	0.28
Nickel (Ni)	mg/L	2.5	3.85	1.79	0.605	0.018	0.033
Phosphorus (P)	mg/L	21	0.078	<0.04	<0.04	<0.04	0.36
Potassium (K)	mg/L	1.9	0.6	2.2	2.4	2.8	44
Selenium (Se)	mg/L	0.015	0.0023	0.0021	0.0021	0.0019	0.019
Silicon (Si)	mg/L	21	2.61	2.18	0.802	1.12	3.6
Silver (Ag)	mg/L	0.00001	<0.00008	<0.00008	<0.00008	<0.00008	<0.00002
Sodium (Na)	mg/L	14	1.7	3.4	3.6	4	21
Strontium (Sr)	mg/L	4.1	0.015	0.203	0.202	0.226	3.9
Thallium (Tl)	mg/L	0.0001	0.0059	0.0032	0.0031	0.0019	0.00024
Tin (Sn)	mg/L	0.0001	<0.02	<0.02	<0.02	<0.02	<0.0001
Titanium (Ti)	mg/L	0.047	<0.02	<0.02	<0.02	<0.02	0.016
Uranium (U)	mg/L	0.048	0.0014	<0.0004	0.0005	<0.0004	0.0052
Vanadium (V)	mg/L	0.056	<0.02	<0.02	<0.02	<0.02	0.00029
Zinc (Zn)	mg/L	7.4	10.1	0.557	0.064	<0.02	0.44
Zirconium (Zr)	mg/L		<0.002	<0.002	<0.002	<0.002	<0.001
Sulphate	mg/L	10,500	11,760	6,380	6,660	5,700	1,700
Hydrated lime consumption	g/L			3.91	3.94	4.49	

Notes:
1. Co, Mn, Ni and Zn removal improves with pH.
2. Sulphate removal is a function of pH and retention time. At higher pH and 60 minute retention time, sulphate concentration could be approximately 2000 mg/L.
3. Manganese precipitation improves with sludge recycle and at higher pH, typically less than 0.1 mg/L with an HDS type system at pH 9.3.

8.3.4 PAG Porewater Quality during Pit Infilling

As the PAG rock is placed in the open pit it will mix with the residual water from the cleaner tailings and groundwater inflows from the pit walls and surface runoff, which will influence the water quality. A key objective of the pit infilling porewater management is to increase the pH to 7 to improve the water quality (with lime addition) to reduce potential groundwater quality effects on Morrison Lake.

An estimate of the lime requirements on closure has been made based on the following:

Waste rock placement within the pit will have an approximate void ratio of 0.37. The contact water associated with this void volume is assumed to be of average ARD and will be released to the pit lake as a one-time loading where it will mix with existing TSF cleaner tailings water, mine-area runoff, precipitation and groundwater inputs. Below are the source terms used in modelling.

- **Cleaner Tailings Water:** EDCM 7 (worst case between the Bell and Granisle EDCMs);
- **Mine Area Runoff:** EDCM pH 6.1 (worst-case between Bell and Granisle EDCMs); and
- **Groundwater:** Pit Area baseline groundwater data from 2007 to 2010.

The general methodology used for calculating net acidity for each time step is as follows:

$$WQ_i = WQ_{PREV}*V_{PREV} - WQ_{PREV}*V_{TR} - WQ_{PREV}*V_{RC} + WQ_{GW}*V_{GW} + WQ_{RO}*V_{RO} + WQ_{CL}*V_{CL} + WQ_{PAG}*V_{PAG} + WQ_{Non\text{-}PAG}*V_{Non\text{-}PAG} / (V_{PREV} – V_{TR} – V_{RC} + V_{GW} + V_{RO} + V_{CL} + V_{PAG} + V_{Non\text{-}PAG})$$

where: WQ_i = Water quality at time step i;

WQ_{PREV} = Water quality of previous time step;

V_{PREV} = Volume of previous time step;

V_{TR} = Volume for treatment;

V_{RC} = Volume for process plant reclaim;

WQ_{GW} = Baseline average groundwater quality near pit;

V_{GW} = Volume of groundwater input to the pit;

WQ_{RO} = Runoff water quality;

V_{RO} = Volume of runoff;

WQ_{CL} = Cleaner tailings water quality;

V_{CL} = Volume of cleaner tailings water;

WQ_{PAG} = PAG water rock pore water quality;

V_{PAG} = PAG waste rock pore water volume;

$WQ_{Non\text{-}PAG}$ = Non-PAG waste rock pore water quality; and

$V_{Non\text{-}PAG}$ = Volume of Non-PAG pore water volume.

Results of the net acidity mass balance modeling using the above approach was then used to calculate a pH using the Bell and Granisle EDCM to determine the estimated water quality (i.e., the worst case water quality between the Bell and Granisle EDCMs). Table 8.8 shows the mass balance dilution modelling, the net-acidity pH derived water quality and the expected water quality after lime addition as discussed in Section 8.3.3. Note that the water quality estimated by EDCM net-acidity and pH is better than the average ARD pH 3 Final Morrison predictions used in bench-scale lime treatment studies (i.e., sulphate at 10,500 mg/L in Table 8.9 versus sulphate at 4,445 mg/L - 5,133 mg/L in Table 8.10). This indicates that water quality after lime treatment should be improved at a final pH of 8.

Table 8.10 Estimated PAG Porewater Quality

Parameter	Water Quality by Dilution Modeling without Lime Addition (mg/L)			Water Quality by EDCM (Net Acidity and pH Estimation) (mg/L)			PAG Porewater Quality with Lime Addition
YEAR	**-2.5**	**0.5**	**4.5**	**-2.5**	**0.5**	**4.5**	
pH				2.7	2.9	2.8	8.0
Acidity	1,742	1,351	1,571	1,742	1,222	1,472	
Alkalinity	152	146	98	0	0	0	
Sulphate	6,934	5,604	6,237	5,133	4,445	5,133	6,660
F	2.1	1.7	1.9	1.5	1.4	1.5	
Cl	16	14	15	27	27	27	
Al	191	146	170	458	312	378	0.41
Sb	-1.0	-0.039	0.00073	<0.0001	<0.0001	<0.0001	<0.002
As	-1.0	-0.0091	0.033	0.28	0.11	0.18	<0.0004
Ba	0.043	0.041	0.029	0.0087	0.0089	0.0087	0.045
Be	0.017	0.013	0.014	0.051	0.036	0.042	<0.0004
B	0.12	0.11	0.10	<0.2	<0.2	<0.2	0.32
Cd	0.014	0.011	0.013	0.011	0.0093	0.011	0.0050
Ca	536	466	487	330	330	330	463
Cr	0.085	0.064	0.075	0.027	0.018	0.027	<0.004
Co	3.3	2.5	3.0	1.8	1.3	1.8	1.1
Cu	52	40	46	51	44	51	0.032
Fe	52	39	46	191	93	134	<0.02
Pb	0.17	0.13	0.15	0.14	0.11	0.14	<0.0008
Li	0.11	0.090	0.097	<0.1	<0.1	<0.1	
Mg	877	704	788	599	495	589	2,030
Mn	15	12	13	26	23	24	13
Hg	0.00029	0.00026	0.00027	<0.0005	<0.0005	<0.0005	
Mo	0.098	0.086	0.090	0.066	0.066	0.066	0.0050
Ni	1.2	0.95	1.1	2.9	2.3	2.6	0.61
P	10	7.7	8.9	15	9.8	12	<0.04
K	39	35	36	<75	<75	<75	2.4
Se	0.0097	0.0078	0.0087	0.033	0.017	0.024	0.0021
Si	15	13	13	25	22	24	0.80
Ag	0.000017	0.000027	0.000031	<0.0001	<0.0001	<0.0001	<0.00008
Na	64	81	78	606	462	606	3.6
Sr	8.0	7.0	7.3	11	10	11	0.20
Te	0.00054	0.00049	0.00050	<0.001	<0.001	<0.001	
Tl	0.00011	0.000098	0.000095	<0.0002	<0.0002	<0.0002	0.0031
Th	0.0096	0.0073	0.0085	0.019	0.0074	0.012	
Sn	0.00049	0.00035	0.00030	<0.001	<0.001	<0.001	<0.02
Ti	0.037	0.031	0.034	0.052	0.049	0.051	<0.02
W	0.15	0.13	0.13	<0.2	<0.2	<0.2	
U	0.025	0.020	0.022	0.026	0.022	0.026	0.00050
V	0.031	0.025	0.028	0.16	0.079	0.11	<0.02
Zn	3.6	2.9	3.4	4.3	2.6	3.3	0.064

The quality of the pit lake will decrease during the waste rock in-pit placement period (Table 8.10) until all waste rock has been submerged. Active liming during waste rock inundation will be done to raise the pit lake to pH 8. The estimated amount of lime required for pit lake treatment is less than 11,000 tonnes per year over the 7 year in-pit waste rock placement, likely 50% of this due to the better water quality predicted for the pit compared to bench scale testing.

Total Volume of Water Entering Pit (Mm3)	Lime Consumption to pH 8 (t/m3)	Average Lime Consumption per Year (t/yr)	Upper Lime Cost per Year	Expected Lime Cost per Year
20.2	3.94×10^{-3}	11,400	$1,700,000	$850,000

Notes:

1. Lime cost assumed to be $150/t

8.3.5 Pit Wall Runoff Water Quality

The pit area will be managed to minimize the volume of contact water. The potential water quality of the pit wall drainage, as it is mixed with the local precipitation, has been made on the basis of the Final Morrison Prediction and an assumed pH=3 and the corresponding water quality is shown in Table 8.11, which also includes the predicted water treatment concentrations. Note that predicted water treatment concentrations are based on bench-scale treatment runs on leachate from the only Morrison humidity cell that is currently acidic, MO-00-19 83-83.4 m BFP / ArSe3+Si3 (199999). This leachate was chosen to represent, as best as possible, the expected water matrix at the project. In addition, elemental spikes were added to approximate the Final Morrison prediction concentrations at pH 3.

Table 8.11 Potential Pit Wall Discharge Water Quality

	Units	Pit Walls (Assumed to be Final Morrison Prediction at pH 3)	Feed (Spiked)	Bench Scale Treated Concentrations to pH 7.0	Bench Scale Treated Concentrations to pH 8.0	Bench Scale Treated Concentrations to pH 9.3
Reaction Time (min)				40	40	40
Aluminum (Al)	mg/L	410	239	0.093	0.41	0.464
Antimony (Sb)	mg/L	0.001	<0.002	<0.002	<0.002	<0.002
Arsenic (As)	mg/L	0.072	0.263	<0.0004	<0.0004	<0.0004
Barium (Ba)	mg/L	0.01	0.055	0.058	0.045	0.031
Beryllium (Be)	mg/L	0.03	<0.0004	<0.0004	<0.0004	<0.0004
Bismuth (Bi)	mg/L		<0.004	<0.004	<0.004	<0.004
Boron (B)	mg/L	0.0042	0.22	0.353	0.319	0.309
Cadmium (Cd)	mg/L	0.028	0.063	0.017	0.00498	0.00032
Calcium (Ca)	mg/L	380	7.2	483	463	535
Chromium (Cr)	mg/L	0.18	0.036	<0.004	<0.004	<0.004
Cobalt (Co)	mg/L	7	5.34	2.67	1.05	0.007
Copper (Cu)	mg/L	110	77.4	0.164	0.0321	0.0049
Iron (Fe)	mg/L	110	107	<0.02	<0.02	<0.02
Lead (Pb)	mg/L	0.34	1.4	<0.0008	<0.0008	<0.0008
Magnesium (Mg)	mg/L	1400	2.8	1880	2030	1660
Manganese (Mn)	mg/L	27	18.1	15	12.7	0.243
Molybdenum (Mo)	mg/L	0.067	0.006	0.008	0.005	<0.004
Nickel (Ni)	mg/L	2.5	3.85	1.79	0.605	0.018
Phosphorus (P)	mg/L	21	0.078	<0.04	<0.04	<0.04
Potassium (K)	mg/L	1.9	0.6	2.2	2.4	2.8
Selenium (Se)	mg/L	0.015	0.0023	0.0021	0.0021	0.0019
Silicon (Si)	mg/L	21	2.61	2.18	0.802	1.12
Silver (Ag)	mg/L	0.00001	<0.00008	<0.00008	<0.00008	<0.00008
Sodium (Na)	mg/L	14	1.7	3.4	3.6	4
Strontium (Sr)	mg/L	4.1	0.015	0.203	0.202	0.226
Thallium (Tl)	mg/L	0.0001	0.0059	0.0032	0.0031	0.0019
Tin (Sn)	mg/L	0.0001	<0.02	<0.02	<0.02	<0.02
Titanium (Ti)	mg/L	0.047	<0.02	<0.02	<0.02	<0.02
Uranium (U)	mg/L	0.048	0.0014	<0.0004	0.0005	<0.0004
Vanadium (V)	mg/L	0.056	<0.02	<0.02	<0.02	<0.02
Zinc (Zn)	mg/L	7.4	10.1	0.557	0.064	<0.02
Zirconium (Zr)	mg/L		<0.002	<0.002	<0.002	<0.002
Sulphate	mg/L	10500	11760	6380	6660	5700

Notes:

1. Co, Mn, Ni and Zn removal improves with pH.
2. Sulphate removal is a function of pH and retention time. At higher pH and 60 minute retention time, sulphate concentration could be approximately 2000 mg/L.
3. Manganese precipitation improves with sludge recycle and at higher pH, typically less than 0.1 mg/L with an HDS type system at pH 9.3.
4. pH after treatment can be reduced to discharge requirements by either adding CO_2, air infusion or H_2SO_4.

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.

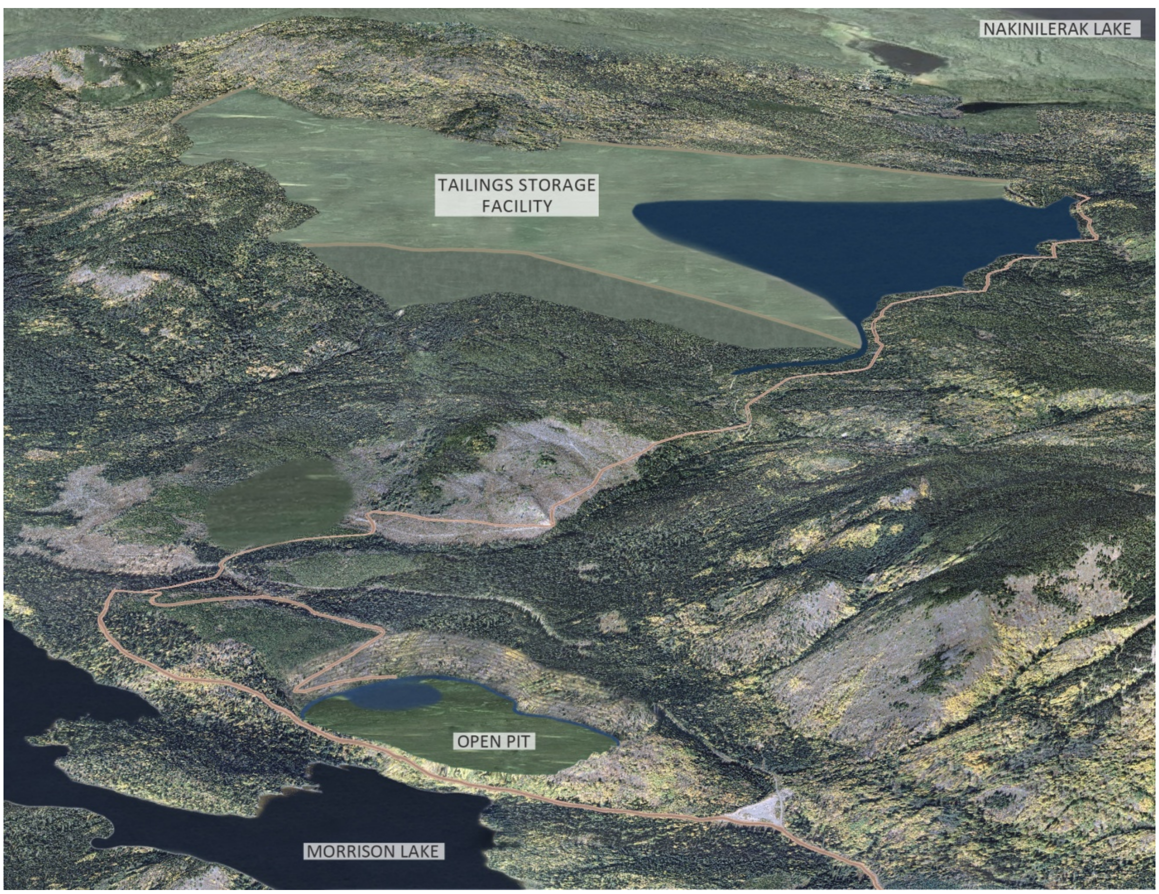


Figure 9.1 Morrison Copper/Gold Project - Post Closure

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

Layout

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.

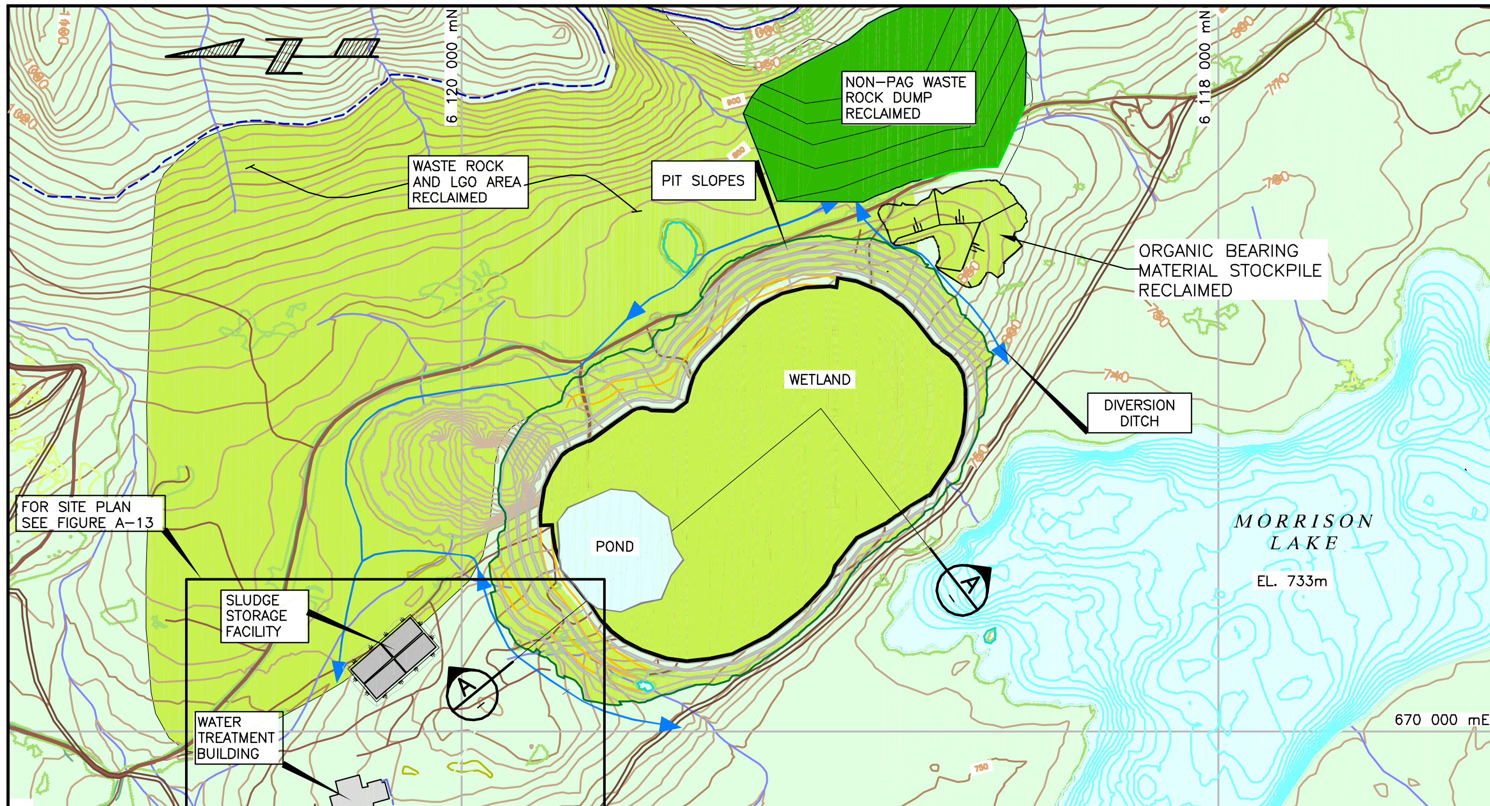
A summary of the revised preliminary cost estimate is provided in Table 9.3.

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**

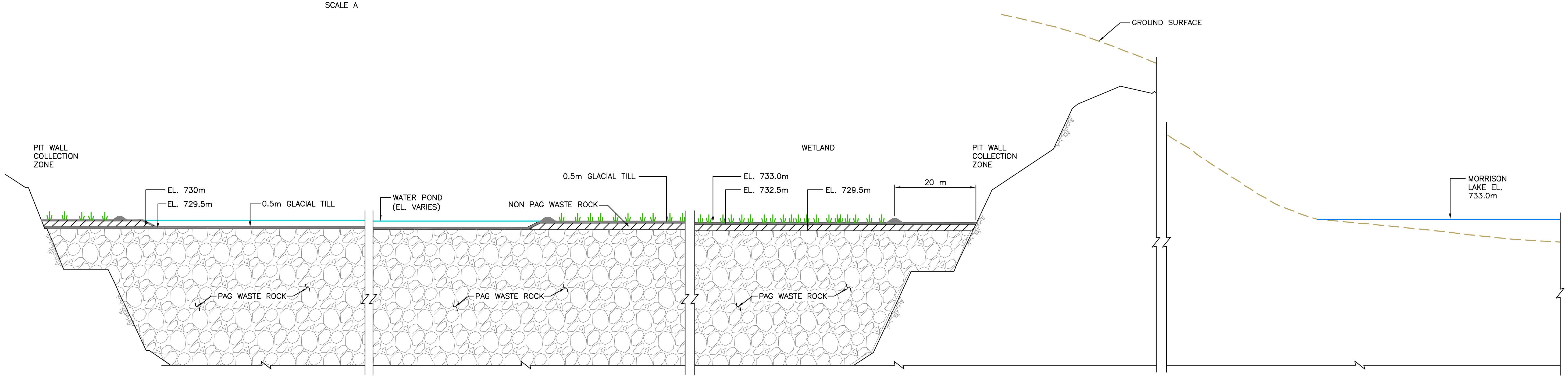
Post-closure monitoring will be required and is estimated to cost $0.62 million per year for the first five years and then decrease with time.

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

CLIENT: pbm

Klohn Crippen Berger

PROJECT: MORRISON COPPER/GOLD PROJECT

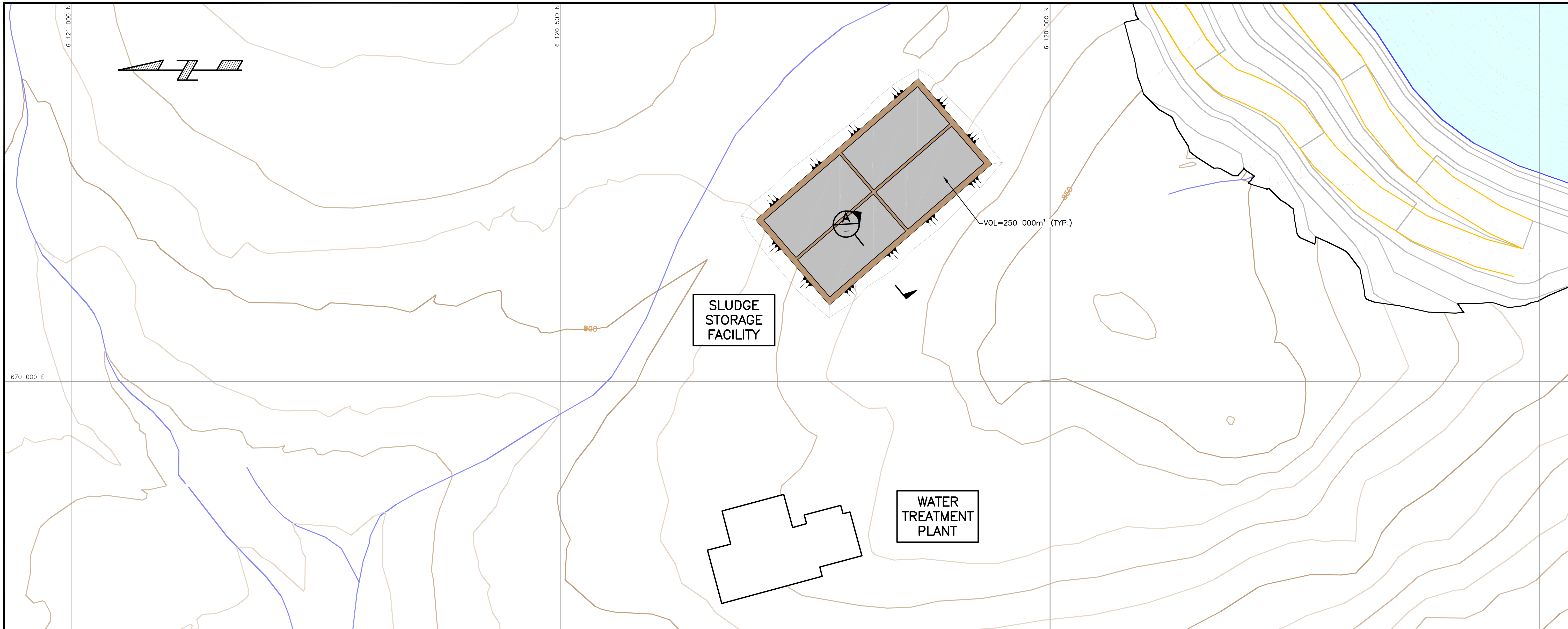
TITLE: CLOSURE PHASE PIT AREA PLAN AND SECTION

PROJECT No. M09382A04

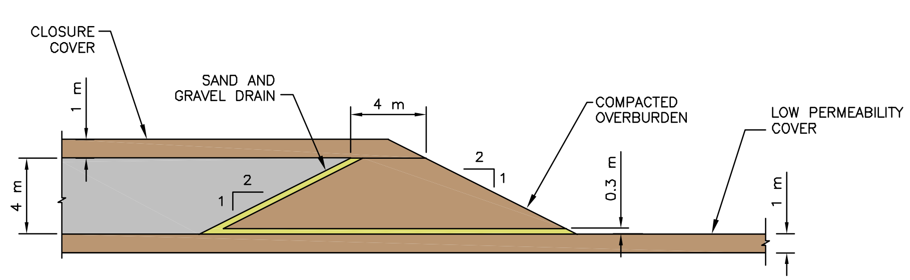
FIG. No. 9.2

KCB–R–MLD

Time: 15:14:36
Date: 5/12/2011
Scale: 1=10(PS)
Drawing File: M:\VCR\M09382A04 – Morrison EAC Support\400 Drawings\MARCH PERMIT REPORT\FIG. 9.2(may92011).dwg (awong)
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.

NOT FOR CONSTRUCTION

TO BE READ WITH KLOHN CRIPPEN BERGER REPORT DATED ________

SCALE: 0 — 200 m

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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Drawing File: M:\VCR\M09382A04 – Morrison EAC Support\400 Drawings\MARCH PERMIT REPORT\FIG. 9.3(may92011).dwg (awong)
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 significant adverse residual environmental effects.

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:

Sulphate

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.

Aluminum

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.

PAG Rock Porewater Effects

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:

<u>TSF Loading</u>

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.

<u>PAG Porewater Loading</u>

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.

<u>Water Treatment Plant</u>

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.

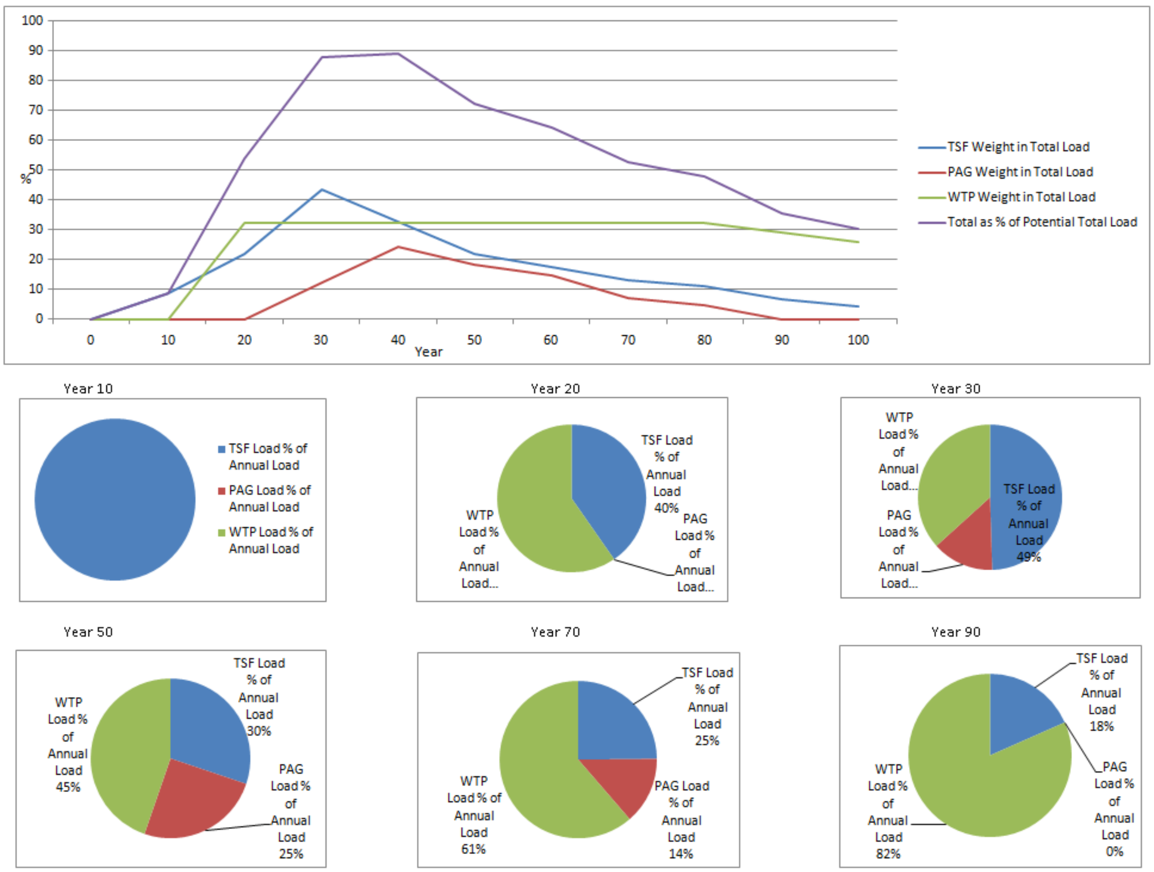

Figure 10.1 Temporal Distribution of Loading Sources to Morrison Lake

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.

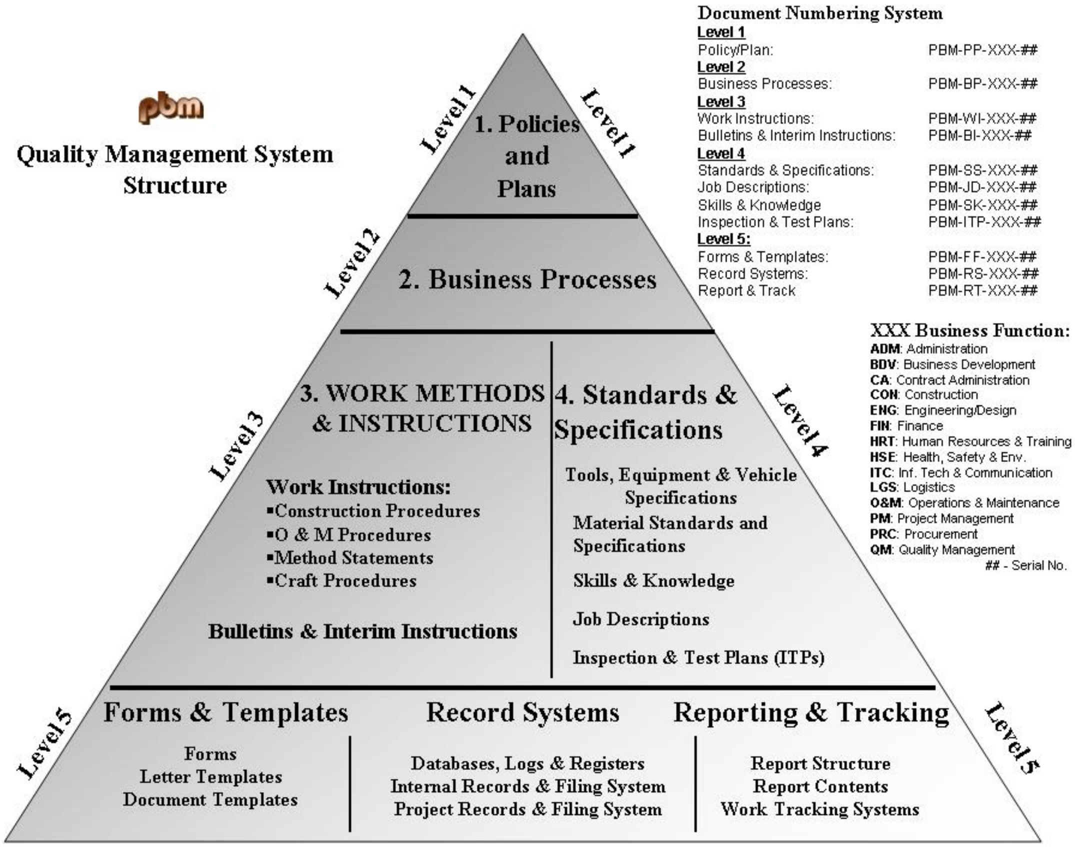

Figure 12.1 Schematic of Environmental Management System

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.

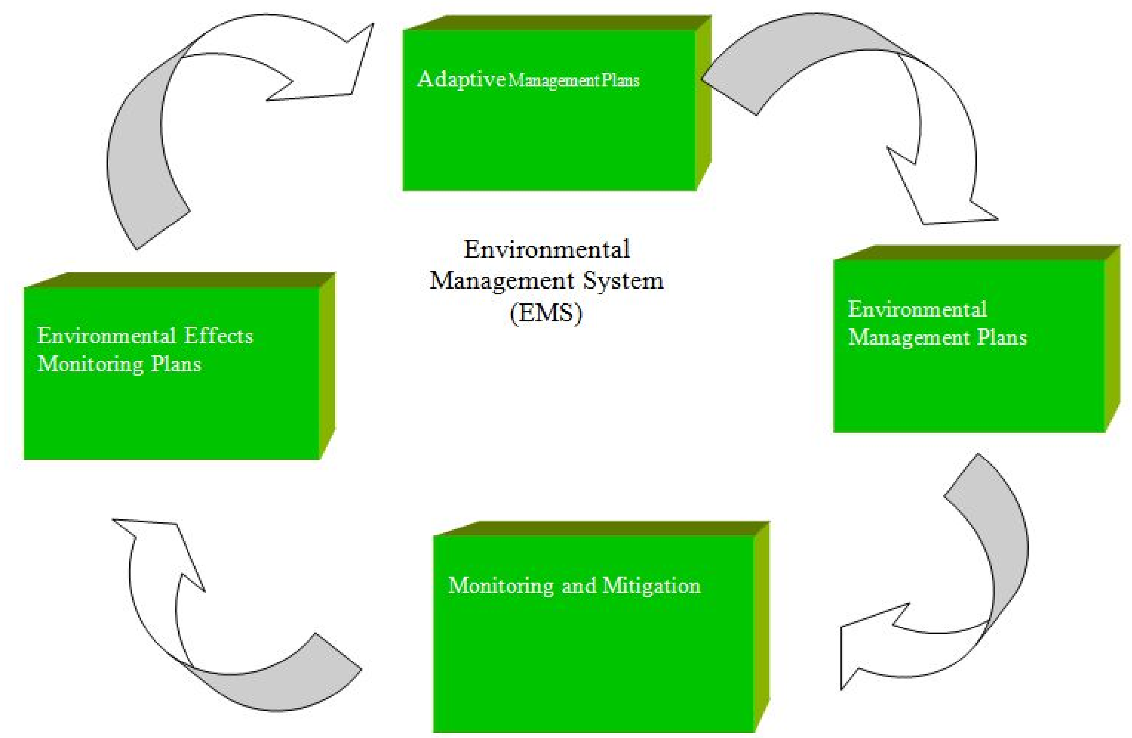

Figure 12.2 Schematic of Environmental Management Framework

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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