Wolverine Project

TAILINGS AND INFRASTRUCTURE DESIGN AND CONSTRUCTION PLAN

VERSION 2009-02

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EXECUTIVE SUMMARY

This *Tailings and Infrastructure Design and Construction Plan* (Version 2009-02) presents the detailed design of the tailings storage facility (TSF) for the Wolverine underground zinc-silver mine located in south eastern Yukon Territory. The Wolverine Project has received *Quartz Mining License QML-0006* (*QML-0006*) and *Type A Water Licence QZ04-065* (*QZ04-065*) and is proceeding with detailed engineering design for all components. The bulk of construction activities are scheduled for spring 2009, and full operation of the tailings facility is scheduled for June 2010 with mill startup. For additional Wolverine Project information, refer to *General Site Plan* (Version 2008-04), which includes updated information on the overall project layout, project development schedule, site and underground mine development overview, and construction details for the permanent camp, and site roads.

This Plan has been prepared to satisfy *QML-0006* Condition 13.3. This report consolidates changes made to the TSF since the *Feasibility Study* and *Optimized Feasibility Study* were issued in 2006 and 2007, respectively, and submission of the *Revised Documentation in Support of A-Licence Application QZ04-065* in January 2007.

Site Conditions

The project is located in gently rolling hills and mountains with elevations up to 1800 m. The TSF area is covered with small shrubs and grasses near elevation 1300 m. The TSF is formed by a 700 m long L-shaped dam, up to 23.5 m high, located in a small drainage northeast of Go Creek. The foundation soils consist of medium dense to dense ablation tills up to 15 m deep that overlie bedrock. Local shallow peat deposits occur within the basin. The area is of moderate seismicity.

The mean annual precipitation and evaporation are 570 mm and 400 mm, respectively. Average snowpack is 175 mm of snow water equivalent. Mean monthly temperatures are below zero from October to April. The hydrogeologic regime consists of a shallow aquifer in the soils

immediately above the bedrock and the estimated groundwater flow beneath the tailings basin is approximately 15 L/s.

A site investigation program was carried out that consisted of 5 drill holes and 20 test pits within the TSF area, and additional drilling, testpits and geopyhysical surveys were completed in the general area. Laboratory testing consisted of index testing, shear strength determination and consolidation tests on the tailings. The dam foundation soils are not susceptible to liquefaction. Dam construction fills, to be borrowed from the interior of the impoundment, consist of competent glacial silty sands and gravels.

Tailings Storage Facility Design

The milling process will produce tailings, which will either be deposited in the underground mine as paste backfill, or deposited in the tailings facility. The tailings have high sulphide content and have the potential to become acid generating if allowed to oxidize. Therefore, tailings will be stored in the saturated containment system described herein.

The design of the facility is based on field and laboratory investigations of the foundation conditions and considerations of geochemical characteristics of the tailings and supernatant water. The design incorporates the availability of local dam borrow materials, storage capacity requirements, site water balance, dam failure consequence rating, and earthquake and flood potential.

The impoundment is designed to safely route the 1:10,000 year return period flood through spillways (Starter Spillway and Ultimate Spillway) located in the west flank of the dam. During operations the TSF will also store the 1:200 year return-period flood event, without the release of water. The design earthquake is a 1:10,000 return period, with a peak ground acceleration of 0.22 g. The minimum geotechnical factors of safety during operations are 1.5 for static stability and 1.1 for pseudo-static stability. Analysis of the impoundment liner leakage rate indicates an actual seepage predicted rate of 10^{-5} L/s. The negligibly low seepage rate provides a safety margin against the potential for long-term degradation of portions of the liner.

The tailings facility includes a L-shaped tailings dam, a tailings pond, a seepage recovery dam and pond, two upland diversion ditches, and spillways (see Drawing D-3001). The impoundment covers an area approximately 600 m long and 300 m wide. The catchment area for the TSF will be reduced with the construction of two main diversion ditches (Ditches A and B). The maximum dam height is 16.5 m and 23.5 m high at project start up and after Year 2 of mining operations, respectively.

The tailings dam is a compacted homogeneous earthfill dam with an impervious geosynthetic liner. The liner will cover the base of the tailings impoundment and the upstream face of the dam up to the Ultimate Dam crest. A seepage collection pond will be constructed downstream of the main dam as a contingency to allow return of contaminated water.

Construction and Operations

Dam construction is scheduled to start in spring 2009, with drainage and surface preparation works having commenced in fall 2008. A QA/QC program will be carried out during construction, and as-built records will be prepared. Construction of the TSF will use best practices for control of erosion and sediment, as outlined in *General Site Plan (2008-04).*

The TSF will be constructed in two stages, a 16.5 m high Starter Dam, which will then be raised to a 23.5 m high Ultimate Dam in 2011. The starter dam will be a homogeneous earthfill dam with a 6 m wide crest and a 2H:1V downstream slope and a 2H:1V upstream slope. The dam raise will be by the downstream method. The impoundment will be lined with a 40 mil linear low-density polyethylene (LLDPE) geomembrane liner placed on a foundation prepared by compaction with a smooth drum roller. Fine material will be placed as required to produce a suitable base.

Tailings will be spigotted from the dam crest and from the upstream edge of the impoundment. A reclaim pond will initially form near the south side of the dam and in approximately Year 5 tailings will be spigotted from the dam at the south end of the impoundment and the reclaim pond will be reformed towards the north end to facilitate closure. In approximately Year 6, the reclaim barge will be moved to the north end.

Water Management and Treatment

Water within the TSF will be reclaimed to the mill. The water balance results in a net annual water surplus of approximately 4.1 m^3/h to 7.6 m^3/h, which will be treated prior to discharge. A pilot water treatment plant will be constructed in the first year of operations to develop the final plant design based on the actual supernatant solutions. Storage capacity is provided in the TSF for the first few years of operations to allow for pilot plant testing with actual process water to design and construct the water treatment plant.

Closure Plan

Reclamation and closure plans for closure of the tailings facility are documented in the approved *Wolverine Project Reclamation and Closure Plan (2008-02).* A revised Reclamation and Closure Plan is required by *QML-0006* to be submitted in December 2009, and updated plans for closure of the tailings facility will be based on as-built drawings. In general, the dam and the closure spillway are designed as "robust" structures which will be resistant to long-term erosion forces. As per *QML-0006* Condition 16.5, a minimum of 1.0 m of coarse grained material, demonstrated to not have ARD/ML potential, will be placed over the stored tailings.

Additional QML-0006 Requirements

An *Operation, Maintenance and Surveillance (OM&S) Manual* will be prepared to document best practices for TSF operations, and will be submitted in 2009 to Yukon Energy, Mines and Resources for review and approval. The preliminary *Emergency Response and Preparedness Plan*, provided in Appendix IV, will be updated and integrated into the *OM&S Manual*.

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1. INTRODUCTION

1.1 General

This report presents the detailed design and construction plan for the tailings facility and related infrastructures for the Yukon Zinc Corporation (YZC) Wolverine Project. The project is an underground zinc-silver, massive sulphide mine located in south-eastern Yukon Territory. Yukon Zinc Corporation was issued *Quartz Mining License QML-0006* by Yukon Energy, Mines and Resources (EMR) in December 2006 and *Type A Water Licence QZ04-065 (A-Licence)* by the Yukon Water Board in October 2007. This report consolidates and updates previous reports or report sections related to the Wolverine Project tailings storage facility (TSF) prepared by Klohn Crippen Berger Ltd. for YZC, including:

- Environmental Assessment Report, (YZC and AXYS 2005).
- Environmental Assessment - Response Document (YZC 2006a).
- Tailings and Infrastructure Design and Construction Plan, Version 2006-01 (KCBL 2006).
- Tailings and Related Infrastructures – Feasibility Design Update Report (KCBL June 2007).
- Revised Documentation in Support of Water Use Application QZ04-065, Sections 35, 37, 38 and 40 (YZC 2007).

This Tailings and Infrastructure Design and Construction Plan has been prepared to satisfy *QML-0006* Condition 13.3, which requires the submission to EMR of a document for review and approval that contains the following information:

a. Final designs and specifications of all structures forming part of the tailings facility including the seepage collection dams, diversion ditches, locations of piezometers and other monitoring instruments;

b. Quality assurance and quality control for construction of all structures forming part of the tailings facility, including dams and liners;

c. An operations and maintenance manual for the tailings facility including details of how tailings, waste rock and dense media separation float material will be deposited within the lined impoundment and an operating manual consistent with

the CDA Dam Safety Guidelines and the Guide to the Management of Tailings Facilities;

d. Descriptions of measures to be in place to respond to any emergencies including descriptions of location and quantities of stockpiled construction materials and equipment always to be available on site;

e. Provisions for managing seepage from the tailings facilities;

f. For high density sludge, carbon column and bio-reactor proposals; and

g. Adaptive management measures to respond and adapt to unexpected changes.

Based on an optimization study conducted in late 2007 and the completion of preliminary detailed engineering design work completed in fall 2008 for the various project components, several minor modifications have been made to the tailings facility including:

- The dense media separation (DMS) circuit has been removed from the plant process, thereby negating the requirement for a DMS stockpile and a DMS haul road to the tailings facility. The removal of the DMS is expected to have a low influence on the geochemistry and geotechnical properties of the tailings;

- The tailings facility water treatment plant and retention pond will be located within the industrial complex area;

- The tailings facility diversions ditches (Ditches A and B) have been re-designed to reduce overall length and minimize disturbance while diverting the same catchment areas around the facility, thereby minimizing water treatment requirements;

- The access road adjacent to the tailings facility has been designed to run along the south and southwest side of the tailings facility. The current site road joining to the access road on the northeast side of the tailings facility will be used for construction of Ditch B and the water reclaim line.;

- The starter and ultimate dam heights have increased from 16.0 m to 16.5 m, and 21 m to 23.5 m, respectively;

- The timing of the process plant start-up has been changed to June 2010, which provides time to capture and store the spring runoff in the TSF for the water required for mill start-up. Consequently, the Go Creek diversion and pipeline is no longer required;

- The dam classification rating presented in the new Canadian Dam Association Dam Safety Guidelines (2007), has a change in terminology and the previously classified "High" category is now equivalent to a "Very High" dam rating; there are no changes to the design criteria;

- The seepage collection ditches have been "downsized" to collection channels at the toe of the dam;

- The tailings pipeline has been realigned along the new access road; and

- The spillways have been relocated to the northwest abutment of the Starter Dam and Ultimate Dam. The new locations result in shorter spillway lengths and lower total hydraulic head drop. These modifications also reduce the potential risk of spillway erosion leading to dam failure because they are located in sections with lower dam heights.

1.2 Tailings Facility Summary

The tailings impoundment site is located in a natural, northwest-southeast trending elongated depression located on the northeast valley slope of Go Creek (See Drawing D-3001). The depression is flanked on the downhill side by a natural ridge that drops in height gently towards the upstream end of the tailings facility. The design of the facility is based on field and laboratory investigations of the foundation conditions and considerations of geochemical characteristics of the tailings and supernatant water. The design incorporates the availability of local dam borrow materials, storage capacity requirements, site water balance, dam failure consequence rating, and earthquake and flood potential.

The tailings dam is a compacted homogeneous earthfill dam with an upstream impervious geosynthetic liner. The liner will cover the base of the tailings impoundment and the upstream face of the dam up to the Ultimate Dam crest. A seepage collection pond will be constructed downstream of the main dam as a contingency to allow return of contaminated water, if required.

The tailings dam will be constructed in two stages: the 16.5 m high Starter Dam will be constructed to elevation 1306.5 m in 2009, in preparation for mill start-up in June 2010; in 2011 the dam will be raised 7 m using the downstream construction method to the final elevation at

1313.5 m. During operations there will be storage for mine tailings plus an operating settling pond and flood storage.

Associated water management facilities include: Ditch A and Ditch B, which will direct clean surface runoff around the impoundment; and a Starter Dam emergency spillway and an Ultimate Dam closure spillway.

During the operation of the Wolverine Mine, approximately 4 Mt of tailings will be generated. Approximately 50% will be stored as paste tailings within the underground stope voids, and the remainder (approximately 2.03 Mt) will be stored in the tailings impoundment. Geochemical testing of the tailings indicates that they have the potential for developing acid rock drainage. The detailed mine design has eliminated the dense media float circuit and, therefore, the resulting tailings may be expected to have a lower sulphide content, on a percentage basis, than the previously tested tailings. The tailings will be stored in a saturated impoundment with a soil and water cover on closure.

1.3 Report Disclaimer

This report is an instrument of service of Klohn Crippen Berger Ltd. The report has been prepared for the exclusive use of Yukon Zinc Corporation for the specific application to the Wolverine Project. The report's contents may not be relied upon by any other party without the express written permission of Klohn Crippen Berger. In this report, Klohn Crippen Berger has endeavoured to comply with generally accepted geotechnical practice common to the local area. Klohn Crippen Berger makes no warranty, express or implied.

The data were obtained by Klohn Crippen Berger Ltd. for a specific purpose and specific project using the standard of care prevailing at the time the work was done. The data are not to be used for any purpose or project other than that for which the data were obtained. The data are provided for information only. Use of the data is at the *third party's* own risk and does not relieve the *third party* of sole responsibility for all liability associated with the *third party's* use of the data.

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2. SITE CONDITIONS

The topography of the general area consists of gently rolling hills and mountains, with an elevation range of 1200 m to 1800 m. The tailings impoundment area is covered with small shrubs and grasslands and is located near elevation 1300 m.

Photo 2.1 presents a photograph of the tailings facility area looking northwest, with the tailings impoundment outlined in yellow and the main dam located at the left end of the yellow outline.

Photo 2.1 Tailings Facility General Area, looking northwest.

Although the area has the potential for permafrost to occur, none of the test pits and drillholes in the vicinity of the dam encountered permafrost. Minor permafrost was noted in one of the test pits at one of the previously proposed dam site locations.

2.1 Geology and Seismicity

The geology characterization and seismicity assessment are included in Appendix I and summarized in the following sections.

2.1.1 Geology

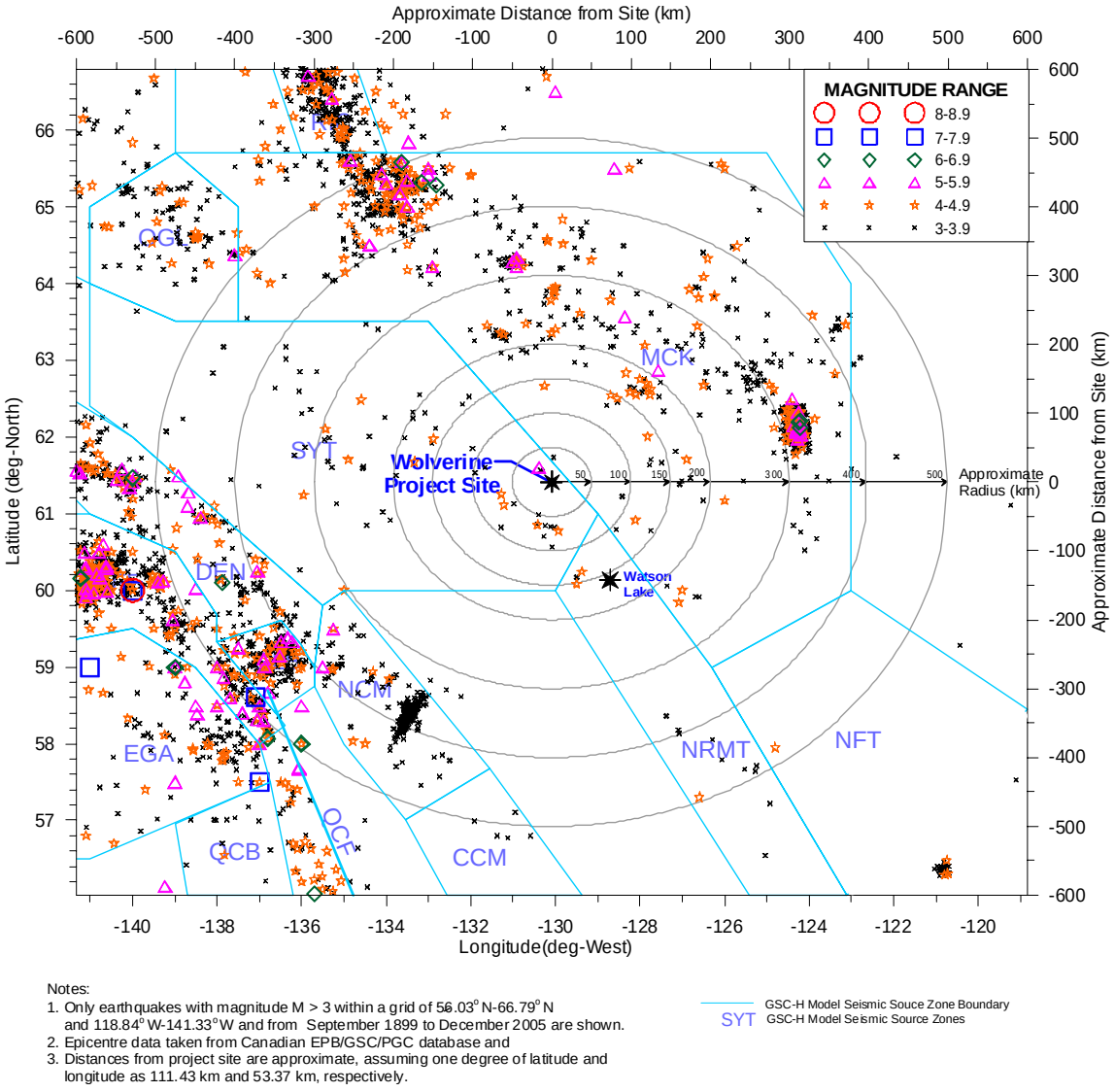
The Wolverine Lake area lies within the limits of the McConnell Glaciation (youngest of the four glaciations in Yukon Territory) and most of the geomorphic features in the area are related to this glaciation. McConnell glacial ice covered this area between 14,000 and 35,000 years ago. As the McConnell ice retreated and down-wasted, a complex network of ice tongues developed in valley bottoms. Morainal deposits are found at lower to mid-elevation and valley floors, and may contain a more complex assemblage of glacio-fluvial, colluvial and fluvial sediments (Mougeot 1996). The main glacial soils in the vicinity of the tailings impoundment consist of up to 20 m of silty sand and gravel, with cobbles overlying bedrock.

The area is underlain by bedrock strata generally paralleling the valley trend, i.e., striking in the direction of the valley. The bedrock consists of an interlayered sequence of volcanoclastic (rhyolite and quartz feldspar) and carbonaceous/argillic sediments, overlain with basalt. The iron formation, which hosts the ore zone, trends northwest-southeast throughout the project area.

2.1.2 Seismicity

The most seismically active region near the Wolverine Project area is along the plate boundaries in the coastal and offshore area. The most significant inland seismicity occurs along segments of the Denali fault zone system, where the seismicity rate is an order of magnitude lower than that in the coastal region. The region between the Denali and Tintina systems is relatively a seismic, with relatively few and small earthquakes.

Data on recent earthquakes that occurred within about 600 km from the project site (61.41°N and 130.09°W) from September 1899 to December 2005 was extracted from the Canadian EPB/GSC/PGC database and are shown on Figure 2-1. No earthquakes with magnitude greater than 5 have occurred within 200 km from the site. However, a magnitude 5 event did occur about 28 km northwest of the project site with a focal depth of 5 km on May 12, 1999.



Notes:
1. Only earthquakes with magnitude M > 3 within a grid of 56.03° N-66.79° N and 118.84° W-141.33° W and from September 1899 to December 2005 are shown.
2. Epicentre data taken from Canadian EPB/GSC/PGC database and
3. Distances from project site are approximate, assuming one degree of latitude and longitude as 111.43 km and 53.37 km, respectively.

GSC-H Model Seismic Souce Zone Boundary
SYT GSC-H Model Seismic Source Zones

Figure 2-1 Location Map of Recent Regional Epicentres

The probabilistic seismic hazard assessment has been determined using both the GSC-H and GSC-R seismic source zonal models developed by the Geological Survey of Canada for the new National Building Code of Canada 2005 (Adams and Halchuk 2003). The model incorporated

the work conducted by Atkinson (2004) for a site-specific seismic hazard analysis for Faro, Yukon (62.2°N and 133.2°W). In that analysis, an apparent linear alignment of seismicity in the region along the Tintina Trench fault system was grouped into a Tintina seismic source zone. This Tintina source zone was incorporated in the model for computing site peak horizontal acceleration as shown in Figure 2-2 and Table 2.1.

Table 2.1 Probabilistic Evaluation of Peak Horizontal Ground Acceleration at Project Site

ANNUAL PROBABILITY OF EXCEEDANCE	RETURN PERIOD (years)	PEAK GROUND ACCELERATION PGA (g)	
		GSC-H 2005 MODEL	GSC-H 2005 MODEL WITH TINTINA SOURCE ZONE
0.0021	475	0.08	0.097
0.001	1,000	0.10	0.12
0.00040	2,475	0.14	0.15
0.0001	10,000	0.20	0.22

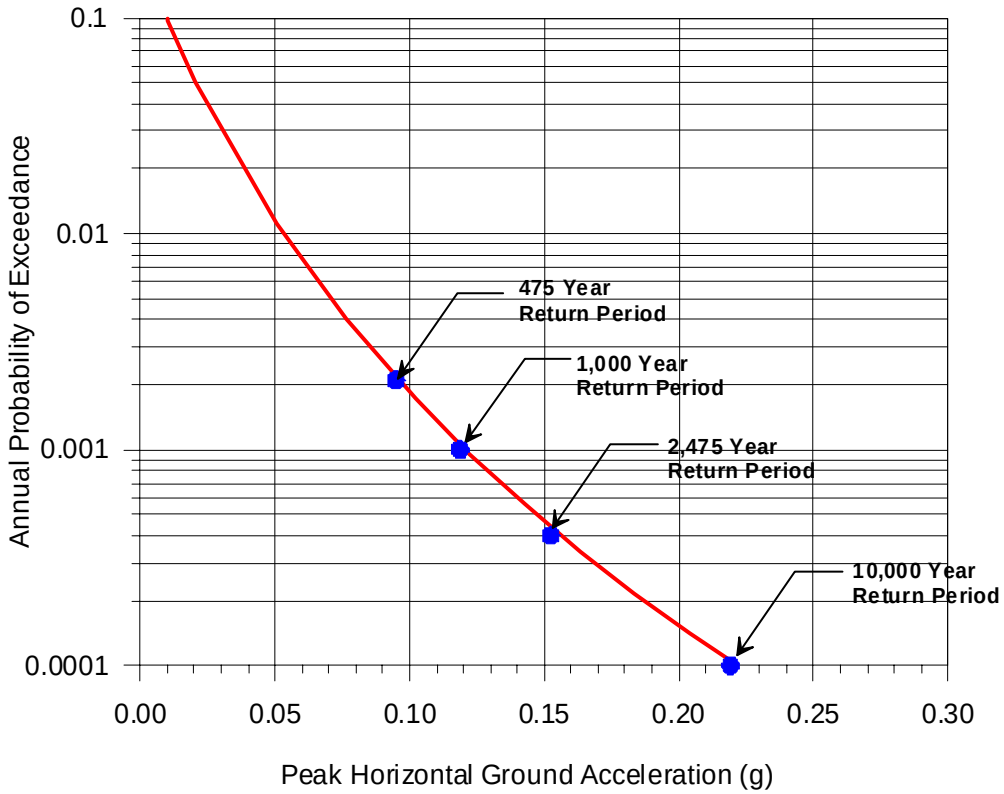


Figure 2-2 Peak Horizontal Ground Acceleration at Various Probability of Annual Exceedance

Two earthquake scenarios were considered for the deterministic evaluation for the site peak horizontal ground acceleration as shown in Table 2.2: a local earthquake at the site with magnitude M=6; and an earthquake at the Tintina Fault with magnitude M=7.2. The deterministic assessment was used to assess the potential for liquefaction of the foundation soils, as discussed in Section 7.2 of this report.

Table 2.2 Deterministic Evaluation of Peak Horizontal Ground Acceleration at Project Site

EARTHQUAKE SCENARIO	MAGNITUDE	EPICENTRAL DISTANCE (km)	FOCAL DEPTH (km)	PEAK GROUND ACCELERATION PGA (g)
Local	6	0	2.9	0.34
Tintina Fault	7.2	53	2.9	0.11

2.2 Hydrology and Groundwater

The estimated mean annual precipitation for the Wolverine Minesite is 570 mm, and the estimated mean annual evaporation rate is 400 mm. Average snowpack for the minesite is estimated to be 175 mm snow-water equivalent.

Table 2.3 presents the ratios of dry and wet year annual precipitations and mean monthly runoff flows, to the average mean annual precipitation and mean monthly flows, respectively (Madrone 2006). Additional hydrology data is provided in Appendix III Part I.

Table 2.3 Ratios of Dry and Wet Year Annual Precipitations and Mean Monthly Runoff Flows

EVENT	RATIO							
	200 yr dry	100 yr dry	10 yr dry	AVERAGE	10 yr wet	100 yr wet	200 yr wet	1,000 yr wet
Annual Precipitation	0.59	0.62	0.76	1	1.16	1.39	1.44	1.56
Mean Monthly Runoff flow	0.61	0.64	0.78	1	1.25	1.52	1.60	1.77

Table 2.4 presents the monthly precipitation distribution and the monthly runoff distribution. A summary of monthly flows for various site locations are shown in Table 2.5.

Table 2.4 Monthly Precipitation and Runoff Distribution

MONTH	% PRECIPITATION	% FLOW
January	7	0
February	6	0
March	5	0
April	4	1
May	7	19
June	11	35
July	14	17
August	11	9
September	10	9
October	9	6
November	8	3
December	8	1

Table 2.5 Expected Mean Monthly and Annual Flows (m^3/s) for Selected Locations

STATION	W31	W16	W12	W44	W14
MONTH	GO CREEK AT AIRSTRIP (4.7 km^2)	GO CREEK AT HAWKOWL CREEK (10.2 km^2)	GO CREEK AT MONEY CREEK (36.5 km^2)	TAILINGS DAM CATCHMENT (1.05 km^2)	MONEY CR. DOWNSTREAM OF GO (238 km^2)
Jan	0.007	0.017	0.065	0.0015	0.479
Feb	0.007	0.016	0.061	0.0015	0.435
Mar	0.007	0.015	0.055	0.0014	0.392
Apr	0.010	0.021	0.079	0.0021	0.537
May	.0.048	0.108	0.410	0.0099	2.938
Jun	0.045	0.111	0.490	0.0079	4.324
Jul	0.034	0.083	0..352	0.0062	2.970
Aug	0.021	0.050	0.212	0.0038	1.772
Sep	0.020	0.047	0.198	0.0036	1.642
Oct	0.018	0.044	0.180	0.0035	1.450
Nov	0.013	0.030	0.119	00025	0.906
Dec	0.009	0.021	0.083	0.0018	0.631
Year	**0.022**	**0.051**	**0.207**	**0.0041**	**1.643**

In the vicinity of tailings impoundment area, the groundwater table is generally sloping southwest following the trend of the topography. Near the downstream end of the impoundment basin at TH05-8 and MW05-7 (refer to Drawing D-3002), the piezometric pressure in the bedrock is slightly artesian (few meters above ground) and the water table rises, with the topography, towards the dam abutments. In general, the groundwater table in the overburden is slightly lower than that in the bedrock except at TH05-9. The groundwater table exhibits seasonal variation, reaching highest elevation after spring runoff season.

Table 2.6 summarizes piezometric elevations monitored during September 7-9, 2005 at test hole locations and monitoring wells installed in the general tailings impoundment area.

Table 2.6 Summary of Piezometric Elevations in Tailings Impoundment Area

MONITORING WELL OR TEST HOLE	GROUND El. (m)	TOP OF RISER PIPE ABOVE GROUND (m)	DEPTH TO WATER FROM TOP OF RISER PIPE (m)	PIEZOMETRIC El. (m)	PRESSURE GAUGE ABOVE GROUND (m)	ARTESIAN PRESSURE (ABOVE PRESSURE Gauge el.)
MW05-6A (Bedrock)	1348	0	6.93	1341.07		
MW05-6B (Overburden)	1348	0.12	7.32	1340.8		
MW05-7A (Bedrock)	1286	0.46	0.17	1286.29	0.53	-
MW05-7B (Overburden)	1286	0.37	0.5	1285.87		
TH05-7A (Bedrock)	1305	0.53	10.26	1295.27		
TH05-8A (Bedrock)	1290	0.18	-	>1290.25	0.25	<1 psi
TH05-8B (Overburden)	1290	0.15	0.46	1289.79	0.22	-
TH05-9A (Bedrock)	1303	0.25	10.71	1292.54		
TH05-9B (Overburden)	1303	0.3	3.82	1299.48		
TH05-10A (Bedrock)	1308	0.25	1.35	1306.9		
TH05-10B (Overburden)	1308	0.25	3.37	1304.88		

Baseline groundwater flow rates for the region have been estimated on the basis of a 10% infiltration rate, over the hydrologic catchment area, and an annual precipitation of 570 mm, and are summarized in Table 2.7.

Table 2.7 Summary of Baseline Groundwater Flow for Selected Locations

LOCATION	CATCHMENT AREA (km^2)	GROUNDWATER FLOW (m^3/s)	PREDICTED WINTER BASEFLOW (m^3/s)
Go Creek, Near Dam	10	0.015	0.01
W – 12 (Go Creek)	36.5	0.060	0.083
W – 14 (Money Creek)	238	0.420	0.54

The main groundwater aquifer is the 10 m to 20 m thick overburden overlying bedrock within the Go Creek Valley. Downstream of Go Creek valley, which appears to be a hanging valley, the morphology changes to a broader terraced valley where much thicker deposits of post glacial outwash soils provide a larger groundwater flow regime.

2.3 Water Quality

Surface and groundwater quality data is included in Appendix III and the main observations are summarized below.

Surface Water Quality in the Tailings Impoundment Area

Baseline surface water quality samples (n=13) were collected from October 2005 to August 2007 from Station W44, which is located on a small stream that drains through the tailings impoundment area. The data indicate that water quality in this small stream is dominated by meteoric waters of low hardness, low alkalinity and circum-neutral pH. The water is low in sulphate, nutrients and metal content is generally low, with slightly higher concentrations observed during peak snow melt periods when TSS levels are elevated. Data is provided in Appendix III Part 3.

Groundwater

Baseline groundwater quality data was collected from 2005 to 2008 at the tailings impoundment area monitoring wells: MW05-2A, MW05-2B, MW05-6A, MW05-6B, and MW05-7B (refer to Drawing D-3002) and data is included in Appendix III Part 3. Two new monitoring wells (MW08-13 and MW08-14), were installed in late October 2008 and water quality data from MW08-13 is provided in Appendix III. Sampling was not conducted at MW08-14 as it was frozen. The results indicate that the groundwater has a neutral to slightly alkaline pH and low conductivity values. The groundwater is generally calcium-bicarbonate ($Ca\text{-}HCO_3$) type water, which is associated with glacio-fluvial sediments and ground moraine.

3. DESIGN CRITERIA

The Wolverine Project tailings dam is designed to national standards, using the Canadian Dam Association – Dam Safety Guidelines (CDA, 2007). The main design criteria are summarized in Table 3.1 and discussed in the following sections.

Table 3.1 Summary of Tailings Dam Design Criteria

ITEM	CRITERIA
Storage Capacity:	
Tailings	2.03 Mt @ 1.6 t/m^3 =1.267 Mm^3
Flood Management during Operation:	
Diversion of upland catchment	1: 100 year peak flow
Flood storage in impoundment	200 year return period (approx. 0.3 m of pond rise) + seasonal storage of water
Flood discharge	Exceeding 1:200 year peak flow, no dam overtopping during 1:10,000 year
Seismic Return Period During Operation and Closure	10,000 year return period (PGA = 0.22g)
Geotechnical Factors of Safety during operations:	
Static	FS = 1.3 (end of construction) and FS = 1.5 (operational)
Pseudo-static, seismic coefficient = 0.125 (a = 0.125 g)	FS = 1.1 (note FS = 1.0 required by CDA 2007)
Environment - Operations	
Tailings pond	Saturated tailings to prevent acid rock drainage
	Effluent treated until water quality meets discharge limits
Allowable seepage flows out of impoundment	Seepage < 0.5 L/s. Contaminated seepage from the TSF, if present, will be collected and pumped to tailings pond
Closure	
Flood Handling	
Diversion Ditches	Diversion ditches to be decommissioned
Spillway	1:10,000 year return period routed peak flow
Geotechnical stability Safety Factor	
Static	FS = 1.5
Pseudo-static, seismic coefficient = 0.125 (a = 0.125 g)	FS = 1.15 (Seed, 1979) (note FS = 1.0 required by CDA 2007)
Geochemical stability	0.5 m minimum water cover to maintain saturation to prevent acid rock drainage.
Suspended sediment stability	1.0 m of soil cover
Allowable Seepage	Seepage <0.5 L/s . Effluent treated until water quality meets discharge limits

3.1 Dam Classification Assessment

The recent Canadian Dam Association Dam Safety Guidelines (CDA 2007) were adopted to confirm the classification of the tailings facility for seismic and flood protection criteria. The dam classification is primarily based on the consequence of failure and the guideline is summarized in Table 3.2. To assess the potential consequence of failure, the industry practice is to conduct a "dam break" assessment, which assumes that the dam could fail and determines what the potential run-out of tailings and water could be.

The selected dam classification, based on the dam break analysis presented in Section 3.1.1, is "High" to "Very High", and the criteria for Very High has been selected for design. The use of the Very High rating provides additional security for the long term performance of the tailings facility after closure.

Table 3.2 Dam Classification Guideline (CDA 2007)

Dam Class	Population at risk (Note 1)	Incremental losses		
		Loss of Life (Note 2)	Environmental and Cultural Values	Infrastructure and Economics
Low	None	0	Minimal short-term loss No long-term loss	-Low economic losses; area contains limited infrastructure or services
Significant	Temporary only	Unspecified	-No significant loss or deterioration of fish or wildlife habitat -Loss of marginal habitat only -Restoration or compensation in kind highly possible	-Losses to recreational facilities, seasonal workplaces, and infrequently used transportation routes
High	Permanent	10 or fewer	-Significant loss or deterioration of *important* fish or wildlife habitat -Restoration or compensation in kind highly possible	-High economic losses affecting infrastructure, public transportation, and commercial facilities
Very High	Permanent	100 or fewer	-Significant loss or deterioration of *critical* fish or wildlife habitat -Restoration or compensation in kind possible but impractical	-Very high economic losses affecting important infrastructure or services (e.g., highway, industrial facility, storage facilities for dangerous substances)
Extreme	Permanent	More than 100	-Major loss of *critical* fish or wildlife habitat -Restoration or compensation in kind impossible	-Extreme losses affecting critical infrastructure or services (e.g. hospital, major industrial complex, major storage facilities for dangerous substances)

Note 1. Definitions for population at risk:

None - There is no identifiable population at risk, so there is no possibility of loss of life other than through unforeseeable misadventure.

Temporary - people are only temporarily in the dam-breach inundation zone (e.g., seasonal cottage use, passing through on transportation routes, participating in recreational activities).

Permanent - The population at risk is ordinarily located in the dam-breach inundation zone (e.g., as permanent residents); three consequence classes (high, very high, extreme) are proposed to allow for more detailed estimates of potential loss of life (to assist in decision-making if the appropriate analysis is carried out).

Note 2. Implications for loss of life:

Unspecified - The appropriate level of safety required at a dam where people are temporarily at risk depends on the number of people, the exposure time, the nature of their activity, and other conditions. A higher class could be appropriate, depending on the requirements. However, the design flood requirement, for example, might not be higher if the temporary population is not likely to be present during the flood season.

3.1.1 Dam Break Assessment

The tailings facility is located in a remote area of Yukon and, except for a campsite on Frances Lake, there are no major population centres or commercial and industrial activities downstream of the impoundment. In the event of an incident at the tailings impoundment, the discharge from the facility would enter Go Creek and then Money Creek. Money Creek discharges into Frances Lake, which is located east of the mine about 40 km downstream of the tailings impoundment. The most significant infrastructure crossing along this flow path is the Robert Campbell Highway over Money Creek, just before the creek enters Frances Lake.

The expected peak flood outflow from the tailings pond occurring as a result of a dam breach was estimated using charts compiled by MacDonald and Monopolis (1984), and by Wahl (1998), based on dam failure case studies. It should be noted that these charts are based on failures of water storage dams. Tailings stored in the tailings ponds have higher viscosity than water and, in the event of a tailings dam failure, usually not all the tailings are released from the pond. Furthermore, tailings tend not travel as far downstream as water. The estimated total storage volume of approximately 1.45 million m^3 (Mm^3) at closure in the tailings pond will contain approximately 1.27 Mm^3 of tailings.

For estimating the peak discharge resulting due to a breach at the Wolverine tailings dam, the following simplifying assumptions were made:

- The total mobilized volume was taken as 100% of the free water in the pond (0.15 Mm3) plus 30% of the stored tailings (0.40 Mm3); and
- The tailings were assumed to behave the same as water, i.e., the entire volume of water plus the 30% of tailings is released from the pond and all of it travels downstream as if it was water.

The analysis of data presented by United States Congress of Large Dams (USCOLD) on tailings dam failures (USCOLD 1995) indicates that, on average, only 30% of the tailings are released from the impoundment as a result of a dam failure. Since the charts being used are based on failures of water storage dams where the entire storage volume above the dam foundation would

be released, only 30% of the total tailings are assumed to be part of the storage volume for the dam break analysis of the tailings dam.

The estimated peak outflow released from the dam is 1,850 m^3/s, which is expected to attenuate as the flood wave travels downstream. The downstream flows were estimated using the attenuation charts prepared by Petrascheck and Sydler (1984), and the results are summarized in Table 3.3.

Table 3.3 Estimated Dam Breach Flood Peaks Downstream of Tailings Dam

LOCATION	DISTANCE FROM DAM (km)	ESTIMATED PEAK FLOW (m^3/s)
At Wolverine Tailings Dam	0	1850
Confluence of Go Creek and Money Creek	5	1700
Robert Campbell Highway and Frances Lake	40	1100

The assumptions made and the charts used herein provide approximate estimates of expected dam breach discharge and downstream attenuation.

As Table 3.3 indicates, little attenuation of the flow is expected by the time the flood peak reaches Money Creek, but it is expected to decrease to about 60% of the original flow by the time the flood peak reaches Robert Campbell Highway and Frances Lake. A comparison of the estimated flood peak resulting from a breach at the tailings dam with the natural stream flows indicates that the dam breach flood peak will be about 150 times the naturally expected 200-year peak flow in Go Creek above Money Creek, and it will be about 10 times the naturally expected 200-year peak flow in Money Creek at the Robert Campbell Highway. The expected attenuation of the flood peak presented in Table 3.3 is based on the assumption that the tailings released from the dam migrate downstream the same as water. In reality, the tailings will not be as mobile and a substantial portion of the tailings are expected to be deposited close to the dam.

The potential consequences of the dam failure, that support the dam rating of "Very High", are summarized below for the key indicators included in Table 3.2.

Populations at Risk and Loss of Life

There are no permanent populations that would be at risk and loss of life would be limited to temporary personnel in the vicinity. Therefore, the "Population at Risk" classification is "Significant".

Environmental and Cultural Effects

The flood flow would damage and have a negative impact on the aquatic habitat in the flow path. The tailings released from the pond as well as those left in the pond are expected to become acid generating, if left exposed to atmosphere for many years, and would remain acid generating indefinitely until the oxidation process is complete. The potential effect could be substantial loss or deterioration of *important* fish or wildlife habitat and could require recovery of all of the tailings and construction of a new containment facility. Given the potential for large socio-economic and environmental damage, as well as substantial clean-up costs, the tailings impoundment is classified as a "Very High" consequence facility

Infrastructure and Economics

There is limited infrastructure and no industrial facilities downstream of the dam. The potential effect of a dam break would be limited to damage to the Robert Campbell Highway and Money Creek bridge. The potential infrastructure and economic damage could be significant. Restoration or compensation would be highly possible. Therefore the dam classification is "High".

3.2 Earthquake, Flood and Seepage Criteria

Recommended design criteria (CDA 2007) for various dam classifications are summarized in Table 3.4 and the selected criteria are discussed in the following sections.

Table 3.4 Inflow Design Flood and Suggested Design Earthquake Levels for Consequence Classes (CDA 2007)

DAM CLASS [NOTE 1]	AEP	
	IDF [NOTE 2]	EDGM [NOTE 3]
Low	1/100	1/500
Significant	Between 1/100 and 1/1000 [note 4]	1/1,000
High	1/3 between 1/1000 and PMF [note 5]	1/2,500
Very High	2/3 between 1/1000 and PMF [note 5]	1/5,000 [note 6]
Extreme	PMF [note 5]	1/10,000 [note 6]

Acronyms: AEP, annual exceedance probability; EDGM, earthquake design ground motion; IDF, inflow design flood; PMF, probable maximum flood.

Note 1. As defined in Table 2-2, Dam Classification

Note 2. Extrapolation of flood statistics beyond 1/1000 year flood (10^{-3} AEP) is discouraged.

Note 3. AEP levels for EDGM are to be used for mean rather than median estimates of the hazard.

Note 4. Selected on the basis of incremental flood analysis, exposure, and consequences of failure.

Note 5. PMF has no associated AEP. The flood defined as "1/3 between 1/1000 year and PMF" or "2/3 between 1/1000 year and PMF" has no defined AEP.

Note 6. The EDGM value must be justified to demonstrate conformance to societal norms of acceptable risk. Justification can be provided with the help of failure modes analysis focused on the particular modes that can contribute to failure initiated by seismic event. If the justification cannot be provided, the EDGM should be 1/10,000.

Design Earthquakes

The tailings facility is classified as "Very High" consequence and the CDA recommendation seismic guideline is for an earthquake return period of 1:5000 years. As per *QML-0006 Condition 16.2,* the tailings facility must withstand a minimum of a 10,000 year return design earthquake, and has been designed to this standard. For the seepage collection dam, the recommended return period is 475 years to reflect the low consequence of failure and the short service life.

Design Floods

The design flood criteria selected for various components of the water management facilities associated with the tailings impoundment are summarized in Table 3.5. The corresponding dam safety criteria for a "Very High" consequence dam is "2/3 between 1/1,000 and PMF" and a

criterion of 10,000 year return period has been used, as per requirements of *QML-0006 Condition 16.2.*

The expected operating life of the mine was also taken into account in the selection of the design floods for temporary facilities, such as the surface runoff diversion ditches, the starter dam emergency spillway and the seepage collection system. During operations all facilities related to the tailings impoundment will be monitored, and personnel, equipment and materials will be readily available in the event that remedial measures are required. Therefore, lower design criteria for temporary facilities have been selected.

Table 3.5 Selected Flood Design Criteria for Water Management Facilities

FACILITY	MIN. DESIGN FLOOD RETURN PERIOD (YEARS)	FLOOD STORAGE & FREEBOARD ALLOWANCE	COMMENTS
Surface water diversion ditches	100	-	-
Starter Dam Emergency Spillway	10,000	Storage for 200 year flood	Assume that upland surface water diversion ditches have failed. Spillway also must be able to pass the 10,000-year flood without overtopping the dam.
Tailings Dam Closure Spillway	10,000	-	Assume that upland surface water diversion ditches have been decommissioned.
Seepage Collection Pond Spillway	100	-	Assume that upland surface water diversion ditch is functioning.
Tailings Pond flood storage allowance below spillway level during mine operation	-	0.3 m	For routing of design flood through the tailings pond after closure, the initial water level is assumed to be at the spillway level, i.e., flood storage allowance is assumed to be zero.
Tailings Dam Spillways	-	1.5 m	Minimum freeboard is defined as the difference in elevation between the top of the dam without camber and the maximum pond level that would result from routing the IDF through the reservoir. This is approximately 2.0 m above spillway invert.

Note: IDF = Inflow Design Flood

Design "Allowable" Seepage Assessment

This section presents the design basis for determining the "allowable" seepage rate from the impoundment. The assessment is based on determining the fate and transport of potential contaminants from the impoundment to the receiving environment. During operations, seepage through the dam will be collected with a seepage collection ditch and pond for return to the impoundment, as required. In addition, a portion of seepage from the impoundment (potentially 25% of total seepage) may bypass the seepage collection system and mix with the regional groundwater flow. The groundwater flow system downstream of the seepage collection dam can be characterized as follows:

- In the immediate vicinity of Go Creek and the tailings impoundment, the groundwater flow system within the glaciofluvial soils overlying bedrock could have an estimated groundwater flow of 15 L/s.
- The area near W12, upstream of the confluence of Money Creek and Go Creek appears to have a similar overburden cover as near the dam and the estimated groundwater flow is 60 L/s.
- In the vicinity of W14, downstream of the confluence of Money Creek and Go Creek, the geomorphology changes to a terrace glacial outwash regime with a thicker overburden aquifer, which could have an estimated groundwater flow of 420 L/s.

A portion of the groundwater will report to the deeper groundwater system and flow towards Go Creek and to the groundwater regime in the vicinity of W14.

The criteria for allowable seepage was estimated on the basis of a simple dilution model, using predicted concentrations of cadmium, selenium and zinc in the impoundment and the potential seepage flows from the impoundment. In addition, a factor of 10% has been applied to account for attenuation and adsorption, which will occur along the flow path. Table 3.6 summarizes the concentrations of cadmium, selenium and zinc in the tailings/DMS float pore water, baseline values at W14 and "tolerable" seepage based on the groundwater "dilution" flow and a 10% factor for adsorption. The pore water chemistry is primarily controlled by the process water chemistry during operations (see Section 5.3). Supporting data includes shake flask extraction tests and aging tests of the tailings supernatant.

Table 3.6 Summary of Concentrations of Parameters of Potential Concern and "Tolerable" Seepage Rates

PARAMETER OF POTENTIAL CONCERN	CCME LIMIT (mg/L)	BASELINE CONCENTRATION (mg/L)	IMPOUNDMENT PORE WATER - RANGE (mg/L)	"TOLERABLE" SEEPAGE (L/s)* W-14	"TOLERABLE" SEEPAGE (L/s)* W-12
Cadmium	0.000 017	0.000 05	0.01	20	3
Selenium	0.001	<0.001	1	40	6
Zinc	0.03	<0.005	1 to 5	50	7

Notes:* "Tolerable" seepage based on groundwater dilution flow at W-12 and W-14, with 10% adsorption factor.

Based on the above, a "tolerable" seepage criterion could be approximately 5 L/s, however if adsorption is discounted, the "tolerable" seepage could be 0.5 L/s and, accordingly, a conservative design criteria of <0.5 L/s has been adopted.

The preceding analysis is based on a simplified groundwater model, which could vary by up to order of magnitude, to provide a framework for estimating the potential seepage effect. To reduce uncertainty in the estimate Yukon Zinc has elected to install a low permeability "linear low density polyethylene" (LLDP) geomembrane. The liner significantly reduces the potential seepage flow to orders of magnitude lower than required. As described in Section 6.3, the seepage analysis indicates that the leakage rate out of the impoundment should be on the order of 0.00001 L/s, which is negligible.

4. GEOTECHNICAL CHARACTERIZATION

4.1 Site Investigations

Geotechnical site investigations for the tailings facility were carried out from July to September 2005. The investigations included 6 drill holes, 2 groundwater monitoring wells and 23 test pits, which are shown in plan in Drawing D-3002. Testing results, and drill hole and test pit logs are included in Appendix I. Subsoil profiles are shown in Drawing D-3003.

4.2 Geotechnical Testing

Geotechnical laboratory testing included visual classification, moisture content, and gradation tests for overburden samples retrieved from field investigations. Additionally, standard Proctor compaction tests, triaxial permeability and direct shear strength tests were carried out on the potential borrow materials for the dam fill and on the tailings. These results are summarized in Table 4.1, and test results are included in Appendix I.

Table 4.1 Summary of Engineering Properties Determined from Laboratory Tests on Dam Fill and Tailings

TYPE OF MATERIAL	UNIT WEIGHT γdry (kN/m3)	EFFECTIVE SHEAR STRENGTH		HYDRAULIC PERMEABILITY k (m/s)
		Cohesion c' (kPa)	Friction Angle ϕ′ (degree)	
Dam Fill	~2.1	0	37	3 E-8
Tailings	~1.85	0	34	7 E-8

Test results for dam fill and tailings were obtained by consolidated-undrained triaxial shear tests with permeability measurement after consolidation and pore pressure measurement during shear. The consolidation stresses used in the laboratory were selected to simulate the field condition.

The tailings testing carried out in 2006 was on a 50:50 mixture of F11 and F12 (Zn, Rougher Scavenger Tail) and F23 and F32 (Zn 1st Cleaner Scavenger Tail). Additional tests were carried out in 2008 on a mixture of 80% rougher tailings and 20% cleaner tailings and the test results are summarized in Table 4.2.

Table 4.2 Summary of Tailings Laboratory Test Results

TEST	TEST RESULTS
Specific gravity	S.G = 3.7 and 3.9
Gradation	% finer than 75 micron = 83% to 92%
5 day jar settling test	Settled density of 71%, equivalent to 1.45 t/m^3
Consolidation	Density at final stress state (75 kPa average) = 80% solid by weight, equivalent to 1.8 t/m^3 Permeability k < 10^{-8} m/s Coefficient of consolidation: Cv = 10^{-2} cm^2/s

Based on the settling and consolidation tests, an average in situ density of 1.6 t/m^3 has been used for storage volume calculations.

Subsequent to the testing of the tailings, detail design of the mill has removed the dense media separation circuit. The potential effects of removing the DMS on the tailings are:

- Slight decrease in specific gravity, which could reduce the settled density by 5%. However, a conservative density has been assumed and actual densities will be measured during operations on the basis of bathymetry surveys and production records; and
- Negligible change to the permeability because the grinding circuit would still be anticipated to produce a similar gradation tailings.

5. GEOCHEMICAL CHARACTERIZATION

Geochemical assessments were conducted on tailings, dam construction material, and tailings supernatant water. A summary is provided below and the databases included in Appendix II. In addition, an update on the humidity cell testing overseen by Marsland Environmental Associates to September 2008 is included in Appendix II.

The assessment presented in the following sections is based on the original design basis of using the dense media separation to segregate low sulphide gangue rock. Detailed mine design has eliminated the dense media float circuit and reduced the amount of dilution rock being mined. The potential effects on the geochemistry of removing the DMS are:

- The tailings may have a slightly higher NP/AP ratio due to the addition of neutral dilution material; and
- The neutral metal leaching properties are anticipated to be similar because the main contaminants are associated with the sulphide tailings and the process solutions.

5.1 Tailings Geochemistry

To assess the geochemical characteristics of the tailings, four ore composite types were prepared and examined. The four samples were prepared with lock cycle tests (LCT) carried out to simulate the milling process, which produces three tailings sub-streams: ~2% pre-float concentrate (PFC), 88% rougher tails (Ro), and 10% cleaner scavenger tails (CS). The composite ore samples include the following:

- Combined overall diluted ore composite (Comb OD Comp) tailings: Combines the three tailings streams generated by using ore and dilution rock from both Wolverine and Lynx ore zones (LCT3).
- Combined overall ore composite (Comb Overall Ore Comp) tailings: Combines the tailings generated from using only ore from the Wolverine and Lynx ore zones, and does not include any dilution rock. The sample is a composite of two lock cycle tests (LCT1 & LCT2).

- Combined Wolverine composite ore with dilution rock (Comb Wolv D Comp) tailings: Combines all three tailings streams generated from ore with dilution rock from the Wolverine ore zone (LCT4).

- Combined Lynx ore with dilution rock composite (Comb Lynx D Comp) tailings: Combines all three tailings streams generated from ore with dilution rock from the Lynx ore zone (LCT5).

Mineralogy

Mineral assemblage percentages for the four composite tailings samples were assessed using optical microscopy on the four samples and the results are summarized in Table 5.1.

In addition, quantitative phase analysis using x-ray diffraction (XRD) with Rietveld refinement was carried out, to identify the carbonate and sulphide species. The results suggest the onset of acidic conditions may have the potential to release metal (loids) from mineral phases, likely from the sulphide phases confirmed by mineralogical characterization. Furthermore, elements that are mobile under neutral pH conditions (e.g., Se, Zn, etc.) may have the potential to be released.

Table 5.1 Mineral Assemblages and Modal Abundances by Optical Microscopy (wt. %)

Mineral	Comb OD Comp	Comb Overall Ore Comp	Comb Wolv D Comp	Comb Lynx D Comp
Pyrite	53.1	60.1	38.3	60.3
Quartz	20.9	17.1	26.7	16.7
Carbonate	10.5	10.6	14.2	11.6
Muscovite	11.9	5.2	14.3	8.9
Chlorite	1.0	1.1	0.9	0.0
Sphalerite	1.1	1.6	1.3	1.8
Pyrrhotite	0.5	1.6	2.1	0
Amphibole	0	0.6	0.5	0
Arsenopyrite	0.3	0.8	0	0.3
Pyroxene	0.2	0.3	1.5	0.0
Chalcopyrite	0.5	0.4	0.2	0.0
Galena	0.0	0.4	0	0.8
Biotite	0	0.2	0	0
Magnetite	0	0.1	0	0
Total	100	100	100	100

Acid Base Accounting

The results of the ABA tests carried out on all of the tailings sub-streams are summarized in Table 5.2. All samples have high sulphide content and a low Neutralization Potential Ratio (NPR) of less than one, and are classified as having a high potential for producing acid rock drainage. However, the samples have enough NP (carbonate neutralization potential of 20 kg to 100 kg $CaCO_3$/t) to remain at a near-neutral pH, when initially exposed to oxygen. This is confirmed with the relatively high paste pH values of 6.9 to 7.85. In addition, most samples indicate the presence of non-carbonate neutralization potential, possibly from the muscovite, clinochlore and kaolinite, indicated by the mineralogical analysis.

Shake Flask Tests

The results of the shake flask extraction tests from the four combined tailings samples are included in Appendix II. The shake flask extraction tests show that the final pH was near neutral to slightly alkaline and ranged from pH 7.3 to pH 8.4. The initial exposure of tailings to atmospheric conditions should result in minimal trace metal(loid) releases, except for the Combined Overall Ore Composite tailings, which shows Cd (0.134 mg/L), Se (0.20 mg/L), Tl (0.022 mg/L) and Zn (6.87 mg/L) releases. The major ions Ca^{2+}, Na^{+}, Mg^{2+}, Mn^{2+}, Cl^{-}, SO_4^{2-} and thiosalts also show releases, most likely due to the dissolution of gypsum ($CaSO_4$) and other salts and sulfosalts present at low abundances.

Table 5.2 Tailings Acid Base Accounting Results for Tailings Sub-Streams

Parameter	Units	Overall Comp LCT2 Ro	Overall Comp LCT2 Cl Sc	Overall Comp LCT2 Comb	OD Ro	OD Cl Sc	OD Comb	Wolv Ro	Wolv Cl Sc	Wolv Comb	Lynx Ro	Lynx Cl Sc	Lynx Comb
Paste pH	-	7.79	7.26	7.42	7.85	6.69	7.27	7.68	6.91	7.35	7.67	6.45	7.36
Fizz Rate	-	3	3	3	3	2	2	3	2	2	3	2	2
Total S	%S	22.3	39.5	29.2	17.5	43.0	26.6	12.3	39.4	19.7	23.7	48.4	31.2
Acid Leachable SO_4^{2-}	%S	1.07	6.98	2.51	0.02	1.18	2.04	0.45	1.63	1.74	0.92	6.45	0.74
Sulphide S	%S	20.2	28.5	25.0	15.7	39.0	22.9	10.1	34.1	15.7	20.4	39.4	27.8
Insoluble SO_4^{2-}	%S	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Organic S	%S	1.10	4.00	1.73	1.72	2.83	1.67	1.79	3.64	2.34	2.35	2.61	2.68
AP	kg $CaCO_3$/t	631	891	781	491	1220	715	315	1070	489	638	1230	869
Sobek NP	kg $CaCO_3$/t	103	41.8	72.8	114	21.9	82.5	119	32.1	94.6	111	20.9	49.4
Net NP	kg $CaCO_3$/t	-528	-849	-708	-377	-1198	-632	-196	-1038	-395	-526	-1209	-820
Sobek NP/AP	-	0.16	0.05	0.09	0.23	0.02	0.12	0.38	0.03	0.19	0.17	0.02	0.06
Carb NP	kg $CaCO_3$/t	72.6	23.4	59.4	91.4	20.5	98.3	105	24.6	106	94.4	22.1	52.3
Carb NP/AP	-	0.11	0.56	0.08	0.19	0.02	0.14	0.33	0.02	0.22	0.15	0.02	0.06
TOC	%C	na	na	na	0.54	0.43	0.62	0.69	0.75	0.98	0.49	0.25	0.48
TIC	%C	na	na	na	1.32	0.11	0.94	1.39	0.14	1.2	1.30	0.21	0.79
C(t)	%C	1.72	0.87	1.48	1.86	0.54	1.56	2.07	0.88	2.14	1.79	0.46	1.27

na= not analyzed

Humidity Cell Testing

Four humidity cells were initiated in mid 2005 and results are included in Appendix II. Two humidity cells containing Overall Ore Composite (OC) and Overall Ore Diluted (OD) samples are operational and an updated report to September 2008 is included in Appendix II. A summary illustrating the changes to water quality during the test period (using week 15 and week 160 as indicator weeks) is presented in Table 5.3 and the main observations of the testing to date include:

- The pH has remained circum-neutral over other the period except for a few anomalous spikes, which appear to be due to variability in reaction rates within the samples;
- The sulphate production rates have shown a slight decline over the testing period and both samples have similar sulphate loading rates (approximately 100 mg/kg/wk);
- A conservative interpretation of potential time to sulphide depletion in the laboratory is 3 years to 10 years for the OD and OC samples respectively, which could equate to >25 years in natural conditions; and
- The elemental loading rates for soluble selenium and zinc appear relatively constant, although the zinc loading rate for the OC samples had a zinc loading rate that declined, then increased slightly from week 90 to week 150. Average loading rates are approximately 2 mg/kg/wk for zinc and 0.08 mg/kg/wk for selenium. Typical Se concentrations in the leachate for week 160 were in the order of 0.05 mg/L to 0.1 mg/L.

The testing indicates that the lag time for acid generation will be many years and that elemental loading of zinc and selenium, via leachates, could continue for a number of years.

Table 5.3 Typical Humidity Cell Leachate Concentrations for Combined OC Composite and Combined OD Tailings

Parameter	Units	OC Tailings		OD Tailings	
		Leachate concentrations (selected Weeks)			
		Week 15	Week 160	Week 15	Week 160
Leachate Volume	ml	401	498	431	424
pH	units	6.87	6.67	6.97	6.72
Alkalinity	mg $CaCO_3$/L	7	7	11	5
Acidity	mg $CaCO_3$/L	163	3	434	1
Conductivity	µS/cm	551	564	1540	651
SO_4^{2-}	mg/L	250	270	890	270
Cl	mg/L	0.1		0.1	
F	mg/L	0.08		0.14	
NO_3^-	mg N /L	0.025		0.025	
$NH_3 + NH_4^+$	mg N /L	0.5		0.2	
Thiosalts	mg S_2O_3/L	156	5	384	5
$CN_{(T)}$	mg/L	0.005		0.001	
CNO	mg/L	0.05		0.5	
CNS	mg/L				
Hg	µg/l	0.05		0.05	
Ag	mg/L	0.0025	0.000005	0.0025	0.000005
Al	mg/L	0.005	0.005	0.005	0.0027
As	mg/L	0.006	0.003	0.017	0.0037
Cd	mg/L	0.0935	0.197	0.0677	0.0456
Cu	mg/L	0.0025	0.0051	0.0031	0.0050
Pb	mg/L	0.019	0.0171	0.0026	0.00188
Sb	mg/L	0.025	0.00291	0.025	0.00124
Se	mg/L	0.285	0.112	1.18	0.147
Tl	mg/L	0.0075	0.0035	0.014	0.00232
Zn	mg/L	4.04	8.19	3.01	2.29

Note: All metals are dissolved concentrations

5.2 Borrow for Dam Construction Materials

Borrow materials from within and adjacent to the impoundment will be used for constructing the earthfill tailings dam. Geochemical tests, including shake flask tests and acid base accounting (ABA) tests, were carried out for samples collected from the test pits located in the impoundment and from the project borrow area located northwest of the tailings facility (see Drawing D-3002), and results are included in Appendix II. These tests indicate that the borrow materials have a low leaching potential, and are not potentially acid generating.

5.3 Supernatant Water Chemistry

The tailings supernatant water quality acquired from the lock cycle test work is summarized in Table 5.4. During operations, variations outside of this range may occur with fluctuations or alterations in reagent dosage during ore processing. Certain dissolved parameters (e.g., Na, K, Cl and SO_4) may tend to re-circulate through the mill in the reclaim water. Eventually these parameters will reach a re-circulating equilibrium concentration, that may in part be controlled by the solubility limit of the parameter of interest (e.g., sulphate can be expected to eventually be limited by gypsum solubility in the presence of calcium addition as lime in the mill circuit). The tailings supernatant chemistry will be typical of the pore water quality in the tailings. The main parameter of potential concern is selenium, which had a typical concentration of approximately 9.5 mg/L.

Table 5.4 Tailings Supernatant Geochemistry

Parameter	Concentration
	(mg/L)
pH	7.4 - 7.9
Ammonia-N	0.1 - 0.35
Nitrate	0.30
CN-total	0.02 - 3.5
Thiosalts	400 - 600
SO_4	500 - 1500
Al	0.02 - 0.14
Sb	0.02 - 0.065
As	0.002 - 0.1
Cd	0.001 - 0.005
Cu	0.012 - 0.11
Fe	<0.03
Pb	0.003 - 0.135
Hg	0.0001
Ni	0.002 - 0.008
Se	9.1 to 9.7
Ag	0.003 - 0.004
Zn	0.01 to 0.13

The supernatant water in the tailings pond will undergo "aging" when tailings deposition stops, which could occur during periods of temporary shutdown or on closure. Aging tests were carried out to assess the behaviour of the supernatant water overlying the tailings. In addition, sub-aqueous column leach tests were carried out to assess the change in void water quality as the tailings are leached with fresh surface water.

Tailings Aging Tests

The four composite tailing samples were "aged" in the laboratory for up to 120 days, to assess the water chemistry changes in the tailings pond over time. During aging, the supernatant was

exposed to atmospheric oxygen and carbon dioxide, as would be the case in the tailings impoundment during temporary suspension of milling activities (e.g., maintenance shutdowns) or post-closure. At closure, or during sustained shutdown, there will be a short lag time (up to 9 months) until the remaining thiosalts are oxidized and water quality stabilizes. During this period there is a slight depression in pH, which then rises after the thiosalts are oxidized. Selenium, cadmium and zinc for some of the samples show elevated concentrations at 120 days (Table 5.5). Concentrations of some parameters had not reached equilibrium after 120 days.

Additional testing will be conducted during the operations period to refine the estimates of post-closure tailings pond water quality behaviour.

Table 5.5 Summary of Tailings Aging Tests at 120 Days

Parameter	COMB Overall ore comp	Comb OD cOMP	comb Wolverine D Comp	comb Lynx D Comp
pH	7.39	7.16	7.11	7.63
Hardness	860	560	544	813
Sulphate	1200	920	890	1200
Thiosalts	<10	133	243	<10
Total Cyanide	0.01	<0.01	<0.01	<0.01
Ammonia	0.2	1.2	1.1	0.9
Ag	<0.0001	0.0003	0.0039	<0.0001
As	0.021	0.006	0.016	0.0050
Cd	0.0169	0.0257	0.0040	0.0027
Cu	0.0024	0.0038	0.0048	0.0050
Pb	0.0266	0.0053	0.0031	0.0047
Hg	<0.0001	<0.0001	0.0002	<0.0001
Sb	0.0142	0.0094	0.0297	0.0072
Se	0.994	0.388	1.26	0.12
Tl	0.0089	0.0029	0.0034	0.0020
Zn	5.57	1.68	0.514	0.54

Note: All metals are dissolved concentrations.

Sub-aqueous Column Leach Tests

Sub-aqueous column leach tests were conducted on the two combined ore composite samples (OC and OD) to simulate the effects of surface water leaching tailings pore water into the base of the impoundment, and the results are summarized in Table 5.6. The columns have similar construction to the humidity cells, however a water cover was maintained on the sample, and leachate was collected from the base of the cell weekly. The leachate volume of each weekly

sample was approximately 7 times the pore volume of the sample. The leachate of the sub-aqueous columns was collected and analyzed for pH, conductivity, acidity, alkalinity, thiosalts, anions (F^-, Cl^-, $SO_4^{2-}$and NO_3^-), cyanide (CN), thiocyanate (CNS), cyanate (CNO), ammonia + ammonium ($NH_3 + NH_4^+$) and a suite of dissolved metal(loid)s via ICP-MS (including mercury) by SGS Lakefield.

Table 5.6 Summary of Subaqueous Column Results after 8 Weeks

Parameter	COMB Overall ore comp (OC)	Comb OD cOMP (OD)
pH	7.86	7.65
Sulphate	52	38
Thiosalts	5	5
Total Cyanide	0.005	0.005
Ammonia	0.1	0.7
Ag	0.00005	0.00005
As	0.0025	0.002
Cd	0.00005	0.000015
Cu	0.004	0.0005
Pb	0.0005	0.0003
Hg	0.00005	0.0014
Sb	0.0092	0.0228
Se	0.008	0.010
Tl	0.0001	0.0021
Zn	0.005	0.009

Note: All metals are dissolved concentrations (mg/L). Italicized values indicate measured valued less than detection limit, and listed as one half of the detection limit; Bold values indicated measured values in excess of 10x CCME guideline.

The water quality of the leachate stabilized after 4 weeks to typical values shown in Table 5.6. The test indicates that the water quality improves with time, as the process water is “flushed” out through seepage. For example, the number of pore water volumes in the four weeks was approximately 30 times indicating that a leaching water volume of approximately 2 L/kg is required to “flush” residual contaminants. The actual leaching rates for the tailings impoundment will be very low due to the geomembrane liner.

6. TAILINGS IMPOUNDMENT

The tailings facility includes a tailings impoundment, L-shaped tailings dam, a seepage recovery dam and pond, two upland diversion ditches, and a spillway (see Drawing D-3004). The tailings impoundment site is located in a natural, northwest-southeast trending elongated ephemeral drainage basin perched on the northeast valley slope of Go Creek (see Drawing D-3001). The basin is flanked on the downhill side by a natural ridge trending in the same direction that drops in elevation gently towards the upstream end of the tailings facility, and ends rather abruptly at the elbow point of the L-shaped tailings dam at the downstream end. The impoundment covers an area approximately 600 m long and 300 m wide.

Site investigations indicate that the tailings basin is mantled by glacio-morainal deposits, which may have been altered by the stream flowing along the thalweg. Along the ridge, the depth to bedrock ranges from 30 m to 40 m, while between the ridge and the northeast valley slope the depth is shallower, ranging from 20 m to 25 m.

6.1 Storage Capacity

The annual storage requirements are summarized in Table 6.1 and the capacities of the impoundment with Stage 1 and Stage 2 dams is shown on Figure 6-1. The stage storage curve has been adjusted to reflect the detailed ground survey that was carried out after stripping of the dam and impoundment foundation was completed.

In addition to storage of tailings solids, the tailings facility will provide for the following:

- Minimum operational water volume of 40,000 m3 for settling of solids and operation of pumps ;
- Seasonal storage for average conditions of 60,000 m3;
- 200 year flood storage consisting of 200 yr wet month precipitation with snowmelt of 37,500 m3; and
- 2 m of freeboard, which provides for routing of the 10,000 year return period flood event through the spillway (0.5 m) and 1.5 m of freeboard.

Table 6.1 Tailings Production Rate (t/y) and Volume

Calendar Year	Operation Year	Total Tailings Production (TONNES)	Tailings to Impoundment (tonnes)
2010[1]	1	305,586	159,486
2011	2	484,319	257,910
2012	3	485,645	272,219
2013	4	484,319	231,690
2014	5	484,319	229,410
2015	6	484,319	229,410
2016	7	485,645	230,039
2017	8	484,319	229,410
2018	9	371,805	187,385
Total Tonnage		4,070,275	2,026,960
Total Volumes[2] (m^3)		na	1,267,000

1: Based on 184 days of production

2: Based on an *in situ* density of 1.6 t/m^3

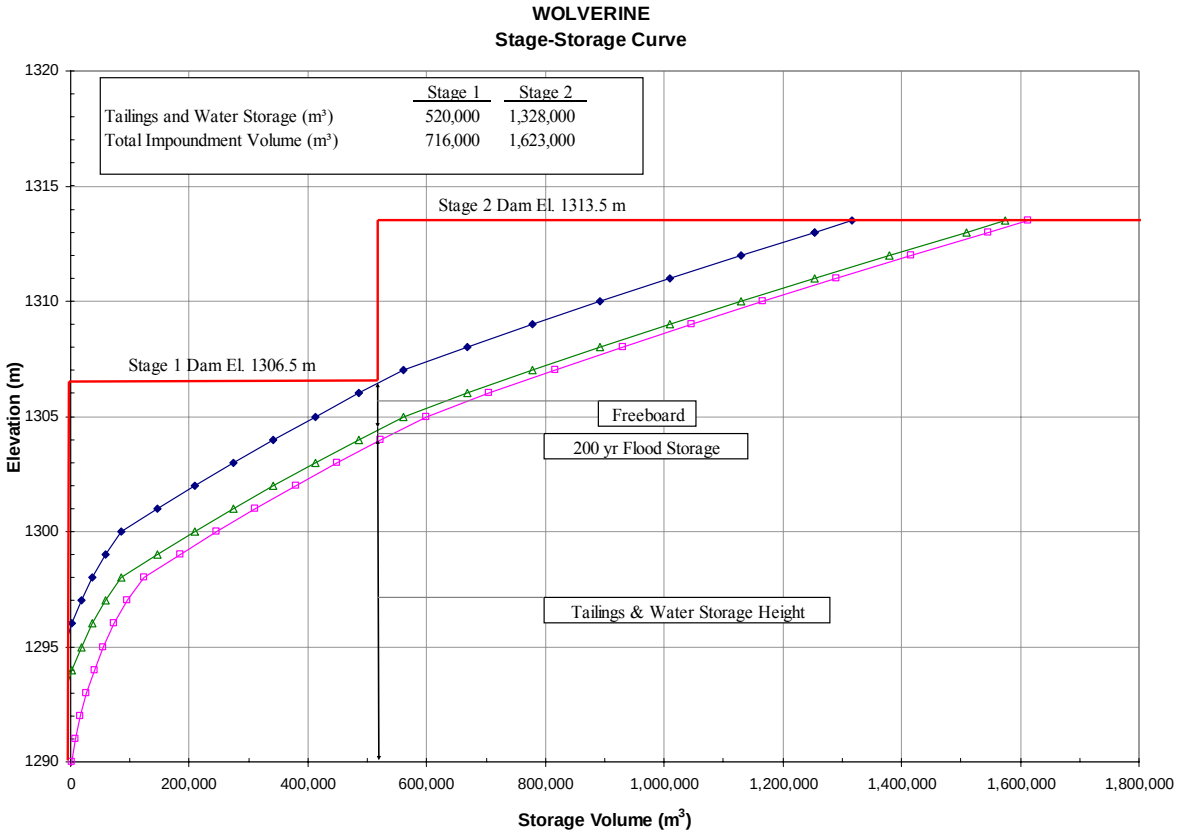


Figure 6-1 Stage Storage Curve – Tailings Impoundment

6.2 Deposition Strategy and Staged Development

The tailings will be deposited via several spigot discharges. In approximately the first five years of operations, tailings will be spigotted from two locations (as shown on Drawing D-3006): a) from the southeast of the impoundment to push the decant pond towards the north, during operations; and b) from the north end of the impoundment to cover the geomembrane. The tailings beach will slope towards the northwest where the water reclaim barge will initially be located. The tailings will form a beach, which will slope at approximately 1% towards the water pond. Typical sections, through the impoundment, for Year 2, Year 6 and closure are shown on Drawing D-1010 and D-3011.

A Surpac spatial model of the impoundment was run to illustrate the deposition of tailings over the life of the mine. Typical model outputs for tailings deposition are shown on Figure 6-2 to Figure 6-5, for Year 1, Year 2, Year 6, and closure, respectively (water pond is coloured blue and the tailings are brown). Typical sections are shown schematically on Drawing D-3010 and Drawing D-3011 for various stages of operations.

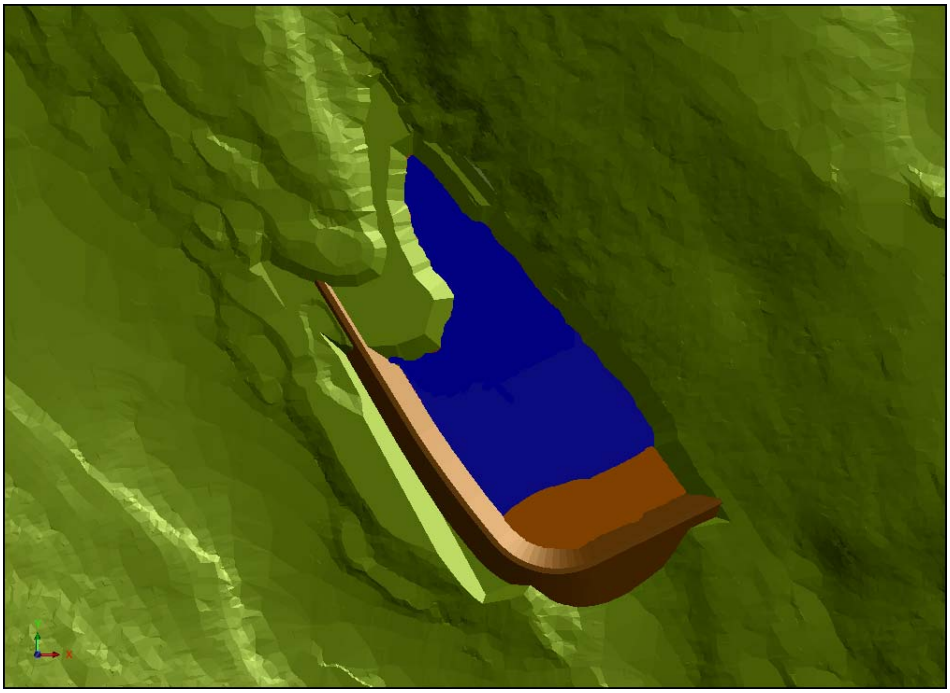


Figure 6-2 Deposition Plan - Year 1

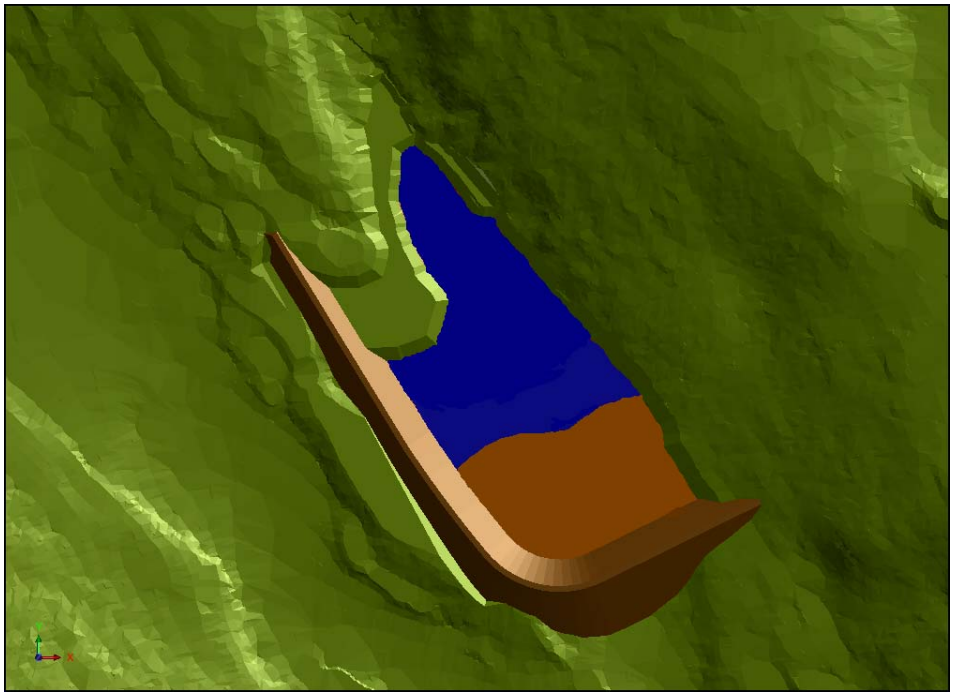


Figure 6-3 Deposition Plan - Year 2

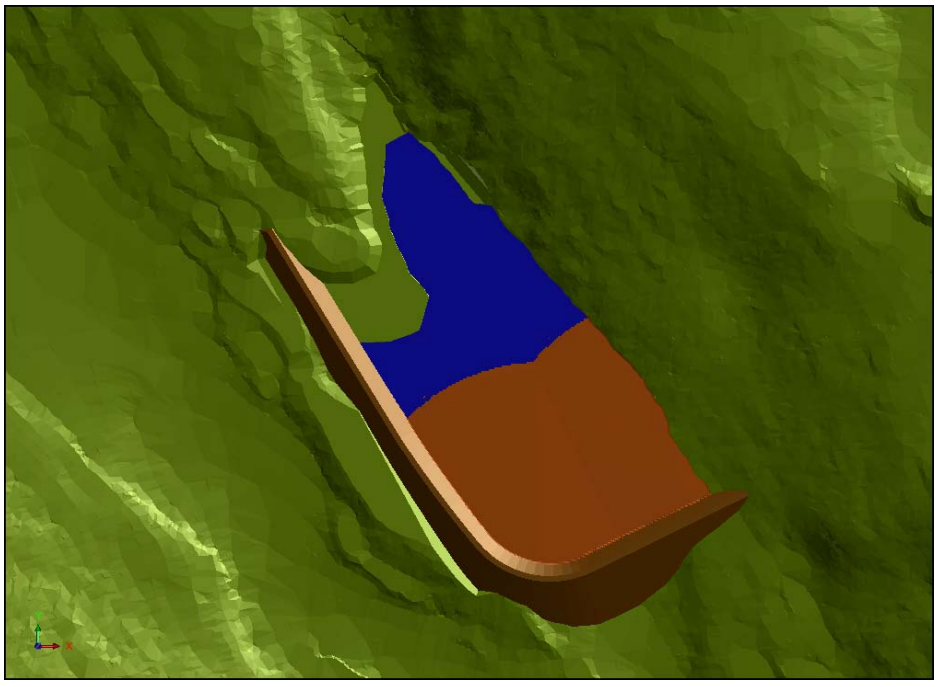


Figure 6-4 Deposition Plan - Year 6

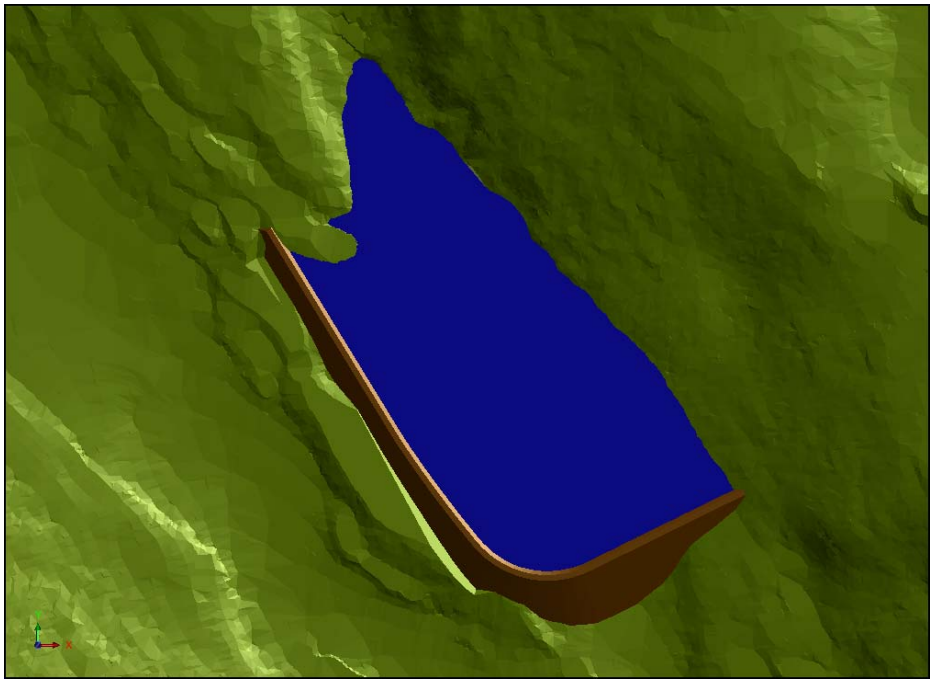


Figure 6-5 Deposition Plan - Closure

6.3 Liner Design

The tailings facility is designed to retain water and minimize seepage from the impoundment and dam. In order to achieve this, A 40 mil LLDPE geosynthetic liner will line the impoundment and along interior face of the dam. Overburden material in the impoundment will be excavated and used as general fill for the dam. Typical excavation and fill sections for the impoundment are shown in Drawings D-3007 and D-3009.

Prior to preparing the foundation base for the liner, a short underdrain will be installed to prevent uplift pressures from developing beneath the liner in the low area of the impoundment, near the upstream toe of the dam (See Drawings D-3006 and D-3007). The drain will become redundant after the liner is covered with water and/or tailings. Following installation of the underdrain, the foundation base of impoundment will be prepared by heavy compaction of the natural soils. Local placement of finer material will be required in areas of very coarse gravel or boulders.

The lining system will be constructed in two stages as shown on Drawings D-3006 and D-3008 Specifications for liner materials and placement are summarized in Section 6.3. The liner will be anchored in a trench around the perimeter of the impoundment (at the edge of the Stage 1 road for the Starter Dam and Stage 2 Road for the Ultimate Dam). The liner in the Stage 2 dam section will have a "backup" low permeability soil zone to provide additional protection in the event of liner degradation, near surface, due to UV degradation and freeze-thaw actions.

An assessment of the potential leakage for various scenarios (i.e., base case, partially degraded liner and no liner) is summarized in Table 6.2 and included in Appendix I. The seepage analyses indicate that the leakage rate out of the impoundment should be on the order of 0.00001 L/s, which is negligible.

Table 6.2 Summary of Leakage Sensitivity Analysis

ANALYSIS CONDITION	BASIN/LINER PERMEABILITY (m/s)	TOTAL SEEPAGE (L/sec)
Base Case – Liner with good QA/QC	Defect Analysis	0.00001
Partially "Degraded" Liner	10^{-10}	0.13
Unlined facility	10^{-6}	6.8

The sensitivity analysis also indicates that the worst-case condition, considering complete degradation of the liner would result in a seepage rate on the order of 6.8 L/s. Because liner degradation is often a result of UV effects, complete degradation of the impoundment liner, which will be covered by tailings, is considered to be highly improbable. As such a more realistic "worst case" evaluation, considering only partial degradation, suggests that seepage under this condition would be less than 0.13 L/s. Life of liner estimates are typically > 125 years and are limited by available service life data. Some designers have suggested a potential life of 300 years to 400 years. A partially degraded liner would be equivalent to about 3,000 m^2 of area with no liner.

6.4 Tailings Facility Water Balance

A water balance for the tailings facility over the 9 year mine life has been carried out and the complete set of tables is included in Appendix III. The water balances for four scenarios are summarized in this section, including:

- The first year of tailings facility operation (Year 2);
- The final year of tailings facility operation (Year 8);
- After mine closure, with diversions; and
- After mine closure, without diversions.

The cases were run for the average year, 100 year wet, and 100 year dry. Inflows to the tailings pond include:

- Surface water runoff and snowmelt from the tailings facility catchment, and direct precipitation on the tailings facility;
- Milling transport water, which includes: tailings transport water, sewage treatment plant effluent, underground mine water and collected runoff from the industrial complex area; and
- Water transferred from the seepage recovery pond to the tailings pond.

Outflows from the tailings facility include:

- Evaporation from the pond;
- Reclaim water recycled to the mill during mining operation;
- Water lost to tailing voids as porewater;
- Water pumped to the water treatment plant for treatment and subsequent discharge; and
- Seepage losses from the tailings pond.

The groundwater table is near surface and after placement of tailings, the groundwater gradients will be downward. Therefore, the contribution of groundwater into the impoundment is considered negligible.

The tailings pond has a total natural catchment area of about 105 ha. With the upland diversion ditches in place, the reduced tailings facility catchment is about 16 ha.

Table 6.3 presents the results of the average annual water balance for the four scenarios. As the table indicates, there will be surplus water of approximately 5 m^3/hr in the tailings pond during mine operation for the average year. The surplus will increase to approximately 9 m^3/hr for the 1:100 year wet year, and a water neutral condition is expected to occur during the 1:100 year dry year. The average annual water balance for the complete mine life and the average monthly water balances for the life of the project are included in Appendix III.

The water balances for the closure scenarios indicate that there will be surplus water during the average year and the 1:100 year wet and dry years, with and without the upland diversion ditches in place. The upland diversion ditches will be decommissioned after mine closure to ensure that water cover on the deposited tailings is maintained.

Table 6.3 Tailings Pond Annual Water Balances for Four Scenarios

CONDITION	NET AVERAGE WATER SURPLUS (m^3/hr)		
	AVERAGE	100 YR DRY	100 YR WET
Year 2 operations with diversions	4.6	-0.5	8.5
Year 8 operations with diversions	5.8	0.2	10.2
Closure with diversions	7.6	2.0	12.0
Closure without diversions	16.6	6.3	24.6

6.5 Water Quality Management

The water balance shows that during operations, over 90% of the water entering the impoundment is tailings slurry water. During operations, the impoundment will have a net water surplus, as indicated in the water balance presented in Section 6.5. Discharge from the

impoundment will be managed to maintain receiving water quality, which will comprise two main components:

- Excess water will be stored in the tailings impoundment during the low flow months of November to April, and treated and discharged during the high flow months of May to October.
- Discharge concentrations and flows will be managed to meet A Licence QZ04-065 requirements.

The Starter Impoundment has sufficient capacity to store excess water in the first few years of operations. This will allow for pilot testing and detailed design of the water treatment plant during the initial years of operations without the requirement for discharge.

7. TAILINGS DAM

The tailings dam is "L-shaped" in plan (see Drawing D-3004), with the short leg of the "L" alignment extending across a side valley from the east to the west for a length of approximately 250 m. The dam alignment then bends around and follows the trend of a flanking ridge for another 450 m towards the northwest. The maximum dam height is 16.5 m and 23.5 m high at project start up and after Year 2 of mining operations, respectively. The dam section has a crest width of 6 m and a 2H:1V downstream slope and a 2H:1V upstream slope (see Drawing D-3007).

The tailings dam is a compacted, homogeneous earthfill embankment dam with an upstream impervious geosynthetic liner. The liner will cover the base of the tailings impoundment and upstream face of the dam up to the ultimate dam crest level (see Drawing D-3007 and Drawing D-3009). In addition, a 5 m wide low permeability glacial till soil zone will be placed adjacent to the liner in the upper 4 m of the Ultimate Dam to provide a contingency against near surface liner degradation due to ultra-violet or freeze-thaw effects.

The dam will be constructed in two stages. The Starter Dam will be constructed to elevation 1306.5 m in 2009, one year prior to mill start-up. The dam will be raised 7 m using the downstream construction method to the final elevation at 1313.5 m in Year 2 of mine operation (2011). During operations there will be storage for tailings plus operations water, and capacity for the 200 year flood. Starter and Ultimate Dam spillways will be constructed to pass larger flood events (see Drawing D-3004).

On closure, a 1.0 m thick layer of granular soil/rockfill will be placed over the tailings to reduce the potential for fine solids to become re-suspended. The cover material could consist of the local borrow material, which is a silty sand and gravel, with cobbles. Trial placement of the cover would be carried out to confirm its suitability. In addition, a 0.5 m minimum depth of water over the stored tailings will provide an oxygen barrier to prevent acid generation and metal leaching of the solids. An ultimate spillway will modified as necessary to function as the closure spillway.

There will be 1.5 m of freeboard (2 m over spillway invert) above the normal pond water level to provide long term security against wave run-up, crest erosion and temporary spillway blockage.

The seepage collection dam is located approximately 150 m downstream of the main dam (see Drawing D-4005). The seepage dam consists of an unlined compacted earthfill embankment, with a minimum 5 m wide crest at elevation 1284.6 m, and outer slopes at 2H:1V. The seepage dam will become part of the mine access road and the crest width will be widened to suit the road requirements.

7.1 Geotechnical Parameters

The dam foundation consists of up to 20 m thick competent till-like overburden overlying bedrock. A layer of about 0.3 m thick topsoil overlies most of the tailings impoundment area. Test pits excavated in the vicinity of the tailings basin indicate that most of the borrow materials are available from within the footprint of the impoundment.

Table 7.1 summarizes the geotechnical properties of materials used in the seepage and limit equilibrium slope stability analyses. These properties are based on field and laboratory test data acquired for the project and supplemented by general properties available in literature.

Table 7.1 Geotechnical Properties Used in the Slope Stability Analyses

MATERIAL	UNIT WEIGHT[1] γ bulk (kN/m^3)	EFFECTIVE SHEAR STRENGTH	
		Cohesion c' (kPa)	Friction ϕ' (deg)
Foundation soils	22	0	34
Foundation bedrock	27	0	40
Dam Fill	22	0	36
Glacial Till	22	0	36
Tailings	22	0	25
Geomembrane liner	-	-	-

[1]Bulk unit weight is the in situ wet density.

7.2 Slope Stability Analyses

Static and pseudo-static stability analyses were carried out using the computer program SLOPE-W (Geo-Slope 2004) and the Morgenstern-Price method to determine the factor of safety. Analyses were carried out on sections for the Starter Dam, Ultimate Dam, and seepage collection dam. The results are summarized in Table 7.2. A summary of the stability analyses and figures depicting the analysis results are provided in Appendix I, Part VI.

Pseudo-static slope stability analyses were carried out using a seismic coefficient (k_h) of 0.125, corresponding to a design earthquake magnitude of 7.2, based on interpolation from Seed (1979). In the analyses, no seismic-induced excess pore pressure was assumed in either the dam or foundation material.

Table 7.2 Summary of Safety Factors for Tailings Dam and Seepage Dam

DAM	FACTORS OF SAFETY	
	STATIC	PSEUDO-STATIC[1]
Starter Dam	1.6	1.3
Ultimate Dam	1.6	1.2
Seepage Dam	1.5	1.2

[1]Pseudo-static analysis used a seisimic coefficient = 0.125 g.
[2] Starter Dam elevation analyses was 1306.5 m and Ultimate Dam elevation analysed was 1313.5 m…..….

The geosynthetic liner will be anchored in a trench, as shown on Drawing D-3007, which is sufficient to maintain the stability of the liner sliding along the liner/dam fill interface.

Dam Foundation Liquefaction Assessment

The liquefaction assessment was carried out in general accordance with the Seed simplified approach as described in Youd et al. (2001). The earthquake induced Cyclic Stress Ratios (CSR) were computed using the Seed's simplified relationship for level ground conditions. The Cyclic Resistance Ratios (CRR) were estimated based on Standard Penetration Test (SPT) $(N_1)_{60cs}$ values derived from the measured SPT and Large Penetration Test (LPT) blow count data. The factor of safety against liquefaction (FOSLiq), which is defined as the ratio of CRR to CSR was determined to evaluate the liquefaction potential of granular soils at the site. Table 7.3 shows the liquefaction assessment based on the LPT data at test holes TH05-07 and TH05-08 and SPT data at test holes, TH05-09 and TH05-10.

Based on the seismic hazard analyses, the following two deterministically based design earthquake scenarios were considered in the liquefaction assessment:

Scenario 1 (Probabilistic): Earthquake with magnitude M7 and Peak Horizontal Ground Acceleration (PHGA) of 0.22 g.

Scenario 2 (Deterministic): Earthquake with magnitude M6 and PHGA of 0.34 g.

The PHGAs listed above are representative for the "firm ground" conditions and they were amplified at the surface. The conventional method was used to determine the LPT/SPT blow counts N_{LPT}/N_{SPT}. If refusal was reached after 150 mm of penetration during the LPT or SPT testing, the LPT/SPT blow counts were estimated based on the data up to the point of refusal.

As can be seen from Table 7.3, the measured SPT and LPT data at these test hole locations indicate that liquefaction will not occur under either design earthquake scenario.

Table 7.3 Dam Foundation Liquefaction Assessment Based on LPT/SPT Data

TEST HOLE	DEPTH (m)	SPT/ LPT	SPT or LPT BLOWCOUNT NLPT or NSPT	SPT $(N_1)_{60}cs$	EARTHQUAKE SCENARIO 1 (M=7, PGA=0.22g)			EARTHQUAKE SCENARIO 2 (M=6, PGA=0.34g)		
					CRR	CSR	FOS_{Liq}	CRR	CSR	FOS_{Li}
TH-07-7	1.52	LPT	101	112	>0.6	0.38	>1.5	>0.8	0.45	>1.8
	3.05	LPT	81	89	>0.6	0.37	>1.5	>0.8	0.44	>1.9
	4.57	LPT	58*	52	>0.6	0.37	>1.5	>0.8	0.44	>1.9
	6.10	LPT	60*	46	>0.6	0.37	>1.5	>0.8	0.43	>1.9
	9.14	LPT	70*	44	>0.5	0.36	>1.5	>0.8	0.42	>1.9
	12.19	LPT	Refusal	-	-	0.33	-	-	0.39	-
	15.24	LPT	Refusal	-	-	0.29	-	-	0.35	-
	18.29	LPT	Refusal	-	-	0.26	-	-	0.31	-
	21.34	LPT	Refusal	-	-	0.23	-	-	0.27	-
	24.38	LPT	Refusal	-	-	0.21	-	-	0.25	-
TH05-8	1.52	LPT	40*	44	>0.6	0.38	>1.5	>0.8	0.45	>1.8
	3.05	LPT	47*	51	>0.6	0.37	>1.5	>0.8	0.44	>1.9
	4.57	LPT	48*	43	>0.6	0.37	>1.5	>0.8	0.44	>1.9
	6.10	LPT	42*	32	>0.6	0.37	>1.5	>0.8	0.43	>1.9
	9.14	LPT	50*	31.5		0.36	>1.5	>0.8	0.42	>1.9
	12.19	LPT	60*	33.5		0.33	>1.5	>0.7	0.39	>1.9
	15.24	LPT	120*	59.4		0.29	>1.5	>0.7	0.35	>1.9
	18.29	LPT	Refusal	-	-	0.26	-	-	0.31	-
TH05-9	1.52	SPT	57	97	>0.6	0.38	>1.5	>0.8	0.45	>1.8
	3.05	SPT	51	86	>0.6	0.37	>1.5	>0.8	0.44	>1.9
	4.57	SPT	125	172	>0.6	0.37	>1.5	>0.8	0.44	>1.9
	6.10	SPT	40*	48	>0.6	0.37	>1.5	>0.8	0.43	>1.9
	9.14	SPT	52*	51	>0.5	0.36	>1.5	>0.8	0.42	>1.9
	12.19	SPT	Refusal	-	-	0.33	-	-	0.39	-
	15.24	SPT	Refusal	-	-	0.29	-	-	0.35	-
	18.29	SPT	Refusal	-	-	0.26	-	-	0.31	-
	21.34	SPT	Refusal	-	-	0.23	-	-	0.27	-
	24.38	SPT	Refusal	-	-	0.21	-	-	0.25	-
	27.43	SPT		-	-	0.20	-	-	0.24	-
	30.48	SPT	Refusal	-	-	0.19	-	-	0.23	-
TH05-10	1.52	SPT	40*	68	>0.6	0.38	>1.5	0.8	0.45	>1.8
	3.05	SPT	40*	67	>0.6	0.37	>1.5	0.8	0.44	>1.9

Notes: * Refusal reached between 150mm and 450 mm penetration and N_{LPT}/N_{SPT} estimated based on blow counts up to the point of refusal; LPT = Large Penetration Test ; SPT = Standard Penetration Test

8. WATER MANAGEMENT INFRASTRUCTURE

The water management infrastructure associated with the tailings impoundment and dam includes the following (refer to Drawing D-3001):

- Operational diversions: Diversion Ditches A and B to direct clean surface water runoff around the tailings storage facility;
- Seepage collection dam and pond to collect runoff from the downstream dam face, and as a contingency measure to collect impoundment/dam seepage;
- Starter Dam spillway; and
- Ultimate Dam spillway.
- Tailings and reclaim pipelines and reclaim pump barge
- Water treatment plant (located at the Industrial Complex)

8.1 Surface Water Diversion Ditches

Two diversion ditches associated with the tailings facility are Ditch A and Ditch B as shown in Drawings D-3032 and D-3033 (Sheets 1 and 2), respectively. The ditches consist of open channel excavations with corrugated steel pipe (CSP) culverts in areas where the gradients are steeper than 2%. The ditch side slopes are typically 2H:1V. Approximate lengths and gradients of the ditches are provided in Table 8.1.

Ditch A:

Runoff from the catchment northwest of the tailings impoundment will be intercepted by the mine access road upstream of the tailings impoundment. This runoff will be picked up by Ditch A and conveyed to Go Creek downstream of the airstrip.

Ditch B:

Ditch B will intercept runoff directly north and northeast of the tailings basin. Ditch B will direct the flow, via a culvert, to Go Creek downstream of the seepage collection pond.

Table 8.1 Length and Gradient of Diversion Ditches

DIVERSION DITCH	APPROX. LENGTH (m)	GRADIENT (%)	
		Minimum	Maximum
Ditch A – open section	220	0.5	0.5
Ditch A – culvert section	270	0.47	8.2
Ditch B – open section	760	1.0	1.96
Ditch B- culvert section	510	1.0	9.74

The catchment area for each diversion ditch and the estimated flows for short and long term duration storms are presented in Table 8.2. These flows were estimated using the Rational Method with an assumed runoff coefficient of 0.6.

Table 8.2 100-year Flood Flows for Ditches A and B based on Rational Method

DIVERSION DITCH	CATCHMENT AREA (ha)	RAINSTORM DURATION			
		25 Minutes*		24 Hour	
		Rainfall (mm)	Peak Flow (m^3/s)	Rainfall (mm)	Average Flow (m^3/s)
Ditch A	67	12	3.2	53	0.25
Ditch B	33	12	1.6	53	0.12

*NOTE: The times of concentration for Ditch A and Ditch B is approximately 25 minutes.

Regional analysis of snowmelt indicates a peak annual daily change in snowpack of about 5 cm to 15 cm, with a mean of 8.6 cm. Assuming a snowmelt rate of 15 cm/day, the snow water equivalent is approximated as 15 mm over a 12 hour period. If this snowmelt is added to the peak design flow values presented in Table 8.2, the flows in Ditch A and Ditch B will increase by 0.2 m^3/s and 0.1 m^3/s, respectively. The mean annual and seasonal flows anticipated in the ditches are summarized in Table 8.3.

Table 8.3 Mean Annual and Seasonal Flow in Diversion Ditches

DIVERSION DITCH	MEAN FLOWS (m^3/s)		
	Mean Annual	Summer (High)	Winter (Low)
Ditch A	0.007	0.006 – 0.012	≈ 0
Ditch B	0.006	0.005 – 0.009	≈ 0

The diversion ditches are temporary structures and will be decommissioned upon mine closure. Since the expected mine life is only 9 years, and since the likelihood of a 100-year storm event

occurring during the 9 years is relatively small, the design of the various components of Ditch A and Ditch B was carried out on the following basis:

- The open channel portion of the ditch is sized to carry the 100-year peak flow corresponding to the time of concentration, plus a 0.3 m freeboard;
- The open channel portion of the ditch has erosion protection up to the 100-year, 24-hour flow. Erosion and repair of the ditch is expected for flows exceeding the 100-year, 24-hour event. The ditches will be seeded with a native grass species.
- The pipe portion of the ditch was sized to carry the 100-year, 24-hour flow (Table 8.2) plus snowmelt (15 mm snow water equivalent over 12 hours). Pipe diameter is 800 mm.

8.2 Tailing Dam Spillways

The spillway design is based on routing the design flood through the impoundment without overtopping the tailings dam. The spillway inlet is a trapezoidal channel with a base width of 3 m and 2H:1V side slopes. The channel invert at the control section near the dam centerline is located 2.0 m below the dam crest level.

Site investigations indicated that the insitu material along the spillway channel will consist primarily of medium dense to dense silty sand and gravel with cobbles.

8.2.1 Hydraulic Design Parameters

Design Flood Selection

The expected 9 year operating life of the mine was taken into account in the selection of the design floods for temporary facilities, such as the Starter Dam spillway and the Seepage Collection Dam spillway. A 200-year design return period was selected for the Starter Dam spillway, with the proviso that the spillway would pass the 10,000-year flood without overtopping the dam. The spillways were sized based on the criteria and assumptions below.

Table 8.4 Flood Design Criteria for Tailings Dam Spillways

STAGE	DESIGN FLOOD RETURN PERIOD (yrs)	COMMENTS
Starter Dam Spillway	200 & 10,000	Assume that upland surface water diversion ditches have failed.
Ultimate Dam Spillway	10,000	Assume that upland surface water diversion ditches are decommissioned.

Inflow Hydrographs

The 1 to 30-day flood inflow hydrographs for the Tailings Pond were developed using the following method:

- The peak runoff for short duration (i.e., 30 min.) rainfall was estimated using the Rational Method with a runoff coefficient of 1.0; and
- The estimated peak runoff plus 2 to 4 times the estimated long duration (i.e., 1 to 30-day) runoff volume were used to develop the inflow hydrograph.

The above method used to develop the inflow hydrographs tends to conservatively over-estimate the rise in pond water level, and pond outflow rates.

Flood Routing

The inflow hydrographs for various scenarios were routed through the Tailings Pond in order to estimate the peak pond water level and the peak spillway discharge. The size of the spillway was determined such that adequate dam freeboard is available under flood conditions with a reasonable spillway size. The results of the flood routing are summarized in Table 8.5.

Table 8.5 Tailings Dam Spillways - Design Flood Flows and Freeboards

DAM	CATCH-MENT AREA (ha)	SURFACE WATER DIVERSION DITCHES	DESIGN STORM	PEAK OUTSFLOW (m^3/s)	DAM FREEBOARD (m)
Starter	16	Functioning	200-yr, 30-min	0.0	2.2
	105	Not functioning	200-yr, 30-min	0.0	2.1
			10,000-yr, 30-min	0.0	2.0
			10,000-yr, 30-days	8.2	0.8
Ultimate	105	Decommissioned	10,000-yr, 30-min	0.2	1.95

Notes:

1. The peak design flows and freeboard for spillways are based on a 3-m wide trapezoidal channel with 2H:1V side slopes, with channel invert located 2.0 m below dam crest level.
2. For routing of the 200-year flood through the Starter Dam, the 0.3 m flood storage allowance is assumed to be fully available. That is, the initial pond level at the beginning of the storm is assumed to be 0.3 m below the spillway invert.
3. For routing of the 10,000-year flood, the flood storage allowance is assumed to be zero for both the Starter Dam and the Ultimate Dam.
4. Minimum freeboard for spillway channel = 0.6 m.

Starter Dam Condition

The 10,000-year, 30-day storm with the diversion ditches assumed to have failed was found to be more critical in terms of flood discharge rate and dam freeboard. The peak inflow to the pond for the 10,000-year, 30-day storm is estimated to be about 9.5 m^3/s, which attenuates to about 8.2 m^3/s as the flood passes through the pond and the spillway. The pond water level will peak at El. 1305.7 m, thus leaving a freeboard of about 0.8 m between the dam crest and the peak flood level.

Ultimate Dam Condition

The 10,000-year, 30-days flood inflows for the Ultimate Dam will be similar to that for the Starter Dam, but the flow will attenuate to about 7.7 m^3/s as the flood passes through the pond, because of the larger pond size.

For the 10,000-year, 30-min. storm, minimal rise in pond water level is expected and about 1.95 m of freeboard between the top of the dam crest and the peak flood level will be available. For the 10,000-year, 30-days storm, the available freeboard will reduce to about 0.95 m, which is considered to be reasonable for such an extreme event.

Effect of Snowmelt

The flood routing presented above is based on rainfall. The effect of combined runoff from rainfall and snowmelt on the Tailings Pond freeboard was also investigated. The maximum snowmelt rate of 15 mm/day water equivalent was added as the base flow of the rainfall inflow hydrograph and the combined runoff was routed through the Tailings Pond.

The flood routing indicates that the pond water level will rise an additional 0.0 m to 0.05 m due to the snowmelt. Therefore, the freeboard between the top of the dam and the peak flood level could be 0.05 m less than that indicated in Table 8.5. The reduced freeboard would still be within the acceptable range of flood freeboard for this type of facility.

8.2.2 Spillway Construction Components

The starter and ultimate spillways will be excavated and lined with a bedding layer and a rip rap layer as shown on Drawing D-3031 and Drawing D-3034, respectively. In addition, the spillway alignments cross the main access road to the mine and culverts will be required for both spillways. Upon closure, the road and culverts would be decommissioned. Erosion protection will be provided along the spillway channel excavated for removal of the culvert.

8.3 Seepage Collection Infrastructure

8.3.1 Seepage Collection Pond

A Seepage Collection Pond will be constructed downstream of the tailings dam to collect potential seepage and local runoff for subsequent return to the tailings impoundment. Flow into the collection pond will be mainly due to precipitation and runoff from the downstream tailings dam slope and the immediate catchment area of the seepage pond, with little or no seepage contribution from the lined tailings impoundment. The quality of the pond water will be monitored and, if it meets discharge quality criteria, it will be discharged to Go Creek; otherwise it will be pumped into the tailings impoundment.

The seepage collection facility will consist of a 5 m high, 5 m wide dyke forming a collection pond with a capacity of approximately 5,000 m^3 and a spillway at the dam's northwest abutment

(Drawings D-3004 and D-3005). The dam will be a homogeneous earthfill embankment constructed of silty sand and gravel material by a cut and fill operation to 1284.6 m elevation. The pond will be approximately 170 m long, 40 m wide at the widest part, and 4 m deep near the centre of the pond. The seepage dam and spillway will be used during mine operations, and decommissioned when no longer required at closure.

The maximum pumping rate likely required during operations is 20 L/s. The maximum static head for pumping water from the Seepage Collection Pond to the Tailings Pond is 27 m to the Starter Dam crest and 34 m to the Ultimate Dam crest. At the rate of 20 L/s, it will take about 3 days to pump the 5,000 m^3 pond storage capacity. A 20 L/s pumping rate is approximately equal to the average pond inflow rate for a 5-year, 24-hour rainfall event.

8.3.2 Seepage Dam Spillway

The seepage dam spillway is designed to route flood water through the pond without overtopping the seepage dam crest. The spillway will consist of an 850 mm diameter culvert discharging directly into Go Creek and the culvert invert is located 1.5 m below the dam crest (refer to Drawing D-3005).

The design criterion for the seepage spillway is the 100-year return period (Table 8.6). The design criterion was selected based on the rationale that the dam is very low (5 m), tailings will not be stored behind the dam, and there is a low probability that contaminated seepage will be collected within the pond.

The estimated peak spillway discharge is 0.7 m^3/s, and the estimated dam freeboard to the flood level is 0.5 m (Table 8.6). This flow can be passed with a 850 mm diameter corrugated steel pipe (CSP), which will extend from the west side of the dam to Go Creek, as shown on Drawing D-3006.

Table 8.6 Seepage Dam Spillway Design Flood Flow and Freeboards for

CATCHMENT AREA (ha)	SURFACE WATER DIVERSION DITCHES	DESIGN STORM	PEAK DESIGN FLOW (m^3/s)	DAM FREEBOARD (m)
9	Functioning	100-yr, 10-min	0.7	0.5

The spillway culvert will be inspected a minimum of three times per year, with particular attention to the inspection prior to the spring freshet. This will ensure that the culvert is not blocked. The performance of the spillway will also be monitored in the operating period during high runoff periods, while the mine is in operation. Potential problems, if any, will be identified and remedial actions taken as necessary.

9. CONSTRUCTION

9.1 Construction Plan

The construction of the tailings facility occurs in three stages over the life of the operation and includes Starter Dam and Impoundment construction, Ultimate Dam and Impoundment construction and closure. The main activities occurring in each of the stages are summarized below.

9.1.1 Stage I Starter Dam and Impoundment (Year 2008 to 2010)

In winter 2008/2009 site preparation work will be completed, including:

- Construction of a drainage channel through the thalweg of the valley to expedite dewatering of the area, in preparation for other construction activities and spring runoff.
- Construction of Diversion Ditch A and Diversion Ditch B to reduce the quantity of water to be managed during construction of the facility in 2009.
- Stripping of organic material from within the impoundment and dam footprint to allow an "early" construction start-up in 2009; and

Once the winter period is over, and approval for the tailings facility construction is received, activities scheduled for the spring to fall 2009 period include:

- Construction of liner underdrain;
- Grading and proof rolling of dam impoundment footprint;
- Excavation of borrow from the impoundment interior and construction of the Starter Dam and Seepage Collection Dam. Construction of the Stage 1 perimeter access road at El. 1305 m;
- Construction of the Starter Dam Spillway (excavation of channel and placement of culverts and riprap;
- Installation of dam instrumentation;
- Final grading and proof rolling of impoundment footprint in preparation for placement of the liner. Placement of liner bedding in areas of "rough" foundation

base. Excavation of a liner anchor trench around the perimeter of the impoundment and dam;

- Placement of the liner and backfilling of the liner anchor trench; and
- Placement of material over the liner to form a pad for the water reclaim barge.

Prior to the startup of the mill in June 2010, the following activities will occur to enable full operation of the tailings facility:

- Selective diversion of surface water from Ditch A and/or Ditch B to provide initially for 5,000 m^3, ramping up to 40,000 m^3 of water for start-up of the mill;
- Placement of tailings delivery pipeline and water reclaim pipeline;
- Installation of water reclaim pump barge and associated electrical works.
- Commencement of mill processing and discharge of tailings, and reclaim of water.

9.1.2 Stage II Ultimate Dam and Impoundment (Year 2011)

During the first full year of operation (2011), construction of the Ultimate Dam will commence in late fall. In order to complete this work, the following activities will take place from the spring to fall:

- Foundation preparation for Ultimate Dam footprint and proof rolling of the foundation;
- Excavation of borrow from within the impoundment area and raising of the dam from the downstream side. If sufficient materials are not available then an alternative borrow area located just north of the impoundment will be used for dam fill (See Drawing D-3001);
- Construction of the Stage 2 perimeter access road at El. 1313.5 m (See Drawing D-3008);
- Excavation of the Ultimate Spillway and placement of riprap bedding and riprap;
- Final grading and proof rolling of Ultimate Impoundment footprint in preparation for placement of the liner. Placement of liner bedding in areas of “rough”

foundation base. Excavation of a liner anchor trench around the perimeter of the impoundment and dam;

- Placement of the liner and backfilling of the liner anchor trench.

9.1.3 Closure (Year 2019 to 2022)

Closure of tailings facility will take place over a few years and will be integrated with water quality management. Consequently the timing of the works will vary to suit discharge requirements. The main components of the closure will include:

- Continued operation of the water treatment plant, until discharge objectives are met;
- Placement of granular soil or rockfill layer on top of the ice in the first winter. The soil will settle during the spring thaw and the impoundment will be surveyed to confirm the extent of the soil. If required to achieve 1.0 m of cover, a second soil layer will be placed in the 2nd winter;
- Final adjustment of dam heights and spillway invert elevations, if required, to maintain 0.5 m minimum water cover;
- Placement of a 10 m wide non acid generating rockfill along the upstream side of the dam crest to provide additional security for long term dam safety and to keep the water pond away from the dam;
- Decommissioning of the Seepage Dam when the seepage water quality is suitable for discharge;
- Decommissioning of Ditch A and Ditch B upon cessation of mine operations; and
- Reclamation of the dam slopes with placement of topsoil and planting of suitable vegetation (conducted during operations as part of the progressive reclamation program).

9.2 Construction Materials and Details

The main construction materials and details for the construction of the dams and spillways are summarized below.

General Dam Fill

General fill will be borrowed from within the impoundment area and used to construct the homogeneous dams. The material consists of a well-graded silty sand and gravel, with cobbles. Finer materials will be placed towards the upstream slope of the dam as well as adjacent to the glacial till zone. Coarser materials will be placed towards the downstream slope of the dam.

Glacial Till Zone

The glacial till zone will be placed in the Stage 2 dam. The till will be placed in a 5 m wide zone on the upstream side of the dam between the elevation of the Starter Dam (1306.5 m) and the Ultimate Dam (1313.5 m), as a "backup" to the geosynthetic liner. The glacial till zone will have a minimum of 20% fines passing the 74 micron sieve size.

Geosynthetic Liner

A 40 mil thick LLDPE geosynthetic liner will be placed over the base of the tailings impoundment and extended up the upstream face of the dam and keyed into the dam crest and the perimeter of the impoundment.

Liner Underdrain

A liner underdrain will be placed in the valley thalweg to provide positive drainage under the geosynthetic liner to prevent liner uplift due to potential artesian groundwater. The underdrain will consist of an excavated ditch filled with drain gravel and a perforated pipe, protected with geotextile and sand. The extension of the drain under the dam will be with a solid pipe, and impervious trench backfill, to allow water transport beneath the dam, should the pipe plug.

Liner Bedding

It is anticipated that some bedding materials for the liner may be required in local areas where grading and proof-rolling of the stripped foundation surface can not achieve a smooth and even

surface for liner placement. The bedding material will consist of screened sand and fine gravel with a maximum particle size of 25 mm.

Liner Protection

In local areas where temporary construction access for the pump barge may be required, a 300 mm thick low-permeability protection layer of silty overburden material, with no sharp coarse particles, will be first placed over the liner.

Riprap and Bedding

The riprap material will consist of hard durable rock obtained from rock quarries along the access road. Riprap bedding will be processed from granular materials in Km 19 borrow area.

Culverts

Corrugated steel pipe culverts will be used for the diversion ditches and the Starter Dam and Seepage Dam Spillways.

9.3 Construction Methods

Construction of the facility will use best practices for control of erosion and sediment, as outlined in *General Site Plan* (2008-04). The main work components are as follows:

Foundation Preparation

The dam foundation areas will be drained with perimeter diversion ditches and internal ditches, as required to ensure a drained foundation suitable for placement of fill materials. Surface water flows, if present during construction, will be cut off by an upstream ditch and collected in a sump and pumped to the downstream side of the dam to settle out sediments before discharging into Go Creek. The dam footprint will be stripped of all organic, loose and soft materials and proof-rolled with 5 passes of a 10-tonne vibratory roller compactor.

Liner Underdrain

The extent of the underdrain will be determined by the Engineer in the field with observation of the groundwater conditions. A 1 m deep ditch will be excavated leading to the downstream toe of the dam. The ditch will be filled with a geotextile, drain gravel and a perforated drainage pipe and covered with a protective sand layer. Under the dam embankment, a solid pipe and impervious trench backfill will be used.

Fill Placement

The general dam fill and glacial till fill will be spread in 300-mm thick horizontal layers and compacted to a density of 95% of the Standard Proctor Maximum Density (SPMD). The water content of the fill will be not more than 2% above or 4% below the optimum SPMD water content. All fills will be placed in the "dry".

Geosynthetic Liner

The liner system will be constructed in 2 stages, as shown on Drawing D-3006 and Drawing D-3008. Overburden material in the impoundment will be excavated and used as damfill. Typical excavation and fill sections for the impoundment are shown in Drawing D-3007 and Drawing D-3009.

Ground preparation in the area of the geosynthetic liner will consist of stripping and grading, followed by proof-rolling. Cobbles, stones, sticks or any other debris that could potentially puncture the liner will be removed. Irregularities in the surface will be levelled, and finer bedding material will be used to cover localized areas with surficial coarse gravel, cobbles or boulders. The geosynthetic liner will be placed in segments and joined in the field. The liner will be placed over the prepared foundation surface in the tailings impoundment and along the upstream face of the dam. The liner will be anchored into the crest of the dam with a 0.6 m deep trench, backfilled with compacted soil.

Seepage Collection Ditch

A provision for a seepage collection ditch is included in the design, however it is very unlikely that the ditch will be required to collect seepage. Nonetheless, a V-shaped ditch would be constructed with a dozer along the downstream toe of the dam to direct seepage and runoff from the face of the dam to the seepage collection pond.

Spillway Control Section

If the control section of the spillway channel, across the dam crest, is excavated through soil, then it will be lined with riprap. This is not only to provide erosion protection but also to discourage future vegetation growth in the channel. The channel side slopes will be excavated at 2H:1V. However, this design slope will be assessed during construction. The side slopes will be adjusted, if necessary, to provide long-term stable slopes.

If the control section of the spillway channel is located in bedrock, then the channel side slopes will be selected based on rock quality. Depending on the depth of cut and rock quality, benches may be provided to intercept rockfalls. All loose rock will be scaled and removed from the channel during excavation and, if required, during operation and closure phases.

The spillway will be constructed using conventional earthworks equipment in conjunction with drilling and blasting for sections of the spillway excavation through bedrock.

9.4 Bill of Quantities

A Bill of Quantities (BOS) for the tailings facility is shown in Table 9.1. The BOQ's are based on a detailed site survey (< 1 m contour accuracy) carried out after completion of the stripping of the dam and impoundment areas. The borrow material for the starter dam will come from the impoundment area. The borrow material for the ultimate dam will come from the impoundment area and from the borrow pit. The actual amount of borrow material available within the impoundment area will depend on the groundwater conditions and will be maximized as far as practical.

Table 9.1 Bill of Quantities for the Tailings Dam and Associated Water Management Structures

ITEM	DESCRIPTION	Total Quantity	UOM	Staged Quantities 1	2	Closure
100	**Site Preparation**					
101	Clear and grub (grasslands and shrubs)	173,600	m^2	101,000	72,600	
102	Strip topsoil embankment footprint (assume 1.4 m)	58,000	b. m^3	28,500	29,500	
103	Strip topsoil impoundment (assume 1.4 m)	185,040	b. m^3	112,900	72,140	
104	Excavate unsuitable soils (allowance)	6,000	b. m^3	6,000		
105	Proof roll embankment footprint	41,400	m^2	20,400	21,000	
200	**Borrow Area Development**					
201	Clear and grub	20,000	m^2	10,000	10,000	
202	Strip topsoil (assume 1.4 m)	28,000	b. m^3	14,000	14,000	
203	Reclamation	2.0	ha			2.0
300	**Tailings Dam**					
301	General Fill - From impoundment	198,800	c. m^3	115,100	83,700	
302	Glacial Till - From impoundment	14,300	c. m^3	0	14,300	
303	General Fill - From borrow	114,000	c. m^3	0	114,000	
304	Glacial Till - From borrow	14,300	c. m^3	0	14,300	
305	Bedding - Access ramp to pump barge	1,700	c. m^3	910	790	
306	General Fill - Access ramp to pump barge	7,500	c. m^3	3,920	3,580	
400	**Geomembrane Liner - Tailings Area**					
401	Shape foundation, as directed (only areas not used as borrow, El. 1288 to 1298)	4,200	c. m^3	4,200		
402	Liner Anchor Trench (by others)	2,770	m	1,110	1,660	
403	Liner Bed Preparation - Scarify and compact impoundment area	131,700	m^2	78,800	52,900	
404	Liner Bed Preparation - Trim, compact dam slope	22,700	m^2	11,100	11,600	
405	Liner Bedding (assumes 10% of impoundment area)	1,976	c. m^3	1,182	794	
406	Geomembrane - Impoundment (by others)	154,400	m^2	89,900	64,500	
407	Liner Underdrain - Trench excavation	90	b. m^3	90		
408	Liner Underdrain - Perforated HDPE pipe (200mm diam.)	200	m	200		
409	Liner Underdrain - Solid HDPE pipe (200 mm diam.)	100	m	100		
410	Liner Underdrain - Filter fabric	500	m^2	500		
411	Liner Underdrain - Drain rock backfill	78	c. m^3	78		
412	Liner Underdrain - Impervious backfill below dam embankment (50 mm-minus)	27	c. m^3	27		
500	**Water Management**					
501	Overburden Excavation - Ditch A	8,710	b. m^3	8,710		
502	Overburden Excavation - Ditch B	32,800	b. m^3	32,800		
503	Overburden Excavation - Starter Dam Spillway	3,200	b. m^3	3,200		
504	Overburden Excavation - Ultimate Dam Spillway	14,000	b. m^3		14,000	
505	Overburden Excavation - Seepage Collection Channels (assumes 1mx1m)	800	b. m^3	700	100	
506	Overburden Excavation - Stilling Basins (3 total)	190	b. m^3	190		
507	Filter 1 - Starter Dam Spillway	69	c. m^3	69		
508	Filter 1 - Ultimate Dam Spillway	860	c. m^3		860	
509	Filter 2 - Ultimate Dam Spillway	320	c. m^3		320	
510	Riprap A - Starter Dam Spillway	170	c. m^3	170		
511	Riprap A - Ultimate Dam Spillway	710	c. m^3		710	
512	Riprap A - Stilling Basins (3 total)	90	c. m^3	90		
513	Riprap B - Ultimate Dam Spillway	580	c. m^3		580	
514	Riprap F - Ultimate Dam Spillway	1,600	c. m^3		1,600	
515	CSP Culvert (800 mm diam.) - Ditch A	260	m	260		
516	CSP Culvert (800 mm diam.) - Ditch B	520	m	520		
517	CSP Culvert (1200 mm diam.) - Starter Dam Spillway	120	m	120		
518	CSP Culvert (1200 mm diam.) - Ultimate Dam Spillway	75	m		75	
519	Culvert Bedding/backfill - Ditch A	760	c. m^3	760		
520	Culvert Bedding/backfill - Ditch B	1,700	c. m^3	1,700		
521	Culvert Bedding/backfill - Starter Dam Spillway	330	c. m^3	330		
522	Culvert Bedding/backfill - Ultimate Dam Spillway	210	c. m^3		210	
523	General Fill - Ditch A (culvert backfill)	2,000	c. m^3	2,000		
524	General Fill - Ditch B (culvert backfill)	5,700	c. m^3	5,700		
525	General Fill - Starter Dam Spillway (culvert backfill)	300	c. m^3	300		
526	General Fill - Ultimate Dam Spillway (culvert backfill)	190	c. m^3		190	
526	Grass seeding - Channel Slopes	3.3	ha	3.1	0.2	
600	**Seepage Control**					
601	Seepage Dam - Excavation (assume 1.4 m topsoil)	8,400	b. m^3	8,400		
602	Seepage Dam - General Fill	12,100	c. m^3	12,100		
603	Seepage Dam Spillway - CSP Culvert (850 mm diam.)	100	m	100		
604	Seepage Dam Spillway - Overburden Excavation	980	b. m^3	980		
605	Seepage Dam Spillway - Culvert Bedding/Backfill	930	c. m^3	930		
700	**Closure**					
701	Topsoil Cover (assume 0.5 m over outer dam slope)	10,400	c. m^3			10,400
702	Ditch A					
	A - Remove and dispose culvert	260	m			260
	B - Backfill ditch upstream of Ultimate Dam Spillway	7,000	c. m^3			7,000
	C - Grass seeding and re-vegetation	0.40	ha			0.40
703	Ditch B					
	A - Remove and dispose culvert	520	m			520
	B - Backfill ditch	25,100	c. m^3			25,100
	C - Grass seeding and re-vegetation	2.2	ha			2.2
704	Neutral Rock on Tailings Dam Beach (10 m width)	24,500	c. m^3			24,500
705	Granular Cover on Tailings (1 m thickness)	122,000	c. m^3			122,000
706	Remove Seepage Dam	12,100	b. m^3			12,100
707	Reclamation - dam slopes	2.1	ha			2.1
708	Reclamation - Seepage Dam & Pond	0.7	ha			0.7

Quality Assurance/Quality Control

All construction work will be monitored by a qualified engineer. The main quality assurance/quality control (QA/QC) components include the following:

- Foundation preparation review and approval;
- Density and moisture content testing of constructed fill for each lift or every 500 m^3 for till and 1,000 m^3 for general fill, whichever is more frequent;
- Gradation analysis of fills every 1,000 m^3 for till and 2,000 m^3 for general fill;
- Liner joint tests, to be carried out by the liner installation contractor;
- Survey control of fill placement and instrument locations; and
- Construction progress reviews, as required.

Diversion ditch and spillway QA/QC measures include general construction survey monitoring of the channel excavation and placement of riprap bedding and riprap for design compliance. The riprap material will be checked visually for quality and size assessment during placement. In addition, the uniformity, thickness and placement limits of the placed riprap will be monitored. Riprap gradation will also be measured if required.

A QA/QC plan will be prepared prior to construction.

10. WATER TREATMENT PLANT

The tailings impoundment will be operated as a closed system with surplus water treated prior to release. Water treatment and discharge will occur during the six month, ice-free window of May to October. For the purposes of developing and designing a water treatment strategy, a tailings supernatant treatment rate of approximately 30 m^3/h (9 L/s) has been assumed. The water treatment plant will be located within the Industrial Complex area. The design of the water treatment plant is being carried out by Lorax Environmental Services Ltd. (Lorax) and will require set up of a full scale pilot plant in 2010 once actual process water is available to properly develop and optimize the plant.

The expected chemistry of Wolverine tailings supernatant is presented in Table 5.4 and illustrates a wide range of parameters requiring treatment prior to discharge including total CN, Al, As, Cd, Cu, Pb, Se and Zn. Thiosalts are also present in tailings supernatant and would be expected to oxidize within the impoundment and generate acidity. Based on the bench scale tests conducted on samples obtained from metallurgical lock-cycle testing, treatment of these waters requires a two-stage process. Testwork has focused on first using a high density sludge (HDS) with iron salt addition followed by a polishing stage utilizing biological reduction. Bioreactor testwork was conducted by Inotec at the University of Utah, and the work was supervised by Lorax.

10.1 High Density Sludge (HDS) Water Treatment

10.1.1 Bench Scale Testing Results of HDS

Due to the low iron concentration and high selenium concentration in the tailings water, it is recommended to add iron salt to provide iron for co-precipitation of other metals and effective adsorption of selenium onto ferrihydrite surface. The addition of iron enhances metals removal to extremely low concentration, and the resulting precipitate has shown to be chemically stable. The addition of iron salts is a common practice in North America and has been used to remove contaminants.

For these tests, the tailings water was neutralized to 4 different pH ranges with high iron to metals ratio. Iron was added as ferric sulphate and at 200:1 iron to selenium ratio. The ratio was based on the molar concentration in solution.

The results are shown in Table 10.1 below. As illustrated in the table, most of the metals can be treated to below discharge limit using HDS process with iron salt addition. However, due to elevated selenium levels, a secondary polishing stage will be needed to meet the discharge limit.

Table 10.1 HDS Effluent Quality Following Treatment (mg/L)

	Test 1	Test 2	Test 3	Test 4
pH	*6.51*	*7.03*	*7.55*	*7.82*
Al	0.002	0.001	0.001	<0.001
Sb	<0.001	<0.001	<0.001	<0.001
As	0.04	0.04	0.05	0.04
Cu	0.07	0.05	0.05	0.06
Cd	0.0006	0.0003	0.0001	<0.0001
Fe	0.04	0.01	0.01	0.02
Pb	<0.0005	<0.0005	<0.0005	<0.0005
Ni	0.02	0.02	<0.01	<0.01
Mn	0.1	0.05	0.04	0.04
Se	4.12	3.98	4.77	5.14
Ag	0.0003	<0.0001	<0.0001	<0.0001
Zn	<0.005	<0.005	<0.005	<0.005

All metals as dissolved

Due to the presence of cyanide, 35% hydrogen peroxide was added to the solution for cyanide destruction and agitated for 30 minutes. Cyanide was reduced from a feed concentration of approximately 3.03 mg/L to 0.41 mg/L.

As illustrated, all parameters are reduced to low concentrations with the exception of Se, which remains at levels on the order of 3.0 mg/L to 5.0 mg/L. Additional removal of Se is required for environmental discharge.

10.1.2 HDS Treatment Process

The HDS Neutralization plant uses well-proven technology to produce clean treated water and a high density sludge containing precipitated metals and gypsum. The high sludge

density is achieved by using recycled sludge mixed with lime slurry as the neutralization agent. A schematic of the HDS water treatment plant and infrastructure is provided in Figure 10-1. A more detailed description of the treatment process is provided below.

Solution entering the plant is directed into Reactor Tank #1 which will overflow (via an upcomer) to Reactor Tank #2. Each Reactor tank will have 30 minutes residence time at design flow and will also receive limed sludge from the sludge/lime mix tank. Iron in the form of ferric sulphate will be added to Reactor #1 to provide sufficient iron to other metals ratio for effective chemical reaction and co-precipitation of other metals. Hydrogen peroxide will be added into Reactor #2. Both Reactor tanks are mechanically agitated and have provision for air sparging to ensure that metals are in their appropriate oxidation state for the desired chemical reaction.

Reactor Tank #2 discharges (via up-comer) into a discharge drop box. Provision will also be made for Reactor #1 to discharge into this box in case Reactor Tank #2 is out of service. From the drop box, the slurry will gravity flow via an open launder to the clarifier center well. Flocculent will be added to the feed launder, with provision for alternative addition points.

The clarifier underflow provides sludge for recycle to the sludge/lime mix tank where the recycled sludge is mixed with lime slurry. This mixture of sludge and lime is used to neutralize the feed solution entering the plant. In addition to the recycle stream, a purge system is also provided and excess sludge is purged for disposal.

The sludge lime mix tank receives sludge from the clarifier continuously. The rate at which sludge is recycled depends on the solution treatment rate, and the solids generation potential of the water to be treated. The sludge/lime mix tank also receives lime slurry from the lime stock tank. The rate of lime addition is controlled by the pH in Reactor Tank #1 (or #2). The sludge/lime mix tank overflows via a launder into Reactor #1, although provision will also be made so it can overflow into Reactor #2 when Reactor #1 is out of service for maintenance.

Clarifier overflow will be directed to the biological treatment system for final polishing and treatment as described below. Residual sludge will be produced at a rate of approximately 260 tonnes per year (~710 kg/d). This material will be blended with the tailings paste backfill cement and placed in the underground voids.

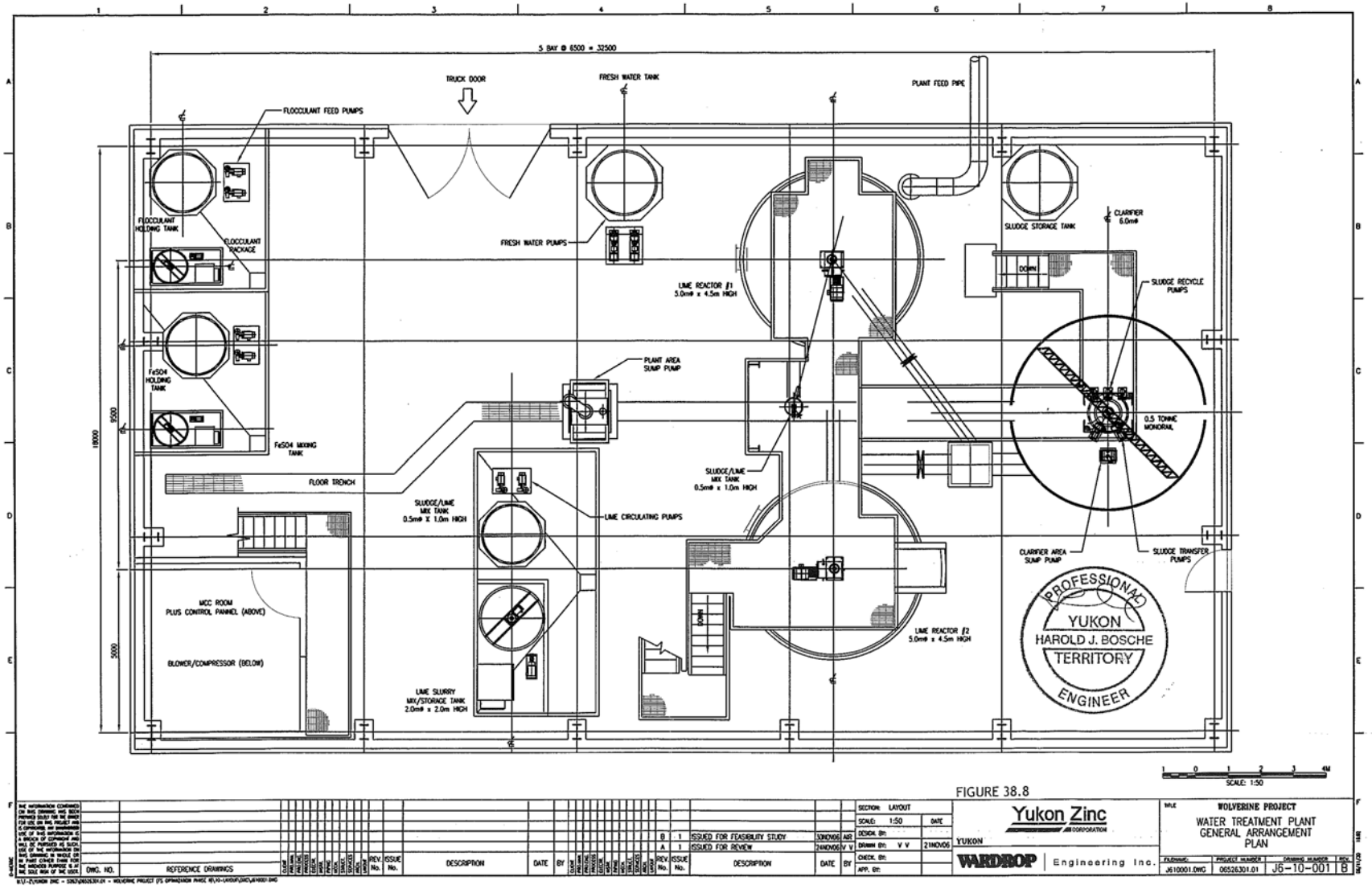


Figure 10-1 Water Treatment Plant General Arrangement Plan

10.2 Bioreactor for Selenium Reduction

Testing of the HDS system indicated good removal of residual cyanide and metal precipitation for essentially all parameters with the exception of selenium. Successful removal of Se to very low levels has been proven using a biological reduction approach. For the Wolverine Project, a bioremediation approach developed and patented by Dr. Jack Adams (University of Utah) has been tested on tailings supernatant water generated from metallurgical testing of Wolverine ore.

The process involves the utilization of naturally occurring bacteria (e.g. *Thauera, Pseudomonas spp*.) immobilized in biofilms in a series of reaction chambers (anaerobic solids bed reactors). A nutrient mixture is added to each bioreactor with an organic substrate to foster growth of microbes that utilize selenate in an analogous fashion to those that reduce sulphate. The result is the conversion of dissolved selenium oxyanions in the water to elemental selenium in the solid phase (Oremland et. al., 1989). There is a potential for economic recovery of the elemental Se produced by this process.

Inorganic selenium is most commonly found in four oxidation states (Se^{6+}, Se^{4+}, Se^{0} and Se^{2-}). Selenate (SeO_4^{2-}) and selenite (SeO_3^{2-}) are highly water soluble; while elemental selenium (Se^{0}) is much less soluble in water. Well-aerated surface waters, especially those with alkaline conditions, represent a highly oxidized condition, which contains the majority of selenium as selenate. The relative proportions of selenite and selenate depend on water redox potentials and pH. Selenite is reduced to elemental selenium under mildly reducing conditions while selenate reduction occurs under stronger reducing conditions (Ehrlich, 1990; Hughes and Poole, 1989; Maiers, 1988).

Numerous biological technologies have been tested for selenium removal from water (Case et al., 1990; U.S. Dept. of Int., and Calif. Res. Agency, 1990). Bench scale processes for selenium and general metal removal from mining and other waters using *Pseudomonas stutzeri* and other microorganisms have been demonstrated (Adams et al., 1996a; Adams et al., 1996b; Adams et al. 1993). Mixed cultures of indigenous bacteria demonstrated a 96%

percent selenium removal at bench scale (Altringer et al., 1989; Larsen et al., 1989). Pilot tests using San Joaquin agricultural waters and *Thauera selenatus* removed 98% of the selenium in an anaerobic bioreactor and produced effluent selenium concentrations of less than 5 µg/L (Cantafio et al., 1996). A pilot plant study was conducted in which *E. coli* was used to treat a base metal smelter, weak acid effluent containing 33 mg/L Se. A rotating biological contactor (RBC) was used as the bioreactor. Initial test results indicated that 97% of the selenium was removed from the contaminated solution with a 4-hr retention time. Tests on other mining process waters using a bench scale RBC, *P. stutzeri*, molasses (1.0 g/L), and a 6 hr retention time removed 97% of the selenium (Adams et al., 1993).

Dr. Adams and Lorax Environmental Services Ltd. have developed and tested a staged process that addresses the need for both a chemical process and immobilized enzymes-microbes to reduce selenium to less than 10 µg/L from tailings supernatant concentrations on the order of 5 mg/L to ~10 mg/L. The A Licence discharge limit is 0.02 mg/L. To effectively remove Se to this level, it is necessary to have a staged reaction scheme to address both higher and lower selenium concentrations as well as any TSS and other problematic co-contaminants that might build up in a treatment process. It is important that redox conditions be such that selenium is the primary target; this can be most effectively addressed using a staged reactor system with components and microorganisms selected specifically for selenium binding, sorption, reduction, and sequestration.

The selenium bioreactor process proposed for Yukon Zinc was originally developed in 2004 and was further tested under the US EPA Mine Waste Technology Program in 2007. The process is a newer generation selenium removal technology, and is currently being patented. This biochemical process represents a significant improvement over previous patented selenium removal technology developed by Dr. Adams. For reference, the previous patented technology was evaluated under the EPA's Mine Waste Technology Program – and the original selenium removal patent is held by Weber State University and was tested in conjunction with the EPA and a local water treatment company.

10.2.1 Summary of Test Results Using Biological Reduction

Biological testing of selenium reduction in Wolverine tailings waters has been ongoing since May 2006; a summary of testwork conducted to date is included in Appendix V. Testing has involved both initial screening analyses for the potential for Se reduction in test waters, followed by collection of sediment samples for isolation and testing of indigenous organisms from Wolverine Creek.

Standard methods were used in all procedural methods and modified or 'special' analysis methods were used for qualitative selenium evaluations. Microbes in site waters were screened for potentially interfering microbes and indigenous selenium reducers using standard culturing and plating procedures.

Screening of stock cultures was completed to select better performing selenium reducing bacterial populations. With screening of 40 selenium reducing cultures, three microbial cultures were found that performed selenium reduction in site waters at high rates at both 4º C and 20º C (Figure 10-2; photos 3a & 3b, respectively). A comparison plate test of one of the microbes on media made with tailings supernatant and purified lab waters is also shown in Figure 10-2 (photos 3c-1 and 3c-2, respectively) cultured at 20º C. As illustrated, microbial growth was not inhibited in the media prepared with tailings supernatant as compared to the purified water media, indicating that growth limitations are not expected to occur due to toxic effects of the tailings supernatant. Selenium bioreduction tests were run for 72 hours at 20º C and 24 hours at 4º C; approximately 3.5 times longer was required for selenium reduction at 4º C than at 20º C.

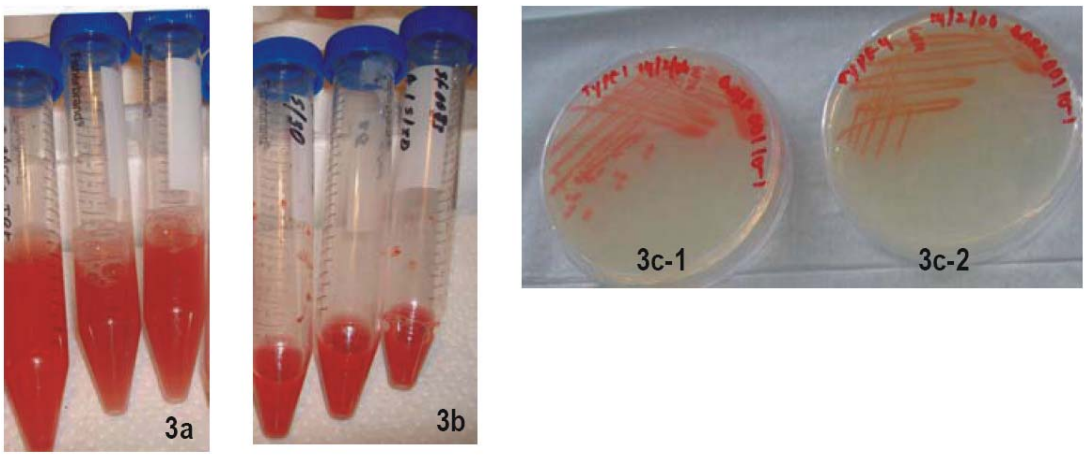


Figure 10-2 Selenium Reduction of Tailings Supernatant Waters (3a and 3b) and Plate Tests of Microbial Growth

Overall, the qualitative tests were very positive and provided a strong demonstration that biological selenium reduction is achievable in undiluted, fresh Wolverine tailings supernatant water. Additional testing was performed to demonstrate the selenium removal levels that could be obtained in a laboratory biotreatment system.

Quantitative selenium reduction tests were completed using a modified plug flow laboratory biotreatment system innoculated with the three microbial populations examined above and a batch treatment system. Tests were conducted at 20^0 C using retention times of 12 and 24 hours. A quantitative 24-element suite was obtained for three samples; the influent solution and two 24 hour effluent samples; a quantitative selenium analysis was requested for the 12 hour effluent sample. Results are summarized in Table 10.2.

Table 10.2 Summary of Biological Reduction Test Results for Key Parameters in Wolverine Tailings Supernatant at 20ºC

Parameter	Feed Concentration (mg/L)	@12 hours (mg/L)	@24 hours (mg/L)
Al	0.298	na	0.005
As	0.0148	*na*	0.0001
Cd	0.00492	*na*	0.00002
Cr	0.00157	*na*	0.0001
Cu	0.0638	*na*	0.00016
Fe	1.23	*na*	0.0008
Mn	0.111	*na*	0.00008
Pb	0.315	*na*	0.00001
Hg	0.00047	*na*	0.00005
Ni	0.0056	*na*	0.00008
Se	9.93	0.00138	0.00015
Ag	0.0018	*na*	0.00001
Zn	0.317	*na*	0.0089

na: not analyzed

Further column and batch testing has been completed using microbial isolates collected from sediments within Wolverine Creek. Optimization of nutrient additions and retention times is the recent focus of testing. Also, in 2007, four tests were conducted on two reactor types – a biochemical-enhanced material reactor and an electro-biochemical reactor. The Inotec report *Treatability and Bench-scale Testing of Waters for Selenium Removal* (January 31, 2008) details the results of the 2007 testwork and recommendations for pilot plant testing. This report is provided in Appendix V.

Overall, the testing to date has been very successful, reducing contaminants to very low levels and demonstrating that biological selenium reduction to levels at or below 1 ppb is obtainable in tailings supernatant with the appropriate microbes, nutrients, and biotreatment system configuration.

10.2.2 Preliminary Design of the Biological Reduction System

A preliminary design schematic of the system of bioreactors used for the biological reduction of selenium is shown in Figure 10-3.

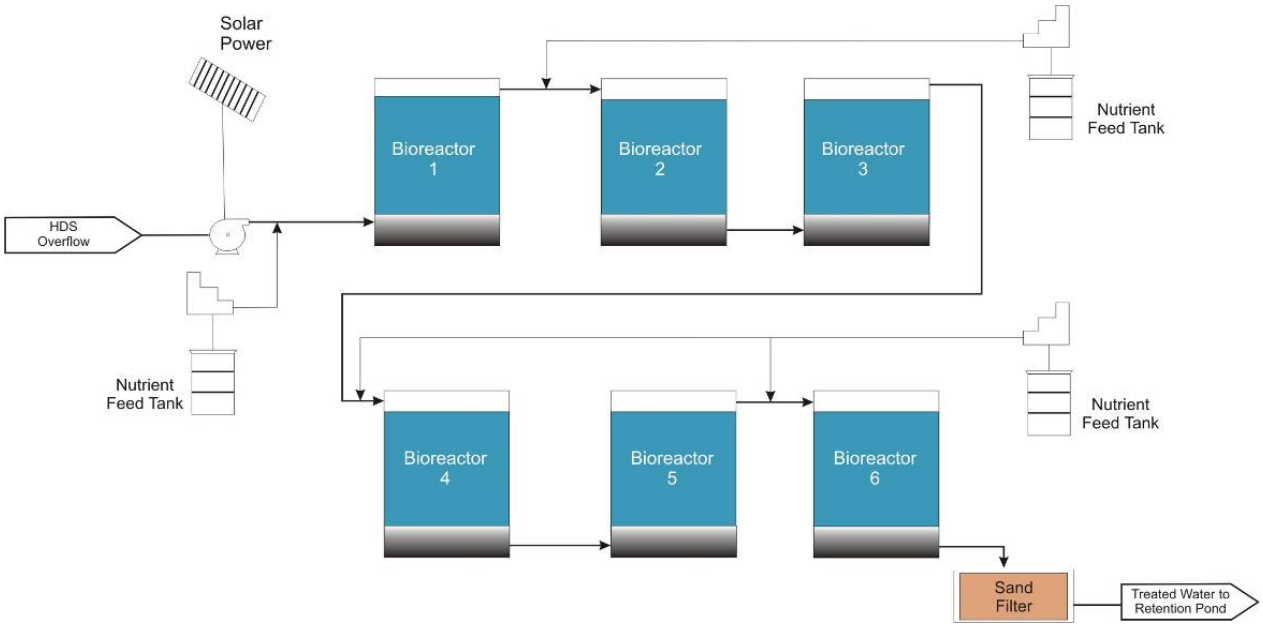


Figure 10-3 Schematic Design of the Bioreactor System for the Treatment of Selenium in Tailings Pond – High Density Sludge (HDS) Overflow Water

The bioreactor system will be located within the Industrial Complex area and will receive water from the HDS water treatment plant. The bioreactor can be designed to treat up to 15 L/s (~55 m^3/h) of HDS or direct tailings water with 1 to 10 mg/L Se. Anticipated flow rates are roughly half this amount or 20 m^3/h to 30 m^3/h.

For these conditions, the system will consist of a series of six semi-buried concrete tanks with a combined void volume of 750 m^3 or a total volume of 1,500 m^3. At the expected flow rates (e.g. ~10 L/s or ~30 m^3/h), this would provide a retention time of approximately 50 hours. In addition, several small capacity pumps will be required to circulate water and introduce nutrients to the influent.

The bioreactor tanks will contain a granular carbon substrate or comparable alternative. Water movement through the bioreactor system will occur in a modified plug up-flow configuration. The water from the HDS plant or tailings pond (influent) will receive a nutrient amendment designed to facilitate the growth of the microbial community inoculated

on the carbon substrate. The water discharged from the bioreactor will be fed through a sand filter prior to discharge to a retention pond, where waters will be further tested prior to release to Go Creek.

As discussed, the ultimate design of the bioreactor system, the required nutrient amendments and optimal flow capacities need to be determined through a field-scale pilot study in which operating characteristics are optimized. Pilot plant studies will commence onsite in 2010 once the process plant has generated 'typical' supernatant. Based on the storage capacity of the tailings impoundment, water treatment plant operation is not required until after 2012.

11. CLOSURE

Reclamation and closure plans for closure of the tailings facility are documented in the approved *Wolverine Project Reclamation and Closure Plan* (2008-02). A revised Reclamation and Closure Plan is required by *QML-0006* to be submitted in December 2009, and updated plans for closure of the tailings facility will be based on as-built drawings.

Prior to mine closure, tailings will be selectively spigotted around the impoundment to maximize the tailings storage and to produce a "near-level" tailings surface.

Following mine operations, excess process water will continue to be treated and will naturally be replaced with runoff water, which, over a period of time, will return the water quality to baseline conditions. There is a potential that some water treatment for a period of a few years may be required to ensure stable impoundment water quality.

The tailings facility will be closed as a saturated facility with a 1.0 m soil cover and a minimum water cover of 0.5 m as shown in Drawings D-3011 and D-3012. The main closure activities required pertain to dam safety, and long-term groundwater quality and surface water quality as outlined below.

11.1 Dam Safety

The dam has a minimum pseudo-static factor of safety of 1.15 for the 10,000 year seismic event and has a very low risk of geotechnical "failure". Consequently, the main concerns with dam safety on closure are associated with erosion of the dam or blockage of the spillway. Accordingly, a long-term care and maintenance plan will be prepared to confirm that erosion is not occurring and the spillway is clear. Measures to mitigate these potential concerns include the following:

- Placement of a 10 m wide neutral rockfill, adjacent to the upstream crest of the dam. The rockfill will keep the "free water" away from the dam crest, further reducing the potential for water release even with a significant erosion event;

- The downstream slope of the dam will be revegetated (during operations as part of the progressive reclamation program) to minimize water and wind erosion; and
- The spillway will be located in an excavated channel lined with large riprap, and have a discharge capacity for the routed peak flow resulting from the 10,000-year rainfall plus snowmelt event.

11.2 Geochemical Stability and Surface Water Quality

On closure, a layer of granular borrow material will be laid over the impoundment ice in winter. When the ice melts, the material will form a stable cover over the tailings and reduce the potential for remobilization of tailings solids and porewater. A typical section through the impoundment on closure is shown in Drawing D-3011.

On closure the excess impoundment water could be in the order of 30,000 m^3 to 150,000 m^3, depending on the time of year, climatic conditions and pond management. Excess water will be treated and discharged. The impoundment water quality should return to near baseline conditions following treatment and removal of the excess water at closure and upon replenishing the pond with fresh water from the spring freshet. The potential for contaminated pore water to mix with the impoundment water to a sufficient degree to impact water quality is considered to be low for the following reasons:

- There would be very little natural transfer of pore water because of the installed geosynthetic liner; and
- The potential quantity of pore water that could mix with the pond water is low; for example, if one assumes that 5% of the pore water in a 1 m thick granular borrow cover layer (1,000 m3) mixes with the pond water (100,000 m3), the dilution ratio would be 100:1.

11.3 Decommissioning of Water Management Infrastructure

The following work is required for decommissioning of the water management structures associated with the tailings impoundment, once the pond water can be directly discharged to the environment:

- Breaching of Ditch A to allow flow into the tailings pond and backfilling the section that is upstream of the Ultimate Spillway;
- Removal of Ditch B Diversion Ditch;
- Removal of the Seepage Dam, collection pond and spillway; and
- Grass seeding and planting in all areas disturbed during the implementation of the above works, as per the Reclamation and Closure *Plan*.

12. DAM SAFETY MONITORING PROGRAM

12.1 Dam Safety Monitoring and Instrumentation

There are four levels of monitoring that will occur to ensure dam safety. The physical and seepage conditions in the dam and area directly downstream of the dam will be monitored as follows:

- Routine: visual monitoring by mine personnel – daily during mine operations and every second month after mine closure until safe long term trends are indicated;
- Intermediate: visual monitoring by the site dam engineer and annual review of monitoring data and dam performance by the design engineer during operations and annually after closure;
- Comprehensive: Dam safety review by dam engineer – on first filling, prior to dam raising, prior to decommissioning and otherwise routinely every 5 years (even after decommissioning); and
- Special Reviews: site visit and review of monitoring data are required after the occurrence of any potentially damaging events (e.g., floods, earthquakes) or unusual observations (e.g., cracks, sinkhole formation).

The following instrumentation will be installed and monitored regularly:

- Two inclinometers located in the dam downstream shell to monitor dam foundation deformations in the overburden and bedrock for confirming dam stability. The inclinometers will be monitored two to three times during dam construction and dam raise periods. They will be protected from damage during construction and maintained for possible monitoring under appropriate circumstances, such as after a seismic event or for a comprehensive dam safety review;
- Four piezometers in the dam downstream shell to monitor damfill saturation level – monitored weekly during construction and dam raising, quarterly during operations, annually after closure. The piezometers will consist of 50 mm diameter PVC pipe, with a slotted screened section. The piezometers could also be used for periodic water quality monitoring, if required;
- Ten survey monuments on the dam crest/downstream slope – monitored quarterly during operations and annually after closure;

- Four groundwater monitoring wells downstream and two upstream of the tailings facility, have been installed with screened sections located in the foundation soils and weathered bedrock unit. Samples will be collected quarterly during construction, monthly during operations and annually at closure;

- Monitoring of precipitation and hydrology during operations as per licence requirements;

- Survey of pond level – monthly during operations and annually after closure. This survey will be supplemented by additional information on quantities of tailings and tailings supernatant. Confirmation of all information related to impoundment storage will be required prior to dam raise and mine closure; and

- Bathymetric survey of pond – annually during operations. More detailed surveys will be required prior to dam raise and mine closure.

It is anticipated that the above instrumentation and monitoring scheme will be sufficient to identify the onset of potential instability. If signs of instability are detected, additional surveillance and remedial measures will be taken to safeguard the stability and integrity of the dam.

This monitoring program will confirm design conditions and monitor the "as-constructed" conditions of the tailings impoundment. This monitoring program is summarized in Table 12.1.

Continuous flow monitoring devices could be installed on the culverts for Ditch A and Ditch B to monitor flows during operations and provide quantification of the actual site runoff response. The tailings delivery line and the water reclaim line should also have continuous flow monitoring.

Table 12.1 Summary of Tailings Facility Monitoring Program

ITEM	PURPOSE	FREQUENCY
Dam survey monuments	Monitor potential dam foundation deformations.	Quarterly during operations, annually at closure
Inclinometers	Monitor potential dam foundation deformations.	2-3 times during dam construction and dam raise periods
Piezometers	Monitor foundation pore pressures.	Weekly during construction and dam raising, quarterly during operations, annually at closure
Groundwater monitoring wells	Monitor groundwater quality.	Quarterly during construction, monthly during operations, annually at closure
Bathymetry of impoundment	Confirm assumed densities for material storage and water balance.	Annually during operations.
Water flow	Confirm water balance.	Continuous
Impoundment water quality and level	Confirm actual water quality.	Monthly during operations and annually at closure

In addition to the above monitoring program, the following manuals will be prepared prior to the start up of mining operation:

- Operation, Maintenance and Surveillance Manual; and
- Emergency Preparedness and Response Plan (a preliminary draft of the plan is included in Appendix IV).

12.2 Adaptive Management Plan

Adaptive management measures with respect to impoundment excavation, liner foundation, dam monitoring, excess water, water shortage and impoundment seepage have been reviewed as they may be potential areas of change encountered during construction and operation phases. Table 10.2 summarizes the adaptive management measures to be taken in response the potential variances outlined.

Table 12.2 Tailings Facility Adaptive Management Plan

ITEM	POTENTIAL VARIANCE	ADAPTIVE MANAGEMENT MEASURES
Impoundment excavation	Groundwater level may vary in the excavation.	Install additional drainage trenches and underdrains to lower the groundwater level and manage the potential for uplift pressures on the liner. Reduce depth of excavation within the impoundment area and source borrow areas from outside the impoundment.
Foundation for liner	Material is very angular	Place more liner bedding soils.
Dam monitoring	Inclinometers indicate movement.	Assess source and mechanism of movement. Place toe berm, if required, for stability.
	Piezometers indicate rise in water levels in the dam.	Assess source and mechanism of movement. Place toe berm, if required, for stability.
Water balance	Wet years	Temporarily store more water in the impoundment. The dam stages allow for storage for several years. Raise dam to store additional water.
	Dry years	Reduce water treatment operations.
Impoundment seepage	Contaminated seepage reports to seepage collection pond.	Activate seepage pond pumpback system.
	Contaminated seepage observed in groundwater monitoring wells.	Carry out assessment of potential source of contamination and potential consequence of contamination. Install pumpback wells, if required, to return water to the tailings pond.

13. SUMMARY AND RECOMMENDATIONS

This report presents the detail design of the tailings facility for the Wolverine Project. The design is based on the results of the site assessment and material characterization studies presented in this report. In 2007, the conceptual design was submitted to regulatory agencies for review and, as a result, this Plan incorporates review comments received. Construction of the facility is scheduled to start in 2009 and be operational in 2010.

The main recommendations for development of the tailings facility and related infrastructure include the following:

- Diversion ditches should be constructed in early 2009 so that as much surface water as practical can be diverted around the construction area prior to spring freshet in 2009. Test pits will be excavated immediately prior to construction to confirm the excavation geometry and suitability of dam borrow materials.
- Based on the content contained herein, construction technical specifications and Issued for Construction drawings will be prepared to guide the construction contractors.
- A QA/QC program will be carried out during construction.
- An Operations, Maintenance and Surveillance Manual will be prepared prior to facility operation.
- The preliminary Emergency Response and Preparedness Plan will be updated prior to facility operation.
- An as-built report will be submitted 60 days after completion of tailings facility construction, as per QML-*0006* requirements.

Yours truly,

KLOHN CRIPPEN BERGER LTD.

Lowell Constable, P.Eng. (BC)
Geotechnical Engineer

Arvind Dalpatram, P.Eng. (BC)
Senior Water Resources Engineer

PROFESSIONAL ENGINEER YUKON TERRITORY H. N. McLEOD

Harvey McLeod, P.Eng (Yukon Territory)
Project Manager

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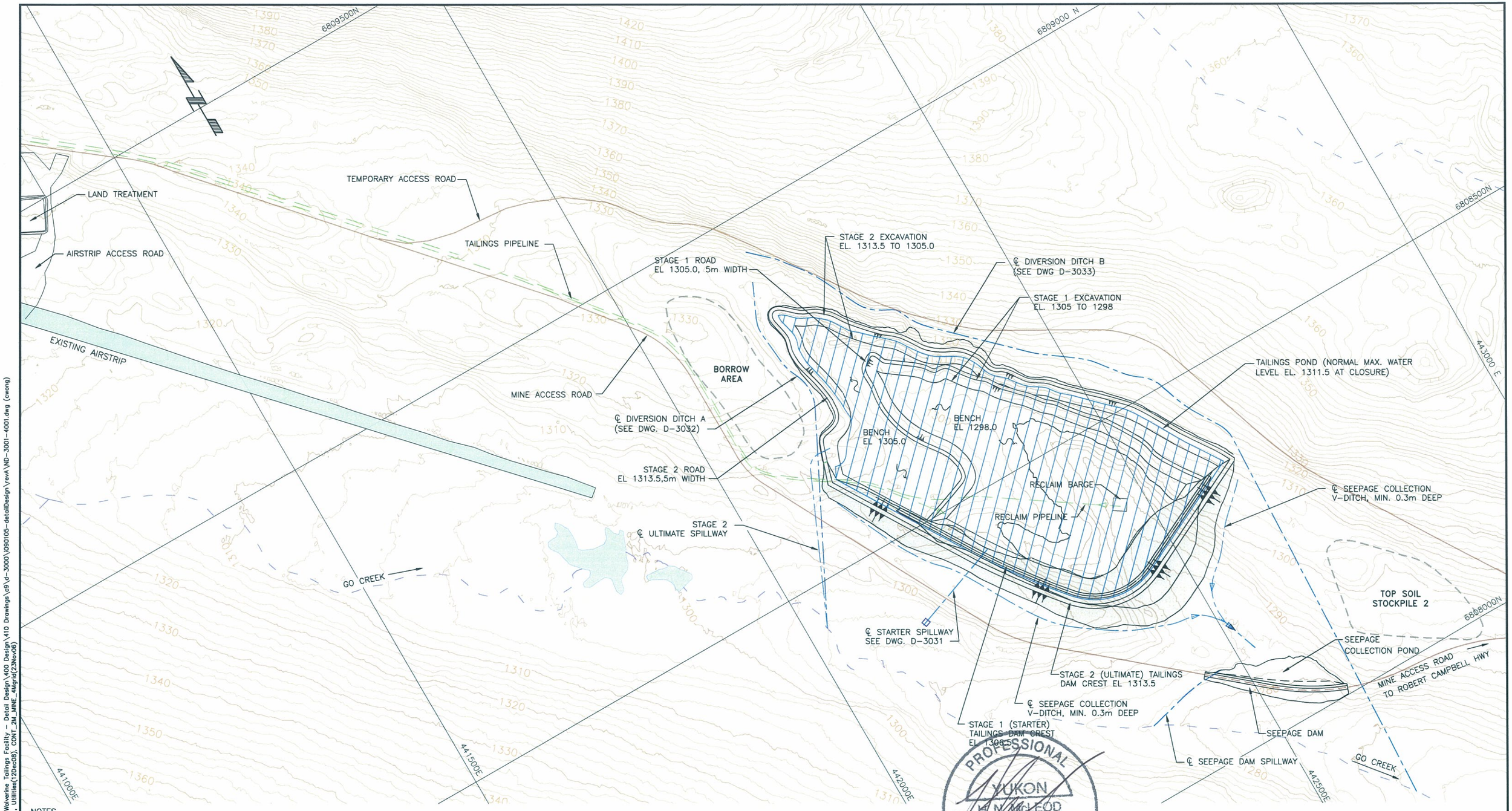
Insert
Appendices I - V

DRAWINGS

Drawing D-3001	General Arrangement
Drawing D-3002	Site Investigation Plan
Drawing D-3003	Subsoil Profiles
Drawing D-3004	Tailings Impoundment Plan and Storage Volumes
Drawing D-3005	Tailings Dam and Seepage Dam – Dam Sections
Drawing D-3006	Starter Impoundment Excavation and Fill – Plan
Drawing D-3007	Starter Impoundment Excavation and Fill – Sections
Drawing D-3008	Ultimate Impoundment Excavation and Fill – Plan
Drawing D-3009	Ultimate Impoundment Excavation and Fill Sections
Drawing D-3010	Starter Impoundment Schematic Sections
Drawing D-3011	Ultimate Impoundment Schematic Sections
Drawing D-3012	Impoundment – Closure Plan
Drawing D-3031	Starter Dam Spillway – Plan, Profile and Sections
Drawing D-3032	Diversion Ditch A – Plan, Profile and Sections
Drawing D-3033	Diversion Ditch B – Plan, Profile and Sections
Drawing D-3034	Closure Spillway – Plan, Profile and Sections



NOTES
1. NOT ALL CULVERTS HAVE BEEN SHOWN.
2. ALL ELEVATIONS IN METRES.

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0 200 m

PROFESSIONAL ENGINEER
YUKON
H. M. MacLEOD
TERRITORY

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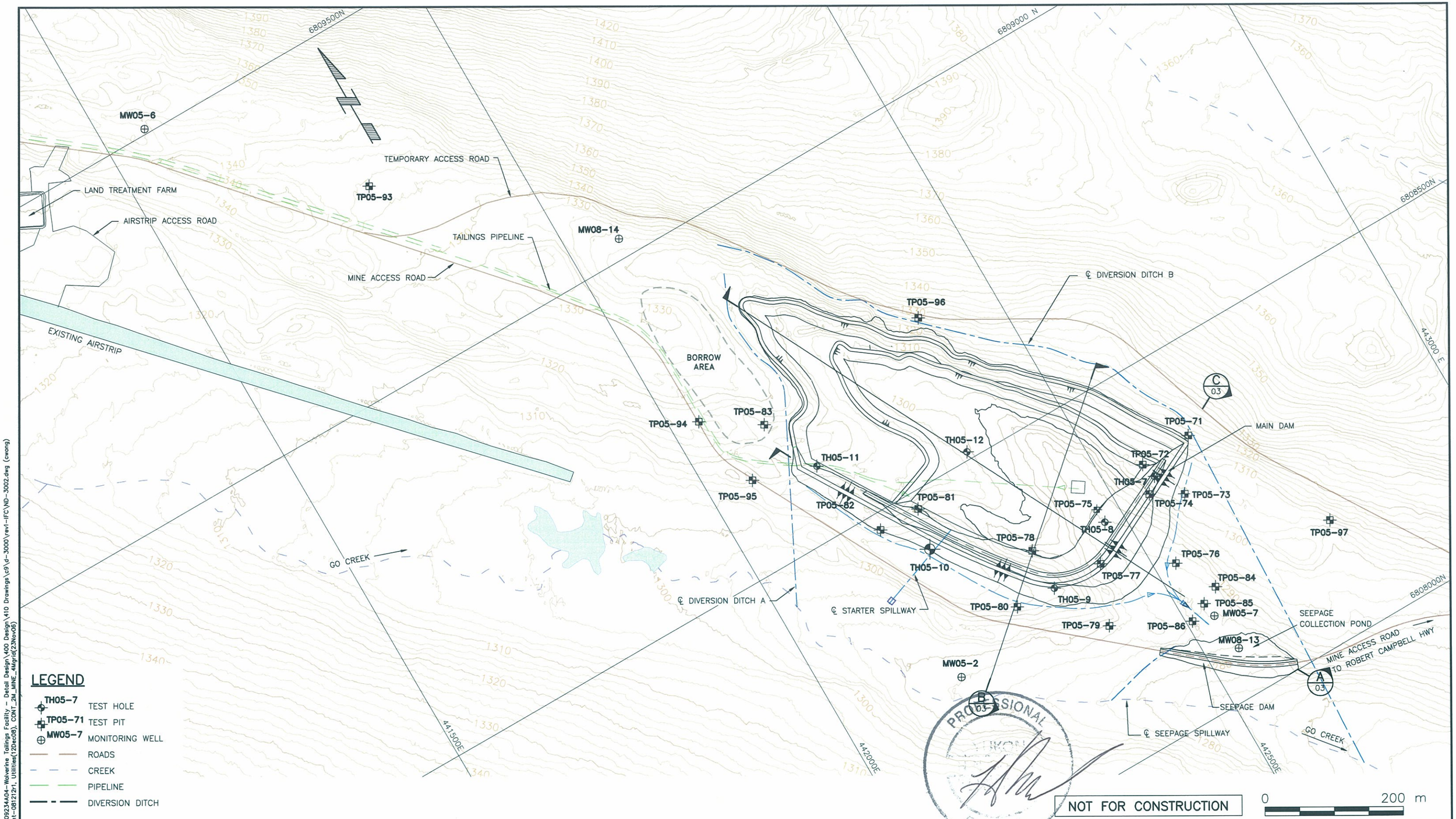
WOLVERINE PROJECT

TAILINGS STORAGE FACILITY GENERAL SITE ARRANGEMENT



LEGEND

- TH05-7 — TEST HOLE
- TP05-71 — TEST PIT
- MW05-7 — MONITORING WELL
- ROADS
- CREEK
- PIPELINE
- DIVERSION DITCH

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TAILINGS STORAGE FACILITY
SITE INVESTIGATION PLAN

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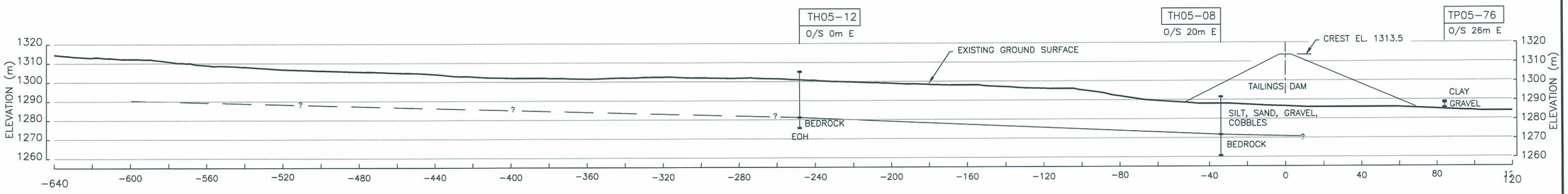

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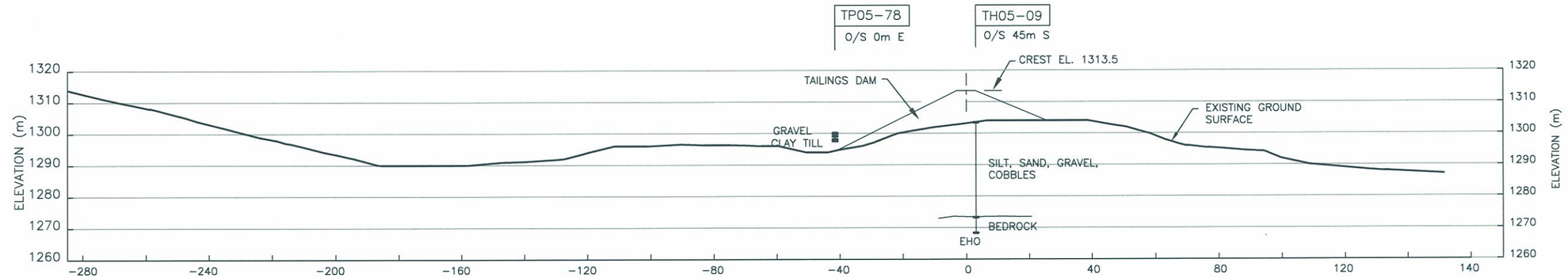

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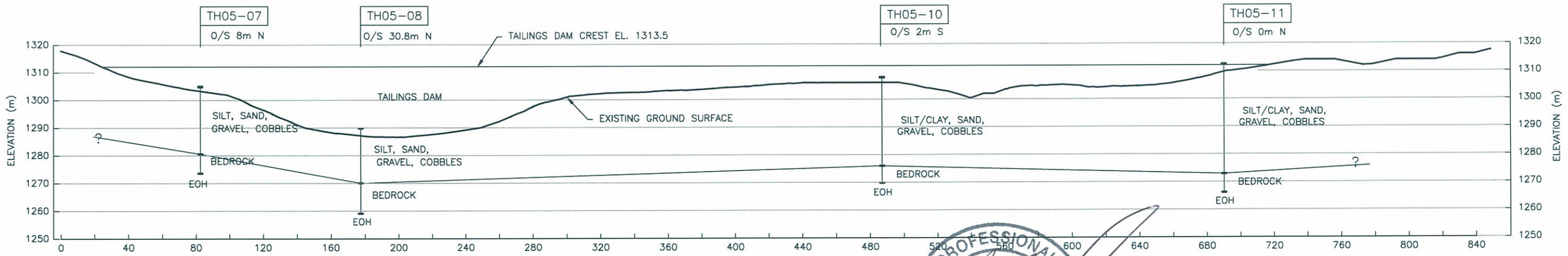

LONGITUDINAL SECTION C

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VERTICAL SCALE = SCALE C

PROFESSIONAL ENGINEER YUKON H.M. McLEOD TERRITORY

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SCALE C 0 100 m
SCALE B 0 100 m
SCALE A 0 100 m

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WOLVERINE PROJECT
TAILINGS STORAGE FACILITY
SUBSOIL PROFILES

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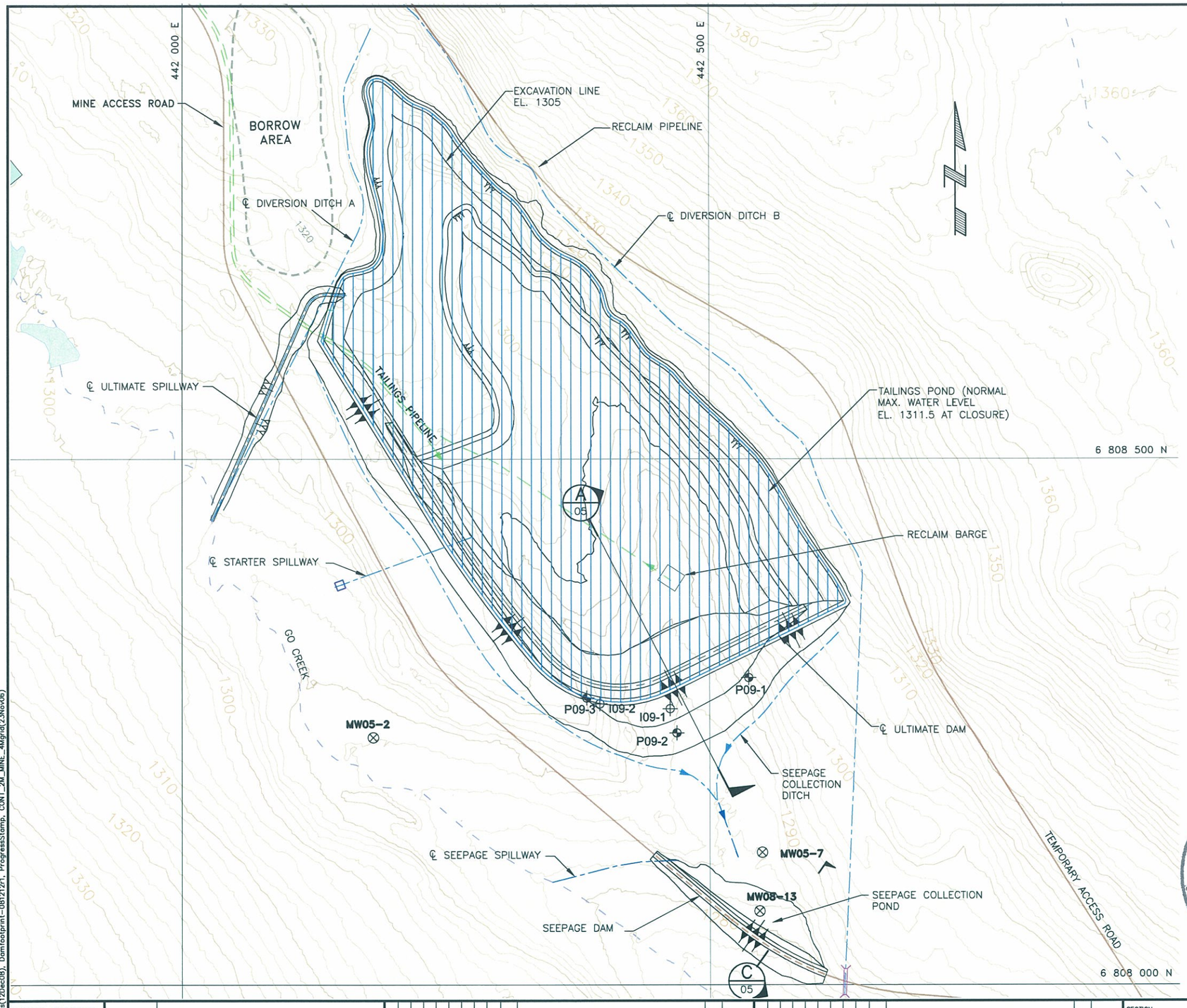

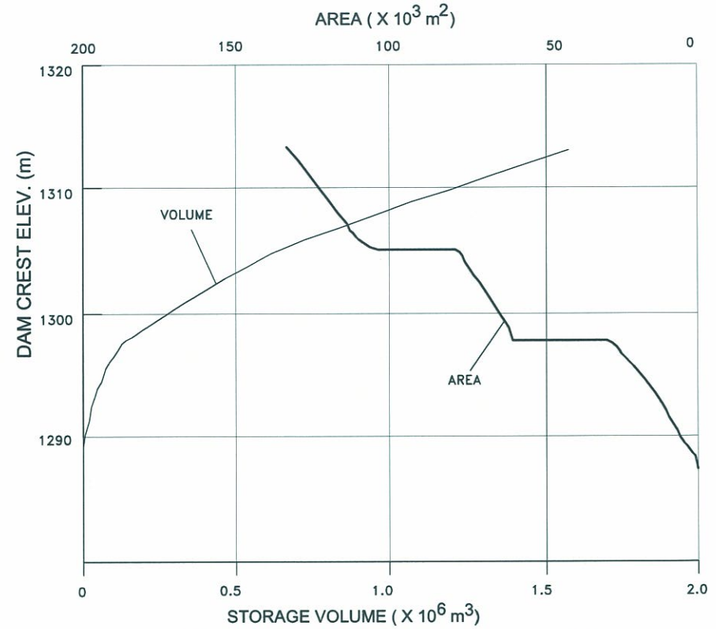

TAILINGS IMPOUNDMENT STORAGE VERSUS DAM CREST ELEVATION

LEGEND

- ROADS
- CREEK
- PIPELINE
- DIVERSION OR COLLECTION DITCH, SPILLWAY
- CULVERT
- P09-1 — PROPOSED DAM FOUNDATION PIEZOMETER
- I09-1 — PROPOSED DAM FOUNDATION INCLINOMETER
- MW05-7 — GROUNDWATER MONITORING WELL

NOTES

1. SURFACE AREA SHOWN IN PLAN REFLECTS BORROW EXCAVATION WITHIN TAILINGS IMPOUNDMENT.
2. IMPOUNDMENT VOLUME SHOWN IS STORAGE CAPACITY TO THE DAM CREST. FREEBOARD ALLOWANCE IS TO BE DEDUCTED WHEN DETERMINING THE AVAILABLE STORAGE CAPACITY.

PROFESSIONAL ENGINEER — YUKON TERRITORY — H. M. McLEOD

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SCALE A 0 100 m

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WOLVERINE PROJECT

TAILINGS STORAGE FACILITY TAILINGS IMPOUNDMENT – PLAN AND STORAGE VOLUME

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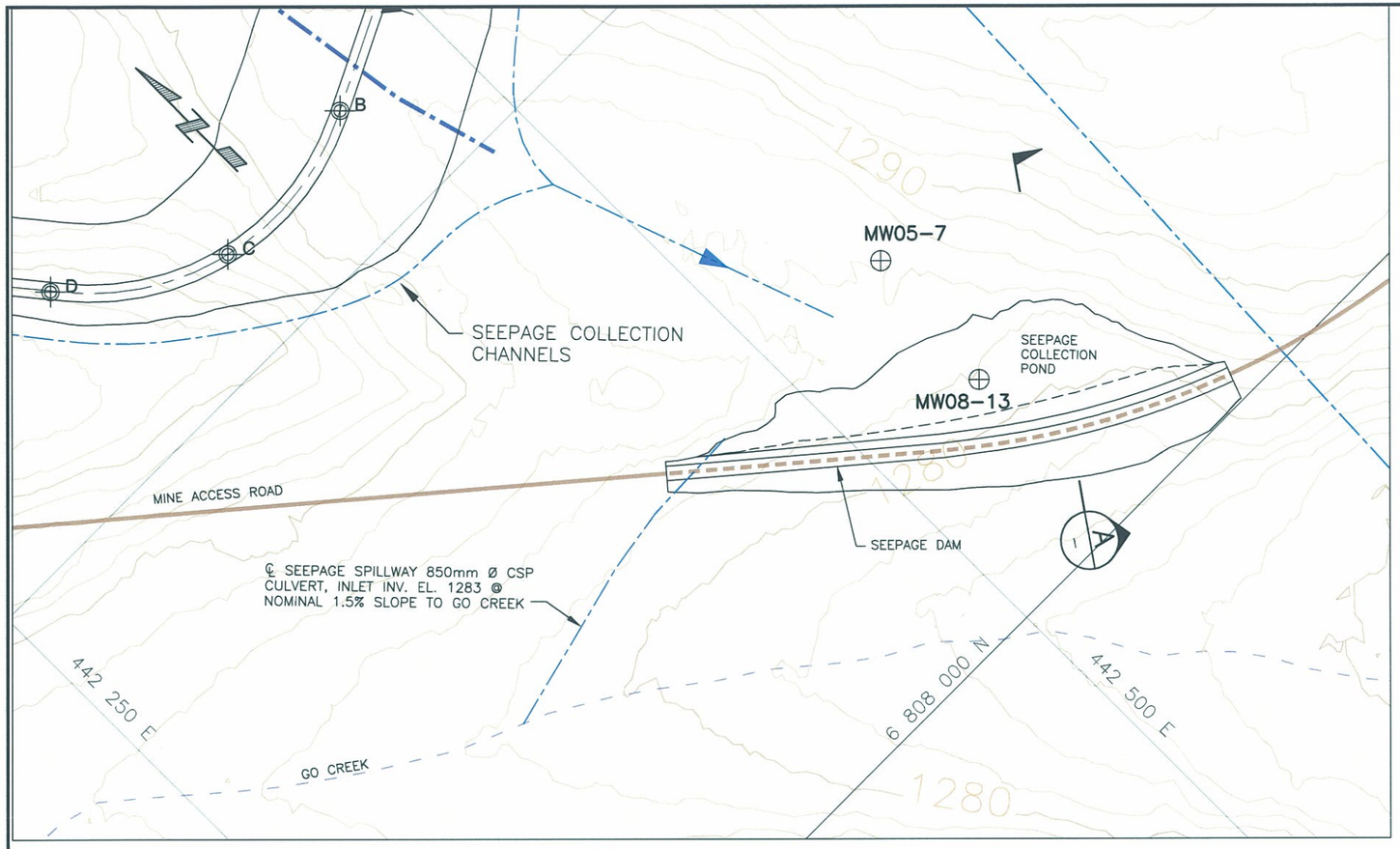
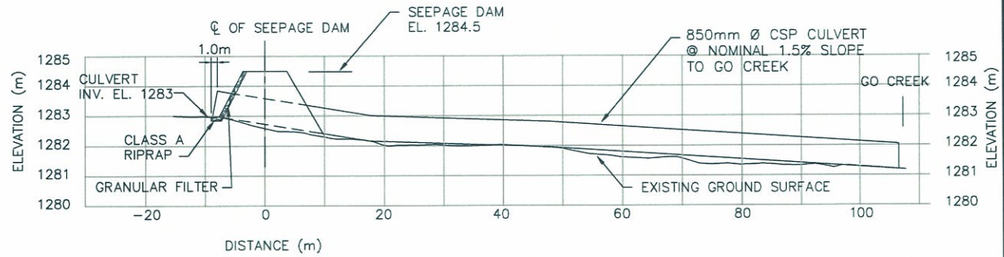


PLAN
SCALE A



PROFILE OF SEEPAGE SPILLWAY

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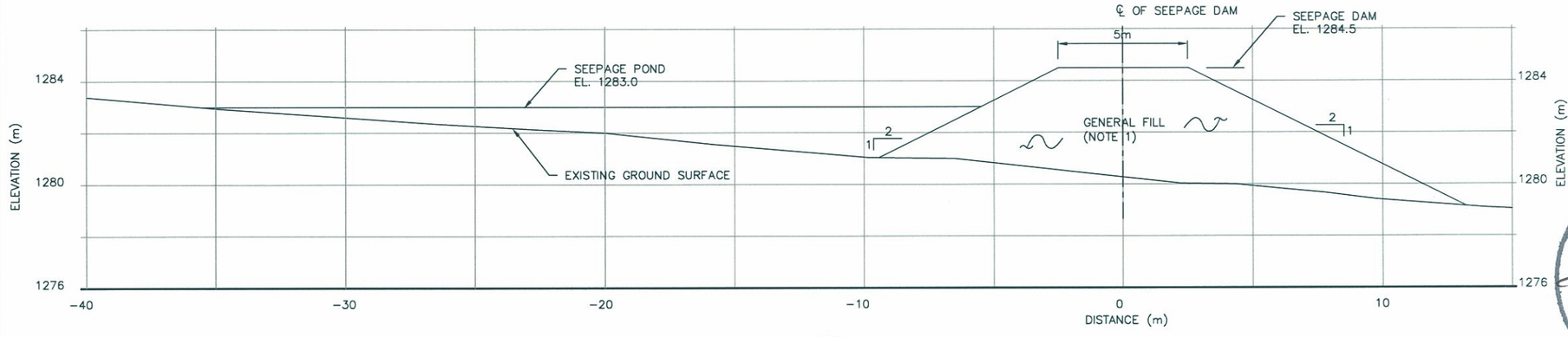

SECTION A
SCALE B

LEGEND

- ROADS
- CREEK
- DIVERSION OR COLLECTION DITCH, SPILLWAY
- LINER UNDERDRAIN
- OVERLAND FLOW

MW05-7 — GROUNDWATER MONITORING WELL (MW08-13) TO BE RELOCATED DOWNSTREAM

A — WORK POINT (COORDINATES LISTED ABOVE)

NOTES

1. FOR DAM FILL AND FOUNDATION SPECIFICATIONS, SEE NOTES ON DRAWING D-3007

PROFESSIONAL ENGINEER — YUKON TERRITORY — H. M. McLEOD

NOT FOR CONSTRUCTION

SCALE A 0 50 m
SCALE B 0 5 m
SCALE C 0 25 m

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WOLVERINE PROJECT
TAILINGS STORAGE FACILITY
SEEPAGE DAM
PLAN AND SECTION

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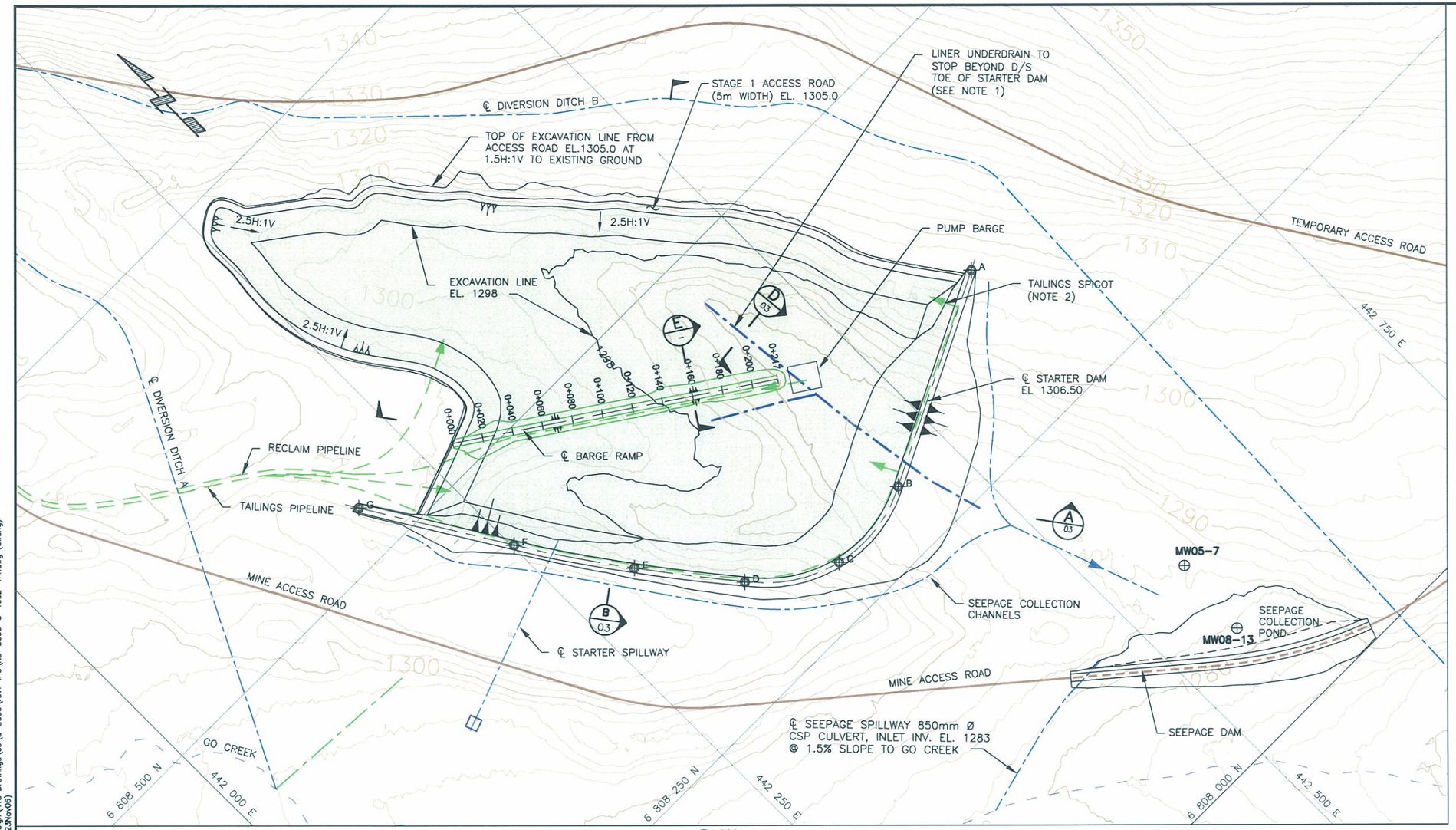


PLAN
SCALE A

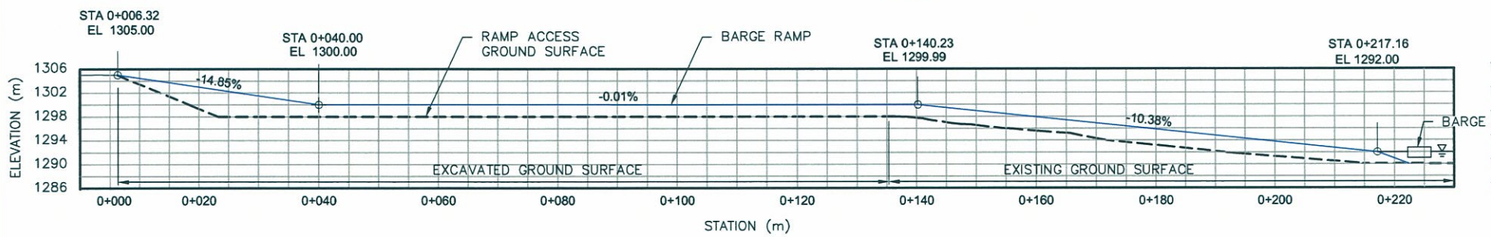
WORK POINTS		
No.	NORTHING	EASTING
A	6808358.95	442590.66
B	6808292.91	442456.28
C	6808285.21	442393.72
D	6808319.70	442340.96
E	6808377.49	442296.33
F	6808443.89	442251.38
G	6808533.25	442196.73

LEGEND

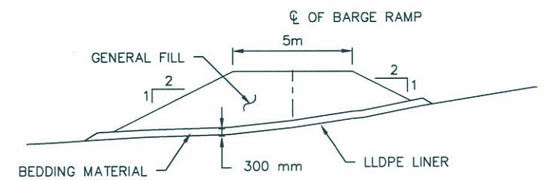
- ROADS
- CREEK
- DIVERSION OR COLLECTION DITCH, SPILLWAY
- LINER UNDERDRAIN
- PIPELINES
- LINER AREA
- MW05-7 ⊕ GROUNDWATER MONITORING WELL
- ⊕A WORK POINT (COORDINATES LISTED ABOVE)

NOTES

1. LOCATION AND EXTENT OF LINER UNDERDRAIN WILL BE DETERMINED IN THE FIELD BY SITE ENGINEER, FOLLOWING THE LOWEST EXISTING DRAINAGE COURSE. THE UNDERDRAIN SHALL EXIT INTO A SOLID PIPE UNDER THE DAM AND INTO AN OPEN DITCH BEYOND THE DAM TOE.
2. TAILINGS TO BE SPIGOTTED FROM DAM TO FORM POND AT NORTH/WEST END.



BARGE RAMP PROFILE
SCALE B



SECTION E
NOT TO SCALE

TYPICAL BARGE RAMP SECTION
SECTION TAKEN AT STA 0+160

PROFESSIONAL ENGINEER YUKON H. M. McLEOD TERRITORY

NOT FOR CONSTRUCTION

SCALE A 0 100 m
SCALE B 0 25 m

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SECTION:	
SCALE:	DATE
DESIGN. BY DK	DEC 19/08
DRAWN BY: CYW	DEC 19/08
CHECK. BY HM	
APP. BY: HM	DEC 19/08

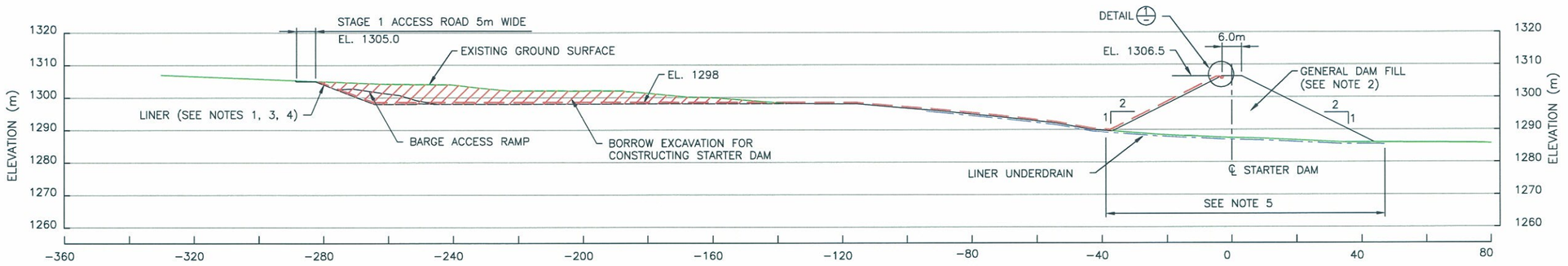
FILENAME:	PROJECT NUMBER	DRAWING NUMBER	REV.
----------	M09234A04	D-3006	A

Klohn Crippen Berger

Yukon Zinc CORP
WOLVERINE PROJECT

TAILINGS STORAGE FACILITY
STARTER IMPOUNDMENT
EXCAVATION AND FILL PLAN

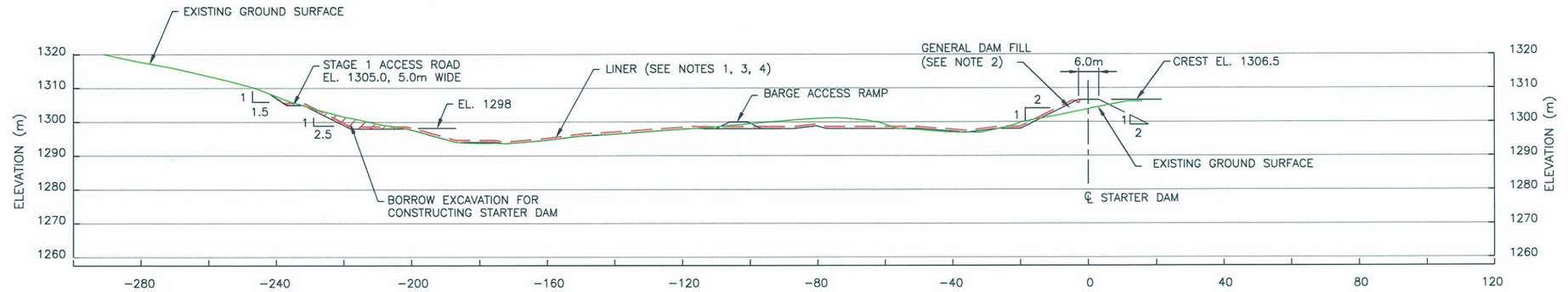
Drawing File: M:\M09\234A04-Wolverine Tailings Facility - Detail Design\41U Design\41U Drawings\D-3000\Revised-IFC\NU-3000-D-4102.dwg (cwong)
Xrefs: starterDamFootprint-081222, Utilities(12Dec08), CONT_2M_MINE_4Mgrid(23Nov06)
3154765ID.DWG



SECTION A (AT MAX VALLEY)

SCALE A 02

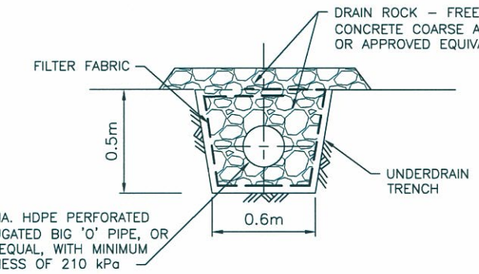
VERTICAL SCALE = HORIZONTAL SCALE



SECTION B (AT RIDGE TOP)

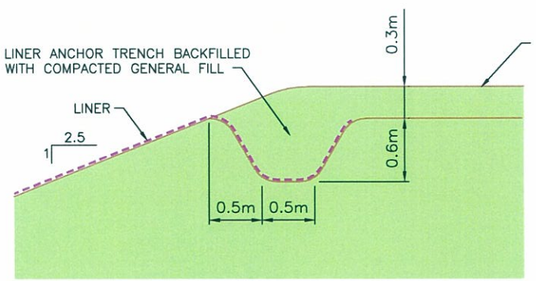
SCALE A 02

VERTICAL SCALE = HORIZONTAL SCALE



TYPICAL SECTION D LINER UNDERDRAIN

NTS 02



DETAIL 1 LINER ANCHOR TRENCH

NTS –

NOTES:

1. ALL LOOSE AND ORGANIC MATERIALS SHALL BE REMOVED, AND THE FOUNDATION SHALL BE PROOFROLLED WITH 6 PASSES WITH A 10 TON VIBRATORY ROLLER, AS DIRECTED BY THE ENGINEER. ALL FOUNDATION AREAS SHALL BE DRY AND APPROVED BY THE ENGINEER PRIOR TO PLACEMENT OF GENERAL FILL OR LINER.
2. GENERAL FILL TO CONSIST OF WELL–GRADED SILTY SAND AND GRAVEL BORROWED FROM IMPOUNDMENT EXCAVATION. FINER GENERAL FILL SHALL BE PLACED TOWARDS THE UPSTREAM SLOPE AS WELL AS ADJACENT TO THE GLACIAL TILL ZONE (STAGE 2 CONSTRUCTION) AND COARSER MATERIAL SHALL BE PLACED TOWARDS THE DOWNSTREAM SLOPE. MATERIAL SHALL BE PLACED IN 300 mm THICK LOOSE LIFTS, WATERED AS REQUIRED, AND COMPACTED TO 95% OF STANDARD PROCTOR DENSITY.
3. LINER FOUNDATION AREAS AND SLOPES SHALL BE PROOFROLLED WITH A SMOOTH DRUM COMPACTOR. ALL AREAS WITH COARSE ANGULAR MATERIALS SHALL BE COVERED WITH LINER BEDDING AS DIRECTED BY THE ENGINEER.
4. LINER SHALL CONSIST OF A 40mil LLDPE LINER OR EQUIVALENT, AS APPROVED BY THE ENGINEER. LINER SHALL BE ANCHORED IN THE DAM CREST AND ACCESS ROAD IN A 0.6m DEEP TRENCH, BACKFILLED WITH COMPACTED FILL.
5. SOLID (NOT PERFORATED) UNDERDRAIN PIPE AND APPROVED IMPERVIOUS TRENCH BACKFILL SHALL BE USED BELOW THE DAM EMBANKMENT.
6. FILTER FABRIC SHALL CONSIST OF NON–WOVEN NEEDLE PUNCHED POLYPROPYLENE GEOTEXTILE (PROPEX 4510 OR EQUIVALENT).

PROFESSIONAL ENGINEER YUKON H.N. McLEOD TERRITORY

NOT FOR CONSTRUCTION

SCALE A 0 100 m

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----------	M09234A04	D–3007	A

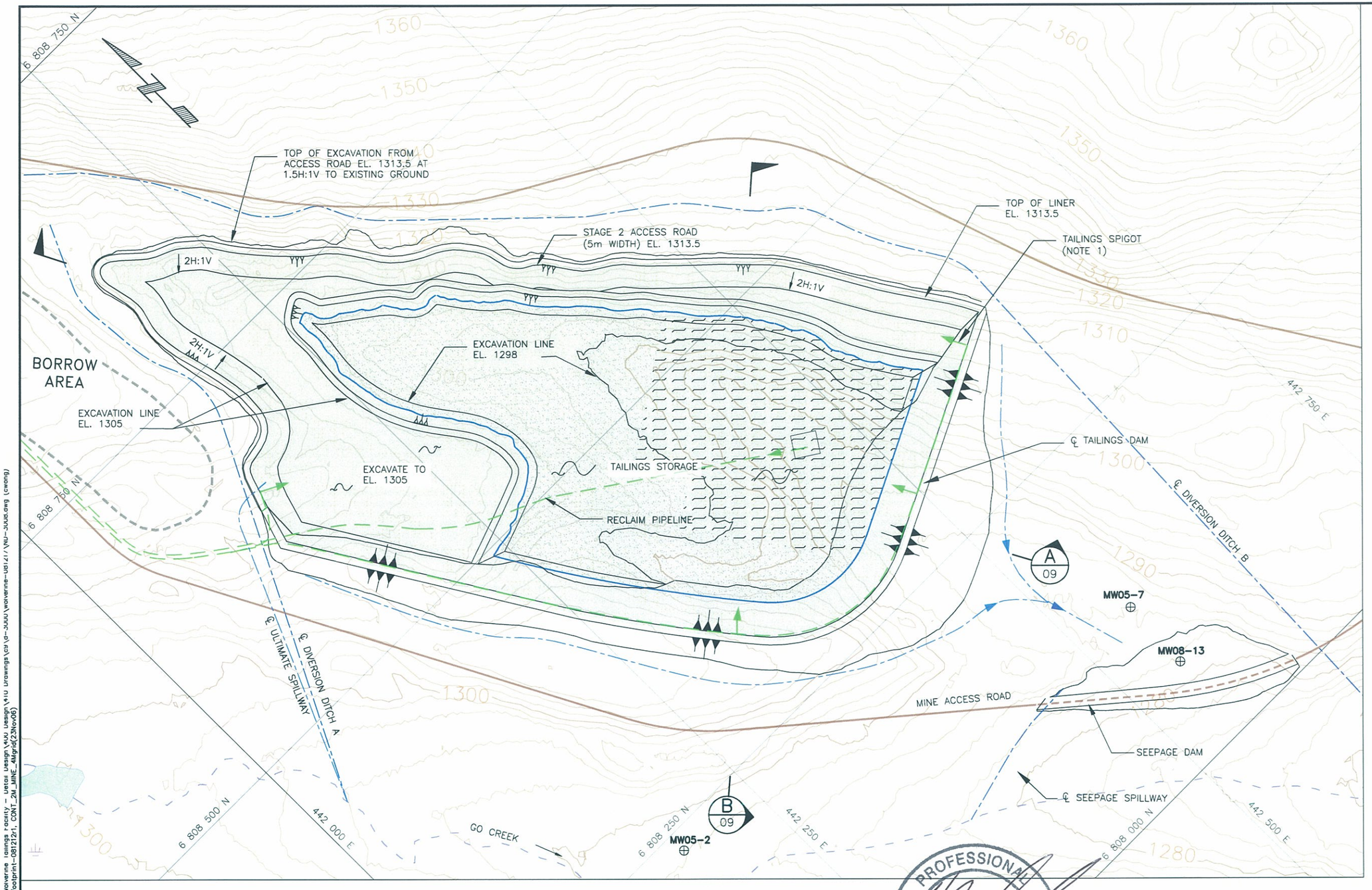
Klohn Crippen Berger

Yukon Zinc CORP

WOLVERINE PROJECT

TAILINGS STORAGE FACILITY
STARTER IMPOUNDMENT
EXCAVATION AND FILL TYPICAL SECTIONS

3154765LDWG Drawing File: M:\M09234A04–Wolverine Tailings Facility – Detail Design\400 Design\410 Drawings\c9\d–3000\rev1–IFC\ND–3007–4003r1.dwg (cwong)
BORREV–0



LEGEND

- ROADS
- CREEK
- DIVERSION OR COLLECTION DITCH, SPILLWAY
- LINER
- SATURATED TAILINGS
- DECANT WATER POND OVERLYING TAILINGS
- MW05-7 ⊕ EXISTING GROUNDWATER MONITOR WELL

NOTES

1. TAILINGS TO BE SPIGOTTED FROM DAM TO FORM POND AT NORTH/WEST END.

PROFESSIONAL ENGINEER YUKON TERRITORY

NOT FOR CONSTRUCTION

SCALE A 0 100 m

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NO	DESCRIPTION	BY	DATE
A	ISSUED FOR DETAIL DESIGN	DK	MAR 17/09

ISSUE/REVISIONS

PROJECT PROCESS CIVIL MECH. STRUCT. PIPING SERVICES ELECT. INSTR.

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SCALE:		DATE
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DRAWN BY:	CYW	DEC 19/08
CHECK. BY	HM	---
APP. BY:	HM	DEC 19/08

FILENAME:	PROJECT NUMBER	DRAWING NUMBER	REV.
----------	M09234A04	D-3008	A

Klohn Crippen Berger

Yukon Zinc CORP

WOLVERINE PROJECT

TAILINGS STORAGE FACILITY ULTIMATE DAM EXCAVATION AND FILL PLAN

3154765TD.DWG Drawing File: M:\YUK\234\A04-Wolverine Tailings Facility - Detail Design\YUK Design\4-10 Drawings\cyw\D-3000\wolverine-08121r1 / YNU-3008.dwg (cwong)
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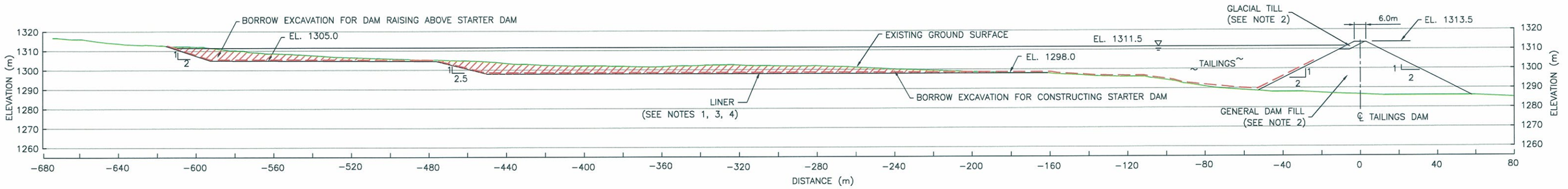
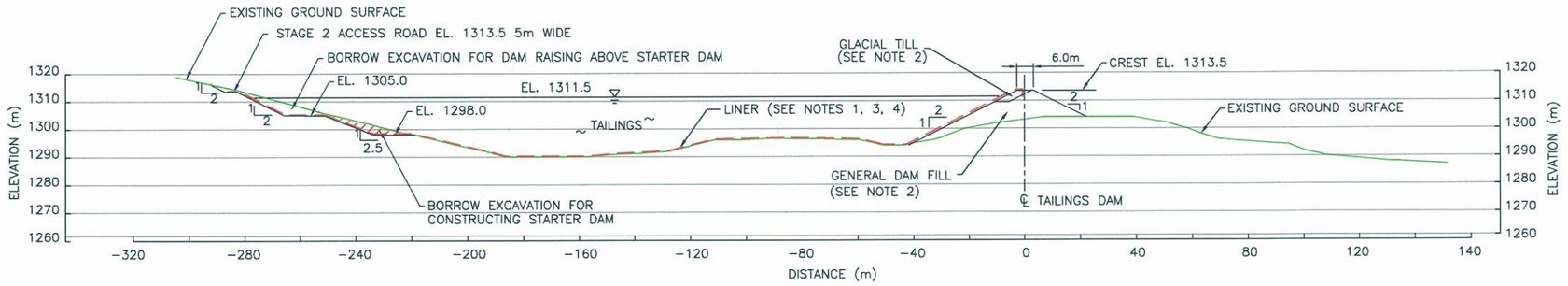


SECTION A (AT MAX VALLEY)

SCALE A 08

VERTICAL SCALE = HORIZONTAL SCALE



SECTION B (AT RIDGE TOP)

SCALE A 08

VERTICAL SCALE = HORIZONTAL SCALE

NOTES:

1. ALL LOOSE AND ORGANIC MATERIALS SHALL BE REMOVED, AND THE FOUNDATION SHALL BE PROOFROLLED WITH 6 PASSES WITH A 10 TON VIBRATORY ROLLER, AS DIRECTED BY THE ENGINEER. ALL FOUNDATION AREAS SHALL BE DRY AND APPROVED BY THE ENGINEER PRIOR TO PLACEMENT OF GENERAL FILL OR LINER.

2. GENERAL FILL TO CONSIST OF WELL-GRADED SILTY SAND AND GRAVEL BORROWED FROM IMPOUNDMENT EXCAVATION. FINER GENERAL FILL SHALL BE PLACED TOWARDS THE UPSTREAM SLOPE AS WELL AS ADJACENT TO THE GLACIAL TILL ZONE AND COARSER MATERIAL SHALL BE PLACED TOWARDS THE DOWNSTREAM SLOPE. MATERIAL SHALL BE PLACED IN 300 mm THICK LOOSE LIFTS, WATERED AS REQUIRED, AND COMPACTED TO 95% OF STANDARD PROCTOR DENSITY.

   GLACIAL TILL TO BE COMPRISED OF LOW PERMEABILITY FILL WITH A FINES CONTENT > 20% PASSING THE 74 MICRON SIEVE SIZE.

3. LINER FOUNDATION AREAS AND SLOPES SHALL BE PROOFROLLED WITH A SMOOTH DRUM COMPACTOR. ALL AREAS WITH COARSE ANGULAR MATERIALS SHALL BE COVERED WITH 150mm THICKNESS OF SCREENED SAND/GRAVEL, AS DIRECTED BY THE ENGINEER.

4. LLINER SHALL CONSIST OF A 40 mil LLDPE LINER OR EQUIVALENT, AS APPROVED BY THE ENGINEER. LINER SHALL BE ANCHORED IN THE DAM CREST IN A 0.6m DEEP TRENCH, BACKFILLED WITH COMPACTED FILL. QA/QC PROGRAM FOR THE LINER TO BE APPROVED BY THE ENGINEER.

PROFESSIONAL ENGINEER
YUKON TERRITORY
H. N. McLEOD

NOT FOR CONSTRUCTION

SCALE A 0 60 m

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A	ISSUED FOR DETAIL DESIGN	DK	MAR 17/09
	ISSUE/REVISIONS		

PROJECT | PROCESS | CIVIL | MECH. | STRUCT. | PIPING | SERVICES | ELECT. | INSTR.

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DRAWN BY:	CYW	DEC 19/08
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APP. BY:	HM	DEC 19/08

FILENAME:	PROJECT NUMBER	DRAWING NUMBER	REV.
----------	M09234A04	D-3009	A

Klohn Crippen Berger

YukonZinc CORP
WOLVERINE PROJECT

TAILINGS STORAGE FACILITY ULTIMATE IMPOUNDMENT EXCAVATION AND FILL - TYPICAL SECTIONS

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Date: 3/16/2009
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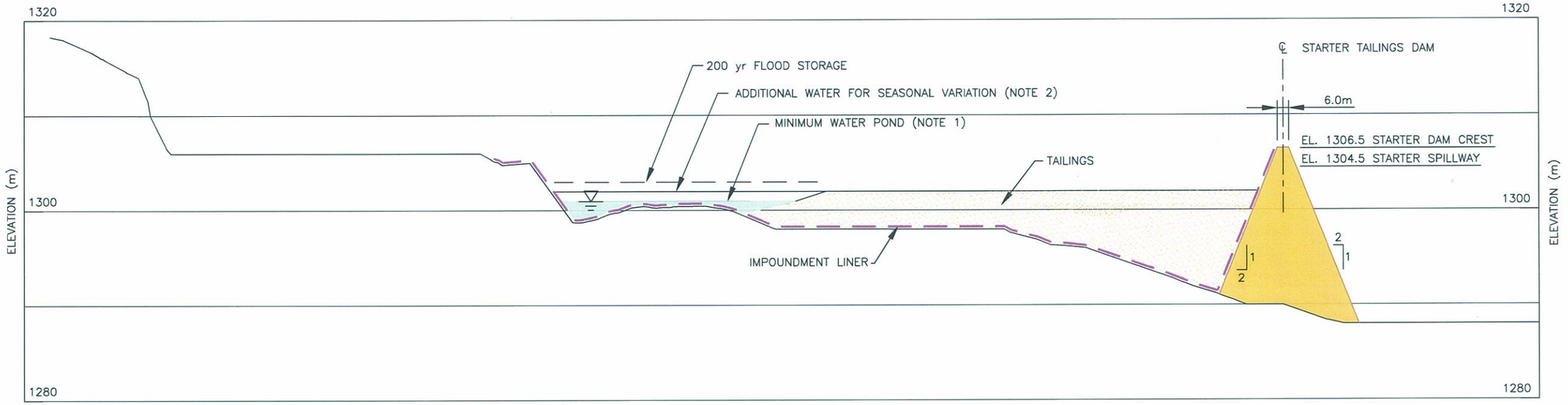

TYPICAL SECTION – YEAR 2

LEGEND

- SATURATED TAILINGS
- DAM EARTHFILL

NOTES:

1. MINIMUM OPERATING POND ~ 40,000m^3
2. SEASONAL STORAGE REQUIREMENT ~ 60,000m^3

PROFESSIONAL ENGINEER YUKON TERRITORY

NOT FOR CONSTRUCTION

VERTICAL SCALE = 5X HORIZONTAL SCALE

HORIZONTAL SCALE 0 100 m

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A	ISSUED FOR DETAIL DESIGN	DK	MAR 17/08
	ISSUE/REVISIONS		

SECTION:		
SCALE:		DATE
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DRAWN BY:	CYW	DEC 19/08
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APP. BY:	HM	DEC 19/08

FILENAME:	PROJECT NUMBER	DRAWING NUMBER	REV.
----------	M09234A04	D-3010	A

Klohn Crippen Berger

Yukon Zinc CORP

WOLVERINE PROJECT

TAILINGS STORAGE FACILITY
STARTER IMPOUNDMENT
TYPICAL SECTION

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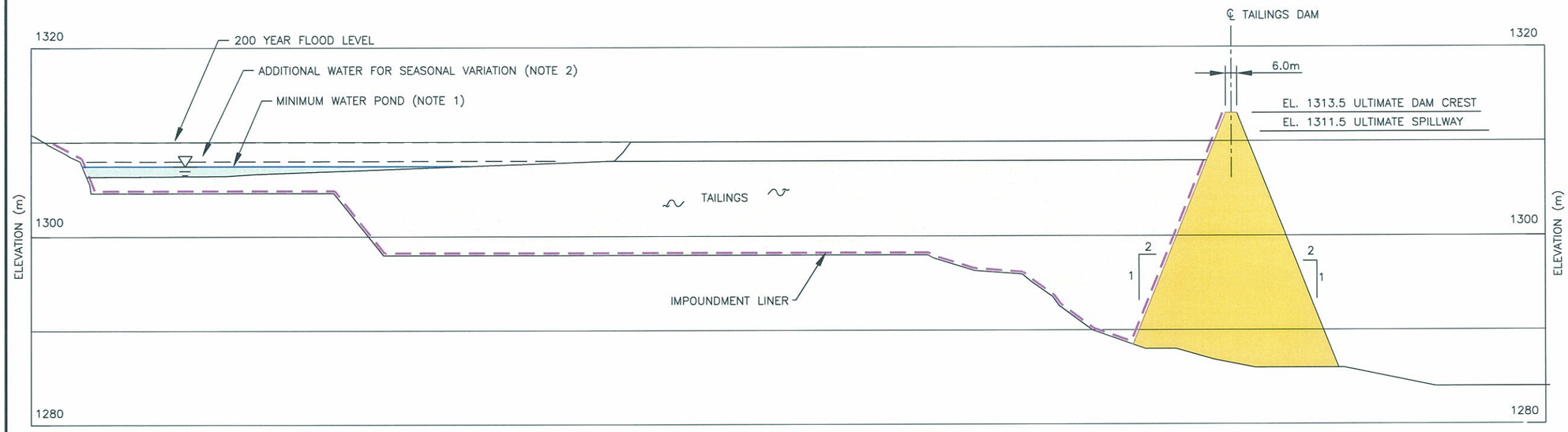
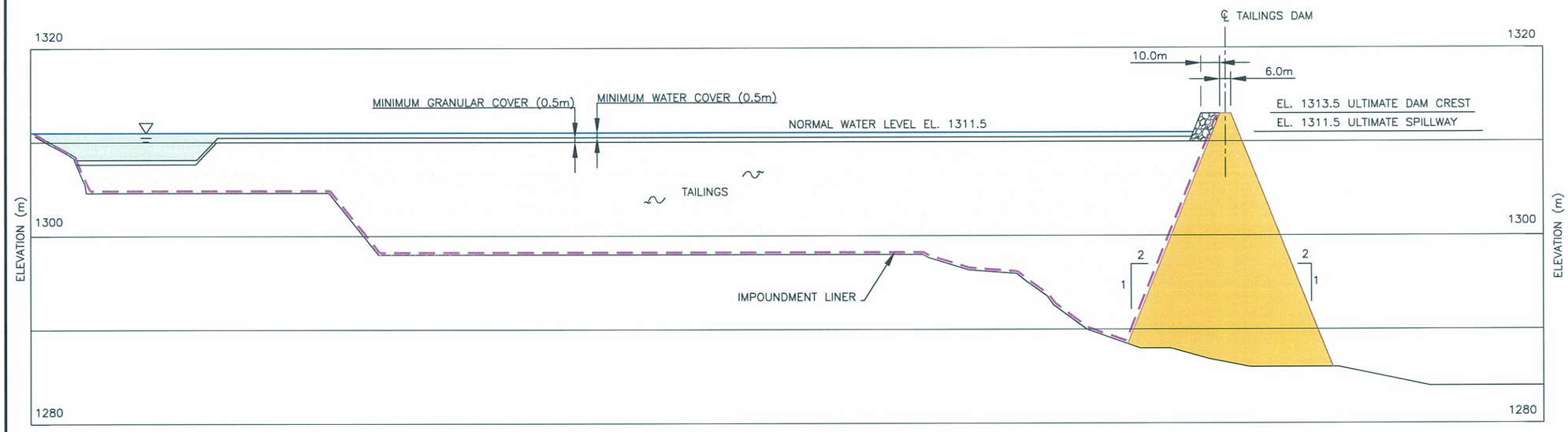


TYPICAL SECTION YEAR 6



TYPICAL SECTION – CLOSURE

LEGEND

- SATURATED TAILINGS
- DAM EARTHFILL
- ROCKFILL

NOTES:

1. MINIMUM OPERATING POND ~ 40,000m³
2. SEASONAL STORAGE REQUIREMENT ~ 60,000m³
3. TRANSITION OF THE POND LOCATION FROM THE SOUTH SIDE WILL OCCUR IN APPROXIMATELY YEAR 7 TO A POND NEAR THE CLOSURE SPILLWAY (NORTH SIDE).

VERTICAL SCALE = 5X HORIZONTAL SCALE

HORIZONTAL SCALE 0 100 m

PROFESSIONAL ENGINEER YUKON TERRITORY

NOT FOR CONSTRUCTION

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DRAWN BY:	CYW		DEC 19/08
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APP. BY:	HM		DEC 19/08

FILENAME:	PROJECT NUMBER	DRAWING NUMBER	REV.
----------	M09234A04	D-3011	A

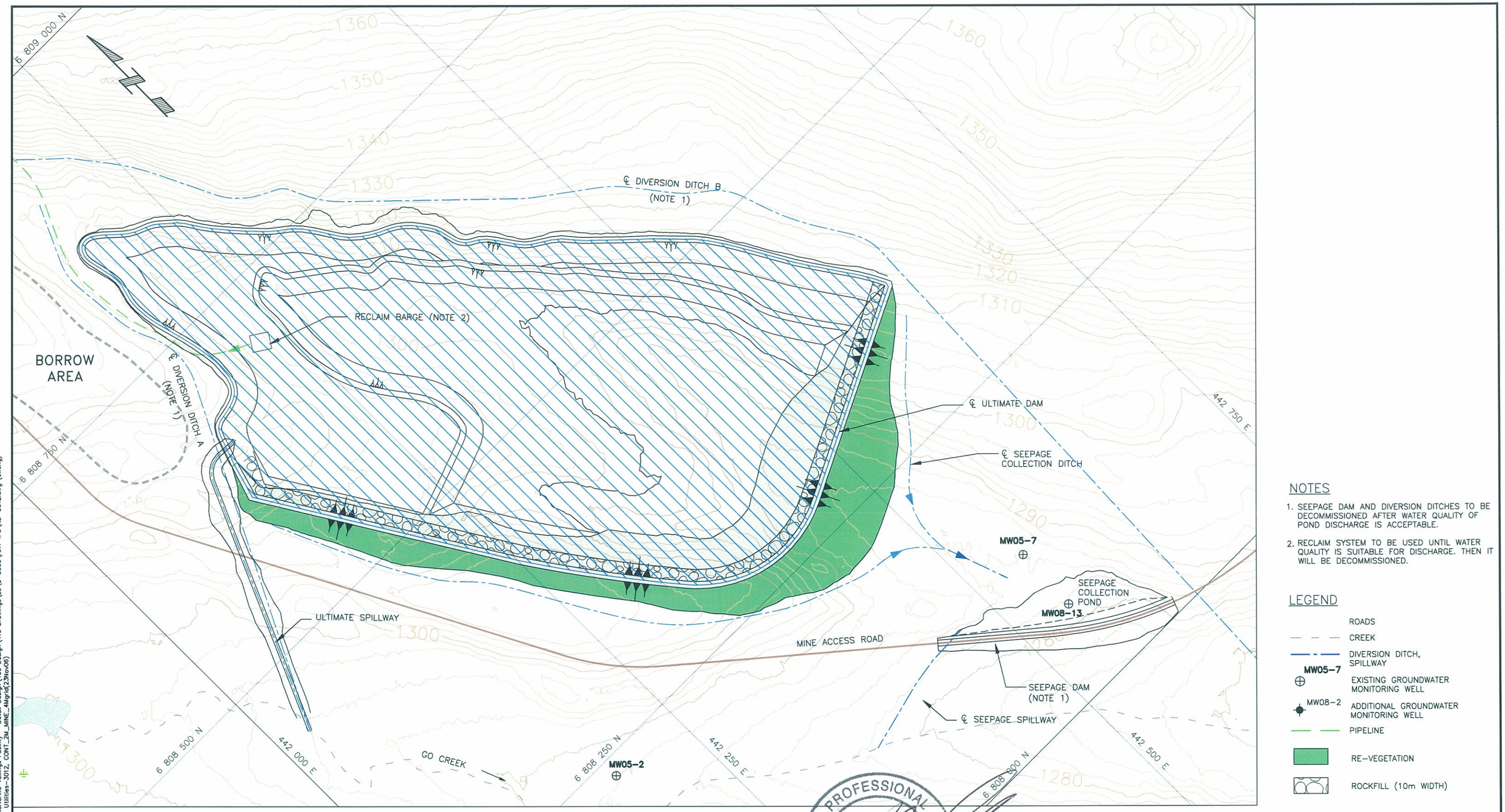
Klohn Crippen Berger

Yukon Zinc Corp

WOLVERINE PROJECT

TAILINGS STORAGE FACILITY
ULTIMATE IMPOUNDMENT
TYPICAL SECTIONS

3154765.DWG Drawing File: M:\M09234A04-Wolverine Tailings Facility - Detail Design\400 Design\410 Drawings\c9\d-3000\rev1-IFC\ND-3011.dwg (cwong) Xrefs: ProgressStamp



NOTES

1. SEEPAGE DAM AND DIVERSION DITCHES TO BE DECOMMISSIONED AFTER WATER QUALITY OF POND DISCHARGE IS ACCEPTABLE.
2. RECLAIM SYSTEM TO BE USED UNTIL WATER QUALITY IS SUITABLE FOR DISCHARGE. THEN IT WILL BE DECOMMISSIONED.

LEGEND

- ROADS
- CREEK
- DIVERSION DITCH, SPILLWAY
- MW05-7 — EXISTING GROUNDWATER MONITORING WELL
- MW08-2 — ADDITIONAL GROUNDWATER MONITORING WELL
- PIPELINE
- RE-VEGETATION
- ROCKFILL (10m WIDTH)

NOT FOR CONSTRUCTION

SCALE A 0 100 m

PROFESSIONAL ENGINEER YUKON TERRITORY H.N. McLEOD

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APP. BY: HM	DEC 19/08

FILENAME:	PROJECT NUMBER	DRAWING NUMBER	REV.
----------	M09234A04	D-3012	A

Klohn Crippen Berger

Yukon Zinc CORP
WOLVERINE PROJECT
TAILINGS STORAGE FACILITY
ULTIMATE IMPOUNDMENT
CLOSURE PLAN

Drawing File: M:\M09\234\A04-Wolverine Tailings Facility - Detail Design\400 Design\410 Drawings\civil-3000\civil-3012.dwg (cwong)
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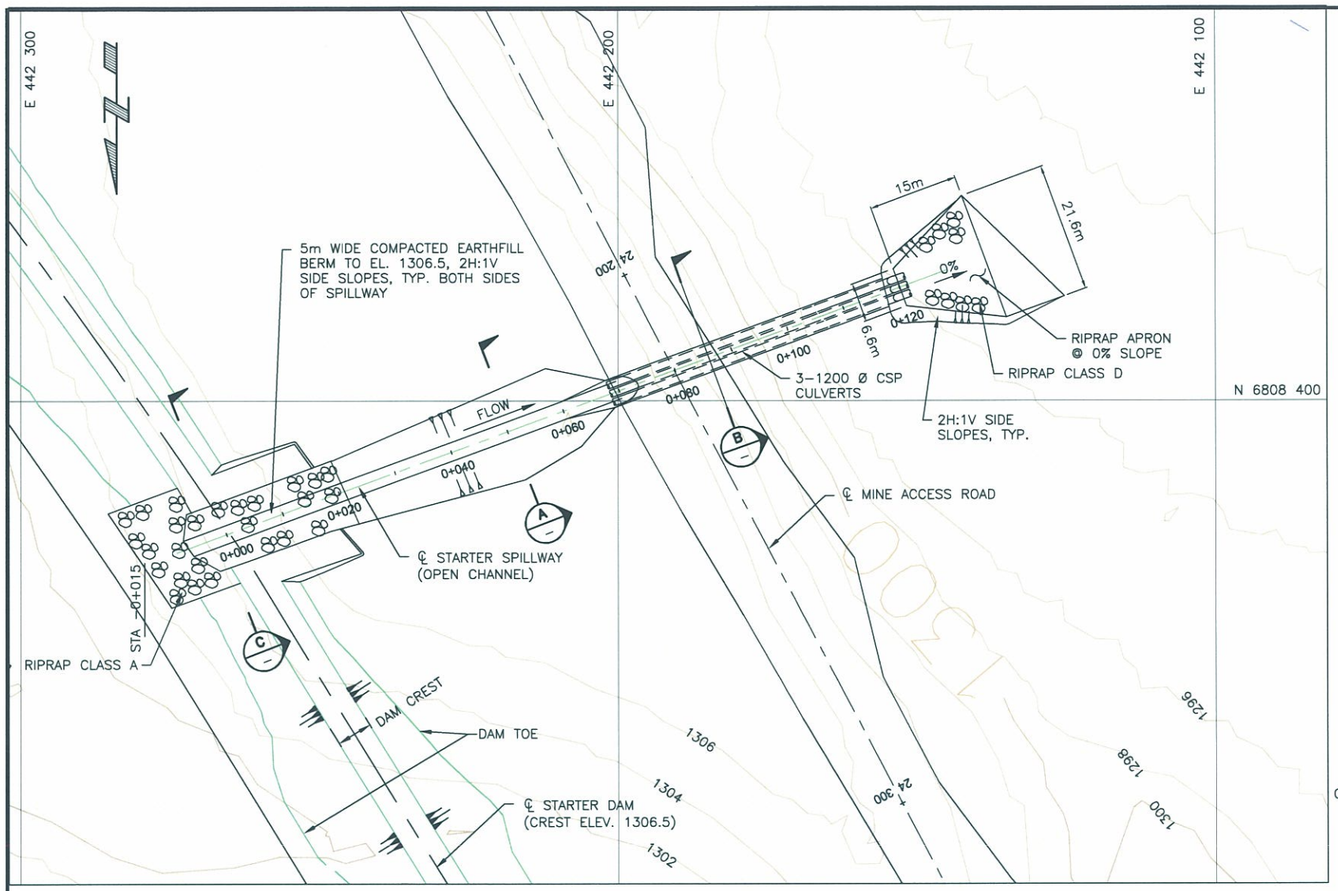
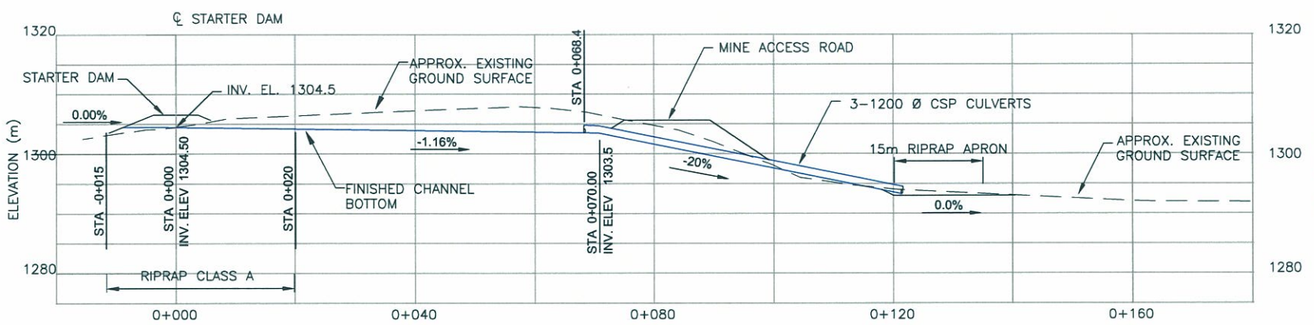
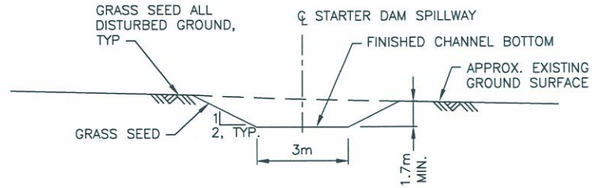


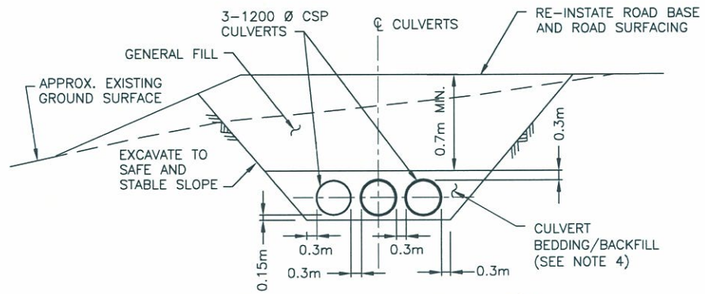
PLAN
SCALE A



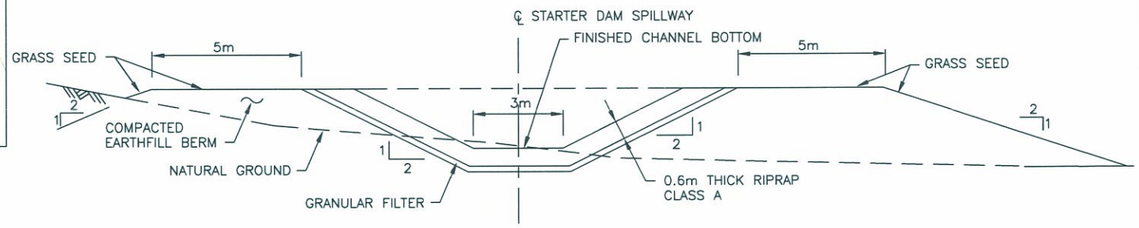
PROFILE – STARTER SPILLWAY
SCALE A



TYPICAL GRASS LINED SECTION (A)
NOT TO SCALE



TYPICAL CULVERT SECTION (B)
NOT TO SCALE



TYPICAL RIPRAP LINED SECTION (C)
NOT TO SCALE

NOTES

1. FOR GENERAL SITE ARRANGEMENT, SEE DWG. D–3001.
2. INVERT ELEVATIONS SHOWN ARE TO FINISHED CHANNEL BOTTOM.
3. FOR RIPRAP AND GRANULAR FILTER GRADATION AND LAYER THICKNESS, SEE DWG. D–3034.
4. CULVERT BEDDING/BACKFILL SHALL BE WELL GRADED 100 mm MINUS MATERIAL WITH LESS THAN 20% PASSING THE #200 SIEVE.

PROFESSIONAL ENGINEER YUKON TERRITORY H.N. MOEED

NOT FOR CONSTRUCTION

SCALE A 0 50 m

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NO	DESCRIPTION	BY	DATE
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PROJECT | PROCESS | CIVIL | MECH. | STRUCT. | PIPING | SERVICES | ELECT. | INSTR.

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TAILINGS STORAGE FACILITY
STARTER SPILLWAY
PLAN, PROFILE AND SECTIONS

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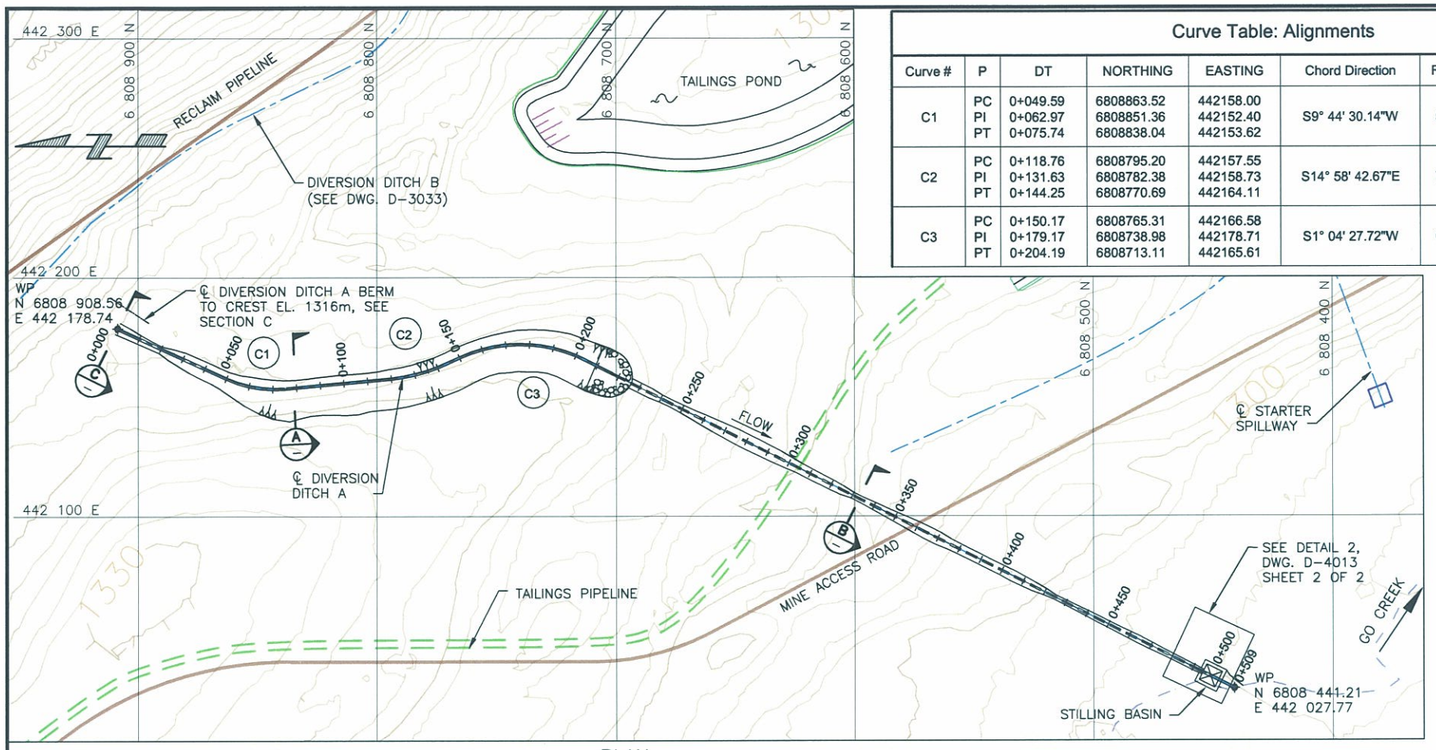

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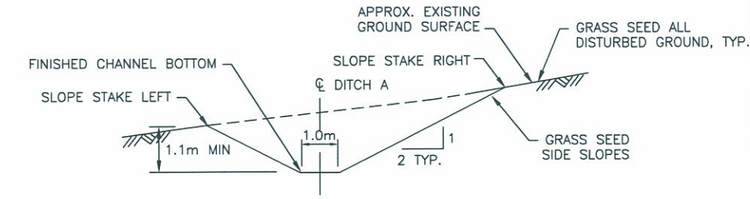
C1	PC PI PT	0+049.59 0+062.97 0+075.74	6808863.52 6808851.36 6808838.04	442158.00 442152.40 442153.62	S9° 44' 30.14"W	50.00	26.15	150° 01' 52"
C2	PC PI PT	0+118.76 0+131.63 0+144.25	6808795.20 6808782.38 6808770.69	442157.55 442158.73 442164.11	S14° 58' 42.67"E	75.00	25.49	160° 31' 43"
C3	PC PI PT	0+150.17 0+179.17 0+204.19	6808765.31 6808738.98 6808713.11	442166.58 442178.71 442165.61	S1° 04' 27.72"W	60.00	54.01	128° 25' 22"



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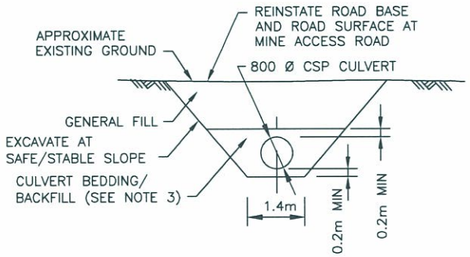

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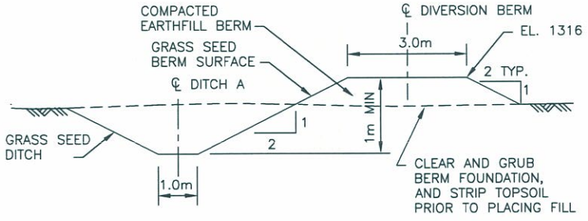
TYPICAL CULVERT SECTION



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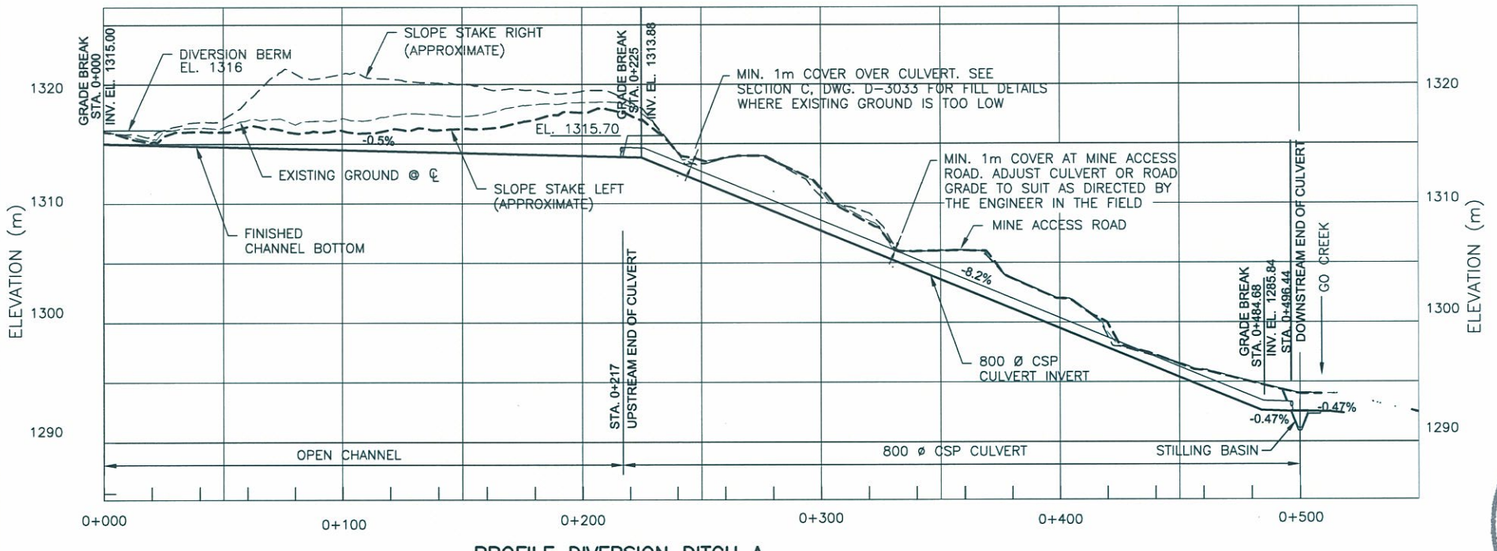

PROFILE DIVERSION DITCH A
SCALE A
VERTICAL SCALE = 5X HORIZONTAL SCALE

NOTES

1. FOR GENERAL SITE ARRANGEMENT SEE DWG. D-3001.
2. INVERT ELEVATIONS SHOWN ARE TO FINISHED CHANNEL BOTTOM.
3. CULVERT BEDDING/BACKFILL SHALL BE WELL GRADED 100 mm MINUS MATERIAL WITH LESS THAN 20% PASSING THE #200 SIEVE.
4. FOR RIPRAP AND GRANULAR FILTER GRADATION AND LAYER THICKNESS, SEE DWG. D-3033 SHEET 2 OF 2.

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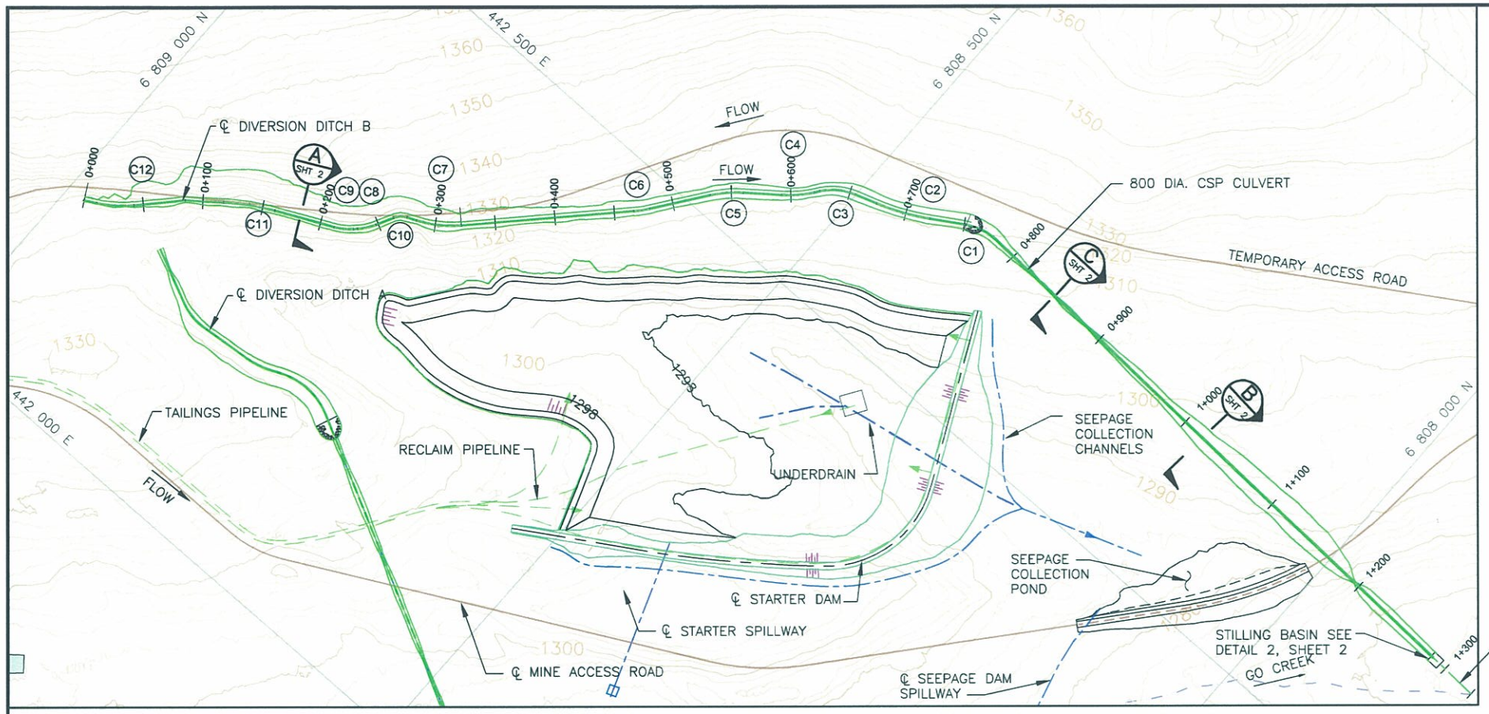
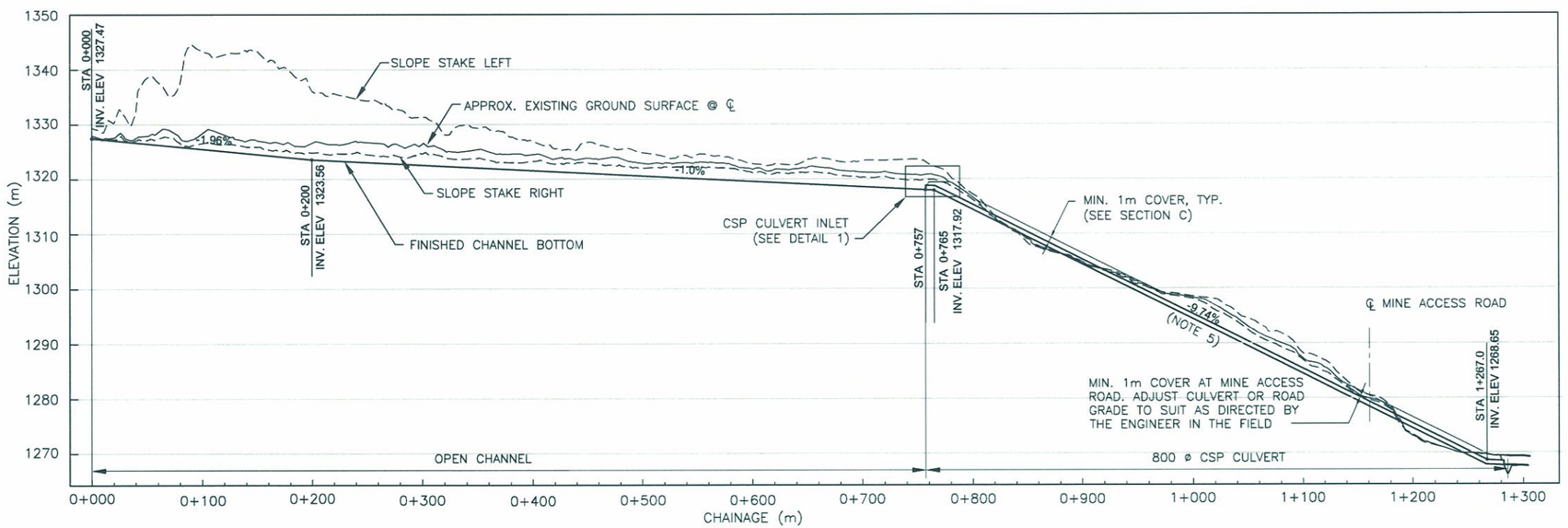


PLAN

Curve Table: Alignments								
Curve #	P	DT	NORTHING	EASTING	Chord Direction	Radius	Length	Ic
C1	PC	0+750.66	6808414.57	442637.94	S12° 20' 00.26"E	50.00	33.96	141° 04' 58"
	PI	0+768.32	6808399.56	442647.25				
	PT	0+784.62	6808382.03	442645.06				
C2	PC	0+674.28	6808481.97	442602.50	S25° 07' 47.29"E	200.00	46.51	166° 40' 32"
	PI	0+697.65	6808459.81	442609.90				
	PT	0+720.80	6808439.95	442622.21				
C3	PC	0+624.40	6808524.66	442578.74	S35° 56' 35.36"E	50.00	30.50	145° 02' 56"
	PI	0+640.14	6808515.28	442591.38				
	PT	0+654.90	6808500.35	442596.36				
C4	PC	0+592.14	6808546.71	442555.36	S45° 31' 23.19"E	100.00	27.56	164° 12' 31"
	PI	0+606.01	6808535.73	442563.82				
	PT	0+619.70	6808527.46	442574.96				
C5	PC	0+532.22	6808591.51	442515.91	S45° 38' 36.55"E	100.00	27.98	163° 58' 05"
	PI	0+546.30	6808583.16	442527.26				
	PT	0+560.20	6808572.01	442535.86				
C6	PC	0+466.43	6808631.21	442463.50	S49° 46' 50.48"E	100.00	13.54	172° 14' 32"
	PI	0+473.21	6808626.49	442468.37				
	PT	0+479.97	6808622.47	442473.83				
C7	PC	0+283.83	6808762.87	442338.15	S34° 46' 17.96"E	98.25	38.17	157° 44' 23"
	PI	0+303.16	6808745.16	442345.90				
	PT	0+322.00	6808731.71	442359.78				
C8	PC	0+232.16	6808795.45	442300.22	S53° 40' 58.72"E	50.00	15.76	161° 56' 33"
	PI	0+240.11	6808789.80	442305.81				
	PT	0+247.92	6808786.16	442312.87				
C9	PC	0+212.24	6808811.29	442288.33	S35° 15' 18.59"E	50.00	16.40	161° 12' 07"
	PI	0+220.52	6808803.84	442291.94				
	PT	0+228.65	6808797.95	442297.75				
C10	PC	0+263.91	6808778.83	442327.08	S43° 10' 35.69"E	16.71	11.39	140° 55' 47"
	PI	0+269.84	6808776.11	442332.35				
	PT	0+275.31	6808770.68	442334.73				
C11	PC	0+117.34	6808894.38	442242.94	S32° 00' 57.85"E	200.00	43.00	167° 40' 48"
	PI	0+138.93	6808877.41	442256.28				
	PT	0+160.35	6808857.99	442265.69				
C12	PC	0+010.71	6808673.90	442172.53	S37° 45' 55.04"E	100.00	31.35	162° 02' 24"
	PI	0+026.51	6808960.05	442180.14				
	PT	0+042.05	6808949.22	442191.65				



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SCALE

NOTES:

1. FOR GENERAL SITE ARRANGEMENT SEE DWG. D-3001.
2. INVERT ELEVATIONS SHOWN ARE TO FINISHED CHANNEL BOTTOM.
3. CULVERT BEDDING/BACKFILL SHALL BE WELL GRADED 100 mm MINUS MATERIAL WITH LESS THAN 20% PASSING THE #200 SIEVE.
4. FOR RIPRAP AND GRANULAR FILTER GRADATION AND LAYER THICKNESS, SEE DWG. D-3034.
5. GRADIENT MAY VARY TO SUIT ACTUAL GROUND ELEVATIONS.

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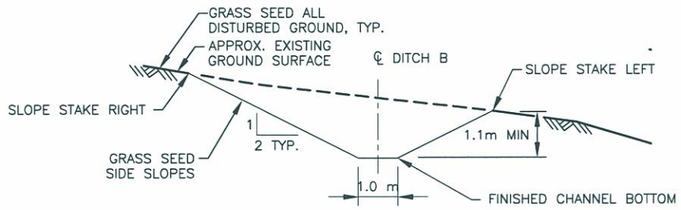

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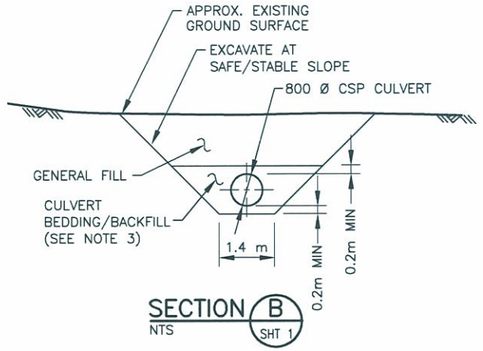

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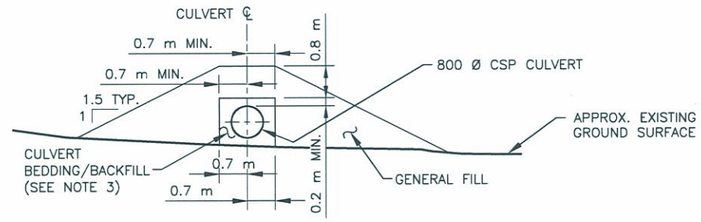

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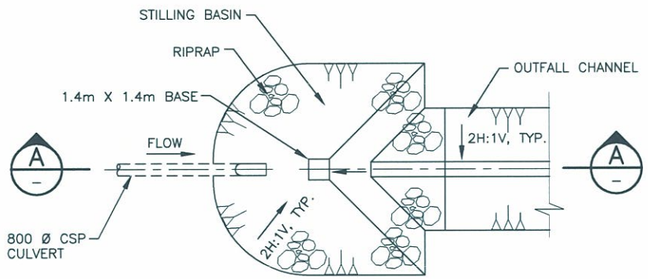

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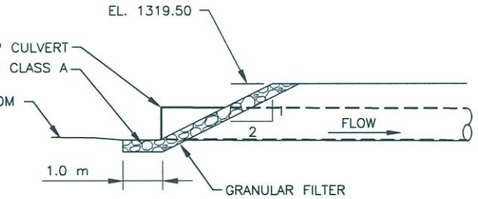

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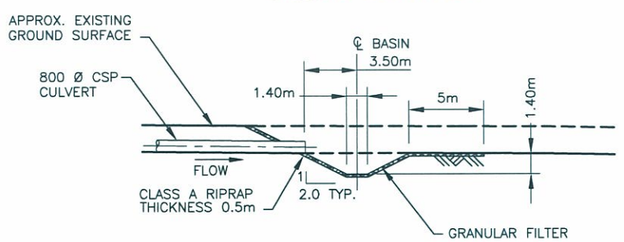

SECTION A NTS

RIPRAP AND GRANULAR FILTER GRADATION AND LAYER THICKNESS

(SEE NOTE 4)

Gradation and Layer Thickness

Material	Particle Size (mm)				Layer Thickness (mm)	
	D_{100}	D_{85}	D_{50}	D_{15}	Riprap	Filter
Riprap A	300	260	200	120	400	200 Filter 1
Riprap B	450	390	300	180	600	200 Filter 1
Riprap C	525	455	350	210	700	300 Filter 1
Riprap D	675	585	450	270	900	300 Filter 1
Riprap E	1200	1040	800	480	1600	300 Filter 1 + 400 Filter 2
Riprap F	1500	1300	1,000	600	2000	400 Filter 1 + 400 Filter 2
Filter 1	75	60 to 70	35 to 50	23 to 28	-	-
Filter 2	300	260	200	120	-	-

- Riprap gradation shall be within –5% to +10% of the specified D_{15}, D_{50}, and D_{85} sizes.
- Filter 1 shall be well graded between the 75 mm and 19 mm screen sizes.
- Filter 2 shall be the same gradation as Riprap A.
- Filter 1 grading is based on the subsoil being a silty sand and gravel

NOTES:

1. FOR GENERAL SITE ARRANGEMENT SEE DWG. D–3001.
2. INVERT ELEVATIONS SHOWN ARE TO FINISHED CHANNEL BOTTOM.
3. CULVERT BEDDING/BACKFILL SHALL BE WELL GRADED 100 mm MINUS MATERIAL WITH LESS THAN 20% PASSING THE #200 SIEVE.
4. UNLESS OTHERWISE DIRECTED BY THE ENGINEER, GRANULAR FILTER IS TO BE PLACED UNDER ALL RIPRAP.

PROFESSIONAL YUKON H. M. MACLEOD TERRITORY ENGINEER

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TAILINGS STORAGE FACILITY
DIVERSION DITCH B
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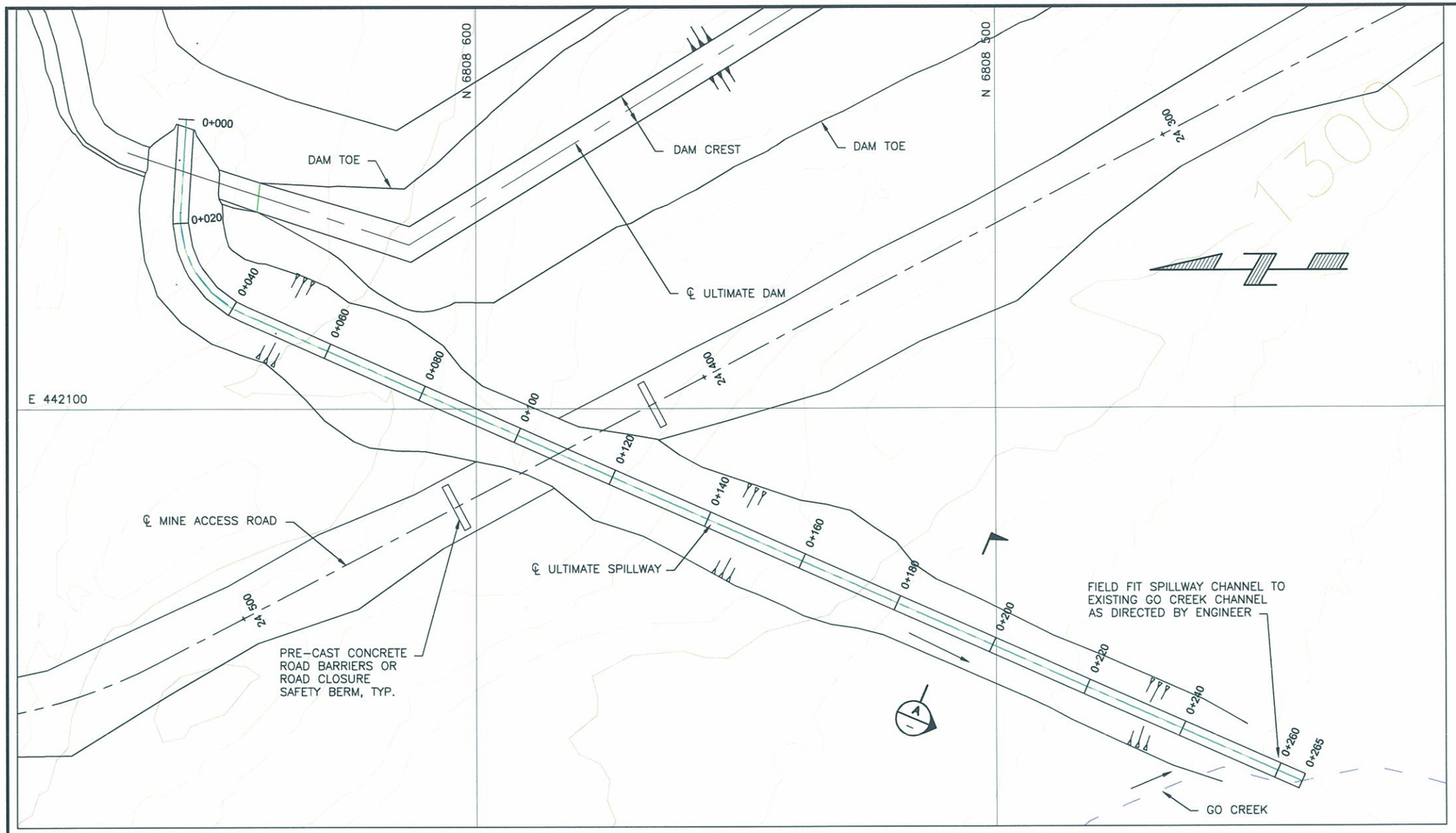

PLAN
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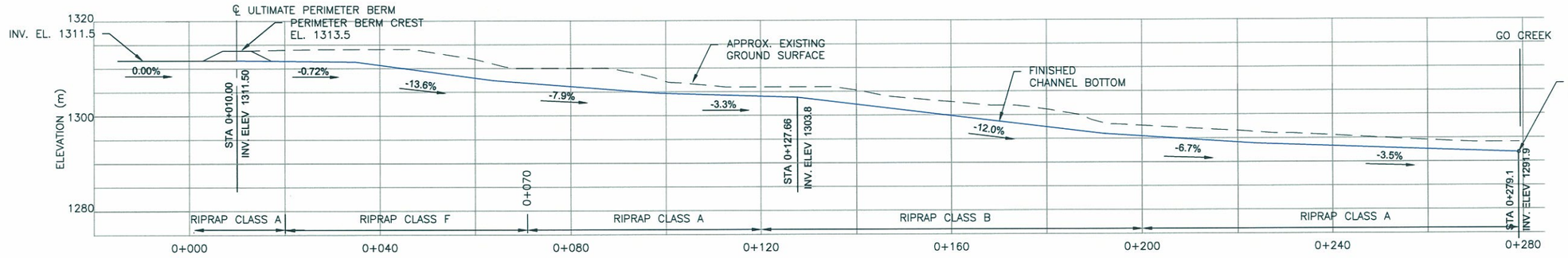

PROFILE – ULTIMATE SPILLWAY
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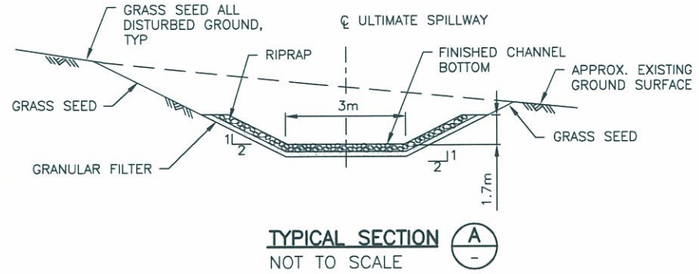

TYPICAL SECTION (A)
NOT TO SCALE

RIPRAP AND GRANULAR FILTER GRADATION AND LAYER THICKNESS

Material	Particle Size (mm)				Layer Thickness (mm)	
	D_{100}	D_{85}	D_{50}	D_{15}	Riprap	Filter
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Riprap B	450	390	300	180	600	200 Filter 1
Riprap C	525	455	350	210	700	300 Filter 1
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Riprap E	1200	1040	800	480	1600	300 Filter 1 + 400 Filter 2
Riprap F	1500	1300	1,000	600	2000	400 Filter 1 + 400 Filter 2
Filter 1	75	60 to 70	35 to 50	23 to 28	-	-
Filter 2	300	260	200	120	-	-

- Riprap gradation shall be within –5% to +10% of the specified D_{15}, D_{50}, and D_{85} sizes.
- Filter 1 shall be well graded between the 75 mm and 19 mm screen sizes.
- Filter 2 shall be the same gradation as Riprap A.
- Filter 1 grading is based on the subsoil being a silty sand and gravel

NOTES

1. FOR GENERAL SITE ARRANGEMENT, SEE DWG. D–3001.
2. INVERT ELEVATIONS SHOWN ARE TO FINISHED CHANNEL BOTTOM.
3. BETWEEN STA 0+002 TO STA 0+020 PLACE RIPRAP UP TO EL. 1313.5 OR EXISTING GROUND SURFACE, WHICHEVER IS HIGHER.

PROFESSIONAL ENGINEER YUKON H.M. MOLTER TERRITORY

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SCALE A 0 50 m

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ULTIMATE SPILLWAY
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APPENDIX I

Geotechnical Characterization

- Part I – Geology
- Part II – Seismicity
- Part III – Laboratory Test Results
- Part IV – Drill Hole and Test Pit Logs
- Part V – Seepage Analysis Results
- Part VI – Stability Analysis Results

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1. GEOLOGY

The Wolverine Lake area lies within the limits of the McConnell Glaciation (youngest of the four glaciations in Yukon Territory) and most of the geomorphic features in the area are related to this glaciation. McConnell glacial ice covered this area between 14,000 and 35,000 years ago. As the McConnell ice retreated and down-wasted, a complex network of ice tongues developed in valley bottoms. Morainal deposits are found at lower to mid-elevation and valley floors, and may contain a more complex assemblage of glacio-fluvial, colluvial and fluvial sediments (Mougeot 1996). Figure I- 1-1, reproduced from Mougeot (1996), shows the quaternary surficial geology units in the area. This local mapping is in general agreement with the regional setting presented by Jackson (1993, 1994) and Dyke (1990). The main glacial soils in the vicinity of the tailings impoundment consist of up to 20 m of silty, sand and gravel, with cobbles overlying bedrock.

The area is underlain by bedrock strata generally paralleling the valley trend, i.e., striking in the direction of the valley. The bedrock consists of an interlayered sequence of volcanoclastic (rhyolite and quartz feldspar) and carbonaceous/argillic sediments, overlain with basalt. The iron formation, which hosts the ore zone, trends northwest-southeast throughout the project area.

Superimposed on the figure is the approximate exploration bedrock geology map prepared by Expatriate (2004). The area is underlain by bedrock strata generally paralleling the valley trend, i.e., striking in the direction of the valley. The bedrock consists of an interlayered sequence of volcanoclastic (rhyolite and quartz feldspar) and carbonaceous/argillic sediments, overlain with basalt. The iron formation, which hosts the ore zone, trends northwest-southeast throughout the project area.

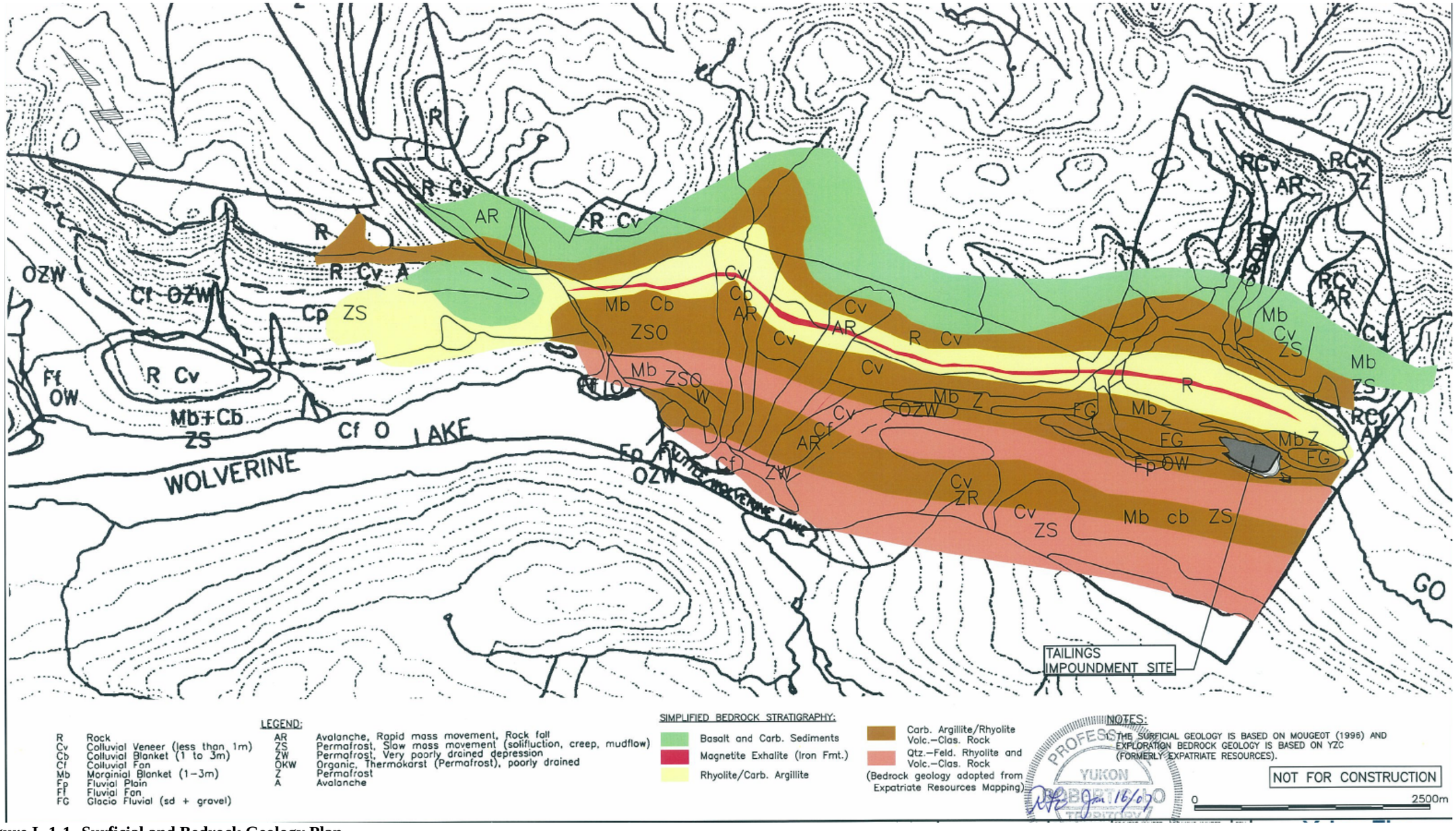


Figure I- 1-1 Surficial and Bedrock Geology Plan

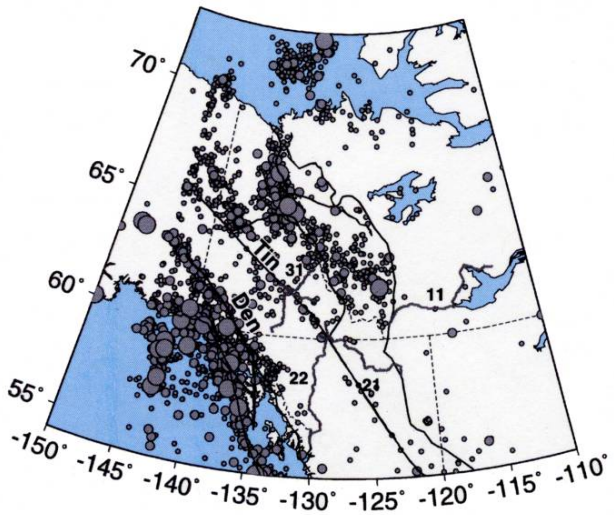
2. SEISMICITY

The regional seismicity is shown on Figure I- 2-1A, and the largest historical earthquakes (equal or greater than magnitude 6) are shown on Figure I- 2-1B (Cassidy et al. 2005). The most seismically active region is along the plate boundaries in the coastal and offshore area. The most significant inland seismicity occurs along segments of the Denali fault zone system, where the seismicity rate is an order of magnitude lower than that in the coastal region. The region between the Denali and Tintina systems is relatively aseismic, with relatively few and small earthquakes. There appears to be an alignment of epicentres along the Tintina fault, however; these are all very small earthquakes (ML less than 3), and most of the activity is at the northern end, close to the Alaskan border. Farther inland, the only significant seismicity is along the eastern edge of the Cordillera, more than 600 km from the active plate boundary. This fold and thrust belt seismicity is concentrated in two areas: the MacKenzie-Ogilvie mountains region and the Richardson Mountains region (Hyndman et al. 2005).

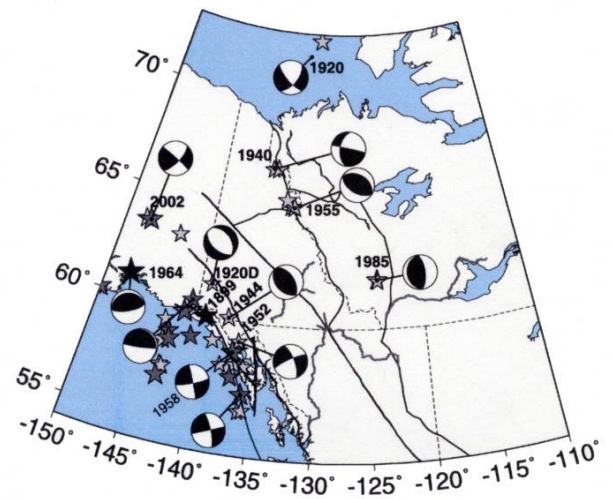
Data on recent earthquakes that occurred within about 600 km from the project site (61.41°N and 130.09°W) from September 1899 to December 2005 was extracted from the Canadian EPB/GSC/PGC database. The epicenters of these events, with magnitude equal to or greater than 3, are plotted on Figure I- 2-2. No earthquakes with magnitude greater than 5 have occurred within 200 km of the site. However, a magnitude 5 event did occur about 28 km northwest of the project site with a focal depth of 5 km on May 12, 1999.

The probabilistic seismic hazard assessment has been determined using both the GSC-H and GSC-R seismic source zonal models developed by the Geological Survey of Canada for the new National Building Code of Canada 2005 (Adams and Halchuk 2003). The GSC-H seismogenic zonal boundaries within Western Canada and the approximate location of the project site are shown on Figure I- 2-3. The model incorporated the work conducted by Atkinson (2004) for a site-specific seismic hazard analysis for Faro, Yukon (62.2°N and 133.2°W). In that analysis, an apparent linear alignment of seismicity in the region along the Tintina Trench fault system was grouped into a Tintina seismic source zone. Figure I- 2-4A shows the boundary of Tintina source zone and seismicity in the region, and Figure I- 2-4B shows the recurrence relationship used to

characterize the source zone. This Tintina source zone was incorporated in the model for computing site peak horizontal acceleration as shown in Table I- 2-1 and Figure I- 2-5. De-aggregation of the seismic hazard corresponding to the 10,000-year return period for the peak horizontal ground acceleration was carried out to evaluate relative contributions of earthquake sources in terms of magnitude and epicentral distance. Figure I- 2-6 presents the calculated magnitude-distance de-aggregation for the peak horizontal ground acceleration of 0.22 g at the Wolverine site. The mean magnitude is Mw 6.1, and mean epicentral distance is 34.8 km.

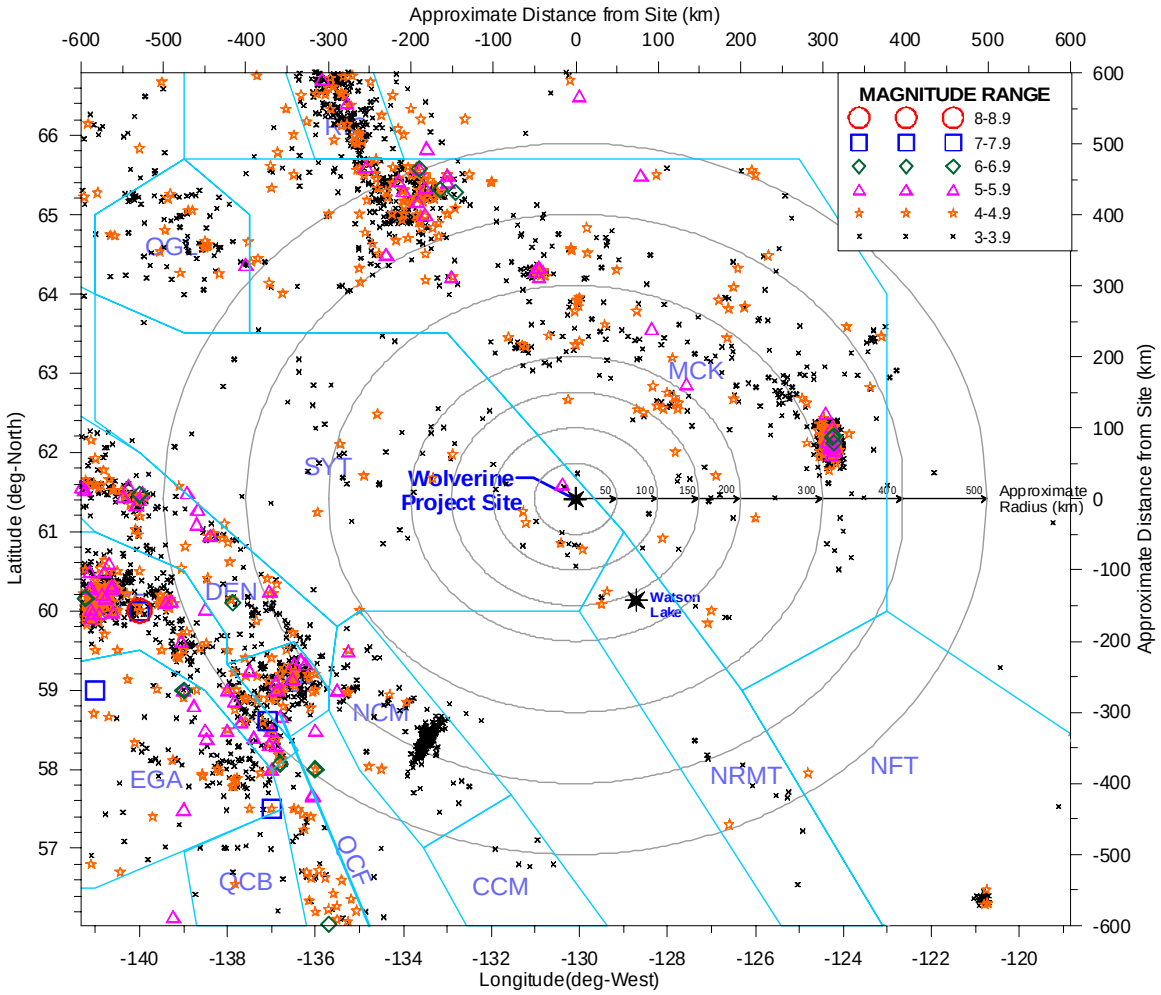


(A) – Seismicity of Northwestern Canada and Adjacent Parts of Alaska During the Period 1899-2002



(B) – Locations of the Largest (M>6) Earthquakes in the Northern Canadian Cordillera

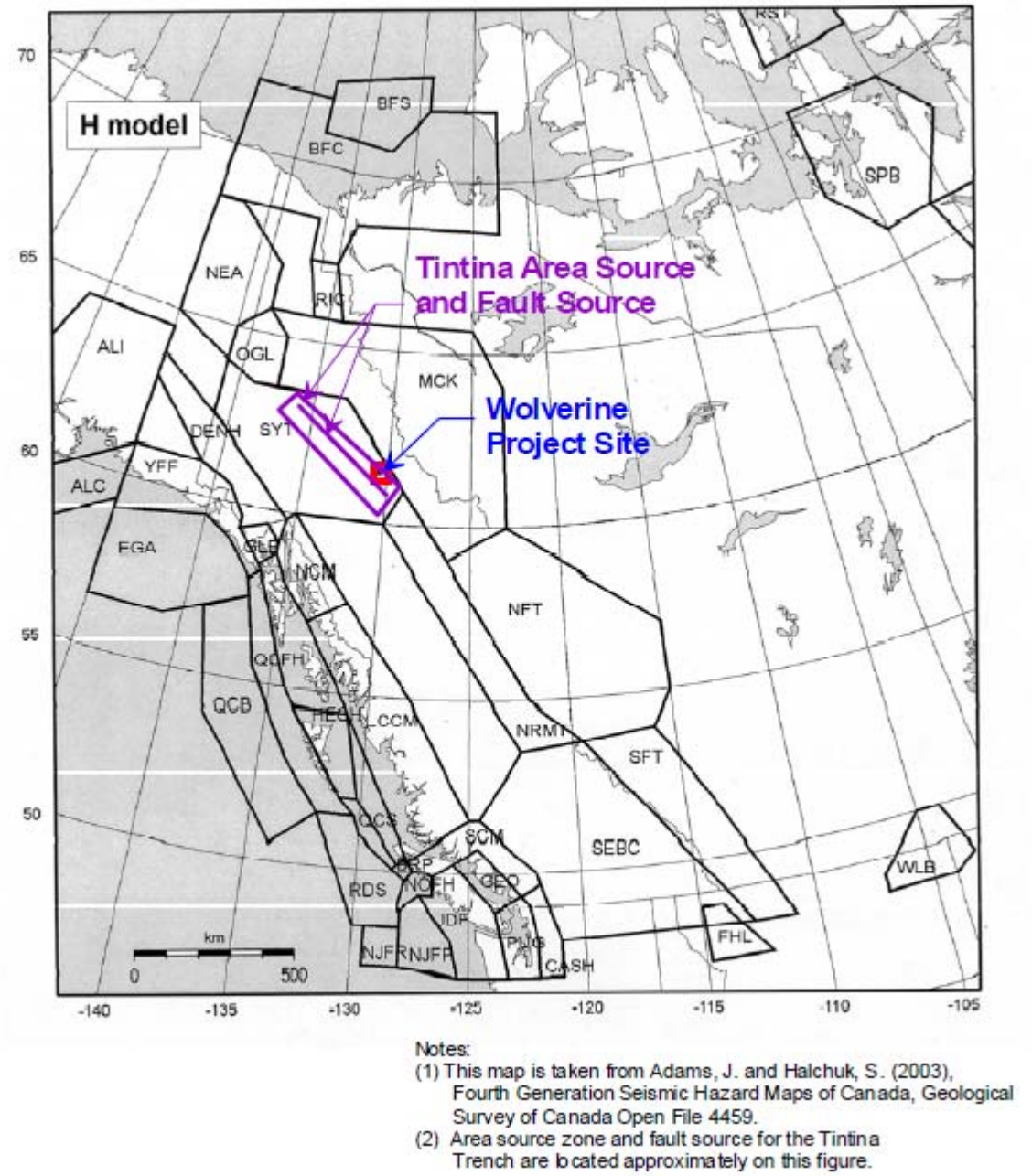
Figure I- 2-1 Regional Seismicity



Notes:
1. Only earthquakes with magnitude M > 3 within a grid of 56.03° N-66.79° N and 118.84° W-141.33° W and from September 1899 to December 2005 are shown.
2. Epicentre data taken from Canadian EPB/GSC/PGC database and
3. Distances from project site are approximate, assuming one degree of latitude and longitude as 111.43 km and 53.37 km, respectively.

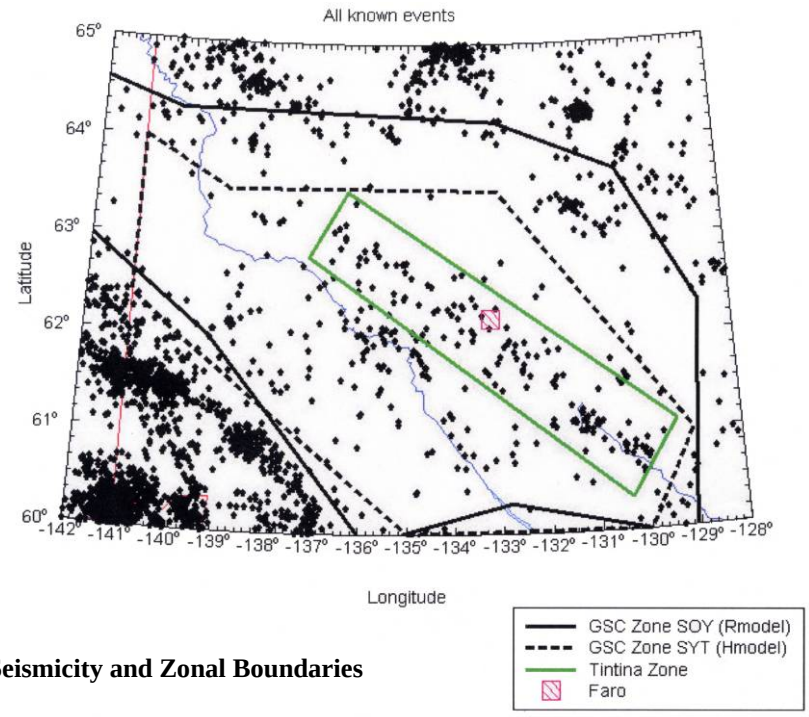
GSC-H Model Seismic Souce Zone Boundary
SYT GSC-H Model Seismic Source Zones

Figure I- 2-2 Location Map of Recent Regional Epicentres

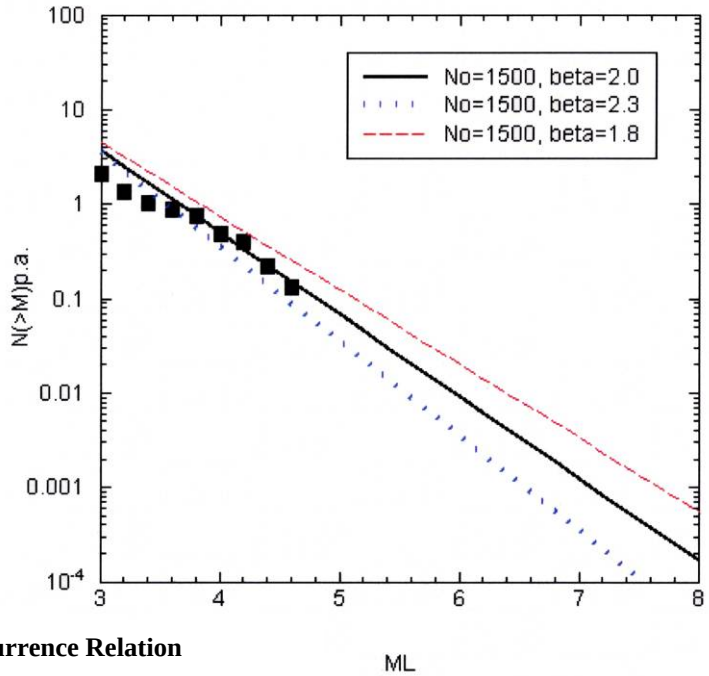


Notes:
(1) This map is taken from Adams, J. and Halchuk, S. (2003), Fourth Generation Seismic Hazard Maps of Canada, Geological Survey of Canada Open File 4459.
(2) Area source zone and fault source for the Tintina Trench are located approximately on this figure.

Figure I- 2-3 Seismogenic Zonal Map – 2005 NBCC H Seismicity Model



(A) Seismicity and Zonal Boundaries



(B) Magnitude Recurrence Relation

Figure I- 2-4 Characteristics of Tintina Source Zone

Table I- 2-1 Probabilistic Evaluation of Peak Horizontal Ground Acceleration at Project Site

ANNUAL PROBABILITY OF EXCEEDANCE	RETURN PERIOD (years)	PEAK GROUND ACCELERATION PGA (g)	
		GSC-H 2005 Model	GSC-H 2005 Model with Tintina Source zone
0.0021	475	0.08	0.097
0.001	1,000	0.10	0.12
0.00040	2,475	0.14	0.15
0.0001	10,000	0.20	0.22

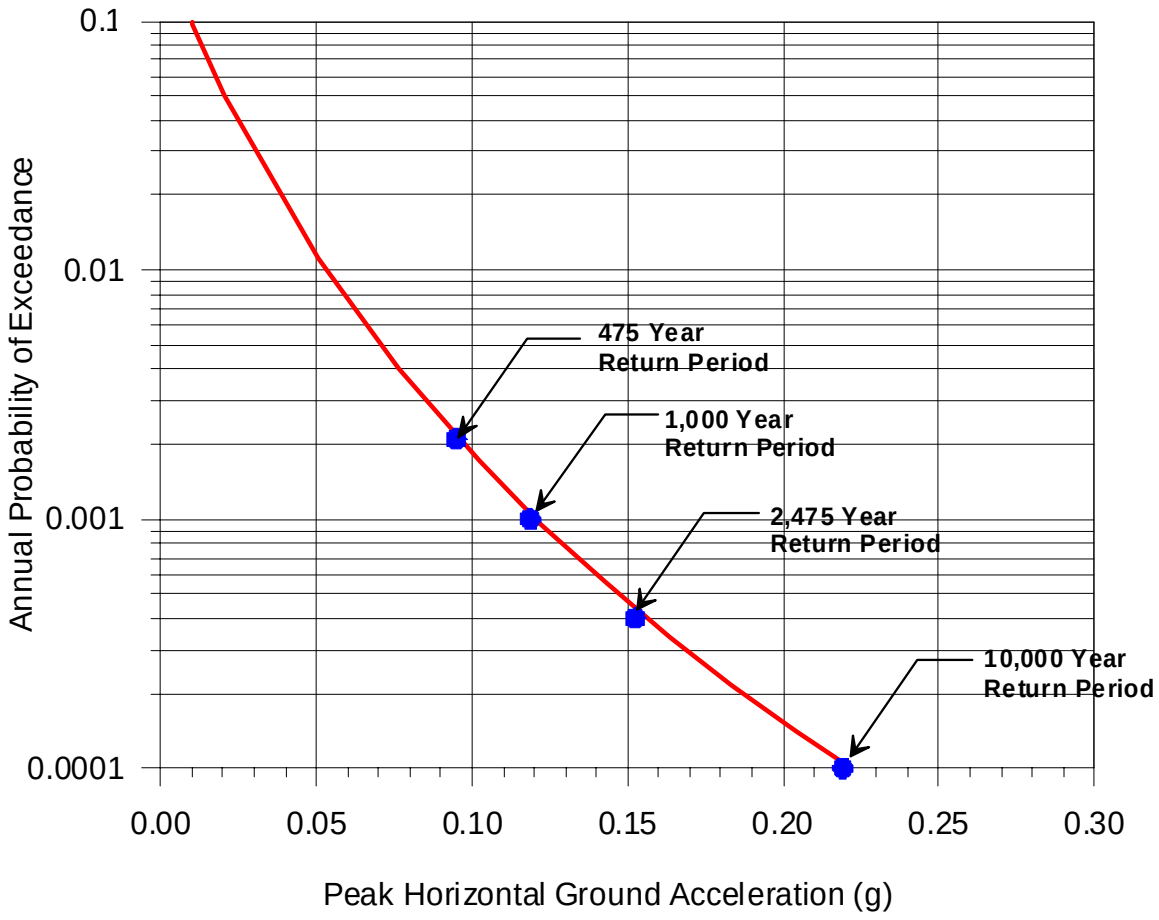


Figure I- 2-5 Peak Horizontal Ground Acceleration at Various Probability of Annual Exceedance

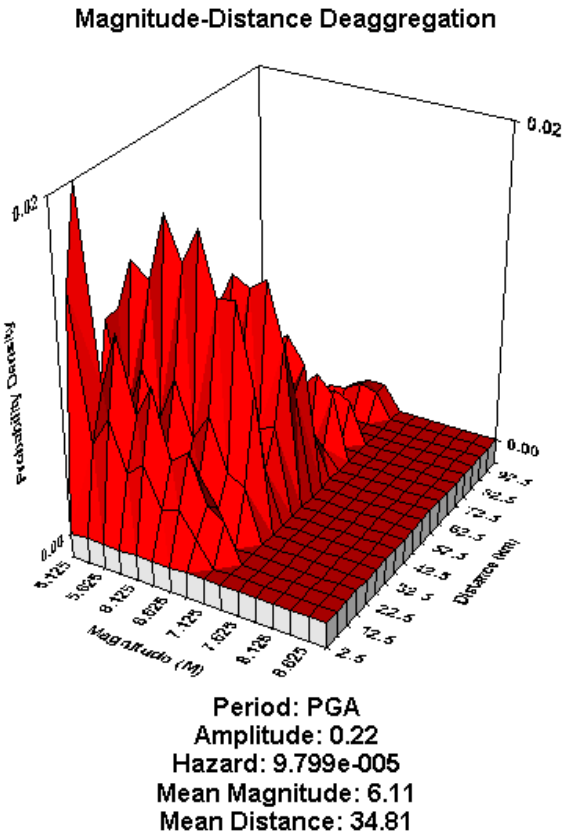


Figure I- 2-6 De-aggregation of Seismic Hazard for Peak Horizontal Ground Acceleration 10,000 year Return Period

Through the interior of the Yukon, there are only three focal mechanisms from recent moderate (M_w = 4 to 5) earthquakes in the vicinity of the Tintina fault system. They are a mixture of right-lateral strike slip and thrust earthquakes, and do not align with the orientation of the Tintina fault system. There has been no evidence found for active faulting along the Tintina fault or the Canadian segments of the Denali fault system (Cassidy et al. 2005). The Tintina fault has been a major strike slip fault through much of the Tertiary. Estimate of displacements for the Tintina Fault ranges from 425 km to 500 km. In the southern part of the Tintina Fault, a set of more northerly trending faults intersect the Tintina at acute angles. Near the Tintina Fault, the faults are steep and are right-lateral strike-slip. Near their southern extremities they appear to be

steeply southwest dipping thrust faults. The Tintina Fault is interpreted, therefore, as a shallowly rooted tear fault along which dextral slip took place as the supracrustal rocks were shortened above a basal detachment (Gabrielse and Yorath 1992).

Two earthquake scenarios were considered for the deterministic evaluation for the site peak horizontal ground acceleration as shown in Table I- 2-2: a local earthquake at the site with magnitude 6; and a nearby earthquake at the Tintina Fault with magnitude M=7.2.

Table I- 2-2 Deterministic Evaluation of Peak Horizontal Ground Acceleration at Project Site

EARTHQUAKE SCENARIO	MAGNITUDE	EPICENTRAL DISTANCE (km)	FOCAL DEPTH (km)	PEAK GROUND ACCELERATION PGA (g)
Local	6	0	2.9	0.34
Tintina Fault	7.2	53	2.9	0.11

3. GEOTECHNICAL LABORATORY TESTS

Below are presented test geotechnical laboratory results for the following materials:

- Overburden soil samples retrieved from field investigations in the tailings impoundment areas including dam foundation and borrow materials; and
- Tailings material.

Index property tests for these materials are covered in Section 3.1, while their engineering properties are described in Section 3.2. Section 3.3 presents laboratory test data sheets either in figure or tabular form.

3.1 Index Property Tests

Overburden soil samples retrieved from test holes and test pits during field investigations were visually classified, and their water content and gradation determined. The logs of test holes and test pits presented in Appendix I – Part IV have incorporated these index properties. Similarly, gradation curves for damfill borrow and tailings materials were also obtained.

The tailings testing carried out in 2006 was on a 50:50 mixture of F11 and F12 (Zn, Rougher Scavenger Tail) and F23 and F32 (Zn 1st Cleaner Scavenger Tail). Additional tests were carried out in 2008 on a mixture of 80% rougher tailings and 20% cleaner tailings. Four specific gravity tests were also performed on the tailings samples.

3.2 Engineering Property Tests

Engineering property tests performed for each material are listed below:

- Damfill Borrow – standard Proctor compaction tests, triaxial permeameter tests, and consolidated-undrained triaxial shear tests with pore pressure measurement.
- Tailings – settling and consolidation tests, triaxial permeameter tests, and consolidated-undrained triaxial shear tests with pore pressure measurement.

For the damfill borrow and tailings materials, consolidated-undrained triaxial shear tests were carried out with permeability measurements after consolidation and pore pressure measurements

during shear. The density values and consolidation stresses used in the laboratory were selected to represent field condition.

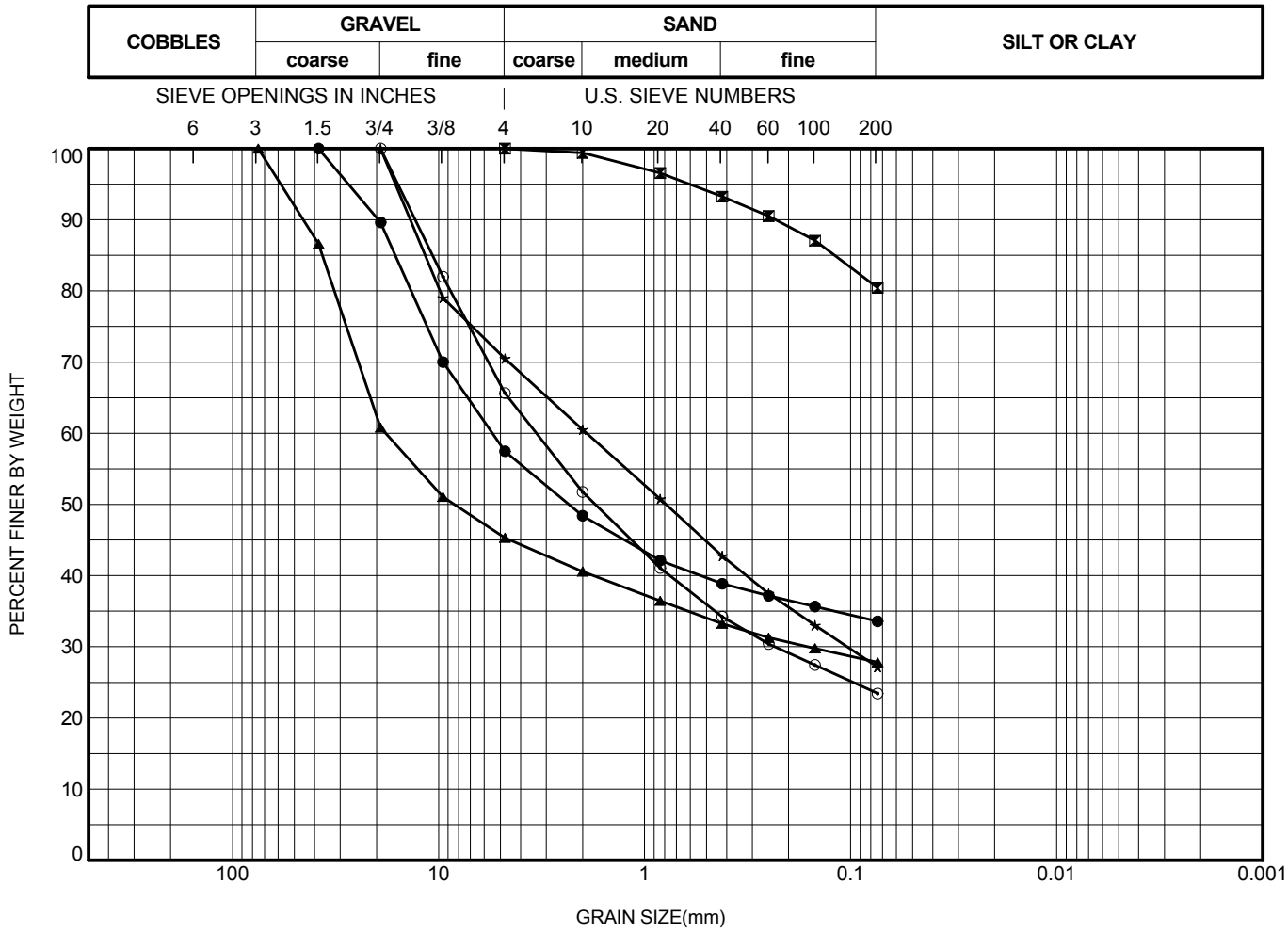
3.3 Test Data Sheets

Data sheets for the index property and engineering property tests are presented in the following pages. They are grouped according to material type in the following order:

- Overburden in Tailings Impoundment Areas;
- Damfill Borrow; and
- Tailings.

Overburden in Tailings Impoundment Areas

GRAIN SIZE DISTRIBUTION



	HOLE	DEPTH (m)	D85	D60	D50	D15	D10	CU	%GRAVEL	%SAND	%FINES
●	TP05- 8	3.00	16.206	5.475	2.329				42.6	23.8	33.6
⊠	TP05- 9	1.00	0.120						0.0	19.4	80.6
▲	TP05-12	1.00	36.578	18.043	8.379				54.7	17.5	27.9
★	TP05-14	1.00	11.607	1.914	0.786				29.5	43.2	27.3
⊙	TP05-15	2.00	10.691	3.349	1.735				34.4	42.1	23.5

	HOLE	SAMPLE	DEPTH (m)	W%	W_L	W_P	PI	REMARKS / SAMPLE DESCRIPTION
●	TP05- 8		3.00	10.8				
⊠	TP05- 9		1.00	109.0				
▲	TP05-12		1.00	8.3				
★	TP05-14		1.00	12.1				
⊙	TP05-15		2.00	9.3				

CU = COEFFICIENT OF UNIFORMITY = D60/D10 **PARTICLE SIZES, e.g. D85, in mm** **Tested by Wet Sieving Method (ASTM D1140 & D422)**

Klohn Crippen Berger

PROJECT NO.: M09234A02 01 01

PROJECT: Wolverine - Test Pit Samples

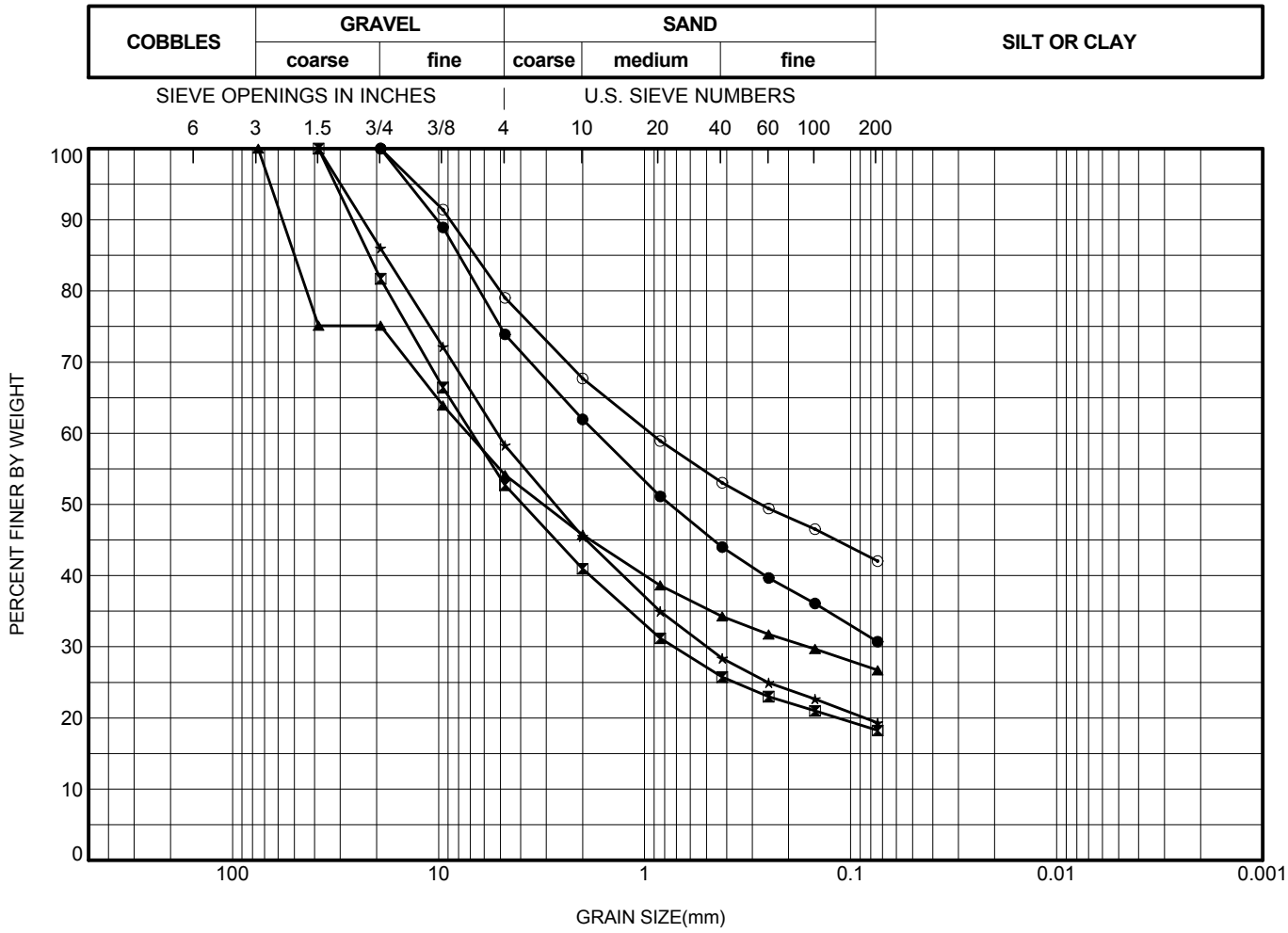
LOCATION: Yukon

FIGURE:

DRAWN BY: SE **CHECKED BY:**

KCB_GRAIN_SIZE-SI M09234A02.GPJ SIEVE.GDT 2/7/06

GRAIN SIZE DISTRIBUTION



	HOLE	DEPTH (m)	D85	D60	D50	D15	D10	CU	%GRAVEL	%SAND	%FINES
●	TP05-16	1.00	7.942	1.711	0.752				26.1	43.0	30.8
⊠	TP05-17	3.50	21.634	6.881	3.897				47.3	34.4	18.3
▲	TP05-18	1.50	49.939	7.213	3.104				45.9	27.4	26.8
★	TP05-19	1.50	18.172	5.184	2.716				41.7	38.9	19.4
⊙	TP05-20	2.00	6.647	0.934	0.272				21.0	36.9	42.1

	HOLE	SAMPLE	DEPTH (m)	W%	W_L	W_P	PI	REMARKS / SAMPLE DESCRIPTION
●	TP05-16		1.00	9.1				
⊠	TP05-17		3.50	9.2				
▲	TP05-18		1.50	11.7				
★	TP05-19		1.50	22.0				
⊙	TP05-20		2.00	15.5				

CU = COEFFICIENT OF UNIFORMITY = D60/D10 **PARTICLE SIZES, e.g. D85, in mm** **Tested by Wet Sieving Method (ASTM D1140 & D422)**

Klohn Crippen Berger

PROJECT NO.: M09234A02 01 01

PROJECT: Wolverine - Test Pit Samples

LOCATION: Yukon

FIGURE:

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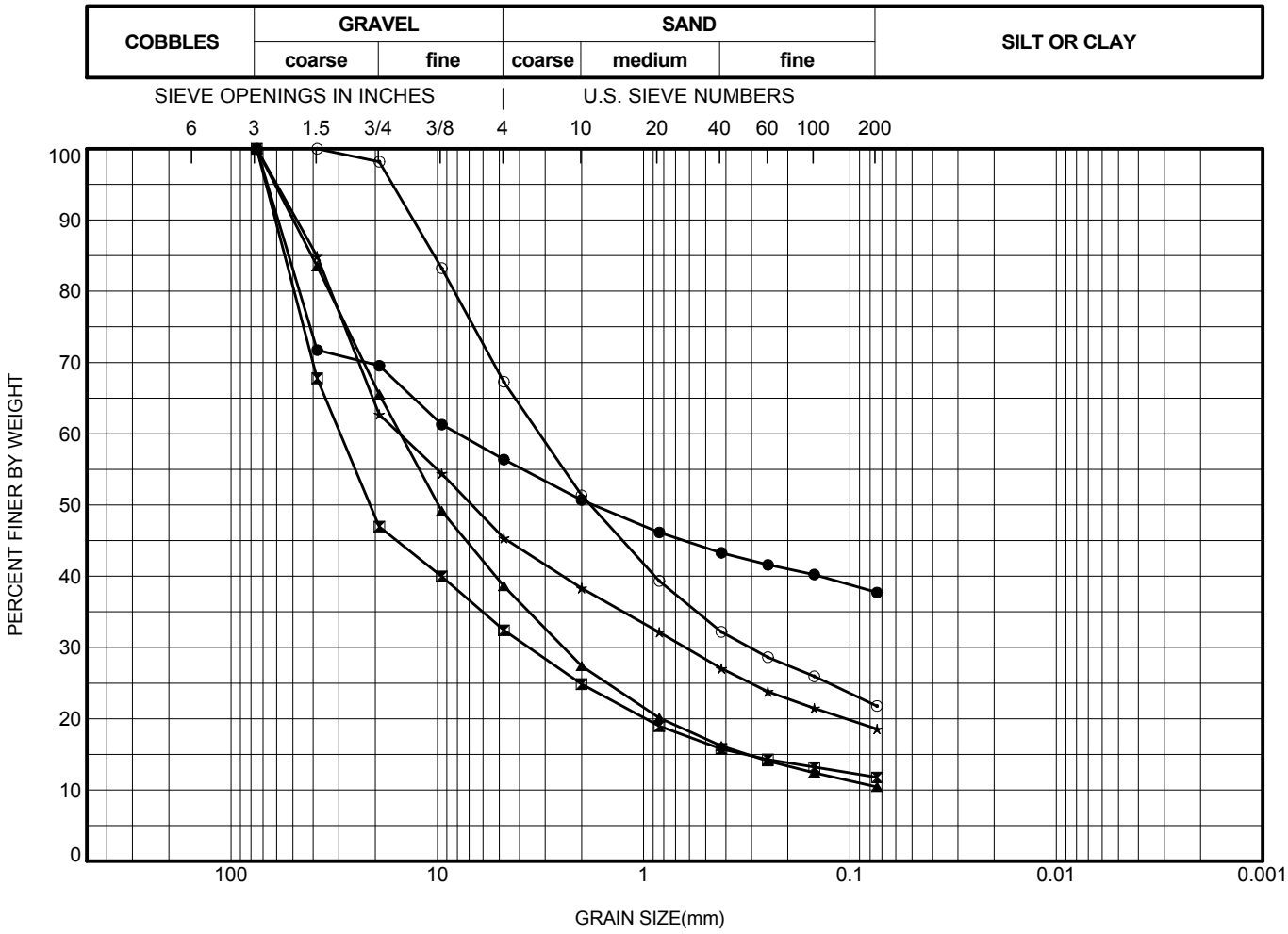
KCB_GRAIN_SIZE-SI M09234A02.GPJ SIEVE.GDT 2/7/06

GRAIN SIZE DISTRIBUTION



	HOLE	DEPTH (m)	D85	D60	D50	D15	D10	CU	%GRAVEL	%SAND	%FINES
●	TP05-22	1.00	52.419	7.936	1.753				43.6	18.6	37.8
⊠	TP05-22	3.00	54.782	29.479	21.131	0.321	0.031	943.614	67.6	20.6	11.8
▲	TP05-23	0.50	40.591	15.107	9.876	0.316			61.4	28.1	10.5
★	TP05-23	2.50	38.359	15.225	6.795				54.7	26.7	18.6
⊙	TP05-24	1.80	10.335	3.202	1.814				32.7	45.4	21.9

	HOLE	SAMPLE	DEPTH (m)	W%	W_L	W_P	PI	REMARKS / SAMPLE DESCRIPTION
●	TP05-22		1.00	11.7				
⊠	TP05-22		3.00	9.7				
▲	TP05-23		0.50	10.5				
★	TP05-23		2.50	7.6				
⊙	TP05-24		1.80	10.6				

CU = COEFFICIENT OF UNIFORMITY = D60/D10 **PARTICLE SIZES, e.g. D85, in mm** **Tested by Wet Sieving Method (ASTM D1140 & D422)**

Klohn Crippen Berger

PROJECT NO.: M09234A02 01 01

PROJECT: Wolverine - Test Pit Samples

LOCATION: Yukon

FIGURE:

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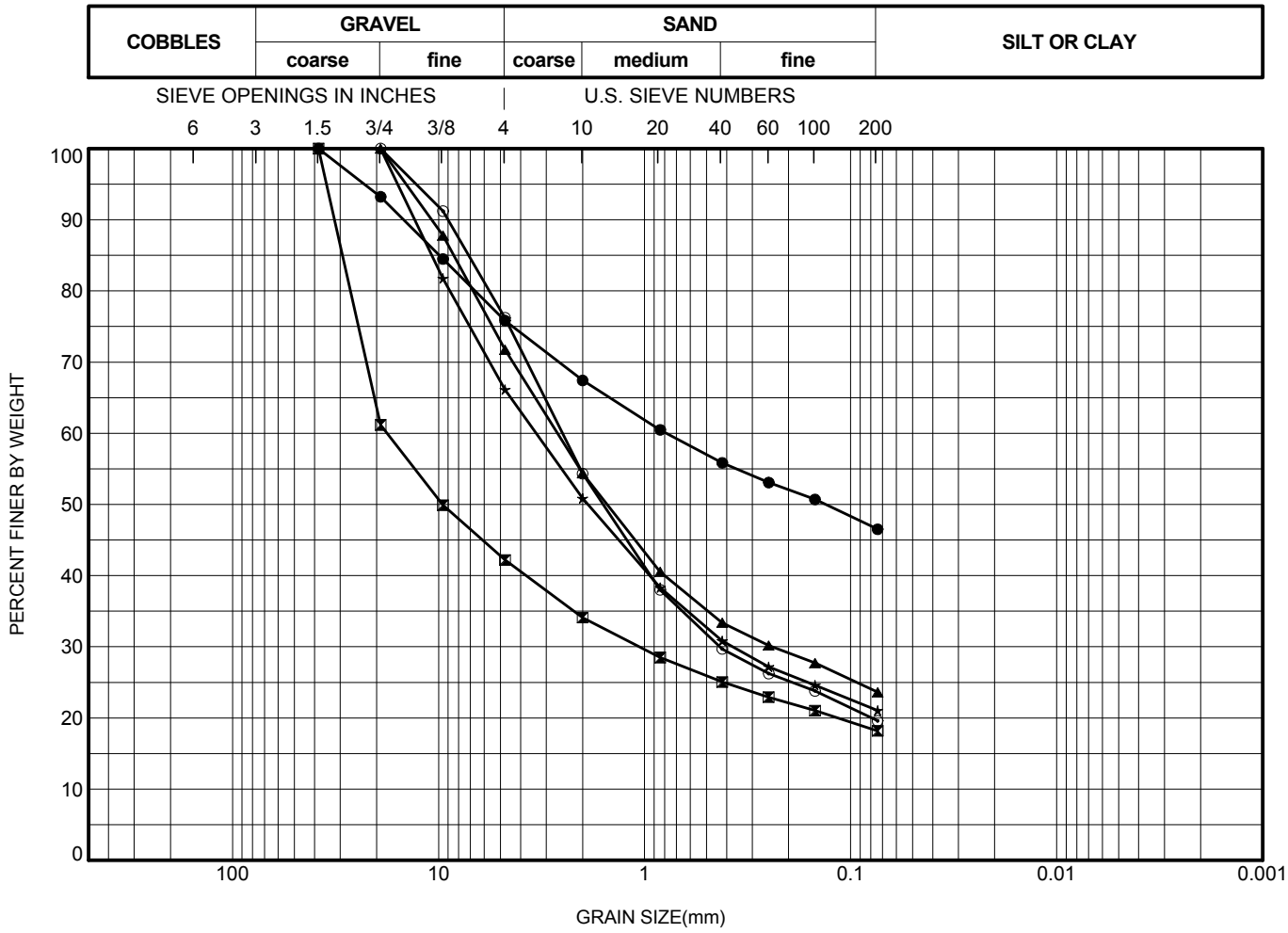
KCB_GRAIN_SIZE-SI M09234A02.GPJ SIEVE.GDT 2/7/06

GRAIN SIZE DISTRIBUTION



	HOLE	DEPTH (m)	D85	D60	D50	D15	D10	CU	%GRAVEL	%SAND	%FINES
●	TP05-25	1.20	9.920	0.782	0.133				24.2	29.2	46.6
⊠	TP05-26	1.50	29.226	17.767	9.579				57.8	23.9	18.2
▲	TP05-27	1.00	8.437	2.648	1.520				28.3	48.0	23.7
★	TP05-28	1.00	10.777	3.362	1.887				33.9	45.0	21.1
⊙	TP05-29	1.00	7.142	2.504	1.590				23.8	56.5	19.7

	HOLE	SAMPLE	DEPTH (m)	W%	W_L	W_P	PI	REMARKS / SAMPLE DESCRIPTION
●	TP05-25		1.20	10.6				
⊠	TP05-26		1.50	8.4				
▲	TP05-27		1.00	10.9				
★	TP05-28		1.00	16.1				
⊙	TP05-29		1.00	19.8				

CU = COEFFICIENT OF UNIFORMITY = D60/D10 **PARTICLE SIZES, e.g. D85, in mm** **Tested by Wet Sieving Method (ASTM D1140 & D422)**

Klohn Crippen Berger

PROJECT NO.: M09234A02 01 01

PROJECT: Wolverine - Test Pit Samples

LOCATION: Yukon

FIGURE:

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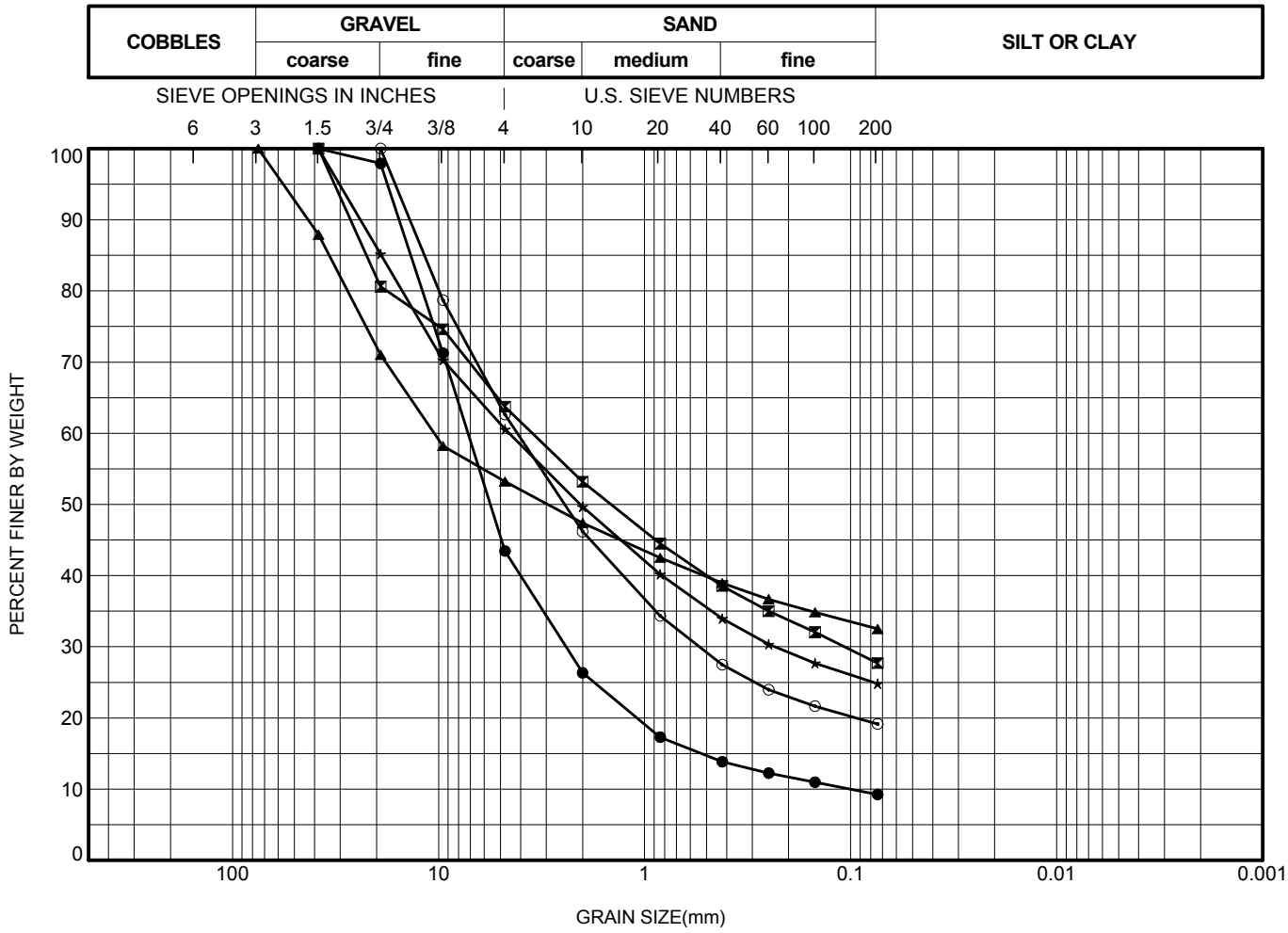
KCB_GRAIN_SIZE-SI M09234A02.GPJ SIEVE.GDT 2/7/06

GRAIN SIZE DISTRIBUTION



	HOLE	DEPTH (m)	D85	D60	D50	D15	D10	CU	%GRAVEL	%SAND	%FINES
●	TP05-31	1.00	13.630	7.191	5.604	0.529	0.101	71.410	56.6	34.1	9.3
⊠	TP05-43	2.00	22.347	3.501	1.454				36.3	35.9	27.8
▲	TP05-44	2.00	33.884	10.489	2.949				46.8	20.7	32.6
★	TP05-45	2.00	18.927	4.551	2.055				39.5	35.7	24.9
⊙	TP05-46	2.00	11.695	4.142	2.446				37.4	43.4	19.2

	HOLE	SAMPLE	DEPTH (m)	W%	W_L	W_P	PI	REMARKS / SAMPLE DESCRIPTION
●	TP05-31		1.00	9.3				
⊠	TP05-43		2.00	7.2				
▲	TP05-44		2.00	11.7				
★	TP05-45		2.00	9.5				
⊙	TP05-46		2.00	10.9				

CU = COEFFICIENT OF UNIFORMITY = D60/D10 **PARTICLE SIZES, e.g. D85, in mm** **Tested by Wet Sieving Method (ASTM D1140 & D422)**

Klohn Crippen Berger

PROJECT NO.: M09234A02 01 01

PROJECT: Wolverine - Test Pit Samples

LOCATION: Yukon

FIGURE:

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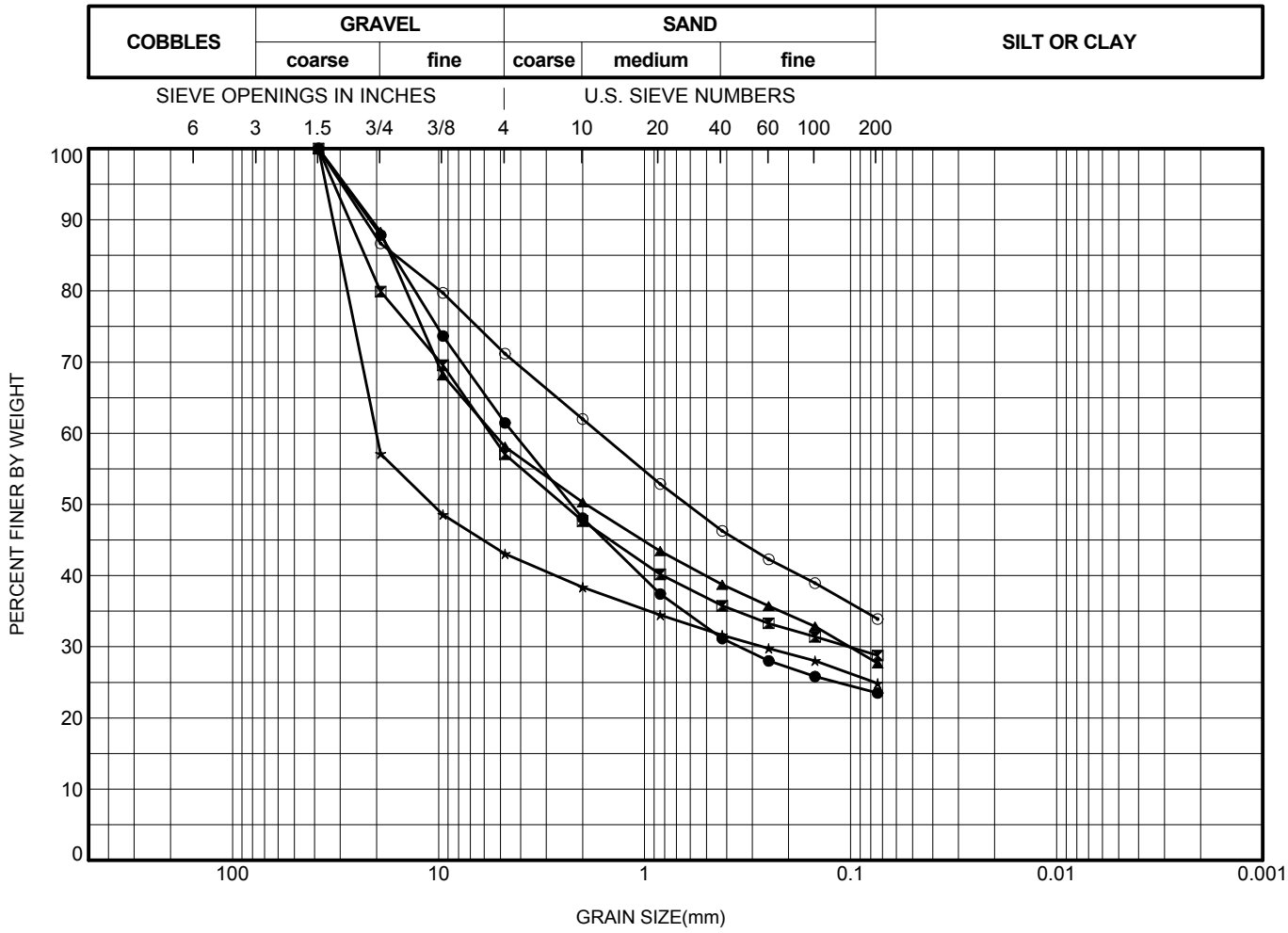
KCB_GRAIN_SIZE-SI M09234A02.GPJ SIEVE.GDT 2/7/06

GRAIN SIZE DISTRIBUTION



	HOLE	DEPTH (m)	D85	D60	D50	D15	D10	CU	%GRAVEL	%SAND	%FINES
●	TP05-47	2.00	16.609	4.332	2.267				38.6	37.9	23.5
⊠	TP05-48	2.00	22.764	5.606	2.482				43.0	28.2	28.8
▲	TP05-72	2.50	17.039	5.427	1.926				41.9	30.3	27.8
★	TP05-74	1.50	29.973	20.007	10.698				57.0	18.1	24.9
⊙	TP05-75	1.50	16.153	1.655	0.621				28.8	37.2	34.0

	HOLE	SAMPLE	DEPTH (m)	W%	W_L	W_P	PI	REMARKS / SAMPLE DESCRIPTION
●	TP05-47		2.00	11.8				
⊠	TP05-48		2.00	9.7				
▲	TP05-72		2.50	8.2				
★	TP05-74		1.50	7.7				
⊙	TP05-75		1.50	10.2				

CU = COEFFICIENT OF UNIFORMITY = D60/D10 **PARTICLE SIZES, e.g. D85, in mm** **Tested by Wet Sieving Method (ASTM D1140 & D422)**

Klohn Crippen Berger

PROJECT NO.: M09234A02 01 01

PROJECT: Wolverine - Test Pit Samples

LOCATION: Yukon

FIGURE:

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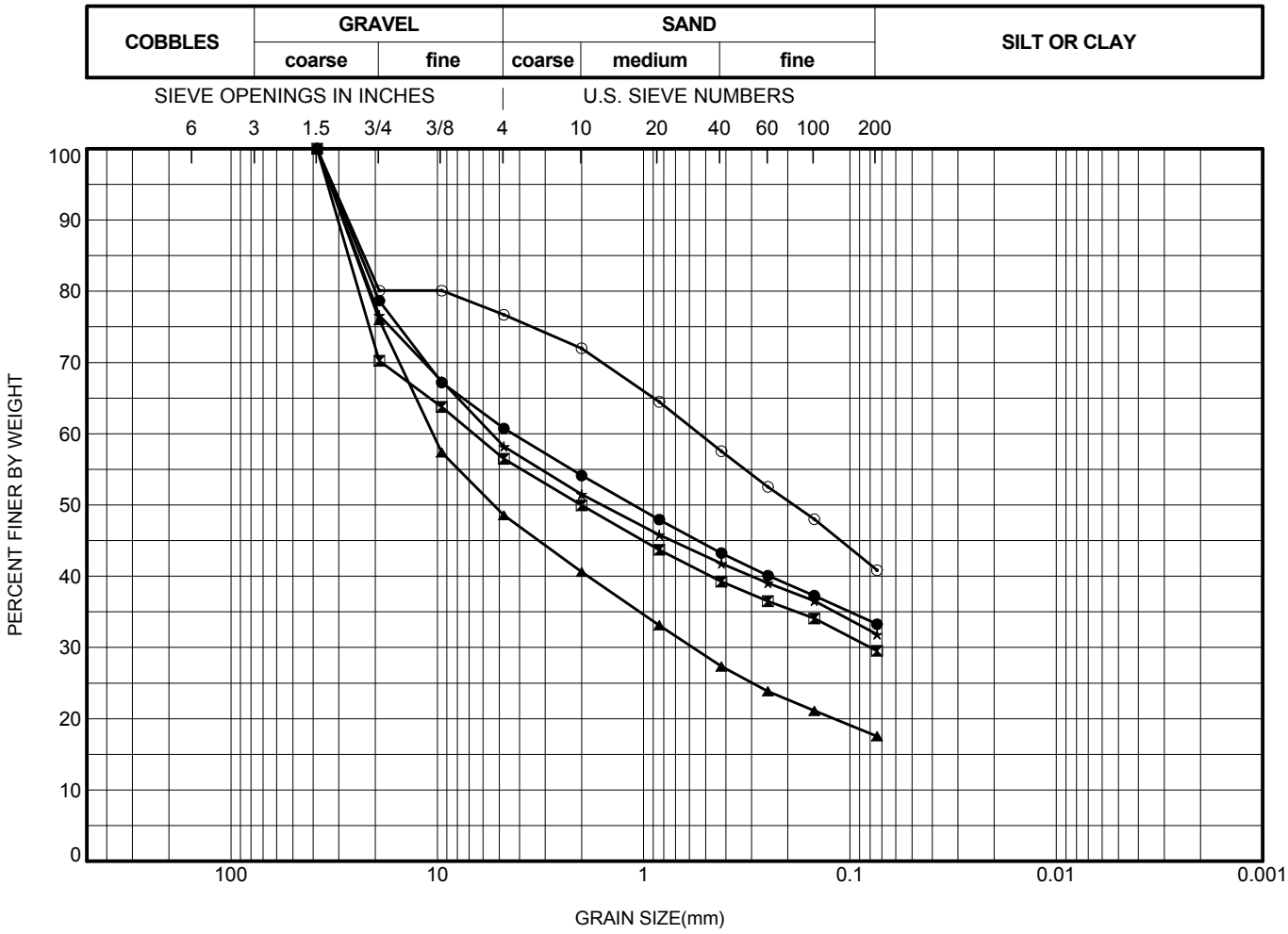
KCB_GRAIN_SIZE-SI M09234A02.GPJ SIEVE.GDT 2/7/06

GRAIN SIZE DISTRIBUTION



	HOLE	DEPTH (m)	D85	D60	D50	D15	D10	CU	%GRAVEL	%SAND	%FINES
●	TP05-76	1.50	23.460	4.323	1.121				39.3	27.4	33.3
⊠	TP05-77	1.50	26.940	6.658	2.016				43.5	26.8	29.6
▲	TP05-83	1.80	24.775	10.503	5.330				51.5	30.9	17.6
★	TP05-84	1.50	24.488	5.453	1.595				41.8	26.3	31.9
⊙	TP05-85	1.50	22.662	0.537	0.187				23.3	35.7	41.0

	HOLE	SAMPLE	DEPTH (m)	W%	W_L	W_P	PI	REMARKS / SAMPLE DESCRIPTION
●	TP05-76		1.50	10.3				
⊠	TP05-77		1.50	7.3				
▲	TP05-83		1.80	6.2				
★	TP05-84		1.50	10.6				
⊙	TP05-85		1.50	17.9				

CU = COEFFICIENT OF UNIFORMITY = D60/D10 **PARTICLE SIZES, e.g. D85, in mm** **Tested by Wet Sieving Method (ASTM D1140 & D422)**

Klohn Crippen Berger

PROJECT NO.: M09234A02 01 01

PROJECT: Wolverine - Test Pit Samples

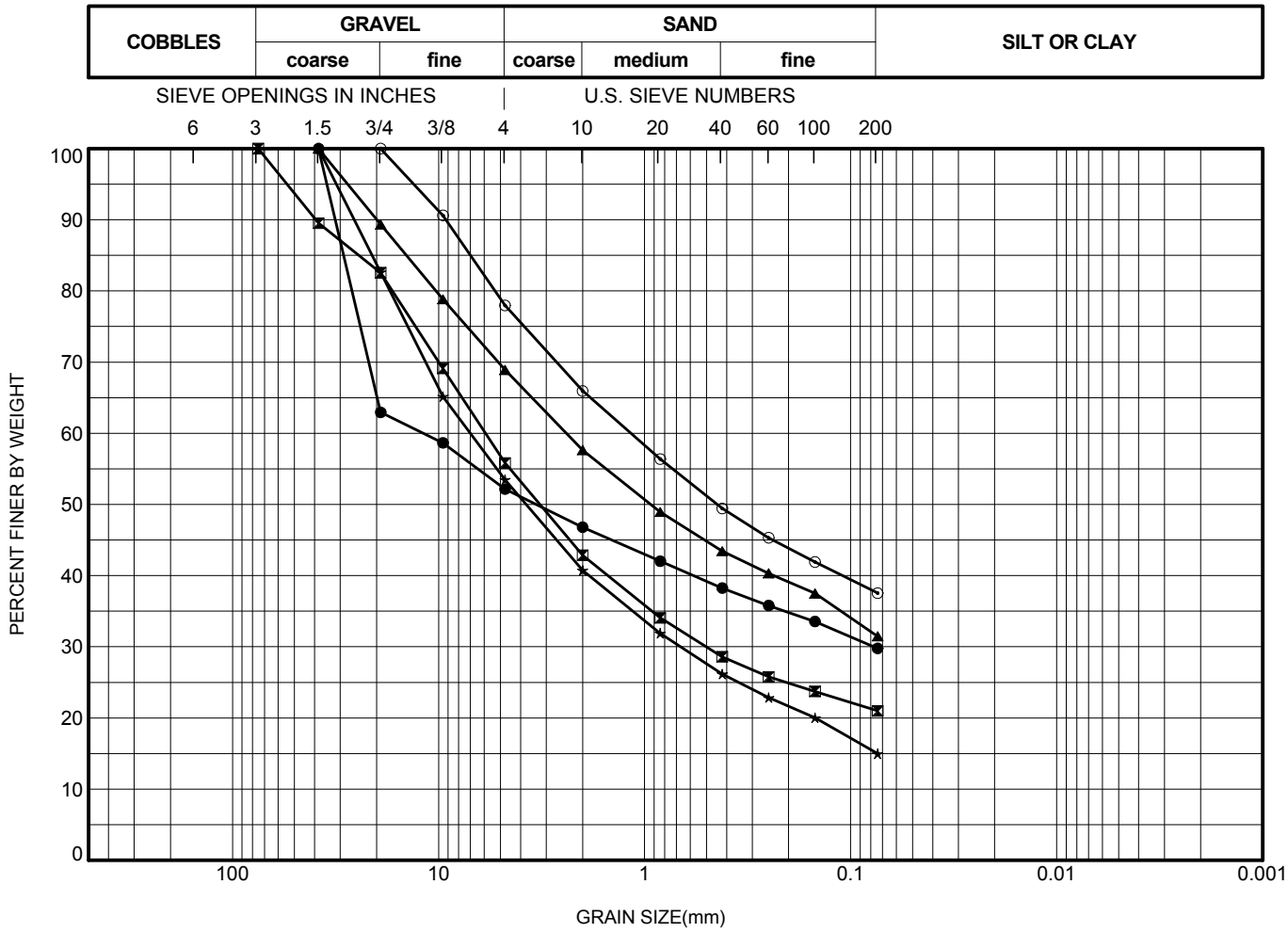
LOCATION: Yukon

FIGURE:

DRAWN BY: DL **CHECKED BY:**

KCB_GRAIN_SIZE-SI M09234A02.GPJ SIEVE.GDT 2/7/06

GRAIN SIZE DISTRIBUTION



	HOLE	DEPTH (m)	D85	D60	D50	D15	D10	CU	%GRAVEL	%SAND	%FINES
●	TP05-86	1.50	28.853	11.841	3.357				47.9	22.3	29.8
⊠	TP05-87	3.30	24.359	5.917	3.223				44.2	34.8	21.0
▲	TP05-89	1.50	14.318	2.400	0.934				31.1	37.3	31.6
★	TP05-89	3.00	20.991	7.008	3.758	0.074			46.6	38.4	15.1
⊙	TP05-91	1.00	7.000	1.167	0.444				22.1	40.3	37.6

	HOLE	SAMPLE	DEPTH (m)	W%	W_L	W_P	PI	REMARKS / SAMPLE DESCRIPTION
●	TP05-86		1.50	8.8				
⊠	TP05-87		3.30	1.6				
▲	TP05-89		1.50	8.9				
★	TP05-89		3.00	3.0				
⊙	TP05-91		1.00	12.7				

CU = COEFFICIENT OF UNIFORMITY = D60/D10 **PARTICLE SIZES, e.g. D85, in mm** **Tested by Wet Sieving Method (ASTM D1140 & D422)**

Klohn Crippen Berger

PROJECT NO.: M09234A02 01 01

PROJECT: Wolverine - Test Pit Samples

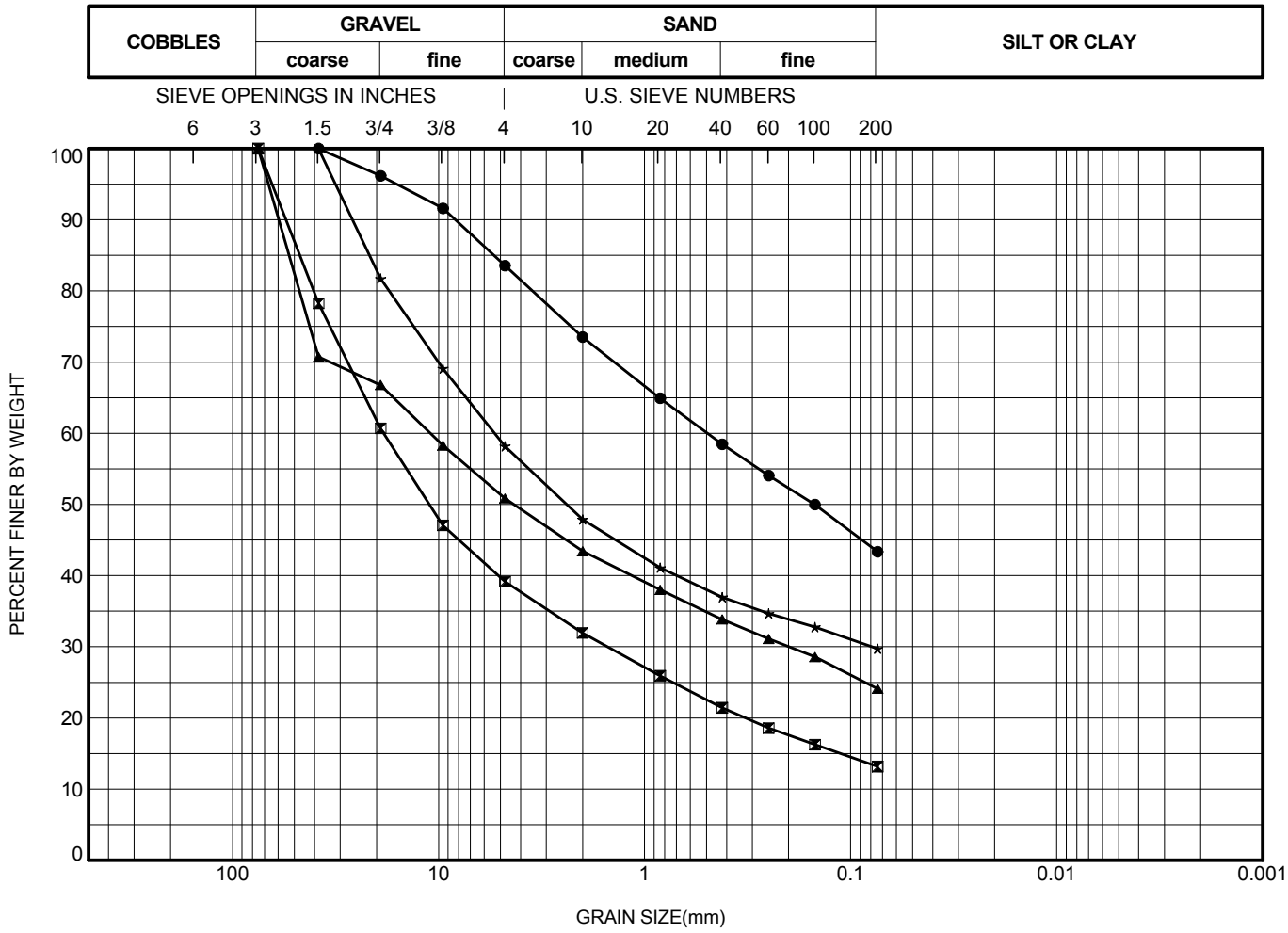
LOCATION: Yukon

FIGURE:

DRAWN BY: DL **CHECKED BY:**

KCB_GRAIN_SIZE-SI M09234A02.GPJ SIEVE.GDT 2/7/06

GRAIN SIZE DISTRIBUTION



	HOLE	DEPTH (m)	D85	D60	D50	D15	D10	CU	%GRAVEL	%SAND	%FINES
●	TP05-93	1.50	5.389	0.496	0.150				16.5	40.1	43.5
⊠	TP05-95	2.30	47.083	18.443	11.066	0.112			60.9	25.9	13.2
▲	TP05-96	1.50	53.074	10.953	4.311				49.2	26.7	24.2
★	TP05-97	1.50	21.618	5.340	2.389				41.8	28.4	29.8

	HOLE	SAMPLE	DEPTH (m)	W%	W_L	W_P	PI	REMARKS / SAMPLE DESCRIPTION
●	TP05-93		1.50	13.0				
⊠	TP05-95		2.30	4.6				
▲	TP05-96		1.50	11.0				
★	TP05-97		1.50	7.7				

CU = COEFFICIENT OF UNIFORMITY = D60/D10 **PARTICLE SIZES, e.g. D85, in mm** **Tested by Wet Sieving Method (ASTM D1140 & D422)**

Klohn Crippen Berger

PROJECT NO.: M09234A02 01 01

PROJECT: Wolverine - Test Pit Samples

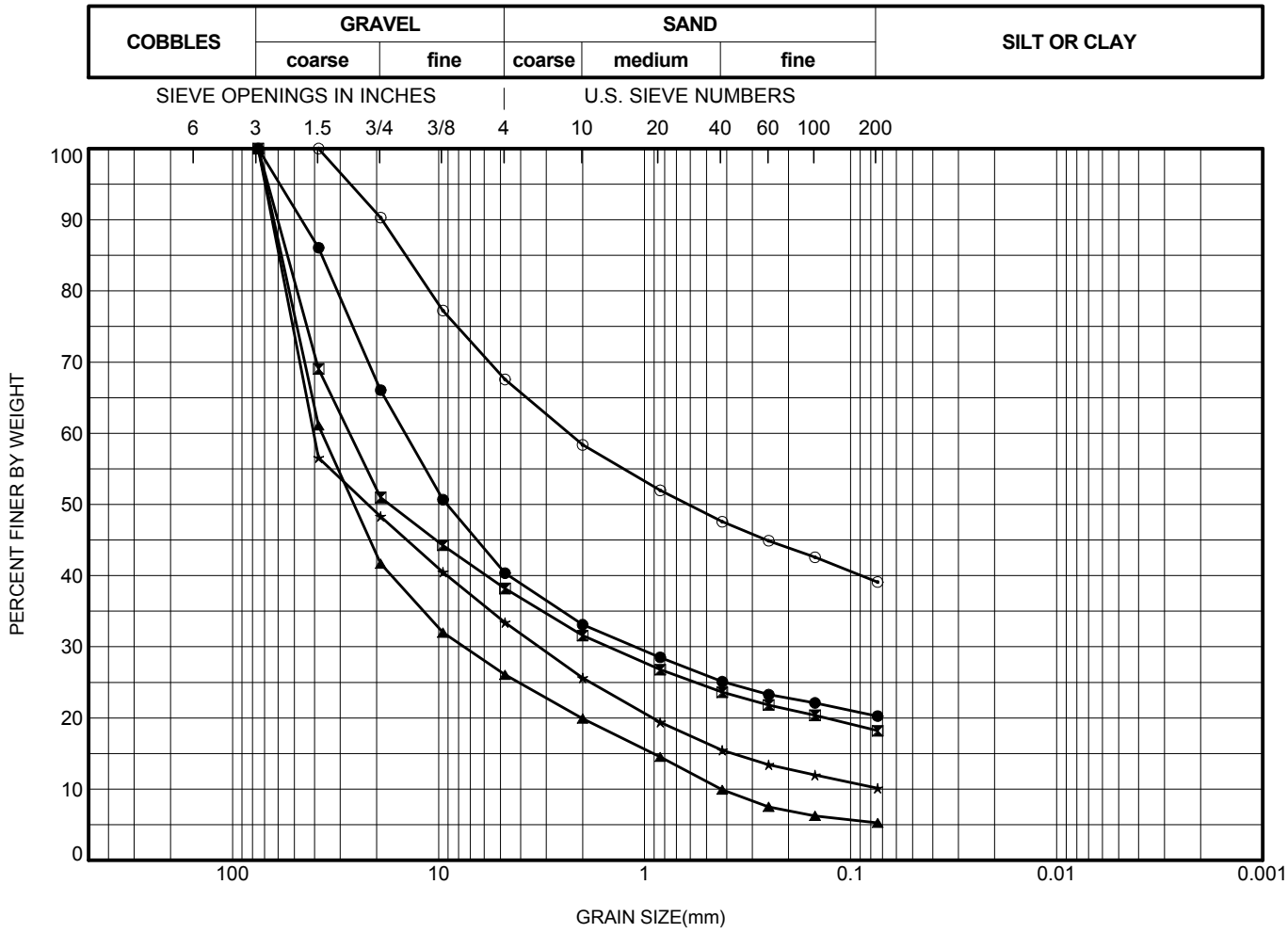
LOCATION: Yukon

FIGURE:

DRAWN BY: DL **CHECKED BY:**

KCB_GRAIN_SIZE-SI M09234A02.GPJ SIEVE.GDT 2/7/06

GRAIN SIZE DISTRIBUTION



	HOLE	DEPTH (m)	D85	D60	D50	D15	D10	CU	%GRAVEL	%SAND	%FINES
●	Borrow 1	0.00	36.810	14.520	9.100				59.7	20.0	20.3
⊠	Borrow 2	0.00	54.083	27.000	17.265				61.8	19.9	18.2
▲	Borrow 3	0.00	57.821	36.732	25.698	0.906	0.426	86.306	73.9	20.8	5.3
★	Go Creek Dam	0.00	59.415	40.298	22.024	0.373	0.071	569.587	66.6	23.2	10.2
⊙	MW05-6	0.00	14.399	2.332	0.615				32.5	28.4	39.2

	HOLE	SAMPLE	DEPTH (m)	W%	W_L	W_P	PI	REMARKS / SAMPLE DESCRIPTION
●	Borrow 1	East	0.00	7.7				
⊠	Borrow 2	Central	0.00	9.0				
▲	Borrow 3	West	0.00	5.5				
★	Go Creek Dam		0.00	2.5				
⊙	MW05-6		0.00	11.4				

CU = COEFFICIENT OF UNIFORMITY = D60/D10 **PARTICLE SIZES, e.g. D85, in mm** **Tested by Wet Sieving Method (ASTM D1140 & D422)**

Klohn Crippen Berger

PROJECT NO.: M09234A02 01 01

PROJECT: Wolverine - General Borrow Materials

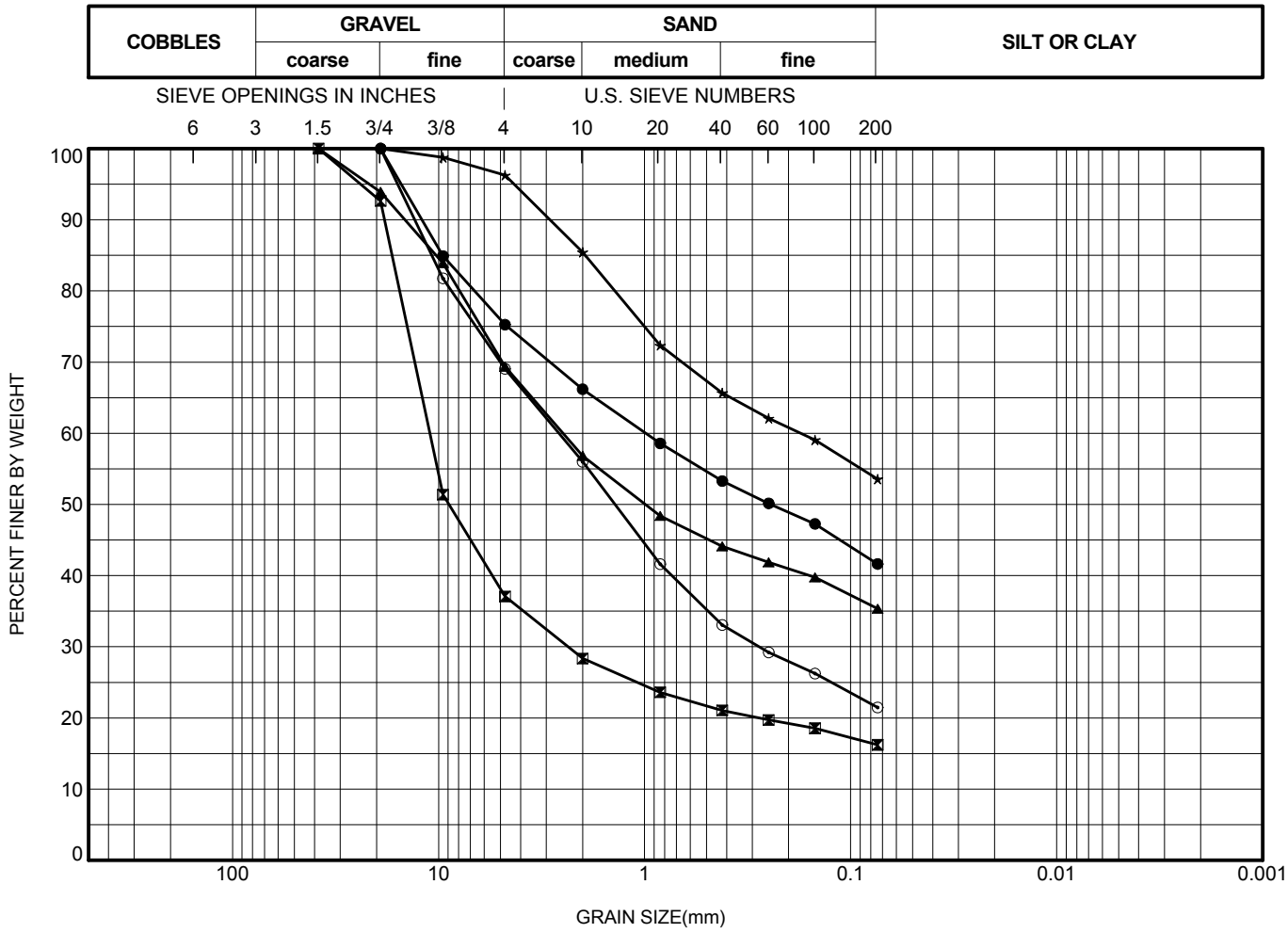
LOCATION: Yukon

FIGURE:

DRAWN BY: DL **CHECKED BY:**

KCB_GRAIN_SIZE-SI M09234A02.GPJ SIEVE.GDT 2/7/06

GRAIN SIZE DISTRIBUTION



	HOLE	DEPTH (m)	D85	D60	D50	D15	D10	CU	%GRAVEL	%SAND	%FINES
●	TH05-1	11.45	9.557	0.988	0.244				24.8	33.5	41.7
⊠	TH05-3	1.00	16.788	11.010	8.902				62.9	20.8	16.3
▲	TH05-3	6.10	10.274	2.490	0.991				30.7	33.9	35.4
★	TH05-3	8.90	1.945	0.175					3.8	42.6	53.7
⊙	TH05-5	1.80	10.773	2.609	1.393				31.0	47.5	21.6

	HOLE	SAMPLE	DEPTH (m)	W%	W_L	W_P	PI	REMARKS / SAMPLE DESCRIPTION
●	TH05-1		11.45	14.5				
⊠	TH05-3		1.00	11.5				
▲	TH05-3		6.10	12.3				
★	TH05-3		8.90	12.2				
⊙	TH05-5		1.80	13.7				

CU = COEFFICIENT OF UNIFORMITY = D60/D10 **PARTICLE SIZES, e.g. D85, in mm** **Tested by Wet Sieving Method (ASTM D1140 & D422)**

Klohn Crippen Berger

PROJECT NO.: M09234A02 01 01

PROJECT: Wolverine - Test Hole Samples

LOCATION: Yukon

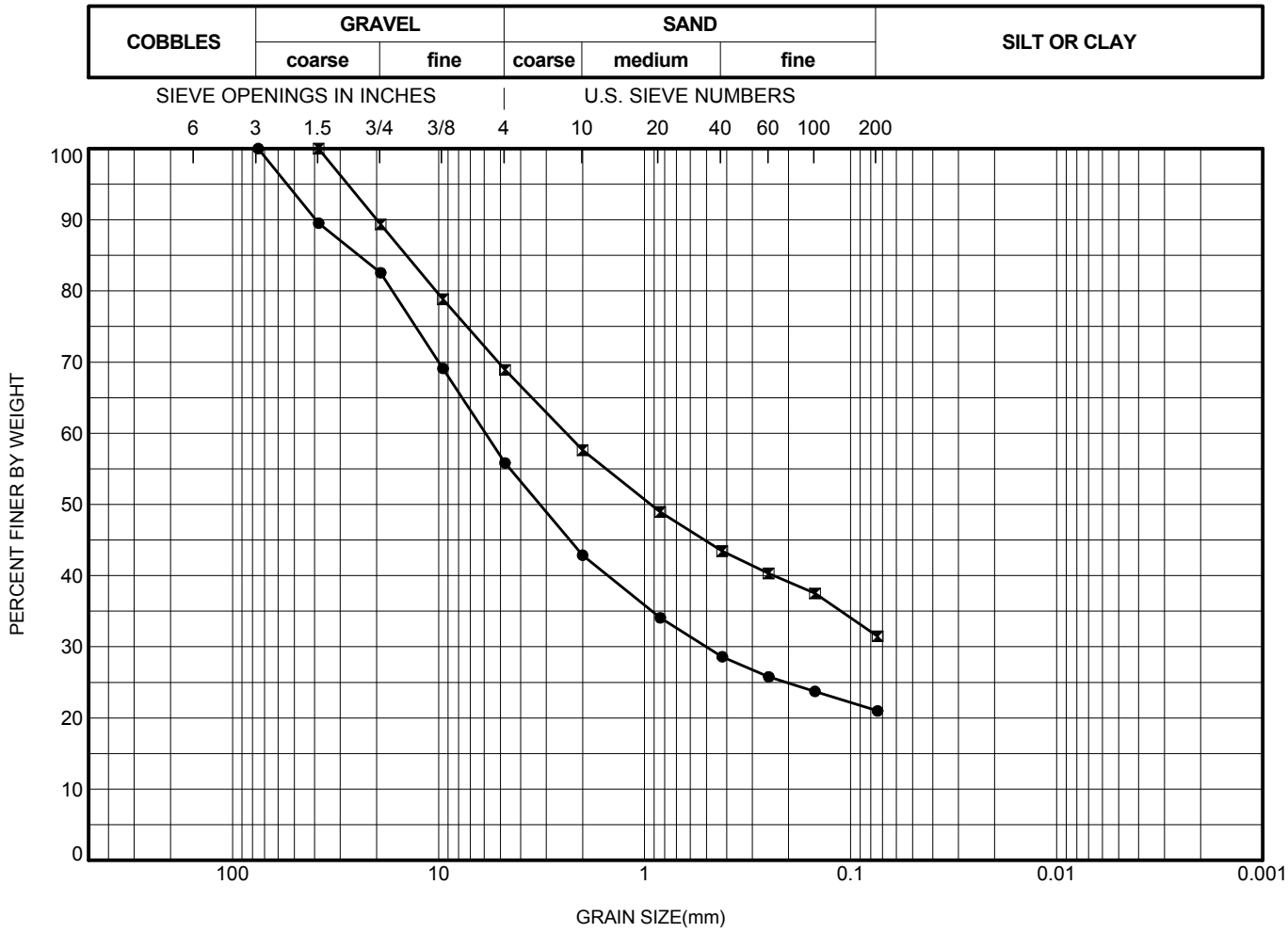
FIGURE:

DRAWN BY: DL **CHECKED BY:**

KCB_GRAIN_SIZE-SI M09234A02.GPJ SIEVE.GDT 2/7/06

Damfill Borrow

GRAIN SIZE DISTRIBUTION



	HOLE	DEPTH (m)	D85	D60	D50	D15	D10	CU	%GRAVEL	%SAND	%FINES
●	TP05-87	3.30	24.359	5.917	3.223				44.2	34.8	21.0
⊠	TP05-89	1.50	14.318	2.400	0.934				31.1	37.3	31.6

	HOLE	SAMPLE	DEPTH (m)	W%	W_L	W_P	PI	REMARKS / SAMPLE DESCRIPTION
●	TP05-87		3.30					
⊠	TP05-89		1.50					

CU = COEFFICIENT OF UNIFORMITY = D60/D10 **PARTICLE SIZES, e.g. D85, in mm** **Tested by Wet Sieving Method (ASTM D1140 & D422)**

Klohn Crippen Berger

PROJECT NO.: M09234A02 01 01

PROJECT: Wolverine - DAM FILL

LOCATION: Yukon

FIGURE:

DRAWN BY: DL **CHECKED BY:**

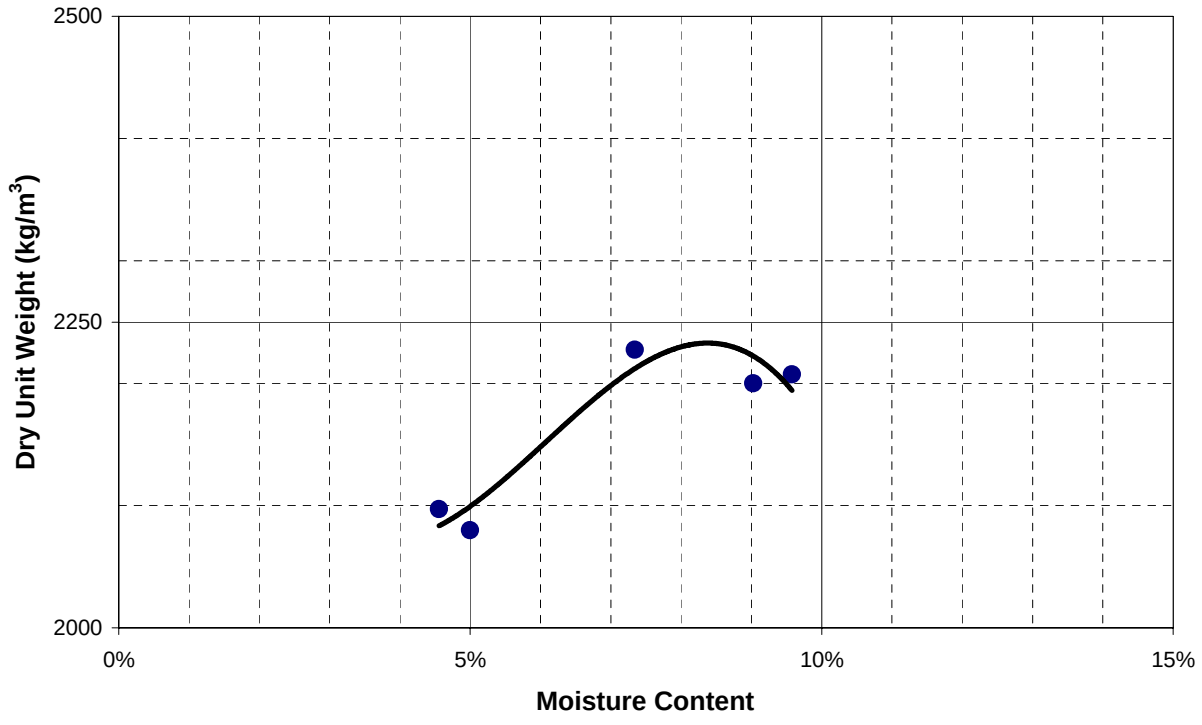
KCB_GRAIN_SIZE-SI M09234A02.GPJ SIEVE.GDT 2/6/06

COMPACTION TEST

Sample Description:

TRIAL NUMBER	1	2	3	4	5	6
Unit Weight Determination						
Wet Wt. Sample & Mold (g)	11592	11608	11651	11171	11152	
Weight of Mold (g)	6515	6515	6515	6515	6515	
Wet Wt. of Sample (g)	5077	5093	5136	4656	4637	
Volume of Mold (cm^3)	2123.48	2123.48	2123.48	2123.48	2123.48	
Wet Unit Wt. (kg/m^3)	2390.9	2398.4	2418.7	2192.6	2183.7	
Dry Unit Wt. (kg/m^3)	2227.3	2199.8	2207.2	2097.0	2079.7	
Moisture Content Determination						
Container No.	1	2	3	4	5	
Wet Wt. Sample & Tare (g)	627.42	392.24	552.74	464.31	105	
Dry Wt. Sample & Tare (g)	591.05	369.84	512.96	448.7	100	
Wt. of Water (g)	36.37	22.4	39.78	15.61	5	
Tare Container (g)	95.85	121.71	97.67	106.3	0	
Dry Wt. of Soil (g)	495.2	248.13	415.29	342.4	100	
Moisture Content (%)	7.3%	9.0%	9.6%	4.6%	5.0%	

Compaction Test



Klohn Crippen Berger

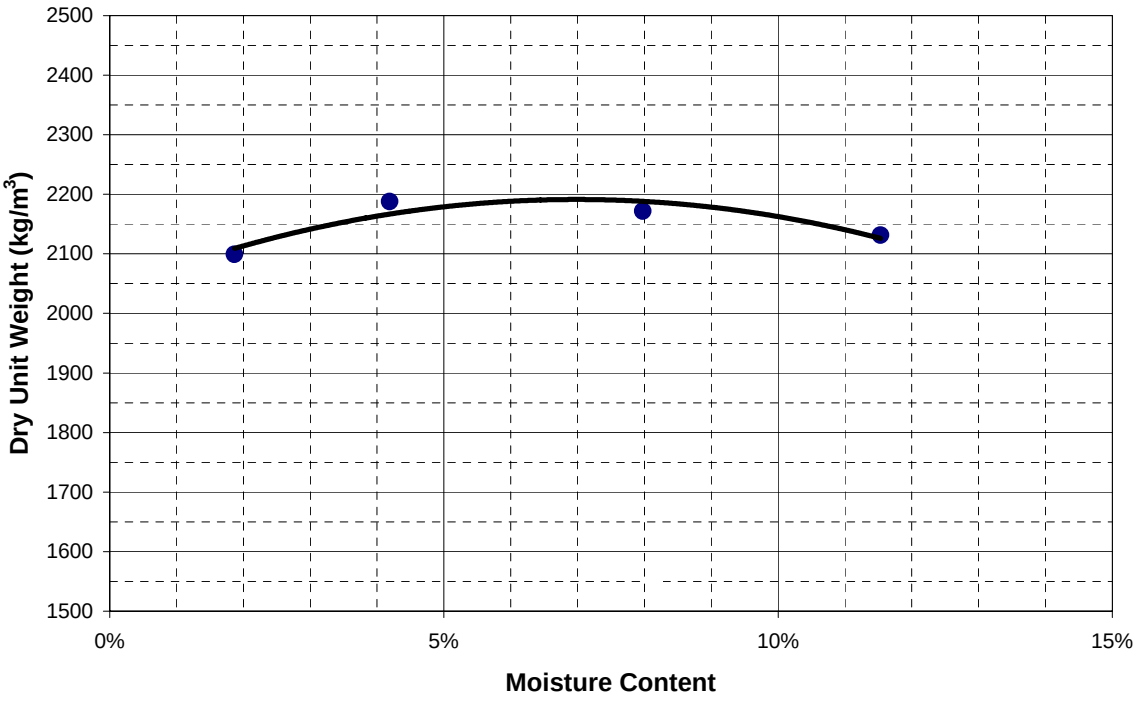
JOB NO.:	M09234A02		
PROJECT:	Wolverine - DAM FILL (TP05-87)		
LOCATION:	Yukon		
DATE:	31-Aug-05		
TESTED BY:	DL	CHECKED BY:	JG

COMPACTION TEST

Sample Description: **TP05 - 89** 1.5 m

TRIAL NUMBER	1	2				
Unit Weight Determination						
Wet Wt. Sample & Mold (g)	6350	6411	6441	6219		
Weight of Mold (g)	4231	4231	4231	4231		
Wet Wt. of Sample (g)	2119	2180	2210	1988		
Volume of Mold (cm^3)	929.623	929.623	929.623	929.623		
Wet Unit Wt. (kg/m^3)	2279.4	2345.0	2377.3	2138.5		
Dry Unit Wt. (kg/m^3)	2187.8	2171.8	2131.5	2099.3		
Moisture Content Determination						
Container No.						
Wet Wt. Sample & Tare (g)	959.93	809.79	1001.51	216.62		
Dry Wt. Sample & Tare (g)	926.21	770.17	927.86	212.95		
Wt. of Water (g)	33.72	39.62	73.65	3.67		
Tare Container (g)	121.38	273.37	289.29	16.35		
Dry Wt. of Soil (g)	804.83	496.8	638.57	196.6		
Moisture Content (%)	4.2%	8.0%	11.5%	1.9%		

Compaction Test



Klohn Crippen Berger

JOB NO.:	M09234A02		
PROJECT:	Wolverine - DAM FILL (TP05-89)		
LOCATION:	Yukon		
DATE:	19-Sep-05		
TESTED BY:	DL	CHECKED BY:	JG

Klohn Crippen Berger

HYDRAULIC CONDUCTIVITY TEST USING A FLEXIBLE WALL PERMEAMETER
(Triaxial Permeability Test) (ASTM D5084-00)

PROJECT NO: M09234A2 TRIAXIAL CELL: Test No.:
PROJECT: Woverine Project PRESSURE PANEL: Tested by: Ganan
SAMPLE INFORMATION: Tailings sample, prepared by moist tamping technique. Date: November 24, 2005

DATE / TIME	TIME INTERVAL (sec)	BASE BURETTE (IN FLOW) READING (cm)	BASE BURETTE (IN FLOW) VOLUME (cm^3)	TOP BURETTE (OUT FLOW) READING (cm)	TOP BURETTE (OUT FLOW) VOLUME (cm^3)	BASE PRESSURE (kPa)	TOP PRESSURE (kPa)	CELL PRESSURE (kPa)	HEAD LOSS (cm)	GRADIENT	COEF. OF PERMEABILITY (cm/sec)
	t		Q_{in}		Q_{out}				h	i	k
11/24/05 11:45		64.05		46.10		205	200	300	68.9	5.4	
	13500		2.90		2.58						1E-06
11/24/05 15:30		63.80		47.10		205	200	300	67.6	5.3	
	6720		1.16		1.29						1E-06
11/24/05 17:22		63.70		47.60		205	200	300	67.0	5.3	
	56280		10.44		10.56						1E-06
11/25/05 9:00		62.80		51.70		205	200	300	62.0	4.9	
11/25/05 9:00		62.75		51.70		210	200	300	112.9	8.8	
	8100		2.90		2.58						1E-06
11/25/05 11:15		62.50		52.70		210	200	300	111.6	8.7	
	13500		4.64		4.38						1E-06
11/25/05 15:00		62.10		54.40		210	200	300	109.5	8.6	
11/25/05 15:00		62.10		40.50		210	200	300	123.4	9.7	
	8100		3.48		3.09						1E-06
11/25/05 17:15		61.80		41.70		210	200	300	121.9	9.6	
	148500		47.56		47.90						1E-06
11/27/05 10:30		57.70		60.30		210	200	300	99.2	7.8	

Base Burette Area: Top Burette Area: Sample Area: Sample Length:
A_{in} (cm^2) = 11.6 A_{out} (cm^2) = 2.575 A (cm^2) = 31.4873 L (cm) = 12.76

Hydraulic Conductivity (Coef. of Permeability), $k = \ln(h_1/h_2) \times (A_{in} \times A_{out} \times L)/(A \times t \times (A_{in} + A_{out}))$ by ASTM D5084-00, method C
(Back pressure saturation applied on the test specimen before consolidation)
(Permeability Test was performed after consolidation at 100 kPa confining pressure.)

Klohn Crippen Berger

HYDRAULIC CONDUCTIVITY TEST USING A FLEXIBLE WALL PERMEAMETER
(Triaxial Permeability Test) (ASTM D5084-00)

PROJECT NO: M09234A2 TRIAXIAL CELL: Test No.: TX271205
PROJECT: Woverine Project PRESSURE PANEL: Tested by: Ganan
SAMPLE INFORMATION: TP05-89 sample, prepared by moist tamping technique. Date: November 19, 2005

DATE / TIME	TIME INTERVAL (sec)	BASE BURETTE (IN FLOW) READING (cm)	BASE BURETTE (IN FLOW) VOLUME (cm^3)	TOP BURETTE (OUT FLOW) READING (cm)	TOP BURETTE (OUT FLOW) VOLUME (cm^3)	BASE PRESSURE (kPa)	TOP PRESSURE (kPa)	CELL PRESSURE (kPa)	HEAD LOSS (cm)	GRADIENT	COEF. OF PERMEABILITY (cm/sec)
	t		Q_{in}		Q_{out}				h	i	k
12/19/05 11:50		63.50		45.90		310	300	750	119.4	9.4	
	5100		4.17		4.00						2.7E-06
12/19/05 13:15		63.15		47.45		310	300	750	117.5	9.3	
	6900		5.95		5.55						2.8E-06
12/19/05 15:10		62.65		49.60		310	300	750	114.9	9.1	
	8100		5.95		6.20						2.7E-06
12/19/05 17:25		62.15		52.00		310	300	750	112.0	8.8	
12/19/05 17:25		62.15		41.20		310	300	750	122.8	9.7	
	5100		4.17		4.39						2.8E-06
12/19/05 18:50		61.80		42.90		310	300	750	120.7	9.5	
12/19/05 19:35		61.75		43.45		305	300	750	69.2	5.5	
	50100		18.45		18.46						2.3E-06
12/20/05 9:30		60.20		50.60		305	300	750	60.5	4.8	
	9900		4.76		4.13						2.9E-06
12/20/05 12:15		59.80		52.20		305	300	750	58.5	4.6	
	11700		4.76		4.65						2.8E-06
12/20/05 15:30		59.40		54.00		305	300	750	56.3	4.4	
12/20/05 15:30		59.40		40.60		305	300	750	69.7	5.5	
	62700		26.18		27.11						2.7E-06
12/21/05 8:55		57.20		51.10		305	300	750	57.0	4.5	

Base Burette Area: Top Burette Area: Sample Area: Sample Length:
A_{in} (cm^2) = 11.9 A_{out} (cm^2) = 2.582 A (cm^2) = 31.4082 L (cm) = 12.68

Hydraulic Conductivity (Coef. of Permeability), $k = \ln(h_1/h_2) \times (A_{in} \times A_{out} \times L)/(A \times t \times (A_{in} + A_{out}))$ by ASTM D5084-00, method C
(Back pressure saturation applied on the test specimen before consolidation)
(Permeability Test was performed after consolidation at 450 kPa confining pressure.)

Klohn Crippen Berger

HYDRAULIC CONDUCTIVITY TEST USING A FLEXIBLE WALL PERMEAMETER
(Triaxial Permeability Test) (ASTM D5084-00)

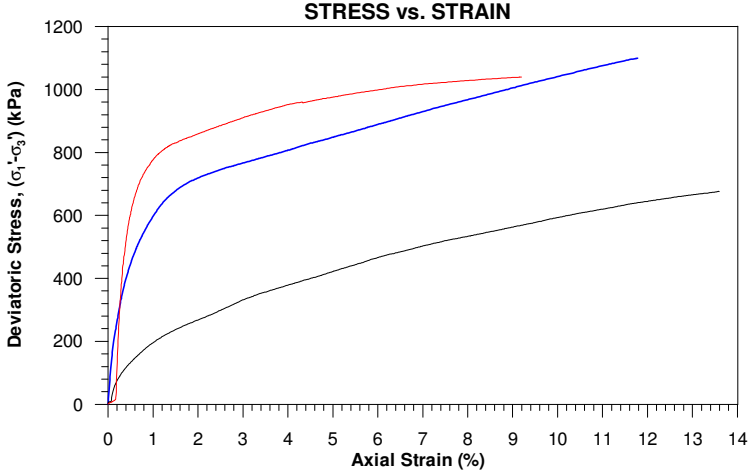
PROJECT NO: M09234A2 TRIAXIAL CELL: Test No.: TX271205
PROJECT: Woverine Project PRESSURE PANEL: Tested by: Ganan
SAMPLE INFORMATION: TP05-89 sample, prepared by moist tamping technique. Date: January 10, 2006

DATE / TIME	TIME INTERVAL (sec)	BASE BURETTE (IN FLOW) READING (cm)	BASE BURETTE (IN FLOW) VOLUME (cm^3)	TOP BURETTE (OUT FLOW) READING (cm)	TOP BURETTE (OUT FLOW) VOLUME (cm^3)	BASE PRESSURE (kPa)	TOP PRESSURE (kPa)	CELL PRESSURE (kPa)	HEAD LOSS (cm)	GRADIENT	COEF. OF PERMEABILITY (cm/sec)
	t		Q_{in}		Q_{out}				h	i	k
1/9/06 10:40		66.60		45.20		210	200	1000	123.2	9.7	
	4800		3.57		3.87						2.6E-06
1/9/06 12:00		66.30		46.70		210	200	1000	121.4	9.6	
	4800		4.16		4.00						2.8E-06
1/9/06 13:20		65.95		48.25		210	200	1000	119.5	9.4	
	4200		2.98		3.23						2.6E-06
1/9/06 14:30		65.70		49.50		210	200	1000	118.0	9.3	
	10200		8.33		8.00						2.8E-06
1/9/06 17:20		65.00		52.60		210	200	1000	114.2	9.0	
1/9/06 17:20		65.00		43.80		204.5	200	1000	67.0	5.3	
	4800		1.79		1.55						2.0E-06
1/9/06 18:40		64.85		44.40		204.5	200	1000	66.3	5.2	
	52200		19.63		19.37						2.5E-06
1/10/06 9:10		63.20		51.90		204.5	200	1000	57.1	4.5	

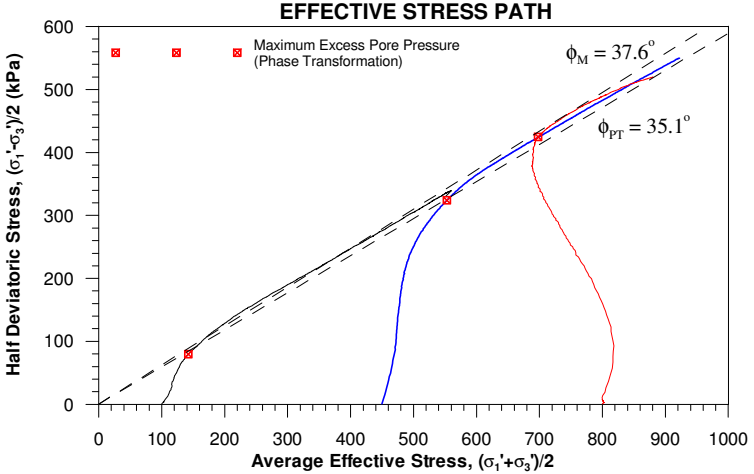
Base Burette Area: Top Burette Area: Sample Area: Sample Length:
A_{in} (cm^2) = 11.9 A_{out} (cm^2) = 2.582 A (cm^2) = 31.2181 L (cm) = 12.69

Hydraulic Conductivity (Coef. of Permeability), $k = \ln(h_1/h_2) \times (A_{in} \times A_{out} \times L)/(A \times t \times (A_{in} + A_{out}))$ by ASTM D5084-00, method C
(Back pressure saturation applied on the test specimen before consolidation)
(Permeability Test was performed after consolidation at 800 kPa confining pressure.)

STRESS vs. STRAIN



EFFECTIVE STRESS PATH



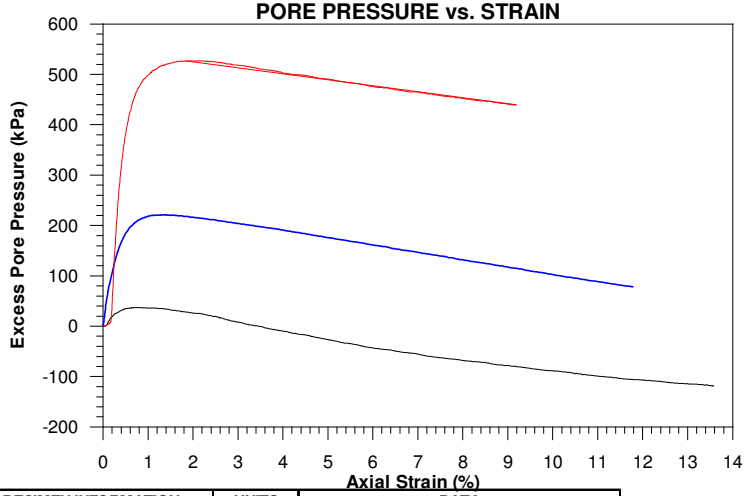
LEGEND

100 kPa

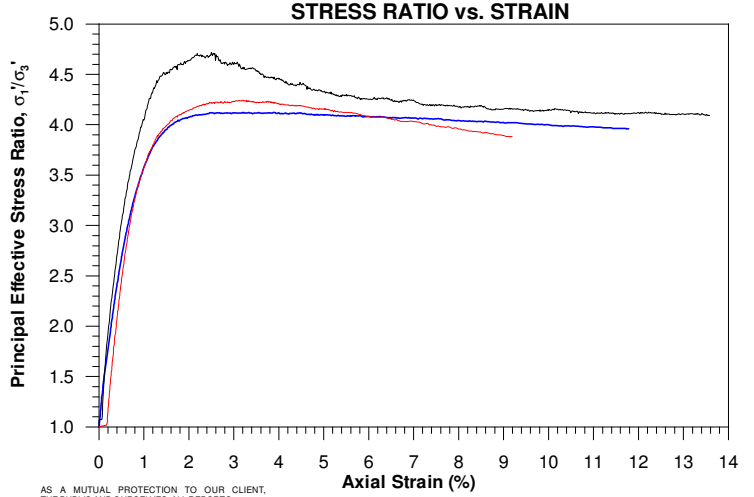
450 kPa

800 kPa

PORE PRESSURE vs. STRAIN



STRESS RATIO vs. STRAIN



SPECIMEN INFORMATION	UNITS	DATA		
Dam Fill - TP05-89				
Initial Water Content	%	10.3	9.0	9.0
Initial Dry Density	kg/m^3	2130	2119	2109
Skempton's B Parameter		0.90	0.95	0.95
Back Pressure	kPa	200	300	200
Consolidation Stress (□$_3$')	kPa	100	450	800
(at start of shear)				
Dry Density	kg/m^3	2146	2149	2150
Specimen Height	mm	127.6	126.8	126.9
Specimen Area	mm^2	3148.7	3140.8	3121.8
Final Water Content	%	11.2	11.3	11.6

AS A MUTUAL PROTECTION TO OUR CLIENT, THE PUBLIC AND OURSELVES, ALL REPORTS AND DRAWINGS ARE SUBMITTED FOR THE CONFIDENTIAL INFORMATION OF OUR CLIENT FOR A SPECIFIC PROJECT AND AUTHORIZATION FOR USE AND/OR PUBLICATION OF DATA, STATEMENTS, CONCLUSIONS OR ABSTRACTS FROM OR REGARDING OUR REPORTS AND DRAWINGS IS RESERVED PENDING OUR WRITTEN APPROVAL.

TO BE READ WITH KLOHN-CRIPPEN REPORT DATED _____

KLOHN-CRIPPEN		DATE
DESIGNED		
DRAWN		
CHECKED		
RECOMMENDED		
APPROVED		

CLIENT

Klohn Crippen Berger

Yukon Zinc CORPORATION

PROJECT

WOLVERINE TAILINGS IMPOUNDMENT

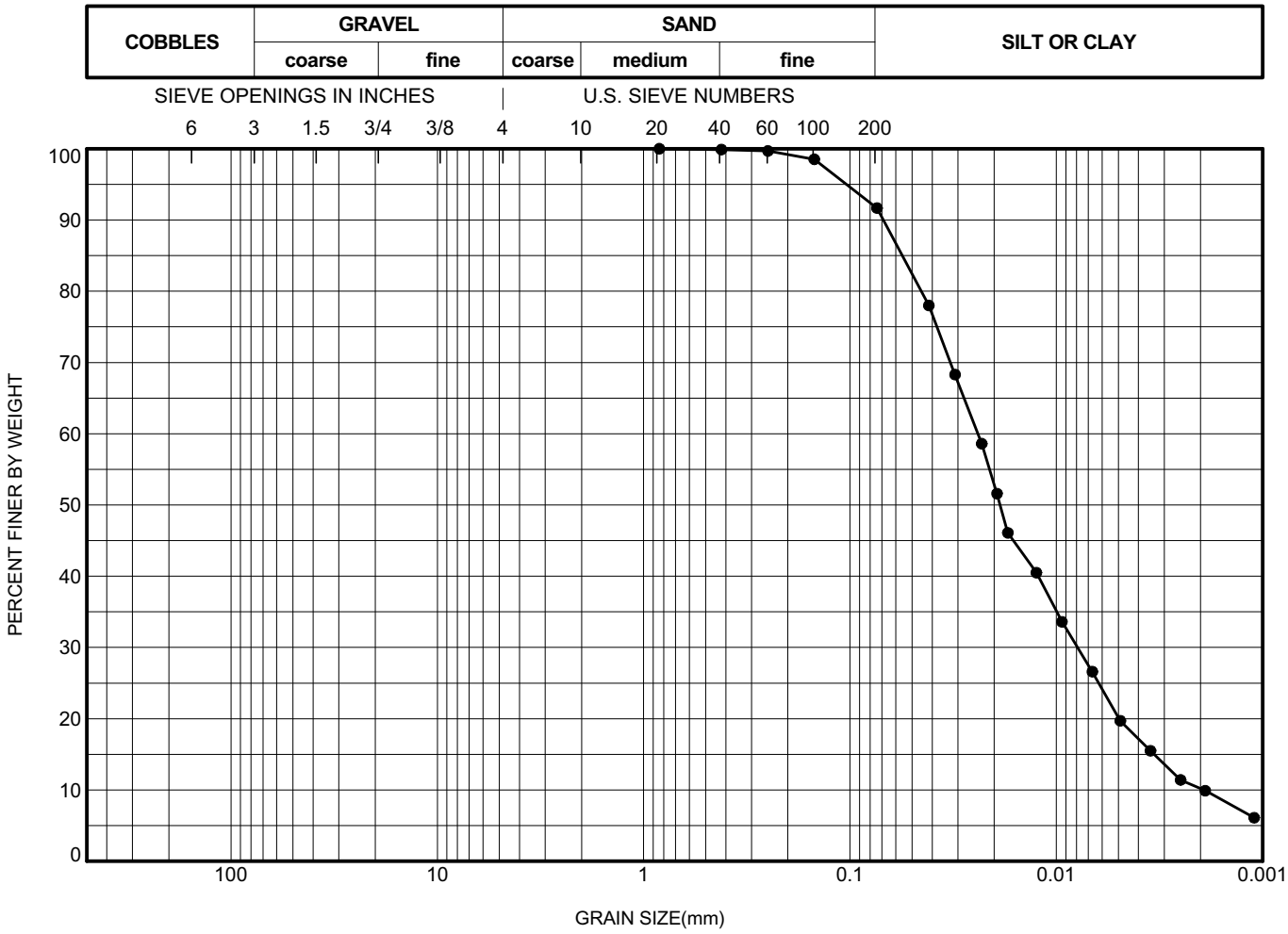
TITLE

CIUC TRIAXIAL TEST RESULTS
DAM FILL (TP05-89) SAMPLE

DATE OF ISSUE	PROJECT No.	DWG. No.	REV.
December 2005	M09234A02	FIG	

Tailings

GRAIN SIZE DISTRIBUTION



	HOLE	DEPTH (m)	D85	D60	D50	D15	D10	CU	%GRAVEL	%SAND	%FINES
●	Tailings	0.00							0.0	8.2	91.8

	HOLE	SAMPLE	DEPTH (m)	W%	W_L	W_P	PI	REMARKS / SAMPLE DESCRIPTION
●	Tailings		0.00					

CU = COEFFICIENT OF UNIFORMITY = D60/D10 **PARTICLE SIZES, e.g. D85, in mm** **Tested by Wet Sieving Method (ASTM D1140 & D422)**

Klohn Crippen Berger

PROJECT NO.: M09234A02 01 01

PROJECT: Wolverine - Tailings Sample

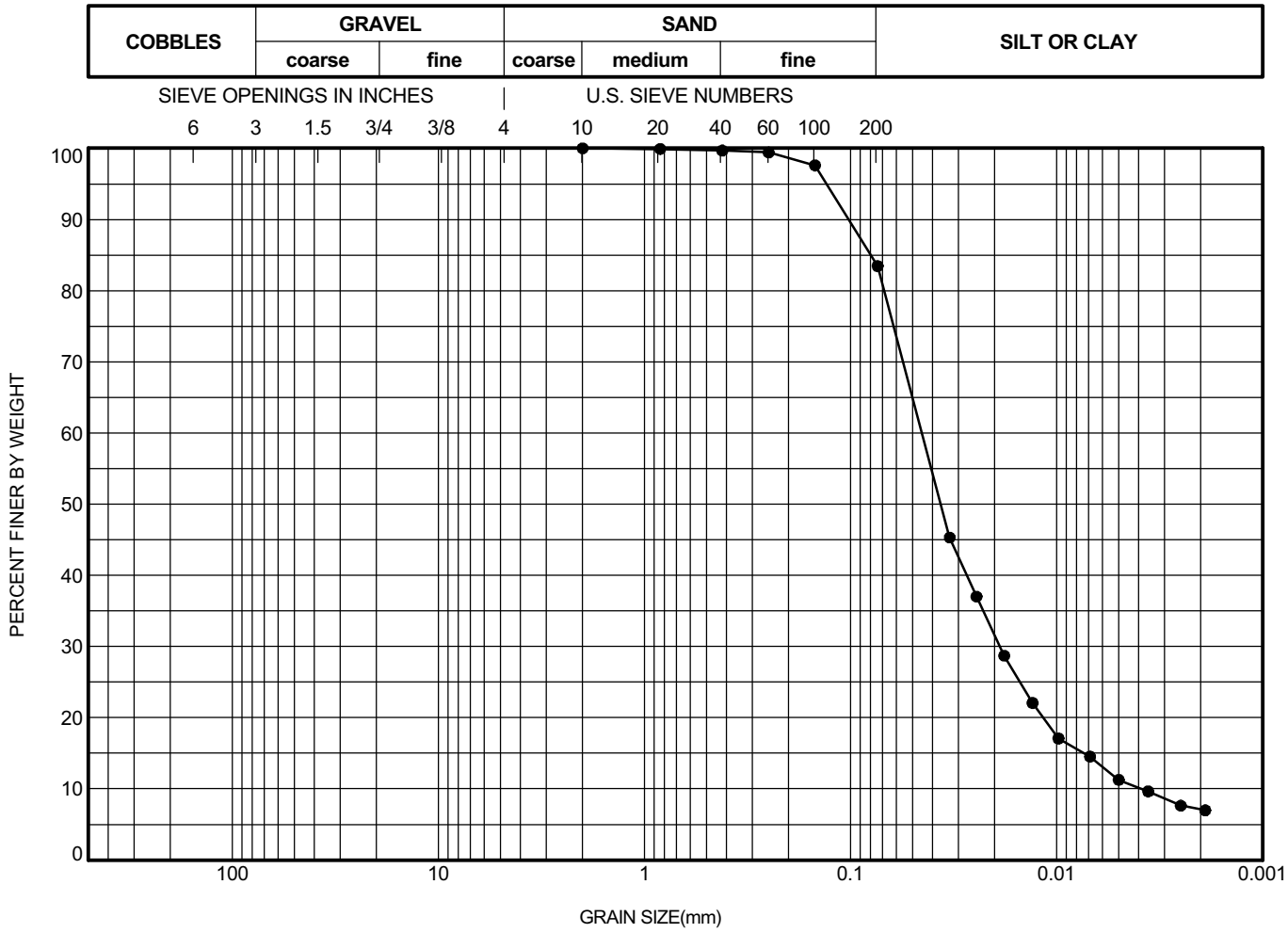
LOCATION: Yukon

FIGURE:

DRAWN BY: JG **CHECKED BY:**

KCB_GRAIN_SIZE-SI M09234A02.GPJ SIEVE.GDT 2/7/06

GRAIN SIZE DISTRIBUTION



	HOLE	DEPTH (m)	D85	D60	D50	D15	D10	CU	%GRAVEL	%SAND	%FINES
●	Tailing	0.00	0.080						0.0	16.3	83.7

	HOLE	SAMPLE	DEPTH (m)	W%	W_L	W_P	PI	REMARKS / SAMPLE DESCRIPTION
●	Tailing		0.00					F11&F12 (20%), F23&F32 (80%)

CU = COEFFICIENT OF UNIFORMITY = D60/D10 **PARTICLE SIZES, e.g. D85, in mm** **Tested by Wet Sieving Method (ASTM D1140 & D422)**

Klohn Crippen Berger

PROJECT NO.: M09234A04

PROJECT: Wolverine Project - Tailings

LOCATION: Yukon

FIGURE:

DRAWN BY: BY **CHECKED BY:**

KCB_GRAIN_SIZE-SI M09234 WOLVERINE_TAILING_HYDROMETER_20081026.GPJ SIEVE.GDT 11/24/08

SPECIFIC GRAVITY OF SOIL SOLIDS (ASTM-D854)

Sample No.		#1					
Flask No.		KL2	KL3				
Volume of Flask @ 20° C	ml	500	500				
Method of Air removal		Boiling	Boiling				
De-airing Period	hr	2	2				
Test temperature	° C	22.6	22.6				
Mass of Flask+Water (M_a)	g	675.46	675.96				
Mass of Flask+Water+Soil (M_b)	g	748.55	751.50				
Mass of Dish/Flask+Soil		277.13	281.12				
Mass of Dish/Flask		177.20	177.49				
Mass of Dry Soil (M_o)	g	99.93	103.63				
Correction factor (K) @ Test Temperature		0.9998	0.9998				
Specific Gravity of Solids @ 20° C		3.72	3.69				
Average Specific Gravity of Solids @ 20° C		3.71					

Sample No.							
Flask No.							
Volume of Flask @ 20° C	ml						
Method of Air removal							
De-airing Period	hr						
Test temperature	° C						
Mass of Flask+Water (M_a)	g						
Mass of Flask+Water+Soil (M_b)	g						
Mass of Dish/Flask+Soil							
Mass of Dish/Flask							
Mass of Dry Soil (M_o)	g						
Correction factor (K) @ Test Temperature							
Specific Gravity of Solids @ 20° C							
Average Specific Gravity of Solids @ 20° C							

Specific Gravity of Solids @ 20° C = $(K \times M_o)/(M_o + M_a - M_b)$

Klohn Crippen Berger

JOB NO.:	M09234A02		
PROJECT:	Wolverine - Tailings Sample		
LOCATION:	Yukon		
DATE:	December 13, 2005		
TESTED BY:	JG	CHECKED BY:	GAN

SPECIFIC GRAVITY OF SOIL SOLIDS (ASTM-D854)

Sample No.		Tailings*					
Flask No.		KL-2	KL-3				
Volume of Flask @ 20° C	ml	500	500				
Method of Air removal		Boiling	Boiling				
De-airing Period	hr	2	2				
Test temperature	° C	16.9	16.9				
Mass of Flask+Water (M_a)	g	675.15	675.53				
Mass of Flask+Water+Soil (M_b)	g	728.62	725.89				
Mass of Dish/Flask+Soil		249.19	245.30				
Mass of Dish/Flask		177.18	177.47				
Mass of Dry Soil (M_o)	g	72.01	67.83				
Correction factor (K) @ Test Temperature		1.0055	1.0055				
Specific Gravity of Solids @ 20° C		3.905	3.904				
Average Specific Gravity of Solids @ 20° C		3.90					

Sample No.							
Flask No.							
Volume of Flask @ 20° C	ml						
Method of Air removal							
De-airing Period	hr						
Test temperature	° C						
Mass of Flask+Water (M_a)	g						
Mass of Flask+Water+Soil (M_b)	g						
Mass of Dish/Flask+Soil							
Mass of Dish/Flask							
Mass of Dry Soil (M_o)	g						
Correction factor (K) @ Test Temperature							
Specific Gravity of Solids @ 20° C							
Average Specific Gravity of Solids @ 20° C							

* Combined tailings F11 & F12 (20%), F23 & F32 (80%)

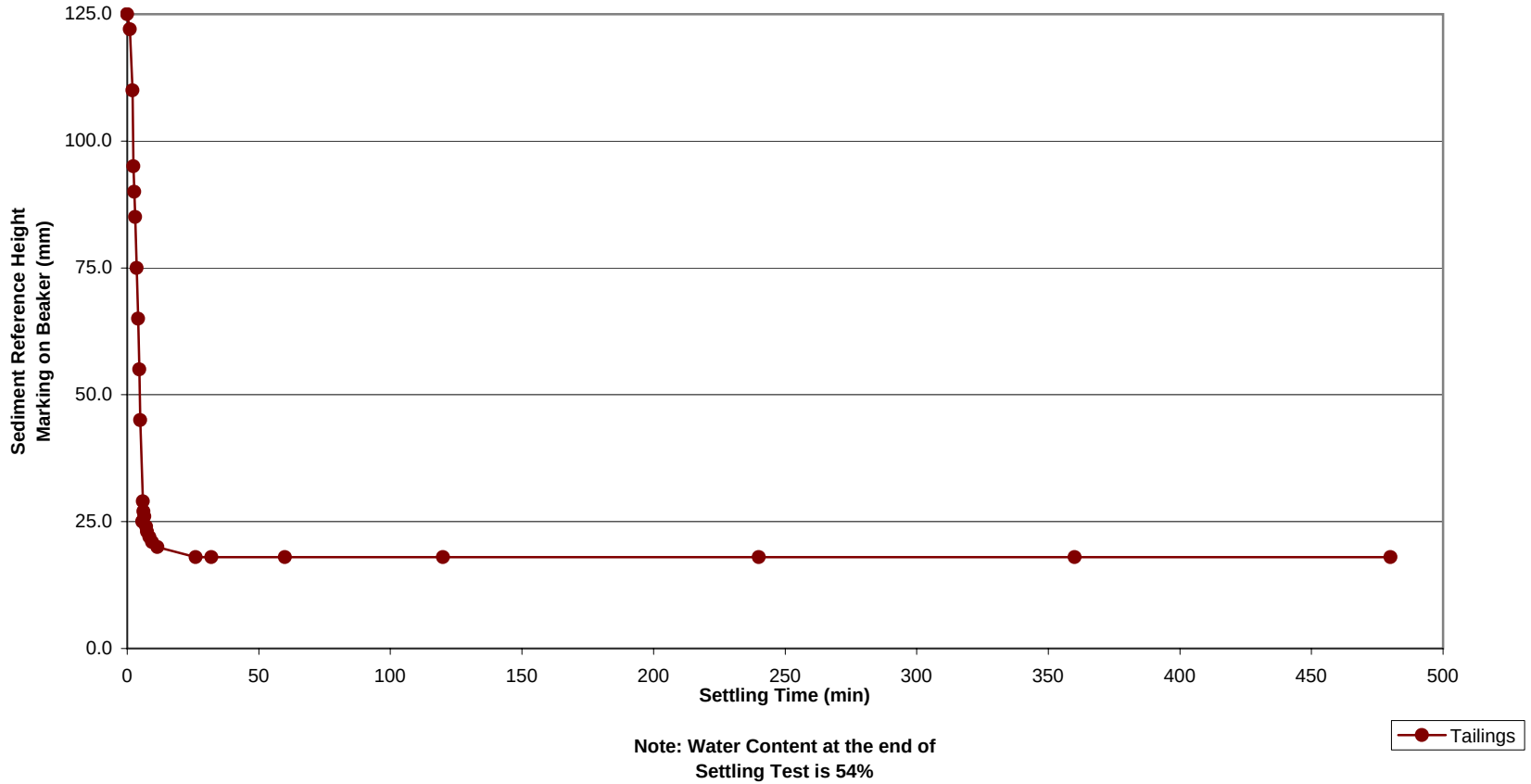
Specific Gravity of Solids @ 20° C = $(K \times M_o)/(M_o + M_a - M_b)$

Klohn Crippen Berger

JOB NO.:	M09234A04	
PROJECT:	Wolverine Project - tailings	
LOCATION:	Yukon	
DATE:	26-Oct-08	
TESTED BY:	BY	CHECKED BY:

Klohn Crippen Berger

Settling Test for Tailings Samples
(14 % Initial Solid Content)



Note: Water Content at the end of Settling Test is 54%

SETTLING TEST (using 2L graduated standard beaker)

Beaker #	A-2000
Beaker Tare (g)	503.54
Proposed Solid Content (%)	30
Supernatant Density (g/cm^3)	1
Start Date	23-Oct-08
Start Time	2:03 PM
Temperature	20.0 ℃

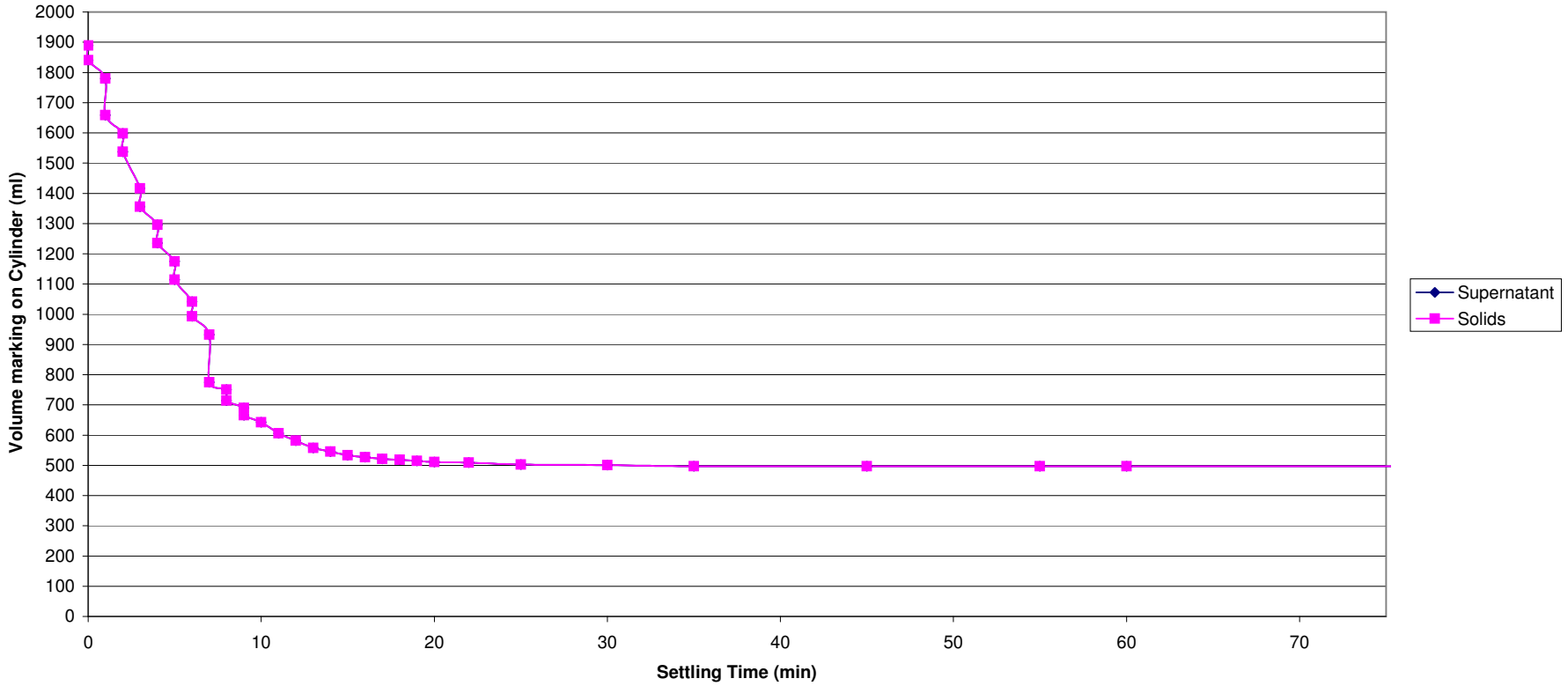
Initial Weight + Tare (g)	2877.78	Final Weight + Tare (g)	2877.8
Intial Dry weight (g)	696.68	Final Dry weight (g)	696.68
Initial Solid Volume (cm^3)	1889	Final Solid Volume (cm^3)	497
Initial Solid Content (%)	29.3	Final Solid Content (%)	70.9
Initial Water Content (%)	240.8	Final Water Content (%)	41.0
Initial Dry Density (g/cm^3)	0.37	Final Dry Density (g/cm^3)	1.40
Initial Wet Density (g/cm^3)	1.26	Final Wet Density (g/cm^3)	1.98

		Readings										
Elapsed Time (min)	Temp. (°C)	Top Supernatant (mm)	Top Solids (mm)	Top Settlement (mm)	Height Supernatant (mm)	Volume Supernatant (cm^3)	Volume Supernatant Variation (cm^3)	Volume Solids (settlement) (cm^3)	Wet Density (g/cm^3)	Dry Density (g/cm^3)	Water Content (%)	Solid Content (%)
0	20.0	359.0	359.0	359.0	0.00	0.00	1888.79	1888.79	1.26	0.37	240.79	29.34
0.5		359.0	355.0	355.0	4.00	48.42	1840.37	1840.37	1.26	0.38	233.84	29.95
1		359.0	350.0	350.0	9.00	108.95	1779.85	1779.85	1.27	0.39	225.16	30.75
1.5		359.0	340.0	340.0	19.00	230.00	1658.79	1658.79	1.29	0.42	207.78	32.49
2		359.0	335.0	335.0	24.00	290.52	1598.27	1598.27	1.30	0.44	199.09	33.43
2.5		359.0	330.0	330.0	29.00	351.05	1537.74	1537.74	1.32	0.45	190.40	34.43
3		359.0	320.0	320.0	39.00	472.10	1416.69	1416.69	1.34	0.49	173.03	36.63
3.5		359.0	315.0	315.0	44.00	532.62	1356.17	1356.17	1.36	0.51	164.34	37.83
4		359.0	310.0	310.0	49.00	593.15	1295.64	1295.64	1.37	0.54	155.65	39.12
4.5		359.0	305.0	305.0	54.00	653.67	1235.12	1235.12	1.39	0.56	146.97	40.49
5		359.0	300.0	300.0	59.00	714.20	1174.59	1174.59	1.41	0.59	138.28	41.97
5.5		359.0	295.0	295.0	64.00	774.72	1114.07	1114.07	1.44	0.63	129.59	43.56
6		359.0	289.0	289.0	70.00	847.36	1041.44	1041.44	1.47	0.67	119.17	45.63
6.5		359.0	285.0	285.0	74.00	895.78	993.02	993.02	1.49	0.70	112.22	47.12
7		359.0	280.0	280.0	79.00	956.30	932.49	932.49	1.52	0.75	103.53	49.13
7.5		359.0	267.0	267.0	92.00	1113.67	775.12	775.12	1.63	0.90	80.94	55.27
8		359.0	265.0	265.0	94.00	1137.88	750.91	750.91	1.65	0.93	77.47	56.35
8.5		359.0	262.0	262.0	97.00	1174.19	714.60	714.60	1.68	0.97	72.25	58.05
9		359.0	260.0	260.0	99.00	1198.40	690.39	690.39	1.70	1.01	68.78	59.25
9.5		359.0	258.0	258.0	101.00	1222.61	666.18	666.18	1.73	1.05	65.30	60.50
10		359.0	256.0	256.0	103.00	1246.82	641.97	641.97	1.76	1.09	61.83	61.79
11		359.0	253.0	253.0	106.00	1283.14	605.65	605.65	1.80	1.15	56.61	63.85
12		359.0	251.0	251.0	108.00	1307.35	581.44	581.44	1.83	1.20	53.14	65.30
13		359.0	249.0	249.0	110.00	1331.56	557.23	557.23	1.87	1.25	49.66	66.82
14		359.0	248.0	248.0	111.00	1343.66	545.13	545.13	1.89	1.28	47.93	67.60
15		359.0	247.0	247.0	112.00	1355.77	533.02	533.02	1.91	1.31	46.19	68.40
16		359.0	246.5	246.5	112.50	1361.82	526.97	526.97	1.92	1.32	45.32	68.81
17		359.0	246.0	246.0	113.00	1367.87	520.92	520.92	1.93	1.34	44.45	69.23
18		359.0	245.8	245.8	113.20	1370.29	518.50	518.50	1.94	1.34	44.10	69.39
19		359.0	245.5	245.5	113.50	1373.93	514.87	514.87	1.94	1.35	43.58	69.65
20		359.0	245.2	245.2	113.80	1377.56	511.23	511.23	1.95	1.36	43.06	69.90
22		359.0	245.0	245.0	114.00	1379.98	508.81	508.81	1.95	1.37	42.71	70.07
25		359.0	244.5	244.5	114.50	1386.03	502.76	502.76	1.97	1.39	41.85	70.50
30		359.0	244.3	244.3	114.70	1388.45	500.34	500.34	1.97	1.39	41.50	70.67
35		359.0	244.0	244.0	115.00	1392.08	496.71	496.71	1.98	1.40	40.98	70.93
45		359.0	244.0	244.0	115.00	1392.08	496.71	496.71	1.98	1.40	40.98	70.93
55		359.0	244.0	244.0	115.00	1392.08	496.71	496.71	1.98	1.40	40.98	70.93
60		359.0	244.0	244.0	115.00	1392.08	496.71	496.71	1.98	1.40	40.98	70.93
90		359.0	244.0	244.0	115.00	1392.08	496.71	496.71	1.98	1.40	40.98	70.93
120		359.0	244.0	244.0	115.00	1392.08	496.71	496.71	1.98	1.40	40.98	70.93
180		359.0	244.0	244.0	115.00	1392.08	496.71	496.71	1.98	1.40	40.98	70.93
300		359.0	244.0	244.0	115.00	1392.08	496.71	496.71	1.98	1.40	40.98	70.93
360		359.0	244.0	244.0	115.00	1392.08	496.71	496.71	1.98	1.40	40.98	70.93
1440		359.0	244.0	244.0	115.00	1392.08	496.71	496.71	1.98	1.40	40.98	70.93

Klohn Crippen Berger

JOB NO.:	M09234		DATE	24-Oct-08
PROJECT:	Wolverine		LOCATION:	
DETAIL:	30% solid content			
DESCRIPTION:	Tailings with F11 and F12 (20%); F23 and F32 (80%)			
TESTED BY:	JG	CHECKED BY:	BY	SHEET 1 of 2

Settling Test for Tailings @ 30% solids



Klohn Crippen Berger	JOB NO.:	M09234		DATE	24-Oct-08
	PROJECT:	Wolverine		LOCATION:	
	DETAIL:	30% solid content			
	DESCRIPTION:	Tailings with F11 and F12 (20%); F23 and F32 (80%)			
	TESTED BY:	JG	CHECKED BY:	BY	SHEET 2 of 2

CONSOLIDATION

PROJECT NO: M09234A04
PROJECT: Wolverine Project - Tailings
SAMPLE NO.: Tailing Mix (F11 and F12 (20%) + F23 and F32 (80%))
DEPTH:
LOADING MACHINE NO.: Machine #9

Initial water content : 41.00 % (based on trimmings)
Final water content : 20.35 % (based on sample at end of test)

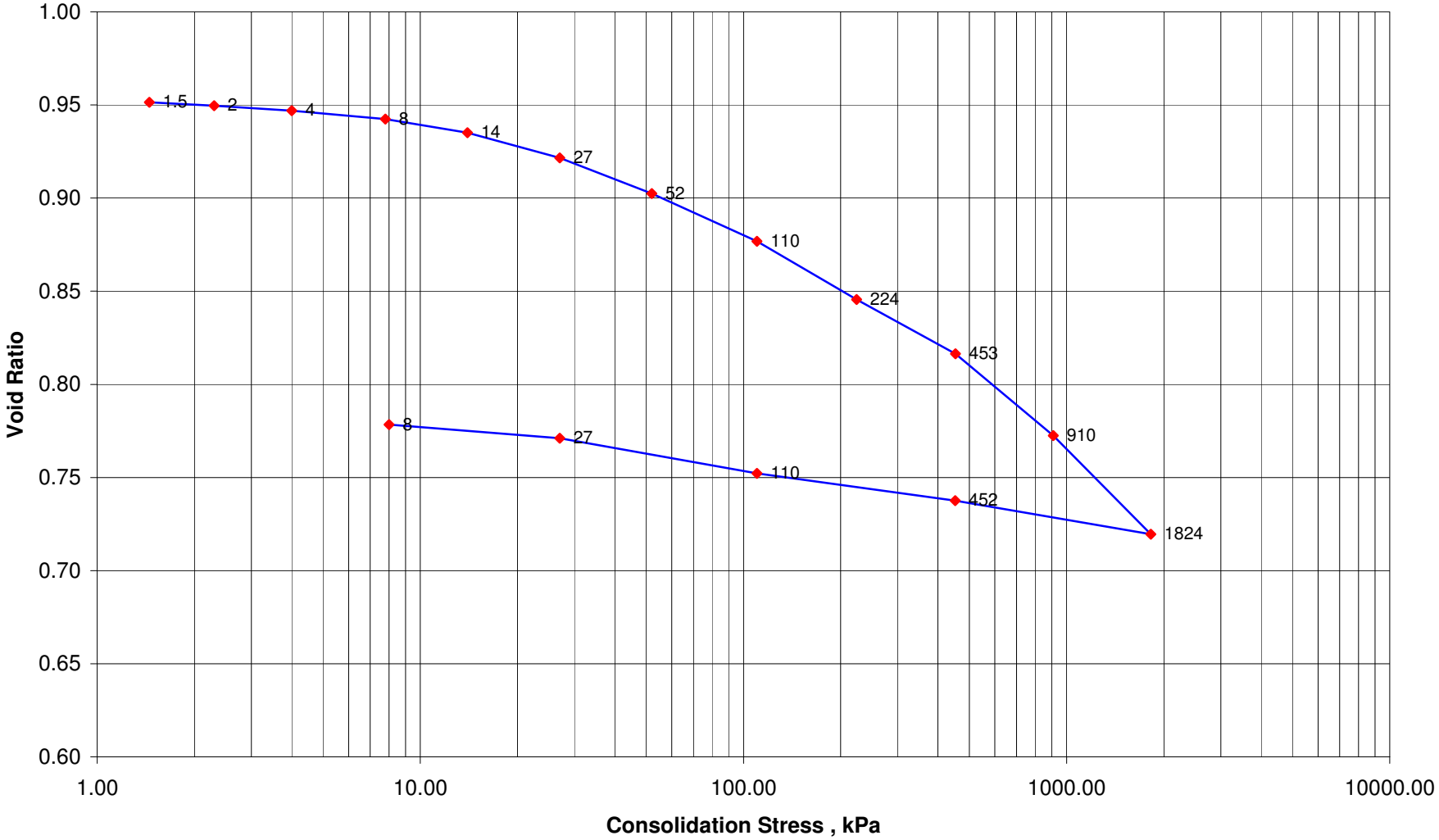
Initial Specimen Height (mm): 15.880
Height of Solid (mm): 5.490 (Initial dry mass = 82.77 g, Specimen area = 3861.7 mm^2, SG=3.90)
Initial void ratio: 1.589 * Calibration to be done after test
Void Ratio Factor 0.1821 ** Estimated t_{90}

Pressure (kPa)		Change in Height	Final	Change in	Change in	Void	t_{90}**	Cv	Mv	k	Cc
From	To	Corrected (mm)	Height (mm)	Void Ratio	Void Ratio Acc	Ratio	(min)	(cm^2/sec)	(cm^2/N)	(cm/sec)	
0.0	**1.5**	3.500	12.380	0.6375	0.6375	**0.951**					
1.5	**2**	0.010	12.370	0.0018	0.6393	**0.950**					
2	**4**	0.015	12.355	0.0027	0.6421	**0.947**					
4	**8**	0.025	12.330	0.0046	0.6466	**0.942**	0.05	1.1E-01	1.4E-02	1.5E-05	**0.016**
8	**14**	0.040	12.290	0.0073	0.6539	**0.935**	0.01	5.4E-01	9.9E-03	5.2E-05	**0.029**
14	**27**	0.074	12.216	0.0135	0.6674	**0.922**	0.5	1.0E-02	1.1E-02	1.1E-06	**0.047**
27	**52**	0.105	12.110	0.0192	0.6866	**0.902**	1.4	3.7E-03	7.7E-03	2.8E-07	**0.067**
52	**110**	0.140	11.970	0.0255	0.7121	**0.877**	0.2	2.2E-02	5.4E-03	1.2E-06	**0.078**
110	**224**	0.172	11.798	0.0314	0.7435	**0.846**	0.5	9.8E-03	2.9E-03	2.8E-07	**0.102**
224	**453**	0.160	11.638	0.0291	0.7726	**0.816**	1.4	3.4E-03	1.4E-03	4.6E-08	**0.095**
453	**910**	0.241	11.397	0.0440	0.8166	**0.772**	2.8	1.7E-03	1.1E-03	1.7E-08	**0.145**
910	**1824**	0.290	11.820	0.0529	0.8695	**0.720**	3.6	1.4E-03	3.8E-02	5.3E-07	**0.118**
1824	**452**	-0.099	11.919	-0.0181	0.8514	**0.738**					
452	**110**	-0.080	11.999	-0.0146	0.8368	**0.752**					
110	**27**	-0.104	12.103	-0.0189	0.8179	**0.771**					
27	**8**	-0.040	12.143	-0.0073	0.8106	**0.778**					

Klohn Crippen Berger

PROJECT NO: M09234A04
PROJECT: Wolverine Project - Tailings
LOCATION: Yukon
FIGURE: DATE TESTED: November 10, 2008
TESTED BY: Juan CHECKED BY:

Tailings Mix 20 %(F11, F12) - 80 % (F23, F32)
e - log(p)



Klohn Crippen Berger

HYDRAULIC CONDUCTIVITY TEST USING A FLEXIBLE WALL PERMEAMETER
(Triaxial Permeability Test) (ASTM D5084-00)

PROJECT NO: M09234A02 TRIAXIAL CELL: Test No.:
PROJECT: Woverine Project PRESSURE PANEL: Tested by: Ganan
SAMPLE INFORMATION: Tailings sample, prepared by moist tamping technique. Date: 11/2/05

DATE / TIME	TIME INTERVAL (sec)	BASE BURETTE (IN FLOW) READING (cm)	BASE BURETTE (IN FLOW) VOLUME (cm^3)	TOP BURETTE (OUT FLOW) READING (cm)	TOP BURETTE (OUT FLOW) VOLUME (cm^3)	BASE PRESSURE (kPa)	TOP PRESSURE (kPa)	CELL PRESSURE (kPa)	HEAD LOSS (cm)	GRADIENT	COEF. OF PERMEABILITY (cm/sec)
	t		Q_{in}		Q_{out}				h	i	k
11/2/05 11:00		66.00		45.40		260	250	350	122.4	9.6	
	900		22.04		22.40						9E-05
11/2/05 11:15		64.10		54.10		258	248	350	111.8	8.8	
	900		20.88		19.57						8E-05
11/2/05 11:30		62.30		61.70		258	248	500	102.4	8.1	
11/2/05 11:40		63.30		43.80		255	250	350	70.4	5.5	
	900		10.44		10.30						7E-05
11/2/05 11:55		62.40		47.80		255	250	350	65.5	5.2	
	900		9.86		9.27						7E-05
11/2/05 12:10		61.55		51.40		256	251	350	61.1	4.8	
11/2/05 13:10		61.50		42.00		255	250	350	70.4	5.5	
	900		9.86		10.30						7E-05
11/2/05 13:25		60.65		46.00		255	250	350	65.6	5.2	
	900		9.86		9.27						7E-05
11/2/05 13:40		59.80		49.60		256	251	350	61.1	4.8	

Base Burette Area: Top Burette Area: Sample Area: Sample Length:
A_{in} (cm^2) = 11.6 A_{out} (cm^2) = 2.575 A (cm^2) = 30.95 L (cm) = 12.69

Hydraulic Conductivity (Coef. of Permeability), $k = \ln(h_1/h_2) \times (A_{in} \times A_{out} \times L)/(A \times t \times (A_{in} + A_{out}))$ by ASTM D5084-00, method C
(Back pressure saturation applied on the test specimen before consolidation)
(Permeability Test was performed after consolidation at 100kPa confining pressure.)

Klohn Crippen Berger

HYDRAULIC CONDUCTIVITY TEST USING A FLEXIBLE WALL PERMEAMETER
(Triaxial Permeability Test) (ASTM D5084-00)

PROJECT NO: M09234A2 TRIAXIAL CELL: Test No.:
PROJECT: Woverine Project PRESSURE PANEL: Tested by: Ganan
SAMPLE INFORMATION: Tailings sample, prepared by moist tamping technique. Date: 11/2/05

DATE / TIME	TIME INTERVAL (sec)	BASE BURETTE (IN FLOW) READING (cm)	BASE BURETTE (IN FLOW) VOLUME (cm^3)	TOP BURETTE (OUT FLOW) READING (cm)	TOP BURETTE (OUT FLOW) VOLUME (cm^3)	BASE PRESSURE (kPa)	TOP PRESSURE (kPa)	CELL PRESSURE (kPa)	HEAD LOSS (cm)	GRADIENT	COEF. OF PERMEABILITY (cm/sec)
	t		Q_{in}		Q_{out}				h	i	k
11/7/05 14:00		67.50		41.00		205	200	475	77.4	6.3	
	1800		2.32		2.45						7E-06
11/7/05 14:30		67.30		41.95		205	200	475	76.3	6.2	
	1800		2.32		2.19						7E-06
11/7/05 15:00		67.10		42.80		205	200	475	75.2	6.1	
	3600		4.64		4.38						7E-06
11/7/05 16:00		66.70		44.50		205	200	475	73.1	5.9	
	3600		4.64		4.12						7E-06
11/7/05 17:00		66.30		46.10		205	200	475	71.1	5.8	
	5400		5.80		6.44						7E-06
11/7/05 18:30		65.80		48.60		205	200	475	68.1	5.5	
11/8/05 9:15		65.80		42.80		210	200	475	124.8	10.1	
	900		2.32		0.77						4E-06
11/8/05 9:30		65.60		43.10		210	200	475	124.3	10.1	
	1800		3.48		5.15						9E-06
11/8/05 10:00		65.30		45.10		210	200	475	122.0	9.9	
	1800		3.48		3.86						7E-06
11/8/05 10:30		65.00		46.60		210	200	475	120.2	9.7	
	3600		7.54		7.21						7E-06
11/8/05 11:30		64.35		49.40		210	200	475	116.8	9.5	
	5400		11.02		11.07						7E-06
11/8/05 13:00		63.40		53.70		210	200	475	111.5	9.0	

Base Burette Area: Top Burette Area: Sample Area: Sample Length:
A_{in} (cm^2) = 11.6 A_{out} (cm^2) = 2.575 A (cm^2) = 29.782 L (cm) = 12.34

Hydraulic Conductivity (Coef. of Permeability), $k = \ln(h_1/h_2) \times (A_{in} \times A_{out} \times L)/(A \times t \times (A_{in} + A_{out}))$ by ASTM D5084-00, method C
(Back pressure saturation applied on the test specimen before consolidation)
(Permeability Test was performed after consolidation at 275kPa confining pressure.)

Klohn Crippen Berger

HYDRAULIC CONDUCTIVITY TEST USING A FLEXIBLE WALL PERMEAMETER
(Triaxial Permeability Test) (ASTM D5084-00)

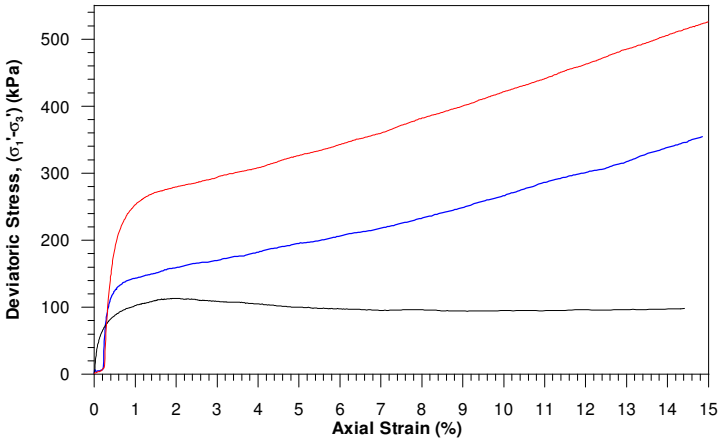
PROJECT NO: M09234A2 TRIAXIAL CELL: Test No.:
PROJECT: Woverine Project PRESSURE PANEL: Tested by: Ganan
SAMPLE INFORMATION: Tailings sample, prepared by moist tamping technique. Date: Nov 17, 2005

DATE / TIME	TIME INTERVAL	BASE BURETTE (IN FLOW)		TOP BURETTE (OUT FLOW)		BASE PRESSURE	TOP PRESSURE	CELL PRESSURE	HEAD LOSS	GRADIENT	COEF. OF PERMEABILITY
		READING	VOLUME	READING	VOLUME						
	(sec)	(cm)	(cm^3)	(cm)	(cm^3)	(kPa)	(kPa)	(kPa)	(cm)		(cm/sec)
	t		Q_{in}		Q_{out}				h	i	k
11/17/05 10:25		68.20		39.90		205	199	650	89.4	7.2	
	2100		2.90		3.09						7.1E-06
11/17/05 11:00		67.95		41.10		205	199	650	87.9	7.1	
	3600		5.22		5.15						7.1E-06
11/17/05 12:00		67.50		43.10		205	199	650	85.5	6.9	
	5400		7.54		7.98						7.5E-06
11/17/05 13:30		66.85		46.20		205	199	650	81.7	6.6	
	3600		4.64		4.63						6.9E-06
11/17/05 14:30		66.45		48.00		205	199	650	79.5	6.4	
	3600		4.64		4.89						7.4E-06
11/17/05 15:30		66.05		49.90		205	199	650	77.2	6.2	
11/17/05 15:30		66.00		49.95		210	199	650	128.0	10.3	
	2100		5.22		5.28						8.5E-06
11/17/05 16:05		65.55		52.00		210	199	650	125.5	10.1	
	5100		12.18		12.10						8.3E-06
11/17/05 17:30		64.50		56.70		210	199	650	119.8	9.6	

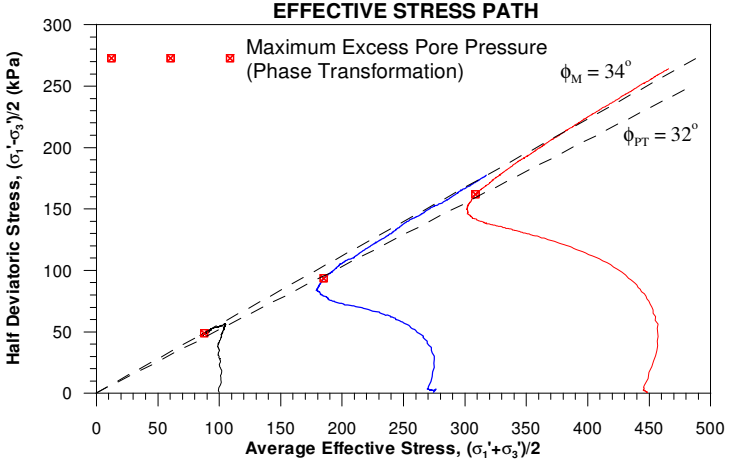
Base Burette Area: Top Burette Area: Sample Area: Sample Length:
A_{in} (cm^2) = 11.6 A_{out} (cm^2) = 2.575 A (cm^2) = 28.8882 L (cm) = 12.45

Hydraulic Conductivity (Coef. of Permeability), $k = \ln(h_1/h_2) \times (A_{in} \times A_{out} \times L)/(A \times t \times (A_{in} + A_{out}))$ by ASTM D5084-00, method C
(Back pressure saturation applied on the test specimen before consolidation)
(Permeability Test was performed after consolidation at 450kPa confining pressure.)

STRESS vs. STRAIN



EFFECTIVE STRESS PATH



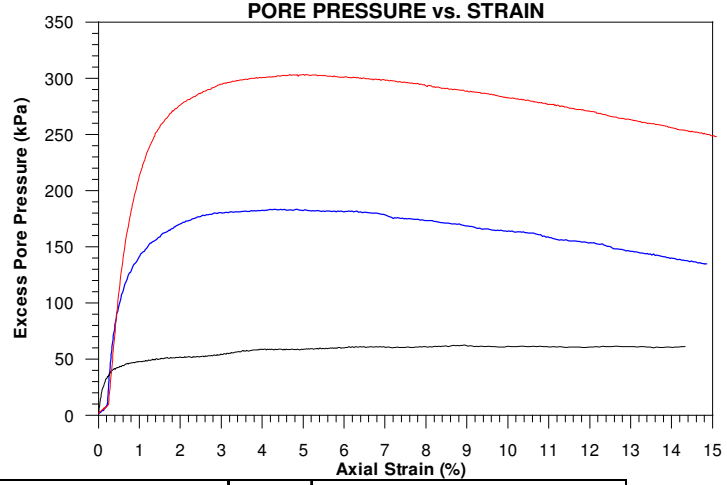
LEGEND

100 kPa

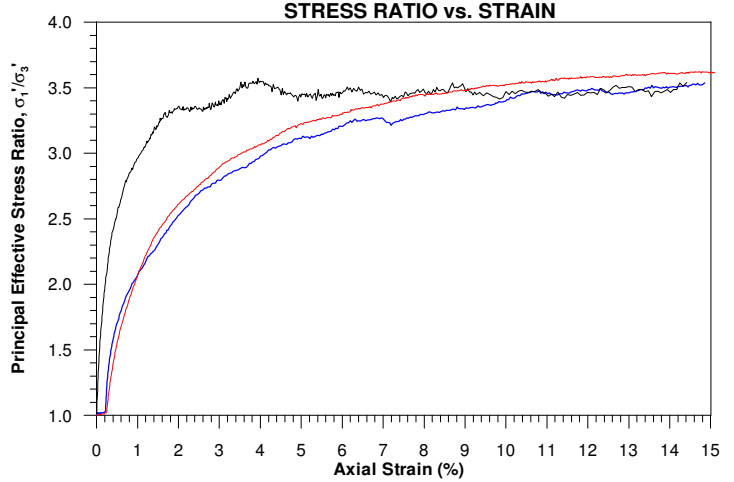
275 kPa

450 kPa

PORE PRESSURE vs. STRAIN



STRESS RATIO vs. STRAIN



SPECIMEN INFORMATION	UNITS	DATA		
Tailings Sample				
Initial Water Content	%	18.5	17.6	17.6
Initial Dry Density	kg/m^3	1848	1858	1842
Skempton's B Parameter		0.96	0.98	0.98
Back Pressure	kPa	250	200	200
Consolidation Stress (σ_3')	kPa	100	275	450
(at start of shear)				
Dry Density	kg/m^3	1905	2036	2080
Specimen Height	mm	126.9	123.4	124.5
Specimen Area	mm^2	3095.2	2978.2	2888.8
Final Water Content	%	23.2	19.6	19.2

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TO BE READ WITH KLOHN-CRIPPEN REPORT DATED _____

KLOHN-CRIPPEN		DATE
DESIGNED		
DRAWN		
CHECKED		
RECOMMENDED		
APPROVED		

Klohn Crippen Berger

CLIENT: Yukon Zinc Corporation

PROJECT: **WOLVERINE TAILINGS IMPOUNDMENT**

TITLE: CIUC TRIAXIAL TEST RESULTS
TAILINGS SAMPLE

DATE OF ISSUE	PROJECT No.	DWG. No.	REV.
November 2005	M09234A02	FIG.	

4. FIELD INVESTIGATIONS

4.1 Summary

Geotechnical site investigations for the tailings facility were carried out from July to September 2005 and drill hole and test pit logs are included in Section 4.2. Geotechnical investigations for the tailings facility included 6 drill holes, 2 groundwater monitoring wells and 23 test pits, summarized as follows:

- Test Holes TH05-7 to TH05-11 were drilled along the dam alignment, and TH05-12 was drilled inside the tailings impoundment.
- Test Pits TP05-71 to TP05-83, TP05-94 and TP05-95 were excavated in the footprint of tailings dam, TP05-84 to TP05-86 excavated in the footprint of the seepage dam, and TP05-91 to TP05-93, TP05-96 and TP05-97 excavated along the diversion ditches and spillway channels.
- Groundwater monitoring well MW05-6 was drilled upstream of the impoundment, while MW05-7 drilled near the downstream toe of the tailings dam.

The site investigation programs were mainly carried out using a 420D Cat backhoe mounted on rubber tires, and a BBS-25A diamond drill rig. Locations of test pits, test holes and groundwater monitoring wells for the tailings facility are shown in Drawing D-3002. Subsoil profiles in the tailings facility area are provided in Drawing D-3003.

The drilling program consisted of Standard or Large Penetration (SPT's and LPT's) tests and falling-head permeability tests in overburden materials, and packer permeability tests and diamond drill coring with HQ_3 or NQ_2 core barrel in bedrock. The penetration tests were carried out to retrieve soil samples for further laboratory testing (see Section 3) and to evaluate *in situ* soil density. Similarly, core samples of bedrock were obtained by diamond coring. *In situ* permeability of subsoil and bedrock were obtained by the falling-head and packer tests.

Most of the test pits were excavated to a maximum depth of about 5 m using the backhoe. In areas inaccessible to the backhoe, shallower test pits were excavated manually or drilled manually using a hand-operated auger drill to a maximum depth of 1 m. All test hole and test pit

locations were surveyed using a GPS unit, and the ground surface elevations were estimated using the site contour map with 2 m contour intervals. Samples retrieved from the drill holes and test pits were further tested in Klohn Crippen Berger's laboratory in Vancouver. Geotechnical laboratory testing included visual classification, moisture content, gradation, standard Proctor compaction, triaxial permeability and shear strength tests (see Section 3).

Two 25 mm diameter, 30 cm long piezometer tips were installed in most test holes with 25 mm Schedule 40 PVC riser pipes. One 55 mm diameter well screen with Schedule 80 PVC well pipe was installed in each monitoring well. A pressure gauge with a by-pass valve set up was installed at the top of each artesian installation. Temperature profiles were also recorded at test holes.

SPT and LPT and falling-head and packer permeability test results are summarized in Table I-4-1 through Table I- 4-5.

Falling-head permeability tests were conducted through the bottom of the monitoring wells or test holes and the test results appear to overestimate the in situ permeability, based on comparison with gradations. This may be due to the boundary condition at the test hole bottom/seal contact, which could increase the measured permeability values significantly.

Table I- 4-1 Summary of Large and Standard Penetrometer Test Results

TEST HOLE	DEPTH (m)	SPT or LPT	SPT OR LPT BLOW COUNT PER FOOT, N	CONVERTED SPT BLOW COUNT, N	CONVERTED (N1) 60
TH05-7	1.52	LPT	101	65	112
	3.05	LPT	81	52	89
	4.57	LPT	29 blows per 6"	-	-
	6.10	LPT	30 blows per 5"	-	-
	9.14	LPT	35 blows per 6"	-	-
	12.19	LPT	30+ blows per 1"	-	-
	15.24	LPT	32+ blows per 4"	-	-
	18.29	LPT	21+ blows per 2"	-	-
	21.34	LPT	37 blows per 3"	-	-
	24.38	LPT	21 blows per 3"	-	-
TH05-8	1.52	LPT	20+ blows per 6"	-	-
	3.05	LPT	47 blows per 12"	-	-
	4.57	LPT	48+ blows per 12"	-	-
	6.10	LPT	42+ blows per 10"	-	-
	9.14	LPT	50+ blows per 12"	-	-
	12.19	LPT	30+ blows per 6"	-	-
	15.24	LPT	60 blows per 6"	-	-
	18.29	LPT	80+ blows per 9"	-	-
TH05-9	1.52	SPT	57	57	97
	3.05	SPT	51	51	86
	4.57	SPT	125	125	172
	6.10	SPT	20 blows per 6"	-	-
	9.14	SPT	26 blows per 5"	-	-
	12.19	SPT	23 blows per 2"	-	-
	15.24	SPT	23 blows per 4"	-	-
	18.29	SPT	23 blows per 2"	-	-
	21.34	SPT	26 blows per 2"	-	-
	24.38	SPT	24 blows per 3.5"	-	-
	27.43	SPT	24 blows per 2.5"	-	-
	30.48	SPT	25 blows per 3"	-	-
TH05-10	1.52	SPT	20+ blows per 6"	-	-
	3.05	SPT	20+ blows per 6"	-	-

Table I- 4-2 Summary of Falling-Head Permeability Test Results

TEST HOLE NO.	TEST SECTION DEPTH (m)		TEST SECTION DIAM. (mm)	k
	from	to		cm/sec
TH05-7	1.52	1.52	101.6	7.8E-02
	3.05	3.05	101.6	8.4E-03
	4.57	4.57	101.6	6.9E-02
	6.10	6.10	101.6	2.7E-02
	9.14	9.14	101.6	2.9E-02
	12.19	12.19	101.6	7.7E-03
	15.24	15.24	101.6	1.0E-02
	18.29	18.29	101.6	2.8E-04
	21.34	21.34	101.6	1.4E-03
	24.38	24.38	101.6	4.3E-03
TH05-8	1.52	1.52	101.6	1.7E-01
	3.05	3.05	101.6	7.0E-02
	4.57	4.57	101.6	2.9E-02
	6.10	6.10	101.6	6.9E-03
TH05-9	1.52	1.52	76.2	1.3E-02
	3.05	3.05	76.2	2.3E-02
	6.10	6.10	76.2	9.5E-03
	9.14	9.14	76.2	5.7E-02
	12.19	12.19	76.2	1.0E-01
	15.24	15.24	76.2	4.1E-01
	18.29	18.29	76.2	5.2E-02
	21.34	21.34	76.2	1.5E-02
	24.38	24.38	76.2	5.7E-02
	27.43	27.43	76.2	9.2E-02
	30.48	30.48	76.2	3.1E-03
TH05-10	1.52	1.52	76.2	5.7E-03
	4.57	4.57	76.2	4.4E-02
	6.10	6.10	76.2	5.0E-02
	9.14	9.14	76.2	3.4E-02
	12.19	12.19	76.2	2.5E-02
	15.24	15.24	76.2	5.0E-02
	18.29	18.29	76.2	7.1E-02
	31.09	31.09	76.2	3.6E-03
	33.53	33.53	76.2	4.0E-03
TH05-11A	3.05	3.05	76.2	1.2E-01
	4.57	4.57	76.2	3.6E-03
	6.10	6.10	76.2	7.7E-03
	9.14	9.14	76.2	4.1E-03
TH05-11B	6.10	6.10	76.2	6.6E-02
	9.14	9.14	76.2	6.0E-03
	12.19	12.19	76.2	1.1E-02
	28.35	28.35	76.2	2.6E-02
	30.48	30.48	76.2	1.9E-03
	36.58	36.58	76.2	6.8E-03
	42.67	42.67	76.2	1.8E-02
	1.52	1.52	76.2	2.6E-01
	3.05	3.05	76.2	6.1E-04
	6.10	6.10	76.2	4.1E-03
	9.14	9.14	76.2	3.1E-03
TH05-12	12.19	12.19	76.2	1.1E-02
	18.29	18.29	76.2	1.4E-02
	21.34	21.34	76.2	1.6E-02
	24.38	24.38	76.2	1.5E-02

Table I- 4-3 Summary of Packer Permeability Test Results

TEST HOLE NO.	TEST SECTION DEPTH (m)		TEST SECTION DIAM. (mm)	AVERAGE k
	From	from		m/s
TH05-8	24.70	30.80	96.0	5.5E-07
TH05-9	30.50	35.10	75.7	3.1E-06
TH05-10	35.05	38.10	75.7	1.5E-06
TH05-11	44.20	46.30	75.7	1.4E-07
TH05-12	27.58	29.60	75.7	1.6E-07

Table I- 4-4 Summary of Falling-Head Permeability Test Results – Monitoring Wells

TEST HOLE NO.	DEPTH (m)		HOLE DIA. (mm)	k
	From	to		cm/sec
MW05-3A	1.07	1.52	96	2.8E-04
	2.60	3.05	96	0.0E+001
	4.12	4.57	96	0.0E+001
	5.65	6.10	96	1.7E-04
	8.69	9.14	96	4.9E-04
	11.74	12.19	96	3.5E-04
	14.79	15.24	96	0.0E+001
	17.84	18.29	96	0.0E+001
MW05-5A	3.05	3.05	76	1.0E-01
	6.10	6.10	76	1.2E-02
	9.14	9.14	76	6.7E-03
	12.19	12.19	76	8.0E-03
	15.24	15.24	76	6.3E-03
	18.29	18.29	76	6.6E-03
MW05-6	1.52	1.52	102	2.0E-04
	3.05	3.05	102	7.8E-04
	4.57	4.57	102	3.6E-03
	6.10	6.10	102	1.3E-03
	9.14	9.14	102	4.8E-03
	12.19	12.19	102	2.3E-04
	15.24	15.24	102	3.1E-03
	18.29	18.29	102	1.4E-02
	21.34	21.34	102	1.8E-02

Notes: 1. No visible change in piezometric head during test.
2. MW05-3A is located northwest of the impoundment.

Table I- 4-5 Summary of Packer Permeability Test Results – Monitoring Wells

TEST HOLE NO.	DEPTH (m)		HOLE DIA. (mm)	AVERAGE k
	From	to		m/s
MW05-5	21.10	26.50	76	4.7E-07
MW05-6A	21.30	25.70	96	1.2E-07
MW05-7A	24.70	30.20	96	3.6E-07

Notes: 1. No visible change in piezometric head during test.

4.2 Site Investigation Data

Test hole and test pit logs are included below for the test holes, test pits, and monitoring wells summarized in Section 4.1.

Test Hole and Test Pit Logs

KLOHN CRIPPEN

GEOLOGIC LOG OF DRILL HOLE NO.: TH05-7

CLIENT: Yukon Zinc Corporation	PROJECT NO.: M09234A02
PROJECT: Wolverine Feasibility Design and Environmental Assessment	DATE HOLE STARTED: 8/6/2005 FINISHED: 8/8/2005
LOCATION:	DATUM: NAD27
DIRECTION AZIMUTH: DIP (from horiz): -90	TOP OF PIPE ELEVATION: m
CO-ORDINATES: E 442660m N 6808160m	GROUND ELEVATION: 1305 m
MANUFACTURER'S DRILL DESIGNATION: BBS 25A	TOTAL DEPTH OF HOLE: 31.4 m
DRILLING CONTRACTOR: Advanced Drilling Ltd.	DRILLING METHOD SOIL: HQ Core ROCK: HQ Core
LOGGED BY: EA	DRILLING FLUID: Water
CHECKED BY:	HOLE DIA.:

DEPTH (m)	SYMBOL	SAMPLE No.	LITHOLOGY	PIEZOMETER DETAILS	HYDRAULIC CONDUCTIVITY CM/SEC (10-6, 10-4, 10-2)	DISCONTINUITY DATA (SEE BOTTOM OF FORM FOR CODES; Dip Angle 30 60)	ROCK STRENGTH BASED ON POINT LOAD TEST (MPa) (a)=axial; (d)=diametrical	TEMPERATURE (0 6 12)	FIELD/LAB DATA: SPT/LPT N ● / CORE RECOVERY % (25 50 75); WATER CONTENT % ○ / R.Q.D. % (5 10 15)
0			0.3 1,304.8 TOPSOIL - organics.						
1			SILT-SAND-GRAVEL-COBBLE, with occasional boulders.						
2		1	- LPT N = 101 blows at 1.52 m depth.						101
3		2	- LPT N = 81 blows at 3.05 m depth.						
4									
5		3	- LPT N = 29+ blows for first 6" at 4.57 m depth.						
6									
7		4	- LPT N = 30+ blows for first 5" at 6.1 m depth.						
8									
9									
10		5	- LPT N = 35+ blows for first 6" at 9.14 m depth.						
11									
12									
13			- LPT N = 30+ blows for first 1" at 12.19 m depth.						
14									
15									
16			- LPT N = 32+ blows for first 4" at 15.24 m depth.						
17									
18									
19			- LPT N = 21+ blows for first 2" at 18.29 m depth.						
20									

DISCONTINUITY CODES: B: BEDDING D: DRILL BRK F: FAULT G: GNEISS'TY J: JOINT M: SCHIST'TY S: SHEAR T: TENSION CRK

CORE LOSS FRACTURED/BROKEN CORE DIP ANGLES MEASURED WITH RESPECT TO

KC_ROCK-SI@4 WOLVERINE TEST HOLES - NOV 17.GPJ ROCK-LOG.GDT 2/8/06

KLOHN CRIPPEN

GEOLOGIC LOG OF DRILL HOLE NO.: TH05-7

DEPTH (m)	SYMBOL	SAMPLE No.	LITHOLOGY	PIEZOMETER DETAILS	HYDRAULIC CONDUCTIVITY CM/SEC 10-6 10-4 10-2	DISCONTINUITY DATA SEE BOTTOM OF FORM FOR CODES Dip Angle 30 60	ROCK STRENGTH BASED ON POINT LOAD TEST (MPa) (a)=axial; (d)=diametrical	TEMPERATURE 0 6 12	FIELD/LAB DATA SPT/LPT N ● CORE RECOVERY % 25 50 75	FIELD/LAB DATA WATER CONTENT % ○ R.Q.D. % 5 10 15
21			(continued from previous page)							
22			- LPT N = 37+ blows for first 3" at 21.34 m depth.							
23										
24			24.4 1,280.6 - LPT N = 21+ blows for first 3" at 24.38 m depth.							
25			BEDROCK.							
26		ARMS	- Grey, laminated, strongly foliated, siliceous argillite, angular gravel, with quartz veins between 24.4 m and 27.4 m depth.						30	0
27										
28		ARMS	- Same as above, with some black graphitic argillite.						21	0
29										
30			Piezometer 7A						0	0
31			31.4 1,273.6 End of Hole at: 31.4 m							
32										
33			Notes:							
34			1. The SPT/LPT N values indicated are the field measured LPT N values.							
35			2. Piezometer stickup length for TH05-07A is ___ m. Water level could not be measured in piezometer TH05-7A due to gasoline in piezometer.							
36										
37			3. Piezometer TH05-7B was not installed in overburden because the 70' casing could not be removed.							
38										
39			4. ARMS = massive argillite.							
40										
41										
42										
43										
44										
45										

DISCONTINUITY CODES: B: BEDDING D: DRILL BRK F: FAULT G: GNEISS'TY J: JOINT M: SCHIST'TY S: SHEAR T: TENSION CRK

CORE LOSS FRACTURED/BROKEN CORE DIP ANGLES MEASURED WITH RESPECT TO

KC_ROCK-S\@4 WOLVERINE TEST HOLES - NOV 17.GPJ ROCK-LOG.GDT 2/8/06

KLOHN CRIPPEN

GEOLOGIC LOG OF DRILL HOLE NO.: TH05-8

CLIENT: Yukon Zinc Corporation	PROJECT NO.: M09234A02
PROJECT: Wolverine Feasibility Design and Environmental Assessment	DATE HOLE STARTED: 8/2/2005 FINISHED: 8/5/2005
LOCATION:	DATUM: NAD27
DIRECTION AZIMUTH: DIP (from horiz): -90	TOP OF PIPE ELEVATION: m
CO-ORDINATES: E 442565m N 6808139m	GROUND ELEVATION: 1290 m
MANUFACTURER'S DRILL DESIGNATION: BBS 25A	TOTAL DEPTH OF HOLE: 30.8 m
DRILLING CONTRACTOR: Advanced Drilling Ltd.	DRILLING METHOD SOIL: HQ Core ROCK: HQ Core
LOGGED BY: EA	DRILLING FLUID: Water
CHECKED BY:	HOLE DIA.:

DEPTH (m)	SYMBOL	SAMPLE No.	LITHOLOGY	PIEZOMETER DETAILS	HYDRAULIC CONDUCTIVITY CM/SEC 10-6 10-4 10-2	DISCONTINUITY DATA SEE BOTTOM OF FORM FOR CODES Dip Angle 30 60	ROCK STRENGTH BASED ON POINT LOAD TEST (MPa) (a)=axial; (d)=diametrical	TEMPERATURE 0 6 12	FIELD/LAB DATA SPT/LPT N ● CORE RECOVERY % 25 50 75	FIELD/LAB DATA WATER CONTENT % ○ R.Q.D. % 5 10 15
1			0.3 1,289.8 TOPSOIL - organics.							
2			SILT-SAND-GRAVEL-COBBLE, low plastic silt, fine to coarse sand and gravel, occasional boulders, flat, subrounded to subangular gravel, grey to green, dry to moist (TILL-like). - LPT N = 20+ blows for first 6" at 1.52 m depth.							
3		1	- LPT N = 47 blows for 12" at 3.05 m depth.							
4										
5		2	- LPT N = 48+ blows over first 12" at 4.57 m depth.							
6										
7		3	- LPT N = 42+ blows over first 10" at 6.10 m depth.							
8										
9										
10		4	- LPT N = 50+ blows over first 12" at 9.14 m depth.							
11										
12										
13			- LPT N = 30+ blows over first 6" at 12.19 m depth.							
14										
15										
16		5	- LPT N = 60 blows over first 6" at 15.24 m depth.							
17										
18										
19		6	- LPT N = 80+ blows over first 9" at 18.29 m depth.							
20			19.8						24	0

DISCONTINUITY CODES: B: BEDDING D: DRILL BRK F: FAULT G: GNEISS'TY J: JOINT M: SCHIST'TY S: SHEAR T: TENSION CRK

CORE LOSS FRACTURED/BROKEN CORE DIP ANGLES MEASURED WITH RESPECT TO

KC_ROCK-SI@4 WOLVERINE TEST HOLES - NOV 17.GPJ ROCK-LOG.GDT 2/8/06

KLOHN CRIPPEN

GEOLOGIC LOG OF DRILL HOLE NO.: TH05-8

DEPTH (m)	SYMBOL	SAMPLE No.	LITHOLOGY	PIEZOMETER DETAILS	HYDRAULIC CONDUCTIVITY CM/SEC 10-6 10-4 10-2	DISCONTINUITY DATA: SEE BOTTOM OF FORM FOR CODES; Dip Angle 30 60	ROCK STRENGTH BASED ON POINT LOAD TEST (MPa) (a)=axial; (d)=diametrical	TEMPERATURE 0 6 12	FIELD/LAB DATA: SPT/LPT N ● CORE RECOVERY % 25 50 75	FIELD/LAB DATA: WATER CONTENT % ○ R.Q.D. % 5 10 15
			(continued from previous page)							
21			1,270.2 BEDROCK. - Weak bedrock encountered at 19.8 m depth.							
22										
23										
24			Piezometer 8B							
25			- Black, well foliated, massive and highly fractured argillite encountered between 24.4 m and 27.4 m depth.							
26		ARMS							33	0
27										
28			- Black, weakly foliated, massive argillite (mudstone) encountered between 27.4 m and 29.4 m depth. Note: last 30 cm of core run encountered milky white bull quartz vein.							
29		ARMS/ QTVN							80	6
30			Piezometer 8A							
31			30.8 1,259.2 End of Hole at: 30.8 m							
32										
33										
34										
35										
36										
37										
38										
39										
40										
41										
42										
43										
44										
45										

Notes:

1. The SPT/LPT N values indicated are the field measured LPT N values.

2. Piezometer stickup lengths are as follows:
- TH05-8A = 0.20 m;
- TH05-8B = 0.17 m.

3. Water levels measured in piezometers TH05-8A and B after installation were artesian.

4. ARMS = massive argillite; QTVN = quartz vein.

DISCONTINUITY CODES: B: BEDDING D: DRILL BRK F: FAULT G: GNEISS'TY J: JOINT M: SCHIST'TY S: SHEAR T: TENSION CRK

CORE LOSS FRACTURED/BROKEN CORE DIP ANGLES MEASURED WITH RESPECT TO

KLOHN CRIPPEN

GEOLOGIC LOG OF DRILL HOLE NO.: TH05-9

CLIENT: Yukon Zinc Corporation	PROJECT NO.: M09234A02
PROJECT: Wolverine Feasibility Design and Environmental Assessment	DATE HOLE STARTED: 8/12/2005 FINISHED: 8/19/2005
LOCATION:	DATUM: NAD27
DIRECTION AZIMUTH: DIP (from horiz): -90	TOP OF PIPE ELEVATION: m
CO-ORDINATES: E 442454m N 6808092m	GROUND ELEVATION: 1303 m
MANUFACTURER'S DRILL DESIGNATION: BBS 25A	TOTAL DEPTH OF HOLE: 35.05 m
DRILLING CONTRACTOR: Advanced Drilling Ltd.	DRILLING METHOD SOIL: NQ Core ROCK: NQ Core
LOGGED BY: EA	DRILLING FLUID: Water
CHECKED BY:	HOLE DIA.:

DEPTH (m)	SYMBOL	SAMPLE No.	LITHOLOGY	PIEZOMETER DETAILS	HYDRAULIC CONDUCTIVITY CM/SEC 10-6 10-4 10-2	DISCONTINUITY DATA: SEE BOTTOM OF FORM FOR CODES; Dip Angle 30 60	ROCK STRENGTH BASED ON POINT LOAD TEST (MPa) (a)=axial; (d)=diametrical	TEMPERATURE 0 6 12	FIELD/LAB DATA: SPT/LPT N ●, CORE RECOVERY %, WATER CONTENT % ○, R.Q.D. % 25 50 75 / 5 10 15
1			0.2 1,302.8 TOPSOIL - organics. SILT-SAND-GRAVEL-COBBLE, low plastic silt, fine to coarse sand and gravel, occasional boulders, flat, subrounded to subangular gravel, grey to green, dry to moist (TILL-LIKE).						
2		1	- LPT N = 57 blows at 1.52 m depth.						
3		2	- LPT N = 51 blows at 3.05 m depth.						
4			Piezometer 9B						
5		3	- LPT N = 125 blows at 4.57 m depth.						125
6			- LPT N = 20 blows over first 6" at 6.10 m depth.						
7									
8									
9			- LPT N = 26 blows over first 5" at 9.14 m depth.						
10									
11									
12			- LPT N = 23 blows over first 2" at 12.19 m depth.						
13									
14									
15		4	- LPT N = 23 blows over first 4" at 15.24 m depth.						
16									
17									
18		5	- LPT N = 23 blows over first 2" at 18.29 m depth.						
19									
20									

DISCONTINUITY CODES: B: BEDDING D: DRILL BRK F: FAULT G: GNEISS'TY J: JOINT M: SCHIST'TY S: SHEAR T: TENSION CRK

CORE LOSS FRACTURED/BROKEN CORE DIP ANGLES MEASURED WITH RESPECT TO

KC_ROCK-S\@4 WOLVERINE TEST HOLES - NOV 17.GPJ ROCK-LOG.GDT 2/6/06

KLOHN CRIPPEN

GEOLOGIC LOG OF DRILL HOLE NO.: TH05-9

DEPTH (m)	SYMBOL	SAMPLE No.	LITHOLOGY	PIEZOMETER DETAILS	HYDRAULIC CONDUCTIVITY CM/SEC 10-6 10-4 10-2	DISCONTINUITY DATA: SEE BOTTOM OF FORM FOR CODES; Dip Angle 30 60	ROCK STRENGTH BASED ON POINT LOAD TEST (MPa) (a)=axial; (d)=diametrical	TEMPERATURE 0 6 12	FIELD/LAB DATA: SPT/LPT N ● CORE RECOVERY % 25 50 75; WATER CONTENT % ○ R.Q.D. % 5 10 15
21			(continued from previous page)						
22			- LPT N = 26 blows over first 2" at 21.34 m depth.						
23									
24									
25			- LPT N = 24 blows over first 3.5" at 24.38 m depth.						
26									
27									
28		6	- LPT N = 24 blows over first 2.5" at 27.43 m depth.						
29									
30			Piezometer 9A						
31			30.1 / 1,272.9 BEDROCK. - LPT N = 25 blows over first 3" at 30.48 m depth. - 5 cm of black carbonaceous argillite (minor pyrite) encountered between 30.5 m and 32.0 m depth. - Dark grey siliceous argillite encountered between 32.0 m and 35.1 m depth.						SPT/LPT N: 36; WATER CONTENT %: 0
32		OVBD/ ARMS							
33									
34		ARMS							SPT/LPT N: 3; WATER CONTENT %: 0
35			35.1 / 1,268.0 End of Hole at: 35.1 m						
36									
37									
38									
39									
40									
41									
42									
43									
44									
45									

Notes:

1. The SPT/LPT N values indicated are the field measured SPT N values.

2. Piezometer stickup lengths are as follows:
- TH05-9A = 0.21 m;
- TH05-9B = 0.31 m.

3. Water levels measured in piezometers TH05-9A and B after installation were 10.72 m and 3.67 m, respectively.

4. OVBN = overburden; ARMS = massive argillite.

5. Two separate holes were drilled for the piezometer installation in overburden and bedrock.

DISCONTINUITY CODES: B: BEDDING D: DRILL BRK F: FAULT G: GNEISS'TY J: JOINT M: SCHIST'TY S: SHEAR T: TENSION CRK

CORE LOSS FRACTURED/BROKEN CORE DIP ANGLES MEASURED WITH RESPECT TO

KC_ROCK-SI@4 WOLVERINE TEST HOLES - NOV 17.GPJ ROCK-LOG.GDT 2/8/06

KLOHN CRIPPEN

GEOLOGIC LOG OF DRILL HOLE NO.: TH05-10

CLIENT: Yukon Zinc Corporation	PROJECT NO.: M09234A02
PROJECT: Wolverine Feasibility Design and Environmental Assessment	DATE HOLE STARTED: 8/19/2005 FINISHED: 8/25/2005
LOCATION:	DATUM: NAD27
DIRECTION AZIMUTH: DIP (from horiz): -90	TOP OF PIPE ELEVATION: m
CO-ORDINATES: E 442328m N 6808233m	GROUND ELEVATION: 1308 m
MANUFACTURER'S DRILL DESIGNATION: BBS 25A	TOTAL DEPTH OF HOLE: 38.1 m
DRILLING CONTRACTOR: Advanced Drilling Ltd.	DRILLING METHOD SOIL: NQ Core ROCK: NQ Core
LOGGED BY: EA/RB	DRILLING FLUID: Water
CHECKED BY:	HOLE DIA.:

DEPTH (m)	SYMBOL	SAMPLE No.	LITHOLOGY	PIEZOMETER DETAILS	HYDRAULIC CONDUCTIVITY CM/SEC (10-6, 10-4, 10-2)	DISCONTINUITY DATA (SEE BOTTOM OF FORM FOR CODES) Dip Angle (30, 60)	ROCK STRENGTH BASED ON POINT LOAD TEST (MPa) (a)=axial; (d)=diametrical	TEMPERATURE (0, 6, 12)	FIELD/LAB DATA: SPT/LPT N ● / CORE RECOVERY % (25, 50, 75)	FIELD/LAB DATA: WATER CONTENT % ○ / R.Q.D. % (5, 10, 15)
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20			0.3 1,307.8 TOPSOIL - organics. OVERBURDEN consisting of SILT/CLAY, SAND, GRAVEL, COBBLE, with occasional boulders. - SPT N = 20+ blows over first 6" at 1.52 m depth. - SPT N = 20+ blows over first 6" at 3.05 m depth.	Piezometer 10B						

DISCONTINUITY CODES: B: BEDDING D: DRILL BRK F: FAULT G: GNEISS'TY J: JOINT M: SCHIST'TY S: SHEAR T: TENSION CRK

CORE LOSS FRACTURED/BROKEN CORE DIP ANGLES MEASURED WITH RESPECT TO

KC_ROCK-SI@4 WOLVERINE TEST HOLES - NOV 17.GPJ ROCK-LOG.GDT 2/8/06

KLOHN CRIPPEN

GEOLOGIC LOG OF DRILL HOLE NO.: TH05-10

DEPTH (m)	SYMBOL	SAMPLE No.	LITHOLOGY	PIEZOMETER DETAILS	HYDRAULIC CONDUCTIVITY CM/SEC 10-6 10-4 10-2	DISCONTINUITY DATA: SEE BOTTOM OF FORM FOR CODES; Dip Angle 30 60	ROCK STRENGTH BASED ON POINT LOAD TEST (MPa) (a)=axial; (d)=diametrical	TEMPERATURE 0 6 12	FIELD/LAB DATA: SPT/LPT N ● CORE RECOVERY % 25 50 75	FIELD/LAB DATA: WATER CONTENT % ○ R.Q.D. % 5 10 15
21–45			(continued from previous page)							
32			32.0 / 1,276.0 BEDROCK.						20	0
33			- Carbonaceous between 32.6 m and 35.1 m depth.							
34									25	0
35			- 80% of core run is gouge; carbonaceous between 35.1 m and 38.1 m depth.							
36										
37									20	0
38			38.1 / 1,269.9 End of Hole at: 38.1 m	Piezometer 10A						
39–45										

Notes:

1. The SPT/LPT N values indicated are the field measured SPT N values.

2. Piezometer stickup lengths are as follows:
- TH05-10A = 0.54 m;
- TH05-10B = 0.60 m.

3. Water levels measured in piezometers TH05-10A and B after installation were 1.09 m and 5.49 m, respectively.

DISCONTINUITY CODES: B: BEDDING D: DRILL BRK F: FAULT G: GNEISS'TY J: JOINT M: SCHIST'TY S: SHEAR T: TENSION CRK

CORE LOSS FRACTURED/BROKEN CORE DIP ANGLES MEASURED WITH RESPECT TO

KC_ROCK-SI@4 WOLVERINE TEST HOLES - NOV 17.GPJ ROCK-LOG.GDT 2/6/06

KLOHN CRIPPEN

GEOLOGIC LOG OF DRILL HOLE NO.: TH05-11

CLIENT: Yukon Zinc Corporation	PROJECT NO.: M09234A02
PROJECT: Wolverine Feasibility Design and Environmental Assessment	DATE HOLE STARTED: 8/26/2005 FINISHED: 8/31/2005
LOCATION:	DATUM: NAD27
DIRECTION AZIMUTH: DIP (from horiz): -90	TOP OF PIPE ELEVATION: m
CO-ORDINATES: E 442248m N 6808417m	GROUND ELEVATION: 1312.5 m
MANUFACTURER'S DRILL DESIGNATION: BBS 25A	TOTAL DEPTH OF HOLE: 46.3 m
DRILLING CONTRACTOR: Advanced Drilling Ltd.	DRILLING METHOD SOIL: NQ Core ROCK: NQ Core
LOGGED BY: RB	DRILLING FLUID: Water
CHECKED BY:	HOLE DIA.:

DEPTH (m)	SYMBOL	SAMPLE No.	LITHOLOGY	PIEZOMETER DETAILS	HYDRAULIC CONDUCTIVITY CM/SEC 10-6 10-4 10-2	DISCONTINUITY DATA SEE BOTTOM OF FORM FOR CODES Dip Angle 30 60	ROCK STRENGTH BASED ON POINT LOAD TEST (MPa) (a)=axial; (d)=diametrical	TEMPERATURE 0 6 12	FIELD/LAB DATA SPT/LPT N ● CORE RECOVERY % 25 50 75	FIELD/LAB DATA WATER CONTENT % ○ R.Q.D. % 5 10 15
0			0.2 1,312.3 TOPSOIL - organics.							
1			TILL-LIKE OVERBURDEN consisting of SILT/CLAY, SAND, GRAVEL, COBBLE, with occasional boulders.							
2										
3										
4										
5										
6										
7										
8				Piezometer 11B						
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										

DISCONTINUITY CODES: B: BEDDING D: DRILL BRK F: FAULT G: GNEISS'TY J: JOINT M: SCHIST'TY S: SHEAR T: TENSION CRK

CORE LOSS FRACTURED/BROKEN CORE DIP ANGLES MEASURED WITH RESPECT TO

KG_ROCK-SI@4 WOLVERINE TEST HOLES - NOV 17.GPJ ROCK-LOG.GDT 2/8/06

KLOHN CRIPPEN

GEOLOGIC LOG OF DRILL HOLE NO.: TH05-11

DEPTH (m)	SYMBOL	SAMPLE No.	LITHOLOGY	PIEZOMETER DETAILS	HYDRAULIC CONDUCTIVITY CM/SEC	DISCONTINUITY DATA	ROCK STRENGTH BASED ON POINT LOAD TEST (MPa) (a)=axial; (d)=diametrical	TEMPERATURE	FIELD/LAB DATA
			(continued from previous page)		10-6 10-4 10-2	SEE BOTTOM OF FORM FOR CODES Dip Angle 30 60		0 6 12	SPT/LPT N ● CORE RECOVERY % 25 50 75 WATER CONTENT % ○ R.Q.D. % 5 10 15
21									
22									
23									
24									
25									
26									
27									
28									
29									
30									
31									
32									
33									
34									
35									
36									
37									
38									
39									
39.6 1,272.9			BEDROCK. - Between 39.6 m and 42.7 m depth: upper one-third is subangular pebbles to cobbles, lower two-third is foliated rhyolite overlying tuffaceous argillite.						
40									
41									50 0
42									
43				Piezometer 11A					
44									
45									2 0

DISCONTINUITY CODES: B: BEDDING D: DRILL BRK F: FAULT G: GNEISS'TY J: JOINT M: SCHIST'TY S: SHEAR T: TENSION CRK

CORE LOSS FRACTURED/BROKEN CORE DIP ANGLES MEASURED WITH RESPECT TO

KC_ROCK-SI@4 WOLVERINE TEST HOLES - NOV 17.GPJ ROCK-LOG.GDT 2/8/06

KLOHN CRIPPEN

GEOLOGIC LOG OF DRILL HOLE NO.: TH05-11

DEPTH (m)	SYMBOL	SAMPLE No.	LITHOLOGY	PIEZOMETER DETAILS	HYDRAULIC CONDUCTIVITY CM/SEC 10-6 10-4 10-2	DISCONTINUITY DATA: SEE BOTTOM OF FORM FOR CODES; Dip Angle 30 60	ROCK STRENGTH BASED ON POINT LOAD TEST (MPa) (a)=axial; (d)=diametrical	TEMPERATURE 0 6 12	FIELD/LAB DATA: SPT/LPT N ● CORE RECOVERY % 25 50 75	FIELD/LAB DATA: WATER CONTENT % ○ R.Q.D. % 5 10 15
46			(continued from previous page)							
			46.3 1,266.2 End of Hole at: 46.3 m							
47			Notes:							
48			1. No SPT or LPT testing was carried out in TH05-11 due to abundance of cobbles and boulders.							
49			2. Two separate holes were drilled for the overburden and bedrock piezometers to facilitate installation and increased reliability of piezometric data.							
50			3. Piezometer stickup lengths are as follows: - TH05-11A = 0.40 m; - TH05-11B = 0.39 m.							
51			4. Water levels measured in piezometers TH05-11A and B after installation were 9.37 m and 8.50 m, respectively.							
52										
53										
54										
55										
56										
57										
58										
59										
60										
61										
62										
63										
64										
65										
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67										
68										
69										
70										

DISCONTINUITY CODES: B: BEDDING D: DRILL BRK F: FAULT G: GNEISS'TY J: JOINT M: SCHIST'TY S: SHEAR T: TENSION CRK

CORE LOSS FRACTURED/BROKEN CORE DIP ANGLES MEASURED WITH RESPECT TO

KC_ROCK-SI@4 WOLVERINE TEST HOLES - NOV 17.GPJ ROCK-LOG.GDT 2/8/06

KLOHN CRIPPEN

GEOLOGIC LOG OF DRILL HOLE NO.: TH05-12

CLIENT: Yukon Zinc Corporation	PROJECT NO.: M09234A02
PROJECT: Wolverine Feasibility Design and Environmental Assessment	DATE HOLE STARTED: 8/9/2005 FINISHED: 8/12/2005
LOCATION:	DATUM: NAD27
DIRECTION AZIMUTH: DIP (from horiz): -90	TOP OF PIPE ELEVATION: m
CO-ORDINATES: E 422438m N 6808331m	GROUND ELEVATION: 1305.5 m
MANUFACTURER'S DRILL DESIGNATION: BBS 25A	TOTAL DEPTH OF HOLE: 29.6 m
DRILLING CONTRACTOR: Advanced Drilling Ltd.	DRILLING METHOD SOIL: NQ Core ROCK: NQ Core
LOGGED BY: EA/RB	DRILLING FLUID: Water
CHECKED BY:	HOLE DIA.:

DEPTH (m)	SYMBOL	SAMPLE No.	LITHOLOGY	PIEZOMETER DETAILS	HYDRAULIC CONDUCTIVITY CM/SEC 10-6 10-4 10-2	DISCONTINUITY DATA: SEE BOTTOM OF FORM FOR CODES; Dip Angle 30 60	ROCK STRENGTH BASED ON POINT LOAD TEST (MPa) (a)=axial; (d)=diametrical	TEMPERATURE 0 6 12	FIELD/LAB DATA: SPT/LPT N ● CORE RECOVERY % 25 50 75	FIELD/LAB DATA: WATER CONTENT % ○ R.Q.D. % 5 10 15
0.3 1,305.3			TOPSOIL - organics. OVERBURDEN.							
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										

DISCONTINUITY CODES: B: BEDDING D: DRILL BRK F: FAULT G: GNEISS'TY J: JOINT M: SCHIST'TY S: SHEAR T: TENSION CRK

CORE LOSS FRACTURED/BROKEN CORE DIP ANGLES MEASURED WITH RESPECT TO

KC_ROCK-SI@4 WOLVERINE TEST HOLES - NOV 17.GPJ ROCK-LOG.GDT 2/8/06

KLOHN CRIPPEN

GEOLOGIC LOG OF DRILL HOLE NO.: TH05-12

DEPTH (m)	SYMBOL	SAMPLE No.	LITHOLOGY	PIEZOMETER DETAILS	HYDRAULIC CONDUCTIVITY CM/SEC (10-6, 10-4, 10-2)	DISCONTINUITY DATA (SEE BOTTOM OF FORM FOR CODES) Dip Angle (30, 60)	ROCK STRENGTH BASED ON POINT LOAD TEST (MPa) (a)=axial; (d)=diametrical	TEMPERATURE (0, 6, 12)	FIELD/LAB DATA: SPT/LPT N ● CORE RECOVERY % (25, 50, 75)	FIELD/LAB DATA: WATER CONTENT % ○ R.Q.D. % (5, 10, 15)
21–45			(continued from previous page)							
24			24.1 1,281.4 BEDROCK.							
30			29.6 1,275.9 End of Hole at: 29.6 m							

DISCONTINUITY CODES: B: BEDDING D: DRILL BRK F: FAULT G: GNEISS'TY J: JOINT M: SCHIST'TY S: SHEAR T: TENSION CRK

CORE LOSS FRACTURED/BROKEN CORE DIP ANGLES MEASURED WITH RESPECT TO

KC_ROCK-SI@4 WOLVERINE TEST HOLES - NOV 17.GPJ ROCK-LOG.GDT 2/8/06

TEST PIT LOG

STARTED: 7/21/2005 **FINISHED:** 7/21/2005

EXCAVATOR TYPE: 420D Cat Backhoe

GROUND ELEV. (m): ~ 1317.5

COORDINATES (m): N 6808187 E 442732

DEPTH (m)	SAMPLE TYPE	SAMPLE No.	SYMBOL	DESCRIPTION OF MATERIALS	INSTRUMENT DETAILS
0.0				TOPSOIL - organics and moss.	
0.20					
				GRAVEL and COBBLE, fine to coarse gravel, some silt and sand, with about 20% coarse sand, yellow, dry to moist.	
1.0		1			
1.70					
				GRAVEL, fine to coarse, sandy silty matrix, trace clay, occasional cobbles and boulders up to 0.5 m size, dense, subrounded to subangular, green, dry to moist (TILL-LIKE).	
2.5		2			
3.00					
				End of Hole at 3.00 m.	
5.0					

Su - kPa: 20 60 100 140 180

VANE PEAK ◆ FIELD ■ LAB ▲ UC/2
REMOLD ◇ □ △ P.PEN/2

★ % FINES

W_P% W% W_L%

× ---- ○ ---- ×

20 40 60 80

KLOHN CRIPPEN

PROJECT NO.: M09234A02

PROJECT: Wolverine FD and EA

LOCATION: Wolverine Lake

LOGGED BY: MSR **CHECKED BY:**

SHEET 1 **OF** 1 **HOLE NO.:** TP05-71

KC_TEST_PIT-SI TESTPITS TP05-51 TO 106.GPJ KC_DATA.GDT 2/3/06

TEST PIT LOG

STARTED: 7/20/2005 **FINISHED:** 7/20/2005

EXCAVATOR TYPE: 420D Cat Backhoe

GROUND ELEV. (m): ~ 1304.5

COORDINATES (m): N 6808183 E 442654

DEPTH (m)	SAMPLE TYPE	SAMPLE No.	SYMBOL	DESCRIPTION OF MATERIALS	INSTRUMENT DETAILS
0.0				TOPSOIL.	
0.15				- organics and black organic rich mud.	
0.25				VOLCANIC ASH, white.	
				GRAVEL and COBBLE, fine to coarse gravel, some fine to coarse sand, flat, subangular to subrounded gravel, brown, moist.	
1.0		1			
1.30				GRAVEL, fine to coarse, silty clayey matrix, medium dense to dense, angular to subangular, grey, moist (TILL).	
2.5		2			
3.00				End of Hole at 3.00 m.	

Su - kPa: 20 60 100 140 180

VANE PEAK ◆ FIELD ■ LAB ▲ UC/2
REMOLD ◇ □ △ P.PEN/2

★ % FINES

W_P% W% W_L%

20 40 60 80

KLOHN CRIPPEN

PROJECT NO.: M09234A02

PROJECT: Wolverine FD and EA

LOCATION: Wolverine Lake

LOGGED BY: MSR **CHECKED BY:**

SHEET 1 **OF** 1 **HOLE NO.:** TP05-72

KC_TEST_PIT-SI TESTPITS TP05-51 TO 106.GPJ KC_DATA.GDT 2/3/06

TEST PIT LOG

STARTED: 7/20/2005 **FINISHED:** 7/20/2005
EXCAVATOR TYPE: 420D Cat Backhoe
GROUND ELEV. (m): ~ 1304
COORDINATES (m): N 6808116 E 442685

DEPTH (m)	SAMPLE TYPE	SAMPLE No.	SYMBOL	DESCRIPTION OF MATERIALS	INSTRUMENT DETAILS
0.0				TOPSOIL.	
0.15				- peat and organics.	
				SILT and SAND, some gravel, medium dense, brown.	
1.50					
				GRAVEL, fine to coarse, sandy silty matrix, occasional cobbles and boulders, dense, angular to subangular, grey, moist (TILL-LIKE).	
		1			
3.00					
				End of Hole at 3.00 m.	

Su - kPa: 20 60 100 140 180
VANE PEAK ◆ FIELD ■ LAB
REMOLD ◇ □
▲ UC/2 △ P.PEN/2
★ % FINES
W_P% W% W_L%
× – – – – o – – – – ×
20 40 60 80

KLOHN CRIPPEN

PROJECT NO.: M09234A02
PROJECT: Wolverine FD and EA
LOCATION: Wolverine Lake
LOGGED BY: MSR **CHECKED BY:**
SHEET 1 **OF** 1 **HOLE NO.:** TP05-73

KC_TEST_PIT-SI TESTPITS TP05-51 TO 106.GPJ KC_DATA.GDT 2/3/06

TEST PIT LOG

STARTED: 7/20/2005 **FINISHED:** 7/20/2005

EXCAVATOR TYPE: 420D Cat Backhoe

GROUND ELEV. (m): ~1298

COORDINATES (m): N 6808142 E 442641

DEPTH (m)	SAMPLE TYPE	SAMPLE No.	SYMBOL	DESCRIPTION OF MATERIALS	INSTRUMENT DETAILS
0.15				TOPSOIL. - organics.	
		1		SILT-SAND-GRAVEL, low to medium plastic silt, fine to coarse sand and gravel, clayey, occasional cobbles and boulders, dense, subrounded to subangular, green to grey, moist (TILL-LIKE).	
				- Encountered a 2.0 m size boulder at 2.0 m depth.	
3.00				End of Hole at 3.00 m.	

Su - kPa: 20 60 100 140 180

VANE PEAK ◆ FIELD ■ LAB
REMOLD ◇ □
▲ UC/2
△ P.PEN/2

★ % FINES

W_P% W% W_L%

× – – – – o – – – – ×

20 40 60 80

KLOHN CRIPPEN

PROJECT NO.: M09234A02

PROJECT: Wolverine FD and EA

LOCATION: Wolverine Lake

LOGGED BY: MSR **CHECKED BY:**

SHEET 1 **OF** 1 **HOLE NO.:** TP05-74

KC_TEST_PIT-SI TESTPITS TP05-51 TO 105.GPJ KC_DATA.GDT 2/3/06

TEST PIT LOG

STARTED: 7/20/2005 **FINISHED:** 7/20/2005

EXCAVATOR TYPE: 420D Cat Backhoe

GROUND ELEV. (m): ~ 1293

COORDINATES (m): N 6808160 E 442564

DEPTH (m)	SAMPLE TYPE	SAMPLE No.	SYMBOL	DESCRIPTION OF MATERIALS	INSTRUMENT DETAILS
0.0				TOPSOIL. - peat and organics.	
0.25				SILT-SAND-GRAVEL, medium plastic silt, fine to coarse sand and gravel, clayey, occasional cobbles, dense, subrounded to subangular, green to grey (TILL-LIKE).	
0.5				- Between 0.25 m and 1.0 m depth, approximately 20% gravel.	
1.0					
1.5		1		- Between 1.0 m and 3.5 m depth, approximately 5% gravel.	
2.0					
2.5					
3.0					
3.5				3.50	
				End of Hole at 3.50 m.	
4.0					
4.5					
5.0					

Su - kPa

20 60 100 140 180

VANE PEAK ◆ FIELD ■ LAB ▲ UC/2

REMOLD ◇ □ △ P.PEN/2

★ % FINES

W_P% W% W_L%

× ---- ○ ---- ×

20 40 60 80

KLOHN CRIPPEN

PROJECT NO.: M09234A02

PROJECT: Wolverine FD and EA

LOCATION: Wolverine Lake

LOGGED BY: MSR **CHECKED BY:**

SHEET 1 **OF** 1 **HOLE NO.:** TP05-75

KC_TEST_PIT-SI TESTPITS TP05-51 TO 106.GPJ KC_DATA.GDT 2/3/06

TEST PIT LOG

STARTED: 7/20/2005 **FINISHED:** 7/20/2005

EXCAVATOR TYPE: 420D Cat Backhoe

GROUND ELEV. (m): ~1289

COORDINATES (m): N 6808036 E 442624

DEPTH (m)	SAMPLE TYPE	SAMPLE No.	SYMBOL	DESCRIPTION OF MATERIALS	INSTRUMENT DETAILS
				TOPSOIL. - peat and organics.	
0.20					
				CLAY, silty, sandy, wet.	
0.50					
0.5				SILT-SAND-GRAVEL, medium plastic silt, fine to coarse sand and gravel, clayey, occasional cobbles, dense, subrounded to subangular, green to grey (TILL-LIKE).	
1.0					
1.5		1			
2.0					
2.5					
3.0					
3.00				End of Hole at 3.00 m.	
3.5					
4.0					
4.5					
5.0					

Su - kPa

20 60 100 140 180

VANE PEAK ◆ FIELD ■ LAB
REMOLD ◇ □

▲ UC/2
△ P.PEN/2

★ % FINES

W_P% W% W_L%

× — — — o — — — ×

20 40 60 80

KLOHN CRIPPEN

PROJECT NO.: M09234A02

PROJECT: Wolverine FD and EA

LOCATION: Wolverine Lake

LOGGED BY: MSR **CHECKED BY:**

SHEET 1 **OF** 1 **HOLE NO.:** TP05-76

KC_TEST_PIT-SI TESTPITS TP05-51 TO 106.GPJ KC_DATA.GDT 2/3/06

TEST PIT LOG

STARTED: 7/20/2005 **FINISHED:** 7/20/2005

EXCAVATOR TYPE: 420D Cat Backhoe

GROUND ELEV. (m): ~ 1294

COORDINATES (m): N 6808090 E 442529

DEPTH (m)	SAMPLE TYPE	SAMPLE No.	SYMBOL	DESCRIPTION OF MATERIALS
0.00				TOPSOIL.
0.15				- organics.
				SILT-SAND-GRAVEL, medium plastic silt, fine to coarse sand and gravel, clayey, occasional cobbles, dense, subrounded to subangular, green to grey (TILL-LIKE).
1.5		1		
2.80				
				End of Hole at 3.00 m.
5.0				

INSTRUMENT DETAILS

Su - kPa

20 60 100 140 180

VANE PEAK ◆ FIELD ■ LAB
REMOLD ◇ □
▲ UC/2
△ P.PEN/2

★ % FINES

W_P% W% W_L%

× ——— ○ ——— ×

20 40 60 80

KLOHN CRIPPEN

PROJECT NO.: M09234A02

PROJECT: Wolverine FD and EA

LOCATION: Wolverine Lake

LOGGED BY: MSR **CHECKED BY:**

SHEET 1 **OF** 1 **HOLE NO.:** TP05-77

KC_TEST_PIT-SI TESTPITS TP05-51 TO 106.GPJ KC_DATA.GDT 2/3/06

TEST PIT LOG

STARTED: 7/21/2005 **FINISHED:** 7/21/2005
EXCAVATOR TYPE: 420D Cat Backhoe
GROUND ELEV. (m): ~1300
COORDINATES (m): N 6808156 E 442453

DEPTH (m)	SAMPLE TYPE	SAMPLE No.	SYMBOL	DESCRIPTION OF MATERIALS	INSTRUMENT DETAILS
0.0				TOPSOIL. - organics.	
0.20				GRAVEL, fine to medium, sandy, silty, trace clay, occasional cobbles, angular to subangular, brown to grey.	
1.80		1		GRAVEL POCKET, coarse, subrounded, small water seep.	
2.00				GRAVEL, fine to coarse, sandy silty matrix, trace clay, occasional cobbles, dense, subrounded to subangular, green, moist (TILL-LIKE).	
2.50				End of Hole at 3.50 m.	
5.0					

Su - kPa
20 60 100 140 180
VANE PEAK ◆ FIELD ■ LAB ▲ UC/2
REMOLD ◇ □ △ P.PEN/2
★ % FINES
W_P% W% W_L%
× ——— ○ ——— ×
20 40 60 80

KLOHN CRIPPEN

PROJECT NO.: M09234A02
PROJECT: Wolverine FD and EA
LOCATION: Wolverine Lake
LOGGED BY: MSR **CHECKED BY:**
SHEET 1 **OF** 1 **HOLE NO.:** TP05-78

KC_TEST_PIT-SI TESTPITS TP05-51 TO 106.GPJ KC_DATA.GDT 2/3/06

TEST PIT LOG

STARTED: 7/21/2005 **FINISHED:** 7/21/2005

EXCAVATOR TYPE: 420D Cat Backhoe

GROUND ELEV. (m): ~ 1295

COORDINATES (m): N 6808007 E 442495

DEPTH (m)	SAMPLE TYPE	SAMPLE No.	SYMBOL	DESCRIPTION OF MATERIALS	INSTRUMENT DETAILS
0.0				TOPSOIL.	
0.15				- organics.	
				GRAVEL, fine to coarse, sandy silty matrix, trace clay, occasional cobbles and boulders up to 0.5 m size, dense, subrounded to subangular, green, moist (TILL-LIKE).	
1.5		1			
2.80					
				End of Hole at 2.80 m.	

Su - kPa: 20 60 100 140 180

VANE PEAK ◆ FIELD ■ LAB ▲ UC/2
REMOLD ◇ □ △ P.PEN/2

★ % FINES

W_P% W% W_L%

20 40 60 80

KLOHN CRIPPEN

PROJECT NO.: M09234A02

PROJECT: Wolverine FD and EA

LOCATION: Wolverine Lake

LOGGED BY: MSR **CHECKED BY:**

SHEET 1 **OF** 1 **HOLE NO.:** TP05-79

KC_TEST_PIT-SI TESTPITS TP05-51 TO 106.GPJ KC_DATA.GDT 2/3/06

TEST PIT LOG

STARTED: 7/21/2005 **FINISHED:** 7/21/2005

EXCAVATOR TYPE: 420D Cat Backhoe

GROUND ELEV. (m): ~ 1306

COORDINATES (m): N 6808097 E 442395

DEPTH (m)	SAMPLE TYPE	SAMPLE No.	SYMBOL	DESCRIPTION OF MATERIALS	INSTRUMENT DETAILS
0.0				TOPSOIL. - peat and organics.	
0.30					
0.35				VOLCANIC ASH, white.	
0.5				GRAVEL, fine to coarse, sandy silty matrix, trace clay, occasional cobbles and boulders up to 0.5 m size, dense, subrounded to subangular, green, moist (TILL-LIKE).	
1.0					
1.5		1			
2.0					
2.5					
3.0					
3.00				End of Hole at 3.00 m.	
3.5					
4.0					
4.5					
5.0					

Su - kPa: 20 60 100 140 180

VANE PEAK ◆ FIELD ■ LAB ▲ UC/2
REMOLD ◇ □ △ P.PEN/2

★ % FINES

W_P% × ---- W% ---- W_L% ×

20 40 60 80

KLOHN CRIPPEN

PROJECT NO.: M09234A02

PROJECT: Wolverine FD and EA

LOCATION: Wolverine Lake

LOGGED BY: MSR **CHECKED BY:**

SHEET 1 **OF** 1 **HOLE NO.:** TP05-80

KC_TEST_PIT-SI TESTPITS TP05-51 TO 106.GPJ KC_DATA.GDT 2/3/06

TEST PIT LOG

STARTED: 7/21/2005 **FINISHED:** 7/21/2005

EXCAVATOR TYPE: 420D Cat Backhoe

GROUND ELEV. (m): ~ 1305.5

COORDINATES (m): N 6808291 E 442343

DEPTH (m)	SAMPLE TYPE	SAMPLE No.	SYMBOL	DESCRIPTION OF MATERIALS	INSTRUMENT DETAILS
0.0				TOPSOIL. - peat and organics.	
0.20					
0.25				VOLCANIC ASH, white.	
0.5				GRAVEL, fine to coarse, sandy silty matrix, trace clay, low to medium plastic silt/clay, occasional cobbles, medium dense, subrounded to subangular, yellow to green, moist (TILL-LIKE).	
1.0				- Dense to very dense between 1.0 m and 3.5 m depth.	
1.5		1			
2.0					
2.5					
3.0					
3.5				3.50	
				End of Hole at 3.50 m.	
4.0					
4.5					
5.0					

Su - kPa

20 60 100 140 180

VANE PEAK ◆ FIELD ■ LAB
REMOLD ◇ □

▲ UC/2
△ P.PEN/2

★ % FINES

W_P% W% W_L%

× – – – ○ – – – ×

20 40 60 80

KLOHN CRIPPEN

PROJECT NO.: M09234A02

PROJECT: Wolverine FD and EA

LOCATION: Wolverine Lake

LOGGED BY: MSR **CHECKED BY:**

SHEET 1 **OF** 1 **HOLE NO.:** TP05-81

KC_TEST_PIT-SI TESTPITS TP05-51 TO 106.GPJ KC_DATA.GDT 2/3/06

TEST PIT LOG

STARTED: 7/21/2005 **FINISHED:** 7/21/2005

EXCAVATOR TYPE: 420D Cat Backhoe

GROUND ELEV. (m): ~ 1310

COORDINATES (m): N 6808291 E 442281

DEPTH (m)	SAMPLE TYPE	SAMPLE No.	SYMBOL	DESCRIPTION OF MATERIALS	INSTRUMENT DETAILS
				0.10 TOPSOIL. - organics. GRAVEL, silty, brown.	
0.5				0.60 COBBLE, some boulders, trace to some sand (approximately 10% coarse sand).	
1.0					
1.5					
2.0				2.00 GRAVEL, fine to coarse, sandy silty matrix, trace clay, low to medium plastic silt/clay, occasional cobbles and boulders up to 1 m size, very dense, subrounded to subangular, yellow to green, moist (TILL-LIKE).	
2.5					
3.0		1			
3.5				3.50 End of Hole at 3.50 m.	
4.0					
4.5					
5.0					

Su - kPa: 20 60 100 140 180

VANE PEAK ◆ FIELD ■ LAB ▲ UC/2
REMOLD ◇ □ △ P.PEN/2

★ % FINES

W_P% W% W_L%

20 40 60 80

KLOHN CRIPPEN

PROJECT NO.: M09234A02

PROJECT: Wolverine FD and EA

LOCATION: Wolverine Lake

LOGGED BY: MSR **CHECKED BY:**

SHEET 1 **OF** 1 **HOLE NO.:** TP05-82

KC_TEST_PIT-SI TESTPITS TP05-51 TO 106.GPJ KC_DATA.GDT 2/3/06

TEST PIT LOG

STARTED: 7/21/2005 **FINISHED:** 7/21/2005
EXCAVATOR TYPE: 420D Cat Backhoe
GROUND ELEV. (m): ~ 1317
COORDINATES (m): N 6808507 E 442212

DEPTH (m)	SAMPLE TYPE	SAMPLE No.	SYMBOL	DESCRIPTION OF MATERIALS	INSTRUMENT DETAILS
0				TOPSOIL. - peat and organics.	
0.25				GRAVEL and COBBLE, coarse gravel, some sand, brown.	
0.80				GRAVEL and BOULDERS, fine to coarse, sandy, some silt, occasional cobbles, very dense, subrounded to angular gravel, boulders between 0.6 m and 1.0 m size, greenish grey, wet (TILL-LIKE).	
2.5		1			
2.90				End of Hole at 2.90 m.	

Su - kPa: 20 60 100 140 180
VANE PEAK ◆ FIELD ■ LAB
REMOLD ◇ □
▲ UC/2
△ P.PEN/2
★ % FINES
W_P% W% W_L%
× – – – – ○ – – – – ×
20 40 60 80

KLOHN CRIPPEN

PROJECT NO.: M09234A02
PROJECT: Wolverine FD and EA
LOCATION: Wolverine Lake
LOGGED BY: MSR **CHECKED BY:**
SHEET 1 **OF** 1 **HOLE NO.:** TP05-83

KC_TEST_PIT-SI TESTPITS TP05-51 TO 106.GPJ KC_DATA.GDT 2/3/06

TEST PIT LOG

STARTED: 7/21/2005 **FINISHED:** 7/21/2005
EXCAVATOR TYPE: 420D Cat Backhoe
GROUND ELEV. (m): ~ 1320
COORDINATES (m): N 6807979 E 442656

DEPTH (m)	SAMPLE TYPE	SAMPLE No.	SYMBOL	DESCRIPTION OF MATERIALS	INSTRUMENT DETAILS
				0.10 TOPSOIL. - organics. SAND and GRAVEL, silty.	
				0.30 GRAVEL, fine to coarse, silty/clayey and sandy, medium plastic silt/clay, dense, flat, subrounded to angular, yellow to grey, wet (TILL-LIKE). - Water encountered at 2.70 m depth.	
1.5		1			
				2.80 End of Hole at 2.80 m.	

Su - kPa
20 60 100 140 180
VANE PEAK ◆ FIELD ■ LAB
REMOLD ◇ □
▲ UC/2
△ P.PEN/2
★ % FINES
W_P% W% W_L%
20 40 60 80

KLOHN CRIPPEN

PROJECT NO.: M09234A02
PROJECT: Wolverine FD and EA
LOCATION: Wolverine Lake
LOGGED BY: MSR **CHECKED BY:**
SHEET 1 **OF** 1 **HOLE NO.:** TP05-84

KC_TEST_PIT-SI TESTPITS TP05-51 TO 106.GPJ KC_DATA.GDT 2/3/06

TEST PIT LOG

STARTED: 7/21/2005 **FINISHED:** 7/21/2005
EXCAVATOR TYPE: 420D Cat Backhoe
GROUND ELEV. (m): ~ 1288
COORDINATES (m): N 6807966 E 442629

DEPTH (m)	SAMPLE TYPE	SAMPLE No.	SYMBOL	DESCRIPTION OF MATERIALS	INSTRUMENT DETAILS
0.0				TOPSOIL. - peat and organics.	
0.20					
				COBBLE and BOULDER.	
1.00					
		1		SILT/CLAY, medium plastic, sandy and gravelly, fine to coarse sand and gravel, stiff, green to black.	
2.30					
				End of Hole at 2.30 m.	

Su - kPa: 20 60 100 140 180
VANE PEAK ◆ FIELD ■ LAB ▲ UC/2
REMOLD ◇ □ △ P.PEN/2
★ % FINES
W_P% W% W_L%
× ——— o ——— ×
20 40 60 80

KLOHN CRIPPEN

PROJECT NO.: M09234A02
PROJECT: Wolverine FD and EA
LOCATION: Wolverine Lake
LOGGED BY: MSR **CHECKED BY:**
SHEET 1 **OF** 1 **HOLE NO.:** TP05-85

KC_TEST_PIT-SI TESTPITS TP05-51 TO 106.GPJ KC_DATA.GDT 2/3/06

TEST PIT LOG

STARTED: 7/21/2005 **FINISHED:** 7/21/2005
EXCAVATOR TYPE: 420D Cat Backhoe
GROUND ELEV. (m): ~ 1289
COORDINATES (m): N 6807952 E 442602

DEPTH (m)	SAMPLE TYPE	SAMPLE No.	SYMBOL	DESCRIPTION OF MATERIALS	INSTRUMENT DETAILS
0.0				TOPSOIL. - organics.	
0.25				GRAVEL, fine to coarse, silty/clayey and sandy, medium plastic silt/clay, occasional cobbles and boulders up to 0.4 m size, dense, flat, subrounded to subangular, yellow to grey, moist to wet (TILL-LIKE).	
1.5		1			
2.90				End of Hole at 2.90 m.	

Su - kPa
20 60 100 140 180
VANE PEAK ◆ FIELD ■ LAB ▲ UC/2
REMOLD ◇ □ △ P.PEN/2
★ % FINES
W_P% W% W_L%
20 40 60 80

KLOHN CRIPPEN

PROJECT NO.: M09234A02
PROJECT: Wolverine FD and EA
LOCATION: Wolverine Lake
LOGGED BY: MSR **CHECKED BY:**
SHEET 1 **OF** 1 **HOLE NO.:** TP05-86

KC_TEST_PIT-SI TESTPITS TP05-51 TO 106.GPJ KC_DATA.GDT 2/3/06

TEST PIT LOG

STARTED: 7/21/2005 **FINISHED:** 7/21/2005
EXCAVATOR TYPE: 420D Cat Backhoe
GROUND ELEV. (m): ~ 1357.5
COORDINATES (m): N 6809620 E 441475

DEPTH (m)	SAMPLE TYPE	SAMPLE No.	SYMBOL	DESCRIPTION OF MATERIALS	INSTRUMENT DETAILS
0.0				TOPSOIL. - peat and organics.	
0.30					
0.5				SAND and SILT, fine to coarse sand, low to medium plastic silt, gravelly, trace to some clay, occasional cobbles, dense, yellow to green, moist to wet (TILL-LIKE). - Ground was frozen to 1.0 m depth.	
1.0		1			
1.5					
1.70					
				End of Hole at 1.70 m.	
2.0					
2.5					
3.0					
3.5					
4.0					
4.5					
5.0					

Su - kPa
20 60 100 140 180
VANE PEAK ◆ FIELD ■ LAB ▲ UC/2
REMOLD ◇ □ △ P.PEN/2
★ % FINES
W_P% W% W_L%
× – – – – o – – – – ×
20 40 60 80

KLOHN CRIPPEN

PROJECT NO.: M09234A02
PROJECT: Wolverine FD and EA
LOCATION: Wolverine Lake
LOGGED BY: MSR **CHECKED BY:**
SHEET 1 **OF** 1 **HOLE NO.:** TP05-91

KC_TEST_PIT-SI TESTPITS TP05-51 TO 106.GPJ KC_DATA.GDT 2/3/06

TEST PIT LOG

STARTED: 7/30/2005 **FINISHED:** 7/30/2005

EXCAVATOR TYPE: Manual

GROUND ELEV. (m):

COORDINATES (m):

DEPTH (m)	SAMPLE TYPE	SAMPLE No.	SYMBOL	DESCRIPTION OF MATERIALS	INSTRUMENT DETAILS
				0.01 TOPSOIL. - organics. SAND, medium, some cream coloured patches of ash (20%), trace silt, grey. 0.37	
0.5				0.40 TOPSOIL. - organics. GRAVEL and COBBLE, fine to coarse gravel, some sand and silt, trace clay, occasional boulders, angular to subrounded, grey to brown, moist (TILL-LIKE). 0.90	
1.0				End of Hole at 0.90 m.	
1.5					
2.0					
2.5					
3.0					
3.5					
4.0					
4.5					
5.0					

Su - kPa

20 60 100 140 180

VANE PEAK ◆ FIELD ■ LAB

REMOLD ◇ □

▲ UC/2

△ P.PEN/2

★ % FINES

W_P% W% W_L%

× – – – ○ – – – ×

20 40 60 80

KLOHN CRIPPEN

PROJECT NO.: M09234A02

PROJECT: Wolverine FD and EA

LOCATION: Wolverine Lake

LOGGED BY: EA/RB **CHECKED BY:**

SHEET 1 **OF** 1 **HOLE NO.:** TP05-92

KC_TEST_PIT-SI TESTPITS TP05-51 TO 106.GPJ KC_DATA.GDT 2/3/06

TEST PIT LOG

STARTED: 5/15/2005 **FINISHED:** 5/15/2005
EXCAVATOR TYPE: 420D Cat Backhoe
GROUND ELEV. (m): ~ 1337.5
COORDINATES (m): N 6809089 E 441893

DEPTH (m)	SAMPLE TYPE	SAMPLE No.	SYMBOL	DESCRIPTION OF MATERIALS	INSTRUMENT DETAILS
0.0				TOPSOIL. - peat and organics.	
0.20				SILT/CLAY, medium plastic, some sand, grey to brown, moist.	
0.5		1			
0.80				SAND and SILT, fine to coarse sand, low to medium plastic silt, some fine to coarse gravel, some clay, yellow, moist.	
1.0					
1.5		2			
2.0					
2.20				End of Hole at 2.20 m.	
2.5					
3.0					
3.5					
4.0					
4.5					
5.0					

Su - kPa
20 60 100 140 180
VANE PEAK ◆ FIELD ■ LAB ▲ UC/2
REMOLD ◇ □ △ P.PEN/2
★ % FINES
W_P% W% W_L%
× ---- ○ ---- ×
20 40 60 80

KLOHN CRIPPEN

PROJECT NO.: M09234A02
PROJECT: Wolverine FD and EA
LOCATION: Wolverine Lake
LOGGED BY: MSR **CHECKED BY:**
SHEET 1 **OF** 1 **HOLE NO.:** TP05-93

KC_TEST_PIT-SI TESTPITS TP05-51 TO 106.GPJ KC_DATA.GDT 2/3/06

TEST PIT LOG

STARTED: 5/14/2005 **FINISHED:** 5/14/2005

EXCAVATOR TYPE: 420D Cat Backhoe

GROUND ELEV. (m): ~ 1320

COORDINATES (m): N 6808558 E 442134

DESCRIPTION OF MATERIALS

DEPTH (m)	SAMPLE TYPE	SAMPLE No.	SYMBOL	DESCRIPTION OF MATERIALS	INSTRUMENT DETAILS
0.0				0.10 TOPSOIL. - peat and organics.	
				GRAVEL, fine to coarse, sandy silty matrix, trace clay, occasional cobbles and boulders up to 0.6 m size, dense, subrounded to subangular, green, moist (TILL-LIKE).	
2.5		1			
				2.80	
				End of Hole at 2.80 m.	

Su - kPa: 20 60 100 140 180

VANE PEAK ◆ FIELD ■ LAB
REMOLD ◇ □
▲ UC/2
△ P.PEN/2

★ % FINES

W_P% W% W_L%

× – – – – o – – – – ×

20 40 60 80

o

KLOHN CRIPPEN

PROJECT NO.: M09234A02

PROJECT: Wolverine FD and EA

LOCATION: Wolverine Lake

LOGGED BY: MSR **CHECKED BY:**

SHEET 1 **OF** 1 **HOLE NO.:** TP05-94

KC_TEST_PIT-SI TESTPITS TP05-51 TO 106.GPJ KC_DATA.GDT 2/3/06

TEST PIT LOG

STARTED: 5/14/2005 **FINISHED:** 5/14/2005
EXCAVATOR TYPE: 420D Cat Backhoe
GROUND ELEV. (m): ~ 1311
COORDINATES (m): N 6808446 E 442158

DEPTH (m)	SAMPLE TYPE	SAMPLE No.	SYMBOL	DESCRIPTION OF MATERIALS	INSTRUMENT DETAILS
				TOPSOIL. - peat and organics.	
0.20					
				VOLCANIC ASH, white.	
0.30					
0.5				GRAVEL, fine to coarse, sandy silty matrix, low plastic, trace clay, occasional cobbles, dense, subrounded to subangular, green, moist (TILL-LIKE).	
1.0					
1.5					
2.0					
		1			
2.5					
3.0					
3.00				End of Hole at 3.00 m.	
3.5					
4.0					
4.5					
5.0					

Su - kPa: 20 60 100 140 180
VANE PEAK ◆ FIELD ■ LAB ▲ UC/2
REMOLD ◇ □ △ P.PEN/2
★ % FINES
W_P% W% W_L%
× – – – o – – – ×
20 40 60 80

o

KLOHN CRIPPEN

PROJECT NO.: M09234A02
PROJECT: Wolverine FD and EA
LOCATION: Wolverine Lake
LOGGED BY: MSR **CHECKED BY:**
SHEET 1 **OF** 1 **HOLE NO.:** TP05-95

KC_TEST_PIT-SI TESTPITS TP05-51 TO 106.GPJ KC_DATA.GDT 2/3/06

TEST PIT LOG

STARTED: 7/30/2005 **FINISHED:** 7/30/2005

EXCAVATOR TYPE: Manual

GROUND ELEV. (m):

COORDINATES (m):

DEPTH (m)	SAMPLE TYPE	SAMPLE No.	SYMBOL	DESCRIPTION OF MATERIALS	INSTRUMENT DETAILS
				TOPSOIL.	
				0.15 - organics.	
0.5				GRAVEL and COBBLE, fine to coarse, sandy silty matrix, low plasticity, trace clay, angular to subrounded gravel, light brown, moist (TILL-LIKE).	
				0.80	
1.0				End of Hole at 0.80 m.	
1.5					
2.0					
2.5					
3.0					
3.5					
4.0					
4.5					
5.0					

Su - kPa

20 60 100 140 180

VANE PEAK ◆ FIELD ■ LAB ▲ UC/2

REMOLD ◇ □ △ P.PEN/2

★ % FINES

W_P% W% W_L%

× – – – – ○ – – – – ×

20 40 60 80

KLOHN CRIPPEN

PROJECT NO.: M09234A02

PROJECT: Wolverine FD and EA

LOCATION: Wolverine Lake

LOGGED BY: EA/RB **CHECKED BY:**

SHEET 1 **OF** 1 **HOLE NO.:** TP05-96

KC_TEST_PIT-SI TESTPITS TP05-51 TO 106.GPJ KC_DATA.GDT 2/3/06

TEST PIT LOG

STARTED: 5/13/2005 **FINISHED:** 5/13/2005
EXCAVATOR TYPE: 420D Cat Backhoe
GROUND ELEV. (m): ~ 1312.5
COORDINATES (m): N 6807978 E 442847

DEPTH (m)	SAMPLE TYPE	SAMPLE No.	SYMBOL	DESCRIPTION OF MATERIALS	INSTRUMENT DETAILS
				0.10 TOPSOIL. - organics.	
				GRAVEL, fine to coarse, sandy silty matrix, low plasticity, trace clay, occasional cobbles and boulders, angular to subrounded, light greenish grey, dry to moist (TILL-LIKE).	
0.5					
1.0					
1.5		1			
2.0					
2.5					
3.0				3.00	
				End of Hole at 3.00 m.	
3.5					
4.0					
4.5					
5.0					

Su - kPa
20 60 100 140 180
VANE PEAK ◆ FIELD ■ LAB ▲ UC/2
REMOLD ◇ □ △ P.PEN/2
★ % FINES
W_P% W% W_L%
× – – – – o – – – – ×
20 40 60 80

o

KLOHN CRIPPEN

PROJECT NO.: M09234A02
PROJECT: Wolverine FD and EA
LOCATION: Wolverine Lake
LOGGED BY: MSR **CHECKED BY:**
SHEET 1 **OF** 1 **HOLE NO.:** TP05-97

KC_TEST_PIT-SI TEST PITS TP05-51 TO 106.GPJ KC_DATA.GDT 2/3/06

Monitoring Wells

KLOHN CRIPPEN

GEOLOGIC LOG OF DRILL HOLE NO.: MW05-6A

CLIENT: Yukon Zinc Corporation	PROJECT NO.: M09234A02
PROJECT: Wolverine Feasibility Design and Environmental Assessment	DATE HOLE STARTED: 7/25/2005 FINISHED: 7/29/2005
LOCATION:	DATUM: NAD27
DIRECTION AZIMUTH: DIP (from horiz): -90	TOP OF PIPE ELEVATION: m
CO-ORDINATES: E 441657m N 6809312m	GROUND ELEVATION: 1348 m
MANUFACTURER'S DRILL DESIGNATION: BBS 25A	TOTAL DEPTH OF HOLE: 25.7 m
DRILLING CONTRACTOR: Advanced Drilling Ltd.	DRILLING METHOD SOIL: HW Casing ROCK: 100mm dia. Tricone
LOGGED BY: EA/RB	DRILLING FLUID: Water
CHECKED BY:	HOLE DIA.:

DEPTH (m)	SYMBOL	SAMPLE No.	LITHOLOGY	PIEZOMETER DETAILS	HYDRAULIC CONDUCTIVITY CM/SEC 10-6 10-4 10-2	DISCONTINUITY DATA — SEE BOTTOM OF FORM FOR CODES — Dip Angle 30 60	ROCK STRENGTH BASED ON POINT LOAD TEST (MPa) (a)=axial; (d)=diametrical	TEMPERATURE 0 6 12	FIELD/LAB DATA: SPT/LPT N ● CORE RECOVERY % 25 50 75	FIELD/LAB DATA: WATER CONTENT % ○ R.Q.D. % 5 10 15
1–19			Overburden							
20			20.1 / 1,327.9 Bedrock							
21–25										
25			25.7 / 1,322.3 End of Hole at: 25.7 m							
26–30										

DISCONTINUITY CODES: B: BEDDING D: DRILL BRK F: FAULT G: GNEISS'TY J: JOINT M: SCHIST'TY S: SHEAR T: TENSION CRK

CORE LOSS FRACTURED/BROKEN CORE DIP ANGLES MEASURED WITH RESPECT TO

KC_ROCK-SI@4 WOLVERINE TEST HOLES - NOV 17.GPJ ROCK-LOG.GDT 2/3/06

KLOHN CRIPPEN

GEOLOGIC LOG OF DRILL HOLE NO.: MW05-6B

CLIENT: Yukon Zinc Corporation	PROJECT NO.: M09234A02
PROJECT: Wolverine Feasibility Design and Environmental Assessment	DATE HOLE STARTED: 7/25/2005 FINISHED: 7/29/2005
LOCATION:	DATUM: NAD27
DIRECTION AZIMUTH: DIP (from horiz): -90	TOP OF PIPE ELEVATION: m
CO-ORDINATES: E 441657m N 6809312m	GROUND ELEVATION: 1348 m
MANUFACTURER'S DRILL DESIGNATION: BBS 25A	TOTAL DEPTH OF HOLE: 13.6 m
DRILLING CONTRACTOR: Advanced Drilling Ltd.	DRILLING METHOD SOIL: HW Casing ROCK: 100mm dia. Tricone
LOGGED BY: EA/RB	DRILLING FLUID: Water
CHECKED BY:	HOLE DIA.:

DEPTH (m)	SYMBOL	SAMPLE No.	LITHOLOGY	PIEZOMETER DETAILS	HYDRAULIC CONDUCTIVITY CM/SEC 10-6 10-4 10-2	DISCONTINUITY DATA SEE BOTTOM OF FORM FOR CODES Dip Angle 30 60	ROCK STRENGTH BASED ON POINT LOAD TEST (MPa) (a)=axial; (d)=diametrical	TEMPERATURE 0 6 12	FIELD/LAB DATA SPT/LPT N ● CORE RECOVERY % 25 50 75	FIELD/LAB DATA WATER CONTENT % ○ R.Q.D. % 5 10 15
1–13			Overburden							
13.6 / 1,334.4			End of Hole at: 13.6 m							

DISCONTINUITY CODES: B: BEDDING D: DRILL BRK F: FAULT G: GNEISS'TY J: JOINT M: SCHIST'TY S: SHEAR T: TENSION CRK

CORE LOSS FRACTURED/BROKEN CORE DIP ANGLES MEASURED WITH RESPECT TO

KC_ROCK-SI@4 WOLVERINE TEST HOLES - NOV 17.GPJ ROCK-LOG.GDT 2/3/06

KLOHN CRIPPEN

GEOLOGIC LOG OF DRILL HOLE NO.: MW05-7A

CLIENT: Yukon Zinc Corporation	PROJECT NO.: M09234A02
PROJECT: Wolverine Feasibility Design and Environmental Assessment	DATE HOLE STARTED: 7/30/2005 FINISHED: 8/1/2005
LOCATION:	DATUM: NAD27
DIRECTION AZIMUTH: DIP (from horiz): -90	TOP OF PIPE ELEVATION: m
CO-ORDINATES: E 442633m N 6807943m	GROUND ELEVATION: 1286 m
MANUFACTURER'S DRILL DESIGNATION: BBS 25A	TOTAL DEPTH OF HOLE: 30.2 m
DRILLING CONTRACTOR: Advanced Drilling Ltd.	DRILLING METHOD SOIL: HW Casing ROCK: 100mm dia. Tricone
LOGGED BY: EA/RB	DRILLING FLUID: Water
CHECKED BY:	HOLE DIA.:

DEPTH (m)	SYMBOL	SAMPLE No.	LITHOLOGY	PIEZOMETER DETAILS	HYDRAULIC CONDUCTIVITY CM/SEC 10-6 10-4 10-2	DISCONTINUITY DATA: SEE BOTTOM OF FORM FOR CODES; Dip Angle 30 60	ROCK STRENGTH BASED ON POINT LOAD TEST (MPa) (a)=axial; (d)=diametrical	TEMPERATURE 0 6 12	FIELD/LAB DATA: SPT/LPT N ● CORE RECOVERY % 25 50 75	FIELD/LAB DATA: WATER CONTENT % ○ R.Q.D. % 5 10 15
1–24			Overburden							
24.5 (1,261.5)			Bedrock							
25–30										

DISCONTINUITY CODES: B: BEDDING D: DRILL BRK F: FAULT G: GNEISS'TY J: JOINT M: SCHIST'TY S: SHEAR T: TENSION CRK

CORE LOSS FRACTURED/BROKEN CORE DIP ANGLES MEASURED WITH RESPECT TO

KC_ROCK-SI@4 WOLVERINE TEST HOLES - NOV 17.GPJ ROCK-LOG.GDT 2/3/06

KLOHN CRIPPEN

GEOLOGIC LOG OF DRILL HOLE NO.: MW05-7A

DEPTH (m)	SYMBOL	SAMPLE No.	LITHOLOGY	PIEZOMETER DETAILS	HYDRAULIC CONDUCTIVITY CM/SEC 10-6 10-4 10-2	DISCONTINUITY DATA: SEE BOTTOM OF FORM FOR CODES; Dip Angle 30 60	ROCK STRENGTH BASED ON POINT LOAD TEST (MPa) (a)=axial; (d)=diametrical	TEMPERATURE 0 6 12	FIELD/LAB DATA: SPT/LPT N ● CORE RECOVERY % 25 50 75	FIELD/LAB DATA: WATER CONTENT % ○ R.Q.D. % 5 10 15
			(continued from previous page)							
30			1285.8 End of Hole at: 30.2 m							
31										
32										
33										
34										
35										
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66										
67										
68										

DISCONTINUITY CODES: B: BEDDING D: DRILL BRK F: FAULT G: GNEISS'TY J: JOINT M: SCHIST'TY S: SHEAR T: TENSION CRK

CORE LOSS FRACTURED/BROKEN CORE DIP ANGLES MEASURED WITH RESPECT TO

KC_ROCK-SI@4 WOLVERINE TEST HOLES - NOV 17.GPJ ROCK-LOG.GDT 2/3/06

KLOHN CRIPPEN

GEOLOGIC LOG OF DRILL HOLE NO.: MW05-7B

CLIENT: Yukon Zinc Corporation	PROJECT NO.: M09234A02
PROJECT: Wolverine Feasibility Design and Environmental Assessment	DATE HOLE STARTED: 7/30/2005 FINISHED: 8/1/2005
LOCATION:	DATUM: NAD27
DIRECTION AZIMUTH: DIP (from horiz): -90	TOP OF PIPE ELEVATION: m
CO-ORDINATES: E 442633m N 6807943m	GROUND ELEVATION: 1286 m
MANUFACTURER'S DRILL DESIGNATION: BBS 25A	TOTAL DEPTH OF HOLE: 4.6 m
DRILLING CONTRACTOR: Advanced Drilling Ltd.	DRILLING METHOD SOIL: HW Casing ROCK: 100mm dia. Tricone
LOGGED BY: EA/RB	DRILLING FLUID: Water
CHECKED BY:	HOLE DIA.:

DEPTH (m)	SYMBOL	SAMPLE No.	LITHOLOGY	PIEZOMETER DETAILS	HYDRAULIC CONDUCTIVITY CM/SEC 10-6 10-4 10-2	DISCONTINUITY DATA SEE BOTTOM OF FORM FOR CODES Dip Angle 30 60	ROCK STRENGTH BASED ON POINT LOAD TEST (MPa) (a)=axial; (d)=diametrical	TEMPERATURE 0 6 12	FIELD/LAB DATA SPT/LPT N ● CORE RECOVERY % 25 50 75	FIELD/LAB DATA WATER CONTENT % ○ R.Q.D. % 5 10 15
1			Overburden							
2										
3										
4										
5			4.6 1,281.4 End of Hole at: 4.6 m							
6										
7										
8										
9										
10										
11										
12										
13										
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28										
29										
30										

DISCONTINUITY CODES: B: BEDDING D: DRILL BRK F: FAULT G: GNEISS'TY J: JOINT M: SCHIST'TY S: SHEAR T: TENSION CRK

CORE LOSS FRACTURED/BROKEN CORE DIP ANGLES MEASURED WITH RESPECT TO

5. POTENTIAL SEEPAGE EFFECTS ON GROUNDWATER

The tailings impoundment is designed to retain water and minimize seepage through the use of a geosynthetic liner beneath the facility and along the interior face of the dam. The design criteria for seepage from the impoundment is presented in Section 3 of the main text, and is based upon the potential leaching of cadmium and selenium into the receiving waters. A design criteria of <0.5 L/s was determined to be protective of the receiving waters.

5.1 Liner Defect Analysis – Design Basis

The tailings impoundment will be lined with a geosynthetic liner, and seepage will be influenced by the presence of liner defects and, potentially, very long-term degradation effects.

Klohn Crippen Berger Ltd. utilized an in-house program that assesses the leakage through liner defects, which considers the "inflow" constraint by the presence of the low permeability tailings. Figure I- **5-1** presents leakage values for tailings with a permeability of 10^{-7} m/s, assuming a conservative level of quality control in liner construction and placement. The figure indicates that, for impoundment tailings permeability of 10^{-7} m/s, and for a tailing impoundment head of 20 m, the leakage rate could be in the order of 20 L/year/hectare. For the Wolverine tailings impoundment of 16 hectares, leakage through the liner is expected to be extremely low and on the order of 0.00001 L/s, which is negligible.

The use of the liner ensures that the potential risk of effects to groundwater or surface water from seepage is very low to negligible. Nonetheless, a sensitivity analysis was carried out to determine the effects of liner degradation and/or the use of a soil liner or no liner at all, and the results are presented in the following section.

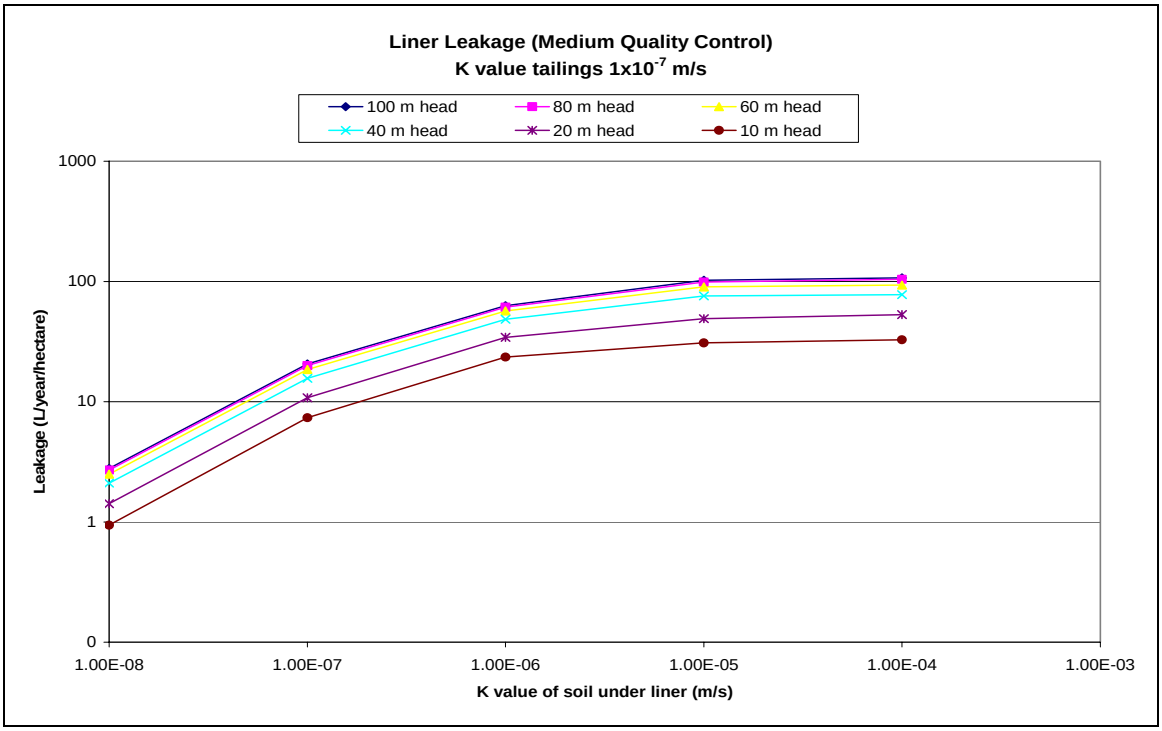


Figure I- 5-1 Linear Leakage (Medium Quality Control) K Value Tailings 1 x 10 $^{-7}$ m/s

5.2 Conventional Seepage Analysis – Sensitivity Analysis

The estimate of seepage from the impoundment was assessed using both conventional seepage analysis and liner defect analyses. With the use of a liner system, the conventional SEEP/W model does not apply, however the SEEP/W model is useful for assessing the sensitivity of the seepage to various lining alternatives.

Seepage analysis was carried out using the 2-D SEEP/W program on a representative upstream-downstream section along the thalweg of the impoundment area through the maximum transverse section of the dam, which is shown in plan in Drawing D-3002. The properties used for the analyses are summarized in Table I- 5-1.

Table I- 5-1 Summary of Engineering Properties

MATERIAL	HYDRAULIC CONDUCTIVITY k (m/s)
Overburden	3.0E-05
Bedrock	1.0E-07
General Dam Fill	5.0E-07
Glacial Till	1.0E-07
Tailings	7.0E-08
Liner	Varies

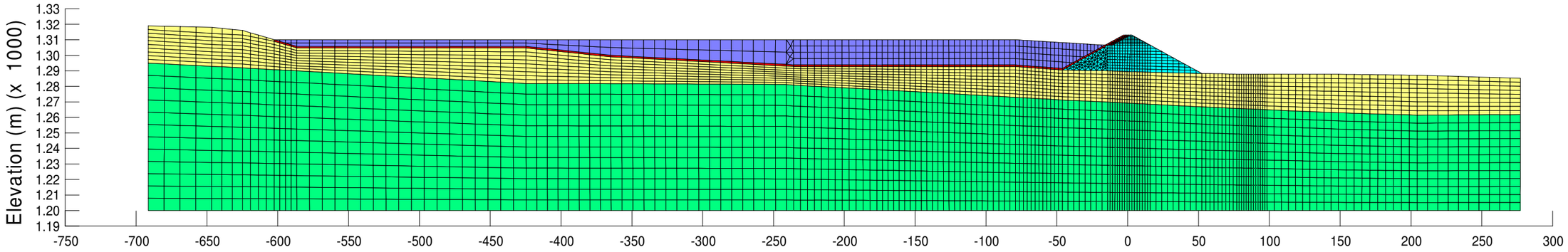
Figure I- 5-1 and Figure I- 5-2 show the SEEP/W finite element model mesh and setup, and model output. The seepage analysis was carried out for the initial dam design section, which included a central low permeability core zone. Sensitivity analysis was carried out for the following conditions, and the results are summarized in Table I- 5-2.

- "Degraded" geomembrane liner with an "equivalent" permeability of 10^{-10} m/s, which simulates a potential long-term condition in which portions of the geomembrane liner degrades;
- Soil liner, with a permeability of 10^{-8} m/s, which assumes the placement of a low permeability soil or clay enhanced soil liner over the impoundment basin; and
- No liner and a basin permeability of 10^{-6} m/s, which simulates the case of no liner and no special treatment of the impoundment foundation.

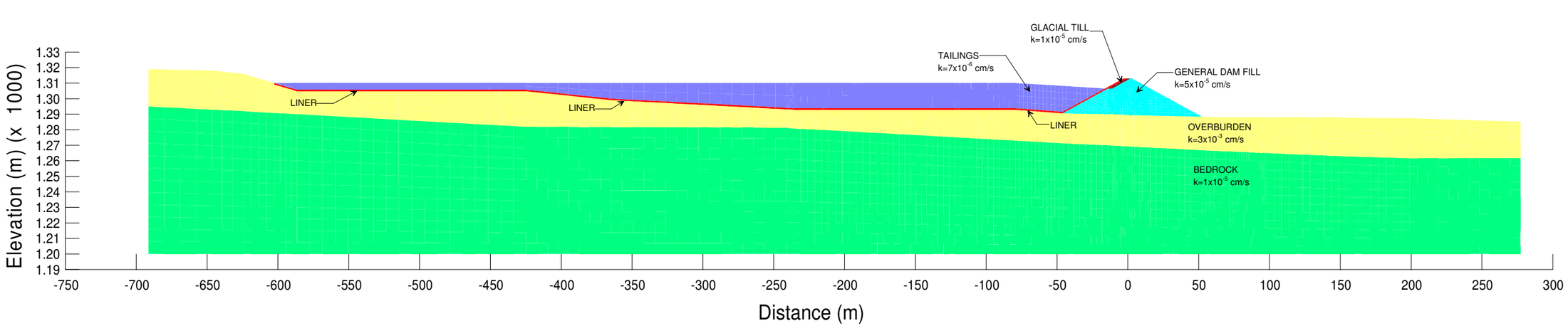
Table I- 5-2 Summary of Seep/W Seepage Sensitivity Analysis

ANALYSIS CONDITION	BASIN/LINER PERMEABILITY (m/s)	TOTAL SEEPAGE (L/sec)
A - "Degraded" geomembrane liner	10^{-10}	0.13
B - Compacted soil liner	10^{-8}	3.8
C - Unlined facility	10^{-6}	6.8

Note: Estimation of total seepage was based on an equivalent dam width of 250 m with constant maximum dam section. Liner was modelled as 1-m thick to minimize numerical modelling difficulty.



FEM MESH USED IN THE SEEPAGE ANALYSES



SEEPAGE MODEL WITH MATERIAL UNITS AND THEIR HYDRAULIC CONDUCTIVITIES

TO BE READ WITH KLOHN CRIPPEN BERGER REPORT DATED _____

AS A MUTUAL PROTECTION TO OUR CLIENT, THE PUBLIC AND OURSELVES, ALL REPORTS AND DRAWINGS ARE SUBMITTED FOR THE CONFIDENTIAL INFORMATION OF OUR CLIENT FOR A SPECIFIC PROJECT AND AUTHORIZATION FOR USE AND/OR PUBLICATION OF DATA, STATEMENTS, CONCLUSIONS OR ABSTRACTS FROM OR REGARDING OUR REPORT AND DRAWINGS IS RESERVED PENDING OUR WRITTEN APPROVAL.

CLIENT: Yukon Zinc CORPORATION

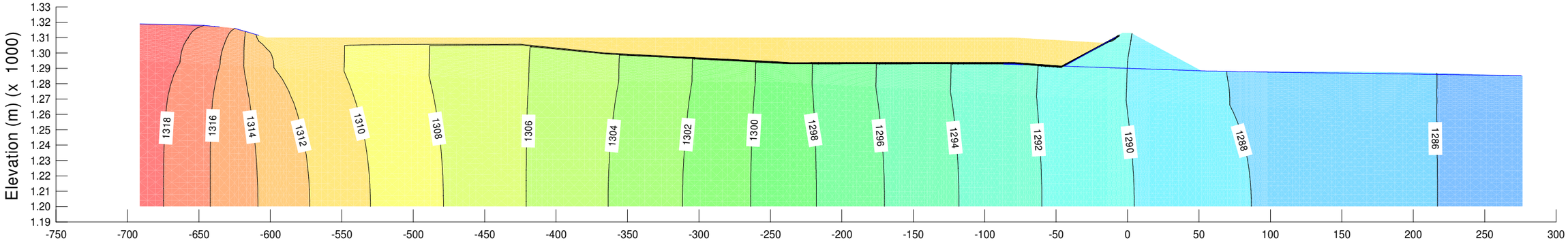
Klohn Crippen Berger

PROJECT: WOLVERINE - DETAILED DESIGN

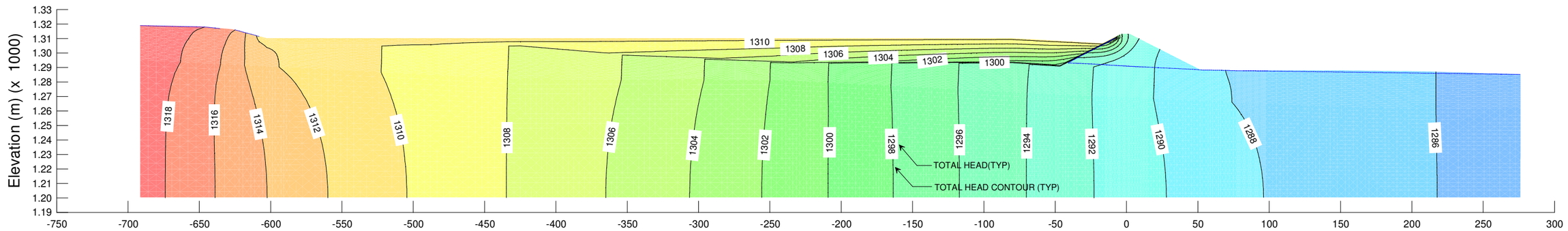
TITLE: FEM SEEPAGE MODEL
ULTIMATE DAM SECTION A

PROJECT NO. M09234A04

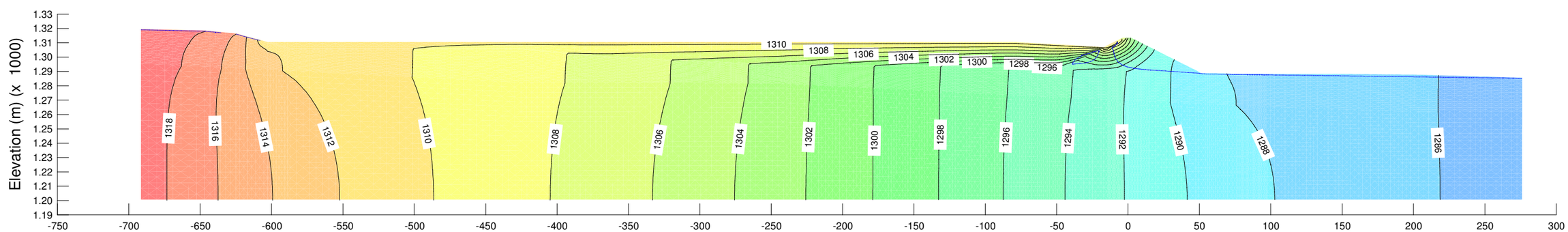
FIGURE NO. I-3.2



CASE A - HYDRAULIC CONDUCTIVITY OF LINER, k=1X10^{-8} cm/s



CASE B - HYDRAULIC CONDUCTIVITY OF LINER, k=1X10^{-6} cm/s



CASE C - HYDRAULIC CONDUCTIVITY OF LINER, k=1X10^{-4} cm/s

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CLIENT

Yukon Zinc CORPORATION

Klohn Crippen Berger

PROJECT

WOLVERINE - DETAILED DESIGN

TITLE

RESULTS OF SEEPAGE ANALYSES FOR ULTIMATE DAM SECTION A

PROJECT NO. M09234A04

FIGURE NO. I-3.3

5.3 Seepage Analysis Results

The seepage analyses indicate that the leakage rate out of the impoundment should be on the order of 0.00001 L/s, which is negligible. The sensitivity analysis also indicates that the worst-case condition, considering complete degradation of the liner would result in a seepage rate on the order of 6.8 L/s. Because liner degradation is often a result of UV effects, complete degradation of the Wolverine impoundment liner, which will be covered by tailings, is considered to be highly improbable. As such a more realistic "worst case" evaluation, considering only partial degradation, suggests that seepage under this condition would be less than 0.13 L/s.

There are also a number of mitigating factors, with respect to the potential for long-term degradation of the liner and are summarized as follows:

- Partial degradation of the liner would still result in acceptable seepage rates;
- Degradation of the liner, if it occurs, will be over a long period of time and would result in a very slow change in the groundwater geochemistry. The benefit of adsorption, which will occur, has not been considered in determining the allowable seepage criteria. Assuming a 10% adsorption factor would result in meeting water quality guidelines, even with complete degradation of the liner; and
- Geochemical processes that control dissolved metal concentrations in natural and tailings sediments have not been considered. Experience from other operations indicates that porewater metal concentrations in unoxidized tailings sediments are often very low, resulting from the gradual development of anoxic conditions in sediments and the tendency for metals to precipitate out of solution as metal sulphides.

6. STABILITY ANALYSIS RESULTS

As discussed in Section 7.2 of the main text, static and pseudo-static slope stability analyses were undertaken to determine the suitability of the design for the Starter Dam, Ultimate Dam, and Seepage Dam (Model geometries for these three dams, including the relevant slip planes, piezometric levels and material parameters are shown in Figures I-6.1, I-6.2, and I-6.3, respectively). The models were developed using Slope/W (Geoslope 2004) software in accordance with the material parameters outlined in Section 7.1 of the main text.

Several upstream and downstream slip surfaces were investigated, with attention paid to those that affected the stability of the dam crest. Modeling results are presented in Table I-6.1 below.

Table I - 6.1 Summary of Safety Factors for Tailings Dam and Seepage Dam

a)

FAILURE SURFACE	STARTER DAM[2] -FACTORS OF SAFETY	
	STATIC	PSEUDO-STATIC[1]
D1	1.6	1.3
D2	1.6	1.3
D3	1.6	1.3
U1	2.2	1.9

b)

FAILURE SURFACE	ULTIMATE DAM[2] -FACTORS OF SAFETY	
	STATIC	PSEUDO-STATIC[1]
D1	1.6	1.3
D2	1.6	1.2
D3	1.5	1.2
D4	1.6	1.2

c)

FAILURE SURFACE	SEEPAGE DAM -FACTORS OF SAFETY	
	STATIC	PSEUDO-STATIC[1]
D1	1.5	1.2
U1	2.5	1.7

[1]Pseudo-static analysis used a seismic coefficient = 0.125 g.

[2] Starter Dam elevation analyses was 1306.5 m and Ultimate Dam elevation analysed was 1313.5 m

SUMMARY OF MATERIAL PROPERTIES

MATERIAL	UNIT WEIGHT, γ_{bulk} (kN/m^3)	EFFECTIVE SHEAR STRENGTH		PIEZOMETRIC LINE
		FRICTION, ϕ' (deg)	COHESION, C' (kpa)	
EARTHFILL	21.8	36	0	1
OVERBURDEN	21.8	34	0	1

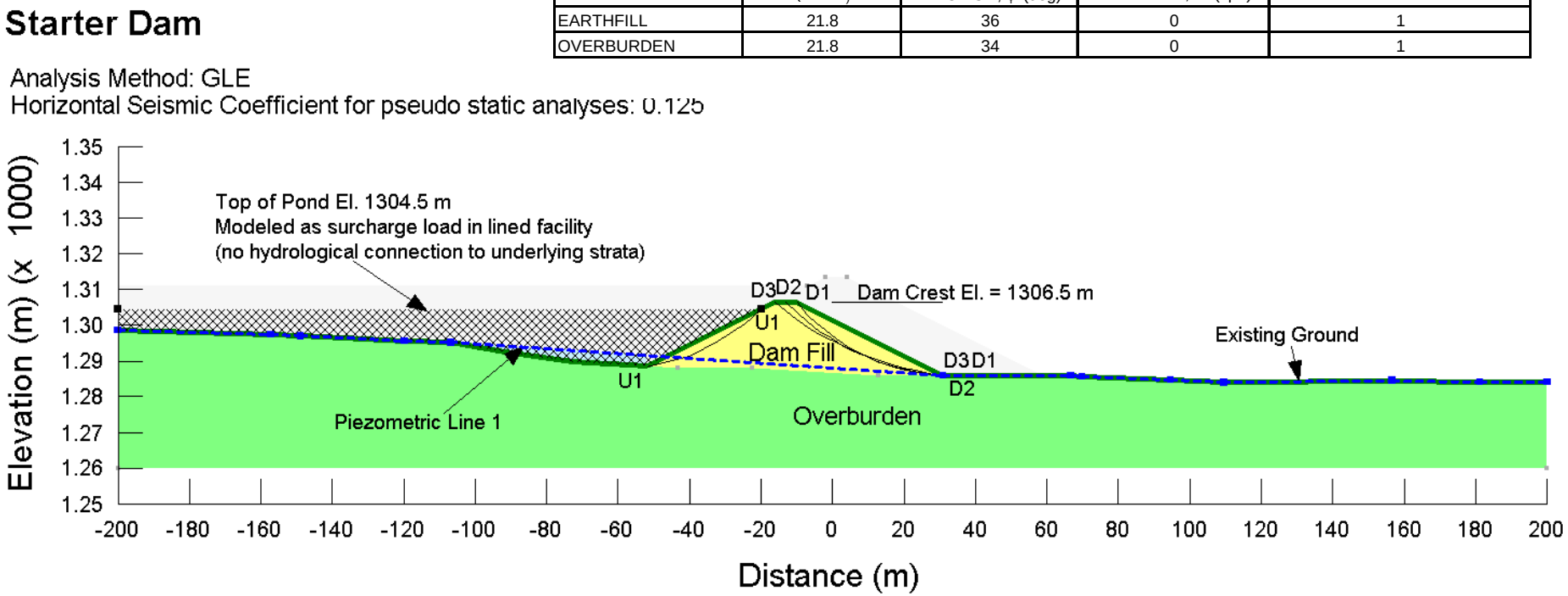

Figure I - 6.1 Starter Dam Stability Section

SUMMARY OF MATERIAL PROPERTIES

MATERIAL	UNIT WEIGHT, γ_{bulk} (kN/m^3)	EFFECTIVE SHEAR STRENGTH		PIEZOMETRIC LINE
		FRICTION, ϕ' (deg)	COHESION, C' (kpa)	
EARTHFILL	21.8	36	0	2
OVERBURDEN	21.8	34	0	2
TAILINGS	23.2	25	0	1

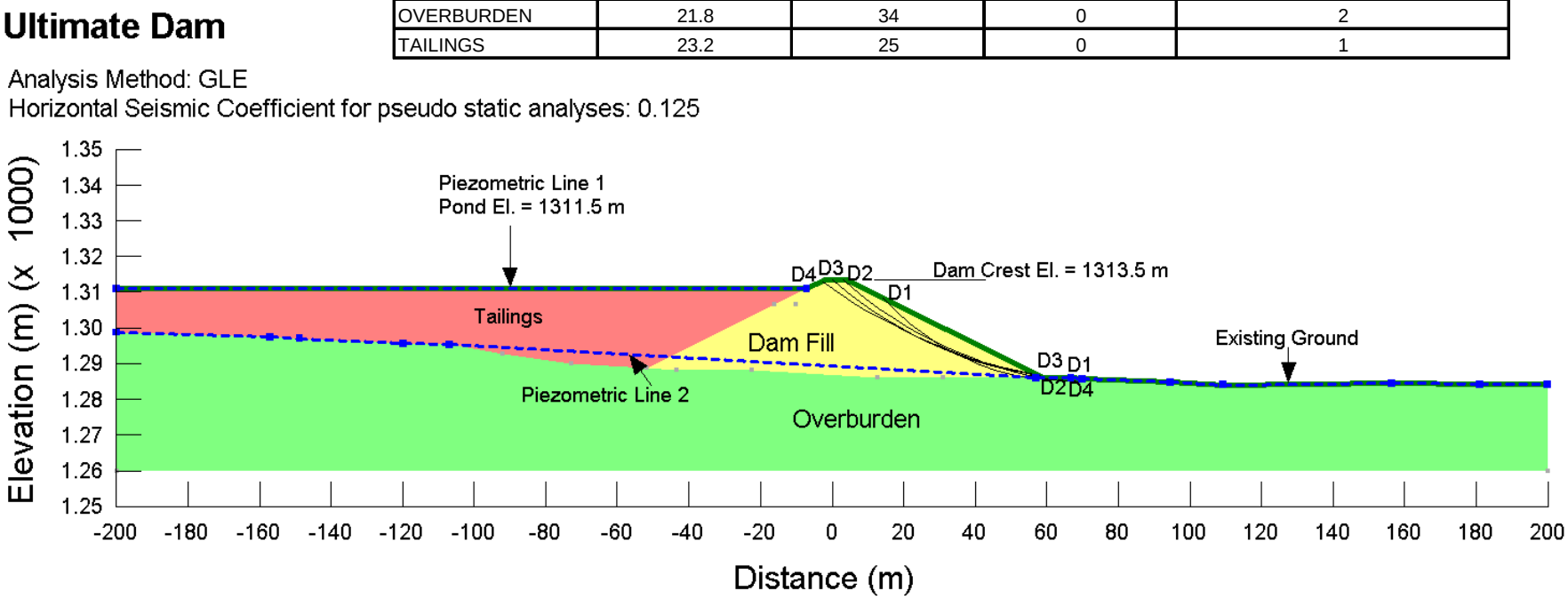

Figure I - 6.2 Ultimate Dam Stability Section

SUMMARY OF MATERIAL PROPERTIES

MATERIAL	UNIT WEIGHT, γ_{bulk} (kN/m^3)	EFFECTIVE SHEAR STRENGTH		PIEZOMETRIC LINE
		FRICTION, ϕ' (deg)	COHENSION, C' (kpa)	
DAM FILL	21.8	36	0	1
OVERBURDEN	21.8	34	0	1

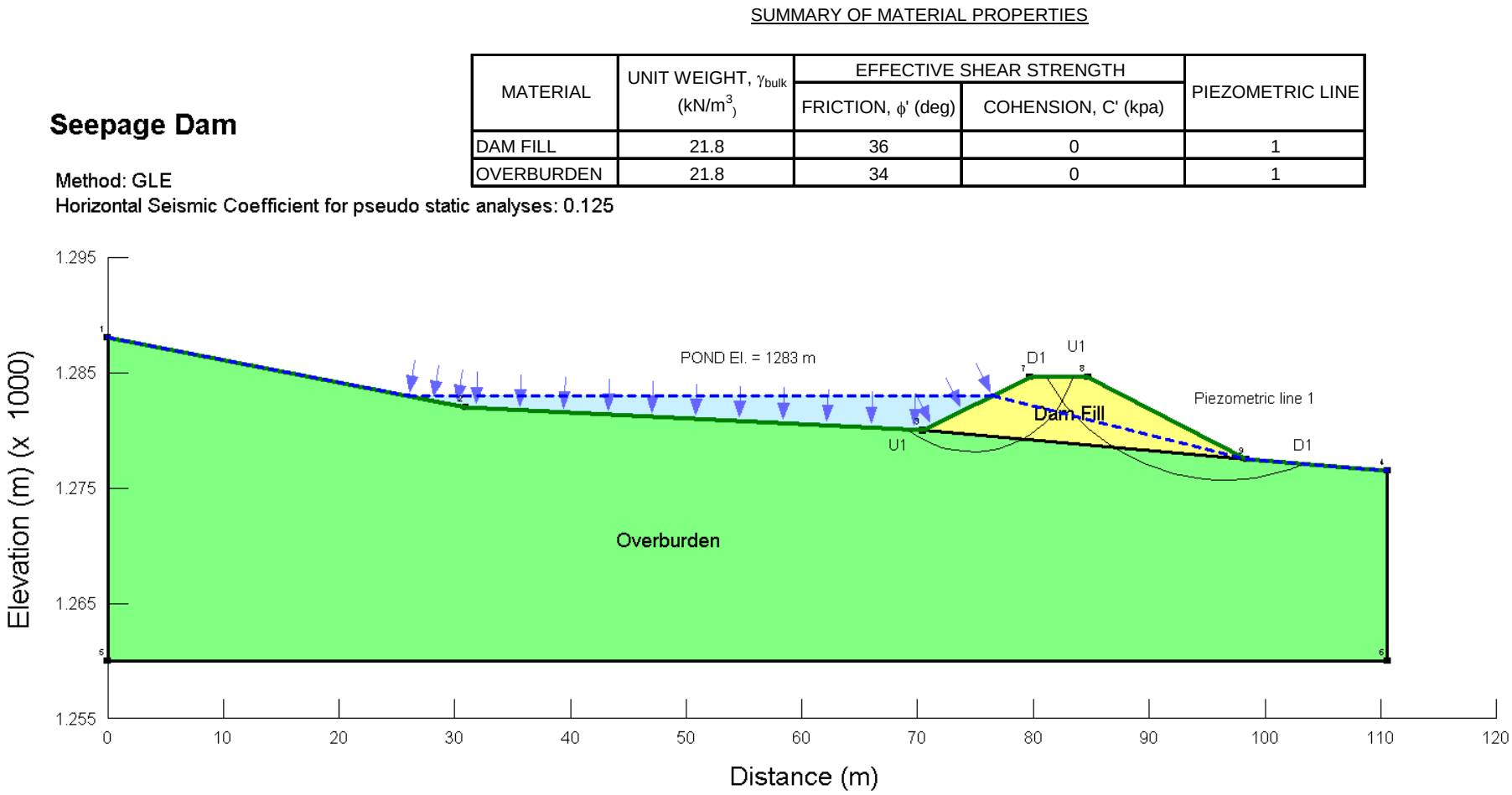

Figure I - 6.3 Seepage Dam Stability Section

APPENDIX II

Geochemical Characterization

- Part I – Tailings Geochemistry (including Tailings Supernatant Water Chemistry)
- Part II – Dam Construction Materials

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1. TAILINGS GEOCHEMISTRY 1
1.1 Summary 1
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ABBREVIATIONS

Ag – Silver
Al – Aluminium
As – Arsenic
Au – Gold
B – Boron
Ba – Barium
Be – Beryllium
Bi – Bismuth
C – Carbon
Ca – Calcium
Cd – Cadmium
Cl – Chlorine
Cl^- – Chloride
Co – Cobalt
CO_3^{2-} – Carbonate
CNO – Cyanate
CNS – Thiocyanate
CNT – Total Cyanate
$CN_{(T)}$ – Total Cyanide
Cr – Chromium
Cu – Copper
F – Flourine
F^- – Floride
Fe – Iron
K – Potassium
Li – Lithium
Mg – Magnesium
Mn – Manganese
Mo – Molybdenum
N – Nitrogen
Na – Sodium
NH_3 – Ammonia
Ni – Nickel
NO_3^- – Nitrate
P – Phosphorous
Pb – Lead
S – Sulphur
Se – Selenium
Si – Silicon
Sn – Tin
SO_4 – Sulphate
S^{2-} – Sulphide
Sr – Strontium
Ti – Titanium
Tl – Thallium
U – Uranium
V – Vanadium
Zn – Zinc

ABA – Acid Base Accounting
AP – Acid Potential
DI – Deionised
ICP-MS – Inductively Coupled Plasma Mass Spectrometry
LOI – Loss On Ignition
Non-PAG – Not Potentially Acid Generating
NNP – Net Neutralization Potential
NP – Neutralization Potential
NPR – Neutralization Potential Ratio
PAG – Potentially Acid Generating
TDS – Total Dissolved Solids
TIC – Total Inorganic Carbon
TSS – Total Suspended Solids
XRD – X-Ray Diffraction
XRF – X-Ray Fluorescence
WDXRD – Wavelength Dispersive X-ray Diffraction

1. TAILINGS GEOCHEMISTRY

1.1 Summary

Environmental characterisation of the Wolverine and Lynx tailings generated from locked cycle flotation testing to date are presented in the following sections. Both static and kinetic testing was employed in the characterisation of samples. The purpose of the testing program was to identify the geochemical, acid rock drainage (ARD) and metal leaching characteristics of tailings materials. To date static testing of tailings has been completed and includes the following:

- Optical petrography;
- X-Ray Diffraction (XRD) with Rietveld Refinement;
- X-Ray Fluorescence (XRF);
- Acid Base Accounting (ABA);
- Inductively Coupled Mass Spectrometry (ICP-MS) 33 element suite; and
- Shake Flask Extractions (SFE).

Kinetic testing continues to date and includes the following analyses:

- Tailings aging testing;
- Acute lethality testing on fresh and aged tailings supernatant;
- Humidity cell testing; and
- Sub-aqueous column leach testing.

A brief summary of results to date are presented in Sections 1.1.1 and 1.1.2, and detailed analyses are presented in the subsequent sections. The summary of the sample counts for each test used to evaluate the metal leaching and ARD potential of the sample tailings is provided in Table II-1.1. The results of these analytical techniques are most useful for interpretation when considered in combination.

Table II-1.1 Number of Tailings Tests by Geochemical Test Method

TEST TYPE	NUMBER OF TESTS
Mineralogy	
Optical Analysis	4
XRD	4
ABA Testing	
Paste pH	12
Total Sulphur	12
Acid Leachable Sulphate	12
Insoluble Sulphate	12
Total Sulphide	12
Organic Sulphide	12
Total Carbon	12
Total Inorganic Carbon	12
Total Organic Carbon	12
Total Carbon as $\%CO_3$	12
Sobek-NP	12
Solid Phase Metals Analysis	
Solid Phase ICP-MS	13
Kinetic Testing	
Humidity Cells	4
Sub-aqueous Column Leach Tests	2
Environmental Aging Tests	4
Toxicity Testing	
Daphnia magna Acute Lethality	8
Rainbow trout Acute Lethality	4

1.1.1 Static Testing

1.1.1.1 Mineralogy

Optical microscopy of analysed samples indicates a high ratio (by sample weight) of sulphides to carbonates (approximately 3:1 to 6:1). The majority of sulphides occur as large liberated grains that are available for oxidation, while the limited abundance of reactive carbonates (exposed or liberated grains) indicates high potential for acid generation. The presence of As-, Pb-, Zn- and Cu-sulphides suggests these particular metal (loid)s may be released to solution if tailings become acid generating.

1.1.1.2 Solid Phase Elemental Concentrations

Results from XRF and ICP-MS analyses show tailings solids have high concentrations of both major and trace elements including:

- Al (1,200 – 12,000 mg/kg);
- As (760 – 4,800 mg/kg);
- Ca (8,300 – 34,000 mg/kg);
- Cu (630 – 2,100 mg/kg);
- K (500 – 3,300 mg/kg);
- Fe (140,000 – 230,000 mg/kg);
- Mg (1,800 – 19,000 mg/kg);
- Pb (1,900 – 15,000 mg/kg); and
- Zn (2,900 – 20,000 mg/kg).

Moderate to minor concentrations of Cd and Cr as well as minor concentrations of Hg, Mo, Ni and U were also detected in the tailings samples.

1.1.1.3 Modified Acid Base Accounting

Modified ABA test results indicate tailings samples have high concentration of sulphide (10.1% to 39.4%) and negative net neutralization potentials (-196 kg $CaCO_3$/t to -1038 kg $CaCO_3$/t). The neutralization potential ratios (NPR) are, therefore, low (0.02 to 0.38) indicating the potential for ARD is likely.

1.1.1.4 Shake Flask Extractions

SFE indicate Zn is above the 1.0 mg/L Metal Mining Effluent Regulations (MMER) only in the Overall Ore Composite (Combine Ro + Cl Sc Tailings) measured at 6.87 mg/L

1.1.2 Kinetic Testing

1.1.2.1 Tailings Aging Testing

Aging testing, scheduled for a total of 120 days, to date are between the 60th (Combined OD, Wolverine D and Lynx D Composite Tailings) and 120th day (Combined Overall Ore Composite Tailings) of testing. Results show Cd, Se and Tl are above CCME guidelines throughout the entire testing period for all tailings samples. Only the Combined Overall Ore Composite Tailings sample shows Zn concentrations exceeding MMER towards the end of the testing period.

1.1.2.2 Acute Lethality Testing

Results from the toxicity tests conducted indicate all the aged decant samples submitted had 100% mortality for *daphnia magna* and rainbow trout at 100% effluent concentrations. Preliminary results indicate the Combined Overall Ore Composite Tailings effluent toxicity for *daphnia magna* increases with effluent aging.

1.1.2.3 Tailings Humidity Cell

Humidity cell testing was done on the Combined OD, Wolverine D and Lynx D Composite Tailings and the Combined Overall Composite Tailings. The initial sulphate in the tailings humidity cells has not been flushed out within this period, therefore, the time to onset of acid generation of the tailings exposed to oxygen and water for a prolonged period cannot be determined at this time. Time to onset of acid generation will certainly be months to years in the field. However, fluctuations in pH over time are observed in some tailings samples nonetheless, likely as a result of incipient thiosalt oxidation in the humidity cell pore-water. Combined Overall Composite, OD, Wolverine D and Lynx D Composite Tailings samples have minimum pH of 6.37, 3.41, 3.36 and 4.27, respectively. Metal(loid)s of concern include Zn, Cd and Se.

1.1.2.4 Sub-aqueous Column Testing

Sub-aqueous column testing has been completed and data is available for 8 weeks on the Combined Overall and OD Composite Tailings samples. Results indicate the Combined Overall

Composite tailings sample initially releases significant Zn and SO_4^{2-} suggesting soluble $ZnSO_4$, a reagent added as part of the lead flotation circuit is responsible for elevated dissolved inventories.

1.2 Sample Compilation and Sample Selection

Ore samples for metallurgical testing to generate products for tailings characterization were prepared by collecting separate Lynx and Wolverine zone ore composites from several drill holes.

Drill holes WV04-122, WV04-123, and WV04-129 were identified as being from the Lynx zone, and drill holes WV04-124, WV04-125, WV04-126, and WV04-127 were identified as being from the Wolverine zone. Adjacent intervals of expected mining dilution rock were also composited from each dill hole and combined with the ore samples, where necessary. Table II-1.2 summarizes the drill hole intervals used to prepare the ore and dilution rock samples.

Table II-1.2 Summary of Samples Compiled for Metallurgical and Environmental Testing

ORE ZONE COMPOSITE	DRILL CORE SAMPLED	MATERIAL TYPE	DEPTH RANGE (m)	SAMPLE WEIGHT (kg)
Lynx	WV04-122	Ore Dilution	118.0-120.6, 128.6-130.6, 143.8-149.7 120.6-121.2,127.2-128.6, 142.6-143.8,149.7-150.5	51.9 11.3
Lynx	WV04-123	Ore Dilution	175.9-176.7, 179.3-183.0 174.9-175.9,176.7-179.3, 183.0-183.9	21.4 11.9
Wolverine	WV04-124	Ore Dilution	118.52-119.33,120.1-123.34 117.38-118.52,119.33-120.10,123.34-123.86	22.1 9.5
Wolverine	WV04-125	Ore Dilution	240.0-240.2, 242.5-246.7 239.0-240.0, 240.4-242.5, 246.7-247.0	27.8 10.6
Wolverine	WV04-126	Ore Dilution	151.7-152.5, 154.3-155.6 149.9-151.7, 152.5-154.3, 155.6-156.6	9.8 11.1
Wolverine	WV04-127	Ore Dilution	175.4-180.6 175.0-175.4, 180.6-181.6	23.0 5.8
Lynx	WV04-129	Ore Dilution	331.7-338.8 331.1-331.7, 338.8-339.0	51.9 3.2

The selected drill core intervals were all crushed to minus ½" prior to compositing, while still keeping ore and dilution rock separate for each drill hole. Then, after some material was removed from each drill core composite for other metallurgical test work, the remaining material was crushed to minus ¼". A sub-sample of each of the Lynx ore only and the Wolverine ore only (no dilution rock) were collected and crushed to minus 10 mesh for undiluted ore flotation. Finally, the ore and dilution rock were combined in the proportions indicated in Table II-1.2 and then separate Lynx and Wolverine diluted ore composites were prepared and screened. Half of each of the Wolverine and Lynx Diluted Ore composites was combined to prepare the Overall Diluted Ore composite.

1.2.1 Laboratory Metallurgical Testing

A total of five locked cycle tests were performed, with he flowsheet used given in Figure II-1.1: two on the Overall composite; and one each on the Diluted Overall Composite; the Diluted Wolverine Composite; and the Diluted Lynx Composite. The tests were run to:

- determine the response of the metallurgy to the recycle of intermediate slurries;
- obtain a projected metallurgical balance for a continuous operation;
- provide final tailing products for environmental evaluation; and
- provide concentrates with detailed analyses for potential buyers.

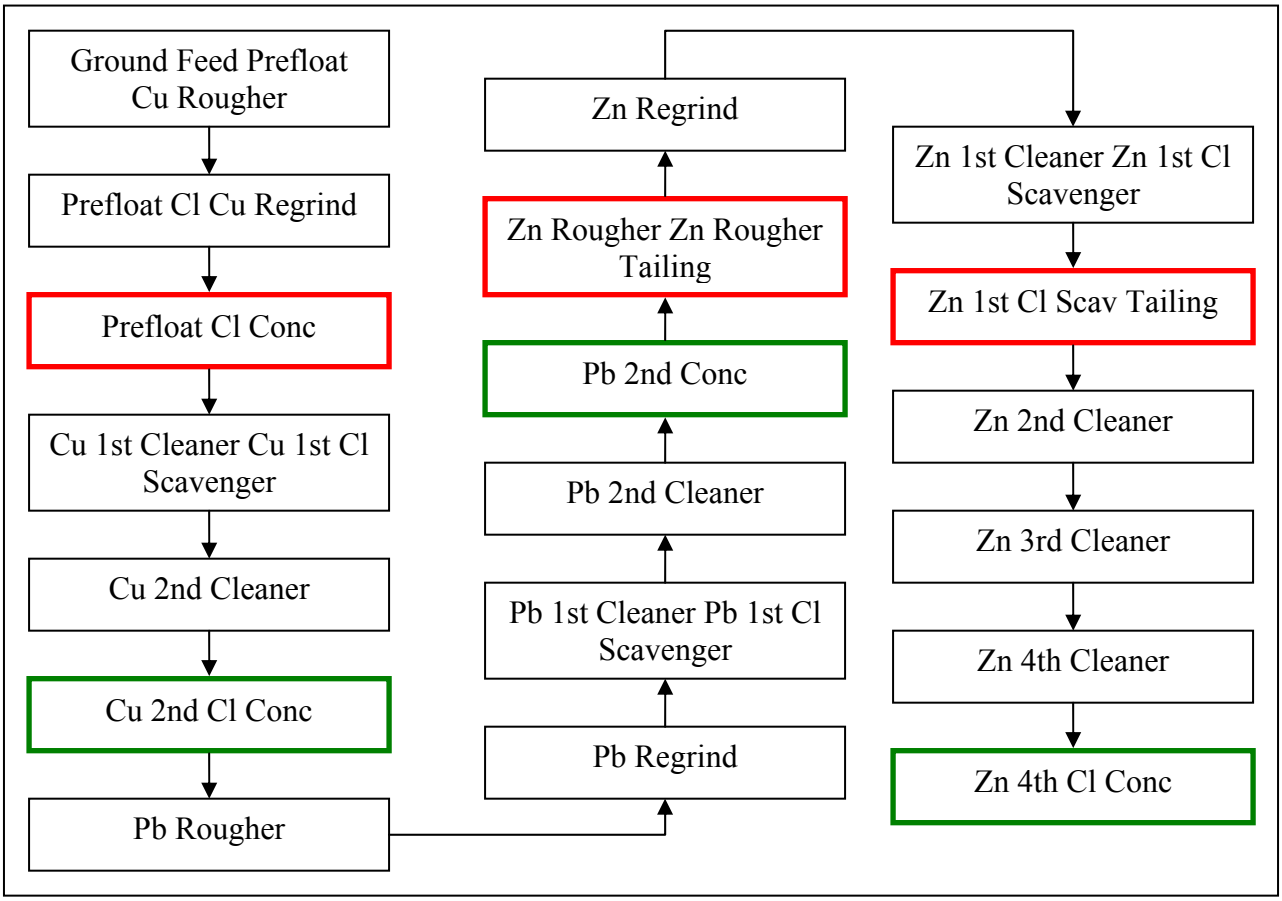

Figure II-1.1 Locked Cycle Test Flowsheet

Note: Items highlighted in green are the concentrates to be dewatered and shipped to market, while the items highlighted in red are the tailings streams to be combined and piped to the tailings impoundment.

The metallurgical test number and the corresponding ore composite are listed in Table II-1.3, and the tests conducted on the resultant ore composites are detailed below.

Table II-1.3 Locked Cycle Tests on Ore Composite Samples

MET TEST	ORE TYPE
LCT1	Overall Ore Composite
LCT2	Overall Ore Composite
LCT3	Overall Dilute Ore Composite
LCT4	Overall Dilute Wolverine Ore Composite
LCT5	Overall Dilute Lynx Ore Composite

In order to generate sufficient liquid sample volumes it was necessary to combine the tailings from the LCT1 and LCT2 metallurgical test runs (which may have been subject to slightly differing process conditions). As seen in the flowsheet, there were three tailings streams generated from any given locked-cycle test. These were combined at the ratios of solids to liquids expected for a full-scale operation such that the combined final slurry is representative of the ultimate tailings discharge to the pond, for that ore type.

Overall Ore Composite (LCT1)

Samples of rougher (Ro) and first cleaner scavenger (Cl Sc) tailings were received by the SGS Lakefield environmental lab from the SGS Lakefield metallurgical operations on May 6, 2005 from a six-cycle locked cycle test (LCT) on an Overall, undiluted, ore sample. The LCT1 products (pulps) from the last four cycles (C, D, E and F) were combined to generate a single composite tailings sample designated Combined LCT Tails Stages C-F. The combined pulp was mixed for 30 minutes at 200 rpm to ensure all solids had been thoroughly recombined before approximately 12 L of pulp was extracted and filtered through a #1 Watman filter paper. The resultant filtrate was submitted for analysis of pH, conductivity, TSS, TDS, acidity, alkalinity, hardness, Cl^-, F^-, NO_3^-, SO_4^{2-}, $CN_{(T)}$, CNO, CNS, NH_3, thiosalts and a suite of dissolved metal(loid)s including Hg. The excess filtrate was reserved in storage. Filter cake solids were submitted for modified ABA, ICP-MS metal(loid) analyses on an *aqua regia* digest, XRF, shake flask testing, humidity cell testing, and mineralogical examination (petrography and Rietveld XRD). No Prefloat cleaner concentrate was received at the time of sample preparation, and therefore it was not included in the combined LCT1 samples; however, analyses were completed on the filtrate samples.

Overall Ore Composite (LCT2)

Tailings slurry and Prefloat cleaner concentrate samples from six cycles of the LCT2 test were received by the SGS Lakefield Environmental Lab from the SGS Lakefield metallurgical lab on May 12, 2005. The six rougher tails and the six first cleaner scavenger tailings were respectively combined to generate composite samples designated Combined LCT2 Ro Tails Stages A-F and Combined LCT2 Cl Sc Tails Stages A-F, respectively. The respective combined pulps were

mixed as previously described before approximately 1.5 L of the Combined LCT2 Ro Tails Stages A-F and three litres of the Combined LCT2 Cl Sc Tails Stages A-F were extracted and filtered through #1 Watman filter paper. Respective filter cake solids were submitted for modified ABA, ICP-MS metal scan on an *aqua regia* digest and whole rock XRF analyses. The respective filtrates were reserved in storage.

The remaining Combined LCT2 Ro Tails Stages A-F, Combined LCT2 Cl Sc Tails Stages A-F and LCT2 Prefloat cleaner concentrate solids were blended with the LCT1 Prefloat cleaner concentrate solids. Blending was based on the proportional ratios of each material component in order to maintain the original ratio of liquids to solids and is referred to as the Combined Ro and Cl Sc Tails sample. The Combined Ro and Cl Sc Tails sample was mixed for 30 minutes at 200 rpm to ensure all solids had been thoroughly recombined before extracting materials for individual aging and toxicity tests. Subsequently, approximately 12 L of pulp was extracted and filtered through a #1 Watman filter paper. The resultant filter cake solids were retained in refrigerated storage and blended manually with the solids retained from the one hour, 24 hour and three day aging samples. The combined filter cake solids were submitted for modified ABA, ICP-MS metal scan on an *aqua regia* digest, whole rock XRF, shake flask tests, humidity cell testing, and mineralogical examination (petrography and Reitveld XRD). Two litres of the excess filtrate was reserved in storage.

Overall Diluted Ore Composite (LCT3)

Tailings slurry and Prefloat cleaner concentrate samples from 6 cycles of the LCT3 (Overall Dilute) test were received from metallurgical operations on June 29, 205. The six rougher tails and the six first cleaner scavenger tailings were respectively combined to generate composite samples designated Combined OD Composite Ro Tails and Combined OD Composite Cl Sc Tails. The respective combined pulps were mixed as previously described before approximately three litres of each of the respective pulps were extracted and filtered through a #1 Watman filter paper. Respective filter cake solids were submitted for modified ABA, ICP-MS metal scan on an *aqua regia* digest and whole rock XRF analyses. Two litres of the respective filtrates were reserved in storage.

The remaining rougher and cleaner scavenger tails pulps were combined with the LCT3 Prefloat cleaner concentrate and blended for 30 minutes at 200 rpm to ensure homogeneity prior to the extraction of materials for individual aging and toxicity tests. Approximately 10 L of the remaining pulp was extracted and filtered through a #1 Watman filter paper. The resultant filter cake solids were retained and blended manually with the solids retained from the one hour, 24 hour and three day aging samples. The combined filter cake solids were submitted for modified ABA, ICP-MS metal scan on an *aqua regia* digest, whole rock XRF analyses, shake flask tests, humidity cell testing, and mineralogical examination (petrography and Rietveld XRD). Two litres of the excess filtrate was reserved in storage.

Overall Dilute Wolverine Composite (LCT4)

Combined rougher samples, combined cleaner pulp samples and combined Prefloat cleaner concentrate samples from six cycles of the LCT4 (Dilute Wolverine) test were received from metallurgical operations on June 20, 2005. The Combined Wolverine D Composite Ro Tails and Combined Wolverine D Composite Cl Sc Tails pulps were mixed following the methodology outlined previously. Approximately three litres of each of the respective pulps were extracted and filtered through a #1 Watman filter paper. Respective filter cake solids were submitted for modified ABA, ICP-MS metal scan on an *aqua regia* digest and whole rock XRF analyses. Two litres of the respective filtrates were reserved in storage.

The remaining rougher and cleaner scavenger tails pulps were combined with the LCT 4 Prefloat cleaner concentrate and mixed as previously outlined before materials extraction for individual aging and toxicity tests. Approximately 10 L of the remaining pulp was extracted and filtered through a #1 Watman filter paper. The resultant filter cake solids were retained and blended manually with the solids retained form the one hour, 24 hour and three day aging samples. The combined filter cake solids were submitted for modified ABA, ICP-MS metal scan on an *aqua regia* digest, whole rock XRF, shake flask testing, humidity cell testing, and mineralogical examination (petrography and Rietveld XRD). Two litres of the excess filtrate was reserved in storage.

Diluted Lynx Composite (LCT5Overall)

Combined rougher samples, combined cleaner pulp samples and combined Prefloat cleaner concentrate samples from six cycles of the LCT5 (Dilute Lynx) test were received by the Environmental lab from the Metallurgical lab, on July 5, 2005. The Combined Lynx D Composite Ro Tails and Combined Lynx D Composite Cl Sc Tails pulps were mixed as previously outlined above. Approximately 10 L of the remaining pulp was extracted and filtered through a #1 Watman filter paper. Respective filter cake solids were submitted for modified ABA, ICP-MS metal scan on an *aqua regia* digest and whole rock XRF analyses. Two litres of the respective filtrates were reserved in storage.

The remaining rougher and cleaner scavenger tails pulps were combined with the LCT5 Prefloat cleaner concentrate and mixed as previously outlined. Approximately 10 L of the remaining pulp was extracted and filtered through a #1 Watman filter paper. The resultant filter cake solids were retained and blended manually with the solids retained from the one hour, 24 hour and three day aging samples. The combined filter cake solids were submitted for modified ABA, ICP-MS metal scan on an *aqua regia* digest, whole rock XRF analyses, shake flask testing, humidity cell testing, and mineralogical examination (petrography and Rietveld XRD). Two litres of the excess filtrated was reserved in storage.

1.2.2 Variation Due to Physical Segregation of Tailings

The proposed grind size for the Wolverine Project ore types is quite fine, with an initial targeted grind of P_{80} <68 microns with the Cleaner Scavenger tailings getting reground in the zinc circuit to a target of P_{80} <23 microns. Therefore, expected quantities of coarser grained tailings will be of little significance. Nevertheless, it should be noted geochemical characterization of the tailings based on grind size has not been undertaken. Sulphides have been known to associate with the fine fraction of mine tailings; however, this has not been addressed in the current assessment. As a result, the geochemical significance of segregation of fine and slightly coarser grained tailings will not be well understood. Even so, the results reported in the following section will apply generally with respect to the range of grain sizes expected to be encountered in the Wolverine tailings. It can be observed that based on qualitative XRD data on flotation circuit feed material

from the Wolverine ore zone, that in the "coarse" fraction (>75 microns), pyrite and dolomite are both present at moderate abundance, whereas for all the finer fractions, pyrite is present with major abundance and dolomite is only present at minor to trace abundance. This suggests that at least for the Wolverine tailings, the coarser material may have a lower acid generation potential (higher Neutralization Potential ratio (NPR), closer to unity). The XRD data for the Lynx ore zone is similar for the >150 micron material (which is only a few percent of the feed) but pyrite is consistently more abundant than dolomite for all the finer grain sizes. Therefore, over the life of the mine it can be expected that there will be little variation in the ARD potential of the tailings due to segregation within the impoundment.

1.3 Mineralogical Assessment

Mineralogical assessment of the Wolverine tailings was undertaken using optical petrography, XRD and whole rock XRF analysis.

1.3.1 Optical Petrography

1.3.1.1 Methodology

Petrographic examination of polished thin sections can provide information on the major and minor mineral phases, grain shapes, grain size, spatial relationship and an estimate of relative proportions. Mineral abundances less than approximately 0.5% will not normally be detected and microscope magnification limits are unable to discern features smaller than approximately 100 μm. Petrographic analyses are most useful for samples that have ABA and trace metals analyses available since the elemental composition of minerals that occur in solid solution is not always precisely distinguishable under the microscope (e.g., differentiating between carbonate minerals). As a result, petrographic analyses are often supplemented with additional mineralogical techniques (Price, 1997), such as XRD and XRF.

One polished thin section and one polished grain mount were prepared for each of the four samples representative of tailings materials. Each polished section was examined optically under incident and transmitted light between 50x and 500x magnification. Mineral assemblage and

modal abundance of the sample were determined by point counting 500 mineral particles from polished thin section. The polished thin sections were further analyzed by Scanning Electron Microscopy (SEM) to identify specific carbonate compositions. The results of the petrographic characterization are discussed below in Section 1.3.1.2.

1.3.1.2 Results

Table II-1.4 lists the minerals identified by optical petrography and their modal abundance.

Table II-1.4 Mineral Assemblages and Modal Abundances by Optical Microscopy (wt.%)

MINERAL	COMB OVERALL ORE COMP	COMB OD COMP	COMB LYNX D COMP	COMB WOLV D COMP
Pyrite	60.1	53.1	60.3	38.3
Quartz	17.1	20.9	16.7	26.7
Carbonate	10.6	10.5	11.6	14.2
Muscovite	5.2	11.9	8.9	14.3
Chlorite	1.1	1.0	0.0	0.9
Sphalerite	1.6	1.1	1.8	1.3
Pyrrhotite	1.6	0.5	0	2.1
Amphibole	0.6	0	0	0.5
Arsenopyrite	0.8	0.3	0.3	0
Pyroxene	0.3	0.2	0.0	1.5
Chalcopyrite	0.4	0.5	0.0	0.2
Galena	0.4	0.0	0.8	0
Biotite	0.2	0	0	0
Magnetite	0.1	0	0	0
Total	**100**	**100**	**100**	**100**

Overall, microscopic examination of the four tailings samples indicate that they are composed primarily of pyrite (approximately 38 to 60 wt.%) with moderate mineral assemblages that include quartz (approximately 10to 14 wt.%), carbonates (approximately 10 to 14 wt.%) and muscovite (approximately 5 to 14 wt.%). Minor sulphide mineral assemblages, defined as less than two weight percent, include sphalerite, pyrrhotite, arsenopyrite, chalcopyrite and galena.

Optical microscopy indicates the Combined Overall Ore Composite, Combined Lynx D Composite Tailings and Combined OD Composite Tailings have high sulphide to carbonate ratios (approximately 3:1 to 6:1). Lack of available reactive carbonates, which provide

neutralizing potential, may be a problem if sulphide oxidation occurs. Carbonate grains range in size from 20 to 300 µm and occur as liberated grains or attached/ inclusions in/on quartz or muscovite assemblages. The latter two points further reduce available neutralizing potential due to the exclusion of carbonate grains to the surrounding solution. Section 1.3.2.2 expands further on the type of carbonates available for neutralizing potential. The majority of the sulphides occur as liberated grains, some pyrite and pyrrhotite grains as large as 150 µm and 300 µm respectively, increasing the potential for oxidation based solely on the available surface area for the reaction to occur. If sulphide oxidation is likely, releases of Zn, As, Cu and Pb may follow due to the presence of the minor sulphides in the samples.

1.3.2 X-Ray Powder Diffraction Using the Rietveld Method

1.3.2.1 Methodology

XRD provides the means of determining the type mineral phases while the Rietveld refinement method quantifies the phases relative to one another. This is one of the first steps in identifying potentially reactive waste materials and, unlike petrographic techniques, mineral identification via XRD is not limited to grains larger than 100 µm (Price, 1997). X-ray diffraction is used to distinguish between similar mineral phases, such as the carbonates, or as a final step in determining an unknown mineral phase targeted by optical microscopy. A full explanation of XRD methods using the Rietveld refinement method can be found in Raudsepp and Pani (2002 and 2003).

1.3.2.2 Results

The results of quantitative phase analysis by the Rietveld refinement are given in Table II-1.5.

Table II-1.5 Mineral Abundances Calculated by Rietveld XRD (wt.%)

MINERAL	IDEAL FORMULA	COMB OVERALL ORE COMP	COMB OD COMP	COMB WOLV D COMP	COMB LYNX D COMP
Pyrite	FeS_2	56.7	48.5	34.1	58.7
Quartz	SiO_2	20.5	21.4	28.0	17.7
Muscovite	$KAl_2AlSi_3O_{10}(OH)_2$	10.7	17.2	19.9	13.5
Dolomite	$CaMg(CO_3)_2$	5.2	5.9	7.4	5.0
Calcite	$CaCO_3$	2.9	3.0	2.6	3.6
Clinochlore	$(Mg,Fe^{2+})_5Al(Si_3Al)O_{10}(OH)_8$	1.6	1.7	4.6	nd
Gypsum	$CaSO_4 \cdot H_20$	1.9	1.0	1.0	nd
Pyrrhotite	$Fe_{(1-x)}S$	nd	0.9	1.7	0.4
Siderite	$Fe^{2+}CO_3$	0.5	0.4	0.4	0.4
Kaolinite	$Al_2Si_2O_5(OH)_4$	nd	nd	nd	0.7
Galena	PbS	nd	nd	0.3	0.1

nd = not detected

These amounts represent the relative amounts of crystalline phases normalized to 100%. Amorphous and nanocrystalline phases are not detected by this method. X-ray diffraction results confirm optical microscopy results. Pyrite is the dominant sulphide phase in all samples with moderate concentrations of quartz and muscovite. Dolomite, calcite and siderite are the three carbonates present in the sample material and indicate the majority of neutralizing potential comes from reactive phases. It is interesting to note some of the minor sulphides (arsenopyrite and sphalerite) were not detected by this method even though optical mineralogy indicates they are present in detectable concentrations. These results suggest the low abundance of reactive carbonates and non-carbonate minerals (less than 10 wt.% total) may not be provide enough neutralizing potential so the tailings, with relatively high concentrations of sulphides, are classified as PAG. The neutralizing role of non-carbonate minerals (muscovite and clinochlore), with measured total concentrations ranging from 12.3 wt.% to 24.5 wt.% which also have potential neutralizing capacity, can only be determined through kinetic testing.

1.3.3 Whole Rock XRF Analysis

Whole rock analyses of the four Wolverine tailings samples were performed in May to early July 2005 by SGS Lakefield.

1.3.3.1 Methodology

Samples from each of the rougher, cleaner and combined tailings samples (12 in total) were submitted for determination of major element oxides by XRF. Samples were crushed to 150 mesh and thermally fused with lithium borate forming a glass disk. The disk was then analyzed by WDXRF spectrometry for the oxides. Loss on ignition is determined separately at a temperature of 1000^{o}C.

1.3.3.2 Results

The whole rock analysis results of the tailings samples are presented in Table II-1.6 as oxides and in Table II-1.7 as elemental concentrations.

Table II-1.6 Whole Rock Analysis of Tailings Samples

Oxide (wt.%)	Overall Ro	Overall Cl Sc	Overall Comb	OD Ro	OD CI Sc	OD Comb	Wolv D Ro	Wolv D CI Sc	Wolv D Comb	Lynx D Ro	Lynx D CI Sc	Lynx D Comb
SiO_2	32.0	7.6	24.2	36.6	6.0	26.8	41.9	10.2	35.3	30.4	4.3	20.6
Al_2O_3	5.6	1.8	3.9	6.3	1.4	4.7	8.0	2.3	6.4	5.1	1.0	3.4
Fe_2O_3	30.1	47.9	37.2	26.5	56.1	34.7	19.8	52.0	27.8	32.9	53.7	42.4
MgO	2.5	0.9	1.8	2.9	0.5	2.1	4.2	0.9	3.3	1.7	0.4	1.2
CaO	4.4	1.9	3.3	5.0	1.4	3.8	4.8	1.7	4.2	5.2	1.3	3.6
Na_2O	0.3	2.9	0.5	0.3	0.8	0.5	0.2	1.0	0.4	0.3	0.6	0.5
K_2O	1.5	0.4	1.0	1.7	0.3	1.2	2.0	0.6	1.6	1.4	0.2	0.9
TiO_2	0.1	0.0	0.1	0.2	0.0	0.1	0.2	0.1	0.2	0.1	0.0	0.1
P_2O_5	0.1	0.0	0.1	0.1	0.0	0.1	0.2	0.1	0.2	0.1	0.0	0.1
MnO	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.1
Cr_2O_3	0.0	0.3	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1
V_2O_5	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.1	0.0	< 0.01	0.0
LOI	19.4	26.4	22.8	16.2	30.3	21.0	13.5	27.4	17.8	18.3	31.0	24.0
Total	**96.2**	**90.1**	**95.1**	**95.8**	**96.9**	**95.0**	**94.9**	**96.4**	**97.3**	**95.8**	**92.8**	**96.9**

Table II-1.7 Elemental Concentrations Calculated from Whole Rock Data

Element (wt.%)	Overall Ro	Overall Cl Sc	Overall Comb	OD Ro	OD CI Sc	OD Comb	Wolv D Ro	Wolv D CI Sc	Wolv D Comb	Lynx D Ro	Lynx D CI Sc	Lynx D Comb
Si	14.96	3.55	11.31	17.11	2.79	12.53	19.59	4.77	16.50	14.21	2.03	9.63
Al	2.96	0.94	2.06	3.33	0.72	2.48	4.23	1.23	3.39	2.69	0.53	1.80
Fe	10.53	16.75	13.01	9.27	19.62	12.14	6.92	18.19	9.72	11.51	18.78	14.83
Mg	1.50	0.55	1.09	1.72	0.33	1.27	2.54	0.55	1.98	1.02	0.27	0.69
Ca	3.13	1.34	2.36	3.54	0.98	2.70	3.42	1.23	2.99	3.72	0.94	2.59
Na	0.13	1.06	0.19	0.12	0.28	0.18	0.06	0.36	0.14	0.12	0.24	0.17
K	0.62	0.16	0.40	0.68	0.14	0.50	0.83	0.23	0.68	0.58	0.08	0.38
Ti	0.08	0.02	0.05	0.09	0.02	0.07	0.11	0.04	0.09	0.07	0.02	0.05
P	0.02	0.01	0.02	0.02	0.01	0.02	0.03	0.02	0.03	0.02	0.01	0.01
Mn	0.09	0.05	0.09	0.09	0.03	0.07	0.07	0.03	0.06	0.11	0.03	0.08
Cr	0.01	0.09	0.02	0.01	0.03	0.02	0.01	0.04	0.02	0.01	0.03	0.02
V	0.02	0.02	0.02	0.03	0.01	0.02	0.03	0.02	0.04	0.02	0.00	0.02

Although whole rock data is traditionally presented as oxides, this does not necessarily indicate oxide minerals are present in the sample. For example, the high Fe_2O_3 concentrations reported in all tailings samples is almost certainly influenced to a large degree by the presence of pyrite, confirmed by optical petrography and XRD, and not solely due to hematite (α-Fe_2O_3) and/or maghemite (γ-Fe_2O_3). The conversion of the oxides to total elemental concentrations is therefore more representative of the overall tailings chemistry.

Results show high concentrations of the major cations (Si, Al, Mg, Ca, and K) as well as Fe. Sodium, Ti, P, Mn, Cr and V are present at less than one weight percent. The high LOI and consistently low totals are reflective of the presence of sulphides, carbonates, phyllosilicates and/or hydrated minerals (Price, 1997). X-ray diffraction confirms the presence of all four of these types of mineral phases suggesting the likely volatile components released during thermal glass disc preparation and their respective mineral phases include:

- OH^- from muscovite, clinochlore and kaolinite;

- CO_2 from organics, dolomite, calcite and/or siderite;
- H_2O from gypsum; and
- SO_x from sulphides.

1.4 Static Testing

1.4.1 Acid Base Accounting (ABA)

Brief descriptions of the ABA parameters are included in the following sections after Sobek (1978) and Price (1997). Tailings samples were tested at the received particle size (80% passing 68 microns).

1.4.1.1 Methodology

Paste pH

Alone, paste pH does not provide an indication of ARD potential of a sample. It is, however, a principal determinant of both mineral reaction rates and mineral solubility. It can therefore have a large affect on drainage chemistry. For example, paste pH values less than pH 7 can be indicative of a limited availability of NP, whereas higher values suggest that available NP exists in a sample.

The paste pH is determined prior to conducting all other tests included an ABA suite. A small amount of pulverized sample (approximately 25 g) is wetted with distilled water while swirling. Upon saturation, the pH of the paste is measured and recorded.

Sulphur Species

Minerals containing sulphur are the main source of acid and trace metal contaminants in mine waste. Therefore, the determination of sulphur species is a fundamental component in the prediction of mine drainage chemistry. The sulphur species measured include:

- Total sulphur;

- Acid-leachable sulphate sulphur;
- Acid-leachable sulphide sulphur;
- Insoluble sulphate sulphur based on barium determination; and
- Organic sulphur (calculated by difference).

Acid Potential Determination

Total Acid Potential is calculated from the total sulphur determination discussed above. Here, total sulphur (%S) is multiplied by the conversion factor of 31.25 to express the acid potential in kg of $CaCO_3$ equivalent per tonne of material.

Sulphide Acid Potential (AP) is calculated from the sulphide determination. The sulphide-sulphur (%S) is multiplied by the conversion factor of 31.25 to express the acid potential in kg of $CaCO_3$ equivalent per tonne of material.

Carbon Content

The following carbon species were analyzed:

- Total carbon;
- Total inorganic carbon;
- Total organic carbon; and
- Carbonate carbon.

Neutralization Potential Determination

In weathering rocks where sulphides are present, ARD will only be produced if there is insufficient release of neutralizing alkalinity. Laboratory Neutralization Potential (NP) measurements such as the bulk NP and carbonate NP measurements provide a first order estimation of the neutralization capacity.

The bulk neutralization potential testing followed the standard Sobek method (Sobek-NP). The Sobek-NP determination yields the NP contributed by all carbonate and non-carbonate neutralizing minerals. This procedure is based upon the results of the fizz test. A fizz test (addition of 25% HCl to a dry, pulverized sample) is used to provide a guide to the strength and amount of acid to be added to each sample. An initial "fizz test" is conducted on a small portion of the sample and the strength and volume of hydrochloric acid is then added according to Table 7-2 of the MEND Manual (MEND, 2000). The addition of acid must ensure acidification of the neutralizing materials though it must avoid over acidification of the sample. The resulting solution is then titrated back to pH 8.3. The NP of the sample is calculated from the titration data.

Carbonate Neutralization Potential (Carb-NP) is calculated using the Total Inorganic Carbon (TIC) measurement converted back to calcium carbonate equivalent, thus assuming all inorganic carbon is in the form of $CaCO_3$. A calculation of the Carb-NP based on TIC provides the NP contributed by carbonate minerals only. This value is the maximum neutralization capacity that could be achieved if all the carbonate in the sample reacted like calcite.

As a result, more Sobek-NP than Carb-NP in a sample indicates there may be significant neutralization from non-carbonate minerals. If the Carb-NP is greater than the Sobek-NP, a measurable portion of the inorganic carbon is not generating alkalinity or is unreactive and suggests the presence of iron and/or manganese carbonates.

Net Neutralization Potential and Neutralization Potential Ratio Calculations

The AP is derived from the total sulphur or sulphide sulphur value as explained above. The NP derived from any one of the above procedures is then used in determining the neutralization potential ratio (NPR), the ratio of the NP:AP or net neutralization potential (NNP), the difference between the NP and the AP. An NPR <1 indicates the material is likely PAG.

Elemental Content - Solid Phase Metals Analysis

Solid phase metals analysis of a sample provides a means of quantifying the elements available in a sample. Samples sent to SGS Lakefield for solid phase metals analyses were examined in-house using a 33 element ICP-MS scan following an *aqua regia* digest.

1.4.1.2 Results

ABA testing of the tailings generated from the four ore composite samples was done by SGS Lakefield. The results of this test work are reported in Table II-1.8.

Table II-1.8 Tailings ABA Results

PARAMETER	UNITS	OVERALL COMP LCT2 RO	OVERALL COMP LCT2 CL SC	OVERALL COMP LCT2 COMB	OD RO	OD CL SC	OD COMB	WOLV RO	WOLV CL SC	WOLV COMB	LYNX RO	LYNX CL SC	LYNX COMB
Paste pH	-	7.79	7.26	7.42	7.85	6.69	7.27	7.68	6.91	7.35	7.67	6.45	7.36
Fizz Rate	-	3	3	3	3	2	2*	3	2	2**	3	2	2
Total S	%S	22.3	39.5	29.2	17.5	43.0	26.6	12.3	39.4	19.7	23.7	48.4	31.2
Acid Leachable SO_4^{2-}	%S	1.07	6.98	2.51	0.02	1.18	2.04	0.45	1.63	1.74	0.92	6.45	0.74
Sulphide S	%S	20.2	28.5	25.0	15.7	39.0	22.9	10.1	34.1	15.7	20.4	39.4	27.8
Insoluble SO_4^{2-}	%S	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*
Organic S	%S	1.10	4.00	1.73	1.72	2.83	1.67	1.79	3.64	2.34	2.35	2.61	2.68
AP	kg $CaCO_3$/t	631	891	781	491	1220	715	315	1070	489	638	1230	869
Sobek NP	kg $CaCO_3$/t	103	41.8	72.8	114	21.9	82.5	119	32.1	94.6	111	20.9	49.4
Net NP	kg $CaCO_3$/t	-528	-849	-708	-377	-1198	-632	-196	-1038	-395	-526	-1209	-820
Sobek NP/AP	-	0.16	0.05	0.09	0.23	0.02	0.12	0.38	0.03	0.19	0.17	0.02	0.06
Carb NP	kg $CaCO_3$/t	72.6	23.4	59.4	91.4	20.5	98.3	105	24.6	106	94.4	22.1	52.3
Carb NP/AP	-	0.11	0.56	0.08	0.19	0.02	0.14	0.33	0.02	0.22	0.15	0.02	0.06
TOC	%C	na	na	na	0.54	0.43	0.62	0.69	0.75	0.98	0.49	0.25	0.48
TIC	%C	na	na	na	1.32	0.11	0.94	1.39	0.14	1.2	1.30	0.21	0.79
C(t)	%C	1.72	0.87	1.48	1.86	0.54	1.56	2.07	0.88	2.14	1.79	0.46	1.27

Samples with higher Sobek-NP than Carb-NP (all samples except possibly OD Combined, Wolv Combined and Lynx Cl Sc) indicate the presence of non-carbonate NP. Mineralogical results suggest muscovite, clinochlore and kaolinite are the non-carbonates with NP. In samples having slightly higher Carb-NP compared to Sobek NP indicating some carbonate minerals are not generating alkalinity or are unreactive. Mineralogical results suggest siderite may be the unreactive carbonate, though it is only present at less than 0.5 wt.% in samples analyzed. However, with the two combined samples, it appears that the Fizz Rating, which is highly subjective, may have lead to inadequate acid addition in the Sobek NP determination. Closer inspection of the data indicates that the standard Sobek method may not have been followed precisely, in that acid normality and acid volume do not vary consistently with Fizz Rating in accordance with Table 7-2 in Price (1997).

ABA test work, in particular the information garnered from the NPR, serves as a guide in identifying the likelihood of ARD conditions and distinguishing samples from a deposit as PAG from Non-PAG. Price (1997) provides some criteria for guiding geochemical test work and evaluating the potential for ARD shown in Table II-1.9.

Table II-1.9 ABA Screening Criteria

POTENTIAL FOR ARD	INITIAL SCREENING CRITERIA
Likely	NPR ≤ 1
Possible	1 < NPR ≤ 2
Low	NPR > 2

The ABA results for the overall composite samples, the two separate deposits and all of the individual tailings streams indicate that the sulphide-rich (10.1-39.4 %) materials are PAG (NPR less than one). However, the samples currently have enough NP (Carb NP of 20-100 kg $CaCO_3$/t) to remain at a near-neutral pH when initially exposed to oxygen. This is confirmed from the paste pH values, which ranges from pH 6.69 to pH 7.85. Kinetic results addressing the long term temporal performance of the samples are presented in Section 1.5.

1.4.2 Metals Analyses

1.4.2.1 Methodology

ICP-MS analyses were done from May to July of 2005 by SGS Lakefield. Trace element analysis by ICP-MS provides a measure of the solid-phase concentrations of various elements within a sample. Solid samples were subjected to near-total digestion in a mixture of strong oxidizing acids (HNO_3 and HCl), known as *aqua regia*, in order to dissolve most mineral phases. Digests were then quantitatively analyzed for a suite of major, minor and trace elements (33 elements in total).

1.4.2.2 Results

The elemental analyses by ICP-MS are presented in Table II-1.10 for twelve samples. When measured sample concentrations are compared to known crustal abundances, it can be determined which elements may be of environmental concern under neutral or acidic drainage conditions. Anomalous elemental concentrations are defined here as greater than five times normal crustal abundance as listed in Appendix 3 of Price (1997). The measured elemental concentrations which exceeded this criterion in at least 50% of the samples are presented in Table II-1.11.

Table II-1.10 ICP-MS Solid-phase Results

Element	Units	CRUSTAL[1]	O RO	O CS	O COMB	OD RO	OD CI SC	OD COMB	WOLV RO	WOLV CI SC	WOLV COMB	LYNX RO	LYNX CI SC	LYNX COMB
Ag	mg/kg	0.08	**39**	**80**	**59**	**42**	**71**	**54.8**	**42**	**170**	**82**	**41**	**65**	**54.4**
Al	%	8.36	0.67	0.22	0.43	0.99	0.18	0.6	1.2	0.33	1	0.43	0.12	0.28
As	mg/kg	1.8	**2100**	**3800**	**2700**	**2200**	**3800**	**2700**	**760**	**2500**	**1200**	**3500**	**4800**	**4100**
Ba	mg/kg	390	51	25	38	70	30	53	94	29	66	59	28	50
Be	mg/kg	2	0.2	0.1	0.1	0.32	0.05	0.17	0.3	0.1	0.24	0.2	0.04	0.12
Bi	mg/kg	0.0082	***7.5***	***7.5***	***7.5***	**8.1**	**13**	**11**	**12**	**42**	**19**	**6**	**8.8**	**6.4**
B	mg/kg	9	*1.5*	*1.5*	*1.5*	6	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*
Ca	%	4.66	3	1.3	2.3	3.2	0.83	2.5	3.1	1.1	2.7	3.4	0.85	2.4
Cd	mg/kg	0.16	**44**	**500**	**140**	**57**	**160**	**97**	**29**	**180**	**74**	**67**	**160**	**110**
Co	mg/kg	29	29	45	37	27	74	42.7	33	100	47.9	27	56	38.5
Cr	mg/kg	122	70	530	120	120	380	200	94	390	160	130	290	210
Cu	mg/kg	68	**750**	**1800**	**1100**	**710**	**930**	**820**	**630**	**2110**	**1100**	**720**	**860**	**820**
Fe	%	6.22	23	**36**	28	18	**38**	23	14	**34**	18	22	**38**	27
Hg	mg/kg	0.086	**1.5**	**9.5**	**3.2**	**2.4**	**5.8**	**3.6**	**2**	**8.5**	**4**	**2.4**	**4.9**	**3.2**
K	%	1.84	0.33	0.012	0.21	0.3	0.06	0.17	0.31	0.1	0.25	0.16	0.05	0.11
Li	mg/kg	18	*1*	*1*	*0.15*	*1.5*	*1.5*	1.6	10	*1.5*	5.5	*1.5*	*1.5*	0.1
Mg	%	2.764	1.2	0.32	0.75	1.4	0.24	1	1.9	0.41	1.6	0.76	0.18	0.52
Mn	mg/kg	1060	870	550	680	840	320	670	730	310	620	980	350	700
Mo	mg/kg	1.2	**21**	**44**	**28**	**37**	**48**	**32.3**	**17**	**32**	**24.5**	**29**	**58**	**45.1**
Na	%	2.27	0.02	0.008	0.011	0.019	0.005	0.014	0.024	0.008	0.015	0.014	0.005	0.01
Ni	mg/kg	99	51	78	65	60	100	60	46	95	56	55	84	63
P	mg/kg	1120	350	150	290	400	100	320	600	200	520	300	74	190
Pb	mg/kg	13	**2600**	**5800**	**3500**	**3000**	**5200**	**3900**	**1900**	**15000**	**5100**	**4300**	**7400**	**5600**
Sb	mg/kg	0.2	**160**	**340**	**220**	**130**	**220**	**170**	**140**	**820**	**310**	**150**	**220**	**180**
Se	mg/kg	0.05	**277**	**479**	**361**	**261**	**514**	**364**	**275**	**979**	**464**	**264**	**452**	**336**
Sn	mg/kg	2.1	9.8	**18**	**11**	**12**	**13**	**13**	8	**16**	10	**34**	**16**	**16**

1. Source: Crust as a Whole in Abundances of chemical elements in the Earth's Crust and chondrites in Appendix 3 of Price (1997)
Italics indicates measured value less than detection limit and listed as one half of the method detection limit
Bold values exceed normal crustal abundance by a factor of at least 5

Table II-1.10 ICP-MS Solid-phase Results (cont'd)

Element	Units	CRUSTAL[1]	O RO	O CS	O COMB	OD RO	OD CI SC	OD COMB	WOLV RO	WOLV CI SC	WOLV COMB	LYNX RO	LYNX CI SC	LYNX COMB
Sr	mg/kg	384	63	25	49	69	17	53	78	19	59	72	17	48
Ti	mg/kg	6320	71	30	54	99	23	68	95	34	82	75	20	53
Tl	mg/kg	0.72	**17**	**14**	**16**	**20**	**18**	**19.1**	**14**	**13**	**13.4**	**25**	**23**	**23.7**
U	mg/kg	2.3	4.6	3.3	3.9	5.2	3.2	4.7	6.6	4.5	6	4	2.5	3.4
V	mg/kg	136	40	32	29	60	23	37	51	37	49	41	18	33
Zn	mg/kg	76	**5000**	**74000**	**19000**	**5500**	**17000**	**9800**	**2900**	**20000**	**8000**	**6500**	**16000**	**11000**

1. Source: Crust as a Whole in Abundances of chemical elements in the Earth's Crust and chondrites in Appendix 3 of Price (1997)
Italics indicates measured value less than detection limit and listed as one half of the method detection limit
Bold values exceed normal crustal abundance by a factor of at least 5

Table II-1.11 Elemental Concentrations Greater Than 5X Crustal Abundance

ELEMENT	ANOMALOUS SAMPLES (%)	AVG. RATIO[1]
Se	100	9512
As	93	1453
Bi	100	1377
Sb	100	1201
Cd	93	836
Ag	100	763
Pb	93	375
Zn	93	218
Hg	93	52
Mo	93	26
Tl	93	23
Cu	93	14
Sn	71	7

1. Measured Concentration: Crustal Abundance

A total of 13 trace elements, listed in Table II-1.11, show concentrations greater than five times crustal abundance in nearly all samples analyzed. These results suggest the onset of acidic conditions may have the potential to release metal(loid)s from mineral phases, likely from the sulphide phases confirmed by mineralogical characterization (see Section 1.3). Furthermore, any of the elements in this table that are mobile under neutral pH conditions (e.g., Se, Zn, etc.) may have the potential to be released at any time.

1.4.3 Shake Flask Testing

1.4.3.1 Methodology

Shake flask testing of four samples was conducted by SGS Lakefield. This short-term leach test was used to determine the leachate that may flush from the tailings solids when exposed to rain, snowmelt or groundwater flow. A modification of the Special Waste Extraction Procedure, or shake flask test, is outlined in the *British Columbia Waste Management Act.* This procedure is a recommended component of static tests and is used to determine the presence of easily soluble mineral components (Price, 1997). Modifications to the above procedure included using a 20:1 water to solid ratio, rather than 3:1, to ensure measured concentrations were not subject to

solubility effects. The test was conducted by adding deionised water to a 50 g dry equivalent tailings sample to create a one litre slurry (liquid:solid = 20:1). The initial pH was measured prior to 24 hr agitation (end over end). After extraction, the final pH was recorded, the sample was filtered through a 0.45 μm filter and a sub-sample of leachate was submitted for analyses of metals by ICP-MS.

1.4.3.2 Results

The results of the shake flask extraction from the four Combined Tailings samples are summarized in Table II-1.12.

Table II-1.12 Shake Flask Extraction Test Results

PARAMETER	UNITS	MMER[1]	10X CCME[2]	COMB OVERALL ORE COMP	COMB OD	COMB WOLV D	COMB LYNX D
Moisture	%			1.0	16	16.8	29.9
Sample Weight	g			50	50	50	50
DI Water Volume	mL			990	992	991.6	985
Initial pH	units		6.5-9.0	7.1	**9.4**	**9.2**	**9.15**
Final pH	units		6.5-9.0	7.3	8.2	8.4	8.3
pH	units		6.5-9.0	7.3	7.6	7.6	7.7
Conductivity	uS/cm			813	263	274	242
Tot.Dissolved Solids	mg/L			740	231	220	186
Tot Suspended Solids	mg/L	15.0		3	*1.5*	*1*	*1.5*
Alkalinity	mg $CaCO_3$ /L			52	na	na	na
Acidity	mg $CaCO_3$ /L			17	na	na	na
F	mg/L			0.06	na	na	na
$NH_3 + NH_4^+$	mg N /L		17.7 (T=15°C and pH 7)	0.3	0.2	1	0.2
Cl	mg/L			1.5	*1*	*1*	*1*
NO_3^-	mg N/L		130	*0.25*	*0.25*	0.79	*0.25*
SO_4^{2-}	mg/L		500†	430	41	41	38.5
$CN_{(T)}$	mg/L	1.0		0.02	0.07	*0.005*	*0.005*
CNO	mg/L			*0.05*	*0.05*	*0.05*	*0.05*
CNS	mg/L			*1*	*1*	*1*	*1*
Thiosalts	mg S_2O_3/L			44	na	na	na
Ag	mg/L		0.0010	*0.00005*	0.0008	0.0006	0.00075
Al	mg/L			*0.002*	0.005	0.007	0.007
As	mg/L	0.50		*0.0025*	0.007	0.007	0.0095
B	mg/L			*0.005*	*0.005*	*0.005*	*0.013*

Table II-1.12 Shake Flask Extraction Test Results (cont'd)

PARAMETER	UNITS	MMER[1]	10X CCME[2]	COMB OVERALL ORE COMP	COMB OD	COMB WOLV D	COMB LYNX D
Ba	mg/L			0.070	0.27	0.20	0.32
Be	mg/L			*0.0025*	*0.0025*	*0.0025*	*0.0025*
Bi	mg/L			*0.00015*	*0.00015*	*0.00015*	*0.00015*
Ca	mg/L			153	46.8	46.8	42.8
Cd	mg/L		0.00017	**0.13**	**0.0051**	**0.0025**	**0.0049**
Co	mg/L			0.011	0.0004	*0.00015*	0.00023
Cr	mg/L		0.010*	*0.0005*	*0.0005*	*0.0005*	*0.0005*
Cu	mg/L	0.30		0.0015	0.0014	0.0009	0.0021
Fe	mg/L			*0.01*	*0.01*	*0.01*	*0.01*
Hg	mg/L		0.00026	*0.00005*	*0.00005*	*0.00005*	*0.00005*
K	mg/L			1.9	0.91	1.2	0.55
Li	mg/L			*0.002*	*0.0025*	*0.0025*	*0.0025*
Mg	mg/L			5.7	2.3	2.8	1.8
Mn	mg/L			2.1	0.22	0.078	0.19
Mo	mg/L		0.73	0.0006	0.0033	0.0029	0.0039
Na	mg/L			1.52	2.39	3.21	2.22
Ni	mg/L	0.50		0.024	0.002	0.001	0.002
P	mg/L			*0.05*	*0.05*	*0.05*	*0.05*
Pb	mg/L	0.20		0.17	0.039	0.020	0.061
Sb	mg/L			0.0034	0.016	0.047	0.011
Se	mg/L		0.010	**0.20**	**0.42**	**0.60**	**0.53**
Si	mg/L			0.36	0.41	0.32	0.33
Sn	mg/L			*0.0005*	*0.0005*	*0.0005*	*0.0005*
Sr	mg/L			0.33	0.064	0.066	0.059
Ti	mg/L			*0.0015*	*0.0015*	*0.0015*	*0.0015*
Tl	mg/L		0.0080	**0.022**	0.0063	0.0023	**0.0087**
U	mg/L			*0.0001*	*0.0001*	*0.0001*	*0.0001*
V	mg/L			0.0010	*0.00045*	*0.00045*	*0.00045*
Zn	mg/L	0.50		**6.87**	0.081	0.037	0.064

1. Metal Mining Effluent Regulations (2002) for maximum monthly mean concentrations.
2. Ten times the Canadian Council of Ministers of the Environment Canadian Water Quality Guidelines for the protection of freshwater aquatic life
† indicates 10X British Columbia water quality guidelines for the protection of freshwater aquatic life.
*Hexavalent chromium
Italics indicates measured value less than detection limit and listed as one half of the detection limit
Bold indicates measured values in excess of MMER and/or 10x CCME
na = not analyzed

Results show the final pH was near neutral to slightly alkaline and ranged from pH 7.3 to pH 8.4. Only Zn, in the Combined Overall Ore Composite tailings sample, was found to exceed the Metal Mining Effluent Regulations (2002) (MMER). In lieu of MMER guidelines, Canadian Council of Ministers of the Environment (CCME) Canadian Water Quality Guidelines for the protection of freshwater aquatic life have been included. Note CCME guidelines are several orders of magnitude more stringent than MMER guidelines. A criteria of 10x the receiving water quality guideline value was selected because, for the parameters where there is an MMER limit because a factor of 10 provides a level of conservatism for protecting downstream aquatic resources similar to or better than the MMER limits. Parameters exceeding 10x CCME guidelines include Cd, Tl and Se in all samples tested.

SFE results suggest the initial exposure of samples to atmospheric conditions will result in minimal trace metal(loid) releases except for the Combined Overall Ore Composite, which shows Cd (0.134 mg/L), Se (0.20), Tl (0.022 mg/L) and Zn (6.87 mg/L) releases. The major ions (Ca^{2+}, Na^{+}, Mg^{2+}, Mn^{2+}, Cl^{-}, SO_4^{2-} and thiosalts) also show releases, likely due to the dissolution of gypsum ($CaSO_4$) and other salts and sulfosalts present at low abundances. An SFE reassay was conducted to confirm the release of $SO4^{2-}$ and appears to be related to the drying and oxidation of the Combined Overall Ore prior to analyses. In addition, a $ZnSO_4$ reagent is added to processing and may also be contributing to the dissolved inventories.

1.5 Kinetic Testing

1.5.1 Tailings Aging Tests

1.5.1.1 Methodology

Aging tests were designed and conducted on combined tailings samples representing possible tailings blends from the Wolverine Project. The procedure is intended to mimic the change in water chemistry in a tailings impoundment over time. In this experiment, a clean polyethylene canister was charged with tailings and water and left to stand in the laboratory for an extended period of time (up to 120 days). Canisters are loosely covered by a plastic lid to facilitate free

exchange with atmospheric CO_2 and O_2. A visible observation was made prior to the collection of each supernatant sample. Supernatant samples were collected at pre-determined time periods (Time 0, Day 1, 4, 7, 15, 29, 60, 90 and 120). It should be noted that Time 0 was approximately 1 hour into the test. Several physical and intermediate parameters including pH, conductivity, hardness, alkalinity, acidity, total suspended solids, nitrogen species, cyanides, sulphate and thiosalts were analyzed for. In addition, total metals analyses by ICP-MS on 33 elements were undertaken. Dissolved metals analysis was not completed since all the samples had very low TSS at the time of sampling. Acute lethality testing was also undertaken at an early (e.g., Day 1) and a late (e.g., Day 120) time period during the aging tests.

1.5.1.2 Results

In the case of the Wolverine deposit, the presence of low pH drainage in the vicinity of the ore body confirms the acid generation potential predictions for the ore, tailings and waste rock. The grain size distribution of the material tested in the laboratory will only be affected by beach segregation within the impoundment, which may result in local differences in permeability and sulphide content. The cooler temperatures at site will increase water viscosity and decrease reaction kinetics, which may combine to reduce tailings aging rates and contaminant mass transfer rates. This is likely to serve to attenuate the severity of water quality changes but will also serve to prolong their duration. The Time 0 characteristics of the tailings supernatant analyzed from the tailings aging tests provides the most reliable concentrations expected as the tailings are first deposited into the impoundment. The results of the aging tests are shown in Table II-1.13 through Table II-1.16. Photos of the testing set-up are shown below in Figure II-1.2.

Figure II-1.2 Aging Test Setup

Table II-1.13 Combined Overall Ore Composite Tailings Aging Test Results

PARAMETER	UNITS	MMER[1]	10X CCME[2]	ELAPSED NUMBER OF DAYS								
				0	1	4	7	15	29	60	90	120
pH	units		6.5-9.0	7.47	7.2	7.04	7.42	7.08	7.91	7.67	7.72	7.39
Conductivity	µS/cm			1570	1570	1570	1660	1650	1780	2010	2010	2140
TDS	mg/L			1290	1290	1290	1290	1420	1520	1690	1950	1840
Acidity	mg $CaCO_3$ /L			432	423	434	378	336	253	*1*	72	< 2
Alkalinity	mg $CaCO_3$ /L			36	29	29	28	34	59	44	81	54
F	mg/L			0.27	0.26	0.27	0.29	0.26	0.35	0.38	0.39	0.38
TSS	mg/L	15.0		**100**	**66**	*2*	2	2	4	3	4	3
Cl	mg/L			19	19	19	20	19	20	18	20	20
NO_3^-	mg N /L			0.43	0.42	0.42	0.43	0.38	*0.25*	*0.025*	*0.025*	*0.025*
SO_4^{2-}	mg/L		500†	**520**	**550**	**550**	**570**	**590**	**740**	**1100**	**1000**	**1200**
$NH_3^+NH_4^+$	mg N/L		17.7 (T=15°C and pH 7)	1.1	1	1.2	1	1	0.8	1.4	0.8	0.2
Thiosalts	mg S_2O_3/L			397	395	426	427	393	307	*5*	248	*5*
$CN_{(T)}$	mg/L	1.0		0.03	0.03	0.01	0.01	0.01	*0.005*	*0.005*	0.02	0.01
CNO	mg/L			2.1	2.1	2	1.3	1.7	*0.05*	0.4	*0.05*	*0.05*
CNS	mg/L			4.1	4.9	5.3	5	5	5	*0.01*	5.9	4.5
Hg	mg/L		0.00026	***0.00005***	***0.00005***	***0.00005***	***0.00005***	0.0002	0.0001	***0.00005***	***0.00005***	***0.00005***
Hardness	mg $CaCO_3$/L			435	433	443	427	434	591	811	851	860
Ag	mg/L		0.0010	**0.022**	**0.0074**	**0.0077**	**0.0072**	**0.0054**	**0.0048**	*0.00005*	*0.0025*	*0.00005*
Al	mg/L			0.031	0.014	0.012	0.009	*0.002*	*0.002*	*0.002*	*0.005*	*0.002*
As	mg/L	0.50		0.01	*0.005*	0.026	0.02	0.014	0.03	0.011	0.023	0.021
Ba	mg/L			0.114	0.079	0.078	0.071	0.065	0.048	0.039	0.035	0.039
B	mg/L			0.02	0.017	0.016	0.018	0.02	0.02	0.017	0.03	0.030
Bi	mg/L			*0.00015*	*0.00015*	*0.00015*	*0.00015*	*0.00015*	*0.00015*	*0.00015*	*0.00015*	*0.00015*
Be	mg/L			*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*
Ca	mg/L			*165*	*165*	*166*	*160*	*159*	*217*	*302*	*317*	*319*
Cd	mg/L		0.00017	*0.0045*	*0.0123*	*0.013*	*0.0109*	*0.02*	*0.0136*	*0.0062*	*0.0227*	*0.0169*

Table II-1.13 Combined Overall Ore Composite Tailings Aging Test Results (cont'd)

PARAMETER	UNITS	MMER[1]	10X CCME[2]	ELAPSED NUMBER OF DAYS								
				0	1	4	7	15	29	60	90	120
Co	mg/L			*0.0011*	*0.0011*	*0.0012*	*0.0009*	*0.0011*	*0.0016*	*0.0009*	*0.0021*	*0.0021*
Cr	mg/L		0.010*	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*	0.004
Cu	mg/L	0.30		0.0454	0.0191	0.0189	0.0037	0.0096	0.0115	0.004	0.0046	0.0024
Fe	mg/L		3.0	0.04	0.03	*0.01*	0.05	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*
K	mg/L			8.05	7.69	10	5.82	8.32	10.5	12	10.2	11.4
Li	mg/L			*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*
Mg	mg/L			5.46	5.28	6.73	6.65	8.89	11.7	14	14.4	15.1
Mn	mg/L			0.0872	0.117	0.116	0.117	0.205	0.545	1.64	1.65	2.44
Mo	mg/L		0.73	0.0503	0.0419	0.0419	0.0192	0.0028	0.0078	0.0115	0.0050	0.0018
Na	mg/L			198	205	204	149	175	177	180	176	169
Ni	mg/L	0.50		0.004	0.005	0.005	0.004	0.007	0.01	0.01	0.012	0.028
P	mg/L			*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.0005*
Pb	mg/L	0.20		0.0255	0.109	0.108	0.125	0.179	0.102	0.0151	0.0266	0.0760
Sb	mg/L			0.0645	0.0506	0.0505	0.0412	0.0172	0.0249	0.0222	*0.025*	0.0142
Se	mg/L		0.010	**1.89**	**1.74**	**3.72**	**1.93**	**1.22**	**0.777**	**0.237**	**0.21**	**0.994**
Si	mg/L			0.42	0.43	0.58	0.6	0.91	1.87	2.05	3.11	2.80
Sn	mg/L			0.006	0.006	0.006	0.006	0.008	0.007	0.005	0.004	0.001
Sr	mg/L			0.304	0.318	0.325	0.325	0.311	0.37	0.495	0.490	0.539
Ti	mg/L			*0.0015*	*0.0015*	*0.0015*	*0.0015*	*0.0015*	*0.0015*	*0.0015*	*0.0025*	*0.0015*
Tl	mg/L		0.0080	0.0067	**0.0084**	**0.0084**	0.0076	**0.0093**	0.0064	0.006	**0.0106**	**0.0089**
U	mg/L			0.0006	0.0004	0.0004	0.0004	0.0008	0.0015	0.0011	0.0021	0.0015
V	mg/L			*0.00045*	*0.00045*	*0.00045*	*0.00045*	*0.00045*	*0.00045*	0.0011	0.003	0.0011
Zn	mg/L	0.50		0.076	**0.749**	**0.764**	**0.833**	**1.68**	**1.98**	**1.78**	**2.76**	**5.57**

1. Metal Mining Effluent Regulations (2002) for maximum monthly mean concentrations.
2. 10X the Canadian Council of Ministers of the Environment Canadian Water Quality Guidelines for the protection of freshwater aquatic life
† indicates BC 10X water quality guidelines for the protection of freshwater aquatic life.
*Hexavalent chromium
Italics indicates measured value less than detection limit and listed as one half of the detection limit
Bold indicates measured values in excess of MMER and/or 10x CCME guidelines

Table II-1.14 Combined OD Composite Tailings Aging Test Results

PARAMETER	UNITS	MMER[1]	10X CCME[2]	ELAPSED NUMBER OF DAYS								
				0	1	4	7	15	30	61	90	120
pH	units		6.5-9.0	8.13	7.20	6.99	6.76	7.02	7.56	7.16	7.37	7.38
Conductivity	uS/cm			1850	1910	1930	1870	1720	1630	1930	3310	2200
TDS	mg/L			1640	1500	1540	1540	1700	1590	1580	1680	1840
Acidity	mg $CaCO_3$ /L			175	*1*	282	178	91	211	64	5	*1*
Alkalinity	mg $CaCO_3$ /L			26	21	9	8	16	33	34	44	44
F	mg/L			0.22	0.32	0.30	0.29	0.34	0.38	0.44	*0.03*	0.49
TSS	mg/L	15.0		**36**	**23**	*1*	*1*	*1*	*1*	2	*1*	2
Cl	mg/L			19	23	19	20	19	20	20	19	21
$NO_3^=$	mg N /L			0.18	0.19	0.18	0.18	0.17	0.10	0.09	0.13	0.06
SO_4^{2-}	mg/L		500†	**630**	**610**	**670**	**640**	**680**	**780**	**920**	**1100**	**1300**
$NH_3^+NH_4$	mg N/L		17.7 (T=15°C and pH 7)	1.3	1.4	1.2	1.3	7.4	1.2	1.2	1.1	1.2
Thiosalts	mg S_2O_3/L			465	458	482	151	330	257	133	85	20
$CN_{(T)}$	mg/L	1.0		0.02	0.02	0.01	0.001	*0.001*	*0.005*	*0.005*	*0.01*	*0.005*
CNO	mg/L			1.6	1.7	1.3	0.6	1	0.6	0.4	*0.05*	*0.5*
CNS	mg/L			3.2	3.1	3.2	3.3	3.4	20	3.4	**	na
Hg	mg/L		0.00026	***0.00005***	***0.00005***	***0.00005***	***0.00005***	***0.00005***	***0.00005***	***0.00005***	0.0003	*0.00005*
Hardness	mg $CaCO_3$/L			510	498	512	499	552	562	560	710	904
Ag	mg/L		0.0010	**0.0047**	**0.0057**	**0.0047**	**0.0095**	**0.0082**	**0.0038**	**0.0013**	0.0008	0.0003
Al	mg/L			0.06	0.045	0.013	0.018	0.007	0.018	*0.002*	0.011	*0.002*
As	mg/L	0.50		0.036	*0.0025*	*0.0025*	0.006	0.01	0.007	0.013	0.014	0.006
Ba	mg/L			0.366	0.306	0.079	0.135	0.085	0.056	0.032	0.029	0.025
B	mg/L			*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*
Be	mg/L			0.011	0.08	0.02	0.014	0.016	0.017	0.023	0.025	0.020
Bi	mg/L			*0.00015*	*0.00015*	*0.00015*	*0.00015*	*0.00015*	*0.00015*	*0.00015*	*0.00015*	*0.00015*
Ca	mg/L			194	190	193	186	204	206	203	257	328
Cd	mg/L		0.00017	**0.0017**	**0.0021**	**0.0017**	**0.0053**	**0.0074**	**0.0096**	**0.0059**	**0.0131**	**0.0257**

Table II-1.14 Combined OD Composite Tailings Aging Test Results (cont'd)

PARAMETER	UNITS	MMER[1]	10X CCME[2]	ELAPSED NUMBER OF DAYS								
				0	1	4	7	15	30	61	90	120
Co	mg/L			0.0007	0.0009	0.0004	0.0008	0.0009	0.0018	0.0017	0.0027	0.0035
Cr	mg/L		0.010*	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*	0.001
Cu	mg/L	0.30		0.0051	0.0029	0.0016	0.002	0.0031	0.0066	0.0075	0.0065	0.0038
Fe	mg/L			*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	0.02	*0.01*	*0.01*	*0.01*
K	mg/L			10.6	12.1	10.4	10.7	11.5	12.4	14.2	12.6	12.3
Li	mg/L			*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*
Mg	mg/L			6	5.93	7.46	8.28	10.5	11.5	12.8	17.0	20.6
Mn	mg/L			0.0169	0.0163	0.0233	0.0608	0.185	0.194	0.373	0.715	1.52
Mo	mg/L		0.73	0.0106	0.0102	0.0090	0.0158	0.0187	0.0207	0.0297	0.0188	0.0096
Na	mg/L			203	196	199	192	213	216	192	205	209
Ni	mg/L	0.50		0.012	0.021	0.010	0.02	0.005	0.020	0.015	0.009	0.032
P	mg/L			*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*
Pb	mg/L	0.20		0.0114	0.0718	0.0206	0.0491	0.0153	0.0047	0.0015	0.0013	0.0053
Sb	mg/L			0.027	0.0183	0.0066	0.0197	0.0284	0.0330	0.0146	0.0146	0.0094
Se	mg/L		0.010	**1.76**	**0.854**	**0.450**	**1.73**	**0.67**	**0.836**	**1.09**	**0.889**	**0.388**
Si	mg/L			0.39	0.38	0.43	0.45	0.68	0.82	1.03	1.30	1.40
Sn	mg/L			0.008	*0.0005*	0.002	0.004	0.003	0.008	0.005	0.001	0.001
Sr	mg/L			0.272	0.230	0.150	0.334	0.358	0.320	0.354	0.398	0.520
Ti	mg/L			*0.0015*	*0.0015*	*0.0015*	*0.0015*	*0.0015*	*0.0015*	*0.0015*	0.011	*0.0015*
Tl	mg/L		0.0080	0.0044	0.0033	0.0021	0.0061	0.004	0.0028	0.0056	0.0063	0.0029
U	mg/L			0.0003	*0.0001*	*0.0001*	0.0002	0.0004	0.0007	0.0007	0.0009	0.0009
V	mg/L			*0.00045*	*0.00045*	*0.00045*	*0.00045*	*0.00045*	*0.00045*	*0.00045*	*0.000045*	*0.00045*
Zn	mg/L	0.50		0.021	0.038	0.050	0.12	0.198	0.162	0.454	**1.04**	**1.68**

1. Metal Mining Effluent Regulations (2002) for maximum monthly mean concentrations.
2. 10X the Canadian Council of Ministers of the Environment Canadian Water Quality Guidelines for the protection of freshwater aquatic life
† indicates 10X British Columbia water quality guidelines for the protection of freshwater aquatic life.
*Hexavalent chromium
Italics indicates measured value less than detection limit and listed as one half of the detection limit
Bold indicates measured values in excess of MMER and/or 10x CCME guidelines
** = could not be determined due to sample matrix
na = not analyzed

Table II-1.15 Combined Wolverine D Composite Aging Test Results

PARAMETER	UNITS	MMER[1]	10X CCME[2]	ELAPSED NUMBER OF DAYS								
				0	1	4	7	15	29	60	90	120
pH	units		6.5-9.0	8.59	7.68	7.58	7.00	6.93	6.88	7.11	7.32	7.65
Conductivity	uS/cm			2000	2010	2040	2040	2030	1770	2080	2240	2360
TDS	mg/L			1590	1600	1610	1780	1790	1700	1720	1900	2030
Acidity	mg $CaCO_3$ /L			398	437	437	397	375	306	235	124	179
Alkalinity	mg $CaCO_3$ /L			47	29	37	14	9	12	28	32	59
F	mg/L			0.42	0.37	0.38	0.34	0.47	0.44	0.50	0.47	0.50
TSS	mg/L	15.0		**25**	2	**32**	*1*	*1*	4	4	2	3
Cl	mg/L			19	19	19	19	20	20	21	21	21
NO_3^-	mg N /L			*0.25*	0.16	0.20	0.17	0.16	0.16	0.15	0.16	0.16
SO_4^{2-}	mg/L		500†	**590**	**550**	**630**	**590**	**630**	**740**	**890**	**1200**	**1200**
$NH_3 + NH_4$	mg N/L		17.7 (T=15°C and pH 7)	**1.3**	**1.1**	**0.4**	**1.1**	**1.2**	**1.2**	**1.1**	**1.0**	**1.0**
Thiosalts	mg S_2O_3/L			553	446	*5*	525	362	386	243	211	260
$CN_{(T)}$	mg/L	1.0		0.02	0.02	0.01	*0.005*	*0.005*	*0.005*	*0.005*	*0.01*	*0.001*
CNO	mg/L			1.2	1.1	1.0	0.8	1.2	0.5	0.2	*0.5*	*0.5*
CNS	mg/L			2.2	2.8	2.4	2.5	3.1	11	6.7	**	na
Hg	mg/L		0.00026	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	0.0001	0.0002	0.0002	0.0002
Hardness	mg $CaCO_3$/L			442	449	467	463	507	511	544	682	762
Ag	mg/L		0.0010	**0.0039**	**0.0017**	**0.0044**	**0.0040**	**0.0072**	**0.0038**	**0.0060**	0.0042	0.0039
Al	mg/L			0.190	0.118	0.112	0.057	0.022	0.018	0.006	*0.002*	0.007
As	mg/L	0.50		0.013	0.006	0.007	0.017	0.022	0.010	0.030	0.012	0.016
Ba	mg/L			0.331	0.227	0.375	0.324	0.123	0.056	0.033	0.024	0.024
Be	mg/L			*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*
B	mg/L			0.04	0.02	0.02	0.014	0.016	0.017	0.026	0.015	0.025
Bi	mg/L			*0.00015*	*0.00015*	*0.00015*	*0.00015*	*0.00015*	*0.00015*	*0.00015*	*0.00015*	*0.00015*
Ca	mg/L			171	174	181	178	191	189	197	244	272
Cd	mg/L		0.00017	**0.0005**	**0.0010**	**0.0046**	**0.0049**	**0.0060**	**0.0096**	**0.0048**	**0.0046**	**0.0040**
Co	mg/L			**0.0008**	**0.0005**	**0.0008**	**0.0008**	**0.0008**	**0.0018**	**0.0010**	**0.0016**	**0.0024**
Cr	mg/L		0.010*	**0.002**	**0.002**	**0.0005**	**0.001**	**0.0005**	**0.0005**	**0.0005**	**0.0005**	**0.0005**

Table II-1.15 Combined Wolverine D Composite Aging Test Results (cont'd)

PARAMETER	UNITS	MMER[1]	10X CCME[2]	ELAPSED NUMBER OF DAYS								
				0	1	4	7	15	29	60	90	120
Cu	mg/L	0.30		0.0080	0.0027	0.0174	0.0048	0.0060	0.0064	0.0046	0.0024	0.0048
Fe	mg/L			*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	0.03	*0.01*	*0.01*	0.05
K	mg/L			11.1	11.2	11.6	11.9	13.3	13.9	15.7	13.4	13.3
Li	mg/L			*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*
Mg	mg/L			3.31	3.45	3.87	4.75	7.36	9.80	12.9	17.6	20.1
Mn	mg/L			0.0013	0.0020	0.0065	0.0190	0.0483	0.190	0.114	0.269	0.288
Mo	mg/L		0.73	0.0497	0.0373	0.0374	0.0402	0.0426	0.0205	0.0262	0.0196	0.0108
Na	mg/L			235	234	237	233	253	259	232	238	227
Ni	mg/L	0.50		0.016	0.013	0.023	0.004	0.003	0.018	0.012	0.005	0.028
P	mg/L			*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*
Pb	mg/L	0.20		0.0089	0.0320	0.112	0.0782	0.0396	0.0046	0.0047	0.0024	0.0031
Sb	mg/L			0.0162	0.0095	0.0313	0.0573	0.119	0.0334	0.0704	0.0413	0.0297
Se	mg/L		0.010	**1.66**	**1.06**	**1.38**	**1.93**	**0.91**	**0.823**	**1.65**	**1.19**	**1.26**
Si	mg/L			0.31	0.33	0.32	0.37	0.51	0.54	0.84	0.99	1.18
Sn	mg/L			0.007	0.002	0.007	0.006	0.004	0.008	0.005	0.002	0.004
Sr	mg/L			0.282	0.213	0.298	0.318	0.312	0.312	0.346	0.470	0.527
Ti	mg/L			*0.0015*	*0.0015*	*0.0015*	0.163	*0.0015*	*0.0015*	*0.0015*	*0.0015*	*0.0015*
Tl	mg/L		0.0080	0.0021	0.0011	0.0021	0.0020	0.0028	0.0028	0.0036	0.0043	0.0034
U	mg/L			*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	0.0007	0.0008	0.0011	0.0018
V	mg/L			*0.00045*	*0.00045*	*0.00045*	*0.00045*	*0.00045*	*0.00045*	*0.00045*	*0.00045*	*0.00045*
Zn	mg/L	0.50		0.010	0.018	0.097	0.125	0.113	0.160	0.226	0.354	**0.514**

1. Metal Mining Effluent Regulations (2002) for maximum monthly mean concentrations.
2. 10X the Canadian Council of Ministers of the Environment Canadian Water Quality Guidelines for the protection of freshwater aquatic life
† indicates 10X British Columbia water quality guidelines for the protection of freshwater aquatic life.
*Hexavalent chromium
Italics indicates measured value less than detection limit and listed as one half of the detection limit
Bold indicates measured values in excess of MMER and/or 10x CCME guidelines
** = could not be determined due to sample matrix
na = not analyzed

Table II-1.16 Combined Lynx D Composite aging test results

PARAMETER	UNITS	MMER[1]	10X CCME[2]	ELAPSED NUMBER OF DAYS								
				0	1	3	7	15	30	59	90	120
pH	units		6.5-9.0	8.36	7.87	7.12	7.26	7.32	6.90	7.63	7.72	7.53
Conductivity	uS/cm			1870	1830	1880	1890	1890	2110	2140	2250	2480
TDS	mg/L			1430	1540	1510	1510	1530	1680	1890	2000	2010
Acidity	$CaCO_3$ mg/L			332	342	334	324	164	9.2	*1*	*1*	*1*
Alkalinity	$CaCO_3$ mg/L			37	29	22	24	40	4	41	53	51
F	mg/L			0.22	0.22	0.23	0.21	0.20	0.21	0.32	0.29	0.25
TSS	mg/L	15.0		**23**	*1*	4	14	*1*	3	8	*1*	*1*
Cl	mg/L			19	20	20	19	19	19	20	21	21
NO_3^-	N mg/L			0.15	0.15	0.15	0.16	0.14	*0.025*	*0.025*	*0.025*	*0.025*
SO_4^{2-}	mg/L		500†	**620**	**600**	**660**	**660**	**840**	**1000**	**1200**	**1400**	**1500**
NH_3+NH_4	N mg/L		0.19	**1.3**	**1.4**	**1.2**	**1.0**	**1.0**	**5.3**	**0.9**	1.4	1.6
Thiosalts	S_2O_3 mg/L			439	414	421	381	260	23	*5*	*5*	*5*
$CN_{(T)}$	mg/L	1.0		0.01	0.01	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.001*
CNO	mg/L			2.1	2.1	2.3	2.0	1.1	*0.05*	*0.5*	*0.5*	*0.5*
CNS	mg/L			16	2.3	3.5	2.3	2.3	4.0	2.0	*0.1*	
Hg	mg/L		0.00026	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	0.0002	*0.00005*
Hardness	$CaCO_3$ mg/L			462	473	526	547	558	663	813	910	946
Ag	mg/L		0.0010	**0.0178**	**0.0145**	**0.0131**	**0.0099**	**0.0068**	*0.00005*	*0.00005*	*0.00005*	*0.00005*
Al	mg/L			0.080	0.073	0.056	0.015	0.011	0.007	*0.002*	*0.002*	0.012
As	mg/L	0.50		0.008	0.007	0.023	0.043	0.008	0.019	0.010	*0.0025*	0.005
Ba	mg/L			0.407	0.468	0.355	0.190	0.072	0.054	0.028	0.025	0.023
Be	mg/L			*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*
B	mg/L			0.018	0.016	0.013	0.01	0.02	0.019	0.017	0.013	0.016
Bi	mg/L			*0.00015*	*0.00015*	*0.00015*	*0.00015*	*0.00015*	*0.00015*	*0.00015*	*0.00015*	*0.00015*
Ca	mg/L			178	182	201	207	209	249	303	337	348
Cd	mg/L		0.00017	**0.0022**	**0.0030**	**0.0040**	**0.0069**	**0.0086**	**0.0028**	**0.0073**	**0.0031**	**0.0027**
Co	mg/L			0.0008	0.0008	0.0004	0.0004	0.0009	0.0005	0.0007	0.0009	0.0018
Cr	mg/L		0.010*	0.002	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*	0.004

Table II-1.16 Combined Lynx D Composite aging test results (cont'd)

PARAMETER	UNITS	MMER[1]	10X CCME[2]	ELAPSED NUMBER OF DAYS								
				0	**1**	**3**	**7**	**15**	**30**	**59**	**90**	**120**
Cu	mg/L	0.30		0.0499	0.0027	0.0063	0.0445	0.0224	0.0182	0.0023	0.0064	0.0050
Fe	mg/L			*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	0.03	0.04	0.03	0.05
K	mg/L			9.49	9.62	10.5	10.8	11.5	11.8	11.2	11.4	11.9
Li	mg/L			*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*
Mg	mg/L			4.47	4.64	5.91	7.40	9.09	10.3	13.5	16.7	18.5
Mn	mg/L			0.0160	0.0196	0.0412	0.160	0.358	1.05	0.836	1.43	0.860
Mo	mg/L		0.73	0.0042	0.0050	0.0083	0.0396	0.0296	0.0203	0.0180	0.0097	0.0059
Na	mg/L			193	196	218	218	215	215	206	204	206
Ni	mg/L	0.50		0.018	0.019	0.005	0.008	0.005	0.005	0.006	0.004	0.038
P	mg/L			*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*
Pb	mg/L	0.20		0.0218	0.0396	0.0614	0.208	0.0470	0.0512	0.0081	0.0064	0.0047
Sb	mg/L			0.0129	0.0167	0.0161	0.0423	0.0334	0.0375	0.0123	0.0073	0.0072
Se	mg/L		0.010	**1.95**	**1.81**	**0.705**	**1.68**	**1.21**	**0.39**	**0.27**	**0.11**	**0.12**
Si	mg/L			0.27	0.28	0.34	0.52	0.86	1.25	1.30	1.23	1.32
Sn	mg/L			0.006	0.008	0.006	0.005	0.005	0.005	0.006	0.001	0.002
Sr	mg/L			0.308	0.318	0.317	0.297	0.313	0.415	0.480	0.515	0.607
Ti	mg/L			*0.0015*	*0.0015*	*0.0015*	*0.0015*	*0.0015*	*0.0015*	0.009	*0.0015*	*0.0015*
Tl	mg/L		0.0080	**0.0100**	**0.0092**	0.0079	0.0074	0.0051	0.0016	0.0016	0.0011	0.0020
U	mg/L			0.0003	0.0004	0.0003	0.0004	0.0007	*0.0001*	0.0004	0.0003	0.0004
V	mg/L			0.0011	0.0010	*1*	0.0011	*0.00045*	*0.00045*	*0.00045*	*0.00045*	0.0013
Zn	mg/L	0.50		0.027	0.039	0.115	0.28	0.36	**0.55**	0.33	0.48	**0.54**

1. Metal Mining Effluent Regulations (2002) for maximum monthly mean concentrations.
2. 10X the Canadian Council of Ministers of the Environment Canadian Water Quality Guidelines for the protection of freshwater aquatic life
† indicates 10X British Columbia water quality guidelines for the protection of freshwater aquatic life.
*Hexavalent chromium
Italics indicates measured value less than detection limit and listed as one half of the detection limit
Bold indicates measured values in excess of MMER and/or 10x CCME guidelines

Figure II-1.3 through Figure II-1.5 shows the concentrations of TSS, thiosalts, pH and alkalinity, respectively, changing over time during the aging tests.

Figure II-1.6 indicates tested tailings materials produce significant suspended particulates during the first few days of testing except for the combined Lynx D composite. However, TSS concentrations drop below the MMER limit (15 mg/L) between Day 4 and Day 7 suggesting tailings materials may only exceed guidelines initially before they equilibrate.

The thiosalts (partly oxidized linear polysulphide chains) are a potential concern because further oxidation results in the production of sulphuric acid leading to the potential solubilization of additional metal(loid)s. Aging tests (Figure II-1.3) show thiosalt concentrations are elevated during the initial stages of the test but decrease over time, suggesting thiosalt release to the aqueous phase is short-lived (0-20 days). During operations, thiosalts can be expected to oxidize in the tailings pond during operations but the sulphuric acid that is generated from the oxidation of thiosalts to sulphate is expected to be neutralized by the alkalinity in the tailings slurry water. On closure, there will be a short lag time until the remaining thiosalts are oxidized and water quality stabilizes. The production of sulphuric acid from thiosalt oxidation appears to be minimal and confined to the time immediately after sample submergence.

Figure II-1.5 shows an initial decrease in pH, most likely a result of thiosalt oxidation, followed by a rise and stabilization after 30 days. The upward trend and stabilization of pH after 20 days is likely a result of lime or carbonate dissolution inferred from the alkalinity production in Figure II-1.6.

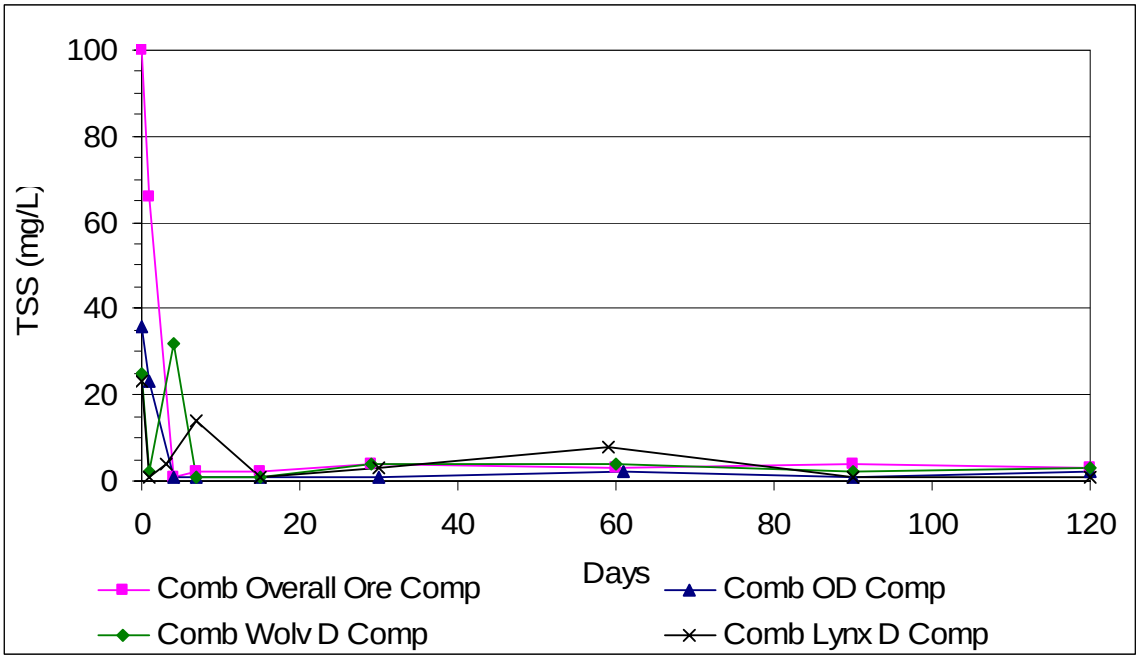

Figure II-1.3 TSS in Supernatant During Aging Tests

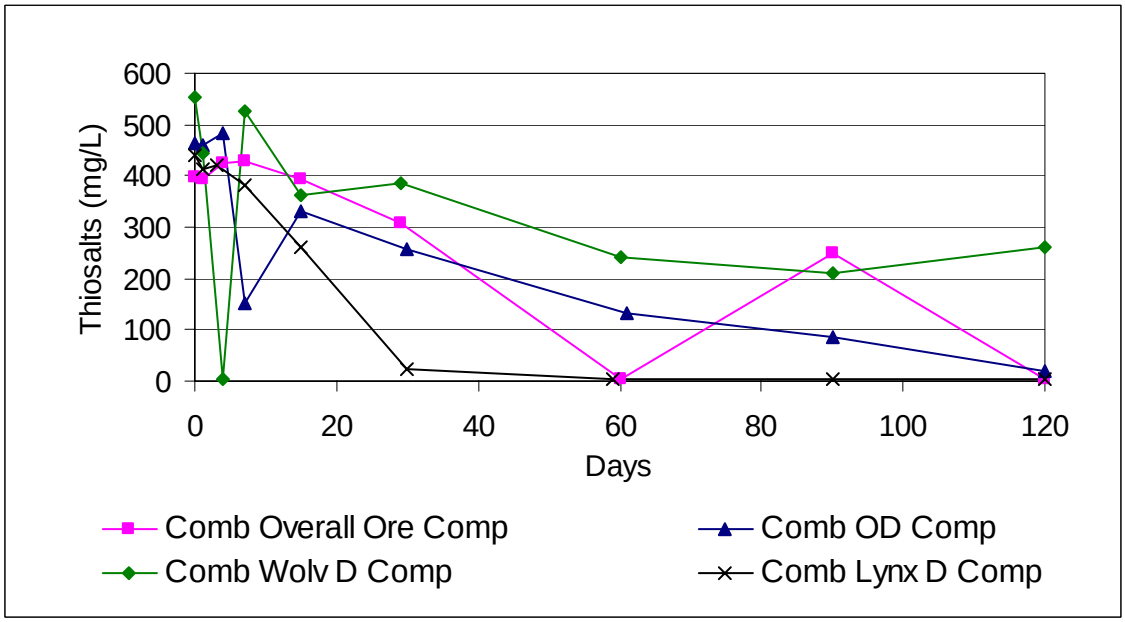

Figure II-1.4 Thiosalt in Supernatant During Aging Tests

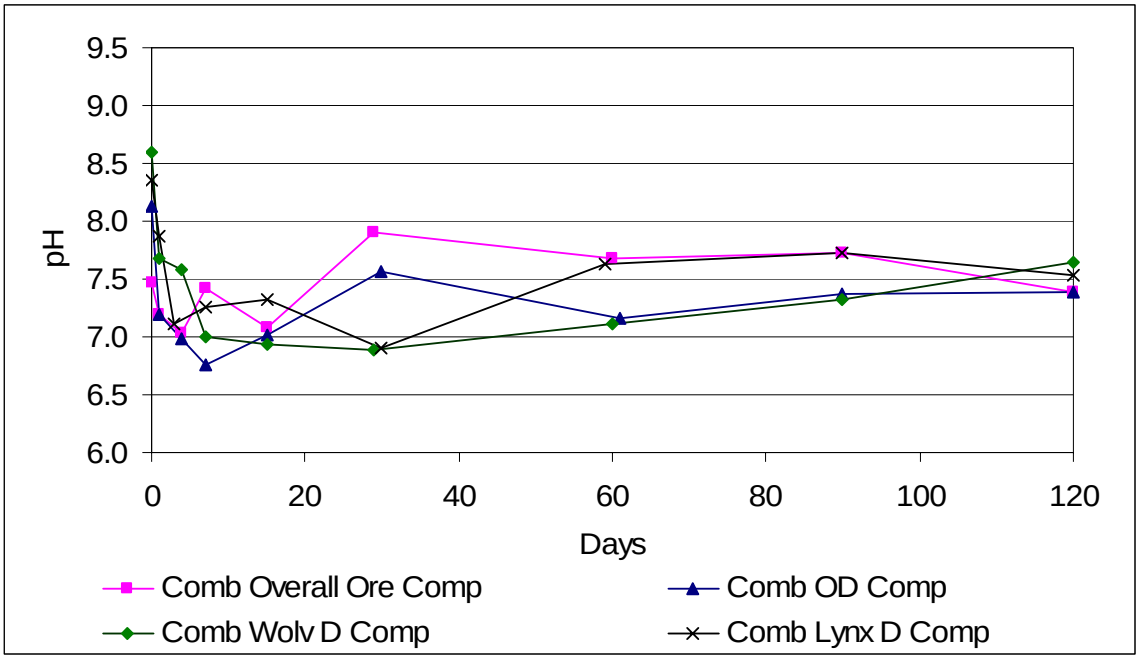

Figure II-1.5 pH in Supernatant During Aging Tests

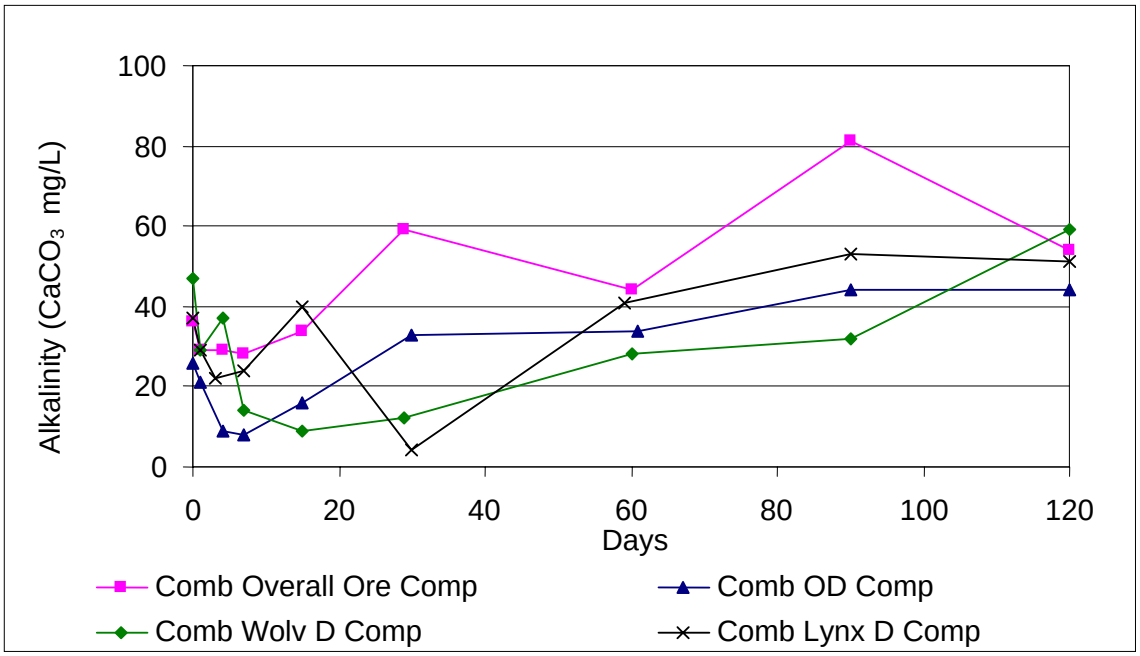

Figure II-1.6 Alkalinity in Supernatant During Aging Tests

Day 0 of the aging tests provides an approximation of total metal concentrations flushed from the tailings as they are first submerged in the Wolverine Tailings impoundment. Due to the abundance of Pb-, Cu-, Zn-, As-, sulphides, initial sulphuric acid production via thiosalt oxidation may result in the solubilization of these elements. Figure II-1.7 and Figure II-1.8 shown Se and Cd may also be released to the surrounding aqueous phase in excess of 10X CCME water quality guidelines (0.01 mg/L and 0.00017 mg/L for Se and Cd, respectively). Se substitution for S in the galena and Cd abundance in sphalerite, reported by Gartner Lee (2004), are likely not the sources of elemental releases due to the lack of concomitant release of dissolved Pb and correlation with dissolved Zn. The origin of the Zn (Figure II-1.9) may be due to several scenarios:

- The dissolution of zinc-bearing carbonates, which is inferred from the concomitant increases in both dissolved Ca and alkalinity with time;
- The dissolution of accumulated oxidation products (zinc sulphate);
- Zn and Cd may be organically complexed, however contributions to dissolved inventories are likely minor due to the small amount of organic C present in these sample (< 1 wt.%); and
- Reagents added to processing streams ($ZnSO_4$).

In addition, Figure II-1.7 through Figure II-1.9 suggests that "aging" may not have reached steady state as concentrations continue to increase at Day 120.

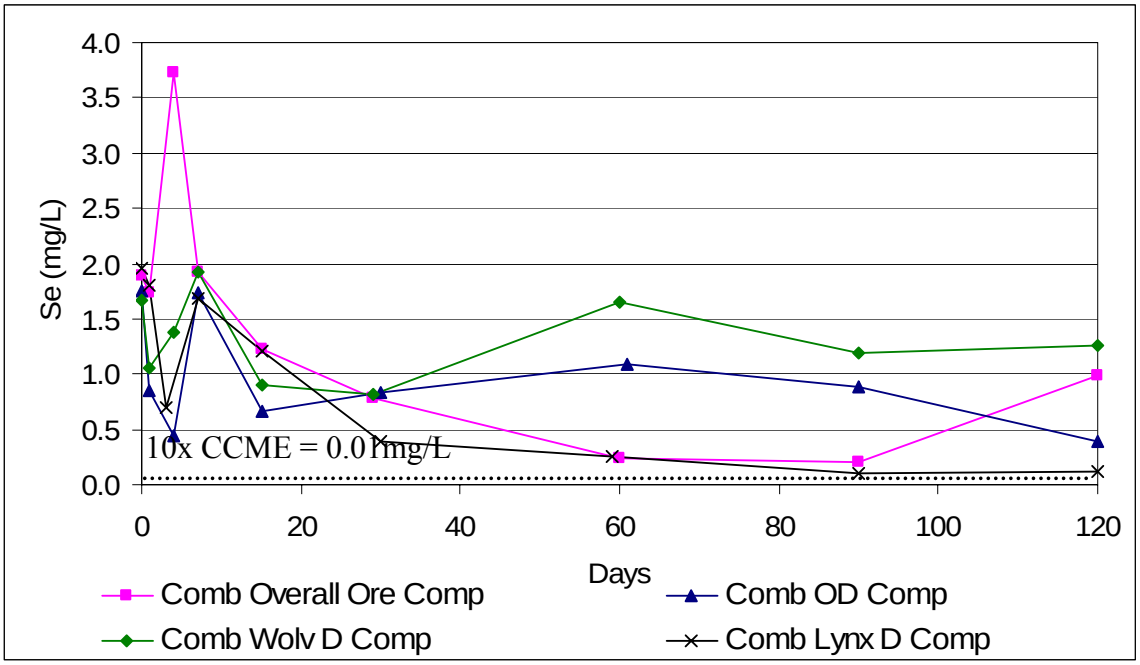

Figure II-1.7 Se in Supernatant During Aging Tests

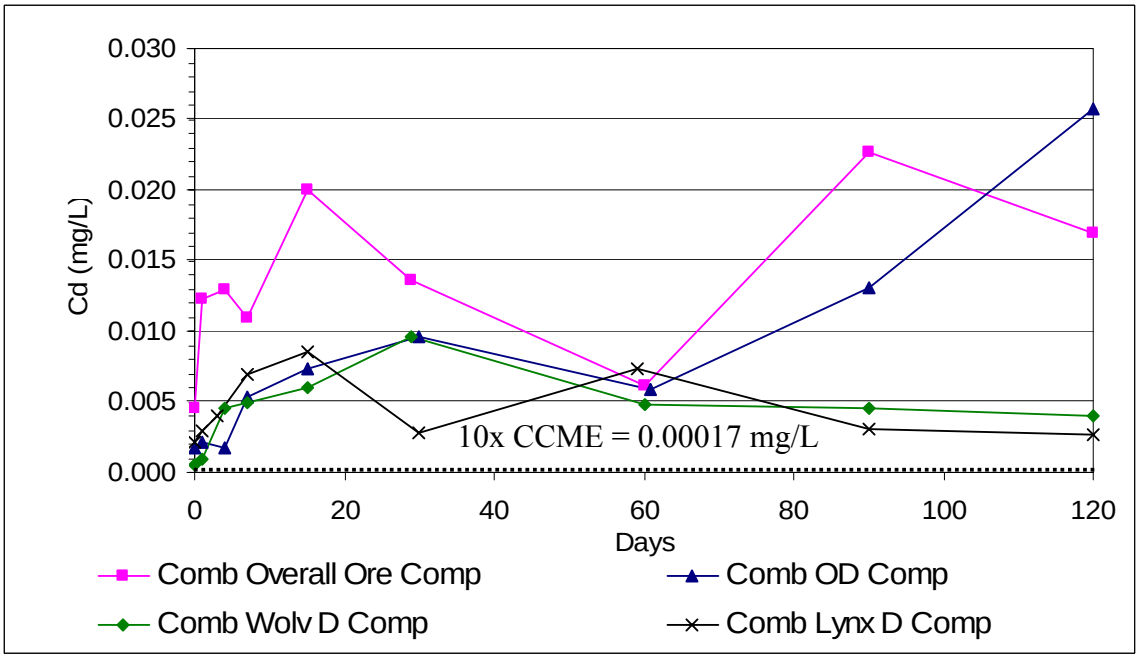

Figure II-1.8 Cd in Supernatant During Aging Tests

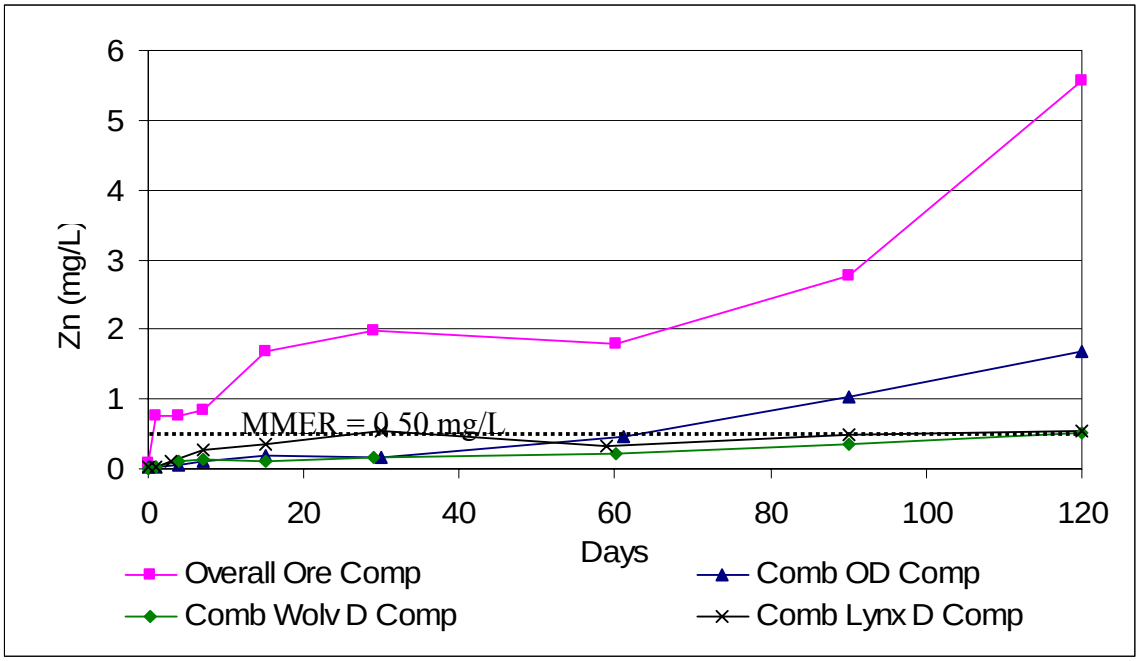

Figure II-1.9 Zn in supernatant during aging tests

1.5.2 Acute Lethality Testing

1.5.2.1 Methodology

The 36 hour decant from the aged Combined Overall Ore Tailings and the 24 hour decant from the aged Combined OD Composite, Combined Wolverine D Composite and Combined Lynx D Composite Tailings were subjected to LC_{50} acute lethality testing of *Daphnia magna* (i.e., the lethal concentration required to kill 50% of the tested population). LC_{50} acute lethality of rainbow trout and Daphnia magna was completed on the 120 Day decant from the aged Combined Overall Ore Tailings, the OD Combined tailings, the Wolverine D tailings and the Lynx D tailings. The test measured the percent mortality of Daphnia magna and rainbow trout in varying concentrations of effluent using standardized test procedures following the *Daphnia magna* Acute Lethality Toxicity Test Protocol EPS 1/RM/14 and Acute Lethality of Liquid Effluents to Fish EPS 1/RM/13 protocols from Environment Canada.

1.5.2.2 Results

Tailings supernatant from acute lethality aging tests results on *Daphnia magna* at day 1 and Day 120 are presented in Table II-1.17. Results indicate that all of the aged decant samples submitted had 100% mortality at 100% effluent concentration. The LC_{50} values indicate that significant dilution of the sample solutions would be required to render the samples non-toxic. Water treatment testing is recommended to evaluate the effective treatment strategies. Similar results are seen for testing results on rainbow trout, presented in Table II-1.18. Comparing the results for Day 1 and Day 120 for both species shows the effect of the increasing Zn concentration on the Combined Overall Ore Tailings. Cd is the element that actually increases and the table below shows the percentage 48-hr LC_{50} decreases from day 1.5 to 120.

Table II-1.17 Tailings Supernatant Acute Lethality Results for *daphnia magna*

TAILINGS SAMPLE	DAY OF TESTING	TOXICITY TEST SPECIES	% MORTALITY AT 100% EFFLUENT CONCENTRATION	48 h LC_{50}
Comb Overall Ore Comp	1.5	*Daphnia magna*	100	37.7 %
Comb OD Comp	1	*Daphnia magna*	100	15.5 %
Comb Wolv D Comp	1	*Daphnia magna*	100	9.7 %
Comb Lynx D Comp	1	*Daphnia magna*	100	19.2%
Comb Overall Ore Comp	120	*Daphnia magna*	100	19.1%

Table II-1.18 Tailings Supernatant Acute Lethality Results for Rainbow Trout

TAILINGS SAMPLE	DAY OF TESTING	TOXICITY TEST SPECIES	% MORTALITY AT 100% EFFLUENT CONCENTRATION	96 h LC_{50}
Comb Overall Ore Comp	120	Rainbow Trout	100	10.9 %
Comb OD Comp	120	Rainbow Trout	100*	< 6 %
Comb Wolv D Comp	120	Rainbow Trout	100**	< 3.1 %
Comb Lynx D Comp	120	Rainbow Trout	100**	> 50 %

* tested in 6 % effluent
** tested in 50 % effluent

The minimum LC_{50} observed, at 100% effluent concentrations, was approximately 10%. This suggests that with at least 10-fold dilution within the tailings pond and downstream of the impoundment, the tailings supernatant would no longer be considered a deleterious substance under the Fisheries Act.

1.5.3 Tailings Humidity Cells

Kinetic testing in the form of flood leach humidity cells of the four combined tailings samples was initiated in June and July of 2005 by SGS Lakefield. The following provides a summary of the Wolverine tailings humidity cells to August 26, 2008, provided by Marsland Environmental Associates. The Overall Ore Composite (OC) and Overall Diluted ore composite (OD) tailings humidity cells have reached weeks 168 and 162, respectively.

1.5.3.1 Results

The humidity cell test data from inception to August 2008 is provided in The pH of all cells has remained relatively constant generally between pH 6.4 and pH 7.0 (see Figure II-1.10). All the Diluted Ore tailings cells experienced a temporary pH depression within the first 20 weeks, before rebounding. The Overall Ore Composite tailings did not experience this. It is surmised that the amount of thiosalt in solution (400 mg/L) did not exceed the rapid neutralization capacity of the tailings for the OC sample, whereas higher amounts of thiosalt (600-1200 mg/L) in the other cells clearly did. Once the initial flush of thiosalts was over (i.e., thiosalts dropped below 400 mg/L), the pH has been unaffected by these comparatively low concentrations.

There have been a few other instances when the pH dropped below pH 6.0 with the lowest pH in Cell OC at pH 4.7 at week 124. It should be noted that coincident with the low pH value at week 124, the sulphate production was measured at 28 mg/kg/wk well below the 5-week average. The low sulphate value is reflected in the lower conductivity. The lower pH is also reflected in the lower alkalinity and higher acidity values than previous and following cycles. In general, there appears to be some additional variability in the data fluctuations since week 109. These fluctuations do not appear to be occurring simultaneously in both Cell OD and OC, which

suggests that the fluctuations are related to variability in reaction rates within the humidity cell and not artifacts of the laboratory testing. However, no trend in median pH is notable.

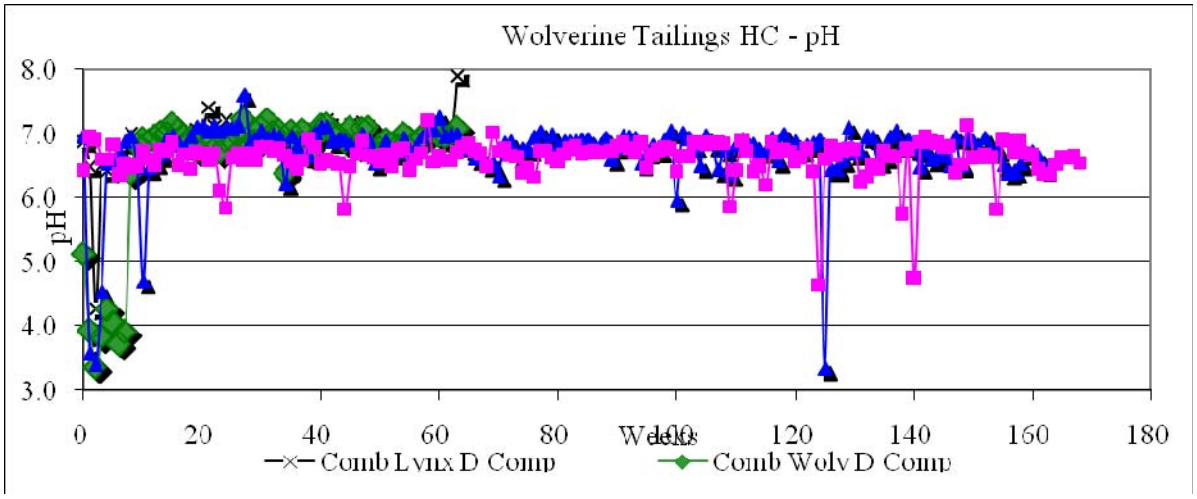

Figure II-1.10 Wolverine Tailings Humidity Cells - pH

Acidity and alkalinity production rates remain low in both cells, consistent with the near-neutral pH and limited by calcite solubility.

The Sulphate production rate for Cell OD has shown a slight decline over the entire testing period (Figure II-1.11). However, this decline has become more evident since week 113 dropping from 232 mg/kg/wk to 116 mg/kg/wk at week 162. Cell OC shows sulphate production remaining relatively constant (fluctuating around 100 mg/kg/wk) from week 70 through week 141. Since week 142 and through to the final measurement taken for this reporting period at week 168, the sulphate production rate has remained consistently above 100 mg/kg/wk and reaching as high as 142 mg/kg/wk at week 150. Both cells now have virtually identical sulphate production rates.

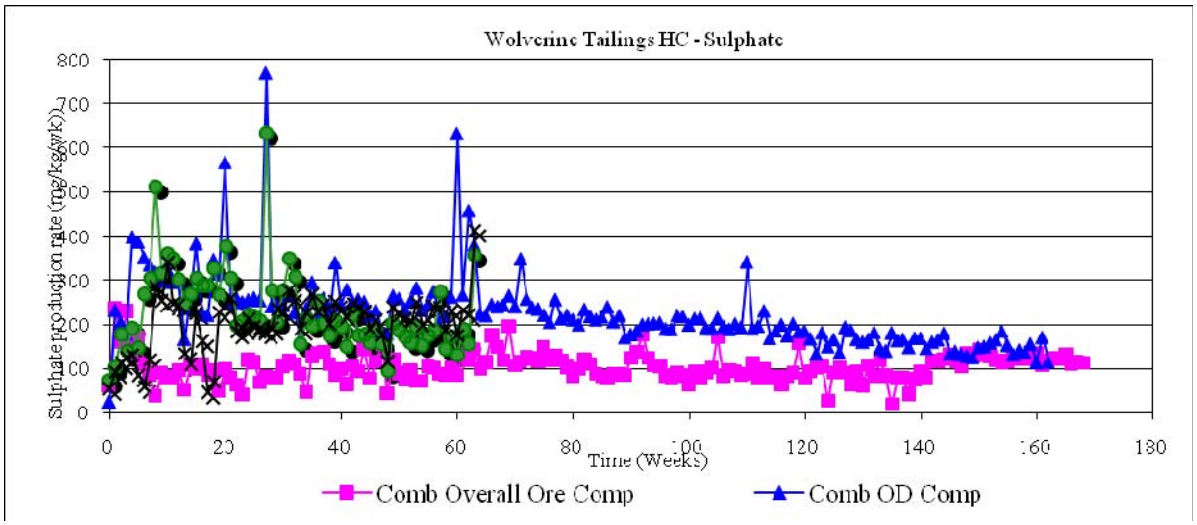

Figure II-1.11 Wolverine Tailings Humidity Cells - Sulphate

Both cells show an abundance of total sulphur (mostly as sulphide) remaining (98.0% and 95.4% for cells OC and OD, respectively) with sulphate sulphur contents of 76.7% and 39.8% for cells OC and OD, respectively.

Table II-1.19 summarizes the range in loading rates for Se and Zn from recent weeks until the current sampling on August 26, 2008.

Table II-1.19 Range in Leachate Elemental Loading Rate over past 20 weeks

ELEMENT	CELL OC LOADING RATE (mg/kg/wk)	CELL OD LOADING RATE (mg/kg/wk)
Se	0.052 – 0.059	0.047 – 0.081
Zn	3.1 – 4.1[1]	0.91 – 1.3

[1] Zinc loading rates in the 20 weeks prior to the previous reporting period ranged from 1.4 to 1.9 mg/kg/wk

Current Zn loadings in both Cell OC and OD are well below the initial flush values. However, since the last reporting period (week 129 for the OC cell), the range in zinc loadings has approximately doubled and appears from Figure II-1.12 to be rising. The increase in Zn loading rates occurred after week 135 and is approximately coincident with the increase in the sulphate production rate noted above.

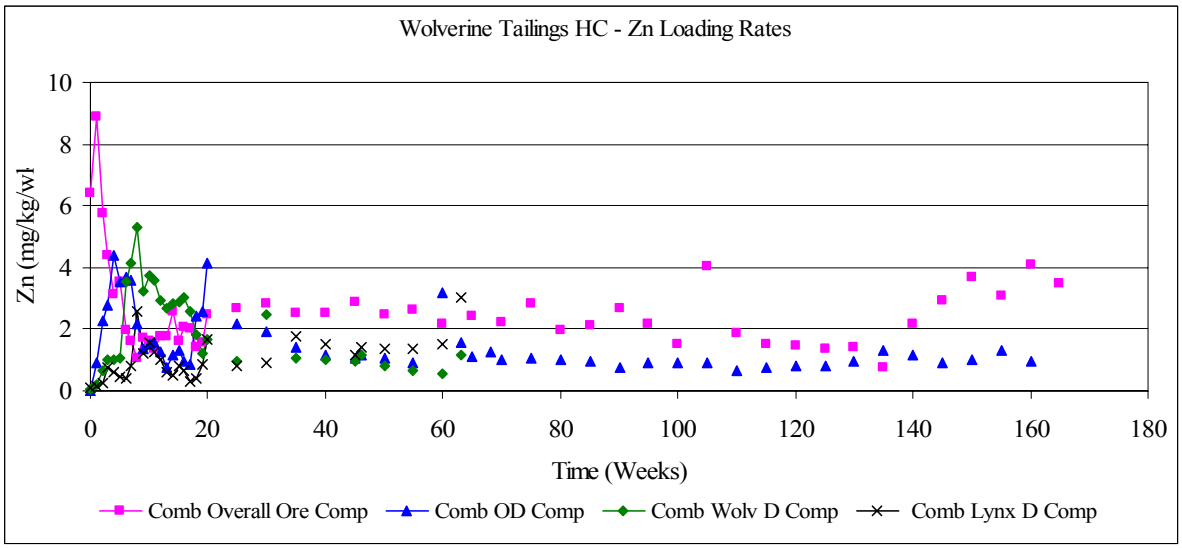

Figure II-1.12 Wolverine Tailings Humidity Cells - Zn Loading Rates

Se loadings have remained relatively constant over the testing period for both cells since the initial flush (see Figure II-1.13). This is likely due to the relatively constant and neutral pH, but shows that soluble minerals still remain even after 3 years of leaching.

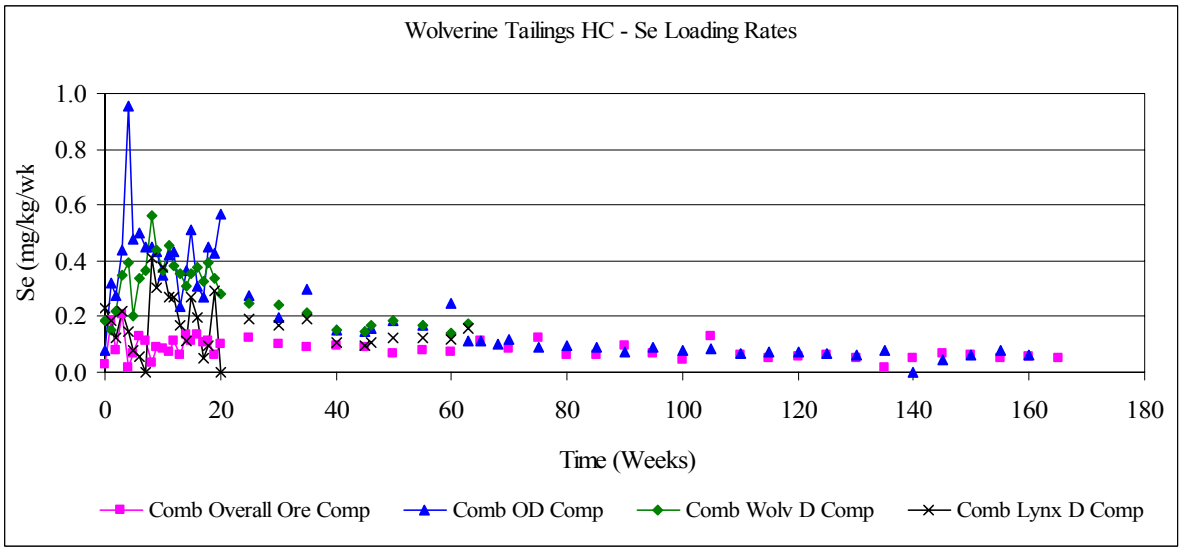

Figure II-1.13 Wolverine Tailings Humidity Cells - Se Loading Rates

Table II-1.20 shows that in the OC cell, of the original Se and Zn contained within the sample used to charge the humidity cell, 5% and 3%, respectively have been flushed out. While, for the OD cell, 14% and 4% of the Se and Zn, respectively have been removed through weekly cell flushing. These low percentages at this stage in the program suggest that Se and Zn leaching will continue for an extended period.

Table II-1.20 Percent Removal of Original Se and Zn

CELL	HEAD ICP Se (mg/kg)	TOTAL Se RELEASED OVER HUMIDITY CELL PERIOD (mg/kg)	% Se REMOVED	HEAD ICP Zn (mg/kg)	TOTAL Zn RELEASED OVER HUMIDITY CELL PERIOD (mg/kg)	% Zn REMOVED
OC	364	17	5	19,000	547	3
OD	261	36	14	5,500	212	4

1.5.3.2 Time to Onset of ARD

In humidity cell testing, it is commonly assumed that sulphide oxidation is not taking place at a substantial rate until flushing of all of the original sulphate measured during the pre-test ABA characterization is complete. Cells OC and OD are showing measurable sulphate in the leachate collected weekly. It is likely that a majority of the sulphate measured is due to flushing of the original sulphate within the sample with some sulphate produced due to sulphide oxidation, particularly in the past few cycles for the OC cell. It is difficult to assess, however, what portion of the sulphate produced is due to sulphide oxidation. Therefore the assumption is made that all sulphate is from flushing as explained above.

The time to sulphate sulphur depletion has been estimated to be 12 and 3 years for Cells OC and OD, respectively. Approximately 60% of the initial sulphate has been removed from the OD cell, however, only 23% has been removed from the OC cell. As mentioned, this assumes that all the sulphate measured in the solution is due to flushing of the original sulphate. It is expected that eventually the sulphide oxidation rate would begin to increase with NP depletion and the onset of acidic conditions.

The time to NP depletion is required to estimate the time to onset of ARD within a laboratory humidity cell. However, the initial sulphate is still flushing from the cells, so it is not possible to ascertain what portion of the sulphate released is from sulphide oxidation. This renders the Carbonate Molar Ratio calculations invalid and precludes an accurate calculation of the time for NP depletion. Once the initial sulphate is believed to have flushed, NP depletion rates can be defined more explicitly. Even if all the current sulphate production from the past 26 weeks in cell OC (the beginning of the rise in sulphate flushing) were to be from sulphide oxidation, it would still take another 11 years in the laboratory humidity cell for all the Sobek-NP to become depleted.

Based on these estimates, acid generation would not occur in the Wolverine tailings for many years. Nevertheless, elevated concentrations of selenium and zinc can be expected in any water contacting the tailings solids.

1.5.3.3 Test Data

The humidity cell test data from inception to August 2008 is provided in the following pages and includes physical parameter and ICP-MS results for cells:

- Lynx – July 22, 2005 through October 3, 2006 (cells decommissioned October 3, 2006)
- Wolverine - July 22, 2005 through October 3, 2006 (cells decommissioned October 3, 2006)
- Overall Diluted Ore Composite - July 22, 2005 through August 26, 2008
- Overall Ore Composite – June 6, 2005 through August 26, 2008

Lynx

Project: Wolverine
Sample: Comb Lynx D Comp

Sample Data - Initial Measurements

Initial organic S	2.68	(%)
Initial total sulphur	31.2	(%)
Initial SO4-S	0.74	(%)
Initial S2--S	27.8	(%)
Sample Weight	1.0	(kg)
Initial NP	49.4	(t $CaCO_3$/1000t)
Assumed NP unreactive		
Initial SO4-S	81,400	(mg)

Results - SO_4 - S Depletion

SO_4 Production (5 wk average)	255	mg/kg/wk
SO_4 Production (5 wk average)	13,287,378	mg/t/yr
SO_4 - S Production (5 wk average)	85	mg/kg/wk
Cumulative SO_4 - S Production	4,312	mg/kg
Time to SO_4 - S Depletion	36	wk

Results - NP Depletion

Initial NP	49,400	mg $CaCO_3$/kg
Cumulative Open System NP Consumption	0	mg $CaCO_3$/kg
Remaining NP	49,400	mg $CaCO_3$/kg
Open System NP Consumption Rate (5 wk average)	0	mg $CaCO_3$/kg/wk
Time to Sobek-NP Depletion	#DIV/0!	wk
Time to Sobek-NP Depletion	#DIV/0!	yr

HUMIDITY CELL TEST DATA

WEEK	DATE	WATER ADDED	LEACHATE COLLECTED	LEACHATE pH	ACIDITY	ALKALINITY	CONDUC-TIVITY	SULPHATE	ACIDITY PRODUCTION			ALKALINITY PRODUCTION RATE	SULPHATE PRODUCTION			SO4-S PRODUCTION		REMAINING SULPHUR (% of ORIGINAL SAMPLE)			THEORETICAL NP CONSUMPTION	WEEK WHERE Ca and Mg WERE LAST SAMPLED	CARBONATE MOLAR RATIO	CARBONATE RATIO CONSUMPTION	OPEN SYSTEM NP CONSUMPTION			REMAINING NP
									PRODUCTION RATE (mg $CaCO_3$/kg/wk)		CUMMULATIVE PRODUCTION		PRODUCTION RATE (mg/kg/wk)		CUMMULATIVE PRODUCTION	PRODUCTION RATE	CUMMULATIVE PRODUCED								CONSUMPTION RATE (mg $CaCO_3$/kg/wk)		CUMMULATIVE CONSUMPTION	
		(L)	(L)		(mg $CaCO_3$/L)	(mg $CaCO_3$/L)	(µS/cm)	(mg/L)	Weekly	5 wk Average	(mg $CaCO_3$/kg)	(mg $CaCO_3$/ /kg/wk)	Weekly	5 wk Average	(mg/kg)	(mg/kg/wk)	(mg/kg)	TOTAL-S	SULPHIDE-S	SULPHATE-S	(mg $CaCO_3$/kg/wk)			(mg $CaCO_3$/ /kg/wk)	Weekly	5 wk Average	(mg $CaCO_3$/kg)	(% of ORIGINAL SAMPLE)
0	July 22/05	0.60		6.9	150	10	397	92	90		90	6.0	55		55	18	18	99.99%	100%	99.75%	0	0	1.7	0	0		0	100.00%
1	July 29/05	0.42	6.5	234	4.0	718	220	98		188	1.7	92		147	31	49	99.98%	100%	99.34%	0	1.0	1.4	0	0		0	100.00%	
2	Aug 5/05	0.42	4.3	376	0.15	758	270	158		345	0.063	113		260	38	87	99.97%	100%	98.83%	0	2.0	1.5	0	0		0	100.00%	
3	Aug 12/05	0.46	6.5	619	4.0	1,120	270	286		631	1.8	125		385	42	129	99.96%	100%	98.26%	0	3.0	2.0	0	0		0	100.00%	
4	Aug 19/05	0.44	6.4	431	3.0	798	300	189	164	820	1.3	132	103	517	44	172	99.94%	100%	97.67%	0	4.0	1.3	0	0	0	0	100.00%	
5	Aug 26/05	0.43	6.5	260	5.0	616	200	112	168	932	2.1	86	110	603	29	201	99.94%	100%	97.28%	0	5.0	1.4	0	0	0	0	100.00%	
6	Sept 2/05	0.43	6.6	193	4.0	437	140	82	165	1,014	1.7	60	103	662	20	221	99.93%	100%	97.01%	0	6.0	1.4	0	0	0	0	100.00%	
7	Sept 9/05	0.45	6.5	352	3.0	775	270	157	165	1,171	1.3	120	104	782	40	261	99.92%	100%	96.47%	0	7.0	1.4	0	0	0	0	100.00%	
8	Sept 16/05	0.46	7.0	504	13	1,300	620	232	154	1,403	6.0	286	137	1,068	95	356	99.89%	100%	95.18%	0	8.0	1.2	0	0	0	0	100.00%	
9	Sept 23/05	0.43	6.8	368	7.0	1,150	590	159	148	1,562	3.0	254	161	1,322	85	441	99.86%	100%	94.04%	0	9.0	1.1	0	0	0	0	100.00%	
10	Sept 30/05	0.49	6.9	295	7.0	1,230	700	144	155	1,705	3.4	341	212	1,663	114	555	99.82%	100%	92.50%	0	10	1.1	0	0	0	0	100.00%	
11	Oct 7/05	0.43	6.8	187	8.0	1,070	580	80	154	1,785	3.4	247	250	1,910	82	638	99.80%	100%	91.38%	0	11	0.89	0	0	0	0	100.00%	
12	Oct 14/05	0.39	7.0	126	10	1,090	620	50	133	1,834	3.9	244	274	2,154	81	719	99.77%	100%	90.29%	0	12	0.97	0	0	0	0	100.00%	
13	Oct 21/05	0.36	6.9	80	7.0	746	370	29	92	1,864	2.5	135	244	2,289	45	764	99.76%	100%	89.68%	0	13	1.00	0	0	0	0	100.00%	
14	Oct 28/05	0.46	6.9	56	8.0	476	240	26	66	1,889	3.7	110	215	2,399	37	801	99.74%	100%	89.18%	0	14	0.93	0	0	0	0	100.00%	
15	Nov 4/05	0.45	7.1	96	10	870	500	43	45	1,933	4.5	227	192	2,625	76	876	99.72%	100%	88.16%	0	15	0.87	0	0	0	0	100.00%	
16	Nov 11/05	0.40	7.1	99	9.0	807	410	39	37	1,972	3.6	163	176	2,788	54	930	99.70%	100%	87.43%	0	16	1.0	0	0	0	0	100.00%	
17	Nov 18/05	0.31	6.9	41	8.0	355	150	13	30	1,985	2.5	47	136	2,835	16	946	99.70%	100%	87.21%	0	17	1.1	0	0	0	0	100.00%	
18	Nov 25/05	0.41	7.0	57	9.0	433	170	24	29	2,008	3.7	70	123	2,905	23	970	99.69%	100%	86.90%	0	18	0.97	0	0	0	0	100.00%	
19	Dec 1/05	0.41	7.1	152	13	999	550	63	36	2,071	5.4	228	147	3,133	76	1,046	99.66%	100%	85.87%	0	19	0.97	0	0	0	0	100.00%	
20	Dec 9/05	0.46	7.0	121	17	938	530	55	39	2,127	7.8	242	150	3,375	81	1,126	99.64%	100%	84.78%	0	20	0.88	0	0	0	0	100.00%	
21	Dec 16/05	0.46	7.4	85	28	1,071	570	39	39	2,165	13	260	169	3,635	87	1,213	99.61%	100%	83.61%	0	20	0.82	0	0	0	0	100.00%	
22	Dec 23/05	0.39	7.1	105	12	868	470	41	44	2,206	4.7	183	197	3,818	61	1,274	99.59%	100%	82.78%	0	20	0.99	0	0	0	0	100.00%	
23	Dec 30/05	0.41	7.0	93	12	856	470	38	47	2,244	4.9	192	221	4,010	64	1,338	99.57%	100%	81.92%	0	20	0.99	0	0	0	0	100.00%	
24	Jan 6/06	0.42	7.2	81	13	963	500	34	41	2,279	5.5	212	218	4,222	71	1,409	99.55%	100%	80.96%	0	20	0.93	0	0	0	0	100.00%	
25	Jan 13/06	0.43	7.0	42	13	864	450	18	34	2,297	5.6	195	208	4,417	65	1,474	99.53%	100%	80.08%	0	25	1.1	0	0	0	0	100.00%	
26	Jan 20/06	0.39	7.2	61	13	897	490	24	31	2,321	5.1	191	195	4,608	64	1,538	99.51%	100%	79.22%	0	25	1.0	0	0	0	0	100.00%	
27	Jan 27/06	0.42	7.1	77	13	858	440	32	29	2,353	5.4	183	195	4,791	61	1,599	99.49%	100%	78.39%	0	25	1.1	0	0	0	0	100.00%	
28	Feb 3/06	0.35	6.9	151	14	1,030	550	52	32	2,405	4.9	191	194	4,982	64	1,663	99.47%	100%	77.53%	0	25	0.90	0	0	0	0	100.00%	
29	Feb 10/06	0.43	6.9	94	12	1,010	550	40	33	2,445	5.1	234	199	5,216	78	1,741	99.44%	100%	76.47%	0	25	0.90	0	0	0	0	100.00%	
30	Feb 17/06	0.39	7.1	76	13	1,030	580	30	36	2,475	5.1	229	206	5,445	76	1,817	99.42%	100%	75.44%	0	30	0.96	0	0	0	0	100.00%	
31	Feb 24/06	0.36	7.1	142	14	1,310	770	51	41	2,526	5.1	278	223	5,723	93	1,910	99.39%	100%	74.19%	0	30	0.73	0	0	0	0	100.00%	
32	Mar 3/06	0.49	7.1	78	23	935	520	38	42	2,564	11	254	237	5,976	85	1,995	99.36%	100%	73.05%	0	30	1.1	0	0	0	0	100.00%	
33	Mar 8/06	0.40	7.0	68	13	929	480	27	37	2,591	5.2	191	237	6,167	64	2,058	99.34%	100%	72.18%	0	30	1.2	0	0	0	0	100.00%	
34	Mar 16/06	0.44	6.8	36	11	1,010	520	16	32	2,607	4.8	227	236	6,394	76	2,134	99.32%	100%	71.16%	0	30	1.1	0	0	0	0	100.00%	
35	Mar 23/06	0.34	7.0	288	22	1,470	800	97	46	2,704	7.4	269	244	6,663	90	2,224	99.29%	100%	69.95%	0	35	1.1	0	0	0	0	100.00%	
36	Mar 31/06	0.41	6.9	173	12	1,080	560	70	50	2,774	4.9	228	234	6,891	76	2,300	99.26%	100%	68.92%	0	35	1.6	0	0	0	0	100.00%	
37	Apr 7/06	0.41	7.1	135	13	1,110	590	56	53	2,830	5.4	244	232	7,135	82	2,381	99.24%	100%	67.82%	0	35	1.5	0	0	0	0	100.00%	
38	Apr 13/06	0.40	6.7	101	15	993	500	41	56	2,871	6.0	201	234	7,336	67	2,448	99.22%	100%	66.91%	0	35	1.8	0	0	0	0	100.00%	
39	Apr 21/06	0.32	7.1	278	28	1,420	780	90	71	2,960	9.0	251	239	7,587	84	2,532	99.19%	100%	65.78%	0	35	1.1	0	0	0	0	100.00%	
40	Apr 28/06	0.41	7.1	98	14	536	560	40	59	3,001	5.8	231	231	7,818	77	2,609	99.16%	100%	64.74%	0	40	1.0	0	0	0	0	100.00%	
41	May 3/06	0.35	7.2	159	15	1,050	610	56	57	3,057	5.3	215	228	8,033	72	2,681	99.14%	100%	63.77%	0	40	0.93	0	0	0	0	100.00%	
42	May 12/06	0.41	7.1	42	13	1,120	600	17	49	3,074	5.3	247	229	8,280	82	2,763	99.11%	100%	62.66%	0	40	0.95	0	0	0	0	100.00%	
43	May 19/06	0.44	7.0	68	13	1,160	550	30	47	3,104	5.7	239	237	8,519	80	2,843	99.09%	100%	61.58%	0	40	1.0	0	0	0	0	100.00%	
44	May 23/06	0.47	7.0	54	13	951	490	25	34	3,129	6.1	229	232	8,748	76	2,920	99.06%	100%	60.55%	0	40	1.2	0	0	0	0	100.00%	
45	May 30/06	0.40	7.1	44	14	891	480	17	29	3,146	5.5	190	224	8,938	63	2,983	99.04%	100%	59.69%	0	45	0.95	0	0	0	0	100.00%	
46	June 5/06	0.45	6.9	46	14	906	470	21	22	3,167	6.2	210	223	9,148	70	3,053	99.02%	100%	58.74%	0	46	1.1	0	0	0	0	100.00%	
47	June 13/06	0.42	7.2	35	11	806	420	15	21	3,182	4.6	177	209	9,325	59	3,112	99.00%	100%	57.94%	0	46	1.2	0	0	0	0	100.00%	
48	June 20/06	0.30	7.1	146	12	837	390	43	24	3,225	3.6	115	184	9,440	39	3,151	98.99%	100%	57.42%	0	46	1.3	0	0	0	0	100.00%	
49	June 27/06	0.40	6.7	155	13	1,090	600	62	32	3,287	5.2	239	186	9,679	80	3,231	98.96%	100%	56.34%	0	46	0.83	0	0	0	0	100.00%	
50	July 4/06	0.37	6.8	170	11	1,070	600	63	41	3,349	4.1	221	193	9,901	74	3,304	98.94%	100%	55.35%	0	50	1.1	0	0	0	0	100.00%	
51	July 11/06	0.38	6.9	176	14	1,110	570	66	50	3,415	5.3	214	193	10,115	71	3,376	98.92%	100%	54.38%	0	50	1.1	0	0	0	0	100.00%	
52	July 18/06	0.36	6.9	204	11	1,170	580	73	61	3,488	3.9	208	200	10,322	69	3,445	98.90%	100%	53.45%	0	50	1.1	0	0	0	0	100.00%	
53	July 25/06	0.37	6.8	177	11	1,230	670	66	66	3,554	4.1	249	226	10,571	83	3,528	98.87%	100%	52.32%	0	50	0.94	0	0	0	0	100.00%	
54	Aug 1/06	0.37	7.0	165	10	988	540	61	66	3,615	3.7	199	218	10,770	66	3,595	98.85%	100%	51.43%	0	50	1.2	0	0	0	0	100.00%	
55	Aug 8/06	0.38	6.8	158	10	1,080	560	59	65	3,674	3.8	210	216	10,980	70	3,665	98.83%	100%	50.48%	0	55	1.1	0	0	0	0	100.00%	
56	Aug 15/06	0.38	6.8	152	13	1,130	640	57	63	3,731	4.9	241	221	11,221	81	3,745	98.80%	100%	49.39%	0	55	0.97	0	0	0	0	100.00%	
57	Aug 22/06	0.35	6.9	138	11	1,100	680	49	58	3,780	3.9	239	228	11,461	80	3,825	98.77%	100%	48.31%	0	55	0.91	0	0	0	0	100.00%	
58	Aug 29/06	0.36	7.1	66	9.0	950	520	24	50	3,804	3.2	186	215	11,647	62	3,887	98.75%	100%	47.47%	0	55	1.2	0	0	0	0	100.00%	
59	Sept 5/06	0.38	7.2	118	11	1,130	610	45	47	3,848	4.2	231	222	11,878	77	3,964	98.73%	100%	46.43%	0	55	1.0	0	0	0	0	100.00%	
60	Sept 12/06	0.37	7.0	102	10	886	480	37	42	3,886	3.7	175	215	12,053	58	4,023	98.71%	100%	45.64%	0	60	1.1	0	0	0	0	100.00%	
61	Sept 19/06	0.34	7.0	88	10	1,170	690	30	37	3,915	3.4	233	213	12,286	78	4,100	98.69%	100%	44.59%	0	60	0.75	0	0	0	0	100.00%	
62	Sept 25/06	0.32	7.0	118	12	1,170	690	38	35	3,953	3.9	222	209	12,508	74	4,175	98.66%	100%	43.59%	0	60	0.75	0	0	0	0	100.00%	
63	Oct 3/06	0.45	7.9	97	16	1,430	920	43	39	3,997	7.2	412	255	12,920	138	4,312	98.62%	100%	41.73%	0	63	0.99	0	0	0	0	100.00%	
Minimum		0.30	4.3	35	0.15	355	92	13	21	90	0.063	47	103	55	16	18	0.986	1.000	0.417	0		0.73	0	0	0	0	1.000	
Median		0.41	7.0	120	12	996	535	44	46	2,545	4.8	215	215	5,850	72	1,952	0.994	1.000	0.736	0		1.1	0	0	0	0	1.000	
Average		0.41	6.9	152	12	965	505	62	61	2,505	4.7	202	203	6,023	67	2,010	0.994	1.000	0.728	0		1.1	0	0	0	0	1.000	
P95		0.47	7.2	375	21	1,309	760	158	164	3,880	7.7	277	244	12,027	92	4,014	1.000	1.000	0.982	0		1.6	0	0	0	0	1.000	
Maximum		0.60	7.9	619	28	1,470	920	286	168	3,997	13	412	274	12,920	138	4,312	1.000	1.000	0.998	0		2.0	0	0	0	0	1.000	

HUMIDITY CELL TEST

Client: **Klohn Crippen**
Project: **Wolverine**
Sample: **LYNX Ro+Cl Sc Tails**

Dry Mass of Samples

SWEP sample mass	0.035050	kg
ICP-MS sample mass =	1.0	kg

Leachate Analysis

Note: Values with Red Text were reported as less than the method detection limit and are shown here as one-half the detection limit

Test Results		SWEP	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS
Week			0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Date			July 22/05	July 29/05	Aug 5/05	Aug 12/05	Aug 19/05	Aug 26/05	Sept 2/05	Sept 9/05	Sept 16/05	Sept 23/05	Sept 30/05	Oct 7/05	Oct 14/05	Oct 21/05	Oct 28/05	Nov 4/05	Nov 11/05	Nov 18/05	Nov 25/05	Dec 1/05	Dec 9/05	Dec 16/05	Dec 23/05	Dec 30/05	Jan 6/06	Jan 13/06	Jan 20/06	Jan 27/06	Feb 3/06	Feb 10/06	Feb 17/06	Feb 24/06	Mar 3/06
Parameter	**Unit**																																		
Leachate Volume	mL	985	598	419	419	462	439	429	425	445	461	431	487	426	393	364	458	453	397	313	414	414	457	456	389	408	424	434	390	416	347	426	394	361	488
pH	pH units	8.3	6.9	6.5	4.3	6.5	6.4	6.5	6.6	6.5	7.0	6.8	6.9	6.8	7.0	6.9	6.9	7.1	7.1	6.9	7.0	7.1	7.0	7.4	7.1	7.0	7.2	7.0	7.2	7.1	6.9	6.9	7.1	7.1	7.1
Hardness	mg $CaCO_3$/L	115	167	319	410	571	421	297	202	383	798	696	770	540	628	385	233	452	431	166	172	553	486					513					582		
Alkalinity	mg/L as $CaCO_3$		10	4.0	0.15	4.0	3.0	5.0	4.0	3.0	13	7.0	7.0	8.0	10	7.0	8.0	10	9.0	8.0	9.0	13	17	28	12	12	13	13	13	13	14	12	13	14	23
Acidity	mg/L as $CaCO_3$		150	234	376	619	431	260	193	352	504	368	295	187	126	80	56	96	99	41	57	152	121	85	105	93	81	42	61	77	151	94	76	142	78
Conductivity	uS/cm		397	718	758	1,120	798	616	437	775	1,300	1,150	1,230	1,070	1,090	746	476	870	807	355	433	999	938	1,071	868	856	963	864	897	858	1,030	1,010	1,030	1,310	935
SO4	mg/L	38	92	220	270	270	300	200	140	270	620	590	700	580	620	370	240	500	410	150	170	550	530	570	470	470	500	450	490	440	550	550	580	770	520
Cl	mg/L	1.0	1.2	1.2	1.3	1.1	0.70	0.40	0.20	0.40	1.0	0.60	1.0	0.30	0.10	1.0	0.10	0.10	0.10	0.10	0.10	0.10	0.30												
F	mg/L		0.030	0.030	0.030	0.060	0.030	0.030	0.030	0.030	0.11	0.12	0.12	0.12	0.11	0.10	0.060	0.070	0.080	0.030	0.030	0.14	0.11												
NO3	as N mg/L	0.25	0.025	0.080	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025												
$NH_3 + NH_4$	as N mg/L	0.20	0.30	0.40	0.30	0.30	0.20	0.20	0.20	0.10	0.30	0.40	0.20	0.050	0.10	0.10	0.20	0.050	0.050	0.050	0.050	0.050	0.10												
Thiosalts	as S_2O_3 mg/L		151	250	371	586	402	226	150	310	452	318	252	168	134	92	62	104	15	25	56	126	101					62					78		
CN(T)	mg/L	0.0050	0.0010	0.0050	0.0050	0.0050	0.0010	0.0010	0.0050	0.0010	0.0050	0.0050	0.0010	0.020	0.0050	0.0050	0.010	0.0010	0.020	0.0050	0.0050	0.0010	0.0010												
CNO	mg/L	0.050	0.050	0.50	0.50	0.050	0.050	0.050	0.50	0.50	0.050	0.050	0.50	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050												
CNS	mg/L	1.0	1.0	36	2.5	10	1.0	2.5	12																										
Mercury	ug/L	0.000050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050												
Silver	mg/L	0.00080	0.00020	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.010	0.0025	0.0025	0.010	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025					0.0025					0.0025		
Aluminum	mg/L	0.0070	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.010	0.0050	0.010	0.0050	0.010	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050					0.0050					0.0050		
Arsenic	mg/L	0.011	0.0025	0.0025	0.0080	0.0090	0.0025	0.0060	0.0025	0.0025	0.0025	0.013	0.0080	0.0090	0.010	0.0060	0.0025	0.0025	0.0060	0.0025	0.0025	0.012	0.0025					0.0025					0.0025		
Barium	mg/L	0.33	0.080	0.042	0.045	0.040	0.027	0.024	0.021	0.012	0.036	0.030	0.036	0.026	0.027	0.024	0.014	0.026	0.026	0.045	0.046	0.040	0.0050					0.026					0.032		
Beryllium	mg/L	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025					0.0025					0.0025		
Bismuth	mg/L	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015					0.00015					0.00015		
Boron	mg/L	0.020	0.0050	0.0050	0.020	0.0050	0.0050	0.0050	0.0050	0.0050	0.010	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050					0.0050					0.0050		
Calcium	mg/L	43	59	115	146	200	144	103	68	123	264	232	258	180	210	126	74	145	139	53	53	175	153					168					183		
Cadmium	mg/L	0.0049	0.0060	0.013	0.020	0.036	0.030	0.023	0.017	0.000050	0.089	0.059	0.063	0.056	0.053	0.031	0.021	0.041	0.037	0.022	0.023	0.051	0.000050					0.049					0.058		
Cobalt	mg/L	0.00015	0.0015	0.0027	0.0035	0.0065	0.0046	0.0031	0.0025	0.0014	0.013	0.0088	0.0084	0.0071	0.0070	0.0049	0.0032	0.0057	0.0048	0.0030	0.0037	0.0089	0.0020					0.0064					0.0090		
Chromium	mg/L	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050					0.00050					0.00050		
Copper	mg/L	0.0021	0.0065	0.0042	0.0035	0.0024	0.0039	0.0015	0.0014	0.028	0.0021	0.0025	0.0018	0.0030	0.0014	0.00040	0.00040	0.0018	0.0011	0.0012	0.0012	0.0015	0.024					0.0010					0.00090		
Iron	mg/L	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010					0.010					0.010		
Potassium	mg/L	0.54	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025					0.0025					0.0025		
Lithium	mg/L	0.0025	2.1	2.0	1.7	2.5	1.6	0.95	0.58	1.3	2.4	1.9	1.8	1.3	1.3	0.77	0.45	0.84	0.73	0.29	0.33	0.79	0.69					0.58					0.46		
Magnesium	mg/L	1.8	4.6	7.6	11	17	15	9.8	8.1	18	34	28	31	22	25	17	12	22	20	8.2	9.6	28	25					23					30		
Manganese	mg/L	0.19	0.31	0.71	0.84	1.9	1.3	0.81	0.53	1.4	4.0	2.3	2.2	1.9	1.6	0.84	0.63	0.97	0.86	0.49	0.66	1.5	2.0					1.1					1.7		
Molybdenum	mg/L	0.0039	0.0012	0.00080	0.00050	0.00030	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00040	0.00015	0.00040	0.00015	0.00015	0.00015	0.00030	0.00040	0.00040	0.00060	0.00060					0.00060					0.00060		
Sodium	mg/L	2.2	11	13	12	14	8.4	4.4	2.5	6.2	9.7	7.2	6.3	3.8	3.1	1.6	0.85	1.3	0.92	0.30	0.26	0.71	0.54					0.23					0.15		
Nickel	mg/L	0.0020	0.0070	0.011	0.014	0.024	0.016	0.011	0.011	0.0030	0.043	0.022	0.020	0.023	0.019	0.0090	0.0070	0.013	0.010	0.0050	0.010	0.015	0.00050					0.023					0.015		
Phosphorous	mg/L	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050					0.050					0.050		
Lead	mg/L	0.062	0.024	0.035	0.053	0.024	0.042	0.024	0.014	0.0053	0.028	0.022	0.020	0.015	0.011	0.0033	0.0054	0.0088	0.0078	0.0072	0.0064	0.0086	0.00010					0.0065					0.0068		
Antimony	mg/L	0.012	0.025	0.025	0.045	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025					0.025					0.025		
Selenium	mg/L	0.50	0.39	0.44	0.30	0.48	0.33	0.18	0.13	0.0025	0.89	0.71	0.77	0.63	0.69	0.46	0.25	0.60	0.49	0.17	0.23	0.71	0.0025					0.44					0.43		
Silicon	mg/L	0.32	0.15	0.13	0.13	0.21	0.14	0.090	0.080	0.15	0.34	0.22	0.24	0.21	0.22	0.13	0.10	0.16	0.15	0.090	0.11	0.19	0.19					0.19					0.18		
Tin	mg/L	0.00050	0.089	0.046	0.022	0.018	0.0080	0.0050	0.0050	0.00050	0.010	0.0070	0.0070	0.0050	0.0040	0.0040	0.0020	0.0040	0.0040	0.0020	0.0030	0.0060	0.00050					0.0020					0.0020		
Strontium	mg/L	0.059	0.074	0.13	0.19	0.37	0.33	0.27	0.22	0.47	0.93	0.78	0.91	0.72	0.78	0.50	0.31	0.62	0.58	0.23	0.25	0.81	0.68					0.68					0.77		
Titanium	mg/L	0.0015	0.0025	0.0025	0.010	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025					0.0025					0.0025		
Thallium	mg/L	0.0086	0.0088	0.013	0.015	0.017	0.015	0.011	0.0084	0.00020	0.025	0.021	0.019	0.015	0.015	0.0027	0.0062	0.015	0.010	0.0052	0.0067	0.014	0.00010					0.011					0.012		
Uranium	mg/L	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010					0.00010					0.00010		
Vanadium	mg/L	0.00045	0.0010	0.0010	0.0030	0.0010	0.0010	0.0010	0.0010	0.0010	0.0030	0.0020	0.0040	0.0030	0.0010	0.0010	0.0010	0.0020	0.0010	0.0010	0.0010	0.0020	0.0010					0.0010					0.0010		
Zinc	mg/L	0.064	0.18	0.42	0.63	1.6	1.4	1.1	0.91	1.8	5.6	2.9	3.2	3.0	2.6	1.7	1.1	1.8	1.7	1.0	0.98	2.1	3.6					1.9					2.3		

--- not analysed
*** could not be determined due to sample matrix
nss = not sufficient sample
red indicates the sample was below detection, and the detection level was used

ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS
33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63		MIN	MEDIAN	AVG	P95	MAX
Mar 8/06	Mar 16/06	Mar 23/06	Mar 31/06	Apr 7/06	Apr 13/06	Apr 21/06	Apr 28/06	May 3/06	May 12/06	May 19/06	May 23/06	May 30/06	June 5/06	June 13/06	June 20/06	June 27/06	July 4/06	July 11/06	July 18/06	July 25/06	Aug 1/06	Aug 8/06	Aug 15/06	Aug 22/06	Aug 29/06	Sept 5/06	Sept 12/06	Sept 19/06	Sept 25/06	Oct 3/06						
398	436	336	407	414	402	322	412	353	411	435	467	396	446	421	296	399	369	375	358	372	368	375	377	352	358	379	365	337	322	448		296	410	405	466	598
7.0	6.8	7.0	6.9	7.1	6.7	7.1	7.1	7.2	7.1	7.0	7.0	7.1	6.9	7.2	7.1	6.7	6.8	6.9	6.9	6.8	7.0	6.8	6.8	6.9	7.1	7.2	7.0	7.0	7.0	7.9		4.3	7.0	6.9	7.2	7.9
		915					591					477	519				656					648					539			950		166	513	499	857	950
13	11	22	12	13	15	28	14	15	13	13	13	14	14	11	12	13	11	14	11	11	10	10	13	11	9.0	11	10	10	12	16		0.15	12	12	21	28
68	36	288	173	135	101	278	98	159	42	68	54	44	46	35	146	155	170	176	204	177	165	158	152	138	66	118	102	88	118	97		35	120	152	375	619
929	1,010	1,470	1,080	1,110	993	1,420	536	1,050	1,120	1,160	951	891	906	806	837	1,090	1,070	1,110	1,170	1,230	988	1,080	1,130	1,100	950	1,130	886	1,170	1,170	1,430		355	996	965	1,309	1,470
480	520	800	560	590	500	780	560	610	600	550	490	480	470	420	390	600	600	570	580	670	540	560	640	680	520	610	480	690	690	920		92	535	505	760	920
																														0.10		0.10	0.35	0.52	1.2	1.3
																														0.18		0.030	0.065	0.075	0.14	0.18
																														0.025		0.025	0.025	0.028	0.025	0.080
																														0.050		0.050	0.15	0.17	0.40	0.40
		204					99					49	45				122					114					77			71		15	122	170	427	586
																														0.0010		0.0010	0.0050	0.0050	0.020	0.020
																														0.050		0.050	0.050	0.15	0.50	0.50
																														1.0		1.0	2.5	8.3	28	36
																														0.000050		0.000050	0.050	0.048	0.050	0.050
		0.0025					0.0025					0.0025	0.0025				0.0025					0.0025					0.0025			0.00025		0.00020	0.0025	0.0028	0.0063	0.010
		0.0050					0.0050					0.0050	0.0050				0.0050					0.0050					0.0050			0.0050		0.0050	0.0050	0.0055	0.010	0.010
		0.0025					0.0029					0.0022	0.0039				0.0059					0.0098					0.0011			0.0094		0.0011	0.0025	0.0051	0.011	0.013
		0.045					0.027					0.030	0.023				0.031					0.024					0.022			0.024		0.0050	0.027	0.031	0.046	0.080
		0.0025					0.000020					0.000020	0.000020				0.000020					0.000020					0.000020			0.000020		0.000020	0.0025	0.0019	0.0025	0.0025
		0.00015					0.000020					0.000010	0.000010				0.000010					0.000010					0.000010			0.000010		0.000010	0.00015	0.00012	0.00015	0.00015
		0.0050					0.0010					0.0010	0.0030				0.015					0.0010					0.0010			0.0020		0.0010	0.0050	0.0053	0.013	0.020
		285					181					148	165				174					148					115			276		53	148	157	270	285
		0.12					0.083					0.066	0.066				0.087					0.083					0.076			0.13		0.000050	0.049	0.049	0.10	0.13
		0.017					0.013					0.0085	0.0085				0.011					0.0095					0.011			0.016		0.0014	0.0065	0.0070	0.015	0.017
		0.00050					0.00070					0.00015	0.00015				0.00015					0.00015					0.00015			0.00015		0.00015	0.00050	0.00044	0.00050	0.00070
		0.0020					0.0023					0.0015	0.0010				0.0015					0.0014					0.0013			0.0017		0.00040	0.0015	0.0035	0.015	0.028
		0.0050					0.0050					0.0050	0.0050				0.010					0.0050					0.0050			0.010		0.0050	0.010	0.0090	0.010	0.010
		0.0020					0.0020					0.0010	0.0020				0.0010					0.0010					0.0010			0.0030		0.0010	0.0025	0.0023	0.0025	0.0030
		0.66					0.35					0.30	0.30				0.33					0.31					0.26			0.29		0.26	0.73	0.97	2.2	2.5
		50					34					26	26				54					68					61			63		4.6	23	26	62	68
		3.2					2.8					1.3	1.4				2.5					2.3					2.0			2.6		0.31	1.4	1.6	3.0	4.0
		0.00080					0.00055					0.00086	0.00056				0.00064					0.00064					0.00036			0.00071		0.00015	0.00040	0.00044	0.00083	0.0012
		0.15					0.050					0.060	0.070				0.10					0.10					0.11			0.10		0.050	0.92	3.5	12	14
		0.031					0.020					0.016	0.016				0.020					0.018					0.018			0.025		0.00050	0.016	0.016	0.028	0.043
		0.020					0.0050					0.0050	0.0050				0.0050					0.0050					0.0050			0.0050		0.0050	0.050	0.039	0.050	0.050
		0.011					0.0092					0.0072	0.0065				0.0080					0.0075					0.0066			0.0098		0.00010	0.0088	0.014	0.038	0.053
		0.0050					0.0050					0.0050	0.0050				0.0050					0.0050					0.0050			0.0050		0.0050	0.025	0.020	0.025	0.045
		0.57					0.26					0.25	0.24				0.34					0.33					0.32			0.35		0.0025	0.35	0.40	0.74	0.89
		0.30					0.18					0.19	0.20				0.19					0.15					0.12			0.22		0.080	0.18	0.17	0.27	0.34
		0.0070					0.0023					0.0023	0.0016				0.0015					0.00070					0.00015			0.00015		0.00015	0.0040	0.0088	0.034	0.089
		1.0					0.69					0.57	0.59				0.74					0.67					0.53			0.98		0.074	0.59	0.56	0.95	1.0
		0.00050					0.00050					0.00050	0.00050				0.00050					0.00050					0.00050			0.00050		0.00050	0.0025	0.0022	0.0025	0.010
		0.015					0.0080					0.0084	0.0085				0.011					0.0097					0.0063			0.010		0.00010	0.011	0.011	0.020	0.025
		0.00010					0.000030					0.000020	0.000030				0.000050					0.000010					0.000010			0.000060		0.000010	0.00010	0.000084	0.00010	0.00010
		0.0010					0.0010					0.00050	0.00050				0.00050					0.00050					0.00050			0.0030		0.00050	0.0010	0.0014	0.0030	0.0040
		5.3					3.7					3.0	3.2				3.7					3.7					4.1			6.7		0.18	2.1	2.5	5.4	6.7

Loading Rates Calculated from Leachate Analysis Results

Note: Loading Rate (mg/kg/wk) = Leachate Concentration (mg/L) x Volume of Leachate Collected (L/cycle) / Sample Weight (kg) * (1 cycle / 1 week)

Test Results		SWEP	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS
Week			0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Date			July 22/05	July 29/05	Aug 5/05	Aug 12/05	Aug 19/05	Aug 26/05	Sept 2/05	Sept 9/05	Sept 16/05	Sept 23/05	Sept 30/05	Oct 7/05	Oct 14/05	Oct 21/05	Oct 28/05	Nov 4/05	Nov 11/05	Nov 18/05	Nov 25/05	Dec 1/05	Dec 9/05	Dec 16/05	Dec 23/05	Dec 30/05	Jan 6/06	Jan 13/06	Jan 20/06	Jan 27/06	Feb 3/06	Feb 10/06	Feb 17/06	Feb 24/06	Mar 3/06
Parameter	**Unit**																																			
Volume	L	0.99	0.60	0.42	0.42	0.46	0.44	0.43	0.43	0.45	0.46	0.43	0.49	0.43	0.39	0.36	0.46	0.45	0.40	0.31	0.41	0.41	0.46	0.46	0.39	0.41	0.42	0.43	0.39	0.42	0.35	0.43	0.39	0.36	0.49
pH	pH units	8.3	6.9	6.5	4.3	6.5	6.4	6.5	6.6	6.5	7.0	6.8	6.9	6.8	7.0	6.9	6.9	7.1	7.1	6.9	7.0	7.1	7.0	7.4	7.1	7.0	7.2	7.0	7.2	7.1	6.9	6.9	7.1	7.1	7.1
Hardness	mg/kg/wk	3,242	100	133	172	264	185	128	86	170	368	300	375	230	247	140	107	205	171	52	71	229	222					223					229			
Alkalinity	mg/kg/wk		6.0	1.7	0.063	1.8	1.3	2.1	1.7	1.3	6.0	3.0	3.4	3.4	3.9	2.5	3.7	4.5	3.6	2.5	3.7	5.4	7.8	13	4.7	4.9	5.5	5.6	5.1	5.4	4.9	5.1	5.1	5.1	11
Acidity	mg/kg/wk		89.7	98	158	286	189	112	82	157	232	159	144	80	50	29	26	43	39	13	24	63	55	39	41	38	34	18	24	32	52	40	30	51	38
Conductivity	uS/cm/kg/wk		237	301	318	517	350	264	186	345	599	496	599	456	428	272	218	394	320	111	179	414	429	488	338	349	408	375	350	357	357	430	406	473	456
SO4	mg/kg/wk	1,068	55	92	113	125	132	86	60	120	286	254	341	247	244	135	110	227	163	47	70	228	242	260	183	192	212	195	191	183	191	234	229	278	254
Cl	mg/kg/wk	28	0.72	0.50	0.54	0.51	0.31	0.17	0.085	0.18	0.46	0.26	0.49	0.13	0.039	0.36	0.046	0.045	0.040	0.031	0.041	0.041	0.14													
F	mg/kg/wk		0.018	0.013	0.013	0.028	0.013	0.013	0.013	0.013	0.051	0.052	0.058	0.051	0.043	0.036	0.027	0.032	0.032	0.0094	0.012	0.058	0.050													
NO3	mg/kg/wk	7.0	0.015	0.034	0.010	0.012	0.011	0.011	0.011	0.011	0.012	0.011	0.012	0.011	0.0098	0.0091	0.011	0.011	0.0099	0.0078	0.010	0.010	0.011													
$NH_3 + NH_4$	mg/kg/wk	5.6	0.18	0.17	0.13	0.14	0.088	0.086	0.085	0.045	0.14	0.17	0.097	0.021	0.039	0.036	0.092	0.023	0.020	0.016	0.021	0.021	0.046													
Thiosalts	mg/kg/wk		90	105	155	271	176	97	64	138	208	137	123	72	53	33	28	47	6.0	7.8	23	52	46					27					31			
CN(T)	mg/kg/wk	0.14	0.00060	0.0021	0.0021	0.0023	0.00044	0.00043	0.0021	0.00045	0.0023	0.0022	0.00049	0.0085	0.0020	0.0018	0.0046	0.00045	0.0079	0.0016	0.0021	0.00041	0.00046													
CNO	mg/kg/wk	1.4	0.030	0.21	0.21	0.023	0.022	0.021	0.21	0.22	0.023	0.022	0.24	0.021	0.020	0.018	0.023	0.023	0.020	0.016	0.021	0.021	0.023													
CNS	mg/kg/wk	28	0.60	15	1.0	4.6	0.44	1.1	5.1																											
Mercury	mg/kg/wk	0.0000014	0.000030	0.000021	0.000021	0.000023	0.000022	0.000021	0.000021	0.000022	0.000023	0.000022	0.000024	0.000021	0.000020	0.000018	0.000023	0.000023	0.000020	0.000016	0.000021	0.000021	0.000023													
Silver	mg/kg/wk	0.022	0.00012	0.0010	0.0010	0.0012	0.0011	0.0011	0.0011	0.0011	0.0012	0.0011	0.0049	0.0011	0.00098	0.0036	0.0011	0.0011	0.00099	0.00078	0.0010	0.0010	0.0011					0.0011					0.00099			
Aluminum	mg/kg/wk	0.20	0.0030	0.0021	0.0021	0.0023	0.0022	0.0021	0.0043	0.0022	0.0046	0.0022	0.0049	0.0021	0.0020	0.0018	0.0023	0.0023	0.0020	0.0016	0.0021	0.0021	0.0023					0.0022					0.0020			
Arsenic	mg/kg/wk	0.31	0.0015	0.0010	0.0034	0.0042	0.0011	0.0026	0.0011	0.0011	0.0012	0.0056	0.0039	0.0038	0.0039	0.0022	0.0011	0.0011	0.0024	0.00078	0.0010	0.0050	0.0011					0.0011					0.00099			
Barium	mg/kg/wk	9.2	0.048	0.018	0.019	0.018	0.012	0.010	0.0089	0.0053	0.017	0.013	0.018	0.011	0.011	0.0087	0.0064	0.012	0.010	0.014	0.019	0.017	0.0023					0.011					0.013			
Beryllium	mg/kg/wk	0.070	0.0015	0.0010	0.0010	0.0012	0.0011	0.0011	0.0011	0.0011	0.0012	0.0011	0.0012	0.0011	0.00098	0.00091	0.0011	0.0011	0.00099	0.00078	0.0010	0.0010	0.0011					0.0011					0.00099			
Bismuth	mg/kg/wk	0.0042	0.000090	0.000063	0.000063	0.000069	0.000066	0.000064	0.000064	0.000067	0.000069	0.000065	0.000073	0.000064	0.000059	0.000055	0.000069	0.000068	0.000060	0.000047	0.000062	0.000062	0.000069					0.000065					0.000059			
Boron	mg/kg/wk	0.56	0.0030	0.0021	0.0084	0.0023	0.0022	0.0021	0.0021	0.0022	0.0046	0.0022	0.0024	0.0021	0.0020	0.0018	0.0023	0.0023	0.0020	0.0016	0.0021	0.0021	0.0023					0.0022					0.0020			
Calcium	mg/kg/wk	1,217	35	48	61	92	63	44	29	55	122	100	126	77	83	46	34	66	55	17	22	72	70					73					72			
Cadmium	mg/kg/wk	0.14	0.0036	0.0055	0.0082	0.017	0.013	0.0097	0.0074	0.000022	0.041	0.025	0.031	0.024	0.021	0.011	0.0097	0.019	0.015	0.0069	0.0096	0.021	0.000023					0.021					0.023			
Cobalt	mg/kg/wk	0.0042	0.00090	0.0011	0.0015	0.0030	0.0020	0.0013	0.0011	0.00062	0.0060	0.0038	0.0041	0.0030	0.0028	0.0018	0.0015	0.0026	0.0019	0.00094	0.0015	0.0037	0.00091					0.0028					0.0035			
Chromium	mg/kg/wk	0.014	0.00030	0.00021	0.00021	0.00023	0.00022	0.00021	0.00021	0.00022	0.00023	0.00022	0.00024	0.00021	0.00020	0.00018	0.00023	0.00023	0.00020	0.00016	0.00021	0.00021	0.00023					0.00022					0.00020			
Copper	mg/kg/wk	0.059	0.0039	0.0018	0.0015	0.0011	0.0017	0.00064	0.00060	0.013	0.00097	0.0011	0.00088	0.0013	0.00055	0.00015	0.00018	0.00082	0.00044	0.00038	0.00050	0.00062	0.011					0.00043					0.00035			
Iron	mg/kg/wk	0.28	0.0060	0.0042	0.0042	0.0046	0.0044	0.0043	0.0043	0.0045	0.0046	0.0043	0.0049	0.0043	0.0039	0.0036	0.0046	0.0045	0.0040	0.0031	0.0041	0.0041	0.0046					0.0043					0.0039			
Potassium	mg/kg/wk	15	0.0015	0.0010	0.0010	0.0012	0.0011	0.0011	0.0011	0.0011	0.0012	0.0011	0.0012	0.0011	0.00098	0.00091	0.0011	0.0011	0.00099	0.00078	0.0010	0.0010	0.0011					0.0011					0.00099			
Lithium	mg/kg/wk	0.070	1.2	0.83	0.71	1.2	0.71	0.41	0.25	0.58	1.1	0.80	0.90	0.53	0.50	0.28	0.21	0.38	0.29	0.091	0.14	0.33	0.32					0.25					0.18			
Magnesium	mg/kg/wk	49	2.8	3.2	4.7	8.0	6.5	4.2	3.5	8.2	16	12	15	9.3	9.9	6.2	5.4	9.9	8.1	2.6	4.0	12	12					9.9					12			
Manganese	mg/kg/wk	5.2	0.19	0.30	0.35	0.85	0.55	0.35	0.22	0.64	1.8	0.98	1.1	0.80	0.61	0.30	0.29	0.44	0.34	0.15	0.27	0.61	0.90					0.49					0.65			
Molybdenum	mg/kg/wk	0.11	0.00072	0.00034	0.00021	0.00014	0.000066	0.000064	0.000064	0.000067	0.000069	0.000065	0.00019	0.000064	0.00016	0.000055	0.000069	0.000068	0.00012	0.00013	0.00017	0.00025	0.00027					0.00026					0.00024			
Sodium	mg/kg/wk	61	6.3	5.4	4.9	6.5	3.7	1.9	1.0	2.8	4.5	3.1	3.1	1.6	1.2	0.58	0.39	0.57	0.37	0.094	0.11	0.29	0.25					0.100					0.059			
Nickel	mg/kg/wk	0.056	0.0042	0.0046	0.0059	0.011	0.0070	0.0047	0.0047	0.0013	0.020	0.0095	0.0097	0.0098	0.0075	0.0033	0.0032	0.0059	0.0040	0.0016	0.0041	0.0062	0.00023					0.0100					0.0059			
Phosphorous	mg/kg/wk	1.4	0.030	0.021	0.021	0.023	0.022	0.021	0.021	0.022	0.023	0.022	0.024	0.021	0.020	0.018	0.023	0.023	0.020	0.016	0.021	0.021	0.023					0.022					0.020			
Lead	mg/kg/wk	1.7	0.014	0.015	0.022	0.011	0.018	0.010	0.0061	0.0024	0.013	0.0093	0.0096	0.0064	0.0044	0.0012	0.0025	0.0040	0.0031	0.0023	0.0026	0.0036	0.000046					0.0028					0.0027			
Antimony	mg/kg/wk	0.32	0.015	0.010	0.019	0.012	0.011	0.011	0.011	0.011	0.012	0.011	0.012	0.011	0.0098	0.0091	0.011	0.011	0.0099	0.0078	0.010	0.010	0.011					0.011					0.0099			
Selenium	mg/kg/wk	14	0.23	0.18	0.13	0.22	0.15	0.077	0.055	0.0011	0.41	0.31	0.38	0.27	0.27	0.17	0.11	0.27	0.19	0.053	0.096	0.29	0.0011					0.19					0.17			
Silicon	mg/kg/wk	9.0	0.090	0.054	0.054	0.097	0.061	0.039	0.034	0.067	0.16	0.095	0.12	0.089	0.086	0.047	0.046	0.072	0.060	0.028	0.046	0.079	0.087					0.082					0.071			
Tin	mg/kg/wk	0.014	0.053	0.019	0.0092	0.0083	0.0035	0.0021	0.0021	0.00022	0.0046	0.0030	0.0034	0.0021	0.0016	0.0015	0.00092	0.0018	0.0016	0.00063	0.0012	0.0025	0.00023					0.00087					0.00079			
Strontium	mg/kg/wk	1.7	0.044	0.056	0.081	0.17	0.14	0.11	0.092	0.21	0.43	0.34	0.44	0.31	0.30	0.18	0.14	0.28	0.23	0.073	0.10	0.34	0.31					0.29					0.30			
Titanium	mg/kg/wk	0.042	0.0015	0.0010	0.0042	0.0012	0.0011	0.0011	0.0011	0.0011	0.0012	0.0011	0.0012	0.0011	0.00098	0.00091	0.0011	0.0011	0.00099	0.00078	0.0010	0.0010	0.0011					0.0011					0.00099			
Thallium	mg/kg/wk	0.24	0.0053	0.0053	0.0062	0.0079	0.0064	0.0047	0.0036	0.000089	0.012	0.0090	0.0092	0.0066	0.0060	0.00098	0.0028	0.0070	0.0040	0.0016	0.0028	0.0059	0.000046					0.0046					0.0047			
Uranium	mg/kg/wk	0.0028	0.000060	0.000042	0.000042	0.000046	0.000044	0.000043	0.000043	0.000045	0.000046	0.000043	0.000049	0.000043	0.000039	0.000036	0.000046	0.000045	0.000040	0.000031	0.000041	0.000041	0.000046					0.000043					0.000039			
Vanadium	mg/kg/wk	0.013	0.00060	0.00042	0.0013	0.00046	0.00044	0.00043	0.00043	0.00045	0.0014	0.00086	0.0019	0.0013	0.00039	0.00036	0.00046	0.00091	0.00040	0.00031	0.00041	0.00083	0.00046					0.00043					0.00039			
Zinc	mg/kg/wk	1.8	0.11	0.18	0.26	0.73	0.60	0.46	0.39	0.81	2.6	1.2	1.6	1.3	1.0	0.63	0.52	0.82	0.66	0.33	0.41	0.87	1.7					0.82					0.90			

ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS		MIN	MEDIAN	AVG	P95	MAX
33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63								
Mar 8/06	Mar 16/06	Mar 23/06	Mar 31/06	Apr 7/06	Apr 13/06	Apr 21/06	Apr 28/06	May 3/06	May 12/06	May 19/06	May 23/06	May 30/06	June 5/06	June 13/06	June 20/06	June 27/06	July 4/06	July 11/06	July 18/06	July 25/06	Aug 1/06	Aug 8/06	Aug 15/06	Aug 22/06	Aug 29/06	Sept 5/06	Sept 12/06	Sept 19/06	Sept 25/06	Oct 3/06								
0.40	0.44	0.34	0.41	0.41	0.40	0.32	0.41	0.35	0.41	0.44	0.47	0.40	0.45	0.42	0.30	0.40	0.37	0.38	0.36	0.37	0.37	0.38	0.38	0.35	0.36	0.38	0.37	0.34	0.32	0.45		0.30	0.41	0.41	0.47	0.60
7.0	6.8	7.0	6.9	7.1	6.7	7.1	7.1	7.2	7.1	7.0	7.0	7.1	6.9	7.2	7.1	6.7	6.8	6.9	6.9	6.8	7.0	6.8	6.8	6.9	7.1	7.2	7.0	7.0	7.0	7.9		4.3	7.0	6.9	7.2	7.9
		308					244					189	231				242					243						197			426		52	222	209	371	426
5.2	4.8	7.4	4.9	5.4	6.0	9.0	5.8	5.3	5.3	5.7	6.1	5.5	6.2	4.6	3.6	5.2	4.1	5.3	3.9	4.1	3.7	3.8	4.9	3.9	3.2	4.2	3.7	3.4	3.9	7.2		0.063	4.8	4.7	7.7	13
27	16	97	70	56	41	90	40	56	17	30	25	17	21	15	43	62	63	66	73	66	61	59	57	49	24	45	37	30	38	43		13	44	62	158	286
370	440	494	440	460	399	457	221	371	460	505	444	353	404	339	248	435	395	416	419	458	364	405	426	387	340	428	323	394	377	641		111	397	388	516	641
191	227	269	228	244	201	251	231	215	247	239	229	190	210	177	115	239	221	214	208	249	199	210	241	239	186	231	175	233	222	412		47	215	202	277	412
																														0.045		0.031	0.15	0.24	0.54	0.72
																														0.081		0.0094	0.030	0.033	0.058	0.081
																														0.011		0.0078	0.011	0.012	0.015	0.034
																														0.022		0.016	0.065	0.076	0.17	0.18
		69					41					19	20				45					43					28			32		6.0	47	74	192	271
																														0.00045		0.00041	0.0019	0.0021	0.0078	0.0085
																														0.022		0.016	0.023	0.067	0.22	0.24
																														0.45		0.44	1.1	3.6	12	15
																														########		########	0.000021	0.000021	0.000024	0.000030
		0.00084					0.0010					0.00099	0.0011				0.00092					0.00094					0.00091			0.00011		0.00011	0.0010	0.0012	0.0024	0.0049
		0.0017					0.0021					0.0020	0.0022				0.0018					0.0019					0.0018			0.0022		0.0016	0.0021	0.0023	0.0044	0.0049
		0.00084					0.0012					0.00087	0.0017				0.0022					0.0037					0.00040			0.0042		0.00040	0.0012	0.0021	0.0046	0.0056
		0.015					0.011					0.012	0.010				0.011					0.0089					0.0081			0.011		0.0023	0.011	0.013	0.019	0.048
		0.00084					0.0000082					0.0000079	0.0000089				0.0000074					0.0000075					0.0000073			0.0000090		0.0000073	0.0010	0.00083	0.0012	0.0015
		0.000050					0.0000082					0.0000040	0.0000045				0.0000037					0.0000038					0.0000037			0.0000045		0.0000037	0.000063	0.000051	0.000071	0.000090
		0.0017					0.00041					0.00040	0.0013				0.0055					0.00038					0.00037			0.00090		0.00037	0.0021	0.0022	0.0051	0.0084
		96					75					59	74				64					56					42			124		17	64	66	123	126
		0.040					0.034					0.026	0.029				0.032					0.031					0.028			0.059		0.000022	0.021	0.020	0.041	0.059
		0.0057					0.0054					0.0034	0.0038				0.0042					0.0036					0.0039			0.0072		0.00062	0.0028	0.0029	0.0059	0.0072
		0.00017					0.00029					0.000059	0.000067				0.000055					0.000056					0.000055			0.000067		0.000055	0.00021	0.00019	0.00027	0.00030
		0.00067					0.00095					0.00059	0.00045				0.00055					0.00053					0.00047			0.00076		0.00015	0.00064	0.0016	0.0073	0.013
		0.0017					0.0021					0.0020	0.0022				0.0037					0.0019					0.0018			0.0045		0.0017	0.0042	0.0038	0.0047	0.0060
		0.00067					0.00082					0.00040	0.00089				0.00037					0.00038					0.00037			0.0013		0.00037	0.0010	0.00097	0.0013	0.0015
		0.22					0.14					0.12	0.13				0.12					0.12					0.095			0.13		0.091	0.29	0.43	1.1	1.2
		17					14					10	12				20					25					22			28		2.6	9.9	11	24	28
		1.1					1.1					0.51	0.62				0.92					0.84					0.73			1.1		0.15	0.61	0.65	1.1	1.8
		0.00027					0.00023					0.00034	0.00025				0.00024					0.00024					0.00013			0.00032		0.000055	0.00017	0.00019	0.00034	0.00072
		0.050					0.021					0.024	0.031				0.037					0.038					0.040			0.045		0.021	0.39	1.6	5.9	6.5
		0.010					0.0084					0.0062	0.0071				0.0072					0.0068					0.0065			0.011		0.00023	0.0062	0.0067	0.011	0.020
		0.0067					0.0021					0.0020	0.0022				0.0018					0.0019					0.0018			0.0022		0.0018	0.021	0.017	0.024	0.030
		0.0036					0.0038					0.0028	0.0029				0.0029					0.0028					0.0024			0.0044		0.000046	0.0036	0.0062	0.016	0.022
		0.0017					0.0021					0.0020	0.0022				0.0018					0.0019					0.0018			0.0022		0.0017	0.010	0.0088	0.014	0.019
		0.19					0.11					0.097	0.11				0.13					0.12					0.12			0.16		0.0011	0.16	0.17	0.34	0.41
		0.10					0.074					0.075	0.089				0.070					0.056					0.044			0.099		0.028	0.072	0.073	0.11	0.16
		0.0024					0.00095					0.00091	0.00071				0.00055					0.00026					0.000055			0.000067		0.000055	0.0016	0.0042	0.014	0.053
		0.35					0.28					0.22	0.26				0.27					0.25					0.19			0.44		0.044	0.25	0.23	0.43	0.44
		0.00017					0.00021					0.00020	0.00022				0.00018					0.00019					0.00018			0.00022		0.00017	0.0010	0.00095	0.0014	0.0042
		0.0051					0.0033					0.0033	0.0038				0.0041					0.0036					0.0023			0.0045		0.000046	0.0046	0.0047	0.0091	0.012
		0.000034					0.000012					0.0000079	0.000013				0.000018					0.0000038					0.0000037			0.000027		0.0000037	0.000042	0.000036	0.000047	0.000060
		0.00034					0.00041					0.00020	0.00022				0.00018					0.00019					0.00018			0.0013		0.00018	0.00043	0.00059	0.0014	0.0019
		1.8					1.5					1.2	1.4				1.4					1.4					1.5			3.0		0.11	0.87	1.0	2.2	3.0

Wolverine

Project: Wolverine
Sample: Comb Wolv D Comp

Sample Data - Initial Measurements

Initial organic S	2.34	(%)
Initial total sulphur	19.7	(%)
Initial SO4-S	1.74	(%)
Initial S2--S	15.7	(%)
Sample Weight	1.0	(kg)
Initial NP	94.6	(t $CaCO_3$/1000t)
Assumed NP unreactive		
Initial SO4-S	17,400	(mg)

Results - SO_4 - S Depletion

SO_4 Production (5 wk average)	210	mg/kg/wk
SO_4 Production (5 wk average)	10,937,359	mg/t/yr
SO_4 - S Production (5 wk average)	70	mg/kg/wk
Cumulative SO_4 - S Production	4,946	mg/kg
Time to SO_4 - S Depletion	178	wk

Results - NP Depletion

Initial NP	94,600	mg $CaCO_3$/kg
Cumulative Open System NP Consumption	0	mg $CaCO_3$/kg
Remaining NP	94,600	mg $CaCO_3$/kg
Open System NP Consumption Rate (5 wk average)	0	mg $CaCO_3$/kg/wk
Time to Sobek-NP Depletion	#DIV/0!	wk
Time to Sobek-NP Depletion	#DIV/0!	yr

HUMIDITY CELL TEST DATA

WEEK	DATE	WATER ADDED	LEACHATE COLLECTED	LEACHATE pH	ACIDITY	ALKALINITY	CONDUC-TIVITY	SULPHATE	ACIDITY PRODUCTION: PRODUCTION RATE (mg $CaCO_3$/kg/wk)		ACIDITY PRODUCTION: CUMMULATIVE PRODUCTION	ALKALINITY PRODUCTION RATE (mg $CaCO_3$/ /kg/wk)	SULPHATE PRODUCTION: PRODUCTION RATE (mg/kg/wk)		SULPHATE PRODUCTION: CUMMULATIVE PRODUCTION	SO4-S PRODUCTION: PRODUCTION RATE	SO4-S PRODUCTION: CUMMULATIVE PRODUCED	REMAINING SULPHUR (% of ORIGINAL SAMPLE)			THEORETICAL NP CONSUMPTION	WEEK WHERE Ca and Mg WERE LAST SAMPLED	CARBONATE MOLAR RATIO	CARBONATE RATIO CONSUMPTION (mg $CaCO_3$/ /kg/wk)	OPEN SYSTEM NP CONSUMPTION: CONSUMPTION RATE (mg $CaCO_3$/kg/wk)		OPEN SYSTEM NP CONSUMPTION: CUMMULATIVE CONSUMPTION	REMAINING NP
									Weekly	5 wk Average	(mg $CaCO_3$/kg)		Weekly	5 wk Average	(mg/kg)	(mg/kg/wk)	(mg/kg)	TOTAL-S	SULPHIDE-S	SULPHATE-S	(mg $CaCO_3$/kg/wk)				Weekly	5 wk Average	(mg $CaCO_3$/kg)	(% of ORIGINAL SAMPLE)
		(L)	(L)		(mg $CaCO_3$/L)	(mg $CaCO_3$/L)	(µS/cm)	(mg/L)				/kg/wk)																
0	July 22/05	0.55		5.1	262	1.0	587	130	145		145	0.55	72		72	24	24	99.99%	100%	99.86%	0	0	1.7	0	0		0	100.00%
1	July 29/05	0.42		3.9	495	0.15	120	250	205		350	0.062	104		176	35	59	99.97%	100%	99.66%	0	1.0	1.6	0	0		0	100.00%
2	Aug 5/05	0.48		3.4	813	0.15	737	370	391		741	0.072	178		354	59	118	99.94%	100%	99.32%	0	2.0	1.8	0	0		0	100.00%
3	Aug 12/05	0.47		3.8	1,000	1.0	1,660	300	468		1,209	0.47	140		494	47	165	99.92%	100%	99.05%	0	3.0	2.7	0	0		0	100.00%
4	Aug 19/05	0.44		4.3	954	1.0	1,380	430	424	327	1,633	0.44	191	137	685	64	229	99.88%	100%	98.69%	0	4.0	1.7	0	0	0	0	100.00%
5	Aug 26/05	0.45		4.1	787	1.0	1,250	330	351	368	1,984	0.45	147	152	832	49	278	99.86%	100%	98.40%	0	5.0	1.8	0	0	0	0	100.00%
6	Sept 2/05	0.44		3.7	1,280	1.0	1,930	610	564	440	2,548	0.44	269	185	1,101	90	367	99.81%	100%	97.89%	0	6.0	1.6	0	0	0	0	100.00%
7	Sept 9/05	0.48		3.9	944	1.0	1,770	640	448	451	2,997	0.48	304	210	1,405	101	469	99.76%	100%	97.30%	0	7.0	1.5	0	0	0	0	100.00%
8	Sept 16/05	0.54		6.4	851	6.0	1,810	940	463	450	3,460	3.3	511	284	1,916	171	640	99.68%	100%	96.32%	0	8.0	1.2	0	0	0	0	100.00%
9	Sept 23/05	0.45		6.8	554	10	1,400	700	250	415	3,710	4.5	316	310	2,233	106	745	99.62%	100%	95.72%	0	9.0	1.2	0	0	0	0	100.00%
10	Sept 30/05	0.48		6.9	451	15	1,500	760	214	388	3,924	7.1	361	352	2,594	120	866	99.56%	100%	95.02%	0	10	1.1	0	0	0	0	100.00%
11	Oct 7/05	0.52		6.9	376	14	1,340	670	196	314	4,120	7.3	349	368	2,943	117	982	99.50%	100%	94.36%	0	11	1.0	0	0	0	0	100.00%
12	Oct 14/05	0.46		7.0	355	13	1,280	660	163	257	4,283	6.0	303	368	3,246	101	1,083	99.45%	100%	93.77%	0	12	1.1	0	0	0	0	100.00%
13	Oct 21/05	0.47		7.0	289	16	1,070	530	135	192	4,418	7.5	248	315	3,494	83	1,166	99.41%	100%	93.30%	0	13	1.1	0	0	0	0	100.00%
14	Oct 28/05	0.49		7.0	301	17	1,110	550	148	171	4,567	8.4	271	306	3,765	90	1,256	99.36%	100%	92.78%	0	14	1.2	0	0	0	0	100.00%
15	Nov 4/05	0.49		7.2	264	30	1,130	620	130	155	4,697	15	306	295	4,071	102	1,359	99.31%	100%	92.19%	0	15	0.94	0	0	0	0	100.00%
16	Nov 11/05	0.52		7.1	234	21	1,120	560	121	139	4,818	11	288	283	4,359	96	1,455	99.26%	100%	91.64%	0	16	1.1	0	0	0	0	100.00%
17	Nov 18/05	0.50		7.0	238	18	1,100	580	119	131	4,936	9.0	289	280	4,648	96	1,551	99.21%	100%	91.08%	0	17	1.0	0	0	0	0	100.00%
18	Nov 25/05	0.50		6.9	259	10	1,300	660	128	129	5,064	5.0	327	296	4,975	109	1,660	99.16%	100%	90.46%	0	18	0.99	0	0	0	0	100.00%
19	Dec 1/05	0.40		6.8	303	7.0	1,230	660	122	124	5,187	2.8	267	295	5,241	89	1,749	99.11%	100%	89.95%	0	19	1.0	0	0	0	0	100.00%
20	Dec 9/05	0.46		6.9	309	11	1,410	820	142	126	5,328	5.0	376	309	5,617	125	1,875	99.05%	100%	89.23%	0	20	0.91	0	0	0	0	100.00%
21	Dec 16/05	0.48			266	13	1,242	640	126	127	5,455	6.2	304	312	5,921	101	1,976	99.00%	100%	88.64%	0	20	1.2	0	0	0	0	100.00%
22	Dec 23/05	0.39		6.9	224	9.0	1,000	510	87	121	5,542	3.5	198	294	6,119	66	2,042	98.96%	100%	88.26%	0	20	1.5	0	0	0	0	100.00%
23	Dec 30/05	0.43		6.7	215	7.0	963	490	92	114	5,633	3.0	209	271	6,328	70	2,112	98.93%	100%	87.86%	0	20	1.5	0	0	0	0	100.00%
24	Jan 6/06	0.42		6.9	232	7.0	1,090	530	97	109	5,730	2.9	222	262	6,550	74	2,186	98.89%	100%	87.44%	0	20	1.4	0	0	0	0	100.00%
25	Jan 13/06	0.44		6.9	179	8.0	984	500	78	96	5,809	3.5	219	230	6,769	73	2,259	98.85%	100%	87.02%	0	25	1.2	0	0	0	0	100.00%
26	Jan 20/06	0.39		7.0	175	8.0	1,020	540	68	84	5,877	3.1	209	211	6,978	70	2,329	98.82%	100%	86.62%	0	25	1.1	0	0	0	0	100.00%
27	Jan 27/06	0.49		7.2	240	21	2,000	1,300	117	90	5,993	10	633	298	7,611	211	2,540	98.71%	100%	85.40%	0	25	0.44	0	0	0	0	100.00%
28	Feb 3/06	0.50		6.9	118	15	1,010	560	59	84	6,052	7.4	278	312	7,889	93	2,633	98.66%	100%	84.87%	0	25	1.0	0	0	0	0	100.00%
29	Feb 10/06	0.43		6.9	91	14	908	480	39	72	6,091	6.0	207	309	8,096	69	2,702	98.63%	100%	84.47%	0	25	1.2	0	0	0	0	100.00%
30	Feb 17/06	0.50		7.1	104	21	1,000	560	52	67	6,143	10	279	321	8,375	93	2,795	98.58%	100%	83.94%	0	30	0.95	0	0	0	0	100.00%
31	Feb 24/06	0.49		7.2	112	25	1,230	710	55	64	6,198	12	349	349	8,724	117	2,912	98.52%	100%	83.27%	0	30	0.75	0	0	0	0	100.00%
32	Mar 3/06	0.55		7.0	70	15	1,020	560	39	49	6,237	8.3	308	284	9,032	103	3,014	98.47%	100%	82.68%	0	30	0.95	0	0	0	0	100.00%
33	Mar 8/06	0.39		7.1	109	22	841	400	42	45	6,279	8.5	155	260	9,187	52	3,066	98.44%	100%	82.38%	0	30	1.3	0	0	0	0	100.00%
34	Mar 16/06	0.44		6.4	61	6.0	999	490	27	43	6,306	2.6	215	261	9,402	72	3,138	98.41%	100%	81.97%	0	30	1.1	0	0	0	0	100.00%
35	Mar 23/06	0.26		7.0	252	16	1,380	760	66	46	6,371	4.2	198	245	9,600	66	3,204	98.37%	100%	81.59%	0	35	1.1	0	0	0	0	100.00%
36	Mar 31/06	0.44		6.9	155	11	1,010	570	69	48	6,440	4.9	253	226	9,853	84	3,289	98.33%	100%	81.10%	0	35	1.4	0	0	0	0	100.00%
37	Apr 7/06	0.42		7.1	141	12	973	490	59	52	6,499	5.0	204	205	10,058	68	3,357	98.30%	100%	80.71%	0	35	1.7	0	0	0	0	100.00%
38	Apr 13/06	0.40		6.7	109	15	906	440	43	53	6,542	5.9	174	209	10,232	58	3,415	98.27%	100%	80.37%	0	35	1.9	0	0	0	0	100.00%
39	Apr 21/06	0.32		6.9	234	23	1,270	660	74	62	6,616	7.2	208	208	10,440	69	3,484	98.23%	100%	79.98%	0	35	1.2	0	0	0	0	100.00%
40	Apr 28/06	0.43		7.1	102	11	812	450	44	58	6,660	4.8	194	207	10,634	65	3,549	98.20%	100%	79.60%	0	40	1.0	0	0	0	0	100.00%
41	May 3/06	0.30		7.2	145	21	901	500	44	53	6,704	6.3	151	186	10,785	50	3,599	98.17%	100%	79.31%	0	40	0.93	0	0	0	0	100.00%
42	May 12/06	0.45		7.0	25	12	952	500	11	43	6,715	5.4	224	190	11,008	75	3,674	98.14%	100%	78.89%	0	40	0.93	0	0	0	0	100.00%
43	May 19/06	0.42		7.0	73	11	1,190	420	30	41	6,745	4.6	174	190	11,183	58	3,732	98.11%	100%	78.55%	0	40	1.1	0	0	0	0	100.00%
44	May 23/06	0.45		6.9	64	11	828	400	28	32	6,774	4.9	178	184	11,361	59	3,792	98.08%	100%	78.21%	0	40	1.2	0	0	0	0	100.00%
45	May 30/06	0.40		7.1	52	13	812	400	21	27	6,794	5.2	159	177	11,519	53	3,845	98.05%	100%	77.90%	0	45	1.0	0	0	0	0	100.00%
46	June 5/06	0.46		6.8	57	12	839	420	26	23	6,820	5.5	192	185	11,711	64	3,908	98.02%	100%	77.54%	0	46	1.1	0	0	0	0	100.00%
47	June 13/06	0.42		7.1	46	10	742	370	19	25	6,840	4.2	156	172	11,867	52	3,960	97.99%	100%	77.24%	0	46	1.2	0	0	0	0	100.00%
48	June 20/06	0.27		7.1	83	11	741	350	23	23	6,862	3.0	95	156	11,962	32	3,992	97.97%	100%	77.06%	0	46	1.3	0	0	0	0	100.00%
49	June 27/06	0.41		6.7	83	11	923	501	34	24	6,896	4.5	203	161	12,165	68	4,060	97.94%	100%	76.67%	0	46	0.90	0	0	0	0	100.00%
50	July 4/06	0.36		6.8	85	10	920	520	31	26	6,927	3.6	188	167	12,353	63	4,123	97.91%	100%	76.31%	0	50	1.0	0	0	0	0	100.00%
51	July 11/06	0.37		6.9	61	9.0	907	470	22	26	6,949	3.3	173	163	12,526	58	4,181	97.88%	100%	75.97%	0	50	1.1	0	0	0	0	100.00%
52	July 18/06	0.35		6.9	65	9.0	927	460	22	26	6,971	3.1	159	164	12,685	53	4,234	97.85%	100%	75.67%	0	50	1.1	0	0	0	0	100.00%
53	July 25/06	0.38		6.8	48	10	962	520	18	25	6,989	3.8	195	184	12,880	65	4,299	97.82%	100%	75.29%	0	50	1.0	0	0	0	0	100.00%
54	Aug 1/06	0.36		7.0	51	9.0	765	430	18	22	7,008	3.2	154	174	13,034	51	4,350	97.79%	100%	75.00%	0	50	1.2	0	0	0	0	100.00%
55	Aug 8/06	0.37		6.8	44	9.0	879	480	16	19	7,024	3.3	177	171	13,210	59	4,409	97.76%	100%	74.66%	0	55	1.0	0	0	0	0	100.00%
56	Aug 15/06	0.36		6.9	43	10	890	510	16	18	7,039	3.6	185	174	13,395	62	4,471	97.73%	100%	74.31%	0	55	0.94	0	0	0	0	100.00%
57	Aug 22/06	0.36		7.0	37	10	904	760	13	16	7,053	3.6	274	197	13,669	91	4,562	97.68%	100%	73.78%	0	55	0.63	0	0	0	0	100.00%
58	Aug 29/06	0.36		7.0	27	8.0	734	400	9.7	15	7,063	2.9	144	187	13,813	48	4,610	97.66%	100%	73.50%	0	55	1.2	0	0	0	0	100.00%
59	Sept 5/06	0.35		7.1	31	9.0	919	490	11	13	7,073	3.2	173	191	13,986	58	4,668	97.63%	100%	73.17%	0	55	0.98	0	0	0	0	100.00%
60	Sept 12/06	0.36		7.0	26	8.0	705	370	9.3	12	7,083	2.8	132	182	14,118	44	4,712	97.61%	100%	72.92%	0	60	1.1	0	0	0	0	100.00%
61	Sept 19/06	0.36		7.0	24	9.0	961	520	8.7	10	7,091	3.3	188	182	14,306	63	4,775	97.58%	100%	72.56%	0	60	0.77	0	0	0	0	100.00%
62	Sept 25/06	0.32		7.0	27	10	874	490	8.6	9.5	7,100	3.2	157	159	14,463	52	4,827	97.55%	100%	72.26%	0	60	0.82	0	0	0	0	100.00%
63	Oct 3/06	0.45		7.1	23	12	1,250	800	10	9.6	7,110	5.4	357	201	14,820	119	4,946	97.49%	100%	71.57%	0	63	0.97	0	0	0	0	100.00%
Minimum		0.26		3.4	23	0.15	120	130	8.6	9.5	145	0.062	72	137	72	24	24	0.975	1.000	0.716	0		0.44	0	0	0	0	1.000
Median		0.44		6.9	143	11	1,000	510	59	55	6,217	4.3	206	210	8,878	69	2,963	0.985	1.000	0.830	0		1.1	0	0	0	0	1.000
Average		0.43		6.6	246	11	1,069	539	111	110	5,503	4.8	232	235	8,044	77	2,685	0.986	1.000	0.846	0		1.2	0	0	0	0	1.000
P95		0.52		7.2	930	22	1,754	794	445	417	7,081	10	360	349	14,098	120	4,705	0.999	1.000	0.990	0		1.8	0	0	0	0	1.000
Maximum		0.55		7.2	1,280	30	2,000	1,300	564	451	7,110	15	633	368	14,820	211	4,946	1.000	1.000	0.999	0		2.7	0	0	0	0	1.000

HUMIDITY CELL TEST

Client: **Klohn Crippen**
Project: **Wolverine**
Sample: **WOLV Ro+Cl Sc Tails**

Dry Mass of Samples

SWEP sample mass	0.041600	kg
ICP-MS sample mass =	1.0	kg

Leachate Analysis

Note: Values with Red Text were reported as less than the method detection limit and are shown here as one-half the detection limit

Test Results		SWEP	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS
Week			0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Date			July 22/05	July 29/05	Aug 5/05	Aug 12/05	Aug 19/05	Aug 26/05	Sept 2/05	Sept 9/05	Sept 16/05	Sept 23/05	Sept 30/05	Oct 7/05	Oct 14/05	Oct 21/05	Oct 28/05	Nov 4/05	Nov 11/05	Nov 18/05	Nov 25/05	Dec 1/05	Dec 9/05	Dec 16/05	Dec 23/05	Dec 30/05	Jan 6/06	Jan 13/06	Jan 20/06	Jan 27/06	Feb 3/06	Feb 10/06	Feb 17/06	Feb 24/06	Mar 3/06
Parameter	**Unit**																																		
Leachate Volume	mL	992	553	415	481	468	444	446	441	475	544	452	475	521	459	468	492	494	515	498	495	404	458	475	389	426	419	438	387	487	496	431	498	492	550
pH	pH units	8.4	5.1	3.9	3.4	3.8	4.3	4.1	3.7	3.9	6.4	6.8	6.9	6.9	7.0	7.0	7.0	7.2	7.1	7.0	6.9	6.8	6.9	8.1	6.9	6.7	6.9	6.9	7.0	7.2	6.9	6.9	7.1	7.2	7.0
Hardness	mg $CaCO_3$/L	128	237	426	691	848	744	623	1,033	985	1,211	892	905	718	786	592	665	609	639	613	680	712	778					600					556		
Alkalinity	mg/L as $CaCO_3$		1.0	0.15	0.15	1.0	1.0	1.0	1.0	1.0	6.0	10	15	14	13	16	17	30	21	18	10	7.0	11	13	9.0	7.0	7.0	8.0	8.0	21	15	14	21	25	15
Acidity	mg/L as $CaCO_3$		262	495	813	1,000	954	787	1,280	944	851	554	451	376	355	289	301	264	234	238	259	303	309	266	224	215	232	179	175	240	118	91	104	112	70
Conductivity	uS/cm		587	120	737	1,660	1,380	1,250	1,930	1,770	1,810	1,400	1,500	1,340	1,280	1,070	1,110	1,130	1,120	1,100	1,300	1,230	1,410	1,242	1,000	963	1,090	984	1,020	2,000	1,010	908	1,000	1,230	1,020
SO4	mg/L	41	130	250	370	300	430	330	610	640	940	700	760	670	660	530	550	620	560	580	660	660	820	640	510	490	530	500	540	1,300	560	480	560	710	560
Cl	mg/L	1.0	1.5	1.4	1.8	1.2	1.1	0.60	0.90	1.0	1.0	0.40	1.0	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.30												
F	mg/L		0.030	0.060	0.080	0.090	0.080	0.070	0.080	0.090	0.17	0.15	0.14	0.15	0.13	0.13	0.14	0.090	0.11	0.13	0.17	0.20	0.19												
NO3	as N mg/L	0.79	0.025	0.27	0.25	0.58	0.15	0.10	0.11	0.080	0.050	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025												
NH_3 + NH_4	as N mg/L	1.0	0.40	0.40	0.40	0.40	0.30	0.30	0.40	0.20	0.30	0.20	0.30	0.20	0.30	0.30	0.30	0.10	0.20	0.050	0.10	0.10	0.20												
Thiosalts	as S_2O_3 mg/L		292	486	824	1,200	569	687	1,100	823	786	500	407	358	330	269	272	249	45	196	224	269	277					148					84		
CN(T)	mg/L	0.0050	0.0010	0.0050	0.0050	0.010	0.0010	0.0010	0.0050	0.0010	0.0050	0.0050	0.0010	0.0050	0.0050	0.0050	0.010	0.0010	0.020	0.0050	0.0050	0.0010	0.0010												
CNO	mg/L	0.050	0.50	0.50	0.50	0.050	0.050	0.050	0.50	0.50	0.050	0.050	0.50	0.050	0.050	0.050	0.050	0.050	0.50	0.050	0.050	0.050	0.050												
CNS	mg/L	1.0	1.0	1.0	2.5	10	13	2.5	1.0																										
Mercury	ug/L	0.000050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.10	0.050	0.050	0.050	0.050	0.050	0.050												
Silver	mg/L	0.00060	0.0011	0.0025	0.0070	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.010	0.0025	0.0025	0.010	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025					0.0025					0.0025		
Aluminum	mg/L	0.0070	0.0050	0.0050	0.0050	0.070	0.0050	0.0050	0.010	0.0050	0.010	0.0050	0.010	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050					0.0050					0.0050		
Arsenic	mg/L	0.0070	0.0025	0.0025	0.018	0.018	0.014	0.0080	0.021	0.019	0.013	0.014	0.0080	0.010	0.0060	0.0060	0.0080	0.0070	0.014	0.0090	0.011	0.013	0.0080					0.0080					0.0025		
Barium	mg/L	0.20	0.097	0.035	0.029	0.032	0.030	0.021	0.033	0.028	0.033	0.025	0.028	0.024	0.023	0.016	0.020	0.021	0.021	0.021	0.023	0.028	0.029					0.020					0.020		
Beryllium	mg/L	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025					0.0025					0.0025		
Bismuth	mg/L	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015					0.00015					0.00015		
Boron	mg/L	0.0050	0.0050	0.0050	0.020	0.0050	0.0050	0.0050	0.0050	0.0050	0.010	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050					0.0050					0.0050		
Calcium	mg/L	47	83	150	240	286	241	205	333	322	411	303	310	246	270	201	227	208	219	212	235	239	262					184					183		
Cadmium	mg/L	0.0025	0.0026	0.013	0.031	0.051	0.053	0.048	0.13	0.12	0.14	0.10	0.11	0.096	0.094	0.072	0.085	0.091	0.094	0.085	0.070	0.068	0.073					0.052					0.085		
Cobalt	mg/L	0.00015	0.00060	0.0042	0.0099	0.014	0.014	0.011	0.035	0.034	0.032	0.028	0.025	0.023	0.024	0.023	0.024	0.023	0.024	0.024	0.016	0.016	0.012					0.011					0.021		
Chromium	mg/L	0.00050	0.035	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050					0.00050					0.00050		
Copper	mg/L	0.00090	0.0026	0.0028	0.0022	0.0021	0.0031	0.00090	0.0038	0.0037	0.0043	0.0034	0.0019	0.0040	0.0012	0.0090	0.0011	0.0027	0.0014	0.0017	0.0023	0.0023	0.0018					0.0048					0.0020		
Iron	mg/L	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010					0.010					0.010		
Potassium	mg/L	1.2	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025					0.0025					0.0025		
Lithium	mg/L	0.0025	3.5	3.4	4.2	5.4	4.2	3.0	4.3	3.9	4.2	2.8	2.8	2.3	2.2	1.7	1.7	1.7	1.6	1.5	1.6	1.7	1.7					1.4					1.2		
Magnesium	mg/L	2.8	7.5	12	22	33	35	27	49	44	45	33	32	25	27	22	24	22	23	20	23	28	30					34					24		
Manganese	mg/L	0.078	0.079	0.45	0.84	1.4	1.2	1.1	2.6	2.6	3.1	2.1	2.2	1.9	1.8	1.5	1.6	1.6	1.7	1.5	1.3	1.1	1.4					1.1					1.7		
Molybdenum	mg/L	0.0029	0.00090	0.00040	0.00040	0.00050	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00050	0.00015	0.00015	0.00015	0.0036	0.00015	0.00015	0.00040					0.00015					0.00015		
Sodium	mg/L	3.2	19	18	22	23	16	11	13	10	7.8	4.4	3.4	2.2	1.6	0.97	0.79	0.59	0.47	0.36	0.30	0.30	0.25					0.13					0.090		
Nickel	mg/L	0.0010	0.0040	0.014	0.029	0.039	0.042	0.028	0.10	0.085	0.10	0.064	0.057	0.070	0.055	0.042	0.040	0.047	0.044	0.039	0.042	0.024	0.024					0.027					0.035		
Phosphorous	mg/L	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050					0.050					0.050		
Lead	mg/L	0.020	0.017	0.046	0.033	0.017	0.074	0.020	0.079	0.083	0.10	0.049	0.046	0.032	0.033	0.014	0.026	0.032	0.036	0.024	0.015	0.019	0.0089					0.0097					0.010		
Antimony	mg/L	0.047	0.025	0.025	0.045	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025					0.025					0.025		
Selenium	mg/L	0.60	0.34	0.36	0.45	0.74	0.89	0.45	0.77	0.77	1.0	0.97	0.77	0.88	0.84	0.76	0.63	0.71	0.74	0.65	0.79	0.83	0.61					0.57					0.49		
Silicon	mg/L	0.32	0.13	0.14	0.18	0.23	0.19	0.14	0.30	0.34	0.45	0.33	0.35	0.30	0.30	0.24	0.25	0.26	0.27	0.25	0.22	0.20	0.20					0.17					0.24		
Tin	mg/L	0.00050	0.049	0.030	0.014	0.010	0.0050	0.0040	0.0060	0.0060	0.0050	0.0030	0.0030	0.0030	0.0030	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0040					0.0020					0.0010		
Strontium	mg/L	0.066	0.11	0.18	0.33	0.52	0.54	0.51	0.95	0.92	1.1	0.80	0.83	0.74	0.73	0.60	0.66	0.64	0.66	0.63	0.69	0.73	0.78					0.66					0.62		
Titanium	mg/L	0.0015	0.0025	0.0025	0.010	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025					0.0025					0.0025		
Thallium	mg/L	0.0023	0.0028	0.0050	0.0075	0.0077	0.0075	0.0063	0.012	0.0089	0.010	0.0085	0.0081	0.0078	0.0074	0.0025	0.0068	0.0086	0.0068	0.0058	0.0059	0.0070	0.013					0.0045					0.0054		
Uranium	mg/L	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00030	0.00020	0.00030	0.00010	0.00010	0.00010	0.00010	0.00020	0.00010	0.00020	0.00010	0.00010	0.00010					0.00010					0.00010		
Vanadium	mg/L	0.00045	0.0010	0.0010	0.0060	0.0020	0.0010	0.0010	0.0020	0.0050	0.0060	0.0040	0.0050	0.0040	0.0030	0.0020	0.0040	0.0030	0.0030	0.0030	0.0040	0.0040	0.0040					0.0010					0.0010		
Zinc	mg/L	0.037	0.080	0.49	1.4	2.2	2.3	2.4	8.1	8.7	9.8	7.1	7.9	6.9	6.4	5.7	5.8	5.8	5.9	5.2	3.7	3.0	3.6					2.2					5.0		

--- not analysed
*** could not be determined due to sample matrix
nss not sufficient sample

ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS
33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	
Mar 8/06	Mar 16/06	Mar 23/06	Mar 31/06	Apr 7/06	Apr 13/06	Apr 21/06	Apr 28/06	May 3/06	May 12/06	May 19/06	May 23/06	May 30/06	June 5/06	June 13/06	June 20/06	June 27/06	July 4/06	July 11/06	July 18/06	July 25/06	Aug 1/06	Aug 8/06	Aug 15/06	Aug 22/06	Aug 29/06	Sept 5/06	Sept 12/06	Sept 19/06	Sept 25/06	Oct 3/06	
388	438	261	444	417	396	315	432	301	447	415	445	397	456	421	272	406	361	368	346	375	357	368	363	360	361	353	356	362	320	446	
7.1	6.4	7.0	6.9	7.1	6.7	6.9	7.1	7.2	7.0	7.0	6.9	7.1	6.8	7.1	7.1	6.7	6.8	6.9	6.9	6.8	7.0	6.8	6.9	7.0	7.0	7.1	7.0	7.0	7.0	7.1	
		852					484					428	468				547					500					417			805	
22	6.0	16	11	12	15	23	11	21	12	11	11	13	12	10	11	11	10	9.0	9.0	10	9.0	9.0	10	10	8.0	9.0	8.0	9.0	10	12	
109	61	252	155	141	109	234	102	145	25	73	64	52	57	46	83	83	85	61	65	48	51	44	43	37	27	31	26	24	27	23	
841	999	1,380	1,010	973	906	1,270	812	901	952	1,190	828	812	839	742	741	923	920	907	927	962	765	879	890	904	734	919	705	961	874	1,250	
400	490	760	570	490	440	660	450	500	500	420	400	400	420	370	350	501	520	470	460	520	430	480	510	760	400	490	370	520	490	800	
																														0.10	
																														0.14	
																														0.025	
																														0.050	
		195					100					43	51				63					35					60			27	
																														0.0010	
																														0.050	
																														0.10	
																														0.000050	
		0.022					0.0025					0.0025	0.0025				0.0025					0.0025					0.0025			0.000015	
		0.0050					0.0050					0.0050	0.0050				0.0050					0.0050					0.0050			0.0050	
		0.0025					0.00060					0.0044	0.0022				0.0037					0.0053					0.0014			0.0053	
		0.043					0.027					0.025	0.018				0.029					0.022					0.021			0.023	
		0.0025					0.000020					0.000020	0.000020				0.000020					0.000020					0.000040			0.000020	
		0.00015					0.000020					0.000010	0.000010				0.000010					0.000010					0.000010			0.000010	
		0.0050					0.0010					0.0010	0.0030				0.015					0.0010					0.0010			0.0010	
		271					148					131	146				151					125					95			247	
		0.099					0.058					0.057	0.053				0.063					0.048					0.038			0.066	
		0.020					0.014					0.012	0.012				0.012					0.0081					0.0079			0.012	
		0.00050					0.00070					0.00015	0.00015				0.00015					0.00015					0.00015			0.00015	
		0.0082					0.0030					0.0021	0.0021				0.0022					0.0014					0.0013			0.0016	
		0.0050					0.0050					0.0050	0.0050				0.010					0.0050					0.0050			0.010	
		0.0030					0.0010					0.0010	0.0010				0.0010					0.0010					0.0010			0.0020	
		1.7					0.88					0.86	0.87				0.88					0.83					0.72			0.84	
		43					28					25	25				41					46					44			46	
		1.8					1.5					1.1	1.2				1.3					0.86					0.73			1.0	
		0.00060					0.00033					0.00096	0.00026				0.00030					0.00031					0.00027			0.00027	
		0.11					0.040					0.040	0.10				0.070					0.050					0.070			0.070	
		0.031					0.019					0.018	0.018				0.017					0.013					0.011			0.019	
		0.020					0.0050					0.0050	0.0050				0.0050					0.020					0.0050			0.0050	
		0.010					0.0080					0.0072	0.0065				0.0069					0.0068					0.0053			0.0069	
		0.0050					0.0050					0.0050	0.0050				0.0050					0.0050					0.0050			0.0050	
		0.81					0.35					0.36	0.37				0.51					0.46					0.39			0.39	
		0.25					0.14					0.16	0.16				0.15					0.12					0.090			0.17	
		0.0020					0.0011					0.00090	0.00080				0.0011					0.00060					0.00015			0.00015	
		0.77					0.48					0.44	0.48				0.53					0.44					0.34			0.77	
		0.00050					0.00050					0.00050	0.00050				0.00050					0.00050					0.00050			0.00050	
		0.0055					0.0029					0.0034	0.0034				0.0037					0.0028					0.0019			0.0035	
		0.00010					0.000050					0.000060	0.000060				0.000090					0.000030					0.00012			0.00012	
		0.0010					0.00050					0.00050	0.00050				0.00050					0.00050					0.00050			0.0020	
		4.0					2.4					2.4	2.5				2.3					1.7					1.6			2.6	

MIN	MEDIAN	AVG	P95	MAX
261	435	426	520	553
3.4	6.9	6.6	7.2	8.1
237	665	679	1,009	1,211
0.15	11	11	22	30
23	143	246	930	1,280
120	1,000	1,069	1,754	2,000
130	510	539	794	1,300
0.10	0.35	0.60	1.5	1.8
0.030	0.13	0.12	0.19	0.20
0.025	0.025	0.088	0.27	0.58
0.050	0.30	0.25	0.40	0.40
27	269	354	962	1,200
0.0010	0.0050	0.0045	0.010	0.020
0.050	0.050	0.19	0.50	0.50
0.10	1.8	3.9	12	13
0.000050	0.050	0.050	0.050	0.10
0.000015	0.0025	0.0036	0.010	0.022
0.0050	0.0050	0.0076	0.010	0.070
0.00060	0.0080	0.0086	0.019	0.021
0.016	0.025	0.028	0.039	0.097
0.000020	0.0025	0.0019	0.0025	0.0025
0.000010	0.00015	0.00012	0.00015	0.00015
0.0010	0.0050	0.0053	0.013	0.020
83	227	222	328	411
0.0026	0.070	0.072	0.12	0.14
0.00060	0.016	0.018	0.033	0.035
0.00015	0.00050	0.0016	0.00060	0.035
0.00090	0.0022	0.0028	0.0065	0.0090
0.0050	0.010	0.0090	0.010	0.010
0.0010	0.0025	0.0022	0.0025	0.0030
0.72	1.7	2.2	4.3	5.4
7.5	28	30	46	49
0.079	1.4	1.5	2.6	3.1
0.00015	0.00015	0.00040	0.00093	0.0036
0.040	0.59	5.0	20	23
0.0040	0.035	0.039	0.093	0.10
0.0050	0.050	0.039	0.050	0.050
0.0053	0.019	0.028	0.081	0.10
0.0050	0.025	0.020	0.025	0.045
0.34	0.65	0.63	0.93	1.0
0.090	0.22	0.22	0.35	0.45
0.00015	0.0020	0.0054	0.022	0.049
0.11	0.64	0.62	0.94	1.1
0.00050	0.0025	0.0022	0.0025	0.010
0.0019	0.0063	0.0062	0.011	0.013
0.000010	0.00010	0.00011	0.00025	0.00030
0.00050	0.0020	0.0025	0.0055	0.0060
0.080	3.6	4.2	8.4	9.8

Loading Rates Calculated from Leachate Analysis Results

Note: Loading Rate (mg/kg/wk) = Leachate Concentration (mg/L) x Volume of Leachate Collected (L/cycle) / Sample Weight (kg) * (1 cycle / 1 week)

Test Results		SWEP	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS
Week			0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Date			July 22/05	July 29/05	Aug 5/05	Aug 12/05	Aug 19/05	Aug 26/05	Sept 2/05	Sept 9/05	Sept 16/05	Sept 23/05	Sept 30/05	Oct 7/05	Oct 14/05	Oct 21/05	Oct 28/05	Nov 4/05	Nov 11/05	Nov 18/05	Nov 25/05	Dec 1/05	Dec 9/05	Dec 16/05	Dec 23/05	Dec 30/05	Jan 6/06	Jan 13/06	Jan 20/06	Jan 27/06	Feb 3/06	Feb 10/06	Feb 17/06	Feb 24/06	Mar 3/06
Parameter	**Unit**																																				
Volume	L	0.99	0.55	0.42	0.48	0.47	0.44	0.45	0.44	0.48	0.54	0.45	0.48	0.52	0.46	0.47	0.49	0.49	0.52	0.50	0.50	0.40	0.46	0.48	0.39	0.43	0.42	0.44	0.39	0.49	0.50	0.43	0.50	0.49	0.55
pH	pH units	8.4	5.1	3.9	3.4	3.8	4.3	4.1	3.7	3.9	6.4	6.8	6.9	6.9	7.0	7.0	7.0	7.2	7.1	7.0	6.9	6.8	6.9	8.1	6.9	6.7	6.9	6.9	7.0	7.2	6.9	6.9	7.1	7.2	7.0
Hardness	mg/kg/wk	3,055	131	177	333	397	330	278	456	468	659	403	430	374	361	277	327	301	329	305	337	288	356					263					277		
Alkalinity	mg/kg/wk		0.55	0.062	0.072	0.47	0.44	0.45	0.44	0.48	3.3	4.5	7.1	7.3	6.0	7.5	8.4	15	11	9.0	5.0	2.8	5.0	6.2	3.5	3.0	2.9	3.5	3.1	10	7.4	6.0	10	12	8.3
Acidity	mg/kg/wk		145	205	391	468	424	351	564	448	463	250	214	196	163	135	148	130	121	119	128	122	142	126	87	92	97	78	68	117	59	39	52	55	39
Conductivity	uS/cm/kg/wk		325	50	354	777	613	558	851	841	985	633	713	698	588	501	546	558	577	548	644	497	646	590	389	410	457	431	395	974	501	391	498	605	561
SO4	mg/kg/wk	977	72	104	178	140	191	147	269	304	511	316	361	349	303	248	271	306	288	289	327	267	376	304	198	209	222	219	209	633	278	207	279	349	308
Cl	mg/kg/wk	24	0.83	0.58	0.87	0.56	0.49	0.27	0.40	0.48	0.54	0.18	0.48	0.052	0.046	0.047	0.049	0.049	0.052	0.050	0.050	0.040	0.14												
F	mg/kg/wk		0.017	0.025	0.038	0.042	0.036	0.031	0.035	0.043	0.092	0.068	0.067	0.078	0.060	0.061	0.069	0.044	0.057	0.065	0.084	0.081	0.087												
NO3	mg/kg/wk	19	0.014	0.11	0.12	0.27	0.067	0.045	0.049	0.038	0.027	0.011	0.012	0.013	0.011	0.012	0.012	0.012	0.013	0.012	0.012	0.010	0.011												
$NH_3 + NH_4$	mg/kg/wk	24	0.22	0.17	0.19	0.19	0.13	0.13	0.18	0.095	0.16	0.090	0.14	0.10	0.14	0.14	0.15	0.049	0.10	0.025	0.050	0.040	0.092												
Thiosalts	mg/kg/wk		161	202	396	562	253	306	485	391	428	226	193	187	151	126	134	123	23	98	111	109	127					65					42		
CN(T)	mg/kg/wk	0.12	0.00055	0.0021	0.0024	0.0047	0.00044	0.00045	0.0022	0.00048	0.0027	0.0023	0.00048	0.0026	0.0023	0.0023	0.0049	0.00049	0.010	0.0025	0.0025	0.00040	0.00046												
CNO	mg/kg/wk	1.2	0.28	0.21	0.24	0.023	0.022	0.022	0.22	0.24	0.027	0.023	0.24	0.026	0.023	0.023	0.025	0.025	0.26	0.025	0.025	0.020	0.023												
CNS	mg/kg/wk	24	0.55	0.42	1.2	4.7	5.8	1.1	0.44																										
Mercury	mg/kg/wk	0.0000012	0.000028	0.000021	0.000024	0.000023	0.000022	0.000022	0.000022	0.000024	0.000027	0.000023	0.000024	0.000026	0.000023	0.000023	0.000049	0.000025	0.000026	0.000025	0.000025	0.000020	0.000023												
Silver	mg/kg/wk	0.014	0.00061	0.0010	0.0034	0.0012	0.0011	0.0011	0.0011	0.0012	0.0014	0.0011	0.0048	0.0013	0.0011	0.0047	0.0012	0.0012	0.0013	0.0012	0.0012	0.0010	0.0011					0.0011					0.0012		
Aluminum	mg/kg/wk	0.17	0.0028	0.0021	0.0024	0.033	0.0022	0.0022	0.0044	0.0024	0.0054	0.0023	0.0048	0.0026	0.0023	0.0023	0.0025	0.0025	0.0026	0.0025	0.0025	0.0020	0.0023					0.0022					0.0025		
Arsenic	mg/kg/wk	0.17	0.0014	0.0010	0.0087	0.0084	0.0062	0.0036	0.0093	0.0090	0.0071	0.0063	0.0038	0.0052	0.0028	0.0028	0.0039	0.0035	0.0072	0.0045	0.0054	0.0053	0.0037					0.0035					0.0012		
Barium	mg/kg/wk	4.7	0.054	0.015	0.014	0.015	0.013	0.0094	0.015	0.013	0.018	0.011	0.013	0.013	0.011	0.0075	0.0098	0.010	0.011	0.010	0.011	0.011	0.013					0.0088					0.0100		
Beryllium	mg/kg/wk	0.060	0.0014	0.0010	0.0012	0.0012	0.0011	0.0011	0.0011	0.0012	0.0014	0.0011	0.0012	0.0013	0.0011	0.0012	0.0012	0.0012	0.0013	0.0012	0.0012	0.0010	0.0011					0.0011					0.0012		
Bismuth	mg/kg/wk	0.0036	0.000083	0.000062	0.000072	0.000070	0.000067	0.000067	0.000066	0.000071	0.000082	0.000068	0.000071	0.000078	0.000069	0.000070	0.000074	0.000074	0.000077	0.000075	0.000074	0.000061	0.000069					0.000066					0.000075		
Boron	mg/kg/wk	0.12	0.0028	0.0021	0.0096	0.0023	0.0022	0.0022	0.0022	0.0024	0.0054	0.0023	0.0024	0.0026	0.0023	0.0023	0.0025	0.0025	0.0026	0.0025	0.0025	0.0020	0.0023					0.0022					0.0025		
Calcium	mg/kg/wk	1,116	46	62	115	134	107	91	147	153	224	137	147	128	124	94	112	103	113	106	116	97	120					81					91		
Cadmium	mg/kg/wk	0.060	0.0014	0.0055	0.015	0.024	0.023	0.021	0.056	0.058	0.077	0.045	0.052	0.050	0.043	0.034	0.042	0.045	0.048	0.042	0.035	0.027	0.033					0.023					0.042		
Cobalt	mg/kg/wk	0.0036	0.00033	0.0017	0.0048	0.0065	0.0063	0.0051	0.016	0.016	0.018	0.013	0.012	0.012	0.011	0.011	0.011	0.012	0.012	0.012	0.0078	0.0066	0.0055					0.0046					0.010		
Chromium	mg/kg/wk	0.012	0.019	0.00021	0.00024	0.00023	0.00022	0.00022	0.00022	0.00024	0.00027	0.00023	0.00024	0.00026	0.00023	0.00023	0.00025	0.00025	0.00026	0.00025	0.00025	0.00020	0.00023					0.00022					0.00025		
Copper	mg/kg/wk	0.021	0.0014	0.0012	0.0011	0.00098	0.0014	0.00040	0.0017	0.0018	0.0023	0.0015	0.00090	0.0021	0.00055	0.0042	0.00054	0.0013	0.00072	0.00085	0.0011	0.00093	0.00082					0.0021					0.00100		
Iron	mg/kg/wk	0.24	0.0055	0.0042	0.0048	0.0047	0.0044	0.0045	0.0044	0.0048	0.0054	0.0045	0.0048	0.0052	0.0046	0.0047	0.0049	0.0049	0.0052	0.0050	0.0050	0.0040	0.0046					0.0044					0.0050		
Potassium	mg/kg/wk	27	0.0014	0.0010	0.0012	0.0012	0.0011	0.0011	0.0011	0.0012	0.0014	0.0011	0.0012	0.0013	0.0011	0.0012	0.0012	0.0012	0.0013	0.0012	0.0012	0.0010	0.0011					0.0011					0.0012		
Lithium	mg/kg/wk	0.060	2.0	1.4	2.0	2.5	1.9	1.3	1.9	1.8	2.3	1.3	1.3	1.2	1.0	0.80	0.85	0.83	0.84	0.76	0.80	0.69	0.80					0.61					0.60		
Magnesium	mg/kg/wk	66	4.1	5.1	11	15	15	12	22	21	24	15	15	13	12	10	12	11	12	10	11	11	14					15					12		
Manganese	mg/kg/wk	1.9	0.044	0.18	0.40	0.65	0.53	0.48	1.1	1.2	1.7	0.95	1.0	0.97	0.83	0.72	0.77	0.77	0.85	0.75	0.64	0.43	0.63					0.48					0.84		
Molybdenum	mg/kg/wk	0.069	0.00050	0.00017	0.00019	0.00023	0.000067	0.000067	0.000066	0.000071	0.000082	0.000068	0.000071	0.000078	0.000069	0.00023	0.000074	0.000074	0.000077	0.0018	0.000074	0.000061	0.00018					0.000066					0.000075		
Sodium	mg/kg/wk	77	10	7.4	10	11	7.2	4.8	5.6	4.8	4.2	2.0	1.6	1.2	0.71	0.45	0.39	0.29	0.24	0.18	0.15	0.12	0.11					0.057					0.045		
Nickel	mg/kg/wk	0.024	0.0022	0.0058	0.014	0.018	0.019	0.012	0.045	0.040	0.054	0.029	0.027	0.036	0.025	0.020	0.020	0.023	0.023	0.019	0.021	0.0097	0.011					0.012					0.017		
Phosphorous	mg/kg/wk	1.2	0.028	0.021	0.024	0.023	0.022	0.022	0.022	0.024	0.027	0.023	0.024	0.026	0.023	0.023	0.025	0.025	0.026	0.025	0.025	0.020	0.023					0.022					0.025		
Lead	mg/kg/wk	0.49	0.0093	0.019	0.016	0.0079	0.033	0.0087	0.035	0.039	0.055	0.022	0.022	0.017	0.015	0.0064	0.013	0.016	0.019	0.012	0.0075	0.0076	0.0041					0.0042					0.0050		
Antimony	mg/kg/wk	1.1	0.014	0.010	0.022	0.012	0.011	0.011	0.011	0.012	0.014	0.011	0.012	0.013	0.011	0.012	0.012	0.012	0.013	0.012	0.012	0.010	0.011					0.011					0.012		
Selenium	mg/kg/wk	14	0.19	0.15	0.22	0.35	0.39	0.20	0.34	0.37	0.56	0.44	0.37	0.46	0.38	0.35	0.31	0.35	0.38	0.33	0.39	0.33	0.28					0.25					0.24		
Silicon	mg/kg/wk	7.6	0.072	0.058	0.087	0.11	0.084	0.062	0.13	0.16	0.24	0.15	0.17	0.16	0.14	0.11	0.12	0.13	0.14	0.12	0.11	0.081	0.092					0.074					0.12		
Tin	mg/kg/wk	0.012	0.027	0.012	0.0067	0.0047	0.0022	0.0018	0.0026	0.0029	0.0027	0.0014	0.0014	0.0016	0.0014	0.00094	0.00098	0.00099	0.0010	0.00100	0.00099	0.00081	0.0018					0.00088					0.00050		
Strontium	mg/kg/wk	1.6	0.059	0.073	0.16	0.24	0.24	0.23	0.42	0.44	0.60	0.36	0.40	0.38	0.33	0.28	0.32	0.32	0.34	0.31	0.34	0.30	0.36					0.29					0.31		
Titanium	mg/kg/wk	0.036	0.0014	0.0010	0.0048	0.0012	0.0011	0.0011	0.0011	0.0012	0.0014	0.0011	0.0012	0.0013	0.0011	0.0012	0.0012	0.0012	0.0013	0.0012	0.0012	0.0010	0.0011					0.0011					0.0012		
Thallium	mg/kg/wk	0.055	0.0015	0.0021	0.0036	0.0036	0.0033	0.0028	0.0051	0.0042	0.0055	0.0038	0.0038	0.0041	0.0034	0.0012	0.0033	0.0042	0.0035	0.0029	0.0029	0.0028	0.0058					0.0020					0.0027		
Uranium	mg/kg/wk	0.0024	0.000055	0.000042	0.000048	0.000047	0.000044	0.000045	0.000044	0.000048	0.00016	0.000090	0.00014	0.000052	0.000046	0.000047	0.000049	0.000099	0.000052	0.000100	0.000050	0.000040	0.000046					0.000044					0.000050		
Vanadium	mg/kg/wk	0.011	0.00055	0.00042	0.0029	0.00094	0.00044	0.00045	0.00088	0.0024	0.0033	0.0018	0.0024	0.0021	0.0014	0.00094	0.0020	0.0015	0.0015	0.0015	0.0020	0.0016	0.0018					0.00044					0.00050		
Zinc	mg/kg/wk	0.88	0.044	0.20	0.67	1.0	1.0	1.0	3.6	4.1	5.3	3.2	3.8	3.6	2.9	2.7	2.8	2.9	3.0	2.6	1.8	1.2	1.7					0.94					2.5		

ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS		MIN	MEDIAN	AVG	P95	MAX
33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63								
Mar 8/06	Mar 16/06	Mar 23/06	Mar 31/06	Apr 7/06	Apr 13/06	Apr 21/06	Apr 28/06	May 3/06	May 12/06	May 19/06	May 23/06	May 30/06	June 5/06	June 13/06	June 20/06	June 27/06	July 4/06	July 11/06	July 18/06	July 25/06	Aug 1/06	Aug 8/06	Aug 15/06	Aug 22/06	Aug 29/06	Sept 5/06	Sept 12/06	Sept 19/06	Sept 25/06	Oct 3/06								
0.39	0.44	0.26	0.44	0.42	0.40	0.32	0.43	0.30	0.45	0.42	0.45	0.40	0.46	0.42	0.27	0.41	0.36	0.37	0.35	0.38	0.36	0.37	0.36	0.36	0.36	0.35	0.36	0.36	0.32	0.45		0.26	0.44	0.43	0.52	0.55
7.1	6.4	7.0	6.9	7.1	6.7	6.9	7.1	7.2	7.0	7.0	6.9	7.1	6.8	7.1	7.1	6.7	6.8	6.9	6.9	6.8	7.0	6.8	6.9	7.0	7.0	7.1	7.0	7.0	7.0	7.1		3.4	6.9	6.6	7.2	8.1
		222					209					170	213				197					184					148			359		131	305	308	462	659
8.5	2.6	4.2	4.9	5.0	5.9	7.2	4.8	6.3	5.4	4.6	4.9	5.2	5.5	4.2	3.0	4.5	3.6	3.3	3.1	3.8	3.2	3.3	3.6	3.6	2.9	3.2	2.8	3.3	3.2	5.4		0.1	4	5	10	15
42	27	66	69	59	43	74	44	44	11	30	28	21	26	19	23	34	31	22	22	18	18	16	16	13	9.7	11	9.3	8.7	8.6	10		9	59	111	445	564
326	438	360	448	406	359	400	351	271	426	494	368	322	383	312	202	375	332	334	321	361	273	323	323	325	265	324	251	348	280	558		50	408	462	831	985
155	215	198	253	204	174	208	194	151	224	174	178	159	192	156	95	203	188	173	159	195	154	177	185	274	144	173	132	188	157	357		72	206	232	360	633
																														0.045		0.04	0.2	0.3	1	1
																														0.062		0.02	0.1	0.1	0.1	0.1
																														0.011		0.01	0.01	0.04	0.1	0.3
																														0.022		0.02	0.1	0.1	0.2	0.2
		51					43					17	23				23					13					21			12		12	126	165	456	562
																														0.00045		0.0004	0.002	0.002	0.00	0.01
																														0.022		0.02	0.02	0.1	0.3	0.3
																														0.045		0.0	1	2	5	6
																														########		########	0.00002	0.00002	0.00003	0.0000
		0.0057					0.0011					0.00099	0.0011				0.00090					0.00092					0.00089			0.0000067		0.00001	0.001	0.002	0.00	0.01
		0.0013					0.0022					0.0020	0.0023				0.0018					0.0018					0.0018			0.0022		0.001	0.002	0.003	0.01	0.03
		0.00065					0.00026					0.0017	0.0010				0.0013					0.0020					0.00050			0.0024		0.0003	0.004	0.004	0.01	0.01
		0.011					0.012					0.0097	0.0083				0.010					0.0082					0.0073			0.010		0.01	0.01	0.01	0.02	0.1
		0.00065					0.0000086					0.0000079	0.0000091				0.0000072					0.0000074					0.000014			0.0000089		0.00001	0.001	0.001	0.001	0.001
		0.000039					0.0000086					0.0000040	0.0000046				0.0000036					0.0000037					0.0000036			0.0000045		0.000004	0.0001	0.0001	0.0001	0.0001
		0.0013					0.00043					0.00040	0.0014				0.0054					0.00037					0.00036			0.00045		0.0004	0.002	0.002	0.01	0.01
		71					64					52	67				55					46					34			110		34	106	101	150	224
		0.026					0.025					0.022	0.024				0.023					0.018					0.013			0.029		0.001	0.03	0.03	0.1	0.1
		0.0052					0.0061					0.0048	0.0055				0.0043					0.0030					0.0028			0.0055		0.0003	0.01	0.01	0.02	0.02
		0.00013					0.00030					0.000060	0.000068				0.000054					0.000055					0.000053			0.000067		0.0001	0.0002	0.001	0.0003	0.02
		0.0021					0.0013					0.00083	0.00096				0.00079					0.00052					0.00046			0.00071		0.0004	0.001	0.001	0.002	0.00
		0.0013					0.0022					0.0020	0.0023				0.0036					0.0018					0.0018			0.0045		0.001	0.00	0.004	0.01	0.01
		0.00078					0.00043					0.00040	0.00046				0.00036					0.00037					0.00036			0.00089		0.0004	0.001	0.001	0.001	0.001
		0.45					0.38					0.34	0.40				0.32					0.31					0.26			0.37		0.3	1	1	2	3
		11					12					9.7	11				15					17					15			20		4	12	13	21	24
		0.46					0.66					0.42	0.52				0.48					0.32					0.26			0.45		0.0	1	1	1	2
		0.00016					0.00014					0.00038	0.00012				0.00011					0.00011					0.000096			0.00012		0.0001	0.0001	0.0002	0.000	0.002
		0.029					0.017					0.016	0.046				0.025					0.018					0.025			0.031		0.02	0.3	2	10	11
		0.0081					0.0080					0.0072	0.0082				0.0062					0.0048					0.0040			0.0084		0.002	0.02	0.02	0.0	0.1
		0.0052					0.0022					0.0020	0.0023				0.0018					0.0074					0.0018			0.0022		0.002	0.02	0.02	0.03	0.03
		0.0027					0.0034					0.0028	0.0030				0.0025					0.0025					0.0019			0.0031		0.002	0.01	0.01	0.04	0.1
		0.0013					0.0022					0.0020	0.0023				0.0018					0.0018					0.0018			0.0022		0.001	0.01	0.01	0.01	0.02
		0.21					0.15					0.14	0.17				0.18					0.17					0.14			0.18		0.1	0.3	0.3	0	1
		0.065					0.060					0.064	0.073				0.054					0.044					0.032			0.076		0.03	0.1	0.1	0.2	0.2
		0.00052					0.00048					0.00036	0.00036				0.00040					0.00022					0.000053			0.000067		0.0001	0.001	0.003	0.01	0.03
		0.20					0.21					0.18	0.22				0.19					0.16					0.12			0.34		0.1	0.3	0.3	0	1
		0.00013					0.00022					0.00020	0.00023				0.00018					0.00018					0.00018			0.00022		0.0001	0.001	0.001	0.001	0.00
		0.0014					0.0013					0.0013	0.0016				0.0013					0.0010					0.00068			0.0016		0.001	0.003	0.003	0.01	0.01
		0.000026					0.000022					0.000024	0.000027				0.000032					0.000011					0.0000036			0.000054		0.000004	0.0000	0.0001	0.0001	0.0002
		0.00026					0.00022					0.00020	0.00023				0.00018					0.00018					0.00018			0.00089		0.0002	0.001	0.001	0.003	0.003
		1.0					1.0					0.96	1.1				0.81					0.64					0.57			1.2		0.0	1	2	4	5

Overall Diluted Ore Composite

Project: **Wolverine**
Sample: **Comb OD Comp**

Sample Data - Initial Measurements

Initial organic S	1.67	(%)
Initial total sulphur	26.6	(%)
Initial SO4-S	2.04	(%)
Initial S2--S	22.9	(%)
Sample Weight	1.0	(kg)
Initial NP	82.5	(t $CaCO_3$/1000t)
Assumed NP unreactive		
Initial SO4-S	20,400	(mg)

Results - SO_4 - S Depletion

SO_4 Production (5 wk average)	139	mg/kg/wk		
SO_4 Production (5 wk average)	7,252,195	mg/t/yr		
SO_4 - S Production (5 wk average)	46	mg/kg/wk		
Cumulative SO_4 - S Production	12,289	mg/kg		
Time to SO_4 - S Depletion	175	wk	3	yr
Time to S2--S Depletion	1,648	wk	32	yr

Results - NP Depletion

Initial NP	82,500	mg $CaCO_3$/kg
Cumulative Open System NP Consumption	66	mg $CaCO_3$/kg
Remaining NP	82,434	mg $CaCO_3$/kg
Open System NP Consumption Rate (5 wk average)	1	mg $CaCO_3$/kg/wk
Time to Sobek-NP Depletion	107,842	wk
Time to Sobek-NP Depletion	2,067	yr

HUMIDITY CELL TEST DATA

WEEK	DATE	WATER ADDED	LEACHATE COLLECTED	LEACHATE pH	ACIDITY	ALKALINITY	CONDUC-TIVITY	SULPHATE	ACIDITY PRODUCTION			ALKALINITY PRODUCTION	SULPHATE PRODUCTION			SO4-S PRODUCTION		REMAINING SULPHUR (% of ORIGINAL SAMPLE)			THEORETICAL NP CONSUMPTION	WEEK WHERE Ca and Mg WERE LAST SAMPLED	CARBONATE MOLAR RATIO	CARBONATE RATIO	OPEN SYSTEM NP CONSUMPTION			REMAINING NP
									PRODUCTION RATE (mg $CaCO_3$/kg/wk)		CUMMULATIVE PRODUCTION	PRODUCTION RATE (mg $CaCO_3$/	PRODUCTION RATE (mg/kg/wk)		CUMMULATIVE PRODUCTION	PRODUCTION RATE	CUMMULATIVE PRODUCED	TOTAL-S	SULPHIDE-S	SULPHATE-S				NP CONSUMPTION (mg $CaCO_3$/	CONSUMPTION RATE (mg $CaCO_3$/kg/wk)		CUMMULATIVE CONSUMPTION	(% of ORIGINAL
		(L)	(L)		(mg $CaCO_3$/L)	(mg $CaCO_3$/L)	(µS/cm)	(mg/L)	Weekly	5 wk Average	(mg $CaCO_3$/kg)	/kg/wk)	Weekly	5 wk Average	(mg/kg)	(mg/kg/wk)	(mg/kg)				(mg $CaCO_3$/kg/wk)			/kg/wk)	Weekly	5 wk Average	(mg $CaCO_3$/kg)	SAMPLE)
0	July 22/05	0.23	7.0	76	11	370	110	18		18	2.6	26		26	8.6	8.6	100.00%	100%	99.96%	0	0	1.3	0	0		0	100.00%
1	July 29/05	0.42	3.6	1,031	0.15	246	560	428		446	0.062	232		258	78	86	99.97%	100%	99.58%	0	1.0	1.6	0	0		0	100.00%
2	Aug 5/05	0.46	3.4	918	0.15	1,560	450	418		863	0.068	205		463	68	154	99.94%	100%	99.24%	0	2.0	1.7	0	0		0	100.00%
3	Aug 12/05	0.47	4.5	995	1.0	1,620	380	469		1,332	0.47	179		642	60	214	99.92%	100%	98.95%	0	3.0	2.2	0	0		0	100.00%
4	Aug 19/05	0.49	6.5	1,190	12	1,980	820	578	382	1,910	5.8	399	208	1,040	133	347	99.87%	100%	98.30%	0	4.0	1.4	0	0	0	0	100.00%
5	Aug 26/05	0.48	6.6	817	13	1,740	800	395	458	2,306	6.3	387	280	1,428	129	476	99.82%	100%	97.66%	0	5.0	1.2	0	0	0	0	100.00%
6	Sept 2/05	0.50	6.7	577	14	1,580	700	290	430	2,596	7.0	352	304	1,780	118	594	99.78%	100%	97.09%	0	6.0	1.3	0	0	0	0	100.00%
7	Sept 9/05	0.49	6.9	630	15	1,670	690	307	408	2,903	7.3	336	331	2,116	112	706	99.73%	100%	96.54%	0	7.0	1.4	0	0	0	0	100.00%
8	Sept 16/05	0.46	7.0	551	10	1,340	690	254	365	3,157	4.6	318	358	2,434	106	812	99.69%	100%	96.02%	0	8.0	1.2	0	0	0	0	100.00%
9	Sept 23/05	0.45	6.5	577	3.0	1,370	670	258	301	3,415	1.3	299	339	2,733	100	912	99.66%	100%	95.53%	0	9.0	1.2	0	0	0	0	100.00%
10	Sept 30/05	0.41	4.7	626	1.0	1,660	800	255	273	3,670	0.41	326	326	3,059	109	1,021	99.62%	100%	95.00%	0	10	1.2	0	0	0	0	100.00%
11	Oct 7/05	0.44	6.5	498	4.0	1,390	670	220	259	3,889	1.8	295	315	3,354	99	1,120	99.58%	100%	94.51%	0	11	1.1	0	0	0	0	100.00%
12	Oct 14/05	0.43	6.6	510	4.0	1,380	690	220	241	4,109	1.7	297	307	3,652	99	1,219	99.54%	100%	94.03%	0	12	1.2	0	0	0	0	100.00%
13	Oct 21/05	0.37	6.7	387	5.0	1,010	450	144	219	4,253	1.9	167	277	3,819	56	1,275	99.52%	100%	93.75%	0	13	1.2	0	0	0	0	100.00%
14	Oct 28/05	0.45	6.9	417	9.0	1,230	600	189	205	4,442	4.1	272	272	4,092	91	1,366	99.49%	100%	93.31%	0	14	1.2	0	0	0	0	100.00%
15	Nov 4/05	0.43	7.0	434	11	1,540	890	187	192	4,629	4.7	384	283	4,475	128	1,494	99.44%	100%	92.68%	0	15	0.95	0	0	0	0	100.00%
16	Nov 11/05	0.42	6.9	309	7.0	1,140	550	128	174	4,758	2.9	228	270	4,703	76	1,570	99.41%	100%	92.31%	0	16	1.2	0	0	0	0	100.00%
17	Nov 18/05	0.28	6.8	530	8.0	1,520	790	148	159	4,906	2.2	221	255	4,925	74	1,644	99.38%	100%	91.94%	0	17	1.1	0	0	0	0	100.00%
18	Nov 25/05	0.45	7.0	381	23	1,480	770	172	165	5,078	10	347	291	5,272	116	1,759	99.34%	100%	91.38%	0	18	0.98	0	0	0	0	100.00%
19	Dec 1/05	0.48	7.1	270	22	1,240	660	129	153	5,207	11	316	299	5,588	106	1,865	99.30%	100%	90.86%	0	19	1.1	0	0	0	0	100.00%
20	Dec 9/05	0.52	7.1	276	33	1,720	1,100	142	144	5,349	17	568	336	6,156	189	2,054	99.23%	100%	89.93%	0	20	0.87	0	0	0	0	100.00%
21	Dec 16/05	0.40	7.0	163	21	1,152	620	65	131	5,414	8.4	247	340	6,402	82	2,137	99.20%	100%	89.53%	0	20	1.5	0	0	0	0	100.00%
22	Dec 23/05	0.50	7.1	120	20	960	520	60	114	5,474	10.0	259	347	6,662	87	2,223	99.16%	100%	89.10%	0	20	1.8	0	0	0	0	100.00%
23	Dec 30/05	0.49	7.0	152	20	930	510	75	94	5,549	9.8	251	328	6,913	84	2,307	99.13%	100%	88.69%	0	20	1.9	0	0	0	0	100.00%
24	Jan 6/06	0.50	7.1	146	21	1,020	510	73	83	5,622	11	256	316	7,169	85	2,393	99.10%	100%	88.27%	0	20	1.9	0	0	0	0	100.00%
25	Jan 13/06	0.49	7.1	125	21	1,010	530	62	67	5,684	10	261	255	7,430	87	2,480	99.07%	100%	87.85%	0	25	1.1	0	0	0	0	100.00%
26	Jan 20/06	0.49	7.1	104	21	965	520	51	64	5,735	10	255	257	7,685	85	2,565	99.04%	100%	87.43%	0	25	1.1	0	0	0	0	100.00%
27	Jan 27/06	0.51	7.6	102	53	2,190	1,500	52	63	5,787	27	770	359	8,454	257	2,822	98.94%	100%	86.17%	0	25	0.40	0	0	0	0	100.00%
28	Feb 3/06	0.48	6.9	104	21	932	500	50	58	5,837	10	241	357	8,695	80	2,902	98.91%	100%	85.77%	0	25	1.2	0	0	0	0	100.00%
29	Feb 10/06	0.49	6.9	82	22	941	500	40	51	5,877	11	244	354	8,939	81	2,983	98.88%	100%	85.38%	0	25	1.2	0	0	0	0	100.00%
30	Feb 17/06	0.50	7.0	114	21	920	490	57	50	5,934	10	244	351	9,182	81	3,065	98.85%	100%	84.98%	0	30	0.99	0	0	0	0	100.00%
31	Feb 24/06	0.33	6.9	287	12	1,420	820	96	59	6,030	4.0	274	354	9,456	91	3,156	98.81%	100%	84.53%	0	30	0.59	0	0	0	0	100.00%
32	Mar 3/06	0.48	7.0	147	14	891	480	70	62	6,100	6.7	228	246	9,684	76	3,232	98.78%	100%	84.16%	0	30	1.0	0	0	0	0	100.00%
33	Mar 8/06	0.33	7.0	199	11	1,030	510	66	66	6,166	3.7	169	232	9,854	57	3,289	98.76%	100%	83.88%	0	30	0.95	0	0	0	0	100.00%
34	Mar 16/06	0.42	6.2	111	5.0	1,140	560	47	67	6,212	2.1	235	230	10,089	78	3,367	98.73%	100%	83.49%	0	30	0.86	0	0	0	0	100.00%
35	Mar 23/06	0.30	7.0	600	18	1,800	990	179	92	6,392	5.4	296	240	10,385	99	3,466	98.70%	100%	83.01%	0	35	1.1	0	0	0	0	100.00%
36	Mar 31/06	0.43	6.8	268	10	1,140	510	114	95	6,506	4.3	217	229	10,602	72	3,538	98.67%	100%	82.66%	0	35	2.2	0	0	0	0	100.00%
37	Apr 7/06	0.41	6.9	257	10	1,230	640	104	102	6,610	4.1	260	235	10,861	87	3,625	98.64%	100%	82.23%	0	35	1.8	0	0	0	0	100.00%
38	Apr 13/06	0.39	6.7	240	16	1,160	560	94	108	6,704	6.2	218	245	11,080	73	3,698	98.61%	100%	81.87%	0	35	2.0	0	0	0	0	100.00%
39	Apr 21/06	0.28	7.0	634	30	2,230	1,200	180	134	6,884	8.5	341	266	11,421	114	3,812	98.57%	100%	81.32%	0	35	0.94	0	0	0	0	100.00%
40	Apr 28/06	0.42	7.1	241	8.0	1,070	580	102	119	6,985	3.4	245	256	11,665	82	3,893	98.54%	100%	80.92%	0	40	1.1	0	0	0	0	100.00%
41	May 3/06	0.35	7.1	307	16	1,320	790	109	118	7,094	5.7	280	269	11,945	93	3,987	98.50%	100%	80.46%	0	40	0.82	0	0	0	0	100.00%
42	May 12/06	0.41	6.9	144	11	1,200	620	59	109	7,153	4.5	252	267	12,197	84	4,071	98.47%	100%	80.04%	0	40	1.0	0	0	0	0	100.00%
43	May 19/06	0.42	6.9	163	11	1,300	610	69	104	7,221	4.6	257	275	12,455	86	4,157	98.44%	100%	79.62%	0	40	1.1	0	0	0	0	100.00%
44	May 23/06	0.48	6.9	108	13	1,020	530	51	78	7,273	6.2	252	257	12,707	84	4,241	98.41%	100%	79.21%	0	40	1.2	0	0	0	0	100.00%
45	May 30/06	0.40	6.8	92	12	1,030	550	37	65	7,309	4.8	220	252	12,927	73	4,314	98.38%	100%	78.85%	0	45	0.98	0	0	0	0	100.00%
46	June 5/06	0.45	6.8	90	12	982	520	40	51	7,350	5.4	233	243	13,160	78	4,392	98.35%	100%	78.47%	0	46	1.1	0	0	0	0	100.00%
47	June 13/06	0.40	7.0	83	12	901	470	33	46	7,383	4.8	188	230	13,348	63	4,455	98.33%	100%	78.16%	0	46	1.2	0	0	0	0	100.00%
48	June 20/06	0.29	6.9	251	11	551	630	72	47	7,455	3.1	180	215	13,528	60	4,515	98.30%	100%	77.87%	0	46	0.87	0	0	0	0	100.00%
49	June 27/06	0.40	6.5	172	14	1,170	670	68	50	7,523	5.5	265	217	13,793	89	4,604	98.27%	100%	77.43%	0	46	0.82	0	0	0	0	100.00%
50	July 4/06	0.37	6.6	181	9.0	1,190	700	67	56	7,590	3.3	259	225	14,052	86	4,690	98.24%	100%	77.01%	0	50	1.0	0	0	0	0	100.00%
51	July 11/06	0.36	6.9	171	12	1,240	650	62	60	7,652	4.3	235	226	14,288	79	4,768	98.21%	100%	76.63%	0	50	1.1	0	0	0	0	100.00%
52	July 18/06	0.36	6.7	201	9.0	1,340	710	71	68	7,723	3.2	252	238	14,540	84	4,853	98.18%	100%	76.21%	0	50	1.0	0	0	0	0	100.00%
53	July 25/06	0.37	6.7	171	9.0	1,340	770	63	66	7,786	3.3	283	259	14,823	95	4,947	98.14%	100%	75.75%	0	50	0.95	0	0	0	0	100.00%
54	Aug 1/06	0.36	6.9	143	17	1,087	640	52	63	7,838	6.2	233	253	15,056	78	5,025	98.11%	100%	75.37%	0	50	1.1	0	0	0	0	100.00%
55	Aug 8/06	0.36	6.7	128	9.0	1,210	680	46	59	7,884	3.3	246	250	15,302	82	5,107	98.08%	100%	74.97%	0	55	1.0	0	0	0	0	100.00%
56	Aug 15/06	0.37	6.8	105	12	1,210	740	39	54	7,923	4.5	275	258	15,577	92	5,199	98.05%	100%	74.51%	0	55	0.94	0	0	0	0	100.00%
57	Aug 22/06	0.37	7.0	92	10	1,170	560	34	47	7,957	3.7	207	249	15,785	69	5,268	98.02%	100%	74.18%	0	55	1.2	0	0	0	0	100.00%
58	Aug 29/06	0.37	7.1	91	8.0	1,030	590	34	41	7,991	3.0	219	236	16,004	73	5,341	97.99%	100%	73.82%	0	55	1.2	0	0	0	0	100.00%
59	Sept 5/06	0.37	7.1	105	9.0	1,270	720	38	38	8,030	3.3	263	242	16,267	88	5,429	97.96%	100%	73.39%	0	55	0.96	0	0	0	0	100.00%
60	Sept 12/06	0.37	7.3	174	30	2,510	1,700	65	42	8,094	11	632	319	16,899	211	5,640	97.88%	100%	72.35%	0	60	1.1	0	0	0	0	100.00%
61	Sept 19/06	0.44	7.0	44	9.0	1,140	610	19	38	8,114	3.9	267	318	17,167	89	5,729	97.85%	100%	71.92%	0	60	3.0	0	0	0	0	100.00%
62	Sept 25/06	0.33	7.0	139	21	2,100	1,400	45	40	8,159	6.9	458	368	17,624	153	5,882	97.79%	100%	71.17%	0	60	1.3	0	0	0	0	100.00%
63	Oct 3/06	0.43	7.0	58	11	1,270	880	25	39	8,184	4.8	382	400	18,006	127	6,010	97.74%	100%	70.54%	0	63	0.88	0	0	0	0	100.00%
64	Oct 10/06	0.33	6.8	89	9.0	1,190	680	29	37	8,214	3.0	224	393	18,230	75	6,084	97.71%	100%	70.18%	0	63	1.1	0	0	0	0	100.00%
65	Oct 17/06	0.28	6.8	174	13	1,320	780	49	34	8,263	3.7	221	310	18,451	74	6,158	97.68%	100%	69.81%	0	65	1.1	0	0	0	0	100.00%
66	Oct 24/06	0.26	6.6	255	7.0	1,600	940	67	43	8,329	1.8	245	306	18,696	82	6,240	97.65%	100%	69.41%	0	65	0.87	0	0	0	0	100.00%
67	Oct 31/06	0.43	6.6	107	6.0	1,060	560	46	43	8,375	2.6	241	263	18,937	80	6,320	97.62%	100%	69.02%	0	65	1.5	0	0	0	0	100.00%
68	Nov 7/06	0.44	6.5	62	12	1,010	560	27	44	8,402	5.2	244	235	19,181	81	6,402	97.59%	100%	68.62%	0	68	1.00	0	0	0	0	100.00%
69	Nov 14/06	0.45	6.5	67	7.0	1,130	590	30	44	8,433	3.2	266	243	19,447	89	6,490	97.56%	100%	68.18%	0	68	0.95	0	0	0	0	100.00%
70	Nov 21/06	0.37	6.4	71	7.0	1,200	660	26	39	8,458	2.6	241	247	19,687	80	6,571	97.53%	100%	67.79%	0	70	0.99	0	0	0	0	100.00%
71	Nov 28/06	0.41	6.9	51	7.0	1,060	860	21	30	8,479	2.8	349	268	20,037	117	6,687	97.49%	100%	67.22%	0	70	0.76	0	0	0	0	100.00%
72	Dec 5/06	0.40	6.9	51	7.0	958	650	20	25	8,499	2.8	259	272	20,295	86	6,774	97.45%	100%	66.80%	0	70	1.0	0	0	0	0	100.00%
73	Dec 12/06	0.38	6.7	53	9.0	1,120	630	20	23	8,520	3.4	239	271	20,535	80	6,853	97.42%	100%	66.40%	0	70	1.0	0	0	0	0	100.00%
74	Dec 19/06	0.29	6.8	99	10	1,320	800	29	23	8,549	2.9	235	265	20,770	78	6,932	97.39%	100%	66.02%	0	70	0.81	0	0	0	0	100.00%
75	Dec 27/06	0.40	6.8	35	7.0	1,030	560	14	21	8,563	2.8	222	261	20,992	74	7,006	97.37%	100%	65.66%	0	75	0.94	0	0	0	0	100.00%
76	Jan 2/07	0.42	7.0	32	7.0	934	490	13	19	8,576	2.9	206	232	21,197	69	7,075	97.34%	100%	65.32%	0	75	1.1	0	0	0	0	100.00%
77	Jan 9/07	0.40	7.0	28	7.0	1,020	640	11	18	8,587	2.8	257	232	21,454	86	7,160	97.31%	100%	64.90%	0	75	0.83	0	0	0	0	100.00%
78	Jan 16/07	0.38	6.8	36	7.0	992	570	14	16	8,601	2.6	214	227	21,668	71	7,232	97.28%	100%	64.55%	0	75	0.93	0	0	0	0	100.00%
79	Jan 23/07	0.33	7.0	49	21	1,170	680	16	14	8,617	6.8	222	224	21,889	74	7,306	97.25%	100%	64.19%	0	75	0.78	0	0	0	0	100.00%
80	Jan 30/07	0.40	6.8	52	7.0	1,040	530	21	15	8,637	2.8	211	222	22,101	71	7,376	97.23%	100%	63.84%	0	80	0.97	0	0	0	0	100.00%
81	Feb 6/07	0.37	6.9	38	7.0	994	540	14	15	8,652	2.6	200	221	22,301	67	7,443	97.20%	100%	63.51%	0	80	0.95	0	0	0	0	100.00%
82	Feb 13/07	0.37	6.9	34	8.0	1,160	630	13	15	8,664	3.0	234	216	22,536	78	7,521	97.17%	100%	63.13%	0	80	0.82	0	0	0	0	100.00%
83	Feb 20/07	0.42	6.9	29	7.0	956	520	12	15	8,676	3.0	219	217	22,755	73	7,595	97.14%	100%	62.77%	0	80	0.99	0	0	0	0	100.00%
84	Feb 27/07	0.34	6.9	42	7.0	1,100	620	14	15	8,691	2.4	211	215	22,967	71	7,665	97.12%	100%	62.43%	0	80	0.83	0	0	0	0	100.00%
85	Mar 5/07	0.36	6.9	44	7.0	1,060	600	16	14	8,707	2.5	218	217	23,184	73	7,738	97.09%	100%	62.07%	0	85	0.93	0	0	0	0	100.00%
86	Mar 13/07	0.32	6.8	55	8.0	1,280	760	17	15	8,724	2.5	240	225	23,424	80	7,818	97.06%	100%	61.68%	0	85	0.74	0	0	0	0	100.00%
87	Mar 20/07	0.41	6.8	33	7.0	952	510	13	15	8,737	2.8	207	219	23,631	69	7,887	97.04%	100%	61.34%	0	85	1.1	0	0	0	0	100.00%
88	Mar 27/07	0.43	6.9	22	7.0	966	510	9.5	14	8,747	3.0	220	219	23,851	74	7,960	97.01%	100%	60.98%	0	85	1.1	0	0	0	0	100.00%
89	Apr 3/07	0.43	6.6	15	6.0	730	400	6.4	13	8,753	2.6	171	211	24,022	57	8,017	96.99%	100%	60.70%	0	85	1.4	0	0	0	0	100.00%
90	Apr 10/07	0.39	6.8	16	7.0	829	460	6.2	11	8,760	2.7	178	203	24,200	59	8,077	96.96%	100%	60.41%	0	90	0.95	0	0	0	0	100.00%
91	Apr 17/07	0.34	7.0	16	7.0	995	550	5.4	8.2	8,765	2.4	185	192	24,386	62	8,139	96.94%	100%	60.10%	0	90	0.80	0	0	0	0	100.00%
92	Apr 24/07	0.36	7.0	23	7.0	980	550	8.4	7.2	8,773	2.5	200	191	24,586	67	8,205	96.92%	100%	59.78%	0	90	0.80	0	0	0	0	100.00%
93	May 1/07	0.37	6.9	23	11	963	540	8.6	7.0	8,782	4.1	202	187	24,788	67	8,273	96.89%	100%	59.45%	0	90	0.81	0	0	0	0	100.00%
94	May 8/07	0.43	6.5	13	6.0	861	470	5.6	6.8	8,788	2.6	203	194	24,991	68	8,341	96.86%	100%	59.11%	0	90	0.93	0	0	0	0	100.00%
95	15-May-07	0.41	6.7	16	6.0	856	500	6.5	6.9	8,794	2.5	205	199	25,195	68	8,409	96.84%	100%	58.78%	0	95	1.0	0	0	0	0	100.00%
96	22-May-07	0.37	6.8	16	6.0	915	520	5.9	7.0	8,800	2.2	190	200	25,386	64	8,472	96.81%	100%	58.47%	0	95	0.97	0	0	0	0	100.00%
97	29-May-07	0.39	6.7	13	5.0	834	490	5.0	6.3	8,805	1.9	190	198	25,575	63	8,536	96.79%	100%	58.16%	0	95	1.0	0	0	0	0	100.00%
98	05-Jun-07	0.41	6.9	12	9.0	973	540	4.9	5.6	8,810	3.7	221	202	25,797	74	8,610	96.76%	100%	57.80%	0	95	0.94	0	0	0	0	100.00%
99	12-Jun-07	0.34	7.0	15	8.0	1,040	640	5.1	5.5	8,815	2.7	218	205	26,015	73	8,682	96.74%	100%	57.44%	0	95	0.79	0	0	0	0	100.00%

Project: Wolverine
Sample: Comb OD Comp

Sample Data - Initial Measurements

Initial organic S	1.67	(%)
Initial total sulphur	26.6	(%)
Initial SO4-S	2.04	(%)
Initial S2--S	22.9	(%)
Sample Weight	1.0	(kg)
Initial NP	82.5	(t $CaCO_3$/1000t)
Assumed NP unreactive		
Initial SO4-S	20,400	(mg)

Results - SO_4 - S Depletion

SO_4 Production (5 wk average)	139	mg/kg/wk		
SO_4 Production (5 wk average)	7,252,195	mg/t/yr		
SO_4 - S Production (5 wk average)	46	mg/kg/wk		
Cumulative SO_4 - S Production	12,289	mg/kg		
Time to SO_4 - S Depletion	175	wk	3	yr
Time to S2-- S Depletion	1,648	wk	32	yr

Results - NP Depletion

Initial NP	82,500	mg $CaCO_3$/kg
Cumulative Open System NP Consumption	66	mg $CaCO_3$/kg
Remaining NP	82,434	mg $CaCO_3$/kg
Open System NP Consumption Rate (5 wk average)	1	mg $CaCO_3$/kg/wk
Time to Sobek-NP Depletion	107,842	wk
Time to Sobek-NP Depletion	2,067	yr

HUMIDITY CELL TEST DATA

WEEK	DATE	WATER ADDED	LEACHATE COLLECTED	LEACHATE pH	ACIDITY	ALKALINITY	CONDUC-TIVITY	SULPHATE	ACIDITY PRODUCTION			ALKALINITY PRODUCTION	SULPHATE PRODUCTION			SO4-S PRODUCTION		REMAINING SULPHUR (% of ORIGINAL SAMPLE)			THEORETICAL NP CONSUMPTION	WEEK WHERE Ca and Mg WERE LAST SAMPLED	CARBONATE MOLAR RATIO	CARBONATE RATIO NP CONSUMPTION	OPEN SYSTEM NP CONSUMPTION			REMAINING NP
									PRODUCTION RATE (mg $CaCO_3$/kg/wk)		CUMMULATIVE PRODUCTION	PRODUCTION RATE (mg $CaCO_3$/ /kg/wk)	PRODUCTION RATE (mg/kg/wk)		CUMMULATIVE PRODUCTION	PRODUCTION RATE	CUMMULATIVE PRODUCED							(mg $CaCO_3$/ /kg/wk)	CONSUMPTION RATE (mg $CaCO_3$/kg/wk)		CUMMULATIVE CONSUMPTION	(% of ORIGINAL
		(L)	(L)		(mg $CaCO_3$/L)	(mg $CaCO_3$/L)	(µS/cm)	(mg/L)	Weekly	5 wk Average	(mg $CaCO_3$/kg)	/kg/wk)	Weekly	5 wk Average	(mg/kg)	(mg/kg/wk)	(mg/kg)	TOTAL-S	SULPHIDE-S	SULPHATE-S	(mg $CaCO_3$/kg/wk)				Weekly	5 wk Average	(mg $CaCO_3$/kg)	SAMPLE)
100	19-Jun-07	0.41	6.0	0	1.0	822	490	0	4	8,815	0.41	200	204	26,215	67	8,749	96.71%	100%	57.11%	0	100	0.95	0	0	0	0	100.00%
101	26-Jun-07	0.38	7.0	8.0	8.0	981	560	3.0	4	8,818	3.0	213	209	26,428	71	8,820	96.68%	100%	56.76%	0	100	0.83	0	0	0	0	100.00%
102	3-Jul-07	0.40	6.9	7.0	7.0	931	540	2.8	3	8,821	2.8	217	214	26,645	72	8,893	96.66%	100%	56.41%	0	100	0.86	0	0	0	0	100.00%
103	10-Jul-07	0.38	6.8	8.0	7.0	947	510	3.0	3	8,824	2.6	191	208	26,836	64	8,956	96.63%	100%	56.10%	0	100	0.91	0	0	0	0	100.00%
104	17-Jul-07	0.35	6.5	10	7.0	877	540	3.5	2	8,827	2.5	191	202	27,027	64	9,020	96.61%	100%	55.78%	0	100	0.86	0	0	0	0	100.00%
105	24-Jul-07	0.42	7.0	7.0	7.0	855	510	3.0	3.1	8,830	3.0	215	206	27,242	72	9,092	96.58%	100%	55.43%	0	105	0.96	0	0	0	0	100.00%
106	31-Jul-07	0.36	6.8	9.0	8.0	958	550	3.2	3.1	8,834	2.8	196	202	27,438	65	9,157	96.56%	100%	55.11%	0	105	0.89	0	0	0	0	100.00%
107	08-Aug-07	0.39	6.4	9.0	6.0	843	490	3.5	3.2	8,837	2.3	190	197	27,628	63	9,221	96.53%	100%	54.80%	0	105	1.00	0	0	0	0	100.00%
108	14-Aug-07	0.40	6.8	7.0	8.0	917	500	2.8	3.2	8,840	3.2	202	199	27,829	67	9,288	96.51%	100%	54.47%	0	105	0.98	0	0.40	0.081	0.81	100.00%
109	21-Aug-07	0.41	6.4	10	7.0	844	470	4.1	3.3	8,844	2.9	194	199	28,023	65	9,353	96.48%	100%	54.15%	0	105	1.0	0	0	0.081	0.81	100.00%
110	28-Aug-07	0.39	6.8	1.0	3.0	197	880	0.39	2.8	8,844	1.2	342	225	28,366	114	9,467	96.44%	100%	53.59%	0	110	0.42	0	0.78	0.24	1.6	100.00%
111	04-Sep-07	0.42	6.9	7.0	7.0	742	450	3.0	2.8	8,847	3.0	191	224	28,556	64	9,531	96.42%	100%	53.28%	0	110	0.82	0	0	0.24	1.6	100.00%
112	11-Sep-07	0.46	6.9	4.0	7.0	761	430	1.8	2.4	8,849	3.2	197	225	28,753	66	9,596	96.39%	100%	52.96%	0	110	0.86	0	1.4	0.51	3.0	100.00%
113	18-Sep-07	0.46	6.8	5.0	9.0	873	500	2.3	2.3	8,851	4.2	232	231	28,985	77	9,674	96.36%	100%	52.58%	0	110	0.74	0	1.9	0.80	4.8	99.99%
114	25-Sep-07	0.45	6.7	1.0	21	716	380	0.45	1.6	8,852	9.4	169	226	29,154	57	9,730	96.34%	100%	52.30%	0	110	0.97	0	8.9	2.6	14	99.98%
115	02-Oct-07	0.44	6.7	4.0	6.0	756	420	1.8	1.9	8,854	2.7	186	195	29,340	62	9,792	96.32%	100%	52.00%	0	115	0.94	0	0.89	2.6	15	99.98%
116	09-Oct-07	0.46	6.9	4.0	12	755	440	1.8	1.6	8,856	5.5	200	197	29,541	67	9,859	96.29%	100%	51.67%	0	115	0.90	0	3.6	3.3	18	99.98%
117	16-Oct-07	0.47	6.6	5.0	7.0	737	370	2.4	1.7	8,858	3.3	175	192	29,716	58	9,918	96.27%	100%	51.38%	0	115	1.1	0	0.95	3.2	19	99.98%
118	23-Oct-07	0.41	7.0	3.0	7.0	850	490	1.2	1.5	8,859	2.9	202	187	29,918	68	9,985	96.25%	100%	51.05%	0	115	0.81	0	1.7	3.2	21	99.97%
119	30-Oct-07	0.41	6.7	6.0	6.0	750	450	2.5	1.9	8,862	2.5	185	190	30,103	62	10,047	96.22%	100%	50.75%	0	115	0.88	0	0	1.4	21	99.97%
120	06-Nov-07	0.40	6.9	6.0	7.0	817	470	2.4	2.1	8,864	2.8	186	190	30,289	62	10,109	96.20%	100%	50.45%	0	120	0.94	0	0	1.3	21	99.97%
121	13-Nov-07	0.37	6.8	7.0	6.0	804	460	2.6	2.2	8,867	2.2	168	183	30,457	56	10,165	96.18%	100%	50.17%	0	120	0.96	0	0	0.6	21	99.97%
122	20-Nov-07	0.39	6.8	5.0	6.0	693	340	2.0	2.1	8,869	2.4	134	175	30,591	45	10,210	96.16%	100%	49.95%	0	120	1.30	0	0	0.5	22	99.97%
123	27-Nov-07	0.40	6.8	5.0	7.0	818	460	2.0	2.3	8,870	2.8	182	171	30,773	61	10,270	96.14%	100%	49.65%	0	120	0.96	0	1	0.3	22	99.97%
124	04-Dec-07	0.41	6.9	3.0	7.0	686	370	1.2	2.0	8,872	2.9	151	164	30,924	50	10,321	96.12%	100%	49.41%	0	120	1.20	0	2	0.6	24	99.97%
125	11-Dec-07	0.41	3.3	41.0	1.0	946	410	16.6	4.9	8,888	0.4	166	160	31,090	56	10,376	96.10%	100%	49.14%	0	125	0.84	0	0	0.6	24	99.97%
126	18-Dec-07	0.42	6.4	6.0	7.0	601	320	2.5	4.9	8,891	3.0	136	154	31,226	45	10,422	96.08%	100%	48.91%	0	125	1.08	0	0	0.6	24	99.97%
127	24-Dec-07	0.41	6.4	7.0	7.0	837	480	2.8	5.0	8,894	2.8	194	166	31,420	65	10,487	96.06%	100%	48.60%	0	125	0.72	0	0	0.6	24	99.97%
128	02-Jan-08	0.44	6.6	7.0	8.0	850	430	3.0	5.3	8,897	3.5	187	167	31,608	62	10,549	96.03%	100%	48.29%	0	125	0.80	0	0	0.5	25	99.97%
129	08-Jan-08	0.43	7.1	4.0	7.0	840	390	1.7	5.4	8,898	3.0	167	170	31,775	56	10,605	96.01%	100%	48.02%	0	125	0.89	0	1	0.4	26	99.97%
130	15-Jan-08	0.42	6.7	3.0	11.0	752	380	1.3	2.3	8,900	4.7	161	169	31,936	54	10,658	95.99%	100%	47.75%	0	130	0.95	0	3	1.1	30	99.96%
131	18-Jan-08	0.41	6.7	3.0	7.0	768	410	1.2	2.0	8,901	2.8	167	175	32,102	56	10,714	95.97%	100%	47.48%	0	130	0.88	0	2	1.3	31	99.96%
132	29-Jan-08	0.43	7.0	2.0	8.0	762	430	0.9	1.6	8,902	3.4	183	173	32,285	61	10,775	95.95%	100%	47.18%	0	130	0.84	0	3	1.9	34	99.96%
133	05-Feb-08	0.41	7.0	1.0	6.0	682	360	0.4	1.1	8,902	2.4	146	165	32,431	49	10,824	95.93%	100%	46.94%	0	130	1.00	0	2	2.2	36	99.96%
134	12-Feb-08	0.41	6.6	3.0	8.0	707	340	1.2	1.0	8,903	3.3	141	159	32,572	47	10,871	95.91%	100%	46.71%	0	130	1.06	0	2	2.3	38	99.95%
135	19-Feb-08	0.47	6.7	3.0	8.0	744	390	1.4	1.0	8,905	3.7	181	164	32,753	61	10,931	95.89%	100%	46.41%	0	135	0.96	0	2	2.1	40	99.95%
136	26-Feb-08	0.42	7.0	1.0	6.0	730	390	0.4	0.9	8,905	2.5	165	163	32,918	55	10,986	95.87%	100%	46.15%	0	135	0.96	0	2	2.2	42	99.95%
137	04-Mar-08	0.40	7.0	1.0	8.0	785	420	0.4	0.8	8,906	3.2	167	160	33,085	56	11,042	95.85%	100%	45.87%	0	135	0.89	0	3	2.3	45	99.95%
138	11-Mar-08	0.44	6.8	3.0	6.0	643	340	1.3	1.0	8,907	2.6	149	161	33,234	50	11,092	95.83%	100%	45.63%	0	135	1.10	0	1	2.1	46	99.94%
139	18-Mar-08	0.41	6.9	2.0	7.0	689	410	0.8	0.9	8,908	2.9	169	166	33,403	57	11,148	95.81%	100%	45.35%	0	135	0.91	0	2	2.1	48	99.94%
140	25-Mar-08	0.39	6.8	4.0	6.0	749	440	1.5	0.9	8,909	2.3	169	164	33,573	57	11,205	95.79%	100%	45.07%	0	140	0.94	0	1	1.8	49	99.94%
141	01-Apr-08	0.42	6.5	4.0	8.0	650	350	1.7	1.2	8,911	3.4	147	160	33,719	49	11,254	95.77%	100%	44.83%	0	140	1.18	0	2	1.7	51	99.94%
142	08-Apr-08	0.46	6.7	12.0	7.0	710	350	5.5	2.2	8,917	3.2	160	159	33,880	54	11,307	95.75%	100%	44.57%	0	140	1.18	0	0	1.2	51	99.94%
143	15-Apr-08	0.46	6.6	5.0	5.0	698	360	2.3	2.4	8,919	2.3	166	162	34,046	55	11,363	95.73%	100%	44.30%	0	140	1.15	0	0	0.9	51	99.94%
144	22-Apr-08	0.43	6.7	4.0	7.0	732	420	1.7	2.5	8,921	3.0	180	164	34,226	60	11,423	95.71%	100%	44.01%	0	140	0.98	0	1	0.7	52	99.94%
145	29-Apr-08	0.43	6.7	5.0	5.0	568	310	2.2	2.7	8,923	2.2	134	157	34,360	45	11,467	95.69%	100%	43.79%	0	145	0.91	0	0	0.6	52	99.94%
146	6-May-08	0.38	6.5	5.0	5.0	696	370	1.9	2.7	8,925	1.9	139	156	34,499	47	11,514	95.67%	100%	43.56%	0	145	0.76	0	0	0.3	52	99.94%
147	13-May-08	0.41	7.0	8.0	9.0	658	320	3.3	2.3	8,928	3.7	132	150	34,632	44	11,558	95.65%	100%	43.34%	0	145	0.88	0	0	0.3	53	99.94%
148	20-May-08	0.42	6.5	7.0	4.0	615	310	2.9	2.4	8,931	1.7	129	143	34,760	43	11,601	95.64%	100%	43.13%	0	145	0.91	0	0	0.3	53	99.94%
149	27-May-08	0.39	7.0	3.0	5.0	655	320	1.2	2.3	8,932	2.0	126	132	34,887	42	11,643	95.62%	100%	42.92%	0	145	0.88	0	1	0.2	53	99.94%
150	03-June-08	0.44	6.9	3.0	5.0	659	340	1.3	2.1	8,933	2.2	149	135	35,035	50	11,693	95.60%	100%	42.68%	0	145	0.83	0	1	0.4	54	99.93%
151	10-Jun-08	0.41	6.7	3.0	6.0	633	370	1.2	2.0	8,935	2.4	151	137	35,186	50	11,743	95.59%	100%	42.44%	0	145	0.76	0	1	0.7	56	99.93%
152	17-Jun-08	0.47	6.9	4.0	8.0	633	340	1.9	1.7	8,936	3.7	159	143	35,345	53	11,796	95.57%	100%	42.18%	0	145	0.83	0	2	1.0	57	99.93%
153	24-Jun-08	0.46	6.7	4.0	6.0	636	360	1.8	1.5	8,938	2.8	166	150	35,511	56	11,852	95.54%	100%	41.90%	0	145	0.78	0	1	1.1	58	99.93%
154	01-July-08	0.45	6.8	2.0	7.0	784	410	0.9	1.4	8,939	3.2	185	162	35,696	62	11,914	95.52%	100%	41.60%	0	145	0.68	0	2	1.4	61	99.93%
155	08-Jul-08	0.43	6.5	5.0	6.0	704	360	2.1	1.6	8,941	2.6	154	163	35,850	51	11,965	95.50%	100%	41.35%	0	145	0.78	0	0	1.3	61	99.93%
156	15-Jul-08	0.40	6.4	6.0	5.0	663	330	2.4	1.8	8,944	2.0	132	159	35,982	44	12,009	95.49%	100%	41.13%	0	145	0.85	0	0	1.1	61	99.93%
157	22-Jul-08	0.41	6.4	5.0	7.0	670	350	2.0	1.9	8,946	2.8	142	156	36,125	48	12,057	95.47%	100%	40.90%	0	145	0.80	0	1	0.9	62	99.93%
158	29-Jul-08	0.43	6.5	6.0	6.0	623	320	2.6	2.0	8,948	2.6	138	150	36,262	46	12,103	95.45%	100%	40.67%	0	145	0.88	0	0	0.7	62	99.93%
159	05-Aug-08	0.41	6.7	2.0	6.0	729	380	0.8	2.0	8,949	2.5	156	144	36,418	52	12,155	95.43%	100%	40.42%	0	145	0.74	0	2	0.6	63	99.92%
160	12-Aug-08	0.42	6.7	1.0	5.0	651	270	0.4	1.7	8,950	2.1	114	137	36,533	38	12,193	95.42%	100%	40.23%	0	145	1.04	0	2	0.8	65	99.92%
161	19-Aug-08	0.45	6.6	6.0	5.0	828	380	2.7	1.7	8,952	2.3	171	144	36,704	57	12,250	95.39%	100%	39.95%	0	145	0.74	0	0	0.8	65	99.92%
162	26-Aug-08	0.48	6.5	3.0	4.0	479	240	1.4	1.6	8,954	1.9	116	139	36,820	39	12,289	95.38%	100%	39.76%	0	145	1.17	0	0	0.8	66	99.92%
Minimum		0.23	3.35	0.0	0.15	197	110	0.00	0.8	18	0.062	26	132	26	8.6	8.6	0.954	1.000	0.398	0		0.40	0	0	0	0	0.999
Median		0.41	6.83	38	7.0	960	520	14	15	8,652	3.0	214	222	22,301	71	7,443	0.972	1.000	0.635	0		1.0	0	0	0	0	1.000
Average		0.41	6.72	132	10	1,017	559	55	53	7,595	4.0	226	228	20,834	75	6,953	0.974	1.000	0.659	0		1.0	0	0.40	0.40	12.62	1.000
P95		0.49	7.10	598	21	1,669	880	255	243	8,939	10	352	351	35,678	117	11,907	0.997	1.000	0.960	0		1.7	0	2.07	2.18	60.3	1.000
Maximum		0.52	7.60	1,190	53	2,510	1,700	578	458	8,954	27	770	400	36,820	257	12,289	1.000	1.000	1.000	0		3.0	0	8.9	3.3	66	1.000

HUMIDITY CELL TEST

Client: **Klohn Crippen**
Project: **Wolverine**
Sample: **OD Ro+Cl Sc Tails**

Dry Mass of Samples

SWEP sample mass	0.042000	kg
ICP-MS sample mass =	1.0	kg

Leachate Analysis

Note: Values with Red Text were reported as less than the method detection limit and are shown here as one-half the detection limit

| Test Results | | SWEP | ICP-MS | ICP-MS | ICP-MS

| ICP-MS | ICP-MS | ICP-MS |

| ICP-MS | ICP-MS | ICP-MS |

checked and switched.

| ICP-MS | ICP-MS | ICP-MS |

Loading Rates Calculated from Leachate Analysis Results

Note: Loading Rate (mg/kg/wk) = Leachate Concentration (mg/L) x Volume of Leachate Collected (L/cycle) / Sample Weight (kg) * (1 cycle / 1 wee

| Test Results | | SWEP | ICP-MS | ICP-MS | ICP-MS

| ICP-MS | ICP-MS | ICP-MS |

| ICP-MS | ICP-MS | ICP-MS |

ICP-MS 131	ICP-MS 132	ICP-MS 133	ICP-MS 134	ICP-MS 135	ICP-MS 136	ICP-MS 137	ICP-MS 138	ICP-MS 139	ICP-MS 140	ICP-MS 141	ICP-MS 142	ICP-MS 143	ICP-MS 144	ICP-MS 145	ICP-MS 146	ICP-MS 147	ICP-MS 148	ICP-MS 149	ICP-MS 150	ICP-MS 151	ICP-MS 152	ICP-MS 153	ICP-MS 154	ICP-MS 155	ICP-MS 156	ICP-MS 157	ICP-MS 158	ICP-MS 159	ICP-MS 160	ICP-MS 161	ICP-MS 162		MIN	MEDIAN	AVG	P95	MAX
18-Jan-08	29-Jan-08	05-Feb-08	12-Feb-08	19-Feb-08	26-Feb-08	04-Mar-08	11-Mar-08	18-Mar-08	25-Mar-08	01-Apr-08	08-Apr-08	15-Apr-08	22-Apr-08	29-Apr-08	39,574	13-May-08	20-May-08	27-May-08	03-June-08	10-Jun-08	17-Jun-08	24-Jun-08	01-July-08	08-Jul-08	15-Jul-08	22-Jul-08	29-Jul-08	05-Aug-08	12-Aug-08	19-Aug-08	26-Aug-08						
0.41	0.43	0.41	0.41	0.47	0.42	0.40	0.44	0.41	0.39	0.42	0.46	0.46	0.43	0.43	0.38	0.41	0.42	0.39	0.44	0.41	0.47	0.46	0.45	0.43	0.40	0.41	0.43	0.41	0.42	0.45	0.48		0.23	0.41	0.41	0.49	0.52
6.7	7.0	7.0	6.6	6.7	7.0	7.0	6.8	6.9	6.8	6.5	6.7	6.6	6.7	6.7	6.5	7.0	6.5	7.0	6.9	6.7	6.9	6.7	6.8	6.5	6.4	6.4	6.5	6.7	6.7	6.6	6.5		3.3	6.8	6.7	7.1	7.6
				181					165					126	2																		2	259	292	508	715
2.8	3.4	2.4	3.3	3.7	2.5	3.2	2.6	2.9	2.3	3.4	3.2	2.3	3.0	2.2	1.9	3.7	1.7	2.0	2.2	2.4	3.7	2.8	3.2	2.6	2.0	2.8	2.6	2.5	2.1	2.3	1.9		0.062	3.0	4.0	10	27
1.2	0.85	0.41	1.2	1.4	0.42	0.40	1.3	0.83	1.5	1.7	5.5	2.3	1.7	2.2	262.4	3.3	2.9	1.2	1.3	1.2	1.9	1.8	0.9	2.1	2.4	2.0	2.6	0.8	0.4	2.7	1.4		0.39	15	57	258	578
313	324	277	293	346	308	312	282	285	288	272	325	322	314	245	139	272	256	258	288	258	296	294	354	301	266	273	268	300	276	373	231		77	381	413	707	1,123
167	183	146	141	181	165	167	149	169	169	147	160	166	180	134		132	129	126	149	151	159	166	185	154	132	142	138	156	114	171	116		26	214	226	352	770
																																	0.037	0.15	0.28	0.76	1.3
																																	0.0070	0.063	0.074	0.11	0.34
																																	0.0059	0.011	0.034	0.099	0.29
				7.9					1.9					2.2					2.2					2.1					2.1				0.022	0.13	0.14	0.29	0.33
																																	1.9	34	106	401	539
																																	0.00023	0.0020	0.0021	0.0047	0.012
																																	0.014	0.024	0.090	0.24	0.25
																																	0.043	0.49	1.1	3.5	4.7
																																	########	0.000022	0.000021	0.000025	0.000026
				0.0000047					0.000039					0.000013					0.000013					0.000002					0.000002				0.0000021	0.0009	0.0010	0.0039	0.010
				0.0023					0.00054					0.00099					0.00118					0.00418					0.00114				0.00050	0.0021	0.0020	0.0041	0.0050
				0.0017					0.00065					0.0011					0.0015					0.0020					0.0016				0.00030	0.0020	0.0036	0.011	0.011
				0.0083					0.042					0.0066					0.0070					0.0086					0.0063				0.0063	0.011	0.013	0.020	0.042
				0.0000047					0.0000039					0.0000043					0.0000044					0.0000043					0.0000042				0.0000039	0.000009	0.00050	0.0012	0.0013
				0.0000023					0.0000019					0.0000022					0.0000022					0.0000021					0.0000021				0.0000019	0.0000045	0.000032	0.000074	0.000077
				0.00047					0.0050					0.00022					0.00074					0.00030					0.00004				0.00004	0.0017	0.0021	0.0053	0.014
				59					55					42					50					50					39				12	74	92	179	212
				0.025					0.00000058					0.018					0.021					0.026					0.019				########	0.025	0.028	0.053	0.068
				0.0033					0.000016					0.0019					0.0020					0.0024					0.0019				0.000016	0.0039	0.0051	0.012	0.013
				0.00012					0.000096					0.00011					0.00011					0.00011					0.00011				0.000042	0.00014	0.00030	0.00027	0.0075
				0.0021					0.0094					0.0016					0.0019					0.0019					0.0021				0.00040	0.0011	0.0014	0.0029	0.0094
				0.0023					0.0019					0.0086					0.0022					0.0021					0.0021				0.0014	0.0026	0.0049	0.0067	0.083
				0.00023					0.0023					0.00022					0.19228					0.22204					0.17384				0.00014	0.00103	0.01210	0.0795	0.2220
				0.25					0.20					0.16					0.00					0.00					0.00				0.00	0.31	0.55	1.9	2.5
				8.2					7.0					4.8					5.5					7.3					5.6				1.00	14	14	24	46
				0.23					0.00010					0.14					0.15					0.21					0.15				0.00010	0.58	0.77	2.1	2.7
				0.00068					0.00035					0.00050					0.00063					0.00064					0.00050				0.000056	0.00020	0.00027	0.00064	0.00100
				0.033					0.023					0.013					0.017					0.017					0.013				0.0044	0.041	1.0	7.3	12
				0.0055					0.000019					0.0029					0.0042					0.0043					0.0034				0.000019	0.0065	0.012	0.035	0.049
				0.0093					0.0039					0.0022					0.0022					0.0021					0.0021				0.0014	0.011	0.012	0.025	0.026
				0.00057					0.00012					0.00075					0.00077					0.00074					0.00080				0.00012	0.00082	0.0053	0.016	0.13
				0.00072					0.0000039					0.00056					0.00076					0.00070					0.00053				0.0000039	0.0022	0.0058	0.012	0.020
				0.080					0.00019					0.047					0.060					0.081					0.062				0.00019	0.16	0.24	0.50	0.95
				0.084					0.065					0.065					0.074					0.081					0.059				0.030	0.073	0.10	0.23	0.29
				0.000098					0.0000019					0.000052					0.000083					0.000090					0.000076				0.0000019	0.00025	0.0023	0.0087	0.042
				0.091					0.080					0.076					0.074					0.078					0.061				0.014	0.25	0.26	0.51	0.60
				0.000023					0.000019					0.000022					0.000022					0.000021					0.000021				0.000019	0.00021	0.00061	0.0012	0.0046
				0.0013					0.00000039					0.00095					0.00107					0.00129					0.00098				########	0.0018	0.0035	0.010	0.012
				0.000024					0.000097					0.0000086					0.0000411					0.0000431					0.0000144				0.0000041	0.000042	0.000051	0.00015	0.00024
				0.000037					0.0000058					0.000013					0.000044					0.000006					0.000006				0.0000058	0.00049	0.00077	0.0020	0.0029
				1.3					1.2					0.91					1.03					1.29					0.97				0.014	1.2	1.5	3.6	4.4

Overall Ore Composite

Project: Wolverine
Sample: Comb Overall Ore Comp

Sample Data - Initial Measurements

Initial organic S	1.73	(%)
Initial total sulphur	29	(%)
Initial SO4-S	2.5	(%)
Initial S2--S	25.0	(%)
Sample Weight	1.0	(kg)
Initial NP	73	(t $CaCO_3$/1000t)
Assumed NP unreactive		
Initial SO4-S	25,100	(mg)

Results - SO_4 - S Depletion

SO_4 Production (5 wk average)	119	mg/kg/wk
SO_4 Production (5 wk average)	6,212,589	mg/t/yr
SO_4 - S Production (5 wk average)	40	mg/kg/wk
Cumulative SO_4 - S Production to date	5,847	mg/kg
Time to SO_4 - S Depletion	484	wk 9 yr
Time to S2- - S Depletion	2,096	wk 40 yr

Results - NP Depletion

Initial NP	72,800	mg $CaCO_3$/kg
Cumulative Open System NP Consumption	156	mg $CaCO_3$/kg
Remaining NP	72,644	mg $CaCO_3$/kg
Open System NP Consumption Rate (5 wk average)	0	mg $CaCO_3$/kg/wk
Time to Sobek-NP Depletion	185,696	wk
Time to Sobek-NP Depletion	3,559	yr

HUMIDITY CELL TEST DATA

WEEK	DATE	WATER ADDED (L)	LEACHATE COLLECTED (L)	LEACHATE pH	ACIDITY ($mg\ CaCO_3$/L)	ALKALINITY ($mg\ CaCO_3$/L)	CONDUC-TIVITY (µS/cm)	SULPHATE (mg/L)	ACIDITY PRODUCTION: PRODUCTION RATE ($mg\ CaCO_3$/kg/wk) Weekly	ACIDITY PRODUCTION: PRODUCTION RATE ($mg\ CaCO_3$/kg/wk) 5 wk Average	ACIDITY PRODUCTION: CUMMULATIVE PRODUCTION ($mg\ CaCO_3$/kg)	ALKALINITY PRODUCTION RATE ($mg\ CaCO_3$/ /kg/wk)	SULPHATE PRODUCTION: PRODUCTION RATE (mg/kg/wk) Weekly	SULPHATE PRODUCTION: PRODUCTION RATE (mg/kg/wk) 5 wk Average	SULPHATE PRODUCTION: CUMMULATIVE PRODUCTION (mg/kg)	SO4-S PRODUCTION: PRODUCTION RATE (mg/kg/wk)	SO4-S PRODUCTION: CUMMULATIVE PRODUCED (mg/kg)	REMAINING SULPHUR (% of ORIGINAL SAMPLE) TOTAL-S	SULPHIDE-S	SULPHATE-S	THEORETICAL NP CONSUMPTION ($mg\ CaCO_3$/kg/wk)	WEEK WHERE Ca and Mg WERE LAST SAMPLED	CARBONATE MOLAR RATIO	CARBONATE RATIO CONSUMPTION ($mg\ CaCO_3$/ /kg/wk)	OPEN SYSTEM NP CONSUMPTION: CONSUMPTION RATE ($mg\ CaCO_3$/kg/wk) Weekly	OPEN SYSTEM NP CONSUMPTION: CONSUMPTION RATE ($mg\ CaCO_3$/kg/wk) 5 wk Average	OPEN SYSTEM NP CONSUMPTION: CUMMULATIVE CONSUMPTION ($mg\ CaCO_3$/kg)	REMAINING NP (% of ORIGINAL SAMPLE)
0	June 6/05		0.28	6.4	32	4.0	485	220	8.8		8.8	1.1	61		61	20	20	99.99%	100%	99.92%	0	0	0.87	0	0		0	100.00%
1	June 17/05		0.50	7.0	79	13	933	480	39		48	6.4	238		299	79	100	99.97%	100%	99.60%	0	1.0	0.92	0	0		0	100.00%
2	June 24/05		0.43	6.9	114	7.0	855	380	49		97	3.0	162		460	54	154	99.95%	100%	99.39%	0	2.0	1.1	0	0		0	100.00%
3	July 1/05		0.37	6.6	202	7.0	1,342	630	74		171	2.6	232		692	77	231	99.92%	100%	99.08%	0	3.0	0.99	0	0		0	100.00%
4	July 8/05		0.43	6.6	182	4.0	771	310	79	50	250	1.7	134	165	826	45	276	99.91%	100%	98.90%	0	4.0	1.2	0	0	0	0	100.00%
5	July 15/05		0.41	6.8	189	12	920	420	77	63	326	4.9	170	187	996	57	333	99.89%	100%	98.68%	0	5.0	1.2	0	0	0	0	100.00%
6	July 22/05		0.43	6.4	149	1.0	664	260	64	68	390	0.43	111	162	1,108	37	370	99.87%	100%	98.53%	0	6.0	1.2	0	0	0	0	100.00%
7	July 29/05		0.43	6.6	112	4.0	527	200	48	68	438	1.7	85	146	1,193	28	398	99.86%	100%	98.41%	0	7.0	1.2	0	0	0	0	100.00%
8	Aug 5/05		0.42	6.5	62	6.7	285	93	26	59	463	2.8	39	108	1,232	13	411	99.86%	100%	98.36%	0	8.0	1.3	0	0	0	0	100.00%
9	Aug 12/05		0.45	6.5	160	3.0	599	200	73	57	536	1.4	91	99	1,322	30	441	99.85%	100%	98.24%	0	9.0	1.0	0	0	0	0	100.00%
10	Aug 17/05		0.45	6.7	128	9.0	436	180	58	54	594	4.1	82	82	1,404	27	469	99.84%	100%	98.13%	0	10	1.2	0	0	0	0	100.00%
11	Aug 26/05		0.40	6.6	136	4.0	510	200	54	52	648	1.6	80	75	1,484	27	495	99.83%	100%	98.03%	0	11	1.1	0	0	0	0	100.00%
12	Sept 2/05		0.46	6.5	157	5.0	565	210	72	56	720	2.3	96	77	1,579	32	527	99.82%	100%	97.90%	0	12	1.2	0	0	0	0	100.00%
13	Sept 9/05		0.35	6.8	117	5.0	389	150	41	59	760	1.7	52	80	1,631	17	544	99.81%	100%	97.83%	0	13	1.2	0	0	0	0	100.00%
14	Sept 16/05		0.42	6.8	187	5.0	654	260	78	61	839	2.1	109	84	1,740	36	581	99.80%	100%	97.69%	0	14	1.3	0	0	0	0	100.00%
15	Sept 23.05		0.40	6.9	163	7.0	551	250	65	62	904	2.8	100	87	1,841	33	614	99.79%	100%	97.55%	0	15	1.0	0	0	0	0	100.00%
16	Sept 30/05		0.45	6.5	160	4.0	0	240	73	66	977	1.8	109	93	1,949	36	651	99.78%	100%	97.41%	0	16	1.3	0	0	0	0	100.00%
17	Oct 7/05		0.43	6.7	127	6.0	531	200	55	62	1,032	2.6	87	91	2,036	29	680	99.77%	100%	97.29%	0	17	1.2	0	0	0	0	100.00%
18	Oct 14/05		0.40	6.5	141	4.0	590	240	57	66	1,089	1.6	97	100	2,133	32	712	99.76%	100%	97.16%	0	18	1.1	0	0	0	0	100.00%
19	Oct 21/05		0.34	6.7	109	6.0	418	150	37	57	1,126	2.0	51	89	2,184	17	729	99.75%	100%	97.10%	0	19	1.2	0	0	0	0	100.00%
20	Oct 28/05		0.45	6.7	180	6.0	570	220	80	60	1,206	2.7	98	88	2,282	33	762	99.74%	100%	96.97%	0	20	1.1	0	0	0	0	100.00%
21	Nov 4/05		0.44	6.6	141	5.0	492	180	62	58	1,267	2.2	79	82	2,361	26	788	99.73%	100%	96.86%	0	20	1.4	0	0	0	0	100.00%
22	Nov 11/05		0.40	6.7	115	4.0	420	160	46	56	1,313	1.6	63	78	2,424	21	809	99.72%	100%	96.78%	0	20	1.5	0	0	0	0	100.00%
23	Nov 18/05		0.32	6.1	116	4.0	362	130	37	52	1,350	1.3	41	66	2,465	14	823	99.72%	100%	96.72%	0	20	1.9	0	0	0	0	100.00%
24	Nov 25/05		0.43	5.9	195	3.0	730	280	84	62	1,433	1.3	120	80	2,585	40	863	99.70%	100%	96.56%	0	20	0.88	0	0	0	0	100.00%
25	Dec 1/05		0.43	6.6	170	4.0	620	270	72	60	1,506	1.7	115	84	2,700	38	901	99.69%	100%	96.41%	0	25	1.1	0	0	0	0	100.00%
26	Dec 9/05		0.41	6.7	108	5.0	408	170	44	56	1,550	2.0	69	82	2,769	23	924	99.68%	100%	96.32%	0	25	1.7	0	0	0	0	100.00%
27	Dec 16/05		0.34	6.6	155	6.0	596	240	52	58	1,602	2.0	81	85	2,850	27	951	99.67%	100%	96.21%	0	25	1.2	0	0	0	0	100.00%
28	Dec 23/05		0.40	6.7	142	4.0	504	200	57	62	1,658	1.6	80	93	2,930	27	978	99.67%	100%	96.10%	0	25	1.5	0	0	0	0	100.00%
29	Dec 30/05		0.35	6.6	140	4.0	520	220	49	55	1,707	1.4	77	84	3,007	26	1,004	99.66%	100%	96.00%	0	25	1.3	0	0	0	0	100.00%
30	Jan 6/06		0.44	6.8	116	5.0	559	240	50	50	1,758	2.2	104	82	3,111	35	1,038	99.64%	100%	95.86%	0	30	1.1	0	0	0	0	100.00%
31	Jan 13/06		0.49	6.8	120	5.0	540	240	59	53	1,817	2.5	118	92	3,229	39	1,078	99.63%	100%	95.71%	0	30	1.1	0	0	0	0	100.00%
32	Jan 20/06		0.48	6.7	111	5.0	541	230	53	54	1,870	2.4	110	98	3,339	37	1,114	99.62%	100%	95.56%	0	30	1.2	0	0	0	0	100.00%
33	Jan 27/06		0.37	6.8	109	6.0	575	240	40	50	1,910	2.2	89	100	3,428	30	1,144	99.61%	100%	95.44%	0	30	1.1	0	0	0	0	100.00%
34	Feb 3/06		0.28	6.7	59	4.0	342	170	17	44	1,927	1.1	48	94	3,475	16	1,160	99.60%	100%	95.38%	0	30	1.6	0	0	0	0	100.00%
35	Feb 10/06		0.44	6.6	110	5.0	598	290	48	43	1,975	2.2	128	98	3,603	43	1,203	99.59%	100%	95.21%	0	35	1.1	0	0	0	0	100.00%
36	Feb 17/06		0.49	6.5	153	3.0	681	280	74	47	2,049	1.5	136	102	3,739	45	1,248	99.57%	100%	95.03%	0	35	1.1	0	0	0	0	100.00%
37	Feb 24/06		0.44	6.6	179	5.0	783	310	79	52	2,128	2.2	137	107	3,876	46	1,293	99.56%	100%	94.85%	0	35	1.0	0	0	0	0	100.00%
38	Mar 3/06		0.50	6.9	104	8.0	536	220	52	54	2,180	4.0	110	111	3,985	37	1,330	99.54%	100%	94.70%	0	35	1.4	0	0	0	0	100.00%
39	Mar 8/06		0.45	6.8	75	6.0	464	190	34	57	2,214	2.7	86	119	4,071	29	1,359	99.53%	100%	94.59%	0	35	1.6	0	0	0	0	100.00%
40	Mar 16/06		0.44	6.5	77	5.0	535	230	34	55	2,248	2.2	100	114	4,172	33	1,392	99.52%	100%	94.45%	0	40	1.1	0	0	0	0	100.00%
41	Mar 23/06		0.33	6.6	94	5.0	506	200	31	46	2,278	1.6	65	100	4,237	22	1,414	99.52%	100%	94.37%	0	40	1.3	0	0	0	0	100.00%
42	Mar 31/06		0.45	6.6	117	4.0	604	240	52	40	2,330	1.8	107	94	4,344	36	1,450	99.50%	100%	94.22%	0	40	1.1	0	0	0	0	100.00%
43	Apr 7/06		0.41	6.5	105	3.0	574	230	43	39	2,373	1.2	94	90	4,438	31	1,481	99.49%	100%	94.10%	0	40	1.1	0	0	0	0	100.00%
44	Apr 14/06		0.40	5.8	98	4.0	733	360	39	40	2,413	1.6	145	102	4,583	48	1,530	99.48%	100%	93.91%	0	40	0.71	0	0	0	0	100.00%
45	Apr 21/06		0.32	6.5	153	4.0	593	240	49	43	2,462	1.3	76	98	4,659	25	1,555	99.47%	100%	93.80%	0	45	1.1	0	0	0	0	100.00%
46	May 1/06		0.42	6.7	52	4.0	333	280	22	41	2,483	1.7	116	108	4,776	39	1,594	99.45%	100%	93.65%	0	45	0.97	0	0	0	0	100.00%
47	May 3/06		0.34	6.9	107	7.0	762	450	37	38	2,520	2.4	155	117	4,930	52	1,646	99.44%	100%	93.44%	0	45	0.60	0	0	0	0	100.00%
48	May 12/06		0.44	6.7	34	5.0	250	100	15	32	2,535	2.2	44	107	4,974	15	1,660	99.43%	100%	93.39%	0	45	2.7	0	0	0	0	100.00%
49	May 19/06		0.43	6.6	69	5.0	693	280	30	30	2,565	2.2	122	103	5,096	41	1,701	99.42%	100%	93.22%	0	45	0.97	0	0	0	0	100.00%
50	May 23/06		0.45	6.6	60	5.0	502	200	27	26	2,592	2.2	90	105	5,186	30	1,731	99.41%	100%	93.10%	0	50	1.0	0	0	0	0	100.00%
51	May 30/06		0.39	6.7	37	3.0	447	190	15	25	2,606	1.2	74	97	5,260	25	1,756	99.40%	100%	93.01%	0	50	1.1	0	0	0	0	100.00%
52	June 5/06		0.46	6.5	50	5.0	478	210	23	22	2,629	2.3	96	85	5,356	32	1,788	99.39%	100%	92.88%	0	50	0.98	0	0	0	0	100.00%
53	June 13/06		0.43	6.8	36	4.0	409	170	15	22	2,644	1.7	72	91	5,428	24	1,812	99.38%	100%	92.78%	0	50	1.2	0	0	0	0	100.00%
54	June 20/06		0.30	6.8	76	5.0	554	240	22	20	2,667	1.5	71	81	5,499	24	1,835	99.37%	100%	92.69%	0	50	0.86	0	0	0	0	100.00%
55	June 27/06		0.42	6.4	52	6.0	546	250	22	19	2,689	2.5	105	84	5,604	35	1,870	99.36%	100%	92.55%	0	55	1.1	0	0	0	0	100.00%
56	July 4/06		0.36	6.6	52	6.0	566	280	19	20	2,708	2.2	102	89	5,706	34	1,905	99.35%	100%	92.41%	0	55	0.98	0	0	0	0	100.00%
57	July 11/06		0.37	6.7	60	5.0	537	240	22	20	2,730	1.8	88	88	5,794	29	1,934	99.34%	100%	92.30%	0	55	1.1	0	0	0	0	100.00%
58	July 18/06		0.35	7.2	64	8.0	572	250	22	21	2,752	2.8	86	90	5,880	29	1,963	99.33%	100%	92.18%	0	55	1.1	0	0	0	0	100.00%
59	July 25/06		0.37	6.6	69	5.0	590	270	26	22	2,777	1.9	101	96	5,981	34	1,996	99.32%	100%	92.05%	0	55	1.0	0	0	0	0	100.00%
60	Aug 1/06		0.36	6.7	75	5.0	516	240	27	23	2,804	1.8	86	93	6,067	29	2,025	99.31%	100%	91.93%	0	60	1.0	0	0	0	0	100.00%
61	Aug 8/06		0.37	6.6	76	5.0	773	360	28	25	2,832	1.8	133	99	6,200	44	2,069	99.29%	100%	91.76%	0	60	0.69	0	0	0	0	100.00%
62	Aug 15/06		0.36	6.6	91	6.0	650	330	33	27	2,865	2.1	118	105	6,318	39	2,109	99.28%	100%	91.60%	0	60	0.75	0	0	0	0	100.00%
63	Aug 22/06		0.35	6.7	95	6.0	745	410	33	29	2,898	2.1	143	116	6,461	48	2,156	99.26%	100%	91.41%	0	60	0.60	0	0	0	0	100.00%
64	Aug 29/06		0.37	6.8	85	4.0	576	270	32	30	2,930	1.5	100	116	6,562	33	2,190	99.25%	100%	91.28%	0	60	0.92	0	0	0	0	100.00%
65	Sept 5/06		0.37	6.8	84	5.0	650	310	31	31	2,961	1.9	115	122	6,676	38	2,228	99.24%	100%	91.12%	0	65	1.1	0	0	0	0	100.00%
66	Sept 12/06		0.38	6.8	111	5.0	827	460	43	34	3,003	1.9	176	130	6,852	59	2,287	99.22%	100%	90.89%	0	65	0.72	0	0	0	0	100.00%
67	Sept 19/06		0.37	6.7	88	5.0	805	400	33	34	3,036	1.9	150	137	7,002	50	2,337	99.20%	100%	90.69%	0	65	0.83	0	0	0	0	100.00%
68	Sept 25/06		0.33	6.5	86	5.0	717	360	28	33	3,064	1.6	118	132	7,120	39	2,376	99.19%	100%	90.53%	0	65	0.92	0	0	0	0	100.00%
69	Oct 3/06		0.45	7.0	73	7.0	830	440	33	33	3,097	3.1	198	151	7,318	66	2,442	99.16%	100%	90.27%	0	65	0.75	0	0	0	0	100.00%
70	Oct 10/06		0.33	6.7	65	6.0	692	330	21	32	3,118	2.0	107	150	7,425	36	2,478	99.15%	100%	90.13%	0	70	1.1	0	0	0	0	100.00%
71	Oct 17/06		0.30	6.8	62	6.0	743	380	19	27	3,137	1.8	115	138	7,540	38	2,517	99.14%	100%	89.97%	0	70	0.92	0	0	0	0	100.00%
72	Oct 24/06		0.24	6.7	92	6.0	991	530	22	25	3,159	1.4	128	133	7,668	43	2,559	99.12%	100%	89.80%	0	70	0.66	0	0	0	0	100.00%
73	Oct 31/06		0.41	6.6	54	5.0	647	300	22	23	3,181	2.0	123	134	7,791	41	2,600	99.11%	100%	89.64%	0	70	1.2	0	0	0	0	100.00%
74	Nov 7/06		0.41	6.4	32	5.0	608	290	13	19	3,194	2.0	117	118	7,908	39	2,639	99.10%	100%	89.48%	0	70	1.2	0	0	0	0	100.00%
75	Nov 14/06		0.43	6.5	80	5.0	708	350	34	22	3,228	2.1	149	126	8,057	50	2,689	99.08%	100%	89.29%	0	75	0.99	0	0	0	0	100.00%
76	Nov 21/06		0.35	6.3	82	4.0	705	340	29	24	3,257	1.4	119	127	8,176	40	2,729	99.07%	100%	89.13%	0	75	1.0	0	0	0	0	100.00%
77	Nov 28/06		0.38	6.7	50	4.0	608	340	19	23	3,276	1.5	128	127	8,304	43	2,772	99.05%	100%	88.96%	0	75	1.0	0	0	0	0	100.00%
78	Dec 5/06		0.45	6.7	49	4.0	524	260	22	23	3,298	1.8	118	126	8,422	39	2,811	99.04%	100%	88.80%	0	75	1.3	0	0	0	0	100.00%
79	Dec 12/06		0.40	6.6	25	6.0	562	260	10.0	23	3,308	2.4	104	124	8,526	35	2,846	99.03%	100%	88.66%	0	75	1.3	0	0	0	0	100.00%
80	Dec 19/06		0.33	6.6	39	4.0	533	250	13	19	3,321	1.3	83	110	8,609	28	2,873	99.02%	100%	88.55%	0	80	1.2	0	0	0	0	100.00%
81	Dec 27/06		0.44	6.7	35	5.0	522	230	15	16	3,336	2.2	100	107	8,709	33	2,907	99.00%	100%	88.42%	0	80	1.3	0	0	0	0	100.00%
82	Jan 2/07		0.43	6.8	23	5.0	582	280	9.9	14	3,346	2.2	121	105	8,830	40	2,947	98.99%	100%	88.26%	0	80	1.0	0	0	0	0	100.00%
83	Jan 9/07		0.43	6.8	26	4.0	534	260	11	12	3,357	1.7	111	104	8,940	37	2,984	98.98%	100%	88.11%	0	80	1.1	0	0	0	0	100.00%
84	Jan 16/07		0.42	6.7	19	4.0	442	210	8.0	11	3,365	1.7	88	100	9,028	29	3,013	98.97%	100%	87.99%	0	80	1.4	0	0	0	0	100.00%
85	Jan 23/07		0.43	6.7	14	4.0	428	190	6.1	10	3,371	1.7	82	100	9,111	28	3,041	98.96%	100%	87.89%	0	85	1.0	0	0	0	0	100.00%
86	Jan 30/07		0.42	6.7	15	4.0	453	190	6.3	8.3	3,378	1.7	80	96	9,191	27	3,068	98.95%	100%	87.78%	0	85	1.0	0	0	0	0	100.00%
87	Feb 6/07		0.41	6.7	13	3.0	468	210	5.4	7.4	3,383	1.2	87	90	9,278	29	3,097	98.94%	100%	87.66%	0	85	0.91	0	0	0	0	100.00%
88	Feb 13/07		0.44	6.7	9.0	4.0	456	200	3.9	5.9	3,387	1.7	87	85	9,365	29	3,126	98.93%	100%	87.55%	0	85	0.96	0	0	0	0	100.00%
89	Feb 20/07		0.43	6.7	10	4.0	434	200	4.3	5.2	3,391	1.7	86	85	9,451	29	3,154	98.92%	100%	87.43%	0	85	0.96	0	0	0	0	100.00%
90	Feb 27/07		0.43	6.8	13	5.0	598	290	5.6	5.1	3,397	2.1	124	93	9,575	41	3,196	98.91%	100%	87.27%	0	90	0.96	0	0	0	0	100.00%
91	Mar 5/07		0.42	6.9	7.0	6.0	653	330	2.9	4.4	3,400	2.5	139	105	9,714	46	3,242	98.89%	100%	87.08%	0	90	0.84	0	0	0	0	100.00%
92	Mar 13/07		0.45	6.8	10	8.0	777	400	4.5	4.2	3,404	3.6	178	123	9,892	59	3,301	98.87%	100%	86.85%	0	90	0.69	0	0	0	0	100.00%
93	Mar 20/07		0.46	6.7	5.0	5.0	566	270	2.3	3.9	3,407	2.3	125	130	10,017	42	3,343	98.86%	100%	86.68%	0	90	1.0	0	0	0	0	100.00%
94	Mar 27/07		0.47	6.9	4.0	5.0	508	230	1.9	3.4	3,408	2.3	107	135	10,124	36	3,379	98.84%	100%	86.54%	0	90	1.2	0	0.47	0.093	0.47	100.00%
95	Apr 3/07		0.44	6.5	6.0	5.0	474	240	2.6	2.8	3,411	2.2	105	131	10,229	35	3,414	98.83%	100%	86.40%	0	95	0.97	0	0	0.093	0.47	100.00%
96	Apr 10/07		0.47	6.7	6.0	4.0	432	180	2.8	2.8	3,414	1.9	84	120	10,313	28	3,442	98.82%	100%	86.29%	0	95	1.3	0	0	0.093	0.47	100.00%
97	Apr 17/07		0.42	6.8	7.0	4.0	417	190	3.0	2.5	3,417	1.7	80	100	10,393	27	3,469	98.81%	100%	86.18%	0	95	1.2	0	0	0.093	0.47	100.00%
98	Apr 24/07		0.44	6.8	5.0	4.0	439	210	2.2	2.5	3,419	1.7	92	94	10,485	31	3,499	98.80%	100%	86.06%	0	95	1.1	0	0	0.093	0.47	100.00%
99	May 1/07		0.44	6.8	6.0	3.0	416	190	2.7	2.6	3,422	1.3	84	89	10,569	28	3,527	98.79%	100%	85.95%	0	95	1.2	0	0	0	0.47	100.00%
100	May 8/07		0.38	6.4	6.0	4.0	384	170	2.3	2.6	3,424	1.5	65	81	10,633	22	3,549	98.78%	100%	85.86%	0	100	0.96	0	0	0	0.47	100.00%
101	15-May-07		0.46	6.7	6.0

Project: Wolverine
Sample: Comb Overall Ore Comp

Sample Data - Initial Measurements

Initial organic S	1.73	(%)
Initial total sulphur	29	(%)
Initial SO4-S	2.5	(%)
Initial S2--S	25.0	(%)
Sample Weight	1.0	(kg)
Initial NP	73	(t $CaCO_3$/1000t)
Assumed NP unreactive		
Initial SO4-S	25,100	(mg)

Results - SO_4 - S Depletion

SO_4 Production (5 wk average)	119	mg/kg/wk
SO_4 Production (5 wk average)	6,212,589	mg/t/yr
SO_4 - S Production (5 wk average)	40	mg/kg/wk
Cumulative SO_4 - S Production to date	5,847	mg/kg
Time to SO_4 - S Depletion	484	wk 9 yr
Time to S2- - S Depletion	2,096	wk 40 yr

Results - NP Depletion

Initial NP	72,800	mg $CaCO_3$/kg
Cumulative Open System NP Consumption	156	mg $CaCO_3$/kg
Remaining NP	72,644	mg $CaCO_3$/kg
Open System NP Consumption Rate (5 wk average)	0	mg $CaCO_3$/kg/wk
Time to Sobek-NP Depletion	185,696	wk
Time to Sobek-NP Depletion	3,559	yr

HUMIDITY CELL TEST DATA

WEEK	DATE	WATER ADDED	LEACHATE COLLECTED	LEACHATE pH	ACIDITY	ALKALINITY	CONDUC-TIVITY	SULPHATE	ACIDITY PRODUCTION			ALKALINITY PRODUCTION	SULPHATE PRODUCTION			SO4-S PRODUCTION		REMAINING SULPHUR (% of ORIGINAL SAMPLE)			THEORETICAL NP CONSUMPTION	WEEK WHERE Ca and Mg WERE LAST SAMPLED	CARBONATE MOLAR RATIO	CARBONATE RATIO CONSUMPTION	OPEN SYSTEM NP CONSUMPTION			REMAINING NP
									PRODUCTION RATE (mg $CaCO_3$/kg/wk)		CUMMULATIVE PRODUCTION	RATE (mg $CaCO_3$/ /kg/wk)	PRODUCTION RATE (mg/kg/wk)		CUMMULATIVE PRODUCTION	PRODUCTION RATE	CUMMULATIVE PRODUCED							(mg $CaCO_3$/ /kg/wk)	CONSUMPTION RATE (mg $CaCO_3$/kg/wk)		CUMMULATIVE CONSUMPTION	(% of ORIGINAL SAMPLE)
		(L)	(L)		(mg $CaCO_3$/L)	(mg $CaCO_3$/L)	(µS/cm)	(mg/L)	Weekly	5 wk Average	(mg $CaCO_3$/kg)	/kg/wk)	Weekly	5 wk Average	(mg/kg)	(mg/kg/wk)	(mg/kg)	TOTAL-S	SULPHIDE-S	SULPHATE-S	(mg $CaCO_3$/kg/wk)				Weekly	5 wk Average	(mg $CaCO_3$/kg)	
103	29-May-07	0.44	6.9	1.0	4.0	364	210	0.44	2.0	3,429	1.8	92	83	10,898	31	4,637	98.75%	100%	85.51%	0	100	0.78	0	1.3	0.35	2.2	100.00%
104	05-Jun-07	0.45	6.9	3.0	6.0	469	230	1.3	1.7	3,430	2.7	103	87	11,001	34	3,672	98.74%	100%	85.37%	0	100	0.71	0	1.3	0.62	3.6	100.00%
105	12-Jun-07	0.90	6.8	3.0	5.0	398	190	2.7	1.8	3,433	4.5	171	108	11,173	57	3,729	98.72%	100%	85.14%	0	105	0.99	0	1.8	0.98	5.4	99.99%
106	19-Jun-07	0.44	6.9	1.0	5.0	388	190	0.44	1.3	3,433	2.2	84	106	11,257	28	3,757	98.71%	100%	85.03%	0	105	0.99	0	1.8	1.3	7.2	99.99%
107	26-Jun-07	0.44	6.9	4.0	5.0	449	220	1.7	1.3	3,435	2.2	96	109	11,353	32	3,789	98.70%	100%	84.90%	0	105	0.85	0	0.44	1.3	7.6	99.99%
108	3-Jul-07	0.43	6.8	1.0	5.0	456	220	0.43	1.3	3,436	2.1	94	110	11,447	31	3,821	98.69%	100%	84.78%	0	105	0.85	0	1.7	1.4	9.3	99.99%
109	10-Jul-07	0.45	5.9	6.0	1.0	434	190	2.7	1.6	3,438	0.45	86	106	11,534	29	3,849	98.68%	100%	84.66%	0	105	0.99	0	0	1.1	9.3	99.99%
110	17-Jul-07	0.42	6.4	6.0	5.0	401	210	2.5	1.6	3,441	2.1	87	90	11,621	29	3,878	98.67%	100%	84.55%	0	110	0.95	0	0	0.79	9.3	99.99%
111	24-Jul-07	0.47	6.9	3.0	5.0	474	240	1.4	1.8	3,442	2.3	112	95	11,733	37	3,916	98.66%	100%	84.40%	0	110	0.83	0	0.94	0.62	10	99.99%
112	31-Jul-07	0.38	6.7	2.0	6.0	452	210	0.76	1.6	3,443	2.3	80	92	11,813	27	3,943	98.65%	100%	84.29%	0	110	0.95	0	1.5	0.83	12	99.98%
113	07-Aug-07	0.42	6.4	4.0	5.0	451	230	1.7	1.8	3,445	2.1	98	93	11,911	33	3,975	98.64%	100%	84.16%	0	110	0.87	0	0.42	0.58	12	99.98%
114	14-Aug-07	0.38	6.5	1.0	9.0	183	210	0.38	1.3	3,445	3.4	80	91	11,991	27	4,002	98.63%	100%	84.06%	0	110	0.95	0	3.1	1.2	15	99.98%
115	21-Aug-07	0.43	6.2	2.0	4.0	409	190	0.86	1.0	3,446	1.7	81	90	12,072	27	4,029	98.62%	100%	83.95%	0	115	0.94	0	0.86	1.4	16	99.98%
116	28-Aug-07	0.37	6.9	1.0	5.0	362	170	0.37	0.81	3,446	1.8	63	80	12,135	21	4,050	98.61%	100%	83.86%	0	115	1.1	0	1.5	1.5	18	99.98%
117	04-Sep-07	0.44	6.7	1.0	5.0	375	190	0.44	0.75	3,447	2.2	83	81	12,217	28	4,078	98.60%	100%	83.75%	0	115	0.94	0	1.7	1.5	19	99.97%
118	11-Sep-07	0.45	6.8	1.0	5.0	403	200	0.45	0.50	3,447	2.3	90	79	12,308	30	4,108	98.59%	100%	83.63%	0	115	0.89	0	1.8	1.8	21	99.97%
119	18-Sep-07	0.46	6.7	4.0	6.0	636	340	1.8	0.79	3,449	2.8	157	95	12,465	52	4,160	98.58%	100%	83.43%	0	115	0.53	0	0.92	1.4	22	99.97%
120	25-Sep-07	0.43	6.6	2.0	4.0	382	180	0.9	0.79	3,450	1.7	77	94	12,542	26	4,186	98.57%	100%	83.32%	0	120	0.95	0	0.86	1.4	23	99.97%
121	02-Oct-07	0.44	6.6	3.0	5.0	431	210	1.3	0.98	3,451	2.2	93	100	12,635	31	4,217	98.56%	100%	83.20%	0	120	0.82	0	0.89	1.2	24	99.97%
122	09-Oct-07	0.46	6.8	1.0	5.0	436	220	0.5	0.99	3,452	2.3	101	104	12,737	34	4,251	98.54%	100%	83.06%	0	120	0.78	0	1.84	1.3	26	99.96%
123	16-Oct-07	0.46	6.4	4.0	5.0	514	230	1.8	1.27	3,453	2.3	106	107	12,842	35	4,286	98.53%	100%	82.92%	0	120	0.75	0	0.46	1.0	26	99.96%
124	23-Oct-07	0.39	4.7	5.0	1.0	181	71	1.9	1.29	3,455	0.4	28	81	12,870	9	4,295	98.53%	100%	82.89%	0	120	2.42	0	0.00	0.8	26	99.96%
125	30-Oct-07	0.40	6.6	1.0	4.0	419	230	0.4	1.19	3,456	1.6	92	84	12,961	31	4,326	98.52%	100%	82.77%	0	125	0.91	0	1.20	0.9	27	99.96%
126	06-Nov-07	0.46	6.8	1.0	5.0	445	220	0.5	1.02	3,456	2.3	101	86	13,063	34	4,360	98.51%	100%	82.63%	0	125	0.96	0	1.84	1.1	29	99.96%
127	13-Nov-07	0.34	6.7	3.0	7.0	541	270	1.0	1.13	3,457	2.4	91	83	13,154	30	4,390	98.50%	100%	82.51%	0	125	0.78	0	1.35	1.0	30	99.96%
128	20-Nov-07	0.35	6.8	1.0	5.0	408	180	0.3	0.83	3,458	1.7	62	75	13,216	21	4,411	98.49%	100%	82.43%	0	125	1.17	0	1.39	1.2	32	99.96%
129	27-Nov-07	0.39	6.8	3.0	6.0	499	240	1.2	0.68	3,459	2.3	93	88	13,309	31	4,442	98.48%	100%	82.30%	0	125	0.88	0	1.16	1.4	33	99.95%
130	04-Dec-07	0.36	6.8	3.0	5.0	368	170	1.1	0.81	3,460	1.8	62	82	13,371	21	4,462	98.47%	100%	82.22%	0	130	1.03	0	0.72	1.3	34	99.95%
131	11-Dec-07	0.90	6.3	4.0	4.0	276	120	3.6	1.44	3,463	3.6	107	83	13,478	36	4,498	98.46%	100%	82.08%	0	130	1.46	0	0.00	0.9	34	99.95%
132	19-Dec-07	0.41	6.3	5.0	7.0	381	200	2.1	1.65	3,466	2.9	83	81	13,561	28	4,526	98.45%	100%	81.97%	0	130	0.88	0	0.83	0.8	35	99.95%
133	24-Dec-07	0.45	6.5	8.0	6.0	540	270	3.6	2.29	3,469	2.7	120	93	13,681	40	4,566	98.44%	100%	81.81%	0	130	0.65	0	0.00	0.5	35	99.95%
134	02-Jan-08	0.40	6.5	5.0	5.0	477	210	2.0	2.46	3,471	2.0	84	91	13,765	28	4,594	98.43%	100%	81.70%	0	130	0.84	0	0.00	0.3	35	99.95%
135	08-Jan-08	0.42	6.7	1.0	3.0	135	46	0.4	2.33	3,471	1.2	19	83	13,784	6	4,601	98.42%	100%	81.67%	0	135	1.07	0	0.83	0.3	35	99.95%
136	15-Jan-08	0.41	6.7	3.0	6.0	423	190	1.2	1.86	3,473	2.5	78	77	13,863	26	4,627	98.42%	100%	81.57%	0	135	0.26	0	1.24	0.6	37	99.95%
137	18-Jan-08	0.39	6.6	1.0	5.0	410	200	0.4	1.52	3,473	2.0	79	76	13,941	26	4,653	98.41%	100%	81.46%	0	135	0.25	0	1.57	0.7	38	99.95%
138	29-Jan-08	0.44	5.8	5.0	1.0	227	97	2.2	1.25	3,475	0.4	42	61	13,984	14	4,667	98.40%	100%	81.41%	0	135	0.51	0	0.00	0.7	38	99.95%
139	05-Feb-08	0.40	6.8	1.0	9.0	419	190	0.4	0.93	3,476	3.6	76	59	14,059	25	4,692	98.39%	100%	81.31%	0	135	0.26	0	3.18	1.4	41	99.94%
140	12-Feb-08	0.47	4.8	26.0	221.0	440	200	12.1	3.27	3,488	103.2	93	74	14,153	31	4,723	98.38%	100%	81.18%	0	140	0.94	0	91.07	19.4	132	99.82%
141	19-Feb-08	0.46	6.9	1.0	2.0	396	170	0.5	3.12	3,488	0.9	79	74	14,231	26	4,750	98.37%	100%	81.08%	0	140	1.10	0	0.46	19.3	133	99.82%
142	26-Feb-08	0.46	7.0	1.0	6.0	505	250	0.5	3.13	3,489	2.8	116	81	14,347	39	4,788	98.36%	100%	80.92%	0	140	0.75	0	2.32	19.4	135	99.81%
143	04-Mar-08	0.47	6.9	1.0	5.0	512	250	0.5	2.79	3,489	2.3	117	96	14,464	39	4,827	98.35%	100%	80.77%	0	140	0.75	0	1.87	19.8	137	99.81%
144	11-Mar-08	0.49	6.9	5.0	6.0	492	250	2.4	3.19	3,492	2.9	121	105	14,586	40	4,868	98.33%	100%	80.61%	0	140	0.75	0	0.49	19.2	138	99.81%
145	18-Mar-08	0.47	6.8	13.0	10.0	467	280	6.1	1.99	3,498	4.7	132	113	14,717	44	4,912	98.32%	100%	80.43%	0	145	0.91	0	0.00	1.0	138	99.81%
146	25-Mar-08	0.45	6.8	6.0	7.0	524	260	2.7	2.43	3,500	3.1	116	120	14,833	39	4,951	98.30%	100%	80.28%	0	145	0.98	0	0.45	1.0	138	99.81%
147	01-Apr-08	0.50	6.4	5.0	5.0	430	210	2.5	2.84	3,503	2.5	105	118	14,939	35	4,986	98.29%	100%	80.14%	0	145	1.21	0	0.00	0.6	138	99.81%
148	08-Apr-08	0.50	6.5	6.0	6.0	559	270	3.0	3.34	3,506	3.0	134	122	15,073	45	5,030	98.28%	100%	79.96%	0	145	0.94	0	0.00	0.2	138	99.81%
149	15-Apr-08	0.49	7.1	4.0	6.0	555	260	2.0	3.25	3,508	3.0	128	123	15,200	43	5,073	98.26%	100%	79.79%	0	145	0.98	0	0.98	0.3	139	99.81%
150	22-Apr-08	0.49	6.6	5.0	6.0	540	290	2.5	2.52	3,510	2.9	142	125	15,343	48	5,121	98.25%	100%	79.60%	0	150	0.89	0	0.49	0.4	140	99.81%
151	29-Apr-08	0.50	6.6	5.0	6.0	501	260	2.5	2.48	3,513	3.0	129	128	15,472	43	5,164	98.23%	100%	79.43%	0	150	0.99	0	0.50	0.4	140	99.81%
152	6-May-08	0.49	6.7	5.0	6.0	505	260	2.4	2.46	3,515	2.9	127	132	15,599	42	5,206	98.22%	100%	79.26%	0	150	0.99	0	0.49	0.5	141	99.81%
153	13-May-08	0.48	6.6	6.0	6.0	541	250	2.9	2.44	3,518	2.9	120	129	15,719	40	5,246	98.20%	100%	79.10%	0	150	1.03	0	0.00	0.5	141	99.81%
154	20-May-08	0.47	5.8	13.0	1.0	494	240	6.1	3.28	3,524	0.5	113	126	15,832	38	5,284	98.19%	100%	78.95%	0	150	1.08	0	0.00	0.3	141	99.81%
155	27-May-08	0.49	6.9	2.0	5.0	503	240	1.0	2.98	3,525	2.4	117	121	15,949	39	5,323	98.18%	100%	78.79%	0	155	0.93	0	1.47	0.5	142	99.80%
156	03-June-08	0.49	6.9	3.0	7.0	516	250	1.5	2.78	3,527	3.4	123	120	16,072	41	5,364	98.16%	100%	78.63%	0	155	0.89	0	1.97	0.8	144	99.80%
157	10-Jun-08	0.48	6.7	6.0	7.0	469	250	2.9	2.87	3,530	3.4	121	119	16,193	40	5,404	98.15%	100%	78.47%	0	155	0.89	0	0.48	0.8	144	99.80%
158	17-Jun-08	0.50	6.9	1.0	8.0	482	250	0.5	2.40	3,530	4.0	124	120	16,317	41	5,446	98.13%	100%	78.30%	0	155	0.89	0	3.47	1.5	148	99.80%
159	24-Jun-08	0.49	6.7	5.0	7.0	465	250	2.5	1.66	3,533	3.4	123	122	16,440	41	5,487	98.12%	100%	78.14%	0	155	0.89	0	0.98	1.7	149	99.80%
160	01-July-08	0.50	6.7	3.0	7.0	564	270	1.5	1.76	3,534	3.5	134	125	16,574	45	5,532	98.11%	100%	77.96%	0	160	0.98	0	1.99	1.8	151	99.79%
161	08-Jun-08	0.47	6.5	4.0	6.0	498	230	1.9	1.85	3,536	2.8	109	122	16,683	36	5,568	98.09%	100%	77.82%	0	160	1.15	0	0.95	1.6	152	99.79%
162	15-Jul-08	0.47	6.4	9.0	8.0	523	250	4.2	2.12	3,540	3.8	118	122	16,801	39	5,607	98.08%	100%	77.66%	0	160	1.06	0	0.00	1.5	152	99.79%
163	22-Jul-08	0.50	6.4	8.0	12.0	528	250	4.0	2.81	3,544	6.0	124	122	16,925	41	5,649	98.07%	100%	77.50%	0	160	1.06	0	1.98	1.2	154	99.79%
164	29-Jul-08	0.48	6.5	7.0	7.0	506	250	3.4	3.00	3,548	3.4	121	121	17,046	40	5,689	98.05%	100%	77.33%	0	160	1.06	0	0.00	1.0	154	99.79%
165	05-Aug-08	0.49	6.6	5.0	6.0	549	270	2.5	3.19	3,550	2.9	132	121	17,178	44	5,733	98.04%	100%	77.16%	0	165	0.92	0	0.49	0.7	154	99.79%
166	12-Aug-08	0.49	6.6	5.0	6.0	507	230	2.4	3.30	3,552	2.9	112	121	17,290	37	5,771	98.02%	100%	77.01%	0	165	1.07	0	0.49	0.6	155	99.79%
167	19-Aug-08	0.48	6.7	5.0	6.0	603	240	2.4	2.93	3,555	2.9	116	121	17,407	39	5,809	98.01%	100%	76.85%	0	165	1.03	0	0.48	0.7	155	99.79%
168	26-Aug-08	0.49	6.6	5.0	6.0	467	230	2.5	2.63	3,557	3.0	114	119	17,520	38	5,847	98.00%	100%	76.70%	0	165	1.07	0	0.49	0.4	156	99.79%
Minimum		0.24	4.7	1.0	1.0	0	46	0.35	0.50	8.8	0.39	19	59	61	6.4	20	0.980	1.000	0.767	0	0.25	0	0	0	0	0	0.998
Median		0.43	6.7	23	5.0	508	240	9	8	3,365	2.2	101	100	9,028	34	3,013	0.990	1.000	0.880	0	1.0	0	0	0	0	0	1.000
Average		0.43	6.6	52	6.5	524	245	21	21	2,759	2.8	104	103	8,789	35	2,933	0.990	1.000	0.883	0	1.0	0	0	0.92	0.94	29.7	1.000
P95		0.50	6.9	162	8.0	781	400	73	61	3,534	3.9	156	134	16,520	52	5,514	0.999	1.000	0.983	0	1.4	0	0	1.9	1.6	150	1.000
Maximum		0.90	7.2	202	221	1,342	630	84	68	3,557	103.2	238	187	17,520	79	5,847	1.000	1.000	0.999	0	2.7	0	0	91.1	19.8	156	1.000

HUMIDITY CELL TEST

Client: **Klohn Crippen**
Project: **Wolverine**
Sample: **Combined Ro+Cl Sc Tails**

Dry Mass of Samples

SWEP sample mass	0.049500	kg
ICP-MS sample mass =	1.0	kg

Leachate Analysis

Note: Values with Red Text were reported as less than the method detection limit and are shown here as one-half the detection limit

Test Results		SWEP	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS
Week			0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34			
Date			June 6/05	June 17/05	June 24/05	July 1/05	July 8/05	July 15/05	July 22/05	July 29/05	Aug 5/05	Aug 12/05	Aug 17/05	Aug 26/05	Sept 2/05	Sept 9/05	Sept 16/05	Sept 23.05	Sept 30/05	Oct 7/05	Oct 14/05	Oct 21/05	Oct 28/05	Nov 4/05	Nov 11/05	Nov 18/05	Nov 25/05	Dec 1/05	Dec 9/05	Dec 16/05	Dec 23/05	Dec 30/05	Jan 6/06	Jan 13/06	Jan 20/06	Jan 27/06	Feb 3/06			
Parameter	**Unit**																																						
Leachate Volume	mL	990	275	496	426	368	432	405	428	426	417	454	453	398	456	347	419	401	454	434	404	337	446	437	396	316	429	426	406	337	399	350	435	491	477	371	280		
pH	pH units		6.4	7.0	6.9	6.6	6.6	6.8	6.4	6.6	6.5	6.5	6.7	6.6	6.5	6.8	6.8	6.9	6.5	6.7	6.5	6.7	6.7	6.6	6.7	6.1	5.9	6.6	6.7	6.6	6.7	6.6	6.8	6.8	6.7	6.8	6.7		
Hardness	mg $CaCO_3$/L	405	199	458	423	649	403	525	336	242	129	218	221	238	261	188	356	272	314	252	276	192	258					306				277							
Alkalinity	mg/L as $CaCO_3$	52	4.0	13	7.0	7.0	4.0	12	1.0	4.0	6.7	3.0	9.0	4.0	5.0	5.0	5.0	7.0	4.0	6.0	4.0	6.0	6.0	5.0	4.0	4.0	3.0	4.0	5.0	6.0	4.0	4.0	5.0	5.0	5.0	6.0	4.0		
Acidity	mg/L as $CaCO_3$	17	32	79	114	202	182	189	149	112	62	160	128	136	157	117	187	163	160	127	141	109	180	141	115	116	195	170	108	155	142	140	116	120	111	109	59		
Conductivity	uS/cm	813	485	933	855	1,342	771	920	664	527	285	599	436	510	565	389	654	551		531	590	418	570	492	420	362	730	620	408	596	504	520	559	540	541	575	342		
SO4	mg/L	430	220	480	380	630	310	420	260	200	93	200	180	200	210	150	260	250	240	200	240	150	220	180	160	130	280	270	170	240	200	220	240	240	230	240	170		
Cl	mg/L	1.5	0.40	0.14	0.80	1.0	0.50	0.50	0.40	0.20	0.10	0.30	0.20	0.20	0.20	0.10	0.30	0.10	1.0	0.20	0.10	0.10	0.10																
F	mg/L	0.060		0.10	0.11	0.10	0.060	0.12	0.090	0.070	0.030	0.060	0.070	0.060	0.030	0.030	0.080	0.080	0.070	0.070	0.070	0.060	0.060																
NO3	as N mg/L	0.25	0.58	0.37	0.070	0.060	0.025	0.025	0.025	0.025	0.025	0.29	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025																
NH_3 + NH_4	as N mg/L								0.10	0.40	0.20	0.20	0.20	0.10	0.20	0.050	0.10	0.50	0.050	0.10	0.10	0.10	0.10																
Thiosalts	as S_2O_3 mg/L	44	5.0	71	100	261	427	210	160	89	64	161	129	132	157	113	226	156	159	128	140	108	173					156				101							
CN(T)	mg/L	0.020		0.0010	0.0050	0.0050	0.0010	0.0050	0.0010	0.0050	0.0050	0.0010	0.0010	0.0010	0.0050	0.0010	0.0010	0.0050	0.0010	0.0050	0.010	0.0010	0.010																
CNO	mg/L	0.50	0.050	0.50	0.50	0.050	0.050	0.25	0.050	0.50	0.50	0.050	0.050	0.050	0.50	0.050	0.050	0.050	0.050	0.50	0.050	0.050	0.050																
CNS	mg/L	1.0	0.10	1.0	1.0	1.0	27	29	1.0	1.0	2.5	1.0	1.0	1.0	20	2.5																								
Mercury	ug/L	0.000050	0.050	0.050	0.050	0.10	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.10	0.050	0.050	0.10	0.050	0.050	0.050																
Silver	mg/L	0.000050	0.0025	0.00030	0.0025	0.0025	0.0025	0.0023	0.0025	0.0025	0.010	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0050	0.0025	0.0025	0.010	0.0025					0.0025				0.0025							
Aluminum	mg/L	0.0020	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.010	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050					0.0050				0.0050							
Arsenic	mg/L	0.0025	0.0025	0.0025	0.012	0.013	0.0070	0.0025	0.0025	0.0025	0.0025	0.0080	0.0025	0.0025	0.0025	0.0025	0.0025	0.0060	0.0025	0.0025	0.0025	0.0025	0.0025					0.0070				0.0025							
Barium	mg/L	0.070	0.059	0.058	0.041	0.048	0.045	0.056	0.044	0.043	0.040	0.037	0.037	0.038	0.034	0.043	0.038	0.039	0.028	0.028	0.022	0.032	0.029					0.037				0.028							
Beryllium	mg/L	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025					0.0025				0.0025							
Bismuth	mg/L	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015					0.00015				0.00015							
Boron	mg/L	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050					0.0050				0.0050							
Calcium	mg/L	153	60	131	117	197	128	175	106	78	42	69	72	78	84	60	116	89	105	84	94	65	87					106				98							
Cadmium	mg/L	0.13	0.30	0.19	0.14	0.17	0.11	0.15	0.082	0.066	0.042	0.065	0.072	0.067	0.071	0.090	0.12	0.094	0.087	0.085	0.075	0.091	0.12					0.15				0.14							
Cobalt	mg/L	0.011	0.018	0.030	0.022	0.024	0.015	0.014	0.0074	0.0048	0.0028	0.0043	0.0042	0.0039	0.0041	0.0042	0.0067	0.0053	0.0044	0.0043	0.0039	0.0046	0.0074					0.0077				0.0066							
Chromium	mg/L	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.0060	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050					0.00050				0.00050							
Copper	mg/L	0.0015	0.0012	0.0022	0.0021	0.0029	0.0021	0.0034	0.0016	0.0015	0.00089	0.0015	0.0017	0.0013	0.0013	0.0022	0.0026	0.0025	0.0016	0.0032	0.0013	0.0019	0.0017					0.0031				0.0026							
Iron	mg/L	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010					0.010				0.010							
Potassium	mg/L	1.9	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025					0.0025				0.0025							
Lithium	mg/L	0.0020	0.68	2.1	2.2	2.9	1.7	1.8	1.6	0.96	1.0	1.1	0.86	0.90	0.97	0.60	1.1	0.91	1.0	0.81	0.90	0.56	0.73					0.69				0.57							
Magnesium	mg/L	5.7	12	32	32	38	20	21	17	12	5.7	11	9.9	10	13	9.3	16	12	13	10	9.9	7.2	9.9					9.9				7.5							
Manganese	mg/L	2.1	3.3	8.1	7.2	6.9	3.7	4.0	2.5	1.6	0.73	1.6	1.1	1.1	1.3	1.1	2.1	1.4	1.5	1.3	1.2	1.1	1.9					2.0				2.0							
Molybdenum	mg/L	0.00060	0.00015	0.00040	0.00015	0.00050	0.00015	0.00070	0.00040	0.00040	0.00050	0.00040	0.00040	0.00040	0.00040	0.00030	0.00040	0.00040	0.00050	0.00015	0.00050	0.00030	0.00050					0.00050				0.00040							
Sodium	mg/L	1.5	3.3	8.2	8.3	10	5.3	5.4	4.3	2.5	1.4	3.2	2.0	2.1	2.5	1.4	2.4	1.9	2.0	1.5	1.5	0.84	1.0					0.66				0.30							
Nickel	mg/L	0.024	0.049	0.060	0.044	0.039	0.020	0.024	0.010	0.0070	0.0040	0.0070	0.0040	0.0050	0.0090	0.0060	0.010	0.0050	0.0050	0.0060	0.0040	0.0050	0.0070					0.0050				0.0070							
Phosphorous	mg/L	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050					0.050				0.050							
Lead	mg/L	0.17	0.40	0.069	0.047	0.060	0.038	0.041	0.028	0.022	0.014	0.024	0.019	0.015	0.019	0.025	0.032	0.019	0.021	0.024	0.017	0.021	0.023					0.030				0.025							
Antimony	mg/L	0.0034	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.045	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025					0.025				0.025							
Selenium	mg/L	0.20	0.10	0.37	0.19	0.57	0.033	0.16	0.30	0.27	0.077	0.20	0.19	0.19	0.25	0.17	0.32	0.29	0.29	0.25	0.28	0.18	0.23					0.29				0.23							
Silicon	mg/L	0.36	0.11	0.28	0.22	0.29	0.16	0.32	0.23	0.17	0.17	0.19	0.17	0.17	0.19	0.16	0.26	0.21	0.22	0.20	0.22	0.16	0.20					0.21				0.21							
Tin	mg/L	0.00050	0.021	0.022	0.010	0.0080	0.0080	0.010	0.0030	0.0020	0.0020	0.0030	0.0020	0.0020	0.0020	0.0010	0.0020	0.0020	0.0010	0.00050	0.0010	0.00050	0.0010					0.0010				0.00050							
Strontium	mg/L	0.33	0.13	0.70	0.75	1.00	0.58	0.72	0.54	0.37	0.20	0.46	0.34	0.38	0.43	0.27	0.57	0.44	0.51	0.41	0.44	0.30	0.42					0.49				0.42							
Titanium	mg/L	0.0015	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.010	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025					0.0025				0.0025							
Thallium	mg/L	0.022	0.015	0.022	0.015	0.022	0.014	0.017	0.0099	0.0082	0.0041	0.0085	0.0062	0.0066	0.0076	0.0048	0.0085	0.0075	0.0069	0.0065	0.0068	0.0015	0.0079					0.0076				0.0063							
Uranium	mg/L	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010					0.00010				0.00010							
Vanadium	mg/L	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010					0.0010				0.0010							
Zinc	mg/L	6.9	23	18	14	12	7.3	8.8	4.6	3.8	2.5	3.8	3.6	3.4	3.9	5.1	6.1	4.0	4.6	4.6	3.5	4.6	5.6					6.3				6.5							

--- not analysed
*** could not be determined due to sample matrix
nss not sufficient sample

| ICP-MS | ICP-MS | ICP-MS |

| ICP-MS | ICP-MS | ICP-MS |

YUKON ZINC CORPORATION
Tailings and Related Infrastructure Design and Construction Plan

| ICP-MS | ICP-MS | ICP-MS |

Loading Rates Calculated from Leachate Analysis Results

Note: Loading Rate (mg/kg/wk) = Leachate Concentration (mg/L) x Volume of Leachate Collected (L/cycle) / Sample Weight (kg) * (1 cycle / 1 wee

| Test Results | | SWEP | ICP-MS | ICP-MS | ICP-MS

| ICP-MS | ICP-MS | ICP-MS |

| ICP-MS | ICP-MS | ICP-MS |

| ICP-MS | ICP-MS | ICP-MS |

1.5.4 Sub-aqueous Column

1.5.4.1 Methodology

The sub-aqueous column tests were conducted to simulate the leaching effects of water infiltration from material stored under water cover. The columns have similar construction to the humidity cells with some modifications. After charging each 15.3 cm diameter cell equipped with an outflow port with one kilogram of sample, the cell was then covered with one layer of nylon mesh on top of which was placed a length of coiled tubing punctured with holes. This tubing passed through the lid of the column and into a feed bottle containing distilled water. Deionised water was added to the tailings to a level of 60 cm above the cell base. Weekly leachate samples were collected via the outflow port in the base after which the water level in the column was topped up to 60 cm. A total of eight weeks of testing was scheduled for each sample. Figure II-1.14 shows the set-up of the trickle leach columns and the material inside each column.

The leachate of the sub-aqueous columns was collected and analyzed for pH, conductivity, acidity, alkalinity, thiosalts, anions (F^-, Cl^-, $SO_4^{2-}$and NO_3^-), cyanide (CN), thiocyanate (CNS), cyanate (CNO), ammonia + ammonium (NH_3 + NH_4^+) and a suite of dissolved metal(loid)s via ICP-MS including Hg by SGS Lakefield.

Figure II-1.14 Set-up of Sub-aqueous Columns

1.5.4.2 Results

Table II-1.21 and Table II-1.22 list the results of the sub-aqueous column tests for the Combined Overall Ore Composite and Combined Overall Dilute Composite Tailings samples.

Table II-1.21 Combined Overall Ore Composite Tailings Sub-aqueous Column Results

PARAMETER	UNIT	MMER[1]	10X CCME[2]	WEEKS							
				1	2	3	4	5	6	7	8
pH	units		6.5-9.0	7.43	7.18	7.66	8.04	7.36	7.24	7.86	na
Conductivity	µS/cm			2520	1670	740	330	167	156	240	na
Acidity	mg $CaCO_3$/L			*1*	*1*	*1*	*1*	*1*	*1*	*1*	na
Alkalinity	mg $CaCO_3$/L			137	93	82	73	29	27	59	na
F	mg/L			0.31	0.46	0.49	0.35	0.06	0.10	0.46	0.38
Cl	mg/L			*0.1*	*0.1*	0.3	0.2	*0.1*	*0.1*	*0.1*	na
NO_3^-	mg N /L		130	*0.025*	0.05	0.13	*0.025*	*0.025*	0.16	*0.025*	na
SO_4	mg/L		500†	**3100**	**1100**	370	95	50	47	52	na
$NH_3 + NH_4^+$	mg N /L		17.7 (T=15°C and pH 7)	0.4	0.1	0.2	*0.05*	*0.05*	*0.05*	0.1	0.1
Thiosalts	mg S_2O_3/L			35	*5*	*5*	*5*	*5*	*5*	*5*	na
$CN_{(T)}$	mg/L	1.0		*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.001*	*0.005*	*0.005*
CNO	mg/L			*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	na
CNS	mg/L			*0.1*	0.6	*0.1*	*0.1*	*0.1*	0.3	*0.1*	*0.1*
Ag	mg/L		0.001	0.0006	0.0001	*0.00005*	*0.00005*	*0.00005*	*0.0025*	*0.00005*	*0.00005*
Al	mg/L			0.012	0.006	*0.002*	*0.002*	*0.002*	*0.005*	*0.002*	*0.002*
As	mg/L	0.5		0.018	0.006	*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*
Ba	mg/L			0.039	0.032	0.041	0.060	0.045	0.040	0.088	0.081
Be	mg/L			*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*
B	mg/L			0.03	0.03	0.02	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*
Bi	mg/L			*0.00015*	*0.00015*	*0.00015*	*0.00015*	*0.00015*	*0.00015*	*0.00015*	*0.00015*
Ca	mg/L			555	441	166	64.4	26.8	27.1	42.3	36.5
Cd	mg/L		0.00017	**0.0057**	**0.0002**	**0.0002**	***0.00005***	**0.0017**	**0.0024**	***0.00005***	***0.00005***
Co	mg/L			0.0013	0.0004	*0.00015*	*0.00015*	0.0003	0.0003	*0.00015*	*0.00015*
Cr	mg/L		0.01*	*0.0005*	**0.001**	*0.0005*	**0.003**	*0.0005*	*0.0005*	*0.0005*	*0.0005*
Cu	mg/L	0.30		0.0109	0.0034	0.0010	*0.0004*	*0.0004*	*0.0004*	*0.0004*	*0.0004*
Fe	mg/L		3.0	**1.01**	**4.06**	0.49	0.05	*0.01*	*0.01*	0.04	0.03
Hg	mg/L		0.00026	**0.0002**	***0.00005***	***0.00005***	***0.00005***	***0.00005***	***0.00005***	***0.00005***	***0.00005***

PARAMETER	UNIT	MMER[1]	10X CCME[2]	WEEKS							
				1	2	3	4	5	6	7	8
K	mg/L			11.9	5.36	2.32	1.43	0.63	0.58	1.31	1.11
Li	mg/L			*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*
Mg	mg/L			34.2	6.69	2.13	1.15	1.47	1.50	1.50	1.42
Mn	mg/L			3.86	2.10	0.569	0.173	0.167	0.166	0.105	0.0900
Mo	mg/L		0.73	0.0055	0.0070	0.0083	0.0112	0.0030	0.0031	0.0195	0.0224
Na	mg/L			51.2	3.46	1.68	1.53	1.33	1.27	1.34	1.16
Ni	mg/L	0.5		0.019	0.002	0.005	*0.0005*	*0.0005*	*0.001*	*0.0005*	*0.0005*
P	mg/L			*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*
Pb	mg/L	0.2		0.0107	0.0003	0.0003	*0.0001*	0.0136	0.0089	0.0004	0.0005
Sb	mg/L			0.0140	0.0113	0.0111	0.0091	0.0046	*0.025*	0.0099	0.0092
Se	mg/L		0.010	**0.199**	**0.015**	***0.0025***	***0.0025***	**0.017**	**0.016**	0.008	0.008
Si	mg/L			4.48	4.37	2.88	2.25	0.58	0.51	2.10	1.96
Sn	mg/L			0.003	0.002	*0.0005*	*0.0005*	0.001	*0.0005*	*0.0005*	*0.0005*
Sr	mg/L			0.917	0.455	0.197	0.106	0.0602	0.0540	0.0959	0.101
Ti	mg/L			***0.0015***	***0.0015***	*0.0015*	*0.0015*	*0.0015*	*0.0025*	*0.0015*	*0.0015*
Tl	mg/L		0.008	0.0046	0.0021	0.0007	0.0002	0.0008	0.0008	*0.0001*	*0.0001*
U	mg/L			0.0060	0.0011	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*
V	mg/L			*0.00045*	*0.00045*	*0.00045*	*0.00045*	*0.00045*	*0.001*	*0.00045*	*0.00045*
Zn	mg/L	0.5		**1.86**	**0.635**	0.055	0.004	0.129	0.17	0.006	0.005

1. Metal Mining Effluent Regulations (2002) for maximum monthly mean concentrations.
2. 10X the Canadian Council of Ministers of the Environment Canadian Water Quality Guidelines for the protection of freshwater aquatic life
† indicates 10X British Columbia water quality guidelines for the protection of freshwater aquatic life.
*Hexavalent chromium
Italics indicates measured value less than detection limit and listed as one half of the detection limit
Bold indicates measured values in excess of MMER and/or 10x CCME guidelines
na = not analyzed

Table II-1.22 Combined OD Composite Tailings Sub-aqueous Column Results

PARAMETER	UNITS	MMER[1]	10X CCME[2]	WEEKS								
				0	1	2	3	4	5	6	7	8
pH	units		6.5-9.0	7.58	7.87	7.97	na	8.06	8.11	7.85	7.77	7.65
Conductivity	µS/cm			360	270	260	na	206	190	173	167	160
Acidity	mg $CaCO_3$/L			18	*1*	*1*	na	*1*	*1*	*1*	*1*	*1*
Alkalinity	mg $CaCO_3$/L			67	87	94	na	73	66	53	51	40
F	mg/L			0.16	0.27	0.20	0.15	0.09	0.11	0.07	0.07	0.07
Cl	mg/L			6.1	1.1	0.7	na	0.7	0.5	0.6	0.5	0.4
NO_3	mg N /L		130	3.85	0.33	0.25	na	0.22	0.25	0.20	0.14	0.05
SO_4	mg/L		500†	41	18	13	na	29	28	31	33	38
$NH_3 + NH_4^+$	mg N /L		17.7 (T=15°C and pH 7)	0.1	0.1	0.2	*0.05*	0.2	0.2	0.2	0.2	0.7
Thiosalts	mg S_2O_3/L			69	30	18	na	*5*	*5*	*5*	*5*	*5*
$CN_{(T)}$	mg/L	1.0		*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*
CNO	mg/L			*0.05*	*0.05*	*0.05*	na	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*
CNS	mg/L			0.8	0.5	0.2	6.2	na	na	na	na	na
Ag	mg/L		0.001	**0.0017**	0.0003	*0.00005*	*0.00005*	0.0001	*0.00005*	*0.00005*	*0.00005*	*0.00005*
Al	mg/L			*0.002*	*0.002*	*0.002*	*0.002*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*
As	mg/L	0.5		*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.002*	*0.002*	0.004	0.007	*0.002*
Ba	mg/L			0.526	0.377	0.398	0.324	*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*
Be	mg/L			*0.0025*	*0.0025*	*0.0025*	*0.0025*	0.262	0.265	0.195	0.166	0.171
B	mg/L			*0.005*	*0.005*	*0.005*	*0.005*	*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*
Bi	mg/L			*0.00015*	*0.00015*	*0.00015*	*0.00015*	*0.005*	*0.005*	0.005	*0.005*	*0.005*
Ca	mg/L			58.6	53.8	49.8	42.0	39.6	31.6	31.4	28.7	25.9
Cd	mg/L		0.00017	**0.0124**	**0.0032**	**0.0009**	**0.0003**	*0.00015*	*0.00015*	*0.00015*	*0.00015*	*0.00015*
Co	mg/L			0.0014	0.0003	*0.00015*	*0.00015*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	0.0002
Cr	mg/L		0.01*	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.00015*	*0.00015*	*0.00015*	*0.00015*	*0.00015*
Cu	mg/L	0.30		0.0044	*0.0004*	*0.0004*	0.0015	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*
Hg	mg/L		3.0	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.0004*	*0.0004*	0.0012	0.0027	0.0014
Fe	mg/L		0.00026	***0.01***	***0.01***	***0.01***	***0.01***	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*

PARAMETER	UNITS	MMER[1]	10X CCME[2]	WEEKS								
				0	1	2	3	4	5	6	7	8
K	mg/L			1.48	1.23	1.10	1.07	1.11	1.06	0.81	0.65	0.58
Li	mg/L			*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*
Mg	mg/L			5.87	2.90	2.55	2.18	1.96	1.56	1.64	1.48	1.53
Mn	mg/L			0.786	0.443	0.362	0.325	0.273	0.168	0.167	0.148	0.129
Mo	mg/L		0.73	0.0012	0.0014	0.0018	0.0022	0.0021	0.0025	0.0045	0.0060	0.0095
Na	mg/L			0.43	0.22	0.25	0.28	0.29	0.21	0.19	0.15	0.11
Ni	mg/L	0.5		0.008	0.005	0.003	0.002	0.001	0.001	*0.0005*	*0.0005*	*0.0005*
P	mg/L			*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*
Pb	mg/L	0.2		0.0410	0.0461	0.0404	0.0104	0.0014	0.0009	0.0008	0.0005	0.0003
Sb	mg/L			0.0097	0.0111	0.0139	0.0153	0.0168	0.0234	0.0216	0.0221	0.0228
Se	mg/L		0.010	**0.081**	**0.038**	**0.032**	**0.053**	**0.015**	**0.012**	**0.012**	0.009	**0.010**
Si	mg/L			1.30	1.51	1.48	1.41	1.31	1.35	1.29	1.08	1.09
Sn	mg/L			0.056	0.039	0.028	0.018	0.013	0.012	0.010	0.009	0.008
Sr	mg/L			0.119	0.0891	0.0843	0.0901	0.0801	0.0717	0.0681	0.0679	0.0589
Ti	mg/L			*0.015*	*0.015*	*0.015*	*0.015*	*0.015*	*0.015*	*0.015*	*0.015*	*0.015*
Tl	mg/L		0.008	0.0076	0.0049	0.0055	0.0050	0.0051	0.0054	0.0035	0.0024	0.0021
U	mg/L			*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*
V	mg/L			0.0009	*0.00045*	*0.00045*	0.0014	*0.00045*	*0.00045*	0.0010	*0.00045*	*0.00045*
Zn	mg/L	0.5		0.327	0.214	0.167	0.130	0.076	0.044	0.025	0.015	0.009

1. Metal Mining Effluent Regulations (2002) for maximum monthly mean concentrations.
2. 10X the Canadian Council of Ministers of the Environment Canadian Water Quality Guidelines for the protection of freshwater aquatic life
† indicates 10X British Columbia water quality guidelines for the protection of freshwater aquatic life.
*Hexavalent chromium
Italics indicates measured value less than detection limit and listed as one half of the detection limit
Bold indicates measured values in excess of MMER and/or 10x CCME guidelines
na = not analyzed

Figure II-1.15 and Figure II-1.16 show dissolved sulphate and thiosalt fluctuations during the sub-aqueous column test. Large concentrations of sulphate are released only from the Combined Overall Ore Composite Tailings samples. The sulphate source is unlikely to originate from thiosalts since both samples have comparable concentrations of thiosalts being released in similar laboratory conditions. The source of the sulphate from the Combined Overall Ore Composite can not be assigned to a single source but may in fact be a combination of sources (e.g., flotation circuit reagents ($ZnSO_4$), gypsum dissolution and Na, K and Mg salt dissolution).

Figures II-2.2.5, II-2.26 & II-2.27 show Cd, Se and Zn releases, respectively, during the initial testing period exceed MMER regulations and water quality guidelines before reaching a steady state suggesting water cover treatment for these particular elements will be required.

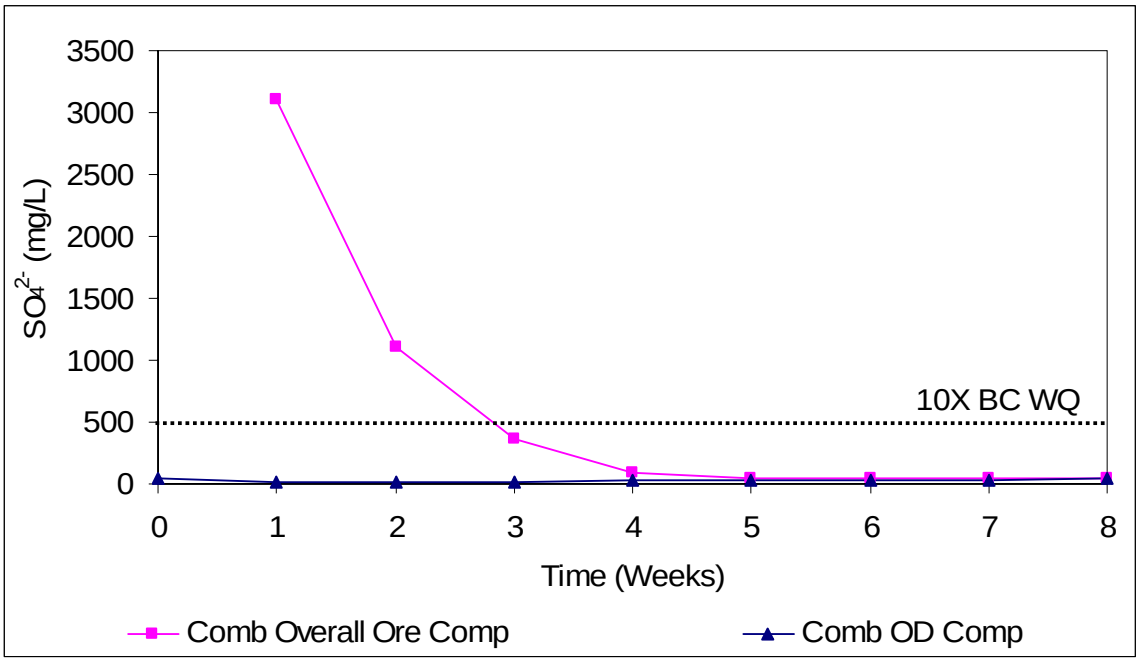

Figure II-1.15 Sulphate Fluctuations During Sub-aqueous Column Tests

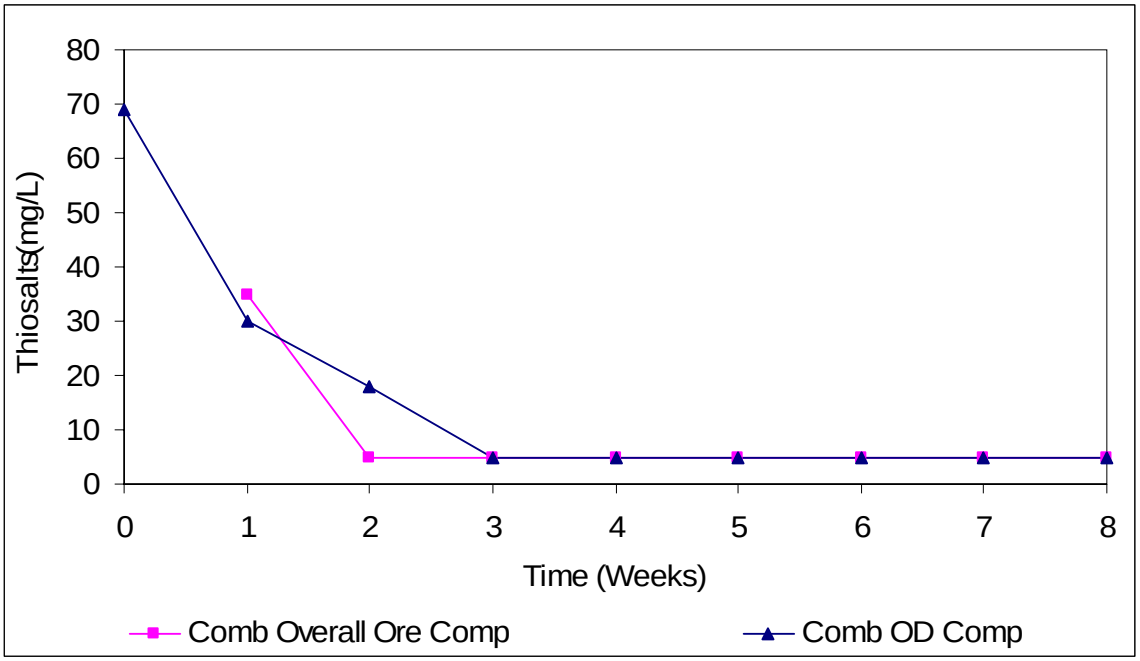

Figure II-1.16 Thiosalt Fluctuations During Sub-aqueous Column Tests

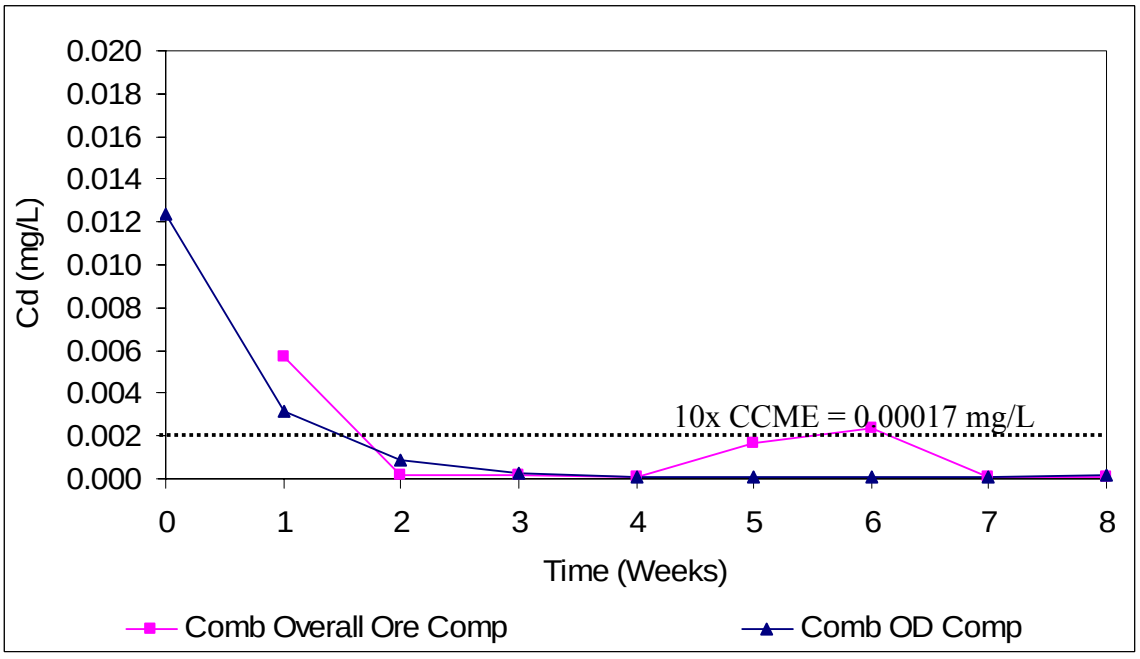

Figure II-1.17 Cd Fluctuations During Sub-aqueous Column Tests

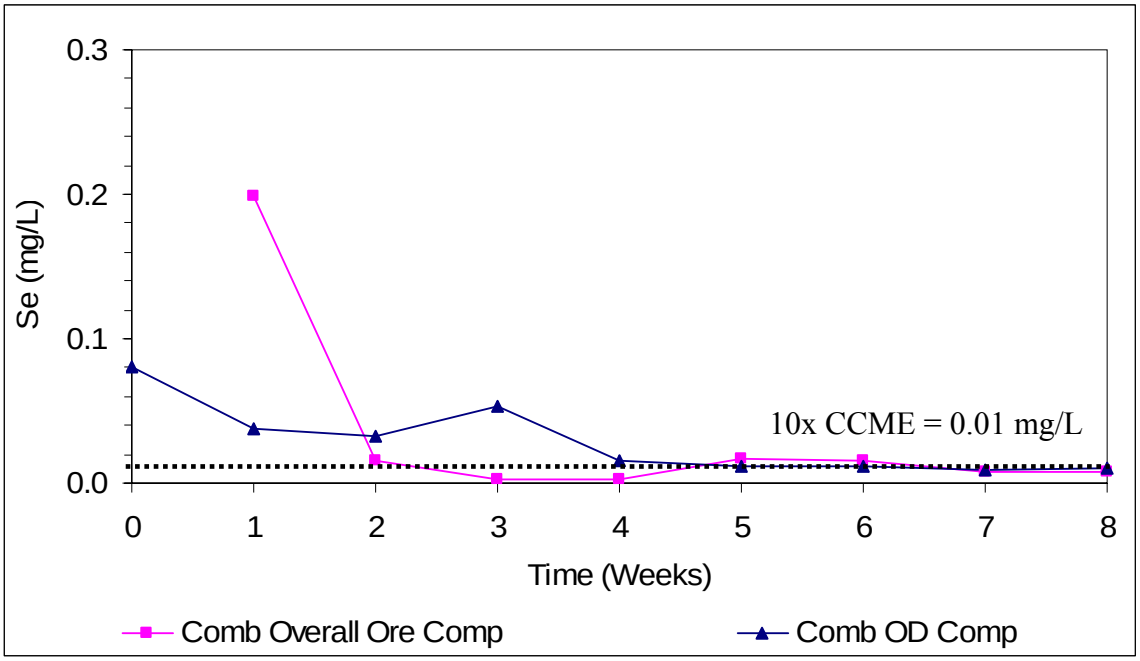

Figure II-1.18 Se Fluctuations During Sub-aqueous Column Tests

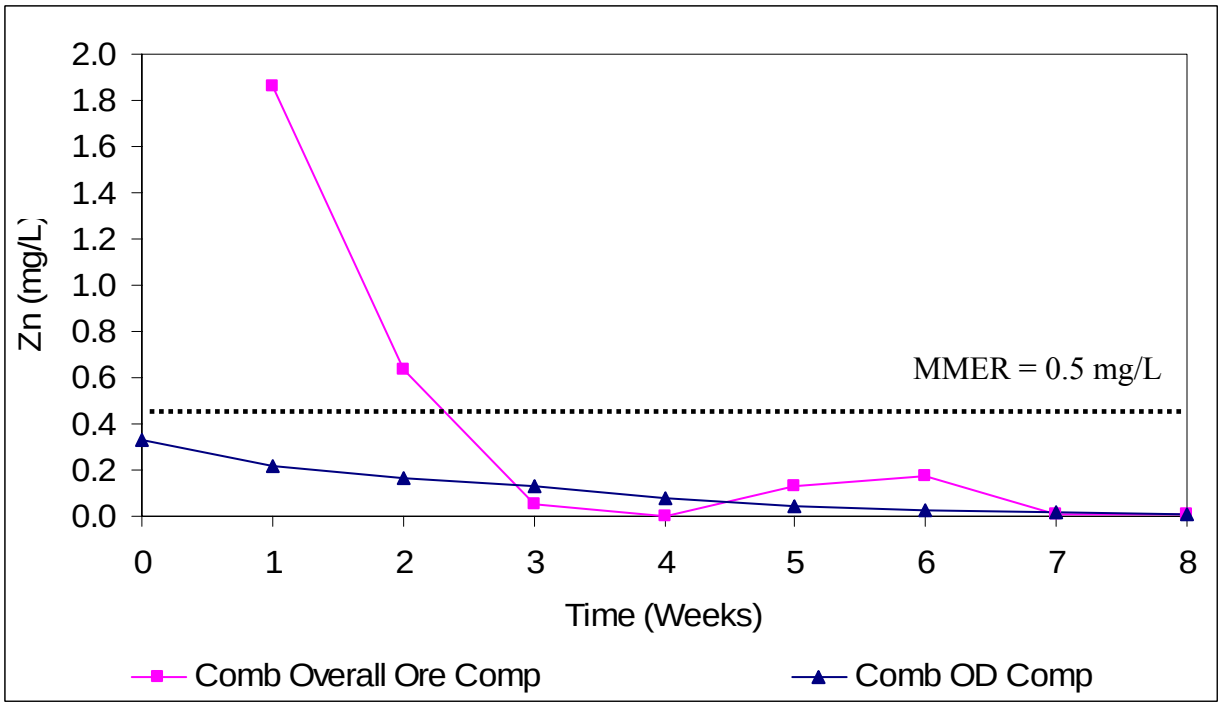

Figure II-1.19 Zn Fluctuations During Sub-aqueous Column Tests

1.6 Examples of Sub-aqueous Disposal of Tailings and Waste Rock Involving the Mobilization of Metal(loid)s Towards the Sediment Water Interface

1.6.1 General

The reviews of literature presented below represent cases that have been studied in detail to determine if sediments composed of tailings either consume metals from the overlying water or release metals into the overlying water. In most cases, extensive scientific work has been completed including sampling of the water column above the sediments, sampling of the sediments, and associated pore waters.

Table II-1.23 provides a summary of the literature review on sub-aqueous disposal of tailings and waste rock and indicates whether metal(loid)s are released by tailings impacted sediment, consumed by sediments from bottom waters and/or whether the sediment are oxic or anoxic. Oxic sediments are sediments in which dissolved oxygen is available and oxidation of sulphide minerals can take place. These conditions could potentially result in the release of metals to bottom waters. Anoxic sediments are sediments in which dissolved oxygen is not available, thus preventing the oxidation of sulphide minerals. These conditions would prevent the release of metals into bottom waters. Studies show lakes used for tailings disposal, and tailings impoundments themselves, have a very thin (maximum thickness of several centimetres) layer of oxic sediments at the sediment-water interface provided the tailings remain permanently submerged. The presence of this oxic sediment-water interface can lead to a slight efflux of metals into the bottom waters of the water body. This slight efflux is however very small resulting in a minimal effect on the water quality within the water body. Often the metals released to the bottom waters are re-precipitated by iron or manganese hydroxides. Alternatively some water bodies cycle between oxic conditions in summer and anoxic conditions in winter resulting in the cycling of metals within the system. Metals are released to the bottom waters during summer and are consumed by the sediment during winter. Below this thin oxic layer, anoxic conditions prevail where sulphidic materials are stable and metal(loid) remobilization is limited.

Table II-1.23 Sub-aqueous Tailings Disposal Summary

SITE	METALS RELEASED BY SEDIMENT	METALS CONSUMED BY SEDIMENT	OXIC OR ANOXIC SEDIMENT
Mandy Lake	Copper and Lead (slight efflux from deep water site).	Zinc, Copper and Lead.	Top 5mm of sediment oxic, anoxic at depths greater than 5mm, with 1 m of water cover.
Anderson Lake	Arsenic and Copper (seasonal cycling).	Copper, Lead, Cadmium, Arsenic, Mercury and Zinc.	Anoxic at very shallow sub bottom depths with an average water depth of 2.1 m (1.5 m to 4 m).
Buttle Lake	Cadmium, Copper, Lead and Zinc Arsenic (seasonal cycling).	Re-precipitation of Cadmium, Copper, Lead and Zinc. Arsenic (seasonal cycling).	Several centimetres of oxic natural sediments overlying anoxic sediments.
Benson Lake	None Reported.	Copper, Zinc, Lead and Cadmium.	Sub oxic or anoxic at very shallow sub bottom depths.
Equity Silver Tailings Pond	Arsenic.	Antimony.	Anoxic at very shallow sub bottom depths with 1.2 m of water cover.
Louvicourt Test Cells	Cadmium and Zinc (very small efflux, minimal effect on water quality).	None reported. Copper neither released nor consumed.	Top 7mm of sediment oxic, anoxic at depths greater than 7mm oxidation rate much reduced (2000 fold) in comparison to tailings exposed to atmosphere with 0.3 m of water cover.
Falconbridge New Tailings Area	Not reported.	Not reported.	Oxic sediment-water interface, oxidation rates much reduced (200 fold) in comparison to tailings exposed to atmosphere.
Lake Junin	None reported for permanently submerged sediment.	Copper and Zinc at permanently submerged sampling site.	Anoxic within several millimetres of the sediment-water interface with 8.5 m water cover. Seasonal exposure to atmospheric oxygen needs to be avoided.

1.6.2 MEND Project 2.11.1b-c Geochemical Assessment of Subaqueous Tailings Disposal in Mandy Lake, Flin Flon Area, Manitoba (Rescan, 1990)

Mandy Lake is located in central Manitoba near the Saskatchewan-Manitoba border. Between 1943 and 1944 the Mandy Mine discharged 75,000 tonnes of tailings from a single launder into Mandy Lake resulting in a fan shaped tailings deposit. The deposited tailings slowly slope away from the east shore to 1 m depth then drop off quickly to a water depth of approximately 5 m. The tailings consisted of primarily pyrite with appreciable quantities of zinc and copper.

Analysis of the submerged tailings in 1976 indicated that little oxidation had occurred. During 1990 two cores were collected from the lake, one from the deepest portion of the lake and one

from the original tailings discharge location. Water quality and sediment sampling was also undertaken in 1990.

Oxygen concentrations were high in the upper 4 m of the water column but bottom waters of the lake were severely depleted. This was attributed to high benthic oxygen demand associated with the organic-rich sediments at the bottom of the lake. The results of the study indicated that tailings bearing deposits with the central portion of the lake are suboxic or anoxic at very shallow below the sediment water interface. Nearer to the shore, where the water cover is approximately 1 m, sediment and pore water results indicated oxic conditions in at least the upper 5 mm of the sediment.

Concentrations of zinc, copper and lead in the pore waters at both locations were very low. The report states that there is clearly no efflux of these metals from the mixed tailings and natural organic-rich sediments collected near the former discharge point, despite the presence of high concentrations of metals in the solid phase with indications of oxic conditions in the top 5 mm of the submerged deposit. In fact, pore water profiles at this location indicated that dissolved metals were diffusing into the deposits from the overlying lake water. At the deeper water site within the central basin a very slight efflux of copper and lead to the overlying water column was interpreted, however an influx of zinc to the deposits was also observed. The contribution of metals from the benthic effusion at the deeper water site was considered negligible.

1.6.3 MEND Project 2.11.3abc Geochemical Assessment of Subaqueous Tailings Disposal in Anderson Lake, Manitoba, 1993 to 1995 Study Program (Rescan, 1996a)

Anderson Lake is a small, shallow (average depth 2.1 m) Precambrian Shield lake located in northwest Manitoba. Between 1979 and 1994, over 8 million tonnes of tailings were deposited into the lake via a floating, moveable pipe. The tailings were rich in sulphide and silicate gangue minerals[1].

[1] Gangue – The valueless rock or mineral assemblages in an ore; that part of an ore that is not economically desirable, but cannot be avoided in mining.

Summer and winter surveys were undertaken at Anderson Lake. Both surveys included water column testing, sampling of sediments and associated pore waters using core extrusion and centrifugation. Diffusion-based dialysis array pore-water sampling was employed in the summer survey to better address fluxes of trace metals across the sediment-water interface.

From the winter survey results, it was concluded anoxia was widespread in the water column under ice during the survey and anoxia may be a common wintertime phenomenon. These was no evidence that oxidation of sulphide particles and resultant release of metals and/or acid was occurring in the tailings deposit on the floor of the lake. Not only would oxidation be prevented by the anoxia that existed in the bottom water but all sulphide grains observed under microscopic analyses were fresh and unaltered regardless of the sample depth within sample cores. In addition, the pH increased in the water column with depth.

Pore water profiles indicated that there was no measurable release of dissolved copper, lead, cadmium, arsenic or mercury from the tailings near the outfall even though the deposits were enriched in each of these metals. Similarly there was no measurable release of dissolved zinc, cadmium or lead from the "natural" tailings-contaminated sediments cored at the natural sediments sampling site. It was not clear from the results of the study if there was an influx or efflux of zinc from the tailings site. Pore water profiles in the 'natural sediments' implied that copper and arsenic were being released to pore solution at very shallow depths. Arsenic and copper undergo active seasonal cycling in the sediments and water cover of Anderson Lake.

From the summer survey, it was concluded that the water column was well mixed and oxygenated, a result of the shallow depth and absence of an ice cover. As with the winter survey, there was no evidence to suggest oxidation of sulphide particles and resultant release of metals and/or acid was occurring in the tailings deposit on the floor of the lake. All sulphide grains observed microscopically were fresh and unaltered.

Sampling of pore water from the sediments of Anderson Lake indicated that at sampling sites, cadmium, copper, lead and zinc were diffusing from the overlying lake water into the sediments.

The study concludes by stating there is no evidence (chemical or visual) to suggest that the sulphide component of the tailings submerged in Anderson Lake is oxidizing on the lake floor and this applies for all seasons under a shallow (1.5 m to 4 m) water cover. This result suggests that oxidation of tailings stored permanently underwater is strongly inhibited even where tailings are reworked under shallow oxygenated water columns.

1.6.4 MEND 2.11.4a Geochemical Assessment of Subaqueous Tailings Disposal in Buttle Lake, British Columbia, 1993 Study Program (Rescan, 1995)

Buttle Lake is large (35 km long, 1 km wide and 80 m deep) occupying a U-shaped valley near the Myra Falls Mine on Vancouver Island, British Columbia. Approximately 5.5 million tonnes of sulphidic tailings were discharged to the South Basin (7 km long) of Buttle Lake via a submerged outfall between 1984 and 1996. Deposited tailings were effectively confined in the south basin by a shallow sill separating it from the remainder of the lake. Copper, lead, zinc, gold, silver and cadmium have been recovered from sulphidic ore deposits in the Myra Falls area.

As part of the study, water column testing, diffusion-based dialysis array pore-water sampling, and coring methods were used at two stations within the south basin (tailings sites) and a control station within the central basin (natural site) to sample the water column, sediments and intestinal waters.

The dissolved metal concentrations within the water column of Buttle Lake were among the lowest observed in the last twenty years of observations despite the continued inputs of several trace elements from acid rock drainage in the Myra Creek watershed. A layer of oxic natural sediments, several centimetres thick admixed with a small component of tailings bioturbated upward from below, was observed in the south basin. At the natural site diffuse influxes of dissolved cadmium and zinc into the sediments was observed while copper and lead showed no indication of reactivity. At both of the tailings sites, near surface pore water sampling results indicated remobilization of cadmium, copper, lead and zinc resulting from oxide dissolution. However, it was noted that the impact of the upward flux toward the water column was likely

attenuated by re-precipitation of manganese and iron oxides, which scavenge trace metals. Arsenic distributions followed manganese and iron cycling but no evidence of efflux was shown.

Flux-based diffusion calculations suggested that effluxes of copper, lead, and zinc to the bottom waters are small and have little impact on water quality. The report concluded that very little, if any, oxidation of sulphide particles can be accommodated by the near-surface pore water data.

1.6.5 MEND Project 2.11.1c-b Chemical Digenesis of Submerged Mine Tailings in Benson Lake and Natural Sediments in Keogh Lake, Vancouver Island, British Columbia (Rescan, 1992)

Benson Lake consists of a single 2.2 km long basin, with a maximum depth of 54 m. The lake, located in northern Vancouver Island, is fed from the eastern end by the Benson and Raging Rivers. The nearby Keogh Lake is similar to Benson Lake in size, shape and depth.

Pyrite rich tailings from the Coast Copper Mine were discharged into Benson Lake from 1962 to 1973. Keogh Lake is within a watershed never used for mine waste disposal and is used in the study as a control site un-impacted by tailings.

Sediment cores were collected and analyzed from the central portion of both lakes. In the central sampling station within Benson Lake, a 300 mm deep natural sediment layer was covering the tailings. A thin veneer (approximately 5 mm thickness) of manganese and iron oxyhydroxide-rich material was present at the sediment water interface at both lakes. High dissolved iron concentrations (relative to bottom waters) at 15 mm depth in the Keogh Lake sediment and below 15 mm in the Benson Lake sediments indicate that the natural sediments are suboxic or anoxic at very shallow depths below the sediment water interface.

Sulphide and dissolved metal concentrations were low in the bottom waters of both lakes. Pore water profiles of dissolved zinc, lead, and cadmium collected from both lakes showed that concentrations of these metals decreased across the sediment water interface and are invariably lower than measured in the bottom waters. This data confirmed that there was no efflux of these metals to the overlying water in either lake.

Pore water profiles for dissolved copper suggested that some copper may be cycled just below the sediment water interface in both the Keogh and Benson Lake sediments. There was however no evidence of a benthic efflux of dissolved copper from the sediments to bottom waters of either lake.

1.6.6 MEND Project 2.11.5c Geochemical Assessment of the Equity Silver Tailings Pond (Rescan 1996b)

The Equity Silver Mine is located in central British Columbia. The mine operated from 1980 to 1994 extracting copper, silver, iron, and zinc from a sulphidic ore body. Tailings were deposited into a man made tailings impoundment via a mobile floating platform, which was periodically moved to distribute tailings around the impoundment. The impoundment has an area of 1.2 km^2 and a maximum depth of 5 m in the central area. Neutralised sludge from an ARD treatment plant (lime addition) was co-disposed with the tailings in a portion of the tailings impoundment.

Water quality sampling, pore water sampling and sediment sampling was undertaken at two stations within the tailings impoundment. The first sampling station was from shallow tailings (1.2 m water cover) while the second sampling station was from the deepest (5 m water cover) central portion of the lake. Dissolved oxygen micro-gradients across the sediment-water interface were measured and used to directly infer tailings oxidation rates.

The distribution of most elements studied was seen to reflect small scale lateral in-homogeneity. Dissolved copper was observed to be neither released nor consumed by the tailings with the exception of one well defined zone possibly arising from dissolution of manganese oxides.

Arsenic and antimony were observed to display opposing behaviour. Arsenic was released universally within the tailings pond sediments via the dissolution of an unidentified solid. Antimony is consumed rapidly within the surface sediments.

Dissolved oxygen micro-gradients across the diffusive sub-layer infer oxidation rates lower than are typical of natural lake sediments.

1.6.7 MEND Project 2.12.1c Subaqueous Disposal of Reactive Mine Tailings Louvicourt Mine Test Cells Geochemical Sampling and Analysis (INRS-Eau, 2001)

Fresh tailings from the Louvicourt Mine were submerged under a 0.3 m water cover in experimental field cells. From 1996 to 1998 the chemistry of the interstitial water near the tailings-water interface was monitored using in situ dialysis. The pH and dissolved oxygen profiles across the tailings-water interface were measured using micro-electrodes.

Dissolved oxygen profiles indicated that penetration of dissolved oxygen into the tailings was limited to less than 7 mm. Anoxia of the tailings was further demonstrated by the reduced chemical species detected at depths of approximately 15 mm below the sediment-water interface.

There was clear evidence of oxidation of the mine tailings from the surface layer of the tailings. Mobilization of cadmium and zinc from this surface layer was indicated. There was no evidence of mobilization of copper from the tailings. The observed releases of cadmium and zinc were very small and the report concluded that the cadmium and zinc fluxes from the tailings to the overlying water would have only minimal impacts on the overlying water quality.

1.6.8 Rates of Oxygen Consumption by Sulphidic Tailings Under Shallow Water Covers – Field Measurements and Modelling, (Li *et al.*, 2000)

This paper described some dissolved oxygen profiles measured across the tailings/water interface at submerged tailings sites and oxygen fluxes derived from these profiles. The Falconbridge New Tailings Area (Falconbridge), situated near the town of Falconbridge, Ontario and the Louvicourt Tailings Field Experimental Cells (Louvicourt), located near Val d'Or, Quebec, were the focus of the study. The Falconbridge tailings were rich in pyrrhotite averaging 7% sulphur while the Louvicourt tailings contained 30% to 50% pyrite.

The paper outlines the significant differences between subaqueous disposal of mine waste in lake environments and shallow water covers typical of tailings impoundments. The comparison shows that tailings under shallow water covers are more prone to oxidation than those in lake environments (at least in the first several years after deposition).

Comparison was drawn between the oxygen fluxes into sulphidic tailings submerged under shallow water covers to the same tailings exposed to the atmosphere. Based on the assumption that the total calculated oxygen flux was used for sulphide oxidation, shallow water covers reduced the tailings oxidation rate by about 200 fold at the Falconbridge site and by about 2000 fold at the Louvicourt site. The results of the study were limited due to no reliable techniques available for distinguishing the proportion of the total oxygen flux consumed by tailings oxidation from that consumed by organic matter oxidation.

1.6.9 Management of Water Quality in a Flooded Tailings Impoundment (DeVos *et al.*, 2000)

This paper describes the closure planning and water quality prediction, using oxidation and diffusion modeling, undertaken for the Falconbridge New Tailings Area, Falconbridge, Ontario. The impoundment covers an area of approximately 60 ha and is divided into two terraces (Upper and Lower). Results of water quality monitoring undertaken since flooding of the tailings is compared to predicted values.

It was concluded that it was still too early to truly evaluate the effectiveness of the water quality prediction modeling completed. While the general downward trend in concentrations predicted was observed, peak values were higher than the average values predicted. The model was not sophisticated enough to take into account additional mechanisms now known to be at work at the site. Lime addition to the tailings impoundment to control nickel concentrations in the water column was required and it is thought that incomplete dissolution of lime could be responsible for some of the peaks. Co-precipitation of solutes and the mass transfer mechanism used in the model were also sighted as being responsible for the observed variation between predicted and measured values. The model does however provide a practical insight into the expected water quality both from an oxidation perspective and from a metal diffusion and mixing perspective.

1.6.10 The Reactivity of Sulphur-Rich Sediments in Lake Junin, Peru: The Importance of Permanent Submergence (Martin *et al.*, 2000)

Lake Junin occupies a large shallow basin at an elevation of 4200 m above mean sea level in the Peruvian altiplano approximately 300 km northeast of Lima. The lake is approximately 25 km long, 9 km wide with a maximum depth of 12 m. The lake has been receiving acid rock drainage, tailings and tailings pond overflow from several copper, lead, and zinc mining operations 10 km to 20 km upstream of the lake. There has been continual and widespread accumulation of sulphur and metal rich sediments in Lake Junin. The drainage system has a relatively high alkalinity stemming from abundant carbonate rocks in the drainage system. The lake is well mixed throughout the year and bottom waters are perennially well-oxygenated.

Sampling, which involved collection of water column samples, sediments and pore waters (high resolution dialysis array sampling), was undertaken at two sampling locations. The deep water station was situated in the centre of the main basin at a depth of 8.5 m with permanently submerged organic-rich sediments containing 2.5 wt % sulphur. The shallow water station was situated in a shallow basin with a water depth of 0.8 m and contained less organics and 2 wt % sulphur. Due to seasonal variation in the water level of the lake, the shallow site remains unsaturated for a significant portion of each year.

For the permanently saturated deep water site, high resolution profiles of dissolved iron, manganese, sulphate, and hydrogen sulphide across the sediment-water interface illustrate the sediments at this location become anoxic at very shallow sub-bottom depths (within several millimetres). Furthermore, it was observed that the permanently submerged deposits consume dissolved copper and zinc from the bottom waters of the lake.

The periodically unsaturated sediments were observed to be oxic to a depth 20 cm, suboxic to a depth of 30 cm at which point the sediments were fully anoxic. Copper and zinc were diffusing upward towards the sediment water interface and subsequently being released to the bottom waters of the lake at this location. This study emphasized the importance of maintaining a permanent water cover for the storage of sulphide bearing mine waste.

2. DAM BORROW MATERIAL CHARACTERIZATION

On-site material is scheduled for the construction of the tailings dam. Exposing large amounts of material to atmospheric conditions may result in the destabilization of minerals and lead to metal(loid) releases. Therefore, geochemical assessment of dam borrow material was conducted, specifically to establish the potential for acid generation and metal(loid) leaching.

Samples of different dam borrow materials were geochemically examined to determine the potential for ARD and metal leaching. Results indicate sampled materials have a low potential for both ARD and metal leaching. However, during construction, additional tests should be conducted to confirm that there is no metal leaching concerns for the actual borrow materials used in construction.

2.1 Acid Base Accounting (ABA)

ABA samples were selected from test pits within the tailings impoundment and main Project Borrow areas. Oversize material (>3" diameter), where present, was avoided in sample collection. Sample analyses were performed only on the <2 mm size fraction, as this size range has a high specific area and is generally seen as the reactive fraction (Price 1997). Brief descriptions of the ABA parameters and methodology are included below.

2.1.1 Methodology

Dry sieving was done to separate the > 100 µm particle size fraction. Stones (>12 mm), gravel (2-12 mm), soil (<2 mm), and sand (2 mm – 50 um) sized particles were separated with standard sieve screens in a Ro-Tap Sieve shaker for 5 to 20 minutes. Wet sieving was done to separate <50 µm sized particles, such as silt and clay, from larger >50 um particles. The sample was placed on top of the screen and deionised water was used to wet the sample to wash the minus fraction through the screen for collection. Both fractions were then filtered, dried and weighed.

To determine whether acid generation had occurred in the material prior to analysis, the pH of a paste of the finely ground sample with water was measured. Approximately 10 g of sample at minus 60 mesh was placed in a beaker with 5 mL of distilled water without stirring. The sample

was allowed to wet by capillary action, however, more water or sample was added to saturate sample (no puddling of water or dry appearance of solid). The sample was stirred with a spatula to form a thin paste, adding more water or sample to keep sample at the saturation point and measured for pH. The rinse pH was measured in the same manner as paste pH except that it was done directly on the -2 mm fraction with a solids to water ratio of 1:1.

Samples were crushed and pulverized to a target size of 80 percent minus 200 mesh (Tyler) for sulphur species determination. Total sulphur was determined by Laboratory Equipment Corporation (LECO) methods. Sulphate and sulphide were determined by the procedure described by Sobek, *et. al*. (1978). In this procedure total sulphur was measured by LECO methods. A portion of sample was treated with 25% HCl to remove sulphate sulphur. The sample was then re-run by LECO methods to determine, by difference, the quantity of sulphate removed. Sulphide sulphur was determined by taking a portion of sample that has been treated to remove sulphate and further treated with 1:7 mixture of HNO_3 to deionissed water to remove the sulphide. The sample was then re-run by LECO methods to determine the quantity of sulphur remaining after sulphate and sulphide have been removed. Sulphide was then determined by difference. The sulphur remaining was considered to be acid insoluble sulphur (e.g. barite, alunite etc.).

Approximately 2.0 g of the pulverized sample was agitated for 24 hours at 150 rpm in HCl to a final pH range between 1.5 and 2.0. The sample was then titrated with NaOH (corresponding to the normality of HCl) to pH 8.3 until a constant pH reading of 8.3 remains for at least 30 seconds. The above procedure yielded data for calculating NP, AP, Net NP and Sobek NPR.

Total Carbon was measured by Leco methods. Inorganic carbon was determined by difference (i.e. a known weight of sample was treated with 25% HCl to remove inorganic carbon (IC) and was then re-analysed for total carbon).

2.1.2 Results

Results for the ABA analyses of the borrow materials are reported in Table II-2.1. Tested materials have low potential for acid generation due to the very low sulphide sulphur content

(0.005 %). The low sulphide sulphur concentrations suggest that oxidation reactions, and subsequent acidic conditions, will not be a major contributor to the liberation of elements within the borrow material. Due to the low sulphide sulphur content the AP within the samples is also low. A negative value of modified Sobek NP indicates that the sample has already accumulated net acidity. This can be noted in the slightly depressed paste and rinse pH values. Paste pH values range from slightly acidic (pH 5.74) to slightly alkaline (pH 8.80).

Table II-2.1 ABA Results for Dam Borrow Materials

Sample ID	Unit	Go Greek Dam Borrow	Project Borrow Sample #1 East	Project Borrow Sample #2 central	Project Borrow Sample #3 West	MW05-6 Borrow	TP05-72 2.5m	TP05-75 1.5m	TP05-78 1.5m	TP05-81 1.5m	TP05-87 3.3m	TP05-89 1.5m
Paste pH	-	7.66	5.74	6.00	6.53	6.54	8.45	8.80	7.89	7.62	8.06	8.11
Rinse pH	-	6.42	4.87	5.01	4.99	5.63	5.88	7.54	6.12	5.7	6.34	6.2
Total Sulphur	%S	*0.005*	0.04	0.07	0.09	0.05	0.06	0.08	0.09	0.02	0.03	*0.005*
Sulphate Sulphur	%S	0.01	0.01	0.02	0.01	0.01	0.005	0.005	0.005	0.005	0.005	0.005
Sulphide Sulphur	%S	0.005	0.005	0.05	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Insoluble Sulphur	%S	0.01	0.03	0.05	0.08	0.04	0.06	0.08	0.09	0.02	0.03	0.005
AP	kg CaCO3/t	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Modified Sobek NP	kg CaCO3/t	3	-4.4	-3.1	-2.4	-1.2	3.1	5.1	2.6	0.2	3.3	2.9
Total Carbon	% C	0.51	1.74	1.52	1.13	0.31	0.14	0.21	0.43	0.25	0.18	0.16
Total Inorganic Carbon	% C	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*
Carb NP	kg CaCO3/t	*0.4*	*0.4*	*0.4*	*0.4*	*0.4*	*0.4*	*0.4*	*0.4*	*0.4*	*0.4*	*0.4*
Net Sobek NP	kg CaCO3/t	3	-4.4	-3.1	-2.4	-1.2	3.1	5.1	2.6	0.2	3.3	2.9
Sobek NPR	-	20.00	-29.33	-20.67	-16.00	-8.00	20.67	34.00	17.33	1.33	22.00	19.33
Carb NPR	-	2.67	2.67	2.67	2.67	2.67	2.67	2.67	2.67	2.67	2.67	2.67

Values in *italics* were reported by the laboratory as less than their detection limit and are shown here at one-half the detection limit.

ABA test work, in particular the information garnered from the NPR, serves as a guide in identifying the likelihood of ARD conditions and distinguishing samples from a deposit as PAG from Non-PAG. Price (1997) provides some criteria for guiding geochemical test work and evaluating the potential for ARD shown in Table 1.9. Table II-2.2 combined with the Sobek NPR and Carbonate NPR from Table II-2.1 confirm the potential for ARD in sample borrow materials is low except for sample TP05-81, where the possibility of ARD may exist, but is still unlikely given the low sulphide content.

Table II-2.2 ABA screening criteria

POTENTIAL FOR ARD	INITIAL SCREENING CRITERIA
Likely	NPR ≤ 1
Possible	1 < NPR ≤ 2
Low	NPR > 2

2.2 Shake Flask Extraction

SFE short-term leachate test was used to determine the leachate that may flush from the dam borrow solids when exposed to rain, snowmelt or groundwater flow. This procedure is a recommended component of static tests and is used to determine the presence of easily soluble mineral components (Price, 1997). The procedure is a modification of the Special Waste Extraction Procedure, or shake flask test, outlined in the *British Columbia Waste Management Act*. Descriptions of the SFE parameters and methodology are included below.

2.2.1 Methodology

SFE were conducted at a 1:20 solids to liquid ratio to avoid solubility limitations and placed in two litre flasks on a gyratory shaker for 24 hr. The gentle 24 hr agitation is to ensure continuous exposure of all surfaces and mixing of the rinse solution. After agitation, the final pH was recorded, the supernatant sample was filtered through a 0.45 μm filter and a sub-sample of the supernatant was submitted for analyses of metal(loid)s by ICP-MS . In addition pH, conductivity, alkalinity, acidity, hardness and sulphate were determined.

2.2.2 Results

Results from the SFE analyses of the borrow materials are reported in Table II-2.3. Metal(loid) leaching concerns are not anticipated from the borrow materials analyzed. It can be noted that Samples #1 East and #3 West from the main Project Borrow area showed a slight degree of pH depression below that of the deionised water used in the test, consistent with the low rinse pH observed for these samples. Nevertheless, very few parameters showed detectable quantities, and all were well within a factor of ten of any applicable guidelines. However, as borrow pits expand and materials outside the current sampling program locales are considered for construction purposes, additional leachate testing may be appropriate to further address potential metal(loid) leaching.

Table II-2.3 Shake flask extractions results for dam borrow materials

Parameter	Units	Go Greek Dam Borrow	Project Borrow Sample #1 East	Project Borrow Sample #3 West	TP05-78 1.5m
pH	-	6.42	5.27	5.35	6.29
Conductivity	µS/cm	6	5	3	3
Alkalinity	mg $CaCO_3$/L	3.5	2.5	2	3
Acidity (pH 8.3)	mg $CaCO_3$/L	1.5	4	3.5	2.5
Sulphate	mg/L	*0.5*	*0.5*	*0.5*	*0.5*
Total Hardness	mg $CaCO_3$/L	3.2	1.1	0.6	1.3
Total Metal(loid)s					
Ag	mg/L	*0.000025*	*0.000025*	*0.000025*	*0.000025*
Al	mg/L	0.059	0.25	0.13	0.066
Sb	mg/L	*0.0001*	*0.0001*	*0.0001*	*0.0001*
As	mg/L	0.0005	0.0002	*0.0001*	0.0005
Ba	mg/L	0.018	0.016	0.0091	0.017
Be	mg/L	*0.0001*	*0.0001*	*0.0001*	*0.0001*
Bi	mg/L	*0.0001*	*0.0001*	*0.0001*	*0.0001*
B	mg/L	*0.005*	*0.005*	*0.005*	*0.005*
Ca	mg/L	1.07	0.38	0.18	0.36
Cd	µg/L	*0.02*	*0.02*	*0.02*	*0.02*
Co	mg/L	*0.0001*	0.0004	*0.0001*	*0.0001*
Cr	mg/L	*0.0001*	0.0004	*0.0001*	*0.0001*
Cu	mg/L	0.0073	0.0053	0.0027	0.0049
Fe	mg/L	0.04	0.13	0.01	0.08
Hg	µg/L	*0.01*	*0.01*	0.03	*0.01*
K	mg/L	0.3	0.43	0.16	0.23
Li	mg/L	*0.0001*	*0.0001*	*0.0001*	*0.0001*
Mg	mg/L	0.13	0.04	0.03	0.11
Mn	mg/L	0.0067	0.01	0.013	0.0039
Mo	mg/L	0.0003	*0.00005*	*0.00005*	*0.00005*
Na	mg/L	0.09	0.16	0.08	0.2
Ni	mg/L	0.0005	0.0003	0.0002	0.0004
P (as PO_4)	mg/L	0.07	0.07	0.04	0.05
Pb	mg/L	*0.0001*	0.0002	*0.0001*	*0.0001*
Se	mg/L	*0.0001*	*0.0001*	*0.0001*	*0.0001*
Si (as SiO_2)	mg/L	0.87	1.18	0.83	2.57
Sn	mg/L	*0.0001*	*0.0001*	*0.0001*	*0.0001*
Sr	mg/L	0.0017	0.0029	0.0012	0.0008
Te	mg/L	*0.0001*	*0.0001*	*0.0001*	*0.0001*
Tl	mg/L	*0.00001*	*0.00001*	*0.00001*	*0.00001*
Th	mg/L	*0.00005*	*0.00005*	*0.00005*	*0.00005*
Ti	mg/L	0.0019	0.0075	0.0035	0.0029
U	mg/L	*0.00005*	*0.00005*	*0.00005*	*0.00005*
V	mg/L	0.0006	0.0004	*0.0001*	0.0007
Zn	mg/L	0.002	0.004	0.003	0.002
Zr	mg/L	*0.001*	*0.001*	*0.001*	*0.001*

Italics indicates measured value less than detection limit and listed as one half of the detection limit

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APPENDIX III

Hydrology, Baseline Water Quality and Water Balance

- Part I – Hydrology Data
- Part II – Surface and Groundwater Data
- Part III – Water Balance Tables

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1. HYDROLOGY DATA

1.1 Annual Precipitation, Evaporation and Snowpack

The estimated mean annual precipitation, estimated mean annual evaporation rate and average snowpack presented in Section 2.2 of the main text were derived from local and regional climate data, as provided below from Type A Licence Application (January 2007).

Regional climate data is available from three Environment Canada stations located within the Liard Basin. Watson Lake is located 175 km south-southeast of the project, at an elevation of 687 masl. Climate data is available for the period 1938-2005. Tuchitua is located 80 km southeast of the project, at an elevation of 724 masl. Climate data is available for the period 1971-2004. Hour Lake is located 60 km east-southeast of the project at an elevation of 890 masl. Climate data is available for the period 1982-2004.

These three stations are sited in valley bottoms and range from 500 m to 900 m lower in elevation than the project site. They are not fully representative of the climate at the project site, which is located in the upland region of the Pelly Mountains. Therefore, interpretation of regional climatic data to characterize conditions in the project area was tempered by the data collected on site. Wherever possible, regional data was corrected for the effects of location and elevation to generate expected conditions at the project.

Baseline data collection began at the project site in 1996 and has continued intermittently to the present. In 1996 and 1997, and again for portions of 2000 and 2001, some automated data was collected at a location near the exploration camp site on Wolverine Lake. In October 2004, an automated HOBO® Weather Station, model H21-001 (Onset Computer Corporation) was installed immediately to the north of the airstrip. The station measured rainfall, atmospheric pressure, solar radiation, wind speed, wind direction, air temperature, and relative humidity at 30 minute increments. This station was upgraded and replaced by a new HOBO Onset weather station, installed on the south end of the airstrip on May 10th, 2006 (Figure III-1.1). The weather station on a 3m tripod tower was outfitted with the following data collection features:

- Temperature;
- Relative Humidity;
- Tripod Mounted Rain Gauge;
- Solar Radiation IN and OUT;

- Wind Speed and Direction; and
- Barometric Pressure.

Climate station data has been logged continuously from this station on an hourly basis since May 20th, 2006.

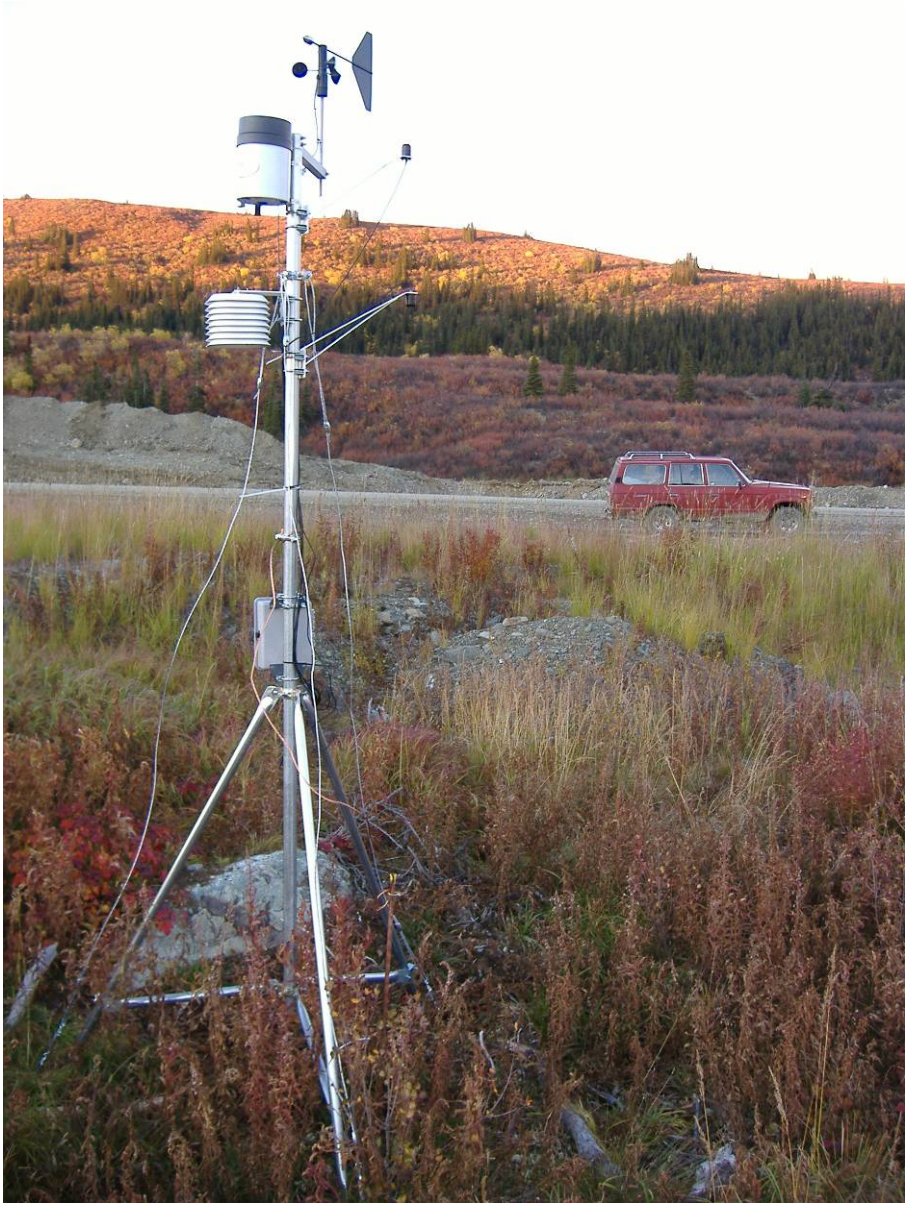


Figure III-1.1 Automated Weather Station Located Near Airstrip

1.1.1 Temperature

Temperatures at the project site have been characterized from the field data recorded in 1996-1997, 2000-2001, and 2004-2005, and more recently during 2006. The data collected in 1996-1997 and 2000-2001 at the exploration camp site (elevation 1150 m asl) was corrected for elevation using an environmental lapse rate (Kushnir 2000) of 1ºC/100 m for winter conditions and 0.6ºC/100 m for summer conditions. The mean annual temperature at project site is -3.5ºC and there is a strong seasonal temperature variation. Mean monthly temperatures are below freezing between October and April, and above freezing from May through September (Figure III-1.2). The minimum recorded winter temperature is -36ºC and the maximum recorded summer temperature is 31ºC. Generally, the temperatures recorded at the project site are comparable to the temperatures recorded at the regional stations, if the regional stations are corrected for the elevation difference.

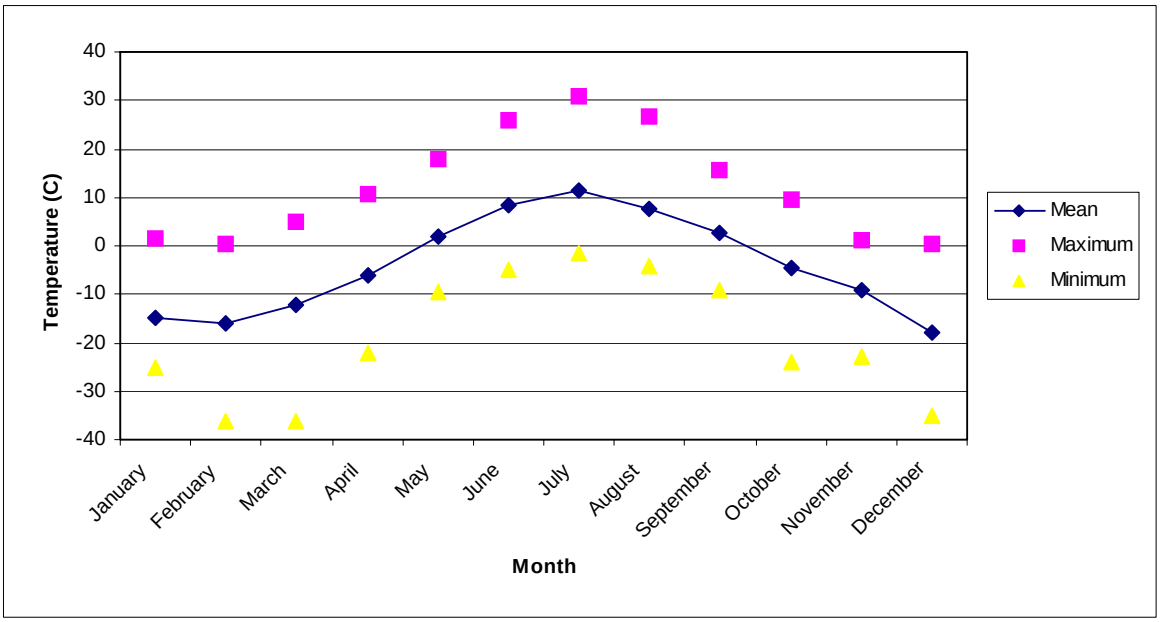


Figure III-1.2 Mean, Maximum and Minimum Temperatures (°C) by Month – Wolverine Project

1.1.2 Precipitation

Like most new mine development projects, site-specific climatic data for the Wolverine Project are of too short a period to be used predominantly in the predictions of site precipitation and the development of project water balances. Accordingly, more regional data were utilized to

estimate annual and monthly precipitation. Two approaches were used in this effort and are described below.

1.1.2.1 Annual Precipitation Estimate from Regional and Wolverine Climate Stations

The three climate stations within the regional study area, for which climate data is available, include Watson Lake, Tuchitua and Hour Lake. Climate measurements at the Wolverine site were collected during the summer of 1996 and 1997, and from October 2004 to September 2005 and May 2006 to October 2006 during the ice-free periods as the automated precipitation sensor does not measure snowfall. Climate measurements were not made during 2005 at Tuchitua and Hour Lake, so the only station for which there is continuous overlap of measured monthly precipitation with the Wolverine site is Watson Lake.

A comparison of the monthly precipitation values measured at Wolverine to the measured monthly precipitation for the same months at Watson Lake indicates that observed monthly precipitation at Wolverine ranges from 59% (June 1997) to 203% (July 2006) of observed monthly precipitation at Watson Lake (Table III-1.1). The average of the monthly Wolverine values are 121% of Watson Lake values, whereas the total precipitation over the observed interval at Wolverine is 112% of Watson Lake. However, if the precipitation at Wolverine is plotted against the precipitation at Watson Lake, the resultant regression equation has a low r-squared value, indicating the relationship is not statistically significant (Figure III-1.3).

Table III-1.1 Ratio of Measured Monthly Precipitation at Wolverine Climate Station and at Watson Lake

	Precip Measured – Wolverine (mm)	Precip Measured – Watson Lake (mm)	Ratio Wolverine to Watson Lake
1996			
Jul	59.8	35.4	1.689
Aug	73.1	56.2	1.301
1997			
May	19.1	24.6	0.776
Jun	51.2	86.9	0.589
Jul	96.2	73.1	1.316
Aug	49.2	67.8	0.726
2005			
March	15.8	10.5	1.505
April	16.2	10.6	1.528
May	51	66.5	0.767
Jun	62.8	61.8	1.016
Jul	83.6	61.8	1.353
Sep	53.2	38.4	1.385
2006			
June	51.0	32.2	1.584
July	67.0	32.9	2.036
Aug	73.4	53.3	1.377
Sept	18.6	37.4	0.497
Mean			1.215
Total	841.2	749.4	1.122

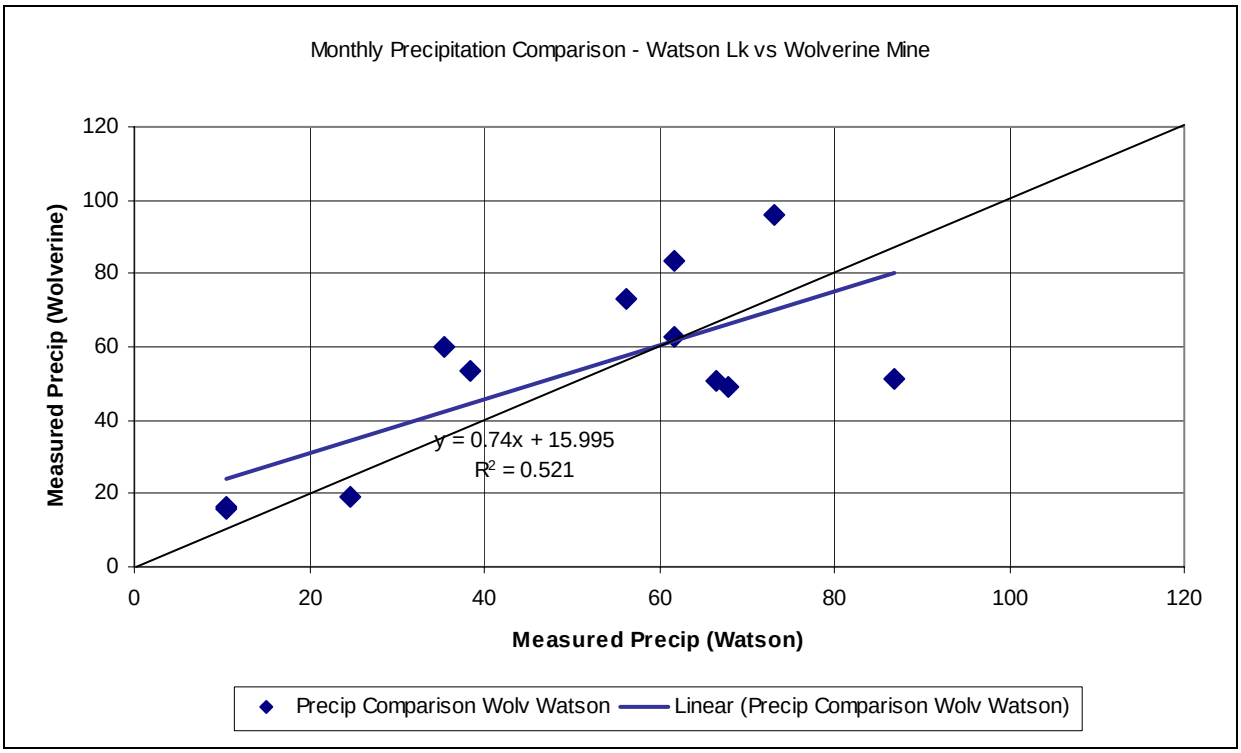


Figure III-1.3 Monthly Precipitation at Watson Lake (mm) vs. Monthly Precipitation at Wolverine (mm)

Although the other two climate stations, Tuchitua and Hour Lake, cannot be compared directly to Wolverine data, they can be compared to Watson Lake. They are both at higher elevation than Watson Lake and receive more precipitation. It would be desirable to extend the regional analysis to include a greater number of climate stations and derive a relation between elevation and precipitation. However, because of the sparseness of the climate station networks within the regional area, it is difficult to compare stations in the same climatic zone at differing elevations. The nearest climate station at an elevation comparable to the Wolverine is at Cassiar, approximately 250 km south; annual precipitation at Cassiar is 750 mm, significantly higher than in the Wolverine region.

The three regional stations and the predicted Wolverine site value plus an estimate of the error are plotted in Figure III-1.4. The predicted value of 556 mm annual precipitation for Wolverine project area was estimated by increasing the average precipitation for Tuchitua and Hour Lake by 111% (the average of the 116% and 106% increases estimated when comparing Wolverine to Watson Lake). The lower error bar represents the regional average precipitation for the three stations (481 mm) increased by 106%; the upper error bar represents the precipitation for Hour Lake (524 mm), the highest of the three stations, increased by 116%.

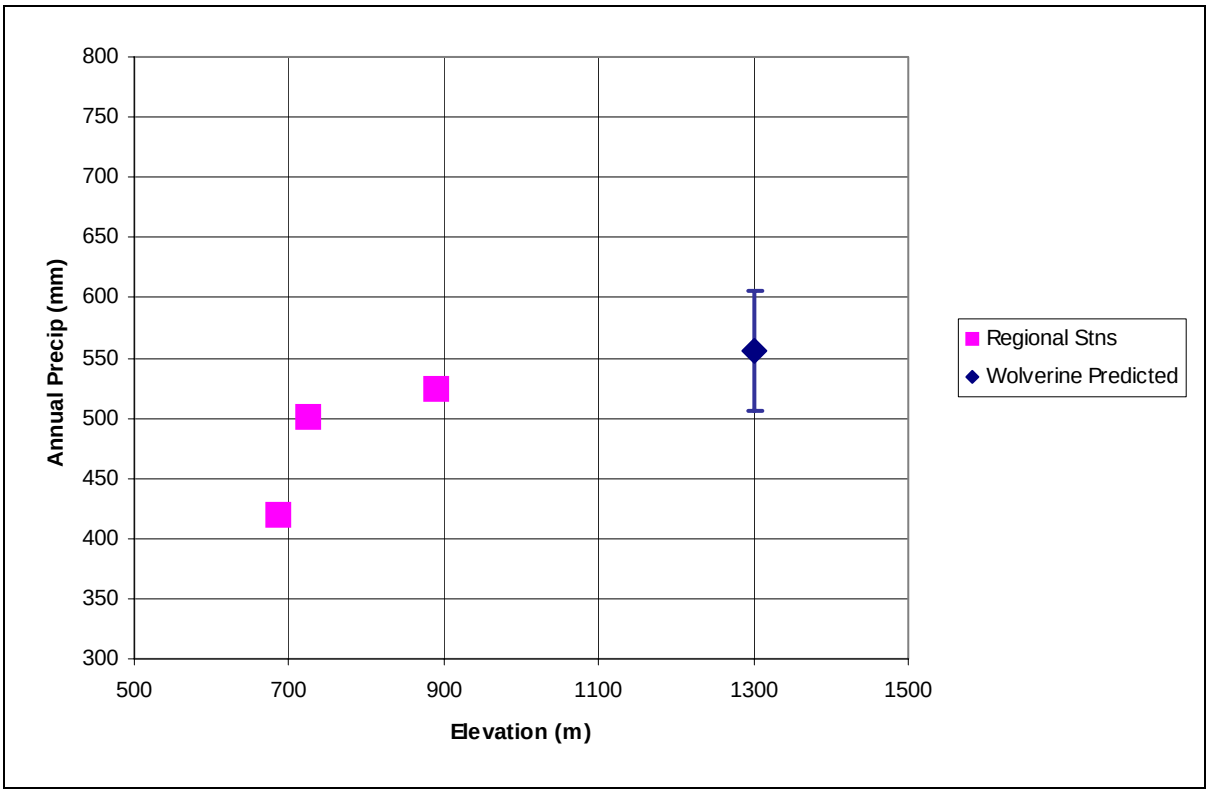


Figure III-1.4 Observed Annual Precipitation at Regional Stations Plotted by Elevation

1.1.2.2 Annual Precipitation Estimate from Precipitation Isoline Maps

As a separate check on the regional estimates described, mean annual precipitation was also estimated from published isolines. Mean annual precipitation of a region is commonly mapped using isolines corresponding to a specified precipitation interval. Because of the spatial variability of precipitation, areas within the precipitation contours will have an intermediate value. Utilizing the Rainfall Atlas of Canada (Bruce, 1968) and an American source for the State of Alaska (Oregon State, 2006), estimates for annual precipitation in the Wolverine Project area are within the range of 500 to 600 mm.

1.1.2.3 Annual Precipitation Estimate from Water Balance

The mean annual precipitation can also be estimated from the water balance. The water balance equation is:

$$\text{Precipitation} = \text{Evaporation} + \text{Runoff} + \text{Change in Storage}$$

Therefore, if runoff and evaporation are reasonably known and long-term change in storage is assumed to be zero, and then precipitation can be estimated. In theory, this is simple. In practice,

it is complicated. For instance, change in storage is usually not zero at all scales. Small watersheds usually have a positive change in storage (water infiltrates into the ground) and thus runoff estimated for small watersheds will underestimate actual runoff. Likewise, for larger watersheds, there is a net negative change in storage (net recharge from groundwater to surface water flow) that will result in the runoff term being overestimated. The scale change in the net change in storage term varies with climate and permeability. For the purposes of this calculation, a figure of 100 km² was assumed to represent no net change in storage. Then the mean annual stream flow (in m³/s/km²) for a 100 km² watershed was calculated and the resultant figure converted to a figure of mm annual runoff/m² unit area.

The calculation for mean annual flow is:

$$\text{Mean Annual Flow} = 0.0041*(\text{watershed area})^{1.1041}$$

For a 100 km² watershed, this gives a mean annual flow of 0.0062 m³/s/km².

Then 0.0062 m³/s/km * 31557600 s/yr * 0.000001 m²/km² = 0.196 m or 196 mm of runoff. This is close to the regional value of 200 mm predicted for the 1300 m elevation for the Cassiar Mountains by Obedkoff (2000).

Mean annual evaporation has been estimated at approximately 400 mm (discussed below). Therefore, annual precipitation should be approximately 196 + 400 = 596 mm. This is close to both the 556 mm value estimated previously and within (but close to the upper boundary of) the 500-600 mm range estimated from regional precipitation maps. The error in the estimates of evaporation is approximately +/- 30 mm. This would give a range of 566-626 mm.

Averaging the three estimates of precipitation (550 mm, 556 mm, and 596 mm) derived above gives a value of 567 mm for total annual precipitation. For the purposes of calculating monthly precipitation values and for design criteria, a value of 570 mm will be used. The overlap in the three error estimates gives the range of 566 to 600 mm.

1.1.2.4 Monthly Precipitation Estimates from Annual Precipitation

To estimate the monthly precipitation distribution at Wolverine, the monthly fraction of annual precipitation has been determined by simply averaging the three regional station values (Table III-1.2). In general, the proportion of mean monthly precipitation as a function of annual precipitation does not vary significantly between regional stations. The summer precipitation at

Tuchitua and Hour Lake shows more of an increase compared to Watson Lake than does the winter precipitation; however, as there is no winter precipitation data from the Wolverine site, this trend cannot be verified against observed site data.

Table III-1.2 Mean Monthly Precipitation at Wolverine Estimated from Regional Monthly Proportion of Annual Rainfall

Regional Data	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
Watson Lake (mm)	30.9	23.3	19.2	15.6	31.2	52	56.6	45.2	42.5	34.8	32.6	34.6	418.6
Tuchitua (mm)	41.2	32.6	22.1	18.4	37.5	53.6	70.2	50.8	49.2	39.1	42.1	44.0	500.8
Hour Lake (mm)	36.2	28.0	25.8	16.6	38.5	59.7	70.0	62.0	53.1	49.7	43.4	41.5	524.4
Mean (mm)	36.1	28.0	22.4	16.9	35.7	55.1	65.6	52.6	48.2	41.2	39.4	40.0	481.3
% Monthly Precipitation	0.08	0.06	0.05	0.04	0.07	0.11	0.14	0.11	0.10	0.09	0.08	0.08	1.00
Site Data Precipitation (mm)	42.8	33.2	26.5	20.0	42.3	65.3	77.7	62.3	57.1	48.8	46.7	47.4	570.0

1.1.3 Snowpack

There are limited winter precipitation records available from Wolverine for the winter months (snowfall), and it is therefore difficult to determine whether there is a seasonal variation in precipitation trend with elevation. Broadly speaking, there are three possibilities with respect to seasonal trends:

- Snowfall at Wolverine in the winter will be greater than the snowfall estimated from the monthly precipitation of the regional stations and scaled for elevation (the effect of elevation on precipitation observed for rain will be intensified for snow).
- Snowfall at Wolverine in the winter will follow the same trend with elevation as observed rainfall. The effect of elevation on precipitation observed for rain can be extended to snowfall. This is the default assumption.
- Snowfall at Wolverine in the winter will be less than the snowfall estimated from the regional stations and scaled for elevation. The effect of elevation on precipitation will be less for snow than is observed for rain.

Examining the monthly differences in precipitation observed at Watson Lake, Tuchitua and Hour Lake, there is no consistent seasonal trend in increased precipitation in winter at the higher elevation Tuchitua and Hour Lake stations when compared to the Watson Lake station in the summer months. This supports the default assumption that the scaling observed for Wolverine in summer will also apply in winter.

If all the snow that fell as snow persisted and accumulated, total snowpack water equivalent (SWE) in the spring would be simply the sum of the winter precipitation values. For the

Wolverine Project area, assuming that all precipitation falling between October and March falls as snow, this total would be 245 mm.

In early March 1997, the snow water equivalent at site was measured to be 128 mm. A depth was not recorded. Anecdotal reports at that time suggested that observed snow depths at the industrial complex and camp sites do not exceed 1 m. A snowpack survey was conducted in late March 2006 in the vicinity of the airstrip. A total of 10 stations along a transect were surveyed with snow depths ranging from 0.95 m to 1.04 m, with an average depth of 0.99 m. These measurements are consistent with anecdotal observations.

The snowpack at maximum depth is not the snowpack at maximum density. Maximum density occurs late in the season when the snow has been partially melted and condensed. At maximum depth, snowpack density will be higher than the 0.1 mm water/1.0 mm snow value for new fallen snow, but most likely lower than 0.2. Maximum density values of 0.2 to 0.25 are usually reached late in the season when the snowpack has begun to melt. The maximum SWE occurs at some point between maximum depth and maximum density.

Assuming only snow accumulation and applying sublimation estimated from the Hamon equation (Figure III-1.5), if the snowpack begins to accumulate on October 1, then on April 1 the net SWE would be 245 mm of precipitation less 42 mm of sublimation, for a total SWE of 203 mm. With an assumed 0.2 snowpack density, this would equate to a snowpack depth of 1 m, similar to the maximum observed depth. However, it is likely that the actual mean SWE on April 1 will be lower than 200 mm, because some of the precipitation in both October and March can fall as rain and is not stored as snow[1]. It has therefore been assumed that mean annual SWE at Wolverine is approximately 175 mm.

Mean SWE for the Liard Basin is 150-175 mm. Mean annual precipitation in the Liard Basin likewise varies between 300 mm and 1000 mm. Since the mean annual precipitation at Wolverine has been estimated to be approximately 570 mm, and is in the midpoint of the range for the Liard Basin, it is assumed that the mean SWE at Wolverine would be relatively close to the mean SWE for the Liard Basin.

[1] The automated climate station has recorded small amounts of rainfall in October and March.

Hamon Equation (1961)

$$\mathrm{ET}_t = 2.1 D_t^2 p_{\mathrm{sw}t}/(T_t + 273)$$

in which D_t is the number of daylight hours during day t and T_t here refers to the mean air temperature during day t (°C). The daylight hours variable can be determined by:

$$D_t = 24\omega_s/\pi$$

where ω_s is the is the sunset hour angle (radians), calculated from:

$$\omega_s = \arccos[-\tan(\phi)\tan(\delta)]$$

with ϕ equal to latitude (radians), and δ is the declination (radians) given by:

$$\delta = 0.4093 \sin[2\pi(284 + \mathrm{DOY})/365]$$

and DOY is the day of the year (1–365). $p_{\mathrm{sw}\ t}$ is the saturation vapour pressure in kilopascals on day t.

Hamon Equation (1963)

$$\mathrm{ET}_t = (715.5 * \Delta * p_{\mathrm{sw}\ t})/(T_t + 273)$$

where Δ is day length as fraction of day (length of daylight hours/24 hours).

Figure III-1.5 Hamon Equations

1.1.4 Evaporation

Evaporation figures were estimated from the Hamon equations and compared to measured evaporation at Carmacks (Figure III-1.6). The average of the two annual totals from the two equations was approximately 400 mm.

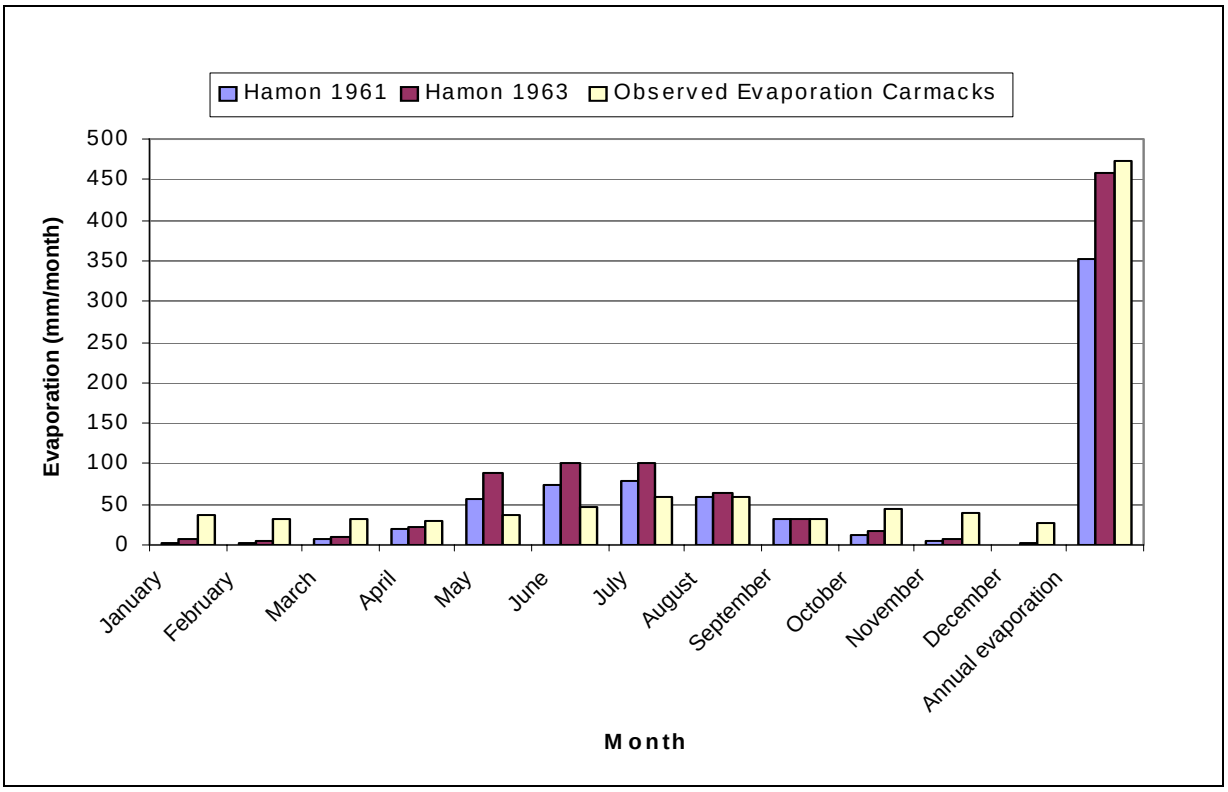


Figure III-1.6 Monthly and Annual Evaporation Estimates

Lake evaporation (free water) has been estimated from both regional data and, more recently employing the Modified Penman Equation and utilizing site specific data collected at the Wolverine project during May through September 2006. Regional lake evaporation figures have been obtained for the period 1951-1980 (the last period for which such statistics were calculated) for four stations in the NWT, three stations in the Yukon and one station in northern BC. The observed values are presented in Table III-1.3.

Table III-1.3 Mean and Standard Deviation of Observed Lake Evaporation (mm) Northwestern Canada, 1951-1980

Station	Elev. (m)	May Mean	SD	June Mean	SD	July Mean	SD	Aug Mean	SD	Sept Mean	SD	Annual
Fort Selkirk	500	107.6	±13	120.3	±12.4	108.0	±16.1	79.8	±13.7	37.2	±5.3	453
Haines Junction	599	99.8	±38.2	139.1	±32.5	128.6	±23.4	88.8	±14.6	37.5	±11.3	494
Whitehorse	706	104.3	±1.6	124.8	±19.8	109.9	±8.1	96.0	±14.6	47.7	±9.4	483
Fort Smith	205	123.4	±20.5	129.3	±9.4	126.3	±15.4	100	±14.3	45.2	±12.9	524
Norman Wells	74	110.4	±29.8	139.9	±15.4	123.0	±15.3	81.4	±15.4	42.3	±4.3	497
Resolute	67	-	-	-	-	100.2	±29.3	52.0	±14.7	-	-	152
Yellowknife	206	-	-	164.1	±10.2	157.9	±12.6	109.6	±14.9	49.9	±8.5	482
Hudson Hope BC	498	102.4	±13.9	121.0	±15.1	111.1	±11.5	98.0	±16.2	48.4	±12.1	481

Annual evaporation figures range from 152 mm for Resolute to 524 mm for Fort Smith. Evaporation is a complex process, being a function of air temperature, wind speed and relative humidity; temperature is a function of elevation as well as latitude. It is therefore reasonable to assume that the evaporation occurring in the Wolverine project area will be lower than these observed values because Wolverine is higher in elevation. However, the stations above vary too widely in latitude and not widely enough with elevation (elevations of the AES stations are between 0 and 700 m) to accurately determine a trend with elevation from the observed data for the latitude of Wolverine. The predicted evaporation values for Wolverine of approximately 400 mm annually seem reasonable given the lower mean temperatures and 1300 m elevation of Wolverine.

With respect to the annual water balance for the site, lake evaporation is largely but not entirely appropriate. Lake evaporation only occurs during the open water season, and drops to zero when the lake is frozen over. However, evaporation from snow-covered ground can occur, particularly when dry air overlies wet snow (sublimation), and is enhanced under windy conditions.

Therefore, the non-zero values estimated from the Hamon equation for winter conditions seen in Figure III-1.6 may have some physical basis.

1.1.4.1 Site Specific Estimation of Free Water Evaporation (ET_0) at Wolverine

Free water evaporation for the Wolverine project was recently re-evaluated using site specific radiation, temperature, wind speed and relative humidity data for the period of May 20 to October 2006. Using the hourly data for the open ice period of 2006, and synthesizing an annual record for certain parameters, an annual estimate of free water evaporation was developed.

1.1.4.1.1 Synthesizing Solar Radiation

Solar radiation incident outside the earth's atmosphere is called extraterrestrial radiation. On average the extraterrestrial irradiance is 1367 Watts/meter^2 (W/m^2). This value varies by +/-3% as the earth orbits the sun. The earth's closest approach to the sun occurs around January 4th and it is furthest from the sun around July 5th. The extraterrestrial radiation is

$$I_0 = 1367 * (R_{av} / R)^2 \text{ I} \quad (\text{W/m}^2)$$

where R_{av} is the mean sun-earth distance and R is the actual sun-earth distance depending on the day of the year. An approximate equation for the effect of the earth-sun distance is

$$(R_{av} / R)^2 = 1.00011 + 0.034221 * \cos\beta + 0.001280 * \sin\beta + 0.000719 * \cos 2\beta + 0.000077 * \sin 2\beta$$

where $\beta = 2\pi n / 365$ radians and n is the day of the year.

The earth's axis is tilted approximately 23.45 degrees with respect to the earth's orbit around the sun. To describe the sun's path across the sky one needs to know the angle of the sun relative to a line perpendicular to the earth's surface – this is called the zenith angle – and the sun's position relative to the north-south axis, the azimuthal angle. The hour angle is easier to use than the azimuthal angle because the hour angle is measured in the plane of the "apparent" orbit of the sun as it moves across the sky. Since the earth rotates approximately once every 24 hours, the hour angle changes by 15 degrees per hour and moves through 360 degrees over the day. Typically, the hour angle is defined to be zero at solar noon, when the sun is highest in the sky.

To describe the position of the sun in local standard time, one needs to know the relationship between solar time and local standard time. Local time is the same in the entire time zone whereas solar time relates to the position of the sun with respect to the observer, and that is

different depending on the exact longitude where solar time is calculated. To adjust solar time for longitude one must subtract ($Long_{local} - Long_{sm}$)/15 (units are hours) from the local time. $Long_{local}$ is the longitude for the observer in degrees and $Long_{sm}$ is the longitude for the standard meridian for the observer's time zone.

As the earth moves around the sun, solar time changes slightly with respect to local standard time. This is important when determining the position of the sun for solar energy calculations. An approximate formula for the equation of time (E_{qt}) in minutes is

$$E_{qt} = -14.2\sin\{\pi(n+7)/111\}$$

for Julian day n between 1 and 106

$$E_{qt} = 4.0\sin\{\pi(n-106)/59\}$$

for n between 107 and 166

$$E_{qt} = -6.5\sin\{\pi(n-166)/80\}$$

for n between 167 and 246

$$E_{qt} = 16.4\sin\{\pi(n-247)/113\}$$

for n between 247 and 365.

Using longitude correction and the equation of time, the relationship between the solar time and local standard time is

$$T_{solar} = T_{local} + \frac{E_{qt}}{60} + \frac{Long_{sm} - Long_{local}}{15}$$

Values are in hours. Since equations use sine and cosine functions, it is conceptually easier to calculate using the hour angle instead of time. The relationship between hour angle and time is:

$$\omega = \pi(12 - T_{solar})/12$$

The hour angle is in units of radians. With the above information, one can now calculate the cosine of the zenith angle:

$$CosZ = \sin\lambda\sin\delta + \cos\lambda\cos\delta\cos\omega$$

where λ is the latitude of the location of interest.

Sunrise and sunset occur when the sun is at the horizon and hence the cosine of the zenith angle is zero. Setting the cosine of the zenith angle to zero in the above equation results in the following equation:

$$\omega_{sr,ss} = \arccos(-\tan\lambda \tan\delta)$$

Near noon on a day without clouds, about 25% of the solar radiation is scattered and absorbed as it passes through the atmosphere. Therefore about 1000 W/m^2 of incident solar radiation reaches the earth's surface without being significantly scattered. This radiation, coming from the direction of the sun, is called direct normal irradiance, or beam irradiance. Some of the scattered sunlight is scattered back into space and some of it also reaches the surface of the earth. The scattered radiation reaching the earth's surface is called diffuse radiation. Some radiation is also scattered off the earth's surface and then re-scattered by the atmosphere to the observer. This is also part of the diffuse radiation the observer sees. This amount can be significant in areas where the ground is covered with snow or consists largely of exposed rocks. This is one of the major reasons why it was decided not to include the effects of solar zenith and shadow casting to the Wolverine mine site. It is extremely difficult to evaluate the diffuse radiation effects properly.

The total solar radiation on a horizontal surface is called global irradiance and is the sum of incident diffuse radiation plus the direct normal irradiance projected onto the horizontal surface. If the surface under study is tilted with respect to the horizontal, the total irradiance is the incident diffuse radiation plus the direct normal irradiance projected onto the tilted surface plus ground reflected irradiance that is incident on the tilted surface. In the present calculation, for simplification purposes, it was assumed the horizontal surface as the surface of interest (free water surface). The calculation also neglected the effects of dust, moisture, and some other elements which may prevent incidental radiation.

Figure III-1.7 graphically presents the calculation results of irradiation for the Wolverine mine site (for one day May 21, 2006, as an example). These values match well with the observed data for this site in sunny days and therefore a longer-term synthesized radiation record will be used for estimating the evapotranspiration values ET_0, which should be similar to the actual free water surface evapotranspiration.

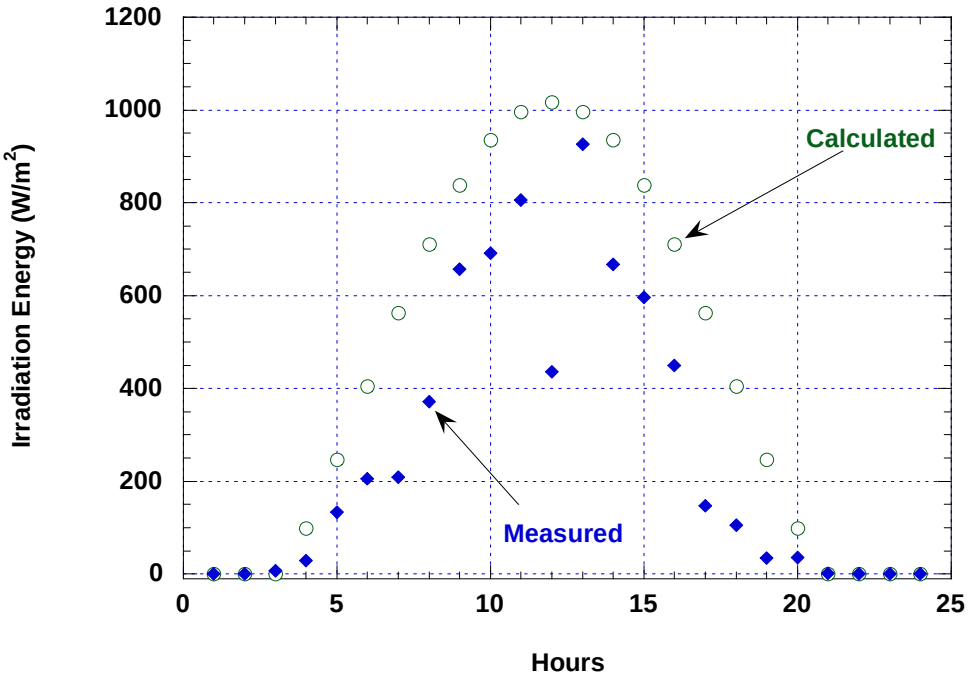


Figure III-1.7 Comparison of Calculated Solar Radiation to Measured Solar Radiation from Site Weather Station (May 21, 2006)

1.1.4.1.2 Estimate of ET_0 value for the Wolverine Mine Site

The evaporation estimate was performed by using the Modified Penman Equation by Pruitt and Doorenbos (Proceedings of the international round table conference on "Evapotranspiration", Budapest, Hungary. 1977). In 1948, Penman combined the energy balance with the mass transfer method and derived an equation to compute the evaporation from an open water surface from standard climatological records of sunshine, temperature, humidity and wind speed. This so-called combination method was further developed by many researchers and extended to cropped surface by introducing resistance factors.

The resistance nomenclature distinguishes between aerodynamic resistance and surface resistance factors. The surface resistance parameters are often combined into one parameter, the 'bulk' surface resistance parameter which operates in series with the aerodynamic resistance. The surface resistance, r_s, describes the resistance of vapour flow through stomata openings, total lead area and soil surface. The aerodynamic resistance, r_a, describes the resistance from the vegetation upward and involves friction from air flowing over vegetative surfaces. Although the exchange process in a vegetation layer is too complex to be fully described by the two resistance

factors, good correlations can be obtained between measured and calculated evapotraspiration rates, especially for a uniform grass reference surface.

Simplified representation of the (bulk) surface and aerodynamic resistances for water vapour flow can be described as following:

The Penman-Monteith form of the combination equation is,

$$\lambda ET = \frac{\Delta(R_n - G) + \rho_a C_p \dfrac{(e_s - e_a)}{r_a}}{\Delta + \gamma\left(1 + \dfrac{r_s}{r_a}\right)}$$

where R_n is the net radiation, G is the soil heat flux, (e_s-e_a) represents the vapour pressure deficit of the air, r_a is the mean air density at constant pressure, C_p is the specific heat of the air, Δ represents the slope of the saturation vapour pressure temperature relationship, γ is the psychrometric constant, and r_s and r_a are the (bulk) surface and aerodynamic resistances. The parameters of the equation will be defined later in this report.

The Penman-Monteith approach as formulated above includes all parameters that govern energy exchange and corresponding latent heat flux (evapotranspiration) from uniform expanses of vegetation. Most of the parameters are measured or can be readily calculated from weather data. The equation can be utilized for the direct calculation of any crop evapotranspiration as the surface and aerodynamic resistances are crop specific.

Aerodynamic resistance (r_a)

The transfer of heat and water vapour from the evaporating surface into the air above the canopy is determined by the aerodynamic resistance:

$$r_a = \frac{\ln\left[\dfrac{Z_m - d}{Z_{0m}}\right]\ln\left[\dfrac{Z_h - d}{Z_{0h}}\right]}{k^2 u_z}$$

where

r_a aerodynamic resistance (s m^{-1})

Z_m height of wind measurements (m)

Z_h height of humidity measurements (m)

d zero plane displacement height (m)

Z_{0m} roughness length governing momentum transfer (m)

Z_{0h} roughness length governing transfer of heat and vapour (m)

k von Karman's constatnt, 0.41 (non-dim)

u_z wind speed at height z (m s^{-1})

The equation is restricted for neutral stability conditions, i.e. where temperature, atmospheric pressure, and wind velocity distributions follow nearly adiabatic conditions (no heat exchange). The application of the equation for short time period (hourly or less) may require the inclusion of corrections for stability. However, when predicting ET_0 in the well-watered reference surface, heat exchange is small, and therefore stability correction is normally not required.

Many studies have explored the nature of the wind regime in plant canopies. Zero displacement heights and roughness lengths have to be considered when the surface is covered by vegetation. The factors depend upon the crop height and architecture. Several empirical equations for the estimate of d, z_{0m}, and z_{0h} have been developed. The aerodynamics resistance term and wind function are also adopted from method developed at the University of California, Davis.

Calculation of ET_0 requires the following variables for the site:

ea mean hourly vapor pressure (kPa)

RH mean hourly relative humidity (%)

Rn mean hourly net radiation (Wm^{-2})

T mean hourly air temperature (^oC)

U mean hourly wind speed at 2 m (m s^{-1})

Z Elevation of the station above mean sea level (m)

Usually these values can be obtained from meteorological observation data, however, for Wolverine, only a limited period of record exists, which are insufficient to calculate annual values of evapotranspiration. As outlined above, radiation (*Rn*) can be mathematically synthesized to produce a longer period of record, while the other remaining variables need to be either synthesized or assumed. The present approach was to use averaged values of these

parameters over the period of 20 May – 2 September, 2006 (the period of full meteorological data collection at site), except for the hourly air temperature. Hourly air temperature was then synthesized from monthly average values available from the site. Simple liner regression was used to create these data. Although these assumptions are rather crude and overly simple, the ET_0 values calculated appear to be fairly reasonable.

Using the synthesized radiation data in concert with the meteorological (wind speed, temperature, RH) data and the Penman equation, calculated hourly ET_0 values for Wolverine (assuming year-round availability of free water) are presented in Figure III-1.8 below.

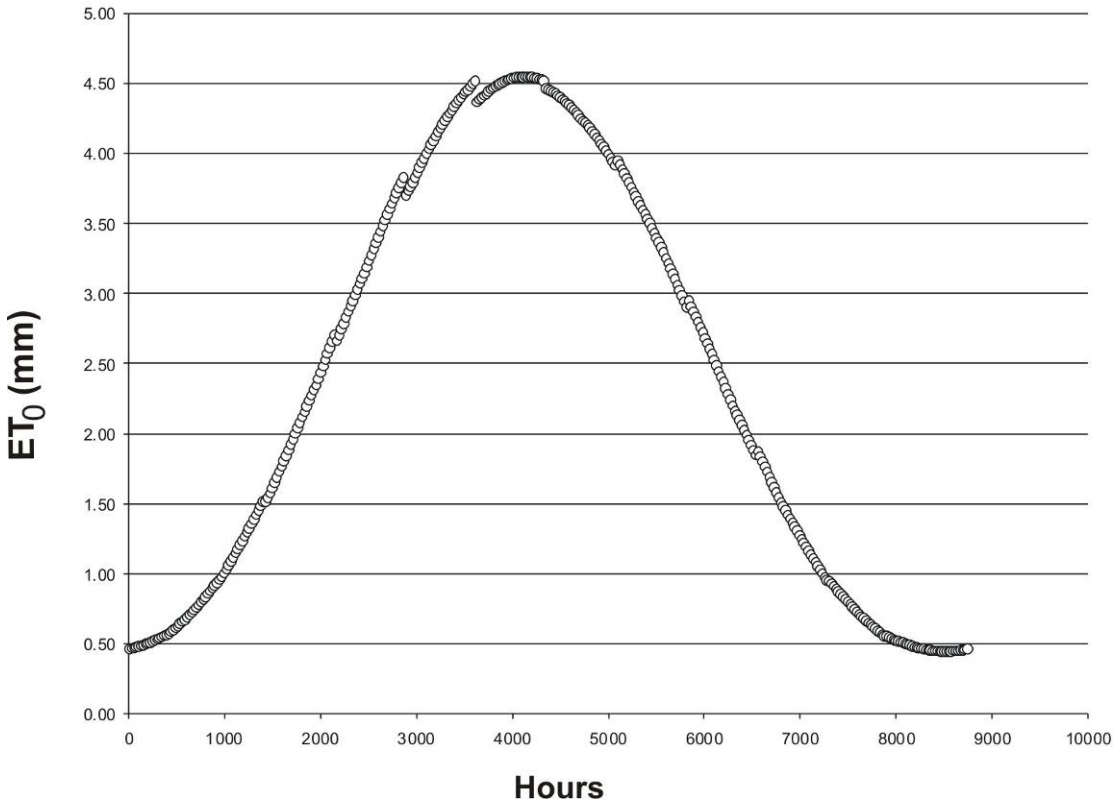


Figure III-1.8 Daily Distribution of ET_0 at Wolverine Assuming Continuous Free Water Availability

Assuming no ice formation, total annual ET_0 is estimated at roughly 865 mm. Clearly, this is inappropriate for the Wolverine site, but nonetheless serves to provide an upper boundary on evaporation potential.

The effects of ice on free water evaporation were included by assigning zero ET_0 values once daily average air temperature becomes below zero ºC. Total annual ET_0 for Wolverine,

assuming no evaporation during ice covered periods is approximately 542 mm with an annual distribution as represented in Figure III-1.9.

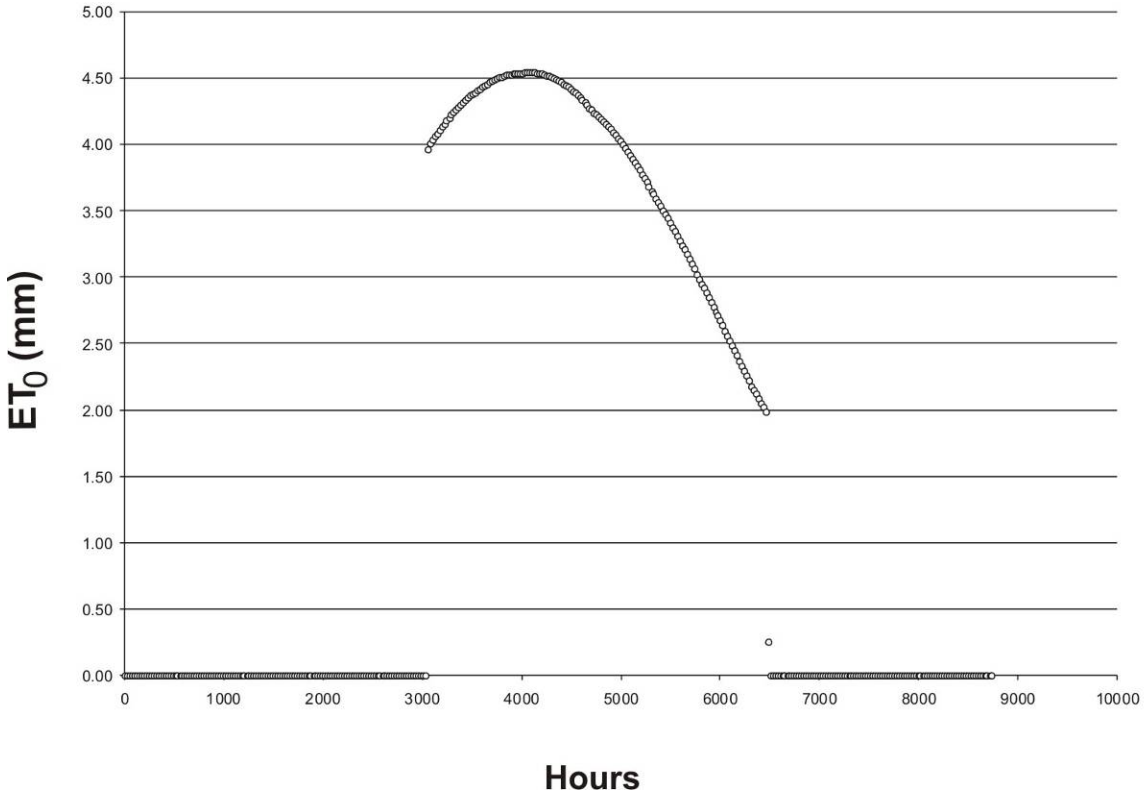


Figure III-1.9 Daily Distribution of ET_0 at Wolverine Considering No Evaporation During Ice Covered Periods

The calculated ET_0 values utilizing synthesized radiation data and averaged wind speed, RH and synthesized hourly temperature data agree reasonably well with ET_0 calculated from site specific meteorological data from the airstrip site for the period of May 21-24, 2006 (Figure III-1.10). These specific dates were chosen randomly to test the comparison. The analysis of site specific data and utilization of calculated radiation data suggest that free water evaporation rates at Wolverine may be somewhat higher than that estimated from pan evaporation and other regional data. Continuation of meteorological data collection will allow this analysis to be further evaluated throughout operations.

In summary, while for water balance purposes described in Section G an annual evaporation rate of 400 mm will be conservatively employed, it is evident from the above analysis that free water evaporation rates could be higher at site. Accordingly, a sensitivity analysis using evaporation rates on the order of 540 mm/y was performed in the water balance analysis (see Section G).

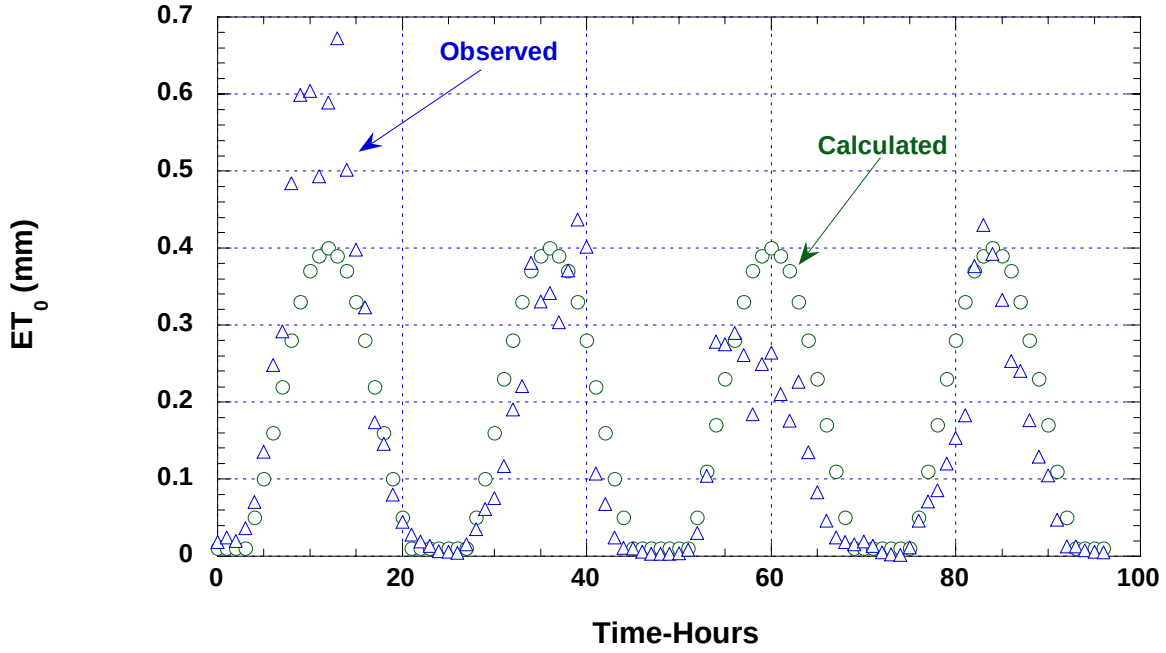


Figure III-1.10 Comparison of Calculated Hourly ET_0 (from Synthesized Data) and Observed ET_0 Generated from Meteorological Station Data for May 21-24, 2006

1.2 Monthly Precipitation

Estimated monthly precipitation by return period and estimated rainfall/duration/intensity are provided in Table X and Table X, respectively, from Madronne Environmental Services Ltd.

Table III-1.4 Estimated Monthly Precipitation (mm) for Wolverine Mine by Return Period

Month	Mean	Return Period (years)																			
		1.001	1.002	1.005	1.01	1.02	1.042	1.053	1.111	1.25	2	5	10	20	25	50	100	200	500	1,000	10,000
Jan	42.8	11.8	13.6	16.2	18.3	20.6	23.0	23.8	26.6	30.0	42.8	42.1	45.2	47.9	48.4	50.4	52.2	54.0	56.0	57.4	63.0
Feb	33.2	9.2	10.6	12.6	14.3	16.0	17.9	18.5	20.7	23.4	33.2	32.7	35.1	37.3	37.6	39.2	40.6	42.0	43.5	44.7	49.0
Mar	26.5	6.9	8.0	9.5	10.7	12.0	13.4	13.9	15.5	17.5	26.5	24.5	26.4	28.0	28.2	29.4	30.5	31.5	32.7	33.5	36.8
April	20.0	6.5	7.6	9.0	10.2	11.4	12.8	13.2	14.8	16.7	20.0	23.4	25.1	26.6	26.9	28.0	29.0	30.0	31.1	31.9	35.0
May	42.3	15.7	18.2	21.6	24.4	27.5	30.7	31.7	35.5	40.0	42.3	56.1	60.2	63.9	64.5	67.2	69.6	72.0	74.6	76.6	84.0
Jun	65.3	22.6	26.2	31.1	35.1	39.5	44.1	45.6	51.1	57.5	65.3	80.7	86.6	91.8	92.7	96.6	100.1	103.4	107.3	110.1	120.8
July	77.7	26.8	31.1	37.0	41.7	46.9	52.4	54.2	60.7	68.4	77.7	95.9	102.9	109.1	110.2	114.8	119.0	122.9	127.5	130.8	143.5
Aug	62.3	20.3	23.5	28.0	31.6	35.5	39.6	41.0	45.9	51.7	62.3	72.5	77.8	82.5	83.3	86.8	90.0	92.9	96.4	98.9	108.5
Sept	57.0	18.6	21.6	25.7	29.0	32.6	36.4	37.7	42.2	47.5	57.0	66.6	71.5	75.9	76.6	79.8	82.7	85.4	88.6	90.9	99.8
Oct	48.8	14.7	17.1	20.3	22.9	25.7	28.8	29.7	33.3	37.5	48.8	52.6	56.5	59.9	60.5	63.0	65.3	67.5	70.0	71.8	78.8
Nov	46.7	13.1	15.2	18.0	20.4	22.9	25.6	26.4	29.6	33.4	46.7	46.8	50.2	53.2	53.8	56.0	58.0	60.0	62.2	63.8	70.0
Dec	47.4	13.1	15.2	18.0	20.4	22.9	25.6	26.4	29.6	33.4	47.4	46.8	50.2	53.2	53.8	56.0	58.0	60.0	62.2	63.8	70.0
TOTAL	**570.0**	**179.2**	**207.7**	**247.1**	**278.9**	**313.5**	**350.2**	**362.2**	**405.5**	**457.0**	**570.0**	**640.6**	**687.7**	**729.4**	**736.5**	**767.2**	**795.1**	**821.5**	**852.1**	**874.1**	**959.0**

Table III-1.5 Estimated Rainfall/Duration/Intensity for Wolverine Mine

Duration	Rainfall (mm)			
	50 year	100 year	200 year	10,000 year
10 min.	7.2	7.9	8.5	-
15 min.	8.6	9.4	10.2	-
20 min.	9.7	10.6	11.5	-
25 min.	10.7	11.7	12.7	-
30 min.	11.6	12.7	13.8	16.3
60 min.	14.5	15.8	17.2	20.4
5 hour	-	-	32.0	38.0
10 hour	-	-	41.0	50.0
15 hour	-	-	48.0	60.0
20 hour	-	-	53.0	66.0
24 hour	-	-	56.0	72.0

2. SURFACE AND GROUNDWATER QUALITY

2.1 Surface Water in Tailings Impoundment Area

Baseline surface water quality samples were collected from 2005 to 2007 from Station W44 (location shown in Figure III-2.1) located on a small stream that drains through the proposed tailings impoundment area. The baseline data is summarized in Table III-2.1, and the full data comprising the averages and ranges in Table III-2.1 are provided in Table III-2.2.

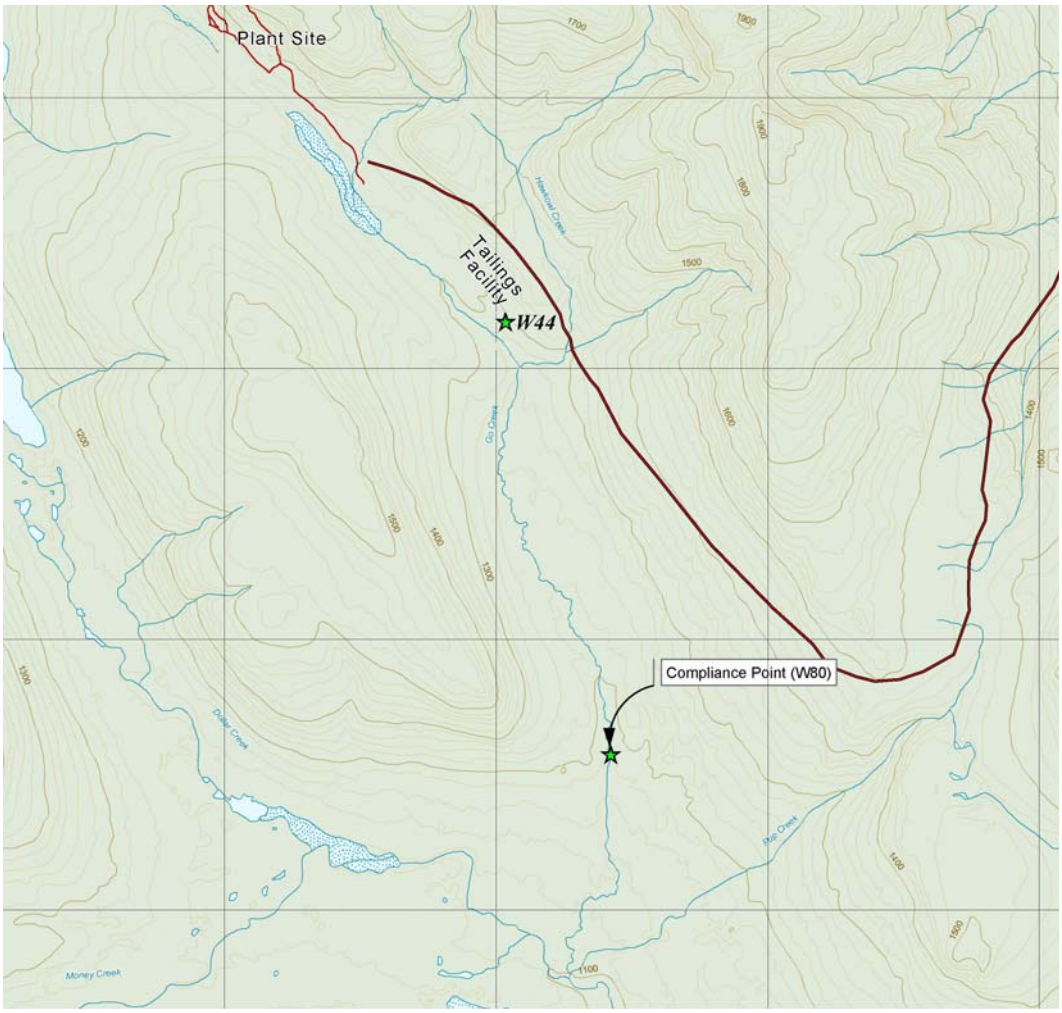


Figure III-2.1 Location Map of Surface Water Sampling Location W44 and Compliance Monitoring Station

The data indicate that water quality in this small stream is dominated by meteoric waters being of low hardness, low alkalinity and circum-neutral pH. The water is low in sulphate, nutrients and metal content is generally low, with slightly higher concentrations observed during peak snow melt periods when TSS levels are elevated.

Table III-2.1 Background Surface Water Quality in Tailings Impoundment Area (Station W44) 2005 – 2007 Averages and Ranges

	AVG	Range		AVG	Range		AVG	Range
Parameters (mg/L)	**n = 13**		**Parameters (mg/L)**	**n = 13**		**Parameters (mg/L)**	**n = 13**	
			Total Metals			**Dissolved Metals**		
Physical Parameters			Aluminum (Al)	0.3092	0.012 - 1.59	Aluminum (Al)	0.0286	0.0085 - 0.162
Conductivity	130.67	80 - 150	Antimony (Sb)	0.0001	<0.00005 - 0.00019	Antimony (Sb)	0.00006	<0.00005 - 0.00006
Hardness	68.04	23 - 93	Arsenic (As)	0.0147	0.0001 - 0.144	Arsenic (As)	0.00017	0.0001 - 0.0002
Total Suspended Solids	40.13	<4 - 74	Cadmium (Cd)	0.0002	<0.00001 - 0.0008	Cadmium (Cd)	0.000039	<0.00001 - 0.00011
Total Dissolved Solids	86.23	40 - 106	Calcium (Ca)	24.72	9.5 - 33.2	Calcium (Ca)	24.61	8.25 - 33.3
pH	7.73	6.6 - 8.1	Chromium (Cr)	0.0017	0.0003 - 0.0042	Chromium (Cr)	0.0004	0.0004 - 0.0004
Turbidity	3.145	0.2 - 26.2	Cobalt (Co)	0.0003	0.00002 - 0.00117	Cobalt (Co)	0.00014	<0.00002 - 0.00035
DOC	3.2	1.3 - 6	Copper (Cu)	0.0026	0.0006 - 0.0098	Copper (Cu)	0.0012	0.0006 - 0.0036
			Iron (Fe)	0.3651	0.031 - 1.94	Iron (Fe)	0.0518	0.012 - 0.202
			Lead (Pb)	0.0005	<0.00002 - 0.00157	Lead (Pb)	0.00007	<0.00002 - 0.00014
Major Anions			Magnesium (Mg)	1.87	1.03 - 2.48	Magnesium (Mg)	1.83	0.64 - 2.32
Alkalinity-Total	59.21	25.3 - 73	Manganese (Mn)	0.0525	0.00032 - 0.334	Manganese (Mn)	0.0345	0.00333 - 0.287
Bromide	<0.01	<0.01	Mercury (Hg)	<0.00001	<0.00001	Mercury (Hg)	<0.00001	<0.00001
Chloride	0.6	<0.5 - 0.6	Molybdenum (Mo)	0.00031	0.00022 - 0.00046	Molybdenum (Mo)	0.00026	0.00015 - 0.00034
Fluoride	0.0393	0.029 - 0.05	Nickel (Ni)	0.1969	0.0007 - 0.781	Nickel (Ni)	0.0011	<0.0005 - 0.0011
Sulphate	6.76	1.5 - 9.6	Phosphorus (P)	0.0636	0.005 - 0.2	Phosphorus (P)	<0.1	<0.1
			Potassium (K)	0.9686	0.513 - 2.95	Potassium (K)	0.9328	0.544 - 2.83
			Selenium (Se)	0.0006	<0.0005 - 0.0007	Selenium (Se)	0.0006	<0.0005 - 0.0007
Nutrient Parameters			Silicon (Si)	3.6958	2.05 - 5.26	Silicon (Si)	3.48	0.68 - 4.19
Ammonial Nitrogen	0.027	<0.005 - 0.07	Silver (Ag)	0.00005	<0.00001 - 0.00007	Silver (Ag)	<0.00001	0.00003 - 0.00003
Nitrate Nitrogen	0.032	0.002 - 0.11	Sodium (Na)	0.8991	0.34 - 1.16	Sodium (Na)	0.8882	0.29 - 1.14
Nitrite Nitrogen	0.0044	<0.002 - 0.009	Strontium (Sr)	0.05415	0.0241 - 0.0744	Strontium (Sr)	0.0548	0.0176 - 0.0717
Total Phosphate	0.0056	0.0042 - 0.007	Thallium (Tl)	<0.00005	<0.00005	Thallium (Tl)	<0.00005	<0.00005
Dissolved Ortho-Phosphate	0.0043	0.001 - 0.007	Vanadium (V)	0.0007	0.00011 - 0.0031	Vanadium (V)	0.00016	0.00006 - 0.00044
			Zinc (Zn)	0.0057	0.0008 - 0.0201	Zinc (Zn)	0.0045	0.0016 - 0.0082

Table III-2.2 Background Surface Water Quality in Tailings Impoundment Area (Station W44) 2005 – 2007 Data

Sample name	W-44	W-44	W44	W44	W44	W44	W44	W44	W44	W44	W44	W44	W44
Date	23-Oct-05	13-Sep-05	10-May-06	1-Jun-06	3-Jul-06	31-Jul-06	7-Sep-06	4-Oct-06	18-Nov-06	4-Jun-07	29-Jun-07	29-Jul-07	26-Aug-07
	W6798	W4423	A619028	A623186	A629169	A635289	A642441	A647966	A656333	A724714	A729135	A734931	A740044
Parameters (mg/L)													
Physical Parameters													
Conductivity	143	150								80	124	139	148
Hardness		75.1	23	54	69	86	83	82	93	40.8	64	74.6	72
Total Suspended Solids	5.4	<3.0	74	<4	<4	<4	<4	<4	41	<4	<4	<4	<4
Total Dissolved Solids	90	95	40	78	82	94	94	84	84	86	94	94	106
pH	7.79	7.66	6.6	7.2	8	8	8.1	8	7.8	7.6	7.9	7.9	8
Turbidity		0.44	26.2	0.5	0.5	0.2	0.3	0.2	8.1	0.4	0.4	0.2	0.3
DOC	2.87	3.03	3	6	-	2.4	4.4	1.3	2.8	4.2	2.5	3	2.9
Major Anions													
Alkalinity-Total		66.3	25.3	49.4	61	69.8	72	69	73	37.7	57.5	62.9	66.6
Bromide	<0.050	<0.050								<0.1	<0.1	<0.01	<0.01
Chloride	<0.50	<0.50	0.6	<0.5	<0.5	<0.5	<0.5	<0.5	0.6	<0.5	<0.5	<0.5	<0.5
Fluoride	0.029	0.037								0.04	0.04	0.04	0.05
Sulphate	9.34	8.83	1.5	4.7	8.4	7.9	7.4	9.2	9.6	1.8	6.2	6.6	6.4
Nutrient Parameters													
Ammonial Nitrogen	<0.020	<0.020	0.07	<0.005	<0.005	<0.005	<0.005	0.012	0.017	<0.005	0.009	<0.005	<0.005
Nitrate Nitrogen	0.037	<0.0050	0.11	<0.02	0.008	<0.002	<0.002	0.016	0.093	0.003	0.012	0.007	0.002
Nitrite Nitrogen	0.0024	<0.0010	<0.005	<0.002	<0.002	<0.002	<0.002	<0.002	0.009	0.003	0.003	<0.002	<0.002
Total Phosphate	0.0042	<0.0020								0.007	0.006	<0.005	0.005
Dissolved Ortho-Phosphate			<0.005	0.005	0.005	-	<0.001	0.001	0.007	0.006	0.002	0.002	0.006
Total Metals													
Aluminum (Al)	<0.20	0.012	1.57	0.0446	0.0318	0.0152	<0.00005	0.0309	1.59	0.0464	0.0252	0.0192	0.0162
Antimony (Sb)	<0.20	<0.00050	0.00008	0.00011	<0.00005	<0.00005	0.0001	<0.00005	0.00019	<0.00005	<0.00005	<0.00005	<0.00005
Arsenic (As)	<0.20	<0.00050	0.0005	0.0002	0.0001	0.0002	0.144	0.0002	0.0006	0.0002	<0.0001	0.0004	0.0001
Cadmium (Cd)	<0.010	<0.000017	0.00013	<0.00001	<0.00001	<0.00001	0.0008	<0.00001	0.00015	0.00002	0.00002	<0.00001	<0.00001
Calcium (Ca)	27	25.7	9.5	19.5	25.2	33.2	30.9	30.3	29.9	14.6	23.6	25.6	26.3
Chromium (Cr)	<0.010	<0.0010	0.0037	<0.0002	0.0005	<0.0002	<0.0002	0.0008	0.0042	0.0003	0.0005	<0.0002	<0.0002
Cobalt (Co)	<0.010	<0.00030	0.00095	0.00005	0.00002	<0.00002	0.0006	0.00002	0.00117	0.00004	0.00003	0.00002	0.00003
Copper (Cu)	<0.010	<0.0010	0.0077	0.0012	0.0021	0.001	<0.00002	0.0006	0.0098	0.0015	0.0009	0.0009	0.0007
Iron (Fe)	<0.030	<0.030	1.53	0.041	0.031	0.242	0.049	0.036	1.94	0.041	0.042	0.031	0.033
Lead (Pb)	<0.050	<0.00050	0.00096	<0.00002	0.00005	<0.00002	0.0002	0.00003	0.00157	<0.00002	0.00004	<0.00002	<0.00002
Magnesium (Mg)	2.15	2.15	1.03	1.44	1.84	2.24	2.1	2.13	2.48	1.17	1.71	1.9	1.97
Manganese (Mn)	<0.0050	0.00415	0.212	0.00645	0.00968	0.0155	0.00032	0.013	0.334	0.00875	0.01	0.00719	0.00949
Mercury (Hg)		<0.000020								<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum (Mo)	<0.030	<0.0010	0.00029	0.00031	0.00035	0.00022	<0.0005	0.00033	0.00046	0.00026	0.00029	0.00029	0.00031
Nickel (Ni)	<0.050	<0.0010	0.0028	<0.0005	<0.0005	<0.0005	0.781	<0.0005	0.0031	<0.0005	0.0007	<0.0005	<0.0005
Phosphorus (P)	<0.30	<2.0	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	0.007	0.006	<0.005	0.005
Potassium (K)	<2.0	<0.0010	1.75	0.573	0.513	0.616	<0.001	0.683	2.95	0.658	0.681	0.606	0.656
Selenium (Se)	<0.20	<0.000020	0.0005	<0.0005	<0.0005	0.0007		<0.0005		<0.0005	<0.0005	<0.0005	<0.0005

Table III-2.2 Background Surface Water Quality in Tailings Impoundment Area (Station W44) 2005 – 2007 Data (con't)

Sample name	W-44	W-44	W44	W44	W44	W44	W44	W44	W44	W44	W44	W44	W44
Date	23-Oct-05	13-Sep-05	10-May-06	1-Jun-06	3-Jul-06	31-Jul-06	7-Sep-06	4-Oct-06	18-Nov-06	4-Jun-07	29-Jun-07	29-Jul-07	26-Aug-07
	W6798	W4423	A619028	A623186	A629169	A635289	A642441	A647966	A656333	A724714	A729135	A734931	A740044
Parameters (mg/L)													
Silicon (Si)	3.59	<2.0	2.05	3.45	3.74	4.22	4.12	3.99	5.26	2.73	3.52	3.75	3.93
Silver (Ag)	<0.010	<0.00020	0.00005	<0.00001	<0.00001	0.00003	<0.00001	<0.00001	0.00007	<0.00001	<0.00001	<0.00001	<0.00001
Sodium (Na)	<2.0	<0.00050	0.34	0.83	1.12	1.16	1.01	1.04	1.02	0.66	0.89	0.86	0.96
Strontium (Sr)	0.0651	<0.010	0.0241	0.0423	0.0573	0.0631	0.0632	0.0616	0.0744	0.0344	0.0507	0.0534	0.0602
Thallium (Tl)	<0.20	<0.00020	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Vanadium (V)	<0.030	<0.030	0.0026	0.00018	0.00016	<0.00005	0.00017	0.00011	0.0031	0.0002	0.00014	0.00016	0.00012
Zinc (Zn)	<0.0050	<0.0050	0.0201	0.0008	0.0037	0.0036	0.0053	0.0063	0.0116	0.0031	0.0053	0.0012	0.0015
Dissolved Metals													
Aluminum (Al)	<0.20	0.0103	0.0226	0.0203	0.0209	0.0135	0.0095	0.0085	0.162	0.0378	0.0141	0.0128	0.0109
Antimony (Sb)	<0.20	<0.00050	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	0.00006	<0.00005	<0.00005	<0.00005	<0.00005
Arsenic (As)	<0.20	<0.00050	0.0002	0.0002	0.0002	0.0001	0.0002	0.0002	0.0001	<0.0001	0.0002	<0.0001	0.0001
Cadmium (Cd)	<0.010	0.000034	0.00005	<0.00001	0.00001	<0.00001	<0.00001	<0.00001	0.00011	0.00001	0.00002	<0.00001	<0.00001
Calcium (Ca)	28.6	26.4	8.25	19.2	24.4	31	29.6	29.2	33.3	14.5	23	26.7	25.8
Chromium (Cr)	<0.010	<0.0010	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0004
Cobalt (Co)	<0.010	<0.00030	0.00004	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	0.00035	0.00003	<0.00002	<0.00002	<0.00002
Copper (Cu)	<0.010	<0.0010	0.0009	0.0011	0.0036	0.0015	0.0006	0.0007	0.0008	0.0014	0.0007	0.0008	0.0007
Iron (Fe)	<0.030	<0.030	0.036	0.012	0.024	0.156	0.025	0.031	0.202	0.025	0.02	0.021	0.018
Lead (Pb)	<0.050	<0.00050	0.00009	<0.00002	0.00006	0.00005	0.00003	0.00002	0.00014	<0.00002	0.00008	<0.00002	<0.00002
Magnesium (Mg)	2.3	2.23	0.64	1.45	1.88	2.13	2.17	2.16	2.32	1.14	1.62	1.94	1.86
Manganese (Mn)	<0.0050	0.00333	0.0377	0.00433	0.00853	0.0146	0.0142	0.0127	0.287	0.00663	0.00867	0.00794	0.00865
Mercury (Hg)		<0.000020								<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum (Mo)	<0.030	<0.0010	0.00021	0.00027	0.00034	0.00026	0.00032	0.0003	0.00015	0.00022	0.00029	0.00026	0.00028
Nickel (Ni)	<0.050	<0.0010	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0011	<0.0005	<0.0005	<0.0005	<0.0005
Phosphorus (P)	<0.30	<2.0	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Potassium (K)	<2.0	<0.0010	1.54	0.544	0.556	0.663	0.893	0.678	2.83	0.66	0.631	0.598	0.668
Selenium (Se)	<0.20	<0.000020	<0.0005	0.0006	0.0007	0.0005	0.0006	0.0006	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Silicon (Si)	3.88	<2.0	0.68	3.37	3.89	3.91	3.96	4.03	4.19	2.72	3.46	3.98	3.74
Silver (Ag)	<0.010	<0.00020	<0.00001	<0.00001	<0.00001	0.00003	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Sodium (Na)	<2.0	<0.00050	0.29	0.77	1.13	1.11	1.14	1.08	1.11	0.65	0.79	0.91	0.79
Strontium (Sr)	0.0687	<0.010	0.0176	0.0407	0.0549	0.0632	0.0677	0.0717	0.0698	0.0325	0.053	0.0574	0.0604
Thallium (Tl)	<0.20	<0.00020	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Vanadium (V)	<0.030	<0.030	0.0002	0.00013	0.00013	0.00006	0.00008	0.00009	0.00044	0.00015	0.00022	0.00011	0.00012
Zinc (Zn)	<0.0050	<0.0050	0.0082	0.0023	0.004	0.005	0.0075	0.0061	0.0034	0.002	0.0047	<0.0005	0.0016

2.2 Groundwater

Baseline groundwater quality data were collected from 2005 to 2008 at the Wolverine tailings impoundment area monitoring wells MW05-2A, MW05-2B, MW05-6A, MW05-6B, MW05-7B, and MW08-13 as shown in Table III-2.3. MW08-14 was installed upstream of the tailings facility in October 2008, however; it was frozen during the December sampling period, hence results are not presented here. Monitoring well locations are shown on Drawing D-3002 and the complete water quality results for the monitoring wells are provided in Table III-2.4.

The results indicate that the groundwater has a neutral to slightly alkaline pH (7.6 to 9.1) and low conductivity values (84.8 µS/cm to 410 µS/cm). Based on the Piper Trilinear plot for September 2005 (Figure III-2.2), the groundwater is generally calcium-bicarbonate (Ca-HCO3) type water, which is associated with glacio-fluvial sediments and ground moraine. These are the main soils underlying the tailings area. MW05-5 is also included on this plot although it is located at the headwaters of the Wolverine Creek watershed.

Table III-2.3 Background Groundwater Quality in Tailings Impoundment Area 2005 – 2008 Averages and Ranges

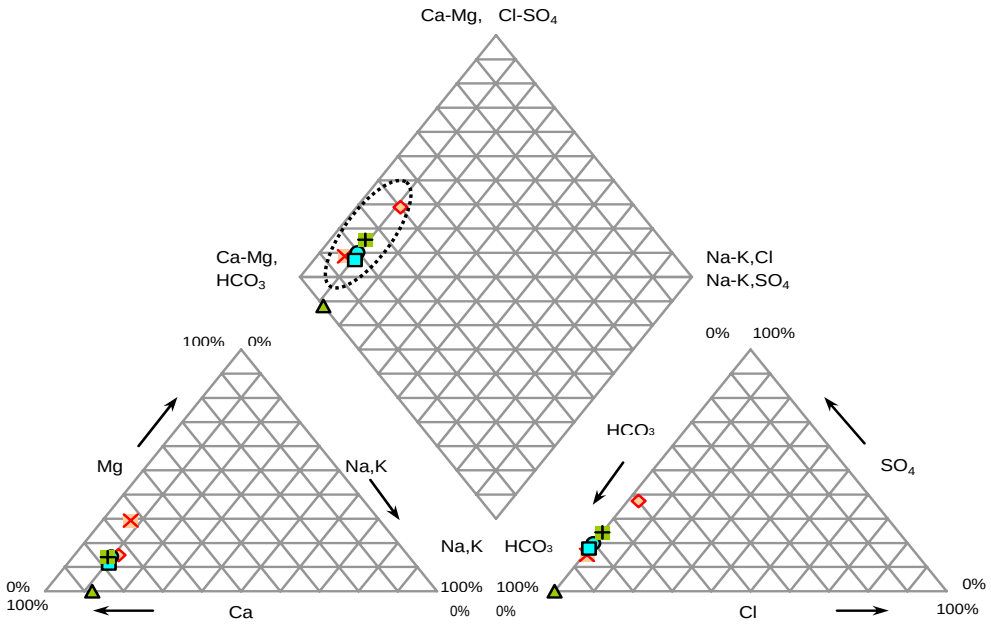
		MW05-2A (n = 6)		MW05-2B (n = 6)		MW05-6A (n = 5)		MW05-6B (n = 4)		MW05-7B (n = 11)		MW08-13
Parameters	**Units**	**AVG**	**Range**	**AVG**	**Range**	**AVG**	**Range**	**AVG**	**Range**	**AVG**	**Range**	**6-Dec-08**
Electrical Conductivity	(µS/cm)	399.5	385 - 410	253	246 - 260	160.76	84.8 - 189	184	172 - 197	160.9	146 - 180	230
pH		8.2	8 - 8.3	7.9	7.6 - 8.2	7.9	7.75 - 7.9	8.4	8 - 9.11	8.3	7.58 - 9	8.0
Total Alkalinity	(mg CaCO3/L)	178.3	170 - 185	126	120 - 131	77	70.3 - 79.1	86	81 - 92.1	66	56.1 - 79	120
Fluoride	(mg/L)	0.28	0.24 - 0.31	0.07	0.06 - 0.08	0.17	0.135 - 0.18	0.05	0.04 - 0.068	0.13	0.09 - 0.166	0.08
Sulphate	(mg/L)	33.3	27.4 - 38	7.5	3.9 - 12	14.6	12.5 - 18.5	10.6	7.3 - 16.6	13.3	6.2 - 22.2	3.1
Aluminum	(mg/L)	0.0108	<0.0002 - 0.0449	0.0165	0.001 - 0.0884	0.0058	0.001 - 0.0219	0.0291	0.0074 - 0.0667	0.0280	0.0003 - 0.112	0.0049
Arsenic	(mg/L)	0.00072	0.00038 - 0.0011	0.0300	0.0136 - 0.0362	0.0048	0.0044 - 0.0061	0.0003	0.0003 - 0.0003	0.0009	0.00047 - 0.0019	0.00148
Cadmium	(mg/L)	0.00001	<0.000005 - 0.00001	0.00003	<0.000005 - 0.00003	0.000043	<0.00001 - 0.000076	<0.00001	<0.00001 - 0.00001	0.00003	<0.000005 - 0.00004	0.000035
Calcium	(mg/L)	59.7	56.9 - 62.2	41.9	40 - 44.6	28.5	25.3 - 29.9	34.4	31.2 - 36.1	27.7	25.1 - 31.3	40.5
Copper	(mg/L)	0.00043	<0.00005 - 0.0007	0.00034	0.00008 - 0.0006	<0.0001	<0.0001 - 0.00094	0.00127	0.0006 - 0.00262	0.00145	<0.0001 - 0.00552	0.00183
Selenium	(mg/L)	<0.00004	<0.00004	<0.00004	<0.00004	0.001075	<0.0010 - 0.0014	0.0009	<0.0010 - 0.0009	<0.0005	<0.00004 - 0.0006	0.00005
Zinc	(mg/L)	0.0011	0.0009 - 0.0012	0.0021	<0.0005 - 0.0047	<0.0005	<0.0005 - 0.0092	<0.0005	<0.0005 - 0.0013	0.0018	<0.0005 - 0.0047	0.003

Table III-2.4 Groundwater Quality in Tailings Impoundment Area 2005 – 2008 Data

Sample name	MW 05-6A	MW 05-6A	MW05-6A	MW 05-6B	MW 05-6B	MW 05-07A	MW 05-7A	MW 05-7A	MW 05-7A	05-7B	05-7B	MW 05-07B	MW 05-7B	MW 05-7B	MW 05-7B	MW05-7B	MW 05-7B	MW 05-7B
Date	2-Sep-07	21-Sep-07	5-Oct-07	1-Sep-07	21-Sep-07	8-Jun-07	12-Jul-07	1-Sep-07	21-Sep-07	27-Apr-07	13-May-07	7-Jun-07	12-Jul-07	1-Sep-07	21-Sep-07	4-Oct-07	21-May-08	3-Sep-08
Job Number	A741295	A745736	A748794	A741295	A745736	A724712	A731839	A741295	A745736	A717990	A719951	A724712	A731839	A741295	A745736	A748794	A825056	A846361
Parameters (mg/L)																		
Physical Parameters																		
Temperature																		5
Conductivity	180	184	189	183	197	3010	695	8120	5710	175		158	146	153	157	153	180	160
Dissolved Hardness	88.1	86.6	84.8	101	101	2420	393	2160	1470	86.5	81.8	75.4	71.5	75.2	78.6	78.1	91	79.3
Total Suspended Solids	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Total Dissolved Solids	118	100	114	102	130	1050	353	1840	1380	120	88	102	96	112	112	93	120	120
pH	7.8	7.9	7.9	8	8.1	12.1	11.5	12.5	12.4	8	8	8.3	8.5	9	8.9	8.1	8.1	8.1
Turbidity	4.8	6.3	4.1	0.2	<0.1	<0.1	<0.1	0.8	0.3	6.1	0.2	<0.1	<0.1	0.2	<0.1	0.3	0.2	0.2
DOC	0.9	1.1	<0.5	1	<0.5	9.5	7.3	1.3	3		0.7	0.5	<0.5	0.8	0.6	<0.5	2.7	0.5
Major Anions																		
Alkalinity-Total	70.3	79.1	78.6	83.4	92.1	811	213	2100	1410	72.5	62.3	56.1	61.3	66.5	67.3	60.6	79	63
Acidity - Total																	<0.5	2
Bromide	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1	<0.1	<0.01	<0.01	<0.1	<0.1	<0.1	<0.1	<0.01	<0.01	<0.01	<0.1	0.1
Chloride	<0.5	1	<0.5	<0.5	<0.5	6.5	1.1	2.5	2.1	<0.5	8.1	5	<0.5	<0.5	<0.5	<0.5	<0.5	2.4
Fluoride	0.18	0.17	0.17	0.04	0.04	0.11	0.12	0.07	0.08			0.14	0.14	0.13	0.13	0.14	0.09	0.12
Sulphate	16.3	12.5	12.9	7.3	8	7.2	14	<0.5	4.7	14.1	6.2	14.8	13.7	12.4	14.8	13.9	8	14
Nutrient Parameters																		
Ammonial Nitrogen	0.006	<0.005	<0.005	<0.005	<0.005	0.064	0.048	0.068	0.092	<0.005	0.006	<0.005	0.038	0.007	0.017	0.016	<0.005	<0.005
Nitrate Nitrogen	0.002	<0.002	<0.002	0.209	0.184	0.044	0.03	0.025	0.027	0.032	0.015	0.005	0.01	0.019	0.007	0.008	0.014	0.011
Nitrite Nitrogen	<0.002	<0.002	<0.002	0.004	<0.002	0.005	0.003	<0.002	0.003	<0.002	<0.002	0.002	<0.002	<0.002	<0.002	<0.002	0.002	<0.002
Total Phosphate	0.776	0.54	0.56	<0.005	0.006	0.013	0.007	<0.005	<0.005			0.041	0.043	0.047	0.051	0.04	0.03	0.052
Dissolved Ortho-Phosphate	0.56	0.57	0.59	0.017	0.009	0.002	0.003	0.006	0.005	0.014	0.033	0.027	0.041	0.045	0.052	0.05	0.024	0.036

Table III-2.4 Groundwater Quality in Tailings Impoundment Area 2005 – 2008 Data (con't)

Sample name	MW 05-6A	MW 05-6A	MW05-6A	MW 05-6B	MW 05-6B	MW 05-07A	MW 05-7A	MW 05-7A	MW 05-7A	05-7B	05-7B	MW 05-07B	MW 05-7B	MW 05-7B	MW 05-7B	MW05-7B	MW 05-7B	MW 05-7B
Date	2-Sep-07	21-Sep-07	5-Oct-07	1-Sep-07	21-Sep-07	8-Jun-07	12-Jul-07	1-Sep-07	21-Sep-07	27-Apr-07	13-May-07	7-Jun-07	12-Jul-07	1-Sep-07	21-Sep-07	4-Oct-07	21-May-08	3-Sep-08
Job Number	A741295	A745736	A748794	A741295	A745736	A724712	A731839	A741295	A745736	A717990	A719951	A724712	A731839	A741295	A745736	A748794	A825056	A846361
Parameters (mg/L)																		
Dissolved Metals																		
Aluminum (Al)	0.001	0.0026	0.0017	0.0074	0.0133	0.0496	0.134	0.0262	0.0369	0.0997	0.0226	0.0367	0.0066	0.0053	0.0049	0.0061	0.0003	0.0074
Antimony (Sb)	0.00033	0.00047	0.00016	0.00006	<0.00005	0.00012	0.00058	0.00006	0.00019	0.00032	0.00013	0.00013	0.00012	0.00012	0.00009	0.0001	0.00012	0.00011
Arsenic (As)	0.0061	0.0045	0.0044	0.0003	<0.0001	0.0007	0.0007	0.0001	0.0002	0.0019	0.0008	0.0012	0.0012	0.0011	0.0005	0.0009	0.00047	0.00057
Cadmium (Cd)	0.00001	<0.00001	<0.00001	0.00001	<0.00001	0.00002	0.00001	<0.00001	0.00001	0.00004	0.00004	0.00003	0.00002	0.00003	0.00002	0.00003	<0.000005	0.000006
Calcium (Ca)	29.9	29.5	28.8	35.8	36.1	969	157	866	589	29.9	28.7	26.3	25.1	26.6	27.6	27.4	31.3	27.7
Chromium (Cr)	<0.0002	<0.0002	<0.0002	<0.0002	0.0003	0.0077	0.0015	0.0081	0.0043	<0.0002	<0.0002	0.0004	<0.0002	<0.0002	<0.0002	<0.0002	<0.0001	<0.0001
Cobalt (Co)	0.00049	0.00029	0.00037	0.00039	0.00017	0.00057	<0.00002	0.00024	<0.00002	0.00057	0.00027	0.00022	0.00009	0.00005	0.00006	0.00006	0.000118	0.000067
Copper (Cu)	<0.0001	<0.0001	<0.0001	0.0006	0.0006	0.0073	0.0033	0.0017	0.0051	0.0024	0.0007	0.001	0.0002	<0.0001	<0.0001	<0.0001	0.00018	0.00016
Iron (Fe)	0.947	0.39	0.595	<0.005	<0.005	0.012	<0.005	<0.005	<0.005	0.179	0.028	0.066	<0.005	0.005	0.005	0.011	0.002	0.018
Lead (Pb)	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	0.00412	0.00032	0.00185	0.0009	0.00012	0.00004	0.00007	0.00009	<0.00002	<0.00002	<0.00002	<0.000005	0.000017
Magnesium (Mg)	3.29	3.13	3.15	2.87	2.74	<0.05	<0.05	<0.05	<0.05	2.87	2.46	2.36	2.13	2.15	2.37	2.35	3.13	2.45
Manganese (Mn)	0.295	0.341	0.352	0.171	0.0624	0.00058	0.00025	0.00003	0.00006	0.159	0.151	0.124	0.109	0.0793	0.0964	0.0986	0.27	0.117
Mercury (Hg)	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	
Molybdenum (Mo)	0.00392	0.00361	0.00324	0.00115	0.0008	0.00483	0.00683	0.00197	0.00445	0.012	0.0098	0.00907	0.00924	0.00969	0.00985	0.0107	0.00769	0.00909
Nickel (Ni)	0.0014	0.0007	<0.0005	0.0048	0.0037	0.0166	<0.0005	0.0124	0.005	0.0049	0.0028	0.0007	<0.0005	<0.0005	<0.0005	<0.0005	0.00022	0.00014
Phosphorus (P)	0.8	0.6	0.7	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.031	
Potassium (K)	1.54	1.2	1.31	1.14	0.87	13.6	5.01	3.4	8.12	0.915	0.848	0.845	0.811	0.96	0.882	0.903	0.84	0.87
Selenium (Se)	0.0009	0.0006	0.0014	0.0009	0.0009	0.0017	0.0008	0.0005	0.0007	<0.0005	<0.0005	0.0006	<0.0005	<0.0005	<0.0005	<0.0005	<0.00004	<0.00004
Silicon (Si)	6.76	6.31	6.27	4.16	3.91	0.23	2.96	0.16	0.44	3.82	3.96	3.82	3.97	4.05	4.04	4.06	4.19	4.39
Silver (Ag)	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.000005	<0.000005
Sodium (Na)	2.78	3.86	3.5	1.39	1.37	8.47	3.15	3.28	4.71	1.59	1.72	1.81	1.63	1.79	1.76	1.89	1.93	2.06
Strontium (Sr)	0.0288	0.0362	0.0351	0.047	0.0492	2.01	0.377	0.687	1.08	0.0693	0.0534	0.0461	0.0472	0.0445	0.0497	0.0485	0.0587	0.0553
Thallium (Tl)	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.000002	<0.000002
Vanadium (V)	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	0.00058	0.00282	0.00008	0.00062	0.0021	0.00204	0.00097	0.00137	0.00103	0.00028	0.00066	<0.0002	0.0003
Zinc (Zn)	0.0006	<0.0005	<0.0005	<0.0005	<0.0005	0.269	0.0047	0.0475	0.019	0.0019	0.0008	0.0015	0.0015	<0.0005	<0.0005	<0.0005	0.0003	0.002



Legend:

- MW05-5A
- MW05-5B
- MW05-6A
- MW05-6B
- MW05-7A
- MW05-7B

NOTES:
Sample date September 8, 2005.

Sample MW05-7B was affected by the cement grout during well installation. Datapoint should be updated when more results become available.

Figure III-2.2 Piper Trilinear Plot of Background Groundwater Chemistry (2005)

3. WATER BALANCE TABLES

This section comprises the water balance tables for the following scenarios:

- Table III-3.1 - Average climate conditions
- Table III-3.2 - Average annual values, as compared to values presented in the Type A Water Licence Application (January 2007)
- Table III-3.3 - Year 2 (the first year of tailings facility operation) – 100 Year Dry
- Table III-3.4 - Year 2 – 100 Year Wet
- Table III-3.5 - Year 8 (the final year of tailings facility operation) – 100 Year Dry
- Table III-3.6 - Year 8 – 100 Year Wet
- Table III-3.7 - Closure (with Diversions) – 100 Year Dry
- Table III-3.8 - Closure (with Diversions) – 100 Year Wet
- Table III-3.9 - Closure (without Diversions) – Average
- Table III-3.10 - Closure (without Diversions) – 100 Year Dry
- Table III-3.11 - Closure (without Diversions) – 100 Year Wet

Table III-3.1 Water Balance Table – Average Climate Conditions

	Mine Year																	
	Calendar Year	2009	2009	2009	2009	2009	2009	2010	2010	2010	2010	2010	2010	1 2010	1 2010	1 2010	1 2010	1 2010	1 2010
	Month	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
	Mean Monthly Temperature	11	8	2	-7	-10	-18	-15	-16	-12	-8	2	9	11	8	2	-7	-10	-18
	Monthly percent of annual precip.	14%	11%	10%	9%	8%	8%	8%	6%	5%	4%	7%	11%	14%	11%	10%	9%	8%	8%
	Monthly Precipitation (mm)	77.7	62.3	57.1	48.8	46.7	47.4	42.8	33.2	26.5	20.0	42.3	65.3	77.7	62.3	57.1	48.8	46.7	47.4
	Average monthly runoff (% of annual)	17%	9%	9%	6%	3%	1%	0%	0%	0%	1%	19%	35%	17%	9%	9%	6%	3%	1%
	Monthly Evaporation (mm)	90	61.5	32	14.5	6	2	5	4.5	9.5	21	72	86.5	90	61.5	32	14.5	6	2
	Incremental ice thickness on pond (m)	0.0	0.0	0.0	0.0	0.3	0.4	0.4	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.4
	Tailings to TSF (tpd)													866.8	866.8	866.8	866.8	866.8	866.8
	Tailings to paste (tpd)													794.0	794.0	794.0	794.0	794.0	794.0
Water Inputs (m³/hr)																			
	Tailings water	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	154.97	154.97	154.97	154.97	154.97	154.97
	Paste plant overflow	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	130.40	130.40	130.40	130.40	130.40	130.40
	Balance of process plant	0.00	0.00	0.00	0.00	0.00	0.00	6.00	6.00	6.00	6.00	6.00	6.00	8.55	8.55	8.55	8.55	8.55	8.55
Climate	Direct precipitation	10.96	8.79	8.32	6.89	6.80	6.69	6.03	5.18	3.74	2.92	5.97	9.52	10.96	8.79	8.32	6.89	6.80	6.69
Climate	Runoff from unlined area	1.27	1.02	0.97	0.12	0.00	0.00	0.00	0.00	0.03	0.05	0.69	1.10	1.27	1.02	0.97	0.12	0.00	0.00
Climate	Snowmelt runoff from unlined area	1.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.43	1.24	1.28	1.24	0.00	0.00	0.00	0.00	0.00
	Seepage from diversion ditch	16.87	8.93	8.96	5.89	3.49	0.99	0.00	0.00	0.00	1.03	18.86	11.97	5.62	2.98	2.99	1.96	1.16	0.33
	Seepage reclaim	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Subtotal: All Inputs	30	19	18	13	10	8	12	11	10	10	33	31	314	308	307	304	303	302
Water Losses (m³/hr)																			
	Tailing voids	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.69	12.69	12.69	12.69	12.69	12.69
	Water reclaim to process plant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	285.37	285.37	285.37	285.37	285.37	285.37
Climate	Pond evapor.	0.00	0.00	0.00	0.00	0.03	0.02	0.06	0.06	0.13	0.33	1.55	2.64	3.15	2.48	2.67	1.19	0.52	0.17
	Seepage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Subtotal: All Losses	0	0	0	0	0	0	0	0	0	0	2	4	302	302	302	300	300	299
	Net water surplus (deficit)	**30**	**19**	**18**	**13**	**10**	**8**	**12**	**11**	**10**	**10**	**31**	**27**	**12**	**6**	**5**	**4**	**3**	**3**
	Discharge period water surplus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Actual water treatment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Incremental pond volume	22,583	13,946	13,138	9,593	7,386	5,698	8,911	7,472	7,176	7,265	23,222	19,604	8,794	4,590	3,939	2,709	2,384	2,016
	Seasonal pond volume	-	-	-	-	7,386	13,084	21,995	29,466	36,643	43,908	67,129	86,733	95,527	100,118	104,056	106,765	109,149	111,165

Table III-3.1 Water Balance Table – Average Climate Conditions (con't)

Mine Year	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3
Calendar Year	2011	2011	2011	2011	2011	2011	2011	2011	2011	2011	2011	2011	2012	2012	2012	2012
Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**
Mean Monthly Temperature	-15	-16	-12	-8	2	9	11	8	2	-7	-10	-18	-15	-16	-12	-8
Monthly percent of annual precip.	8%	6%	5%	4%	7%	11%	14%	11%	10%	9%	8%	8%	8%	6%	5%	4%
Monthly Precipitation (mm)	42.8	33.2	26.5	20.0	42.3	65.3	77.7	62.3	57.1	48.8	46.7	47.4	42.8	33.2	26.5	20.0
Average monthly runoff (% of annual)	0%	0%	0%	1%	19%	35%	17%	9%	9%	6%	3%	1%	0%	0%	0%	1%
Monthly Evaporation (mm)	5	4.5	9.5	21	72	86.5	90	61.5	32	14.5	6	2	5	4.5	9.5	21
Incremental ice thickness on pond (m)	0.4	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.4	0.4	0.4	0.1	0.0
Tailings to TSF (tpd)	706.6	706.6	706.6	706.6	706.6	706.6	706.6	706.6	706.6	706.6	706.6	706.6	745.8	745.8	745.8	745.8
Tailings to paste (tpd)	620.3	620.3	620.3	620.3	620.3	620.3	620.3	620.3	620.3	620.3	620.3	620.3	584.7	584.7	584.7	584.7
Water Inputs (m³/hr)																
Tailings water	126.33	126.33	126.33	126.33	126.33	126.33	126.33	126.33	126.33	126.33	126.33	126.33	133.34	133.34	133.34	133.34
Paste plant overflow	101.87	101.87	101.87	101.87	101.87	101.87	101.87	101.87	101.87	101.87	101.87	101.87	96.03	96.03	96.03	96.03
Balance of process plant	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55
Climate: Direct precipitation	6.03	5.18	3.74	2.92	5.97	9.52	10.96	8.79	8.32	8.53	8.42	8.28	7.47	6.41	4.64	3.61
Climate: Runoff from unlined area	0.00	0.00	0.03	0.05	0.69	1.10	1.27	1.02	0.97	0.08	0.00	0.00	0.00	0.00	0.02	0.03
Climate: Snowmelt runoff from unlined area	0.00	0.00	0.00	0.43	1.24	1.28	1.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29
Seepage from diversion ditch	0.00	0.00	0.00	0.34	6.29	11.97	5.62	2.98	2.99	1.96	1.16	0.33	0.00	0.00	0.00	0.34
Seepage reclaim	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Subtotal: All Inputs	244	243	242	241	252	262	257	251	250	248	247	246	246	245	244	243
Water Losses (m³/hr)																
Tailing voids	10.34	10.34	10.34	10.34	10.34	10.34	10.34	10.34	10.34	10.34	10.34	10.34	10.92	10.92	10.92	10.92
Water reclaim to process plant	228.20	228.20	228.20	228.20	228.20	228.20	228.20	228.20	228.20	228.20	228.20	228.20	229.37	229.37	229.37	229.37
Climate: Pond evapor.	0.42	0.42	0.80	1.87	6.29	7.93	8.23	5.62	3.02	2.03	0.87	0.28	0.70	0.70	1.33	3.03
Seepage	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Subtotal: All Losses	240	240	240	241	246	247	248	245	243	242	240	240	242	242	243	244
Net water surplus (deficit)	**4**	**3**	**1**	**0**	**6**	**14**	**9**	**5**	**7**	**7**	**7**	**7**	**4**	**3**	**1**	**-1**
Discharge period water surplus	0.0	0.0	0.0	0.0	11.6	11.6	11.6	11.6	11.6	11.6	0.0	0.0	0.0	0.0	0.0	0.0
Actual water treatment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
													Year 3-5 extra water treatment:	Min. pond	38,105	m³
Incremental pond volume	2,844	1,992	876	56	4,541	10,186	6,759	3,998	5,371	5,021	4,987	4,861	3,275	2,251	715	(807)
Seasonal pond volume	114,009	116,001	116,878	116,934	121,475	131,661	138,420	142,418	147,789	152,810	157,796	162,657	165,933	168,184	168,900	168,092

Table III-3.1 Water Balance Table – Average Climate Conditions (con't)

	Mine Year	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4
	Calendar Year	2012	2012	2012	2012	2012	2012	2012	2012	2013	2013	2013	2013	2013	2013	2013	2013
	Month	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**
	Mean Monthly Temperature	2	9	11	8	2	-7	-10	-18	-15	-16	-12	-8	2	9	11	8
	Monthly percent of annual precip.	7%	11%	14%	11%	10%	9%	8%	8%	8%	6%	5%	4%	7%	11%	14%	11%
	Monthly Precipitation (mm)	42.3	65.3	77.7	62.3	57.1	48.8	46.7	47.4	42.8	33.2	26.5	20.0	42.3	65.3	77.7	62.3
	Average monthly runoff (% of annual)	19%	35%	17%	9%	9%	6%	3%	1%	0%	0%	0%	1%	19%	35%	17%	9%
	Monthly Evaporation (mm)	72	86.5	90	61.5	32	14.5	6	2	5	4.5	9.5	21	72	86.5	90	61.5
	Incremental ice thickness on pond (m)	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.4	0.4	0.4	0.1	0.0	0.0	0.0	0.0	0.0
	Tailings to TSF (tpd)	745.8	745.8	745.8	745.8	745.8	745.8	745.8	745.8	634.8	634.8	634.8	634.8	634.8	634.8	634.8	634.8
	Tailings to paste (tpd)	584.7	584.7	584.7	584.7	584.7	584.7	584.7	584.7	692.1	692.1	692.1	692.1	692.1	692.1	692.1	692.1
Water Inputs (m³/hr)																	
	Tailings water	133.34	133.34	133.34	133.34	133.34	133.34	133.34	133.34	113.49	113.49	113.49	113.49	113.49	113.49	113.49	113.49
	Paste plant overflow	96.03	96.03	96.03	96.03	96.03	96.03	96.03	96.03	113.67	113.67	113.67	113.67	113.67	113.67	113.67	113.67
	Balance of process plant	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55
Climate	Direct precipitation	7.39	11.78	13.57	10.88	10.31	8.53	8.42	8.28	7.47	6.41	4.64	3.61	7.39	11.78	13.57	10.88
Climate	Runoff from unlined area	0.47	0.75	0.86	0.69	0.66	0.08	0.00	0.00	0.00	0.00	0.02	0.03	0.47	0.75	0.86	0.69
Climate	Snowmelt runoff from unlined area	0.84	0.87	0.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.84	0.87	0.84	0.00
	Seepage from diversion ditch	6.29	11.97	5.62	2.98	2.99	1.96	1.16	0.33	0.00	0.00	0.00	0.34	6.29	11.97	5.62	2.98
	Seepage reclaim	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Subtotal: All Inputs	254	264	260	253	253	249	249	248	244	243	241	241	252	262	258	251
Water Losses (m³/hr)																	
	Tailing voids	10.92	10.92	10.92	10.92	10.92	10.92	10.92	10.92	9.29	9.29	9.29	9.29	9.29	9.29	9.29	9.29
	Water reclaim to process plant	229.37	229.37	229.37	229.37	229.37	229.37	229.37	229.37	227.16	227.16	227.16	227.16	227.16	227.16	227.16	227.16
Climate	Pond evapor.	10.06	12.49	12.58	8.60	4.62	2.03	0.87	0.28	0.70	0.70	1.33	3.03	10.06	12.49	12.58	8.60
	Seepage	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Subtotal: All Losses	251	254	254	250	246	243	242	242	238	238	239	240	248	250	250	246
Net water surplus (deficit)		**3**	**11**	**6**	**4**	**7**	**6**	**6**	**6**	**6**	**5**	**3**	**1**	**4**	**12**	**8**	**5**
Discharge period water surplus		9.2	9.2	9.2	9.2	9.2	9.2	0.0	0.0	0.0	0.0	0.0	0.0	12.4	12.4	12.4	12.4
Actual water treatment		17.1	17.1	17.1	17.1	17.1	17.1	0.0	0.0	0.0	0.0	0.0	0.0	20.3	20.3	20.3	20.3
		Max. pond	168,900	m³			Excess treatment rate	7.9	m³/h								
Incremental pond volume		(10,820)	(4,746)	(8,288)	(10,051)	(7,302)	(8,128)	4,573	4,434	4,485	3,344	1,925	363	(12,010)	(5,898)	(9,478)	(11,241)
Seasonal pond volume		157,272	152,525	144,237	134,186	126,885	118,757	123,330	127,764	132,249	135,593	137,518	137,881	125,871	119,973	110,495	99,254

Table III-3.1 Water Balance Table – Average Climate Conditions (con't)

	Mine Year	4	4	4	4	5	5	5	5	5	5	5	5	5	5	5	5	6
	Calendar Year	2013	2013	2013	2013	2014	2014	2014	2014	2014	2014	2014	2014	2014	2014	2014	2014	2015
	Month	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**
	Mean Monthly Temperature	2	-7	-10	-18	-15	-16	-12	-8	2	9	11	8	2	-7	-10	-18	-15
	Monthly percent of annual precip.	10%	9%	8%	8%	8%	6%	5%	4%	7%	11%	14%	11%	10%	9%	8%	8%	8%
	Monthly Precipitation (mm)	57.1	48.8	46.7	47.4	42.8	33.2	26.5	20.0	42.3	65.3	77.7	62.3	57.1	48.8	46.7	47.4	42.8
	Average monthly runoff (% of annual)	9%	6%	3%	1%	0%	0%	0%	1%	19%	35%	17%	9%	9%	6%	3%	1%	0%
	Monthly Evaporation (mm)	32	14.5	6	2	5	4.5	9.5	21	72	86.5	90	61.5	32	14.5	6	2	5
	Incremental ice thickness on pond (m)	0.0	0.0	0.3	0.4	0.4	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.4	0.4
	Tailings to TSF (tpd)	634.8	634.8	634.8	634.8	628.5	628.5	628.5	628.5	628.5	628.5	628.5	628.5	628.5	628.5	628.5	628.5	628.5
	Tailings to paste (tpd)	692.1	692.1	692.1	692.1	698.4	698.4	698.4	698.4	698.4	698.4	698.4	698.4	698.4	698.4	698.4	698.4	698.4
Water Inputs (m³/hr)																		
	Tailings water	113.49	113.49	113.49	113.49	112.37	112.37	112.37	112.37	112.37	112.37	112.37	112.37	112.37	112.37	112.37	112.37	112.37
	Paste plant overflow	113.67	113.67	113.67	113.67	114.69	114.69	114.69	114.69	114.69	114.69	114.69	114.69	114.69	114.69	114.69	114.69	114.69
	Balance of process plant	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	12.55
Climate	Direct precipitation	10.31	8.53	8.42	8.28	7.47	6.41	4.64	3.61	7.39	11.78	13.57	10.88	10.31	8.53	8.42	8.28	7.47
Climate	Runoff from unlined area	0.66	0.08	0.00	0.00	0.00	0.00	0.02	0.03	0.47	0.75	0.86	0.69	0.66	0.08	0.00	0.00	0.00
Climate	Snowmelt runoff from unlined area	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.84	0.87	0.84	0.00	0.00	0.00	0.00	0.00	0.00
	Seepage from diversion ditch	2.99	1.96	1.16	0.33	0.00	0.00	0.00	0.34	6.29	11.97	5.62	2.98	2.99	1.96	1.16	0.33	0.00
	Seepage reclaim	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Subtotal: All Inputs	251	247	246	245	244	243	241	241	252	262	258	251	251	247	246	245	248
Water Losses (m³/hr)																		
	Tailing voids	9.29	9.29	9.29	9.29	9.20	9.20	9.20	9.20	9.20	9.20	9.20	9.20	9.20	9.20	9.20	9.20	9.20
	Water reclaim to process plant	227.16	227.16	227.16	227.16	227.07	227.07	227.07	227.07	227.07	227.07	227.07	227.07	227.07	227.07	227.07	227.07	227.07
Climate	Pond evapor.	4.62	2.03	0.87	0.28	0.70	0.70	1.33	3.03	10.06	12.49	12.58	8.60	4.62	2.03	0.87	0.28	0.70
	Seepage	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Subtotal: All Losses	242	239	238	238	238	238	239	240	247	250	250	246	242	239	238	238	238
Net water surplus (deficit)		**9**	**8**	**8**	**8**	**6**	**5**	**3**	**1**	**4**	**12**	**8**	**5**	**9**	**8**	**8**	**8**	**10**
Discharge period water surplus		12.4	12.4	0.0	0.0	0.0	0.0	0.0	0.0	12.6	12.6	12.6	12.6	12.6	12.6	0.0	0.0	0.0
Actual water treatment		20.3	20.3	0.0	0.0	0.0	0.0	0.0	0.0	20.5	20.5	20.5	20.5	20.5	20.5	0.0	0.0	0.0
Incremental pond volume		(8,453)	(9,318)	5,744	5,644	4,553	3,405	1,993	429	(12,077)	(5,963)	(9,545)	(11,308)	(8,518)	(9,385)	5,810	5,712	7,529
Seasonal pond volume		90,801	81,484	87,227	92,871	97,424	100,829	102,822	103,251	91,174	85,211	75,667	64,359	55,841	46,456	52,266	57,978	65,507

Table III-3.1 Water Balance Table – Average Climate Conditions (con't)

Mine Year		6	6	6	6	6	6	6	6	6	6	6	7	7	7	7	7	7
Calendar Year		2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	2016	2016	2016	2016	2016	2016
Month		**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**
	Mean Monthly Temperature	-16	-12	-8	2	9	11	8	2	-7	-10	-18	-15	-16	-12	-8	2	9
	Monthly percent of annual precip.	6%	5%	4%	7%	11%	14%	11%	10%	9%	8%	8%	8%	6%	5%	4%	7%	11%
	Monthly Precipitation (mm)	33.2	26.5	20.0	42.3	65.3	77.7	62.3	57.1	48.8	46.7	47.4	42.8	33.2	26.5	20.0	42.3	65.3
	Average monthly runoff (% of annual)	0%	0%	1%	19%	35%	17%	9%	9%	6%	3%	1%	0%	0%	0%	1%	19%	35%
	Monthly Evaporation (mm)	4.5	9.5	21	72	86.5	90	61.5	32	14.5	6	2	5	4.5	9.5	21	72	86.5
	Incremental ice thickness on pond (m)	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.4	0.4	0.4	0.1	0.0	0.0	0.0
	Tailings to TSF (tpd)	628.5	628.5	628.5	628.5	628.5	628.5	628.5	628.5	628.5	628.5	628.5	630.2	630.2	630.2	630.2	630.2	630.2
	Tailings to paste (tpd)	698.4	698.4	698.4	698.4	698.4	698.4	698.4	698.4	698.4	698.4	698.4	700.3	700.3	700.3	700.3	700.3	700.3
Water Inputs (m³/hr)																		
	Tailings water	112.37	112.37	112.37	112.37	112.37	112.37	112.37	112.37	112.37	112.37	112.37	112.68	112.68	112.68	112.68	112.68	112.68
	Paste plant overflow	114.69	114.69	114.69	114.69	114.69	114.69	114.69	114.69	114.69	114.69	114.69	115.01	115.01	115.01	115.01	115.01	115.01
	Balance of process plant	12.55	12.55	12.55	12.55	12.55	12.55	12.55	12.55	12.55	12.55	12.55	12.55	12.55	12.55	12.55	12.55	12.55
Climate	Direct precipitation	6.41	4.64	3.61	7.39	11.78	13.57	10.88	10.31	8.53	8.42	8.28	7.47	6.41	4.64	3.61	7.39	11.78
Climate	Runoff from unlined area	0.00	0.02	0.03	0.47	0.75	0.86	0.69	0.66	0.08	0.00	0.00	0.00	0.00	0.02	0.03	0.47	0.75
Climate	Snowmelt runoff from unlined area	0.00	0.00	0.29	0.84	0.87	0.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.84	0.87
	Seepage from diversion ditch	0.00	0.00	0.34	6.29	11.97	5.62	2.98	2.99	1.96	1.16	0.33	0.00	0.00	0.00	0.34	6.29	11.97
	Seepage reclaim	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Subtotal: All Inputs	247	245	245	256	266	262	255	255	251	250	249	249	248	246	246	256	267
Water Losses (m³/hr)																		
	Tailing voids	9.20	9.20	9.20	9.20	9.20	9.20	9.20	9.20	9.20	9.20	9.20	9.23	9.23	9.23	9.23	9.23	9.23
	Water reclaim to process plant	227.07	227.07	227.07	227.07	227.07	227.07	227.07	227.07	227.07	227.07	227.07	227.69	227.69	227.69	227.69	227.69	227.69
Climate	Pond evapor.	0.70	1.33	3.03	10.06	12.49	12.58	8.60	4.62	2.03	0.87	0.28	0.70	0.70	1.33	3.03	10.06	12.49
	Seepage	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Subtotal: All Losses	238	239	240	247	250	250	246	242	239	238	238	239	239	239	241	248	250
Net water surplus (deficit)		**9**	**7**	**5**	**8**	**16**	**12**	**9**	**13**	**12**	**12**	**12**	**10**	**9**	**7**	**5**	**8**	**16**
Discharge period water surplus		0.0	0.0	0.0	20.5	20.5	20.5	20.5	20.5	20.5	0.0	0.0	0.0	0.0	0.0	0.0	20.5	20.5
Actual water treatment		0.0	0.0	0.0	20.5	20.5	20.5	20.5	20.5	20.5	0.0	0.0	0.0	0.0	0.0	0.0	20.5	20.5
Incremental pond volume		6,093	4,969	3,309	(9,127)	(3,108)	(6,595)	(8,358)	(5,663)	(6,434)	8,690	8,688	7,510	6,076	4,950	3,291	(9,108)	(3,090)
Seasonal pond volume		71,600	76,569	79,877	70,751	67,643	61,049	52,691	47,028	40,594	49,283	57,971	65,481	71,557	76,507	79,798	70,690	67,600

Table III-3.1 Water Balance Table – Average Climate Conditions (con't)

	Mine Year	7	7	7	7	7	7	8	8	8	8	8	8	8	8	8	8	8
	Calendar Year	2016	2016	2016	2016	2016	2016	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017
	Month	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**
	Mean Monthly Temperature	11	8	2	-7	-10	-18	-15	-16	-12	-8	2	9	11	8	2	-7	-10
	Monthly percent of annual precip.	14%	11%	10%	9%	8%	8%	8%	6%	5%	4%	7%	11%	14%	11%	10%	9%	8%
	Monthly Precipitation (mm)	77.7	62.3	57.1	48.8	46.7	47.4	42.8	33.2	26.5	20.0	42.3	65.3	77.7	62.3	57.1	48.8	46.7
	Average monthly runoff (% of annual)	17%	9%	9%	6%	3%	1%	0%	0%	0%	1%	19%	35%	17%	9%	9%	6%	3%
	Monthly Evaporation (mm)	90	61.5	32	14.5	6	2	5	4.5	9.5	21	72	86.5	90	61.5	32	14.5	6
	Incremental ice thickness on pond (m)	0.0	0.0	0.0	0.0	0.3	0.4	0.4	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
	Tailings to TSF (tpd)	630.2	630.2	630.2	630.2	630.2	630.2	628.5	628.5	628.5	628.5	628.5	628.5	628.5	628.5	628.5	628.5	628.5
	Tailings to paste (tpd)	700.3	700.3	700.3	700.3	700.3	700.3	698.4	698.4	698.4	698.4	698.4	698.4	698.4	698.4	698.4	698.4	698.4
Water Inputs (m³/hr)																		
	Tailings water	112.68	112.68	112.68	112.68	112.68	112.68	112.37	112.37	112.37	112.37	112.37	112.37	112.37	112.37	112.37	112.37	112.37
	Paste plant overflow	115.01	115.01	115.01	115.01	115.01	115.01	114.69	114.69	114.69	114.69	114.69	114.69	114.69	114.69	114.69	114.69	114.69
	Balance of process plant	12.55	12.55	12.55	12.55	12.55	12.55	12.55	12.55	12.55	12.55	12.55	12.55	12.55	12.55	12.55	12.55	12.55
Climate	Direct precipitation	13.57	10.88	10.31	8.53	8.42	8.28	7.47	6.41	4.64	3.61	7.39	11.78	13.57	10.88	10.31	8.53	8.42
	Runoff from unlined area	0.86	0.69	0.66	0.08	0.00	0.00	0.00	0.00	0.02	0.03	0.47	0.75	0.86	0.69	0.66	0.08	0.00
	Snowmelt runoff from unlined area	0.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.84	0.87	0.84	0.00	0.00	0.00	0.00
	Seepage from diversion ditch	5.62	2.98	2.99	1.96	1.16	0.33	0.00	0.00	0.00	0.34	6.29	11.97	5.62	2.98	2.99	1.96	1.16
	Seepage reclaim	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Subtotal: All Inputs	262	256	255	252	251	250	248	247	245	245	256	266	262	255	255	251	250
Water Losses (m³/hr)																		
	Tailing voids	9.23	9.23	9.23	9.23	9.23	9.23	9.20	9.20	9.20	9.20	9.20	9.20	9.20	9.20	9.20	9.20	9.20
	Water reclaim to process plant	227.69	227.69	227.69	227.69	227.69	227.69	227.07	227.07	227.07	227.07	227.07	227.07	227.07	227.07	227.07	227.07	227.07
Climate	Pond evapor.	12.58	8.60	4.62	2.03	0.87	0.28	0.70	0.70	1.33	3.03	10.06	12.49	12.58	8.60	4.62	2.03	0.87
	Seepage	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Subtotal: All Losses	250	247	243	240	239	238	238	238	239	240	247	250	250	246	242	239	238
Net water surplus (deficit)		**12**	**9**	**13**	**12**	**12**	**12**	**10**	**9**	**7**	**5**	**8**	**16**	**12**	**9**	**13**	**12**	**12**
Discharge period water surplus		20.5	20.5	20.5	20.5	0.0	0.0	0.0	0.0	0.0	0.0	20.5	20.5	20.5	20.5	20.5	20.5	0.0
Actual water treatment		20.5	20.5	20.5	20.5	0.0	0.0	0.0	0.0	0.0	0.0	20.5	20.5	20.5	20.5	20.5	20.5	0.0
Incremental pond volume		(6,576)	(8,339)	(5,645)	(6,416)	8,672	8,669	7,529	6,093	4,969	3,309	(9,127)	(3,108)	(6,595)	(8,358)	(5,663)	(6,434)	8,690
Seasonal pond volume		61,024	52,685	47,040	40,624	49,295	57,964	65,493	71,586	76,555	79,864	70,737	67,629	61,035	52,677	47,014	40,580	49,270

Table III-3.1 Water Balance Table – Average Climate Conditions (con't)

Mine Year		8	9	9	9	9	9	9	9	9	9	9	9	9	Closure	Closure	Closure
Calendar Year		2017	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2019	2019	2019
Month		**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**
Mean Monthly Temperature		-18	-15	-16	-12	-8	2	9	11	8	2	-7	-10	-18	-15	-16	-12
Monthly percent of annual precip.		8%	8%	6%	5%	4%	7%	11%	14%	11%	10%	9%	8%	8%	8%	6%	5%
Monthly Precipitation (mm)		47.4	42.8	33.2	26.5	20.0	42.3	65.3	77.7	62.3	57.1	48.8	46.7	47.4	42.8	33.2	26.5
Average monthly runoff (% of annual)		1%	0%	0%	0%	1%	19%	35%	17%	9%	9%	6%	3%	1%	0%	0%	0%
Monthly Evaporation (mm)		2	5	4.5	9.5	21	72	86.5	90	61.5	32	14.5	6	2	5	4.5	9.5
Incremental ice thickness on pond (m)		0.4	0.4	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.4	0.4	0.4	0.1
Tailings to TSF (tpd)		628.5	513.4	513.4	513.4	513.4	513.4	513.4	513.4	513.4	513.4	513.4	513.4	513.4			
Tailings to paste (tpd)		698.4	505.3	505.3	505.3	505.3	505.3	505.3	505.3	505.3	505.3	505.3	505.3	505.3			
Water Inputs (m³/hr)																	
Tailings water		112.37	91.79	91.79	91.79	91.79	91.79	91.79	91.79	91.79	91.79	91.79	91.79	91.79	0.00	0.00	0.00
Paste plant overflow		114.69	82.98	82.98	82.98	82.98	82.98	82.98	82.98	82.98	82.98	82.98	82.98	82.98	0.00	0.00	0.00
Balance of process plant		12.55	12.55	12.55	12.55	12.55	12.55	12.55	12.55	12.55	12.55	12.55	12.55	12.55	3.78	3.78	3.78
	Direct precipitation	8.28	7.47	6.41	4.64	3.61	7.39	11.78	13.57	10.88	10.31	8.53	8.42	8.28	7.47	6.41	4.64
Climate	Runoff from unlined area	0.00	0.00	0.00	0.02	0.03	0.47	0.75	0.86	0.69	0.66	0.08	0.00	0.00	0.00	0.00	0.02
	Snowmelt runoff from unlined area	0.00	0.00	0.00	0.00	0.29	0.84	0.87	0.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Seepage from diversion ditch	0.33	0.00	0.00	0.00	0.34	6.29	11.97	5.62	2.98	2.99	1.96	1.16	0.33	0.00	0.00	0.00
	Seepage reclaim	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Subtotal: All Inputs	249	196	195	193	193	203	214	209	203	202	199	198	197	12	11	9
Water Losses (m³/hr)																	
Tailing voids		9.20	7.52	7.52	7.52	7.52	7.52	7.52	7.52	7.52	7.52	7.52	7.52	7.52	0.00	0.00	0.00
Water reclaim to process plant		227.07	174.77	174.77	174.77	174.77	174.77	174.77	174.77	174.77	174.77	174.77	174.77	174.77	0.00	0.00	0.00
Climate	Pond evapor.	0.28	0.70	0.70	1.33	3.03	10.06	12.49	12.58	8.60	4.62	2.03	0.87	0.28	0.70	0.70	1.33
	Seepage	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Subtotal: All Losses	238	184	184	185	186	193	196	196	192	188	185	184	184	2	2	2
Net water surplus (deficit)		**12**	**12**	**11**	**8**	**6**	**10**	**18**	**13**	**11**	**14**	**14**	**14**	**13**	**11**	**9**	**7**
Discharge period water surplus		0.0	0.0	0.0	0.0	0.0	23.9	23.9	23.9	23.9	23.9	23.9	0.0	0.0	0.0	0.0	0.0
Actual water treatment		0.0	0.0	0.0	0.0	0.0	23.9	23.9	23.9	23.9	23.9	23.9	0.0	0.0	0.0	0.0	0.0
Incremental pond volume		8,688	8,783	7,226	6,223	4,522	(10,360)	(4,301)	(7,828)	(9,591)	(6,857)	(7,668)	9,903	9,942	7,850	6,383	5,290
Seasonal pond volume		57,957	66,740	73,966	80,189	84,711	74,351	70,050	62,222	52,630	45,774	38,105	48,009	57,951	65,800	72,183	77,473

Table III-3.1 Water Balance Table – Average Climate Conditions (con't)

Mine Year	Closure	Closure	Closure	Closure	Closure	Closure	Closure	Closure	Closure	Closure	Closure	Closure	Closure	Closure	Closure	Closure	Closure	Closure	Closure	Closure	Closure	
Calendar Year	2019	2019	2019	2019	2019	2019	2019	2019	2019	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	
Month	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	
Mean Monthly Temperature	-8	2	9	11	8	2	-7	-10	-18	-15	-16	-12	-8	2	9	11	8	2	-7	-10	-18	
Monthly percent of annual precip.	4%	7%	11%	14%	11%	10%	9%	8%	8%	8%	6%	5%	4%	7%	11%	14%	11%	10%	9%	8%	8%	
Monthly Precipitation (mm)	20.0	42.3	65.3	77.7	62.3	57.1	48.8	46.7	47.4	42.8	33.2	26.5	20.0	42.3	65.3	77.7	62.3	57.1	48.8	46.7	47.4	
Average monthly runoff (% of annual)	1%	19%	35%	17%	9%	9%	6%	3%	1%	0%	0%	0%	1%	19%	35%	17%	9%	9%	6%	3%	1%	
Monthly Evaporation (mm)	21	72	86.5	90	61.5	32	14.5	6	2	5	4.5	9.5	21	72	86.5	90	61.5	32	14.5	6	2	
Incremental ice thickness on pond (m)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.4	0.4	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.4	**Averages**
Tailings to TSF (tpd)																						653
Tailings to paste (tpd)																						658
Water Inputs (m³/hr)																						
Tailings water	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	116.74
Paste plant overflow	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	108.10
Balance of process plant	3.78	3.78	3.78	3.78	3.78	3.78	3.78	3.78	3.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.43
Climate Direct precipitation	3.61	7.39	11.78	13.57	10.88	10.31	8.53	8.42	8.28	7.47	6.41	4.64	3.61	7.39	11.78	13.57	10.88	10.31	8.53	8.42	8.28	8.28
Runoff from unlined area	0.03	0.47	0.75	0.86	0.69	0.66	0.08	0.00	0.00	0.00	0.00	0.02	0.03	0.47	0.75	0.86	0.69	0.66	0.08	0.00	0.00	0.33
Snowmelt runoff from unlined area	0.29	0.84	0.87	0.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.84	0.87	0.84	0.00	0.00	0.00	0.00	0.00	0.25
Seepage from diversion ditch	0.34	6.29	11.97	5.62	2.98	2.99	1.96	1.16	0.33	0.00	0.00	0.00	0.34	6.29	11.97	5.62	2.98	2.99	1.96	1.16	0.33	2.79
Seepage reclaim	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Subtotal: All Inputs	9	20	30	26	19	19	15	14	13	8	7	6	5	16	26	22	16	15	12	11	10	247.91
Water Losses (m³/hr)																						
Tailing voids	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.56
Water reclaim to process plant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	224.83
Climate Pond evapor.	3.03	10.06	12.49	12.58	8.60	4.62	2.03	0.87	0.28	0.70	0.70	1.33	3.03	10.06	12.49	12.58	8.60	4.62	2.03	0.87	0.28	4.40
Seepage	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Subtotal: All Losses	4	11	13	14	10	6	3	2	1	2	2	2	4	11	13	14	10	6	3	2	1	239.79
Net water surplus (deficit)	**5**	**9**	**17**	**12**	**10**	**13**	**12**	**13**	**12**	**7**	**6**	**3**	**1**	**5**	**13**	**8**	**6**	**9**	**9**	**9**	**8**	8.1
Discharge period water surplus	0.0	21.4	21.4	21.4	21.4	21.4	21.4	0.0	0.0	0.0	0.0	0.0	0.0	13.9	13.9	13.9	13.9	13.9	13.9	0.0	0.0	7.7
Actual water treatment	0.0	21.4	21.4	21.4	21.4	21.4	21.4	0.0	0.0	0.0	0.0	0.0	0.0	13.9	13.9	13.9	13.9	13.9	13.9	0.0	0.0	8.4
Incremental pond volume	3,619	(9,442)	(3,413)	(6,910)	(8,673)	(5,968)	(6,750)	9,000	9,009	5,038	3,843	2,477	898	(6,676)	(736)	(4,144)	(5,907)	(3,291)	(3,984)	6,279	6,196	
Seasonal pond volume	81,092	71,650	68,237	61,327	52,654	46,685	39,935	48,935	57,944	62,981	66,824	69,301	70,199	63,523	62,787	58,644	52,737	49,446	45,462	51,741	57,937	90,805

Table III-3.2 Water Balance Table – Average Annual Values (m^3/hr)

Wolverine Tailings Facility Water Balance: Average Annual Values (m^3/hr)

Green text indicates number copied from Type A Water License Application, January 2007 (shown for comparison)

Year	1	2	3	4	5	6	7	8	9	Closure
Net surplus	**11.2**	**5.9**	**4.6**	**6.3**	**6.4**	**10.4**	**10.3**	**10.4**	**12.0**	**10.8**
A-License	***10.2***	***8.1***	***8.1***	***8.1***	***8.1***	***12.4***	***12.4***	***12.4***	***13.0***	***11.3***
Actual water treatment	**0.0**	**0.0**	**8.5**	**10.2**	**10.3**	**10.3**	**10.2**	**10.3**	**11.9**	**10.7**
INPUTS										
Tailings water	77.5	126.3	133.3	113.5	112.4	112.4	112.7	112.4	91.8	0.0
Paste overflow	65.2	101.9	96.0	113.7	114.7	114.7	115.0	114.7	83.0	0.0
Total	142.7	228.2	229.4	227.2	227.1	227.1	227.7	227.1	174.8	0.0
A-License	*43.3*	*129.7*	*129.7*	*129.7*	*129.7*	*129.7*	*129.7*	*129.7*	*81.7*	*21.4*
Industrial Plant Balance	7.3	8.6	8.6	8.6	8.6	12.6	12.6	12.6	12.6	3.8
A-License	*6.6*	*7.1*	*7.1*	*7.1*	*7.1*	*11.1*	*11.1*	*11.1*	*10.3*	*7.1*
Direct Precipitation	6.8	7.2	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4
A-License	*8.8*	*8.8*	*8.8*	*8.8*	*8.8*	*8.8*	*8.8*	*8.8*	*8.8*	*8.8*
Runoff from unlined area	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Snowmelt runoff	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Total	0.8	0.8	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
A-License	*1.1*	*1.1*	*1.1*	*1.1*	*1.1*	*0.7*	*0.7*	*0.7*	*0.7*	*0.7*
Seepage from diversions	3.9	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8
A-License	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*
Seepage reclaim	0.6	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
A-License	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*
All Inputs	***162.1***	***248.6***	***250.7***	***248.5***	***248.4***	***252.4***	***253.0***	***252.4***	***200.1***	***16.6***
A-License	*60.9*	*148.3*	*148.3*	*148.3*	*148.3*	*150.8*	*150.8*	*150.8*	*102.8*	*40.4*
LOSSES										
Tailings voids	6.3	10.3	10.9	9.3	9.2	9.2	9.2	9.2	7.5	0.0
A-License	*1.1*	*4.2*	*4.2*	*4.2*	*4.2*	*4.2*	*4.2*	*4.2*	*2.7*	*1.3*
Reclaim to Process Plant	142.7	228.2	229.4	227.2	227.1	227.1	227.7	227.1	174.8	0.0
A-License	*42.6*	*127.5*	*127.5*	*127.5*	*127.5*	*127.5*	*127.5*	*127.5*	*80.3*	*21.0*
Pond evaporation	1.2	3.1	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8
A-License	*6.1*	*6.8*	*6.8*	*6.8*	*6.8*	*6.8*	*6.8*	*6.8*	*6.8*	*6.8*
Seepage	0.6	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
A-License	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*
All Losses	***150.9***	***242.7***	***246.1***	***242.2***	***242.0***	***242.0***	***242.7***	***242.0***	***188.1***	***5.8***
A-License	*50.7*	*140.2*	*140.2*	*140.2*	*140.2*	*138.4*	*138.4*	*138.4*	*89.8*	*29.1*

Table III-3.3 Water Balance Table – Year 2 100 Year Dry (m^3/hr)

Annual Precipitation:	279 mm

Red text indicates number that differs from average climate case

--> Stage 2 construction complete

Mine Year	2	2	2	2	2	2	2	2	2	2	2	2	
Calendar Year	2011	2011	2011	2011	2011	2011	2011	2011	2011	2011	2011	2011	
Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	
Mean Monthly Temperature	-15	-16	-12	-8	2	9	11	8	2	-7	-10	-18	
Monthly percent of annual precip.	8%	6%	5%	4%	7%	11%	14%	11%	10%	9%	8%	8%	
Monthly Precipitation (mm)	**20.9**	**16.2**	**13.0**	**9.8**	**20.7**	**31.9**	**38.0**	**30.5**	**27.9**	**23.9**	**22.8**	**23.2**	
Average monthly runoff (% of annual)	0%	0%	0%	1%	19%	35%	17%	9%	9%	6%	3%	1%	
Monthly Evaporation (mm)	5	4.5	9.5	21	72	86.5	90	61.5	32	14.5	6	2	
Incremental ice thickness on pond (m)	0.4	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.4	**Averages**
Tailings to TSF (tpd)	706.6	706.6	706.6	706.6	706.6	706.6	706.6	706.6	706.6	706.6	706.6	706.6	707
Tailings to paste (tpd)	620.3	620.3	620.3	620.3	620.3	620.3	620.3	620.3	620.3	620.3	620.3	620.3	620
Water Inputs (m^3/hr)													
Tailings water	126.33	126.33	126.33	126.33	126.33	126.33	126.33	126.33	126.33	126.33	126.33	126.33	126.33
Paste plant overflow	101.87	101.87	101.87	101.87	101.87	101.87	101.87	101.87	101.87	101.87	101.87	101.87	101.87
Balance of process plant	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55
Climate Direct precipitation	**2.95**	**2.54**	**1.83**	**1.43**	**2.92**	**4.66**	**5.37**	**4.30**	**4.07**	**4.17**	**4.12**	**4.05**	**3.54**
Climate Runoff from unlined area	**0.00**	**0.00**	**0.02**	**0.02**	**0.34**	**0.54**	**0.62**	**0.50**	**0.47**	**0.04**	**0.00**	**0.00**	**0.21**
Climate Snowmelt runoff from unlined area	**0.00**	**0.00**	**0.00**	**0.43**	**1.24**	**1.28**	**1.24**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.35**
Seepage from diversion ditch	**0.00**	**0.00**	**0.00**	**0.17**	**3.08**	**5.86**	**2.75**	**1.46**	**1.46**	**0.96**	**0.57**	**0.16**	**1.37**
Seepage reclaim	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Subtotal: All Inputs	**241**	**240**	**240**	**240**	**245**	**250**	**248**	**244**	**244**	**243**	**242**	**242**	**243.22**
Water Losses (m^3/hr)													
Tailing voids	10.34	10.34	10.34	10.34	10.34	10.34	10.34	10.34	10.34	10.34	10.34	10.34	10.34
Water reclaim to process plant	228.20	228.20	228.20	228.20	228.20	228.20	228.20	228.20	228.20	228.20	228.20	228.20	228.20
Climate Pond evapor.	0.42	0.42	0.80	1.87	6.29	7.93	8.23	5.62	3.02	2.03	0.87	0.28	3.15
Seepage	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Subtotal: All Losses	**240**	**240**	**240**	**241**	**246**	**247**	**248**	**245**	**243**	**242**	**240**	**240**	**242.70**
Net water surplus (deficit)	**1**	**0**	**-1**	**-2**	**-1**	**3**	**0**	**-1**	**1**	**1**	**2**	**2**	**0.5**
Discharge period water surplus	0.0	0.0	0.0	0.0	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	0.0	0.0	**0.5**
Actual water treatment	0.0	0.0	0.0	0.0	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	0.0	0.0	**0.0**
Operational pond volume													
Incremental pond volume	**552**	**215**	**(558)**	**(1,161)**	**(376)**	**1,884**	**(25)**	**(860)**	**858**	**1,006**	**1,463**	**1,592**	
Seasonal pond volume	**111,717**	**111,932**	**111,374**	**110,213**	**109,838**	**111,721**	**111,696**	**110,836**	**111,695**	**112,701**	**114,163**	**115,755**	**111,970**

Table III-3.4 Water Balance Table – Year 2 100 Year Wet (m^3/hr)

Annual Precipitation:	795 mm

Red text indicates number that differs from average climate case

--> Stage 2 construction complete

Mine Year	2	2	2	2	2	2	2	2	2	2	2	2	
Calendar Year	2011	2011	2011	2011	2011	2011	2011	2011	2011	2011	2011	2011	
Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Averages**
Mean Monthly Temperature	-15	-16	-12	-8	2	9	11	8	2	-7	-10	-18	
Monthly percent of annual precip.	8%	6%	5%	4%	7%	11%	14%	11%	10%	9%	8%	8%	
Monthly Precipitation (mm)	**59.6**	**46.2**	**37.0**	**27.9**	**59.0**	**91.0**	**108.4**	**86.9**	**79.6**	**68.0**	**65.1**	**66.1**	
Average monthly runoff (% of annual)	0%	0%	0%	1%	19%	35%	17%	9%	9%	6%	3%	1%	
Monthly Evaporation (mm)	5	4.5	9.5	21	72	86.5	90	61.5	32	14.5	6	2	
Incremental ice thickness on pond (m)	0.4	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.4	
Tailings to TSF (tpd)	706.6	706.6	706.6	706.6	706.6	706.6	706.6	706.6	706.6	706.6	706.6	706.6	707
Tailings to paste (tpd)	620.3	620.3	620.3	620.3	620.3	620.3	620.3	620.3	620.3	620.3	620.3	620.3	620
Water Inputs (m^3/hr)													
Tailings water	126.33	126.33	126.33	126.33	126.33	126.33	126.33	126.33	126.33	126.33	126.33	126.33	126.33
Paste plant overflow	101.87	101.87	101.87	101.87	101.87	101.87	101.87	101.87	101.87	101.87	101.87	101.87	101.87
Balance of process plant	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55
Climate: Direct precipitation	**8.41**	**7.23**	**5.22**	**4.07**	**8.32**	**13.27**	**15.29**	**12.26**	**11.61**	**11.89**	**11.75**	**11.54**	10.07
Climate: Runoff from unlined area	**0.00**	**0.00**	**0.05**	**0.07**	**0.97**	**1.54**	**1.78**	**1.42**	**1.35**	**0.11**	**0.00**	**0.00**	0.61
Climate: Snowmelt runoff from unlined area	**0.00**	**0.00**	**0.00**	**0.43**	**1.24**	**1.28**	**1.24**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.35
Seepage from diversion ditch	**0.00**	**0.00**	**0.00**	**0.48**	**8.77**	**16.69**	**7.84**	**4.15**	**4.16**	**2.74**	**1.62**	**0.46**	3.91
Seepage reclaim	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Subtotal: All Inputs	**246**	**245**	**243**	**243**	**257**	**271**	**264**	**256**	**255**	**252**	**251**	**250**	**252.69**
Water Losses (m^3/hr)													
Tailing voids	10.34	10.34	10.34	10.34	10.34	10.34	10.34	10.34	10.34	10.34	10.34	10.34	10.34
Water reclaim to process plant	228.20	228.20	228.20	228.20	228.20	228.20	228.20	228.20	228.20	228.20	228.20	228.20	228.20
Climate: Pond evapor.	0.42	0.42	0.80	1.87	6.29	7.93	8.23	5.62	3.02	2.03	0.87	0.28	3.15
Seepage	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Subtotal: All Losses	**240**	**240**	**240**	**241**	**246**	**247**	**248**	**245**	**243**	**242**	**240**	**240**	**242.70**
Net water surplus (deficit)	**6**	**5**	**3**	**1**	**11**	**23**	**16**	**10**	**12**	**11**	**11**	**10**	**10.0**
Discharge period water surplus	0.0	0.0	0.0	0.0	**19.8**	**19.8**	**19.8**	**19.8**	**19.8**	**19.8**	0.0	0.0	**9.9**
Actual water treatment	0.0	0.0	0.0	0.0	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	0.0	0.0	**0.0**
Operational pond volume													
Incremental pond volume	**4,616**	**3,367**	**1,986**	**997**	**8,343**	**16,605**	**12,005**	**7,754**	**8,860**	**8,125**	**7,711**	**7,389**	
Seasonal pond volume	**115,781**	**119,148**	**121,133**	**122,130**	**130,474**	**147,078**	**159,083**	**166,837**	**175,697**	**183,822**	**191,533**	**198,922**	**152,636**

Table III-3.5 Water Balance Table – Year 8 100 Year Dry (m^3/hr)

Annual Precipitation:	279 mm

Red text indicates number that differs from average climate case

		Mine Year	8	8	8	8	8	8	8	8	8	8	8	8	
		Calendar Year	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	
		Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	
		Mean Monthly Temperature	-15	-16	-12	-8	2	9	11	8	2	-7	-10	-18	
		Monthly percent of annual precip.	8%	6%	5%	4%	7%	11%	14%	11%	10%	9%	8%	8%	
		Monthly Precipitation (mm)	**20.9**	**16.2**	**13.0**	**9.8**	**20.7**	**31.9**	**38.0**	**30.5**	**27.9**	**23.9**	**22.8**	**23.2**	
		Average monthly runoff (% of annual)	0%	0%	0%	1%	19%	35%	17%	9%	9%	6%	3%	1%	
		Monthly Evaporation (mm)	5	4.5	9.5	21	72	86.5	90	61.5	32	14.5	6	2	
		Incremental ice thickness on pond (m)	0.4	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.4	**Averages**
		Tailings to TSF (tpd)	628.5	628.5	628.5	628.5	628.5	628.5	628.5	628.5	628.5	628.5	628.5	628.5	629
		Tailings to paste (tpd)	698.4	698.4	698.4	698.4	698.4	698.4	698.4	698.4	698.4	698.4	698.4	698.4	698
Water Inputs (m^3/hr)															
		Tailings water	112.37	112.37	112.37	112.37	112.37	112.37	112.37	112.37	112.37	112.37	112.37	112.37	112.37
		Paste plant overflow	114.69	114.69	114.69	114.69	114.69	114.69	114.69	114.69	114.69	114.69	114.69	114.69	114.69
		Balance of process plant	12.55	12.55	12.55	12.55	12.55	12.55	12.55	12.55	12.55	12.55	12.55	12.55	12.55
	Climate	Direct precipitation	**3.66**	**3.14**	**2.27**	**1.77**	**3.62**	**5.77**	**6.64**	**5.33**	**5.04**	**4.17**	**4.12**	**4.05**	**4.13**
	Climate	Runoff from unlined area	**0.00**	**0.00**	**0.01**	**0.02**	**0.23**	**0.37**	**0.42**	**0.34**	**0.32**	**0.04**	**0.00**	**0.00**	**0.15**
	Climate	Snowmelt runoff from unlined area	**0.00**	**0.00**	**0.00**	**0.29**	**0.84**	**0.87**	**0.84**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.24**
		Seepage from diversion ditch	**0.00**	**0.00**	**0.00**	**0.17**	**3.08**	**5.86**	**2.75**	**1.46**	**1.46**	**0.96**	**0.57**	**0.16**	**1.37**
		Seepage reclaim	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
		Subtotal: All Inputs	**244**	**244**	**243**	**243**	**248**	**253**	**251**	**248**	**247**	**246**	**245**	**245**	**246.50**
Water Losses (m^3/hr)															
		Tailing voids	9.20	9.20	9.20	9.20	9.20	9.20	9.20	9.20	9.20	9.20	9.20	9.20	9.20
		Water reclaim to process plant	227.07	227.07	227.07	227.07	227.07	227.07	227.07	227.07	227.07	227.07	227.07	227.07	227.07
	Climate	Pond evapor.	0.70	0.70	1.33	3.03	10.06	12.49	12.58	8.60	4.62	2.03	0.87	0.28	4.77
		Seepage	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
		Subtotal: All Losses	**238**	**238**	**239**	**240**	**247**	**250**	**250**	**246**	**242**	**239**	**238**	**238**	**242.04**
Net water surplus (deficit)			**6**	**6**	**4**	**3**	**1**	**4**	**1**	**2**	**6**	**6**	**7**	**7**	**4.5**
Discharge period water surplus			0.0	0.0	0.0	0.0	**8.9**	**8.9**	**8.9**	**8.9**	**8.9**	**8.9**	0.0	0.0	**4.4**
Actual water treatment			0.0	0.0	0.0	0.0	**8.9**	**8.9**	**8.9**	**8.9**	**8.9**	**8.9**	0.0	0.0	**4.4**
Operational pond volume															
Incremental pond volume			**4,692**	**3,892**	**3,200**	**1,842**	**(5,803)**	**(3,696)**	**(5,519)**	**(5,189)**	**(2,374)**	**(1,753)**	**5,166**	**5,418**	
Seasonal pond volume			**62,656**	**66,548**	**69,748**	**71,590**	**65,788**	**62,092**	**56,573**	**51,383**	**49,009**	**47,257**	**52,422**	**57,841**	**59,409**

Table III-3.6 Water Balance Table – Year 8 100 Year Wet (m^3/hr)

Annual Precipitation:	795 mm

Red text indicates number that differs from average climate case

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Mine Year		8	8	8	8	8	8	8	8	8	8	8	8	
Calendar Year		2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	
Month		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	
Mean Monthly Temperature		-15	-16	-12	-8	2	9	11	8	2	-7	-10	-18	
Monthly percent of annual precip.		8%	6%	5%	4%	7%	11%	14%	11%	10%	9%	8%	8%	
Monthly Precipitation (mm)		**59.6**	**46.2**	**37.0**	**27.9**	**59.0**	**91.0**	**108.4**	**86.9**	**79.6**	**68.0**	**65.1**	**66.1**	
Average monthly runoff (% of annual)		0%	0%	0%	1%	19%	35%	17%	9%	9%	6%	3%	1%	
Monthly Evaporation (mm)		5	4.5	9.5	21	72	86.5	90	61.5	32	14.5	6	2	
Incremental ice thickness on pond (m)		0.4	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.4	**Averages**
Tailings to TSF (tpd)		628.5	628.5	628.5	628.5	628.5	628.5	628.5	628.5	628.5	628.5	628.5	628.5	629
Tailings to paste (tpd)		698.4	698.4	698.4	698.4	698.4	698.4	698.4	698.4	698.4	698.4	698.4	698.4	698
Water Inputs (m^3/hr)														
Tailings water		112.37	112.37	112.37	112.37	112.37	112.37	112.37	112.37	112.37	112.37	112.37	112.37	112.37
Paste plant overflow		114.69	114.69	114.69	114.69	114.69	114.69	114.69	114.69	114.69	114.69	114.69	114.69	114.69
Balance of process plant		12.55	12.55	12.55	12.55	12.55	12.55	12.55	12.55	12.55	12.55	12.55	12.55	12.55
Climate	Direct precipitation	**10.42**	**8.95**	**6.47**	**5.04**	**10.30**	**16.43**	**18.93**	**15.18**	**14.37**	**11.89**	**11.75**	**11.54**	**11.77**
Climate	Runoff from unlined area	**0.00**	**0.00**	**0.03**	**0.05**	**0.66**	**1.05**	**1.21**	**0.97**	**0.92**	**0.11**	**0.00**	**0.00**	**0.42**
Climate	Snowmelt runoff from unlined area	**0.00**	**0.00**	**0.00**	**0.29**	**0.84**	**0.87**	**0.84**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.24**
	Seepage from diversion ditch	**0.00**	**0.00**	**0.00**	**0.48**	**8.77**	**16.69**	**7.84**	**4.15**	**4.16**	**2.74**	**1.62**	**0.46**	**3.91**
	Seepage reclaim	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Subtotal: All Inputs	**251**	**250**	**247**	**246**	**261**	**276**	**269**	**261**	**260**	**255**	**254**	**253**	**256.95**
Water Losses (m^3/hr)														
	Tailing voids	9.20	9.20	9.20	9.20	9.20	9.20	9.20	9.20	9.20	9.20	9.20	9.20	9.20
	Water reclaim to process plant	227.07	227.07	227.07	227.07	227.07	227.07	227.07	227.07	227.07	227.07	227.07	227.07	227.07
Climate	Pond evapor.	0.70	0.70	1.33	3.03	10.06	12.49	12.58	8.60	4.62	2.03	0.87	0.28	4.77
	Seepage	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Subtotal: All Losses	**238**	**238**	**239**	**240**	**247**	**250**	**250**	**246**	**242**	**239**	**238**	**238**	**242.04**
Net water surplus (deficit)		**13**	**12**	**9**	**6**	**14**	**26**	**20**	**15**	**18**	**16**	**16**	**15**	**14.9**
Discharge period water surplus		0.0	0.0	0.0	0.0	**29.6**	**29.6**	**29.6**	**29.6**	**29.6**	**29.6**	0.0	0.0	**14.8**
Actual water treatment		0.0	0.0	0.0	0.0	**29.6**	**29.6**	**29.6**	**29.6**	**29.6**	**29.6**	0.0	0.0	**14.8**
Operational pond volume														
Incremental pond volume		**9,723**	**7,795**	**6,337**	**4,443**	**(11,697)**	**(2,653)**	**(7,426)**	**(10,807)**	**(8,206)**	**(10,055)**	**11,414**	**11,216**	
Seasonal pond volume		**67,687**	**75,482**	**81,818**	**86,261**	**74,564**	**71,911**	**64,485**	**53,678**	**45,472**	**35,417**	**46,832**	**58,048**	**63,471**

Table III-3.7 Water Balance Table – Closure (With Diversions) 100 Year Dry (m^3/hr)

Annual Precipitation:	279 mm

Red text indicates number that differs from average climate case

	Mine Year	Closure	Closure	Closure	Closure	Closure	Closure	Closure	Closure	Closure	Closure	Closure	Closure	
	Calendar Year	2019	2019	2019	2019	2019	2019	2019	2019	2019	2019	2019	2019	
	Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	
	Mean Monthly Temperature	-15	-16	-12	-8	2	9	11	8	2	-7	-10	-18	
	Monthly percent of annual precip.	8%	6%	5%	4%	7%	11%	14%	11%	10%	9%	8%	8%	
	Monthly Precipitation (mm)	**20.9**	**16.2**	**13.0**	**9.8**	**20.7**	**31.9**	**38.0**	**30.5**	**27.9**	**23.9**	**22.8**	**23.2**	
	Average monthly runoff (% of annual)	0%	0%	0%	1%	19%	35%	17%	9%	9%	6%	3%	1%	
	Monthly Evaporation (mm)	5	4.5	9.5	21	72	86.5	90	61.5	32	14.5	6	2	
	Incremental ice thickness on pond (m)	0.4	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.4	**Averages**
	Tailings to TSF (tpd)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
	Tailings to paste (tpd)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
Water Inputs (m^3/hr)														
	Tailings water	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Paste plant overflow	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Balance of process plant	3.78	3.78	3.78	3.78	3.78	3.78	3.78	3.78	3.78	3.78	3.78	3.78	3.78
Climate	Direct precipitation	**3.66**	**3.14**	**2.27**	**1.77**	**3.62**	**5.77**	**6.64**	**5.33**	**5.04**	**4.17**	**4.12**	**4.05**	**4.13**
Climate	Runoff from unlined area	**0.00**	**0.00**	**0.01**	**0.02**	**0.23**	**0.37**	**0.42**	**0.34**	**0.32**	**0.04**	**0.00**	**0.00**	**0.15**
Climate	Snowmelt runoff from unlined area	**0.00**	**0.00**	**0.00**	**0.29**	**0.84**	**0.87**	**0.84**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.24**
	Seepage from diversion ditch	**0.00**	**0.00**	**0.00**	**0.17**	**3.08**	**5.86**	**2.75**	**1.46**	**1.46**	**0.96**	**0.57**	**0.16**	**1.37**
	Seepage reclaim	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Subtotal: All Inputs	**8**	**8**	**7**	**7**	**13**	**18**	**15**	**12**	**12**	**10**	**9**	**9**	**10.67**
Water Losses (m^3/hr)														
	Tailing voids	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Water reclaim to process plant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Climate	Pond evapor.	0.70	0.70	1.33	3.03	10.06	12.49	12.58	8.60	4.62	2.03	0.87	0.28	4.77
	Seepage	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Subtotal: All Losses	**2**	**2**	**2**	**4**	**11**	**13**	**14**	**10**	**6**	**3**	**2**	**1**	**5.77**
Net water surplus (deficit)		**7**	**6**	**5**	**3**	**1**	**4**	**2**	**2**	**6**	**7**	**8**	**8**	**4.9**
Discharge period water surplus		0.0	0.0	0.0	0.0	**9.7**	**9.7**	**9.7**	**9.7**	**9.7**	**9.7**	0.0	0.0	**4.9**
Actual water treatment		0.0	0.0	0.0	0.0	**9.7**	**9.7**	**9.7**	**9.7**	**9.7**	**9.7**	0.0	0.0	**4.9**
Operational pond volume														
Incremental pond volume		**5,013**	**4,182**	**3,521**	**2,153**	**(6,118)**	**(4,002)**	**(5,834)**	**(5,505)**	**(2,680)**	**(2,068)**	**5,476**	**5,739**	
Seasonal pond volume		**62,963**	**67,145**	**70,666**	**72,819**	**66,701**	**62,699**	**56,864**	**51,359**	**48,680**	**46,612**	**52,088**	**57,827**	**59,702**

Table III-3.8 Water Balance Table – Closure (With Diversions) 100 Year Wet (m^3/hr)

Annual Precipitation:	795 mm

Red text indicates number that differs from average climate case

Mine Year		Closure	Closure	Closure	Closure	Closure	Closure	Closure	Closure	Closure	Closure	Closure	Closure	
Calendar Year		2019	2019	2019	2019	2019	2019	2019	2019	2019	2019	2019	2019	
Month		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	
Mean Monthly Temperature		-15	-16	-12	-8	2	9	11	8	2	-7	-10	-18	
Monthly percent of annual precip.		8%	6%	5%	4%	7%	11%	14%	11%	10%	9%	8%	8%	
Monthly Precipitation (mm)		**59.6**	**46.2**	**37.0**	**27.9**	**59.0**	**91.0**	**108.4**	**86.9**	**79.6**	**68.0**	**65.1**	**66.1**	
Average monthly runoff (% of annual)		0%	0%	0%	1%	19%	35%	17%	9%	9%	6%	3%	1%	
Monthly Evaporation (mm)		5	4.5	9.5	21	72	86.5	90	61.5	32	14.5	6	2	
Incremental ice thickness on pond (m)		0.4	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.4	**Averages**
Tailings to TSF (tpd)		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
Tailings to paste (tpd)		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
Water Inputs (m^3/hr)														
Tailings water		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Paste plant overflow		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Balance of process plant		3.78	3.78	3.78	3.78	3.78	3.78	3.78	3.78	3.78	3.78	3.78	3.78	3.78
Climate	Direct precipitation	**10.42**	**8.95**	**6.47**	**5.04**	**10.30**	**16.43**	**18.93**	**15.18**	**14.37**	**11.89**	**11.75**	**11.54**	**11.77**
Climate	Runoff from unlined area	**0.00**	**0.00**	**0.03**	**0.05**	**0.66**	**1.05**	**1.21**	**0.97**	**0.92**	**0.11**	**0.00**	**0.00**	**0.42**
Climate	Snowmelt runoff from unlined area	**0.00**	**0.00**	**0.00**	**0.29**	**0.84**	**0.87**	**0.84**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.24**
Seepage from diversion ditch		**0.00**	**0.00**	**0.00**	**0.48**	**8.77**	**16.69**	**7.84**	**4.15**	**4.16**	**2.74**	**1.62**	**0.46**	**3.91**
Seepage reclaim		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Subtotal: All Inputs		**15**	**14**	**11**	**11**	**25**	**40**	**34**	**25**	**24**	**20**	**18**	**17**	**21.12**
Water Losses (m^3/hr)														
Tailing voids		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Water reclaim to process plant		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Climate	Pond evapor.	0.70	0.70	1.33	3.03	10.06	12.49	12.58	8.60	4.62	2.03	0.87	0.28	4.77
Seepage		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Subtotal: All Losses		**2**	**2**	**2**	**4**	**11**	**13**	**14**	**10**	**6**	**3**	**2**	**1**	**5.77**
Net water surplus (deficit)		**13**	**12**	**9**	**7**	**14**	**26**	**20**	**15**	**19**	**16**	**16**	**16**	**15.3**
Discharge period water surplus		0.0	0.0	0.0	0.0	**30.4**	**30.4**	**30.4**	**30.4**	**30.4**	**30.4**	0.0	0.0	**15.2**
Actual water treatment		0.0	0.0	0.0	0.0	**30.4**	**30.4**	**30.4**	**30.4**	**30.4**	**30.4**	0.0	0.0	**15.2**
Operational pond volume														
Incremental pond volume		**10,044**	**8,085**	**6,658**	**4,753**	**(12,013)**	**(2,958)**	**(7,742)**	**(11,123)**	**(8,511)**	**(10,370)**	**11,725**	**11,537**	
Seasonal pond volume		**67,994**	**76,079**	**82,736**	**87,489**	**75,477**	**72,519**	**64,777**	**53,654**	**45,143**	**34,772**	**46,497**	**58,034**	**63,764**

Table III-3.9 Water Balance Table – Closure (Without Diversions) Average (m^3/hr)

	Annual Precipitation:	570 mm												
	Red text indicates number that differs from average climate case or "with diversions" case													
	Mine Year	Closure	Closure	Closure	Closure	Closure	Closure	Closure	Closure	Closure	Closure	Closure	Closure	
	Calendar Year	2019	2019	2019	2019	2019	2019	2019	2019	2019	2019	2019	2019	
Month		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	
	Mean Monthly Temperature	-15	-16	-12	-8	2	9	11	8	2	-7	-10	-18	
	Monthly percent of annual precip.	8%	6%	5%	4%	7%	11%	14%	11%	10%	9%	8%	8%	
	Monthly Precipitation (mm)	**42.8**	**33.2**	**26.5**	**20.0**	**42.3**	**65.3**	**77.7**	**62.3**	**57.1**	**48.8**	**46.7**	**47.4**	
	Average monthly runoff (% of annual)	0%	0%	0%	1%	19%	35%	17%	9%	9%	6%	3%	1%	
	Monthly Evaporation (mm)	5	4.5	9.5	21	72	86.5	90	61.5	32	14.5	6	2	
	Incremental ice thickness on pond (m)	0.4	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.4	**Averages**
	Tailings to TSF (tpd)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
	Tailings to paste (tpd)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
Water Inputs (m^3/hr)														
	Tailings water	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Paste plant overflow	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Balance of process plant	3.78	3.78	3.78	3.78	3.78	3.78	3.78	3.78	3.78	3.78	3.78	3.78	3.78
Climate	Direct precipitation	**7.47**	**6.41**	**4.64**	**3.61**	**7.39**	**11.78**	**13.57**	**10.88**	**10.31**	**8.53**	**8.42**	**8.28**	**8.44**
	Runoff from unlined area & **uphill catchment**	**0.00**	**0.00**	**0.48**	**0.75**	**10.29**	**16.40**	**18.90**	**15.15**	**14.35**	**1.78**	**0.00**	**0.00**	**6.51**
	Snowmelt runoff from unlined area & **uphill catchment**	**0.00**	**0.00**	**0.00**	**6.36**	**18.46**	**19.08**	**18.46**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**5.20**
	~~Seepage from diversion ditch~~	**~~0.00~~**	**~~0.00~~**	**~~0.00~~**	**~~0.00~~**	**~~0.00~~**	**~~0.00~~**	**~~0.00~~**	**~~0.00~~**	**~~0.00~~**	**~~0.00~~**	**~~0.00~~**	**~~0.00~~**	**~~0.00~~**
	Seepage reclaim	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Subtotal: All Inputs	**12**	**11**	**10**	**16**	**41**	**52**	**56**	**31**	**29**	**15**	**13**	**13**	**24.93**
Water Losses (m^3/hr)														
	Tailing voids	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Water reclaim to process plant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Climate	Pond evapor.	0.70	0.70	1.33	3.03	10.06	12.49	12.58	8.60	4.62	2.03	0.87	0.28	4.77
	Seepage	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Subtotal: All Losses	**2**	**2**	**2**	**4**	**11**	**13**	**14**	**10**	**6**	**3**	**2**	**1**	**5.77**
Net water surplus (deficit)		**11**	**9**	**8**	**11**	**30**	**39**	**42**	**21**	**24**	**12**	**11**	**12**	**19.2**
Discharge period water surplus		0.0	0.0	0.0	0.0	**38.0**	**38.0**	**38.0**	**38.0**	**38.0**	**38.0**	0.0	0.0	**19.0**
Actual water treatment		0.0	0.0	0.0	0.0	**38.0**	**38.0**	**38.0**	**38.0**	**38.0**	**38.0**	0.0	0.0	**19.0**
Operational pond volume														
Incremental pond volume		**7,850**	**6,383**	**5,633**	**8,261**	**(6,058)**	**399**	**3,083**	**(12,479)**	**(10,211)**	**(19,297)**	**8,163**	**8,762**	
Seasonal pond volume		**65,800**	**72,183**	**77,817**	**86,078**	**80,020**	**80,418**	**83,501**	**71,022**	**60,811**	**41,514**	**49,678**	**58,440**	**68,940**

Table III-3.10 Water Balance Table – Closure (Without Diversions) 100 Year Dry (m^3/hr)

Annual Precipitation:	279 mm

Red text indicates number that differs from average climate case or "with diversions" case

Mine Year		Closure	Closure	Closure	Closure	Closure	Closure	Closure	Closure	Closure	Closure	Closure	Closure	
Calendar Year		2019	2019	2019	2019	2019	2019	2019	2019	2019	2019	2019	2019	
Month		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	
Mean Monthly Temperature		-15	-16	-12	-8	2	9	11	8	2	-7	-10	-18	
Monthly percent of annual precip.		8%	6%	5%	4%	7%	11%	14%	11%	10%	9%	8%	8%	
Monthly Precipitation (mm)		**20.9**	**16.2**	**13.0**	**9.8**	**20.7**	**31.9**	**38.0**	**30.5**	**27.9**	**23.9**	**22.8**	**23.2**	
Average monthly runoff (% of annual)		0%	0%	0%	1%	19%	35%	17%	9%	9%	6%	3%	1%	
Monthly Evaporation (mm)		5	4.5	9.5	21	72	86.5	90	61.5	32	14.5	6	2	
Incremental ice thickness on pond (m)		0.4	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.4	**Averages**
Tailings to TSF (tpd)		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
Tailings to paste (tpd)		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
Water Inputs (m^3/hr)														
Tailings water		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Paste plant overflow		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Balance of process plant		3.78	3.78	3.78	3.78	3.78	3.78	3.78	3.78	3.78	3.78	3.78	3.78	3.78
Climate	Direct precipitation	**3.66**	**3.14**	**2.27**	**1.77**	**3.62**	**5.77**	**6.64**	**5.33**	**5.04**	**4.17**	**4.12**	**4.05**	**4.13**
Climate	Runoff from unlined area & **uphill catchment**	**0.00**	**0.00**	**0.24**	**0.37**	**5.03**	**8.03**	**9.25**	**7.42**	**7.02**	**0.87**	**0.00**	**0.00**	**3.19**
Climate	Snowmelt runoff from unlined area & **uphill catchment**	**0.00**	**0.00**	**0.00**	**3.11**	**9.04**	**9.34**	**9.04**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**2.54**
-	~~Seepage from diversion ditch~~	**~~0.00~~**	**~~0.00~~**	**~~0.00~~**	**~~0.00~~**	**~~0.00~~**	**~~0.00~~**	**~~0.00~~**	**~~0.00~~**	**~~0.00~~**	**~~0.00~~**	**~~0.00~~**	**~~0.00~~**	**~~0.00~~**
	Seepage reclaim	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Subtotal: All Inputs	**8**	**8**	**7**	**10**	**22**	**28**	**30**	**18**	**17**	**10**	**9**	**9**	**14.64**
Water Losses (m^3/hr)														
	Tailing voids	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Water reclaim to process plant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Climate	Pond evapor.	0.70	0.70	1.33	3.03	10.06	12.49	12.58	8.60	4.62	2.03	0.87	0.28	4.77
	Seepage	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Subtotal: All Losses	**2**	**2**	**2**	**4**	**11**	**13**	**14**	**10**	**6**	**3**	**2**	**1**	**5.77**
Net water surplus (deficit)		**7**	**6**	**5**	**6**	**11**	**14**	**16**	**8**	**11**	**7**	**7**	**8**	**8.9**
Discharge period water surplus		0.0	0.0	0.0	0.0	**17.6**	**17.6**	**17.6**	**17.6**	**17.6**	**17.6**	0.0	0.0	**8.8**
Actual water treatment		0.0	0.0	0.0	0.0	**17.6**	**17.6**	**17.6**	**17.6**	**17.6**	**17.6**	0.0	0.0	**8.8**
Operational pond volume														
Incremental pond volume		**5,013**	**4,182**	**3,689**	**4,318**	**(4,603)**	**(2,283)**	**(1,085)**	**(7,189)**	**(4,583)**	**(8,030)**	**5,067**	**5,619**	
Seasonal pond volume		**62,963**	**67,145**	**70,834**	**75,152**	**70,549**	**68,265**	**67,181**	**59,992**	**55,409**	**47,379**	**52,445**	**58,064**	**62,948**

Table III-3.11 Water Balance Table – Closure (Without Diversions) 100 Year Wet (m^3/hr)

Annual Precipitation:	795 mm

Red text indicates number that differs from average climate case or "with diversions" case

Mine Year		Closure	Closure	Closure	Closure	Closure	Closure	Closure	Closure	Closure	Closure	Closure	Closure	
Calendar Year		2019	2019	2019	2019	2019	2019	2019	2019	2019	2019	2019	2019	
Month		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	
Mean Monthly Temperature		-15	-16	-12	-8	2	9	11	8	2	-7	-10	-18	
Monthly percent of annual precip.		8%	6%	5%	4%	7%	11%	14%	11%	10%	9%	8%	8%	
Monthly Precipitation (mm)		**59.6**	**46.2**	**37.0**	**27.9**	**59.0**	**91.0**	**108.4**	**86.9**	**79.6**	**68.0**	**65.1**	**66.1**	
Average monthly runoff (% of annual)		0%	0%	0%	1%	19%	35%	17%	9%	9%	6%	3%	1%	
Monthly Evaporation (mm)		5	4.5	9.5	21	72	86.5	90	61.5	32	14.5	6	2	
Incremental ice thickness on pond (m)		0.4	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.4	**Averages**
Tailings to TSF (tpd)		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
Tailings to paste (tpd)		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
Water Inputs (m^3/hr)														
Tailings water		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Paste plant overflow		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Balance of process plant		3.78	3.78	3.78	3.78	3.78	3.78	3.78	3.78	3.78	3.78	3.78	3.78	3.78
Climate	Direct precipitation	**10.42**	**8.95**	**6.47**	**5.04**	**10.30**	**16.43**	**18.93**	**15.18**	**14.37**	**11.89**	**11.75**	**11.54**	**11.77**
	Runoff from unlined area & **uphill catchment**	**0.00**	**0.00**	**0.68**	**1.05**	**14.35**	**22.88**	**26.36**	**21.14**	**20.01**	**2.48**	**0.00**	**0.00**	**9.08**
	Snowmelt runoff from unlined area & **uphill catchment**	**0.00**	**0.00**	**0.00**	**8.87**	**25.75**	**26.61**	**25.75**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**7.25**
-	~~Seepage from diversion ditch~~	**~~0.00~~**	**~~0.00~~**	**~~0.00~~**	**~~0.00~~**	**~~0.00~~**	**~~0.00~~**	**~~0.00~~**	**~~0.00~~**	**~~0.00~~**	**~~0.00~~**	**~~0.00~~**	**~~0.00~~**	**~~0.00~~**
	Seepage reclaim	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Subtotal: All Inputs	**15**	**14**	**12**	**20**	**55**	**71**	**76**	**41**	**39**	**19**	**17**	**16**	**32.88**
Water Losses (m^3/hr)														
Tailing voids		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Water reclaim to process plant		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Climate	Pond evapor.	0.70	0.70	1.33	3.03	10.06	12.49	12.58	8.60	4.62	2.03	0.87	0.28	4.77
	Seepage	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Subtotal: All Losses	**2**	**2**	**2**	**4**	**11**	**13**	**14**	**10**	**6**	**3**	**2**	**1**	**5.77**
Net water surplus (deficit)		**13**	**12**	**10**	**16**	**44**	**57**	**62**	**32**	**34**	**16**	**15**	**15**	**27.1**
Discharge period water surplus		0.0	0.0	0.0	0.0	**53.8**	**53.8**	**53.8**	**53.8**	**53.8**	**53.8**	0.0	0.0	**26.9**
Actual water treatment		0.0	0.0	0.0	0.0	**53.8**	**53.8**	**53.8**	**53.8**	**53.8**	**53.8**	0.0	0.0	**26.9**
Operational pond volume														
Incremental pond volume		**10,044**	**8,085**	**7,137**	**11,310**	**(7,183)**	**2,473**	**6,305**	**(16,570)**	**(14,562)**	**(28,008)**	**10,558**	**11,193**	
Seasonal pond volume		**67,994**	**76,079**	**83,216**	**94,525**	**87,342**	**89,815**	**96,120**	**79,550**	**64,988**	**36,980**	**47,538**	**58,731**	**73,573**

APPENDIX IV

Preliminary Emergency Response and Preparedness Plan

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1. INTRODUCTION

The purpose of the Emergency Response Plan (ERP) is to provide a plan that includes mechanisms and processes for addressing potential or actual failures of structures, equipment and material stockpiles, and programs for the training of employees.

This ERP describes the more general aspects of the emergency response for the project site as well as the requirements to respond to a potential or actual failure of the tailings facility. This ERP does not include details of a response to a catastrophic event and all the external agencies and services that will likely be involved. In the event of a major emergency, it is expected that local government, crown corporations and other territorial agencies, the federal and territorial emergency response programs as well as private sector support organizations in the region of the mine will be involved and will respond according to their capabilities and own emergency plans. A coordinated joint emergency response effort is expected in such a situation.

The ERP applies to all site employees: mine personnel, contractor management and supervisors, subcontractor supervisors, as well as employees of contractors transporting, handling & transferring hazardous/toxic materials on site.

2. GENERAL EMERGENCY RESPONSE PLAN

Having an ERP in place enables site personnel to be prepared in the event of an emergency situation. It also provides one component of a comprehensive environmental management system for the site.

This plan briefly defines the responsibilities of key personnel and outlines general procedures to be followed when responding to emergencies in a way that will avoid or reduce health and safety risks, and minimize trauma, safety hazards and environmental damage. It is expected that the ERP will continue to be developed throughout the permitting and associated construction phases, culminating with further refinement during operations. The plan will be reviewed and updated on an annual basis. Furthermore, a documented program of updating, document control, training and testing will be established to ensure the effectiveness of the ERP during an emergency.

The scope of the ERP encompasses the extent of Wolverine Project including:

- the access road,
- the airstrip, the mine, the industrial complex (the mill, maintenance buildings, laboratories, etc.) and camp facilities.

Typical emergencies situations described within this plan include:

- Security Breaches;
- Medical emergencies;
- Missing persons;
- Fires and explosions;
- Natural disasters; and
- Site evacuation.

Spills of hazardous materials may constitute an emergency depending on the circumstances of the spill, and the nature and quantity of the substance spilled and procedures and processes to deal with spills are outlined in the *Spill Contingency Plan*.

The EPR Plan will be widely distributed to personnel within YZC, interested government agencies and members of the local emergency response units that may become involved in case of an emergency.

The goals of the EPR Plan are firstly to *prevent the occurrence of emergencies* and secondly to *reduce the impact of emergencies*, should they arise. In both cases, the ultimate goal is to protect:

- Human life and health;
- Social well-being of the local community and employees;
- Public infrastructure and company facilities; and
- Environment.

The objective of the EPR plan is to ensure timely and appropriate response to emergencies, and compliance with applicable laws, industry standards, and legal codes of practice. Effort has been made to ensure that response guidelines to possible site scenarios are included to better enable

timely and appropriate actions. Emergency preparedness begins with prevention of emergency situations. This is achieved through constructing, operating and maintaining systems to high standards, and by implementing continuous monitoring and surveillance programs to identify potential issues.

2.1 Training

During mining operations, the Site Manager will provide annual training workshops for personnel working at the Wolverine Tailings Facility including: YZC foremen, operators, contractors and site engineers. The workshop will focus on operational procedures, improvements planned for the tailings operation system and an overview of planned construction and maintenance activities. Moreover, a more detailed version of this Emergency Response Plan will be covered. Participants will be required to pass a written examination to demonstrate their understanding of the workshop material.

All personnel will receive training that includes instruction in general emergency response, spill contingency measures and communication procedures. Training for preparedness will be conducted in accordance with both Yukon Workers Compensation Health and Safety Board Regulations and regional legislation. At a minimum, a first responder awareness level training program will be implemented with all key staff and contractors. Emergency Response Team members will undergo more rigorous training and will be appropriately tested and certified in relevant emergency response procedures. Training will include pertinent emergency response topics such as:

- Company Policies and Environmental Protection Plans;
- Responsibilities for updating the ERP and the distribution list;
- Internal/External communication networks;
- Available internal/external resources (equipment, emergency response teams, spill cleanup materials);
- Accessing and the deployment of equipment;
- Dealing with seasonal diversities, adverse weather conditions, terrain, snow/ice;
- Personal protective equipment use;

- Properties of substances transported, handled, stored and used on site (Material Safety Data Sheets; MSDS);
- Individual 'Action Plans' for each material/chemical handled;
- On/off-site transportation;
- Response procedure including initial action, clean-up procedures, storage, disposal, reporting and reclamation;
- Relevant Environmental Legislation;
- Workplace Hazardous Materials Information System (WHMIS);
- Standard First Aid and CPR;
- Transportation of Dangerous Goods (TDG) Regulations;

The level of training required for site personnel will vary depending on their respective roles, for example:

- Emergency Response Teams - Training exercises for the ER teams will be organized by the Environmental/Safety Department and be designed to cover a comprehensive range of emergency situations. The Environmental/Safety Department will also maintain a list of names and training modules and specialized simulations completed.
- Loss Control Officer and any site personnel handling dangerous materials will be appropriately trained with TDG certification, as required.
- New employees and contractors – the training of new employees and contractors will include environmental and cultural awareness, spill cleanup procedures, emergency situations and accident/incident reporting as part of their comprehensive site orientation session.
- Drivers of trucks carrying hazardous materials and concentrate will have additional training including spill response (along roads and into water bodies), emergency driving techniques, emergency communications, hazard avoidance, etc.
- Refresher training for all site personnel will be held at least once per year. Training records will be maintained at both the on-site office by the training coordinator. The trainees will receive a certificate indicating the title of the course, dates attended and the type of simulation training received. These records will be updated regularly and a summary list provided to Site Manager monthly. Based on a predetermined schedule (typically every 2-3 years), a multi-

department emergency response scenario will be organized by the Environmental/Safety Department.

Contractors will be required to be familiar with the most recent version of the Emergency Response Plan and to assist response measures in the following ways:

- Advise all employees of the existence of these procedures;
- Assist with evacuation practice sessions and equipment tests;
- Maintain daily employee lists to be used in the event of employee head counts at assembly areas during an evacuation;
- Assist with notification, first-aid, securing of site, etc., during an emergency;
- Provide manpower and equipment on a priority basis as requested to assist in emergency evacuation or response; and

2.2 Documentation and Updating

2.2.1 Emergency Response Plan

The ERP will be reviewed on a yearly basis and following any emergency, spill, incident or emergency simulation exercise. The reviews will ensure that the EPR is consistent with current best management practices in the field of emergency response and spill management. This review will involve a de-briefing to allow the assessment and documenting of what went right, what went wrong, and what changes should be implemented to improve the performance/outcome. Furthermore, the updating process provides a mechanism that allows for timely adjustments to the ERP (outside of the annual review), if required, as the circumstances at the mine site evolve.

The Environmental/Safety Department will be responsible for updating the ERP annually. The list of personnel on the Emergency Response Teams is the responsibility of the individual department heads (or designates) with updates to be forwarded to the Environmental/Safety Department. The Loss Prevention Department will maintain and update the communication hierarchy and the Contact List of all the appropriate site and company personnel. All changes to the plan are to be accompanied by a revised title page showing the latest revision date as well a revision summary page. Revisions are to be forwarded to all personnel on the primary

distribution list. Outdated copies are to be returned to Environmental/Safety Department for disposal. Each new hardcopy is to include an updated distribution list on its cover. If changes to the Plans are minor or involve only one section, to minimize waste, only those sections relevant to the changes need be distributed with instructions as to the replacement of the out-dated sections. In all cases, whether complete or partial replacement of the hard copy, the revised title page with the latest revision date and the revision summary page are required.

2.2.2 Material Safety Data Sheets (MSDS)

The ER team will be provided with an inventory of chemicals and the Material Safety Data Sheets (MSDS) of all materials transported, stored and used on-site. The MSDS will be made available in all strategic locations on-site and at hazardous substance storage locations and points of use. Each registrar will be organized by location and the specific substances relevant to that location in order to facilitate the rapid finding of pertinent information in the event of a spill or emergency. A copy of the MSDS documents will also be available in Environmental Supervisor's Office, Safety Supervisor's Office, Occupational Health & Safety Committee and First Aid centre. They will be updated regularly as the project develops.

2.2.3 Resource Inventory

A resource inventory will provide information on emergency response personnel (manpower), machinery, equipment, first-aid kits, spill kits and tools for clean-up works available to respond to incidental spills, emergency situations or clean-up situations. The resources will include on-site support as well as external support from other bodies/organizations like the fire department, RCMP, and similar mining establishments or exploration camps in the vicinity. This resource list will be reviewed and updated regularly.

2.2.4 Inspections

Periodic inspections will be carried out to verify that all resources and equipment for emergency response are available and in good working condition. Inspectors will check to ensure that the records of maintenance and repairs for each piece of equipment are current or complete, and that appropriate recommendations are made. Inspections will also be carried out at each of the facilities where hazardous materials or waste streams are handled or stored. An inspection

reporting schedule and checklist for relevant site locations will be provided by the Environmental/Safety Department.

2.3 Emergency Response Procedure

For all situations, the first person on the scene of an emergency is designated the On-Scene Coordinator until such time as the Security Officer, Environmental or Safety Supervisor or Management delegates someone else and releases him/her of this duty. The general emergency response procedure is outlined in Figure 2.1.

Procedures will include steps to be taken during various scenarios and depending on the severity of the emergency.

General Emergency Response Procedure

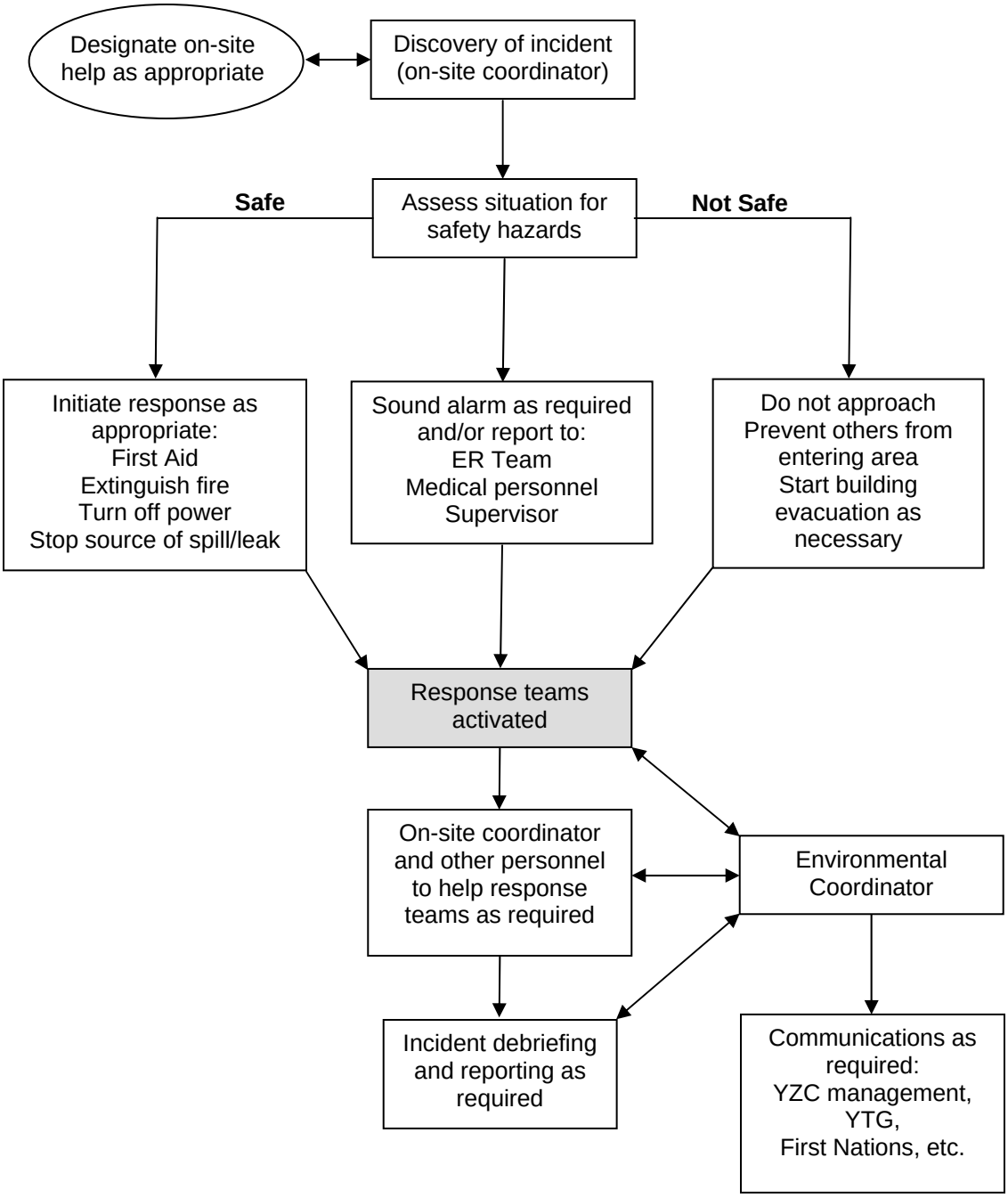

Figure 2.1 General Emergency Response Procedures

2.3.1 Security Breaches

The mine site will be relatively secure due to its remote location and single access road. Use of the road must be authorized and access is controlled with locked gates.

In cases where a security breach is suspected, specific procedures will be developed implemented.

2.3.2 Bomb Threats

A bomb threat cannot be regarded as a meaningless nuisance and is always considered an emergency situation. The project will require storage of large quantities of petroleum products and explosives; therefore a plan, commensurate with the assessed risk, will be developed to specifically deal with potential bomb threats. Any bomb threat will be considered authentic until confirmed otherwise.

2.3.3 Emergency Situations

The emergency response station in the administration building will be equipped for first aid, environmental and mine rescue activities. The first aid room will be separate from the environmental response and mine rescue room where specialized equipment must be stored and maintained. The first aid room will be fully serviced with hot and cold water, toilets and communications. A subsidiary first aid room will be located in the camp. An emergency helipad is located at the northwest corner of the industrial complex area.

2.3.4 Accidents Resulting in Injuries

In the event of a major accident or incident that results in injuries the Safety Supervisor and Medical Personnel should be immediately called to the scene by radio. He or she will then delegate upward depending on the severity of the situation/incident. The following procedures are recommended depending on the seriousness of the injury:

2.3.4.1 Minor Injury - Non-Medical Aid

- The On-Scene Coordinator (until released of his/her duty) is to:

- Ensure the safety of personnel near the site/incident;
- Call ER team and medical personnel;

- Seek assistance or help from others;
- Administer first aid on location at the first aid room;
- Record the first-aid actions taken in the First Aid Log-Book;
- Advise the Supervisor of the incident; and
- Fill out an Incident Report for incident tracking purposes and to implement corrective measures and/or actions, if necessary and to prevent reoccurrence to others.

2.3.4.2 Major Injury - Medical Aid

- The On-Scene Coordinator (until released of his/her duty) is to:
  - Ensure the safety of personnel near the site/incident;
  - Call ER team and medical personnel;
- Seek assistance and medical attention immediately;
- Medical assistants will assess mobility of casualty and administer first aid, as needed;
- Advise the Supervisor, who will:
  - Provide or arrange for further aid;
  - Debrief relevant personnel;
  - Prepare an Incident Report; and
  - Follow Company reporting guidelines and hierarchy as required.

2.3.4.3 Fatalities

In case of an accident/incident leading to a fatality, the following procedures will be carried out:

- The On-Scene Coordinator (until released of his/her duty) is to:
  - Ensure the safety of personnel near the site/incident;

- Call ER team and medical personnel;
- Shut down/turn off any equipment/machinery that may represent an additional safety hazard;
- All material and equipment involved in a fatality are to remain untouched until cleared by the RCMP; and
- Advise immediate Supervisor of the incident, who will advise the Site Manager.

- The Site Manager is to:
  - Call RCMP, ambulance, and fire department as required;
  - Prepare Incident Report; and
  - Follow Company reporting guidelines and hierarchy as required.
- Next of kin to be notified only by RCMP and/or Senior Management;

2.3.4.4 Missing Persons

In the event of a missing person(s), the Site Manager will be notified immediately. A designated supervisor(s) will take charge and initiate the following actions:

- Assess emergency situation;
- Initiate the following, if required;
  - Mobilize search personnel and equipment;
  - Divide areas into quadrants and assign Quadrant Leaders;
  - Distribute communications equipment, as required;
  - Establish routine call-in times;
  - If required, coordinate the search process with RCMP;
  - Prepare necessary reports;
  - Debrief Search Team once emergency search is over; and
  - Notify Senior Management as applicable.

2.3.4.5 Fire or Explosion

In the event of a fire or explosion, the On-Scene Co-coordinator's role will be turned over to the Safety Supervisor, as they arrive on the scene. In the event of a fire or explosion, the On-Scene Coordinator will:

- Assess the situation and determine emergency response needs;
- Activate the fire alarm and call the Emergency Response team;
- Direct and ensure evacuation of personnel, as necessary;
- If evacuation is required, a head-count will be conducted to ensure all personnel have been evacuated;
- Secure area to prevent unauthorized access and to protect equipment, facilities and records;

Employees will be trained and equipped to fight fires in the initial stages only. If a fire is small enough and the risk deemed minimal, extinguish the fire with nearby hand-held or wheeled fire extinguishers;

General Fire Fighting Procedures include:

- Wear SCBA and eye protection when responding to fires;
- Extinguish fires with CO_2, dry chemical, alcohol foam or water fog (note that water or foam may cause frothing); and
- Use water to cool containers exposed to fire.
- Shut off fuel and power supplies.

Firefighting efforts by employees for larger fires will not be encouraged. Notify the Emergency Response Team; providing details of the fire and, if advising of a major fire(s), the requirement for professional fire-fighters to prevent subsequent environmental damage.

2.3.4.6 Natural Disasters

In the event of a natural disaster or severe weather causing damage to a facility and possibly requiring evacuation, the Site Manager assumes the position of On-Scene Coordinator. All site employees must follow the Manager's (or designate's) directions through the emergency broadcast system or other means.

2.4 General Evacuation

Site evacuation will be under the control of the Site Manager, or his designate. A site- wide notification and alarm system will be established. A general evacuation will go into effect upon the sounding of an alarm at any or all of the buildings and facilities on site. The Evacuation Plan may be triggered automatically by fire or gas detectors or manually by an individual or site management upon awareness that an incident requires evacuation.

Muster stations will be established clearly around the project area and site personnel will have been made aware of them during orientation and follow-up training programs.

Primary evacuation from the various project areas will be by road. In the event the road is impassable, evacuation will be conducted by aircraft.

2.4.1 Air Support Operations

Air support will be a very important component of an emergency situation at the site. The airstrip may be used during a major emergency to expedite the movement of emergency resources (manpower and equipment) and to help evacuate site personnel (if required). The responsibility for the operation of the airstrip during an emergency situation will fall under the Site Manager (or designate).

Site-wide evacuation drills will be a part of the regular testing of the emergency response systems. Personnel will receive desktop updates at annual refresher training sessions and major practical drills will occur every two years.

General evacuation guidelines include:

- Keep calm;
- If in a room, take sufficient outdoor clothing (to be kept in rooms at all times) and proceed quickly to the closest muster area; do not congregate in an Office, Control Room or on-site buildings;
- Follow instructions of immediate Supervisor or Environment or Safety Supervisor; and
- When evacuating, leave personal property such as lunch containers, briefcases, etc.

2.5 Communications

Communications during an emergency situation are of utmost importance, and a plan will be prepared that provides direction for how communications are to be undertaken during such a situation. The Communications Plan will provide an organizational structure with specific responsibilities and communications protocols. Generally, in the event of an emergency, only absolutely necessary information should be relayed via the site communication system (e.g., radios and/or cell phones). At all times during an emergency, personnel using the site communication system should only disclose immediately pertinent information to aid the emergency response and should not disclose names or personal details of the casualties.

2.5.1 Public Relations

The Communications Plan will address issues concerning the public, First Nations and affected nearby communities on matters relevant to the situation. The Plan will provide a system to ensure dialogue between YZC and stakeholders of the Wolverine Project. Any reporting to the public or media regarding Emergency Response events or actions will be made directly by, or on authority of, the VP Environment and Community Affairs only, in accordance with the Communications Plan.

3. TAILINGS FACILITY EMERGENCY RESPONSE PLAN

The following section describes the main features of the Tailings Facility Emergency Response Plan, and will be updated with more details regarding the site communication protocols prior to the start up of mine operation.

3.1 Emergency Situations and Response Procedures

Possible emergencies and unusual situations at the Wolverine Tailings Facility may range from a potentially small incident such as a pipeline breakage to the highly unlikely and extreme event of dam instability. All of these situations require site personnel to first be observant and recognize a potential emergency or unusual situation, then follow an established communication procedure and finally, respond appropriately.

This section covers only those emergency situations that could potentially pose a threat to the structural integrity of the tailings dam or result in the release of tailings materials, tailings transportation water, and/or supernatant pond water into the surrounding environment. In the event of an emergency, prompt action will be taken to avoid delays which could have serious consequences.

Emergency situations may include, but are not limited to, the following:

- Failure or suspect impending failure of the tailings dam;
- Slumping, sliding, cracking or bulging of the tailings dam;
- Rapid increase or unexplained cloudy appearance of seepage through the tailings dam and/or its foundation;
- Formation of sinkholes on the tailings beach or dam;
- Breakage of tailings pipelines, which may result in dam erosion and/or release of tailings slurry;
- Large earthquakes;
- Extreme floods; and
- Sabotage and other criminal activities.

Particular attention will be given to inspecting and, where necessary, repairing the tailings facility following unusual or extreme events. All unusual events will be reported to supervisory personnel. In an unlikely event that high seepage flows occur downstream of the tailings dam, and particularly if seepage water is carrying soil particles from the dam or its foundation, which is an early indication of a potential “piping” problem (i.e., internal erosion), it will be reported immediately and the engineering consultant notified.

In the event of an emergency or unusual situation, all instrumentation in the affected area will be monitored during and/or immediately following the event by either the engineering consultant, if on-site, or by YZC personnel. This information will be forwarded to the design engineer(s) immediately so that the situation can be assessed and any required remedial actions taken promptly.

3.1.1 Emergency Response Procedures and Communications

Communication of a potential or actual emergency is essential, in order to get qualified individuals to assess the situation or to assist in response as soon as possible. In virtually all situations the Site Manager must be notified. If there is imminent and substantial danger to people, the environment, or to company property that overwhelms on-site resources, outside assistance must be summoned quickly. Possible examples include: a spill that threatens the environment and cannot be contained, or a catastrophic dam failure that threatens personnel, the public and the environment.

The procedure for response and communication are detailed below. In the event of an emergency or potential emergency:

- Respond to the incident, ensuring safety of yourself and others.
- Notify the supervisor(s), and the Site Manager, as soon as possible.
- In case of an emergency requiring immediate outside assistance, take the following steps:
    - Call the applicable emergency numbers to request for assistance by police and/or other emergency personnel.
    - Be prepared to give the following information:
        - your name and telephone number;
        - the location and time of the incident;
        - (if dam emergency) the dam structure involved;
        - the nature of the emergency situation (e.g., spill, dam incident, etc.);
        - the cause of the emergency (e.g., pipeline break, slope instability, or other unknown causes);
        - actions taken to control the problem and their effect (e.g., close off isolation valves, repair dam slope);
        - the names of the agencies on the scene; and
        - the names of other persons or agencies advised concerning the incident.

3.1.2 Notification Procedures

Notification is done to alert others of an unusual condition that has occurred or is still occurring, that may require action. It is to be done promptly, but there is typically time to first gather more information on a situation, to analyze possible causes, and to perhaps take some initial remedial measures. Notification will occur internally, and externally as deemed necessary by the Site Manager.

Internal notification is given to the supervisor(s) according to the chain of command including the Site Manager, as appropriate. As a general rule, always inform the supervisor(s) of any unusual incident that has occurred on site, any anomalous monitoring results, or any potentially hazardous condition. If in doubt about the significance or importance of something you have observed, err on the side of caution and report it to the supervisor(s). The supervisor(s) will then investigate and determine necessary actions.

Corporate personnel will be notified in the event of significant incidents on site, particularly events where external notifications to government agencies or downstream-affected persons are necessary.

External notification is communication by the Site Manager, or his designate, to persons or agencies outside of the Wolverine Mine site. Contact details (names of key individuals, their agencies and telephone numbers) will be provided prior to the start up of mining operations.

Some key persons or agencies that will be notified of an incident include:

- Government: in the event of a significant spill, or dam incident, the Site Manager or Environmental Supervisor will notify the Yukon Department of Energy, Mines and Resources and Department of Environment, and other appropriate agencies.
- Downstream-Affected Persons: a dam incident could result in off-site effects, for example a spill, water quality issue, or dam breach. In this case, effort must be made to ensure that all those potentially affected by the situation are notified and given directions to reduce their exposure. Actions must also be taken to prevent the public from unknowingly being affected by the situation (e.g., possibly by restricting access to downstream roads and waterways). The Site Manager will work closely with territorial and appropriate authorities to ensure that notification of downstream-affected persons is timely and comprehensive.

- Dam Consultant: in the unlikely event of potential dam instability or leakage, the dam consultant will be immediately contacted and investigative and mitigate actions will be taken as recommended by the consultant.

- Other: During and after a significant event, it may be necessary to respond to questions and concerns by the media, general public, special interest groups, and other stakeholders. The corporate office is responsible for this communication.

3.2 Actions to Prevent Tailings Dam Breach

In an unlikely event, the Wolverine tailings facility could fail due to the breach of the tailings dam, resulting in flooding to the downstream area. The dam breach could be triggered by "piping" (i.e., internal erosion) or overtopping. It is difficult to predict where a dam breach would be initiated and precisely what corrective actions would be required. Nevertheless, to assist the mine in dealing with emergency situations threatening the tailings dam, this section describes the resources available to the mine and the potential course of actions that could be taken promptly to avert a dam breach. These actions could include: (1) lower tailings pond level; (2) arrest or retard dam internal erosion; and (3) arrest or retard dam external erosion.

During mine operations there will be continual personnel presence around the Wolverine Tailings Facility. If a situation arises that requires immediate attention, YZC has at its disposal the equipment, material, labour and engineering expertise to respond immediately. These resources include those within the mine and those available through outside contractors and consultants.

3.2.1 Lower Tailings Pond Level

In the early stage of either a "piping" or overtopping scenario, the most effective action to reduce the threat of further development of the failure mechanism is to lower the level of water in the tailings pond upstream of the tailings dam, as fast as practical. Actions that can be taken to achieve a lower water level behind the dam include stopping tailings discharge into the tailings impoundment (shut down mill). If this action alone is unable to lower the pond level sufficiently to improve the dam condition, the Site Manager or Environmental Manager will request the Yukon Department of Energy, Mines and Resources and Department of Environment to declare a state of emergency, and to allow YZC to release tailings pond water downstream of the tailings

dam into Go Creek. This request will only be made in the event of imminent dam failure to prevent substantial environmental consequences.

If permission is not granted, YZC could consider pumping tailings pond water to the underground mine, once it has been evacuated.

3.2.2 Arrest or Retard Dam Internal Erosion

Excess and/or murky seepage caused by internal erosion of the tailings dam may indicate a "piping" failure of the dam. If a sinkhole develops, it should be immediately filled with damfill materials compatible with the internal zoning of the dam. If the sinkhole is located upstream of the dam, efforts should be made to prevent pond water from flowing into it. This could be accomplished by placing additional earthfill in the surrounding area to block access, and/or pumping tailings materials to move the tailings beach/water away from the sinkhole.

In the area where excess and/or murky seepage exits from the tailings dam toe a weighted filter buttress berm should be promptly placed along the seepage exit area. The filter berm would allow free exit of seepage water without carrying away existing damfill and/or foundation materials. The filter berm should be constructed of filter and drainage materials with progressively increasing particle size towards the berm outer surface.

3.2.3 Arrest or Retard Dam External Erosion

As the dam freeboard decreases during a major hydrologic event, additional actions can be taken to arrest external erosion of the dam. Concurrent with lowering the tailings pond level, the existing dam crest should be raised by placing additional dam fill on the crest. While raising the crest uniformly across the entire dam, additional dam fill material should be placed in local areas where signs of weakening such as slope slumps, crest deformations and cracks are discovered.

In an event that an open channel begins to form on the dam crest, granular materials should be used to plug the channel. Materials of sufficient size and weight can be dozed into the breach from alternate sides of the channel. As the channel is gradually being closed, the materials used to plug the channel should increase in size and weight to cope with the increasing flow velocity. After the channel is completely closed, additional fill material with sufficient fines should be placed upstream of the granular-fill plug in order to prevent the seepage through the plug.

APPENDIX V

Treatability and Bench-Scale Bioreactor Testing of Waters for Selenium Removal

January 31, 2008

TREATABILITY AND BENCH-SCALE BIOREACTOR TESTING OF WATERS FOR SELENIUM REMOVAL - FINAL REPORT

January 31, 2008

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EXECUTIVE SUMMARY

This report summarizes data presented in *Phase 1* and *2 reports* and presents new data gathered for Phases *3* and *4* that addresses bench-scale testing of three potential process waters and provides a cost breakdown for an on-site pilot-scale test. Good microbial growth and selenium reduction was obtained using a defined media and a molasses, yeast, phosphate media (MYP nutrient) at 3.75 gm/L molasses, 1.5 gm/L yeast extract, and 2.0 mg/L phosphate in waters containing ~4.3 mg/L selenium. DGGE profiling of the selected SF036, Z0, SF056, and Lorax-1 (L-1) microbial population and individual isolated microbial constituents was conducted and on-line database sequence comparisons yielded no matches with sequenced microorganisms. These microorganisms are unknowns at the genus and species level. Microbial stock cultures have been made and are available for pilot-scale testing.

Reactor testing was conducted in two new reactor types 1) a biochemical-enhanced material reactor (BEMR) and 2) an electro-biochemical reactor (EBR). Both had void volumes of ~700 mL and used mostly modified pumice as a microbial growth surface. *Phase 3* testing used water spiked with selenium to ~9 mg/L and nine buckets of visibly different waters, received as one process run. Two tests were made with these waters, one at ~4.3 mg/L selenium and one at ~15 mg/L selenium. The first tests used two BEMR in series with feed waters containing ~9 mg/L (spiked) selenium and nutrient addition to only the first bioreactor and produced effluents that averaged ~0.58 mg/L selenium using a total retention time of forty-four hours. In Test 2 the bioreactor configuration was changed to include a pretreatment step and used the feed waters containing ~9 mg/L selenium, with microbes and nutrient, to simulate a holding or equilibration pond, and removed an average of ~2.9 mg/L selenium. Test waters were again supplemented with 100 mL nutrient before entering reactor 1 as described for Test 1; no nutrients were added to the bottom of BEMR-2 during this test except what carried over from BEMR-1. A bioreactor retention time of forty-four hours produced a final effluent averaging ~0.029 mg/L selenium.

In Test 3 the bioreactor configuration was changed to eliminate the pretreatment step and waters containing ~4.3 mg/L selenium were introduced into BEMR-1 and BEMR-2 as in Test 1. In this test 100 mL of 3.75 gm/L MYP nutrient was added to the bottom of both BEMR-1 and BEMR-2 for a total of 200 mL nutrient once daily; the effluent was sampled at the top of BEMR-2. A total retention time of forty-four hours produced a final effluent averaging ~0.031 mg/L selenium. During Test 3, the EBR was started and operated in the same manner as the BEMRs. A retention time of twenty-two hours produced a final effluent averaging ~0.030 mg/L selenium. In Test 4 the bioreactor configuration was again changed to connect the BEMRs and EBR in series using new test waters containing ~15 mg/L selenium and a total retention time of sixty-six hours. Limited data gathered showed an effluent averaging ~0.47 mg/L selenium from the two stage BEMRs and a final effluent from the EBR averaging ~0.072 mg/L selenium. A number of additional metals identified as potential permitting criteria were also removed to a large extent by the bioreactors.

Testing and site conditions indicate that both pre and post treatment steps will be required and sizing is given for both a 1/10 and a 1/50 pilot-scale system. Treatment costing assumptions and items are provided for a 1/10 pilot-scale test running three months with a cost estimate just under $163,000.00.

TREATABILITY AND BENCH-SCALE BIOREACTOR TESTING OF WATERS FOR SELENIUM REMOVAL - FINAL REPORT

INTRODUCTION

This report summarizes data presented in earlier reports, *Phases 1* and *2*, addressing selenium treatability and initial testing of several different potential process and waste waters for a new mine at the Wolverine Project, YK. *Phases 3* and *4* address bench-scale testing of several different process water samples and provides a cost breakdown for an on-site pilot-scale test. Limiting conditions with respect to treatability at this site are temperature and high selenium concentrations; up to 14 mg/L selenium. It is planned to run the selenium biotreatment system seasonally; six months of the year - spring through fall. Water samples were obtained from tailings pilot plant runs that simulated actual full-scale tailings plant waters; samples were received from *Lorax Environmental Services Ltd.*, 2289 Burrard Street, Vancouver, BC V6J 3H9. The waters received were examined using different methods to assess potential selenium treatability, including two newly developed selenium removal technologies demonstrated to enhance biofilm growth and metal removal.

Data Summary

Phase 1 Goals

- Evaluation of pilot plant process water chemistry for microbial toxicity and required nutrient supplementation
- Qualitative assessment of biotreatability effectiveness at temperatures of 20º C and 4º C using site and repository microbes
- Qualitative assessment of biotreatability effectiveness of several microbial mixtures

Phase 1 testing produced the following conclusions:

- Microbial screening successfully demonstrated that site microbes and two microbial populations were capable of good selenium reduction in site waters at ~20º C and to a lesser degree at 4º C
- Overall, the tests were very positive and provided a strong demonstration that biological selenium reduction was achievable in the waters tested
- If effluents containing higher levels of selenium, e.g., <50 ppb can be considered, they would be possible with considerable less development and capital investment

Phase 1 Recommendations:

- Continue testing the microbial populations and site isolates in *Phase 2*
- Continue investigation of microbial adaptation for lower temperature selenium reduction
- Perform preliminary assessment of selenium removal using selected nutrient combinations

Phase 2 Goals

- Select an optimal microbial population for selenium removal in process test waters received
- Continue to qualitatively assess selenium removal at 20º C and 4º C
- Perform preliminary assessment of selenium removal using selected nutrient combinations
- Evaluate microbial selenium removal characteristics

Phase 2 testing produced the following conclusions:

- Several microbial isolates and microbial populations were capable of selenium reduction in site waters at ~24º C using an economical nutrient and a 72 hour retention time
  - A microbial population – SF036, Z0, SF056, and Lorax-1 (L-1) will be used in bioreactor tests
  - Following mixed culture co-adaptation, site microbes volatized selenium to a high degree
- pH was not an issue, but the waters provided for the *Phase 2* tests did affect selenium reduction

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    - Cyanide or another contaminant removed with hydrogen peroxide made a significant difference in the selenium removal obtained
    - Selenium concentration will require at least two treatment stages to remove selenium to <50 ppb
- Nutrient component levels formulated for *Phase 3* tests included sugars, protein (carbon), nitrogen, iron, magnesium, and phosphate
    - Nutrients were provided in test solutions containing molasses/soy (3.75 to 0.75 gm/L), yeast (1.5 to 0.75 gm/L), and phosphate (0.05 to 2 gm/L)
    - The best performing defined media contained 3.75 gm/L molasses/soy, 1.5 gm/L yeast, and .5 to 2.0 gm/L phosphate – MYP media
    - Growth rates in the MYP media were slower than in a rich commercially available trypticase soy microbial media
    - Microbial selenium reduction at ~4º C in the waters provided for the *Phase 2* tests was not acceptable

Phase 2 Recommendations:

- Testing and evaluation should proceed to the next level of bench-scale reactor testing at 24º C
- Testing can be conducted in two new, but tested, biotreatment system designs
    - Electro-biochemical reactor (EBR)
    - Biochemical-enhanced materials reactor (BEMR)
- Profile microbial population using Denaturing Gradient Gel Electrophoresis (DGGE)
- Continue to track selected microbial adaptation and selenium volatization

BACKGROUND - BIOREACTOR TESTING

Phases 3 and 4

Phases 3 and *4* have not been covered in a formal report and are reported here. This document reports on the bench-scale process tests using three different waters, evaluates bioreactor testing for an on-site pilot-scale test, and provides a rough cost estimate for this test. The objectives include:

- Evaluate the new process waters received for microbial toxicity and required nutrient supplements
- Re-evaluate the selected microbial population in the process waters for relative selenium reduction
- Fingerprint the microbes identified as important for selenium reduction in site waters using DGGE
- Evaluate selenium reduction in two new bioreactor types – a bio-electrochemical (BEC) reactor and a biochemical-enhanced microbial support materials (BEMS) reactor
- Use the developed nutrient containing 3.75 gm/L molasses/soy, 1.5 gm/L yeast, and 1.0 gm/L phosphate – (continued *Phase 2* testing indicated a lower phosphate concentration could be used)
- Target a bioreactor effluent with selenium concentrations below 20 µg/L (ppb)
- Assess technologies for pilot-scale and provide a rough cost estimate for on-site tests

Water Samples

Water Chemistry Analysis

Selenium and other metal concentrations in samples analyzed were obtained by direct ICP MS analysis of the sample or through a dilution of the sample by a factor of 10:1 or 100:1. Samples and sample dilutions were run against calibration curves constructed using response measurements on known calibration standards. For example, for the lower selenium concentrations, the following 0, 40, 80,120, and 240 ng Se/L calibration standards were used. When required the selenium or other metal concentrations in the calibration standards were revised, for example to 0, 25, 250 and 2500 ng/L. In addition, dilution factors were calculated so that the selenium and other metal concentrations in the resulting dilutions approximated one-half the Se concentration in the new high calibration standard. The new dilutions were then prepared and run on the ICP MS against the calibration standards at the revised concentration levels; detection limits were 2 ppb for selenium. Results presented are corrected for dilution.

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Water Samples Received

Phase 3 testing was initiated with five buckets of waters initially received for *Phase 3* that did not contain any significant selenium or other contaminants. These pH ~7 waters did not have any visible precipitates, were initially thought to contain selenium, and be from a process run. Water samples received were re-analyzed three times with the same result, no selenium present. However, analysis of another water sample from the same run, held by *Lorax Environmental Services Ltd.,* was shown to contain selenium, but not enough to conduct the tests required. The five buckets of pH ~7 water were spiked to ~9 mg/L selenium and used to start reactor conditioning and initial reactor tests.

A second water sample received for *Phase 3* tests consisted of nine buckets of water, provided as one process run with the water chemistry listed under the Bulk Tailings analysis in *Attachment 1*. This set of water samples was reported to have a pH of ~10 and a selenium concentration of ~2.5 mg/L. The pH in all buckets was ~10; however, the selenium concentration varied considerably, from ~4.3 mg/L to ~15 mg/L selenium, as did the appearance of the waters, *Figure 1*. The clear solution, five buckets total, containing ~4.3 mg/L selenium was used along with the spiked solution described above for the bulk of the bioreactor testing.

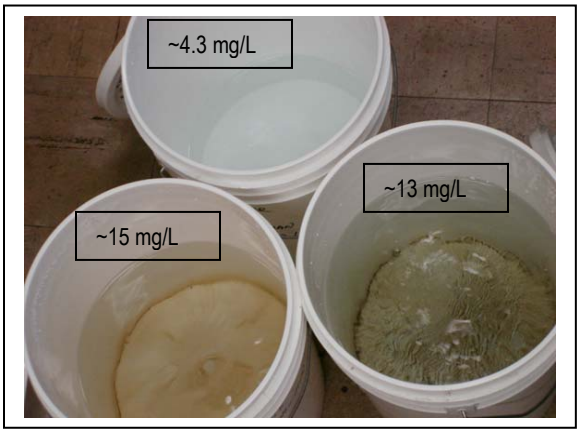

Figure 1. Three different buckets of the nine buckets of test solution received for *Phase 3* testing. These buckets have a selenium concentration of between ~4.3 to 15 mg/L. This photo shows the difference in the solutions received for testing. The clear solution, five buckets total, was assayed at average value of ~4.3 mg/L selenium. The colored solutions contain the higher selenium amounts – there were two buckets each of the red and brown colored solutions. The red colored solutions contained ~15 mg Se/L and the brown colored solutions contain ~13 mg/L selenium; this analysis represents a 0.22 µm filtered sample analysis. Observation: The amount of precipitate in the buckets increased two- to three-fold with time, over approximately two months, and was not a function of settling. Buckets were held at pH ~10, as received, until used in bioreactor or other testing.

METHODS AND RESULTS

Standard and modified methods were used for all microbial analyses conducted. Standard and modified methods were used in all procedural protocols and modified or 'special' analysis methods were used for qualitative microbial selenium evaluations. Data presented represents summary, combined, and average data from individual tests and the screening conducted.

Re-evaluation of test microbes in new waters

In this step, the new process waters received were evaluated for microbial toxicity and nutrient supplements required for good microbial growth and selenium reduction. Evaluation media was made with new test waters containing 4.3 mg/L selenium and various concentrations of nutrient components in a test matrix. Individual microbes were screened in this test procedure for relative growth and selenium reduction. *Figures 2, 3, and 4* depict good microbial growth and selenium reduction using a defined media and a molasses/soy, yeast, phosphate media (MYP nutrient) in waters

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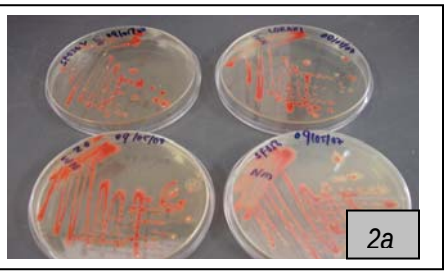
containing ~4.3 mg/L selenium. Growth tests were conducted in static test flasks held at ~24° C (Laboratory temperature); absorbance shown in *Figures 3 and 4* is correlated in a direct manner with microbial growth.



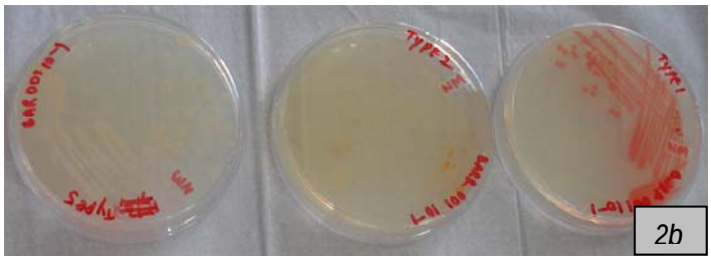


Figure 2a and 2b. *2a* shows SF036, Z0, SF056, and Lorax-1 (L-1), the individual bioreactor test microbes, with good microbial growth and selenium reduction using a defined media. *2b* shows a screen for selenium reduction using three different media containing different amounts of selected media components. The best growth and selenium reduction is on the plate on the right side of *Figure 2b*.

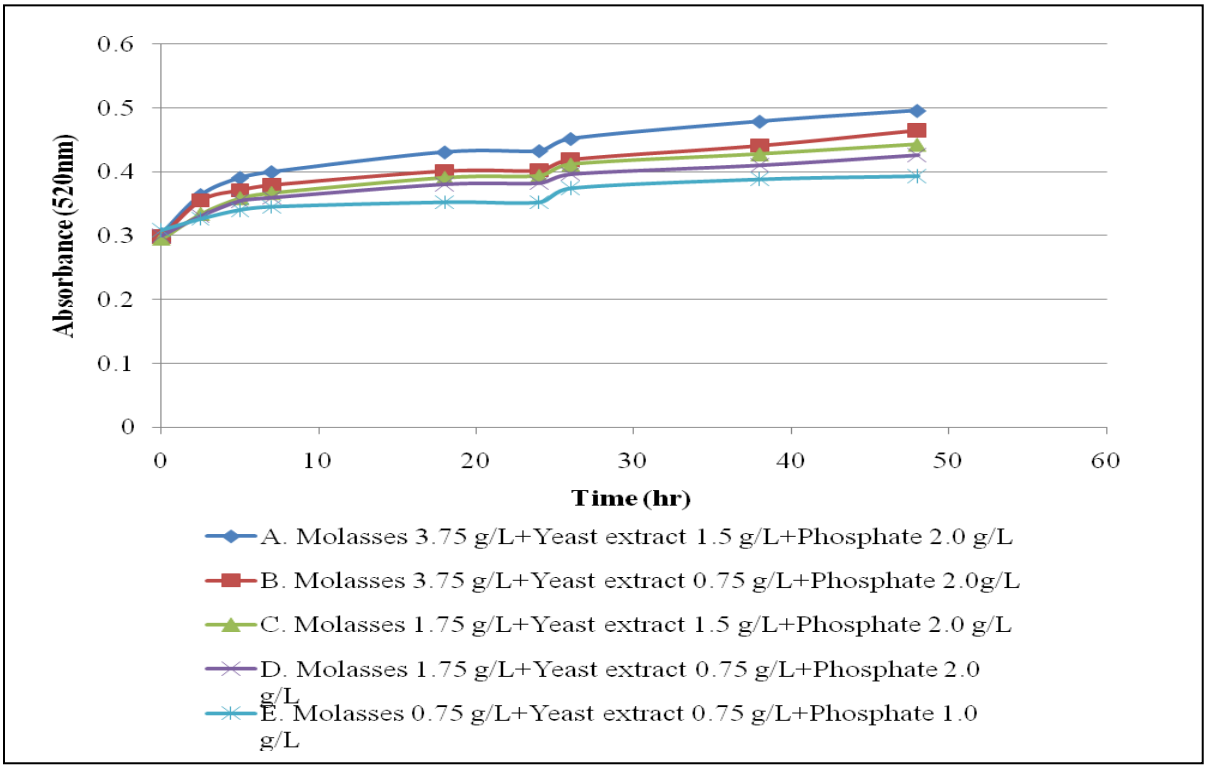


Figure 3. Sample growth curves of the selected microbial population in various media component concentrations.

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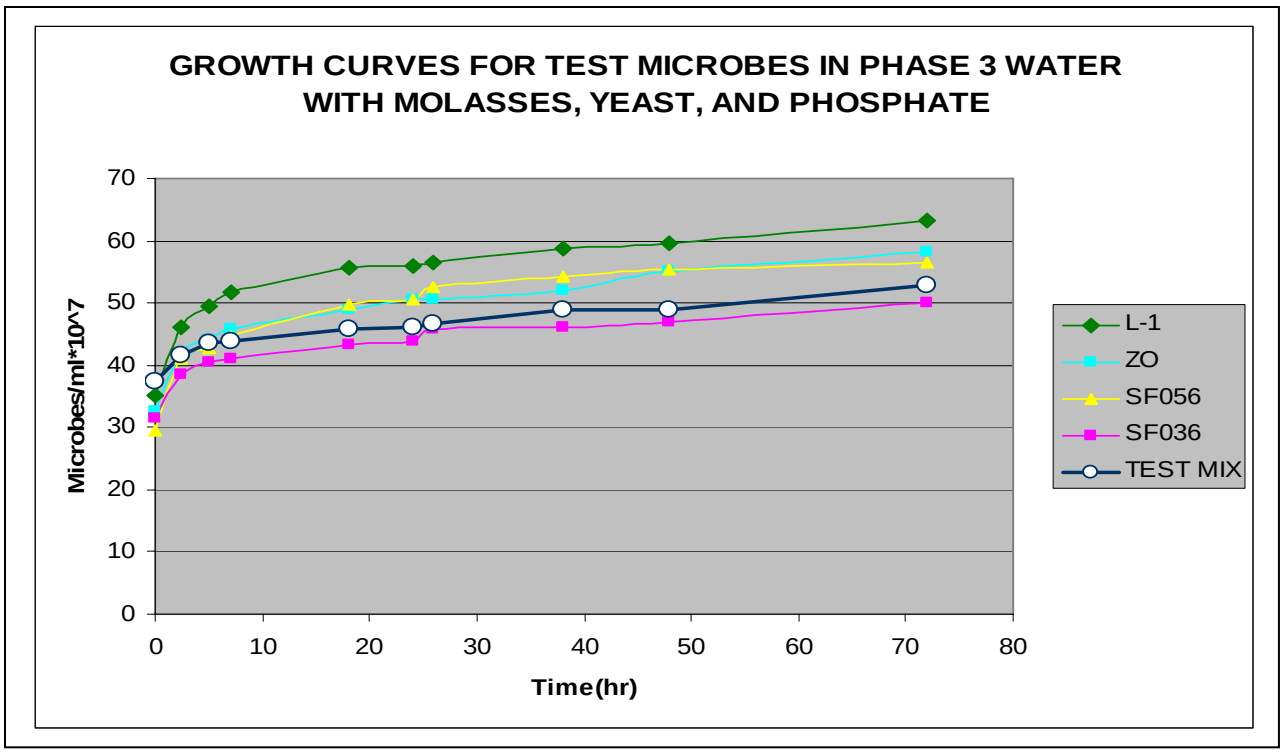

Figure 4. Growth curves of individual test microbes and the test population mix in MYP nutrient over a 72 hour period at 24° C (Laboratory temperature).

Nucleic Acid Profiling

The following discussion is presented because initially these bacteria were sub-cultured together to enhance selenium reduction in the site microbes and in a bioreactor test population that later became defined as containing SF036, Z0, SF056, and Lorax-1 (L-1). It is now accepted that the vast majority of microbes have not yet been isolated, identified or characterized. This is largely due to a lack of knowledge of how these organisms survive and grow in natural habitats. When one also considers that a bacterium is often part of a larger more complex community or ecosystem with possible co-dependence on other members, it is understandable why traditional culturing techniques fail to accurately reflect the large microbial diversity in an environmental sample. Identification and classification of microbes is further confounded by a general absence of morphologically distinct features, thousands of bacterial species are classically categorized by a few different (~17) morphologies.

The advent of culture-independent techniques has transformed the field of microbiology. PCR-based techniques allow the classification of microorganisms based on particular genetic markers and the profiling of complex microbial communities on the basis of nucleic acid sequence diversity (including the uncultured majority). For the past 10 –15 years, microbiologists have relied upon DNA sequence information for microbial identification, based primarily on the genes encoding the small subunit RNA molecule of the ribosome (16S rRNA or SSU rRNA).

Functional constraints on the cellular nucleic acid translational apparatus limit variability in the 16S rRNA molecule, resulting in a high degree of sequence conservation; therefore, a high degree of matching between the same microbes from different sources and different growth conditions. So, even if microbes exchange genes for selenium reduction, the conservation of the rRNA gene sequence permits bacterial characterization and identification based on sequence information obtained from pure cultures or cloned genes from mixed communities. This is possible because rRNA sequence data is used to design phylogenetically conserved probes that target both individual and closely related groups of microorganisms without cultivation.

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A principle repository of 16S rRNA sequences, the Ribosomal Database Project (RDP), currently maintains over 17,000 aligned entries representing 850 of 940 formally recognized prokaryotic genera, which are placed into 1,149 phylogenetic groups. Comparative DNA sequencing analysis is widely considered to be the best genotypic method for microbial identification. The most common approach is PCR amplification and sequencing of all or a 500 Base Pair portion of the 16S ribosomal RNA gene. Sequence data is then compared against a sequence database, which ideally contains only validated microbial sequences.

One technique, based on PCR amplification and sequencing of 16S ribosomal RNA, now routinely used is denaturing gradient gel electrophoresis (DGGE). DGGE is a genetic fingerprinting technique that is used to separate individual sequences from a complex mixture. DNA sequences with differing base composition have different melting properties when passed through an acrylamide gel containing an increasing gradient of a chemical denaturant. The melting temperature of a double stranded DNA fragment is influenced by hydrogen bonds formed between complementary base pairs and also by the attraction between neighboring bases on the same strand (known as stacking interactions). The order of bases on a strand determines the degree of stacking. A DNA molecule may therefore have several melting domains with characteristic melting temperatures. DGGE profiles of the selected microbial population and individual isolated microbial constituents were conducted and results are shown in *Figure 5.* As can be seen, all test microbes are quite similar, but slightly different, and the bands found on the individual test microbes are present in the population profile 4M.

DGGE bands were extracted, amplified, and sent for sequence analysis. The DGGE and amplified sequence analysis shows that all microbes tested appear closely related, but their sequences matched no known microbial sequences in the on-line databases; they are unknown at both the genus and species level but closely related. Metabolic tests have shown that these microbes are quite different metabolically. A previous database check of repository microbe SF036 had shown no matching sequences and cultures of all test microbes exhibited the same DGGE profile before and after sub-culturing.

Microbial stock cultures have been made and are available for pilot-scale testing.

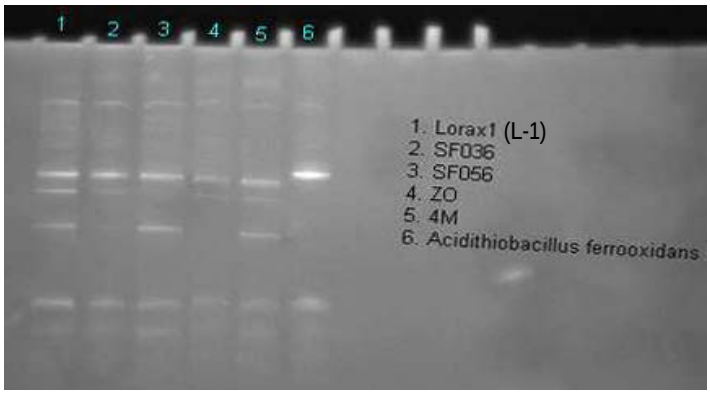

Figure 5. DGGE profiles of site microbial RNA from L-1 and ZO, two repository microbes, 4M - a mixture of all bioreactor test microbes, and a A. ferrooxidans control.

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BIOREACTOR TESTING

Bioreactor Configuration and Operation

Both reactors contained modified pumice materials as the bulk of the microbial support surface. Each bioreactor has a void volume of approximately 700mls and test waters have a twenty-two hour retention time in each bioreactor. Each reactor has three sampling ports used to monitor conditions within the bioreactor at the bottom, middle, and top. Bioreactors were operated at Laboratory temperatures of ~24º C. Bioreactor feed water was added to a clean feed water container on a daily or every other day basis followed by adjustment of the pH between 6.8 and 7.2 using hydrochloric acid. For one test, nutrients, at 3.75 gm/L, were added every other day to a pretreatment container that contained two days of test waters spiked to 9 mg/L selenium. In all other tests shown, nutrients were added to one or each reactor separately at a rate of 3.75 gm/L on a daily basis by mixing the nutrient into a 100mls of pH adjusted test water and pumping it into the reactor over a five minute time period. The flow rate through the bioreactor was then re-adjusted for a twenty-two hour retention time and re-connected to the feed water container.

All reactors were tested with an economical nutrient solution containing 3.75 gm/L MYP nutrient added to test waters. Testing was initially conducted in two new biochemical-enhanced material reactors (BEMR) while a third electro-biochemical reactor (EBR) was being constructed and undergoing preliminary tests. The BEMRs were operated in series for a total retention time of forty-four hours. *Figure 6* depicts the two initial BEMRs tested; no photo of the EBR is provided because patent approval is still in progress. The EBR was constructed and operated in a manner similar to the BEMR; a twenty-two hour retention time was used in this reactor. In one test all three reactors were connected in series, two BEMRs followed by the EBR for a total retention time of sixty-six hours.

Bioreactor effluent samples were collected during nutrient addition into a sterile 50 ml tube. All samples, including paired feed samples were centrifuged for 30 minutes and filtered through a pre-filter followed by a 0.22 micron filter. Samples were preserved by adjusting the pH below 1 with nitric acid and stored at 4º C until analysis. pH and ORP measurements were made before nutrient addition using the three sampling ports; fifteen milliliter samples were collected, centrifuged for 10 minutes, and pH and ORP were measured.

Bioreactor Testing Results and Discussion

BEMR inoculation and start-up was initiated with waters spiked to 9 mg/l selenium at pH ~7. This water was from the first five buckets of waters initially received for *Phase 3* that did not initially contain any significant selenium or other contaminants. Bioreactors were started and operated for one month using these waters. A second water sample was received for *Phase 3* tests that consisted of nine buckets of water; five buckets containing a clear test solution were used for the bulk of the bioreactor testing; these buckets were the ones that closely matched the water chemistry shown in attachment 1. The selenium content of these waters was ~4.3 mg/L. The EBR was started using test waters containing ~4.3 mg/L selenium. The final tests, conducted with three reactors in series, two BEMRs followed by the EBR, with a total retention time of 66 hours used water from a bucket containing a redish precipitate and ~15 mg/L selenium. Testing results are presented in *Figure 7*.

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Figure 6. Two BEMR in series using a retention time of twenty-two hour each for a total retention time of forty-four hours.

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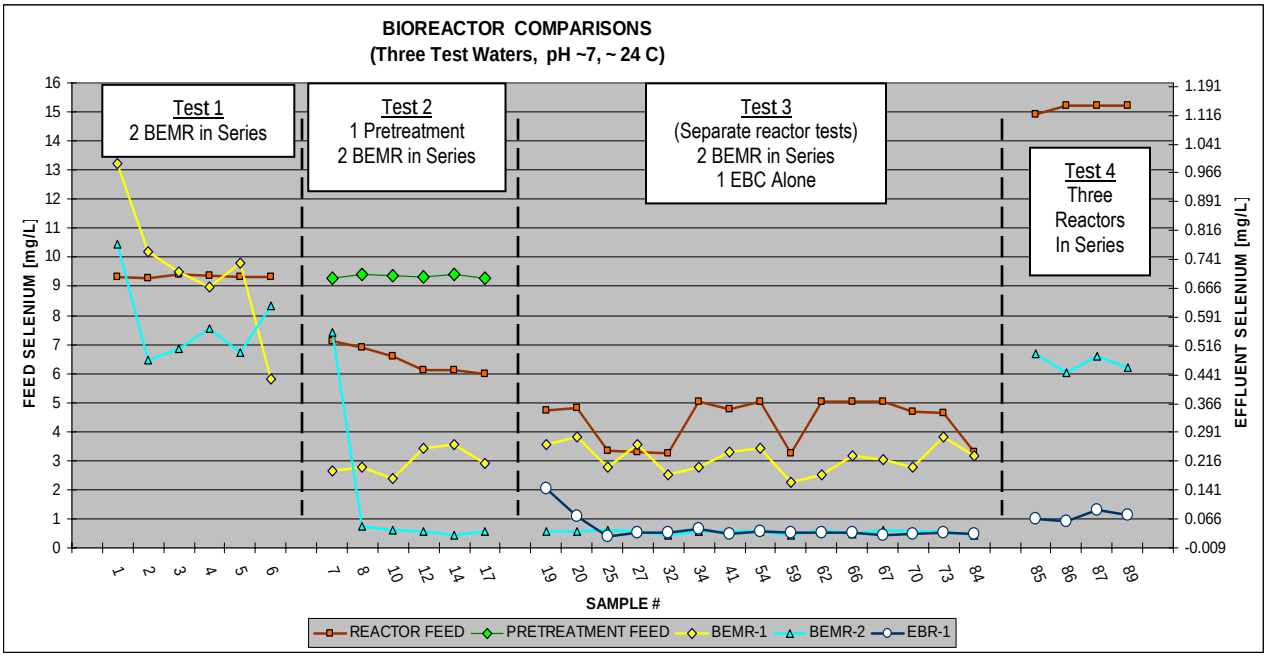

Figure 7. A comparison of a two-stage BEMR and a separate single-stage EBR comparison using a twenty-two hour retention time per stage for a forty-four hour overall retention time in the BEMRs and a twenty-two hour retention time in the EBR. Dashed lines show breaks in reactor testing that included reactor start-up, down time, and re-equilibration of bioreactors for new test solutions or test configurations. The BEMRs and EBR comparisons were made with one test water at ~4.3 mg/L selenium; the BEMRs tests used three different test waters. The BEMRs were used to test three different test water selenium concentrations ~9 mg/L (spiked), ~4.3 mg/L, and ~15 mg/L. The reactor data shown represents operation at one nutrient concentration; 3.75 g/L. Reactors were operated at Laboratory temperature ~24° C.

In Test 1 the bioreactors appear to still be approaching a steady state. In this test, waters containing ~9 mg/L selenium were introduced into the bottom of BEMR-1 and flowed from the bottom to the top of BEMR-1 then into the bottom of BEMR-2; effluents were sampled at the top of BEMR-1 and BEMR-2. Nutrients were added to the feed solution entering the bottom of BEMR-1 using 100 mL of 3.75 gm/L nutrient once daily; no nutrients were added to BEMR-2 during this test except what carried over from BEMR-1. Retention time in each BEMR stage was twenty-two hours for a total retention time of forty-four hours and produced a final effluent averaging ~0.58 mg/L selenium.

In Test 2 the bioreactor configuration was changed to include a pretreatment step in which the feed waters containing ~9 mg/L selenium were held at ~24° C for forty eight hours with microbes and 100 mL of nutrient before entering the bioreactor. This simulated holding pond, with no microbial support materials, removed an average of ~2.9 mg/L selenium. At this point, the test water now containing ~6.5 mg/L selenium was again supplemented with 100 mL of nutrient and continued to flow into BEMR-1 and BEMR-2 as in Test 1; no nutrients were added to BEMR-2 during this test except what carried over from BEMR-1. Retention time in each BEMR stage was twenty-two hours for a total retention time of forty-four hours and produced a final effluent averaging ~0.029 mg/L selenium, if the first data point in this test is not included.

In Test 3 the bioreactor configuration was changed to eliminate the pretreatment step in Test 2. In this test, waters containing ~4.3 mg/L selenium were introduced into BEMR-1 and BEMR-2 as in Test 1, but 100 mL nutrient was added to the bottom of both BEMR-1 and BEMR-2 for a total of 200 mL nutrient once daily; the effluent was sampled at the top of BEMR-2. Retention time in each BEMR stage was twenty-two hours for a total retention time of forty-four hours producing an average final effluent of ~0.031 mg/L selenium.

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During Test 3, the EBR was started after a period of preliminary tests and operated independent of the BEMRs; no pretreatment step was included. Separate test waters were introduced into the bottom of the EBR and flowed to the top where the effluent was sampled. One hundred milliliters of 3.75 gm/L nutrient was added to the bottom of the EBR once daily. Retention time in the EBR was twenty-two hours and produced a final effluent of ~0.030 mg/L selenium if the initial data point is discarded.

In Test 4 the bioreactor configuration was again changed to connect the BEMRs and EBR in series using new test waters containing ~15 mg/L selenium and a different water chemistry than in Tests 1, 2, and 3; no pretreatment step was included. In this test, waters were introduced into the bottom of BEMR-1 - to the bottom of BEMR-2 - to the bottom of the EBR; 100 mL of 3.75 gm/L nutrient was added to the bottom all reactors for a total of 300 mL nutrient once daily. Retention time in each reactor stage was twenty-two hours for a total retention time of sixty-six hours and produced an effluent averaging ~0.47 mg/L selenium from the two stage BEMRs and a final effluent from the EBR averaging ~0.072 mg/L selenium.

Evaluation for pilot-scale tests

Several different water chemistries were tested in *Phase 3*; one was close to the provided target process water chemistry with ~4.3 mg/L selenium, and all three were samples were initially thought to be samples of potential water chemistry. A two stage BEMR system of a single stage EBR came close to meeting target discharge criteria of 20 ppb on two of the potential target water chemistries. Addition of another reactor stage or increased retention times should meet these goals, but selenium removal is dependent on the water chemistry, and initial selenium concentration. In assessment of reactor performance, using the five buckets containing ~4.3 gm/L selenium, good selenium reduction and removal was achieved in the BEMRs with a forty-four hour retention time and in the EBR with a twenty-two hour retention time. Oxidation–reduction potential and pH were measured at three points within each reactor and provided for the BEMRs as Attachment 2.

Testing results indicate that a holding pond can be used for slower but significant selenium reduction if treated with nutrients and microbes. The effectiveness of the holding pond could be increased by addition of a microbial support growth surface; however, this would reduce the effective size of the pond. There was no attempt to determine the trade-off between pond size and addition of microbial growth surface which would increase the reaction kinetics.

The single stage EBR, with a twenty-two hour retention time, had the same performance as the two-stage BEMRs with a forty-four hour retention time. The level of selenium removals should be improved in both systems with the addition of a holding pond with microbes and nutrients. *It is likely that target selenium goals of 20 ug/L would have been obtained if a holding pond, with microbial support materials, had been used ahead of the bioreactors in Test 3, Figure 7.*

Selenium removal was good within the BEMRs even as the oxidation-reduction potential dropped into the -200 to -250 mV range between samples 40 and 45. This range is lower than is often considered optimal for the best selenium removal and is due to the amount of nutrients added to the bioreactors. This profile decrease in ORP has been noted in bench- pilot- and full-scale bioreactors and indicates that even though lower nutrient levels exhibited lower growth rates, *Figure 3*, in the long term these lower nutrient concentrations will still develop a substantial biofilm that should function well for selenium removal with significantly lower nutrient concentrations. *In all full-scale biotreatment systems implemented to date, significantly less nutrients were required once biofilm establishment was complete.*

Therefore, it is appropriate to start out a pilot- or full-scale bioreactor with higher nutrient levels to establish a biofilm and then reduce the nutrients significantly once the biofilm is developed. In colder water temperatures the formation of microbial biofilms is slowed considerably and unless the water can be heated, the development of a robust biofilm can take many months. This means the drop in ORP, observed in the bench-scale reactors, may not be observed for a much longer time, but is a good indicator of a mature biofilm and excess nutrients.

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The pH increased within the BEMR environment as expected because the concentrated nutrient solution was slightly acidic even when made up with pH adjusted test water; it initially degrades into less acidic byproducts. The bench-scale reactors exhibited pH profiles similar to those observed in full-scale bioreactors. A similar pH profile would be expected during pilot-scale tests.

When nutrient levels in biotreatment systems are not well balanced and in some instances where they are well balanced, post treatment to reduce biological oxygen demand (BOD) is required. In colder climates and instances where the biotreatment systems are shut down for any period a post treatment system is required to reduce BOD.

Additional Water Quality Criteria

As *Phase 3* was being completed, a number of additional metals were identified as potential permitting criteria. As indicated in *Table 1*, the pumice materials used as a microbial growth support were a significant source of several metals of interest. This source of metals could be removed by using gravel or activated carbon, but the gravel would provide significantly less surface area for a microbial biofilm, therefore lower selenium reduction kinetics, and virgin activated carbon would be considerably more expensive. The two different bioreactor types removed different amounts of different metals; however a significant reduction in all metals of interest except copper and nickel was achieved. Copper, at these levels is a component in many nutrients; but the origin of the nickel increase is currently unknown in the BEMRs. *Table 1* data is average data from14 points throughout the experiment.

Table 1. Additional Water Quality Criteria - Bench-Scale Bioreactors

	ITEM	ELEMENT	Al	S	Fe	Ni	Cu	Zn	As	Mo	Ag	Cd	Sb	Pb	Hg
			µg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
	AVERAGE FEED WATERS		998.95	460.67	32.00	6.23	3.00	19.48	2.61	632.52	2.04	1.77	14.93	5.02	2.15
TWO BR	AVERAGE BEMR-1 EFFLUENT	22 HR RETENTION	162.63	421.73	177.37	8.31	3.00	21.77	2.67	57.64	0.30	0.16	6.21	0.77	3.41
IN SERIES	AVERAGE BEMR-2 EFFLUENT	44 HR RETENTION	58.17	339.88	255.68	11.49	4.05	32.51	1.93	12.25	0.21	0.06	3.05	2.61	1.46
	AVERAGE EBR EFFLUENT	22 HR RETENTION	23.21	176.09	339.41	10.41	3.04	31.65	1.40	55.65	0.00	0.18	10.69	5.31	2.74
BR FILL	AVERAGE ELUTED FROM PUMICE*	(gm)	200.07	0.00	175.19	1.22	1.07	7.73	0.00	0.00	0.00	0.00	0.00	0.00	0.08

(BEMR) – Bio-enhanced Materials Reactor

(BER) – Bio-electrochemical reactor

* - Average of two pumice elutions in amount per gram of pumice. Second elution amounts generally decreased by 50% to 75% with the exception of mercury which did not decrease with the 2nd elution. Elutions carried out in a manner to approximate release over the course of the experiments. No new elements showed up in 2nd elution; might expect some elution of these elements to continue over the course of the experiments conducted.

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BACKGROUND FOR PILOT-SCALE TESTING

Pre- and Post-Treatments

Considering the range of selenium values and water chemistry differences in the water samples tested in *Phases 1-3*, a pre-treatment stage is strongly recommended. This system should be sized to handle any larger than normal flow events such as those that normally occur in the spring and fall. A recommended system would consist of a holding or equilibration pond either unfilled or partially filled with a microbial growth support. Based on water chemistry and temperature, this pond should have a minimum retention time of seven days to two weeks; or based on a flow rate of 9 L/s, a void volume of ~13,000 m^3 for two weeks retention time. A better estimate of pond size, optimal retention time, and an economical trade-off in microbial support surface fill depth can be determined during pilot-scale testing.

Post-treatment is required to reduce treatment system BOD, and will be required at this site due to temperatures and operational requirements; a post-treatment system is also usually required to deal process water chemistry changes. Post-treatment consists of an aerobic stage where the selenium treatment effluents would be aerated in contact with a dense microbial population. Usually this microbial population will be available in site waters and will ultimately consist of a portion of the selenium reducing population; some of the facultative anaerobes. The type of post-treatment system required is dependent on nutrient load and can vary from a conventional trickling filter to an actively aerated system.

Pilot-Scale Treatment Size

The project flow rate for full scale treatment is approximately 9 L/s; therefore, recommended flow rates for a large pilot-scale test would be 0.7, 0.9, and 1.1 L/s or flow rates about one-tenth of the full-scale flow. Smaller pilot-scale tests can be conducted and are often designed around flow rates of 0.02% of the target flow rate or 0.14, 0.18, and 0.22 L/s. Test flow rates are not fixed and should be adjusted to meet site requirements. Based on 50% void volumes and retention times needed, estimated system sizes for the pilot-scale tests are presented in *Table 2* below.

Table 2. Treatment System Component Size – Void Volume 50%.

Flow Rate (L/s)	Total Flow/ Tmt Cycle (L/Day)	Pre-treatment Size (m^3)	Treatment System Size (m^3)	Post-treatment Size (m^3)
0.14	12,096.0	406.4	79.8	14.5
0.18	15,552.0	522.5	102.6	18.7
0.22	19,008.0	638.7	125.5	22.8
0.7	60,480.0	2032.1	399.2	72.6
0.9	77,760.0	2612.7	513.2	93.3
1.1	95,040.0	3193.3	627.3	114.0

Total Flow – Flow Rate L/sec*60 sec/min*60 min/hr*24 hrs/day

Pre-treatment Size – (Flow Rate L/sec*60 sec/min*60 min/hr*24 hrs/day*14 days)/1,000 L/m^3 *2 vv*1.2 sizing factor

Treatment System – (Flow Rate L/sec*60 sec/min*60 min/hr*66 hrs)/1,000 L/m^3 *2 vv*1.2 sizing factor

Post-Treatment Size – (Flow Rate L/sec*60 sec/min*60 min/hr*12 hrs)/1,000 L/m^3 *2 vv*1.2 sizing factor

Treatment Costing Assumptions

The following assumptions are made for the included pilot-scale cost estimate.

- Site lodging and meals will be provided during time at site
- Testing time is June through August – three months
- Labor assistance by on-site personnel
- Weekends or cycle time in Whitehorse, YK (~24 days) - Transportation to Whitehorse
- Power, pumps, tanks/ponds, piping, and water heater at site
- Near-by gravel or pumice supply – provided on site
- Inoculum scale-up tanks – can use treatment system tanks
- Nutrient tank, costs, and transportation to site – ~106 tons OR ~20,000 gal – covered in cost estimate
- 1/10 flow pilot-scale test

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Cost Estimate

This is a rough estimate of costs for a 1/10 flow pilot-scale test for a period of three months. Costs will change upon further discussion and refinement of desired test period, test parameters, potential site personnel involvement, and materials that can be provided on site.

Cost Proposal for Pilot-Scale Study at Yukon Mine Site

	Technical Director Consultant	Principal Engineer/ Scientist	Senior Engineer	Associate Engineer/ Scientist	Environmental Scientist Microbiologist	Technician	TOTAL HOURS	TOTAL LABOR $
Hourly Billing Rate	$185	$120	$80	$83	$54	$36		
TASKS								
1. Project Management								
a. Coordination and Oversight	30			20	40		90	$9,370.00
b. Client Review Meetings	16				16		32	$3,824.00
Project Management Hours	**46**	**0**	**0**	**20**	**56**	**0**	**122**	
Project Management Subtotal Labor Dollars	**$8,510**	**$0**	**$0**	**$1,660**	**$3,024**	**$0**		**$13,194.00**
2. Laboratory Optimization								
a. Water Characterization	4			8	16		28	$2,268.00
b. Culture Screening	4				24		28	$2,036.00
Laboratory Optimization Subtotal Hours	**8**	**0**	**0**	**8**	**40**	**0**	**56**	
Laboratory Optimization Subtotal Labor Dollars	**$1,480**	**$0**	**$0**	**$664**	**$2,160**	**$0**	**$4,304**	**$4,304.00**
3. Pilot-Scale Operations								
a. Bioreactor Preparation	40			16	160		216	$17,368.00
b. Inoculum Preparation	40				160	40	240	$17,480.00
c. Pilot-Scale Operation	40			16	160		216	$17,368.00
d. Microbial Support	8				8	40	56	$3,352.00
e. Report Preparation	24			16	24		64	$7,064.00
Pilot-Scale Operations Hours	**152**	**0**	**0**	**48**	**512**	**80**	**792**	
Total Pilot-Scale Operations Labor Dollars	**$28,120**	**$0**	**$0**	**$3,984**	**$27,648**	**$2,880**		**$62,632.00**
Total Project Hours	**206**	**0**	**0**	**76**	**608**	**80**	**970**	
Total Project Labor Dollars	**$38,110**	**$0**	**$0**	**$6,308**	**$32,832**	**$2,880**	**$80,130**	**$80,130.00**
							Total Other Direct Charges	**$82,351.50**
							Total Estimated Project Fees	**$162,481.50**

Other Direct Charges (ODC's)

Air/Mileage	Mileage Cost	Misc. Supplies	Nutrients	Equipment Lease	Lodging & Meals	TOTAL ODC's
	0.45					
2000	900.00					$900.00
						$0.00
$9,600.00					$2,880.00	$12,480.00
Project Management Subtotal ODC's						**$13,380.00**
400	180.00					$180.00
	-					$0.00
Laboratory Optimization Subtotal Subtotal ODC's						**$180.00**
	-	$2,000.00		$3,700.00		$5,700.00
	-	$350.00	$50,000.00			$50,350.00
	-	$2,000.00				$2,000.00
	-					$0.00
	-					$0.00
Total Pilot-Scale Operations Subtotal ODC's						**$58,050.00**

Subtotal Other Direct Charges	**$71,610.00**
Administrative and Handleing Fee @ 15%	**$10,741.50**
Total Other Direct Charges	**$82,351.50**

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ATTACHMENT 1. BULK TAILINGS ANALYSIS

ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES

Environmental Division

ANALYTICAL REPORT

LORAX ENVIRONMENTAL SERVICES
ATTN: JONATHAN MACKIN
2289 BURRARD STREET
VANCOUVER BC V6J 3H9

Reported On: 27-SEP-07 11:13 AM

Lab Work Order #: L550876 Date Received: 06-SEP-07

Project P.O. #:
Job Reference: 474-1 YUKON ZINC
Legal Site Desc:
CofC Numbers:

Other Information:

Comments:

Timothy Guy Crowther
General Manager, Vancouver

For any questions about this report please contact your Account Manager:

Andre Langlais

THIS REPORT SHALL NOT BE REPRODUCED EXCEPT IN FULL WITHOUT THE WRITTEN AUTHORITY OF THE LABORATORY.
ALL SAMPLES WILL BE DISPOSED OF AFTER 30 DAYS FOLLOWING ANALYSIS. PLEASE CONTACT THE LAB IF YOU REQUIRE ADDITIONAL SAMPLE STORAGE TIME.

ALS Canada Ltd.
[illegible] ALS Laboratory Group
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A Campbell Brothers Limited Company

ALS LABORATORY GROUP ANALYTICAL REPORT

Grouping	Analyte	Sample ID Description Sampled Date Sampled Time Client ID	L550876-1 05-SEP-07 BULK TAILINGS 1 (9/10/11)	L550876-2 05-SEP-07 BULK TAILINGS 2 (12/13/17)	L550876-3 05-SEP-07 BULK TAILINGS 3 (14/15/16)	L550876-4 05-SEP-07 PB RO CONC	L550876-5 05-SEP-07 CU RO CONC
WATER							
Physical Tests	Hardness (as CaCO3) (mg/L)		802	834	697	411	463
	Conductivity (uS/cm)		1730	1830	1530	1110	1190
	pH (pH)		10.3	10.7	10.2	7.62	7.91
	Total Dissolved Solids (mg/L)		1550	1560	1330	875	952
	Total Suspended Solids (mg/L)		9.3	<3.0	5.3	<3.0	<3.0
	Turbidity (NTU)		7.38	0.57	3.48	13.9	19.9
Anions and Nutrients	Ammonia as N (mg/L)		0.265	0.389	0.184	0.235	0.197
	Alkalinity, Total (as CaCO3) (mg/L)		106	151	101	7.3	81.3
	Bromide (Br) (mg/L)		<0.050	<0.050	<0.050	<0.050	<0.050
	Chloride (Cl) (mg/L)		4.44	4.91	5.27	6.07	5.89
	Fluoride (F) (mg/L)		0.167	0.161	0.134	0.114	0.093
	Sulfate (SO4) (mg/L)		597	632	534	393	460
	Nitrate (as N) (mg/L)		0.556	0.550	0.459	0.434	0.473
	Nitrite (as N) (mg/L)		0.0167	0.0085	0.0115	0.0067	0.0059
	Ortho Phosphate as P (mg/L)		0.0042	0.0048	0.0029	0.0035	<0.0010
	Total Phosphate as P (mg/L)		0.213	0.142	0.130	0.242	0.0038
Cyanides	Cyanide, Weak Acid Diss (mg/L)		<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
	Cyanide, Total (mg/L)		<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
	Thiocyanate (SCN) (mg/L)		<0.50	0.58	0.55	<0.50	0.69
Total Metals	Aluminum (Al)-Total (mg/L)		1.19	1.26	1.11	0.0219	0.0117
	Antimony (Sb)-Total (mg/L)		0.0287	0.0294	0.0301	0.0253	0.0598
	Arsenic (As)-Total (mg/L)		0.00789	0.00532	0.00611	0.00379	0.00458
	Barium (Ba)-Total (mg/L)		0.190	0.188	0.174	0.120	0.160
	Beryllium (Be)-Total (mg/L)		<0.0025	<0.0025	<0.0025	<0.0025	<0.0025
	Bismuth (Bi)-Total (mg/L)		<0.0025	<0.0025	<0.0025	<0.0025	<0.0025
	Boron (B)-Total (mg/L)		<0.050	<0.050	<0.050	<0.050	<0.050
	Cadmium (Cd)-Total (mg/L)		<0.0020	<0.0020	<0.0020	0.00229	0.00601
	Calcium (Ca)-Total (mg/L)		321	334	279	155	175
	Chromium (Cr)-Total (mg/L)		<0.0025	<0.0025	<0.0025	<0.0025	<0.0025
	Cobalt (Co)-Total (mg/L)		<0.00050	<0.00050	<0.00050	<0.00050	0.00195
	Copper (Cu)-Total (mg/L)		0.00335	0.00095	0.00125	0.0118	0.0652
	Iron (Fe)-Total (mg/L)		0.308	0.039	0.158	0.048	1.02
	Lead (Pb)-Total (mg/L)		0.469	0.748	0.239	0.294	0.622
	Lithium (Li)-Total (mg/L)		<0.025	<0.025	<0.025	<0.025	<0.025
	Magnesium (Mg)-Total (mg/L)		<0.10	<0.10	<0.10	5.81	6.14
	Manganese (Mn)-Total (mg/L)		0.00548	0.00048	0.00208	0.146	2.98
	Molybdenum (Mo)-Total (mg/L)		0.661	0.696	0.562	0.0183	0.00529
	Nickel (Ni)-Total (mg/L)		<0.0025	<0.0025	<0.0025	<0.0025	0.0546
	Phosphorus (P)-Total (mg/L)		<0.30	<0.30	<0.30	<0.30	<0.30

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ALS LABORATORY GROUP ANALYTICAL REPORT

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		L550876-1 05-SEP-07 BULK TAILINGS 1 (9/10/11)	L550876-2 05-SEP-07 BULK TAILINGS 2 (12/13/17)	L550876-3 05-SEP-07 BULK TAILINGS 3 (14/15/16)	L550876-4 05-SEP-07 PB RO CONC	L550876-5 05-SEP-07 CU RO CONC
WATER						
Total Metals	Potassium (K)-Total (mg/L)	8.2	7.4	6.4	5.7	5.4
	Selenium (Se)-Total (mg/L)	3.05	3.21	2.54	0.907	0.676
	Silicon (Si)-Total (mg/L)	0.149	0.110	0.148	0.145	1.05
	Silver (Ag)-Total (mg/L)	0.00262	0.00217	0.00122	0.00317	0.00849
	Sodium (Na)-Total (mg/L)	80.8	87.6	70.5	65.8	66.3
	Strontium (Sr)-Total (mg/L)	0.859	0.876	0.747	0.396	0.433
	Thallium (Tl)-Total (mg/L)	0.00152	0.00154	0.00187	0.00721	0.0103
	Tin (Sn)-Total (mg/L)	0.00825	0.00897	0.0165	0.00126	0.00194
	Titanium (Ti)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Uranium (U)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	0.000520
	Vanadium (V)-Total (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
	Zinc (Zn)-Total (mg/L)	0.314	0.486	0.293	0.190	2.44

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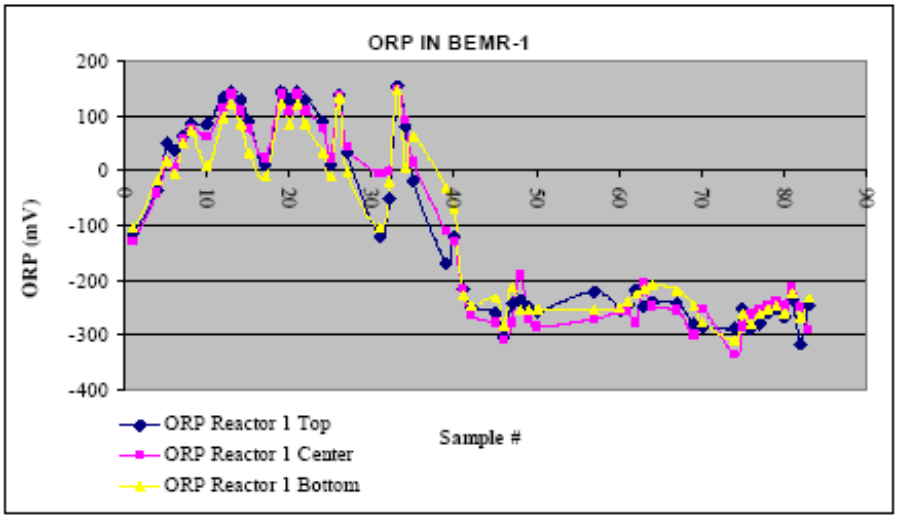
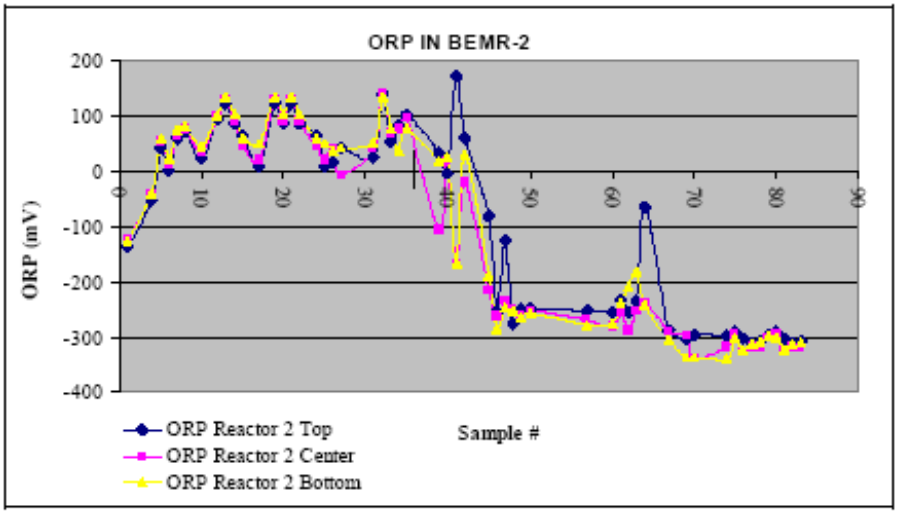
ATTACHMENT 2. BEMR ORP and pH PROFILES

ATTACHMENT 2. OXIDATION REDUCTION POTENTIAL AND pH IN BEMRs

Oxidation Reduction Potential





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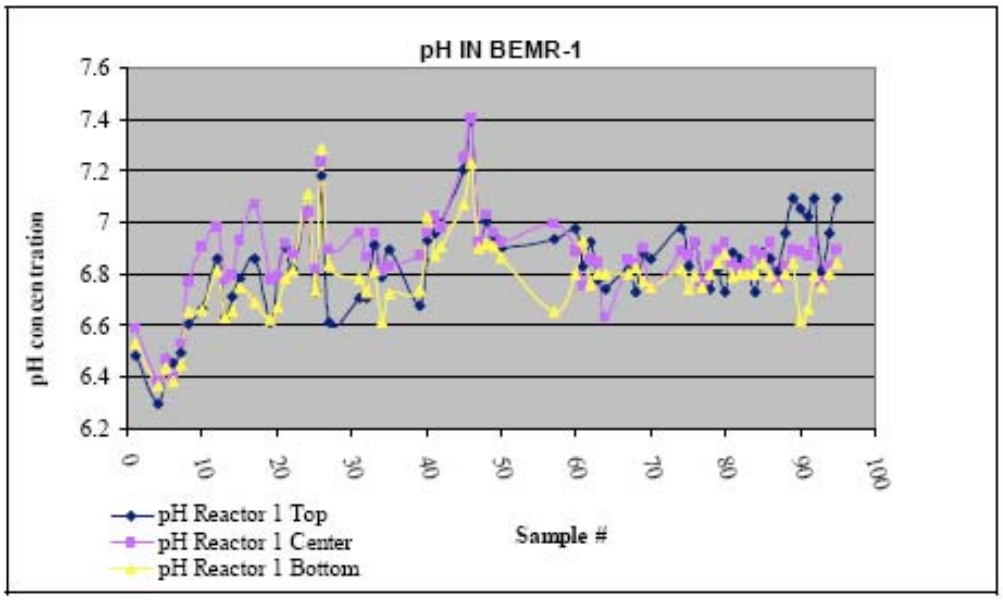
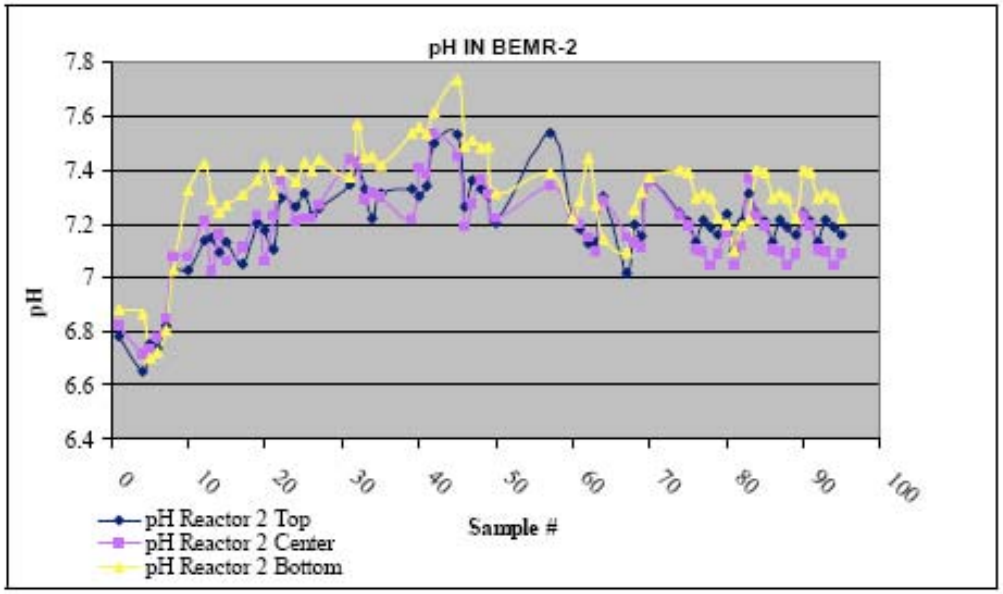
pH in Bemrs





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