



APPENDIX F-2
Geochemical Characterization

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ABBREVIATIONS

Ag – Silver	CNS – Thiocyanate	NO ₃ ⁻ – Nitrate
Al – Aluminium	CNT – Total Cyanate	P – Phosphorous
As – Arsenic	Cr – Chromium	Pb – Lead
Au – Gold	Cu – Copper	S – Sulphur
B – Boron	F – Flourine	Se – Selenium
Ba – Barium	Fe – Iron	Si – Silicon
Be – Beryllium	K – Potassium	Sn – Tin
Bi – Bismuth	Li – Lithium	SO ₄ – Sulphate
C – Carbon	Mg – Magnesium	S ²⁻ – Sulphide
Ca – Calcium	Mn – Manganese	Sr – Strontium
Cd – Cadmium	Mo – Molybdenum	Ti – Titanium
Cl – Chlorine	N – Nitrogen	Tl – Thallium
Co – Cobalt	Na – Sodium	U – Uranium
CO ₃ ²⁻ – Carbonate	NH ₃ – Ammonia	V – Vanadium
CNO – Cyanate	Ni – Nickel	Zn – Zinc

ABA – Acid Base Accounting

AP – Acid Potential

DI – Deionised

ICP MS – Inductively Coupled Plasma Mass Spectrometry

ICP OES – Inductively Coupled Plasma Optical Emission 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 CHARACTERIZATION

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, mineralogical examination and 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 below.

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 CaCO₃/t to -1038 kg CaCO₃/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

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 ageing.

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 SO₄²⁻ suggesting soluble ZnSO₄, 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 prior to DMS floatation, where necessary. Table 1.1 summarizes the drill hole intervals used to prepare the ore and dilution rock samples.

Table 1.1 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	118.0-120.6, 128.6-130.6, 143.8-149.7	51.9
		Dilution	120.6-121.2,127.2-128.6, 142.6-143.8,149.7-150.5	11.3
Lynx	WV04-123	Ore	175.9-176.7, 179.3-183.0	21.4
		Dilution	174.9-175.9,176.7-179.3, 183.0-183.9	11.9
Wolverine	WV04-124	Ore	118.52-119.33,120.1-123.34	22.1
		Dilution	117.38-118.52,119.33-120.10,123.34-123.86	9.5
Wolverine	WV04-125	Ore	240.0-240.2, 242.5-246.7	27.8
		Dilution	239.0-240.0, 240.4-242.5, 246.7-247.0	10.6
Wolverine	WV04-126	Ore	151.7-152.5, 154.3-155.6	9.8
		Dilution	149.9-151.7, 152.5-154.3, 155.6-156.6	11.1
Wolverine	WV04-127	Ore	175.4-180.6	23.0
		Dilution	175.0-175.4, 180.6-181.6	5.8
Lynx	WV04-129	Ore	331.7-338.8	51.9
		Dilution	331.1-331.7, 338.8-339.0	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 1.1 and then separate Lynx and Wolverine diluted ore composites were prepared and screened. The +20 mesh material was treated through Dense Media Separation. The sinks fraction was then recombined with the minus 20 mesh screened fraction and this material became the flotation test feed materials. 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, 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 by SGS Lakefield 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.

The flowsheet used is given in Figure 1.1. The SGS Lakefield metallurgical test number and the corresponding ore composite are listed in Table 1.2:

Ground Feed Prefloat Cu Rougher
Prefloat Cl Cu Re grind
Prefloat Cl Conc
Cu 1st Cleaner Cu 1st Cl Scavenger
Cu 2nd Cleaner
Cu 2nd Cl Conc
Pb Rougher
Pb Re grind
Pb 1st Cleaner Pb 1st Cl Scavenger
Pb 2nd Cleaner
Pb 2nd Cl Conc
Zn Rougher Zn Rougher Tailing
Zn Re grind
Zn 1st Cleaner Zn 1st Cl Scavenger
Zn 1st Cl Scav Tailing
Zn 2nd Cleaner
Zn 3rd Cleaner
Zn 4th Cleaner
Zn 4th Cl Conc

Figure 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.

Table 1.2 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 (pulp) 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 solid 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, total suspended solids (TSS), total dissolved solids (TDS), acidity, alkalinity, hardness, chloride (Cl⁻), fluoride (F⁻), nitrate (NO₃⁻), sulphate (SO₄²⁻), total cyanide (CN_(T)), cyanate (CNO), thiocyanate (CNS), ammonia (NH₃), thiosalts and a suite of dissolved metal(loid)s including mercury (Hg). The excess filtrate was reserved in storage. Filter cake solids were submitted for modified acid base accounting (ABA), inductively coupled plasma-mass spectroscopy (ICP-MS) metal(loid) analyses on an *aqua regia* digest, whole rock X-ray fluorescence (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 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, 2005. 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 ageing 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 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 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 ageing 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 filtrate 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 this 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.

Number of Geochemical Tests

Table 1.3 provides a summary of the sample counts for each test used to evaluate the metal leaching and ARD potential of the sample tailings. The results of these analytical techniques are most useful for interpretation when considered in combination.

Table 1.3 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	
<i>Daphnia magna</i> Acute Lethality	8
Rainbow trout Acute Lethality	4

1.3 Mineralogical Assessment

Mineralogical assessment of the Wolverine tailings was undertaken using optical petrography, XRD and whole rock XRF analysis. Optical petrography and XRD with Rietveld refinements were performed by the University of British Columbia while whole rock XRF was performed by SGS Lakefield.

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. Minerals 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 1.4 lists the minerals identified by optical petrography and their modal abundance.

Table 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 10 to 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

Samples from the four combined tailings samples were sent to Dr. Mati Raudsepp, Department of Earth and Ocean Sciences, University of British Columbia, for quantitative phase analysis using x-ray diffraction (XRD) by the Rietveld Method. 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 1.5.

Table 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 ₂ AlSi ₃ O 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⁺) ₅ Al(Si ₃ Al)O ₁₀ (OH) ₈	1.6	1.7	4.6	nd
Gypsum	CaSO ₄ ·H ₂ O	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 ₂ Si ₂ O 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 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 X-ray fluorescence (XRF).

Samples were crushed to 150 mesh and thermally fused with lithium borate forming a glass disk. The disk was then analyzed by wavelength dispersive x-ray fluorescence (WDXRF) spectrometry for the oxides. Loss on ignition is determined separately at a temperature of 1000 °C.

1.3.3.2 Results

The whole rock analysis results of the tailings samples are presented in Table 1.6 as oxides and in Table 1.7 as elemental concentrations.

Table 1.6 Whole Rock Analysis of Tailings Samples

Oxide	Overall Ro	Overall CI 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 (wt. %)	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 ₂ O ₃ (wt. %)	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 ₂ O ₃ (wt. %)	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 (wt. %)	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 (wt. %)	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 ₂ O (wt. %)	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 ₂ O (wt. %)	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 (wt. %)	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 ₂ O ₅ (wt. %)	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 (wt. %)	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 ₂ O ₃ (wt. %)	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 ₂ O ₅ (wt. %)	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 (wt. %)	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 1.7 Elemental concentrations calculated from whole rock data

Element	Overall Ro	Overall CI 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 (wt. %)	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 (wt. %)	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 (wt. %)	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 (wt. %)	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 (wt. %)	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 (wt. %)	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 (wt. %)	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 (wt. %)	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 (wt. %)	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 (wt. %)	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 (wt. %)	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 (wt. %)	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 Fe₂O₃ 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 -Fe₂O₃) and/or maghemite (γ -Fe₂O₃). 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, clinocllore and kaolinite;
- CO₂ from organics, dolomite, calcite and/or siderite;
- H₂O 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 (TAP) 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 CaCO₃ 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 CaCO₃ 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 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. 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 neutralization potential (NP) of the sample is calculated from the titration data.

Carbonate Neutralization Potential is calculated using the TIC measurement converted back to calcium carbonate equivalent, thus assuming all inorganic carbon is in the form of CaCO₃. 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 acid producing potential (AP) is derived from the total sulphur or sulphide sulphur value as explained previously. The neutralization potential (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 1.8.

Table 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, clinocllore 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 Neutralizing Potential Ratio (NPR), serves as a guide in identifying the likelihood of ARD conditions and distinguishing samples from a deposit as Potentially Acid Generating (PAG) from Non-potentially Acid Generating (Non-PAG). Price (1997) provides some criteria for guiding geochemical test work and evaluating the potential for ARD shown in Table 1.9.

Table 1.9 ABA Screening Criteria

POTENTIAL FOR ARD	INITIAL SCREENING CRITERIA
Likely	$NPR \leq 1$
Possible	$1 < NPR \leq 2$
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 likely PAG (NPR less than one). However, the samples currently have enough NP (Carb NP of 20-100 kg CaCO₃/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

Inductively Coupled Plasma-Mass Spectrometry 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 (HNO₃ 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 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 1.11.

Table 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	82.0	41	65	54.4
Al	%	8.36	0.67	0.22	0.43	0.99	0.18	0.60	1.2	0.33	1.0	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	0.30	0.10	0.24	0.20	0.04	0.12
Bi	mg/kg	0.0082	7.5	7.5	7.5	8.1	13	11	12	42	19	6.0	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	3.0	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	23.0	36.0	28.0	18.0	38.0	23.0	14.0	34.0	18.0	22.0	38.0	27.0
Hg	mg/kg	0.086	1.5	9.5	3.2	2.4	5.8	3.6	2.0	8.5	4.0	2.4	4.9	3.2
K	%	1.84	0.33	.012	0.21	0.30	0.06	0.17	0.31	0.10	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	1.0	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

Table 1.10 ICP-MS Solid-phase Results (continued)

ELEMENT	UNITS	CRUSTAL¹	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	6.0	4.0	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 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 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 1.12.

Table 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 ₂ O 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
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

Parameter	Units	MMER ¹	10X CCME ²	Comb Overall Ore Comp	Comb OD	Comb Wolv D	Comb Lynx D
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	<i>0.00015</i>	0.00023
Cr	mg/L		0.010*	<i>0.0005</i>	<i>0.0005</i>	<i>0.0005</i>	<i>0.0005</i>
Cu	mg/L	0.30		0.0015	0.0014	0.0009	0.0021
Fe	mg/L			<i>0.01</i>	<i>0.01</i>	<i>0.01</i>	<i>0.01</i>
Hg	mg/L		0.00026	<i>0.00005</i>	<i>0.00005</i>	<i>0.00005</i>	<i>0.00005</i>
K	mg/L			1.9	0.91	1.2	0.55
Li	mg/L			<i>0.002</i>	<i>0.0025</i>	<i>0.0025</i>	<i>0.0025</i>
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			<i>0.05</i>	<i>0.05</i>	<i>0.05</i>	<i>0.05</i>
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			<i>0.0005</i>	<i>0.0005</i>	<i>0.0005</i>	<i>0.0005</i>
Sr	mg/L			0.33	0.064	0.066	0.059
Ti	mg/L			<i>0.0015</i>	<i>0.0015</i>	<i>0.0015</i>	<i>0.0015</i>
Tl	mg/L		0.0080	0.022	0.0063	0.0023	0.0087
U	mg/L			<i>0.0001</i>	<i>0.0001</i>	<i>0.0001</i>	<i>0.0001</i>
V	mg/L			0.0010	<i>0.00045</i>	<i>0.00045</i>	<i>0.00045</i>
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, 10x CCME and/or 10X BC guidelines

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). In lieu of MMER guidelines, Canadian Council of Ministers of the Environment (CCME) Canadian Water Quality Guidelines (CWQG) 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 CXCME 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 reassy was conducted to confirm the release of SO_4^{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 1.13 through

Table 1.16. Photos of the testing set-up are shown below in Figure 1.2.



Figure 1.2 Aging Test Setup

Table 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 ₂ O 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
Co	mg/L			0.0011	0.0011	0.0012	0.0009	0.0011	0.0016	0.0009	0.0021	0.0021

Table 1.13 Combined Overall Ore Composite Tailings Aging Test Results (continued)

PARAMETER	UNITS	MMER ¹	10X CCME ²	ELAPSED NUMBER OF DAYS									
				0	1	4	7	15	29	60	90	120	
Cr	mg/L		0.010*	<i>0.0005</i>	<i>0.0005</i>	<i>0.0005</i>	<i>0.0005</i>	<i>0.0005</i>	<i>0.0005</i>	<i>0.0005</i>	<i>0.0005</i>	<i>0.0005</i>	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	0.0024
Fe	mg/L		3.0	0.04	0.03	<i>0.01</i>	0.05	<i>0.01</i>	<i>0.01</i>	<i>0.01</i>	<i>0.01</i>	<i>0.01</i>	<i>0.01</i>
K	mg/L			8.05	7.69	10	5.82	8.32	10.5	12	10.2	11.4	11.4
Li	mg/L			<i>0.0025</i>	<i>0.0025</i>	<i>0.0025</i>	<i>0.0025</i>	<i>0.0025</i>	<i>0.0025</i>	<i>0.0025</i>	<i>0.0025</i>	<i>0.0025</i>	<i>0.0025</i>
Mg	mg/L			5.46	5.28	6.73	6.65	8.89	11.7	14	14.4	15.1	15.1
Mn	mg/L			0.0872	0.117	0.116	0.117	0.205	0.545	1.64	1.65	2.44	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	0.0018
Na	mg/L			198	205	204	149	175	177	180	176	169	169
Ni	mg/L	0.50		0.004	0.005	0.005	0.004	0.007	0.01	0.01	0.012	0.028	0.028
P	mg/L			<i>0.05</i>	<i>0.05</i>	<i>0.05</i>	<i>0.05</i>	<i>0.05</i>	<i>0.05</i>	<i>0.05</i>	<i>0.05</i>	<i>0.0005</i>	<i>0.0005</i>
Pb	mg/L	0.20		0.0255	0.109	0.108	0.125	0.179	0.102	0.0151	0.0266	0.0760	0.0760
Sb	mg/L			0.0645	0.0506	0.0505	0.0412	0.0172	0.0249	0.0222	<i>0.025</i>	0.0142	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	0.994
Si	mg/L			0.42	0.43	0.58	0.6	0.91	1.87	2.05	3.11	2.80	2.80
Sn	mg/L			0.006	0.006	0.006	0.006	0.008	0.007	0.005	0.004	0.001	0.001
Sr	mg/L			0.304	0.318	0.325	0.325	0.311	0.37	0.495	0.490	0.539	0.539
Ti	mg/L			<i>0.0015</i>	<i>0.0015</i>	<i>0.0015</i>	<i>0.0015</i>	<i>0.0015</i>	<i>0.0015</i>	<i>0.0015</i>	<i>0.0015</i>	<i>0.0015</i>	<i>0.0015</i>
Tl	mg/L		0.0080	0.0067	0.0084	0.0084	0.0076	0.0093	0.0064	0.006	0.0106	0.0089	0.0089
U	mg/L			0.0006	0.0004	0.0004	0.0004	0.0008	0.0015	0.0011	0.0021	0.0015	0.0015
V	mg/L			<i>0.00045</i>	<i>0.00045</i>	<i>0.00045</i>	<i>0.00045</i>	<i>0.00045</i>	<i>0.00045</i>	0.0011	0.003	0.0011	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	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
** = could not be determined due to sample matrix
na = not analyzed

Table 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	<i>1</i>	282	178	91	211	64	5	<i>1</i>
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	<i>0.03</i>	0.49
TSS	mg/L	15.0		36	23	<i>1</i>	<i>1</i>	<i>1</i>	<i>1</i>	2	<i>1</i>	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 ₂ O 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	<i>0.001</i>	<i>0.005</i>	<i>0.005</i>	<i>0.01</i>	<i>0.005</i>
CNO	mg/L			1.6	1.7	1.3	0.6	1	0.6	0.4	<i>0.05</i>	<i>0.5</i>
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	<i>0.00005</i>
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	<i>0.002</i>	0.011	<i>0.002</i>
As	mg/L	0.50		0.036	<i>0.0025</i>	<i>0.0025</i>	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			<i>0.0025</i>	<i>0.0025</i>	<i>0.0025</i>	<i>0.0025</i>	<i>0.0025</i>	<i>0.0025</i>	<i>0.0025</i>	<i>0.0025</i>	<i>0.0025</i>
Be	mg/L			0.011	0.08	0.02	0.014	0.016	0.017	0.023	0.025	0.020
Bi	mg/L			<i>0.00015</i>	<i>0.00015</i>	<i>0.00015</i>	<i>0.00015</i>	<i>0.00015</i>	<i>0.00015</i>	<i>0.00015</i>	<i>0.00015</i>	<i>0.00015</i>
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
Co	mg/L			0.0007	0.0009	0.0004	0.0008	0.0009	0.0018	0.0017	0.0027	0.0035

PARAMETER	UNITS	MMER ¹	10X CCME ²	ELAPSED NUMBER OF DAYS								
				0	1	4	7	15	30	61	90	120
Cr	mg/L		0.010*	<i>0.0005</i>	<i>0.0005</i>	<i>0.0005</i>	<i>0.0005</i>	<i>0.0005</i>	<i>0.0005</i>	<i>0.0005</i>	<i>0.0005</i>	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			<i>0.01</i>	<i>0.01</i>	<i>0.01</i>	<i>0.01</i>	<i>0.01</i>	0.02	<i>0.01</i>	<i>0.01</i>	<i>0.01</i>
K	mg/L			10.6	12.1	10.4	10.7	11.5	12.4	14.2	12.6	12.3
Li	mg/L			<i>0.0025</i>	<i>0.0025</i>	<i>0.0025</i>	<i>0.0025</i>	<i>0.0025</i>	<i>0.0025</i>	<i>0.0025</i>	<i>0.0025</i>	<i>0.0025</i>
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			<i>0.05</i>	<i>0.05</i>	<i>0.05</i>	<i>0.05</i>	<i>0.05</i>	<i>0.05</i>	<i>0.05</i>	<i>0.05</i>	<i>0.05</i>
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	<i>0.0005</i>	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			<i>0.0015</i>	<i>0.0015</i>	<i>0.0015</i>	<i>0.0015</i>	<i>0.0015</i>	<i>0.0015</i>	<i>0.0015</i>	0.011	<i>0.0015</i>
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	<i>0.0001</i>	<i>0.0001</i>	0.0002	0.0004	0.0007	0.0007	0.0009	0.0009
V	mg/L			<i>0.00045</i>	<i>0.00045</i>	<i>0.00045</i>	<i>0.00045</i>	<i>0.00045</i>	<i>0.00045</i>	<i>0.00045</i>	<i>0.00045</i>	<i>0.00045</i>
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 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	<i>1</i>	<i>1</i>	4	4	2	3
Cl	mg/L			19	19	19	19	20	20	21	21	21
NO ₃ ⁻	mg N /L			<i>0.25</i>	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 ₂ O ₃ /L			553	446	5	525	362	386	243	211	260
CN _(T)	mg/L	1.0		0.02	0.02	0.01	<i>0.005</i>	<i>0.005</i>	<i>0.005</i>	<i>0.005</i>	<i>0.01</i>	<i>0.001</i>
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	<i>0.00005</i>	<i>0.00005</i>	<i>0.00005</i>	<i>0.00005</i>	<i>0.00005</i>	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	<i>0.002</i>	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			<i>0.0025</i>	<i>0.0025</i>	<i>0.0025</i>	<i>0.0025</i>	<i>0.0025</i>	<i>0.0025</i>	<i>0.0025</i>	<i>0.0025</i>	<i>0.0025</i>
B	mg/L			0.04	0.02	0.02	0.014	0.016	0.017	0.026	0.015	0.025
Bi	mg/L			<i>0.00015</i>	<i>0.00015</i>	<i>0.00015</i>	<i>0.00015</i>	<i>0.00015</i>	<i>0.00015</i>	<i>0.00015</i>	<i>0.00015</i>	<i>0.00015</i>
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

PARAMETER	UNITS	MMER ¹	10X CCME ²	ELAPSED NUMBER OF DAYS								
				0	1	4	7	15	29	60	90	120
Cr	mg/L	0.30	0.010*	0.002	0.002	<i>0.0005</i>	0.001	<i>0.0005</i>	<i>0.0005</i>	<i>0.0005</i>	<i>0.0005</i>	<i>0.0005</i>
Cu	mg/L			0.0080	0.0027	0.0174	0.0048	0.0060	0.0064	0.0046	0.0024	0.0048
Fe	mg/L	0.50	0.010*	<i>0.01</i>	<i>0.01</i>	<i>0.01</i>	<i>0.01</i>	<i>0.01</i>	0.03	<i>0.01</i>	<i>0.01</i>	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	0.20	0.010	<i>0.0025</i>	<i>0.0025</i>	<i>0.0025</i>	<i>0.0025</i>	<i>0.0025</i>	<i>0.0025</i>	<i>0.0025</i>	<i>0.0025</i>	<i>0.0025</i>
Mg	mg/L			3.31	3.45	3.87	4.75	7.36	9.80	12.9	17.6	20.1
Mn	mg/L	0.50	0.010	0.0013	0.0020	0.0065	0.0190	0.0483	0.190	0.114	0.269	0.288
Mo	mg/L			0.0497	0.0373	0.0374	0.0402	0.0426	0.0205	0.0262	0.0196	0.0108
Na	mg/L	0.20	0.010	235	234	237	233	253	259	232	238	227
Ni	mg/L			0.016	0.013	0.023	0.004	0.003	0.018	0.012	0.005	0.028
P	mg/L	0.50	0.010	<i>0.05</i>	<i>0.05</i>	<i>0.05</i>	<i>0.05</i>	<i>0.05</i>	<i>0.05</i>	<i>0.05</i>	<i>0.05</i>	<i>0.05</i>
Pb	mg/L			0.0089	0.0320	0.112	0.0782	0.0396	0.0046	0.0047	0.0024	0.0031
Sb	mg/L	0.50	0.010	0.0162	0.0095	0.0313	0.0573	0.119	0.0334	0.0704	0.0413	0.0297
Se	mg/L			1.66	1.06	1.38	1.93	0.91	0.823	1.65	1.19	1.26
Si	mg/L	0.50	0.010	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	0.50	0.010	0.282	0.213	0.298	0.318	0.312	0.312	0.346	0.470	0.527
Ti	mg/L			<i>0.0015</i>	<i>0.0015</i>	<i>0.0015</i>	0.163	<i>0.0015</i>	<i>0.0015</i>	<i>0.0015</i>	<i>0.0015</i>	<i>0.0015</i>
Tl	mg/L	0.50	0.0080	0.0021	0.0011	0.0021	0.0020	0.0028	0.0028	0.0036	0.0043	0.0034
U	mg/L			<i>0.0001</i>	<i>0.0001</i>	<i>0.0001</i>	<i>0.0001</i>	<i>0.0001</i>	<i>0.0001</i>	<i>0.0001</i>	<i>0.0001</i>	<i>0.0001</i>
V	mg/L	0.50	0.010	<i>0.00045</i>	<i>0.00045</i>	<i>0.00045</i>	<i>0.00045</i>	<i>0.00045</i>	<i>0.00045</i>	<i>0.00045</i>	<i>0.00045</i>	<i>0.00045</i>
Zn	mg/L			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 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 ₂ O 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
Cu	mg/L	0.30		0.0499	0.0027	0.0063	0.0445	0.0224	0.0182	0.0023	0.0064	0.0050

PARAMETER	UNITS	MMER ¹	10X CCME ²	ELAPSED NUMBER OF DAYS								
				0	1	3	7	15	30	59	90	120
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	<i>1</i>	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
** = could not be determined due to sample matrix
na = not analyzed

Figure 1.3 through 1.5 shows the concentrations of TSS, Zn, thiosalts and alkalinity, respectively, changing over time during the ageing tests. Metal Mining Effluent Regulation (MMER) and 10X CCME water quality guidelines for the protection of aquatic life also shown for comparison.

Figure 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 MMER limits 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 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 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 1.6.

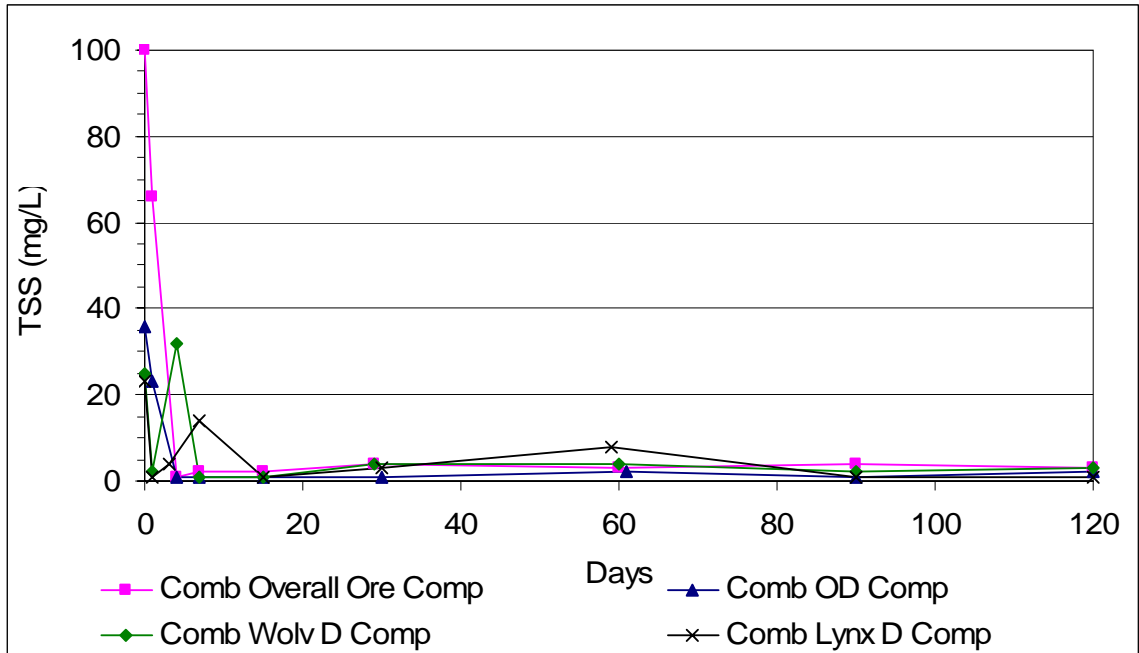


Figure 1.3 TSS in Supernatant During Aging Tests

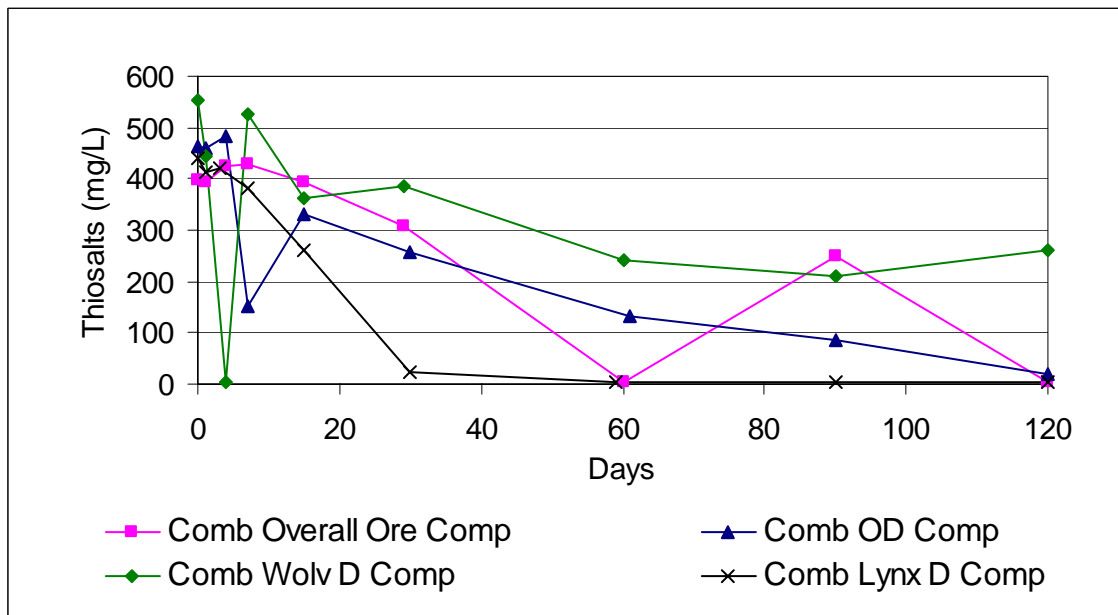


Figure 1.4 Thiosalt in Supernatant During Aging Tests

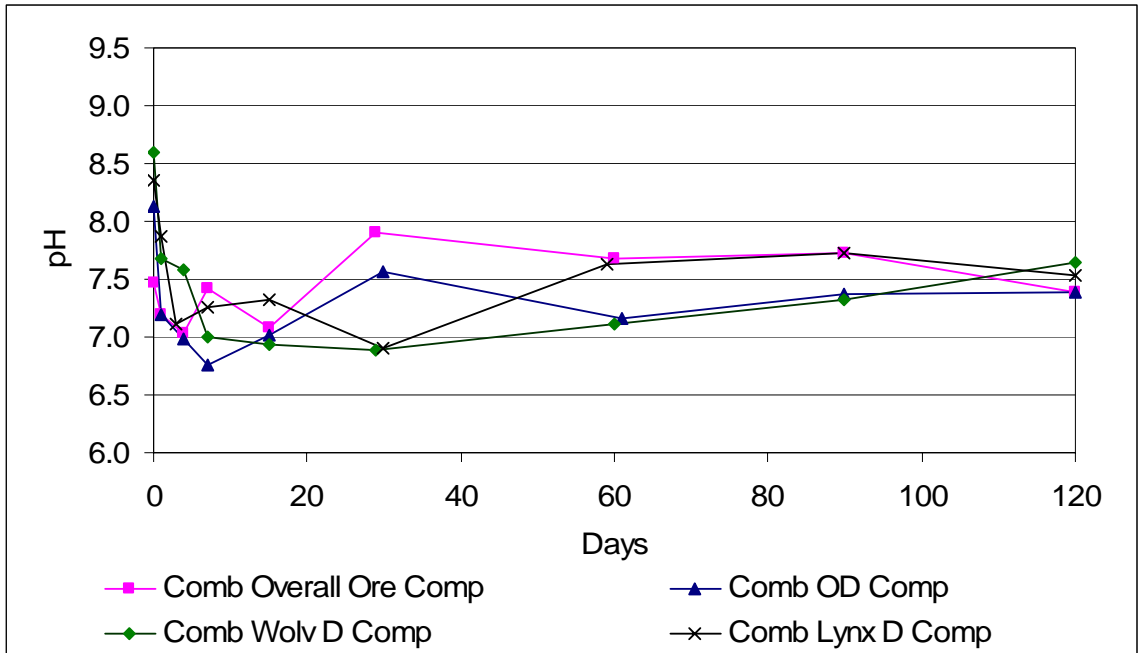


Figure 1.5 pH in Supernatant During Aging Tests

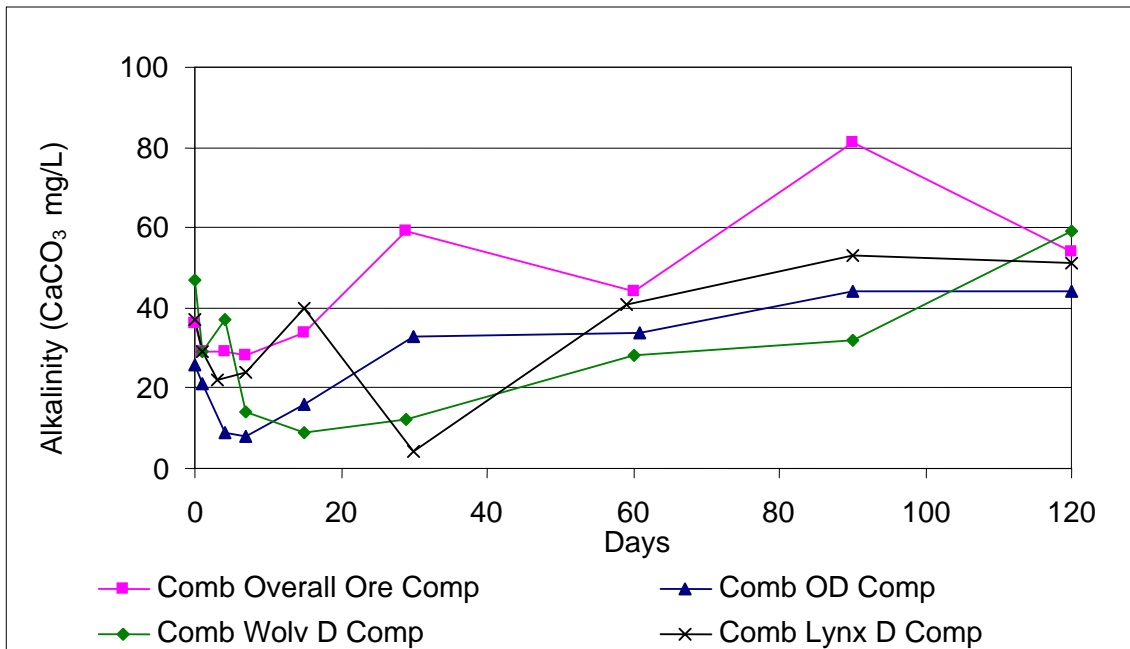


Figure 1.6 Alkalinity in Supernatant During Aging Tests

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 1.7 and Figure 1.8 shown Se and Cd may also be released to the surrounding aqueous phase in excess of 10X CCME water quality guidelines. 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 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 1.7 through Figure 1.9 suggests that “aging” may not have reached steady state as concentrations continue to increase at Day 120. Additional aging tests will be conducted in 2006 for a longer period of time.

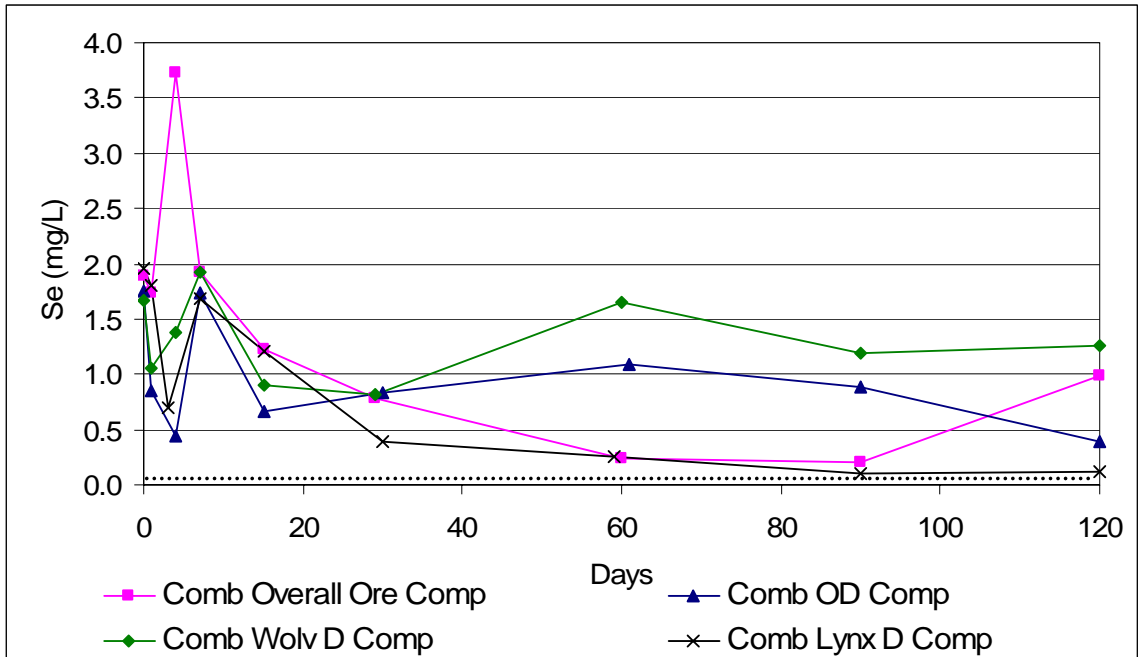


Figure 1.7 Se in Supernatant During Aging Tests

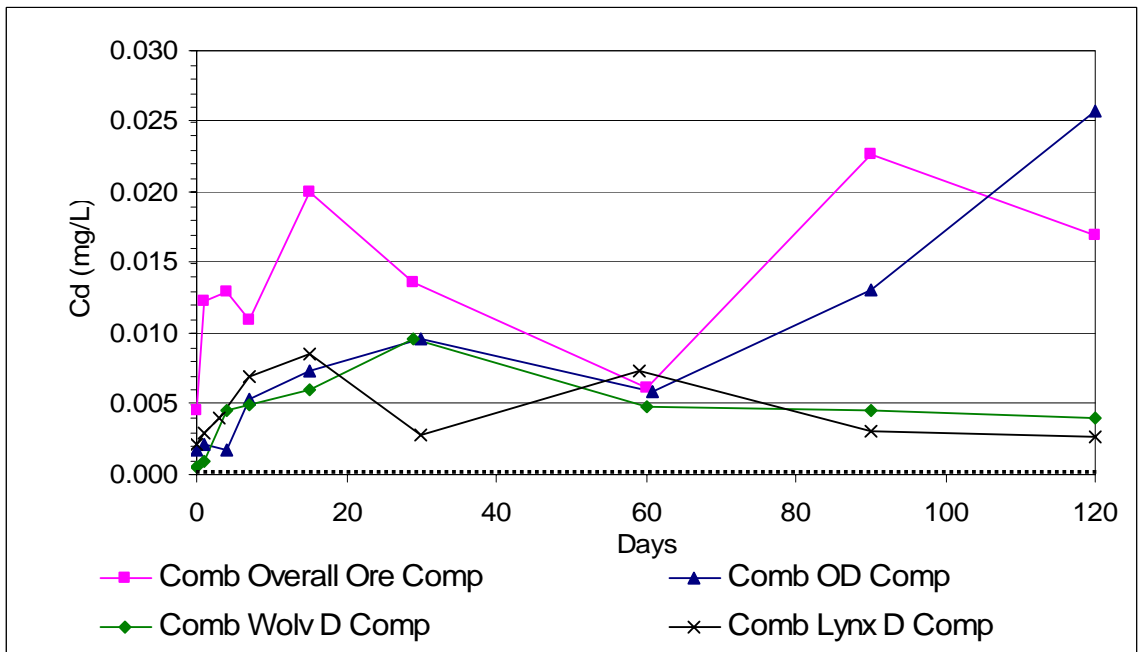


Figure 1.8 Cd in Supernatant During Aging Tests

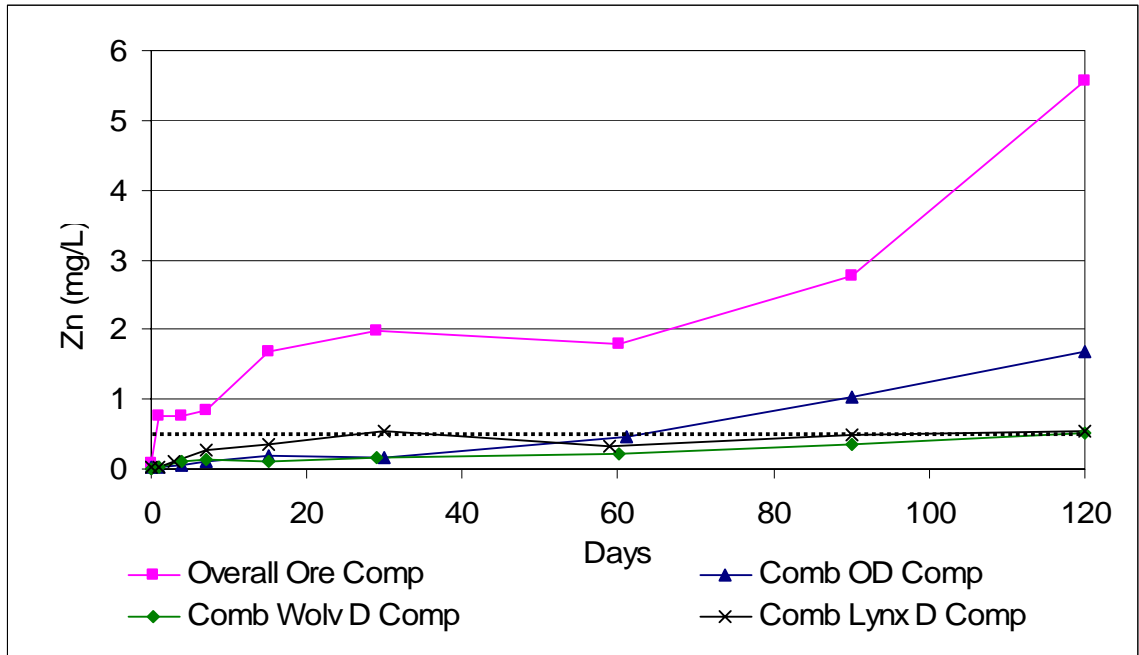


Figure 1.9 Zn in supernatant during aging tests

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 lethal concentrations 50 (LC50) acute lethality testing of *Daphnia magna*. LC50 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. Analyses were performed by Stantec Consulting Ltd.

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 1.17. Results indicate that all of the aged decant samples submitted had 100% mortality at 100% effluent concentration. The LC50 values

(concentrations of effluent at which 50% of the test organisms die) 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 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 48LC50 decreases from day 1.5 to 120.

Table 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 LC50
Comb Overall Ore Comp	1.5	<i>Daphnia magna</i>	100	37.7 %
Comb OD Comp	1	<i>Daphnia magna</i>	100	15.5 %
Comb Wolv D Comp	1	<i>Daphnia magna</i>	100	9.7 %
Comb Lynx D Comp	1	<i>Daphnia magna</i>	100	19.2%
Comb Overall Ore Comp	120	<i>Daphnia magna</i>	100	19.1%

Table 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 LC50
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 LC50 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. Results of the test work to date are discussed below.

1.5.3.1 Methodology

The humidity cells were constructed using acrylic tubing and base plate with an approximately 20 cm inside diameter and 10 cm height. The base plate was glued to the tube and threaded with a nylon hose adapter to which a length of tubing was attached allowing for leachate drainage into a collection container. A perforated PVC support plate was positioned inside the cell approximately 1.3 cm above the base plate and covered with six layers of nylon mesh. A nylon adapter was threaded into the side of the cell between the support plate, and the base plate and a length of tubing was connected from the side adapter to a humidifier to facilitate the inflow of humid air to the cell. A dry air line was also connected to each cell. Each cell was covered with a removable acrylic lid. The modifications made to the tailings flood leach humidity cell were adopted to facilitate the movement of water through the finer grained tailings.

A saturated 1.0 kg sample of tailings is used to charge each cell. The overall depth of tailings within the flood leach humidity cell is approximately five centimetres. No additional sample preparation was done on the tailings material in order to ensure that the testing was done on the material likely to be generated by the Wolverine mill. At the end of each weekly cycle, the volume of leachate collected in the container for the tailings flood leach humidity cell is recorded. The leachate is filtered through a Gelman magnetic filter funnel fitted with a membrane filter of pore size 0.45 µm and analyzed for the following parameters: pH, conductivity, acidity, alkalinity, and sulphate. The filtered leachate sample collected was analysed for a suite of elements by ICP-MS as well as acidity, alkalinity and SO_4^{2-} .

1.5.3.2 Results

Table 1.19 through Table 1.22 list the results for the humidity cell tests.

Table 1.19 Humidity Cell Results for Combined Overall Ore Composite Tailings

PARAMETER	UNITS	MMER ¹	10X CCME ²	MINIMUM	MEDIAN	AVERAGE	MAXIMUM
Leachate Volume	ml			275	426	413	496
pH	units		6.5-9.0	6.37	6.61	6.64	6.96
Alkalinity	mg CaCO ₃ /L			1.00	5.00	5.84	13.0
Acidity	mg CaCO ₃ /L			32.0	141	137	202
Conductivity	µS/cm			285	568	630	1342
SO ₄ ²⁻	mg/L		500†	93.0	220	262	630
Cl	mg/L			0.100	0.300	0.459	1.00
F	mg/L			0.0300	0.0700	0.0710	0.120
NO ₃ ⁻	mg N /L		130	0.0250	0.0250	0.0843	0.580
NH ₃ + NH ₄ ⁺	mg N /L		17.7 (T=15°C and pH 7)	0.05	0.100	0.167	0.500
Thiosalts	mg S ₂ O ₃ /L			5.00	148	155	427
CN _(T)	mg/L	1.0		0.00100	0.00100	0.00321	0.0100
CNO	mg/L			0.0500	0.0500	0.23	0.500
CNS	mg/L			0.100	1.00	6.36	29.0
Hg	µg/l		0.26	0.0500	0.0500	0.0571	0.100
Ag	mg/L		0.0010	0.0003	0.00250	0.00322	0.0100
Al	mg/L	0.50		0.00500	0.00500	0.00500	0.00500
As	mg/L			0.00250	0.00250	0.00410	0.0130
Ba	mg/L			0.0220	0.0390	0.0400	0.0590
Be	mg/L			0.00250	0.00250	0.00250	0.00250
Bi	mg/L			0.000150	0.000150	0.000150	0.000150
B	mg/L			0.00500	0.00500	0.00500	0.00500
Ca	mg/L			42.4	87.0	97.0	197.0
Cd	mg/L		0.00017	0.0423	0.0896	0.109	0.301
Co	mg/L			0.00280	0.00480	0.00931	0.0302
Cr	mg/L		0.010*	0.000500	0.000500	0.000762	0.006000
Cu	mg/L	0.30		0.000800	0.0019	0.0024	0.0117
Fe	mg/L		3.0	0.0100	0.0100	0.0100	0.0100
K	mg/L			0.560	0.970	1.21	2.89
Li	mg/L			0.00250	0.00250	0.00250	0.00250
Mg	mg/L			5.70	12.0	15.3	38.1
Mn	mg/L			0.726	1.55	2.60	8.14
Mo	mg/L		0.73	0.000150	0.000400	0.000381	0.000700
Na	mg/L			0.840	2.41	3.39	10.10
Ni	mg/L	0.50		0.00400	0.00700	0.0157	0.0600
P	mg/L			0.0500	0.0500	0.0500	0.0500
Pb	mg/L	0.20		0.0144	0.0238	0.0465	0.4000
Sb	mg/L			0.0250	0.0250	0.0260	0.0450

PARAMETER	UNITS	MMER ¹	10X CCME ²	MINIMUM	MEDIAN	AVERAGE	MAXIMUM
Se	mg/L		0.010	0.0330	0.227	0.233	0.570
Si	mg/L			0.110	0.200	0.205	0.320
Sn	mg/L			0.001	0.002	0.005	0.022
Sr	mg/L			0.129	0.436	0.474	0.995
Ti	mg/L			0.00250	0.00250	0.00286	0.0100
Tl	mg/L		0.0080	0.00150	0.00790	0.00983	0.0223
U	mg/L			0.000100	0.000100	0.000100	0.000100
V	mg/L			0.00100	0.00100	0.00100	0.00100
Zn	mg/L	0.50		2.54	4.59	6.97	23.4

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 1.20 Humidity Cell Results for Combined OD Composite Tailings

PARAMETER	UNITS	MMER ¹	10X CCME ²	MINIMUM	MEDIAN	AVERAGE	MAXIMUM
Leachate Volume	ml			234	444	426	503
pH	units		6.5-9.0	3.41	6.63	6.14	6.97
Alkalinity	mg CaCO ₃ /L			0.150	7.50	7.13	15.0
Acidity	mg CaCO ₃ /L			76.0	564	615	1190
Conductivity	µS/cm			370	1520	1418	1980
SO ₄ ²⁻	mg/L		500†	110	680	628	890
Cl	mg/L			0.100	1.00	0.828	3.20
F	mg/L			0.0300	0.135	0.133	0.180
NO ₃ ⁻	mg N /L		130	0.0250	0.0250	0.0906	0.710
NH ₃ + NH ₄ ⁺	mg N /L		17.7 (T=15°C and pH 7)	0.100	0.350	0.378	0.800
Thiosalts	mg S ₂ O ₃ /L			53.0	480	544	1110
CN _(T)	mg/L	1.0		0.00100	0.00500	0.00539	0.030
CNO	mg/L			0.050	0.05	0.225	0.500
CNS	mg/L			1.00	1.00	2.50	10.0
Hg	µg/l		0.26	0.0500	0.0500	0.0500	0.0500
Ag	mg/L		0.0010	0.0006	0.00250	0.00353	0.0230

PARAMETER	UNITS	MMER ¹	10X CCME ²	MINIMUM	MEDIAN	AVERAGE	MAXIMUM
Al	mg/L	0.50		0.00500	0.00500	0.00583	0.0100
As	mg/L			0.00250	0.0155	0.0146	0.0240
Ba	mg/L			0.0270	0.0340	0.0391	0.0970
Be	mg/L			0.00250	0.00250	0.00250	0.00250
Bi	mg/L			0.00015	0.00015	0.00015	0.00015
B	mg/L			0.00500	0.00500	0.00667	0.030
Ca	mg/L			50.6	292.0	282.8	437.0
Cd	mg/L		0.00017	0.00270	0.0696	0.0674	0.115
Co	mg/L			0.0005	0.0134	0.0149	0.0269
Cr	mg/L		0.010*	0.0005	0.0005	0.00225	0.0320
Cu	mg/L	0.30		0.00100	0.00290	0.00350	0.0116
Fe	mg/L		3.0	0.0100	0.0100	0.0206	0.20
K	mg/L			0.00250	0.00250	0.00250	0.00250
Li	mg/L			0.00250	1.51	1.74	4.83
Mg	mg/L			4.27	30.7	32.1	59.9
Mn	mg/L			0.147	1.91	2.50	5.47
Mo	mg/L		0.73	0.00015	0.00023	0.00038	0.00250
Na	mg/L			0.230	1.51	6.55	29.6
Ni	mg/L	0.50		0.004	0.0300	0.0433	0.101
P	mg/L			0.0500	0.0500	0.0500	0.0500
Pb	mg/L	0.20		0.00180	0.0126	0.0314	0.3140
Sb	mg/L			0.0250	0.0250	0.0261	0.0450
Se	mg/L		0.010	0.325	0.942	0.921	1.96
Si	mg/L			0.130	0.245	0.311	0.600
Sn	mg/L			0.00300	0.00500	0.0161	0.100
Sr	mg/L			0.0604	0.919	0.828	1.12
Ti	mg/L			0.00250	0.00250	0.00292	0.0100
Tl	mg/L		0.0080	0.00320	0.0139	0.0147	0.0250
U	mg/L			0.0001	0.0001	0.0001	0.0003
V	mg/L			0.00100	0.00300	0.00289	0.00600
Zn	mg/L	0.50		0.0600	3.36	4.18	9.05

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

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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 1.21 Humidity Cell Results for Combined Wolverine Dilute Composite Tailings

PARAMETER	UNITS	MMER ¹	10X CCME ²	MINIMUM	MEDIAN	AVERAGE	MAXIMUM
Leachate Volume	ml			415	475	480	553
pH	units		6.5-9.0	3.36	6.61	5.64	7.16
Alkalinity	mg CaCO ₃ /L			0.150	8.00	9.24	30.0
Acidity	mg CaCO ₃ /L			234	473	580	1280
Conductivity	µS/cm			587	1280	1304	1930
SO ₄ ²⁻	mg/L		500†	130	570	535	940
Cl	mg/L			0.100	0.750	0.700	1.80
F	mg/L			0.030	0.100	0.107	0.17
NO ₃ ⁻	mg N /L		130	0.025	0.025	0.102	0.58
NH ₃ + NH ₄ ⁺	mg N /L		17.7 (T=15°C and pH 7)	0.100	0.300	0.294	0.40
Thiosalts	mg S ₂ O ₃ /L			45.0	447	522	1200
CN _(T)	mg/L	1.0		0.0010	0.0050	0.0045	0.010
CNO	mg/L			0.050	0.50	0.30	0.50
CNS	mg/L			1.00	2.50	4.43	13.0
Hg	µg/l		0.26	0.050	0.050	0.050	0.050
Ag	mg/L		0.0010	0.00110	0.00250	0.00309	0.0100
Al	mg/L	0.50		0.00500	0.00500	0.00944	0.070
As	mg/L			0.00250	0.00950	0.0110	0.0210
Ba	mg/L			0.0160	0.0265	0.0298	0.0970
Be	mg/L			0.0025	0.0025	0.0025	0.0025
Bi	mg/L			0.000150	0.000150	0.000150	0.000150
B	mg/L			0.00500	0.00500	0.00611	0.0200
Ca	mg/L			82.6	241	248	411
Cd	mg/L		0.00017	0.00260	0.0884	0.0785	0.141
Co	mg/L			0.000600	0.0233	0.0207	0.0352
Cr	mg/L		0.010*	0.000500	0.0005	0.0024	0.0350
Cu	mg/L	0.30		0.000900	0.0027	0.0029	0.0090
Fe	mg/L		3.0	0.0100	0.0100	0.0100	0.0100
K	mg/L			0.00250	0.00250	0.00250	0.00250
Li	mg/L			0.0025	2.22	2.40	5.35
Mg	mg/L			7.45	26.1	27.9	49.0
Mn	mg/L			0.0790	1.57	1.61	3.10
Mo	mg/L		0.73	0.000150	0.0002	0.00043	0.00360
Na	mg/L			0.360	6.09	8.57	23.20
Ni	mg/L	0.50		0.0040	0.043	0.050	0.103
P	mg/L			0.050	0.050	0.050	0.050
Pb	mg/L	0.20		0.0136	0.0330	0.0423	0.101

PARAMETER	UNITS	MMER ¹	10X CCME ²	MINIMUM	MEDIAN	AVERAGE	MAXIMUM
Sb	mg/L			0.0250	0.0250	0.0261	0.0450
Se	mg/L		0.010	0.339	0.749	0.707	1.03
Si	mg/L			0.130	0.255	0.258	0.450
Sn	mg/L			0.00200	0.00350	0.00839	0.0490
Sr	mg/L			0.107	0.648	0.635	1.100
Ti	mg/L			0.00250	0.00250	0.00458	0.0100
Tl	mg/L		0.0080	0.00250	0.00750	0.00721	0.0116
U	mg/L			0.000100	0.000100	0.000128	0.0003
V	mg/L			0.00100	0.00300	0.00311	0.00600
Zn	mg/L	0.50		0.080	5.81	5.11	9.77

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

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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 1.22 Humidity Cell Results for Combined Lynx Dilute Composite Tailings

PARAMETER	UNITS	MMER ¹	10X CCME ²	MINIMUM	MEDIAN	AVERAGE	MAXIMUM
Leachate Volume	ml			313	430	434	598
pH	units		6.5-9.0	4.27	6.83	6.64	7.05
Alkalinity	mg CaCO ₃ /L			0.150	7.00	6.68	13.0
Acidity	mg CaCO ₃ /L			41.00	214	248	619
Conductivity	µS/cm			355	798	823	1300
SO ₄ ²⁻	mg/L		500†	92.0	285	363	700
Cl	mg/L			0.100	0.500	0.606	1.30
F	mg/L			0.0300	0.0450	0.0644	0.12
NO ₃ ⁻	mg N/L		130	0.0250	0.0250	0.0281	0.080
NH ₃ + NH ₄ ⁺	mg N/L		17.7 (T=15°C and pH 7)	0.050	0.200	0.194	0.400
Thiosalts	mg S ₂ O ₃ /L			15.0	197	226	586
CN _(T)	mg/L	1.0		0.00100	0.00500	0.00561	0.020
CNO	mg/L			0.050	0.275	0.275	0.500
CNS	mg/L			1.00	2.50	9.29	36.0
Hg	µg/l		0.26	0.0500	0.0500	0.0500	0.0500
Ag	mg/L		0.0010	0.000200	0.003	0.003	0.010
Al	mg/L	0.50		0.00500	0.00500	0.00583	0.0100
As	mg/L			0.00250	0.00250	0.00522	0.0130
Ba	mg/L			0.0120	0.0270	0.0323	0.0800
Be	mg/L			0.00250	0.00250	0.00250	0.00250
Bi	mg/L			0.000150	0.000150	0.000150	0.000150
B	mg/L			0.00500	0.00500	0.00556	0.0100
Ca	mg/L			53.1	142	147	264
Cd	mg/L		0.00017	0.0000500	0.0303	0.0342	0.0890
Co	mg/L			0.00140	0.00470	0.00509	0.0130
Cr	mg/L		0.010*	0.000500	0.000500	0.000500	0.000500
Cu	mg/L	0.30		0.000400	0.00195	0.00375	0.0284
Fe	mg/L		3.0	0.0100	0.0100	0.0100	0.0100
K	mg/L			0.00250	0.00250	0.00250	0.00250
Li	mg/L			0.00250	0.00250	0.244	1.28
Mg	mg/L			4.60	17.2	17.3	33.7
Mn	mg/L			0.310	0.915	1.30	3.98
Mo	mg/L		0.73	0.000150	0.000150	0.000322	0.00120
Na	mg/L			0.300	5.33	5.88	14.0
Ni	mg/L	0.50		0.00300	0.0120	0.0149	0.0430
P	mg/L			0.0500	0.0500	0.0500	0.0500
Pb	mg/L	0.20		0.00330	0.0174	0.0194	0.0528
Sb	mg/L			0.025	0.0250	0.0261	0.0450

PARAMETER	UNITS	MMER ¹	10X CCME ²	MINIMUM	MEDIAN	AVERAGE	MAXIMUM
Se	mg/L		0.010	0.00250	0.452	0.439	0.885
Si	mg/L			0.0800	0.150	0.163	0.340
Sn	mg/L			0.00050	0.00500	0.0135	0.0890
Sr	mg/L			0.0742	0.420	0.468	0.927
Ti	mg/L			0.00250	0.00250	0.00292	0.01000
Tl	mg/L		0.0080	0.00020	0.0136	0.0124	0.0250
U	mg/L			0.00010	0.00010	0.00010	0.00010
V	mg/L			0.00100	0.00100	0.00156	0.00400
Zn	mg/L	0.50		0.180	1.62	1.81	5.56

1. Metal Mining Effluent Regulations (2002) for maximum monthly mean concentrations.

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*Hexavalent chromium

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Bold indicates measured values in excess of MMER and/or 10x CCME guidelines

** = could not be determined due to sample matrix

na = not analyzed

At this time all tailings samples have greater than 80% solid phase sulphate and 99% or more of the remaining NP. Therefore, predictions for time to acid generation onset can not be made. Figure 1.10 shows the tailings humidity cell samples all begin at near neutral conditions except for the Wolverine D combined tailings sample, which has an initial pH of 5.13. Subsequent weeks show all samples fall well below CCME standards, likely from the flushing and oxidation of thiosalts (Figure 1.11) and/or Mn oxidation (Figure 1.12) rather than Fe oxidation (i.e., Fe is below detection limit throughout the current testing period). The Combined Overall tailings sample appears to have some additional buffering capacity which counter balances proton releases. At week 4 the pH rises again to near neutral conditions and remains stable except for the Combine Wolverine D Composite tailings sample which hovers at pH 4 until week 8 when the pH rises to near neutral conditions.

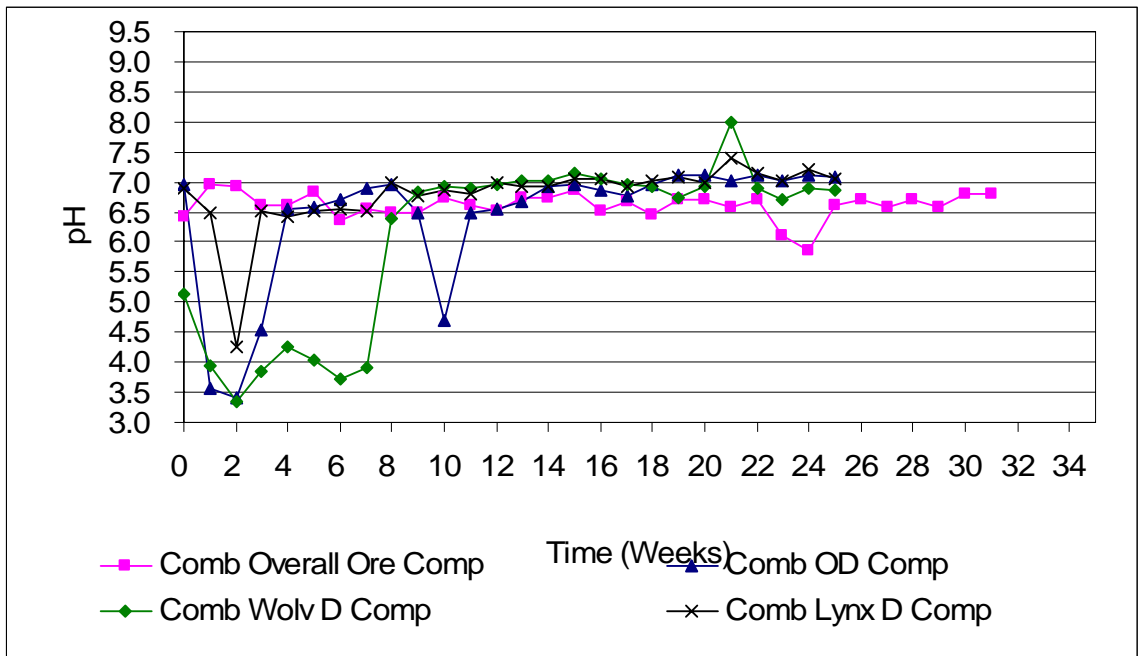


Figure 1.10 pH Fluctuation in the Tailings Humidity Cells

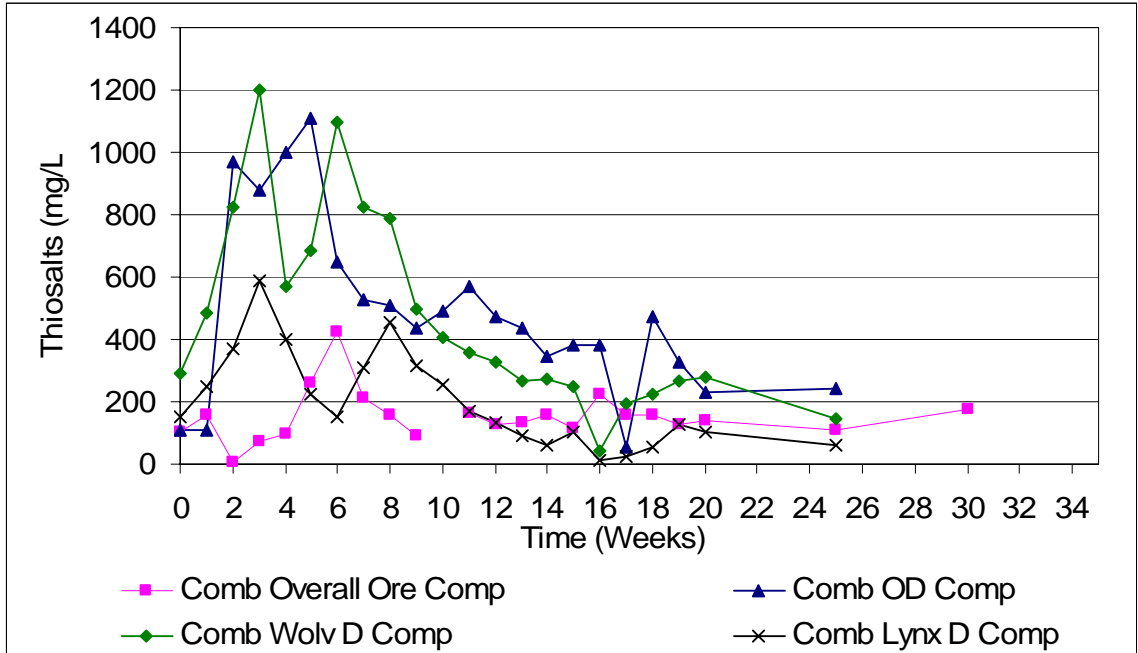


Figure 1.11 Thiosalt Fluctuation in the Tailings Humidity Cells

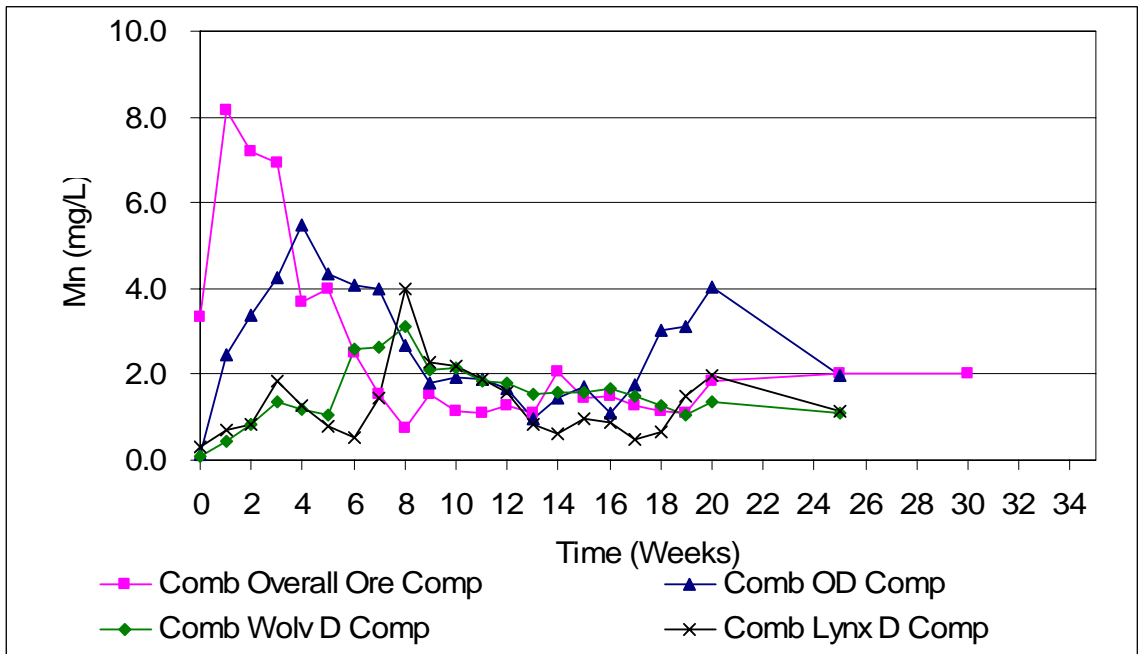


Figure 1.12 Mn Fluctuation in the Tailings Humidity Cells

Figure 1.13 does not show initial flushing of sulphate and fluctuations have not shown a trend throughout the humidity cell testing cycles to date. Until the initial sulphate has been flushed from the humidity cell, the sulphate production rate does not necessarily reflect sulphate produced through the sulphide oxidation process. For example, the presence and dissolution of gypsum (CaSO_4) or oxidation of thiosalts may contribute to solution sulphate inventories. Current calculations indicate that approximately 5% to 20% of the original sulphate has been flushed out in the first 17 to 20 weeks of testing. These percentages suggest almost all of the sulphate is associated with a moderately insoluble mineral phase (subject to dissolution by hydrochloric acid but not DI water).

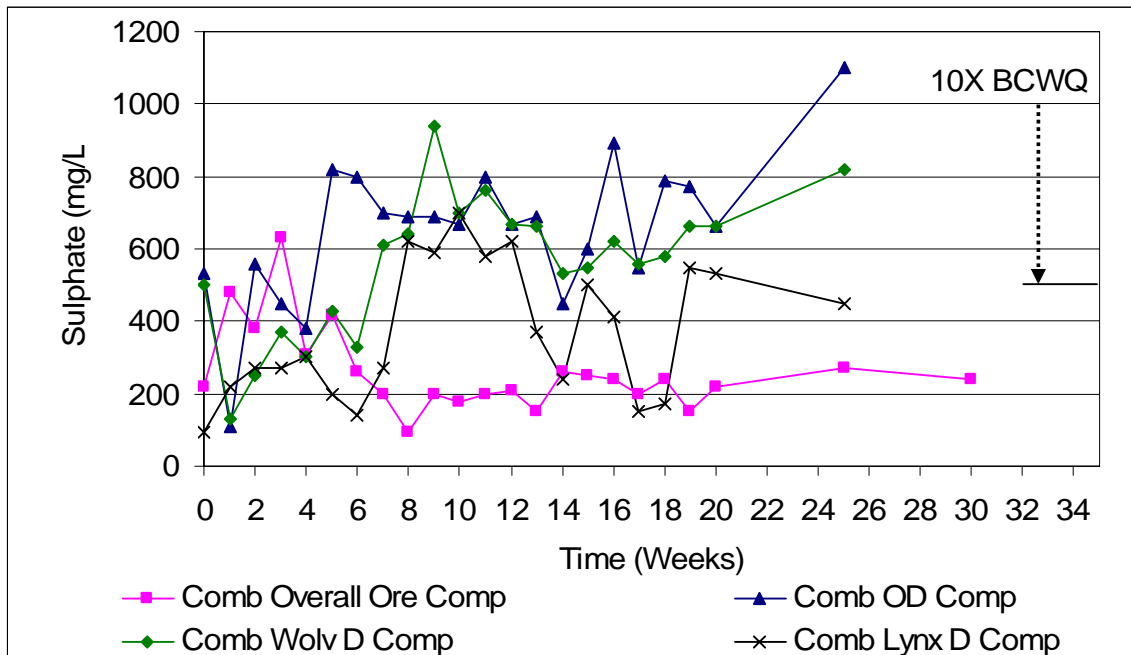


Figure 1.13 Sulphate Fluctuation in the Tailings Humidity Cells

Figure 1.14 shows Ca and sulphate concentrations scatter about the gypsum composition line suggesting the dissolution of gypsum, carbonates and sulphosalts. Interestingly, the Combined Overall Ore Composite sample shows the closest correlation to the gypsum line while alkalinity (Figure 1.15) remains relatively stable suggesting the dissolved Ca and sulphate is indeed originating from gypsum dissolution. Deviations above the gypsum line may be attributed to carbonate dissolution while deviations below the gypsum line may be attributed to the oxidation of thiosalts (Figure 1.11), which show a lag time before peak flushing occurring between weeks three and six.

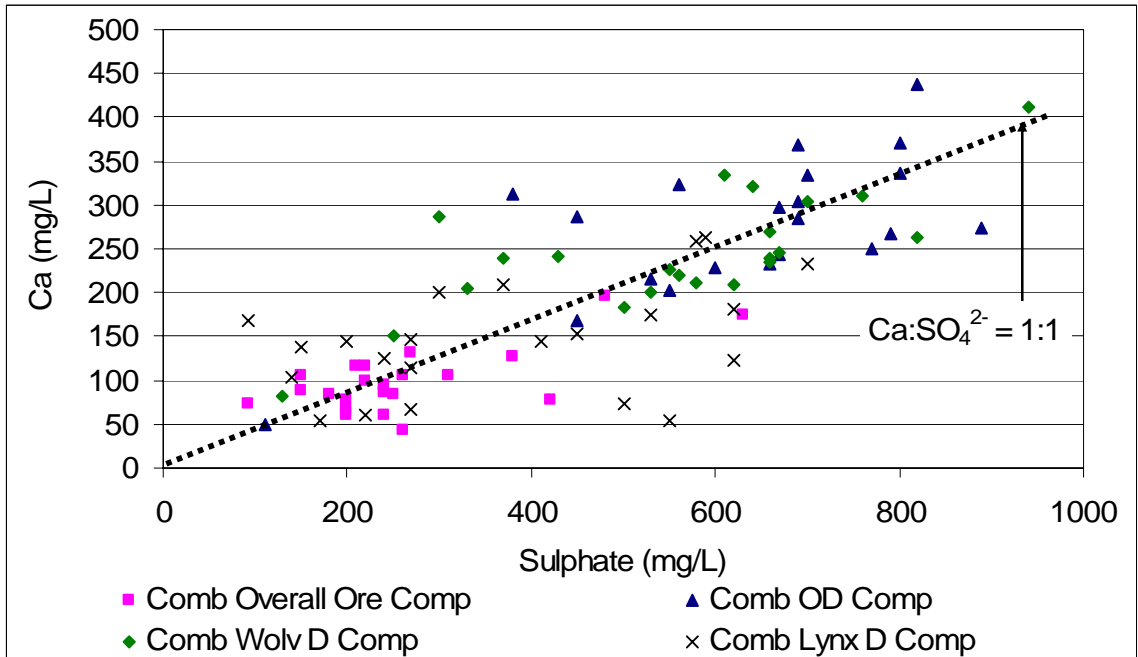


Figure 1.14 Ca versus Sulphate in the Tailings Humidity Cells

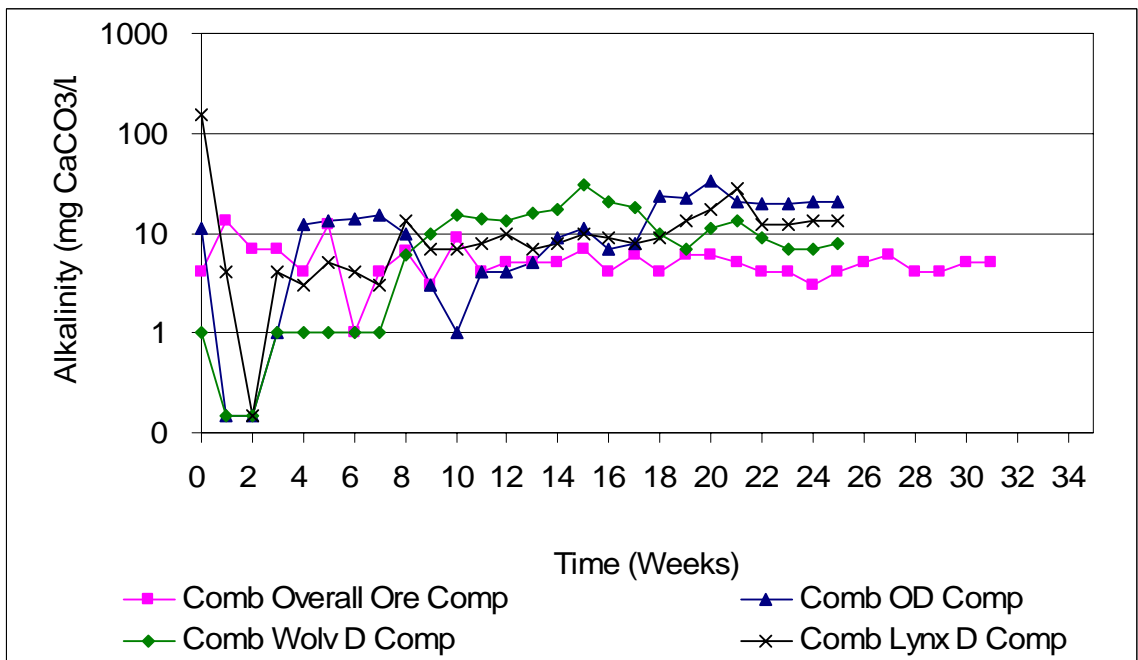


Figure 1.15 Alkalinity in the Tailings Humidity Cells

Humidity cell results indicate Se, Cd and Zn concentrations are above water quality guidelines throughout the entire testing period. Selenium concentration increases with time (Figure 1.16) are likely a combination of neutral pH mobility and Se substitution for sulphide in soluble sulphosalts (Figure 1.17). Cadmium and Zn chemistry is very similar (i.e., Zn and Cd are in group 12 in periodic table) seen from the similar profiles (Figure 1.18 and Figure 1.19). Figure 1.20 shows very good correlation between the two metals with Zn approximately two orders a magnitude higher than Cd suggesting a common source for both metals. Correlations between Zn and sulphate are poor, however Zn and Mn show a good association (Zn:Mn = 1.6-3.7).

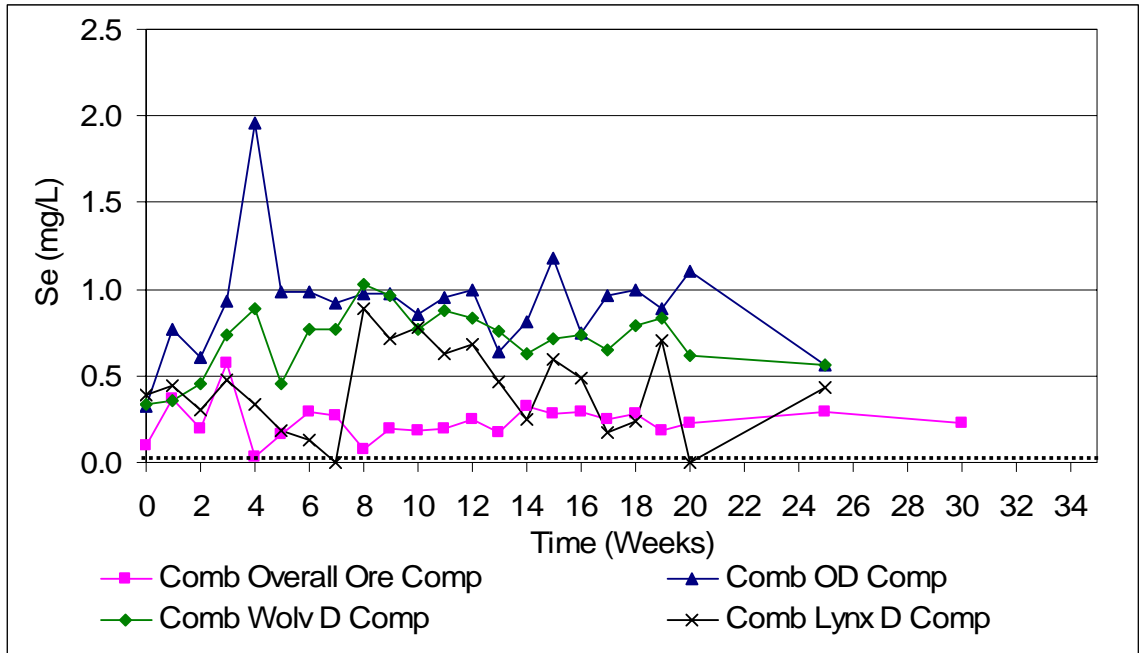


Figure 1.16 Se Loading Fluctuation in the Tailings Humidity Cells

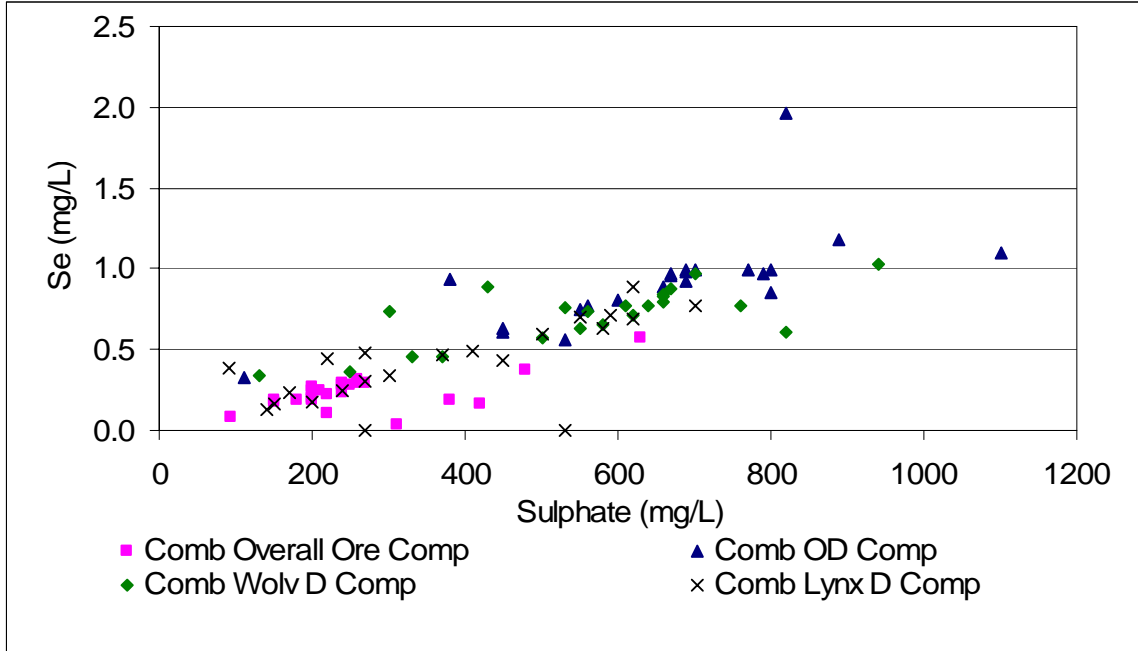


Figure 1.17 Se versus Sulphate in Tailings Humidity Cells

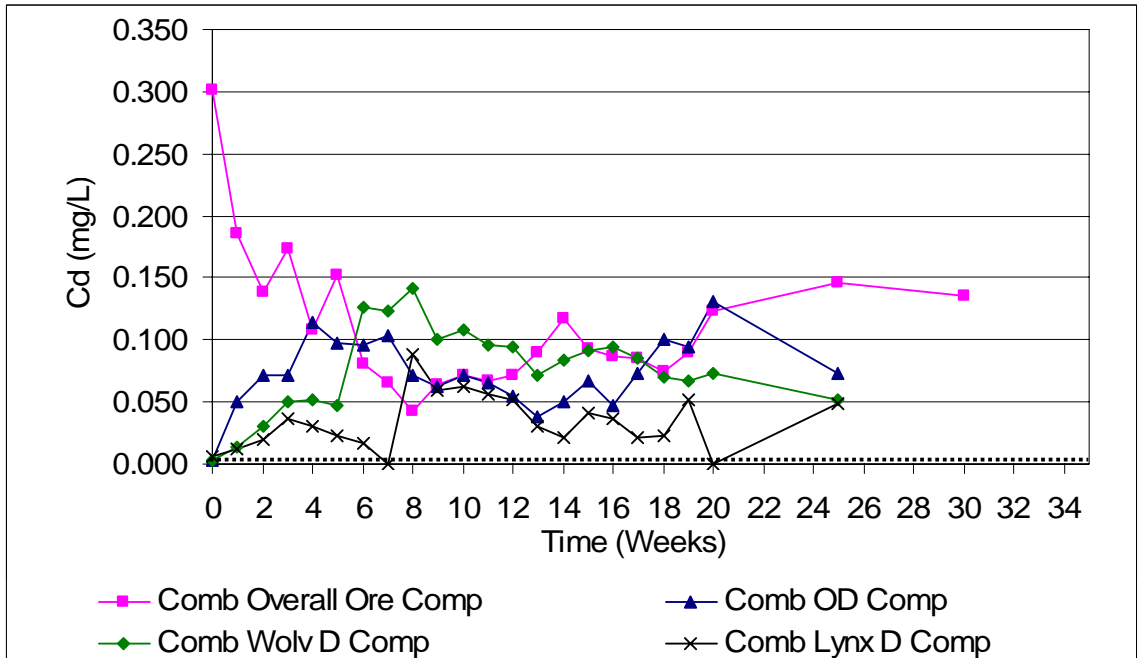


Figure 1.18 Cd Loading Fluctuation in the Tailings Humidity Cells

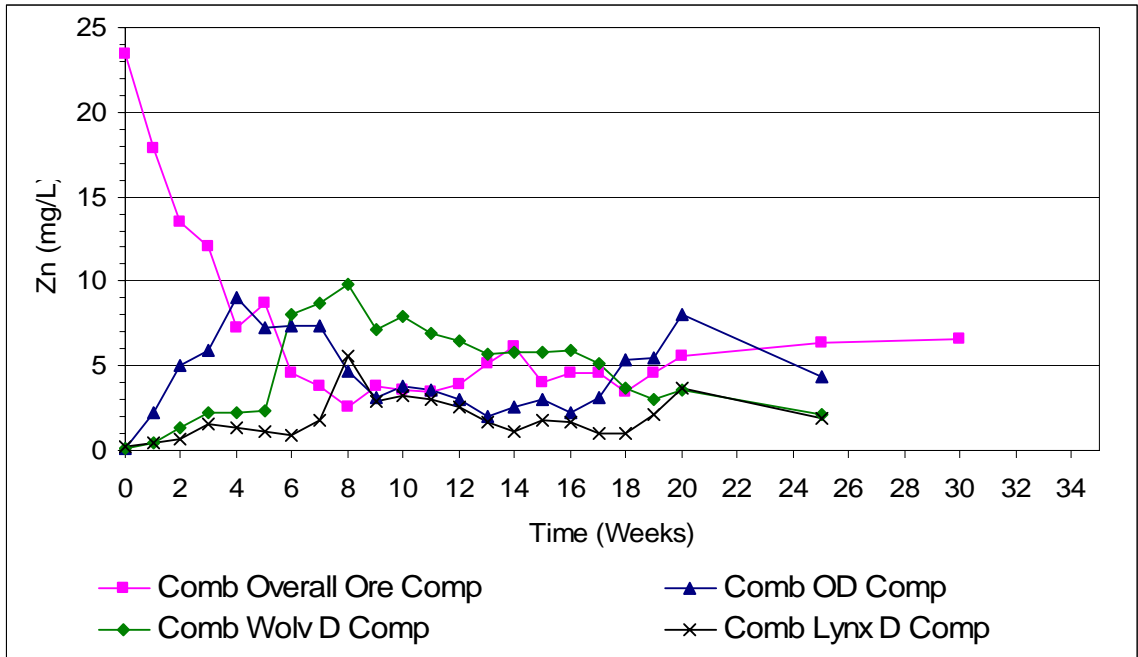


Figure 1.19 Zn Loading Fluctuation in the Tailings Humidity Cells

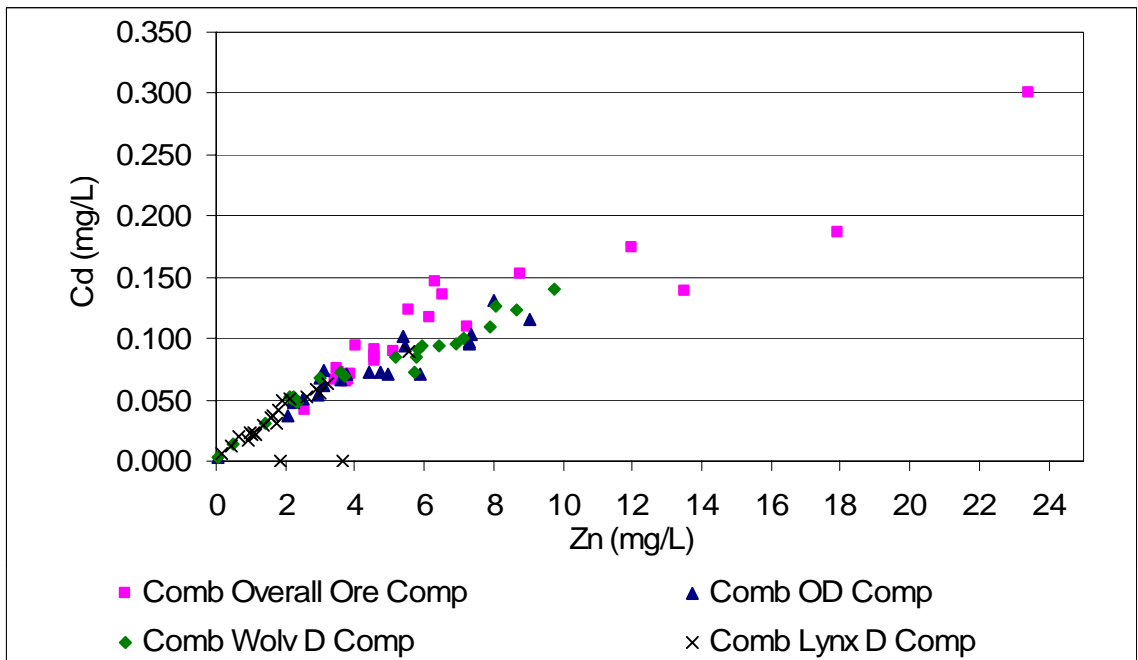


Figure 1.20 Zn versus Cd in the Tailings Humidity Cells

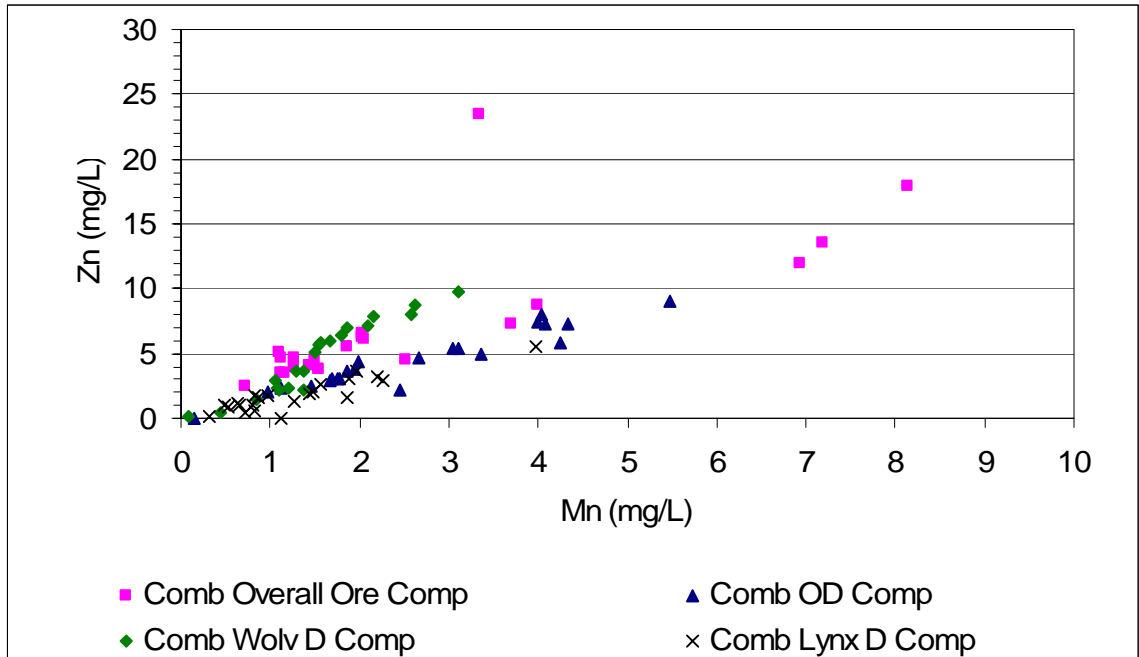


Figure 1.21 Zn versus Mn in the Tailings Humidity Cells

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 1.22 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 1.22 Set-up of Sub-aqueous Columns

1.5.4.2 Results

Table 1.23 and Table 1.24 list the results of the sub-aqueous column tests for the Combined Overall Ore Composite and Combined Overall Dilute Composite Tailings samples.

Table 1.23 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 ₂ O 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

PARAMETER	UNIT	MMER ¹	10X CCME ²	WEEKS							
				1	2	3	4	5	6	7	8
Fe	mg/L		3.0	1.01	4.06	0.49	0.05	<i>0.01</i>	<i>0.01</i>	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
K	mg/L			11.9	5.36	2.32	1.43	0.63	0.58	1.31	1.11
Li	mg/L			<i>0.0025</i>	<i>0.0025</i>	<i>0.0025</i>	<i>0.0025</i>	<i>0.0025</i>	<i>0.0025</i>	<i>0.0025</i>	<i>0.0025</i>
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	<i>0.0005</i>	<i>0.0005</i>	<i>0.001</i>	<i>0.0005</i>	<i>0.0005</i>
P	mg/L			<i>0.05</i>	<i>0.05</i>	<i>0.05</i>	<i>0.05</i>	<i>0.05</i>	<i>0.05</i>	<i>0.05</i>	<i>0.05</i>
Pb	mg/L	0.2		0.0107	0.0003	0.0003	<i>0.0001</i>	0.0136	0.0089	0.0004	0.0005
Sb	mg/L			0.0140	0.0113	0.0111	0.0091	0.0046	<i>0.025</i>	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	<i>0.0005</i>	<i>0.0005</i>	0.001	<i>0.0005</i>	<i>0.0005</i>	<i>0.0005</i>
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	<i>0.0015</i>	<i>0.0015</i>	<i>0.0015</i>	<i>0.0025</i>	<i>0.0015</i>	<i>0.0015</i>
Tl	mg/L		0.008	0.0046	0.0021	0.0007	0.0002	0.0008	0.0008	<i>0.0001</i>	<i>0.0001</i>
U	mg/L			0.0060	0.0011	<i>0.0001</i>	<i>0.0001</i>	<i>0.0001</i>	<i>0.0001</i>	<i>0.0001</i>	<i>0.0001</i>
V	mg/L			<i>0.00045</i>	<i>0.00045</i>	<i>0.00045</i>	<i>0.00045</i>	<i>0.00045</i>	<i>0.001</i>	<i>0.00045</i>	<i>0.00045</i>
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

** = could not be determined due to sample matrix

na = not analyzed

Table 1.24 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	<i>1</i>	<i>1</i>	na	<i>1</i>	<i>1</i>	<i>1</i>	<i>1</i>	<i>1</i>
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 ₂ O 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

PARAMETER	UNITS	MMER ¹	10X CCME ²	WEEKS								
				0	1	2	3	4	5	6	7	8
Cu	mg/L	0.30		0.0044	<i>0.0004</i>	<i>0.0004</i>	0.0015	<i>0.0005</i>	<i>0.0005</i>	<i>0.0005</i>	<i>0.0005</i>	<i>0.0005</i>
Hg	mg/L		3.0	<i>0.00005</i>	<i>0.00005</i>	<i>0.00005</i>	<i>0.00005</i>	<i>0.0004</i>	<i>0.0004</i>	0.0012	0.0027	0.0014
Fe	mg/L		0.00026	0.01	0.01	0.01	0.01	<i>0.01</i>	<i>0.01</i>	<i>0.01</i>	<i>0.01</i>	<i>0.01</i>
K	mg/L			1.48	1.23	1.10	1.07	1.11	1.06	0.81	0.65	0.58
Li	mg/L			<i>0.0025</i>	<i>0.0025</i>	<i>0.0025</i>	<i>0.0025</i>	<i>0.0025</i>	<i>0.0025</i>	<i>0.0025</i>	<i>0.0025</i>	<i>0.0025</i>
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	<i>0.0005</i>	<i>0.0005</i>	<i>0.0005</i>
P	mg/L			<i>0.05</i>	<i>0.05</i>	<i>0.05</i>	<i>0.05</i>	<i>0.05</i>	<i>0.05</i>	<i>0.05</i>	<i>0.05</i>	<i>0.05</i>
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			<i>0.015</i>	<i>0.015</i>	<i>0.015</i>	<i>0.015</i>	<i>0.015</i>	<i>0.015</i>	<i>0.015</i>	<i>0.015</i>	<i>0.015</i>
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			<i>0.0001</i>	<i>0.0001</i>	<i>0.0001</i>	<i>0.0001</i>	<i>0.0001</i>	<i>0.0001</i>	<i>0.0001</i>	<i>0.0001</i>	<i>0.0001</i>
V	mg/L			0.0009	<i>0.00045</i>	<i>0.00045</i>	0.0014	<i>0.00045</i>	<i>0.00045</i>	0.0010	<i>0.00045</i>	<i>0.00045</i>
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

** = could not be determined due to sample matrix

na = not analyzed

Figure 1.23 and Figure 1.24 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 Combined 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).

Figure 1.27 shows Cd, Se and Zn releases 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.

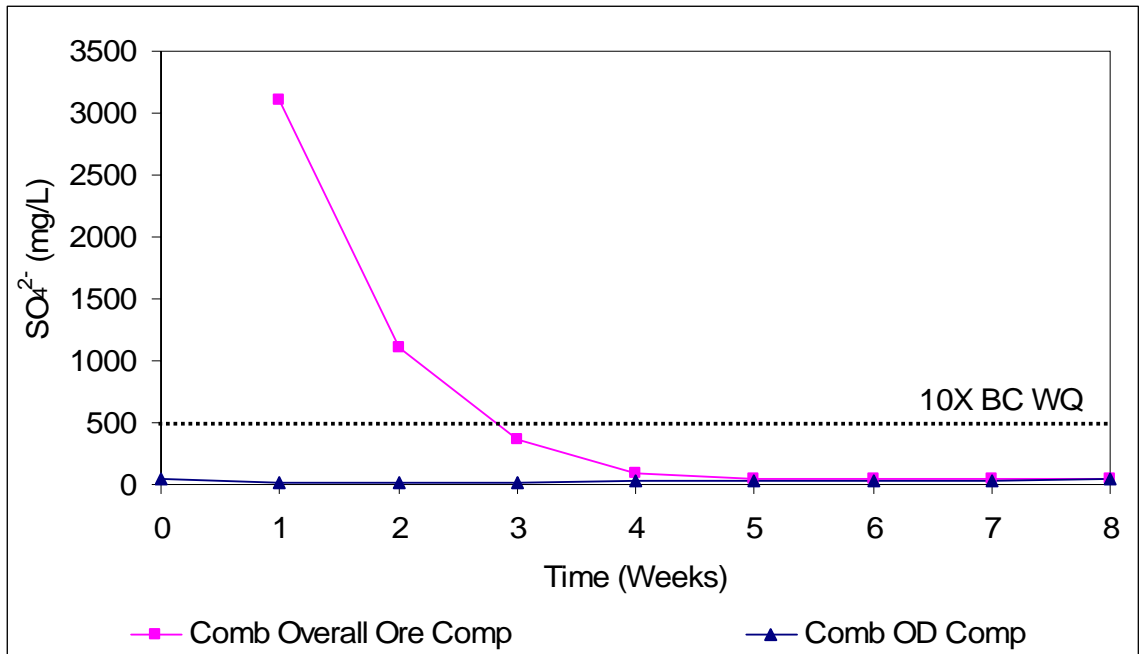


Figure 1.23 Sulphate Fluctuations During Sub-aqueous Column Tests

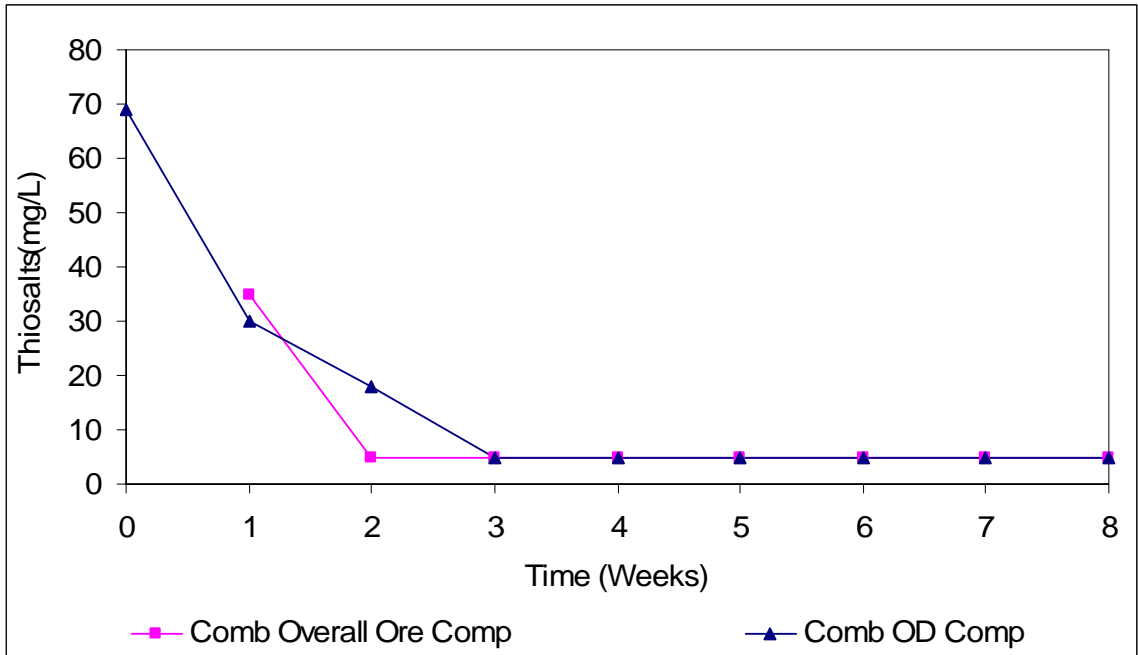


Figure 1.24 Thiosalt Fluctuations During Sub-aqueous Column Tests

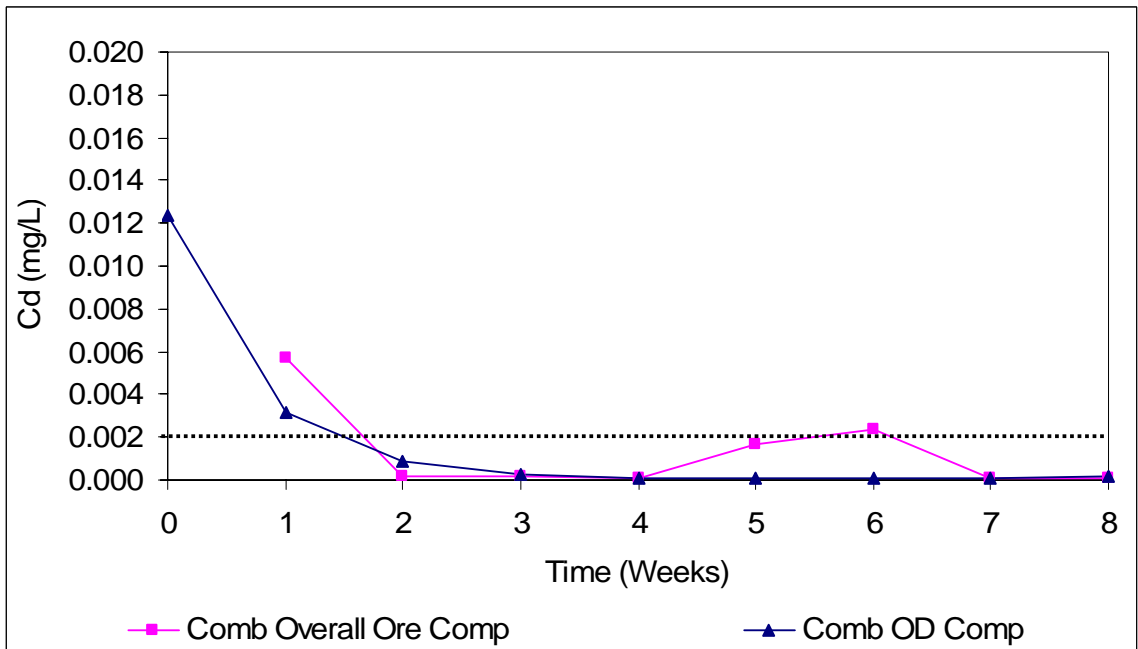


Figure 1.25 Cd Fluctuations During Sub-aqueous Column Tests

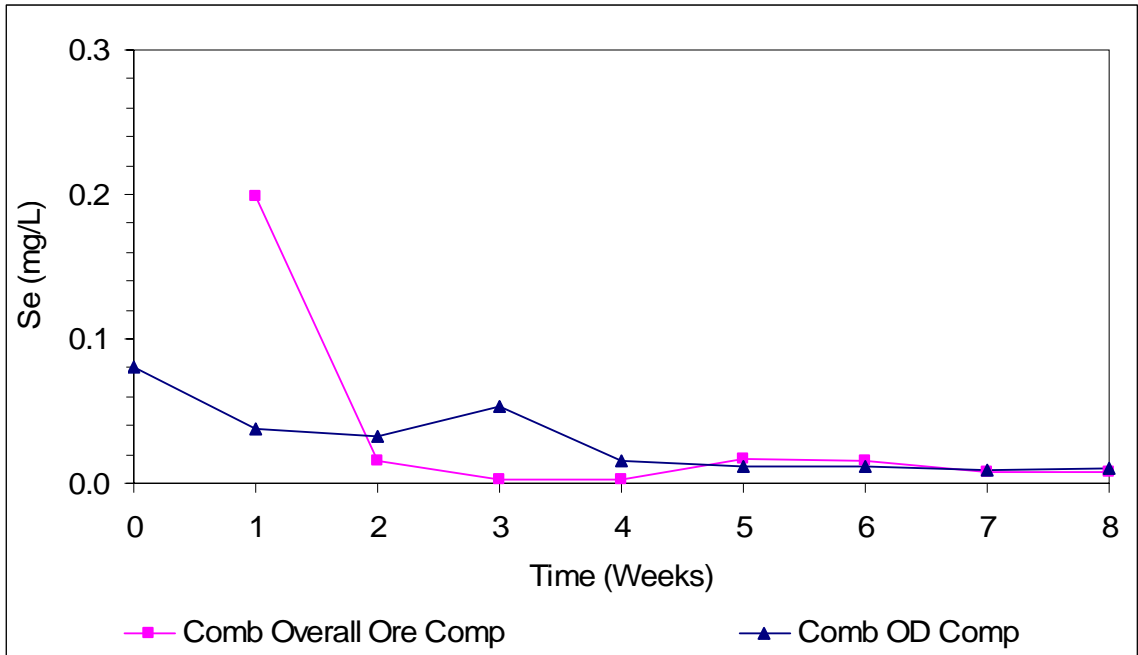


Figure 1.26 Se Fluctuations During Sub-aqueous Column Tests

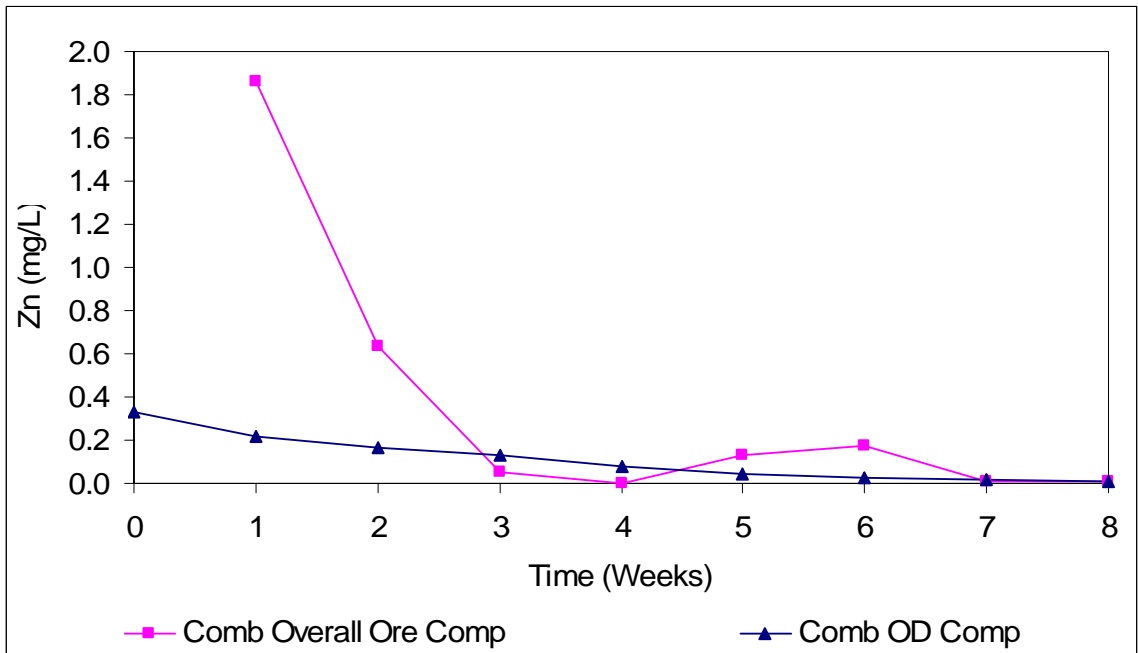


Figure 1.27 Zn Fluctuations During Sub-aqueous Column Tests

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.

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 1.25 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 minerals¹.

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. There 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

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.

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 interstitial 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 Diagenesis 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 km² 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.

1.7 Supplemental Test Data (January 2006)

CLIENT : Yukon Zinc
PROJECT : Wolverine
PROJECT # : 0520
TEST : Modified ABA
Date : Dec 12, 2005

Sample ID	Paste pH	Total C %	CO2 %	CaCO3 NP	S(T) %	S(SO4) %	S(S-2) %	Insoluble S %	HCL		24 Hr pH	NaOH		AP	NP	Net NP	Fizz Test
									Norm.	mL added		Norm.	mL to 8.3				
HLS Hump Floats ETC 139-144	8.3	4.76	10.9	247.7	1.94	0.06	1.77	0.11	0.25	50	1.61	0.25	11.45	55.3	240.9	185.6	strong
HLS Wolv Floats ETC 152-168	7.9	4.12	3.77	85.7	1.17	0.07	0.90	0.20	0.25	21	1.83	0.25	7.50	28.1	84.4	56.3	strong
HLS Lynx Floats ETC 167-173	8.4	3.11	5.84	132.7	1.78	0.06	1.62	0.10	0.25	27	1.66	0.25	7.65	50.6	120.9	70.3	strong
Duplicate																	
HLS Hump Floats ETC 139-144	8.3	-	-	-	-	0.06	1.77	-	0.25	50	1.52	0.25	11.20	-	242.5	-	strong
HLS Lynx Floats ETC 169-173	-	3.19	5.8	131.8	1.87	-	-	-	-	-	-	-	-	-	-	-	-

Note:

AP = Acid potential in tonnes CaCO3 equivalent per 1000 tonnes of material. AP is determined from sulphide sulphur.

NP = Neutralization potential in tonnes CaCO3 equivalent per 1000 tonnes of material.

NET NP = NP - AP

Carbonate NP is calculated from CO2 originating from carbonates and is expressed in kg CaCO3/tonne.

CLIENT : Yukon Zinc
 PROJECT : Wolverine
 PROJECT # : 0520
 TEST : Metals by Aqua Regia Digestion
 Date : Dec 19, 2005

ELEMENT SAMPLES	Mo ppm	Cu ppm	Pb ppm	Zn ppm	Ag ppm	Ni ppm	Co ppm	Mn ppm	Fe %	As ppm	U ppm	Au ppb	Th ppm	Sr ppm	Cd ppm	Sb ppm	Bi ppm	V ppm	Ca %	P %	La ppm	Cr ppm	Mg %	Ba ppm	Ti %	B ppm	Al %	Na %	K %	W ppm	Hg ppm	Sc ppm	Tl ppm	Ga ppm	Se ppm	
HLS Hump Floats ETC 139-144	18	198	130.1	1229	7	44.6	4.6	1334	2.48	83.5	4.8	14	5.2	177	15.3	38.8	1	79	8.51	0.134	8	194.6	0.84	37	0.011	2	0.42	0.009	0.16	0.5	1.16	1.2	3.8	2	26.5	
HLS Wov Floats ETC 152-168	41	567.9	140.8	1248	14.7	66.2	4.6	688	2.32	92.7	8.8	6.9	9.8	69	13.8	36.8	1.2	103	2.99	0.259	17	197.6	0.96	60	0.01	2	1.24	0.012	0.25	1.2	0.67	1	3.8	4	37.2	
HLS Lynx Floats ETC 169-173	28.6	754.5	198.5	1577	10.7	49.2	5.1	660	2.24	72.3	6	39.8	5	111	16.4	39	0.7	73	4.01	0.122	5	289.5	0.79	38	0.009	3	0.58	0.006	0.25	0.6	0.74	1.3	13.6	3	39.6	
Duplicate																																				
HLS Lynx Floats ETC 169-173	27	739.5	199.8	1548	10.8	52	5.2	646	2.23	72	5.7	6.9	4.7	109	16.7	37.3	0.7	69	3.95	0.127	5	283.3	0.78	35	0.008	3	0.57	0.006	0.24	0.6	0.78	1.2	13.3	3	37.2	

CLIENT : Yukon Zinc
PROJECT : Wolverine
PROJECT # : 0520
TEST : Whole Rock Analysis by XRF
Date : Dec 14, 2005

Sample ID	SiO2 %	TiO2 %	Al2O3 %	Fe2O3 %	FeO %	MnO %	MgO %	CaO %	Na2O %	K2O %	P2O5 %	Ba(F) %	LOI %	Total %
HLS Hump Floats ETC 139-144	57.68	0.18	4.88	4.03		0.15	1.92	12.44	0.01	1.21	0.31	0.67	9.90	93.38
HLS Wolv Floats ETC 152-168	66.69	0.28	8.31	3.91		0.07	2.08	4.61	0.01	1.82	0.63	0.95	6.05	95.41
HLS Lynx Floats ETC 169-173	68.09	0.20	5.84	3.58		0.07	1.70	5.98	0.01	1.62	0.25	0.90	5.57	93.81

ANALYTICAL METHODS

FeO determined by acid digestion /volumetric. LOI determined gravimetrically
 Other elements by Li borate fusion/XRF. Where no FeO value shown "Fe2O3" is total Fe as Fe2O3

Client : Yukon Zinc
Project : Wolverine
CEMI Project : 0520
Test : 24 Hour NanoPure Water Leach Extraction Test at 20:1 Liquid to Solid Ratio
Test Date : Dec 8, 2005

Leachate Analysis

Sample Name:			HLS Hump Floats ETC 139-144	HLS Wolv Floats ETC 152-168	HLS Lynx Floats ETC 169-173	Blank
Parameter	Method	Units				
nanopure water volume		mL	1000	1000	1000	1000
Sample Weight		g	50	50	50	-
pH	meter		7.56	7.33	7.4	5.33
Conductivity	meter	uS/cm	113	77	89	1
Acidity (to pH 4.5)	titration	mg CaCO3/L	#N/A	#N/A	#N/A	#N/A
Total Acidity (to pH 8.3)	titration	mg CaCO3/L	4	4	5	2.5
Alkalinity	titration	mg CaCO3/L	44.5	26.5	32.75	1.25
Sulphate	turbidity	mg/L	15	15	12	<1
Ion Balance						
Major Anions	#N/A	#N/A	1.20	0.84	0.91	#N/A
Major Cations	#N/A	#N/A	1.17	0.88	0.97	#N/A
Diff. (%)	#N/A	#N/A	-1.5%	2.0%	3.5%	#N/A
Dissolved Metals						
Hardness CaCO3	ICP-MS	mg/L	57.1	42	46.5	< 0.2
Aluminum Al	ICP-MS	mg/L	0.019	0.009	0.005	0.001
Antimony Sb	ICP-MS	mg/L	0.029	0.024	0.026	< 0.0002
Arsenic As	ICP-MS	mg/L	0.0019	0.0033	0.0015	< 0.0002
Barium Ba	ICP-MS	mg/L	0.036	0.042	0.059	< 0.0002
Beryllium Be	ICP-MS	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Bismuth Bi	ICP-MS	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Boron B	ICP-MS	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Cadmium Cd	ICP-MS	mg/L	0.0014	0.0042	0.003	< 0.00004
Calcium Ca	ICP-MS	mg/L	20.9	14.7	16.8	< 0.01
Chromium Cr	ICP-MS	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cobalt Co	ICP-MS	mg/L	0.0015	0.0019	0.0036	< 0.0002
Copper Cu	ICP-MS	mg/L	0.0006	0.0022	0.0038	0.0013
Iron Fe	ICP-MS	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Lead Pb	ICP-MS	mg/L	0.0018	0.0037	0.0058	< 0.0002
Lithium Li	ICP-MS	mg/L	0.0006	0.0006	0.0006	< 0.0002
Magnesium Mg	ICP-MS	mg/L	1.19	1.29	1.1	< 0.01
Manganese Mn	ICP-MS	mg/L	0.164	0.172	0.169	< 0.0002
Mercury Hg	CVA	ug/L	< 0.02	< 0.02	< 0.02	< 0.02
Molybdenum Mo	ICP-MS	mg/L	0.001	0.0008	0.0017	< 0.0001
Nickel Ni	ICP-MS	mg/L	0.014	0.038	0.024	< 0.0002
Phosphorus PO4	ICP-MS	mg/L	< 0.03	< 0.03	< 0.03	< 0.03
Potassium K	ICP-MS	mg/L	0.63	0.71	0.81	< 0.02
Selenium Se	ICP-MS	mg/L	0.01	0.0083	0.019	< 0.0002
Silicon SiO2	ICP-MS	mg/L	0.34	0.35	0.29	< 0.05
Silver Ag	ICP-MS	mg/L	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Sodium Na	ICP-MS	mg/L	0.24	0.44	0.49	< 0.01
Strontium Sr	ICP-MS	mg/L	0.055	0.039	0.05	< 0.0002
Tellurium Te	ICP-MS	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Thallium Tl	ICP-MS	mg/L	0.0004	0.00025	0.002	< 0.00002
Thorium Th	ICP-MS	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Tin Sn	ICP-MS	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Titanium Ti	ICP-MS	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Uranium U	ICP-MS	mg/L	0.0008	0.0002	< 0.0001	< 0.0001
Vanadium V	ICP-MS	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Zinc Zn	ICP-MS	mg/L	0.064	0.3	0.21	< 0.001
Zirconium Zr	ICP-MS	mg/L	< 0.002	< 0.002	< 0.002	< 0.002

NP Calculation

Blank = **mL HCL** **mL NaOH**
 20 19.95

Blank Factor = 1.002506

NP = mL HCl - (mL NaOH * Blk F) * 25 * N

mL HCl	mL NaOH	N	NP =
0	0	0.05	0.0
0	0	0.1	0.0

CLIENT :
PROJECT :
PROJECT # :
TEST :
Date :

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Sample ID	Paste pH	CO2 %	CaCO3 NP	S(T) %	S(SO4) %	S(S-2) %	AP	NP	Net NP	Fizz Test
			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	
			0.0			0	0		0	
			0.0			0	0		0	
			0.0			0	0		0	
Duplicate										
			0.0			0	0		0	

Note:

AP = Acid potential in tonnes CaCO3 equivalent per 1000 tonnes of material. AP is determined from calculated sulphide sulphur content: $S(T) - S(SO_4)$.

NP = Neutralization potential in tonnes CaCO3 equivalent per 1000 tonnes of material.

NET NP = NP - AP

Carbonate NP is calculated from CO2 originating from carbonates and is expressed in kg CaCO3/tonne.

Client : Klohn Crippen
Project : Wolverine Yukon Zinc
CEMI Project : 0520
Test : 24 Hour NanoPure Water Leach Extraction Test at 20:1 Liquid to Solid Ratio
Test Date : Jan 10, 2006

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Leachate Analysis

Sample Name:			10961-001 Wolverine Dil (-1/4" reject)	10961-001 Lynx Dil (-1/4" reject)	Blank
Parameter	Method	Units			
nanopure water volume		mL	1000	1000	1000
Sample Weight		g	50	50	-
pH	meter		6.88	6.92	5.45
Conductivity	meter	uS/cm	130	169	1
Acidity (to pH 4.5)	titration	mg CaCO3/L	#N/A	#N/A	#N/A
Total Acidity (to pH 8.3)	titration	mg CaCO3/L	10.75	5.5	2.5
Alkalinity	titration	mg CaCO3/L	11.5	16	1.25
Sulphate	Turbidity	mg/L	45	60	<1
Dissolved Metals					
Aluminum Al	ICP-MS	mg/L			
Antimony Sb	ICP-MS	mg/L			
Arsenic As	ICP-MS	mg/L			
Barium Ba	ICP-MS	mg/L			
Beryllium Be	ICP-MS	mg/L			
Bismuth Bi	ICP-MS	mg/L			
Boron B	ICP-MS	mg/L			
Cadmium Cd	ICP-MS	mg/L			
Calcium Ca	ICP-MS	mg/L			
Chromium Cr	ICP-MS	mg/L			
Cobalt Co	ICP-MS	mg/L			
Copper Cu	ICP-MS	mg/L			
Iron Fe	ICP-MS	mg/L			
Lead Pb	ICP-MS	mg/L			
Lithium Li	ICP-MS	mg/L			
Magnesium Mg	ICP-MS	mg/L			
Manganese Mn	ICP-MS	mg/L			
Mercury Hg	CVAA	ug/L			
Molybdenum Mo	ICP-MS	mg/L			
Nickel Ni	ICP-MS	mg/L			
Phosphorus PO4	ICP-MS	mg/L			
Potassium K	ICP-MS	mg/L			
Selenium Se	ICP-MS	mg/L			
Silicon SiO2	ICP-MS	mg/L			
Silver Ag	ICP-MS	mg/L			
Sodium Na	ICP-MS	mg/L			
Strontium Sr	ICP-MS	mg/L			
Tellurium Te	ICP-MS	mg/L			
Thallium Tl	ICP-MS	mg/L			
Thorium Th	ICP-MS	mg/L			
Tin Sn	ICP-MS	mg/L			
Titanium Ti	ICP-MS	mg/L			
Uranium U	ICP-MS	mg/L			
Vanadium V	ICP-MS	mg/L			
Zinc Zn	ICP-MS	mg/L			
Zirconium Zr	ICP-MS	mg/L			



DI Leach 20:1 Ratio (Shake Flask) Reassay Results

Parameter	Units	MMER ¹	Combined Ro + Cl Sc Tailings Solids	Combined OD Composite Tails	Combined Wolverine D Composite Tails	Combined Lynx D Composite Tails
Moisture	%		0.9	< 0.5	18.7	12.5
Sample	weight(g)		50	50	50	50
Initial pH	units		5.62	8.08	8.37	8.45
Final pH	units	6.0 - 9.5	6.65	7.96	7.69	7.61
pH	units	6.0 - 9.5	7.07	7.70	7.58	7.60
Conductivity	uS/cm		1470	1060	596	458
Acidity	mg/L as CaCO ₃		18	< 2	55	15
Alkalinity	mg/L as CaCO ₃		85	30	41	36
SO ₄	mg/L		910	560	220	150
Ag	mg/L		< 0.0001	0.0005	0.0001	0.0006
Al	mg/L		< 0.004	0.014	< 0.004	< 0.004
As	mg/L	0.50	0.008	0.008	0.012	0.008
Ba	mg/L		0.058	0.091	0.059	0.105
Be	mg/L		< 0.001	< 0.001	< 0.001	< 0.001
B	mg/L		< 0.005	0.007	< 0.005	< 0.005
Bi	mg/L		< 0.0003	< 0.0003	< 0.0003	< 0.0003
Ca	mg/L		305	208	110	82.0
Cd	mg/L		0.559	0.009	0.026	0.037
Co	mg/L		0.04	< 0.01	< 0.01	< 0.01
Cr	mg/L		< 0.02	< 0.02	< 0.02	< 0.02
Cu	mg/L	0.30	0.006	< 0.005	< 0.005	< 0.005
Fe	mg/L		< 0.02	< 0.02	< 0.02	< 0.02
K	mg/L		0.89	10.6	1.25	0.67
Li	mg/L		< 0.005	< 0.005	< 0.005	< 0.005
Mg	mg/L		16.9	15.9	5.58	3.79
Mn	mg/L		5.85	0.456	0.763	1.18
Mo	mg/L		< 0.0003	0.0089	0.0009	0.0016
Na	mg/L		0.83	3.08	3.55	1.97
Ni	mg/L	0.50	0.194	0.004	0.015	0.022
Pb	mg/L	0.20	0.254	0.0123	0.0419	0.143
Sb	mg/L		0.0042	0.0359	0.0596	0.0125
Se	mg/L		0.307	0.603	1.13	0.773
Si	mg/L		0.70	1.13	0.27	0.47
Sn	mg/L		< 0.001	< 0.001	< 0.001	< 0.001
Sr	mg/L		0.646	0.351	0.164	0.138
Ti	mg/L		< 0.003	< 0.003	< 0.003	< 0.003
Tl	mg/L		0.0120	0.0041	0.0051	0.0216
U	mg/L		< 0.0002	0.0003	0.0003	< 0.0002
V	mg/L		< 0.0009	< 0.0009	< 0.0009	< 0.0009
Zn	mg/L	0.50	46.6	0.29	0.78	0.76

LIMS #10358DEC05 and #10023JAN06

DI Leach 20:1 Ratio (Shake Flask) Results

Parameter	Units	MMER ¹	HLS Wolv Floats	Wolverine Dil Ore	Combined Wolverine D Tailings	Combined Wolverine D Composite Tails Reassay	HLS Lynx Floats	Lynx Dil Ore	Combined Lynx D Tailings	Combined Lynx D Composite Tailings Reassay	Combined OD Tailings	Combined OD Composite Tailings Reassay	Combined Overall Tailings	Combined Overall Tailings Reassay	HLS Hump Floats
Moisture	%				16.8	18.7			29.9	12.5	16	<0.5	1.0	0.9	
Sample	weight(g)		50	50	50	50	50	50	50	50	50	50	50	50	50
Volume mL	D.I. H ₂ O		1000	1000	991.6	***	1000	1000	985	***	992	***	990	***	1000
Initial pH	units				9.2	8.37			9.1	8.45	9.4	8.08	7.1	5.62	
Final pH	units	6.0 - 9.5			8.35	7.69			8.33	7.61	8.17	7.96	7.27	6.65	
pH	units	6.0 - 9.5	7.33	6.88	***	7.58	7.4	6.92	***	7.60	***	7.70	7.33	7.07	7.56
Conductivity	uS/cm		77	130	***	596	89	169	***	458	***	1060	813	1470	113
Acidity	mg/L as CaCO ₃		4	10.75	***	55	5	5.5	***	15	***	1	17	18	4
Alkalinity	mg/L as CaCO ₃		26.5	11.5	***	41	32.75	16	***	36	***	30	52	85	44.5
SO ₄	mg/L		15	45	41	220	12	60	38	150	41	560	430	910	15
Al	mg/L		0.009	< 0.001	0.007	0.005	0.005	0.001	0.007	0.005	0.005	0.01	0.002	0.005	0.019
Antimony Sb	mg/L		0.024	0.0068	0.0471	0.025	0.026	0.0068	0.0115	0.025	0.0155	0.025	0.0034	0.025	0.029
As	mg/L	0.50	0.0033	0.0008	0.001	0.025	0.0015	0.0008	0.011	0.025	0.007	0.025	0.0025	0.025	0.0019
Ba	mg/L		0.042	0.058	0.198	0.063	0.059	0.054	0.326	0.110	0.272	0.092	0.070	0.058	0.036
Be	mg/L		0.0001	< 0.0002	0.0025	0.0005	0.0001	< 0.0002	0.0025	0.0005	0.0025	0.0005	0.0025	0.0005	0.0001
Bi	mg/L		0.0001	< 0.0002	0.00015	0.025	0.0001	< 0.0002	0.00015	0.025	0.00015	0.025	0.00015	0.025	0.0001
Boron B	mg/L		0.005	< 0.01	0.005	0.005	0.005	< 0.01	0.02	0.005	0.005	0.005	0.005	0.005	0.005
Cadmium Cd	mg/L		0.0042	0.072	0.0025	0.026	0.003	0.038	0.0049	0.037	0.0051	0.009	0.134	0.559	0.0014
Calcium Ca	mg/L		14.7	13.3	46.8	110	16.8	22.2	43.3	82.0	46.8	208	153	305	20.9
Chromium Cr	mg/L		0.0001	< 0.0002	0.0005	0.01	0.0001	< 0.0002	0.0005	0.01	0.0005	0.01	0.0005	0.01	0.0001
Co	mg/L		0.0019	0.0039	0.00015	0.005	0.0036	0.0069	0.00015	0.005	0.0004	0.005	0.0106	0.04	0.0015
Cu	mg/L	0.30	0.0022	0.0021	0.0009	0.0025	0.0038	0.0036	0.0021	0.0025	0.0014	0.0025	0.0015	0.006	0.0006
Fe	mg/L		0.005	< 0.01	0.01	0.01	0.005	< 0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.005
Lead Pb	mg/L	0.20	0.0037	0.049	0.0204	0.05	0.0058	0.0062	0.0618	0.15	0.0392	0.01	0.171	0.27	0.0018
Li	mg/L		0.0006	0.0008	0.0025	0.0025	0.0006	0.0006	0.0025	0.0025	0.0025	0.0025	0.002	0.0025	0.0006
Mg	mg/L		1.29	2.84	2.75	5.58	1.1	3.13	1.76	3.79	2.31	15.9	5.70	16.9	1.19
Mn	mg/L		0.172	0.155	0.0783	0.763	0.169	0.366	0.185	1.18	0.215	0.456	2.14	5.85	0.164
Mercury Hg	mg/L		< 0.02	< 0.02	0.00005	< 0.02	< 0.02	0.00005	0.00005	< 0.02	0.00005	0.00005	0.00005	< 0.02	< 0.02
Mo	mg/L		0.0008	0.0005	0.0029	0.01	0.0017	0.0013	0.0039	0.01	0.0033	0.01	0.0006	0.01	0.001
Ni	mg/L	0.50	0.038	0.095	0.001	0.01	0.024	0.133	0.002	0.02	0.002	0.01	0.024	0.18	0.014
P	mg/L		0.71	< 0.03	0.05	1.25	0.81	< 0.03	0.05	0.67	0.05	0.05	0.05	0.05	0.05
Potassium K	mg/L		0.0083	0.015	0.597	0.4	0.019	0.021	0.499	0.3	0.418	0.2	0.20	0.2	0.01
Se	mg/L			0.25	0.32	0.27		0.21	0.32	0.47	0.41	1.13	0.36	0.70	
Si	mg/L		0.000025	< 0.00005	0.0006	0.0025	0.000025	< 0.00005	0.0008	0.0025	0.0008	0.0025	0.00005	0.0025	0.000025
Silver Ag	mg/L		0.44	0.18	3.21	3.55	0.49	0.12	2.18	1.97	2.39	3.08	1.52	0.83	0.24
Sodium Na	mg/L		0.039	0.049	0.0664	0.184	0.05	0.091	0.0594	0.138	0.0641	0.351	0.329	0.646	0.055
Sr	mg/L			< 0.0002				< 0.0002							
Te	mg/L		0.00025	0.0019	0.0023	0.05	0.002	0.0014	0.0086	0.05	0.0063	0.05	0.0219	0.05	0.0004
Thallium Tl	mg/L			< 0.0001				< 0.0001							
Thorium Th	mg/L		0.0001	< 0.0002	0.0015	0.0025	0.0001	< 0.0002	0.0015	0.0025	0.0015	0.0025	0.0015	0.0025	0.0001
Ti	mg/L		0.0001	< 0.0002	0.0005	0.05	0.0001	< 0.0002	0.0005	0.05	0.0005	0.05	0.0005	0.05	0.0001
Tin Sn	mg/L		0.0002	< 0.0001	0.0001	0.02	0.00005	0.0002	0.0001	0.02	0.0001	0.02	0.0001	0.02	0.0008
U	mg/L		0.0001	< 0.0002	0.00045	0.001	0.0001	< 0.0002	0.00045	0.001	0.00045	0.004	0.0010	0.005	0.0001
V	mg/L		0.0001	< 0.0002	0.00045	0.001	0.0001	< 0.0002	0.00045	0.001	0.00045	0.004	0.0010	0.005	0.0001
Zn	mg/L	0.50	0.3	5.09	0.037	0.78	0.21	1.71	0.064	0.76	0.081	0.29	6.87	46.6	0.064
Zirconium Zr	mg/L		0.001	< 0.002			0.001	< 0.002							0.001
Tot. Dissolved Solids	mg/L				***	***			***	***	***	***	740	*** Results pending	
Tot Suspended Solids	mg/L				***	***			***	***	***	***	3		
F	mg/L				***	***			***	***	***	***	0.06		
NH ₃ +NH ₄	as N mg/L				1				0.2		0.2		0.3		
Cl	mg/L				1				1		1		1.5		
NO ₃	as N mg/L				0.79				0.25		0.25		0.25		
CN(T)	mg/L				0.005				0.005		0.07		0.02		
CNO	mg/L				0.05				0.05		0.05		0.5		
CNS	mg/L				1				1		1		1		
Thiosalts	as S ₂ O ₃ mg/L				***	***			***	***	***	***	44		

DI Leach 20:1 Ratio (Shake Flask) Reassay Results

Parameter	Units	MMER ¹	Combined Ro + CI Sc Tailings Solids	Combined OD Composite Tails	Combined Wolverine D Composite Tails	Combined Lynx D Composite Tails
Moisture	%		0.9	< 0.5	18.7	12.5
Sample	weight(g)		50	50	50	50
Volume mL	D.I. H ₂ O		***	***	***	***
Initial pH	units		5.62	8.08	8.37	8.45
Final pH	units	6.0 - 9.5	6.65	7.96	7.69	7.61
pH	units	6.0 - 9.5	7.07	7.70	7.58	7.60
Conductivity	uS/cm		1470	1060	596	458
Acidity	mg/L as CaCO ₃		18	< 2	55	15
Alkalinity	mg/L as CaCO ₃		85	30	41	36
SO ₄	mg/L		910	560	220	150
Ag	mg/L		< 0.005	< 0.005	< 0.005	< 0.005
Al	mg/L		< 0.01	0.01	< 0.01	< 0.01
As	mg/L	0.50	< 0.05	< 0.05	< 0.05	< 0.05
Ba	mg/L		0.058	0.092	0.063	0.110
Be	mg/L		< 0.001	< 0.001	< 0.001	< 0.001
B	mg/L		< 0.01	< 0.01	< 0.01	< 0.01
Bi	mg/L		< 0.05	< 0.05	< 0.05	< 0.05
Ca	mg/L		305	208	110	82.0
Cd	mg/L		0.559	0.009	0.026	0.037
Co	mg/L		0.04	< 0.01	< 0.01	< 0.01
Cr	mg/L		< 0.02	< 0.02	< 0.02	< 0.02
Cu	mg/L	0.30	0.006	< 0.005	< 0.005	< 0.005
Fe	mg/L		< 0.02	< 0.02	< 0.02	< 0.02
K	mg/L		0.89	10.6	1.25	0.67
Li	mg/L		< 0.005	< 0.005	< 0.005	< 0.005
Mg	mg/L		16.9	15.9	5.58	3.79
Mn	mg/L		5.85	0.456	0.763	1.18
Mo	mg/L		< 0.02	< 0.02	< 0.02	< 0.02
Na	mg/L		0.83	3.08	3.55	1.97
Ni	mg/L	0.50	0.18	< 0.02	< 0.02	0.02
Pb	mg/L	0.20	0.27	< 0.02	0.05	0.15
Sb	mg/L		< 0.05	< 0.05	< 0.05	< 0.05
Se	mg/L		0.2	0.2	0.4	0.3
Si	mg/L		0.70	1.13	0.27	0.47
Sn	mg/L		< 0.1	< 0.1	< 0.1	< 0.1
Sr	mg/L		0.646	0.351	0.164	0.138
Ti	mg/L		< 0.005	< 0.005	< 0.005	< 0.005
Tl	mg/L		< 0.1	< 0.1	< 0.1	< 0.1
U	mg/L		< 0.04	< 0.04	< 0.04	< 0.04
V	mg/L		0.005	0.004	< 0.002	< 0.002
Zn	mg/L	0.50	46.6	0.29	0.78	0.76

*** Results pending.

DI Leach 20:1 Ratio (Shake Flask) Reassay Results

Parameter	Units	Combined OD Composite Tails	Combined Wolverine D Composite Tails	Combined Lynx D Composite Tails	Combined Ro + CI Sc Tailings Solids
Moisture	%	< 0.5	18.7	12.5	0.9
Sample	weight(g)	50	50	50	50
Volume mL	D.I. H ₂ O	***	***	***	1001
Initial pH	units	8.08	8.37	8.45	5.62
Final pH	units	7.96	7.69	7.61	6.65
pH	units	7.70	7.58	7.60	7.07
Conductivity	uS/cm	1060	596	458	1470
Acidity	mg/L as CaCO ₃	***	***	***	***
Alkalinity	mg/L as CaCO ₃	30	41	36	85
SO ₄	mg/L	560	220	150	910

LIMS #10358DEC05

DI Leach 20:1 Ratio (Shake Flask) Reassay Results

Parameter	Units	MMER ¹	Combined Ro + CI Sc Tailings Solids	Combined OD Composite Tails	Combined Wolverine D Composite Tails	Combined Lynx D Composite Tails
Moisture	%		0.9	< 0.5	18.7	12.5
Sample	weight(g)		50	50	50	50
Volume mL	D.I. H ₂ O		***	***	***	***
Initial pH	units		5.62	8.08	8.37	8.45
Final pH	units	6.0 - 9.5	6.65	7.96	7.69	7.61
pH	units	6.0 - 9.5	7.07	7.70	7.58	7.60
Conductivity	uS/cm		1470	1060	596	458
Acidity	mg/L as CaCO ₃		18	< 2	55	15
Alkalinity	mg/L as CaCO ₃		85	30	41	36
SO ₄	mg/L		910	560	220	150
Ag	mg/L		< 0.005	< 0.005	< 0.005	< 0.005
Al	mg/L		< 0.01	0.01	< 0.01	< 0.01
As	mg/L	0.50	< 0.05	< 0.05	< 0.05	< 0.05
Ba	mg/L		0.058	0.092	0.063	0.110
Be	mg/L		< 0.001	< 0.001	< 0.001	< 0.001
B	mg/L		< 0.01	< 0.01	< 0.01	< 0.01
Bi	mg/L		< 0.05	< 0.05	< 0.05	< 0.05
Ca	mg/L		305	208	110	82.0
Cd	mg/L		0.559	0.009	0.026	0.037
Co	mg/L		0.04	< 0.01	< 0.01	< 0.01
Cr	mg/L		< 0.02	< 0.02	< 0.02	< 0.02
Cu	mg/L	0.30	0.006	< 0.005	< 0.005	< 0.005
Fe	mg/L		< 0.02	< 0.02	< 0.02	< 0.02
K	mg/L		0.89	10.6	1.25	0.67
Li	mg/L		< 0.005	< 0.005	< 0.005	< 0.005
Mg	mg/L		16.9	15.9	5.58	3.79
Mn	mg/L		5.85	0.456	0.763	1.18
Mo	mg/L		< 0.02	< 0.02	< 0.02	< 0.02
Na	mg/L		0.83	3.08	3.55	1.97
Ni	mg/L	0.50	0.18	< 0.02	< 0.02	0.02
Pb	mg/L	0.20	0.27	< 0.02	0.05	0.15
Sb	mg/L		< 0.05	< 0.05	< 0.05	< 0.05
Se	mg/L		0.2	0.2	0.4	0.3
Si	mg/L		0.70	1.13	0.27	0.47
Sn	mg/L		< 0.1	< 0.1	< 0.1	< 0.1
Sr	mg/L		0.646	0.351	0.164	0.138
Ti	mg/L		< 0.005	< 0.005	< 0.005	< 0.005
Tl	mg/L		< 0.1	< 0.1	< 0.1	< 0.1
U	mg/L		< 0.04	< 0.04	< 0.04	< 0.04
V	mg/L		0.005	0.004	< 0.002	< 0.002
Zn	mg/L	0.50	46.6	0.29	0.78	0.76

*** Results pending.

Humidity Cell Test Report ASTM D 5744-96 (2001)

Head Assay

Parameter	Units	Value
S%:	%	29.20
S ²⁻ %:	%	25.00
NP:	t CaCO ₃ /1000 tonne of material	72.8

Sample I.D.: Overall Combined Composite
 Ro + Cl Sc Tails
Sample Weight: 1000 grams
NP results from Modified ABA Testing
LIMS Ref. # 10279MAY05

Week	Leachate Analyses					Sulphate (SO ₄)			Sulphide Depletion		NP Depletion	
	Leachate Volume mL	pH units	Acidity CaCO ₃ eq. mg/L	Alkalinity CaCO ₃ eq. mg/L	Conductivity µmhos/cm	Ind. Assay mg/L	Production Rate g/t/wk	Cum. Production g/t	Ind. Depletion %	S ²⁻ Calc. Depletion %	Calculated Consumption CaCO ₃ g/t/wk	NP Calc. Depletion %
0	275	6.43	32	4	485	220	60.5	60.5	0.01	0.01	63.02	0.09
1	496	6.96	79	13	933	480	238.1	298.6	0.03	0.04	248.00	0.43
2	426	6.92	114	7	855	380	161.9	460.5	0.02	0.06	168.63	0.66
3	368	6.61	202	7	1342	630	231.8	692.3	0.03	0.09	241.50	0.99
4	432	6.61	182	4	771	310	133.9	826.2	0.02	0.11	139.50	1.18
5	405	6.83	189	12	920	420	170.1	996.3	0.02	0.13	177.19	1.43
6	428	6.37	149	<2	664	260	111.3	1107.6	0.01	0.15	115.92	1.58
7	426	6.55	112	4	527	200	85.2	1192.8	0.01	0.16	88.75	1.71
8	417	6.48	62	6.7	285	93	38.8	1231.6	0.01	0.16	40.40	1.76
9	454	6.50	160	3	599	200	90.8	1322.4	0.01	0.18	94.58	1.89
10	453	6.73	128	9	436	180	81.5	1403.9	0.01	0.19	84.94	2.01
11	398	6.60	136	4	510	200	79.6	1483.5	0.01	0.20	82.92	2.12
12	456	6.52	157	5	565	210	95.8	1579.3	0.01	0.21	99.75	2.26
13	347	6.75	117	5	389	150	52.1	1631.3	0.01	0.22	54.22	2.33
14	419	6.75	187	5	654	260	108.9	1740.3	0.01	0.23	113.48	2.49
15	401	6.87	163	7	551	250	100.3	1840.5	0.01	0.25	104.43	2.63
16	454	6.52	160	4	541	240	109.0	1949.5	0.01	0.26	113.50	2.79
17	434	6.68	127	6	531	200	86.8	2036.3	0.01	0.27	90.42	2.91
18	404	6.45	141	4	590	240	97.0	2133.2	0.01	0.28	101.00	3.05
19	337	6.71	109	6	418	150	50.6	2183.8	0.01	0.29	52.66	3.12
20	446	6.69	180	6	570	220	98.1	2281.9	0.01	0.30	102.21	3.27
21	437	6.59	141	5	492	180	78.7	2360.6	0.01	0.31	81.94	3.38
22	396	6.70	115	4	420	160	63.4	2423.9	0.01	0.32	66.00	3.47
23	316	6.11	116	4	362	130	41.1	2465.0	0.01	0.33	42.79	3.53
24	429	5.85	195	3	730	280	120.1	2585.1	0.02	0.34	125.13	3.70
25	426	6.62	170	4	620	270	115.0	2700.2	0.02	0.36	119.81	3.86
26	406	6.69	108	5	408	170	69.0	2769.2	0.01	0.37	71.90	3.96
27	337	6.59	155	6	596	240	80.9	2850.1	0.01	0.38	84.25	4.08
28	399	6.70	142	4	504	200	79.8	2929.9	0.01	0.39	83.13	4.19
29	350	6.59	140	4	520	220	77.0	3006.9	0.01	0.40	80.21	4.30
30	435	6.79	116	5	559	240	104.4	3111.3	0.01	0.41	108.75	4.45
31	491	6.80	120	5	540	240	117.8	3229.1	0.02	0.43	122.75	4.62
Maximum Value	6.96	-	13	1342	630	238.1	-	0.03	-	248.00	-	
Minimum Value	5.85	-	2	285	93	38.8	-	0.01	-	40.40	-	
Average Value	6.53	-	5	590	244	100.4	-	0.01	-	104.54	-	

Week 16 conductivity value interpolated due to insufficient sample.

**Overall Combined Composite
Dissolved Metal Concentrations**

Parameter	Units	MMER ¹	Week												
			0	1	2	3	4	5	6	7	8	9	10	11	12
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
LIMS #			10094JUN05	10202JUN05	10327JUN05	10460JUL05	10003JUL05	10125JUL05	10256JUL05	10347JUL05	10013AUG05	10115AUG05	10253AUG05	10377AUG05	10005SEP05
Hum Cell Leachate Vol	mLs		275	496	426	368	432	405	428	426	417	454	453	398	456
pH	units	6.0 - 9.5	6.43	6.96	6.92	6.61	6.81	6.83	6.37	6.55	6.48	6.50	6.73	6.60	6.52
Alkalinity	mg/L as CaCO ₃		4	13	7	7	4	12	< 2	4	6.7	3	9	4	5
Acidity	mg/L as CaCO ₃		32	79	114	202	182	189	149	112	62	160	128	136	157
Conductivity	uS/cm		485	933	855	1342	771	920	864	527	285	599	436	510	565
SO ₄	mg/L		220	480	380	630	310	420	260	200	93	200	180	200	210
Cl	mg/L		0.4	0.14	0.8	< 2.0	0.5	0.5	0.4	0.2	< 0.2	0.3	0.2	0.2	0.2
F	mg/L		---	0.10	0.11	0.10	0.06	0.12	0.09	0.07	< 0.06	0.06	0.07	0.06	< 0.06
NO ₃	as N mg/L		0.58	0.37	0.07	0.08	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.29	< 0.05	< 0.05	< 0.05
NH ₃ + NH ₄	as N mg/L		---	---	---	---	---	---	0.1	0.4	0.2	0.2	0.2	0.1	0.2
Thiosalts	as S ₂ O ₃ mg/L		< 10	71	100	261	427	210	160	89	64	161	129	132	157
CN(T)	mg/L	1.00	---	< 0.002	< 0.01	< 0.01	< 0.002	< 0.01	< 0.002	< 0.01	< 0.01	< 0.002	< 0.002	< 0.002	< 0.01
CNO	mg/L		< 0.1	< 1	< 1	< 0.1	< 0.1	< 0.5	< 0.1	< 1.0	< 1.0	< 0.1	< 0.1	< 0.1	< 1.0
CNS	mg/L		< 0.2	< 2	< 2	< 2	27	29	< 2	< 2	< 5.0	< 2.0	< 2.0	< 2.0	20
Hg	μg/L		< 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
Ag	mg/L		< 0.005	0.0003	< 0.005	< 0.005	< 0.005	0.0023	< 0.005	< 0.005	< 0.02	< 0.005	< 0.005	< 0.005	< 0.005
Al	mg/L		< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.02
As	mg/L	0.50	< 0.005	< 0.005	0.013	0.013	0.007	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Ba	mg/L		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
Be	mg/L		< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Bi	mg/L		< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003
B	mg/L		< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Ca	mg/L		59.8	131	117	128	175	106	77.7	42.4	68.6	72.4	78.4	83.6	
Cd	mg/L		0.301	0.186	0.138	0.174	0.109	0.153	0.0815	0.0681	0.0423	0.0646	0.0720	0.0670	0.0711
Co	mg/L		0.0182	0.0302	0.0216	0.0244	0.0152	0.0137	0.0074	0.0048	0.0028	0.0043	0.0042	0.0039	0.0041
Cr	mg/L		< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.006	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Cu	mg/L	0.30	0.0117	0.0022	0.0021	0.0029	0.0021	0.0034	0.0016	0.0015	0.0008	0.0015	0.0017	0.0013	0.0013
Fe	mg/L		< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Li	mg/L		< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
K	mg/L		0.68	2.10	2.15	2.89	1.74	1.84	1.62	0.96	1.01	1.11	0.86	0.90	0.97
Mg	mg/L		12.0	31.7	31.7	38.1	20.2	21.3	17.3	11.7	5.70	11.3	9.85	10.3	12.7
Mn	mg/L		3.33	8.14	7.19	6.93	3.69	4.00	2.51	1.55	0.726	1.55	1.12	1.11	1.27
Mo	mg/L		< 0.0003	0.0004	< 0.0003	0.0005	< 0.0003	0.0007	0.0004	0.0004	0.0005	0.0004	0.0004	0.0004	0.0004
Na	mg/L		3.33	8.18	8.32	10.1	5.29	5.44	4.33	2.54	1.38	3.19	2.02	2.12	2.50
Ni	mg/L	0.50	0.049	0.080	0.044	0.039	0.020	0.024	0.010	0.007	0.004	0.007	0.004	0.005	0.009
P	mg/L		< 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
Pb	mg/L	0.20	0.400	0.0685	0.0473	0.0596	0.0383	0.0412	0.0275	0.0144	0.0238	0.0185	0.0185	0.0193	0.0193
Sb	mg/L		< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.09	< 0.05	< 0.05	< 0.05	< 0.05
Se	mg/L		0.10	0.37	0.19	0.57	0.033	0.16	0.297	0.27	0.077	0.20	0.186	0.19	0.247
Si	mg/L		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
Sn	mg/L		0.021	0.022	0.010	0.008	0.008	0.010	0.003	0.002	0.002	0.003	0.002	0.002	0.002
Sr	mg/L		0.129	0.697	0.750	0.995	0.575	0.723	0.538	0.371	0.198	0.459	0.344	0.379	0.433
Ti	mg/L		< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.02	< 0.005	< 0.005	< 0.005	< 0.005
Tl	mg/L		0.0148	0.0220	0.0151	0.0223	0.0140	0.0167	0.0099	0.0082	0.0041	0.0085	0.0062	0.0066	0.0076
U	mg/L		< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
V	mg/L		< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Zn	mg/L	0.50	23.4	17.9	13.5	12.0	7.27	8.75	4.56	3.79	2.54	3.76	3.56	3.43	3.87

Week #0 signifies the initial flooding of the humidity cell initiating the 20 week test period.

Metal Mining Effluent Regulations

---Not Analysed

---Could not be determined due to sample matrix.

nss - Not sufficient sample.

Overall Combined Composite
Dissolved Metal Concentrations

Parameter	Units	MMER ¹	Week												
			13	14	15	16	17	18	19	20	21	22	23	24	25
Date			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
LIMS #			12082SEP05	10157SEP05	10275SEP05	10489SEP05	10032OCT05	10186OCT05	10288OCT05	10450OCT05	10014NOV05	10099NOV05	10236NOV05	10405NOV05	10007DEC05
Hum Cell Leachate Vol	mLs		347	419	401	454	434	404	337	446	437	396	316	429	426
pH	units	6.0 - 9.5	6.75	6.75	6.87	6.52	6.68	6.45	6.71	6.69	6.59	6.70	6.11	5.85	6.62
Alkalinity	mg/L as CaCO ₃		5	5	7	4	6	4	6	6	5	4	4	3	4
Acidity	mg/L as CaCO ₃		117	187	163	160	127	141	109	180	141	115	116	195	170
Conductivity	uS/cm		389	654	551	nss	531	590	418	570	492	420	362	730	620
SO ₄	mg/L		150	260	250	240	200	240	150	220	180	160	130	280	270
Cl	mg/L		< 0.2	0.3	< 0.2	< 2	0.2	< 0.2	< 0.2	< 0.2	---	---	---	---	---
F	mg/L		< 0.06	0.08	0.08	0.07	0.07	0.07	0.06	0.06	---	---	---	---	---
NO ₃	as N mg/L		< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	---	---	---	---	---
NH ₃ + NH ₄	as N mg/L		< 0.1	0.1	0.5	< 0.1	0.1	0.1	0.1	0.1	---	---	---	---	---
Thiosalts	as S ₂ O ₃ mg/L		113	226	156	159	128	140	108	173	---	---	---	---	156
CN(T)	mg/L	1.00	< 0.002	< 0.002	< 0.01	< 0.002	< 0.01	0.01	< 0.002	< 0.02	---	---	---	---	---
CNO	mg/L		< 0.1	< 0.1	< 0.1	< 0.1	< 1	< 0.1	< 0.1	< 0.1	---	---	---	---	---
CNS	mg/L		2.5	***	***	***	---	---	---	---	---	---	---	---	---
Hg	µg/L		< 0.1	0.1	< 0.1	< 0.1	0.1	< 0.1	< 0.1	< 0.1	---	---	---	---	---
Ag	mg/L		< 0.005	< 0.005	< 0.005	< 0.01	< 0.005	< 0.005	< 0.02	< 0.005	---	---	---	---	< 0.005
Al	mg/L		< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	---	---	---	---	< 0.01
As	mg/L	0.50	< 0.005	< 0.005	0.006	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	---	---	---	---	0.007
Ba	mg/L		0.043	0.038	0.039	0.028	0.028	0.022	0.032	0.029	---	---	---	---	0.037
Be	mg/L		< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	---	---	---	---	< 0.005
Bi	mg/L		< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	---	---	---	---	< 0.0003
B	mg/L		< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	---	---	---	---	< 0.01
Ca	mg/L		59.9	116	89.0	105	84.3	94.1	65.0	87.0	---	---	---	---	106
Cd	mg/L		0.0896	0.117	0.0935	0.0866	0.0851	0.0748	0.0905	0.124	---	---	---	---	0.146
Co	mg/L		0.0042	0.0067	0.0053	0.0044	0.0043	0.0039	0.0046	0.0074	---	---	---	---	0.0077
Cr	mg/L		< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	---	---	---	---	< 0.001
Cu	mg/L	0.30	0.0022	0.0026	0.0025	0.0016	0.0032	0.0013	0.0019	0.0017	---	---	---	---	0.0031
Fe	mg/L		< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	---	---	---	---	< 0.02
Li	mg/L		< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	---	---	---	---	< 0.005
K	mg/L		0.60	1.12	0.91	1.03	0.81	0.90	0.56	0.73	---	---	---	---	0.69
Mg	mg/L		9.29	16.1	12.1	12.6	10.0	9.88	7.22	9.88	---	---	---	---	9.92
Mn	mg/L		1.10	2.06	1.43	1.50	1.27	1.16	1.11	1.85	---	---	---	---	2.02
Mo	mg/L		0.0003	0.0004	0.0004	0.0005	< 0.0003	0.0005	0.0003	0.0005	---	---	---	---	0.0005
Na	mg/L		1.40	2.41	1.89	2.04	1.50	1.46	0.84	1.01	---	---	---	---	0.66
Ni	mg/L	0.50	0.006	0.010	0.005	0.005	0.006	0.004	0.005	0.007	---	---	---	---	0.005
P	mg/L		< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	---	---	---	---	< 0.1
Pb	mg/L	0.20	0.0254	0.0315	0.0190	0.0207	0.0242	0.0170	0.0205	0.0229	---	---	---	---	0.0296
Sb	mg/L		< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	---	---	---	---	< 0.05
Se	mg/L		0.171	0.321	0.285	0.291	0.245	0.279	0.183	0.227	---	---	---	---	0.287
Si	mg/L		0.16	0.26	0.21	0.22	0.20	0.22	0.16	0.20	---	---	---	---	0.21
Sn	mg/L		0.001	0.002	0.002	0.001	< 0.001	0.001	< 0.001	0.001	---	---	---	---	0.001
Sr	mg/L		0.274	0.574	0.442	0.514	0.408	0.436	0.296	0.424	---	---	---	---	0.487
Ti	mg/L		< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	---	---	---	---	< 0.005
Tl	mg/L		0.0048	0.0085	0.0075	0.0069	0.0065	0.0068	0.0015	0.0079	---	---	---	---	0.0076
U	mg/L		< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	---	---	---	---	< 0.0002
V	mg/L		< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	---	---	---	---	< 0.002
Zn	mg/L	0.50	5.11	6.13	4.04	4.57	4.60	3.51	4.59	5.55	---	---	---	---	6.31

Week #0 signifies the initial flooding of the humidity cell initiating the 20 w

Metal Mining Effluent Regulations

---Not Analysed

***Could not be determined due to sample matrix.

nss - Not sufficient sample

**Overall Combined Composite
Dissolved Metal Concentrations**

Parameter	Units	MMER ¹	Week						
			26	27	28	29	30	31	
Date			Dec 9/05	Dec 16/05	Dec 23/05	Dec 30/05	Jan 6/06	Jan 13/06	
LIMS #			10041DEC05	10281DEC05	10419DEC05	10505DEC05	10007JAN06	10081JAN06	
Hum Cell Leachate Vol	mLs		406	337	399	350	435	491	
pH	units	6.0 - 9.5	6.69	6.59	6.70	6.59	6.79	6.80	
Alkalinity	mg/L as CaCO ₃		5	6	4	4	5	5	
Acidity	mg/L as CaCO ₃		108	155	142	140	116	120	
Conductivity	uS/cm		408	596	504	520	559	540	
SO ₄	mg/L		170	240	200	220	240	240	
Cl	mg/L		---	---	---	---	---	---	
F	mg/L		---	---	---	---	---	---	
NO ₃	as N mg/L		---	---	---	---	---	---	
NH ₃ + NH ₄	as N mg/L		---	---	---	---	---	---	
Thiosalts	as S ₂ O ₃ mg/L		---	---	---	---	101	---	
CN(T)	mg/L	1.00	---	---	---	---	---	---	
CNO	mg/L		---	---	---	---	---	---	
CNS	mg/L		---	---	---	---	---	---	
Hg	µg/L		---	---	---	---	---	---	
Ag	mg/L		---	---	---	---	< 0.005	---	
Al	mg/L		---	---	---	---	< 0.01	---	
As	mg/L	0.50	---	---	---	---	< 0.005	---	
Ba	mg/L		---	---	---	---	0.028	---	
Be	mg/L		---	---	---	---	< 0.005	---	
Bi	mg/L		---	---	---	---	< 0.0003	---	
B	mg/L		---	---	---	---	< 0.01	---	
Ca	mg/L		---	---	---	---	98.4	---	
Cd	mg/L		---	---	---	---	0.136	---	
Co	mg/L		---	---	---	---	0.0066	---	
Cr	mg/L		---	---	---	---	< 0.001	---	
Cu	mg/L	0.30	---	---	---	---	0.0026	---	
Fe	mg/L		---	---	---	---	< 0.02	---	
Li	mg/L		---	---	---	---	< 0.005	---	
K	mg/L		---	---	---	---	0.57	---	
Mg	mg/L		---	---	---	---	7.52	---	
Mn	mg/L		---	---	---	---	2.03	---	
Mo	mg/L		---	---	---	---	0.0004	---	
Na	mg/L		---	---	---	---	0.30	---	
Ni	mg/L	0.50	---	---	---	---	0.007	---	
P	mg/L		---	---	---	---	< 0.1	---	
Pb	mg/L	0.20	---	---	---	---	0.0249	---	
Sb	mg/L		---	---	---	---	< 0.05	---	
Se	mg/L		---	---	---	---	0.231	---	
Si	mg/L		---	---	---	---	0.21	---	
Sn	mg/L		---	---	---	---	< 0.001	---	
Sr	mg/L		---	---	---	---	0.418	---	
Ti	mg/L		---	---	---	---	< 0.005	---	
Tl	mg/L		---	---	---	---	0.0063	---	
U	mg/L		---	---	---	---	< 0.0002	---	
V	mg/L		---	---	---	---	< 0.002	---	
Zn	mg/L	0.50	---	---	---	---	6.53	---	

Week #0 signifies the initial flooding of the humidity cell initiating the 20 w

Metal Mining Effluent Regulations

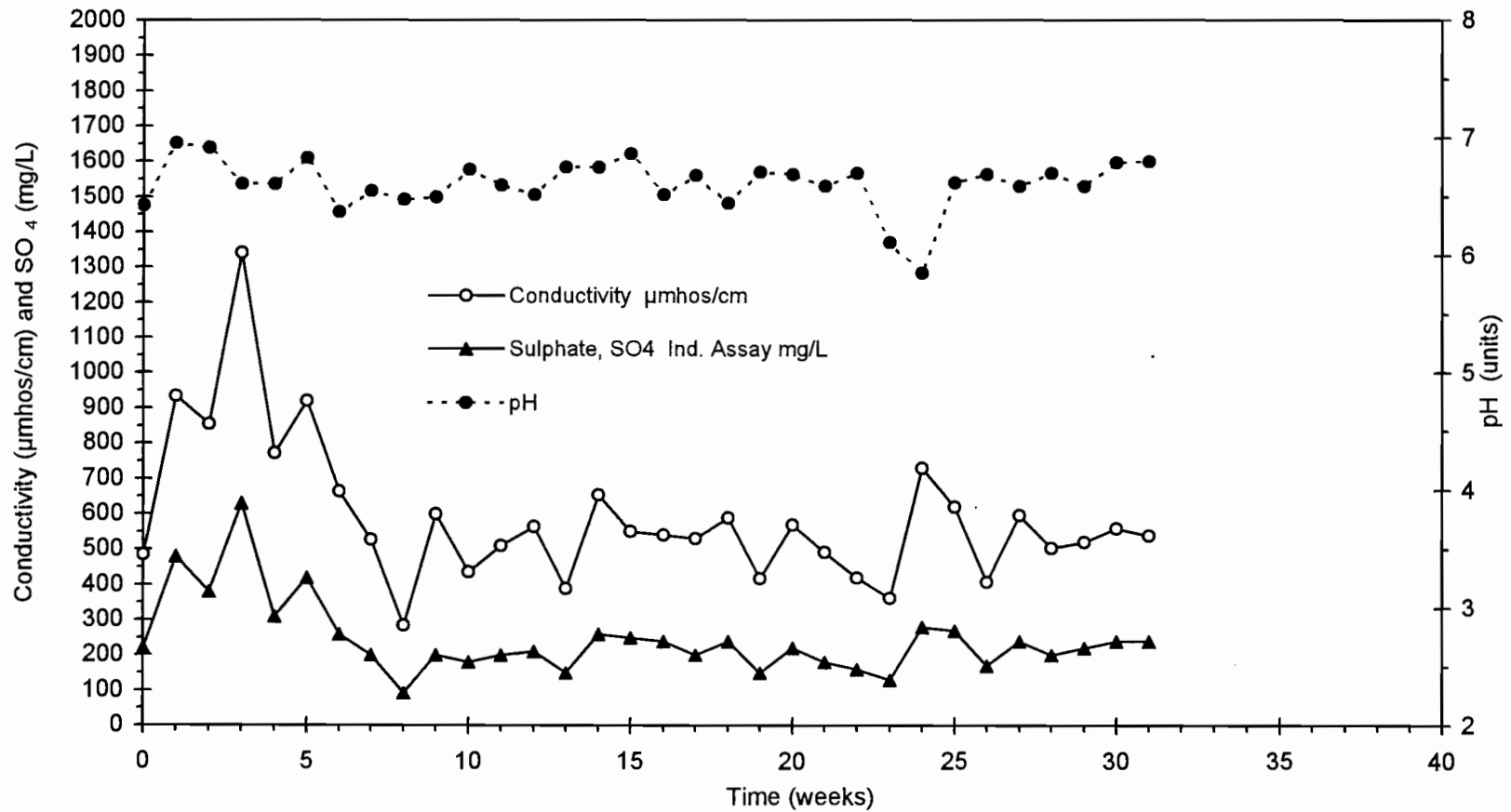
---Not Analysed

***Could not be determined due to sample matrix.

nss - Not sufficient sample.

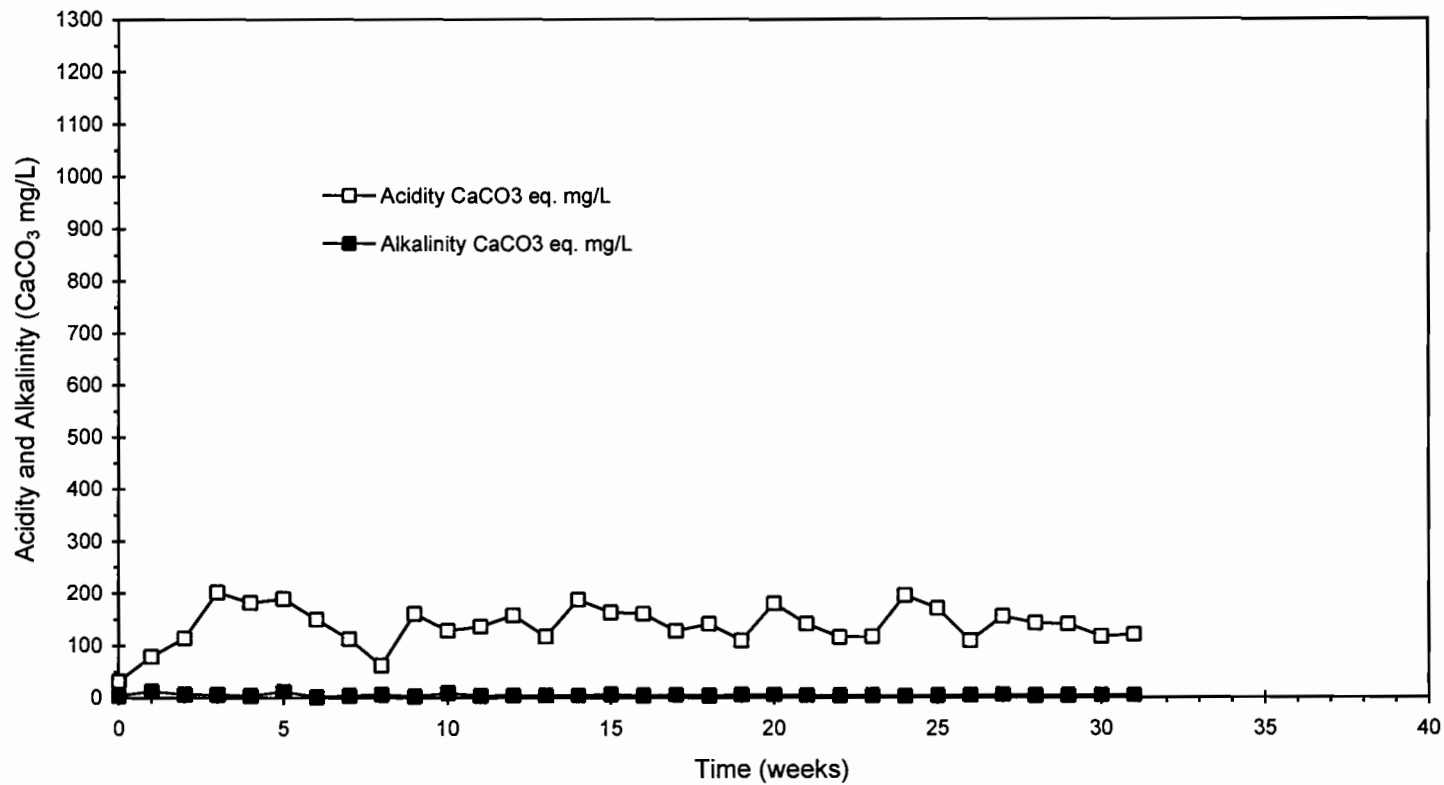
Humidity Cell Test Report ASTM D 5744-96 (2001)
Sample I.D.: Overall Combined Composite Ro + Cl Sc Tails

Conductivity, Sulphate and pH vs. Time



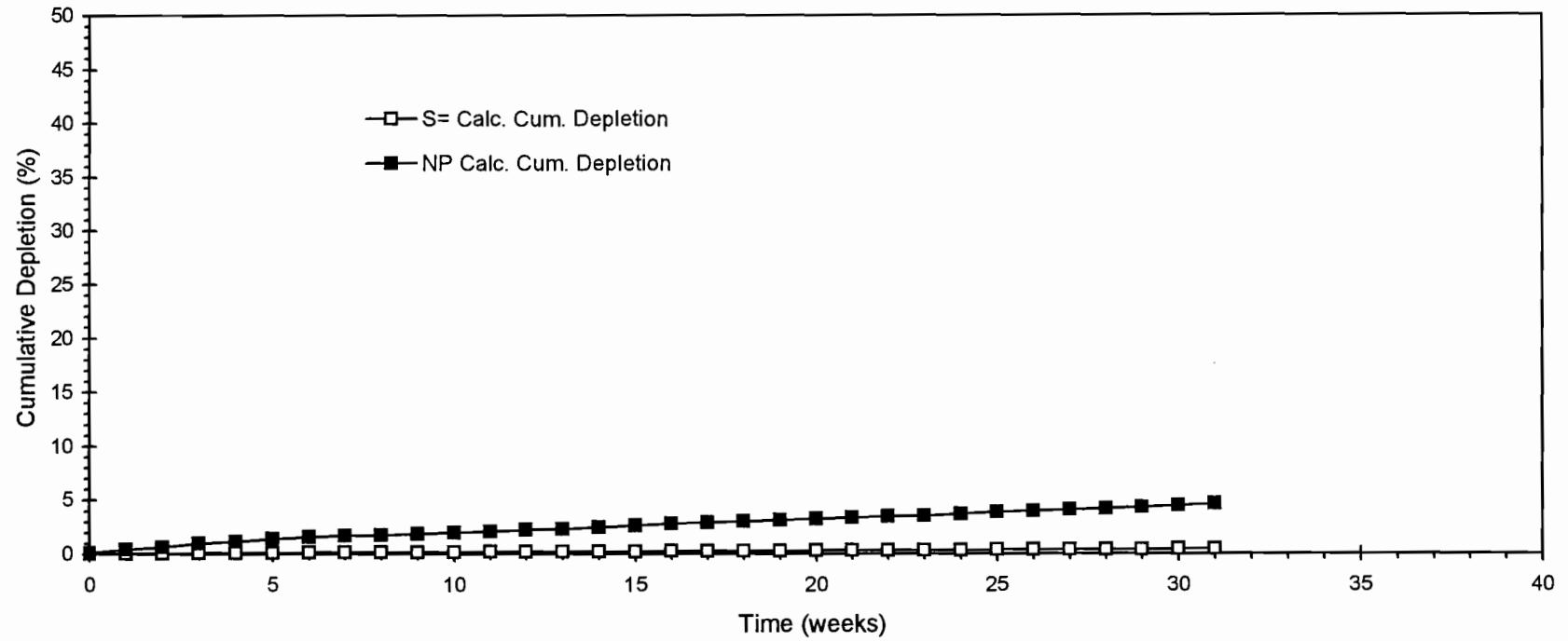
Humidity Cell Test Report ASTM D 5744-96 (2001)
Sample I.D.: Overall Combined Composite Ro + CI Sc Tails

Alkalinity & Acidity vs. Time



Humidity Cell Test Report ASTM D 5744-96 (2001)
Sample I.D.: Overall Combined Composite Ro + Cl Sc Tails

Cumulative Depletion vs. Time



Humidity Cell Test Report ASTM D 5744-96 (2001)

Head Assay

Parameter	Units	Value
S%:	%	26.6
S ²⁻ %:	%	22.9
NP:	t CaCO ₃ /1000 tonne of material	82.5

Sample I.D.: Combined Overall Dilute (OD) Composite
 Sample Weight: 1000 grams
 NP results from Modified ABA Testing
 LIMS Ref. # 10059JUL05

Week	Leachate Analyses					Sulphate (SO ₄)			Sulphide Depletion		NP Depletion	
	Leachate Volume mL	pH units	Acidity CaCO ₃ eq. mg/L	Alkalinity CaCO ₃ eq. mg/L	Conductivity µmhos/cm	Ind. Assay mg/L	Production Rate g/t/wk	Cum. Production g/t	Ind. Depletion %	S ²⁻ Calc. Depletion %	Calculated Consumption CaCO ₃ , g/t/wk	NP Calc. Depletion %
0	234	6.97	76	11	370	110	25.7	25.7	0.004	0.004	26.81	0.03
1	415	3.58	1031	<0.3	246	560	232.4	258.1	0.03	0.04	242.08	0.33
2	455	3.41	918	<0.3	1560	450	204.8	462.9	0.03	0.07	213.28	0.58
3	471	4.54	995	< 2	1620	380	179.0	641.9	0.03	0.09	186.44	0.81
4	486	6.54	1190	12	1980	820	398.5	1040.4	0.06	0.15	415.13	1.31
5	484	6.58	817	13	1740	800	387.2	1427.6	0.06	0.21	403.33	1.80
6	503	6.72	577	14	1580	700	352.1	1779.7	0.05	0.26	366.77	2.25
7	487	6.88	630	15	1670	690	336.0	2115.7	0.05	0.31	350.03	2.67
8	461	6.96	551	10	1340	690	318.1	2433.8	0.05	0.35	331.34	3.07
9	447	6.49	577	3	1370	670	299.5	2733.3	0.04	0.40	311.97	3.45
10	407	4.70	626	<2	1660	800	325.6	3058.9	0.05	0.45	339.17	3.86
11	441	6.47	498	4	1390	670	295.5	3354.4	0.04	0.49	307.78	4.24
12	431	6.56	510	4	1380	690	297.4	3651.8	0.04	0.53	309.78	4.61
13	372	6.67	387	5	1010	450	167.4	3819.2	0.02	0.56	174.38	4.82
14	454	6.91	417	9	1230	600	272.4	4091.6	0.04	0.60	283.75	5.17
15	431	6.97	434	11	1540	890	383.6	4475.2	0.06	0.65	399.57	5.65
16	415	6.85	309	7	1140	550	228.3	4703.4	0.03	0.68	237.76	5.94
17	280	6.78	530	8	1520	790	221.2	4924.6	0.03	0.72	230.42	6.22
18	451	6.96	381	23	1480	770	347.3	5271.9	0.05	0.77	361.74	6.66
19	479	7.10	270	22	1240	660	316.1	5588.0	0.05	0.81	329.31	7.06
20	516	7.12	276	33	1720	1100	567.6	6155.6	0.08	0.90	591.25	7.77
21	398	7.03	163	21	1152	620	246.8	6402.4	0.04	0.93	257.04	8.08
22	499	7.12	120	20	960	520	259.5	6661.9	0.04	0.97	270.29	8.41
23	492	7.03	152	20	930	510	250.9	6912.8	0.04	1.01	261.38	8.73
24	502	7.11	146	21	1020	510	256.0	7168.8	0.04	1.04	266.69	9.05
25	492	7.08	125	21	1010	530	260.8	7429.6	0.04	1.08	271.63	9.38
Maximum Value	7.12	-	33	1980	1100	567.6	-	0.08	-	591.25	-	
Minimum Value	3.41	-	0	246	110	25.7	-	0.004	-	26.81	-	
Average Value	4.57	-	13	1302	636	285.8	-	0.04	-	297.66	-	

**Combined OD Composite
Dissolved Metal Concentrations**

Parameter	Units	MMER ¹	Week												
			0	1	2	3	4	5	6	7	8	9	10	11	12
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
LIMS #			10296JUL05	10344JUL05	10010AUG05	10112AUG05	10250AUG05	10380AUG05	10003SEP05	12079SEP05	10154SEP05	10272SEP05	10486SEP05	10029OCT05	10183OCT05
HumCell Leachate Vol	mLs		234	415	455	471	486	484	503	487	461	447	407	441	431
pH	units	6.0 - 9.5	6.97	3.58	3.41	4.54	6.54	6.58	6.72	6.88	6.96	6.49	4.70	6.47	6.56
Alkalinity	mg/L as CaCO ₃		11	< 0.3	< 0.3	< 2	12	13	14	15	10	3	< 2	4	4
Acidity	mg/L as CaCO ₃		76	1031	918	995	1190	817	577	630	551	577	626	498	510
Conductivity	uS/cm		370	246	1560	1620	1980	1740	1580	1670	1340	1370	1660	1390	1380
SO ₄	mg/L		110	560	450	380	820	800	700	690	690	870	800	670	690
Cl	mg/L		1.7	3.2	1.7	1.1	< 2.0	0.5	< 0.2	< 2	< 2	< 0.2	< 2	< 0.2	< 0.2
F	mg/L		< 0.06	0.11	0.09	0.09	0.13	0.13	0.09	0.12	0.16	0.18	0.17	0.17	0.16
NO ₃	as N mg/L		< 0.05	0.71	0.22	0.16	0.12	0.05	0.07	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
NH ₃ +NH ₄	as N mg/L		0.3	0.8	0.6	0.5	0.6	0.5	0.4	0.2	0.3	0.5	0.3	0.3	0.4
Thiosalts	as S ₂ O ₃ mg/L		112	971	878	1000	1110	650	530	510	436	489	571	470	434
CN(T)	mg/L	1.00	< 0.002	< 0.01	< 0.01	0.01	< 0.002	< 0.002	< 0.01	< 0.002	< 0.01	< 0.01	< 0.002	< 0.01	< 0.01
CNO	mg/L		< 1.0	< 1.0	< 1.0	< 0.1	< 0.1	< 0.1	< 1.0	< 1	< 0.1	< 0.1	< 1	< 0.1	< 0.1
CNS	mg/L		< 2	< 2	< 5.0	< 20	< 2.0	< 5.0	< 2	***	***	***	***	---	---
Hg	µg/L		< 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
Ag	mg/L		0.0006	< 0.005	0.023	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.02	< 0.005
Al	mg/L		< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.02	< 0.01	< 0.02	< 0.01	< 0.02	< 0.01	< 0.01
As	mg/L	0.50	< 0.005	0.019	0.024	0.023	0.022	0.019	0.021	0.011	0.016	0.015	0.008	0.012	0.009
Ba	mg/L		0.097	0.053	0.040	0.037	0.036	0.031	0.035	0.031	0.034	0.034	0.043	0.031	0.030
Be	mg/L		< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Bi	mg/L		< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003
B	mg/L		< 0.01	< 0.01	0.03	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.02	< 0.01	< 0.01	< 0.01	< 0.01
Ca	mg/L		50.6	324	286	313	437	370	334	369	303	298	337	243	265
Cd	mg/L		0.0027	0.0509	0.0714	0.0715	0.115	0.0976	0.0963	0.104	0.0724	0.0619	0.0716	0.0656	0.0547
Co	mg/L		0.0005	0.0123	0.0199	0.0193	0.0269	0.0214	0.0234	0.0241	0.0144	0.0133	0.0135	0.0117	0.0114
Cr	mg/L		0.032	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Cu	mg/L	0.30	0.0051	0.0116	0.0046	0.0030	0.0057	0.0024	0.0028	0.0019	0.0020	0.0039	0.0030	0.0068	0.0014
Fe	mg/L		< 0.02	0.20	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Li	mg/L		< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
K	mg/L		2.16	6.11	4.09	4.27	4.83	3.14	2.30	2.36	1.81	1.58	1.88	1.41	1.49
Mg	mg/L		4.27	24.0	23.4	26.4	34.6	23.4	22.7	24.2	23.8	30.6	42.2	34.8	42.7
Mn	mg/L		0.147	2.45	3.37	4.26	5.47	4.34	4.08	3.99	2.66	1.78	1.95	1.87	1.67
Mo	mg/L		0.0025	0.0004	0.0004	0.0004	0.0004	< 0.0003	0.0003	0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	0.0004
Na	mg/L		14.6	29.6	20.9	16.4	14.3	7.56	4.50	3.22	1.80	1.21	1.06	0.68	0.55
Ni	mg/L	0.50	0.004	0.040	0.071	0.081	0.101	0.068	0.090	0.067	0.049	0.028	0.027	0.032	0.025
P	mg/L		< 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
Pb	mg/L	0.20	0.0134	0.314	0.0355	0.0214	0.0320	0.0249	0.0403	0.0175	0.0139	0.0116	0.0112	0.0118	0.0040
Sb	mg/L		< 0.05	< 0.05	< 0.09	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Se	mg/L		0.325	0.77	0.61	0.93	1.96	0.99	0.99	0.92	0.978	0.973	0.85	0.954	0.998
Si	mg/L		0.13	0.27	0.45	0.45	0.60	0.49	0.47	0.48	0.36	0.23	0.25	0.23	0.23
Sn	mg/L		0.074	0.100	0.027	0.011	0.012	0.009	0.007	0.005	0.005	0.004	0.005	0.004	0.003
Sr	mg/L		0.0604	0.420	0.516	0.688	1.05	0.916	0.921	1.03	0.934	0.894	1.12	0.945	0.988
Ti	mg/L		< 0.005	< 0.005	< 0.02	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Tl	mg/L		0.0064	0.0250	0.0224	0.0190	0.0241	0.0197	0.0199	0.0176	0.0141	0.0139	0.0136	0.0124	0.0115
U	mg/L		< 0.0002	0.0002	< 0.0002	< 0.0002	0.0003	0.0003	0.0003	0.0003	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
V	mg/L		< 0.002	0.002	0.002	0.002	0.004	0.003	0.002	0.006	0.003	0.003	0.005	0.004	0.003
Zn	mg/L	0.50	0.06	2.21	4.97	5.88	9.05	7.28	7.32	7.36	4.73	3.10	3.77	3.60	2.96

Week #0 signifies the initial flooding of the humidity cell initiating the 20 week test period.

Metal Mining Effluent Regulations

--Not Analysed

***Could not be determined due to sample matrix.

Combined OD Composite
Dissolved Metal Concentrations

Parameter	Units	MMER ¹	Week												
			13	14	15	16	17	18	19	20	21	22	23	24	25
Date			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
LIMS #			10293OCT05	10457OCT05	10010NOV05	10097NOV05	10240NOV05	10402NOV05	10001DEC05	10039DEC05	10374DEC05	10411DEC05	10502DEC05	10005JAN06	10096JAN06
HumCell Leachate Vol	mLs		372	454	431	415	280	451	479	516	398	499	492	502	492
pH	units	6.0 - 9.5	6.67	6.91	6.97	6.85	6.78	6.96	7.10	7.12	7.03	7.12	7.03	7.11	7.08
Alkalinity	mg/L as CaCO ₃		5	9	11	7	8	23	22	33	21	20	20	21	21
Acidity	mg/L as CaCO ₃		387	417	434	309	530	381	270	276	163	120	152	146	125
Conductivity	uS/cm		1010	1230	1540	1140	1520	1480	1240	1720	1152	960	930	1020	1010
SO ₄	mg/L		450	600	890	550	790	770	660	1100	620	520	510	510	530
Cl	mg/L		< 0.2	< 0.2	< 0.2	< 0.2	< 2	< 0.2	0.2	0.4	---	---	---	---	---
F	mg/L		0.15	0.16	0.14	0.13	0.18	0.17	0.71	0.21	---	---	---	---	---
NO ₃	as N mg/L		< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	---	---	---	---	---
NH ₃ +NH ₄	as N mg/L		0.4	0.2	0.2	0.2	0.1	0.1	0.1	0.2	---	---	---	---	---
Thiosalts	as S ₂ O ₃ mg/L		347	384	384	53	470	325	232	241	---	---	---	---	109
CN(T)	mg/L	1.00	< 0.01	< 0.02	< 0.002	0.03	< 0.01	< 0.01	< 0.002	< 0.002	---	---	---	---	---
CNO	mg/L		< 0.1	< 0.1	< 1	< 1	< 0.1	< 0.1	< 0.1	< 0.1	---	---	---	---	---
CNS	mg/L		---	---	---	---	---	---	---	---	---	---	---	---	---
Hg	µg/L		< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	---	---	---	---	---
Ag	mg/L		< 0.02	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	---	---	---	---	< 0.005
Al	mg/L		< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	---	---	---	---	< 0.01
As	mg/L	0.50	0.005	0.012	0.017	0.010	0.018	0.009	0.019	0.016	---	---	---	---	0.008
Ba	mg/L		0.031	0.031	0.032	0.027	0.050	0.038	0.033	0.035	---	---	---	---	0.027
Be	mg/L		< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	---	---	---	---	< 0.005
Bi	mg/L		< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	---	---	---	---	< 0.0003
B	mg/L		< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	---	---	---	---	< 0.01
Ca	mg/L		169	229	274	202	267	249	233	342	---	---	---	---	215
Cd	mg/L		0.0377	0.0508	0.0677	0.0472	0.0737	0.101	0.0943	0.131	---	---	---	---	0.0725
Co	mg/L		0.0085	0.0111	0.0132	0.0092	0.0147	0.0205	0.0237	0.0256	---	---	---	---	0.0130
Cr	mg/L		< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	---	---	---	---	< 0.001
Cu	mg/L	0.30	0.0014	0.0010	0.0031	0.0012	0.0021	0.0030	0.0020	0.0024	---	---	---	---	0.0033
Fe	mg/L		< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	---	---	---	---	< 0.02
Li	mg/L		< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	---	---	---	---	< 0.005
K	mg/L		1.02	1.18	1.52	1.10	1.42	1.21	1.12	1.47	---	---	---	---	0.93
Mg	mg/L		30.8	42.9	48.1	38.3	59.9	40.0	34.9	35.5	---	---	---	---	20.0
Mn	mg/L		0.966	1.46	1.70	1.11	1.75	3.04	3.10	4.04	---	---	---	---	1.99
Mo	mg/L		< 0.0003	< 0.0003	< 0.0003	< 0.0003	0.0004	< 0.0003	< 0.0003	0.0004	---	---	---	---	< 0.0003
Na	mg/L		0.31	0.34	0.35	0.23	0.29	0.21	0.19	0.21	---	---	---	---	0.11
Ni	mg/L	0.50	0.014	0.018	0.024	0.017	0.023	0.053	0.038	0.058	---	---	---	---	0.041
P	mg/L		< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	---	---	---	---	< 0.1
Pb	mg/L	0.20	0.0018	0.0028	0.0026	0.0027	0.0034	0.0039	0.0043	0.0058	---	---	---	---	0.0031
Sb	mg/L		< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	---	---	---	---	< 0.05
Se	mg/L		0.634	0.808	1.18	0.750	0.966	0.997	0.889	1.10	---	---	---	---	0.562
Si	mg/L		0.15	0.19	0.24	0.17	0.21	0.28	0.31	0.41	---	---	---	---	0.30
Sn	mg/L		0.003	0.003	0.004	0.003	0.010	0.003	0.002	0.002	---	---	---	---	< 0.001
Sr	mg/L		0.664	0.869	1.08	0.801	1.01	1.01	0.902	1.15	---	---	---	---	0.733
Ti	mg/L		< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	---	---	---	---	< 0.005
Tl	mg/L		0.0032	0.0100	0.0139	0.0090	0.0093	0.0110	0.0115	0.0129	---	---	---	---	0.0076
U	mg/L		< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	0.0004	---	---	---	---	< 0.0002
V	mg/L		< 0.002	0.003	0.004	0.002	0.004	0.004	0.003	0.005	---	---	---	---	< 0.002
Zn	mg/L	0.50	2.06	2.53	3.01	2.26	3.11	5.40	5.43	8.03	---	---	---	---	4.39

Week #0 signifies the initial flooding of the humidity cell initiating the 20

Metal Mining Effluent Regulations

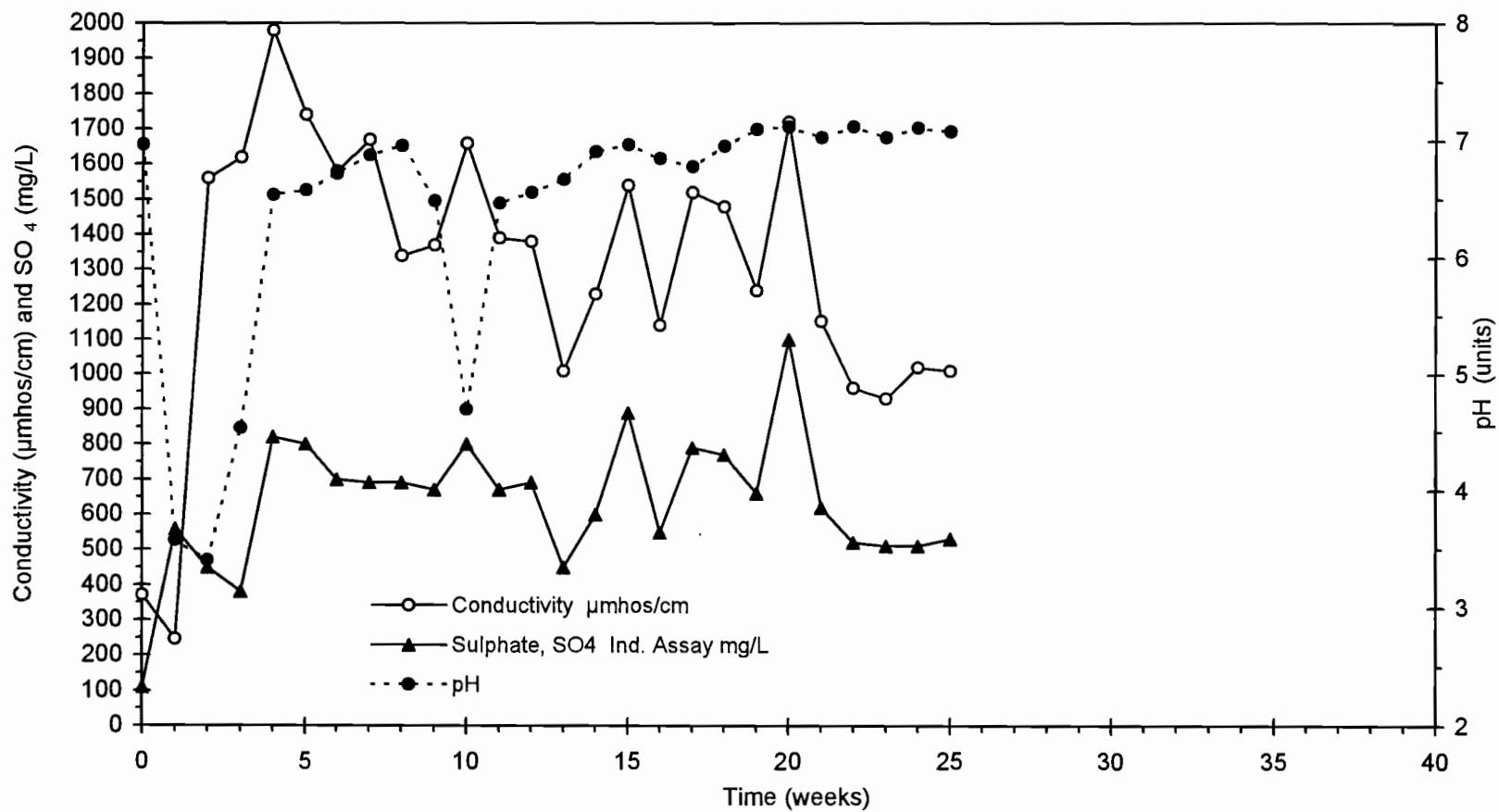
---Not Analyzed

***Could not be determined due to sample matrix.

Humidity Cell Test Report ASTM D 5744-96 (2001)

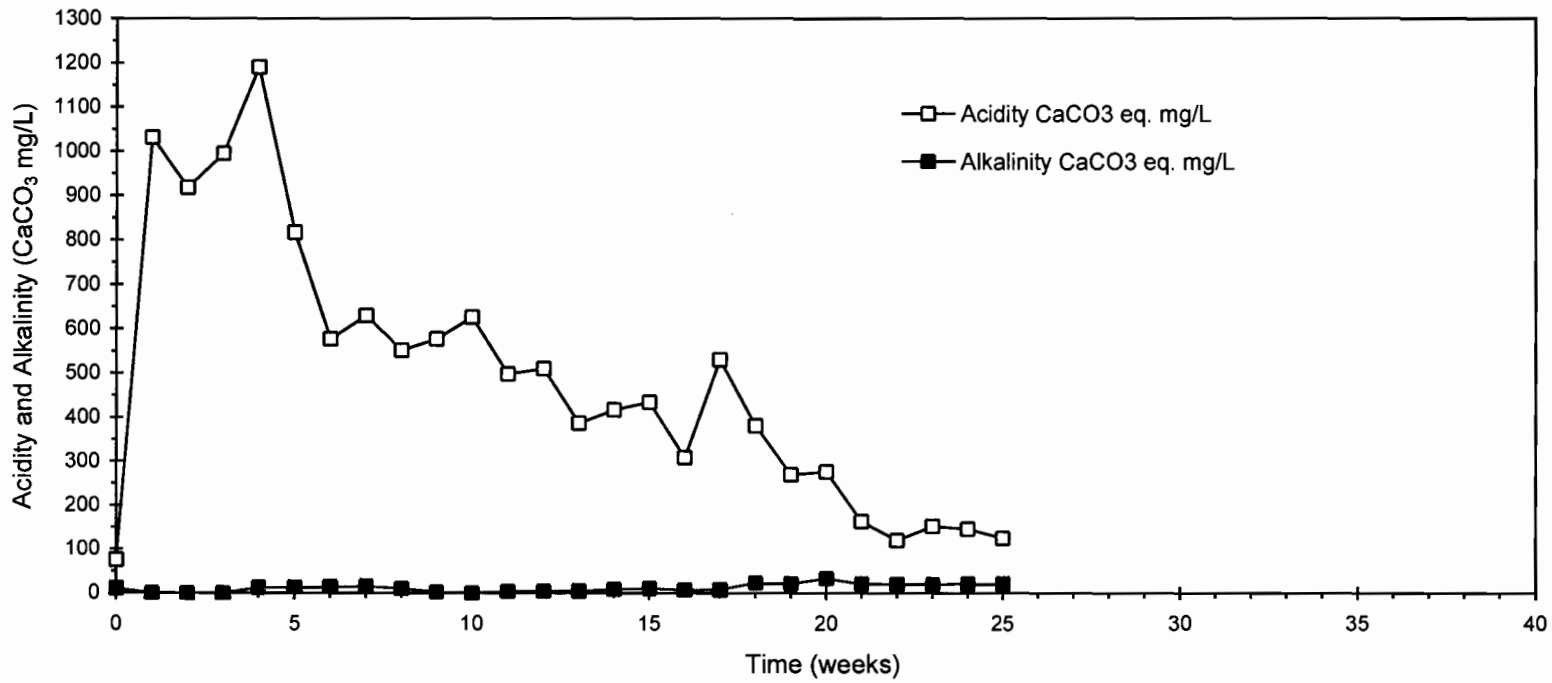
Sample I.D.: Combined OD Composite

Conductivity, Sulphate and pH vs. Time



Humidity Cell Test Report ASTM D 5744-96 (2001)
Sample I.D.: Combined OD Composite

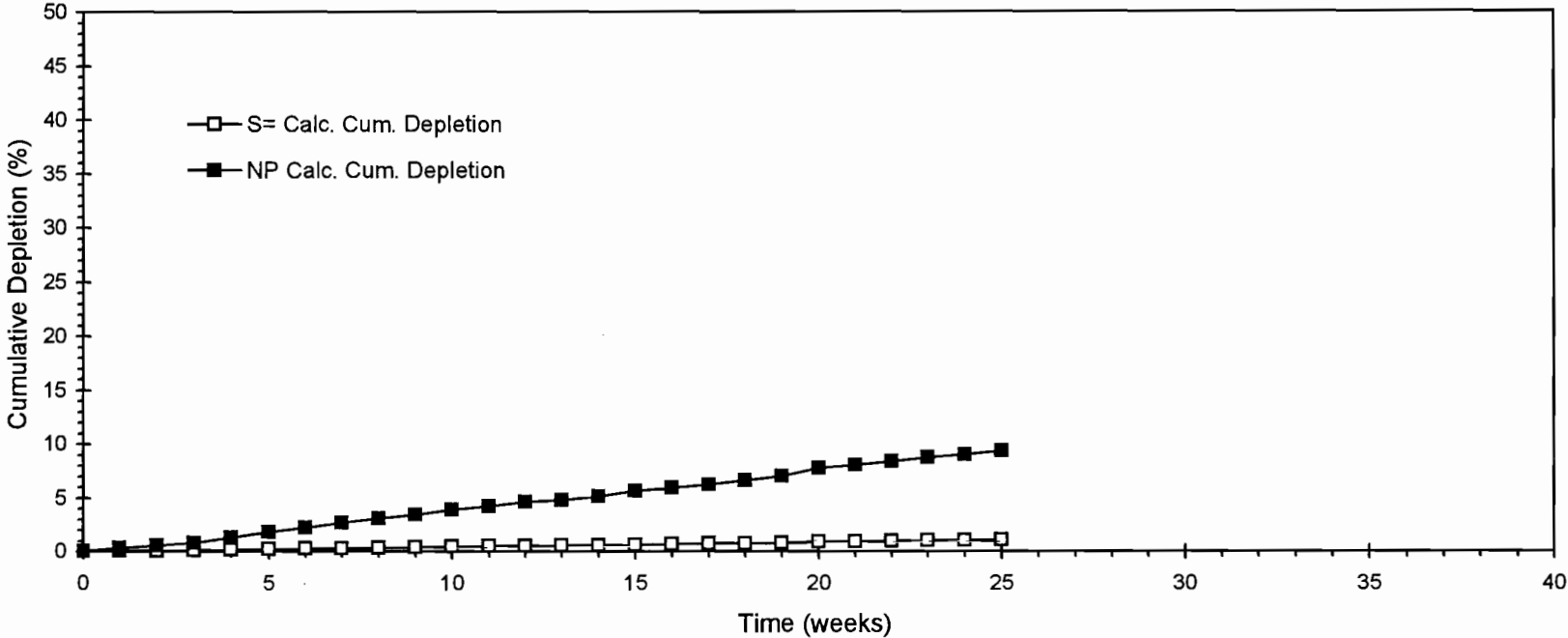
Alkalinity & Acidity vs. Time



Humidity Cell Test Report ASTM D 5744-96 (2001)

Sample I.D.: Combined OD Composite

Cumulative Depletion vs. Time



Humidity Cell Test Report ASTM D 5744-96 (2001)

Head Assay

Parameter	Units	Value
S%:	%	19.7
S ²⁻ %:	%	15.7
NP:	t CaCO ₃ /1000 tonne of material	94.6

Sample I.D.: Combined Wolverine Dilute
(D) Composite

Sample Weight: 1000 g
NP results from Modified ABA Testing
LIMS Ref. # 10059JUL05

Week	Leachate Analyses					Sulphate (SO ₄)			Sulphide Depletion			NP Depletion	
	Leachate Volume	pH	Acidity CaCO ₃ eq.	Alkalinity CaCO ₃ eq.	Conductivity	Ind. Assay	Production Rate	Cum. Production	Ind Depletion	S ²⁻ Calc. Depletion	Cum. Depletion	Calculated Consumption	NP Calc. Depletion
	mL	units	mg/L	mg/L	µmhos/cm	mg/L	g/t/wk	g/t	%	%	%	CaCO ₃ , g/t/wk	%
0	553	5.13	262	<2	587	130	71.9	71.9	0.02	0.02		74.89	0.08
1	415	3.94	495	<0.3	120	250	103.8	175.6	0.02	0.04		108.07	0.19
2	481	3.36	813	<0.3	737	370	178.0	353.6	0.04	0.08		185.39	0.39
3	468	3.84	1000	< 2	1660	300	140.4	494.0	0.03	0.10		146.25	0.54
4	444	4.27	954	< 2	1380	430	190.9	684.9	0.04	0.15		198.88	0.75
5	446	4.05	787	< 2	1250	330	147.2	832.1	0.03	0.18		153.31	0.92
6	441	3.73	1280	< 2	1930	610	269.0	1101.1	0.06	0.23		280.22	1.21
7	475	3.92	944	< 2	1770	640	304.0	1405.1	0.06	0.30		316.67	1.55
8	544	6.39	851	6	1810	940	511.4	1916.5	0.11	0.41		532.67	2.11
9	452	6.83	554	10	1400	700	316.4	2232.9	0.07	0.47		329.58	2.46
10	475	6.93	451	15	1500	760	361.0	2593.9	0.08	0.55		376.04	2.86
11	521	6.89	376	14	1340	670	349.1	2943.0	0.07	0.62		363.61	3.24
12	459	6.96	355	13	1280	660	302.9	3245.9	0.06	0.69		315.56	3.57
13	468	7.02	289	16	1070	530	248.0	3493.9	0.05	0.74		258.38	3.85
14	492	7.01	301	17	1110	550	270.6	3764.5	0.06	0.80		281.88	4.15
15	494	7.16	264	30	1130	620	306.3	4070.8	0.07	0.86		319.04	4.48
16	515	7.05	234	21	1120	560	288.4	4359.2	0.06	0.93		300.42	4.80
17	498	6.97	238	18	1100	580	288.8	4648.1	0.06	0.99		300.88	5.12
18	495	6.94	259	10	1300	660	326.7	4974.8	0.07	1.06		340.31	5.48
19	404	6.75	303	7	1230	660	266.6	5241.4	0.06	1.11		277.75	5.77
20	458	6.93	309	11	1410	820	375.6	5617.0	0.08	1.19		391.21	6.18
21	475	8.00	266	13	1242	640	304.0	5921.0	0.06	1.26		316.67	6.52
22	389	6.90	224	9	1000	510	198.4	6119.3	0.04	1.30		206.66	6.74
23	426	6.72	215	7	963	490	208.7	6328.1	0.04	1.34		217.44	6.97
24	419	6.89	232	7	1090	530	222.1	6550.2	0.05	1.39		231.32	7.21
25	438	6.87	179	8	984	500	219.0	6769.2	0.05	1.44		228.13	7.45
Maximum Value	8.00	-	30	1930	940	511.4	-	-	0.11	-	-	532.67	-
Minimum Value	3.36	-	0.3	120	130	71.9	-	-	0.02	-	-	74.89	-
Average Value	4.35	-	11.2	1212	555	260.4	-	-	0.06	-	-	271.20	-

**Combined Wolverine D Composite
Dissolved Metal Concentrations**

Parameter	Units	MMER ¹	Week												
			0	1	2	3	4	5	6	7	8	9	10	11	12
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
LIMS #			10296JUL05	10344JUL05	10010AUG05	10112AUG05	10250AUG05	10380AUG05	10003SEP05	12079SEP05	10154SEP05	10272SEP05	10486SEP05	10029OCT05	10183OCT05
HumCell Leachate Vol	mLs		553	415	481	468	444	446	441	475	544	452	475	521	459
pH	units	6.0 - 9.5	5.13	3.94	3.36	3.84	4.27	4.05	3.73	3.92	6.39	6.83	6.93	6.89	6.96
Alkalinity	mg/L as CaCO ₃		< 2	< 0.3	< 0.3	< 2	< 2	< 2	< 2	< 2	6	10	15	14	13
Acidity	mg/L as CaCO ₃		262	495	813	1000	954	787	1280	944	851	554	451	376	355
Conductivity	uS/cm		587	120	737	1660	1380	1250	1930	1770	1810	1400	1500	1340	1280
SO ₄	mg/L		130	250	370	300	430	330	610	640	940	700	780	670	660
Cl	mg/L		1.5	1.4	1.8	1.2	1.1	0.6	0.9	< 2	< 2	0.4	< 2	< 0.2	< 0.2
F	mg/L		< 0.06	0.06	0.08	0.09	0.08	0.07	0.08	0.09	0.17	0.15	0.14	0.15	0.13
NO ₃	as N mg/L		< 0.05	0.27	0.25	0.58	0.15	0.10	0.11	0.08	0.05	< 0.05	< 0.05	< 0.05	< 0.05
NH ₃ + NH ₄	as N mg/L		0.4	0.4	0.4	0.4	0.3	0.3	0.4	0.2	0.3	0.2	0.3	0.2	0.3
Thiosalts	as S ₂ O ₃ mg/L		292	486	824	1200	569	687	1100	823	786	500	407	358	330
CN(T)	mg/L	1.00	< 0.002	< 0.01	< 0.01	0.01	< 0.002	< 0.002	< 0.01	< 0.002	< 0.01	< 0.01	< 0.002	< 0.01	< 0.01
CNO	mg/L		< 1.0	< 1.0	< 1.0	< 0.1	< 0.1	< 0.1	< 1.0	< 1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
CNS	mg/L		< 2	< 2	< 5.0	< 20	13	< 5.0	< 2	***	***	***	***	---	---
Hg	µg/L		< 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
Ag	mg/L		0.0011	< 0.005	0.007	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.02	< 0.005	< 0.005
Al	mg/L		< 0.01	< 0.01	< 0.01	0.07	< 0.01	< 0.01	< 0.02	< 0.01	< 0.02	< 0.01	< 0.02	< 0.01	< 0.01
As	mg/L	0.50	< 0.005	< 0.005	0.018	0.018	0.014	0.008	0.021	0.019	0.013	0.014	0.008	0.010	0.006
Ba	mg/L		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
Be	mg/L		< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Bi	mg/L		< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003
B	mg/L		< 0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.02	< 0.01	< 0.01	< 0.01	< 0.01
Ca	mg/L		82.6	150	240	286	241	205	333	322	411	303	310	246	270
Cd	mg/L		0.0026	0.0132	0.0306	0.0505	0.0525	0.0478	0.126	0.123	0.141	0.100	0.109	0.0962	0.0941
Co	mg/L		0.0006	0.0042	0.0099	0.0138	0.0142	0.0114	0.0352	0.0339	0.0324	0.0279	0.0249	0.0230	0.0242
Cr	mg/L		0.035	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Cu	mg/L	0.30	0.0026	0.0028	0.0022	0.0021	0.0031	0.0009	0.0038	0.0037	0.0043	0.0034	0.0019	0.0040	0.0012
Fe	mg/L		< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Li	mg/L		< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
K	mg/L		3.54	3.41	4.19	5.35	4.17	2.97	4.32	3.89	4.15	2.81	2.80	2.25	2.19
Mg	mg/L		7.45	12.4	22.4	32.5	34.5	26.9	49.0	44.0	44.8	33.0	31.9	25.2	27.1
Mn	mg/L		0.079	0.445	0.840	1.38	1.20	1.07	2.58	2.62	3.10	2.10	2.15	1.86	1.80
Mo	mg/L		0.0009	0.0004	0.0004	0.0005	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003
Na	mg/L		18.9	17.9	21.8	23.2	16.3	10.7	12.8	10.1	7.81	4.37	3.42	2.22	1.55
Ni	mg/L	0.50	0.004	0.014	0.029	0.039	0.042	0.028	0.103	0.085	0.100	0.064	0.057	0.070	0.055
P	mg/L		< 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
Pb	mg/L	0.20	0.0168	0.0461	0.0327	0.0168	0.0743	0.0195	0.0793	0.0826	0.101	0.0486	0.0459	0.0323	0.0333
Sb	mg/L		< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Se	mg/L		0.339	0.36	0.45	0.74	0.888	0.45	0.77	0.77	1.03	0.968	0.77	0.878	0.837
Si	mg/L		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
Sn	mg/L		0.049	0.030	0.014	0.010	0.005	0.004	0.006	0.006	0.005	0.003	0.003	0.003	0.003
Sr	mg/L		0.107	0.175	0.334	0.515	0.540	0.508	0.952	0.918	1.10	0.796	0.832	0.736	0.725
Ti	mg/L		< 0.005	< 0.005	< 0.02	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Tl	mg/L		0.0028	0.005	0.0075	0.0077	0.0075	0.0063	0.0116	0.0089	0.0102	0.0085	0.0081	0.0078	0.0074
U	mg/L		< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	0.0003	0.0002	0.0003	< 0.0002
V	mg/L		< 0.002	< 0.002	0.002	< 0.002	< 0.002	< 0.002	0.002	0.005	0.006	0.004	0.005	0.004	0.003
Zn	mg/L	0.50	0.08	0.49	1.39	2.20	2.26	2.35	8.07	8.68	9.77	7.13	7.90	6.93	6.42

Week #0 signifies the initial flooding of the humidity cell initiating the 20 week test period.

Metal Mining Effluent Regulations

—Not Analysed

****Could not be determined due to sample matrix.*

**Combined Wolverine D Composite
Dissolved Metal Concentrations**

Parameter	Units	MMER ¹	Week												
			13	14	15	16	17	18	19	20	21	22	23	24	25
Date			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
LIMS #			10293OCT05	10457OCT05	10010NOV05	10097NOV05	10240NOV05	10402NOV05	10001DEC05	10039DEC05	10374DEC05	10411DEC05	10502DEC05	10005JAN06	10096JAN06
HumCell Leachate Vol	mLs		468	492	494	515	498	495	404	458	475	389	426	419	438
pH	units	6.0 - 9.5	7.02	7.01	7.16	7.05	6.97	6.94	6.75	6.93	8.00	6.90	6.72	6.89	6.87
Alkalinity	mg/L as CaCO ₃		16	17	30	21	18	10	7	11	13	9	7	7	8
Acidity	mg/L as CaCO ₃		289	301	264	234	238	259	303	309	266	224	215	232	179
Conductivity	uS/cm		1070	1110	1130	1120	1100	1300	1230	1410	1242	1000	963	1090	984
SO ₄	mg/L		530	550	620	560	580	660	660	820	640	510	490	530	500
Cl	mg/L		< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	0.3	---	---	---	---	---
F	mg/L		0.13	0.14	0.09	0.11	0.13	0.17	0.20	0.19	---	---	---	---	---
NO ₃	as N mg/L		< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	---	---	---	---	---
NH ₃ + NH ₄	as N mg/L		0.3	0.3	0.1	0.2	< 0.1	0.1	0.1	0.2	---	---	---	---	---
Thiosalts	as S ₂ O ₃ mg/L		269	272	249	45	196	224	269	277	---	---	---	---	148
CN(T)	mg/L	1.00	< 0.01	< 0.02	< 0.002	0.02	< 0.01	< 0.01	< 0.002	< 0.002	---	---	---	---	---
CNO	mg/L		< 0.1	< 0.1	< 0.1	< 1	< 0.1	< 0.1	< 0.1	< 0.1	---	---	---	---	---
CNS	mg/L		---	---	---	---	---	---	---	---	---	---	---	---	---
Hg	µg/L		< 0.1	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	---	---	---	---	---
Ag	mg/L		< 0.02	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	---	---	---	---	< 0.005
Al	mg/L		< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	---	---	---	---	< 0.01
As	mg/L	0.50	0.006	0.008	0.007	0.014	0.009	0.011	0.013	0.008	---	---	---	---	0.008
Ba	mg/L		0.016	0.020	0.021	0.021	0.021	0.023	0.028	0.029	---	---	---	---	0.020
Be	mg/L		< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	---	---	---	---	< 0.005
Bi	mg/L		< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	---	---	---	---	< 0.0003
B	mg/L		< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	---	---	---	---	< 0.01
Ca	mg/L		201	227	208	219	212	235	239	262	---	---	---	---	184
Cd	mg/L		0.0719	0.0845	0.0914	0.0940	0.0853	0.0698	0.0678	0.0727	---	---	---	---	0.0521
Co	mg/L		0.0226	0.0238	0.0231	0.0235	0.0236	0.0158	0.0164	0.0120	---	---	---	---	0.0105
Cr	mg/L		< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	---	---	---	---	< 0.001
Cu	mg/L	0.30	0.0090	0.0011	0.0027	0.0014	0.0017	0.0023	0.0023	0.0018	---	---	---	---	0.0048
Fe	mg/L		< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	---	---	---	---	< 0.02
Li	mg/L		< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	---	---	---	---	< 0.005
K	mg/L		1.70	1.72	1.69	1.63	1.53	1.62	1.70	1.74	---	---	---	---	1.40
Mg	mg/L		22.0	23.9	21.7	22.5	20.4	22.6	28.0	30.1	---	---	---	---	34.2
Mn	mg/L		1.54	1.57	1.56	1.66	1.50	1.29	1.06	1.38	---	---	---	---	1.10
Mo	mg/L		0.0005	< 0.0003	< 0.0003	< 0.0003	0.0036	< 0.0003	< 0.0003	0.0004	---	---	---	---	< 0.0003
Na	mg/L		0.97	0.79	0.59	0.47	0.36	0.30	0.30	0.25	---	---	---	---	0.13
Ni	mg/L	0.50	0.042	0.040	0.047	0.044	0.039	0.042	0.024	0.024	---	---	---	---	0.027
P	mg/L		< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	---	---	---	---	< 0.1
Pb	mg/L	0.20	0.0136	0.0262	0.0319	0.0362	0.0235	0.0152	0.0187	0.0089	---	---	---	---	0.0097
Sb	mg/L		< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	---	---	---	---	< 0.05
Se	mg/L		0.758	0.626	0.712	0.735	0.653	0.790	0.829	0.612	---	---	---	---	0.568
Si	mg/L		0.24	0.25	0.26	0.27	0.25	0.22	0.20	0.20	---	---	---	---	0.17
Sn	mg/L		0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.004	---	---	---	---	0.002
Sr	mg/L		0.602	0.656	0.640	0.663	0.629	0.692	0.733	0.783	---	---	---	---	0.658
Ti	mg/L		< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	---	---	---	---	< 0.005
Tl	mg/L		0.0025	0.0068	0.0066	0.0068	0.0058	0.0059	0.0070	0.0127	---	---	---	---	0.0045
U	mg/L		< 0.0002	< 0.0002	0.0002	< 0.0002	0.0002	< 0.0002	< 0.0002	< 0.0002	---	---	---	---	< 0.0002
V	mg/L		0.002	0.004	0.003	0.003	0.003	0.004	0.004	0.004	---	---	---	---	< 0.002
Zn	mg/L	0.50	5.71	5.78	5.83	5.92	5.15	3.69	2.97	3.61	---	---	---	---	2.15

Week #0 signifies the initial flooding of the humidity cell initiating the 20

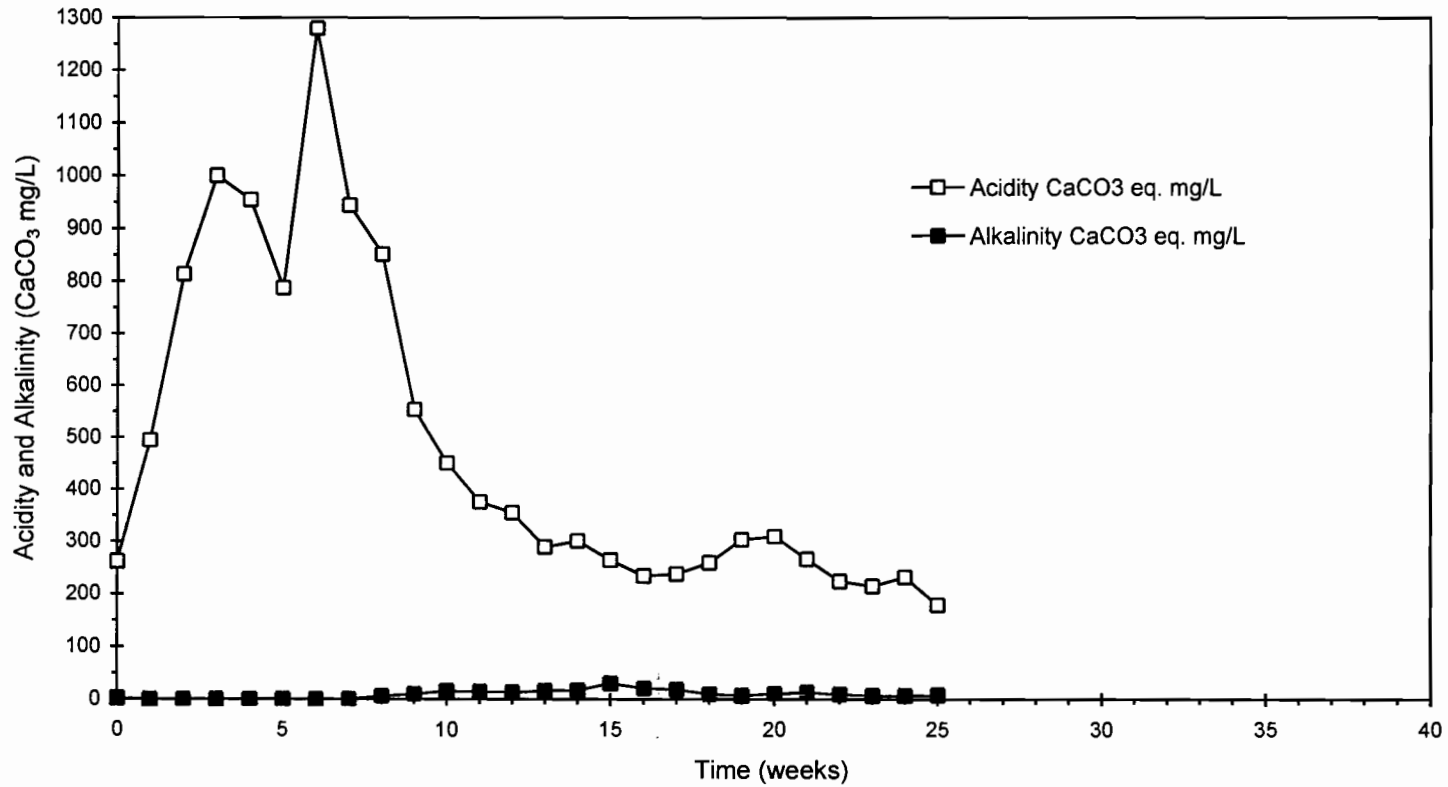
Metal Mining Effluent Regulations

---Not Analysed

***Could not be determined due to sample matrix.

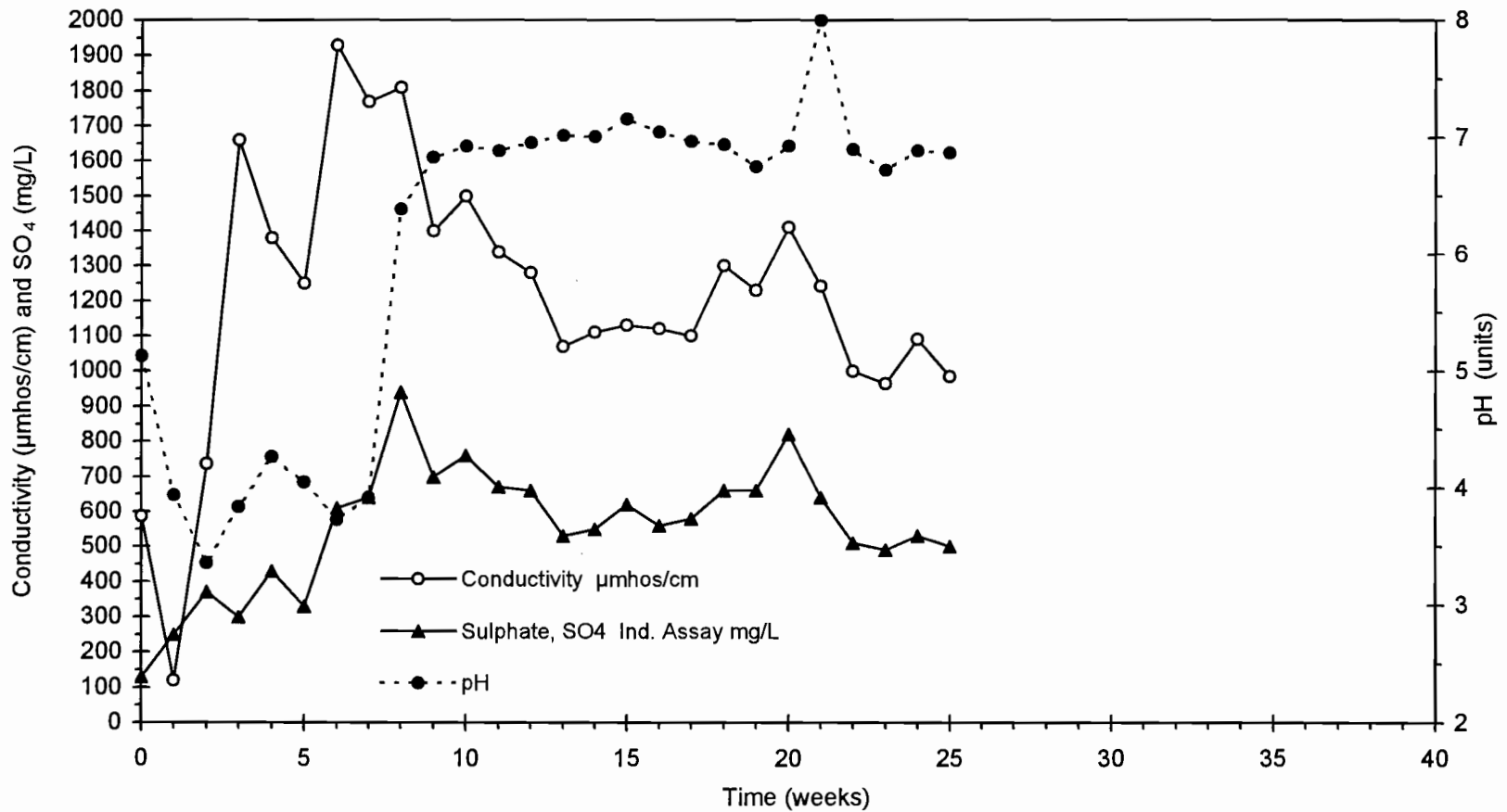
Humidity Cell Test Report ASTM D 5744-96 (2001)
Sample I.D.: Combined Wolverine D Composite

Alkalinity & Acidity vs. Time



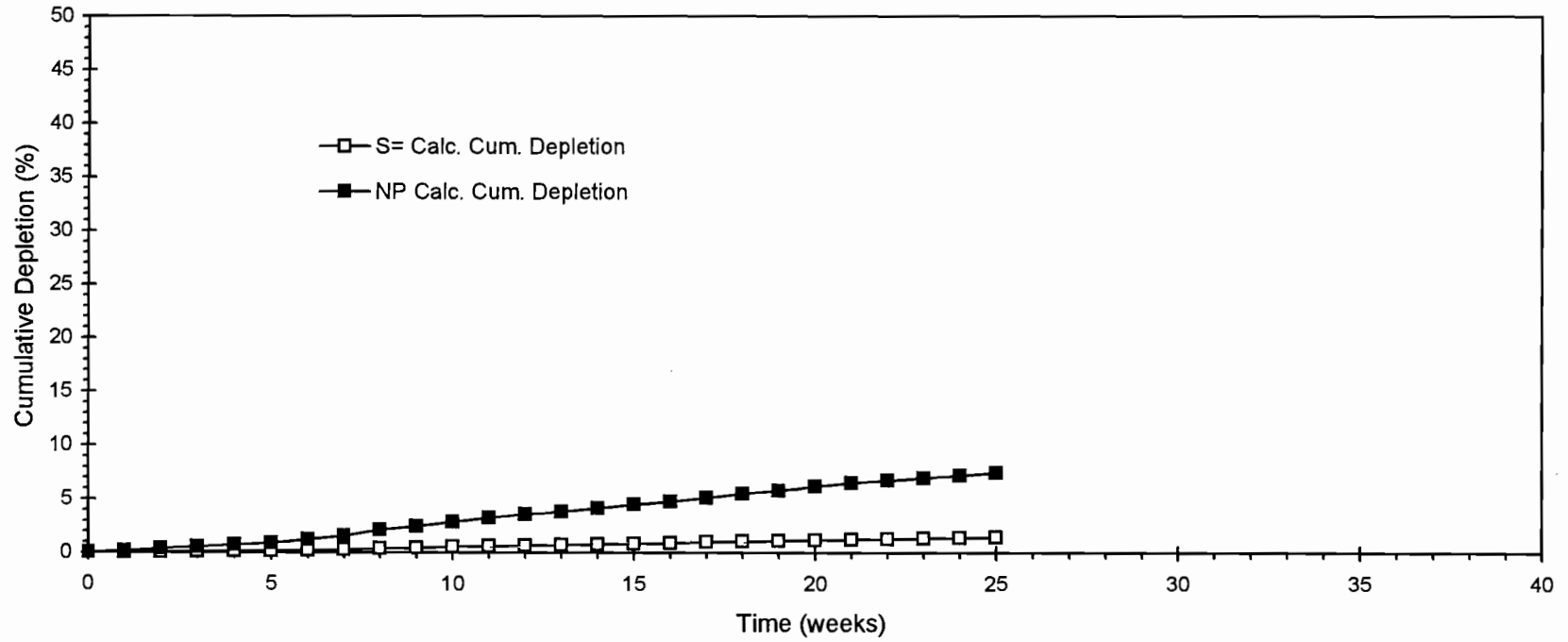
Humidity Cell Test Report ASTM D 5744-96 (2001)
Sample I.D.: Combined Wolverine D Composite

Conductivity, Sulphate and pH vs. Time



Humidity Cell Test Report ASTM D 5744-96 (2001)
Sample I.D.: Combined Wolverine D Composite

Cumulative Depletion vs. Time



Humidity Cell Test Report ASTM D 5744-96 (2001)

Head Assay

Parameter	Units	Value
S%:	%	31.2
S ⁻ %:	%	27.8
NP:	t CaCO ₃ /1000 tonne of material	49.4

Sample I.D.: Combined Lynx Dilute (D)
Composite

Sample Weight: 1000 g
NP results from Modified ABA Testing
LIMS Ref. # 10059JUL05

Week	Leachate Analyses					Sulphate (SO ₄)			Sulphide Depletion		NP Depletion	
	Leachate Volume	pH	Acidity CaCO ₃ eq.	Alkalinity CaCO ₃ eq.	Conductivity μ mhos/cm	Ind. Assay	Production Rate	Cum. Production	Ind Depletion %	S ⁻ Calc. Depletion %	Calculated Consumption CaCO ₃ , g/t/wk	NP Calc. Depletion %
0	598	6.88	10	150	397	92	55.0	55.0	0.01	0.01	57.31	0.12
1	419	6.49	234	4	718	220	92.2	147.2	0.01	0.02	96.02	0.31
2	419	4.27	376	<0.3	758	270	113.1	260.3	0.01	0.03	117.84	0.55
3	462	6.53	619	4	1120	270	124.7	385.1	0.01	0.05	129.94	0.81
4	439	6.42	431	3	798	300	131.7	516.8	0.02	0.06	137.19	1.09
5	429	6.51	260	5	616	200	85.8	602.6	0.01	0.07	89.38	1.27
6	425	6.55	193	4	437	140	59.5	662.1	0.01	0.08	61.98	1.40
7	445	6.53	352	3	775	270	120.2	782.2	0.01	0.09	125.16	1.65
8	461	7.00	504	13	1300	620	285.8	1068.0	0.03	0.13	297.73	2.25
9	431	6.78	368	7	1150	590	254.3	1322.3	0.03	0.16	264.89	2.79
10	487	6.85	295	7	1230	700	340.9	1663.2	0.04	0.20	355.10	3.51
11	426	6.80	187	8	1070	580	247.1	1910.3	0.03	0.23	257.38	4.03
12	393	6.99	126	10	1090	620	243.7	2154.0	0.03	0.26	253.81	4.54
13	364	6.91	80	7	746	370	134.7	2288.6	0.02	0.27	140.29	4.83
14	458	6.92	56	8	476	240	109.9	2398.6	0.01	0.29	114.50	5.06
15	453	7.05	96	10	870	500	226.5	2625.1	0.03	0.31	235.94	5.54
16	397	7.05	99	9	807	410	162.8	2787.8	0.02	0.33	169.55	5.88
17	313	6.91	41	8	355	150	47.0	2834.8	0.01	0.34	48.91	5.98
18	414	7.03	57	9	433	170	70.4	2905.2	0.01	0.35	73.31	6.13
19	414	7.07	152	13	999	550	227.7	3132.9	0.03	0.38	237.19	6.61
20	457	7.00	121	17	938	530	242.2	3375.1	0.03	0.40	252.30	7.12
21	456	7.41	85	28	1071	570	259.9	3635.0	0.03	0.44	270.75	7.66
22	389	7.13	105	12	868	470	182.8	3817.8	0.02	0.46	190.45	8.05
23	408	7.03	93	12	856	470	191.8	4009.6	0.02	0.48	199.75	8.45
24	424	7.21	81	13	963	500	212.0	4221.6	0.03	0.51	220.83	8.90
25	434	7.04	42	13	864	450	195.3	4416.9	0.02	0.53	203.44	9.31
Maximum Value	7.41	-	150	1300	700	340.9	-	-	0.04	-	355.10	-
Minimum Value	4.27	-	0.3	355	92	47.0	-	-	0.01	-	48.91	-
Average Value	5.65	-	15	835	394	169.9	-	-	0.02	-	176.96	-

Combined Lynx D Composite
Dissolved Metal Concentrations

Parameter	Units	MMER ¹	Week												
			0	1	2	3	4	5	6	7	8	9	10	11	12
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
LIMS #			10296JUL05	10344JUL05	10010AUG05	10112AUG05	10250AUG05	10380AUG05	10003SEP05	12079SEP05	10154SEP05	10272SEP05	10486SEP05	10029OCT05	10183OCT05
HumCell Leachate Vol	mLs		598	419	419	462	439	429	425	445	461	431	467	426	393
pH	units	6.0 - 9.5	6.88	6.49	4.27	6.53	6.42	6.51	6.55	6.53	7.00	6.78	6.85	6.80	6.99
Alkalinity	mg/L as CaCO ₃		10	4	< 0.3	4	3	5	4	3	13	7	7	8	10
Acidity	mg/L as CaCO ₃		150	234	376	619	431	260	193	352	504	368	295	187	126
Conductivity	uS/cm		397	718	758	1120	798	616	437	775	1300	1150	1230	1070	1090
SO ₄	mg/L		92	220	270	270	300	200	140	270	620	590	700	580	620
Cl	mg/L		1.2	1.2	1.3	1.1	0.7	0.4	0.2	0.4	< 2	0.6	< 2	0.3	< 0.2
F	mg/L		< 0.06	< 0.06	< 0.06	0.06	< 0.06	< 0.06	< 0.06	< 0.06	0.11	0.12	0.12	0.12	0.11
NO ₃	as N mg/L		< 0.05	0.08	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
NH ₃ ⁺ NH ₄	as N mg/L		0.3	0.4	0.3	0.3	0.2	0.2	0.2	0.1	0.3	0.4	0.2	< 0.1	0.1
Thiosalts	as S ₂ O ₃ mg/L		151	250	371	586	402	226	150	310	452	318	252	168	134
CN(T)	mg/L	1.00	< 0.002	< 0.01	< 0.01	< 0.01	< 0.002	< 0.002	< 0.01	< 0.002	< 0.01	< 0.01	< 0.002	0.02	< 0.01
CNO	mg/L		< 0.1	< 1.0	< 1.0	< 0.1	< 0.1	< 0.1	< 1.0	< 0.1	< 0.1	< 0.1	< 1	< 0.1	< 0.1
CNS	mg/L		< 2	36	< 5.0	< 20	< 2.0	< 5.0	12	***	***	***	***	---	---
Hg	µg/L		< 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
Ag	mg/L		0.0002	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.02	< 0.005	< 0.005
Al	mg/L		< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.02	< 0.01	< 0.02	< 0.01	< 0.02	< 0.01	< 0.01
As	mg/L	0.50	< 0.005	< 0.005	0.008	0.009	< 0.005	0.006	< 0.005	< 0.005	< 0.005	0.013	0.008	0.009	0.010
Ba	mg/L		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
Be	mg/L		< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Bi	mg/L		< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003
B	mg/L		< 0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.02	< 0.01	< 0.01	< 0.01	< 0.01
Ca	mg/L		59.3	115	146	200	144	103	67.6	123	264	232	258	180	210
Cd	mg/L		0.0060	0.0131	0.0195	0.0361	0.0299	0.0225	0.0174	< 0.0001	0.0890	0.0589	0.0631	0.0560	0.0525
Co	mg/L		0.0015	0.0027	0.0035	0.0065	0.0046	0.0031	0.0025	0.0014	0.0130	0.0088	0.0084	0.0071	0.0070
Cr	mg/L		< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Cu	mg/L	0.30	0.0065	0.0042	0.0035	0.0024	0.0039	0.0015	0.0014	0.0284	0.0021	0.0025	0.0018	0.0030	0.0014
Fe	mg/L		< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Li	mg/L		< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
K	mg/L		2.06	1.97	1.70	2.52	1.62	0.95	0.58	1.31	2.41	1.85	1.84	1.25	1.28
Mg	mg/L		4.60	7.62	11.1	17.3	14.9	9.79	8.14	18.4	33.7	28.4	30.5	21.9	25.2
Mn	mg/L		0.310	0.710	0.835	1.85	1.26	0.806	0.526	1.44	3.98	2.27	2.19	1.88	1.56
Mo	mg/L		0.0012	0.0008	0.0005	0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	0.0004	< 0.0003	0.0004
Na	mg/L		10.6	13.0	11.8	14.0	8.44	4.43	2.45	6.22	9.69	7.16	6.28	3.76	3.06
Ni	mg/L	0.50	0.007	0.011	0.014	0.024	0.016	0.011	0.011	0.003	0.043	0.022	0.020	0.023	0.019
P	mg/L		< 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
Pb	mg/L	0.20	0.0237	0.0351	0.0528	0.0241	0.0416	0.0237	0.0143	0.0053	0.0283	0.0216	0.0198	0.0150	0.0111
Sb	mg/L		< 0.05	< 0.05	< 0.09	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Se	mg/L		0.386	0.44	0.30	0.48	0.334	0.18	0.13	< 0.005	0.885	0.710	0.774	0.631	0.685
Si	mg/L		0.15	0.13	0.13	0.21	0.14	0.09	0.08	0.15	0.34	0.22	0.24	0.21	0.22
Sn	mg/L		0.089	0.046	0.022	0.018	0.008	0.005	0.005	< 0.001	0.010	0.007	0.007	0.005	0.004
Sr	mg/L		0.0742	0.134	0.193	0.374	0.330	0.266	0.217	0.466	0.927	0.782	0.909	0.721	0.775
Ti	mg/L		< 0.005	< 0.005	< 0.02	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Tl	mg/L		0.0088	0.0126	0.0147	0.0171	0.0146	0.0110	0.0084	0.0002	0.0250	0.0209	0.0189	0.0154	0.0152
U	mg/L		< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
V	mg/L		< 0.002	< 0.002	0.003	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.003	0.002	0.004	0.003	< 0.002
Zn	mg/L	0.50	0.18	0.42	0.63	1.59	1.36	1.08	0.91	1.83	5.56	2.87	3.24	2.99	2.62

Week #0 signifies the initial flooding of the humidly cell initiating the 20 week test period.

Metal Mining Effluent Regulations

—Not Analysed

***Could not be determined due to sample matrix.

**Combined Lynx D Composite
Dissolved Metal Concentrations**

Parameter	Units	MMER ¹	Week												
			13	14	15	16	17	18	19	20	21	22	23	24	25
Date			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
LIMS #			10293OCT05	10457OCT05	10010NOV05	10097NOV05	10240NOV05	10402NOV05	10001DEC05	10039DEC05	10374DEC05	10411DEC05	10502DEC05	10005JAN06	10096JAN06
HumCell Leachate Vol	mLs		364	458	453	397	313	414	414	457	456	389	408	424	434
pH	units	6.0 - 9.5	6.91	6.92	7.05	7.05	6.91	7.03	7.07	7.00	7.41	7.13	7.03	7.21	7.04
Alkalinity	mg/L as CaCO ₃		7	8	10	9	8	9	13	17	28	12	12	13	13
Acidity	mg/L as CaCO ₃		80	56	96	99	41	57	152	121	85	105	93	81	42
Conductivity	uS/cm		746	476	870	807	355	433	999	938	1071	868	856	963	864
SO ₄	mg/L		370	240	500	410	150	170	550	530	570	470	500	500	450
Cl	mg/L		< 2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	0.3	---	---	---	---	---
F	mg/L		0.10	0.06	0.07	0.08	< 0.06	< 0.06	0.14	0.11	---	---	---	---	---
NO ₃	as N mg/L		< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	---	---	---	---	---
NH ₃ ⁺ NH ₄	as N mg/L		0.1	0.2	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.1	---	---	---	---	---
Thiosalts	as S ₂ O ₃ mg/L		92	62	104	15	25	56	126	101	---	---	---	---	62
CN(T)	mg/L	1.00	< 0.01	< 0.02	< 0.002	0.02	< 0.01	< 0.01	< 0.002	< 0.002	---	---	---	---	---
CNO	mg/L		< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	---	---	---	---	---
CNS	mg/L		---	---	---	---	---	---	---	---	---	---	---	---	---
Hg	µg/L		< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	---	---	---	---	---
Ag	mg/L		< 0.002	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	---	---	---	---	< 0.005
Al	mg/L		< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	---	---	---	---	< 0.01
As	mg/L	0.50	0.006	< 0.005	< 0.005	0.006	< 0.005	< 0.005	0.012	< 0.005	---	---	---	---	< 0.005
Ba	mg/L		0.024	0.014	0.026	0.026	0.046	0.046	0.040	---	---	---	---	---	0.026
Be	mg/L		< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	---	---	---	---	< 0.005
Bi	mg/L		< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	---	---	---	---	< 0.0003
B	mg/L		< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	---	---	---	---	< 0.01
Ca	mg/L		126	73.7	145	139	53.1	53.0	175	153	---	---	---	---	168
Cd	mg/L		0.0306	0.0212	0.0411	0.0366	0.0222	0.0232	0.0512	< 0.0001	---	---	---	---	0.0488
Co	mg/L		0.0049	0.0032	0.0057	0.0048	0.0030	0.0037	0.0089	0.0020	---	---	---	---	0.0064
Cr	mg/L		< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	---	---	---	---	< 0.001
Cu	mg/L	0.30	< 0.0008	< 0.0008	0.0018	0.0011	0.0012	0.0012	0.0015	0.0236	---	---	---	---	0.0010
Fe	mg/L		< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	---	---	---	---	< 0.02
Li	mg/L		< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	---	---	---	---	< 0.005
K	mg/L		0.77	0.45	0.84	0.73	0.29	0.33	0.79	0.69	---	---	---	---	0.58
Mg	mg/L		17.1	11.8	21.8	20.3	8.17	9.61	28.2	25.3	---	---	---	---	22.7
Mn	mg/L		0.835	0.628	0.970	0.860	0.489	0.658	1.47	1.97	---	---	---	---	1.12
Mo	mg/L		< 0.0003	< 0.0003	< 0.0003	0.0003	0.0004	0.0004	0.0006	0.0006	---	---	---	---	0.0006
Na	mg/L		1.59	0.85	1.26	0.92	0.30	0.26	0.71	0.54	---	---	---	---	0.23
Ni	mg/L	0.50	0.009	0.007	0.013	0.010	0.005	0.010	0.015	< 0.001	---	---	---	---	0.023
P	mg/L		< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	---	---	---	---	< 0.1
Pb	mg/L	0.20	0.0033	0.0054	0.0088	0.0078	0.0072	0.0064	0.0086	< 0.0002	---	---	---	---	0.0065
Sb	mg/L		< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	---	---	---	---	< 0.05
Se	mg/L		0.464	0.250	0.599	0.491	0.168	0.233	0.705	< 0.005	---	---	---	---	0.438
Si	mg/L		0.13	0.10	0.16	0.15	0.09	0.11	0.19	0.19	---	---	---	---	0.19
Sn	mg/L		0.004	0.002	0.004	0.004	0.002	0.003	0.006	< 0.001	---	---	---	---	0.002
Sr	mg/L		0.503	0.311	0.622	0.584	0.233	0.248	0.810	0.682	---	---	---	---	0.675
Ti	mg/L		< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	---	---	---	---	< 0.005
Tl	mg/L		0.0027	0.0154	0.0100	0.0052	0.0067	0.0067	0.0142	< 0.0002	---	---	---	---	0.0105
U	mg/L		< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	---	---	---	---	< 0.0002
V	mg/L		< 0.002	< 0.002	0.002	< 0.002	< 0.002	< 0.002	0.002	< 0.002	---	---	---	---	< 0.002
Zn	mg/L	0.50	1.72	1.14	1.82	1.65	1.04	0.98	2.11	3.63	---	---	---	---	1.88

Week #0 signifies the initial flooding of the humidity cell initiating the 20

Metal Mining Effluent Regulations

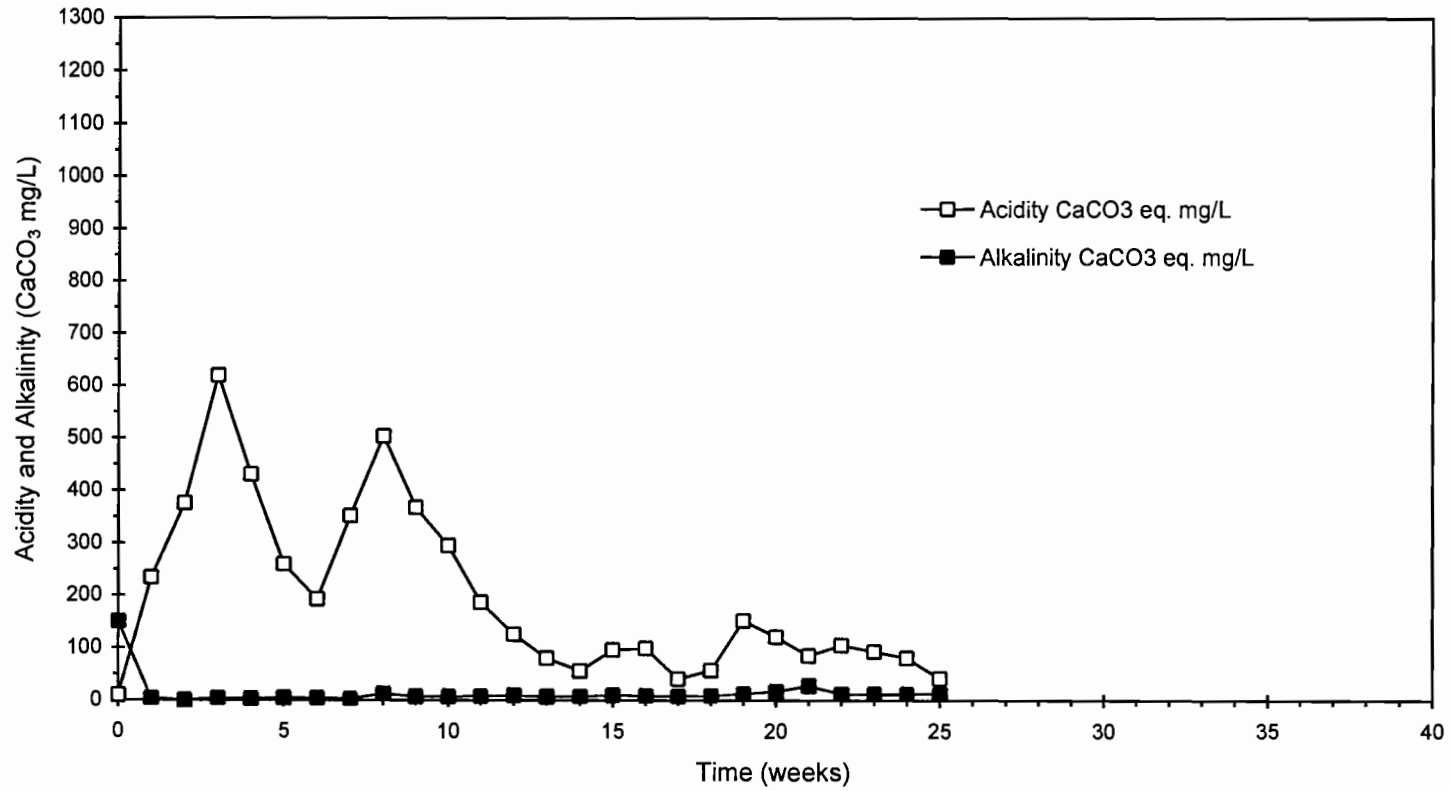
---Not Analyzed

***Could not be determined due to sample matrix.

Humidity Cell Test Report ASTM D 5744-96 (2001)

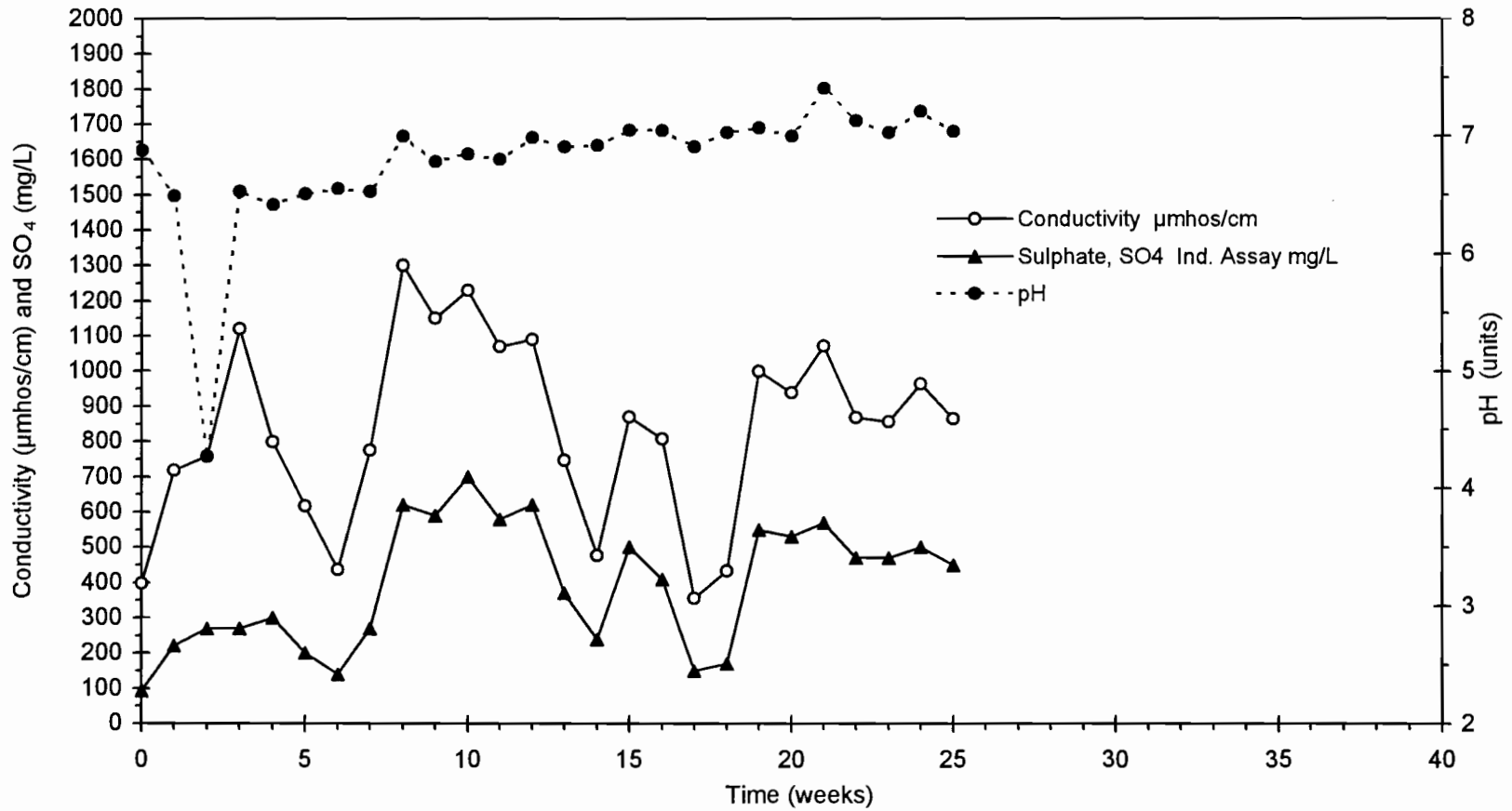
Sample I.D.: Combined Lynx D Composite

Alkalinity & Acidity vs. Time



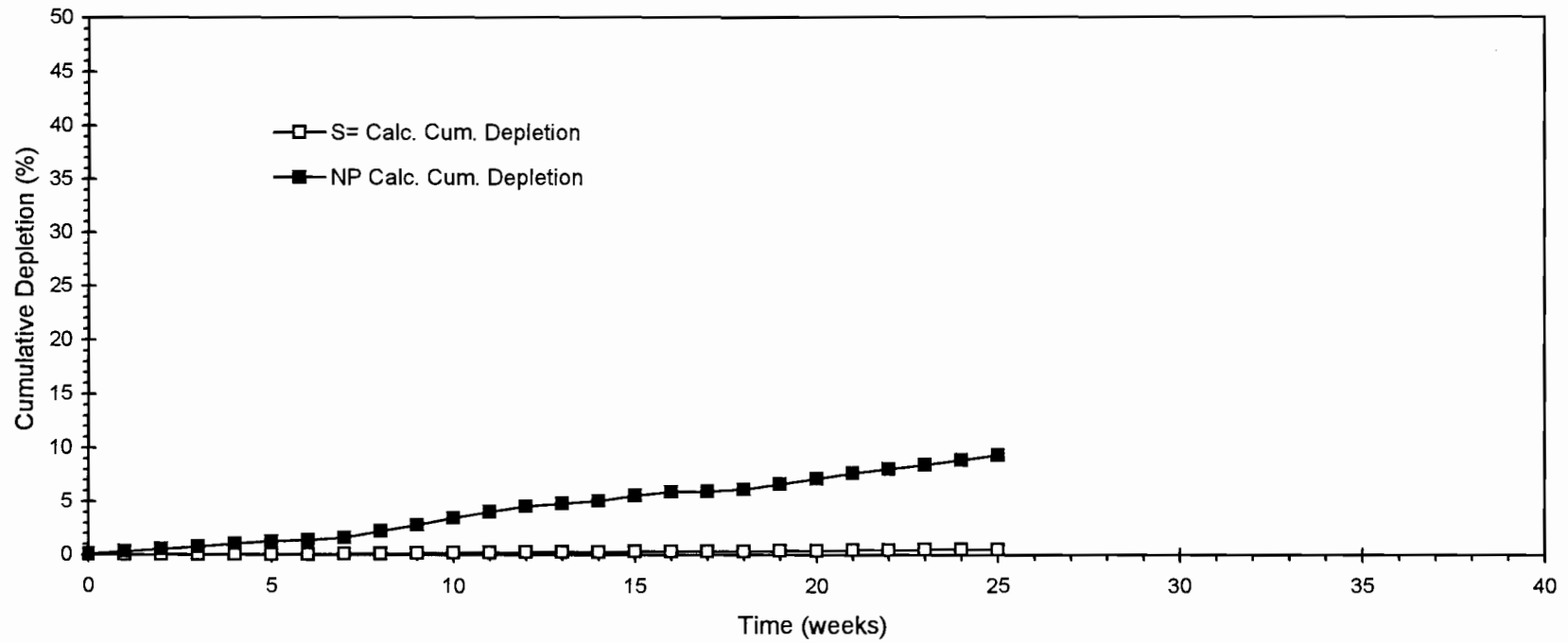
Humidity Cell Test Report ASTM D 5744-96 (2001)
Sample I.D.: Combined Lynx D Composite

Conductivity, Sulphate and pH vs. Time



Humidity Cell Test Report ASTM D 5744-96 (2001)
Sample I.D.: Combined Lynx D Composite

Cumulative Depletion vs. Time



2. DAM BORROW MATERIAL CHARACTERIZATION

Material is scheduled for the construction of the tailings dam at site. 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 done, specifically the potential for acid generation and metal(loid) leaching.

Samples of different dam borrow materials were geochemically examined to determine the potential for acid rock drainage (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)

Acid base accounting was conducted by Canadian Environmental and Metallurgical Inc., Burnaby, British Columbia. Brief descriptions of the ABA parameters and methodology are included below. The samples were selected from test pits within the tailings impoundment and main Project Borrow areas. Oversize material (>3" diameter), were 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).

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 µm) 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 µm 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 has 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 of St. Joseph, Michigan (LECO) methods. Sulphate and sulphide were determined by the procedure described by Sobek, *et. al.* (1978). In this procedure total sulphur is measured by LECO methods. A portion of sample is treated with 25% HCl to remove sulphate sulphur. The sample is then re-run by LECO methods to determine, by difference, the quantity of sulphate removed. Sulphide sulphur is determined by taking a portion of sample that has been treated to remove sulphate and further treated with 1:7 mixture of HNO₃ to deionised water to remove the sulphide. The sample is then re-run by LECO methods to determine the quantity of sulphur remaining after sulphate and sulphide have been removed. Sulphide is then determined by difference. The sulphur remaining is considered to be acid insoluble sulphur (e.g. barite, alunite etc.).

Approximately 2.00 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 yields data for calculating the Neutralizing Potential (NP), Acid Potential (AP), Net Neutralization Potential (Net NP) and Sobek Neutralization Potential Ratios (Sobek NPR).

Total Carbon was measured by Leco methods. Inorganic carbon was determined by difference (i.e. a known weight of sample is treated with 25% HCl to remove inorganic carbon (IC) and then re-analysed for total carbon).

2.1.2 Results

Results for the ABA analyses of the borrow materials are reported in Table 2.2. Materials have low potential for acid generation due to the very low sulphide sulphur content (0.005 %). The low sulphide sulphur concentrations suggest 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 acid potential (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). ABA test work, in particular the information garnered from the Neutralizing Potential Ratio (NPR), serves as a guide in identifying the likelihood of ARD conditions and distinguishing samples from a deposit as Potentially

Acid Generating (PAG) from Non-potentially Acid Generating (Non-PAG). Price (1997) provides some criteria for guiding geochemical test work and evaluating the potential for ARD shown in Table 1.9. Table 2.1 combined with the Sobek NPR and Carbonate NPR from Table 2.2 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 2.1 ABA screening criteria

POTENTIAL FOR ARD	INITIAL SCREENING CRITERIA
Likely	$\text{NPR} \leq 1$
Possible	$1 < \text{NPR} \leq 2$
Low	$\text{NPR} > 2$

Table 2.2 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	<i>0.005</i>	0.04	0.07	0.09	0.05	0.06	0.08	0.09	0.02	0.03	<i>0.005</i>
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	<i>0.005</i>	<i>0.005</i>	<i>0.005</i>	<i>0.005</i>	<i>0.005</i>	<i>0.005</i>	<i>0.005</i>	<i>0.005</i>	<i>0.005</i>	<i>0.005</i>	<i>0.005</i>
Carb NP	kg CaCO3/t	<i>0.4</i>	<i>0.4</i>	<i>0.4</i>	<i>0.4</i>	<i>0.4</i>	<i>0.4</i>	<i>0.4</i>	<i>0.4</i>	<i>0.4</i>	<i>0.4</i>	<i>0.4</i>
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.

2.2 Shake Flask Extraction

This 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*. Shake flask extractions (SFE) were conducted by Canadian Environmental and Metallurgical Inc., Burnaby, British Columbia. Descriptions of the SFE parameters and methodology are included below.

2.2.1 Methodology

Shake flask extractions 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 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 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	<i>0.000025</i>	<i>0.000025</i>	<i>0.000025</i>	<i>0.000025</i>
Al	mg/L	0.059	0.25	0.13	0.066
Sb	mg/L	<i>0.0001</i>	<i>0.0001</i>	<i>0.0001</i>	<i>0.0001</i>
As	mg/L	0.0005	0.0002	<i>0.0001</i>	0.0005
Ba	mg/L	0.018	0.016	0.0091	0.017
Be	mg/L	<i>0.0001</i>	<i>0.0001</i>	<i>0.0001</i>	<i>0.0001</i>
Bi	mg/L	<i>0.0001</i>	<i>0.0001</i>	<i>0.0001</i>	<i>0.0001</i>
B	mg/L	<i>0.005</i>	<i>0.005</i>	<i>0.005</i>	<i>0.005</i>
Ca	mg/L	1.07	0.38	0.18	0.36
Cd	µg/L	<i>0.02</i>	<i>0.02</i>	<i>0.02</i>	<i>0.02</i>
Co	mg/L	<i>0.0001</i>	0.0004	<i>0.0001</i>	<i>0.0001</i>
Cr	mg/L	<i>0.0001</i>	0.0004	<i>0.0001</i>	<i>0.0001</i>
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	<i>0.01</i>	<i>0.01</i>	0.03	<i>0.01</i>
K	mg/L	0.3	0.43	0.16	0.23
Li	mg/L	<i>0.0001</i>	<i>0.0001</i>	<i>0.0001</i>	<i>0.0001</i>
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	<i>0.00005</i>	<i>0.00005</i>	<i>0.00005</i>
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	<i>0.0001</i>	0.0002	<i>0.0001</i>	<i>0.0001</i>
Se	mg/L	<i>0.0001</i>	<i>0.0001</i>	<i>0.0001</i>	<i>0.0001</i>
Si (as SiO ₂)	mg/L	0.87	1.18	0.83	2.57
Sn	mg/L	<i>0.0001</i>	<i>0.0001</i>	<i>0.0001</i>	<i>0.0001</i>
Sr	mg/L	0.0017	0.0029	0.0012	0.0008
Te	mg/L	<i>0.0001</i>	<i>0.0001</i>	<i>0.0001</i>	<i>0.0001</i>
Tl	mg/L	<i>0.00001</i>	<i>0.00001</i>	<i>0.00001</i>	<i>0.00001</i>
Th	mg/L	<i>0.00005</i>	<i>0.00005</i>	<i>0.00005</i>	<i>0.00005</i>
Ti	mg/L	0.0019	0.0075	0.0035	0.0029
U	mg/L	<i>0.00005</i>	<i>0.00005</i>	<i>0.00005</i>	<i>0.00005</i>
V	mg/L	0.0006	0.0004	<i>0.0001</i>	0.0007
Zn	mg/L	0.002	0.004	0.003	0.002
Zr	mg/L	<i>0.001</i>	<i>0.001</i>	<i>0.001</i>	<i>0.001</i>

Italics indicates measured value less than detection limit and listed as one half of the detection limit

3. DMS FLOAT ROCK CHARACTERIZATION

This material represents the mining dilution rock that is separated from the ore by Dense Media Separation. To assess the geochemical characteristics of the DMS Float Rock, three ore zones (using drill core) were tested including both the Lynx and Wolverine ore bodies as well as the “Hump” zone that connects the two main zones. The actual material separation method used to generate these samples was Heavy Liquid Separation, which uses a methylene iodide solution rather than a ferro-silicon slurry to effect the density separation of the ore particles from the gangue. Static testing included Whole Rock Analyses by XRF, Acid Base Accounting (ABA), ICP-MS element determinations and Shake Flask Extractions (SFE) and results are presented below.

3.1 Whole Rock Analysis

3.1.1 Methodology

Samples from the three ore zones were submitted for determination of major element oxides by X-ray fluorescence (XRF) to Global Discovery Labs. A predetermined amount of 150 - 200 mesh sample pulp was roasted to determine the LOI. Two grams of the roasted sample was fused in a platinum-gold crucible with a commercial lithium tetraborate flux. The molten material was then cast in a graphite mold, producing a stable, transparent, homogeneous and crack-free disk.

The fusion disks are analysed using a Siemens SRS-200 sequential X-Ray Spectrometer with a chromium tube for eleven elements which include CaO, K₂O, P₂O₅, SiO₂, Al₂O₃, MgO, Na₂O, Fe₂O₃, TiO₂, MnO and Ba. All elements analysed are corrected for absorption effect, enhancement effect, line overlap, background correction and LOI.

3.1.2 Results

The results of the whole rock analysis, using x-ray fluorescence are presented in Table 7.4.14 and individual elements concentrations are presented in .

Table 3.1 DMS Whole Rock Analysis (%)

Element	HLS Hump Floats	HLS Wolv Floats	HLS Lynx Floats
SiO ₂	57.68	66.69	68.09
TiO ₂	0.18	0.28	0.2
Al ₂ O ₃	4.88	8.31	5.84
Fe ₂ O ₃	4.03	3.91	3.58
MnO	0.15	0.07	0.07
MgO	1.92	2.08	1.7
CaO	12.44	4.61	5.98
Na ₂ O	<i>0.01</i>	<i>0.01</i>	<i>0.01</i>
K ₂ O	1.21	1.82	1.62
P ₂ O ₅	0.31	0.63	0.25
Ba(F)	0.67	0.95	0.9
LOI	9.9	6.05	5.57
Total	93.38	95.41	93.81

Italics indicates sample below detection

Table 3.2 DMS Whole Rock Analysis (%)

Element	HLS Hump Floats	HLS Wolv Floats	HLS Lynx Floats
Si	26.96	31.18	31.83
Ti	0.11	0.17	0.12
Al	2.58	4.40	3.09
Fe	1.41	1.37	1.25
Mn	0.12	0.05	0.05
Mg	1.16	1.25	1.03
Ca	8.89	3.29	4.27
K	0.50	0.76	0.67
P	0.07	0.14	0.05

Although whole rock data is traditionally presented as oxides, this does not necessarily indicate oxide minerals are present in the sample. The conversion of the oxides to total elemental concentrations is therefore more representative of the overall DMS chemistry.

Results show moderate to high concentrations of the major cations (Si, Al, Mg and Ca) as well as Fe. Potassium, Ti, P and Mn are present at less than one weight percent. The high LOI and consistently low totals are reflective of the presence of sulphides, carbonates, phyllosilicates or hydrated minerals (Price, 1997). X-ray diffraction nor optical mineralogy was not done on the samples and the presence of all these types of mineral phases can not be confirmed. However, the likelihood of a volatile component present is high since totals are low and LOI concentrations are significant released during thermal glass disc preparation and their respective mineral phases include.

3.2 Acid Base Accounting

Acid base accounting was conducted by Canadian Environmental and Metallurgical Inc., Burnaby, British Columbia. Brief descriptions of the ABA parameters and methodology are included below. The samples were selected from test pits within the tailings impoundment and main Project Borrow areas. Oversize material (>3" diameter), were 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).

3.2.1 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 µm) 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 µm 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 has 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 of St. Joseph, Michigan (LECO) methods. Sulphate and sulphide were determined by the procedure described by Sobek, *et. al.* (1978). In this procedure total sulphur is measured by LECO methods. A portion of sample is treated with 25% HCl to remove sulphate sulphur. The sample is then re-run by LECO methods to determine, by difference, the quantity of sulphate removed. Sulphide sulphur is determined by taking a portion of sample that has been treated to remove sulphate and further treated with 1:7 mixture of HNO₃ to deionised water to remove the sulphide. The sample is then re-run by LECO methods to determine the quantity of sulphur remaining after sulphate and sulphide have been removed. Sulphide is then determined by difference. The sulphur remaining is considered to be acid insoluble sulphur (e.g. barite, alunite etc.).

Approximately 2.00 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 yields data for calculating the Neutralizing Potential (NP), Acid Potential (AP), Net Neutralization Potential (Net NP) and Sobek Neutralization Potential Ratios (Sobek NPR).

Total Carbon was measured by Leco methods. Inorganic carbon was determined by difference (i.e. a known weight of sample is treated with 25% HCl to remove inorganic carbon (IC) and then re-analysed for total carbon).

3.2.2 Results

Table 3.3 lists the DMS Float Rock ABA results.

Table 3.3 DMS Float Rock ABA Results

Parameter	Units	HLS Hump Floats	HLS Wolv Floats	HLS Lynx Floats
Paste pH	-	8.3	7.9	8.4
Fizz Rate	-	strong	strong	strong
Total S	%S	1.94	1.17	1.78
Acid Leachable SO ₄ ²⁻	%S	0.06	0.07	0.06
Sulphide S	%S	1.77	0.90	1.62
Insoluble S	%S	0.11	0.20	0.10
AP	kg CaCO ₃ /t	55.3	28.1	50.6
Sobek NP	kg CaCO ₃ /t	240.9	84.4	120.9
Net NP	kg CaCO ₃ /t	185.6	56.3	70.3
Sobek NP/AP	-	4.36	3.00	2.39
Carb NP	kg CaCO ₃ /t	247.7	85.7	132.7
Carb NP/AP	-	4.48	3.05	2.62
CO ₂	%CO ₂	10.9	3.77	5.84
C(T)	%C	4.76	4.12	3.11

Samples with higher Sobek-NP than Carb-NP (all samples) indicate the presence of non-carbonate NP. Possible candidates may include phyllosilicates, inferred from the high XRF Si totals, and are non-carbonates with NP. 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.

ABA test work, in particular the information garnered from the Neutralizing Potential Ratio (NPR), serves as a guide in identifying the likelihood of ARD conditions and distinguishing samples from a deposit as Potentially Acid Generating (PAG) from Non-

potentially Acid Generating (Non-PAG). Price (1997) provides some criteria for guiding geochemical test work and evaluating the potential for ARD shown in Table 1.9.

Table 3.4 ABA Screening Criteria

POTENTIAL FOR ARD	INITIAL SCREENING CRITERIA
Likely	$NPR \leq 1$
Possible	$1 < NPR \leq 2$
Low	$NPR > 2$

The ABA results for the DMS samples indicate that the materials have low potential for ARD ($NPR > 2$).

3.3 Metal Analyses

3.3.1 Methodology

Inductively Coupled Plasma-Mass Spectrometry analyses were done in December of 2005 by Canadian Environmental and Metallurgical Inc. 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 (35 elements in total).

3.3.2 Results

When measured sample concentrations are compared to known crustal abundances, it can give an indication as to 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). Table 7.4.16 lists a summary of the trace element determinations for the three DMS samples, and show concentrations for those parameters with greater than five times crustal abundance for all three samples analyzed.

Table 3.5 Summary of Anomalous elements in DMS Float Rock

Element	Avg Ratio	Maximum (mg/kg)	Median (mg/kg)	Minimum (mg/kg)
Se	689	41	29	18
Sb	191	39	39	37
Ag	135	14.7	10.7	7.0
Bi	118	1.2	1.0	0.70
Cd	95	16	15	14
As	46	93	83	72
Mo	24	41	28.6	18
Zn	18	1577	1248	1229
Pb	12	199	141	130
Tl	14	3.8	3.8	72
Cu	7	754	568	158
Th	6	9.8	5.2	5.0
Au	5	0.040	0.014	0.0069

Avg Ratio = measured concentration divided by typical crustal abundance. Values greater than 5 are considered anomalous for this assessment.

3.4 Shake Flask Extraction

3.4.1 Methods

Shake flask extractions 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 in December of 2005 by Canadian Environmental and Metallurgical Inc. 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.

3.4.2 Results

This short-term leach test was used to determine what contaminants might flush from the DMS solids when exposed to rain, snowmelt or groundwater flow. The results of the shake flask test are summarized in Table 7.4.17. This procedure is a recommended component of static tests and is used to determine the presence of easily soluble mineral components (Price, 1997). Results suggest Cd and to a lesser extent, Se, exceed water quality guidelines and may be PCOC.

Table 3.6 Summary of Shake Flask Tests in DMS Float Rock

Parameter	Units	MMER ¹	10X CCME ²	HLS Hump Floats	HLS Wolv Floats	HLS Lynx Floats	Blank
nanopure water volume	mL			1000	1000	1000	1000
Sample Weight	g			50	50	50	-
pH			6.5-9.0	7.56	7.33	7.4	5.33
Conductivity	µS/cm			113	77	89	1
Total Acidity (to pH 8.3)	mg CaCO ₃ /L			4	4	5	2.5
Alkalinity	mg CaCO ₃ /L			44.5	26.5	32.75	1.25
Hardness CaCO ₃	mg/L			57.1	42	46.5	< 0.2
Sulphate	mg/L		500†	15	15	12	<1
Dissolved Metals							
Aluminum Al	mg/L			0.019	0.009	0.005	0.001
Antimony Sb	mg/L			0.029	0.024	0.026	< 0.0002
Arsenic As	mg/L	0.50		0.0019	0.0033	0.0015	< 0.0002
Barium Ba	mg/L			0.036	0.042	0.059	< 0.0002
Beryllium Be	mg/L			< 0.0002	< 0.0002	< 0.0002	< 0.0002
Bismuth Bi	mg/L			< 0.0002	< 0.0002	< 0.0002	< 0.0002
Boron B	mg/L			< 0.01	< 0.01	< 0.01	< 0.01
Cadmium Cd	mg/L		0.00017	0.0014	0.0042	0.003	< 0.00004
Calcium Ca	mg/L			20.9	14.7	16.8	< 0.01
Chromium Cr*	mg/L		0.010*	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cobalt Co	mg/L			0.0015	0.0019	0.0036	< 0.0002
Copper Cu	mg/L	0.30		0.0006	0.0022	0.0038	0.0013
Iron Fe	mg/L			< 0.01	< 0.01	< 0.01	< 0.01
Lead Pb	mg/L	0.20		0.0018	0.0037	0.0058	< 0.0002
Lithium Li	mg/L			0.0006	0.0006	0.0006	< 0.0002
Magnesium Mg	mg/L			1.19	1.29	1.1	< 0.01
Manganese Mn	mg/L			0.164	0.172	0.169	< 0.0002
Mercury Hg	µg/L		0.00026	< 0.02	< 0.02	< 0.02	< 0.02
Molybdenum Mo	mg/L		0.73	0.001	0.0008	0.0017	< 0.0001
Nickel Ni	mg/L	0.50		0.014	0.038	0.024	< 0.0002
Phosphorus PO ₄	mg/L			< 0.03	< 0.03	< 0.03	< 0.03
Potassium K	mg/L			0.63	0.71	0.81	< 0.02
Selenium Se	mg/L		0.010	0.01	0.0083	0.019	< 0.0002
Silicon SiO ₂	mg/L			0.34	0.35	0.29	< 0.05
Silver Ag	mg/L		0.0010	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Sodium Na	mg/L			0.24	0.44	0.49	< 0.01
Strontium Sr	mg/L			0.055	0.039	0.05	< 0.0002
Tellurium Te	mg/L			< 0.0002	< 0.0002	< 0.0002	< 0.0002
Thallium Tl	mg/L			0.0004	0.00025	0.002	< 0.00002
Thorium Th	mg/L			< 0.0001	< 0.0001	< 0.0001	< 0.0001
Tin Sn	mg/L			< 0.0002	< 0.0002	< 0.0002	< 0.0002

Parameter	Units	MMER ¹	10X CCME ²	HLS Hump Floats	HLS Wolv Floats	HLS Lynx Floats	Blank
Titanium Ti	mg/L			< 0.0002	< 0.0002	< 0.0002	< 0.0002
Uranium U	mg/L			0.0008	0.0002	< 0.0001	< 0.0001
Vanadium V	mg/L			< 0.0002	< 0.0002	< 0.0002	< 0.0002
Zinc Zn	mg/L	0.50		0.064	0.3	0.21	< 0.001
Zirconium Zr	mg/L			< 0.002	< 0.002	< 0.002	< 0.002

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

Bold indicates measured values in excess of MMER, 10x CCME and/or 10X BC guidelines

4. WASTE ROCK

The following data and interpretation of results has been extracted from preliminary information supplied by AMEC in support of their report entitled “Acid Rock Drainage and Metal Leaching Assessment of Waste Rock and the Underground Workings, Appendix E.”

Six major waste rock types have been identified in the deposit that will be excavated during mining. Samples collected during the 2005 program included discrete samples selected for the six major lithologies present in the deposit, and several composite samples of rock and massive sulphide selected from eighteen drillholes advanced in 2005. Static test analyses completed in 2005 included acid-base accounting and 35 element ICP-MS analysis for metals. Neutralization potential was determined using the Modified Sobek method. Thirty-seven samples representing the six major rock types were analyzed for ABA and metals.

4.1 Mineralogy

Eight samples were reduced into fine powder to the optimum grain-size range for X-ray analysis. Quartz (α -SiO₂) was the dominant mineral (>60%) in all Rock Types. Muscovite (KAl₂AlSi₃O₁₀(OH)₂), ankerite (Ca(Fe²⁺,Mg,Mn)(CO₃)₂) and pyrite (FeS₂) in decreasing order of abundance were also identified in all Rock Types. Potassium feldspar was detected in all but Rock Type 3 and calcite was not detected in Rock Types 2 and 3. The phyllosilicates biotite, clinocllore, talc, and kaolinite, were detected in some samples. Barite, magnetite, and celsian (barium feldspar) were detected in some Rock Types. The zeolite harmotome (Ba_{0.5},Ca_{0.5},K,Na)₅[Al₅Si₁₁O₃₂] \cdot 12H₂O) was reported in Rock Type 5. In contrast to previous reports carbonate minerals dolomite (Ca,Mg(CO₃)₂), and siderite (FeCO₃) were not detected in the samples. Sulphide minerals sphalerite (ZnS), galena (PbS), and chalcopyrite (CuFeS₂). pyrrhotite (Fe₁-XS) marcasite (FeS₂), arsenopyrite (FeAsS) and sulphosalts reported previously in ore samples were also not detected in any of the samples analyzed here.

4.2 Acid Base Accounting (ABA)

ABA analyses were performed on thirty-seven samples representing the six major rock types. The acid generation potential differed between the six rock types ranging from net acid generating to net non-acid generating (see Table 4.1) The highest content of sulphide was observed in the carbonaceous argillite (rock type 2) samples which averaged 8.78% sulphide. The lowest sulphide-S concentrations (0.98%) were observed in the interbedded rhyolite/argillite (rock type 5). Although the calcite-pyrite exhalite (rock type 3) samples contained the second highest concentrations of sulphide-S (average 3.96%) the samples contained the highest values for NP (average carbonate-NP = 2.86 kg CaCO₃/tonne) and thus had the highest value for NNP (average 163 kg CaCO₃/tonne).

Sobek-NP exceeded carbonate-NP for all rock types except type 4 (iron formation and silica-pyrite exhalite) suggesting that the type 4 samples contain some iron-rich carbonates (e.g. siderite and/or ankerite) that do not contribute to alkalinity. In terms of NNP the rock types were ranked 3>5>4>7>1>2. The average NP:AP values ranged from 0.13 to 2.37 indicating that the waste rock at the site is possibly acid generating at best.

The overall acid generation potential for all waste rock was calculated as a weighted average. Approximately 2,000,000 tonnes of waste rock is expected to be produced at the site, although only 150,000 tonnes of this material will be brought to surface and ultimately deposited in the tailings impoundment. Using the estimated percentages of each waste rock type and average values for sulphide-S and carbonate NP (see Table 1) a weighted overall average for net neutralizing potential (NNP) and the NP:AP ratio was calculated for each rock type. The overall NNP was -29.2 kg CaCO₃ / tonne and NP:AP ratio 0.67 indicating that the overall acid generation potential exceeds the neutralization potential. Consequently, there is insufficient NP overall to neutralize the AP generated from the waste rock at the Wolverine Site.

Table 4.1 Average ABA parameters for all Rock Types and a weighed average for all waste rock at the Wolverine site.

Rock Type	Percentage of Deposit	Average Sulphide-S (%)	Average AP	Average Carb-NP (kg CaCO ₃ /tonne)	Calculated NNP	Calculated NP:AP
1	32%	1.73	53.9	33.5	-20.4	0.62
2	17%	8.78	274.3	35.0	-239.3	0.13
3	6%	3.96	123.9	286.8	162.9	2.32
4	10%	1.45	45.3	74.2	28.9	1.64
5	18%	0.98	30.5	72.3	41.9	2.37
7	18%	1.61	50.4	35.9	-14.5	0.71
Weighted Average	99%	2.83	88.5	59.36	-29.2	0.67

4.3 Elemental Content

The concentrations of Ag, Sb, As, Cd, Cu, Mo, Pb, Zn and Se were higher by at least one order of magnitude, compared to average crustal abundances. The concentrations of all other elements of interest (Ba, B, Cr, Co, V, Ni, Sn, and Hg) were generally similar to, or lower, than average crustal abundance values

4.4 Metal Leaching

The concentrations for the elements of interest in extracts from the shake flask extraction tests provide an index for the solubility and release of elements, in this case, during initial stages of weathering. It should be noted that all measured concentrations for As, Cu, Pb, Ni and Zn were much lower than the Metal Mining Effluent Regulation (MMER) concentrations for discharge established under the Fisheries Act.

The concentration of elements in the solutions extracted from the rock samples were also compared directly to CCME guidelines (Canadian Council of Ministers of Environment - CCME, 2003) for fresh water to be protective of aquatic life. Although these results cannot be directly compared to the CCME values, the exercise provides an indication of the magnitude of release of elements from rock when compared to expected guidelines for fresh water. The concentrations of As, Zn, Mo, Cr, Ni and Hg in the extracts were below CCME guidelines for fresh water. The concentrations of Ag and Al in several samples exceeded CCME guidelines for fresh water. The concentrations of Cd, Cu, Pb and Se in extracts from most samples exceeded CCME guidelines for fresh water, however values were typically within the same order of magnitude as the guidelines with the exception of Se. The concentration of Se in the extracts exceeded the CCME guideline of 0.001 mg/L by up to 100 times. However, given the small amount of waste rock to be deposited in the tailings impoundment it is not anticipated that the solute load from the waste rock would be sufficient to detrimentally affect the tailings pond water quality given the generally much higher concentrations seen in the tailings supernatant and tailings aging test results.

4.5 Summary of Static Testing Findings

Based on the analytical results presented above, the major findings of this work are as follows:

- Acid generation potentials differed between the six assigned rock types ranging from net acid generating to net non-acid generating;
- The highest content of sulphide was observed in the carbonaceous argillite (Rock Type 2) samples which averaged 8.78% sulphide;
- Sobek-NP exceeded carbonate-NP for all rock types except type 4 (iron formation and silica-pyrite exhalite) suggesting that the iron formation / silica-pyrite exhalite rocks contain some iron-rich carbonates (e.g. siderite and/or ankerite) that do not contribute to alkalinity;
- Average NP:AP ratios ranged from 0.13 to 2.37 indicating that the waste rock at the site is acid generating to possibly acid generating at best;

- The weighted NNP was -29.2 kg CaCO₃ / tonne and NP:AP ratio was 0.67 indicating that acidification potential exceeds the neutralization potential when all rock at the site is considered. Consequently, there is insufficient NP within the proposed mine rock to neutralize the expected AP from the waste rock at the Wolverine Site;
- The average total concentrations of Ag, Sb, As, Cd, Cu, Mo, Pb, Zn and Se in the rock samples were higher by at least one order of magnitude, compared to average crustal abundances;
- The average concentration of Al, Fe, Ca, Mg, Na, K P and Ti were less than average crustal abundances;
- The concentrations of S in all Rock Types exceeded background concentrations;
- All measured concentrations for As, Cu, Pb, Ni and Zn in shake flask extracts were much lower than the Metal Mining Effluent Regulation (MMER) concentrations;
- The concentrations of As, Zn, Mo Cr Ni and Hg in the shake flask extracts were below CCME guidelines for fresh water; and,
- The concentrations of Cd, Cu, Pb and Se in extracts from most samples exceeded CCME guidelines for fresh water.

4.6 Kinetic Testing Program

A kinetic testing program for mine rock using humidity cells was initiated by AMEC in December 2005. Thirteen humidity cells of mine rock samples are currently in operation. In general, two samples were selected from each rock type. One sample was selected to best represent the median characteristics of the rock type, whereas the second sample was selected to best represent the 'worst case' characteristics. The objectives of the program are to determine the weathering characteristics of the six mine rock types, including rates of sulphide oxidation, neutralization potential consumption, and metal release. These rate determinations will be used to help estimate the time to sulphide and NP exhaustion and the resulting future geochemical conditions of the mine rock. Metal release rates from the cells will also be used to estimate water quality of the flooded mine at Closure.

The design and operation of the cells follows the methods described in the Draft BC ARD Guidelines (Price 1997). These cells will be operated indefinitely until stable leaching rates are observed. The shutdown of each cell will include the closedown procedure described in the Draft BC ARD Guidelines (Price 1997).

Leachates from the humidity cells will be analyzed weekly for pH, sulphate, conductivity, acidity, alkalinity and metals, including low level selenium and mercury.

REFERENCES

- AMEC, 2006. Acid Rock Drainage and Metal Leaching Assessment of Waste Rock and the Underground Workings, Appendix E.
- DeVos, K., Barone, F., Hall, G., Brown, D. 2000. Management of Water Quality in a Flooded Tailings Impoundment, Proceedings from the Fifth International Conference on Acid Rock Drainage, Volume 2, ICARD, 2000.
- Gartner Lee Ltd., 2004. Wolverine Project Description Report. Prepared for Expatriate Resources, Reference GLL 40-755, November 2004.
- INRS-Eau, 2001. MEND Project 2.12.1c Subaqueous Disposal of Reactive Mine Tailings Louvicourt Mine Test Cells Geochemical Sampling and Analysis. Sponsored by Aur Resources Inc, Noranda Inc, Teck Corporation, le Ministere des Ressources Naturelles de Quebec, and CAMNET.
- Klohn Crippen, 1994. Izok Project Waste Management Report - Izok Lake Option. Prepared for Metal Mining Corp.
- Li, H., Catalan, L., and St-Germain, P. 2000. Rates of Oxidation Consumption by Sulphidic Tailings Under Shallow Water Covers – Field Measurement and Modelling, Proceedings from the Fifth International Conference on Acid Rock Drainage, Volume 2, ICARD, 2000.
- Lorax Environmental, 2000. Tambo Grande Project Characterisation of ARD Potential in Waste Rock – Static Testing Results. Prepared for Manhattan Sechura Compania Minera S.A.
- Lorax Environmental, 2001. Tambo Grande Project Characterisation of ARD Potential in Waste Rock and Tailings – Kinetic Test Results. Prepared for Manhattan Sechura Compania Minera S.A.
- Martin, A., McNee, J., Pedersen, T. 2000. The Reactivity of Sulphur-Rich Sediments in Lake Junin, Peru: The Importance of Permanent Submergence. Proceedings from the Fifth International Conference on Acid Rock Drainage, Volume 1, ICARD, 2000.
- MDAG, 2005. International Kinetic Database Version 16.
- Mine Environment Neutral Drainage (MEND), 2000. Acid Rock Drainage Predication Manual A Manual for Chemical Evaluation Procedures for the Prediction of Acid Generation in Mine Wastes in MEND Reports 1988-2000 CD Rom. Prepared by Coastech Research Inc., March 1991.

Morin K., Hutt, N. 1997, Environmental Geochemistry of Minesite Drainage Practical Theory and Case Studies. MDAG Publishing.

Morin, Kevin A. and Hutt, Nora M., 1997. Environmental Geochemistry of Minesite Drainage, Practical Theory and Case Studies. MDAG Publishing, Vancouver, BC, Canada.

Morin, Kevin, personal communication. May 19, 2005.

Price, William A., 1997. DRAFT Guidelines and Recommended Methods for the Prediction of Metal Leaching and Acid Rock Drainage at Minesites in British Columbia. Ministry of Employment and Investment, Energy and Mines Division, 159 pp.

Province of British Columbia, 2001. British Columbia Approved Water Quality Guidelines (Criteria). Ministry of Water Land and Air Protection, August 24, 2001.

Raudsepp, M. and Pani, E, 2002. The crystal structure of cabalthurite, $\text{Co}^{2+}\text{Fe}_2^{3+}(\text{AsO}_4)_2(\text{OH})_2 \cdot 4\text{H}_2\text{O}$: a Rietveld refinement. Canadian Mineralogist, 40: pp. 733-737.

Raudsepp, M. and Pani, E, 2003. Application of Rietveld Analysis to Environmental Mineralogy. In: Environmental Aspects of Mine Wastes, Mineralogical Association of Canada, Short Course Series, Volume 31 (J.L. Jambor, D.W. Blowes & A.I.M. Ritchie, eds), Chapter 8, p. 165-180.

Rescan Environmental Services Ltd, 1990. MEND Project 2.11.1b-c Geochemical Assessment of Subaqueous Tailings Disposal in Mandy Lake, Flin Flon Area, Manitoba. Sponsored by British Columbia Ministry of Energy, Mines and Petroleum Resources, CAMNET, Environment Canada, and Hudson Bay Mining and Smelting Company.

Rescan Environmental Services Ltd, 1992. MEND Project 2.11.1c-b Chemical Diagnosis of Submerged Mine Tailings in Benson Lake and Natural Sediments in Keogh Lake, Vancouver Island, British Columbia. Sponsored by Placer Dome Inc and CAMNET.

Rescan Environmental Services Ltd, 1995. MEND Project 2.11.4a Geochemical Assessment of Subaqueous Tailings Disposal in Buttle Lake, British Columbia, 1993 Study Program. Sponsored by Environment Canada, and Hudson Bay Mining and Smelting Company, and Placer Dome Inc.

Rescan Environmental Services Ltd, 1996a. MEND Project 2.11.3abc Geochemical Assessment of Subaqueous Tailings Disposal in Anderson Lake, Manitoba, 1993 to

1995 Study Program. Sponsored by Environment Canada, Hudson Bay Mining and Smelting Company, Manitoba Energy and Mines, and CAMNET.

Rescan Environmental Services Ltd, 1996b. MEND Project 2.11.5c Geochemical Assessment of the Equity Silver Tailings Pond. Sponsored by Placer Dome Inc and CAMNET.

Snoeyink, V.L., and D. Jenkins, "Water Chemistry", John Wiley and Sons, Inc., New York, 1980

Sobek et al, 1978. Field and Laboratory Methods Applicable to Overburdens and Minesoils. Report EPA-600/2-78-054, U.S. Technical Information Report PB-280 495.

Stumm, W., and J.J. Morgan, "Aquatic Chemistry: An Introduction Emphasizing Chemical Equilibria in Natural Waters 2nd Ed.", John Wiley and Sons, Inc., New York, 1981

T.W. Higgs Associates Ltd, 1993. Eskay Creek Project Acid Generation Characteristics of Waste Rock and Ore. Prepared for Homestake Canada Inc (1993).