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OSISKO
HAMMOND REEF GOLD

HAMMOND REEF GOLD PROJECT

Geochemistry, Geology and Soils Technical Support Document

VERSION 2

Submitted to:
Osisko Hammond Reef Gold Ltd.
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PART A

Introduction

Version 1 of the Geochemistry, Geology and Soils Technical Support Document (TSD) was published on February 15, 2013 as part of Osisko Hammond Reef Gold's (OHRG) Draft Environmental Impact Statement/Environmental Assessment (EIS/EA) Report.

The Draft EIS/EA Report underwent a seven-week public review comment period after which, on April 5, 2013, OHRG received comments from the public, Aboriginal groups and the Government Review Team (GRT) seeking clarification and requesting new information.

Approximately 20 comments regarding the Geochemistry, Geology and Soils TSD and components of the EIS/EA Report were received from the GRT. Written responses were prepared for each comment and are provided in Appendix 1.IV of the EIS/EA Report.

Version 1 of the Geochemistry, Geology and Soils TSD has not been revised. The methods used to define baseline conditions and predict the potential effects of the Project are technically defensible and based on standard industry practices. The conclusions and results presented in the Geochemistry, Geology and Soils TSD are sound and have remained the same after consideration of comments received.

The EIS/EA Report has been revised and updated based on comments received. Version 2 of the Geochemistry, Geology and Soils TSD is comprised of the following:

- Part A: Introduction
- Part B: Supplemental Information Package (attached) that provides additional detail on new work undertaken related to the Geochemistry, Geology and Soils component and the information presented in the Geochemistry, Geology and Soils TSD.
- Part C: Version 1 of the Geochemistry, Geology and Soils TSD. Part C was issued in February 2013, and is available online on OHRG's website; it has not been re-printed as part of this Version 2 of the Geochemistry, Geology and Soils TSD. The Version 1 document should be reviewed within the context of this Version 2 document, and associated updated information as presented in Part A or Part B should be considered as correct should it differ from the information presented in Version 1.

A summary of the information found in Part B is provided below. Throughout the EIS/EA Report, unless otherwise noted, all references made to the Geochemistry, Geology and Soils TSD are to Part C.

Part B: Supplemental Information

Several information requests from the Ontario Ministry of Environment and Environment Canada requested that more detail and information be provided on several aspects of the geochemical assessment. In response to these Information Requests, additional information was assembled and has been provided in the attached Supplemental Information Package. The table below provides a summary of the additional information requested and the corresponding document provided in the Supplemental Information Package.

Additional Information Requested	Location of Information in the Supplemental Information Package
Geochemical and mineralogical characterization of the tailings	Response to Information Request EC-21

Additional Information Requested	Location of Information in the Supplemental Information Package
Representativeness of the composite tailings sample	Letter entitled "*Geochemical Sample Representation*" (in response to MOE-GW-02)
Results from geochemical testing performed on the ore	Response to Information Request MOE-GW-03
Potential for elevated chromium concentrations based on NAG test results	Response to Information Request MOE-GW-04
Geochemical characterization of the overburden	Response to Information Request EC-29 and Attachment *Geochemical Analytical Program* – results from overburden testing

Supplemental Information Provided in Part B

- Response to Information Request EC-21
- Letter: Geochemical Sample Representation, Hammond Reef Gold Project (Rev 0, November 21, 2013)
- Response to Information Request MOE-GW-03
- Response to Information Request MOE-GW-04
- Response to Information Request EC-29
- Letter: Geochemical Analytical Program, Hammond Reef Gold Project (Rev 0, December 4, 2013)

PART B

Supplemental Information Package

INFORMATION REQUEST – EC-21

Source: Environment Canada

Summary of Comment

The Proponent's geochemical characterization of tailings is based on only one (1) tailings sample, which was produced as an aggregate of many samples of the ore. Given the volume of tailings (231 Mt) that would be generated from the processing of the ore, this is not an adequate coverage of the number of tailings samples.

The Proponent has not undertaken or provided the mineralogical information on the tailings samples.

In the EIS Guideline in Section 10.2.3.2 and in Section 9.1.1 Geology and Geochemistry it is specified the Proponent will provide:

- representative lithologic descriptions including age, colour, grain size, mineralogy, physical strength, hardness, weathering characteristics, depositional setting and correlations; and
- estimates of the potential for mined materials (including waste rock, tailings and low grade ore) to be sources of ARD or ML.

Potential Environmental Effects

It is important to properly undertake the geochemical characterization of all waste materials that would be generated by a mine. This characterization is critical to understanding the potential impacts that these waste materials can have on water quality, and the mitigation measures that would need to be implemented to prevent such impacts from occurring. This information is necessary to determine the significance of effects on the environment of the proposed tailings disposal option.

Proposed Action

Provide a complete geochemical and mineralogical characterization of the tailings which:

- Consider more samples of the tailings as representative of the total volume of tailings that would be generated, following the MEND (2009) guidelines;
- Consider both pre samples as well as post-metallurgical test samples for geochemical characterization;
- Consider both individual samples as well as composites of samples and run them for the geochemical characterization.
- Describe the mineral phases present in the tailings;
- Describe the abundance of the mineral phases present in the tailings; and
- Indicate the relative proportion of sulphide and carbonate mineral phases in the tailings.

Reference to EIS

Geochemistry, Geology and Soil TSD 3.3.1.2 Tailings, page 28

Response

Tailings are composed of the rock types described in the Geochemistry, Geology and Soils TSD as further discussed in a letter to Osisko in response to MOE-NR-GW-02, which can be found in the Supplemental Information package of the Geochemistry, Geology and Soil TSD. Only gold is removed in the process, thus the tailings and rock are essentially the same. For all rock types expected to be encountered in the tailings ample information is provided with respect to that as indicated in the EIS Guideline in Section 10.2.3.2 and in Section 9.1.1 Geology and Geochemistry:

- Representative lithologic descriptions (Section 2.0 of the Geochemistry, Geology and Soils TSD) – these are the same as those of the waste and ore.
- Age – (Geological age range is provided in Section 2.0 of the Geochemistry, Geology and Soils TSD) – the age of the minerals is the same as that of the ore.
- Colour – provided in geochemical sample descriptions (Appendix A of the Geochemistry, Geology and Soils TSD) – the colour of the minerals will be the same as those of the host rocks.
- Grain size – not relevant for bedrock – provided for tailings in Geochemistry, Geology and Soils TSD Appendix 2.VI, Attachment 2.VI.1 “Final Data Report: Tailings Mineralogy, Geochemistry and Grain Size – Hammond Reef Gold Project – April 2012”.
- Mineralogy – provided in Appendix 2.IV of Geochemistry, Geology and Soils TSD.
- Physical strength, hardness, and weathering characteristics – these factors are more relevant for engineering design and for geochemical conditions when evaluating mines in tropical regions, or sedimentary deposits and are generally noted only when the lack of physical strength may lead to geochemical implications for the deposit. For the rock types encountered in this deposit Bedrock types of the Canadian shield such as the tonalities, granites and altered granites found within this deposit the rocks are typically indurate and do not rapidly weather. The hardness of the rock types encountered is typically between about 5 and 7 on the Mohs scale, however the hardness of individual mineral grains within the rock type will vary.
- Depositional setting and correlations – this is provided in Section 2.0 of the Geochemistry, Geology and Soils TSD.
- Estimates of the potential for mined materials (including waste rock, tailings and low grade ore) to be sources of ARD or ML – these are provided in the Geochemistry, Geology and Soils TSD, and in the Supplemental Information Package of the Geochemistry, Geology and Soil TSD. To summarize, the waste rock, tailings, low grade ore, and open pit walls are expected to be non-acid generating with excess neutralizing capacity for all rock types and lithologies encountered on site. Metal leaching potential is expected to be low as indicated in the Geochemistry, Geology and Soils TSD, and as evaluated for the site conditions and project description in the Site Water Quality TSD.

The questions presented in this information request are further addressed as follows:

Q: “Consider more samples of the tailings as representative of the total volume of tailings that would be generated, following the MEND (2009) guidelines;”

A: The tailings sample was generated from a set of ten variable Metallurgical (Met) samples each of which was tested individually, the results of which are provided in the Supplemental Information Package of the Geochemistry, Geology and Soil TSD. The ABA results show that regardless of the location within the deposit, the sulphide-sulphur contents of the samples were generally low, ranging from 0.09 to 0.35 wt% as S. The CaNPR values ranged from 5.8 to 62 t $CaCO_3$/1,000 t. Each of the individual samples, as well as the composite sample, are classified as non-acid generating with excess neutralization potential according to the MEND (2009) and AMIRA (2002) guidelines. It should be noted that at this stage of the project there is very little actual tailings available for testing. As stated in MEND (2009), Section 8.2 “Prior to mining, the choice of material to sample is often restricted to drill core and to metallurgical testing for tailings”; and , “Limitations in the availability and accessibility of materials to be sampled need to be considered in the design of a sampling program”.

Q: Consider both pre samples as well as post-metallurgical test samples for geochemical characterization;

A: These have been considered. Gold makes up very little of the overall rock (less than 1 g/t or 1 part per million), therefore the post-metallurgical tailings samples and the pre-metallurgical tailings samples are expected to be essentially the same, although the post metallurgical samples are expected to be more homogeneous. Additional discussion regarding sample representativeness and processing is provided in the Supplemental Information Package of the Geochemistry, Geology and Soil TSD. It is expected that during operations additional geochemical monitoring of post-metallurgical tailings will be conducted.

Q: Consider both individual samples as well as composites of samples and run them for the geochemical characterization.

A: This has been considered. In addition to the metallurgical samples, several of the waste rock samples contained some higher grade material that could be considered ore if it occurred in closer proximity to larger ore zones. These samples were tested and were sampled from the drillholes BR-165; BR-167; BR-164, BR-166 and BR-169. Table 1 presents these waste rock sample IDs. The results from these samples are included in Appendix 2.III of the Geochemistry, Geology and Soils TSD and are similar to the overall waste rock and tailings results.

Table 1: Comparison of ABA and NAG Test Results for Higher Grade Waste Rock, Tailings and Overall Waste Rock Samples.

Samples		Sulphur Species (wt %)			Carbonate (wt %)	Potentials (t $CaCO_3$/1,000t)			NPR[(a)] (ratio)	CaNPR[(a)] (ratio)	NAG[(a)] pH (s.u.)
		Total	Sulphate	Sulphide		NP[(a)]	AP[(a)]	CaNP[(a)]			
Higher Grade Waste Rock Samples											
Drill Hole ID	**Sample ID**										
BR-164	2010-HR-103	0.019	0.02	< 0.01	2.67	49.9	0.31	44	161	143	10.95
BR-165	2010-HR-014	0.009	< 0.01	< 0.01	0.539	15.8	0.31	9	51	29	8.01
	2010-HR-016	0.022	< 0.01	0.02	1.01	27	0.62	17	43.5	27	8.73
	2010-HR-021	0.124	0.02	0.11	1.36	33.3	3.33	23	10	6.8	10.75
BR-166	2010-HR-093	0.03	0.03	< 0.01	3.18	49.7	0.31	53	160	170	10.57
	2010-HR-096	0.012	0.01	< 0.01	2.41	45.5	0.31	40	147	129	10.95
BR-167	2010-HR-072	0.005	< 0.01	< 0.01	2.30	44.7	0.31	38	144	123	11.2
	2010-HR-073	0.005	< 0.01	< 0.01	0.574	15	0.31	10	48.4	31	8.3
BR-169	2010-HR-077	0.114	0.05	0.07	2.16	44	2.19	36	20.1	16	11.01
Tailings Sample											
SGS Lakefield		0.175	0.08	0.09	4.84	76.6	2.85	80	27	28	11.14
Overall Waste Rock Samples - Average by Lithology											
Fine Grained Granite (n = 16)		0.03	0.02	0.02	4.3	75	0.59	72	143	127	11
Chloritic Granite (n = 31)		0.04	0.02	0.02	2.9	54	0.76	48	135	120	11
Tonalite (n = 30)		0.04	0.02	0.03	1.5	33	0.93	24	76	55	10
Altered Granitoid (n = 8)		0.04	0.03	0.01	2.5	45	0.43	41	120	112	10
Pegmatite (n = 11)		0.04	0.02	0.03	2.1	41	0.79	35	71	55	10
Mafic Dyke (n = 9)		0.06	0.04	0.03	6.3	116	0.93	105	228	209	11
Chloritic Granite Porphyry (n = 5)		0.05	0.03	0.02	5.4	91	0.67	90	195	196	11
Minor Units (n = 13)		0.06	0.02	0.05	3.4	62	1.4	56	189	173	10

Notes:

(a) NP = neutralization potential; AP = acid potential; CaNP = carbonate neutralization potential; NPR = neutralization potential ratio; and CaNPR = carbonate neutralization potential ratio; and NAG = net acid generation.

Q: Describe the mineral phases present in the tailings; Describe the abundance of the mineral phases present in the tailings.

A: The mineral phases present in the tailings are the same as those of the waste rock and ore and are described in detail in Section 2.0 of the Geochemistry, Geology and Soils TSD. Additional information on the mineralogy of the tailings specifically including abundances is provided in Geochemistry, Geology and Soils TSD Appendix 2.VI, Attachment 2.VI.1 "Final Data Report: Tailings Mineralogy, Geochemistry and Grain Size – Hammond Reef Gold Project – April 2012".

Q: Indicate the relative proportion of sulphide and carbonate mineral phases in the tailings.

A: This is provided in the Supplemental Information Package of the Geochemistry, Geology and Soil TSD, including the range present in the metallurgical samples, and combined composite sample.

References

AMIRA (AMIRA International Ltd.). 2002. *ARD Test Handbook – Prediction and Kinetic Control of Acid Mine Drainage*. Environmental Geochemistry International Pty. Ltd. and Ian Wark Institute, University of South Australia.

MEND (Mine Environment Neutral Drainage). 2009. Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials. MEND Report 1.20.1. Mining Environment Neutral Drainage Program, Natural Resources Canada. December 2009.

November 21, 2013

Project No. 13-1118-0010

DOC No. : 006 (REV 0)

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RE: GEOCHEMICAL SAMPLE REPRESENTATION, HAMMOND REEF PROJECT

Dear Ms. Drapack

This letter provides information related to the representativeness of ore, tailings and waste rock samples, and testing procedures used on the tailings and waste rock samples. Additional information is provided in the Geochemistry Geology and Soils TSD, and is expected to be presented in the feasibility study for the project, when released. Excerpts from metallurgical and geological reports that will be referenced or become part of the feasibility study, and a summary of the geochemical testing program that was performed on the waste rock and tailings generated by Osisko (SGS Lakefield and Ounpuu) for the Osisko Hammond Reef Gold (OHRG) Project are provided.

Given that only gold will be removed from the mined ore, the tailings will be reflective of the blended ore. Blending of the ore will be required to provide a consistent “head grade” to the mill for processing, hence the tailings are expected to be relatively homogeneous in nature. The tailings composite sample as tested represents the best estimate of the overall tailings composition; however, results from additional sample testing which help define the variability of the deposit, and which have been used to develop the overall tailings composite sample are provided herein.

Gold Emplacement and Geological Makeup of Overall Deposit, Ore and Waste Zones

To understand if the tailings are representative, it is first necessary to have knowledge of the deposit geology, and rock types of tailings and waste materials. This information is typically made available in the feasibility study for the project, however given that the feasibility study has not yet been released at the time of writing this letter, some relevant portions are provided herein.

The deposit rock, waste rock, and tailings distribution by percentage rock type is presented in Table 1. The dominant rock types are tonalite, chloritic granite, and altered granite.

Table 1: Rock Type Distribution for Deposit, Waste Rock and Tailings.

Rock Type[a]	Rock Distribution (%)			
	Deposit[b]		Waste Rock samples[c]	Tailings Composite sample[d]
	West Pit	East Pit		
Chloritic Granite (n = 31)	14%	19%	25%	5%
Tonalite (n = 30)	28%	6%	24%	10%
Fine Grained Granite (n = 16)	16%	16%	14%	-
Pegmatite (n = 11)	12%	9%	9%	35%
Mafic Dyke (n = 9)	3%	6%	7%	5%
Altered Granitoid (n = 8)	8%	19%	6%	35%
Chloritic Granite Porphyry (n = 5)	8%	13%	4%	-
Minor Units[e] (n = 13)	11%	12%	11%	10%

Notes:
"-" dash indicates that the Tailings Composite sample does not contain the specified rock type.
(a) Rock type includes the total sample number for waste rock samples (indicated by "n=") for each lithology type.(b) Results will be presented in the pending 2013 Feasibility Study Report.
(c) Results presented in the Geochemistry, Geology and Soils TSD.
(d) Estimated based on Mike Ounpuu, *personal communication*, April 20, 2012.
(e) Includes aplite, diorite, gneiss, sheared mafic unit, sheared granitoid, tectonized-sheared vein zone, quartz vein zone, sericite schist, chlorite schist, ankeritized dyke and intermediate dyke.

Gold was introduced into the Hammond Reef Deposit probably during the late Archean (Neoarchean) hydrothermal or metamorphic episode, along with pyrite and accessory sulfides and tellurides (Geochemistry, Geology and Soils TSD). The gold occurs within the mineralized zone as free grains on mineral surfaces concentrated along micro-fractures and quartz veins within the altered granitic rock. The boundary of the ore zone is defined by grade which roughly corresponds to the degree of brecciation and quartz stockwork veining within the altered granitoid (Hydrogeology TSD). The association of gold with fracture infilling has resulted in the overall deposit rock types being the same in either ore zones or waste zones; however, ore zones are differentiated by slightly more fracturing resulting in the occurrence of more sulphide and gold.

Where mineralization occurs, the ore (and tailings) is predominantly composed of quartz with lesser percentages of chlorite, calcite and sericite with less than about 0.3% pyrite by weight with trace amounts of galena, chalcopyrite, sphalerite, pyrrhotite, bornite, chalcocite and native gold. Telluride, strometerite and molybedenite have also been identified. Neutralizing minerals include carbonate ranging from 2.6 to 20% overall. The veins and stockwork are generally composed of quartz, carbonate (ankerite-calcite), chlorite and sulfides. The aluminosilicate mineral potassium feldspar is a component of the tonalite that will occur in the pit faces and the waste rock (Geochemistry, Geology and Soils TSD).

As can be observed in Table 1, the same lithologies and rock types are represented and occur within the overall deposit, waste rock samples, and tailings composite sample. Of note is that the ore zone is expected to contain slightly higher amounts of pegmatite and altered granite relative to the waste materials which is consistent with expectations due to gold emplacement mechanisms in these units; however, samples from all rock types and alterations are represented within the data set for waste rock. With regard to the tailings, the metallurgical composite sample primary rock types are considered reasonable for use in evaluating deposit variability, and for preparation of the tailings composite sample.

Tailings and Ore Sample Representativeness

In 2009, ten (10) individual drillhole composite samples (BR-2, BR-13, BR-23, BR-28, BR-64, BR-67, BR-68, BR-87, BR-88 and BR-102) were collected from various locations in the deposit (Brett, 2009). Several composite samples (A-Zone, 41-Zone, Master, LG A-Zone Variability, HG A-Zone Variability and EHG Variability composites) were created from these 10 drillhole composites in the following manner:

- The A-Zone composite was created from six drillhole composites from the following drill holes: BR-28, BR-64, BR-68, BR-87, BR-88 and BR-102;
- The 41-Zone composite was created from three drillhole composites from the following drill holes: BR-02, BR-13 and BR-23;
- The Master composite (2009) sample was created from 78% A-Zone composite and 22% 41-Zone composite. LG (low grade) A-Zone Variability Composite was created from drillhole composites BR-28, BR-87 and BR-102;
- HG (high grade) A-Zone Variability Composite was created from drillhole composites BR-64, BR-68 and BR-88; and
- EHG (extreme high grade) Variability Composite was created from drillhole composites BR-13, BR-23, BR-28, BR-64, BR-68, BR-87 and BR-102.

Acid base accounting (ABA) and net acid generation (NAG) testwork was carried out at the SGS analytical laboratory in Lakefield, Ontario (SGS) on 9 of the 10 individual drill hole composites (BR-2, BR-13, BR-23, BR-28, BR-64, BR-67, BR-87, BR-88 and BR-102) as well as the Master Composite, LG A-Zone Variability Composite, HG A-Zone Variability Composite and the EHG Variability Composite samples.

The methodology performed on the samples included a modified Sobek method (Sobek et al. 1978) that comprised of analysis for paste pH, sulphur species, acid potential (AP), neutralization potential (NP) and carbon species (total carbon, carbonate content and organic carbon content). The NAG testing was performed as per AMIRA (2002) and Miller et al. (1997). Further details on the ABA and NAG test methods are included in the "Geochemical Characterization" section below. Carbonate NP was calculated as per MEND (2009). Acid generation potential is commonly interpreted according to the ratio of NP to AP, referred to as the neutralization potential ratio (NPR), and the ratio CaNP to AP, referred to as the carbonate neutralization potential ratio (CaNPR) as per the guidelines recommended by Mine Environment Neutral Drainage (MEND) (2009) (see Table 2).

Table 2: Acid Generation Potential Criteria

Acid Generation Potential	Criteria	Comments
Potentially Acid Generating	NPR/CaNPR < 1	Potentially acid generating unless sulphide minerals are non-reactive.
Uncertain	NPR/CaNPR < 2	Possibly acid generating if NP is insufficiently reactive or is depleted at a rate faster than sulphides.
Non-Acid Generating	2 < NPR/CaNPR	Not expected to generate acidity.

Table 3 provides a detailed description of proportion and lithology of the individual samples and the composite samples as well as the results and interpretation of the geochemical characterization tests.

The ABA and NAG results show that regardless of the location within the deposit, the sulphide-sulphur contents of the samples were generally low, ranging from 0.09 to 0.42 wt% as S. The CaNPR values ranged from 4.2 to 24.6 t CaCO3/1000 t. Each of the individual samples, as well as the composite sample, are classified as non-acid generating with excess neutralization potential according to the MEND (2009) and AMIRA (2002) guidelines.

Table 3: Location, Lithology, Acid Base Accounting and Net Acid Generation Test Results for 2009 Ore and Composite Samples

Parameter	Collar location				From (m)	To (m)	Lithology ID[c]	Acid Base Accounting											Net Acid Generation Testing
	Zone	Section	Easting	Northing				Paste pH	NP[d]	AP[d]	NPR[d]	CaNPR[d]	Total Sulphur	Sulphate	Sulphide	Total Carbon	Carbonate	Carbonate NP	Final NAG-pH
								s.u.	t CaCO3/1000 t	t CaCO3/1000 t	ratio	ratio	%	%	%	%	%	%	s.u.
Drill Hole Composites																			
BR-2	41	3470E	613783.11	5422056.3	145	191	11, 20, 50	9.31	73.2	5.43	**13.5**	**14.0**	0.16	< 0.01	0.17	1.02	4.55	75.8	10.8
BR-13	41	3370E	613613.95	5422128.9	40.5	126	20, 32, 33, 34	9.23	70.4	6.59	**10.7**	**10.7**	0.33	0.12	0.21	0.98	4.23	70.5	10.1
BR-23	41	3270E	613543.79	5422052.9	63	139.5	20, 33, 40, 60	9.23	102	4.51	**22.6**	**24.2**	0.26	0.12	0.14	1.47	6.56	109.4	10.1
BR-28	A	1820E	612237.07	5421397.1	21.5	102.5	20, 33, 34, 40	9.15	51.2	4.41	**11.6**	**11.8**	0.26	0.11	0.14	0.72	3.11	51.8	10.1
BR-64	A	1670E	612220.71	5421160.8	91.5	292.5	11, 15, 20, 32, 40	9.29	59.8	6.42	**9.3**	**8.8**	0.35	0.14	0.21	0.84	3.40	56.7	10.6
BR-67	A	1670E	611838.62	5420825.7	NR	NR	NR	9.36	71.3	5.27	**13.5**	**13.1**	0.43	0.26	0.17	0.96	4.13	68.8	10.9
BR-68 [a]	A	1800E	612374.18	5421187.2	141	256.5	13, 15, 40	-	-	-	**-**	**-**	-	-	-	-	-	-	-
BR-87	A	1420E	611912.97	5421162.9	3.74	88.5	12, 15, 20	9.37	46.9	3.23	**14.5**	**13.8**	0.35	0.25	0.1	0.60	2.67	44.5	10.9
BR-88	A	1420E	611985.14	5421059.7	160.5	252	20	9.6	37.8	4.68	**8.1**	**7.6**	0.37	0.22	0.15	0.50	2.13	35.5	10.3
BR-102	A	1670E	612149.06	5421258	6.52	213	20, 33, 40	9.47	53	4.71	**11.3**	**10.9**	0.26	0.11	0.15	0.70	3.08	51.3	10.9
Zone Composites																			
A-Zone [b]	A	---	---	---	---	---	---	9.12	57.7	5.09	**11.3**	**11.3**	0.31	0.14	0.16	0.85	3.46	57.7	10.3
41-Zone [b]	41	---	---	---	---	---	---	9.39	85.2	3.54	**24.0**	**24.6**	0.39	0.28	0.11	1.17	5.22	87.0	9.8
Master Composite[b]	A and 41	---	---	---	---	---	---	9.32	66.3	7.8	**8.5**	**7.4**	0.31	0.1	0.3	0.93	3.5	57.8	10.6
Grade Composites																			
LG A-Zone [b]	A	---	---	---	---	---	---	9.05	55.9	2.83	**19.7**	**18.8**	0.19	0.1	0.09	0.75	3.19	53.2	10.5
HG A-Zone [b]	A	---	---	---	---	---	---	9.31	54.8	7.22	**7.6**	**7.0**	0.45	0.22	0.23	0.74	3.05	50.8	10.2
EHG[b]	41	---	---	---	---	---	---	9.07	71.2	13.00	**5.5**	**4.2**	0.80	0.38	0.42	1.02	3.26	54.3	9.3

Notes:

0.1 - Non-Potentially Acid Generating (Non- PAG), according to MEND (2009) guidelines.

(a) Acid base accounting (ABA) and net acid generation (NAG) testing were not conducted on the drill composite sample BR-68.
(b) See text for details of sample composition for the composite samples.
(c) Description of the lithology ID codes is as follows: 11- fine grained granite; 12- contaminated granite; 15 - chloritic granite porphyry; 20 - altered granitoid; 32- sheared granitoid; 33 - chlorite schist; 34 - tectonized-sheared vein zone/brecciated pegmatite; 40 - pegmatite; 50 - mafic dyke; 60 - intermediate dyke.
(d) NP = neutralization potential; AP = acid potential; NPR = neutralization potential ratio; and CaNPR = carbonate neutralization potential ratio.
A dash "-" indicates that no data was reported. A triple dash "---" indicates that the data is presented in the Brett Resources Inc., 2009. An investigation of gold recovery from Hammond Reef Project samples, Project 11734-002 – Final Report. "NR" indicates that no information was recorded.

In 2011, a tailings composite sample was created from 10 Metallurgical (Met) Composite samples, obtained from across the ore deposit and selected based on the type and degree of alteration, which is correlated to the expected ore composition as determined from the overall deposit assay database (to be described as part of the feasibility study report) (Ounpuu, 2011). The samples were selected to evaluate variability within the deposit, which would then be used to provide an expected head grade sample based on the relative proportions of the materials expected to be milled and processed. The combined sample provides the expected tailings that are to be deposited at the site (Geochemistry, Geology and Soils TSD). Partial ABA testing was carried out on all ten samples at SGS which included the reporting of sulfide sulfur (%), carbon dioxide (%). The acid potential (AP), carbonate neutralization potential (CaNP) and CaNP ratio to AP (CaNPR) were calculated based on this information. Table 4 provides a detailed description of proportion and lithology of the individual samples that comprise the 10 Met Composite samples and the results and interpretation from the partial ABA testwork. The general composition by rock type of the ore and tailings composite sample is presented in Table 1. Figure 1 presents the plan-view of the Hammond Reef Deposit, showing the location of the Met composite sample drillholes and waste rock sample locations.

The ABA results show that regardless of the location within the deposit, the sulphide-sulphur contents of the samples were generally low, ranging from 0.09 to 0.35 wt% as S. The CaNPR values ranged from 5.8 to 62 t CaCO3/1000 t. Each of the individual samples, as well as the composite sample, are classified as non-acid generating with excess neutralization potential according to the MEND (2009) and AMIRA (2002) guidelines.

Table 4: Location, Lithology and Acid Base Accounting Results for the Metallurgical Composite Samples

Tailings Composite sample	Drillhole ID	Collar location				From (m)	To (m)	Lithology ID[(a)]	Sulphide-Sulphur (wt % as S)	CO_2 (%)	AP[(b)] (t CaCO3 /1000t)	CaNP[(b)] (t CaCO3 /1000t)	CaNPR[(b)]
		Zone	Section	Easting	Northing								
Met Comp 1	207	A	1795 E	612359.8	5421169.5	152.8	177.4	20,40	0.28	3.4	8.8	78	**8.9**
Met Comp 2	207	A	1795 E	612359.8	5421169.5	321	350	20,40	0.25	3.4	7.8	77	**9.8**
Met Comp 3	220	A	1420 E	612040	5420972.6	7	28	40,20,18	0.21	3.1	6.6	71	**11**
Met Comp 4	220	A	1420 E	612040	5420972.6	28	52	18	0.11	3.2	3.4	72	**21**
Met Comp 5	220	A	1420 E	612040	5420972.6	68.8	86.7	20	0.09	2.6	2.8	60	**21**
Met Comp 6	220	A	1420 E	612040	5420972.6	166	187	50,40	0.33	2.9	10	65	**6.3**
Met Comp 7	240	A	1770 E	612067.5	5421388.6	8.5	30.8	13, 20,40	0.24	3.4	7.5	76	**10**
Met Comp 8	240	A	1770 E	612067.5	5421388.6	58	81.6	20,40,35	0.35	2.8	11	63	**5.8**
Met Comp 9	248	41	3420 E	613663	5422151	72	86.5	30,34	0.23	20	7.2	448	**62**
Met Comp 10	257	41	3160E	613501	5421935	171	197	20,40	0.2	4.0	6.3	90	**14**

Notes:

0.1 - Non-Potentially Acid Generating (Non- PAG), according to the MEND (2009) guidelines.

(a) The description of the lithology ID codes is as follows: 13 - chloritic granite; 18 - tonalite; 20 - altered granitoid; 30 - sheared mafic unit; 34 - tectonized-sheared vein zone/brecciated pegmatite; 35 - ankeritized dyke; 40 - pegmatite; 50 - mafic dyke.
(b) AP = acid potential; CaNP = carbonate neutralization potential; and CaNPR = carbonate neutralization potential ratio.

Processing of ore will include crushing, grinding, flotation, cyanidation-leaching, carbon-in-pulp gold recovery, gold elution, gold electro-winning, smelting using an induction furnace, cyanide destruction and tailings recovery. The gold recovery process will begin with crushing and grinding of the ore, to produce bulk pyrite-bearing gold concentrates that will undergo flotation. The flotation process will be optimised based on the gold recovery and sulphide content to produce gold using head feed with relatively uniform sulphide/gold concentrations, therefore it is not expected that the sulphide content of the tailings will materially change from those values used in the metallurgical samples.

The rougher flotation concentrates (comprising less than 10% of the overall ore processed) will be reground and then subjected to cyanidation to leach out the gold, while the flotation tailings (greater than 90% of materials) will bypass the cyanide circuit and be sent directly to the thickener. The cyanide residues generated from the leach tests completed on flotation concentrates will be combined with the flotation tailings in the thickener and discharged to the tailings facility. The solubilised gold will be recovered from the cyanide solution via the carbon-in-pulp process, followed by electro-winning and subsequent smelting in an induction furnace to produce gold doré bars.

Based on the process description, the ore and tailings will not be materially different given that the only product expected to leave the site as a result of processing is gold. All the other components of the ore will end up in the tailings in a much more homogenized manner compared to the ore given that the ore will undergo crushing and grinding before being processed, and that a relatively consistent gold and sulphide content will be required to ensure that the process plant runs efficiently.

Waste Rock Sample Representativeness

The waste rock sampling program included the collection of 123 samples of various rock types as identified in Appendix A of the Geochemistry, Geology and Soils TSD. Drill holes were selected for sampling based on both lithologies logged, and spatial and stratigraphical representativeness using cross sections and plan views provided by OHRG. Some of the waste rock samples that underwent testing, were sampled from drillholes BR-165, BR-167, BR-164, BR-166 and BR-169, that contained higher grade material and consequently could be considered ore if they occurred in closer proximity to larger ore zones. Table 5 presents the waste rock sample IDs that contain this higher grade material.

Table 5: Waste Rock Sample IDs of Higher Grade Material

Drill Hole ID	Sample ID
BR-164	2010-HR-103
BR-165	2010-HR-014
	2010-HR-016
	2010-HR-021
BR-166	2010-HR-093
	2010-HR-096
BR-167	2010-HR-072
	2010-HR-073
BR-169	2010-HR-077

Table 6 presents the drillhole ID and location from which waste material was sampled. A complete list of samples including sample descriptions description of lithology, colour and texture are provided in Appendix A of the Geochemistry, Geology and Soils TSD. Figure 1 presents the plan-view of the Hammond Reef Deposit showing the location of the waste rock sample drillholes. A typical cross section of a drill hole (BR-162) indicating the location of the waste rock sample intervals is presented in Figure 2. Additional discussion of regional geology including lithology, and features such as fractures is provided in Section 2 of the Geochemistry Geology and Soils TSD and in the Hydrogeology TSD.

Table 6: Waste Rock Sample List

Drillhole ID	Collar location				From (m)	To (m)	Lithology ID[(a)]
	Zone	Section	Easting	Northing			
BR-182 [n=13]	Mitta	1870 E	612437.2	5421196	8	178.3	18, 50, 11, 13, 16, 40
BR-165 [n=15]	Mitta	2070 E	612623.8	5421281	3	212.45	18, 50, 40, 34, 11, 20
BR-164 [n=4]	Mitta	2320 E	612773.1	5421506	103.9	128	11, 40, 13
BR-162 [n=4]	A	1820 E	612400.7	5421156	20	140	19, 17, 18, 20
BR-171 [n=11]	A	2120 E	612651	5421355	1.4	153	18, 17, 45, 13, 40
BR-167 [n=7]	A	2220 E	612691	5421430	3	393	50, 13, 18, 15
BR-226 [n=7]	A	1470 E	612062.1	5421037	3	82	13, 20, 15
BR-261 [n=5]	A	NR	612469	5420783	3	52	18, 40, 50
BR-275 [n=4]	A	NR	612096	5420988	2	135	13, 30, 20
BR-304 [n=12]	A	NR	611915.5	5420719	0	146.5	20, 13, 50, 34, 18, 40
BR-334 [n=15]	A	NR	612063.8	5420853	6	173	18, 40, 13, 60, 50, 15, 11
BR-329 [n=2]	A	NR	612230	5420966	30	104	13
BR-169 [n=8]	41	3295 E	613559.3	5422084	2	70	18, 34, 13, 11
BR-166 [n=5]	41	2945 E	613312.8	5421811	6.8	52	20, 11
BR-173 [n=6]	41	3245 E	613566.1	5421983	3.4	68	18, 11, 50, 13, 30
BR-176 [n=1]	41	3270 E	613571.7	5422013	4.4	12.6	13

Drillhole ID	Collar location				From (m)	To (m)	Lithology ID[(a)]
	Zone	Section	Easting	Northing			
BR-170 [n=4]	41	NR	613833.4	5421888	12	102	15, 18, 32, 13

Notes:
"NR" indicates that the information was not recorded.
"n" denotes the number of samples collected from each specific drillhole.
(a) The description of the lithology ID codes is as follows: 13 - chloritic granite; 18 - tonalite; 20 - altered granitoid; 30 - sheared mafic unit; 34 - tectonized-sheared vein zone/brecciated pegmatite; 35 - ankeritized dyke; 40 - pegmatite; 50 - mafic dyke.

GEOCHEMICAL CHARACTERIZATION

Geochemical testing (static testing and humidity cell testing) was conducted on the waste rock and processed tailings composite samples. Ore samples underwent some static geochemical testing prior to being processed into tailings.

The geochemical tests that were conducted on the waste rock and tailings samples have been presented in Section 3.3.2 of the Geochemistry, Geology and Soils TSD. The geochemical test results have been presented in Section 3.5 of the Geochemistry, Geology and Soils TSD. Testing of the waste rock samples was conducted at SGS Canada Inc., Lakefield, Ontario (SGS Lakefield), and testing of the tailings composite sample was split and conducted at both SGS Lakefield and Lakehead University (Lakehead) for QA/QC purposes and to verify analytical results.

The testing program conducted includes the test work indicated below. Method references are also provided. As indicated in MEND (2009) and ICARD (2011), the program must be appropriate and should be tailored to the deposit and project. This was considered in the program plan, implementation and result analyses as described herein and in the EIS/EA.

Specific test methods are described in Section 3.3.2 of the Geochemistry, Geology and Soils TSD, and included the following:

Geochemical static testing – performed on solids of all waste rock and tailings samples:

- Whole rock analysis for major oxides (Al_2O_3, CaO, Cr_2O_3, Fe_2O_3, K_2O, MgO, MnO, Na_2O, P_2O_5, SiO_2, TiO_2, V_2O_5) by borate fusion/X-ray fluorescence (XRF).
- Trace metal analysis for aluminum, arsenic, antimony, barium, beryllium, bismuth, cadmium, calcium, chromium, cobalt, copper, iron, lead, lithium, magnesium, manganese, molybdenum, nickel, phosphorus, potassium, selenium, silver, sodium, strontium, tin, titanium, thallium, uranium, vanadium, yttrium and zinc.
- Acid-base accounting (ABA) by sulphide and carbonate content and by the modified Sobek method (Sobek et al. 1978) which includes analysis for paste pH, sulphur species, acid potential (AP), neutralization potential (NP), carbon species (total carbon, carbonate content and organic carbon content) and carbonate neutralization potential (CaNP).
- Net acid generation (NAG) performed according to the method recommended by AMIRA (2002) and Miller et al. (1997) to determine the acid generation and metal leaching potential of rock in oxidizing conditions. The results of the NAG test are used to assess the potential of a material to produce acidity after a period of exposure and weathering. NAG leachate water quality analyzed after complete oxidation of reactive sulphides by the addition of hydrogen peroxide. The NAG leachate was analyzed for:

- pH, alkalinity, acidity, conductivity, sulphate, chloride, ICP metal scan (including aluminum, arsenic, antimony, barium, beryllium, bismuth, boron, cadmium, calcium, chromium, cobalt, copper, iron, lead, lithium, magnesium, manganese, molybdenum, nickel, potassium, silver, sodium, strontium, tin, uranium, vanadium, zinc) and mercury by CVAAS.

- Shake flask extraction (SFE) test (ASTM D3987) performed according to ASTM (2006) and modified to a 4:1 liquid to solid ratio, to determine the acid generation and metal leaching potential due to the interaction with meteoric water. The SFE leachate was analyzed for:
  - pH, alkalinity, acidity, conductivity, sulphate, chloride, ICP metal scan (including aluminum, arsenic, antimony, barium, beryllium, bismuth, boron, cadmium, calcium, chromium, cobalt, copper, iron, lead, lithium, magnesium, manganese, molybdenum, nickel, potassium, silver, sodium, strontium, tin, uranium, vanadium, zinc) and mercury by CVAAS.

- Mineralogical analysis by X-ray diffraction (XRD) using the Rietveld method and petrographic analysis of polished thin sections.

Tailings process water quality analyses:

- Aging tests on the water associated with the tailings were performed. The sample of Day 0 process water, as well as the process water that was shipped with the tailings solids was sampled on days 0, 7, 15 and 29. These samples were tested for the following:
  - pH, alkalinity, conductivity, acidity, thiosalts, chloride, sulphate, ammonia, nitrite, nitrate and ICP dissolved metals scan (including aluminum, arsenic, antimony, barium, beryllium, bismuth, boron, cadmium, calcium, total and hexavalent chromium, cobalt, copper, iron, lead, lithium, magnesium, manganese, molybdenum, nickel, potassium, silver, sodium, strontium, tin, uranium, vanadium, zinc).

Kinetic testing:

- Humidity cell tests (HCTs) were performed according to the ASTM D5744-96 Standard Test Method for Accelerated Weathering of Solid Materials Using a Modified Humidity Cell (ASTM 2001).
  - Nine waste rock samples were selected for 44 weeks of HCT testing at SGS Lakefield.
  - The tailings composite sample was split for HCT testing at SGS Lakefield (20 weeks total) and Lakehead University (23 weeks total) for QA/QC purposes and to verify analytical results.

- The weekly leachate from HCTs was filtered and analyzed for the following parameters:
  - pH, conductivity, acidity, alkalinity and sulphate, every week;
  - for the first five cycles (including the initial flush), filtered leachate samples were submitted for dissolved metals analysis by ICP-MS, mercury (CVAAS) and chloride;
  - after the fifth week, leachate analysis were performed at five-week intervals (i.e., weeks 10, 15, 20, etc.); and
  - all intermediate weekly samples (i.e., weeks in which metals analyses are not completed) were retained and preserved as required, for possible future analyses.

Kinetic testing of the waste rock and tailings samples was terminated after 44 and 20/23 weeks, respectively, due to low and generally stable key parameter concentrations.

The testing programs completed indicated the potential for acid generation and chemical releases from the solid phase and the process water quality of the waste rock, ore and tailings.

Conclusion

It is considered that selection and representativeness of the ore, tailings, and waste rock samples are consistent with the intent and guidance as provided in MEND (2009) for the current stage of the project. The samples are expected to provide a reasonable representation of what may be encountered and produced during the OHRG project and the test program and test methods follow the MEND (2009) guidelines, including appropriate consideration and provision of descriptions of lithology, colour, texture, spatial representation, and static and kinetic geochemical evaluation (Geochemistry, Geology and Soils TSD). As recommended in the guidelines, the programs were tailored to the project stage, project type and rock types expected to be encountered and the results were taken within the overall context of the project to develop appropriate water quality estimates as provided in the Site Water Quality TSD and Lake Water Quality TSD.

GOLDER ASSOCIATES LTD.

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Principal, Senior Geochemist

Attachments:
Figure 1: Drill Hole Sample Locations
Figure 2: Example Sample Location at Depth Section 1820_E

REJ/KDV/sp

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REFERENCES

AMIRA, 2002. AMIRA International Ltd. ARD Test Handbook – Prediction and Kinetic Control of Acid Mine Drainage. Environmental Geochemistry International Pty. Ltd. and Ian Wark Institute, University of South Australia.

ASTM, 2001b. E1915-01 - Test Methods for Analysis of Metal Bearing Ores and Related Materials by Combustion Infrared Absorption Spectrometry. Volume 03.06.

ASTM, 2001a. D5744-96 - Standard Test Method for Accelerated Weathering of Solid Materials Using a Modified Humidity Cell. Annual Book of ASTM Standards, Volume 11.04: 259-271.

ASTM, 2002. D422-63 - Standard Test Method for Particle-Size Analysis of Soils, Annual Book of ASTM Standards. Volume 04.08.

ASTM, 2006. D3987 Standard Test Method for Shake Extraction of Solid Waste with Water.

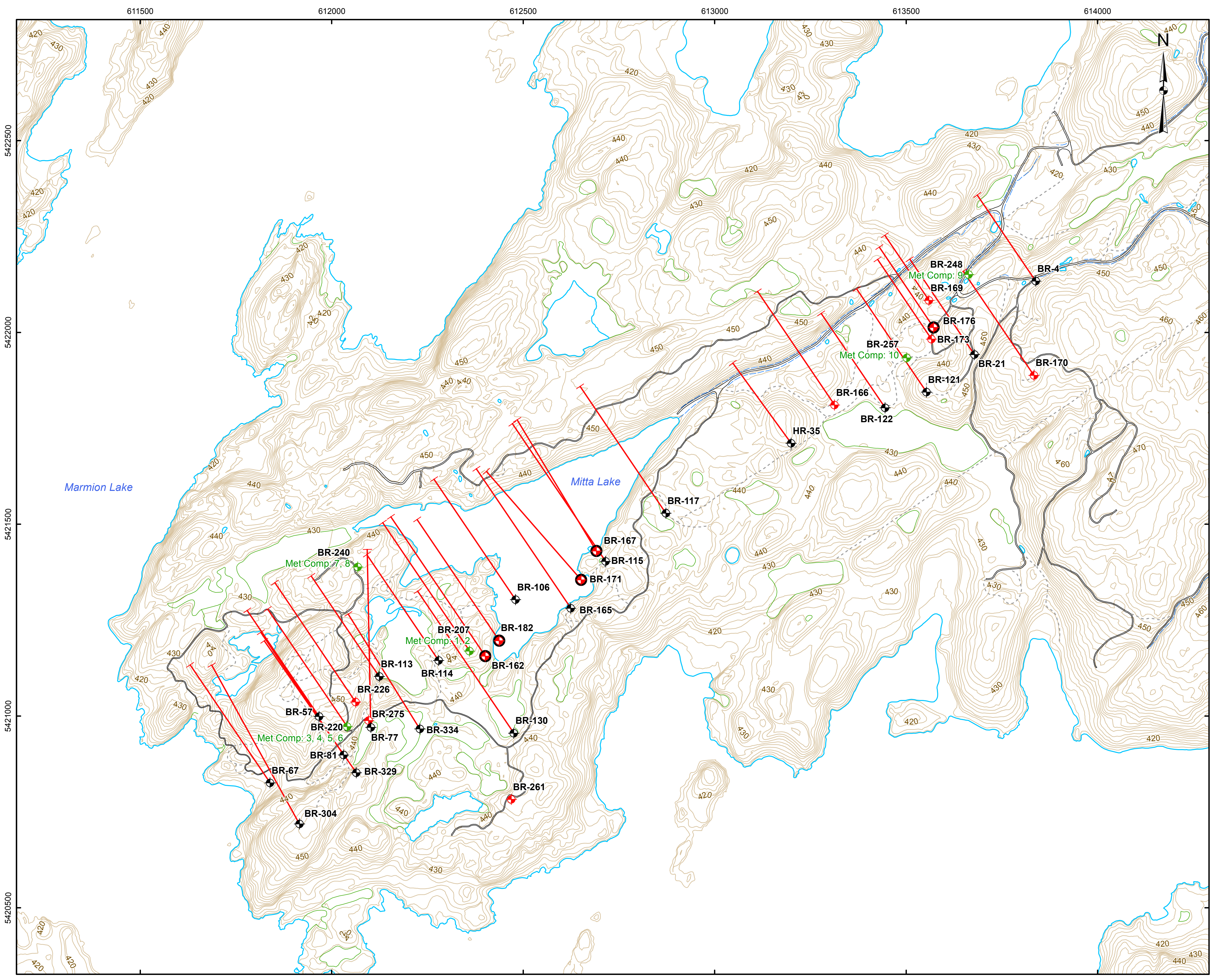
Brett Resources Inc., 2009. An investigation of gold recovery from Hammond Reef Project samples, Project 11734-002 – Final Report.

Ounpuu, 2011. "Metallurgical Update on Hammond Reef Testwork". Memorandum issued to Osisko February 10, 2011 by Mike Ounpuu (Consulting Metallurgist).

MEND, 2009. Prediction Manual for Drainage Chemsitry from Sulphidic Geologic Materials. MEND Report 1.20.1. Mining Environment Neutral Drainage Program, Natural Resources Canada. December 2009.

Price, W.A., 1997. Draft Guidelines and Recommended Methods for the Prediction of Metal Leaching and Acid Rock Drainage. BC Ministry of Employment & Investment, Energy and Minerals Division, 1997.

Sobek, A.A., W.A. Schuller, J.R. Freeman and R.M. Smith, 1978. Field and Laboratory Methods Applicable to Overburdens and Minesoils. Report EPA-600/2-78-054, US National Technical Information Report PB-280 495.



LEGEND

Met Comp: 10 Tailings Composite Sample
Met Composite Sample Drill Hole
Pit Sample Drill Hole
Waste Rock Sample Drill Hole
Waste Rock and Pit Sample Drill Hole
Length and Direction of Drill Hole
Contour (2m Interval)
Ditch
Marsh/Swamp
Road
Trail
Shoreline
River/Stream

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd
Base Data - MNR NRVIS, obtained 2004
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

250 0 250 500
SCALE 1:10,000 METERS

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
DRILL HOLE SAMPLE LOCATIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1118-0010			SCALE AS SHOWN	VERSION 2
DESIGN	CGE	14 Nov. 2008	FIGURE: 1	
GIS	JO	28 Jun. 2013		
CHECK	RJ	28 Jun. 2013		
REVIEW		28 Jun. 2013		

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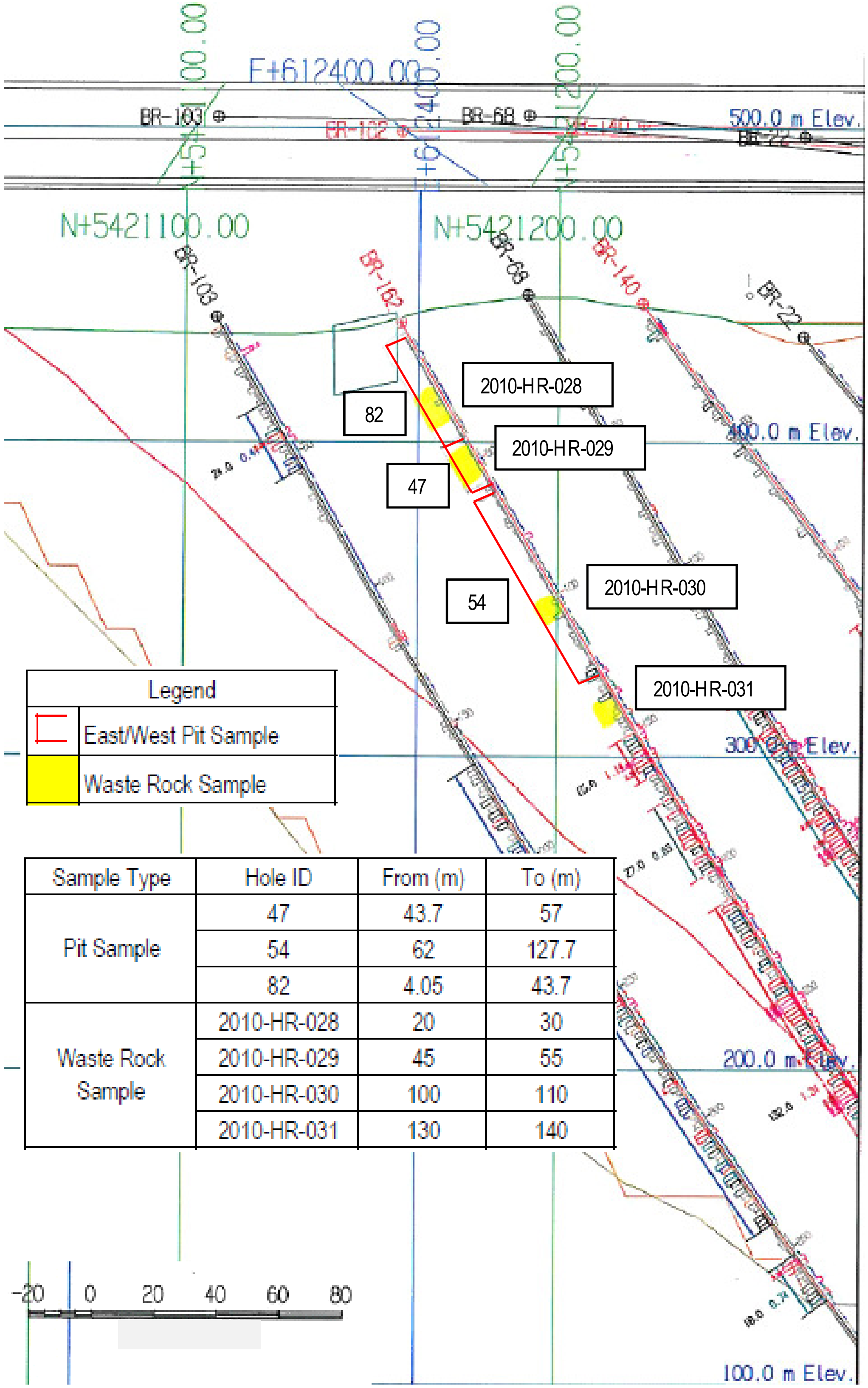

Sample Type	Hole ID	From (m)	To (m)
Pit Sample	47	43.7	57
	54	62	127.7
	82	4.05	43.7
Waste Rock Sample	2010-HR-028	20	30
	2010-HR-029	45	55
	2010-HR-030	100	110
	2010-HR-031	130	140

REFERENCE

Figure based on HR 201 RAB Sec 1820_E 2010 Drill Holes as Red Traces. Gems Profile: 09PRES5G-R

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

EXAMPLE SAMPLE LOCATION AT DEPTH - SECTION 1820_E

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1118-0010			VERSION 2
DESIGN	RY	14 Nov. 2008	
GIS	JO	2 Jul. 2013	
CHECK	RJ	2 Jul. 2013	
REVIEW		2 Jul. 2013	

FIGURE: 2

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INFORMATION REQUEST – MOE-NR-GW-03

Source: Ministry of Environment

Summary of Comment

ABA, NAG and leach testing were all done on the waste rock, as was chemical characterization. Was ABA and NAG done on the ore? Or are there chemistry results for the ore with regards to overall composition and metals content?

Potential Environmental Effects

Although testing was done on the tailings, as noted above, it is possible that the composite sample could have masked effects of the different types of ore. Therefore, it would be useful to have ABA on a variety of the ore material to determine the potential for ARD.

Proposed Action

A discussion of ore chemistry and its effect on tailings composition and reactivity is needed, including discussion of the homogeneity/heterogeneity of the ore within and between ore zones.

Reference to EIS

Section 3.3.2 & Section 3.3.2.1

Response

Yes, ABA and leach testing was done on the ore. Chemical results were to be included in the feasibility study but are included in response to MOE-NR-GW-02 and provided in the Supplemental Information package of the Geochemistry, Geology and Soil TSD. To summarize, testing on ore samples occurred in two phases, one in March 2009 with a follow-up as provided in April 2011. The characterization testwork was conducted on a wide selection of ore samples which captured the different alterations, lithologies and the grade variations that are present within the ore deposit and included the following:

2009 (see Tables 1 and 2)

- Ten (10) individual drill hole composites (BR-2, BR-13, BR-23, BR-28, BR-64, BR-67, BR-68, BR-87, BR-88 and BR-102) were collected in 2009, representing various locations in the deposit. Several composite samples (A-Zone, 41-Zone, Master, LG A-Zone Variability, HG A-Zone Variability and EHG Variability composites) were created from these 10 drill hole composites.
- The A-Zone composite was created from six drill hole composites from the following drill holes: BR-28, BR-64, BR-68, BR-87, BR-88 and BR-102.
- The 41-Zone composite was created from three drill hole composites from the following drill holes: BR-02, BR-13 and BR-23.
- The Master composite (2009) sample was created from 78% A-Zone composite and 22% 41-Zone composite. LG (low grade) A-Zone Variability Composite was created from drill hole composites BR-28, BR-87 and BR-102.

- HG (high grade) A-Zone Variability Composite was created from drill hole composites BR-64, BR-68 and BR-88.
- EHG (extreme high grade) Variability Composite was created from drill hole composites BR-13, BR-23, BR-28, BR-64, BR-68, BR-87 and BR-102.
- Characterization testing was carried out on 9 of the 10 individual drill hole composites (BR-2, BR-13, BR-23, BR-28, BR-64, BR-67, BR-87, BR-88 and BR-102) as well as the Master Composite, LG A-Zone Variability Composite, HG A-Zone Variability Composite and the EHG Variability Composite samples.

2011 (see Table 3)

- Ten (10) variability metallurgical (Met) composite samples were collected in 2011 to represent various zones in the deposit.
- One Master composite sample was created from the ten variability Met composites, selected to be representative of expected mill head grade.

The characterization testwork consisted of static tests designed to assess the general physical and geochemical characteristics, and included elemental composition, acid-base accounting (ABA) and net acid generation (NAG) testing. The results of the elemental composition testwork are presented in Table 1 (see attached). The results of the ABA and NAG testwork are presented in Table 2 (for 2009 ore and composite samples, see attached) and Table 3 (for 2011 ore and composite samples, see attached). The ABA and NAG test results indicated that all ore and ore composite samples are expected to be non-potentially acid generating with excess neutralizing capacity according to the MEND (2009) guidelines.

As indicated in the attached response to MOE-NR-GW-02, the ore and tailings will not be materially different given that the only product expected to leave the site as a result of processing is gold. All the other components of the ore will end up in the tailings in a much more homogenized manner compared to the ore given that the ore will be crushed and ground before being processed.

Attachments

Table 1: Elemental composition for the 2009 ore samples.

Table 2: Acid Base Accounting and Net Acid Generating Results for the 2009 ore samples.

Table 3: Location, Lithology and Acid Base Accounting Results for the 2011 Met Composite Samples.

References

Brett Resources Inc., 2009. An investigation of gold recovery from Hammond Reef Project samples, Project 11734-002 – Final Report.

Ounpuu, 2011. Memorandum titled “Metallurgical Update on Hammond Reef Testwork”. Issued to Osisko February 10, 2011 by Mike Ounpuu (Consulting Metallurgist).

Table 1: Elemental composition for the 2009 ore samples.

Sample	Zone	Ag g/t	Al g/t	As g/t	Ba g/t	Be g/t	Bi g/t	Ca g/t	Cd g/t	Co g/t	Cr g/t	Cu g/t	Fe g/t	K g/t	Li g/t	Mg g/t	Mn g/t	Mo g/t	Na g/t	Ni g/t	P g/t	Pb g/t	Sb g/t	Se g/t	Sn g/t	Sr g/t	Ti g/t	Tl g/t	U g/t	V g/t	Y g/t	Zn g/t
Drill Hole Composites																																
BR-2	41	< 2	80000	< 30	410	0.80	< 20	25000	< 2	< 20	18	20	23000	27000	< 5	5800	360	11	26000	< 20	530	30	< 10	< 30	< 20	130	1900	< 30	< 20	34	5.3	150
BR-13	41	< 2	75000	< 30	490	0.88	< 20	21000	< 2	< 20	31	28	25000	24000	< 5	7200	370	< 10	22000	< 20	460	31	< 10	< 30	< 20	120	2300	< 30	< 20	51	4.8	160
BR-23	41	< 2	70000	< 30	430	0.74	< 20	28000	< 2	< 20	100	24	29000	22000	< 5	12000	430	< 10	19000	84	320	76	< 10	< 30	< 20	120	2300	< 30	< 20	45	4.2	360
BR-28	A	< 2	78000	< 30	550	0.86	< 20	17000	< 2	< 20	33	14	23000	23000	< 5	5300	330	26	22000	< 20	490	< 20	< 10	< 30	27	100	2000	< 30	< 20	39	4.8	66
BR-64	A	< 2	71500	< 30	435	0.81	< 20	22500	< 2	< 20	26.5	24	23500	24000	< 5	5000	320	11.5	21500	< 20	450	< 20	< 10	< 30	< 20	120	2050	< 30	< 20	36	4.7	67.5
BR-67	A	< 2	73000	< 30	460	0.86	< 20	24000	< 2	< 20	24	26	22000	24000	< 5	5200	350	< 10	24000	< 20	430	< 20	< 10	< 30	< 20	120	2000	< 30	< 20	35	4.4	79
BR-68 [(a)]	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BR-87	A	< 2	72000	< 30	500	0.80	< 20	18000	< 2	< 20	17	15	20000	23000	< 5	3800	310	< 10	21000	< 20	330	25	< 10	< 30	< 20	120	1800	< 30	< 20	29	4.5	110
BR-88	A	< 2	68000	< 30	450	0.76	< 20	14000	< 2	< 20	35	60	24000	20000	< 5	2900	220	< 10	23000	< 20	240	140	< 10	< 30	< 20	100	1400	< 30	< 20	22	3.4	100
BR-102	A	< 2	73000	< 30	490	0.88	< 20	19000	< 2	< 20	44	25	22000	24000	< 5	4300	270	< 10	24000	< 20	380	25	< 10	< 30	< 20	110	1600	< 30	< 20	30	5.2	93
Zone Composites																																
A-Zone [(b)]	A	< 2	66500	< 30	440	0.81	< 20	19000	< 2	< 10	43	15.5	21000	24500	< 5	4850	310	13	22000	< 20	395	< 40	< 10	< 30	< 20	110	1650	< 30	< 20	32	4.8	43
41-Zone [(b)]	41	< 2	67000	< 30	420	0.72	< 20	24000	< 2	28	76	21	27000	21000	< 5	8600	370	12	18000	39	430	< 40	< 10	< 30	< 20	120	2000	< 30	< 20	43	4.6	48
Master Composite [(b)]	A and 41	< 2	67000	< 30	450	0.80	< 20	20000	< 2	< 10	49.0	20.0	22000	22000	< 5	6300	330.0	13.0	20000.0	22.0	430	< 40	< 10	< 30	< 20	120	1800	< 30	< 20	35	4.9	220
Grade Composites																																
LG A-Zone [(b)]	A	< 2	72000	< 30	480	0.70	< 20	18000	< 2	< 20	42	17	19000	22000	< 5	5000	330	< 10	23000	< 20	380	< 30	< 10	< 30	< 20	110	1700	< 30	< 20	33	4.5	41
HG A-Zone [(b)]	A	< 2	67000	< 30	410	0.80	< 20	18000	< 2	< 20	39	15	20000	22000	< 5	4300	310	15	21000	< 20	430	< 30	< 10	< 30	< 20	110	1800	< 30	< 20	31	3.9	42
EHG [(b)]	41	< 2	72000	< 30	470	0.80	< 20	23000	< 2	< 20	22	25	29000	27000	< 5	5800	440	18	18000	< 20	760	30	< 10	< 30	< 20	110	2800	< 30	< 20	46	5.3	57

Notes:

(a) Elemental analysis was not conducted on the drill composite sample BR-68.

(b) See text for details of sample composition for the composite samples.

A dash "-" indicates that no data was reported.

Table 2: Acid Base Accounting and Net Acid Generating Results for the 2009 ore samples.

Sample	Collar location				From (m)	To (m)	Lithology ID [c]	Acid Base Accounting											Net Acid Generation Testing
	Zone	Section	Easting	Northing				Paste pH	NP[d]	AP[d]	NPR[d]	CaNPR[d]	Total Sulphur	SO_4	Sulphide	Total Carbon	Carbonate	Carbonate NP	Final NAG-pH
								s.u.	t CaCO3/1000 t	t CaCO3/1000 t	ratio	ratio	%	%	%	%	%	%	s.u.
Drill Hole Composites											-	-							
BR-2	41	3470E	613783.11	5422056.3	145	191	11, 20, 50	9.31	73.2	5.43	**13.5**	**14.0**	0.16	< 0.01	0.17	1.02	4.55	75.8	10.8
BR-13	41	3370E	613613.95	5422128.9	40.5	126	20, 32, 33, 34	9.23	70.4	6.59	**10.7**	**10.7**	0.33	0.12	0.21	0.98	4.23	70.5	10.1
BR-23	41	3270E	613543.79	5422052.9	63	139.5	20, 33, 40, 60	9.23	102	4.51	**22.6**	**24.2**	0.26	0.12	0.14	1.47	6.56	109.4	10.1
BR-28	A	1820E	612237.07	5421397.1	21.5	102.5	20, 33, 34, 40	9.15	51.2	4.41	**11.6**	**11.8**	0.26	0.11	0.14	0.72	3.11	51.8	10.1
BR-64	A	1670E	612220.71	5421160.8	91.5	292.5	11, 15, 20, 32, 40	9.29	59.8	6.42	**9.3**	**8.8**	0.35	0.14	0.21	0.84	3.40	56.7	10.6
BR-67	A	1670E	611838.62	5420825.7	NR	NR	NR	9.36	71.3	5.27	**13.5**	**13.1**	0.43	0.26	0.17	0.96	4.13	68.8	10.9
BR-68 [a]	A	1800E	612374.18	5421187.2	141	256.5	13, 15, 40	-	-	-	**-**	**-**	-	-	-	-	-	-	-
BR-87	A	1420E	611912.97	5421162.9	3.74	88.5	12, 15, 20	9.37	46.9	3.23	**14.5**	**13.8**	0.35	0.25	0.1	0.60	2.67	44.5	10.9
BR-88	A	1420E	611985.14	5421059.7	160.5	252	20	9.6	37.8	4.68	**8.1**	**7.6**	0.37	0.22	0.15	0.50	2.13	35.5	10.3
BR-102	A	1670E	612149.06	5421258	6.52	213	20, 33, 40	9.47	53	4.71	**11.3**	**10.9**	0.26	0.11	0.15	0.70	3.08	51.3	10.9
Zone Composites																			
A-Zone [b]	A	---	---	---	---	---	---	9.12	57.7	5.09	**11.3**	**11.3**	0.31	0.14	0.16	0.85	3.46	57.7	10.3
41-Zone [b]	41	---	---	---	---	---	---	9.39	85.2	3.54	**24.0**	**24.6**	0.39	0.28	0.11	1.17	5.22	87.0	9.8
Master Composite [b]	A and 41	---	---	---	---	---	---	9.32	66.3	7.8	**8.5**	**7.4**	0.31	0.1	0.3	0.93	3.5	57.8	10.6
Grade Composites											-	-							
LG A-Zone [b]	A	---	---	---	---	---	---	9.05	55.9	2.83	**19.7**	**18.8**	0.19	0.1	0.09	0.75	3.19	53.2	10.5
HG A-Zone [b]	A	---	---	---	---	---	---	9.31	54.8	7.22	**7.6**	**7.0**	0.45	0.22	0.23	0.74	3.05	50.8	10.2
EHG [g]	41	---	---	---	---	---	---	9.07	71.2	13.00	**5.5**	**4.2**	0.80	0.38	0.42	1.02	3.26	54.3	9.3

Notes:

0.1 - Non-Potentially Acid Generating (Non- PAG) according to MEND (2009).

(a) Acid Base Accounting and net acid generation (NAG) testing were not conducted on the drill composite sample BR-68.

(b) See text for details of sample composition for the composite samples.

(c) Description of the lithology ID codes is as follows: 11- fine grained granite; 12- contaminated granite; 15 - chloritic granite porphyry; 20 - altered granitoid; 32- sheared granitoid; 33 - chlorite schist; 34 - tectonized-sheared vein zone/brecciated pegmatite; 40 - pegmatite; 50 - mafic dyke; 60 - intermediate dyke.

(d) NP = neutralization potential; AP = acid potential; NPR = neutralization potential ratio; and CaNPR = carbonate neutralization potential ratio

A dash "-" indicates that no data was reported. A triple dash "---" indicates that the data is presented in the Brett Resources Inc., 2009. An investigation of gold recovery from Hammond Reef Project samples, Project 11734-002 – Final Report. "NR" indicates that no information was recorded.

Table 3: Location, Lithology and Acid Base Accounting Results for the 2011 Metallurgical Composite Samples.

Sample	Drillhole ID	Collar location				From (m)	To (m)	Lithology ID [(a)]	Sulphide-Sulphur (wt % as S)	CO_2 (%)	AP [(b)] (t $CaCO_3$/1,000t)	CaNP [(c)] (t $CaCO_3$/1,000t)	CaNPR [(d)]
		Zone	Section	Easting	Northing								
Met Comp 1	207	A	1795 E	612360	5421170	153	177	20,40	0.28	3.4	8.8	78	**8.9**
Met Comp 2	207	A	1795 E	612360	5421170	321	350	20,40	0.25	3.4	7.8	77	**9.8**
Met Comp 3	220	A	1420 E	612040	5420973	7.0	28	40,20,18	0.21	3.1	6.6	71	**11**
Met Comp 4	220	A	1420 E	612040	5420973	28	52	18	0.11	3.2	3.4	72	**21**
Met Comp 5	220	A	1420 E	612040	5420973	69	87	20	0.09	2.6	2.8	60	**21**
Met Comp 6	220	A	1420 E	612040	5420973	166	187	50,40	0.33	2.9	10	65	**6.3**
Met Comp 7	240	A	1770 E	612067	5421389	8.5	31	13,20,40	0.24	3.4	7.5	76	**10**
Met Comp 8	240	A	1770 E	612067	5421389	58	82	20,40,35	0.35	2.8	11	63	**5.8**
Met Comp 9	248	41	3420 E	613663	5422151	72	87	30,34	0.23	20	7.2	448	**62**
Met Comp 10	257	41	3160E	613501	5421935	171	197	20,40	0.2	4.0	6.3	90	**14**

Notes:

0.1 - Non-Potentially Acid Generating (Non- PAG) according to MEND (2009).

(a) The description of the lithology ID codes is as follows: 13 - chloritic granite; 18 - tonalite; 20 - altered granitoid; 30 - sheared mafic unit; 34 - tectonized-sheared vein zone/brecciated pegmatite; 35 - ankeritized dyke; 40 - pegmatite; 50 - mafic dyke.

(b) Acid Potential = acid potential; CaNP = carbonate neutralization potential; and CaNPR = carbonate neutralization potential ratio.

INFORMATION REQUEST – MOE-NR-GW-04

Source: Ministry of Environment

Summary of Comment

Results of the NAG leach test found total chromium concentrations greater than the CCME standard and PWQO for hexavalent chromium. And hexavalent chromim was found in excess of standards in Tailings NAG Leach Test (Sec 3.5.2.4.2), but dismissed as a product of elevated ph, and not expected in typical site conditions.

Potential Environmental Effects

Total chromium in excess of the standards for hexavalent chromium could indicate hexavalent chromium, which is significant environmental toxicity effects in comparison to total chromium, at levels that could result in impacts.

Proposed Action

The NAG leach test should include speciation of total chromium to determine if the standards are exceeded. Further discussion is required regarding the significance of elevated hexavalent chromium in the Tailings NAG leach test.

Reference to EIS

Section 3.5.1.4

Response

In nature, chromium exists in four oxidation states (0, 2+, 3+ and 6+). In groundwater, chromium is present predominantly in the 3+ (trivalent) and 6+ (hexavalent) valence states. The species of the chromium in natural waters is highly dependent on pH and redox potential (Eh). Under more reducing and acidic conditions, Cr(III) is thermodynamically stable. Cr(VI), the more mobile and toxic species in groundwater (Palmer and Wittbrodt, 1991), predominates under more oxidizing and alkaline conditions.

The NAG leach test intentionally pushes the pH and Eh of the water to a condition not likely to be experienced in the natural environment for the purpose of enhancing the liberation of metals to provide a worst case load estimate. While the NAG leach test is a useful screening tool, the expected natural conditions must be considered to accurately interpret the test results.

Figure 1 presents an Eh-pH diagram showing approximate predominance or stability fields for Cr(III) and Cr(VI). The expected receiving surface water pH and Eh at the mine site discharge point (i.e., south end of Sawbill Bay), represented by the range (minimum to maximum) of baseline monitoring data for the surface and bottom samples collected at Sawbill Bay and Lynxhead Bay, are indicated on Figure 1 as the circle labeled “A” (see the Water and Sediment Quality TSD for baseline surface water quality monitoring data). The baseline pH and Eh at Sawbill Bay ranges from 5.7 to 7.6 and 0.04 to 0.3 V, respectively. The resultant NAG test leachate pH and expected Eh for the tailings sample are indicated on Figure 1 as the circle labeled “B”. The tailings NAG leachate pH ranges from 11.1 to 11.4. The NAG test leachate Eh was not reported. Conservatively, an Eh range can be assumed assigning a minimum Eh for typical groundwater (approximately 0.2 V) and the maximum Eh observed in baseline monitoring data for all surface water stations for the Project (0.34 V) (Water and Sediment Quality TSD).

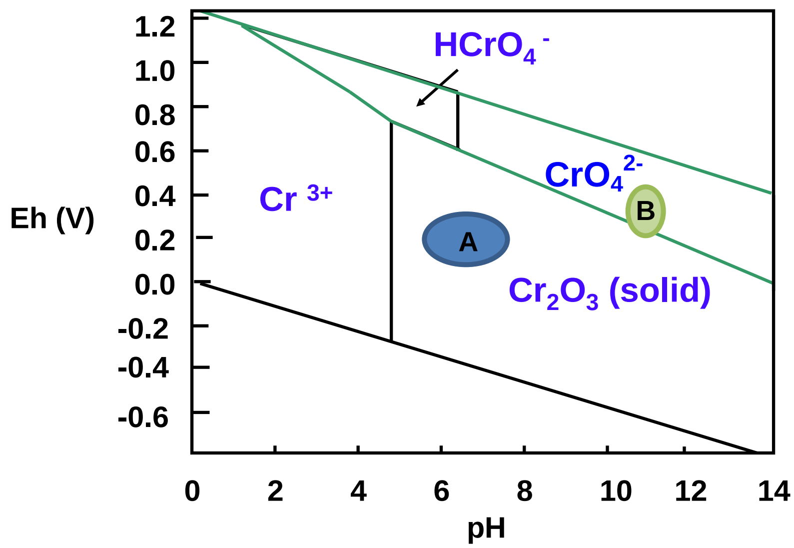

Figure 1: Eh-pH diagram for chromium with predominance field of Cr (VI) bounded in green. The circle labeled “A” indicates the expected Eh and pH range for Sawbill Bay, and the circle labeled “B” indicates the measured pH and expected Eh range for the tailings NAG test leachate.

Under moderately oxidizing conditions (200 mV), the transition from Cr(III) to Cr(VI) will occur at approximately pH 10.5. Based on the discussion above, because the tailings NAG test leachate was alkaline (pH 11.1 to 11.4), chromium would be expected to be predominantly present in the 6+ valence state over the entire range of expected redox conditions. In contrast to the NAG leachate test results, the shake flask extraction testing of the tailings sample resulted in concentrations of total and hexavalent chromium that were below detection (<0.0005 and <0.00002 mg/L, respectively). In addition, total chromium concentrations were below detection (<0.0005 mg/L) throughout the humidity cell testing of the tailings sample. This is in agreement with the expected predominance of solid Cr_2O_3 for the given Eh and pH conditions in the receiving waters as indicated in Figure 1 (label “A”).

Elevated concentrations of chromium (hexavalent or trivalent) are therefore not expected to occur in waters on site given the conditions expected on site, and the chromium is expected to continue to remain in solid phase in the rock mass or tailings.

References

Palmer, C.D., and Wittbrodt, P.R., 1991. Processes Affecting the Remediation of Chromium Contaminated Sites, Environmental Health Perspectives, Vol. 92, pp. 25-40. Published by the National Institute of Environmental Health Sciences, National Institute of Health, Department of Health and Human Services. NIH Publication No. (=DHHS) 91-218.

INFORMATION REQUEST – EC-29

Source: Environment Canada

Summary of Comment

None

Potential Environmental Effects

There is missing information on the geochemical characterization of overburden material as well as the total volume of the material. This information is needed to assess the potential impacts that the effluent generated from the overburden stockpiles could have in the receiving aquatic environment, and whether these impacts can be mitigated.

Proposed Action

The Proponent should undertake detailed geochemical characterization of the overburden material that includes mineralogical analyses, acid base accounting, shake-flask leaching and humidity cell kinetic testing, as undertaken for waste rock and tailings samples.

Information should also be provided on:

- the total volume of overburden that would be generated from the mine development;
- the volume of overburden material that is to be used for construction; and
- the volume of overburden material that will remain stockpiled during closure.

Reference to EIS

Geochemistry, Geology and Soil TSD

Response

The quaternary mapping of the area describes the typical overburden expected in the project site (Section 2.1 of the Geochemistry, Geology and Soil TSD). As indicated in Ontario Geological Survey Open file Report 5986, the surface sediments in the RSA are discontinuous due to bedrock outcrops, and consist predominately of a thin, discontinuous veneer of drift (till) over bedrock (Dyer 1999). Within the RSA modern fluvial deposits occupy major river valleys, such as along the Seine River (Dyer 1999). Glaciolacustrine deposits may contain sand silt or clay and may occur in localized zones. One of these zones containing sand and silt till is located to the northeast of Marmion Reservoir. A zone of glaciolacustrine wet silt with organics is also found immediately at the north end of Sawbill Bay (Figure 2-1).

The overburden stockpile would be designed to contain all overburden material excavated during mine development. Based on the mining plan, the stockpile will contain about 9.2 Mt (about 4.5 Mm^3) of overburden, and it will occupy a 36.8 ha footprint (see Project Description TSD). Runoff and seepage from the stockpile would be collected in a perimeter ditch system and conveyed to one of four collection ponds, with the collected water pumped to the PPCP for use as re-claim in the plant or for treatment and discharge.

According to the Conceptual Closure and Rehabilitation Plan (CCRP), some of the overburden will be used at closure for site regrading purposes. This has not been quantified, but it may be that about 25% of the original volume will be used around the site. The top surface of the material remaining in the stockpile (roughly 3.8 Mm^3)

will be graded and drainage measures will be put in place. The overburden is expected to support vegetation, so the surface will be directly revegetated, without the use of topsoil. Water in the four collection ponds will continue to be monitored after closure. Runoff and seepage water will continue to be pumped to the open pits until such time as the water quality becomes acceptable for direct discharge to the environment. At that time, the ponds will be breached and the pumping systems will be removed.

Given the moderate side slopes, it is expected that the reshaped Overburden Stockpile will be resistant to erosion once the vegetation is established. In the short term, good construction practice measures (e.g., silt fences, hay bale barriers, etc.) will be used to control erosion. Also, all runoff from the stockpile will report to one of the four collection ponds which will be effective in removing suspended solids by sedimentation.

Geochemical Discussion - Overburden

Of note is that the overburden materials are generally of similar characteristics to the nearby host materials from which they originate. Given that the waste rock and ore deposit chemistry is non-acid generating with low potential for metal leaching it follows that the chemistry of the overburden derived from this material will have similar characteristics, furthermore, the overburden will have been subjected to more weathering and leaching over a very long period of time, as such is expected to have lower potential for metal leaching than the bedrock from which the material originated, especially that which is fluvial, or lacustrine in origin.

Overburden units are described in Section 4.0 (Soils) of the Geochemistry Geology and Soils TSD. Given the glacial history of the region the discontinuous, overburden will be similar to surface soils, as such the chemistry result presented in Table 4-5 of the Geochemistry, Geology and Soils TSD are considered reasonable and valid for evaluation of overburden chemistry characteristics. Test results from these materials show consistent, low solid phase metal concentrations over the local study area.

In addition to the chemistry analyses of near surface samples presented in Table 4-1 of the Geochemistry, Geology and Soils TSD, six additional overburden samples were analyzed for geochemical characteristics as part of the feasibility study (Supplemental Information package of the Geochemistry, Geology and Soil TSD). These samples were subjected to static testing (e.g. ABA, metal analyses and short term leach tests). It is expected that additional geochemical sampling of overburden would be undertaken as part of operational monitoring, furthermore, water management at the project site as described in the Site Water Quality TSD has allowed for capture and treatment of water from the overburden stockpile until such time as the water is suitable for direct release to the environment.

The results of the available overburden chemical and geochemical test results show that the overburden is expected to be non-acid generating with low metal leaching potential. Given that the ABA results show the samples are clearly non-acid generating the metal leaching results would be expected to improve over time, thus use of these short term leach test results in overburden water quality evaluation is considered a reasonable worst case. As indicted in MEND (2009) “kinetic testing is often limited to samples identified as important and representative by static tests”, thus, given the site overburden emplacement characteristics and static test results for overburden to date, humidity cell tests are not recommended or considered appropriate for these overburden materials at this time.

References

MEND (Mine Environment Neutral Drainage). 2009. *Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials*. MEND Report 1.20.1. Mining Environment Neutral Drainage Program, Natural Resources Canada. December 2009.

December 4, 2013 Project No. 13-1118-0010

DOC No. 029 (Rev 0)

Ms. Alexandra Drapack,
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M5H 3B7

RE: GEOCHEMICAL ANALYTICAL PROGRAM, HAMMOND REEF PROJECT

Dear Ms. Drapack

This letter provides information related to static geochemical testing of six overburden samples from three locations (see Figure 1) was carried out in June 2012 as part of the feasibility study for the project. Given that the feasibility study has not yet been released at the time of writing this letter, some relevant geochemical results and discussion are provided herein.

Table 1: Sample List

Location I.D	Depth	
	Shallow	**Deep**
1	1A Sample 2	TP1-3 Sample 4
7	7B Sample 2	TP7-2 Sample 3
14/16	14 Sample 2	TP16-1 Sample 2

The following geochemical analytical tests were performed on all six samples:

- Metal and whole rock analysis;
- Bulk metal analysis;
- Short-term de-ionized (DI) water leach test; and
- Acid-Base Accounting (ABA).

Metal and whole rock analyses were conducted to quantify the elemental (solid-phase chemical) composition. Whole rock analysis measures the concentrations of major oxides by borate fusion / X-ray fluorescence (XRF) in order to determine the percentage of the following major oxides:

- SiO_2, Al_2O_3, Fe_2O_3, MgO, CaO, Na_2O, K_2O, TiO_2, P_2O_5, MnO, Cr_2O_3, and V_2O_5.

Bulk metal analysis evaluates the concentrations of major and trace elements by a multi-acid leach followed by ICP analysis so as to determine the concentrations of the following elements:

- Ag, Al, As, Ba, Be, Bi, Ca, Cd, Co, Cr, Cu, Fe, K, Li, Mg, Mn, Mo, Na, Ni, Pb, P, Sb, Se, Sn, Sr, Ti, Tl, U, V, Y and Zn.

A short-term leach test was performed on all samples to evaluate the metal leaching potential under laboratory conditions, with the aim of quantifying the concentrations of constituents in the samples that are readily soluble in water (ASTM D3987). Samples were mixed with DI water at a modified 4:1 liquid to solid ratio by weight in an extraction vessel. The vessel was shaken immediately and an initial pH was recorded. The slurry was then shaken for 18-hours, after which a final pH was measured and the supernatant was extracted for metal analysis including the following elements:

- Ag, Al, As, Ag, B, Be, Bi, Ca, Cd, Co, Cr, Cu, Fe, K, Li, Mg, Mn, Mo, Na, Ni, P, Pb, Sb, Se, Sn, Sr, Ti, Tl, U, V, W, Y and Zn.

Acid-Base Accounting (ABA) was conducted to evaluate the acid generation potential and neutralization potential of the three samples (MEND, 2009). A modified Sobek procedure was used to determine the following parameters: paste pH, sulphur species (total sulphur, sulphate and sulphide content), acid potential (AP) and neutralization potential (NP), and carbon species (total carbon and carbonate) (Sobek et al., 1978).

Geochemical Analytical Results

The results of the geochemical testing program are summarized in Tables 2 to 5 below.

Elemental Analysis

The whole rock and elemental analytical results are presented in Tables 2 and 3 respectively. A summary of the results is as follows:

- Silica is the predominant oxide (65.8 to 71.5%) with aluminum oxide (13.3 to 14.8%) the second most prevalent, compared to the other oxides. Oxides of iron, magnesium, calcium, sodium and potassium oxides were observed to be present in lower concentrations (1.23 to 4.87%).

- Aluminum concentrations ranged from 71,000 to 82,000 µg/L. The minimum and maximum concentrations were observed in 7B Sample 2 and TP16-1 Sample 2 respectively.

- Chromium concentrations ranged from 93 to 110 µg/L. The minimum and maximum concentrations were observed in TP7-2 Sample 3 and 14 Sample 2 respectively.

- Copper concentrations ranged from 15 to 27 µg/L. The minimum and maximum concentrations were observed in 14 Sample 2 and TP1-3 Sample 4 respectively.

- Iron concentrations ranged from 15,000 to 24,000 µg/L. The minimum and maximum concentrations were observed in TP7-2 Sample 3 and TP16-1 Sample 2 respectively.

- Nickel concentrations ranged from 17 to 35 µg/L. The minimum and maximum concentrations were observed in TP7-2 Sample 3 and 14 Sample 2 respectively.

- Lead concentrations ranged from 11 to 14 µg/L. The minimum concentrations were observed in 14 Sample 2 and TP16-1 Sample 2. The maximum concentrations were reported for 7B Sample 2 and TP1-3 Sample 4.

- Zinc concentrations ranged from 31 to 54 µg/L. The minimum and maximum concentrations were observed in TP7-2 Sample 3 and 14 Sample 2 respectively.

Table 2: Whole Rock Analysis Results (XRF)

Chemical Composition	Units	Sample ID					
		1A Sample 2	7B Sample 2	14 Sample 2	TP1-3 Sample 4	TP7-2 Sample 3	TP16-1 Sample 2
SiO_2	%	69.1	70.7	65.8	68.9	71.5	66.3
Al_2O_3	%	14.8	14.5	14.3	14.0	13.3	14.9
Fe_2O_3	%	3.68	3.31	4.65	3.20	3.02	4.87
MgO	%	1.75	1.39	1.99	1.42	1.23	2.14
CaO	%	2.18	2.59	2.96	2.02	2.55	3.23
Na_2O	%	4.21	3.92	3.35	4.07	3.89	3.90
K_2O	%	2.83	3.16	2.09	2.97	2.58	2.27
TiO_2	%	0.30	0.32	0.50	0.29	0.31	0.46
P_2O_5	%	0.08	0.08	0.15	0.07	0.09	0.12
MnO	%	0.05	0.03	0.08	0.05	0.04	0.07
Cr_2O_3	%	0.03	0.02	0.03	0.02	0.02	0.02
V_2O_5	%	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
LOI[1]	%	1.25	0.99	4.08	1.31	0.73	1.66
Sum	%	100.3	101.0	99.9	98.3	99.3	100.0

Notes:

(1) LOI - denotes Loss On Ignition, and reflects volatilized elements such as sulphur (SO_2), carbon (CO_2) and water of crystallization (H_2O) (Price, 1997)

Table 3: Solid Phase Metal Analysis (ICP) Results

PARAMETERS	UNITS	Sample ID					
		1A Sample 2	7B Sample 2	14 Sample 2	TP1-3 Sample 4	TP7-2 Sample 3	TP16-1 Sample 2
METALS							
Ag	µg/g	0.38	0.11	0.18	0.07	0.02	< 0.01
Al	µg/g	76000	71000	77000	79000	72000	82000
As	µg/g	< 0.5	< 0.5	0.9	< 0.5	< 0.5	< 0.5
Ba	µg/g	510	570	530	490	530	440
Be	µg/g	1.1	1.3	1.0	1.5	1.1	1.0
Bi	µg/g	< 0.09	< 0.09	< 0.09	< 0.09	< 0.09	< 0.09
Ca	µg/g	14000	17000	20000	15000	18000	22000
Cd	µg/g	0.11	0.11	0.18	0.17	0.12	0.13
Co	µg/g	9.6	7.9	12	9.1	7.2	12
Cr	µg/g	95	100	110	97	93	100
Cu	µg/g	23	17	15	21	18	27
Fe	µg/g	18000	16000	23000	16000	15000	24000
K	µg/g	19000	21000	14000	21000	18000	16000
Li	µg/g	16	13	15	14	10	16
Mg	µg/g	9400	7400	11000	8100	6800	12000
Mn	µg/g	420	340	540	360	330	510
Mo	µg/g	0.4	0.9	1.1	0.8	1.2	0.7
Na	µg/g	19000	17000	15000	19000	18000	18000
Ni	µg/g	25	20	35	22	17	29
P	µg/g	320	290	600	290	360	460
Pb	µg/g	13	14	11	14	12	11
Sb	µg/g	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8
Se	µg/g	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7
Sn	µg/g	1.6	1.0	1.4	1.0	1.4	1.7
Sr	µg/g	260	300	260	260	320	260
Ti	µg/g	1300	1500	2200	1200	1500	2100
Tl	µg/g	0.54	0.50	0.35	0.64	0.43	0.44
U	µg/g	1.1	1.2	1.1	1.4	1.0	1.3
V	µg/g	49	45	67	43	42	71
Y	µg/g	6.7	7.0	8.3	7.0	7.9	11
Zn	µg/g	43	34	54	36	31	44

Short-Term Leach Test

The results of the short-term leach test were compared with the Provincial Water Quality Objectives (PWQO) (Ontario Ministry of Environment and Energy, 1994). These results do not directly translate to the expected environmental behaviour of materials for several reasons, including:

- The relatively small sample size and volume of the sample;
- Potential heterogeneities in the sample;
- The short test duration; and
- The enhanced contact between liquid and the solid test charge due to agitation.

Although there are limitations with the testing, it is a very useful indication of leachable metals of concern. The key findings of the short-term leach test are reported in Table 4, and are summarized as follows:

- Leachate pH values were near-neutral to mildly alkaline, and ranged from 7.42 to 9.22;
- The leachate conductivity of TP16-1 Sample 2 was relatively high compared to that of the other five samples probably due to its high alkalinity;
- Aluminum and iron were the most abundant metals in all leachates. Aluminum concentrations ranged from 0.76 to 3.27 mg/L and were greater than the PWQO criterion (0.075 mg/L) for all samples. Iron concentrations ranged from 0.794 to 3.7 mg/L and were greater than the PWQO criterion (0.03 mg/L) for TP1-3 Sample 4 and TP7-2 Sample 3; and
- As shown in Table 4, additional metal concentrations in the leachates that were marginally greater than the PWQOs include the following: boron, chromium, copper, cobalt, lead, silver, vanadium and zinc.
- Sulphate concentrations for all sample leachates were less than 2 mg/L, except for TP16-1 Sample 2 that had a concentration of 19 mg/L.

Table 4: DI Water Leach Test Results

PARAMETERS	UNITS	PROVINCIAL WATER QUALITY OBJECTIVES (1-4)	Sample ID					
			1A Sample 2	7B Sample 2	14 Sample 2	TP1-3 Sample 4	TP7-2 Sample 3	TP16-1 Sample 2
Final pH	_	6.5-8.5	8.90	7.42	7.99	8.17	8.09	9.22
Alkalinity	mg/L as CaCO3		22	15	28	24	28	119
Acidity	mg/L as CaCO3		< 2	< 2	< 2	< 2	< 2	< 2
Conductivity	µS/cm		49	38	72	49	63	274
ANIONS								
Cl	mg/L		< 2	< 2	< 2	< 2	2.4	< 2
SO_4	mg/L		< 2	< 2	3.3	< 2	< 2	19
METALS								
Hg	mg/L	0.0002	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001
Ag	mg/L	0.0001	0.00026	0.00010	0.00012	0.00006	0.00006	0.00007
Al	mg/L	0.015, 0.075 (2)	0.76	1.37	2.42	1.68	3.27	2.30
As	mg/L	0.005	0.0011	0.0029	0.0015	0.0005	0.0027	0.0011
Ba	mg/L		0.00499	0.0108	0.0230	0.0169	0.0456	0.0223
B	mg/L	0.2	0.128	0.180	0.396	0.120	0.161	0.287
Be	mg/L	0.011, 1.1 (3)	< 0.00002	0.00002	0.00005	0.00005	0.00007	0.00006

PARAMETERS	UNITS	PROVINCIAL WATER QUALITY OBJECTIVES (1-4)	Sample ID					
			1A Sample 2	7B Sample 2	14 Sample 2	TP1-3 Sample 4	TP7-2 Sample 3	TP16-1 Sample 2
Bi	mg/L		0.00001	0.00001	< 0.00001	0.00001	0.00005	< 0.00001
Ca	mg/L		0.39	0.38	1.37	0.71	1.06	2.51
Cd	mg/L	0.0001, 0.005 (3)	0.000112	0.000069	0.000043	0.000074	0.000101	0.000025
Co	mg/L	0.0009	0.00226	0.00131	0.000861	0.00788	0.00780	0.00189
Cr	mg/L	0.001 (4)	0.0023	0.0014	0.0023	0.0043	0.0035	0.0065
Cu	mg/L	0.001, 0.005 (3)	0.0092	0.0096	0.0033	0.0263	0.0528	0.0191
Fe	mg/L	0.3	1.24	0.794	1.53	3.06	3.70	2.29
K	mg/L		0.355	0.459	0.661	0.466	0.560	0.953
Li	mg/L		0.001	< 0.001	< 0.001	0.001	0.002	0.002
Mg	mg/L		0.242	0.198	0.294	0.494	0.645	0.645
Mn	mg/L		0.131	0.0577	0.0620	0.215	0.147	0.0576
Mo	mg/L	0.04	0.00210	0.00087	0.00028	0.00064	0.00133	0.00161
Na	mg/L		11.4	7.24	14.7	10.2	14.3	66.4
Ni	mg/L	0.025	0.0017	0.0015	0.0012	0.0044	0.0053	0.0029
Pb	mg/L	0.001, 0.003, 0.005 (3)	0.00161	0.00119	0.00116	0.00461	0.00572	0.00223
Sb	mg/L	0.02	0.0005	0.0006	0.0005	0.0004	0.0005	0.0006
Se	mg/L	0.1	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Sn	mg/L		0.00009	0.00010	0.00011	0.00009	0.00009	0.00009
Sr	mg/L		0.0017	0.0021	0.0033	0.0039	0.0049	0.0069
U	mg/L		0.000124	0.000154	0.000089	0.000293	0.000892	0.000847
V	mg/L	0.006	0.00392	0.00249	0.00476	0.00496	0.0101	0.00603
Zn	mg/L	0.02	0.104	0.052	0.015	0.013	0.020	0.008

Notes:
0.1 - Denotes a value that is greater than PWQOs, but less than 10 times PWQOs.
0.1 - Denotes a value that is at least 10 times greater than PWQOs.
Concentrations are considered to represent "dissolved" concentrations (samples were filtered using 0.45 µm filter in the field
(1) MOEE (Ontario Ministry of Environment and Energy), 1994. Policies Guidelines Provincial Water Quality Objectives. Reprinted 1999.
(2) PWQO for Al depends on pH as follows: pH = 4.5-5.5, PWQO = 0.015 mg/L; PWQO = 10% of background concentration; pH >6.5-9.0, PWQO = 0.075 mg/L
(3) PWQO for Be, Cd, Cu and Pb depends on hardness. Assuming hardness will be >100 mg/L in receiving environment, the higher value for all ranges was selected for comparison purposes.
(4) PWQO for Cr is based on either hexavalent Cr (PWQO for Cr[VI] = 0.001 mg/L) or trivalent Cr (PWQO for Cr(III) = 0.0089 mg/L). The PWQO for Cr[VI] (most conservative form) is applied.

Acid-Base Accounting (ABA)

The ABA results are presented in Table 5. The paste pH values ranged from 6.49 to 9.28 (near-neutral to mildly alkaline) and the sulphide content was low (< 0.01 wt%) for all samples.

Table 5: Acid Base Accounting Test Results

PARAMETERS	UNITS	SAMPLE ID					
		1A Sample 2	7B Sample 2	14 Sample 2	TP1-3 Sample 4	TP7-2 Sample 3	TP16-1 Sample 2
Paste pH	-	8.77	8.12	6.49	8.28	9.28	8.18
Final pH	units	1.05	0.98	1.14	1.06	1.06	1.12
NP(1)	t CaCO3/1000 t	6.8	7.3	5.6	6.1	7.2	7.7
AP(2)	t CaCO3/1000 t	0.31	0.31	0.31	0.31	0.31	0.31
CO_3-NP(3)	t CaCO3/1000 t	2.08	3.17	83.01	2.08	1.25	3.42
Net NP	t CaCO3/1000 t	6.49	6.99	5.29	5.79	6.89	7.39

PARAMETERS	UNITS	SAMPLE ID					
NNP(4)	t CaCO3/1000 t	6.18	6.68	4.98	5.48	6.58	7.08
NPR(5)	ratio	21.90	23.50	18.10	19.70	23.20	24.80
Total Sulphur	%	< 0.005	< 0.005	0.020	< 0.005	< 0.005	0.019
Sulphate - Sulphur	%	<0.01	<0.01	0.02	<0.01	<0.01	0.02
Sulphide - Sulphur	%	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Total Carbon	%	0.025	0.038	0.996	0.025	0.015	0.041
Carbonate	%	0.030	0.025	0.030	0.025	0.025	0.040

Notes:
(1) Neutralization potential (NP) is determined using the Sobek method (Sobek, 1978).
(2) Acid potential (AP) is determined using the total sulphur values as follows: AP = Sulphide - Sulphur Content x 31.25.
(3) Carbonate neutralization potential (CO_3-NP) is calculated from the total carbon content as follows: CO_3-NP = Total carbon x (100.09/12.01) x 10
(4) Net neutralization potential (NNP) is calculated from the AP and NP values respectively: NNP = NP-AP
(5) NPR is calculated as follows: NPR = NP/AP. See Table 6 for acid generation potential criteria.

The potential for acid generation is usually interpreted using the net potential ratio (NPR) which is the ratio of neutralization potential (NP) to acid potential (AP), according to the guidelines recommended by MEND (2009), which are described in Table 6:

Table 6: Acid Generation Potential based on NP:AP ratio (based on MEND, 2009)

Acid Generation Potential	Criteria	Comments
Potentially Acid Generating	NPR < 1	Potentially acid generating, unless sulphide minerals are non-reactive.
Uncertain	1≤ NPR ≤ 2	Possibly acid generating, if NP is insufficiently reactive or is depleted at a faster rate than supplies
Non-Potentially Acid Generating	NPR > 2	Not expected to generate acidity

The NPR of all samples ranged from 18.1 to 24.8, indicating that acid generation is not expected. Carbonate neutralization potential (CO_3-NP) was calculated and found to be less than NP for all samples, indicating that significant neutralization may result from non-carbonate minerals.

Geochemical Conclusions

Conclusions drawn from the results of the geochemical testing were as follows:

- The whole rock data indicated that all samples comprised mostly silica and aluminum oxides. Oxides of iron, magnesium, calcium, sodium and potassium oxides were present in marginal quantities (> 5 wt%).
- The short-term test results indicated that aluminum and iron were the most abundant trace metals in all sample leachates. Aluminum and iron concentrations in leachates were elevated relative to the PWQO criteria. Other metals reporting sporadic concentrations slightly greater that the PWQO criterion were silver, boron, cobalt, chromium, copper, zinc, lead, vanadium and zinc. The final pH of all samples leachates ranged from 7.42 to 9.22.

The ABA results indicated that all the samples are considered to be non-acid generating, based on the low sulphide contents (<0.01 wt%) and the NPR criteria. The NPR ranged from 19.7 to 24.8 for all samples.

Given that the materials are expected to be non-acid generating based on the ABA testing completed, it was considered that the shake flask extraction (or short term leach) test was suitable for evaluation of leaching potential, thus no humidity cell testing was completed on these samples.

Overburden in the pit and site areas has been subjected to weathering over the past several thousands of years and is currently contributing to the water quality of the basin, as such it is not expected that removal or movement of this overburden will change the overall water quality. Although overburden directly over the pit has not been tested, as part of the feasibility evaluation, some samples of nearby potential aggregate material have been collected and tested for geochemistry. Based on geochemical testing of these overburden samples and the evaluation of the host rock chemistry the overburden is expected to be non-acid generating with low metal leaching potential.

As part of the construction monitoring and management overburden will be moved and stockpiled, and it will be necessary during construction and operations to continue to monitor for ARD and ML potential to confirm initial estimates and adjust management practices if necessary.

GOLDER ASSOCIATES LTD.

Ken DeVos, M.Sc., P.Geo.
Principal, Senior Geochemist
KDV/sp

CC: Adam Auckland

Attachments: Figure 1: Borrow Source Identification Summary of Sample Locations

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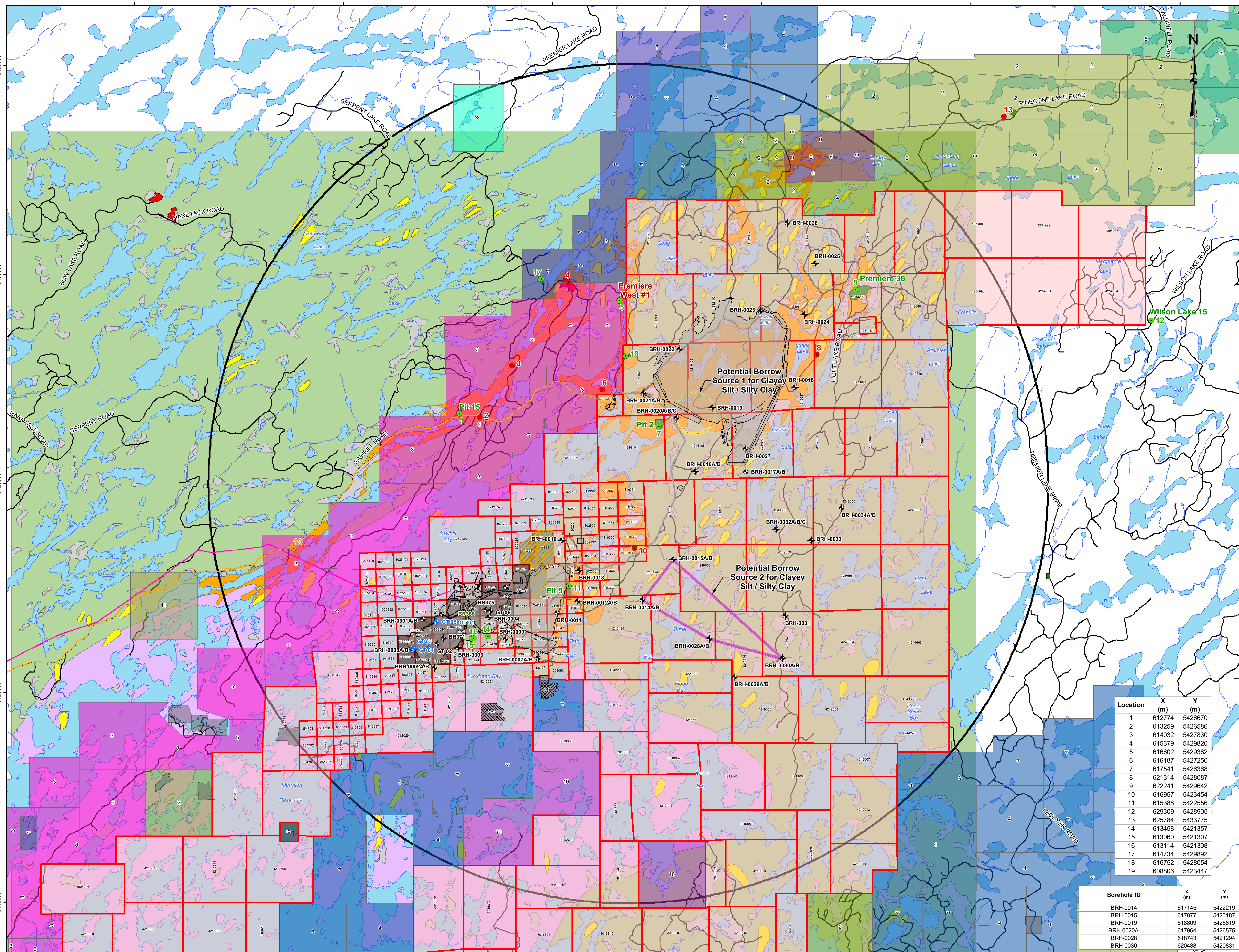

Location	X (m)	Y (m)
1	612774	5426670
2	613259	5426586
3	614032	5427830
4	615379	5429820
5	616602	5429382
6	616187	5427250
7	617541	5426368
8	621314	5428087
9	622241	5429642
10	616957	5423454
11	615388	5422556
12	629309	5428905
13	625784	5433775
14	613458	5421357
15	613060	5421307
16	613114	5421308
17	614734	5429892
18	616752	5428054
19	608806	5423447

Borehole ID	X (m)	Y (m)
BRH-0014	617145	5422219
BRH-0015	617877	5423187
BRH-0019	618809	5426819
BRH-0020A	617964	5426575
BRH-0028	618743	5421294
BRH-0030	620488	5420831

LEGEND

- Potential Borrow Site Visited - Sample Not Taken
- Potential Borrow Site Visited - Sample Taken
- Potential Borrow Site Observed - Sample Not Taken
- Geotechnical Hole - Golder 2011 (Televiewered and Piezometer Installed)
- Geotechnical Hole - Golder 2011 (Logged Only)
- Geotechnical Hole - Golder 2011 (Televiewered and Logged)
- Mine Site Road
- Access Road
- Project Transmission Line
- Mine Facilities
- Aggregate Site Authorized - Active
- Aggregate Site Authorized - Surrendered
- Potential Borrow Source 1 for Clayey Silt / Silty Clay
- Potential Borrow Source 2 for Clayey Silt / Silty Clay
- Approximate 10 km Radius around the Site

Claims

- OSISKO Mineral Claims
- OSISKO Dispositions
- Manley Patents - Osisko Dispositions (Mining Rights Only) *
- Disposition Ownership Uncertain
- Other Dispositions
- 1 Asselin, Robert/Kulik, Henry Stanislaus
- 2 Bjorkman, Karl Everett
- 3 Bjorkman, Karl Everett/Davidson, Blaine Robert
- 4 Bjorkman, Karl Everett/Fenwick, Kenneth George
- 5 Bjorkman, Karl Everett/Fern Elizabeth Gold Exploration Ltd.
- 6 China Metallurgical Exploration Corp.
- 7 Fancamp Exploration Ltd.
- 8 Natti, Eric Olavi
- 9 Saunders, David Bruce
- 10 Sparton Resources Inc.
- 11 Thurier, Todd Garnet

HOLOCENE NONGLACIAL ENVIRONMENT

Terrain Unit and Significance to Mineral Exploration

Organic Terrain

Areas where peat and muck are greater than 1m, constituting bogs and muskeg, low-lying floodplains (peat underlain by sand) and lake shore swamps. Significant detriment to exploration due to masking effect of thick organic material and creation of false anomalies by spurious concentration of metals.

PLEISTOCENE GLACIAL ENVIRONMENT

Finlayson Moraine

A continuous, long and narrow ridge of sand and gravel, with a hummocky surface. The bedrock surface is nearly always buried by thick gravel in areas of end moraine, but in a few places moraine ridges have a core of solid rock. Exposures of the moraine show a delta morphology, indicating a sub-aqueous ice margin. Local bedrock geochemical and geophysical signatures are masked by thick, exotic gravel deposits, but up-ice mineralized bedrock sources may be detected using drift prospecting methods.

Outwash Deltas and Meltwater Channels

Sand and gravel deposits are found in broad valleys at the head of Marmion and Finlayson Lakes. Thicknesses vary widely from >10m to less than 1m and bedrock is exposed sporadically. These deposits consist of subaqueously deposited, parallel-laminated, graded bed of coarse/fine sand and open-work gravels overlain by bouldery, gravel deposits. Deposits are considered detrimental to geochemical prospecting because of far-travelled material diluting a local bedrock signature. Sand deposits are probably more extensive than mapped.

Till Veneer-Discontinuous

Bedrock outcrop interspersed with deposits of till. 10-80% outcrop. Topography controlled by bedrock Till is divisible into two facies: Unit 1: silty-sandy, locally-derived basal facies. Unit 2: Bouldery sandy ablation facies with high erratic content. Terrain is suitable for prospecting and geochemical/ geophysical surveys as local bedrock is either at surface or within 1m, burried by a locally-derived till Soil may be too thin for sampling. Occasional deposits of thick ablation till may mask local bedrock.

Scoured Bedrock

Bedrock outcrop or moss/boulder covered outcrop, devoid of sediment cover. Outcrops moulded by ice action with ubiquitous striations and grooves. Waterlain boulders, gravel and sand were the only sediment boulders, gravel and sand were the only sediment found in exposures throughout Marmion Lake. A period of intense meltwater flow may also be indicated and may account for the lack of sediment cover. Terrain suitable for prospecting because bedrock is ubiquitous. Soils may be thin or absent.

Rock Drumlin: rock-cored hill streamlined by glacier erosion

NOTE

* Surface rights on patent X314 are being acquired by OHRG.

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Claims - Provided by OSISKO Hammond Reef Gold Project Ltd. (2010)
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

0 5,000

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

BORROW SOURCE IDENTIFICATION SUMMARY OF SAMPLE LOCATIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 11-1118-0074			SCALE AS SHOWN	REV. 0
DESIGN	CGE	30 May. 2012	FIGURE: 1	
GIS	JO	1 Feb. 2013		
CHECK	IM	1 Feb. 2013		
REVIEW	KAB	1 Feb. 2013		

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PART C

Geochemistry, Geology and Soils Technical Support Document, Version 1

February 2013

OSISKO
HAMMOND REEF GOLD

HAMMOND REEF GOLD PROJECT

Geochemistry, Geology and Soil Technical Support Document

VERSION 1

Submitted to:
Osisko Hammond Reef Gold Ltd.
155 University Avenue, Suite 1440
Toronto, Ontario M5H 3B7

Project Number: 10-1118-0020

Document Number: **2012-060**

Distribution:

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Golder Associates

Hammond Reef Gold Project
Geochemistry, Geology and Soils Technical Support Document

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Date: February 19, 2013

Reviewed by: Ken DeVos, M.Sc., P.Geo.
Principal, Project Director
Golder Associates Ltd.

Date: February 19, 2013

Table of Contents

TABLES

FIGURES

APPENDICES

1.0 INTRODUCTION

Osisko Hammond Reef Gold Ltd. (OHRG) proposes the development of an open pit gold mine in north-western Ontario, herein referred to as the Hammond Reef Gold Project (Project). This Technical Support Document (TSD) is one of a series of reports in support of the Project's Environmental Impact Statement/Environmental Assessment Report (EIS/EA Report).

The following reports have been prepared to support the EIS/EA Report:

- Atmospheric Environment TSD.
- **Geochemistry, Geology and Soil TSD.**
- Hydrogeology TSD.
- Hydrology TSD.
- Water and Sediment Quality TSD.
- Site Water Quality TSD.
- Lake Water Quality TSD.
- Aquatic Environment TSD.
- Terrestrial Ecology TSD.
- Aboriginal Interests TSD.
- Cultural Heritage Resources TSD.
- Human Health and Ecological Risk Assessment TSD.
- Socio-economic Environment TSD.
- Alternatives Assessment Report.
- Conceptual Closure and Rehabilitation Plan.

The EIS/EA Report will summarize the findings of this TSD and of the above-listed supporting reports.

1.1 Purpose and Scope

The purpose of this TSD is to fulfill the assessment scope outlined in the Project's Terms of Reference (ToR) approved by the Ontario Minister of the Environment (July 2012), and in the Environmental Impact Statement Guidelines (EIS Guidelines) published by the Canadian Environmental Assessment Agency (CEA Agency) (December 2011).

This TSD describes the existing conditions of the geological, geochemical and soil environment and their predicted variability where applicable over Project phases. The assessment is broken down into the following subcomponents:

- Geology.
- Geochemistry.
- Terrain and soils.

The overall objective of the programs completed and described in the TSD is to provide specific information at a level sufficient for inclusion in the EIS/EA Report in order to guide decision making regarding the potential for environmental effects of the Project, or to allow for further analyses as part of other TSDs or work related to the environmental assessment.

Specific objectives of the geology (Section 2) and geochemistry (Section 3) sections include:

- Provide a description of the geological properties of the materials to be encountered or disturbed.
- Develop a geochemical database sufficient for inclusion in the EIS/EA Report.
- Develop an understanding of potential influencing factors that can be used in estimation of water quality and water quantity predictions.
- Provide sufficient information to guide environmental management and material handling decisions.

Specific objectives of the terrain and soils (Section 4) section is to:

- Provide an understanding of terrain and soils in the vicinity of the Project and potential changes to terrain that may result from the Project.
- Identify soil chemistry and trace element existing conditions including details of sample analyses.
- Evaluate possible erosion considerations and identify soil monitoring requirements if necessary.
- Provide information for use in assessment of terrestrial habitat and erosion implications as defined in the Terrestrial Ecology TSD and in the EIS/EA report.

The results as presented in this TSD are used in the EIS/EA Report, Terrestrial Ecology TSD, and Site Water Quality TSD.

1.2 Report Organization

Given the differences in methods between the geological, geochemical, terrain and soils aspects of this TSD each of these sections are treated independently in Sections 2 through 4. Within each of these sections the methods used to gather and evaluate the data are presented followed by a discussion of relevant, related results. To summarize, the TSD is structured as follows:

- Section 1 provides an overview of the purpose and scope of this TSD and overall aspects of the Project as they relate to the TSD topics (i.e., geology, geochemistry, and terrain and soils).
- Section 2 the presents the key geological information relevant to the Project.
- Section 3 presents the geochemistry program including:
  - Geochemical methods used.
  - Discussion of the results of the geochemical assessment.
- Section 4 provides the terrain and soils description program including:
  - Methods used to evaluate terrain and soils.
  - Discussion of the results of the terrain and soils assessment.
  - Summary of erosion management and monitoring strategy.

1.3 Project Overview

The Project overview and Project description is provided in Chapter 5 of the EIS/EA Report. Characteristics of the Project setting that influence the development of the geology, geochemistry and terrain and soils programs and resulting interpretation of the data are described in Sections 1.3 to 1.8.

1.3.1 Project Location

The Project is located within the Thunder Bay Mining District in north-western Ontario, approximately 170 km west of Thunder Bay and 23 km northeast of the town of Atikokan (Figure 1-1).

Access to the Hammond Reef property is presently via two routes: the Premier Lake Road, a gravel road that intersects Highway 623 near Sapawe and the Hardtack-Sawbill Road, a gravel road that intersects Highway 622 northwest of the Town of Atikokan. The Project Site is also accessible by water from the southwest end of the Marmion Reservoir at its access point from Highway 622. The existing Hardtack-Sawbill road located to the north of Finlayson Lake has been upgraded to provide an improved and more direct linkage to the Project Site in support of the expanded exploration program.

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.;
Base Data - MNR NRVIS, obtained 2004. Produced by Golder Associates Ltd
under licence from Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

100 0 100 200 300 400
SCALE 1:10,000,000 KILOMETRES

Golder Associates
Mississauga, Ontario

DATE	January, 2013	TITLE	PROJECT LOCATION
DESIGN	CGE		
GIS	JO		
CHECK	REJ	PROJECT	HAMMOND REEF GOLD PROJECT ATIKOKAN, ONTARIO, CANADA
REVIEW	KJD	FIGURE: 1-1	

PROJECT No. 10-1118-0020
SCALE AS SHOWN VERSION 1

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The Hammond Reef deposit is located mainly on a peninsula of land extending into the north end of the Upper Marmion Reservoir. The peninsula containing the deposit is surrounded by the Marmion Reservoir on three sides with Sawbill Bay to the northwest and Lynxhead Bay to the southeast. The property also contains a number of smaller lakes. Mitta Lake is a small, steep-sided water body located atop mineralized zones of the deposit. Due to its location, the open pit mining activities require the draining of Mitta Lake. Lizard Lake is located immediately to the east of the proposed Project Site and drains into Marmion Reservoir.

1.3.2 Climate

The Project is located in a typical boreal climate region, which is characterized by long, usually very cold winters, and short, cool to mild summers. The annual temperature average is 1.6°C for Atikokan with a seasonal maximum of 16.2°C (average) for summer and a minimum of minus 15.4°C (average) for winter. Temperatures lower than minus 37°C have been recorded during the fall and winter. The annual normal total for precipitation is 788 mm (568 mm of rainfall and 220 mm of snowfall) for Atikokan with a seasonal maximum of 299 mm for the summer period.

1.3.3 Project Phases

The Project comprises four phases: construction, operations, closure and post-closure. Additional details regarding activities expected to take place in each phase of the Project are provided in Chapter 5 of the EIS/EA Report. With respect to geochemistry, geology and soil the existing information needs to be collected prior to construction.

1.3.4 Project Components

The existing pre-construction conditions need to be understood when collecting existing information including:

- Existing road access.
- Existing exploration camp and previous exploration activities.

An understanding of the Project components and proposed locations is also necessary to ensure adequate spatial coverage of existing information and appropriate data regarding materials to be relocated is obtained. The Project consists of eight main components:

- Mine, including two open pits (east pit and west pit).
- Waste Rock Management Facility (WRMF).
- Ore Processing Facility.
- Tailings Management Facility (TMF).
- Support and Ancillary Infrastructure.
- Water Management System.
- Linear Infrastructure.

- Borrow Sites.

Proposed Project components are shown in Figure 1-2. A detailed description of Project components is provided in Chapter 5 of the EIS/EA Report.

1.4 General Assessment Approach

The assessment presented in this TSD includes the following key steps:

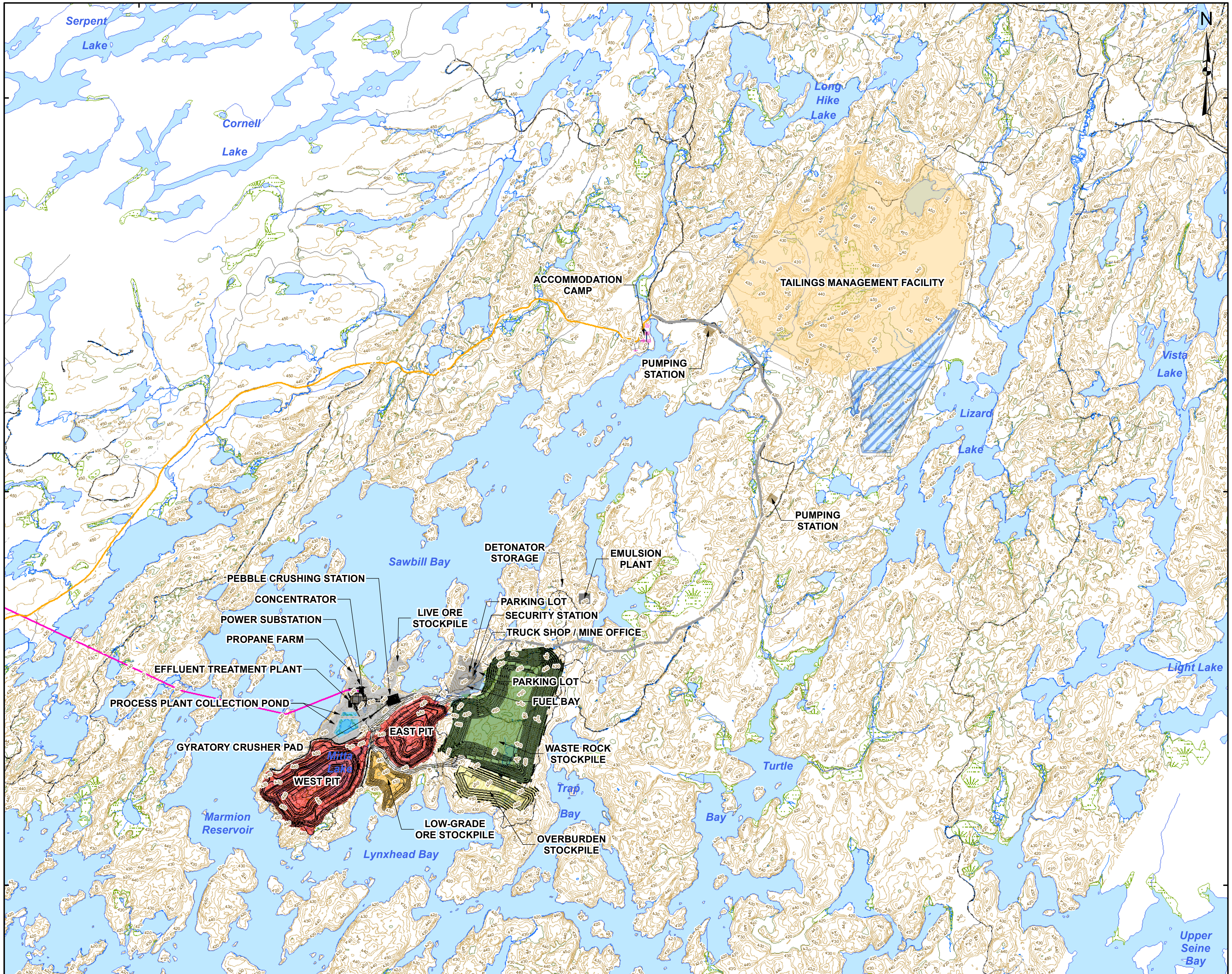
- Step 1: Carry out a screening of Project activities to determine which activities have the potential to interact with the environment (i.e. a review of the mine plan, and planned placement of the facilities).
- Step 2: Identify temporal and spatial boundaries of the assessment.
- Step 3: Identify parameters used to characterize potential changes to the environment.
- Step 4: Design and carry out field studies and/or background research to characterize the existing environment, and to support the prediction of potential changes to the environment as a result of the Project.
- Step 5: Carry out a predictive evaluation of potential changes to the environment during the Project phases. In the case of the geological and geochemical evaluation these aspects provide inputs to modelling conducted as described in the Site Water Quality TSD and Lake Water Quality TSD.
- Step 6: Outline the monitoring requirements for each Project phase to confirm predicted changes to the environment and to ensure that requirements are being met for identified parameters.

This TSD is intended to support the EIS/EA Report and as such does not assess the significance of potential effects on the geochemical, geological, and terrain and soils environment; nor does it identify mitigation measures. These topics are addressed in the EIS/EA Report and in other TSDs.

1.5 Incorporation of Traditional Knowledge

Traditional knowledge is valuable in achieving a better understanding of the Project's potential effects on the environment. It also contributes to the description of the existing biophysical and human environment, natural cycles, resource distribution and abundance, and the use of land and water resources.

A detailed discussion on traditional knowledge is included in the Aboriginal Interests TSD, including any aspects relevant to geology, geochemistry, and terrain and soils.



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LEGEND

- Index Contour (5m interval)
- Ditch
- Marsh/Swamp
- River/Stream
- Road
- Trail
- Lake
- Wetland
- Mine Site Road
- Access Road (Hardtack / Sawbill)
- Project Transmission Line
- Accommodation Camp
- Laydown Area
- Office and Truck Shop, Explosives Storage and Processing Plant
- Open Pits
- Low-Grade Ore Stockpile
- Overburden Stockpile
- Process Plant Collection Pond
- Pumping Station
- Tailings Management Facility
- Tailings Management Facility Reclaim Pond
- Waste Rock Stockpile

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004
Produced by Golder Associates Ltd under licence from Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

500 0 500 1,000 1,500 2,000 2,500
SCALE 1:50,000 METERS

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
SITE LAYOUT

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020			SCALE AS SHOWN	VERSION 1
DESIGN	CGE	14 Nov. 2008	FIGURE: 1-2	
GIS	JO	4 Feb. 2013		
CHECK	REJ	4 Feb. 2013		
REVIEW	KJD	4 Feb. 2013		

1.6 Selection of Valued Ecosystem Components

Valued ecosystem components (VECs) are not selected for geology, geochemistry, and terrain and soils. These provide input parameters for assessing impacts on overall land use and water quality. Potential effects of the Project on VECs are not discussed in this TSD, however the information provided in this TSD is evaluated in other TSDs in their consideration of VECs. Land use is described in the Aboriginal Interests TSD, Terrestrial Ecology TSD, and Socio-economic Environment TSD. Water quality is addressed in the Water and Sediment Quality TSD, and Lake Water Quality TSD.

1.7 Effects Assessment

Geology, geochemistry, and terrain and soils are components of the environment which inform the assessment of effects of the Project, but are not in and of themselves the endpoints of the assessment. As such, the effects assessment of potential changes to geology, geochemistry, and terrain and soils is presented in the EIS/EA Report and in the following supporting documents:

- Aquatic Environment TSD.
- Terrestrial Ecology TSD.
- Site Water Quality TSD.
- Socio-economic Environment TSD.
- Human Health and Ecological Risk Assessment TSD.

1.8 Temporal and Spatial Boundaries

1.8.1 Temporal Boundaries

The temporal boundary to determine existing conditions is pre-construction. Temporal boundaries for Project phases and the duration of these phases are:

- Construction phase: 30 months.
- Operations phase: 11 years.
- Closure phase: 2 years.
- Post-closure phase: Duration of pit flooding (78 years) and release plus 10 years.

This TSD presents the pre-construction existing geology, geochemistry, terrain and soils conditions. Geology is not expected to change over all Project phases other than material relocation and grain size changes due to blasting and grinding.

1.8.2 Spatial Boundaries

Spatial boundaries define the geographical extents within which potential environmental changes may occur. As such, spatial boundaries become the Project's study areas for the purposes of sample collection and evaluation. The study areas for the collection of geology, geochemistry, and terrain and soils information were selected based on the following factors:

- The Project footprint.
- The location of users (Socio-economic Environment TSD).

This TSD has three study areas, as described in the following sections.

1.8.2.1 Regional Study Area

For this TSD the Regional Study Area (RSA) is relevant to the geological setting only. The Project Site is located in Ontario at approximately 150 km west of Thunder Bay and 23 km northeast of the Town of Atikokan. Regional mapping is available from the Ontario Ministry of Natural Resources (MNR 2004) and supplemented by additional information where available. Figure 2-1 provides an illustration of the RSA boundaries.

1.8.2.2 Local Study Area

Local Study Area (LSA) maps are subsets of the regional mapping provided by the Ontario Ministry of Natural Resources (MNR 2004) and supplemented by additional information where available. The LSA extends generally to the middle of Sawbill and Lynxhead Bays of Marmion Reservoir on the west and south sides respectively, the Lizard Lake catchment area to the east is also included. Figures showing the RSA and LSAs are provided in Sections 2.2, 3.2.1 and 4.3.

1.8.2.3 Mine Study Area

The Mine Study Area encompasses the footprints of the Mine, the Waste Rock Management Facility, the Ore Processing Facility, the Tailings Management Facility, and the Support and Ancillary Infrastructure (Project boundary as shown in Figure 1-2). Borrow Sites are not included, as they are subject to a separate permitting process.

2.0 GEOLOGY

A description of the geological conditions including surface and bedrock geology, regional and local setting, metamorphism, lithology, rock types and structure, cross-sections, colour and texture is included in this section as well as the geochemical mineralogical descriptions (Section 3) and the Hydrogeology TSD. This TSD in combination with the Hydrogeology TSD fulfils the recommended information requirements as defined in the ToR and EIS Guidelines.

Background information in this section is based on data previously published by OHRG through public filings (Rennie et al. 2009) and from a review of geological information and core samples during site visits.

2.1 Quaternary Geology

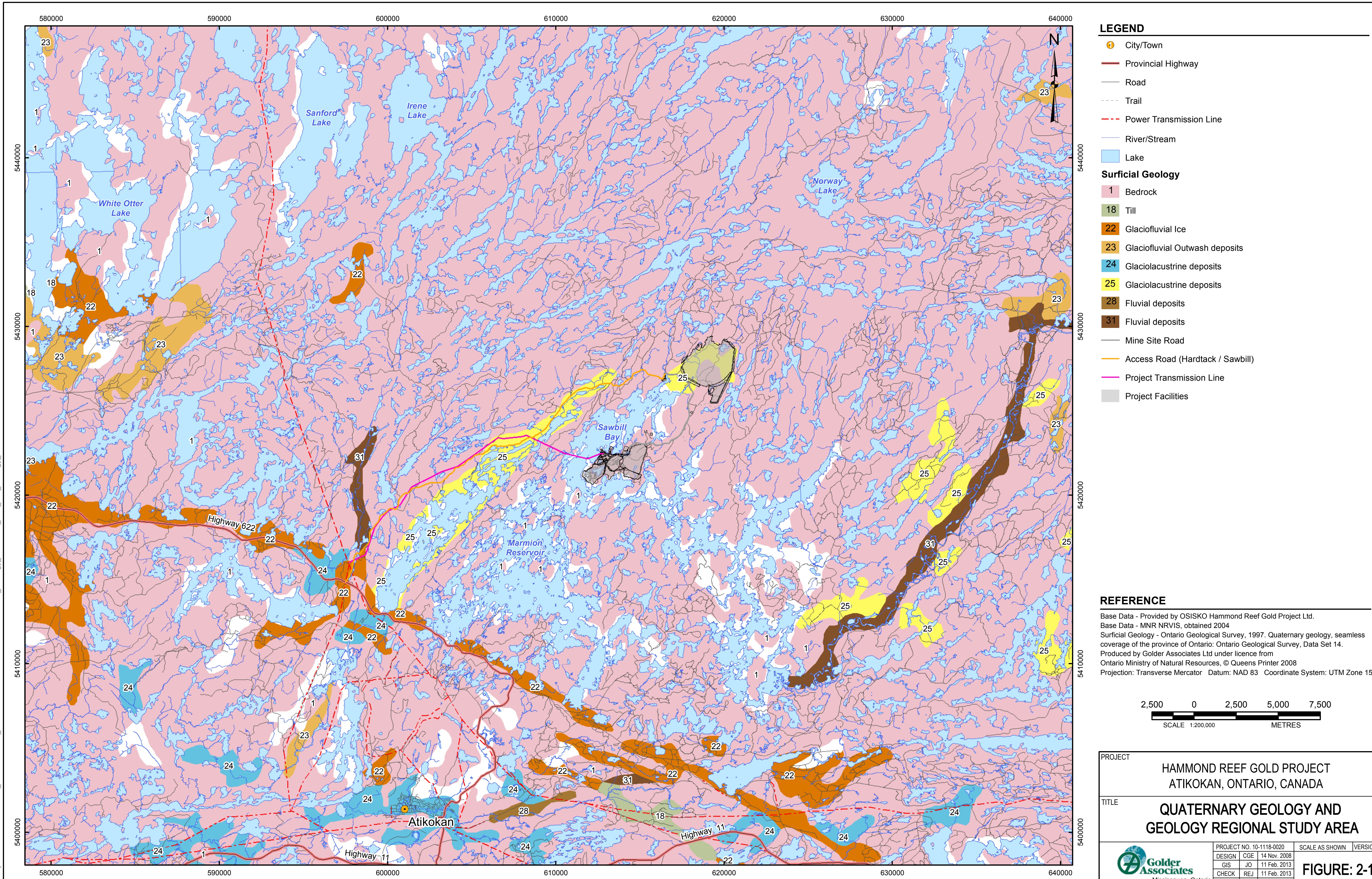
As indicated in Ontario Geological Survey Open file Report 5986, the surface sediments in the RSA are discontinuous due to bedrock outcrops, and consist predominately of a thin, discontinuous veneer of drift (till) over bedrock (Dyer 1999). Within the RSA modern fluvial deposits occupy major river valleys, such as along the Seine River (Dyer 1999). Glaciolacustrine deposits may contain sand silt or clay and may occur in localized zones. One of these zones containing sand and silt till is located to the northeast of Marmion Reservoir. A zone of glacolacustrine wet silt with organics is also found immediately at the north end of Sawbill Bay (Figure 2-1). Section 4 provides more detail on surface deposits, soils and terrain.

2.2 Regional Geology

The Hammond Reef property is underlain by Archean rocks of the Canadian Shield. Geologically, it is located in the Marmion batholith of the central Wabigoon sub-province in the western Superior Province near the northwest trending contact with the Finlayson Greenstone Belt (Figure 2-2, Appendix 2.I). It is flanked to the south by the Quetico sub-province (Blackburn et al. 1991, DST 2009).

The central Wabigoon subprovince is a granite-greenstone assemblage. It consists of thin, anastomosed greenstone belts separated by large, commonly oval felsic intrusive rocks. The greenstone belts comprise metamorphosed and highly deformed packages of mafic volcanic rocks with lesser components of intermediate to felsic volcanic rocks, intrusive rocks and sedimentary rocks (DST 2009).

The Mesoarchean Marmion batholith is a fault-bounded assemblage in the southern part of the central Wabigoon sub-province. Elongated in the east-west direction, it is approximately 100 km long and 30 km wide. It extends from Marmion Reservoir in the west to the village of Upsala in the east. Lithologically, the Marmion batholith is a diverse assemblage of felsic intrusive rocks described as biotite tonalite to granodiorite. It is predominantly tonalite in composition but varies from pegmatite to diorite (Stone 2008a, 2008b). Gneissic tonalite remnants and local rafts of mafic xenoliths are incorporated in the intrusive melt that was later invaded by ultramafic to felsic dykes. The west end of the Marmion batholith is terminated by the north-northeast trending Marmion Fault. In the area of the Project Site, the Marmion Fault is a complex braided zone of fault segments that have an important role in gold mineralization.



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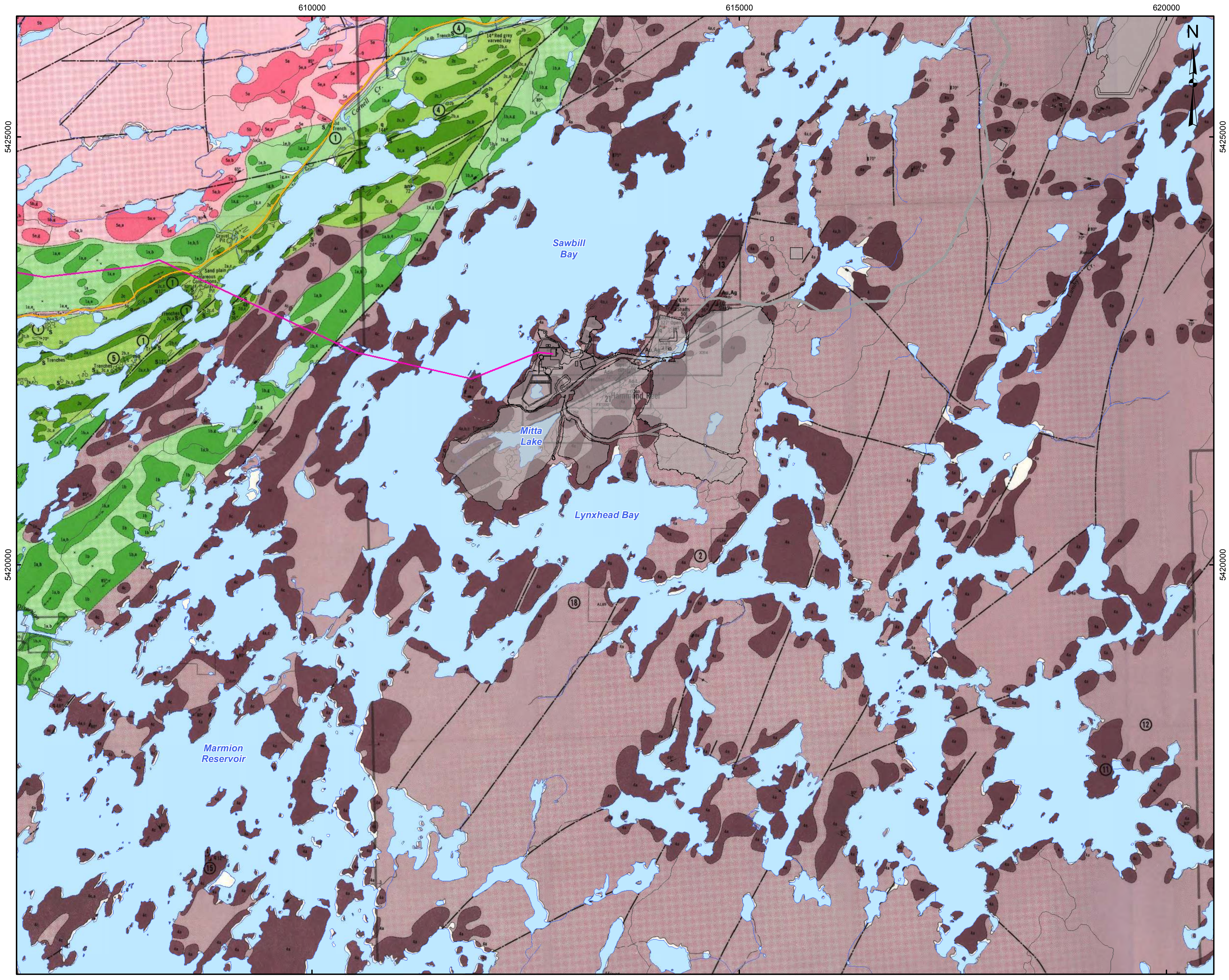

LEGEND

CENOZOIC[a]
QUATERNARY
RECENT
Lake, stream and swamp deposits.
PLEISTOCENE
Sand, gravel, clay, varved clay.
UNCONFORMITY

PRECAMBRIAN[b]
EARLY PRECAMBRIAN (ARCHEAN)

MAFIC INTRUSIVE ROCKS
- 6a Diabase.
- 6b Lamprophyre and andesite.

INTRUSIVE CONTACT

FELSIC INTRUSIVE ROCKS
DASHWA LAKE BATHOLITH[c]
- 5 Unsubdivided.
- 5a Biotite and hornblende granite, quartz monzonite, porphyritic trondhjemite.
- 5b Granite gneiss, quartz monzonite gneiss.
- 5c Pegmatite.
- 5d Aplite.f
- 5e Feldspar-quartz porphyry.
- 5f Mylonite.f
- 5g Migmatite.

CONTACT RELATIONS UNCERTAIN

MARMION LAKE BATHOLITH[c]
- 4 Unsubdivided.
- 4a Biotite and hornblende trondhjemite.
- 4b Quartz-sericite schist.
- 4c Complex of felsic intrusive rocks, metavolcanic rocks, and mafic dikes.

INTRUSIVE CONTACT

METASEDIMENTS
- 3 Unsubdivided.
- 3a Conglomerate.f
- 3b Greywacke, arkosic grit.
- 3c Quartzite.f
- 3d Graphitic argillite.
- 3e Slate.f
- 3f Phyllite.f
- 3g Biotite-feldspar-quartz schist.f
- 3h Intercalated metasediments and metavolcanics.f

Iron Formation.f

METAVOLCANICS AND METASEDIMENTS
FELSIC TO INTERMEDIATE METAVOLCANICS
- 2 Unsubdivided.
- 2a Massive lava.
- 2b Quartz-sericite schist.
- 2c Intermediate volcanic rocks, minor intercalated mafic tuff and lava.
- 2d Tuff, agglomerate, pillow lava.
- 2e Feldspar porphyry.f

Iron Formation.

MAFIC TO INTERMEDIATE METAVOLCANICS
- 1 Unsubdivided.
- 1a Massive lava.
- 1b Chlorite schist, chlorite carbonate schist.
- 1c Pillow lava.
- 1d Tuff, agglomerate.
- 1e Amphibolite, hornblende schist.
- 1g Coarse-grained volcanic or mafic intrusive rock.
- 1h Tuffs and intercalated metasediments.f

Iron Formation.f

- Road
- Trail
- River/Stream
- Lake
- Mine Site Road
- Access Road (Hardtack / Sawbill)
- Project Transmission Line
- Project Facilities

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004
Bedrock Geology - Fenwick, K.G. 1976. Marmion Lake - Rainy River District Bedrock Geology; Ontario Geological Survey, Map 2298.
Produced by Golder Associates Ltd under licence from Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

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SCALE 1:45,000 METRES

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
BEDROCK GEOLOGY IN THE MARMION LAKE AREA

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020			SCALE AS SHOWN	VERSION 1
DESIGN	CGE	14 Nov. 2008	FIGURE: 2-2	
GIS	JO	11 Feb. 2013		
CHECK	REJ	11 Feb. 2013		
REVIEW	KJD	11 Feb. 2013		

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These units are all variably sheared and altered along a 1 km to 6 km wide anastomosing deformation corridor that runs along the entire length of the Marmion batholith and is sub-parallel to the contact with the Finlayson Greenstone Belt. The Marmion Deformation Corridor (MDC) is the locus of numerous gold occurrences along its entire length, including the Hammond Reef deposit. As with other structurally-controlled gold deposits around the world, the Hammond Reef deposit occurs within a significant flexure of the MDC.

The MDC displays numerous characteristics of brittle-ductile deformation, including moderately to strongly sheared rocks, brecciation, veining and stockwork. The veins and stockwork are generally composed of quartz ± carbonate (ankerite-calcite) ± chlorite ± sulfides. Brecciation and quartz stockwork are more common, particularly within the tonalite. Quartz veins tend to be best developed within or at the contacts of the mafic dykes and xenoliths. The MDC is also characterized by an alteration overprint where the original plagioclase-biotite-hornblende mineral assemblage of the fresh tonalite was altered to a sericite-chlorite-ankerite-hematite assemblage during a late Archean (Neoarchean) hydrothermal or metamorphic episode. Gold was probably introduced during this late Archean episode, along with pyrite and accessory sulfides and tellurides.

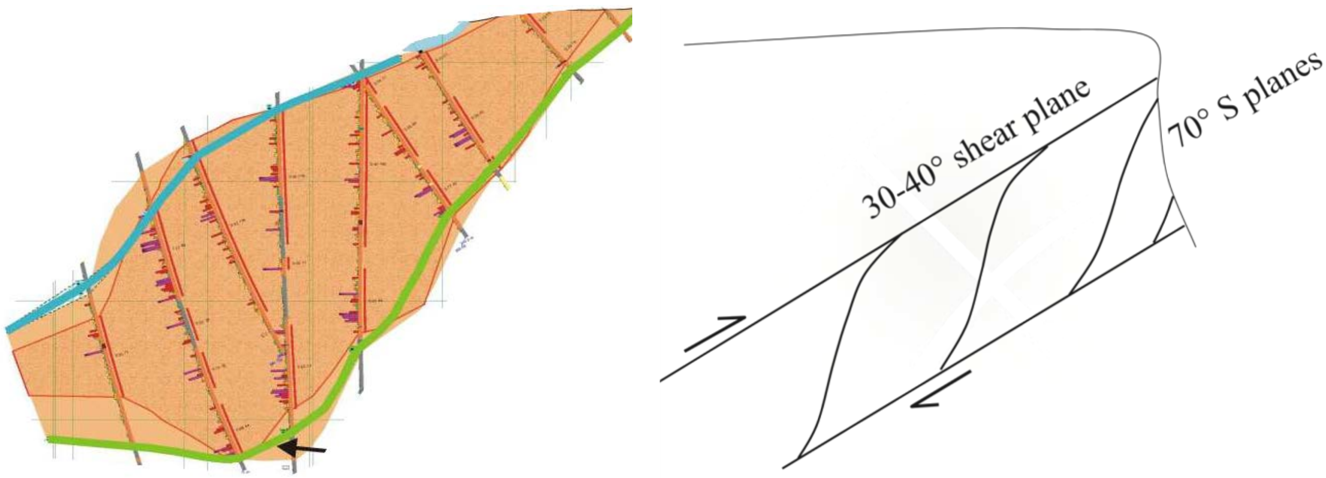
A late west-north-west trending Proterozoic mafic dyke, which outcrops south of the Hammond Reef deposit, intrudes all the above units and post-dates the gold mineralization. The main rock units expected to daylight in the pit walls are, in general, tonalite, chloritic tonalite, fine grained tonalite, and sericite-chlorite-ankerite-hematite altered granitoid.

2.3 Site Geology

2.3.1 Major Geological Structures

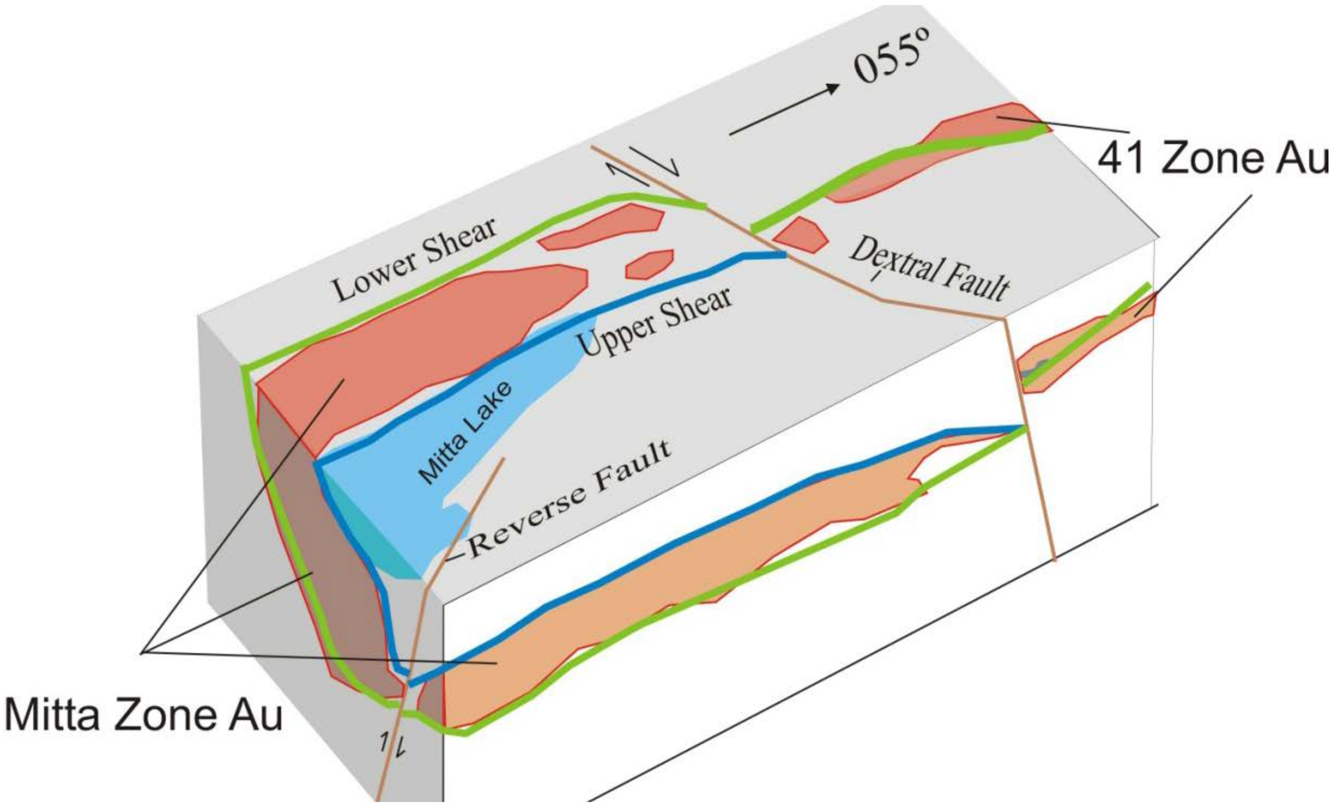
The north-north-east trending MDC was probably emplaced during a late Archean compressional or transpressional shear event. The main compressional direction was northwest-southeast, with resultant extension in the orthogonal directions. This compressional event was the second of five identified through detailed mapping and the one believed to be synkinematic with the gold mineralization, alteration and veining. Lineation measurements of the S-C fabric in outcrop along with the arcuate shallowing of the main ore body tend to point to an important reverse or thrust component (Figure 2-3). Regionally, several parallel shallow-dipping faults have been identified south of the ore body, some with alteration and gold mineralization similar to the Hammond Reef deposit and others intruded by Neoarchean ultramafic sills.

Two main shear zones were identified in the A Zone, the Upper Shear and Lower Shear, with several en echelon subsidiary shears in between. These two shears encompass the pervasively altered tonalite and much of the gold mineralization in this zone. The smaller 41 Zone is similar to the A Zone in many respects although it does not appear to be bound by the Upper and Lower Shears. Instead, the 41 Zone is bisected by one main shear (SAF shear) that is interpreted to be the northeast extension of the Lower Shear in the A Zone. A late stage dextral fault displaces the 41 Zone from the A Zone (Figure 2-4).



Source: Fedorowich 2010, Villeneuve 2011.

Figure 2-3: Cross-section (looking southwest) through the Ore Mimics Outcrop Scale S-C Fabric



Source: Villeneuve 2011.

Figure 2-4: Structural Components of Ore Body

2.3.2 Mineralization and Ore Deposit

Figure 2-5 outlines the different zones that make up the Hammond Reef deposit. In addition to A Zone and 41 Zone, three new zones were delineated through the OHRG advanced exploration project – the South A Zone, the Mitta Zone and the South Mitta Zone. The Mitta Zone is the mineralized interval over Mitta Lake between the two original zones. The South A and South Mitta Zones are down-dip lobes of the main A Zone and Mitta Zone, respectively.

Four ore types were identified through the geological work completed by OHRG (2013 Feasibility Report) and are shown in (Figures 2-4, 2-5, 2-6, and 2-7):

Type 1a - Structurally confined mineralization: Between A Zone and Mitta Zone (Sections 1695E to 2575E) the gold mineralization and strong to moderate pervasive alteration are confined between two shear zones (Figure 2-4), the Upper and the Lower Shears. In this central part of the ore body, the two controlling shears (Upper and Lower) confine the pervasive sericite/ankerite alteration (orange unit on Figures 2-4 and 2-5) as well as the mineralization. Above and below these two shears, the hanging wall rocks and the footwall rocks (tonalites) are only sporadically mineralized and altered.

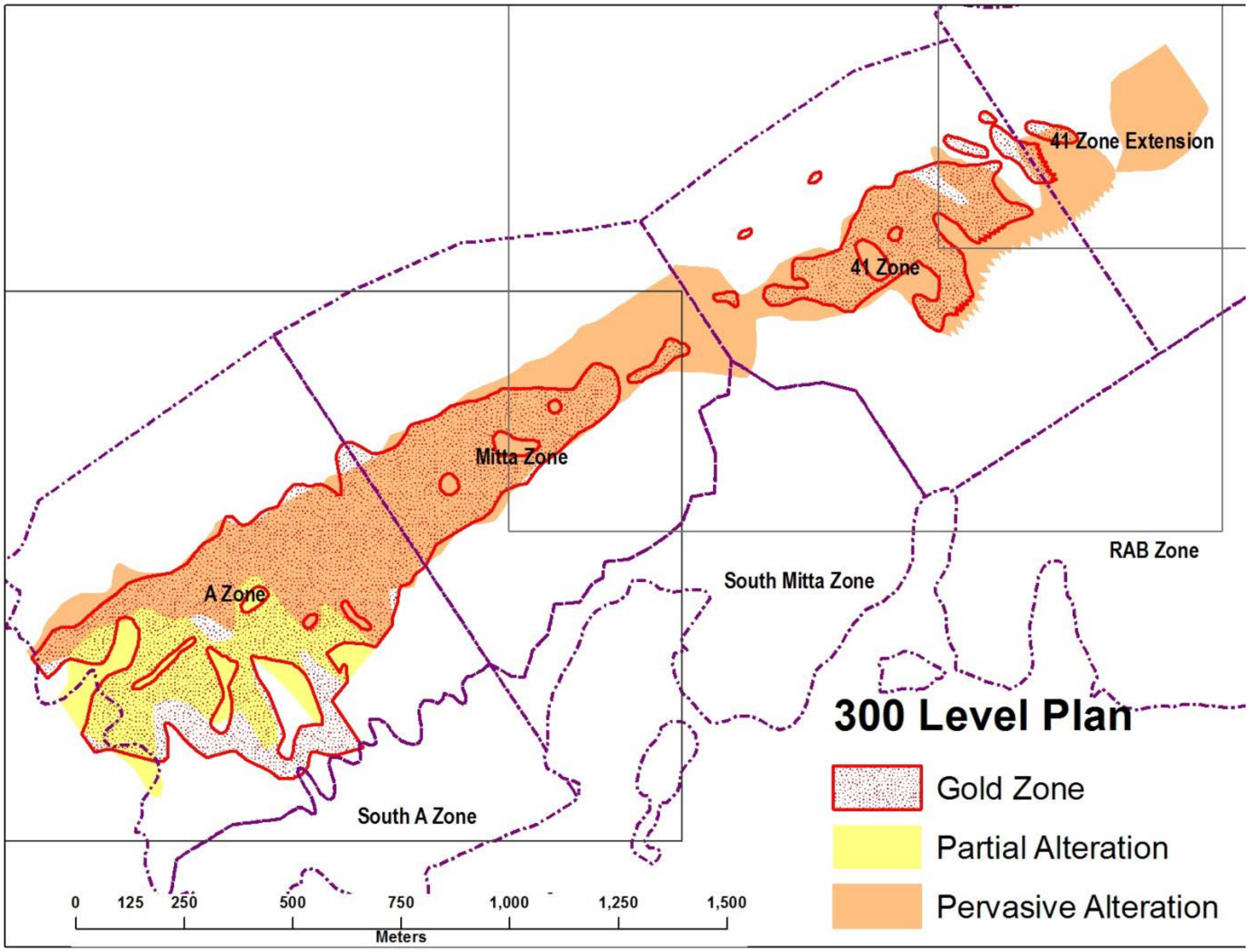
Type 1b - 41 Zone style: At the eastern end of the deposit, the 41 Zone (Section 3155E to 3420E) exhibits slightly different mineralization and alteration features. The mineralization is hosted in strongly to moderately and pervasively altered tonalite similar to what is observed in Type 1, except both the alteration and mineralization are not as clearly confined between two distinct shears (Figure 2-4). The Upper and the Lower Shears appear to merge into one shear called the SAF. The SAF shear is asericite-ankerite-fuschite schist which bisects both the alteration and the mineralization (Figure 2-6, Section 3245E). Moreover, fuschite is also part of the alteration assemblage. The SAF shear cuts across the 41 Zone from top to bottom of the mineralized envelope.

Type 2 - Partially altered tonalite: Observed in the western portion of the A Zone and the deeper part of the South A Zone (Sections 1020E to 1670E, Figure 2-3) where gold mineralization occurs in partially altered tonalite above the Lower Shear. In this portion of the deposit, the Upper Shear disappears or is more diffuse, while the alteration becomes more patchy and intermittent in a unit of partially altered tonalite (Illustrated in yellow in Figures 2-4 and 2-5). The gold mineralization also extends into these lesser altered tonalites. The alteration assemblages are similar to those observed in Type 1 mineralization above but the alteration is patchy or spotty leaving about 50% of the tonalite unaltered.

Type 3 - Mineralization in 'unaltered' rocks: Occurring principally in the western part of the deposit, down dip from A Zone (Sections 1020E to 1670E, Figures 2-4 and 2-5) the gold mineralization is hosted in what would have often been described as unaltered tonalites (Figure 2-6, Section 1210E). At closer look, however, these auriferous green tonalites are in fact altered by a chlorite/carbonate alteration accompanied by pyrite. In turn, the pyrite is associated with fractures, veinlets and veins filled with various combinations of chlorite, calcite and quartz. The pyrite is either in the fractures, veinlets or veins, usually with the chlorite or in the vein wall rock over a few centimeters on either side of the features. If pyrite is absent from the assemblage, usually no gold values are observed.

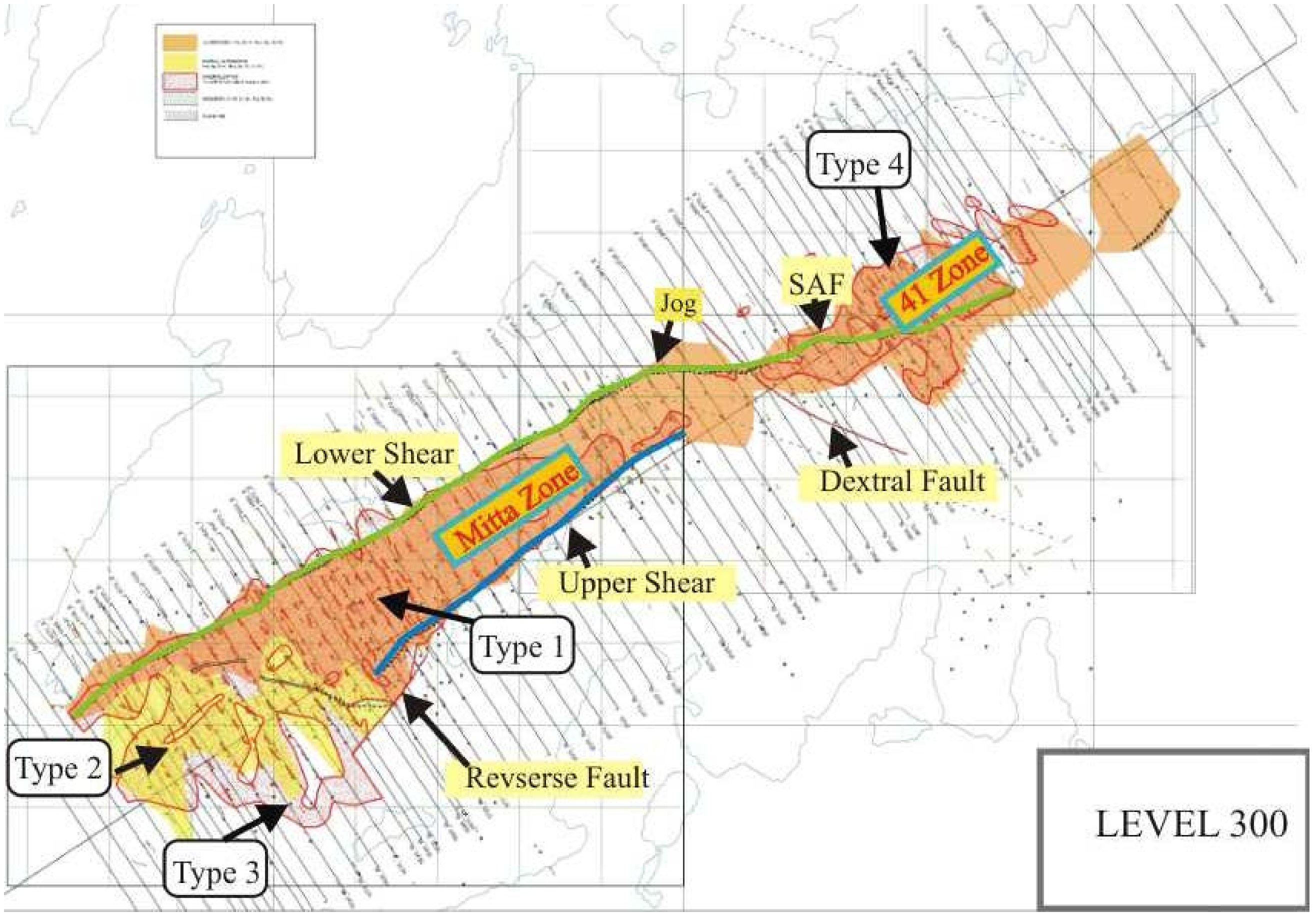
Gold mineralization at the Hammond Reef deposit occurs mainly as native gold inclusions in pyrite. To a lesser degree, gold tellurides (petzite, hessite) are found as inclusions in pyrite as well. A considerable proportion of the native gold is found along healed fractures in pyrite, along py-py contacts, and at pyrite-silicate boundaries (usually involving sericite, chlorite and quartz). A subordinate number of native gold grains occur at silicate-silicate contacts. In one sample, native gold inclusions were also found in magnetite. The most common minerals that are spatially and temporally associated with native gold and petzite are galena, chalcopyrite and hessite.

Early probe work on the native gold grains indicates that most are actually electrum, a gold-silver alloy. The electrum at the Hammond Reef deposit is approximately 90% gold and 10% silver. Mineral resources and grade of the resource will be provided in the OHRG 2012 feasibility reports (expected in December 2012).



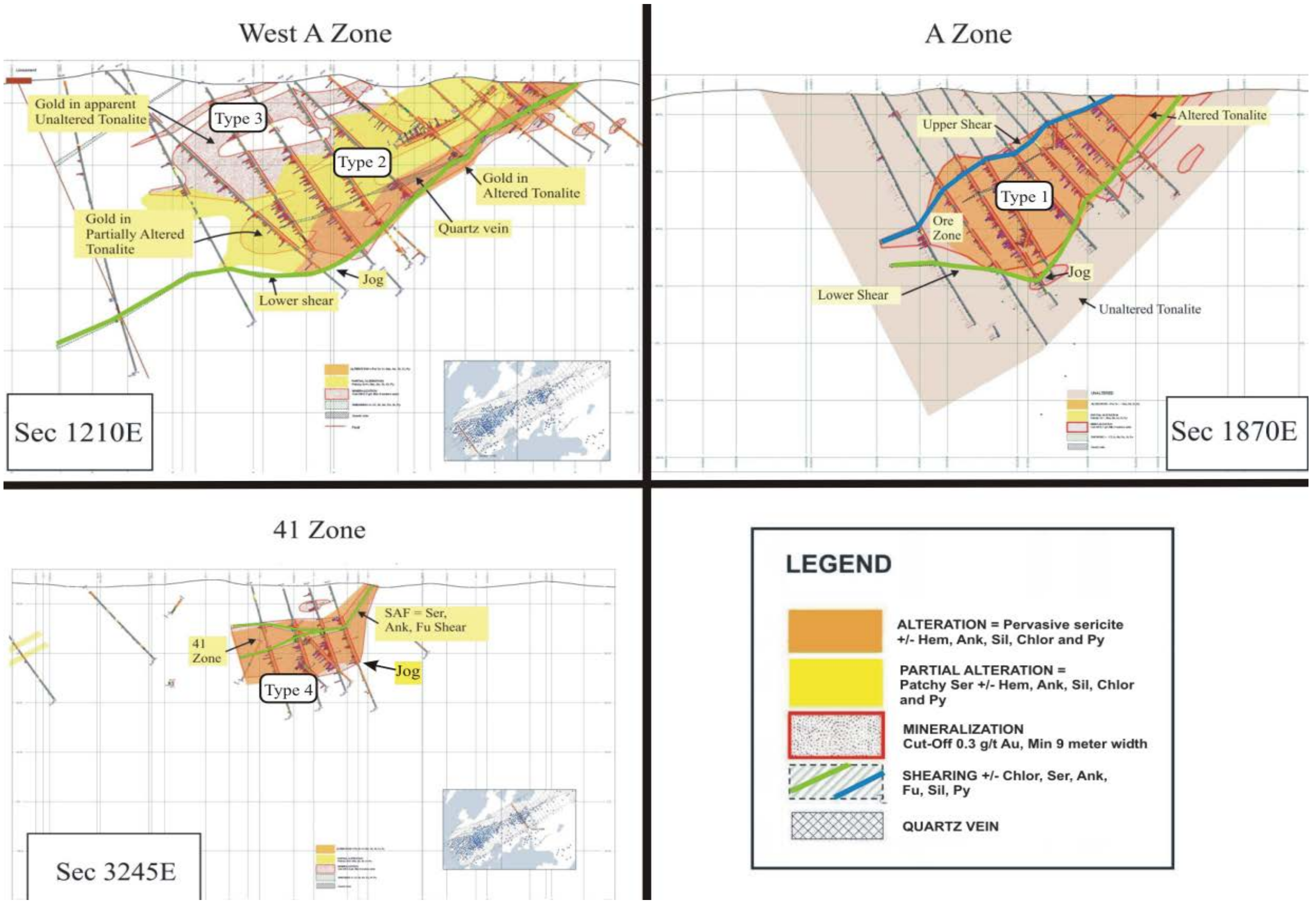
Source: OHRG 2012.

Figure 2-5: 300 Level Plan with the Location of the Mineralized Zones



Source: Villeneuve 2011.

Figure 2-6: Ore Deposit Cross-Sections with Ore Types



Source: Villeneuve 2011,

Figure 2-7: Detailed Ore Deposit Cross-Sections with Ore Types

3.0 GEOCHEMISTRY

OHRG retained Golder to conduct a geochemical characterization program at the Project Site to meet the requirements of the Project's EIS Guidelines and ToR, and to assist with Project planning. The results of the geochemical characterization are presented in Section 3.5.

The geochemical characterization program was carried out to determine the acid generation and metal leaching behaviour of the waste rock and tailings and to determine the expected quality of the water associated with the tailings. The sample selection, collection, analytical testing and interpretation of results are consistent with international guidelines (Price 1997; MEND 2009; INAP 2012). This work is also consistent with the requirements listed in Regulation 240/00 of the Ontario *Mining Act*.

The geochemical characterization program evaluates the geochemical characteristics of mine waste materials, which will be generated once the Project is approved and mining commences. As such, the program focuses on forward-looking information (i.e., predictions of how wastes will behave once they are excavated and/or stored on the surface).

The only relevant observations with respect to the existing conditions of the geochemical environment are those related to the water quality. Detailed information concerning this topic can be found in the Hydrogeology TSD and the Water and Sediment Quality TSD.

3.1 Objectives

Existing conditions data were collected to meet the requirements of the EIS Guidelines and ToR and to be consistent with provincial and federal requirements. Regulation 240/00 of the Ontario *Mining Act* also requires that materials encountered during proposed mining projects undergo geochemical characterization.

The primary objective of the geochemical characterization program is to provide sufficient data for the evaluation of the environmental behaviour of the various waste materials expected to be produced during mining and mineral processing. Components of this objective include:

- Identify methods used for assessment.
- Identification of mine materials (i.e., overburden, waste rock, ore and tailings) that may generate elevated acid rock drainage (ARD) and/or metal leaching (ML).
- Quantification of mineral reactions to develop metal leaching rates.
- Identification key factors that could influence site water quality including mitigation or management strategies.
- To provide input to engineering design and other environmental evaluations for the Project (such as data required to assess feasibility of management options).
- Fulfilling other requirements under the ToR and EIS Guidelines (Section 3.6.3).

The geochemical characterization includes the following tasks:

- Review of the site geology and general mine location.
- Collection of drill core samples.
- Static testing of mine material.
- Kinetic testing of a selected subset of mine materials.
- Data evaluation and characterization of ARD/ML potentials of all collected materials.

The characterization of these materials will help develop waste and water management designs, assist in avoiding, managing and limiting environmental impacts, aid in designing sustainable closure strategies, and assist with the engineering design. The results of the geochemical characterization are integral for the impact assessments related to other disciplines such as water quality, human health and ecological risk, aquatic environment, terrestrial ecology, and socio-economics.

The scope of work is consistent with the EIS Guidelines, ToR and the guidance documents that have gained regulatory acceptance in jurisdictions around the world and include:

- Draft Guidelines and Recommended Methods for the Prediction of Metal Leaching and Acid Rock Drainage at Minesites in British Columbia (Price 1997).
- Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials (MEND 2009).
- Global Acid Rock Drainage (GARD) Guide (INAP 2012).

3.2 Methods

The geochemical work was performed to characterize and evaluate the existing environment and to provide existing conditions data to support the environmental assessment process and permitting for the Project. Geochemical work comprised consultation with regulatory agencies, Aboriginal engagement, a review of existing data sources, and sampling programs.

Feedback from various regulatory agencies was received as part of consultation on the EIS Guidelines, the Project Description and ToR but none were applicable to the geochemistry existing program. Any traditional knowledge information gathered through Aboriginal engagement activities with respect to geology, geochemistry, and terrain and soils is presented in the Aboriginal Interests TSD.

3.2.1 Local Study Area

The geochemical characterization specifically focuses on the extraction of ore from two proposed open pits. All samples were collected from drillholes that are located within the mining claim, or generated from material within that claim.

The geochemistry LSA contains the Hammond Reef deposit, the Mine including the two open pits (i.e., east pit and west pit), all Project infrastructure, and all associated servicing and maintenance areas. The ore body, waste rock stockpile, Ore Processing Facility and other infrastructure are confined to the peninsula upon which the Hammond Reef deposit occurs, while the TMF is located to the northwest of the peninsula and north of Sawbill Bay (Figure 3-1).

3.2.2 Secondary Data Review

Data source reviewed for the geochemistry characterization include:

- Published reports and literature that describe the geology and mineralization of the deposit.
- Reports describing drill logs, geological mapping, cross-sections and conversations with site geologists.
- Information included in geochemical guidance documents (i.e., Price 1997, MEND 2009, INAP 2012) and published literature that describe the mechanism of acid rock drainage.

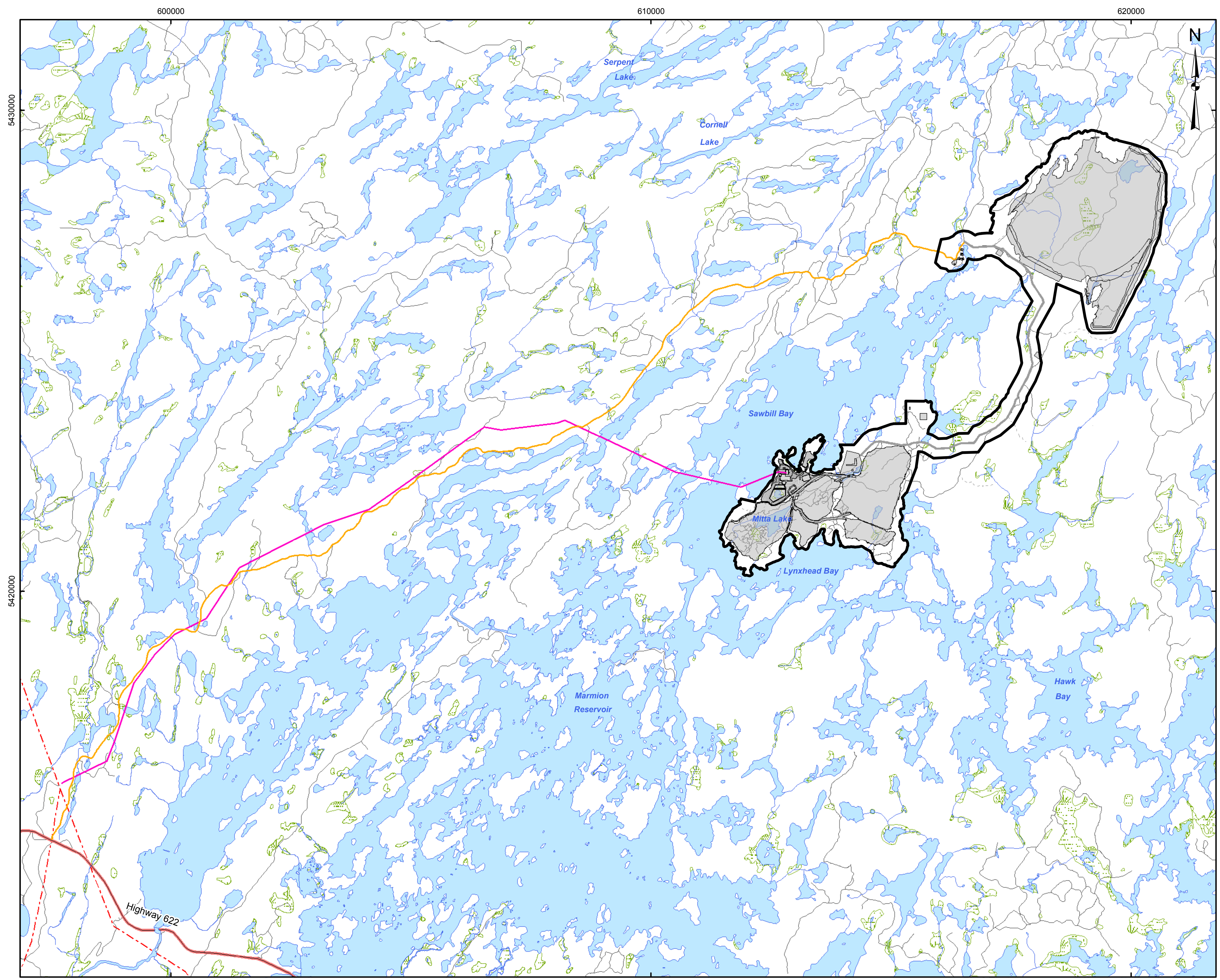
A summary of the information listed above is included in the following sections and data sources are referenced where appropriate.

3.2.2.1 Geochemical Implications of Geology

There is a direct correlation between pyrite concentration and gold values. The mineralized bodies are predominantly composed of quartz with lesser percentages of chlorite, calcite, sericite and less than 1% pyrite. Trace amounts of galena, chalcopyrite, sphalerite, pyrrhotite, bornite, chalcocite and native gold are present. Telluride, strometerite and molybdenite have also been identified. A grey metallic mineral that is considered an excellent indicator of the presence of gold has been identified as a bismuth telluride (Smyk 2009, pers. comm., cited in DST 2009).

Neutralizing minerals include some carbonate within the veins and stockwork which are generally composed of quartz ± carbonate (ankerite-calcite) ± chlorite ± sulfides. The main rock units expected to daylight in the pit walls are, in general, tonalite, chloritic tonalite, fine grained tonalite, and sericite-chlorite-ankerite-hematite altered granitoid. The aluminosilicate mineral potassium feldspar is a component of the tonalite that will occur in the pit faces and waste rock.

The geochemical samples were collected using an assumed total waste rock tonnage of 420 Mt and assuming the process would produce 17.2 Mm^3 of tailings. Based on the updated values as presented in Chapter 5 of the EIS/EA Report it is considered that the geochemical sampling program as described herein is relevant and appropriate for the Project.



LEGEND

- Provincial Highway
- Road
- Trail
- Power Transmission Line
- River/Stream
- Lake
- Wetland
- Mine Site Road
- Access Road (Hardtack / Sawbill)
- Project Transmission Line
- Project Facilities
- Geochemistry Local Study Area

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

1,000 0 1,000 2,000 3,000 4,000
SCALE 1:80,000 METERS

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
GEOCHEMISTRY LOCAL STUDY AREA

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020			SCALE AS SHOWN	VERSION 1
DESIGN	CGE	14 Nov. 2008	FIGURE: 3-1	
GIS	JO	11 Feb. 2013		
CHECK	REJ	11 Feb. 2013		
REVIEW	KJD	11 Feb. 2013		

G:\Projects\2010\10-1118-0020_BrettResources_HammondReef\GIS\MXDs\Draft\Geochemistry\TSD\Geochem_LSA.mxd

3.2.2.2 Mechanisms for Acid Rock Drainage and Metal Leaching

Waste rock and tailings are two types of materials that are by-products of mining. Waste rock is the material that is removed to access the ore deposit. Waste rock is often stored in piles and contains some mineralization due to its proximity to the ore deposit, but at grades that are not considered to be economical.

Mine tailings are principally composed of the uneconomic gangue minerals that are separated from the ore constituents through milling and concentration processes. Once the ore minerals have been isolated, the uneconomic fraction, or tailings, is typically deposited into a contained management facility.

Typically, gangue minerals within waste rock and tailings are comprised of silicate, aluminosilicate, carbonate, oxide and uneconomic metal sulphide minerals. Exposure of waste rock and tailings to atmospheric conditions can result in the oxidation of metal sulphide minerals, the generation of acidity and the release of constituents into the dissolved phase. Pore water within the waste rock and tailings can migrate through the subsurface and transport oxidation products into the groundwater and nearby surface water bodies. The generation of acidic and metal-rich waters, as a result of sulphide oxidation, is commonly referred to as Acid Rock Drainage (ARD).

The acidity produced through oxidation reactions may be attenuated by gangue minerals that contain neutralizing capacity. Carbonate minerals, for example, are particularly important neutralizing minerals, since they are generally the most effective in counteracting acidic conditions. Other gangue minerals such as aluminosilicates or silicates may also contribute to the overall neutralization potential, but the dissolution of aluminosilicate and silicate minerals are kinetically limited (Jambor et al. 2003). Gangue minerals are only significant neutralizing minerals under low-pH conditions (less than 4.5) or where water-rock interaction times are very long (Blowes et al. 2004). If the amount of neutralizing minerals is insufficient, significant quantities of acidity may be released and mobilized as a result of the oxidation of sulphide minerals.

3.3 Primary Data Collection

3.3.1 Sample Selection and Collection

The number of samples required to suitably characterize the waste rock and tailings materials is dependent on the Project phase and homogeneity of the materials encountered. Based on a review of drill records and drill core on site the Hammond Reef deposit is essentially a single tonalite unit with minor mafic dyke material which has been subdivided as identified in Table 3-1. Given the observed homogeneity of the materials and similarity of results from the materials as discussed in this TSD it is considered that the number of samples (123) selected are suitable for the initial geochemical evaluation. As the Project moves through permitting, feasibility, and operations it will be necessary to continue to collect samples for geochemical analyses to confirm design parameters and closure strategies.

Table 3-1 provides a summary of the sub-units within the overall granodiorite sequence, including dykes and number of samples collected. Detailed descriptions and a listing of these samples are included in Appendix 2.II.

Table 3-1: Waste Rock and Tailings Sample List

Rock Type	Samples Collected	
	Number	Percentage
Waste Rock	**123**	**100%**
Chloritic Granite	31	25%
Tonalite	30	24%
Fine Grained Granite	16	14%
Pegmatite	11	9%
Mafic Dyke	9	7%
Altered Granitoid	8	6%
Chloritic Granite Porphyry	5	4%
Minor Units[(a)]	13	11%
Tailings[(b)]	**1 (split)**	**100%**

Notes:

(a) Includes aplite, diorite, gneiss, sheared mafic unit, sheared granitoid, tectonized-sheared vein zone, quartz vein zone and intermediate dyke.

(b) Tailings sample resulted from process test work and is representative of the appropriate blended waste products from this testing. The tailings sample was split and analysed in duplicate.

A description on each of the waste rock types is included in Section 3.3.1.1.2. A description of the tailings samples is included in Section 3.3.1.2. The methods for waste rock and tailings sample collection are provided in the following sections.

3.3.1.1 Waste Rock

The waste rock sampling program included analysis of both major (more than 1% of waste rock) and minor (less than 1% of waste rock) rock types. Major lithologies include fine-grained granite, chloritic granite, tonalite, altered granitoid, pegmatite, mafic dykes and chloritic granite porphyry. Minor units include aplite, diorite, gneiss, sheared mafic unit, sheared granitoid, tectonized sheared vein zone, quartz vein zone and intermediate dykes. Less than five samples were collected for each minor lithology. Of note is that many of the rock types observed (with the exception of the mafic materials) are geochemically similar and are grouped together for the purposes of waste rock geochemical evaluation.

3.3.1.1.1 Waste Rock Sampling

A sample program including 123 samples was developed, and sample numbers for each lithology were determined based on the rock types observed. Drill holes were selected for sampling based on both lithologies logged and spatial and stratigraphical representativeness, using cross sections and plan views provided by OHRG.

Samples were collected by Golder during one site visit to the core storage facility and OHRG office in Atikokan conducted in September 2010. In consultation with site geologists, core was laid out at site and the identified samples were collected consistent with the following procedures:

- The following information from the drill holes and core was recorded:
  - A description including a unique sample number, drill hole, sample depth/interval.
  - Rock type.
  - Photographs and visual description of the core sample (oxidization/weathering characteristics, estimate of sulphide content).
- Approximately 5 kg of core for each sample was collected in order to conduct laboratory tests. The samples were collected as follows:
  - The sample was collected over a continuous 10 m interval. To collect a sample from discreet rock types, in some instances, shorter intervals were sampled where the continuity of the rock type was smaller.
  - Sub-samples were taken from 1 m intervals (for example a 10 m sample interval required 10 sub-samples of about 0.5 kg each).
  - Each sub-sample was approximately equal in weight and visually representative of the interval of the core.
  - The sub-samples were combined into a single sample bag to develop the sample for the interval.
  - The sample bag was labelled with a unique sample identification number.
- Samples were then packaged and prepared for shipment to the analytical laboratory (SGS Canada Inc., Lakefield, Ontario).

A summary of the samples descriptions, including borehole identification (ID), rock code, and a detailed description by Golder during sampling, are shown in Appendix 2.II.

3.3.1.1.2 Waste Rock Types

As can be observed in the rock type descriptions presented in this section the composition of most waste rock is dominated by potassium feldspar, plagioclase and quartz. The rock types have been further subdivided based on specific occurrences, visual properties and characteristics of the minerals as described.

Chloritic Granite

The unit is generally fine to medium grained and medium grey to green. Chloritic granite is composed of primarily potassium feldspar, plagioclase and quartz, with strong pervasive chlorite alteration. Unaltered granite zones were observed as minor units throughout the chloritic granite. Generally, trace to no sulphides were observed in this unit.

Tonalite

The unit is fine to coarse grained and generally light grey to pink in colour. Tonalite is primarily composed of plagioclase and potassium feldspar. Weak to moderate pervasive chlorite alteration occurs throughout the unit, and generally no sulphides were observed.

Fine Grained Granite

The unit is fine grained and generally grey or light pink, composed primarily of plagioclase and potassium feldspar. Potassium feldspar and carbonate veinlets occur throughout the unit in most cases. Patchy hematite alteration and rusty fracture surfaces were observed, along with trace pyrite.

Pegmatite

The pegmatite ranged in grain size from fine to coarse in zones and was generally light pink to beige. Chlorite, sericite and hematite alteration types were observed throughout most of the unit. The unit is primarily composed of quartz and potassium feldspar and trace pyrite was observed.

Mafic Dyke

The unit is generally less than 2 m thick, the entirety of which was collected for the majority of samples. The mafic dykes are fine grained and dark grey to black. No visible sulphides were observed in the unit.

Altered Granitoid

The unit is fine to medium grained and medium grey-green. Alteration of the unit is generally moderate to strong, and includes spotty hematite, pervasive sericite and pervasive chlorite. Trace sulphides were observed in several samples.

Chloritic Granite Porphyry

The unit is generally fine to medium grained and light pink to green. Strong chlorite alteration was observed throughout, as well as silicification of the unit in zones. Trace sulphides were observed in several samples.

Minor Units

Minor units varied in composition and alteration. Generally, no sulphides were observed. However, the quartz vein zone contained trace pyrite.

3.3.1.2 Tailings

Processing of ore will include crushing, grinding, flotation, cyanidation-leaching, carbon-in-pulp gold recovery, gold elution, gold electro-winning, smelting using an induction furnace, cyanide destruction and tailings recovery. Ten samples of ore, from across the deposit, were selected based on the type and degree of alteration, which is correlated with the grade of ore. A single tailings sample was provided for geochemical testing by OHRG in 2012 as part of the process recovery test work. This sample was split for geochemical testing. Although there was only one sample, it was produced from many samples of the ore that would be encountered throughout the pits and is considered to be a reasonable representation of expected tailings to be produced from the process (Ounpuu 2012, pers. comm.).

The tailings generated for the geochemical characterization program were produced as follows:

- Ore samples were crushed and ground and then sent to a flotation circuit.
- Flotation tailings were separated and sent to the thickener.
- The remaining flotation concentrate was then reground.
- Cyanide was then added to recover for gold. The gold-containing solution was then sent for further processing.
- The remaining cyanide residue was then thickened and combined with the flotation tailings. These combined tailings are the tailings that would then be discharged to the tailings facility. The final tailings slurry sample had an approximate composition of 90% flotation tailings and 10% cyanide residue tailings for both the solids and water.
- Prior to discharge, tailings water will be treated through a cyanide destruction process to remove cyanide. After the cyanide destruction and dilution from the flotation tailings, analytical results of the process water indicate that expected cyanide concentrations in the tailings pond will be less than 1 mg/L of total cyanide (Ounpuu 2012, pers. comm.).

3.3.2 Geochemical Testing Program

The analytical program consisted of a series of static tests designed to assess the general physical and geochemical characteristics as follows:

- Elemental composition.
- Acid-base accounting (ABA).
- Net acid generating (NAG) testing.
- Short-term leach tests.

The number of samples submitted by test name and material type are presented in Table 3-2. All samples were submitted for elemental composition, ABA and NAG testing. A sub-set of samples were selected for short-term leach testing and future kinetic testing and mineralogical analysis based on the range of solid-phase composition of each material type observed in the results of ABA and metal analysis. Each of the physical and geochemical analyses listed above are described in greater detail below.

Table 3-2: Geochemical Testing Program Sample List

Material Type	Number of Samples Collected	Static Testing						Kinetic Testing	
		Elemental	ABA	NAG	Leach		Tailings Water Ageing Test	Mineralogy	Humidity Cells
					SFE	NAG			
Waste Rock	123	123	123	123	41	41	—	9	9
Tailings									2[(a)]

Notes:
(a) One tailings sample was produced and split to complete humidity cell testing and testing on the water in duplicate.
— Not analysed.

3.3.2.1 *Solid-Phase Metal and Whole Rock Analysis*

Major and trace element analysis was conducted to quantify the elemental composition of the waste rock. Both analyses were conducted on all 123 waste rock samples collected in 2010. Element analyses were conducted according to the methods listed below:

- Whole rock analysis for major oxides (Al_2O_3, CaO, Cr_2O_3, Fe_2O_3, K_2O, MgO, MnO, Na_2O, P_2O_5, SiO_2, TiO_2, V_2O_5) by borate fusion/X-ray fluorescence (XRF).
- Trace metal analysis for aluminum, arsenic, antimony, barium, beryllium, bismuth, cadmium, calcium, chromium, cobalt, copper, iron, lead, lithium, magnesium, manganese, molybdenum, nickel, phosphorus, potassium, selenium, silver, sodium, strontium, tin, titanium, thallium, uranium, vanadium, yttrium and zinc.

3.3.2.2 *Acid-Base Accounting*

Acid-base accounting and NAG testing were performed to evaluate the acid generation potential. As part of ABA, the bulk quantities of acid generating minerals (e.g., sulphide minerals) and acid neutralizing minerals (e.g., carbonate minerals) are measured to assess whether the materials tested will have sufficient capacity to neutralize acidity or if the materials have the potential to generate acidity. The methodology performed on the samples is a modified Sobek method (Sobek et al. 1978) that includes analysis for paste pH, sulphur species, acid potential (AP), neutralization potential (NP) and carbon species (total carbon, carbonate content and organic carbon content).

3.3.2.2.1 Acid Potential (AP)

The acid potential (AP) represents the bulk amount of acidity that can be produced by oxidation of sulphide minerals. The AP is calculated from the sulphide content and assumes that all sulphide minerals occur as pyrite. Total sulphur concentrations often include oxidized, non-reactive forms of sulphur, such as sulphate. Although the dissolution of sulphate minerals can contribute some AP in the short-term, sulphate minerals do not generally contribute to the long-term acid generation potential of a material. Therefore, calculation of AP using the sulphide content (the reactive portion of the pyrite mineral that will contribute acidity) rather than the total sulphur is the most appropriate method for determining AP.

3.3.2.2.2 Neutralization Potential (NP) and Carbonate Neutralization Potential (CaNP)

The neutralization potential (NP) represents the bulk amount of acidity that the sample can potentially consume or neutralize. The “bulk” NP was determined by acidifying the sample with sulphuric acid. Following the acidification of the sample, the amount of acid that is consumed during the test period is determined by a reverse titration. Negative NP values indicate that samples contained stored acidity in the form of soluble phases that contribute acidity on dissolution.

The carbonate neutralization potential (CaNP) is a calculated value that represents the bulk amount of acidity that the sample can potentially consume through the dissolution of carbonate minerals. The CaNP is calculated from the carbonate content (wt% as CO_3).

NP and CaNP are typically compared for the purpose of evaluating the mineralogical source of NP in a sample. The difference between the NP and CaNP is that the NP represents the ‘bulk’ neutralization potential, whereas

CaNP is solely based on the carbonate content of a sample. Thus, in addition to the consumption of acid by readily soluble carbonate minerals, the 'bulk' NP incorporates the consumption of acid by less soluble aluminosilicate, silicate and/or other minerals. If the NP is approximately equal to the CaNP, the NP is likely attributable to the dissolution of carbonate minerals. In cases where the NP is significantly greater than CaNP, the NP is likely supplied by the partial dissolution of other, non-carbonate minerals. Aluminosilicate or silicate mineral contributions to bulk NP are slower than those of carbonate minerals; as such they may only be effective where water-rock interaction times are very long, and/or where the bulk NP is substantially greater than the AP. Where bulk NP is provided by non-carbonate minerals additional information such as sulphide content, NAG test results and humidity cell test results are useful in determining the propensity of the material to generate acidity.

An evaluation of the acid generation potential and neutralization potential was conducted using the ABA results. Acid generation potential is commonly interpreted according to the ratio of NP to AP, referred to as the neutralization potential ratio (NPR), according to the guidelines recommended by Mine Environment Neutral Drainage (MEND) (2009) and described in Table 3-3.

Table 3-3: Acid Generation Potential Criteria

Acid Generation Potential	Criteria	Comments
Potentially Acid Generating	NPR < 1	Potentially acid generating unless sulphide minerals are non-reactive.
Uncertain	NPR < 2	Possibly acid generating if NP is insufficiently reactive or is depleted at a rate faster than sulphides.
Non-Acid Generating	2 < NPR	Not expected to generate acidity.

Using bulk NP in the NPR calculation accounts for less reactive silicate minerals as well as the more reactive carbonate minerals. CaNP can be used in the NPR calculations (CaNPR = CaNP/AP) to account for buffering capacity from carbonate minerals only and ignores the buffering capacity of other and more slowly reacting minerals. Therefore, CaNPR is also presented and used in assessing ARD potential.

For several reasons, no single NPR is universally applicable with respect to acid generation prediction. The actual threshold values for a particular test sample are material specific, and could depend on several factors, including chemical and mineralogical composition (i.e., presence and amounts of acid generation and neutralization minerals), morphology (i.e., grain size, texture and crystallinity) and site-specific exposure conditions.

3.3.2.3 Net Acid Generation Testing

Samples were submitted for NAG testing, conducted according to the protocols in Australian Mineral Industries Research Association (AMIRA) (2002) and Miller et al. (1997). The purpose of the NAG test is to evaluate the acid generation characteristics of a sample under an enhanced oxidation scenario. During the NAG test, hydrogen peroxide is added to a sample in quantities sufficient to completely oxidize the sulphide minerals present. The pH of the oxidized solution is measured after the completion of the reaction to determine the NAG-pH, followed by titration of the solution to a pH of 4.5 with sodium hydroxide. Back-titration to a pH of 7 was completed to provide added information on buffering capacity.

The results of the NAG test are used to assess the potential of a material to produce acidity after a period of exposure and weathering. The NAG pH is a useful indicator of whether a sample contains sufficient internal buffering capacity to neutralize all of the acidity produced through complete sulphide oxidation over a short period of time.

According to the recommendations in AMIRA (2002) and MEND (2009), samples reporting a NAG pH value greater than 4.5 are classified as non-acid generating and samples reporting a pH value below 4.5 are classified as potential acid generating (Table 3-4).

Table 3-4: Net Acid Generation Criteria for Acid Generation Potential

Net Acid Generation pH	Potentially Acid Generating[(a)]
≥ 4.5	non-potentially acid generating
< 4.5	potentially acid generating

Notes:
[(a)] Based on AMIRA (2002).

3.3.2.4 Short-Term Leach Tests

The results of short-term leach tests are commonly used as a qualitative screening tool to identify elements of potential environmental concern and to select samples for kinetic testing. The results of these tests do not directly translate to the expected environmental behaviour of materials for several reasons, including:

- The relatively small sample size and volume of the sample.
- Potential heterogeneities in the sample.
- The short test duration.
- The enhanced contact between liquid and the solid test charge due to agitation.

Although there are limitations with the testing, it is a very useful indication of leachable metals of concern and is intended as a screening tool to identify metals of potential concern.

The results of short term leach test results are compared to the following guidelines:

- Municipal/Industrial Strategy for Abatement (MISA): Effluent Monitoring and Effluent Limits — Metal Mining Sector (O.Reg. 560/94).
- Canadian Council of Ministers of the Environment (CCME 2007), Canadian Environmental Quality Guidelines, for the protection of freshwater aquatic life.
- Provincial Water Quality Objectives (PWQO) (Ontario Ministry of Environment and Energy 1999).

The following notes apply to the application of the above criteria:

- Several of the criteria report ranges depending on water hardness or other properties. In these cases, the lowest criterion value was used, with the exception of aluminum.
- PWQO and CCME guidelines for aluminum in waters reporting pH values greater than 6.5 was used based on the neutral to alkaline pH values reported in all materials during leach testing.
- There is no applicable criteria for total chromium, however the PWQO and CCME guidelines for hexavalent chromium was used when hexavalent chromium was not analyzed.

Three short-term leach tests were performed; shake flask extraction (SFE), and analysis of the NAG leachate. Leach tests are described below.

3.3.2.4.1 Shake Flask Extraction (SFE)

This leach test is designed to measure the interaction with meteoric water. This test was modified so that the liquid to solid ratio was decreased from 20:1 to 4:1 in order to increase the volume of rock with respect to the volume of water and thereby reduce dilution in the leachate. This is consistent with procedures presented in Price (1997).

Testing (using distilled water) was performed as described in ASTM (2006). Solids material and de-ionized water were combined at the modified ratio of 4:1 and shaken for a 24-hour period. The generated leachate was analyzed for the following parameters:

- pH, alkalinity, acidity, conductivity, sulphate, chloride, ICP metal scan (including aluminum, arsenic, antimony, barium, beryllium, bismuth, boron, cadmium, calcium, chromium, cobalt, copper, iron, lead, lithium, magnesium, manganese, molybdenum, nickel, potassium, silver, sodium, strontium, tin, uranium, vanadium, zinc) and mercury by CVAAS.

3.3.2.4.2 NAG Leachate

Comprehensive analysis of the NAG testing leachate provides an assessment of the waters after a complete oxidation of reactive sulphides and concurrent buffering. During the NAG test, hydrogen peroxide is added to a sample in quantities sufficient to completely oxidize all sulphide minerals. A sample of the oxidized solution is collected after the completion of the reaction, followed by titration of the solution to a pH of 4.5 with sodium hydroxide. The leach sample is taken prior to the titration. The results of the NAG test were used to determine possible parameter mobility after a period of exposure and weathering. The NAG supernatant was tested for:

- pH, alkalinity, acidity, conductivity, sulphate, chloride, ICP metal scan (including aluminum, arsenic, antimony, barium, beryllium, bismuth, boron, cadmium, calcium, chromium, cobalt, copper, iron, lead, lithium, magnesium, manganese, molybdenum, nickel, potassium, silver, sodium, strontium, tin, uranium, vanadium, zinc) and mercury by CVAAS.

3.3.2.5 Tailings Water

Aging tests on the water that was associated with the tailings was performed. The sample of Day 0 process water, as well as the process water that was shipped with the tailings solids was sampled on days 0, 7, 15 and 29. These samples were tested for the following:

- pH, alkalinity, conductivity, acidity.
- Thiosalts.
- Dissolved metals, including total and hexavalent chromium.
- Chloride and sulphate.
- Ammonia, nitrite and nitrate.

3.3.2.6 Humidity Cell Testing

Humidity cell tests (HCTs) were performed according to the ASTM D5744-96 Standard Test Method for Accelerated Weathering of Solid Materials Using a Modified Humidity Cell (ASTM 2001). A humidity cell is a chamber designed to provide control over air, temperature and moisture, while allowing for the removal of weathering products (principally oxidation products) in solution. The HCTs consist of a one-kilogram sample (dry equivalent) sample. The samples are leached with 1 L of de-ionized (DI) water prior to the regular weekly cycle. This initial leach was considered the first flush, or Week 0. The weekly cycles consisted of a three-day period where dry air is circulated in the cell followed by a 3-day period where humid air is circulated in the cell and a final leach day when the cell is flooded with 1 L of distilled water (1:1 liquid to solid ratio by weight). After one hour of retention, the leach water is drained from the bottom of the cell, filtered (0.45 µm filter) and collected for analysis.

The results of kinetic testing are used to evaluate the composition of leachates resulting from weathering and to estimate the lag time to the onset of acid generation in each sample in laboratory conditions. Changes in pH and concentrations of sulphate, alkalinity, acidity and key trace metals provide insight with respect to mineral reaction rates.

3.3.2.7 Mineralogical Analysis

The waste rock samples selected for kinetic testing were also submitted for mineralogical analysis. Mineralogical analysis was completed by SGS to identify the major, minor and trace mineralogical assemblages by X-ray diffraction analysis (XRD). Analysis was conducted using the Rietveld method. XRD cannot identify amorphous phases, and therefore semi-crystalline precipitate minerals may not be fully represented by the results of XRD. In addition, trace concentrations of minerals are difficult to identify due to the limitations of the analytical method. Generally, the minimum detection limit for XRD is approximately 1%.

3.4 Criteria and Indicators

The details and rationale for the criteria used to evaluate acid generation and metal leaching of the materials tested as part of the geochemical characterization have been previously described in Section 3.2 but are summarized here for reference:

- **Acid Generation**: NPR and CaNPR values as per MEND (2009) and NAG pH (AMIRA 2002). It must be noted that determining the potential for acid generation is not solely based on these criteria, but on the guidance provided in Price (1997), MEND (2009) and INAP (2012) and professional interpretation as no single criterion is universally applicable with respect to acid generation prediction. The actual threshold values for a particular test sample are material specific, and could depend on several factors, including chemical and mineralogical composition (i.e., presence and amounts of acid generation and neutralization minerals), morphology (i.e., grain size, texture and crystallinity), long-term weathering and site-specific exposure conditions.
- **Metal Leaching and Tailings Water Quality:** Values for pH and concentration of other parameters were compared to some or all of MISA (O. Reg. 560/94), PWQO (1999) and CCME (2007). Again, the potential for metal leaching is not solely based on the comparison to criteria, but the long-term behaviour the material, professional judgement and the guidance provided in Price (1997), MEND (2009) and INAP (2012).

It should be noted that these are criteria used in the geochemical characterization and not related to the effects assessment. As there is no impact assessment associated with geochemistry, the development of effects assessment criteria is not appropriate, nor is the development of indicators. As per the EIS Guidelines, the results of the geochemical analysis will be included in the effects assessment to inform the prediction of potential changes to water quality.

3.5 Results

The full set of geochemical results is presented in the following attachments:

- Appendix 2.III (Static Test Results).
- Appendix 2.IV (Tabulated Kinetic Testing Results) and Appendix 2.V (Kinetic Testing Results Figures).
- Appendix 2.VI (Mineralogical Results).

A description of the results and tabulated summaries are presented in the following sections.

3.5.1 Waste Rock

3.5.1.1 Elemental Composition

Analyses to determine whole rock and trace metal concentrations within the solid phase sample were completed on all of the samples. The results of this analysis are reported in Appendix 2.III and summarized in Table 3-5. A summary of elemental composition in waste rock is as follows:

- The major felsic units (fine grained granite, chloritic granite, tonalite, altered granitoid, chloritic granite porphyry and pegmatite) generally hosted minor (1 to 10%) concentrations of the major ions reported as oxide equivalents (MgO, CaO, Na_2O and K_2O).
- Most of the minor units, including aplite, diorite, gneiss, sheared granitoid, tectonized sheared vein zone and intermediate dykes have a similar major ion composition as compared to the major felsic units.
- Average silica content (as SiO_2 equivalent) in all rock types was 67%. The minimum (36.5%) and maximum (87%) silica content were observed in the tonalite and quartz vein zone samples, respectively. The mafic dyke is generally composed of less SiO_2 (43 to 72%) in comparison to the other major units.
- Average aluminum content (as Al_2O_3 equivalent) was 14%. The minimum (5.3%) and maximum (17%) aluminum content was observed in the quartz vein zone and diorite samples, respectively.
- Average iron content (as Fe_2O_3 equivalent) was 3.8%. The minimum (0.60%) and maximum (14%) iron content was observed in the pegmatite and fine grained granite samples, respectively.
- Chromium content (as Cr_2O_3 equivalent) was greatest in the fine grained granite, with a maximum value of 0.27%. An overall minimum of less than 0.01% was observed in chloritic granite porphyry and an overall average of 0.03% was observed.
- The average silver concentration was 1.05 µg/g. The lowest average silver concentrations were observed in the chloritic granite porphyry (0.37 µg/g), and the maximum (63 µg/g) concentration was observed in a tonalite sample.
- The average arsenic concentration was 1.1 µg/g. The lowest average arsenic concentrations were observed in the chloritic granite porphyry (less than 0.05 µg/g), and the maximum (2.4 µg/g) concentration was observed in a tonalite sample.
- The average copper concentration was 22 µg/g. The minimum (1.2 µg/g) copper concentration was observed in a pegmatite sample, and the maximum (130 µg/g) concentration was observed in a chloritic granite sample.

Table 3-5: Summary of Elemental Composition for Waste Rock for Selected Parameters

Rock Type	SiO_2	Al_2O_3	Fe_2O_3	Cr_2O_3	Ag	As	Cu	Mo	V	Cd	Se	Zn
	%	%	%	%	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g
Fine Grained Granite												
Minimum	37	5.8	2.5	0.01	0.2	< 0.5	2.5	0.2	17	0.11	<0.7	22
Maximum	71	16	14	0.27	1.6	2.1	120	2.0	160	0.47	0.8	95
Average	63	13	4.9	0.05	0.50	0.72	36	0.59	50	0.25	0.71	51
Chloritic Granite												
Minimum	59	11.9	1.51	0.01	0.2	< 0.5	3.3	0.3	5	0.04	<0.7	18
Maximum	73	15	6.1	0.04	1.2	1.6	130	3.8	170	0.33	0.9	74
Average	68	14	3.1	0.02	0.45	0.61	16	0.76	29	0.22	0.71	43
Tonalite												
Minimum	58	14	2.2	0.01	0.13	< 0.5	3.7	0.2	14	0.10	<0.7	21

Table 3-5: Summary of Elemental Composition for Waste Rock for Selected Parameters (Continued)

Rock Type	SiO_2	Al_2O_3	Fe_2O_3	Cr_2O_3	Ag	As	Cu	Mo	V	Cd	Se	Zn
	%	%	%	%	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g
Maximum	71	17	6.3	0.05	63	2.4	52	3.9	75	0.36	1.0	82
Average	67	15	4.0	0.03	2.5	0.85	22	0.69	39	0.21	0.71	53
Altered Granitoid												
Minimum	66	13	1.1	0.02	0.21	< 0.5	3.7	0.4	< 1	0.07	<0.7	9.9
Maximum	76	15	4.0	0.04	4.7	2.0	29	16	35	0.26	<0.7	68
Average	70	14	2.5	0.03	0.95	0.69	13	2.7	21	0.17	<0.7	35
Pegmatite												
Minimum	64	12	0.60	0.02	0.05	< 0.5	1.2	0.20	< 1	0.02	<0.7	3.2
Maximum	78	15	3.7	0.04	4.5	1.0	46	3.6	33	0.29	0.80	47
Average	72	14	2.0	0.03	0.78	0.64	11	1.1	14	0.14	0.71	25
Mafic Dyke												
Minimum	43	11	2.4	0.01	0.12	< 0.5	3.8	0.10	20	0.09	<0.7	31
Maximum	72	15	13	0.12	3.4	1.4	110	0.60	240	0.45	<0.7	160
Average	56	13	7.0	0.06	0.81	0.72	36	0.30	97	0.22	<0.7	81
Chloritic Granite Porphyry												
Minimum	58	13	2.8	< 0.01	0.19	< 0.5	5.8	0.30	27	0.14	<0.7	33
Maximum	70	16	5.5	0.03	0.58	< 0.5	32	0.80	66	0.25	<0.7	80
Average	63	14	4.1	0.02	0.37	< 0.5	22	0.46	45	0.21	<0.7	58
Minor Units												
Minimum	47	5.3	1.5	0.01	0.22	< 0.5	1.5	0.10	10	0.03	<0.7	9.1
Maximum	87	17	8.7	0.15	0.83	2.5	80	3.5	120	0.37	<0.7	99
Average	68	13	3.9	0.04	0.48	0.91	21	1.8	45	0.21	<0.7	47

- The average cadmium concentration was 0.21 µg/g. The minimum (0.02 µg/g) cadmium concentration was observed in a pegmatite sample, and the maximum (0.47 µg/g) concentration was observed in a fine grained granite sample.
- Selenium concentrations were generally below the analytical detection limit (0.7 µg/g), however detectable maximum concentrations were observed in the fine grained granite (0.8 µg/g), chloritic granite (0.9 µg/g), pegmatite (0.8 µg/g) and the tonalite (1.0 µg/g).
- The average molybdenum concentration was 0.93 µg/g. The minimum (0.1 µg/g) molybdenum concentration was observed in the mafic dyke and sheared mafic unit samples, and the maximum (16 µg/g) concentration was observed in an altered granitoid sample.
- The average vanadium concentration was 41 µg/g. The minimum (less than 1 µg/g) vanadium concentration was observed in the pegmatite and altered granitoid samples, and the maximum (240 µg/g) concentration was observed in a mafic dyke sample.
- The average zinc concentration was 48 µg/g. The minimum (3.2 µg/g) zinc concentration was observed in the pegmatite, and the maximum (160 µg/g) concentration was observed in a mafic dyke sample.

3.5.1.2 Acid Base Accounting

The ABA results are summarized in Table 3-6 and plotted in Figures 3-2 through 3-5. The full set of ABA results is presented in Appendix 2.III. The ABA results are discussed by analysis type below.

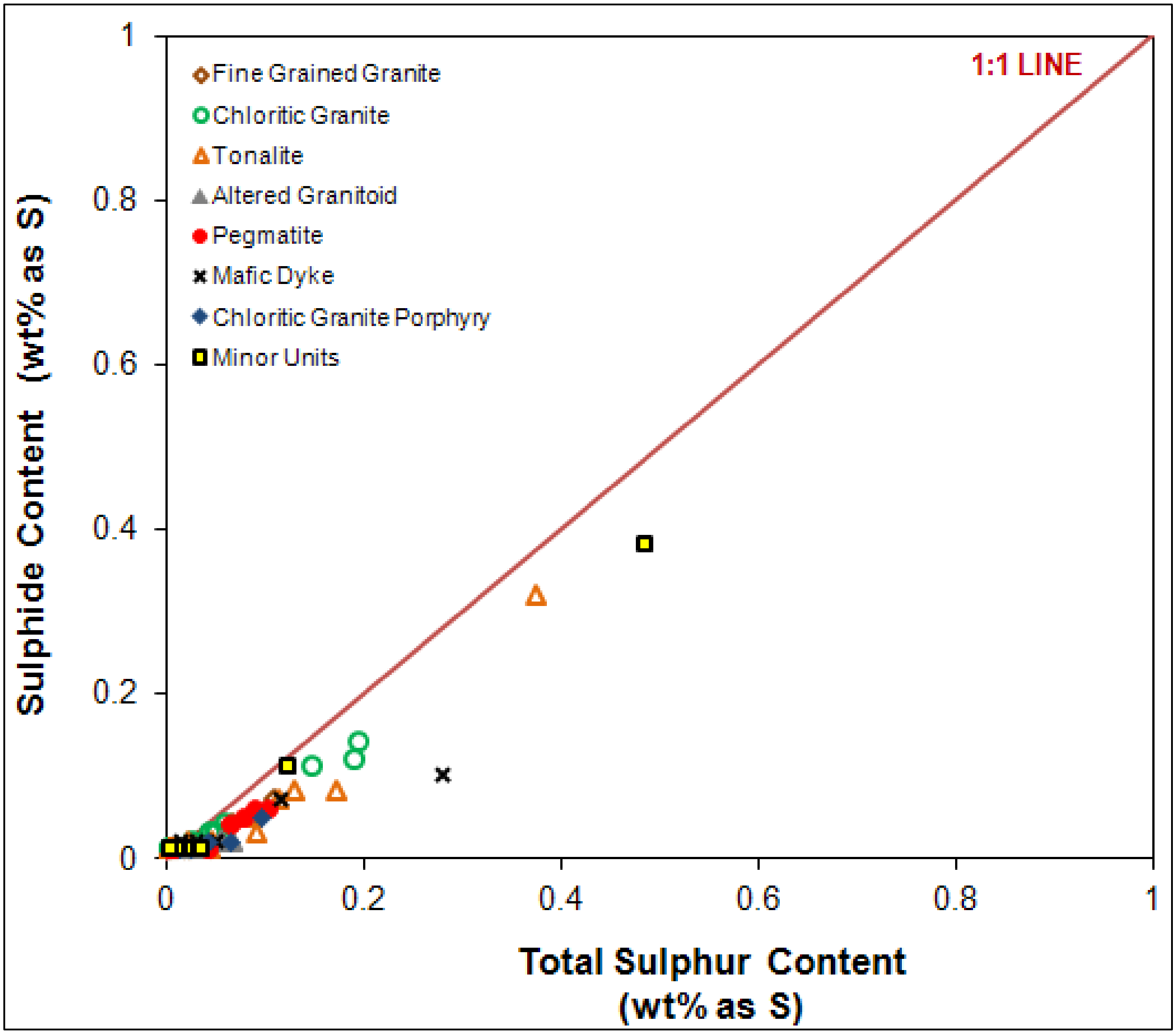


Figure 3-2: Total Sulphur Content versus Sulphide Content for Waste Rock

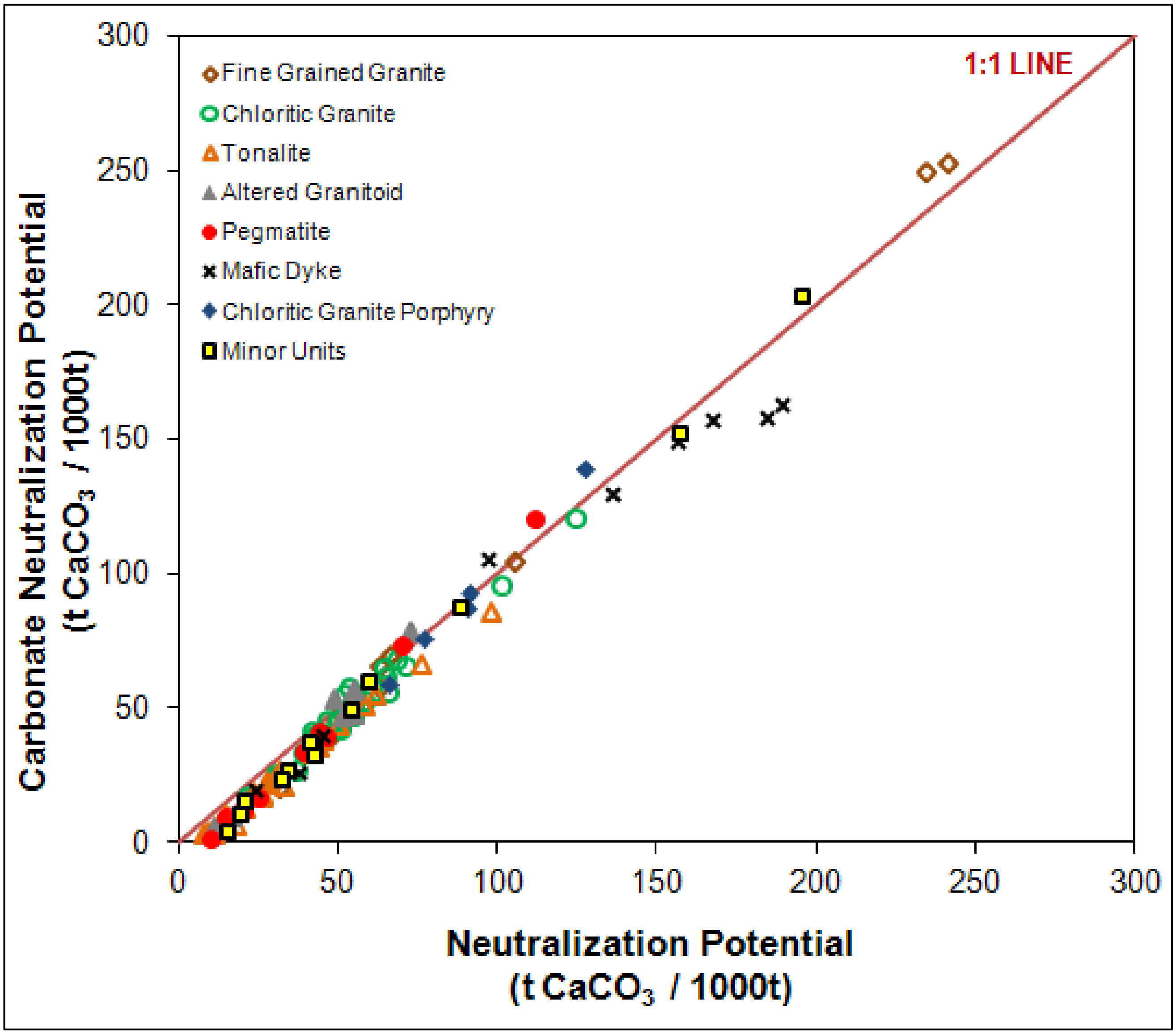


Figure 3-3: Neutralization Potential (NP) versus Carbonate Neutralization Potential (CaNP) for Waste Rock

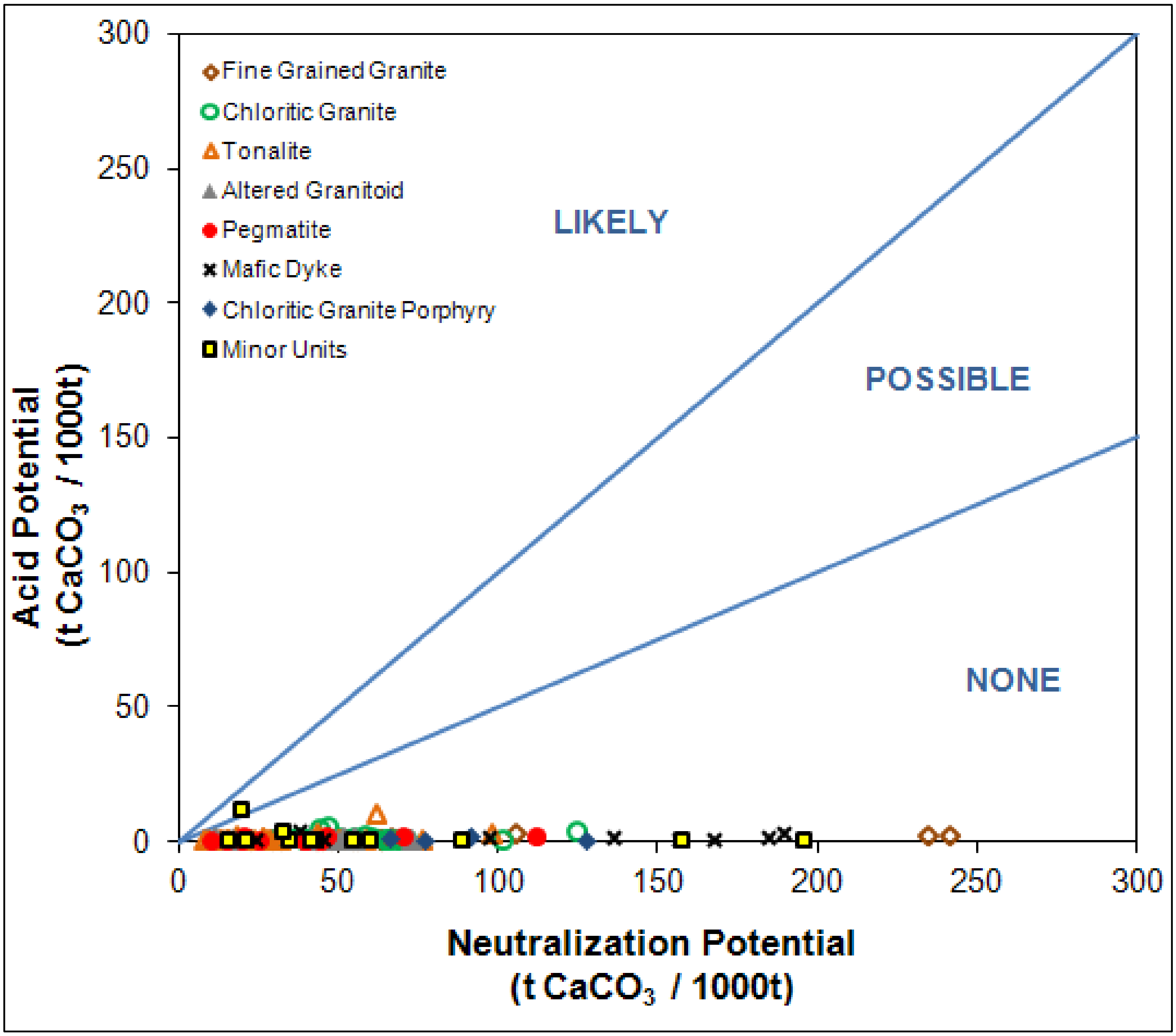


Figure 3-4: Neutralization Potential (NP) versus Acid Potential (AP) for Waste Rock

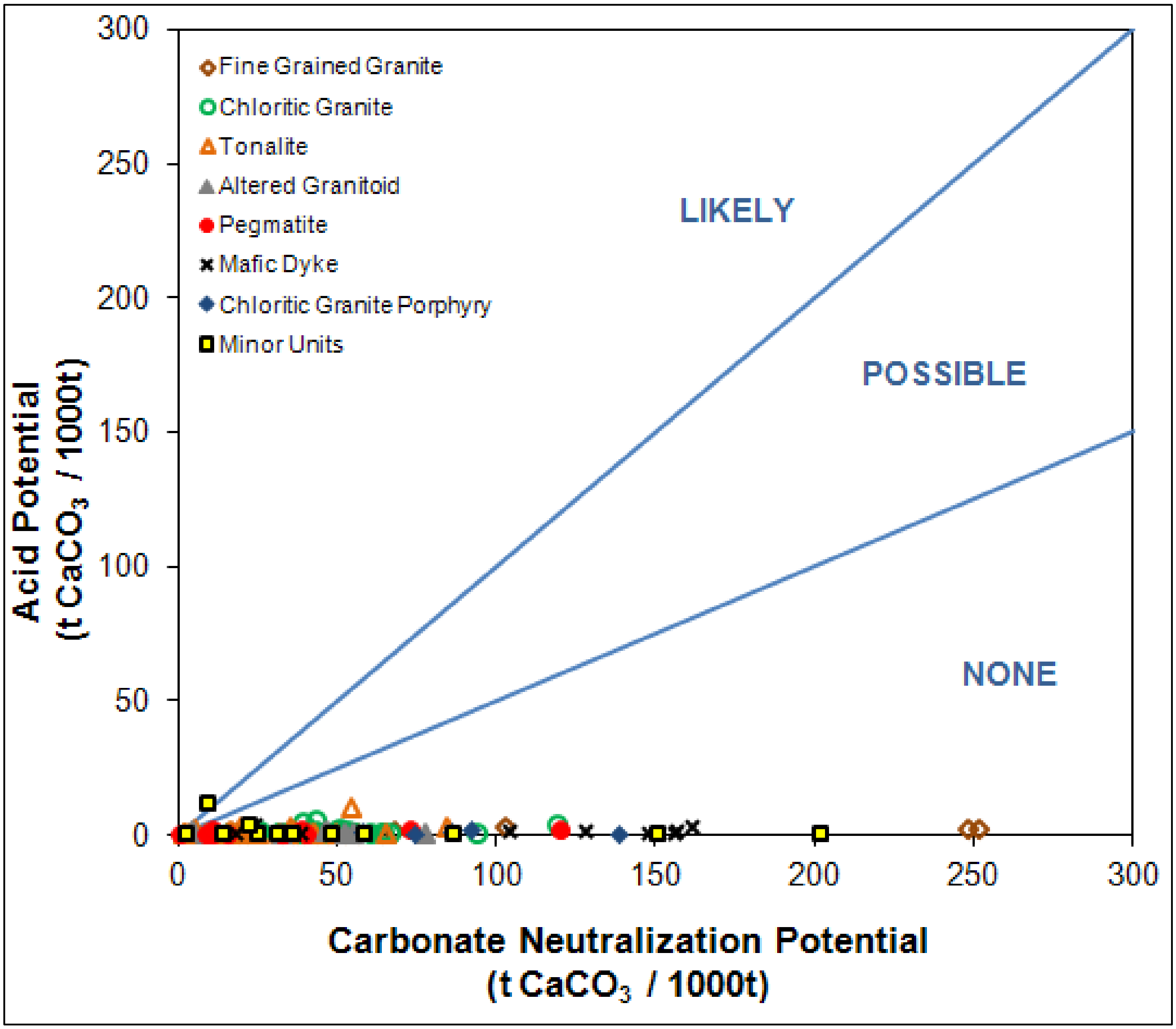


Figure 3-5: Carbonate Neutralization Potential (CaNP) versus Acid Potential (AP) for Waste Rock

Table 3-6: Summary of Acid Base Accounting and Net Acid Generation Results for Waste Rock

Rock Type	Sulphur Species (wt %)			CO_3 (wt %)	Potentials (*t $CaCO_3$/1000t*)			NPR	CaNPR	NAG
	Total	Sulphate	Sulphide		NP	AP	CaNP			pH
Fine Grained Granite										
Minimum	0.005	< 0.01	< 0.01	0.95	23	0.31	16	47	46	9.0
Maximum	0.11	0.04	0.07	15	242	2.3	252	205	209	11.2
Average	0.03	0.02	0.02	4.3	75	0.59	72	143	127	11
Chloritic Granite										
Minimum	0.005	< 0.01	< 0.01	0.99	22	0.31	17	11	9.8	10.2
Maximum	0.20	0.07	0.14	7.2	125	4.5	120	330	306	11.3
Average	0.04	0.02	0.02	2.9	54	0.76	48	135	120	11
Tonalite										
Minimum	0.005	< 0.01	< 0.01	0.15	8.3	0.31	3.0	6.2	3.6	7.2
Maximum	0.38	0.10	0.32	5.1	99	10	85	248	213	11.3
Average	0.04	0.02	0.03	1.5	33	0.93	24	76	55	10
Altered Granitoid										
Minimum	0.02	0.02	< 0.01	0.30	12	0.31	5.0	19	8.1	7.9
Maximum	0.07	0.05	0.02	4.7	73	0.62	78	27	252	11.0
Average	0.04	0.03	0.01	2.5	45	0.43	41	120	112	10
Pegmatite										
Minimum	0.005	< 0.01	< 0.01	0.06	11	0.31	1.0	13	3.1	7.2
Maximum	0.10	0.05	0.06	7.3	112	1.9	120	143	130	11.2
Average	0.04	0.02	0.03	2.1	41	0.79	35	71	55	10
Mafic Dyke										
Minimum	0.005	< 0.01	< 0.01	1.1	25	0.31	19	12	8.0	10.9
Maximum	0.28	0.18	0.10	9.8	190	3.1	162	542	505	11.4
Average	0.06	0.04	0.03	6.3	116	0.93	105	228	209	11
Chloritic Granite Porphyry										
Minimum	0.01	0.01	< 0.01	3.5	66	0.31	59	59	59	11.1
Maximum	0.09	0.05	0.05	8.4	128	1.6	139	413	447	11.2
Average	0.05	0.03	0.02	5.4	91	0.67	90	195	196	11
Minor Units										
Minimum	0.005	< 0.01	< 0.01	0.18	16	0.31	2.9	1.7	0.83	7.7
Maximum	0.49	0.11	0.38	12	196	12	203	633	653	11.2
Average	0.06	0.02	0.05	3.4	62	1.4	56	189	173	10

Paste pH

The paste pH values reported for all samples were alkaline, ranging from 8.6 to 10. These paste pH values indicate the samples do not host appreciable concentrations of readily soluble stored acidity.

Sulphur Species

The concentrations of total sulphur, sulphide and sulphate contents (all wt% as S) were measured as part of the ABA analyses. The sulphide content is plotted as a function of total sulphur in Figure 3-2. Sulphide contents range from less than 0.01% to 0.38% by weight, with the highest concentrations observed in the tonalite rock type and the quartz vein zone and the lowest concentrations observed in the other minor units and altered granitoid rock types.

Added to the plot is a 1:1 reference line to assess the speciation of the sulphur minerals in the samples of test material. Samples that lie along this line indicate sulphur present in the form of sulphide, presumably as sulphide minerals. As the sample moves below the reference line, the sulphate form of sulphur is increasingly present. The sulphur speciation results for all rock types show that the distribution of data is variable. Generally, sulphur is primarily in the form of sulphide in the majority of units, including fine grained granite, chloritic granite, tonalite, pegmatite, mafic dyke and all the minor units. Sulphur is primarily in the form of sulphate for the majority of the altered granitoid and chloritic granite porphyry samples.

Neutralization and Carbonate Neutralization Potentials

Waste rock samples show a relatively wide range of NP values; between 8.3 to 242 t $CaCO_3$/1000 t. The highest values were observed in the fine grained granite and sheared mafic unit rock types and the lowest concentrations observed in the tonalite and pegmatite rock types.

Carbonate neutralization potential (CaNP) is presented as a function of bulk NP in Figure 3-3. To assess the proportion of NP that consists of CaNP, a 1:1 reference line was added to the graph. Where NP is equal to the CaNP, the NP is derived from carbonate minerals. Sample points that are not located near the 1:1 reference line have a significant proportion of bulk NP from non-carbonate minerals, such as aluminosilicate and silicate minerals. All samples are clustered near the 1:1 line, thus, the majority of the samples of waste rock have neutralization potentials principally derived from carbonate minerals.

Acid Potential

The NPR values of the waste rock samples are plotted in Figure 3-4. As per the MEND (2009) criteria (Table 3-3) reference lines representing the potentially-acid generating (PAG) classification criteria are also plotted. One sample from the quartz vein zone reported a NPR value of 1.7 and is therefore classified as having unknown acid generation potential based on MEND (2009). All remaining major and minor lithologies reported NPR values greater than 2 and are classified as non-acid generating.

The CaNPR value was also calculated. The CaNPR is a more conservative estimate of the acid generation potential of a material, as it only accounts for the more reactive buffering minerals. The CaNP versus AP values were plotted in Figure 3-5, along with the MEND (2009) criteria. Similar to the NPR values, all rock types with the exception of the quartz vein zone are classified as non-acid generating. The quartz vein zone reported a CaNPR of 0.83, and is classified as potentially acid generating.

3.5.1.3 Net Acid Generation Testing

The NAG testing results are presented in Table 3-6. All waste rock samples reported paste pH values greater than 4.5, and are therefore all waste rock samples are classified as non-acid generating.

3.5.1.4 Short-Term Leach Testing

The results of the two short-term leach tests (SFE and NAG) are presented in the following sections.

Shake Flask Extraction Leach Test

The results of SFE leach testing conducted on samples of waste rock are reported in Appendix 2.III and summarized in Table 3-7. The results and observations from the SFE leach test are summarized as follows:

- Leachate pH values were basic, ranging from 9.5 to 10.1 and all samples were greater than the PWQO, CCME and MISA guidelines (8.5, 9.0 and 9.5, respectively).
- Aluminum concentrations ranged from 0.09 to 1.2 mg/L and were greater than the PWQO guidelines (0.075 mg/L) in all samples for all rock types and the CCME guidelines (0.1 mg/L) in all but one tonalite sample (0.10 mg/L) and one sheared mafic unit (0.09 mg/L).
- Additional parameters that were greater than the PWQOs for four or fewer samples include the following:
  - Arsenic concentrations were greater than the CCME and PWQO guidelines (0.005 mg/L) in one diorite sample [2010-HR-029] (0.012 mg/L) and two tonalite samples [2010-HR-005 and 2010-HR-025] (0.019 mg/L and 0.0069 mg/L, respectively).
  - One intermediate dyke sample [2010-HR-059] reported cadmium concentrations of 0.000021 mg/L, greater than the PWQO guidelines (0.000017 mg/L).
  - Copper concentrations were greater than the PWQOs (0.001 mg/L) in one tonalite sample [2010-HR-014] with 0.0014 mg/L copper.
  - Selenium concentrations were greater than the CCME guidelines (0.001 mg/L) in two samples from the minor units, including the tectonized-sheared vein zone [2010-HR-021] (0.003 mg/L) and the quartz vein zone [2010-HR-035] (0.016 mg/L).
  - Vanadium concentrations were greater than the PWQOs (0.006 mg/L) in two fine grained granite samples [2010-HR-003 and 2010-HR-006] (0.00845 and 0.0097 mg/L, respectively) and two tonalite samples [2010-HR-005 and 2010-HR-014] (0.00662 and 0.00669 mg/L, respectively).

Table 3-7: Summary of Shake Flask Extraction (SFE) Leach Test Results for Waste Rock

Rock Type	pH	SO_4	Ag	Al	As	B	Cd	Cr	Cu	Se	V	Zn
	units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
PWQO	6.5 to 8.5	—	0.0001	0.075[(a)]	0.005	0.2	0.0001	0.001[(b)]	0.001	0.1	0.006	0.02
CCME Aquatic Life	6.5 to 9	—	0.0001	0.1[(a)]	0.005	—	0.000017	0.001[(b)]	0.002	0.001	—	0.03
MISA	6 to 9.5	—	—	—	1	—	—	—	0.6	—	—	1.0
Fine Grained Granite												
Minimum	**9.62**	<0.2	<0.00001	**0.60**	0.0006	0.0027	<0.000003	<0.0005	<0.0005	<0.001	0.0020	<0.001
Maximum	**10.1**	2.0	<0.00001	**0.51**	0.0003	0.0017	<0.000003	<0.0005	0.0007	<0.001	**0.0097**	<0.001
Average	**9.8**	0.73	<0.00001	**0.90**	0.002	0.005	<0.000003	<0.0005	0.0005	<0.001	0.005	<0.001
Chloritic Granite												
Minimum	**9.76**	0.30	<0.00001	**0.51**	0.0003	0.0017	<0.000003	<0.0005	<0.0005	<0.001	0.0017	<0.001
Maximum	**10.0**	1.3	<0.00001	**1.2**	0.003	0.0082	0.000003	<0.0005	0.0006	0.003	0.004	<0.001
Average	**9.9**	0.45	<0.00001	**0.91**	0.001	0.005	0.000003	<0.0005	0.0005	0.001	0.003	<0.001
Tonalite												
Minimum	**9.48**	0.3	<0.00001	**0.10**	0.0004	0.0023	<0.000003	<0.0005	<0.0005	<0.001	0.0009	<0.001
Maximum	**10.0**	0.3	0.00001	**1.2**	**0.019**	0.032	0.000004	<0.0005	**0.0014**	<0.001	**0.007**	0.001
Average	**9.8**	0.3	0.0001	**0.86**	0.003	0.007	0.000003	<0.0005	0.0006	<0.001	0.004	0.001
Altered Granitoid												
2010-HR-086	**9.92**	0.3	<0.00001	**0.93**	0.0011	0.0036	<0.000003	<0.0005	<0.0005	<0.001	0.0028	<0.001
2010-HR-093	**9.66**	0.3	<0.00001	**0.30**	0.0004	0.005	<0.000003	<0.0005	<0.0005	<0.001	0.00081	<0.001
Pegmatite												
Minimum	**9.85**	0.3	<0.00001	**0.66**	0.001	0.0036	<0.000003	<0.0005	<0.0005	<0.001	0.00081	<0.001
Maximum	**10.12**	0.3	<0.00001	**1.28**	0.0038	0.008	0.000003	<0.0005	0.0006	<0.001	0.0034	<0.001
Average	**10**	0.3	<0.00001	**1.0**	0.002	0.005	0.000003	<0.0005	0.0005	<0.001	0.002	<0.001
Mafic Dyke												
Minimum	**9.74**	0.3	<0.00001	**0.46**	0.0002	0.0042	<0.000003	<0.0005	<0.0005	<0.001	0.00093	<0.001
Maximum	**9.95**	0.3	<0.00001	**1.13**	0.0005	0.0048	0.000003	<0.0005	<0.0005	<0.001	0.0045	<0.001
Average	**9.8**	0.3	<0.00001	**0.75**	0.0004	0.005	0.000003	<0.0005	<0.0005	<0.001	0.003	<0.001
Chloritic Granite Porphyry												
2010-HR-067	**9.68**	0.3	<0.00001	**0.95**	0.0017	0.008	<0.000003	<0.0005	<0.0005	<0.001	0.0029	<0.001

Table 3-7: Summary of Shake Flask Extraction (SFE) Leach Test Results for Waste Rock (Continued)

Rock Type	pH	SO_4	Ag	Al	As	B	Cd	Cr	Cu	Se	V	Zn
	units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Minor Units												
Minimum	**9.53**	0.3	<0.00001	**0.09**	0.0004	0.0023	<0.000003	<0.0005	<0.0005	<0.001	0.00089	<0.001
Maximum	**10.06**	0.3	**0.00012**	**1.2**	0.012	0.0068	**0.000021**	<0.0005	<0.0005	**0.016**	0.0035	<0.001
Average	**9.82**	0.3	0.00003	**0.66**	0.0033	0.005	0.000008	<0.0005	<0.0005	**0.004**	0.003	<0.001

Notes: Bolded values do not meet one or more of the criteria considered. The formatting applies to this summary table only. For a complete comparison of all results and parameters tested to the criteria, refer to Appendix 2.III. For criteria where a range exists, the lowest criterion was used, except in the case of aluminum.

(a) Criteria for aluminum based on observed pH values greater than 6.5.

(b) Criteria for hexavalent chromium used.

— Guideline does not apply for this parameter.

Net Acid Generation Leach Test

The results of NAG leach testing conducted on samples of waste rock are reported in Appendix 2.III and summarized in Table 3-8. The results and observations from the NAG leach test are summarized as follows:

- NAG pH values ranged from 7.2 to 11.4. The highest pH values were reported in the NAG leachates from the chloritic granite and mafic dyke, and the lowest were reported in the tonalite and pegmatite rock type and the quartz vein zone [2010-HR-035]. Several samples reported NAG pH values more alkaline than the applicable criteria, including the following:
  - 34 samples (83%) reported pH values greater than the PWQO guidelines of 8.5.
  - 32 samples (78%) reported pH values greater than the CCME guidelines of 9.0.
  - 29 samples (71%) reported pH values greater than the MISA criterion of 9.5.
- Aluminum concentrations in the NAG leachate (ranging from ranging from less than 0.01 to 14 mg/L) were greater than the PWQO and CCME guidelines (0.075 and 0.1 mg/L, respectively) in all samples with the exception of one fine grained granite sample [2010-HR-095].
- Chromium concentrations in the NAG leachates ranged from less than 0.0005 to 0.19 mg/L. There is no applicable criterion for total dissolved chromium concentrations, however, the CCME and PWQO guidelines for hexavalent chromium was used for comparison (0.001 mg/L). All samples reported total dissolved chromium concentrations greater than 0.001 mg/L with the exception of one fine grained granite [2010-HR-095] sample that a concentration below detection (less than 0.0005 mg/L).
- Boron concentrations were greater than the PWQO guidelines of 0.2 mg/L in 24 samples (59%), including fine grained granite (0.04 to 3.5 mg/L), chloritic granite (0.15 to 0.77 mg/L), tonalite (0.04 to 0.66 mg/L), altered granitoid (0.15 and 0.89 mg/L), pegmatite (0.05 to 1.2 mg/L), mafic dyke (0.56 to 1.2 mg/L) and a sheared mafic unit sample [2010-HR-113] (0.78 mg/L).
- Selenium concentrations were greater than the CCME guidelines (0.001 mg/L) in two minor unit samples, including the tectonized-sheared vein zone [2010-HR-021] (0.002 mg/) and the quartz vein zone [2010-HR-035] (0.006 mg/L).
- Vanadium concentrations were greater than the PWQO guidelines (0.006 mg/L) in 12 samples (29%), including fine grained granite (0.002 to 0.025 mg/L), tonalite (0.002 to 0.008 mg/L), pegmatite (0.0005 to 0.0075 mg/L), two (67%) mafic dyke (0.005 to 0.0075 mg/L) and the chloritic granite porphyry sample (0.007 mg/L).
- Additional parameters that were greater than the PWQO and CCME guidelines in individual samples include the following:
  - Arsenic concentrations ranged between less than 0.0002 to 0.0061 mg/L and one tonalite sample [2010-HR-025] had a value greater than the PWQO and CCME guidelines (both 0.005 mg/L).

- Copper concentrations with two samples, a tonalite [2010-HR-014] and a pegmatite [2010-HR-014] had concentrations of 0.0036 mg/L and 0.0021 mg/L, respectively that were greater than both the PWQO (0.001 mg/L) and CCME (0.002 mg/L) guidelines.

It should be noted that the NAG leach test is aggressive and not analogous to field conditions.

Table 3-8: Summary of Net Acid Generation (NAG) Leach Test Results for Waste Rock

Rock Type	pH	SO_4	Ag	Al	As	B	Cd	Cr	Cu	Se	V	Zn
	units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
PWQO	6.5 to 8.5	—	0.0001	0.075[a]	0.005	0.2	0.0001	0.001[b]	0.001	0.1	0.006	0.02
CCME Aquatic Life	6.5 to 9	—	0.0001	0.1[a]	0.005	—	0.000017	0.001[b]	0.002	0.001	—	0.03
MISA	6 to 9.5	—	—	—	1	—	—	—	0.6	—	—	1.0
Fine Grained Granite												
Minimum	**8.91**	<2	<0.00001	<0.01	<0.0002	**0.37**	<0.000003	<0.0005	<0.0005	<0.001	0.0018	<0.001
Maximum	**10.8**	8.6	<0.00001	**5.54**	0.0007	**3.5**	0.000003	**0.022**	<0.0005	<0.001	**0.025**	0.003
Average	**9.5**	4.5	<0.00001	**3.33**	0.0003	**0.96**	0.000003	**0.02**	<0.0005	<0.001	**0.009**	0.002
Chloritic Granite												
Minimum	**9.31**	<2	<0.00001	**2.81**	<0.0002	0.15	<0.000003	**0.0053**	<0.0005	<0.001	0.0016	<0.001
Maximum	**11.2**	24	<0.00001	**13.8**	0.0003	**0.77**	0.000003	**0.035**	0.0009	<0.001	0.0055	0.004
Average	**10.1**	6.2	<0.00001	**6.7**	0.0002	**0.55**	0.000003	**0.02**	0.0005	<0.001	0.003	0.001
Tonalite												
Minimum	7.46	<2	<0.00001	**0.26**	<0.0002	0.036	<0.000003	**0.013**	<0.0005	<0.001	0.0017	<0.001
Maximum	**11.0**	43	0.00003	**8.19**	**0.0061**	**0.656**	0.00001	**0.047**	**0.0036**	<0.001	**0.0084**	0.004
Average	8.1	9.3	0.00001	**3.6**	0.002	**0.26**	0.000004	**0.03**	0.0009	<0.001	**0.006**	0.002
Altered Granitoid												
2010-HR-086	**10.3**	7.5	<0.00001	**7.73**	<0.0002	0.152	<0.000003	**0.0143**	<0.0005	<0.001	0.00348	<0.001
2010-HR-093	**10.2**	4.2	<0.00001	**1.14**	0.0005	**0.889**	<0.000003	**0.0244**	<0.0005	<0.001	0.00461	<0.001
Pegmatite												
Minimum	7.22	<2	<0.00001	**0.16**	0.0002	0.047	<0.000003	**0.029**	<0.0005	<0.001	0.0005	<0.001
Maximum	**11.1**	11	0.00005	**1.3**	0.0022	**1.18**	0.000003	**0.043**	**0.0021**	<0.001	**0.0086**	0.002
Average	7.6	5.7	0.00002	**0.73**	0.001	**0.435**	0.000003	**0.04**	**0.001**	<0.001	0.003	0.001
Mafic Dyke												
Minimum	**10.3**	<2	<0.00001	**0.16**	<0.0002	0.07	<0.000003	**0.022**	<0.0005	<0.001	0.0045	<0.001
Maximum	**11.4**	78	<0.00001	**1.3**	0.0002	**1.18**	<0.000003	**0.066**	0.0007	<0.001	**0.0075**	0.003
Average	**11**	29	<0.00001	**0.73**	0.0002	**0.60**	<0.000003	**0.05**	0.0006	<0.001	**0.006**	0.002
Chloritic Granite Porphyry												
2010-HR-067	**10.6**	3.2	<0.00001	**4.39**	0.0003	0.171	<0.000003	**0.0275**	<0.0005	<0.001	**0.00712**	0.001

Table 3-8: Summary of Net Acid Generation (NAG) Leach Test Results for Waste Rock (Continued)

Rock Type	pH	SO_4	Ag	Al	As	B	Cd	Cr	Cu	Se	V	Zn
	units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Minor Units												
Minimum	7.67	<2	<0.00001	**0.55**	<0.0002	0.043	<0.000003	**0.011**	<0.0005	<0.001	0.00047	<0.001
Maximum	**10.6**	150	<0.00001	**8.38**	0.0046	**0.784**	0.000009	**0.189**	<0.0005	**0.006**	0.0055	0.001
Average	**9.61**	38	<0.00001	**3.2**	0.0012	**0.22**	0.000004	**0.09**	<0.0005	**0.0022**	0.004	0.001

Notes: NAG test results are not analogous and should not be used for estimates of field conditions but are provided only for general information purposes only. Bolded values do not meet one or more of the criteria considered. The formatting applies to this summary table only. For a complete comparison of all results and parameters tested to the criteria, refer to Appendix 2.III. For criteria where a range exists, the lowest criterion was used, except in the case of aluminum.

(a) Criteria for aluminum based on observed pH values greater than 6.5.

(b) Criteria for hexavalent chromium used.

— Guideline does not apply for this parameter.

3.5.1.5 Mineralogy

Mineralogical analysis was conducted to determine the general mineralogical composition of nine waste rock samples. Mineralogy results are presented in Appendix 2.VI. The pertinent observations with respect to the mineralogical composition of the nine waste rock samples submitted for kinetic testing are:

- Sulphides were primarily in the form of pyrite [FeS_2] with trace chalcopyrite [$CuFeS_2$]. Total sulphide mineral concentrations ranged from 0.019 to 0.662%, by weight. The highest sulphide concentrations were reported in the tonalite [2010-HR-027] (0.662%) and the chloritic granite [2010-HR-091] (0.467%). The lowest sulphide mineral concentrations were reported in the chloritic granite [2010-HR-117] (0.072%) and the tonalite [2010-HR-005] (0.019%). Sulphide mineral concentrations correlate with sulphide concentrations reported in ABA analysis.
- The mineralogical composition of the tonalities, pegmatite [2010-HR-065], chloritic granite porphyry [2010-HR-065], altered granitoid [2010-HR-086] and chloritic granites [2010-HR-091 and 2010-HR-117] was dominated by quartz (28 to 45%) [SiO_2], plagioclase (18 to 36%) [$CaAl_2Si_2O_8$-$NaAlSi_3O_8$] and muscovite (9.7 to 28%) [$KAl_2(AlSi_3O_{10})(F,OH)_2$].
- The mineralogical composition of the fine grained granites [2010-HR-095 and 2010-HR-004] were generally dominated by quartz (18 and 25%) and chlorite (39%) [$(Mg,Fe)_3(Si,Al)_4O_{10}(OH)_2 \cdot (Mg,Fe)_3(OH)_6$]. Fine grained granite sample 2010-HR-095 also reported a significant concentration (24%) of dolomite [$(Ca,Mg)CO_3$].
- All samples reported trace (less than 1%) concentrations of apatite [$Ca_5(PO_4)_3(OH,F,Cl)$], ranging from 0.09% by weight in the fine grained granite [2010-HR-004] to 0.35% by weight in the tonalite [2010-HR-027].
- Carbonate minerals accounted for 0.75 to 29% of the samples, averaging 8.8% by weight. The highest carbonate concentrations were reported in the fine-grained granite [2010-HR-095], and the lowest were reported in the tonalite [2010-HR-005]. The distribution of carbonate in the samples is reported in Table 3-9 below.

Table 3-9: Carbonate Deportation in Waste Rock Samples

Sample	Calcite [$CaCO_3$]	Dolomite [$CaMg(CO_3)_2$]	Magnesite [$MgCO_3$]
	(%)	(%)	(%)
Fine Grained Granite [2010-HR-004]	10.5	1.27	0
Fine Grained Granite [2010-HR-095]	0.28	24.3	3.93
Tonalite [2010-HR-005]	0.75	0	0
Tonalite [2010-HR-027]	6.07	0	0
Pegmatite [2010-HR-065]	3.2	6.64	0
Chloritic Granite Porphyry [2010-HR-067]	3.24	4.99	0

Table 3-9: Carbonate Deportation in Waste Rock Samples (Continued)

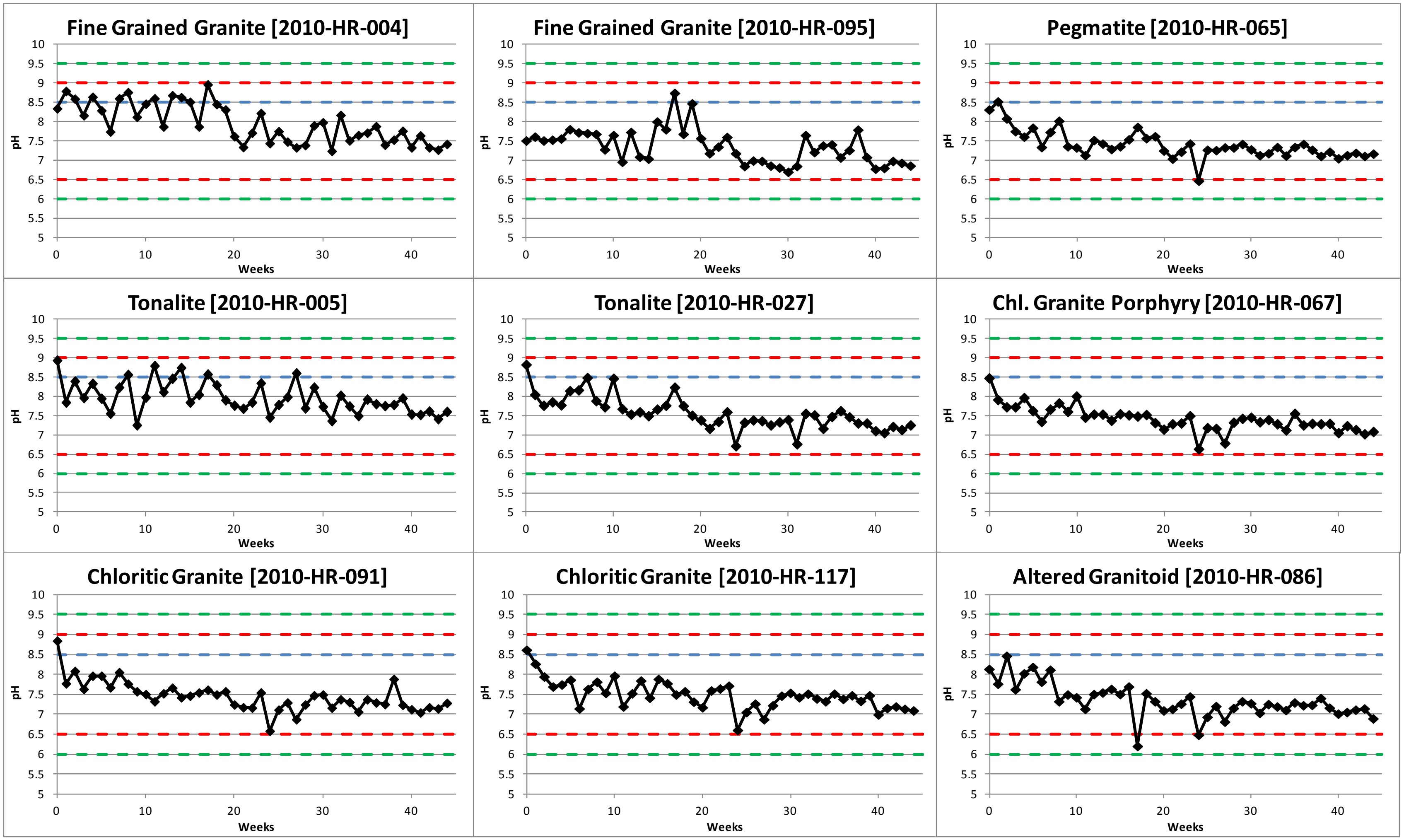
Sample	Calcite [$CaCO_3$]	Dolomite [$CaMg(CO_3)_2$]	Magnesite [$MgCO_3$]
	(%)	(%)	(%)
Altered Granitoid [2010-HR-086]	4.17	0.41	0
Chloritic Granite [2010-HR-091]	3.09	1.5	0
Chloritic Granite [2010-HR-117]	4.63	0.07	0

3.5.1.6 Humidity Cell Results

Nine waste rock humidity cells were initiated in April 2011. Humidity cell samples were selected based on the static results, representativeness of the typical geochemical characteristics and the observed occurrences of waste rock types from the drill logs and cross-sections available at the time. The following samples were selected for humidity cells:

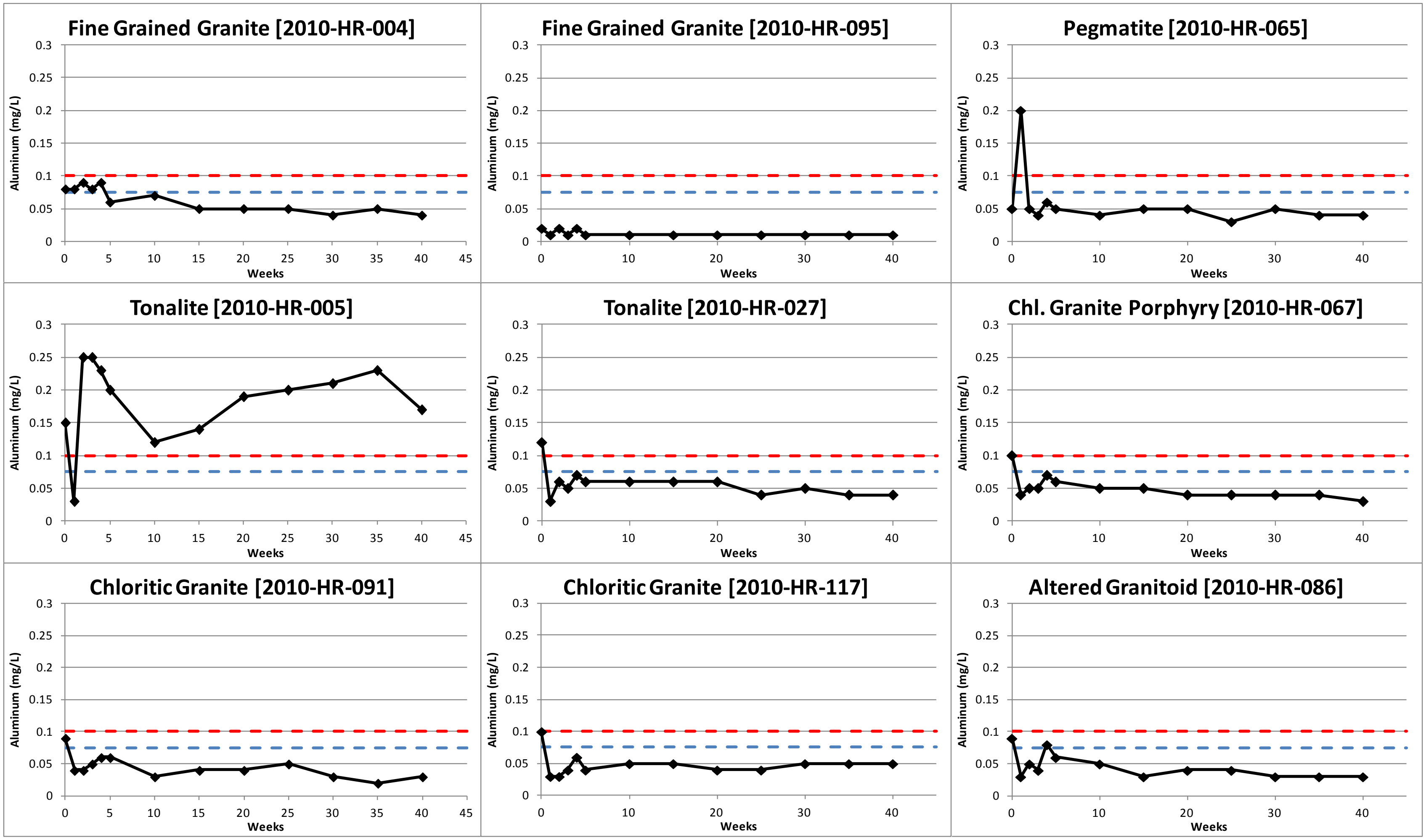
- Fine Grained Granite:
  - 2010-HR-095
  - 2010-HR-004
- Tonalite:
  - 2010-HR-005
  - 2010-HR-027
- Chloritic Granite:
  - 2010-HR-091
  - 2010-HR-117
- Pegmatite [2010-HR-065]
- Chloritic Granite Porphyry [2010-HR-067]
- Altered Granitoid [2010-HR-086]

Humidity cells results from week zero through week 44 are presented in Figures 3-6 to 3-10.



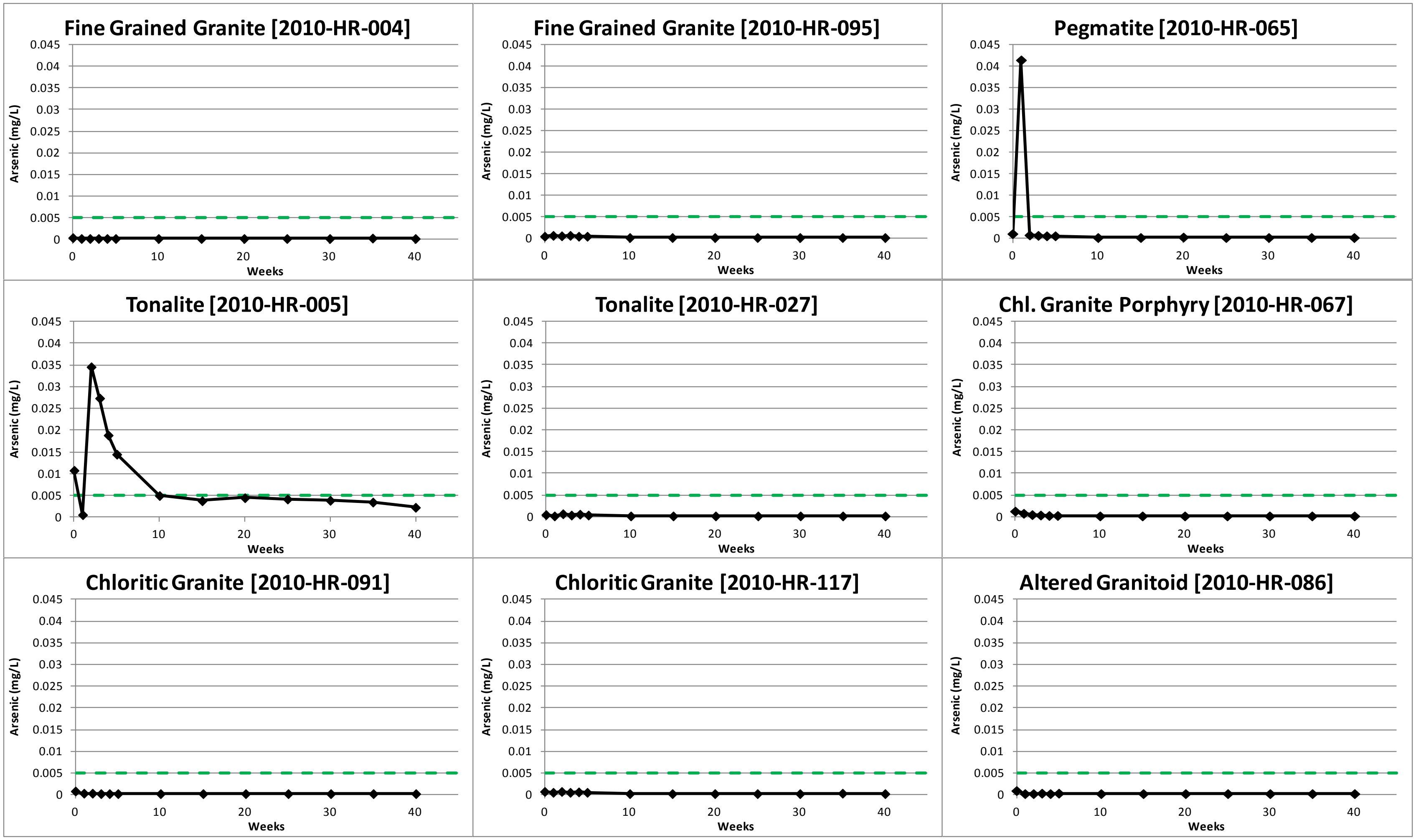
Note: Dashed lines represent pH criteria ranges for PWQO (6.5 to 8.5), CCME (6.5 to 9.0) and MISA (6.0 to 9.5).

Figure 3-6: Waste Rock Humidity Cell Testing – pH Trends



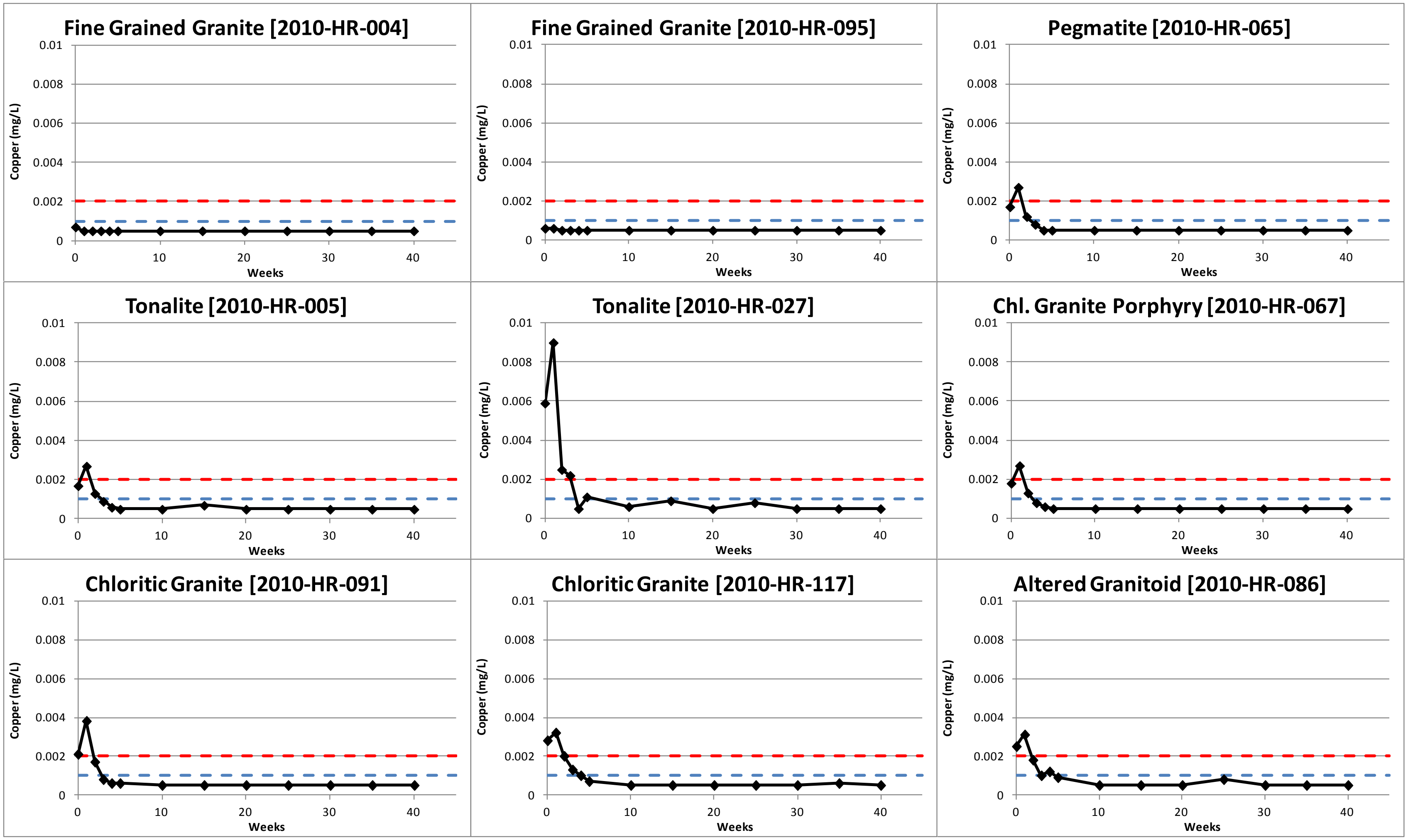
Note: Dashed red line represents CCME criterion for aluminum for pH values exceeding 6.5 (0.1 mg/L) and blue dashed line represents PWQO guidelines for aluminum for pH values exceeding 6.5 (0.075 mg/L)

Figure 3-7: Waste Rock Humidity Cell Testing – Aluminum Trends



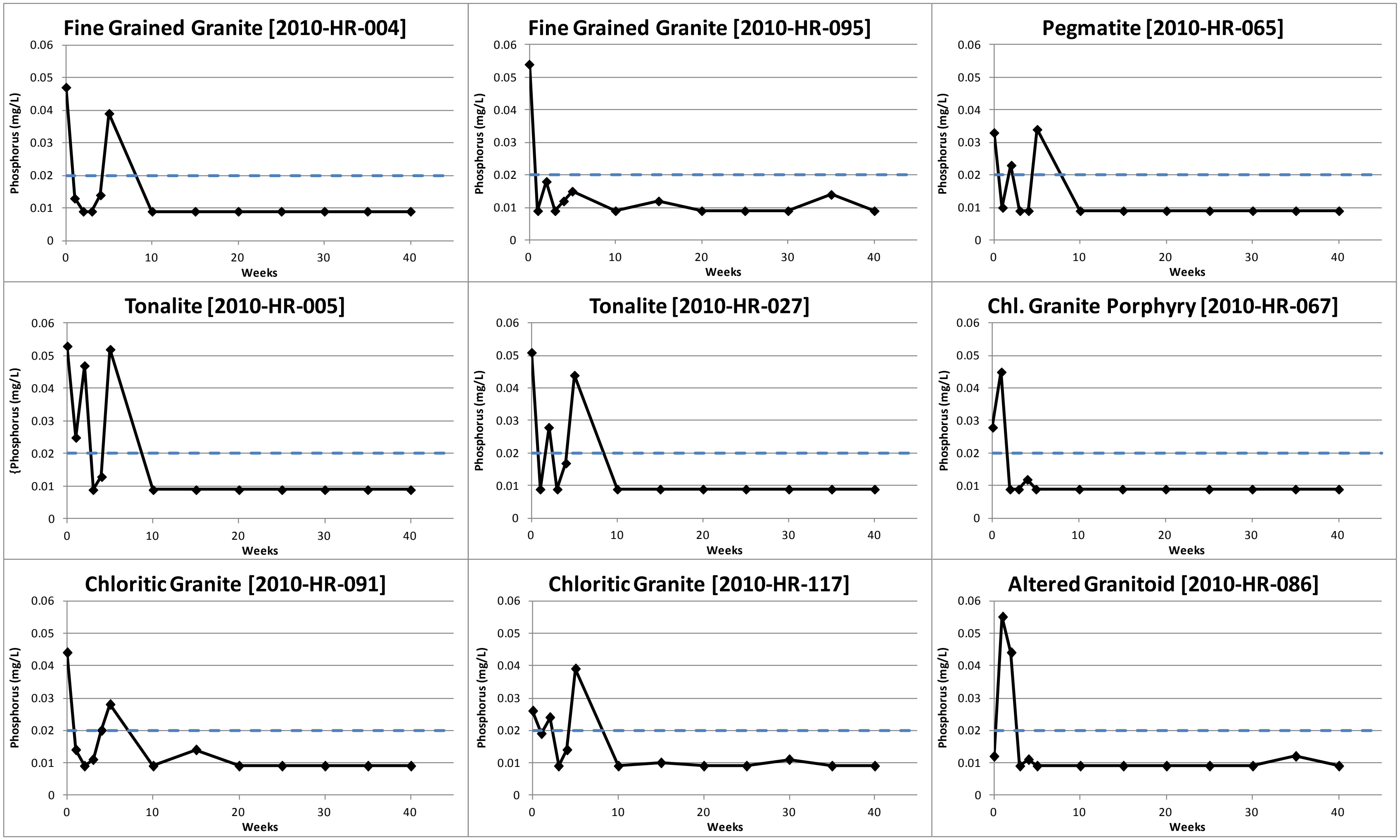
Note: Dashed green line represents CCME and PWQO criteria for arsenic (0.005 mg/L).

Figure 3-8: Waste Rock Humidity Cell Testing – Arsenic Trends



Note: Dashed red line represents CCME guidelines for copper (0.002 mg/L) and blue dashed line represents PWQO guidelines for copper (0.001 mg/L)

Figure 3-9: Waste Rock Humidity Cell Testing – Copper Trends



Note: Dashed blue line represents PWQO guidelines for phosphorus in lake water (0.02 mg/L)

Figure 3-10: Waste Rock Humidity Cell Testing – Phosphorus Trends

3.5.1.7 Acid Generation Potential

Based on the results of ABA and NAG testing, all nine samples submitted for humidity cell testing were classified as non-acid generating. The results of humidity cell testing generally support this classification based on the following observations:

- Sulphate concentrations ranged from less than 0.2 to 3.1 mg/L and were stable below 0.5 mg/L in all cells after week 10 of testing, or sooner. The highest sulphate concentrations were reported in week one of the chloritic granite [2010-HR-091] (3.0 mg/L) and the tonalite [2010-HR-027] (3.1 mg/L).
- Alkalinity concentrations ranged from 6 to 33 mg/L as $CaCO_3$ and were generally stable after week 10 of testing. The highest alkalinity value was reported in week zero of the tonalite [2010-HR-005], however all cells reported maximum alkalinity values between 24 and 33 mg/L as $CaCO_3$ during the first flush. Generally, no trend was observed differentiating the rock types based on alkalinity.
- Acidity values were below the analytical detection limit (2 mg/L as $CaCO_3$) throughout the testing for all cells.
- The pH value ranges reported in kinetic testing are summarized in Figure 3-6. All samples reported pH values within the range specified by MISA (6.0 to 9.5). The following humidity cell tests reported pH values decreasing from alkaline to neutral by week five including:
  - Tonalite [2010-HR-027].
  - Chloritic Granite Porphyry [2010-HR-067].
  - Chloritic Granite [2010-HR-091].
  - Chloritic Granite [2010-HR-117].
  - Pegmatite [2010-HR-065].
  - Chloritic Granite Porphyry [2010-HR-067].

All pH values in the leachate from the above samples were within the range specified by the CCME (6.5 to 9.0), however several pH values were greater than the PWQO range (6.5 to 8.5) in the first flush.

- The following cells reported pH values outside the ranges specified by the CCME and PWQO after the first flush:
  - Fine Grained Granite [2010-HR-095]: remains generally stable and neutral throughout testing (6.7 to 8.74), and reports a value greater than the PWQO guidelines (8.5) in week 17.
  - Tonalite [2010-HR-005]: remains generally stable and neutral throughout testing (7.25 to 8.93), and reports values greater than the PWQO guidelines (8.5) in six leachates from weeks zero to 28.

- Altered Granitoid [2010-HR-086]: decreased from alkaline and stabilized to neutral by week ten, ranging from 6.2 to 8.46. Two samples were below the PWQO and CCME guidelines (6.5) in weeks 17 (6.2) and 24 (6.48).
- The fine grained granite sample [2010-HR-004] reported generally decreasing pH values to 30 weeks, from a maximum value of 9.0 that then stabilized to near 7.5. Several samples reported pH values greater than the PWQO guidelines (8.5) from weeks zero to 16.

3.5.1.8 Metal Leaching

Generally, concentrations of most measured parameters, including both major parameters and metals, stabilized after the first five weeks of testing.

The following parameters were greater than one or more of the applicable criteria during the first flush, and then stabilized to below the criteria for the remainder of testing:

- Aluminum concentrations were greater than the applicable PWQO and CCME guidelines (0.075 and 0.1 mg/L, respectively) during the first five weeks of testing for all cells with the exception of the fine grained granite [2010-HR-095] (Figure 3-7).
- Arsenic concentrations were greater than the CCME and PWQO guidelines (both 0.005 mg/L) in leachates collected at week two of testing from the pegmatite [2010-HR-065] (0.04 mg/L), and from weeks zero to five for the tonalite [2010-HR-005] (0.011 to 0.035 mg/L) (Figure 3-8).
- Copper concentrations were greater than one or both of the CCME and PWQO guidelines (0.002 and 0.001 mg/L, respectively) during the first five weeks of testing for all samples with the exception of the fine grained granite samples [2010-HR-004 and 2010-HR-095] (Figure 3-9). The highest copper concentrations were reported in week one of testing of the tonalite [2010-HR-027] (0.009 mg/L).

Additionally, the following samples reported one or two leachate concentrations greater the applicable criteria:

- Selenium concentrations were below the detection limit and CCME and PWQO guidelines (0.001 and 0.1 mg/L, respectively) throughout testing for all samples, with the exception of two samples collected from week four of the fine grained granite cells [2010-HR-004 and 2010-HR-095], reporting 0.002 mg/L.
- The maximum phosphorus concentrations ranged from 0.034 to 0.055 mg/L, and the highest values were reported in week zero of the fine grained granite [2010-HR-095] (0.054 mg/L) and week one of the altered granitoid [2010-HR-086] (0.055 mg/L). Phosphorus concentrations in humidity cell testing decreased after the first five weeks of testing near or below the analytical detection limit (0.009 mg/L) in the long term (Figure 3-10). Initial phosphorus concentrations, reported from week zero to five in all cells, are greater than the PWQO guidelines for lake water (0.02 mg/L) in one or more samples. No relationship between solid phase apatite concentrations and phosphorus mobility was observed.

All remaining parameters were within the guidelines specified by the CCME and PWQO and all parameters were within the range specified by the MISA.

3.5.2 Tailings

The tailings sample was split and sent for analysis at two different laboratories: SGS Lakefield and Lakehead University. The testing on a split sample was done for QA/QC purposes and to verify analytical results. The laboratories generally reported similar results, with a few exceptions that are described in the sections below.

3.5.2.1 Elemental Composition

The results of the whole rock and trace metal analyses are reported in Appendix 2.III and summarized in Table 3-10. The observations show that:

- Similar to the waste rock, the major ions in tailings are primarily silicon (67.8 and 67.4% as SiO_2 equivalent and aluminum (13.3 and 13.4 % as Al_2O_3 equivalent).
- The tailings generally reported lower metal concentrations relative to the waste rock for the following: iron (3.61 and 3.65% Fe_2O_3 equivalent) chromium (0.01% Cr_2O_3 equivalent), silver (0.22 and less than 0.5 µg/g) and vanadium (30 and 39 µg/g).
- Several parameters were higher in the tailings than average waste rock concentrations, including arsenic (2.5 and 5.3 µg/g), molybdenum (3.6 and 5.0 µg/g), cadmium (0.33 and less than 0.5 µg/g), zinc (46 and 64 µg/g) and copper (30 and 39 µg/g).
- Concentrations were generally similar between the two laboratories, however analytical detection limits varied.

Table 3-10: Summary of Elemental Composition of Tailings

Laboratory	SiO_2	Al_2O_3	Fe_2O_3	Cr_2O_3	Ag	As	Cu	Mo	V	Cd	Zn
	%	%	%	%	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g
SGS Lakefield	67.8	13.3	3.61	0.01	0.22	2.5	30	3.6	35	0.33	46
Lakehead	67.4	13.4	3.65	0.01	< 0.5	5.3	39	5.0	43	<0.5	64

3.5.2.2 Acid Base Accounting

The ABA results for the tailings are summarized in Table 3-11.

Table 3-11: Summary of Acid Base Accounting (ABA) and Net Acid Generation (NAG) of Tailings

Rock Type	Sulphur Species (wt %)			CO_3 wt %	Potentials (t $CaCO_3$/1000t)			NPR	CaNPR	NAG
	Total	Sulphate	Sulphide		NP	AP	CaNP			pH
SGS Lakefield	0.175	0.08	0.09	4.84	77	2.85	80	27	28	11
Lakehead	0.26	—	—	—	103.8	—	—	—	—	10.7/11.5

Notes:

— = Not analysed.

Total sulphur concentrations varied between SGS Lakefield (0.175%) and Lakehead (0.26%). Based on the ABA results reported at SGS Lakefield, the sulphur content is almost equally represented by sulphide-sulphur (0.09%) and sulphate sulphur (0.08%).

The CaNP of the tailings (80 t $CaCO_3$/1000 t) is similar to the NP of the sample (77 t $CaCO_3$/1000 t), suggesting buffering minerals are primarily carbonates. The occurrence of less reactive carbonates, including magnesite ($MgCO_3$) and siderite ($FeCO_3$) may be the reason for the slightly lower neutralization potential, as they provide less buffering capacity than more reactive carbonates including calcite ($CaCO_3$). However these minerals occurred only in small amounts relative to the other carbonate minerals as indicated in the mineralogical report (Section 3.5.2.5)

Based on the NPR and CaNPR values of 27 t $CaCO_3$/1000 t and 28 t $CaCO_3$/1000 t, respectively, the tailings sample is classified as non-acid generating.

3.5.2.3 Net Acid Generation Testing

The NAG testing results are presented in Table 3-11. The tailings sample reported an alkaline NAG pH between 10.7 and of 11.5 and, therefore, is classified as non-acid generating. This is in agreement with the available ABA information which also indicates the tailings are non-acid generating.

3.5.2.3.1 Aging Tests

Aging tests were conducted at both laboratories on the water associated with the tailings sample. The samples were analyzed for total and dissolved concentrations, when possible. When insufficient leachate sample was available, only total concentrations were measured. Tailings aging test results are included in Appendix 2.III. The results are summarized in Table 3-12 and as follows:

- All concentrations are within the acceptable MISA pH range of 6.0 to 9.5.
- Several parameters analyzed at Lakehead University reported detection limits greater than the applicable criteria, including total and dissolved silver (less than 0.05 and less than 0.01 mg/L, respectively), total and dissolved cadmium (less than 0.0002 mg/L), total and dissolved lead (less than 0.0025 mg/L and less than 0.025 mg/L, respectively), total uranium (less than 0.05 mg/L), dissolved uranium (less than 0.08 mg/L) and dissolved cobalt (less than 0.005 mg/L).
- Total and dissolved molybdenum (0.06 to 0.086 and 0.06 to 0.091 mg/L, respectively) concentrations were greater than the PWQO guidelines (0.04 mg/L) throughout testing at both laboratories. Molybdenum concentrations were generally lower in results collected at Lakehead University (0.06 to 0.065 mg/L) than those reported from SGS Lakefield (0.072 to 0.091 mg/L).
- Total and dissolved copper (0.0045 to 0.16 and 0.0027 to 0.016 mg/L, respectively) concentrations were greater than the PWQO and CCME guidelines (0.001 and 0.002 mg/L, respectively) throughout testing at both laboratories. Copper concentrations were generally higher in results collected at Lakehead University (0.016 to 0.057 mg/L) than those reported from SGS Lakefield (0.0027 to 0.016 mg/L).

- Total aluminum concentrations were greater than the PWQO and CCME guidelines (0.075 and 0.1 mg/L, respectively) in all samples analyzed at Lakehead University (0.18 to 0.75 mg/L), as well as the Day 0 sample analyzed at SGS Lakefield (0.44 mg/L).
- Total cobalt concentrations were greater than the PWQO guidelines (0.0009 mg/L) in all samples analyzed at Lakehead University (0.0025 to 0.0029 mg/L) and SGS Lakefield (0.0028 to 0.003 mg/L).
- Total nickel concentrations were greater than the PWQO and CCME guidelines (0.025 mg/L) in Day 7. Fifteen and 30 water samples analyzed at Lakehead University (0.029 to 0.039 mg/L).
- Total and dissolved uranium concentrations analyzed at SGS Lakefield (0.0062 to 0.0094 and 0.0060 to 0.0072 mg/L, respectively) were greater than the PWQO guidelines (0.005 mg/L) throughout testing.
- Total lead concentrations were greater than the PWQO and CCME guidelines (0.001 mg/L) in one sample from Day 7 water at SGS Lakefield (0.0032 mg/L).
- Cadmium concentrations were greater than the CCME guidelines (0.000017 mg/L) in two samples analyzed at SGS Lakefield, including total cadmium measured at Day 30 (0.00005 mg/L) and dissolved cadmium measured at Day 7 (0.000026 mg/L).

Table 3-12: Aging Tests Results – Tailings Process Water

Parameter	Unit	MISA	CCME Aquatic Life	PWQO	SGS Lakefield				Lakehead			
					Day 0	Day 7	Day 15	Day 30	Day 0	Day 7	Day 15	Day 30
pH	units	6 - 9.5	6.5 - 9.0	6.5 - 8.5	8.46	8.39	8.36	8.31	7.9	7.9	7.7	7.7
SO_4	mg/L	—	—	—	210	240	240	280	160	256	275	270
Total Concentrations												
Al	mg/L	—	0.1	0.075	**0.44**	0.04	0.01	0.04	**0.48**	**0.75**	**0.18**	**0.27**
Cd	mg/L	—	0.000017	0.0001	0.000012	0.000016	<0.000003	**0.00005**	<0.0002	0.0002	<0.0002	<0.0002
Co	mg/L	—	—	0.0009	**0.0028**	**0.0029**	**0.0028**	**0.003**	**0.0027**	**0.0025**	**0.0028**	**0.0029**
Cu	mg/L	0.3	0.002	0.001	**0.0047**	**0.015**	**0.0093**	**0.0045**	**0.019**	**0.057**	**0.16**	**0.16**
Mo	mg/L	—	—	0.04	**0.076**	**0.086**	**0.08**	**0.087**	**0.065**	**0.062**	**0.06**	**0.06**
Ni	mg/L	0.5	0.025	0.025	0.0077	0.0077	0.0067	0.0073	0.012	**0.029**	**0.039**	**0.034**
Pb	mg/L	0.2	0.001)	0.001	0.00089	**0.0032**	0.00024	0.00062	<0.0025	<0.0025	0.0026	<0.0025
U	mg/L	—	—	0.005	**0.0065**	**0.0062**	**0.0074**	**0.0094**	<0.05	<0.05	<0.05	<0.05
Zn	mg/L	0.5	0.03	0.02	<0.002	<0.002	<0.002	0.002	**0.032**	**0.031**	**0.043**	**0.051**
Dissolved Concentrations												
Al	mg/L	—	0.1	0.075	0.04	0.02	<0.01	0.04	0.017	-	-	-
Cd	mg/L	—	0.000017	0.0001	0.000009	0.000026	<0.000003	0.000028	<0.0002	-	-	-
Co	mg/L	—	—	0.0009	<0.0005	<0.0005	<0.0005	<0.0005	<0.005	-	-	-
Cu	mg/L	0.3	0.002	0.001	0.0027	0.016	0.0091	0.0044	0.012	-	-	-
Mo	mg/L	—	—	0.04	0.072	0.083	0.079	0.091	0.06	-	-	-
Ni	mg/L	0.5	0.025	0.025	0.007	0.0078	0.0066	0.0079	0.011	-	-	-
Pb	mg/L	0.2	0.001)	0.001	0.00006	0.00008	0.00004	0.00044	<0.025	-	-	-
U	mg/L	—	—	0.005	0.0063	0.0060	0.0072	0.0086	<0.08	-	-	-
Zn	mg/L	0.5	0.03	0.02	<0.002	<0.002	<0.002	<0.002	0.002	-	-	-

Notes: Bolded values do not meet one or more of the criteria considered. The formatting applies to this summary table only. For a complete comparison of all results and parameters tested to the criteria, refer to Appendix 2.III.
— There is no criteria for the parameter.
- Parameter was not analysed.

3.5.2.4 Short-Term Leach Testing

The results of the both the SFE and NAG leach tailings test results are provided Table 3-13 and are summarized by test type below.

3.5.2.4.1 Shake Flask Extraction Leach Test

The Shake Flask Extraction (SFE) leach test was conducted on one split sample at SGS Lakefield and the results are summarized as follows:

- All concentrations were within the MISA criteria.
- The pH value reported in the SFE leachate was more alkaline than the PWQO range of 6.5 to 8.5 (8.65).
- Copper concentrations were greater than the PWQO guidelines (0.001 mg/L) in the SFE leachate (0.0013 mg/L).
- Concentrations for aluminum (0.14 mg/L) were greater than the CCME aquatic and PWQO guidelines (0.1 and 0.075 mg/L, respectively).

3.5.2.4.2 NAG Leach Test

The NAG leach test was conducted on the split samples at both SGS Lakefield and Lakehead University. The results are summarized as follows:

- pH values from the NAG leachates conducted at SGS Lakefield and Lakehead (11.1 and 11.4, respectively) were greater than all applicable criteria, including PWQO (6.5 to 8.5), CCME (6.5 to 9.0) and MISA (6.0 to 9.5).
- All metal concentrations were below the MISA values.
- Silver concentrations were greater than the PWQO and CCME guidelines (0.0001 mg/L) in the NAG leachate collected at SGS Lakefield (0.00033 mg/L). The detection limit for silver at Lakehead (less than 0.01 mg/L) exceeded the criteria.
- Boron concentrations were greater than the PWQO guidelines (0.2 mg/L) in the NAG leachate collected at SGS Lakefield (0.801 mg/L). Boron was not measured at Lakehead.
- Concentrations for aluminum reported at SGS Lakefield and Lakehead (1.6 mg/L and 2.3 mg/L, respectively) were greater than the CCME aquatic and PWQO guidelines (0.1 and 0.075 mg/L).
- Zinc concentrations were greater than the PWQO and CCME guidelines (0.02 and 0.03 mg/L, respectively) in the NAG leachate collected at Lakehead (0.048 mg/L), but was below the analytical detection limit at SGS Lakefield (less than 0.001 mg/L).

- Hexavalent chromium concentrations measured in the NAG leachate at SGS Lakefield (0.02 mg/L) were greater than the PWQO and CCME guidelines (0.001 mg/L) and were not measured at Lakehead. Given that in the short term leach tests both total and hexavalent chromium were below detection limits, the presence of hexavalent chromium in the NAG test is likely a function of the redox conditions and elevated pH that result from the NAG test procedure and is not expected under typical site conditions.

Table 3-13: Summary of Short Term Leach Test Results for Tailings

Parameter	Unit	MISA	CCME Aquatic Life	PWQO	SGS Lakefield		Lakehead
					SFE Leach	NAG Leach	NAG Leach
pH	units	6 - 9.5	6.5 - 9.0	6.5 - 8.5	**8.65**	**11.1**	**11.4**
SO_4	mg/L	—	—	—	55	19	-
Ag	mg/L	—	0.0001	0.0001	<0.00001	**0.00033**	< 0.01
Al[(a)]	mg/L	—	0.1[(a)]	0.075[(a)]	**0.14**	**1.6**	**2.31**
As	mg/L	1.0	0.005	0.005	0.001	0.0006	< 0.025
B	mg/L	—	—	0.2	0.0038	**0.801**	-
Cd	mg/L	—	0.0001	0.000017	0.000005	<0.000003	<0.0005
Cr (total)	mg/L	—	0.001	0.001	<0.0005	0.021	0.024
Cr (VI)	mg/L	—	0.001	0.001	<0.00002	**0.02**	-
Cu	mg/L	0.6	0.002 - 0.004	0.001	**0.0013**	<0.0005	<0.005
Se	mg/L	—	0.001	0.1	<0.001	<0.001	<0.05
V	mg/L	—	—	0.006	0.00005	0.000003	-
Zn	mg/L	—	0.03	0.02	<0.001	<0.001	**0.048**

Notes: Bolded values do not meet one or more of the criteria considered. The formatting applies to this summary table only. For a complete comparison of all results and parameters tested to the criteria, refer to Appendix 2.III. For criteria where a range exists, the lowest criterion was used, except in the case of aluminum.

(a) Criteria for aluminum based on observed pH values greater than 6.5.

— = There is no criteria for the parameter.

- = Parameter was not analysed.

3.5.2.5 Mineralogy

Mineralogical analysis was conducted at Lakehead to determine the general mineralogical composition of the tailings sample. Mineralogy results are presented in Appendix 2.VI.

The tailings sample is primarily composed of quartz [SiO_2] (43.4%), albite [$NaAlSi_3O_8$] (27.3%) and muscovite [$KAl_2(AlSi_3O_{10})(F,OH)_2$] with minor (1 to 10%) chlorite [$(Mg,Fe)_3(Si,Al)_4O_{10}(OH)_2 \cdot (Mg,Fe)_3(OH)_6$] (4.9%), ankerite [$Ca(Fe,Mg,Mn)(CO_3)_2$] (4.8%) and calcite [$CaCO_3$] (2.4%). Pyrite [$FeS_2$] and magnetite [$Fe_3O_4$] were identified petrographically, though represent less than 1% of the sample by weight.

3.5.2.6 Humidity Cell Results

Tailings humidity cells were performed at both SGS Lakefield and Lakehead using the split tailings sample and results are available to 20 and 23 weeks, respectively. The results are presented in Appendix 2.IV and plotted in Appendix 2.V. Key parameters results are plotted in Figure 3-11. The results of the tailings humidity cell testing are summarized as follows:

- pH values are near-neutral and similar between the two laboratories, ranging between 6.5 and 8.3 at Lakehead and 6.97 to 7.81 at SGS Lakefield. All pH values were within the ranges specified by the PWQO (6.5 to 8.5), CCME (6.5 to 9.0) and MISA (6.0 to 9.5) guidelines.
- Aluminum concentrations reported no observable trend over time, and were greater than the PWQO guidelines (0.075 mg/L) for pH values greater than 6.5 in samples collected in weeks zero and one of testing at Lakehead (0.08 mg/L), though SGS Lakefield reported lower concentrations in the same time period (0.02 and less than 0.01 mg/L). Aluminum concentrations were below applicable criteria at both laboratories for the remainder of testing.
- Copper concentrations were greater than the PWQO (0.001 mg/L) and CCME (0.002 mg/L) guidelines in weeks zero and one at Lakehead (0.013 and 0.006 mg/L) and were greater than only the PWQO during the same time period at SGS Lakefield (0.0018 and 0.0015 mg/L).
- Cadmium concentrations were greater than the CCME and PWQO guidelines (0.000017 mg/L and 0.0001 mg/L, respectively) in week two of testing at SGS Lakefield (0.00103 mg/L) and were greater than the CCME guidelines at week 15 (0.000026 mg/L). The detection limit for cadmium at Lakehead was greater than both criteria (0.004 mg/L).
- Iron concentrations were greater than the PWQO and CCME guidelines at week 10 of testing at Lakehead (0.35 mg/L), however the week 10 leachate iron concentration reported at SGS Lakefield was below the analytical detection limit (0.003 mg/L).
- Zinc concentrations were greater than both the PWQO and CCME guidelines (0.02 and 0.03 mg/L, respectively) in week two leachates from both SGS Lakefield (0.043 mg/L) and Lakehead (0.038 mg/L). Zinc concentrations were greater than only the PWQO guidelines (0.02 mg/L) in weeks four and five (0.029 and 0.03 mg/L, respectively) of the Lakehead humidity cell test.
- All other parameters meet the MISA, PWQO and CCME guidelines.

Stable pH values in the kinetic leachates support the results of ABA testing which characterize the material as non-acid generating.

Kinetic testing of the tailings sample was terminated after 20 weeks due to low and generally stable key parameter concentrations.

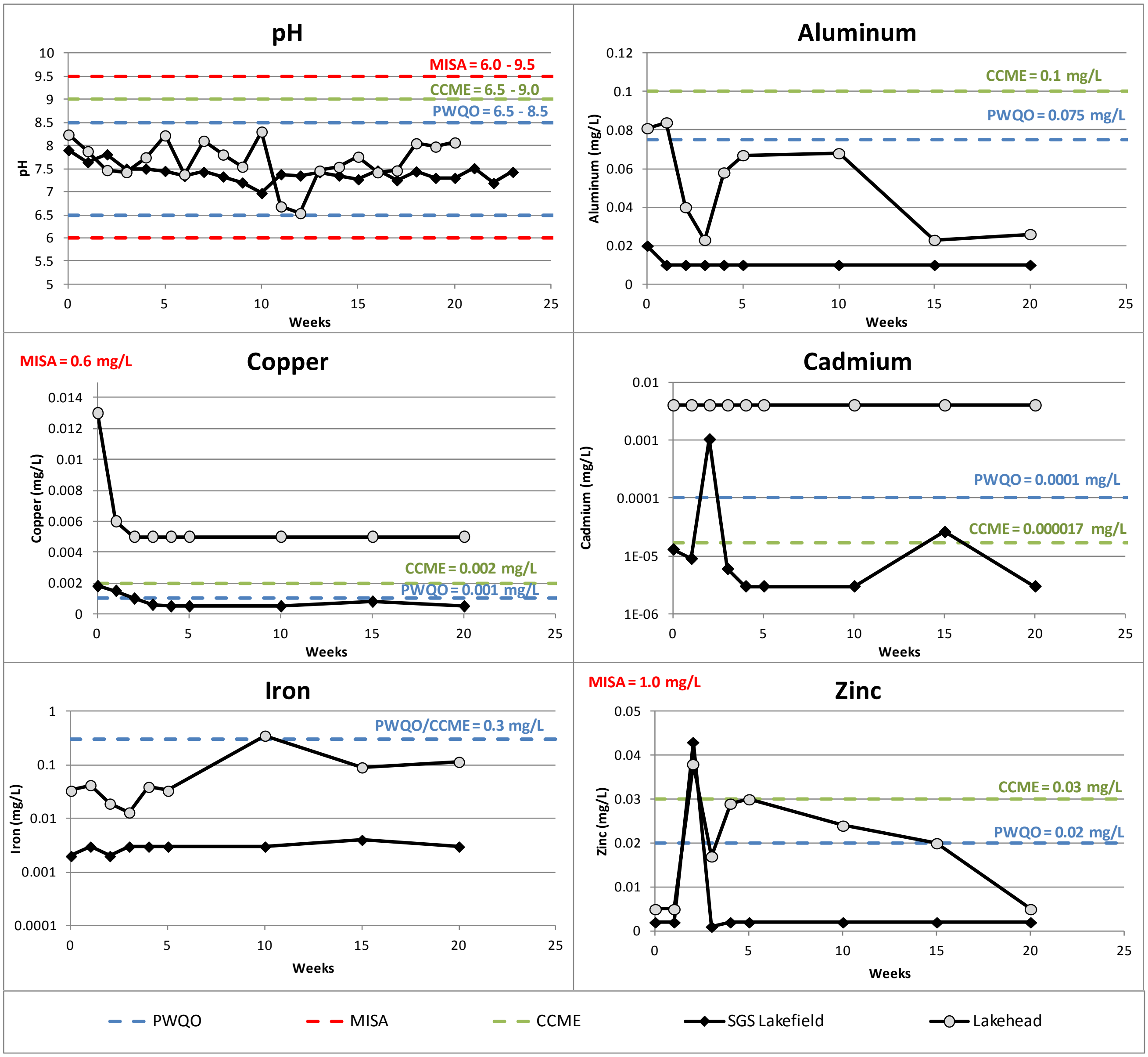


Figure 3-11: Tailings Humidity Cells – Key Parameter Trends

3.6 Summary and Conclusions

3.6.1 Waste Rock

A total of 123 waste rock samples were collected from the Hammond Reef deposit. Several geochemical tests, both static and kinetic, were performed to determine the potential for acid generation and metal leaching of these materials. Based on the analysis completed the waste rock is expected to be non-acid generating with excess neutralization potential primarily resulting from carbonate minerals. The neutralization potential of the waste rock is generally high and is attributable to carbonate minerals, resulting in NPR and CaNPR values exceeding 2.0 for almost all samples tested, with one exception, a sample from the quartz vein zone. Additionally, neutral to basic NAG pH results for all samples indicate the waste rock is unlikely to generate acidity. The results of short term leach testing and kinetic testing support the classification of the waste rock material as non-acid generating.

The pH values of waste rock were observed to be more alkaline than the criteria in the results of short term leach testing. However, kinetic testing results report neutral pH values over longer time periods.

Concentrations of metals in leachate from the waste rock are generally below comparison criteria with some exceptions. Aluminum concentrations were elevated with respect to the applicable criteria in several samples including both short term and kinetic tests. Other metals reporting sporadic concentrations slightly greater than the comparison criteria in waste rock leach testing include arsenic, copper, selenium and vanadium. Phosphorus concentrations in humidity cells ranged initially from 0.034 to 0.055 mg/L, decreasing after the first five weeks of testing to values near or below the analytical detection limit (0.009 mg/L). Where sample values are above the comparison criteria, additional water quality evaluation within an overall site wide context is required.

3.6.2 Tailings

One tailings sample was generated, split, and submitted for static and kinetic testing at two analytical laboratories. The tailings are not expected to be acid generating. The pH values of the tailings were observed to be more alkaline than the comparison criteria in the results of short term leach testing. However, kinetic testing results report neutral pH values over longer time periods.

The tailings material has the potential to leach elevated aluminum concentrations with respect to comparison criteria over both the long and short term, as identified by short term and kinetic leach testing. Short term leach testing and first flush results from kinetic testing also reported elevated copper concentrations over the short term, decreasing to below the criteria in the long term. Other metals reporting sporadic concentrations greater than the comparison guideline values in waste rock leach testing include cadmium, silver, chromium, zinc and iron. Two parameters were reported at concentrations elevated with respect to the comparison guideline values by Lakehead but not SGS Lakefield. These parameters include zinc and nickel. Several metals in the process waters generated as part of the initial tailings program are also greater than the comparison guideline values considered. These metals include aluminum, cobalt, copper, cadmium, molybdenum, lead and uranium. Where values are above guideline values, additional water quality evaluation within an overall site wide context is required.

4.0 TERRAIN AND SOILS

4.1 Objectives

The general objectives of the terrain and soils mapping are to describe and characterize the existing terrain and soils resources, the distribution across the landscape, and associated soil quality and sensitivities within the terrain and soils LSA. The specific objectives are:

- Existing conditions mapping and description of landforms and landform processes and soils within the Regional Study Area and Local Study Area, to support the effects assessment for all terrestrial disciplines.
- Map soil depth by horizon within the Mine Study Area to support soil salvage and reclamation efforts; details of soil sample analysis completed and the quality assurance/quality control program followed.
- Summarize existing data on the concentration of trace elements in site soils prior to Project development.

4.2 Background

Soil is the naturally occurring, unconsolidated mineral or organic material at least 10 cm thick that occurs at the earth's surface and is capable of supporting plant growth. Naturally occurring includes disturbance of the surface horizons by human activities such as cultivation and logging, but not displaced materials such as gravel dumps and mine spoils. Soil extends from the earth's surface through the genetic horizons, if present, into the underlying material to the depth of the control section (Soil Classification Working Group 1998). Soil development involves climatic factors and organisms, as conditioned by relief and hence water regimes, acting through time on geological materials and thus modifying the properties of the parent materials (Soil Classification Working Group 1998).

Individual soils occupy distinct places in the landscape, so patterns of soils and landscape features can be found. The soil horizons that develop on the landscape are differentiated as follows:

- LFH is a surface horizon on forested soils that consists of leaf litter and is composed of organic matter and very little mineral material.
- A horizon is a mineral horizon that forms at or near the surface in the zone of leaching or eluviation of materials, or of maximum in-situ accumulation of organic matter, or both.
- B horizon is the horizon that has been altered from the original parent material and occurs under the A horizon; this mineral horizon is characterized by enrichment in organic matter, sesquioxides, or clay; or by the development of soil structure; or by a change in color denoting hydrolysis, reduction, or oxidation.
- C horizon is comparatively unaffected by the pedogenic processes operating in A and B horizons, except the process of gleying (Cg) and the accumulation of calcium and magnesium carbonates (Cca) and more soluble salts (Cs, Csa).

Some key soil concepts include (Fricklin 2008):

- Soil properties reflect the progressive alteration and redistributions of nutrients, minerals and organic matter over time.
- Soils, landscapes and their biota have co-evolved over geologic time.
- Soils, landscapes and biota are arranged and respond to the temporal and spatial distributions of water, nutrients and energy.
- Landforms (the individual features of the landscape) control the distributions of water, nutrients and energy.

Soils are important because they:

- Filter water.
- Provide habitat for millions of species of organisms.
- Provide water, nutrients and support for plants.
- Sequester carbon from the atmosphere.

4.3 Methods

This section provides specific methods as related to evaluation of terrain and soils. The terrain mapping used data collected from terrestrial ecology and geochemistry field programs in the LSA and regional terrain mapping as identified in Sections 4.3.2 and 4.3.3. The approach to classifying and describing terrain and soils units involved a review of existing information, soil sampling and analysis, and development of terrain and soils maps in a Geographical Information System (GIS) platform.

For soil mapping, the Ecological Land Classification (ELC) vegetation units are used as part of the mapping process to derive correlations between soil types and the ELC vegetation types. Due to the resolution of the ELC data, the soil map units are presented as complexes to capture the range of soil types on the landscape and minor components of a soil series (i.e., less than 20% representation within a map unit) are not mapped. The soil map unit delineations are inferred from the interpretation of landscape features (i.e., elevation contours and landform) and ELC units, without field groundtruthing. Thus, the soil map should be viewed as a general predictive model of soil distribution. The information provided is suitable for inclusion in an environmental assessment; however it should not be used to predict discretised site-specific characteristics for purposes such as engineering design without collecting additional field information.

The wind erosion risk ratings are adapted from the publication Wind Erosion Risk (Coote and Pettapiece 1989), while the water erosion risk ratings are adapted from the publication Water Erosion Risk (Tejak and Coote 1993).

4.3.1 Parameters and Criteria

Soil quality parameters and criteria used to define the existing conditions for the Project soil conditions were selected from the following data sources:

- OHRG's site investigations from 2012 to 2012.
- O. Reg. 153 Standard for Soils.
- CCME Soil Standards (CCME 2012).

4.3.2 Primary Data (Field Studies)

Soil samples were collected within the proposed footprint of the Mine and analyzed for metals. Soil metal data was collected during the April 2012 field program at 18 sites (Table 4-1, Figure 4-1).

Table 4-1: 2012 Existing Conditions Soil Metal Analyses

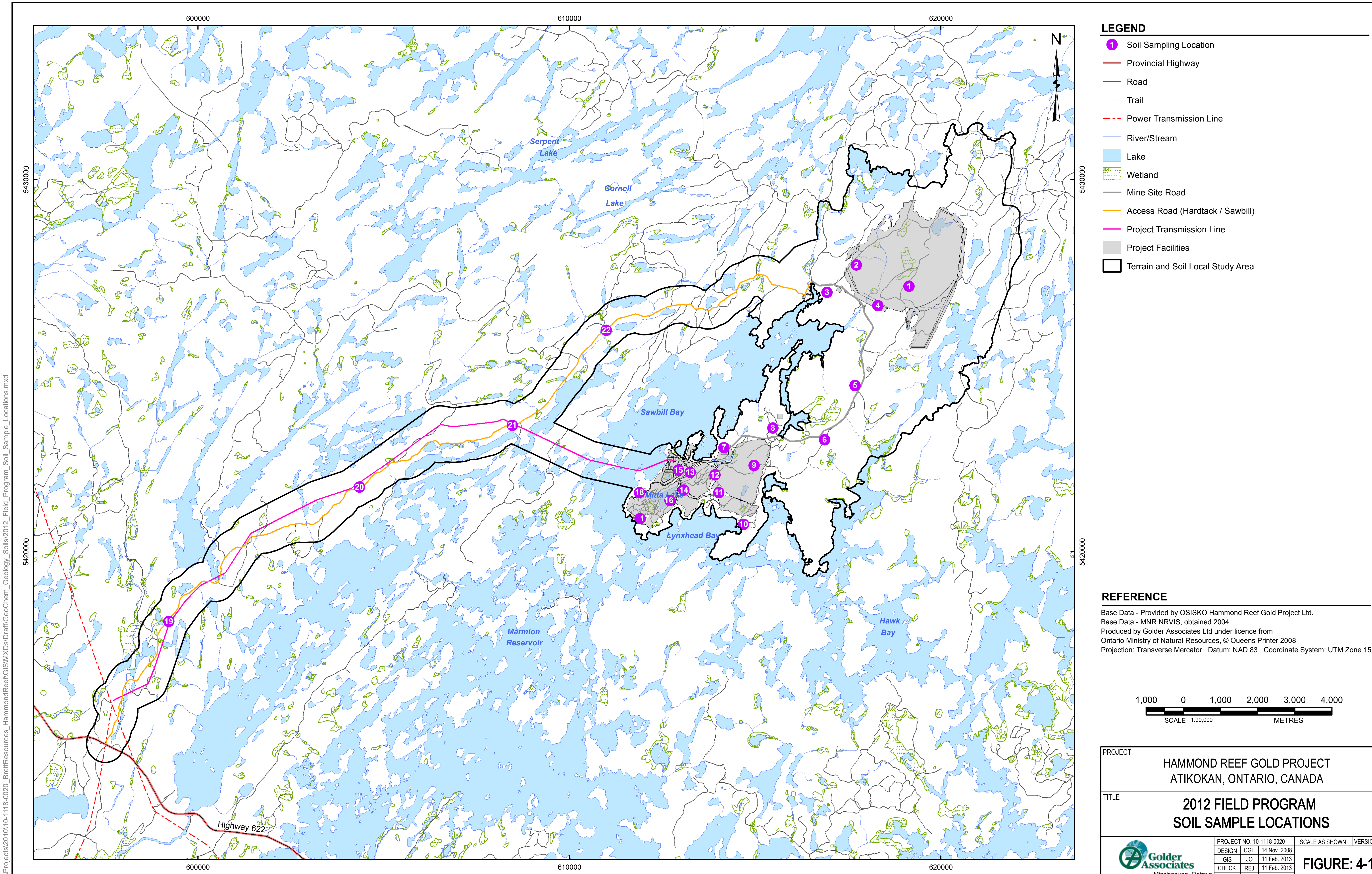
Parameter	Soil Samples
pH	✓
% moisture	✓
Nitrate and nitrite N	✓
Total P	✓
Total organic C	✓
CCME metals (Ag, As, hot water soluble B, Ba, Be, Cd, Co, Cr (total) and Cr (6+), Cu, Hg, Mo, Ni, Pb, Sb, Se, Tl, U, V, Zn); Al and Mn	✓

4.3.3 Secondary Data Review

The secondary data used for terrain mapping was the regional mapping that is available from the Ontario Ministry of Natural Resources (MNR 2004).

4.4 Existing Conditions

Five terrain units have been defined and mapped for the LSA (Table 4-2, Figure 4-2). The most common terrain map unit encountered in the LSA is the bedrock terrain unit which covers 5,633 ha (66% of LSA). The second most abundant terrain unit is the glaciolacustrine unit which covers 1,277 ha (15% of LSA). The remaining terrain units compose less than 10% of the LSA. The topography of the LSA is outlined in Figure 4-2.


600000
610000
620000
5430000
5420000
N
Serpent Lake
Cornell Lake
Sawbill Bay
Mitta Lake
Lynxhead Bay
Marmion Reservoir
Hawk Bay
Highway 622
LEGEND
Soil Sampling Location
Provincial Highway
Road
Trail
Power Transmission Line
River/Stream
Lake
Wetland
Mine Site Road
Access Road (Hardtack / Sawbill)
Project Transmission Line
Project Facilities
Terrain and Soil Local Study Area
REFERENCE
Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N
1,000 0 1,000 2,000 3,000 4,000
SCALE 1:90,000 METRES
PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA
TITLE
2012 FIELD PROGRAM
SOIL SAMPLE LOCATIONS
Golder Associates
Mississauga, Ontario
PROJECT NO. 10-1118-0020
SCALE AS SHOWN
VERSION 1
DESIGN CGE 14 Nov. 2008
GIS JO 11 Feb. 2013
CHECK REJ 11 Feb. 2013
REVIEW KJD 11 Feb. 2013
FIGURE: 4-1
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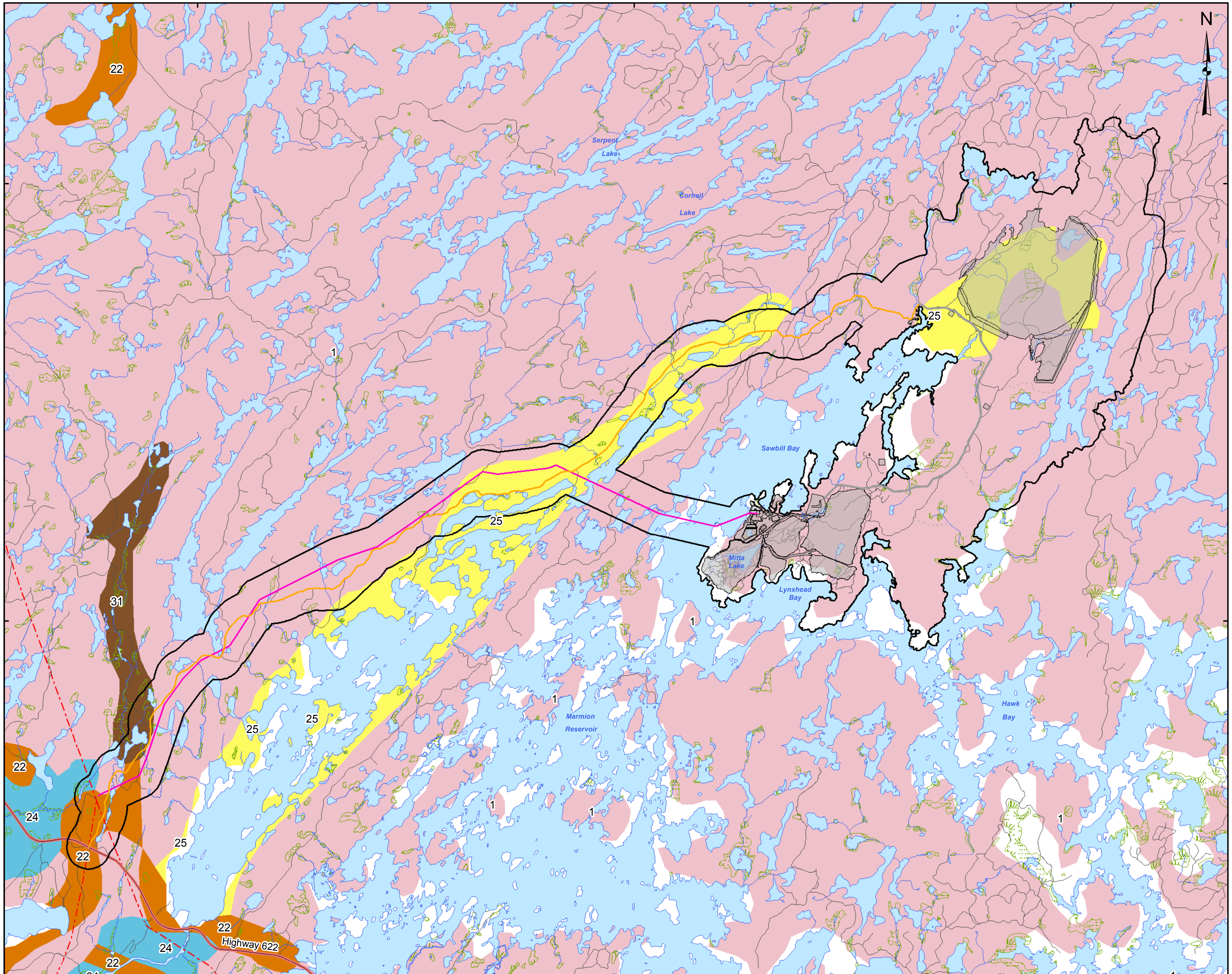

LEGEND

- Trail
- Road
- River/Stream
- Lake
- Wetland

Surficial Geology

- 1 Bedrock
- 22 Glaciofluvial Ice
- 24 Glaciolacustrine deposits
- 25 Glaciolacustrine deposits
- 31 Fluvial deposits
- Mine Site Road
- Access Road (Hardtack / Sawbill)
- Project Transmission Line
- Project Facilities
- Terrain and Soil Local Study Area

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004
Surficial Geology - Ontario Geological Survey, 1997. Quaternary geology, seamless coverage of the province of Ontario: Ontario Geological Survey, Data Set 14.
Produced by Golder Associates Ltd under licence from Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

1,000 0 1,000 2,000 3,000 4,000
SCALE 1:90,000 METRES

PROJECT

HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE

TERRAIN MAP UNITS IN THE LOCAL STUDY AREA

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020			SCALE AS SHOWN	VERSION 1
DESIGN	CGE	14 Nov. 2008	FIGURE: 4-2	
GIS	JO	11 Feb. 2013		
CHECK	KDV	11 Feb. 2013		
REVIEW	KDV	11 Feb. 2013		

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Table 4-2: Area of Terrain Map Units in the Local Study Area

Terrain Map Unit	Total Local Study Area	
	Area (ha)	%
Bedrock	5,633	66
Glaciolacustrine	1,277	15
Glacioflvuial ice contact deposits	187	2
Fluvial	70	1
Water	902	4
Total	**8,494**	**100**

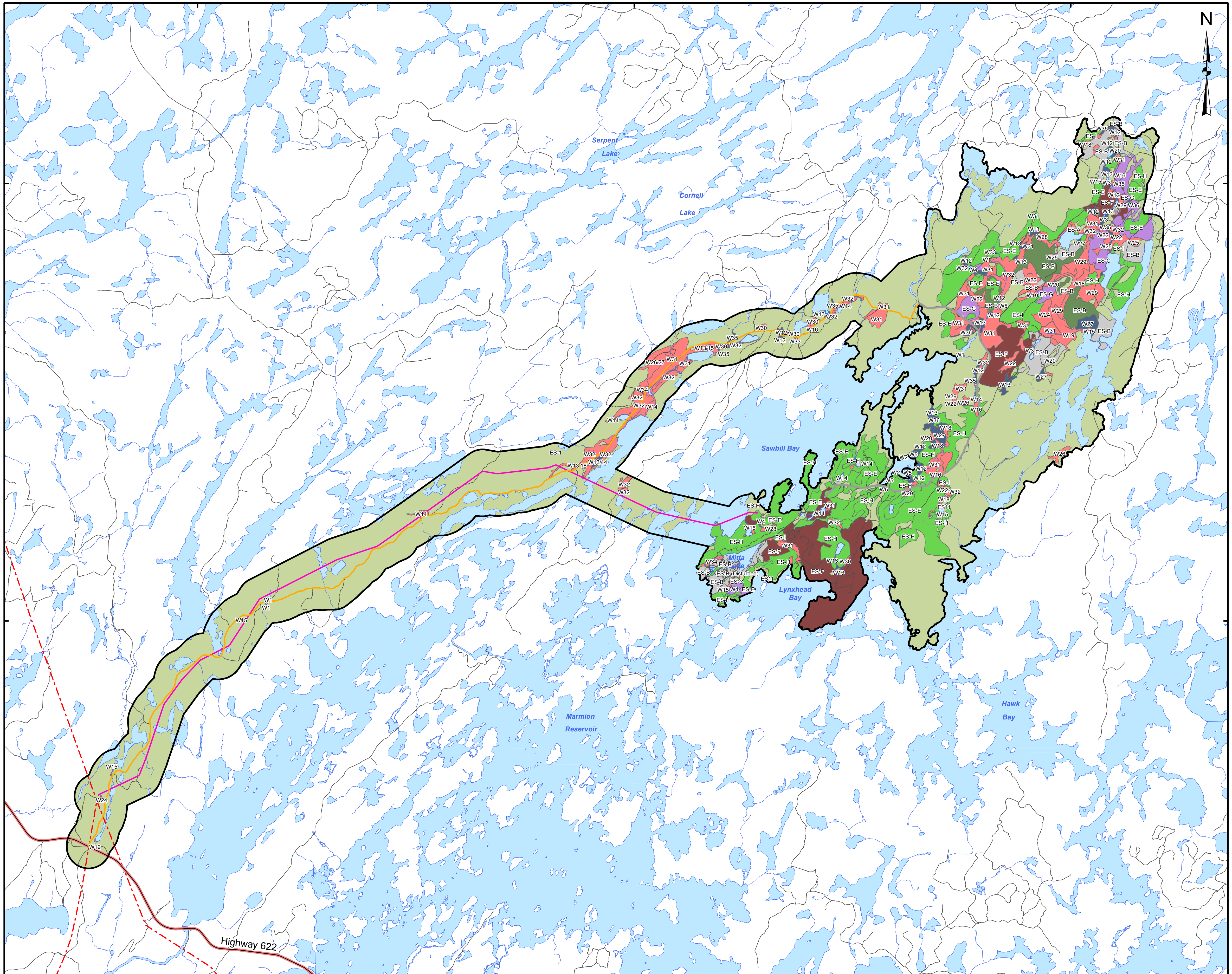
Notes: Numbers are rounded for presentation purposes; therefore, it may appear that the totals do not equal the sum of the individual values.

Soil map units were described and mapped for the LSA (Table 4-3, Figure 4-3). The most common soil map unit in the LSA is the Regosol-bedrock (4,816 ha, 57% of LSA), followed by Dystric Brunisol-Gleysol-fine (1,096 ha, 13% of LSA). The rest of the soil map units occupy less than 10% of the LSA (Table 4-3).

Table 4-3: Distribution of Soil Map Units in the Local Study Area

Soil Map Unit	Distribution in Local Study Area	
	Area (ha)[(a)]	%[(a)]
Dystric Brunisol-fine	382	4
Dystric Brunisol-Gleysol –coarse	142	2
Dystric Brunisol-Gleysol –fine	1,097	13
Dystric Brunisol-Regosol	205	2
Gleysol-Regosol	120	1
Gleysol-Terric Organic	125	1
Terric Organic-Gleysol	693	8
Regosol-bedrock	4,816	57
Water	915	11
Total	**8,495**	**100**

Notes:
(a) Numbers are rounded for presentation purposes; therefore, it may appear that the totals do not equal the sum of the individual values.



LEGEND

- Provincial Highway
- Trail
- Road
- Power Transmission Line
- River/Stream
- Mine Site Road
- Access Road (Hardtack / Sawbill)
- Project Transmission Line
- Terrain and Soil Local Study Area

Soil Type	Vegetation Code
Dystric Brunisol-Gleysol-course	ES-C, ES-G
Dystric Brunisol-Gleysol-fine	ES-E, ES-H, ES-I
Dystric Brunisol-Regosol	ES-A, ES-B
Dystric Brunisol-fine	ES-F
Gleysol-Regosol	ES-B
Gleysol-Terric Organic	W5, W12, W13, W13/W14, W27, W35, W36
Terric Organic-Gleysol	W14, W15, W16, W18, W19, W22, W24, W25, W26/W27, W29, W30-W34
Regosol-Bedrock	ES1/ES11/Other
Water	

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004
Surficial Geology - Ontario Geological Survey, 1997. Quaternary geology, seamless coverage of the province of Ontario: Ontario Geological Survey, Data Set 14.
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Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

1,000 0 1,000 2,000 3,000 4,000
SCALE 1:90,000 METRES

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
SOIL MAP UNITS IN THE LOCAL STUDY AREA

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1118-0020			SCALE AS SHOWN	VERSION 1
DESIGN	CGE	14 Nov. 2008	FIGURE: 4-3	
GIS	JO	11 Feb. 2013		
CHECK	REJ	11 Feb. 2013		
REVIEW	KJD	11 Feb. 2013		

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The following is a description of the soil types in the LSA after Soil Classification Working Group (1998).

Dystric Brunisol

These are acid Brunisolic soils that lack a well-developed mineral-organic surface horizon. They occur widely, usually on parent materials of low base status and typically under forest vegetation. Dystric Brunisols have a Bm, Bfj, thin Bf, or Btj horizon at least 5 cm thick, and a pH (0.01 M $CaCl_2$) of less than 5.5 throughout the upper 25 cm of the B horizon, or throughout the B horizon and the underlying material to a total depth of at least 25 cm or to a lithic contact above this depth. Dystric Brunisols may have L, F, H horizons; an Ae or Aej horizon, and an Ah horizon less than 10 cm thick, but they do not have either a Bt or a podzolic B horizon.

Gleysolic Soils

Soils of the Gleysolic order have properties that indicate prolonged periods of intermittent or continuous saturation with water and reducing conditions during their genesis. Saturation with water may result from either a high groundwater table or temporary accumulation of water above a relatively impermeable layer, or both. In contrast, soils saturated periodically with aerated water or saturated for prolonged cold periods, which restricts biological activity without developing properties associated with reducing conditions, are not classified as Gleysols.

Gleysolic soils occur in association with other soils in the landscape, in some cases as the dominant soils, in others as a minor component. In areas of subhumid climate, Gleysolic soils occur commonly in shallow depressions and on level lowlands that are saturated with water every spring. In more humid areas, they may also occur on slopes and on undulating terrain. The native vegetation associated with Gleysolic soils commonly differs from that of associated soils of other orders.

Organic Soils

Soils of the Organic order are composed largely of organic materials. They include most of the soils commonly known as peat, muck, or bog and fen soils. Most Organic soils are saturated with water for prolonged periods. These soils occur widely in poorly and very poorly drained depressions and level areas in regions of subhumid to perhumid climate and are derived from vegetation that grows in such sites.

4.4.1 Soil Quality in the Local Study Area

4.4.1.1 Soil Erosion Risk

Soil erosion risk is one of the primary concerns for disturbed soils because the limited amount of vegetation cover exposes soil materials to the elements (e.g., wind and water). With continuous exposure to wind or rain, the uppermost portions of the soil profile may be eroded, washed, or blown away, depending on terrain and soils characteristics, resulting in loss of topsoil and subsequent soil quality.

Sandy soils and low moisture soils are especially at risk of wind erosion. The majority of soils in the LSA are rated as having a low risk of wind erosion due to a relatively low wind intensity and high forest cover.

Most soil series on the LSA are rated as having a low risk for water erosion on slopes less than 5%. Slopes more than 10% are generally rated as a high risk for water erosion in the LSA. However, most of the LSA has slopes in the range of 5 to 9%. There are limited areas within the LSA at risk of water erosion due to a combination of slopes more than 10% and sandy-textured surface soils overlaid by a clay-textured subsoil located mainly within the creek and river valleys. On average, the overall water erosion risk varies from low to moderate. However, special attention to soil conservation is required on erosion prone areas.

A summary of the overall erosion sensitivity for each soil map unit is presented in Table 4-4.

Table 4-4: Erosion Sensitivity in the Local Study Area

Soil Map Unit	Soil Wind Erosion Sensitivity	Soil Water Erosion Sensitivity
Dystric Brunisol-fine	Low-moderate	Low <5% slope Moderate 5 to 9% slope High >10% slope
Dystric Brunisol-Gleysol -coarse	High	Low 0 to 9% slope Moderate >10% slope
Dystric Brunisol-Gleysol -fine	Low-moderate	Low <5% slope Moderate 5 to 9% slope High >10% slope
Dystric Brunisol-Regosol	Low	Low <5% slope Moderate 5 to 9% slope High >10% slope
Gleysol-Regosol	Low	Low <5% slope
Gleysol-Terric Organic	Low	Low <5% slope
Terric Organic-Gleysol	Low	Low <5% slope
Regosol-bedrock	Low	Low <5% slope Moderate 5 to 9% slope High >10% slope
Water	N/A	N/A

Notes:
N/A = Not applicable

4.4.1.2 Soil Chemistry

Sampling for the existing conditions metal chemistry of soil was completed in 2012 during the vegetation field program. Results from the existing conditions metal chemistry sampling program are summarized in Table 4-5.

Table 4-5: Soil Chemistry Results 2012

Sample ID		DUP-1	DUP-2	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18	S19	S20	S21	S22
Nitrate-N		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Nitrite-N		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Phosphorus, Total		330	377	232	318	216	357	276	475	192	429	420	562	312	426	237	310	126	425	348	307	330	398	175	851
Total Organic Carbon		3.27	3.04	0.90	2.62	1.17	3.10	2.95	6.57	1.49	3.50	3.74	4.46	3.19	2.40	0.77	0.55	0.74	1.08	1.80	2.31	3.40	1.84	2.35	1.15
Metals	**CCME[a]**																								
Aluminum (Al)	—	24100	22800	7230	15200	9570	8780	21900	14200	16000	14400	22600	17700	22200	17600	13900	18100	13900	17200	21700	13900	17500	19600	18400	8340
Antimony (Sb)	—	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Arsenic (As)	12	3.68	3.48	1.00	2.40	0.95	2.12	2.36	1.80	1.80	2.10	3.44	4.52	3.14	3.91	1.27	1.40	1.12	1.57	2.27	2.14	2.71	1.94	1.56	1.13
Barium (Ba)	750	53.9	33.0	15.9	39.8	19.8	20.8	42.4	59.1	22.2	72.3	33.7	76.4	50.1	37.4	22.3	27.4	41.5	40.4	101	33.8	52.5	37.2	72.8	26.0
Beryllium (Be)	4	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Bismuth (Bi)	—	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Boron (B)	2	**<5.0**	**<5.0**	**<5.0**	**<5.0**	**<5.0**	**<5.0**	**<5.0**	**<5.0**	**<5.0**	**<5.0**	**<5.0**	**<5.0**	**<5.0**	**<5.0**	**<5.0**	**<5.0**	**<5.0**	**<5.0**	**<5.0**	**<5.0**	**<5.0**	**<5.0**	**<5.0**	**<5.0**
Cadmium (Cd)	1.4	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Calcium (Ca)	—	2960	1810	1230	2220	1620	1110	1760	2190	1430	2470	1690	2250	1690	2050	1970	1890	1640	2080	2690	1580	1520	1670	4440	1170
Chromium (Cr)	64	24.6	26.6	11.1	25.8	16.3	16.8	23.0	16.3	20.5	27.3	26.4	33.0	22.8	24.8	23.7	26.5	20.2	22.0	27.0	18.1	29.4	26.4	36.6	12.3
Cobalt (Co)	40	7.6	5.9	2.5	6.5	4.1	2.9	5.2	3.4	3.9	5.5	5.8	6.0	6.8	5.9	5.7	5.7	4.6	5.7	7.5	3.7	6.2	5.1	10.1	2.8
Copper (Cu)	63	58.9	13.5	3.0	11.2	5.3	5.2	7.8	12.0	6.0	5.3	8.5	7.0	11.5	7.6	7.1	8.7	9.7	8.7	16.3	5.2	18.9	6.7	26.5	2.8
Iron (Fe)		21300	18500	10400	21400	11500	16400	18500	14700	14100	17400	18600	19900	18400	25500	15400	16700	11900	15800	18300	14300	21800	20600	19200	10200
Lead (Pb)	70	17.0	8.4	3.5	6.3	3.3	6.6	6.5	9.9	5.3	10.3	7.8	10.6	9.5	7.4	4.2	4.2	4.3	4.6	6.8	8.0	8.7	6.2	6.2	4.1
Lithium (Li)		10.9	7.8	4.1	9.7	5.5	6.0	9.0	8.5	7.2	7.9	8.6	10.9	11.1	9.8	7.7	8.0	7.5	8.2	9.0	7.2	13.0	12.6	11.6	6.8
Magnesium (Mg)		2420	2500	957	2900	1990	1480	1950	2070	1530	2000	2550	3090	2120	2530	2370	2670	2060	2380	3090	1740	2250	2070	4490	1260
Manganese (Mn)		106	101	62.6	129	83.7	63.7	80.5	101	76.2	553	104	364	100	176	122	126	84.1	139	293	90.6	89.4	101	511	124
Mercury (Hg)	6.6	0.077	0.060	0.012	0.027	0.014	0.024	0.045	0.044	0.031	0.034	0.050	0.060	0.072	0.070	0.021	0.032	0.023	0.038	0.039	0.036	0.042	0.026	0.036	0.017
Molybdenum (Mo)	5	**6.8**	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.4	**6.2**	1.4	<1.0	<1.0	<1.0	<1.0	2.1	<1.0	1.6	<1.0	<1.0	<1.0
Nickel (Ni)	50	17.2	13.9	6.5	16.4	9.5	7.1	13.4	8.9	9.2	15.4	13.6	16.4	15.0	12.5	13.8	13.1	11.2	13.2	17.7	8.6	16.0	16.8	38.3	5.9
Potassium (K)	—	450	370	200	440	250	320	350	590	260	430	370	710	400	410	320	390	230	330	420	350	390	330	500	290
Selenium (Se)	1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Silver (Ag)	20	0.49	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.39	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Sodium (Na)	—	230	220	130	180	150	100	150	150	130	150	200	130	170	200	210	310	150	210	270	160	140	140	260	<100
Strontium (Sr)	—	10.7	9.9	7.1	13.1	8.8	7.7	10.3	14.9	9.7	16.8	10.0	16.0	10.0	11.3	11.0	10.3	13.8	11.6	16.9	10.8	10.3	10.5	15.8	9.2
Thallium (Tl)	1	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Tin (Sn)	5	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Titanium (Ti)	—	880	977	671	1040	734	779	936	651	858	764	973	973	878	1050	1050	1140	849	956	1000	793	1050	1010	921	519
Uranium (U)	23	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.4	<1.0	<1.0	<1.0	<1.0	<1.0

Table 4-5: Soil Chemistry Results 2012 (Continued)

Sample ID		DUP-1	DUP-2	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18	S19	S20	S21	S22
Vanadium (V)	130	57.0	61.9	32.0	60.9	32.5	44.7	58.0	40.7	45.5	52.5	61.2	55.5	53.6	66.0	50.4	58.2	39.0	49.4	57.6	47.5	63.7	60.8	54.6	25.3
Zinc (Zn)	200	88.4	30.8	14.1	30.7	13.8	21.1	24.5	29.8	22.4	37.0	27.7	47.4	27.0	27.5	21.5	22.9	16.8	36.9	32.3	24.0	22.7	24.6	40.0	25.2

Notes:

[(a)] Bolded values represent exceedances of CCME 2012 Criteria.

— Guideline does not apply for this parameter.

Metals concentrations in excess of the CCME (2012) guidelines for contaminated soils as related to agricultural land were highlighted for further evaluation as part of the Terrestrial Ecology TSD.

The majority of soil metal concentrations in 2012 sample plots were within below criteria with the exception of molybdenum (Mo), which exceeded CCME limits on two plots (Table 4-6). It was not possible to evaluate boron due to elevated detection limits for boron relative to the criteria

4.5 Prediction of Potential Changes

4.5.1 Alteration or Loss of Terrain and Soils Units

Terrain features will be altered during plant and associated mine facility construction and as a result, topography, site elevation and drainage patterns will be altered at the local scale. Since the topography of the LSA varies from level to rolling, cut and fill will be necessary in constructing facilities. While progressive reclamation will restore terrain, there will be short to moderate- term disturbances to terrain.

Activities resulting in the direct loss or alteration of soil units in the LSA include site clearing and surface disturbance to permit construction and operation. Area preparation for facility construction will involve the removal of the soil cover. Surface soil will be salvaged for future reclamation operations. Plant and associated mine facilities will be progressively reclaimed, which minimizes impacts to soils. However, there will still be a net increase in surface disturbance associated with the Project.

4.5.1.1 Soil Quality/Capability

Soil erosion is a process involving soil movement from one area to another by wind and water. Soil erosion can result in alteration or loss of soil quality, a process that can subsequently affect vegetation growth. The Project will result in vegetation removal, thereby exposing the soil and increasing the probability for erosion.

Surface disturbance from the Project may result in the following soil quality/capability impacts:

- Soil wind and water erosion that could alter and/or decrease soil quality.
- Soil compaction that could alter soil structure and decrease soil quality.
- Soil admixing that could decrease soil fertility.
- Soil disturbance that could alter and decrease soil capability for forestry.
- Soil contamination that could decrease soil quality.
- Reclamation that could restore soil quality/capability.

Soil handling and reclamation for the Project will involve stripping, salvage and storage of organic and mineral soil materials for use during reclamation. Soil admixing may result from improper soil handling procedures, and can affect soil fertility and consequently vegetation growth. Soil disturbance during construction will alter soil quality that in turn can change the land capability for forestry rating of soils.

4.5.1.2 Mitigation

Mitigation for terrain and soils effects involves minimizing the amount and extent of surface disturbance at any one time. Although not quantifiable, soil quality changes can be minimized through proper construction and operation practices. A discussion of mitigation techniques follows. Many of the techniques will mitigate more than one effect and will be considered if necessary as part of reclamation planning:

4.5.1.2.1 Terrain

Terrain will be altered during the construction and operations phases of the Project. As a result, topography, site elevation and drainage patterns will be altered on a local scale. While progressive reclamation will restore terrain, there will be short to long-term terrain disturbances. The following mitigation can be applied to minimize changes to terrain:

- Existing pre-construction topography, elevations and drainage patterns have been documented and will be used to help with reclamation planning.
- Prior to closure, a reclamation plan will be prepared to meet the approval requirements and with input from local stakeholders that will protect landform stability and limit erosion.

The main mitigation for terrain stability for the Project is to assess terrain characteristics prior to any mining, and to appropriately design the waste stockpiles and pits to ensure long-term stability. Geotechnical assessments will be made of all mine facilities to ensure long-term stability. Monitoring of waste stockpiles and other facilities will also be undertaken to verify that the materials are stable over time.

4.5.1.2.2 Erosion

Soil erosion is the displacement of soil by wind or water action. Soil erodibility is affected by organic matter content and texture. Soils high in silt and very fine sand are more susceptible to water erosion than other soils.

Wind and water erosion risk in the LSA is low when there is a vegetative cover. During disturbance, the risk of wind and water erosion will increase. The risk of wind erosion depends on soil texture, moisture and organic matter content, with sandy soils having a higher risk. Water erosion risk increases where slopes exceed 10% and fine-textured sub soils underlay coarse-textured soils.

To prevent soil erosion and potential sedimentation from occurring during construction, soil exposure must be minimized and surface runoff controlled, especially during wet weather and in areas close to watercourses.

An Erosion Management Plan will be developed and implemented during construction, operations and closure. Site drainage will be managed to ensure that runoff does not cause erosion, flooding, or contamination in downstream areas.The Erosion Management Plan may include some of the following considerations:

- Salvage topsoil and store on the site away from areas of potential erosion.
- On slopes more than 10%, construct temporary berms of imported logs, construction timbers, sandbags or other material as appropriate and available.
- Construct berms with sub soils, where topsoil has been stripped.

- Use temporary erosion control measures such as mulches, mats, netting, or straw crimping to control erosion prior to establishment of a protective vegetative cover.
- Apply measures where necessary to stabilize soils and use hydroseeders for seeding on steep slopes.
- Progressive rehabilitation and limiting the amount of disturbed areas at one time.

4.5.1.2.3 Soil Compaction

Heavy equipment traffic may create ridges and ruts that mix and compact soil horizons. Soil compaction can also modify soil hydrology and groundwater recharge and increase the risk of runoff and erosion (McNabb 1997). The reduced growth from compaction can persist for several decades (Went and Thomas 1981). Soil compaction is most severe under wet conditions and very high loads. Since soils can be disced or deep ripped during reclamation, soil compaction can be mitigated relatively quickly.

The following mitigation will be considered if necessary as part of reclamation planning:

- Deep rip subsoil prior to surface soil replacement.
- Crimp straw or peat into the subsoil after ripping.
- Mix additional peat into the surface soil.

Mechanical means (e.g., subsoilers) will be the primary method for mitigating soil compaction.

4.5.1.2.4 Admixing

Topsoil and subsoil mixing (admixing) is possible during both the construction and reclamation phases of the Project. Overstripping (i.e., salvaging both topsoil and subsoil horizons in one pass) or understripping (i.e., salvaging only a portion of the topsoil horizon in one pass) during soil salvage can result in admixing whether due to operator error, equipment limitations, or variability in horizon depths.

Soil mixing, burial or loss will dilute the organic matter content and decrease soil quality. Organic matter is positively correlated with water retention and fertility of undisturbed soils (Hillel 1971). Admixing has been documented to reduce soil quality for both linear rights-of-way (Hardy 1983) and facility construction (Akinremi et al. 1999). As organic matter decreases, soil cation exchange capacity also decreases, a phenomena that can also decrease soil quality and fertility by reducing the soil nutrient holding capacity.

Soils in areas being developed will be salvaged, stored and protected for future replacement and reclamation. Proper soil handling can minimize soil mixing. The following mitigation will be considered if necessary as part of a soil reclamation plan:

- Undertaking a topsoil survey prior to soil salvage operations to develop a site-specific soil salvage plan.
- Utilizing experienced equipment operators for topsoil salvage operations.
- Holding site meetings to brief all site personnel on the goals of the Project prior to initiating all soil salvage operations.

- Supervising soil salvage operations with experienced environmental personnel to ensure quality control.
- Clearing trees and salvaging soil materials during dry conditions, where and when practical.

4.5.1.2.5 Soil Contamination

The chemistry of soils, and hence their capability, can be altered by spills, leaks and seepage of substances. The types of materials that could be spilled on the soil as a result of the Project include the following:

- Hydrocarbons (e.g., oils, greases, fuels).
- Salts.
- Materials used in the mining process.

The Project will be constructed and operated in compliance with any approvals requirements. A Spill Mannagement Plan will be developed and implemented throughout the Project. The Spill Management Plan may include consideration of the following: Ensuring equipment and vehicles are in good working order.

- Identifying any potential sources of leaks and having collection systems in place.
- Conducting regular inspections during drilling for early leak identification.
- Designing and constructing waste storage and disposal pits and ponds to eliminate the potential for leakage and subsurface migration.
- Using water instead of road salt or oil for dust control to eliminate the potential salt and oil contamination.
- Cleaning up spills and leaks immediately.

4.5.1.2.6 Restoration of Soil Quality during Reclamation

Reclamation will be the primary mitigation for terrain and soils changes. Mitigation will include implementing progressive reclamation for the Project to minimize the net area disturbed at any one time.

The Reclamation Management Plan for the Project is expected to include the following:

- Vegetated riparian buffers will remain around watercourses at access road crossings to the extent possible.
- Native species of trees, shrubs and other vascular plants will be used for re-vegetation at closure.
- Where feasible, the same variety of plant species currently composing the different forest ecosites will be used for reclamation.
- Demarked areas will be established for all project activities to minimize encroachment into natural areas
- To mitigate the transport and introduction of non-native plant species into native plant communities, construction equipment will be regularly cleaned on-site, particularly before moving into sensitive vegetation areas.

- Areas undergoing natural regeneration may need to be isolated until native vegetation established.

4.5.2 Terrain and Soils Disturbance

The Project will require construction of two open pits and associated infrastructure. The total area of terrain and soils disturbance associated with Project facilities will be 1,074 ha (13% of the LSA) (Tables 4-7 and 4-8). The largest area of disturbed soils will be Dystric Brunisol-Gleysol-fine (315 ha, 4% of LSA) followed by terric Organic-Gleysol 281 ha (3% of LSA) and Dystric Brunisol-fine (125 ha, 1% LSA). All other soil types represent less than 1% of the LSA. Loss of soils will be minimized through reclamation following mining; the resulting potential for impact is evaluated as part of the Terrestrial Ecology TSD and within the EIS/EA document.

Table 4-7: Loss/Alteration to Soil Series in the Local Study Area

Soil Map Unit	Existing Conditions		Project Disturbance	
	Area (ha)	% Local Study Area	Area (ha)	% Local Study Area
Dystric Brunisol-fine	382	4	125	1
Dystric Brunisol-Gleysol-coarse	142	2	11	<1
Dystric Brunisol-Gleysol-fine	1,097	13	315	4
Dystric Brunisol-Regosol	205	2	75	1
Gleysol-Regosol	120	1	116	1
Gleysol-Terric Organic	125	1	15	<1
Terric Organic-Gleysol	693	8	281	3
Regosol-bedrock	4,816	57	64	1
Water	915	11	40	1
Total	**8,495**	**100**	**1,074**	**13**

For terrain the largest disturbance will be for the bedrock class (632 ha, 7% of LSA) followed by glaciolacustrine (371 ha, 4% of LSA).

Table 4-8: Loss/Alteration to Terrain Units in the Local Study Area

Soil Map Unit	Existing Conditions		Project Disturbance	
	Area (ha)	% Local Study Area	Area (ha)	% Local Study Area
Bedrock	5,633	66	632	7
Glaciolacustrine	1,277	15	371	4
Glacioflvuial ice contact deposits	187	2	36	<1
Fluvial	70	1	0	0
Water	902	4	36	<1
Total	**8,494**	**100**	**1,074**	**13**

When developed the soils reclamation plan should include monitoring to confirm the plant communities health, composition and diversity as further detailed in the Terrestrial Biology TSD.

5.0 LIST OF REFERENCES

Akinremi, O.O., F.J. Larney, R.L. Lemke and V. Klaassen. 1999. *Effect of Topsoil Depth and Organic Amendments on Productivity of Oil Well Sites*. Proceedings of 1999 Alberta Soil Science Workshop.

AMIRA (AMIRA International Ltd.). 2002. *ARD Test Handbook – Prediction and Kinetic Control of Acid Mine Drainage*. Environmental Geochemistry International Pty. Ltd. and Ian Wark Institute, University of South Australia.

ASTM (American Society for Testing and Materials). 2001. *D5744-96 - Standard Test Method for Accelerated Weathering of Solid Materials Using a Modified Humidity Cell*. Annual Book of ASTM Standards, Volume 11.04: 259- 271.

ASTM D 3987 – 06. 2006. *Standard Test Method for Shake Extraction of Solid Waste in Water.*

Blackburn, C.E., Johns, G.W., Ayer, J. and Davis, D.W.. 1991. *Wabigoon Subprovince; in Geology of Ontario, Ontario Geological Survey Special*. Volume 4, Part 1, p. 303-381.

Blowes, D.W., Ptacek, C.J., Jambor, J.L., Weisner, C.G.. 2004. *The geochemistry of acid mine drainage. In: Lollar, B.S., Holland, H.D., Turekian, K.K. (Eds.)*. Treatise on Geochemistry, Environmental Geochemistry. Volume 9, p. 149-204.

CCME (Canadian Council of Ministers of the Environment). 2007. *Water Quality Guidelines for the Protection of Aquatic Life.*

CCME. 2012. *Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health: Summary Tables*. Available at: http://st-ts.ccme.ca/

Coote, D.R. and W.W. Pettapiece. 1989. *Wind Erosion Risk: Alberta*. Agriculture Canada. Ottawa, ON.

DST (DST Consulting Engineers Inc.). 2009. *Hammond Reef Gold Project: Project Definition.* Report to Brett Resources Inc. December, 2009.

Dyer, R.D. 1999. *Atikokan area high density lake sediment and water geochemical survey, northwestern Ontairo: new Au and PGE exploration targets*. Ontario Geological Survey, Open File Report 5986, 79pp.

Fedorowich, J. 2010. *Hammond Reef Preliminary Structural Observations*. 31 pp.

Fricklin, R. 2008. *An Introduction to Soil Science*. University of Arkansas.

Hardy BBT Ltd. (Hardy). 1983. *Evaluation of Pipeline Reclamation Practices on Agricultural Lands in Alberta*. Reclamation Research Technical Advisory Committee. Report 83-3.

Hillel, D. 1971. *Soil and Water*. Academic Press Inc. New York, NY.

INAP (International Network for Acid Prevention). 2012. *Global Acid Rock Drainage (GARD) Guide*. www.gardguide.com

Jambor, J.L., Dutrizac, J.E., Raudsepp, M. and Groat, L.A., 2003. *Effect of Peroxide on Neutralization-Potential Values of Siderite and Other Carbonate Minerals*. J. Environ. Qual. 32:2373–2378 (2003).

McNabb, D.H. 1997. *Improving the Physical Properties of Modified Soil*. 34th Alberta Soil Science Workshop.

MEND (Mine Environment Neutral Drainage). 2009. *Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials*. MEND Report 1.20.1. Mining Environment Neutral Drainage Program, Natural Resources Canada. December 2009.

Miller, S., A. Robertson, and T. Donahue. 1997. *Advances in Acid Drainage Prediction Using the Net Acid Generating (NAG) Test*. Proceedings of the 4th International Conference on Acid Rock Drainage, Vancouver, B.C. May 31-June 6, 1997. p. 533 to 549.

MNR (Ontario Ministry of Natural Resources). 2004. *Natural Resources and Values Information System.*

MOEE (Ontario Ministry of the Environment and Energy). 1999. *Provincial Water Quality Objectives (PWQO).*

OHRG (Osisko Hammond Reef Gold Ltd.). 2012. *Project Details – Draft Report*.

Ontario Regulation 240/00. *Mine Development and Closure under Part VII of the Act*.

Ontario Regulation 560/94. *Municipal/Industrial Strategy for Abatement (MISA):* Effluent Monitoring and Effluent Limits — Metal Mining Sector.

Ounpuu, M. 2012. Metallurgical consultant to OHRG. Personal Communication, March 22, 2012.

Price, W.A., 1997. *Draft Guidelines and Recommended Methods for the Prediction of Metal Leaching and Acid Rock Drainage at Minesites in British Columbia*. Ministry of Energy and Mines. 159 pp.

Rennie, D.W, Lambert, R.J. and Krutzelmann, H.. 2009. *Preliminary assessment of the Hammond Reef gold project, Atikokan, Ontario, Canada*. Scott Wilson Roscoe Postle Associates Inc.. NI 43-101 Report, 175 pp.

Smyk, M. 2009. Resident Geologist. Ministry of Northern Development and Mines. Personal Communication cited in DST 2009. Sobek, A.A., W.A. Schuller, J.R. Freeman and R.M. Smith, 1978. Field and Laboratory Methods Applicable to Overburdens and Minesoils. Report EPA-600/2-78-054, US National Technical Information Report PB-280 495.

Sobek, A.A., W.A. Schuller, J.R. Freeman and R.M. Smith, 1978. *Field and Laboratory Methods Applicable to Overburdens and Minesoils.* Report EPA-600/2-78-054, US National Technical Information Report PB-280 495.

Soil Classification Working Group. 1998. *The Canadian System of Soil Classification*. 3rd Edition. Research Branch, Agriculture and Agri-food Canada. Publication 1646.

Stone, D. 2008a. Precambrian geology, Atikokan area; Ontario Geological Survey, Preliminary Map P.3349-Revised, scale 1:50 000.

Stone, D. 2008b. *Precambrian geology, Sapawe area*. Ontario Geological Survey Preliminary Map p3350-Revised. Scale 1:50,000.

Tejak, K. and D.R. Coote. 1993. *Water Erosion Risks: Alberta*. Agriculture Canada. Ottawa, ON.

University of Saskatchewan. 2012. *Soils of Canada*. Department of Soil Sciences. Available at http://www.soilsofcanada.ca/glossary.php

Villeneuve, D. 2011. *Notes on the Hammond Reef Model*. Internal OHRG Report. 30 pp.

Went, S. and B.R. Thomas. 1981. *Effects of Skid Roads on Diameter, Height, and Volume Growth of Douglas Fir*. Journal of Soil Science Society of America. 45: 629-632. In: A. Strartsev, D.H. McNabb, Z. Florence and S. Paquin. 1995. Province Wide Study of Soil Compaction. 32nd Annual Soil Science Workshop.

6.0 GLOSSARY OF TERMS

Table 6-1: Glossary of Terms

Term	Definition
A	In reference to soils, an A horizon is a mineral horizon meaning it contains ≤ 17% organic C (about 30% organic matter) by weight. It forms at or near the surface in the zone of leaching or eluviation of materials in solution or suspension, or of maximum in situ accumulation of organic matter or both. (University of Saskatchewan 2012)
Acid Base Accounting	The determination and evaluation of the acid-neutralizing potential relative to the acid-generating potential in order to determine the propensity of a sample to generate acidity under sub-aerial weathering conditions..
Acid generating	Refers to ore and mine wastes that contain sulphur or sulphides at sufficient quantities to produce acid when oxidized. Acid can also be present as acid sulphates or generated by their weathering, produced originally from oxidation of sulphides. (INAP 2012)
Acid Potential	The ability of a rock or geologic material to produce acidity within a sample, may also be referred to as acid generation potential (INAP 2012).
Acid Rock Drainage	The discharge of acidic water from a mine or mineralized rock or materials.
Ae	In reference to soils, an A horizon characterized by the eluviation of clay, Fe, Al, or organic matter alone or in combination. When dry, it is usually lighter colored (higher in color value by one or more units) than an underlying B horizon. (University of Saskatchewan 2012)
Aej	In reference to soils, an A horizon dominantly characterized by the eluviation of clay, Fe, Al, or organic matter alone or in combination. When dry, it is usually lighter colored (higher in color value by one or more units) than an underlying B horizon. Secondary features include the presence of faint to distinct mottles within 50 cm of the soil surface. (University of Saskatchewan 2012)
Ah	In reference to soils, an A horizon enriched with organic matter, that is darker (has a color value at least one unit lower than the original parent material) and/or has 0.5% more organic C than inorganic C. It contains ≤ 17% organic C by weight. Some Ah horizons satisfy the criterion for "f" but are not designated this suffix. (University of Saskatchewan 2012)
B	In reference to soils, a B horizon is a mineral horizon meaning it contains ≤ 17% organic C (about 30% organic matter) by weight. It is characterized by enrichment in organic matter, sesquioxides, or clay; or by the development of

Table 6-1: Glossary of Terms (Continued)

Term	Definition
	soil structure; or by a change of color denoting hydrolysis, reduction, or oxidation. (University of Saskatchewan 2012)
Bf	In reference to soils, a B horizon commonly found in podzolic soils that has: ■ A moist crushed color of black, a hue of 7.5YR or redder, or a hue of 10YR near the horizon boundary becoming yellower with depth. ■ Amorphous material with brown to black coatings on grains or aggregates and a silty feel when rubbed wet. ■ ≥ 0.6% pyrophosphate-extractable Al+Fe in textures finer than sand and ≥ 0.4% in sands. Organic C ranges between 0.5 and 5%. ■ ≥ 10 cm in depth (depth satisfies the podzolic B criteria). (University of Saskatchewan 2012)
Bfj	In reference to soils, is a B horizon commonly found in podzolic soils has some accumulation of pyrophosphate-extractable Al+Fe (< 0.6% for texture finer than sand and < 0.4% for sand), but not enough to meet the limits of a true Bf horizon. (University of Saskatchewan 2012)
Bm	In reference to soils, a horizon slightly altered by chemical weathering to give a change in color and/or structure. It has the following properties: ■ Higher chromas and redder hues than the original parent materials. ■ Removal of carbonates either partially (Bmk) or completely (Bm) and hence little or no reaction with dilute HCl. ■ A change in structure from that of the original material. ■ Very little illuviation, if any. (University of Saskatchewan 2012)
Bt	In reference to soils, a Bt horizon is one that contains illuvial layer lattice clays. It forms below an eluvial horizon but may occur at the surface of a soil that has been partially truncated. It usually has a higher ratio of fine clay to total clay than the inorganic C. (University of Saskatchewan 2012)
Btj	In reference to soils, a B horizon with no distinct features. It does have some illuviation of clay (i.e., more clay in the B horizon than the overlying Ae or Aej) but not enough to meet the limits of Bt. As well as faint to distinct mottles within 50 cm of the soil surface. (University of Saskatchewan 2012)
L	In reference to soils, a L horizon is characterized by an accumulation of organic matter in which the original structures are easily discernible. (University of Saskatchewan 2012)

Table 6-1: Glossary of Terms (Continued)

Term	Definition
F	In reference to soils, a F horizon is characterized by an accumulation of partly decomposed organic matter. Some of the original structures are difficult to recognize. The material may be partly comminuted (pulverized) by soil fauna as in moder (a non-matted forest humus), or it may be a partly decomposed mat permeated by fungal hyphae as in mor. (University of Saskatchewan 2012)
H	In reference to soils, a H horizon is characterized by an accumulation of decomposed organic matter in which the original structures are indiscernible. This horizon differs from the F by having greater humification due chiefly to the action of organisms. It is frequently intermixed with mineral grains, especially near the junction with mineral horizons. (University of Saskatchewan 2012)
LFH	In reference to soils, LFH is an organic horizon containing > 17% organic C (approximately ≥ 30% organic matter) by weight. It is developed primarily from the accumulation of leaves, twigs, and woody materials with or without a minor component of mosses. It is also normally associated with upland forested soils with imperfect drainage or drier. (University of Saskatchewan 2012)
Leaching	Removal by dissolution, desorption, or other chemical reaction from a solid matrix by passing liquids through the material (INAP 2012).
Net Acid Generating	Net acid generation (NAG) is a type of test designed measure of the potential of a material to produce acid under enhanced oxidation conditions which are designed to represent an extended period of exposure and weathering.
Neutralization Potential	The amount of alkaline or basic material in rock or soil materials that is estimated by acid reaction followed by titration to determine the capability of neutralizing acid from exchangeable acidity or pyrite oxidation. May also be referred to as acid neutralization potential or ANP. (INAP 2012)
Pore water	Water between the grains of a soil or rock.

7.0 ABBREVIATIONS, ACRONYMS AND INITIALISMS

Table 7-1: List of Abbreviations, Acronyms and Initialisms

Acronym	Definition
ABA	Acid Base Accounting
ANP	Acid neutralization potential
AMIRA	AMIRA International Ltd.
AP	Acid Potential
ARD	Acid Rock Drainage
ASTM	American Society for Testing and Materials
BC	British Columbia
CaNP	Carbonate neutralization potential
CCME	Canadian Council of Ministers of the Environment
CEA Agency	Canadian Environmental Assessment Agency
CVAAS	Cold Vapour Atomic Absorption Spectrometry
DI	De-ionized
DST	DST Consulting Engineers Ltd.
EIS/EA Report	Environmental Impact Statement/Environmental Assessment Report
ELC	Ecological Land Classification
EPA	Environmental Protection Agency
GARD	Global Acid Rock Drainage
GIS	Geographic Information System
ICP	Inductively Coupled Plasma
ID	Identification
INAP	International Network for Acid Prevention
LSA	Local Study Area
MDC	Marmion Deformation Corridor

Table 7-1: List of Abbreviations, Acronyms and Initialisms (Continued)

Acronym	Definition
MEND	Mine Environment Neutral Drainage
MISA	Municipal/Industrial Strategy for Abatement
ML	Metal leaching
MNR	Ontario Ministry of Natural Resources
MOEE	Ontario Ministry of the Environment and Energy
NAG	Net acid generating
non-PAG	Non-potentially acid generating
NP	Neutralization potential
NPR	Neutralization potential ratio
NRVIS	Natural Resources and Values Information System
NY	New York
OHRG	Osisko Hammond Reef Gold Ltd.
ON	Ontario
PAG	Potentially acid generating
PGE	Platinum group elements
PWQO	Provincial Water Quality Objectives
PY	Pyrite
QA/QC	Quality Assurance/Quality Control
RSA	Regional study area
S	Sulphur
SAF	Sericite-Ankerite-Fuschite
SFE	Shake Flask Extraction
SGS	SGS Canada Inc.
TMF	Tailings management facility
TSD	Technical support document

Table 7-1: List of Abbreviations, Acronyms and Initialisms (Continued)

Acronym	Definition
US	United States of America
VEC	Valued ecosystem components
WRMF	Waste Rock Management Facility
XRD	X-ray diffraction analysis
XRF	X-ray fluorescence

8.0 LIST OF UNITS

Table 8-1: List of Units

Abbreviation	Unit
°C	degrees Celsius
cm	centimetre
g/t	grams per tonne
kg	kilogram
km	kilometre
<	less than
L	litre
m	metre
µg/g	micrograms per gram
µm	micrometre
mg/L	milligrams per litre
mm	millimetre
Mm^3	million cubic metres
MOZ	million ounces
Mt	million tonnes
>	more than
%	percent
t	tonne
t CaCO3/1000 t	tonnes of Calcium Carbonate per thousand tonnes
t/d	tonnes per day
wt%	weight percentage

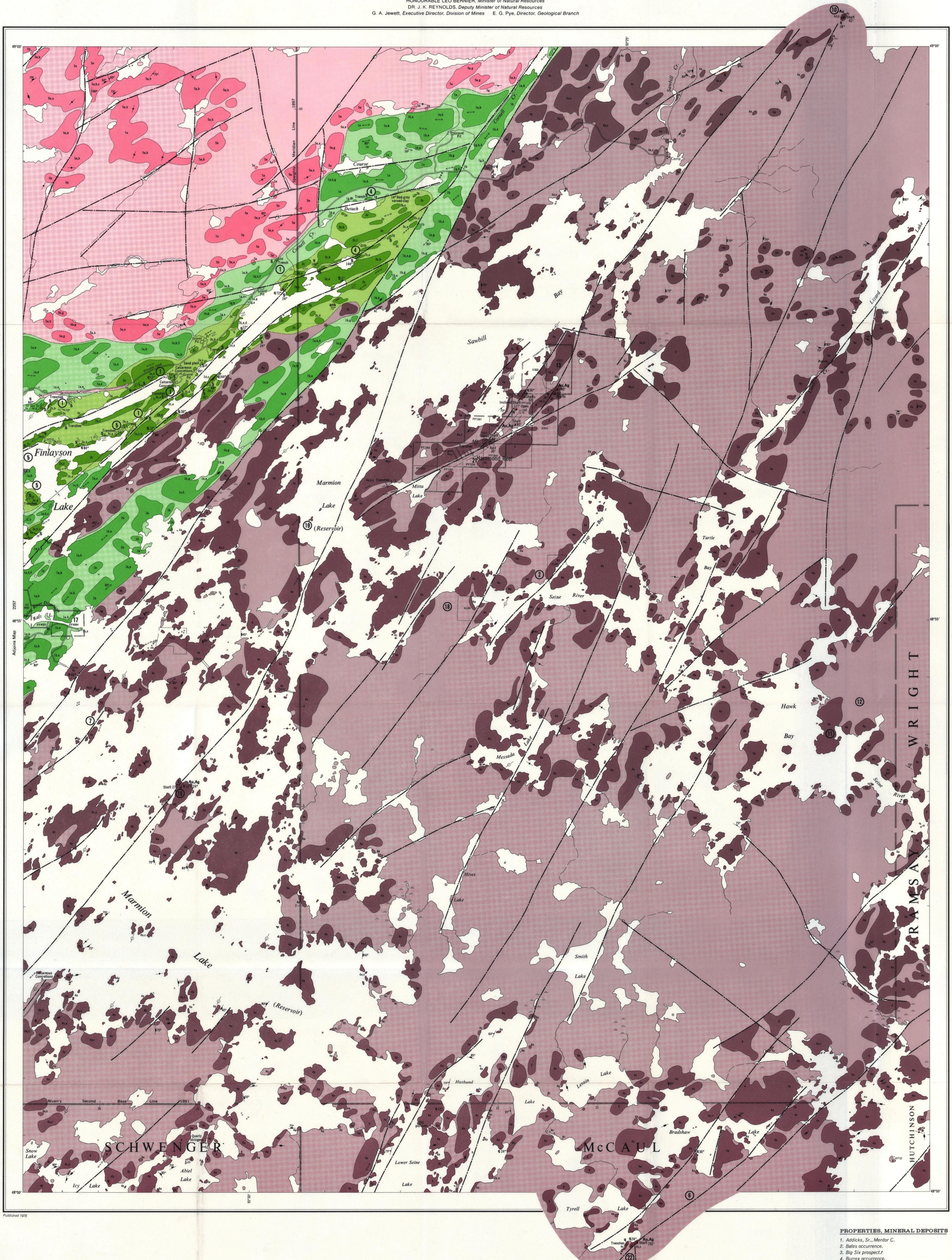
APPENDIX 2.I

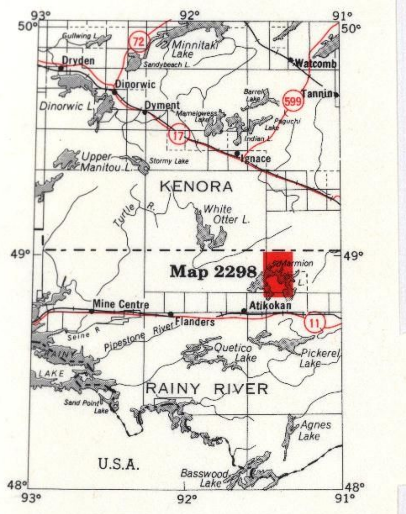
Ontario Geological Survey Map 2298

ONTARIO
DIVISION OF MINES

HONOURABLE LEO BERNIER, *Minister of Natural Resources*
DR. J. K. REYNOLDS, *Deputy Minister of Natural Resources*
G. A. Jewett, *Executive Director, Division of Mines* E. G. Pye, *Director, Geological Branch*

Map 2298
Marmion Lake





Scale 1 inch to 50 miles
N.T.S reference 52B/13, 52B/14

LEGEND

CENOZOIC[a]

QUATERNARY

RECENT
Lake, stream and swamp deposits.

PLEISTOCENE
Sand, gravel, clay, varved clay.

UNCONFORMITY

PRECAMBRIAN[b]

EARLY PRECAMBRIAN (ARCHEAN)

MAFIC INTRUSIVE ROCKS

6a *Diabase.*
6b *Lamprophyre and andesite.*

INTRUSIVE CONTACT

FELSIC INTRUSIVE ROCKS

DASHWA LAKE BATHOLITH[c]

5 *Unsubdivided.*
5a *Biotite and hornblende granite, quartz monzonite, porphyritic trondhjemite.*
5b *Granite gneiss, quartz monzonite gneiss.*
5c *Pegmatite.*
5d *Aplite.†*
5e *Feldspar-quartz porphyry.*
5f *Mylonite.†*
5g *Migmatite.*

CONTACT RELATIONS UNCERTAIN

MARMION LAKE BATHOLITH[c]

4 *Unsubdivided.*
4a *Biotite and hornblende trondhjemite.*
4b *Quartz-sericite schist.*
4c *Complex of felsic intrusive rocks, metavolcanic rocks, and mafic dikes.*

INTRUSIVE CONTACT

METASEDIMENTS

3 *Unsubdivided.*
3a *Conglomerate.†*
3b *Greywacke, arkosic grit.*
3c *Quartzite.†*
3d *Graphitic argillite.*
3e *Slate.†*
3f *Phyllite.†*
3g *Biotite-feldspar-quartz schist.†*
3h *Intercalated metasediments and metavolcanics.†*

Iron Formation.†

METAVOLCANICS AND METASEDIMENTS

FELSIC TO INTERMEDIATE METAVOLCANICS

2 *Unsubdivided.*
2a *Massive lava.*
2b *Quartz-sericite schist.*
2c *Intermediate volcanic rocks, minor intercalated mafic tuff and lava.*
2d *Tuff, agglomerate, pillow lava.*
2e *Feldspar porphyry.†*

Iron Formation.

MAFIC TO INTERMEDIATE METAVOLCANICS

1 *Unsubdivided.*
1a *Massive lava.*
1b *Chlorite schist, chlorite carbonate schist.*
1c *Pillow lava.*
1d *Tuff, agglomerate.*
1e *Amphibolite, hornblende schist.*
1g *Coarse-grained volcanic or mafic intrusive rock.*
1h *Tuffs and intercalated metasediments.†*

Iron Formation.†

Ag	*Silver.*
ank	*Ankerite*
Au	*Gold.*
mo	*Molybdenite.*
q	*Quartz.*
qc	*Quartz-Carbonate.†*
S	*Sulphide mineralization.*

[a] *Unconsolidated deposits. Cenozoic deposits are represented by the lighter coloured parts of the map.*

[b] *Bedrock geology. Outcrops and inferred extensions of each rock map unit are shown respectively in deep and light tones of the same colour. Where in places a formation is too narrow to show colour and must be represented in black, a short black bar appears in the appropriate block.*

[c] *Age relations with respect to 4 and 5 are uncertain.*

† *Appears on accompanying Map 2297, Finlayson Lake Area report.*

SYMBOLS

Glacial striae.
Small bedrock outcrop.
Area of bedrock outcrop.
Bedding, top (arrow) from grain gradation: (inclined, vertical, overturned).
Lava flow; top in direction of arrow.
Schistosity; (horizontal, inclined, vertical.
Gneissosity, (horizontal, inclined, vertical).
Foliation; (horizontal, inclined, vertical).
Geological boundary, observed.
Geological boundary, position interpreted.
Lineament.
Jointing; (horizontal, inclined, vertical).
Drag folds with plunge
Anticline, syncline, with plunge.
Drill hole; (projected vertically, projected up dip).
Vein. Width in inches.
Swamp.
Motor road.
Trail, portage, winter road.
Building.
Township boundary, base or meridian line with mileposts, approximate position only.
Township boundary, unsurveyed, approximate position only.
Mining property, surveyed. Boundary approximate position only.
Mineral deposit; mining property, unsurveyed. Approximate position only.
Surveyed line, approximate position only.

Published 1976

SOURCES OF INFORMATION

Geology by K. G. Fenwick and assistants, Geological Branch, 1967, 1968.
Geology is not tied to surveyed lines.

Maps and plans of mining companies.

Assessment files, Ministry of Natural Resources, Port Arthur office.

Aeromagnetic maps 1133G, 1123G, ODM-G.S.C.

Ministry of Natural Resources, ODM:
Map 38e, Sapawe Lake Area, Scale 1 inch to ¾ mile, 1929.
Map 48a, Atikokan Area, Scale 1 inch to 1 mile, 1939.
Map 48b, Steeprock Lake Area, Scale 1 inch to ¼ mile, 1939.
Map 1960g, Lumby Lake Area, Scale 1 inch to ½ mile, 1959.
Map 2065, Atikokan-Lakehead Sheet, Scale 1 inch to 4 miles, 1965.

Preliminary maps P. 543, Finlayson Lake Area (East Half), Scale 1 inch to ¼ mile, 1969.
P. 348, Steeprock Lake Iron Area, Scale 1 inch to 1,000 feet, 1966.

Cartography by M. G. Sefton and assistants, Surveys and Mapping Branch, 1974.

Basemap derived from maps of the Forest Resources Inventory, Surveys and Mapping Branch with additional information by K. G. Fenwick.

Magnetic declination in the area was approximately 3°30′ East, 1969.

Map 2298
MARMION LAKE
RAINY RIVER DISTRICT

Scale 1:31,680 or 1 Inch to ½ Mile

Chains 80 60 40 20 0 1 2 Miles
Metres 1000 0 1 2 3 Kilometres
Feet 1000 0 5,000 10,000 Feet

PROPERTIES, MINERAL DEPOSITS

1. *Addicks, Sr., Mentor C.*
2. *Bates occurrence.*
3. *Big Six prospect.†*
4. *Burrex occurrence.*
5. *Canadian-Addicks Mining Corporation.*
6. *Clearwater occurrence.*
7. *Connolly occurrence.*
8. *Fin-Lan Copper Mines Limited (Nic-Cop occurrence).†*
9. *Freeborn Mining Syndicate.†*
10. *Golden Winner Mines.*
11. *Hawk Bay occurrence.*
12. *Hendry and Tilden occurrence.*
13. *Manley, J. P. (Sawbill Mine; Upper Seine Gold Mine).*
14. *New Gold Twins prospect.†*
15. *Plator Gralouise prospect.*
16. *Scheider occurrence.†*
17. *Steeprock Iron Mines Limited.*
18. *Toronto and Western occurrence No. 1.*
19. *Toronto and Western occurrence No. 2.*
20. *Tripp, B. W.†*
21. *Ventures Claims Limited (Hammond Reef Mine; Rossmore Mines).*
22. *Wicheruk, M. (Jack Lake Mines).*
23. *Wicheruk occurrence.†*

Information current to December 31st, 1970. Only current and defunct properties for which geological or related information is available are listed and located on the map face.
For further information see report.

† *Appears on accompanying Map 2297, Finlayson Lake Area report.*

APPENDIX 2.II

Summary of Sample Descriptions

Sample ID	Hole ID	From (m)	To (m)	Lithology ID (Osisko)	Description
2010-HR-001	BR-182	8	18	18	Fine to medium grained, porphyritic texture in zones, quartz and carbonate veinlets and quartz clasts throughout, trace pyrite, feldspar clasts and veins, fresh fractures
2010-HR-002	BR-182	20.7	21.9	50	Fine grained, light grey, chlorite alteration pervasive, serpentine veins, trace magnetite, no visible sulphides, fresh fractures
2010-HR-003	BR-182	21.9	23.9	11	Fine grained, medium grey, pegmatite zones, primarily plagioclase, 1% visible sulphides, chlorite alteration pervasive, fresh fractures
2010-HR-004	BR-182	23.9	26.8	50	Medium grey, fine grained, chlorite alteration pervasive, no visible sulphides, micro-faults, fresh fractures, trace carbonate veinlets
2010-HR-005	BR-182	31	41	18	Coarse to medium grained, medium pink to light grey, mafic clasts, fresh fractures, trace sulphides, carbonate veinlets
2010-HR-006	BR-182	41	42.9	11	Granite with 30% mafic dykes, Fine to medium grained, pervasive chlorite alteration, serpentine veins, trace chalcopyrite and pyrite on fracture surfaces
2010-HR-007	BR-182	56	66	13	Fine to medium grained, medium grey and pink granite, chloritic (grey-gren) throughout, with granite zones of 0.5 to 1m consisting of mainly potassium feldspar, trace magnetite on fractures, no visible sulphides
2010-HR-008	BR-182	78	88	13	Fine to medium grained, medium grey, some un-altered granite sections (medium pink, 30 - 100cm), chlorite alteration pervasive, trace sulphides
2010-HR-009	BR-182	101.1	102.4	16	Medium grained, light to medium pink, patchy hematite alteration, 1% magnetite, trace sulphides, fresh fractures
2010-HR-010	BR-182	102.4	112.4	13	Fine to medium grained, medium grey, granite clasts (pink, 10-20cm), pervasive chlorite alteration, trace sulphides on fractures and in veins
2010-HR-011	BR-182	126	136	11	Fine grained, grey, chlorite alteration pervasive, pink granite zones (10 - 40cm), patchy hematite alteration, rusty fracture surfaces, 1% pyrite
2010-HR-012	BR-182	140	150	13	Fine to medium grained, dark pink, pervasive chlorite and hematite alteration, trace to 1% sulphides (veinlets) and carbonate veinlets
2010-HR-013	BR-182	177	178.3	40	Coarse grained, light pink, 1% blebby pyrite, trace magnetite, hematite alteration on fracture surfaces, chlorite alteraiton pervasive, quartz veins
2010-HR-014	BR-165	3	13	18	Fine to medium grained, medium grey, potassium feldspar veins and clasts, hematite and chlorite alteration (weak, pervasive), broken core zones, trace magnetite, no visible sulphides, carbonate veinlets
2010-HR-015	BR-165	23.5	26.5	50	Fine grained, medium green-grey, quartz veins, evidence of shearing throughout, pervasive chlorite alteration, magnetite veinlets, no visible sulphides
2010-HR-016	BR-165	50	60	18	Fine to medium grained, medium grey, coarse-grained granite zones (0.5 - 2m), pervasive chlorite alteration, trace sulphides on fracture surfaces
2010-HR-017	BR-165	71.05	77.8	40	Coarse grained, medium pink, quartz clasts, pervasive chlorite alteration, weak patchy hematite alteration, tonalite zones (0.5 - 1m), no visible sulphides
2010-HR-018	BR-165	77.8	82.4	18	Coarse grained white plagioclase clasts in fine grained medium grey matrix, pervasive chlorite alteration, trace magnetite, trace pyrrhotite blebs, fresh fractures
2010-HR-019	BR-165	82.4	92	40	Coarse grained, medium pink, quartz clasts, pervasive chlorite alteration, weak patchy hematite alteration, tonalite zones (10 - 50cm), trace magnetite, trace sulphide veinlets
2010-HR-020	BR-165	102	112	18	Medium grey and pink tonalite, medium grained with coarse white plagioclase grains, pervasive chlorite alteration, 1% magnetite, trace sulphides on fracture surfaces
2010-HR-021	BR-165	112.4	114.25	34	Mixed tonalite, granite and mafic shear zone, pervasive chlorite alteration, patchy hematite alteration, 1-10cm potassium feldspar veins, 30cm broken hematized core zone, 1% euhedral (cubic) pyrite grains
2010-HR-022	BR-165	130	140	18	Fine to medium grained, medium grey-green, chlorite alteration, plagioclase grains in zones (coarse-grained), trace pyrite, trace magnetite, quartz and carbonate veinlets
2010-HR-023	BR-165	150	160	11	Fine grained with potassium feldspar veins (1 - 2cm), medium grey-green, chlorite alteration pervasive, trace pyrite, trace magnetite
2010-HR-024	BR-165	175	180	20	Fine to medium grained, medium grey-green, moderate hematite/sericite/chlorite alteration throughout, trace sulphides, tonalite zones
2010-HR-025	BR-165	185	195	18	Fine grained, medium grey, carbonate veinlets, granite (coarse grained, pink) zones (1 - 10cm), chlorite alteration pervasive, no visible sulphides
2010-HR-026	BR-165	203.8	206.9	40	Medium grained to coarse grained, light pink, potassium feldspar clasts, no visible sulphides
2010-HR-027	BR-165	206.9	212.45	18	Fine to medium grained, grey-green, chlorite alteration pervasive, pink granite zones (1 - 10cm), carbonate veinlets, no visible sulphides
2010-HR-028	BR-162	20	30	19	Dark grey, fine to medium grained, weakly banded gneiss, white coarse-grained bands (0.5 - 5cm), 1% blebby pyrite, weak chlorite alteration, carbonate associated with quartz veins
2010-HR-029	BR-162	45	55	17	Fine grained diorite, dark grey, plagioclase veins (1 - 5cm), carbonate veinlets, chlorite alteration pervasive, trace magnetite, trace pyrrhotite
2010-HR-030	BR-162	100	110	18	Mix of granite, gneiss and tonalite in brecciated rock, trace pyrite on fractures, medium grey, medium pink in granite zones, fine to coarse grained, generally tonalite matrix
2010-HR-031	BR-162	130	140	20	Coarse grained, dark pink, quartz veins, chlorite alteration of veins, trace pyrite, tonalite zones near top of lithological unit
2010-HR-032	BR-171	1.4	4.7	18	Medium grey, fine grained, tonalite with 30% pegmatite and granite veins (1 - 10cm), medium grained plagioclase grains, no visible sulphides
2010-HR-033	BR-171	4.7	8.7	17	Fine-grained with medium grained plagioclase grains, dark grey, thin potassium feldspar veins, no visible sulphides, weak pervasive chlorite alteration
2010-HR-034	BR-171	9	19	18	Fine grained, green-grey, carbonate veinlets, granite/pegmatite intrusions (10%), chlorite alteration, trace pyrrhotite, trace pyrite, trace magnetite on fracture surfaces
2010-HR-035	BR-171	19.4	20.9	45	Mainly quartz, tonalite matrix, strong chlorite alteration in tonalite, trace pyrite, trace chalcopyrite, trace magnetite
2010-HR-036	BR-171	20.9	24.9	13	Fine grained, medium blue-grey, strong chlorite alteration, potassium feldspar veins, trace magnetite, trace blebby pyrite
2010-HR-037	BR-171	25	35	18	Fine grained with medium grained plagioclase grains (30%), potassium feldspar vines (1 - 5cm), carbonate veinlets, weak chlorite alteration, no visible sulphides
2010-HR-038	BR-171	50	60	18	Fine grained with medium grained plagioclase grains, 20% pegmatite intrusion (light pink), strong chlorite alteration, locally banded, trace magnetite, no visible sulphides

Sample ID	Hole ID	From (m)	To (m)	Lithology ID (Osisko)	Description
2010-HR-039	BR-171	90	100	18	Fine grained with medium grained plagioclase grains, 10% pegmatite intrustion (pink), strong pervasive chlorite alteration, dark grey, trace magnetite, trace pyrite
2010-HR-040	BR-171	120	130	13	Fine grained with potassium feldpsar clasts (decrease in concentration with depth), carbonate veinlets, strong chlorite alteration, medium green-grey, micro-faults, trace magnetite, no visible sulphides
2010-HR-041	BR-171	140	150	13	Fine-grained, 30% pegmatite (pink, coarse grained) intrustions, granite is medium green-grey, strong chlorite alteration pervasive associated with veins, quartz veins, hematite alteration on fractures, trace magnetite, trace sulphides
2010-HR-042	BR-171	151.7	153	40	Massive, fine-grained, spotty hematite alteration, dark pink, tonalite "veins" (dark grey, fine-grained), shearing as evidenced by sericite alteration in zones and micro-faults, trace sulphides associated with quartz veins
2010-HR-043	BR-165	60	70	11	Fine grained, potassium feldspar and carbonate veinlets, medium green-grey, trace sulphides and magnetite, moderate pervasive chlorite alteration
2010-HR-044	BR-304	0	10	20	Fine grained, medium grey to light green, chlorite alteration pervasive, carbonate veinlets, hematite alteration associated with veins, trace disseminated sulphides
2010-HR-045	BR-304	15	25	13	Fine grained with coarse-grained white plagioclase grains in zones, medium green-grey, micro-faults, strong pervasive chlorite alteration, trace sulphides
2010-HR-046	BR-304	40	50	20	Fine grained, beige with black veins/veinlets, chlorite alteration pervasive, carbonate veinlets, fractures along veins, no visible sulphides, rusty fracture surfaces
2010-HR-047	BR-304	64	69	50	Brecciated at top of unit, shear zone near 65m, fine grained, medium green grey, spotty hematite alteration in shear zone, chlorite alteration pervasive, 1% pyrite
2010-HR-048	BR-304	69	73	34	Brecciated at top of unit, potassium feldspar veins, grain size variable, pervasive chlorite alteration, sericite alteration on fractures, medium grey, trace sulphides, trace magnetite
2010-HR-049	BR-304	74	84	13	Fine grained, medium grey and pink granite clasts, strong pervasive chlorite alteration, carbonate veinlets, spotty hematite alteration (moderae), trace magnetite, no visible sulphides
2010-HR-050	BR-304	84	85	34	Fine grained, medium green, white medium grain plagioclase grains, pervasive chlorite alteration, spotty hematite alteration, sericite alteration on fracture surfaces, trace sulphides
2010-HR-051	BR-304	90	100	18	Fine grained, weak brecciated texture, medium green, strong chlorite alteration, medium grained plagioclase in zones, carbonate veinlets, 0.5% pyrrhotite and pyrite (disseminated)
2010-HR-052	BR-304	125	135	18	Fine grained with medium grained white plagioclase, dark green, bleaching around 126m, carbonate veinlets, trace magnetite, trace disseminated sulphides
2010-HR-053	BR-304	135	137	50	Half of this unit was gone at the time of sampling. Medium grained, granite intrusions, green-grey, bleaching in zones, trace magnetite, micro-faults, strong chlorite alteration, no visible sulphides
2010-HR-054	BR-304	137	140	18	Fine-grained, dark grey and pink, carbonate veinlets, spotty hematite alteration, white coarse grained round plagioclase grains, trace magnetite, trace sulphides
2010-HR-055	BR-304	140	146.5	40	Dark grey at top, light green at bottom, potassium feldspar clasts (0.5 - 5cm), bleaching in zones, chlorite alteration pervasive, carbonate veinlets, no visible sulphides, hematite alteration in clast matrix
2010-HR-056	BR-334	6	8.6	18	Fine grained, carbonate veinlets, dark grey/green, trace magnetite, no visible sulphides
2010-HR-057	BR-334	8.6	17	40	This looks like a tonalite, with pegmatite in the top 1m, dark grey, medium grained plagioclase white round grains, no visible sulphides, pegmatite is light pink and coarse grained
2010-HR-058	BR-334	17	24	13	Pink and green, coarse grained, brecciated, trace magnetite, tonalite matrix with euhedral quartz and feldspar clasts, no visible sulphides
2010-HR-059	BR-334	31.5	33.4	60	Medium green-grey, fine grained, pervasive chlorite alteration, plagioclase veins (0.5 - 1cm), no visible sulphides
2010-HR-060	BR-334	33.4	41	13	Medium green, fine grained, brecciated in zones, chlorite alteration pervasive and strong, trace magnetite, carbonate veinlets, trace sulphides
2010-HR-061	BR-334	41	42	50	Looks same as sample 2010-HR-060, not sure why unit was logged separately
2010-HR-062	BR-334	50	60	13	Large pegmatite and tonalite zones, generally fine grained, dark green, carbonate veinlets, quartz veins, trace magnetite, trace sulphides
2010-HR-063	BR-334	63	66.5	40	Still looks like unit 13 with weak banding, medium grained, medium green, strong chlorite alteration, trace magnetite, no visible sulphides
2010-HR-064	BR-334	105.5	110.5	13	Coarse-grained, medium pink, pervasive chlorite alteration, quartz clasts, trace magnetite, trace sericite, trace visible sulphides, spotty hematite alteration
2010-HR-065	BR-334	112	121	40	Light pink/yellow-green, chlorite alteration, coarse grained, quartz/potassium feldspar clasts, trace hematite, sericite alteration near shear zones at contacts, trace sulphides
2010-HR-066	BR-334	122	132	13	Fine grained, sheared at 45 degrees to core axis, strong chlorite alteration, medium green, pervasive sericite alteration, trace magnetite, potassium feldspar veins, trace sulphides
2010-HR-067	BR-334	135	145	15	Shearing at 45 degrees to core axis, fine-grained, medium pink and green, strong chlorite alteration, carbonate veinlets, silicification in zones, trace sulphides
2010-HR-068	BR-334	149	159	13	Fine grained, medium grey-green, strong chlorite alteration pervasive, no visible sulphides, magnetite veinlets
2010-HR-069	BR-334	159	167	11	Dark pink, medium grained, quartz veins, spotty hematite alteration, 0.5% pyrite, trace magnetite, weak chlorite alteration associated with hematite, sericite alteration on fracture surfaces
2010-HR-070	BR-334	167	173	11	Dark grey-pink, fine grained, moderate spotty hematite alteration near fractures, quartz veins, trace sulphides
2010-HR-071	BR-167	3	7.2	50	Dark grey, fine grained, carbonate veinlets, potassium feldspar clasts (2%), trace magnetite, no visible sulphides, bleaching near 6m, weak pervasive chlorite alteration
2010-HR-072	BR-167	8	18	13	Fine grained with medium grained plagioclase white round grains, medium grey green, quartz veins, spotty hematite alteration, trace pyrite, hematitve associated with quartz veins, strong pervasive chlorite alteration
2010-HR-073	BR-167	30	40	18	Medium green grey, fine grained with white medium grained round plagioclase grains, spotty hematite alteration, trace sulphides, strong pervasive chlorite alteration, carbonate veinlets
2010-HR-074	BR-167	92	102	18	Coarse grained, dark grey matrix with white plagioclase clasts, pink granite zones, trace pyrrhotite, trace magnetite, quartz veins
2010-HR-075	BR-167	102	108	15	Coarse grained, dark grey and beige, chlorite alteration pervasive, spotty hematite alteration associated with quartz veins, 1% pyrrhotite, brecciated texture at botom
2010-HR-076	BR-167	113	123	13	Fine grained, medium green grey, strong chlorite alteration, trace carbonate veinlets, no visible sulphides, trace magnetite associated with fracture surfaces
2010-HR-077	BR-169	2	11.2	18	Medium pink and grey, medium grained, trace hematite alteration, rusting on fractures near top of lithology, quartz clasts, no visible sulphides

Sample ID	Hole ID	From (m)	To (m)	Lithology ID (Osisko)	Description
2010-HR-078	BR-169	11.2	15	34	Coarse grained, medium pink and dark grey, brecciated in zones, looks more like an altered tonalite, plagioclase clasts in zones, strong hematite alteration (blebby and spotty), strong chlorite alteration pervasive, trace disseminated sulphides
2010-HR-079	BR-169	16	26	13	Granite and tonalite, medium grey and pink, strong chlorite alteration, medium plagioclase grains, carbonate veinlets, no visible sulphides
2010-HR-080	BR-169	26	34.5	13	More altered than above, sericite alteration, fine grained, no plagioclase medium grains, strong chlorite alteration, quartz veins, trace hematite, no visible sulphides
2010-HR-081	BR-169	38	48	11	Fine grained, medium green grey, moderate hematite alteration zones, weak sericite alteration, moderate pervasive chlorite alteration, carbonate veinlets, no visible sulphides
2010-HR-082	BR-169	48	58	11	Same as 2010-HR-082, more carbonate veinlets, weak brecciated zone near 58m
2010-HR-083	BR-169	61.8	63.1	18	Sheared tonalite, fine grained, orange-red, strong pervasive hematite alteration, broken core, fractures at 90 degrees to core axis, strong chlorite alteration, quartz veins, no visible sulphides
2010-HR-084	BR-169	63.1	70	11	Fine grained, medium green grey, carbonate veinlets, hematite alteration of veins, strong chlorite alteration (increasing in strength with depth), grain size increases with depth, trace pyrrhotite associated with veinlets
2010-HR-085	BR-226	3	11.4	13	Fine to medium grained, medium green, carbonate veinlets, hematite alteration at veinlets, rusting on fracture surfaces, trace pyrrhotite and pyrite (disseminated)
2010-HR-086	BR-226	11.4	16	20	Fine grained, light grey green, dark veins/veinlets, micro-faults, strong pervasive chlorite alteration, spotty hematite alteration, granite clasts, trace sulphides
2010-HR-087	BR-226	16	26	13	Porphyritic at top (16 - 18m), hematite alteration on fractures, generally fine grained, medium green, carbonate veinlets, some porphyritic zones throughout, micro-faults, strong chlorite alteration, trace pyrrhotite
2010-HR-088	BR-226	30	40	15	Looks more like chlorite-altered tonalite, carbonate veinlets associated with quartz veins, medium plagioclase grains (white), generally fine grained, medium green, trace sulphides, strong pervasive chlorite alteration
2010-HR-089	BR-226	44.5	50	13	Fine grained, medium grained white plagioclase grains, dark green, strong chlorite alteration, carbonate veinlets, trace magnetite associated with serpentine veinlets, 0.5% disseminated pyrrhotite
2010-HR-090	BR-226	50.3	60	15	Coarse grained with fine grained matrix, beigey green, quartz/carbonate veinlets, 1% spotty hematite, 1% disseminated pyrrhotite, strong chlorite alteration pervasive
2010-HR-091	BR-226	72	82	13	Medium to dark pink, fine grained with 10% quartz veins, potassium feldspar veins throughout, pervasive strong chlorite alteration, spotty hematite alteration, 0.5% disseminated pyrrhotite
2010-HR-092	BR-166	6.8	14	20	Fine grained, light green, quartz veins, strong chlorite alteration, weak sericite alteration, weak hematite alteration associated with veins, trace blebby pyrrhotite
2010-HR-093	BR-166	14	21	20	Fine grained, light green, quartz veins with yellowing around contacts, potassium feldspar-rich zone around 15m, strong chlorite alteration pervasive, trace blebby pyrrhotite
2010-HR-094	BR-166	22	32	11	Dark green, fine grained, carbonate veinlets, moderate pervasive chlorite alteration, trace sulphides, trace magnetite
2010-HR-095	BR-166	32	42	11	Fine grained, medium green (lighter with depth), carbonate veinlets with yellowing at contacts, moderate chlorite alteration, trace sulphides
2010-HR-096	BR-166	42	52	11	Fine grained, medium green-blue, tonalite sections (10%) with plagioclase grains, carbonate veinlets, quartz veins, 1% very fine grained dusty sulphides
2010-HR-097	BR-173	3.4	8.6	18	Medium grained, medium green, strong hematite alteration from 6 - 6.5m and on fracture surfaces, carbonate veinlets, medium grained plagioclase grains, strong chlorite alteration, trace dusty sulphides
2010-HR-098	BR-173	8.6	13.2	11	Fine grained, dark green, brecciated texture of dark green in potassium feldspar matrix (10%), some tonalite clasts, moderate pervasive chlorite alteration, weak spotty hematite alteration in matrix, no visible sulphides
2010-HR-099	BR-173	25	35	18	Fine grained with medium grained white plagioclase, medium green, spotty hematite alteration in zones, trace carbonate veinlets, moderate pervasive chlorite alteration, 1% disseminated pyrrhotite
2010-HR-100	BR-173	40.9	41.7	50	Very fine grained, dark grey, sharp contacts, no visible sulphides
2010-HR-101	BR-173	42	52	13	Fine grained, dark green, some porphyritic sections (10 - 100cm), magnetite veins, 1% disseminated pyrrhotite, spotty hematite alteration, pervasive strong chlorite alteration
2010-HR-102	BR-173	58	68	30	Fine grained, medium green, strong pervasive chlorite alteration, moderate hematite alteration associated with veins, carbonate veinlets, trace dusty sulphides, sulphide concentration is higher surrounding shear zone from 66.5 - 68m
2010-HR-103	BR-164	103.9	110	11	Dark pink, fine grained, brecciated zones, strong pervasive chlorite alteration, strong hematite alteration on fracture surfaces, carbonate veinlets, trace sulphides
2010-HR-104	BR-164	110	117	11	Same as 2010-HR-104, stronger hematite alteration, a more pinkish colour generally
2010-HR-105	BR-164	117	120	40	Yellow quartz matrix, black and pink clasts, hematite staining on contacts, weak chlorite alteration on fractures, trace magnetite, yellowed fracture surfaces, trace sulphides, spotty hematite
2010-HR-106	BR-164	120	128	13	Fine grained with medium grained plagioclase grains and dark green matrix, shearing around 128m at 30 degrees to core axis, strong pervasive chlorite alteration, trace carbonate veinlets, weak spotty hematite alteration, no visible sulphides
2010-HR-107	BR-261	3	11.2	18	Medium grey, medium grained, speckly texture, white plagioclase oikocrysts (fine grained) and clasts, no visible sulphides, weak rusting on fracture surfaces
2010-HR-108	BR-261	11.2	16	40	White with bits of 18 (as with 2010-HR-107) in it (30%), trace hematite associated with quartz veins, weak chlorite alteration, no visible sulphides
2010-HR-109	BR-261	30	40	18	Same as 2010-HR-0107. carbonate veinlets, less rusting on fractures, trace sulphides, weakly brecciated in zones
2010-HR-110	BR-261	41	42	50	Fine grained, black, bites of tonalite, white bleached contacts with chlorite alteration, no visible sulphides\
2010-HR-111	BR-261	42	52	18	Medium grained, medium green, trace carbonate veinlets, moderate pervasive chlorite alteration, micro-faults, trace sulphides localized
2010-HR-112	BR-275	2	12	13	Fine grained, medium green, trace magnetite, strong pervasive chlorite alteration, trace carbonate veinlets, trace spotty hematite alteration, no visible sulphides
2010-HR-113	BR-275	19	22	30	Appears to be mafic dyke, strong chlorite alteration, dark green, fine grained, no visible sulphides
2010-HR-114	BR-275	30	40	13	Fine grained, dark green, 1% magnetite veinlets, no visible sulphides, 1 - 2cm potassium feldspar rains, medium grained white plagioclase oikocrysts
2010-HR-115	BR-275	125	135	20	Fine to medium grained, medium green, medium grained potassium feldspar grains and veins, trace magnetite, carbonate veinlets, trace chalcopyrite, moderate pervasive chlorite alteration
2010-HR-116	BR-329	30	40	13	Fine grained, medium green, strong chlorite alteration, weakly sheared, trace magnetite, trace hematite (spotty on fractures), trace pyrrhotite, 30% non-chloritic granite (pink)

Sample ID	Hole ID	From (m)	To (m)	Lithology ID (Osisko)	Description
2010-HR-117	BR-329	94	104	13	Strongly sheared, medium grained, medium green, medium plagioclase grains, 1% pyrrhotite, trace magnetite, almost a quartz-feldspar gneiss, moderately banded
2010-HR-118	BR-176	4.4	12.6	13	Fine grained, medium green, spotty hematite alteration, pervasive chlorite alteration, magnetite veins, trace pyrrhotite, hematite alteration on fracture surfaces
2010-HR-119	BR-167	383	393	18	Fine grained with coarse grained plagioclase white grains, carbonate veinlets, dark green, trace magnetite, trace sulphides, strong pervasive chlorite alteration
2010-HR-120	BR-170	12	22	15	Fine grained, 3 distinct types brecciated, 1 - 10% mafic, fine grained, black, carbonate veinlets, trace magnetite, chlorite alteration, no visible sulphides, 2 - 30% porphyry, light green, fine grained, trace sulphides, trace magnetite, 3 - chloritic granite, fine grained, trace magnetite, carbonate veinlets, feldspar veins
2010-HR-121	BR-170	69	79	18	Fine grained, medium green, potassium feldspar veins, micro-faults, no visible sulphides, strong chlorite alteration pervasive, trace magnetite, carbonate veinlets
2010-HR-122	BR-170	89	91	32	Medium grained, green, spotty hematite alteration, quartz veins, micro-faults, potassium feldspar clasts, trace pyrite, trace magnetite, rusty fracture surfaces
2010-HR-123	BR-170	92	102	13	Fine grained, medium green, strong chlorite alteration, weakly sheared, trace magnetite, no visible sulphides

APPENDIX 2.III

Static Test Results

Sample ID	SiO_2 %	Al_2O_3 %	Fe_2O_3 %	MgO %	CaO %	Na_2O %	K_2O %	TiO_2 %	P_2O_5 %	MnO %	Cr_2O_3 %	V_2O_5 %	LOI %	Sum %
FINE GRAINED GRANITE n=16														
2010-HR-003	68.9	14.3	2.99	1.34	2.47	5.78	0.98	0.33	0.06	0.04	0.01	0.02	3.33	100.5
2010-HR-006	63.0	16.0	5.38	2.04	5.15	3.99	1.42	0.55	0.10	0.10	0.02	0.02	2.91	100.7
2010-HR-011	67.2	14.9	3.59	1.19	3.16	4.03	2.38	0.38	0.09	0.06	0.01	0.02	3.72	100.7
2010-HR-023	70.5	14.3	2.50	0.55	2.98	3.85	2.14	0.24	0.08	0.02	0.02	0.01	3.13	100.4
2010-HR-043	69.6	14.9	2.94	0.87	3.33	4.46	1.59	0.25	0.10	0.05	0.03	0.02	2.20	100.3
2010-HR-004	63.5	13.7	3.97	1.73	4.29	3.25	2.74	0.35	0.14	0.06	0.04	0.02	6.74	100.5
2010-HR-070	66.6	14.2	3.36	1.04	3.22	3.01	2.85	0.33	0.12	0.05	0.02	0.01	4.91	99.8
2010-HR-081	68.1	14.2	3.00	0.91	3.77	3.84	1.99	0.29	0.07	0.03	0.02	< 0.01	4.26	100.5
2010-HR-082	66.8	14.6	4.27	0.88	3.20	3.08	2.51	0.39	0.14	0.05	0.02	0.01	4.12	100.1
2010-HR-084	63.7	14.9	4.80	1.44	3.23	2.77	3.16	0.50	0.17	0.05	0.02	0.02	4.75	99.6
2010-HR-094	36.5	5.81	14.0	16.2	7.30	0.03	0.38	1.13	0.08	0.21	0.27	0.04	17.7	99.7
2010-HR-095	36.6	5.86	13.9	16.1	7.57	0.02	0.06	1.15	0.08	0.20	0.26	0.04	17.6	99.4
2010-HR-096	69.9	14.2	2.95	0.65	2.75	3.95	2.16	0.27	0.10	0.04	0.02	0.01	3.23	100.3
2010-HR-098	65.9	15.0	4.38	1.73	4.30	4.04	1.16	0.42	0.08	0.07	0.02	0.02	2.79	99.9
2010-HR-103	70.1	13.9	2.86	0.73	2.98	3.45	2.41	0.28	0.09	0.03	0.03	< 0.01	3.61	100.5
2010-HR-104	68.3	14.3	2.94	0.76	3.31	3.46	2.32	0.27	0.09	0.03	0.02	*0.01*	4.15	99.9
Minimum	*36.5*	*5.81*	*2.5*	*0.55*	*2.47*	*0.02*	*0.06*	*0.24*	*0.06*	*0.02*	*0.01*	*< 0.01*	*2.2*	*99.4*
Maximum	*70.5*	*16*	*14*	*16.2*	*7.57*	*5.78*	*3.16*	*1.15*	*0.17*	*0.21*	*0.27*	*0.04*	*17.7*	*100.7*
Average	*63*	*13*	*4.9*	*3.0*	*3.9*	*3.3*	*1.9*	*0.45*	*0.10*	*0.07*	*0.05*	*0.02*	*5.6*	*100.2*
CHLORITIC GRANITE n=31														
2010-HR-007	70.7	13.7	2.78	0.68	3.14	3.60	2.07	0.27	0.08	0.05	0.02	< 0.01	3.01	100.1
2010-HR-008	72.0	14.5	1.79	0.37	1.81	4.67	2.10	0.15	0.05	0.03	0.01	< 0.01	2.55	100.0
2010-HR-010	69.7	14.4	2.67	0.71	2.37	4.00	2.34	0.24	0.07	0.05	0.03	< 0.01	3.13	99.7
2010-HR-012	68.8	14.0	2.67	0.74	3.22	3.87	2.41	0.26	0.09	0.06	0.02	0.01	3.85	100.0
2010-HR-036	66.9	11.9	5.01	1.50	4.70	2.38	1.82	0.62	0.27	0.06	0.03	0.02	4.49	99.7
2010-HR-040	67.2	14.4	4.04	1.04	4.37	3.79	1.33	0.41	0.14	0.03	0.02	< 0.01	3.79	100.5
2010-HR-041	72.0	13.9	2.02	0.54	2.76	4.36	1.61	0.20	0.06	0.01	0.03	< 0.01	2.76	100.3
2010-HR-045	72.7	14.2	1.51	0.30	1.80	4.13	2.23	0.10	0.03	0.02	0.04	< 0.01	2.64	99.7
2010-HR-049	69.8	14.5	2.79	0.64	2.47	3.02	2.67	0.29	0.10	0.03	0.03	< 0.01	3.52	99.8
2010-HR-058	72.0	14.2	2.33	0.54	2.08	4.64	2.00	0.21	0.05	0.04	0.03	0.01	1.99	100.1
2010-HR-060	67.7	14.4	3.07	0.82	3.23	3.99	2.05	0.31	0.10	0.05	0.03	< 0.01	4.04	99.8
2010-HR-062	69.7	13.9	2.63	0.67	2.84	3.96	2.12	0.25	0.08	0.03	0.03	0.01	3.65	99.9
2010-HR-064	71.1	13.0	2.55	0.50	3.27	3.60	2.09	0.18	0.06	0.03	0.03	< 0.01	3.89	100.3
2010-HR-066	59.0	13.8	5.14	2.07	5.98	2.27	2.99	0.51	0.18	0.07	0.02	0.01	7.83	100.0
2010-HR-068	71.2	13.2	2.60	0.68	2.58	2.93	2.68	0.24	0.07	0.04	0.03	< 0.01	3.77	100.0
2010-HR-072	68.4	14.6	3.30	1.01	2.64	3.59	2.47	0.36	0.11	0.03	0.02	< 0.01	3.69	100.3
2010-HR-076	62.8	14.9	2.60	0.64	5.81	4.03	2.39	0.26	0.09	0.05	0.02	0.01	6.09	99.7
2010-HR-079	70.2	13.8	3.22	0.80	2.55	3.40	2.30	0.30	0.11	0.05	0.03	0.02	3.48	100.2
2010-HR-080	71.3	13.8	2.50	0.79	2.27	3.46	2.35	0.22	0.09	0.03	0.02	< 0.01	3.14	100.0
2010-HR-085	65.7	14.9	3.44	0.77	3.70	3.48	2.52	0.42	0.16	0.04	0.03	< 0.01	4.70	99.8
2010-HR-087	70.4	13.7	2.63	0.55	2.75	3.17	2.50	0.24	0.08	0.04	0.03	< 0.01	3.68	99.7
2010-HR-089	67.0	14.2	3.34	0.81	3.75	3.62	2.09	0.41	0.15	0.04	0.02	< 0.01	4.49	99.9
2010-HR-091	70.6	13.7	2.70	0.65	2.46	3.34	2.62	0.25	0.09	0.04	0.02	< 0.01	3.74	100.2
2010-HR-101	64.8	15.3	3.62	1.02	3.72	3.73	2.57	0.49	0.17	0.04	0.02	0.01	4.08	99.5
2010-HR-106	63.8	14.6	4.45	1.69	4.03	4.03	1.85	0.43	0.11	0.08	0.01	< 0.01	4.82	99.9
2010-HR-112	69.7	14.7	2.80	0.73	2.41	3.63	2.44	0.30	0.10	0.03	0.02	< 0.01	3.41	100.3
2010-HR-114	67.7	15.0	2.96	0.72	3.02	3.29	2.75	0.35	0.10	0.03	0.02	0.01	4.12	100.1
2010-HR-116	69.7	14.3	2.86	0.68	2.45	3.51	2.38	0.26	0.09	0.04	0.02	< 0.01	3.18	99.5
2010-HR-117	67.4	14.4	2.70	1.48	4.04	4.21	1.69	0.26	0.07	0.05	0.02	< 0.01	3.66	100.0
2010-HR-118	60.1	14.1	6.09	4.11	4.27	2.67	1.65	0.52	0.23	0.08	0.03	0.02	6.07	99.9
2010-HR-123	66.5	15.2	3.26	0.96	3.35	4.75	1.69	0.36	0.12	0.03	0.03	< 0.01	3.66	99.9
Minimum	*59.0*	*11.9*	*1.51*	*0.30*	*1.80*	*2.27*	*1.33*	*0.10*	*0.03*	*0.01*	*0.01*	*< 0.01*	*1.99*	*99.5*
Maximum	*72.7*	*15.3*	*6.09*	*4.11*	*5.98*	*4.75*	*2.99*	*0.62*	*0.27*	*0.08*	*0.04*	*0.02*	*7.83*	*100.5*
Average	*68*	*14*	*3.1*	*0.94*	*3.2*	*3.6*	*2.2*	*0.31*	*0.11*	*0.04*	*0.02*	*0.01*	*3.9*	*100*

Sample ID	SiO_2 %	Al_2O_3 %	Fe_2O_3 %	MgO %	CaO %	Na_2O %	K_2O %	TiO_2 %	P_2O_5 %	MnO %	Cr_2O_3 %	V_2O_5 %	LOI %	Sum %
TONALITE n=30														
2010-HR-001	70.7	14.9	2.86	0.81	3.12	4.50	1.15	0.28	0.08	0.04	0.04	0.01	1.47	99.9
2010-HR-005	71.4	14.6	2.19	0.55	2.54	4.26	2.23	0.18	0.05	0.04	0.03	0.01	1.40	99.5
2010-HR-014	67.6	15.5	3.91	0.99	3.29	3.63	2.21	0.42	0.15	0.05	0.02	0.01	2.24	100.1
2010-HR-016	68.7	14.4	3.58	0.95	3.37	3.69	2.25	0.40	0.18	0.05	0.02	0.02	2.55	100.1
2010-HR-018	68.5	14.5	3.20	0.90	3.28	3.75	2.62	0.30	0.11	0.05	0.03	0.01	2.23	99.5
2010-HR-020	66.6	14.9	4.85	1.26	4.07	4.09	1.70	0.38	0.28	0.07	0.03	0.01	1.81	100.0
2010-HR-022	70.0	14.0	3.02	0.84	3.11	3.81	1.78	0.32	0.11	0.05	0.02	< 0.01	2.68	99.8
2010-HR-025	70.8	14.3	2.68	0.65	2.64	4.36	2.03	0.23	0.10	0.04	0.04	< 0.01	1.85	99.7
2010-HR-027	62.8	15.2	5.49	1.02	3.74	4.22	2.38	0.36	0.23	0.07	0.02	0.02	3.65	99.1
2010-HR-030	71.0	14.1	2.64	0.61	2.33	4.32	2.12	0.23	0.06	0.04	0.04	*0.01*	2.34	99.8
2010-HR-032	67.3	15.3	4.25	1.04	3.43	4.19	2.08	0.48	0.17	0.05	0.04	0.02	1.81	100.2
2010-HR-034	69.6	14.9	3.53	1.10	3.57	3.92	1.74	0.36	0.07	0.05	0.02	0.01	1.35	100.1
2010-HR-037	68.0	14.8	3.99	1.01	3.45	3.88	1.73	0.41	0.15	0.05	0.02	< 0.01	2.32	99.8
2010-HR-038	61.4	16.5	5.78	1.66	4.66	4.04	1.77	0.64	0.27	0.07	0.02	0.02	3.28	100.0
2010-HR-039	69.0	14.9	2.98	0.87	3.15	4.64	1.63	0.26	0.09	0.05	0.04	< 0.01	2.26	99.8
2010-HR-051	67.2	15.4	2.86	0.80	3.47	4.05	2.16	0.27	0.08	0.03	0.03	< 0.01	3.31	99.6
2010-HR-052	65.2	14.9	4.03	1.19	4.08	3.64	2.13	0.48	0.14	0.07	0.01	0.01	3.85	99.7
2010-HR-054	61.1	14.9	5.24	2.63	4.94	4.10	1.82	0.52	0.19	0.08	0.02	0.02	5.39	100.9
2010-HR-056	58.1	15.2	5.57	1.99	5.62	2.57	3.16	0.61	0.13	0.09	0.01	0.02	6.52	99.6
2010-HR-073	70.3	14.7	3.66	0.86	2.84	4.02	1.66	0.34	0.09	0.04	0.03	< 0.01	1.84	100.4
2010-HR-074	65.9	15.2	3.87	1.32	3.95	4.03	1.72	0.40	0.13	0.06	0.02	0.01	3.54	100.1
2010-HR-077	68.5	14.4	3.73	0.93	2.39	2.16	3.27	0.35	0.14	0.05	0.03	0.01	3.89	99.8
2010-HR-083	66.2	14.3	4.23	1.34	3.36	3.39	2.23	0.43	0.12	0.05	0.05	0.02	4.64	100.4
2010-HR-097	65.3	15.2	5.31	1.50	3.39	3.96	1.50	0.60	0.27	0.06	0.01	0.02	2.64	99.8
2010-HR-099	65.6	15.4	4.29	1.42	3.61	4.00	2.01	0.42	0.14	0.05	0.03	< 0.01	3.49	100.5
2010-HR-107	69.5	15.4	3.37	0.88	3.74	4.05	1.33	0.34	0.10	0.03	0.04	< 0.01	1.50	100.2
2010-HR-109	68.7	14.7	3.77	1.28	3.83	3.94	1.33	0.37	0.12	0.05	0.02	< 0.01	1.50	99.6
2010-HR-111	69.8	15.2	3.36	0.89	3.58	4.15	1.39	0.35	0.10	0.04	0.03	< 0.01	1.45	100.3
2010-HR-119	61.5	16.0	5.18	1.95	5.03	3.30	2.33	0.51	0.17	0.07	0.03	0.02	4.19	100.3
2010-HR-121	61.6	16.0	6.27	2.32	5.75	3.47	1.25	0.62	0.10	0.08	0.04	0.02	3.03	100.6
Minimum	*58.1*	*14.0*	*2.19*	*0.55*	*2.33*	*2.16*	*1.15*	*0.18*	*0.05*	*0.03*	*0.01*	*< 0.01*	*1.35*	*99.1*
Maximum	*71.4*	*16.5*	*6.27*	*2.63*	*5.75*	*4.64*	*3.27*	*0.64*	*0.28*	*0.09*	*0.05*	*0.02*	*6.52*	*100.9*
Average	*67*	*15*	*4.0*	*1.2*	*3.6*	*3.9*	*2.0*	*0.40*	*0.14*	*0.05*	*0.03*	*0.02*	*2.8*	*100*
ALTERED GRANITOID n=8														
2010-HR-024	74.9	14.2	1.21	0.14	0.96	5.94	1.37	0.04	0.03	0.03	0.03	*< 0.01*	1.41	100.2
2010-HR-031	70.6	13.4	2.52	0.85	2.81	4.57	1.59	0.21	0.08	0.05	0.02	0.01	3.79	100.5
2010-HR-044	66.0	14.7	3.00	0.90	3.57	3.26	2.71	0.33	0.09	0.05	0.02	< 0.01	5.04	99.7
2010-HR-046	68.6	14.3	2.72	0.79	3.01	3.45	2.48	0.29	0.09	0.04	0.02	< 0.01	4.02	99.9
2010-HR-086	69.4	13.9	2.87	0.67	2.81	4.00	2.02	0.30	0.11	0.04	0.03	< 0.01	3.77	100.0
2010-HR-092	75.7	13.8	1.10	0.20	0.43	5.81	1.42	0.03	0.01	0.01	0.04	< 0.01	1.77	100.4
2010-HR-093	70.4	13.5	2.67	0.90	1.97	2.70	3.16	0.27	0.09	0.03	0.02	0.01	3.89	99.7
2010-HR-115	65.6	15.2	4.04	0.97	4.12	4.12	1.65	0.50	0.18	0.04	0.03	0.01	3.10	99.6
Minimum	*65.6*	*13.4*	*1.10*	*0.14*	*0.43*	*2.70*	*1.37*	*0.03*	*0.01*	*0.01*	*0.02*	*< 0.01*	*1.41*	*99.6*
Maximum	*75.7*	*15.2*	*4.04*	*0.97*	*4.12*	*5.94*	*3.16*	*0.50*	*0.18*	*0.05*	*0.04*	*0.01*	*5.04*	*100.5*
Average	*70*	*14*	*2.5*	*0.68*	*2.5*	*4.2*	*2.1*	*0.25*	*0.09*	*0.04*	*0.03*	*0.01*	*3.3*	*100*
PEGMATITE n=11														
2010-HR-013	72.7	13.9	1.43	0.25	2.15	4.56	2.09	0.12	0.03	0.02	0.02	0.01	3.13	100.4
2010-HR-017	71.3	14.7	1.78	0.46	1.69	5.10	2.64	0.14	0.05	0.03	0.03	< 0.01	1.89	99.7
2010-HR-019	74.5	13.7	1.06	0.11	1.24	3.65	4.54	0.04	*0.01*	*0.01*	0.04	< 0.01	1.03	99.9
2010-HR-026	77.8	12.2	1.53	0.07	1.09	5.38	1.06	0.04	0.02	*0.01*	0.04	< 0.01	1.55	100.7
2010-HR-042	70.5	13.7	2.52	1.37	2.05	5.33	1.31	0.17	0.07	0.03	0.04	< 0.01	3.05	100.1
2010-HR-055	72.0	15.1	0.84	0.10	2.41	4.40	2.33	0.02	*0.01*	*0.01*	0.03	< 0.01	3.02	100.2
2010-HR-057	70.9	14.6	2.60	0.62	2.63	4.43	1.66	0.26	0.10	0.03	0.04	< 0.01	2.47	100.4
2010-HR-063	68.1	13.6	3.10	0.89	3.38	3.02	2.67	0.36	0.11	0.04	0.02	< 0.01	4.94	100.3
2010-HR-065	63.8	13.2	3.67	2.07	4.40	2.56	2.89	0.29	0.09	0.06	0.03	0.01	6.98	100.0
2010-HR-105	75.2	12.9	0.60	0.10	2.73	4.72	1.26	0.02	0.02	0.01	0.03	< 0.01	2.66	100.2
2010-HR-108	70.3	14.9	3.39	0.99	2.60	4.28	2.18	0.34	0.24	0.04	0.03	< 0.01	1.35	100.6
Minimum	*63.8*	*12.2*	*0.60*	*0.07*	*1.09*	*2.56*	*1.06*	*0.02*	*0.01*	*0.01*	*0.02*	*< 0.01*	*1.03*	*99.7*
Maximum	*77.8*	*15.1*	*3.67*	*2.07*	*4.40*	*5.38*	*4.54*	*0.36*	*0.24*	*0.06*	*0.04*	*0.01*	*6.98*	*100.7*
Average	*72*	*14*	*2.0*	*0.64*	*2.4*	*4.3*	*2.2*	*0.16*	*0.07*	*0.03*	*0.03*	*0.01*	*2.9*	*100*

Sample ID	SiO_2 %	Al_2O_3 %	Fe_2O_3 %	MgO %	CaO %	Na_2O %	K_2O %	TiO_2 %	P_2O_5 %	MnO %	Cr_2O_3 %	V_2O_5 %	LOI %	Sum %
MAFIC DYKE n=9														
2010-HR-002	43.1	11.0	12.7	8.45	10.3	0.77	*0.01*	1.11	0.08	0.17	0.11	0.05	12.4	100.3
2010-HR-069	45.0	11.8	12.9	8.02	9.96	0.75	0.01	1.24	0.10	0.18	0.10	0.05	10.2	100.4
2010-HR-015	47.8	11.0	6.82	8.13	11.3	2.00	0.07	0.50	0.28	0.14	0.09	0.02	11.6	99.8
2010-HR-047	62.9	14.2	4.39	1.58	4.51	2.54	2.72	0.42	0.12	0.07	0.01	0.01	6.28	99.8
2010-HR-053	72.3	13.8	2.38	0.82	2.62	4.19	1.67	0.23	0.07	0.02	0.02	< 0.01	2.19	100.3
2010-HR-061	68.4	15.2	2.96	0.78	2.57	2.98	3.01	0.31	0.10	0.03	0.02	< 0.01	3.94	100.2
2010-HR-071	46.8	11.5	8.82	10.6	8.60	0.40	0.05	0.61	0.33	0.12	0.12	0.02	12.0	100.0
2010-HR-100	47.9	12.0	8.91	7.73	9.47	1.35	0.41	0.67	0.32	0.14	0.05	0.03	11.4	100.3
2010-HR-110	68.3	14.4	3.37	0.81	3.13	3.58	2.53	0.36	0.12	0.04	0.02	0.01	2.43	99.1
Minimum	*43.1*	*11.0*	*2.38*	*0.78*	*2.57*	*0.40*	*0.01*	*0.23*	*0.07*	*0.02*	*0.01*	*< 0.01*	*2.19*	*99.1*
Maximum	*72.3*	*15.2*	*12.90*	*10.60*	*11.30*	*4.19*	*3.01*	*1.24*	*0.33*	*0.18*	*0.12*	*0.05*	*12.40*	*100.4*
Average	*56*	*13*	*7.0*	*5.2*	*6.9*	*2.1*	*1.2*	*0.61*	*0.17*	*0.10*	*0.06*	*0.02*	*8.0*	*100*
CHLORITIC GRANITE PORPHYRY n=5														
2010-HR-067	65.7	14.4	2.92	1.23	3.34	2.90	3.17	0.27	0.11	0.04	0.03	0.02	5.59	99.7
2010-HR-075	69.6	13.2	2.77	0.86	3.75	3.59	1.85	0.27	0.10	0.05	0.02	< 0.01	4.27	100.3
2010-HR-088	59.3	13.9	5.04	2.33	5.52	2.94	2.45	0.43	0.13	0.09	0.02	0.03	8.17	100.3
2010-HR-090	63.5	14.2	4.30	1.42	4.21	3.44	2.33	0.42	0.13	0.07	0.02	0.02	6.12	100.2
2010-HR-120	58.0	15.7	5.49	2.39	5.29	3.18	2.47	0.53	0.16	0.08	< 0.01	0.02	6.33	99.7
Minimum	*58.0*	*13.2*	*2.77*	*0.86*	*3.34*	*2.90*	*1.85*	*0.27*	*0.10*	*0.04*	*< 0.01*	*< 0.01*	*4.27*	*99.7*
Maximum	*69.6*	*15.7*	*5.49*	*2.39*	*5.52*	*3.59*	*3.17*	*0.53*	*0.16*	*0.09*	*0.03*	*0.03*	*8.17*	*100.3*
Average	*63*	*14*	*4.1*	*1.6*	*4.4*	*3.2*	*2.5*	*0.38*	*0.13*	*0.07*	*0.02*	*0.02*	*6.1*	*100*
MINOR UNITS														
Aplite n=1														
2010-HR-009	70.7	14.3	1.92	0.59	2.44	4.52	2.04	0.16	0.05	0.03	0.03	< 0.01	3.25	100.0
Diorite n=2														
2010-HR-029	69.5	14.9	2.90	0.85	3.04	3.85	2.02	0.26	0.08	0.03	0.04	< 0.01	2.90	100.4
2010-HR-033	60.8	16.9	6.70	1.96	5.95	3.90	1.21	0.90	0.38	0.07	0.02	0.03	1.95	100.7
Gneiss n=1														
2010-HR-028	65.1	14.8	4.58	1.58	4.36	3.82	1.66	0.45	0.16	0.07	0.02	0.01	3.34	100.0
Sheared mafic unit n=2														
2010-HR-102	47.0	12.8	8.65	8.34	7.93	2.33	0.32	0.78	0.37	0.14	0.05	0.03	11.2	100.0
2010-HR-113	53.4	10.1	6.88	7.92	6.38	2.36	0.44	0.57	0.07	0.09	0.15	0.03	11.8	100.1
Sheared granitoid n=1														
2010-HR-122	72.4	12.7	1.50	0.42	3.57	4.33	1.52	0.11	0.04	0.04	0.02	< 0.01	3.43	100.1
Tectonized-sheared vein zone n=4														
2010-HR-021	78.3	9.96	2.26	0.46	1.96	2.47	1.92	0.16	0.06	0.03	0.05	< 0.01	2.24	99.9
2010-HR-048	63.7	14.3	4.45	1.34	4.51	2.81	2.53	0.44	0.13	0.06	0.01	< 0.01	6.02	100.3
2010-HR-050	70.1	14.4	2.45	0.54	2.92	4.22	2.00	0.22	0.08	0.04	0.03	< 0.01	2.86	99.9
2010-HR-078	70.3	14.9	3.32	0.90	1.30	3.76	2.15	0.34	0.11	0.03	0.03	< 0.01	2.66	99.7
Quartz vein zone n=1														
2010-HR-035	87.4	5.27	1.90	0.24	1.03	1.35	1.09	0.08	0.03	0.01	0.08	< 0.01	1.77	100.2
Intermediate dyke n=1														
2010-HR-059	68.8	14.4	2.89	0.71	3.19	3.25	2.55	0.29	0.11	0.05	0.01	0.01	4.13	100.5
Minimum	*47*	*5.27*	*1.5*	*0.24*	*1.03*	*1.35*	*0.32*	*0.08*	*0.03*	*0.01*	*0.01*	*< 0.01*	*1.77*	*99.7*
Maximum	*87.4*	*16.9*	*8.65*	*8.34*	*7.93*	*4.52*	*2.55*	*0.9*	*0.38*	*0.14*	*0.15*	*0.03*	*11.8*	*100.7*
Average	*68*	*13*	*3.9*	*2.0*	*3.7*	*3.3*	*1.7*	*0.37*	*0.13*	*0.05*	*0.04*	*0.01*	*4.4*	*100*
TAILINGS n=1														
SGS Lakefield	67.8	13.3	3.61	1.18	3.53	3.00	2.81	0.35	0.11	0.06	0.01	< 0.01	4.9	100.6
Lakehead	67.4	13.4	3.65	1.11	3.73	2.83	2.93	0.34	0.12	0.06	0.01	---	5.6	101.3

Sample ID	Ag µg/g	Al µg/g	As µg/g	Ba µg/g	Be µg/g	Bi µg/g	Ca µg/g	Cd µg/g	Co µg/g	Cr µg/g	Cu µg/g	Fe µg/g	K µg/g	Li µg/g	Mg µg/g	Mn µg/g	Mo µg/g	Na µg/g	Ni µg/g	P µg/g	Pb µg/g	Sb µg/g	Se µg/g	Sn µg/g	Sr µg/g	Ti µg/g	Tl µg/g	U µg/g	V µg/g	Y µg/g	Zn µg/g
FINE GRAINED GRANITE n=16																															
2010-HR-003	0.24	76000	0.6	290	0.55	< 0.09	15000	0.17	7.1	140	24	19000	8000	7	7100	280	0.2	33000	12	240	3.0	< 0.8	< 0.7	1.0	140	1300	0.11	1.0	44	6.0	22
2010-HR-006	0.41	82000	2.1	240	0.66	< 0.09	30000	0.23	11	140	37	33000	12000	13	11000	600	0.4	24000	15	360	21	< 0.8	< 0.7	2.0	190	3100	0.22	1.5	74	12	62
2010-HR-011	0.27	79000	< 0.5	380	0.78	< 0.09	19000	0.17	7.1	150	14	23000	20000	8	6300	390	0.5	23000	6.8	350	4.3	< 0.8	< 0.7	1.3	150	2000	0.32	1.4	34	7.8	53
2010-HR-023	0.40	77000	< 0.5	410	0.69	< 0.09	19000	0.21	3.5	120	2.5	17000	18000	5	3100	200	0.4	24000	4.9	320	5.6	< 0.8	0.8	1.7	180	1100	0.23	1.2	17	6.7	30
2010-HR-043	0.20	79000	1.1	470	0.70	< 0.09	20000	0.11	5.5	190	12	19000	13000	5	4700	300	0.4	25000	7.7	370	6.9	< 0.8	< 0.7	1.4	320	1500	0.17	0.83	26	6.8	38
2010-HR-004	0.67	85000	< 0.5	410	0.87	0.13	30000	0.22	8.6	130	43	28000	25000	3	11000	510	0.7	24000	21	620	7.0	1.1	< 0.7	1.6	140	1700	0.26	0.81	43	5.4	40
2010-HR-070	0.42	91000	< 0.5	450	0.82	< 0.09	24000	0.26	6.8	170	10	26000	26000	6	6600	320	0.4	22000	12	510	5.9	0.9	< 0.7	1.5	140	1500	0.28	0.76	29	5.3	52
2010-HR-081	0.41	82000	< 0.5	390	0.80	< 0.09	21000	0.28	6.4	150	14	27000	18000	11	5700	330	0.5	25000	9.1	720	7.6	< 0.8	< 0.7	1.0	170	2700	0.18	1.7	31	6.8	38
2010-HR-082	1.6	91000	< 0.5	430	0.89	0.13	23000	0.47	6.7	170	11	31000	24000	14	5500	360	0.4	23000	5.9	610	4.8	< 0.8	< 0.7	1.7	130	1600	0.23	1.4	28	9.8	56
2010-HR-084	0.47	89000	< 0.5	450	0.85	< 0.09	22000	0.31	9.5	130	28	33000	28000	14	8600	380	1.4	20000	13	730	4.9	< 0.8	< 0.7	1.5	110	1800	0.28	0.88	51	6.4	57
2010-HR-094	0.31	22000	1.2	14	0.43	< 0.09	46000	0.23	83	1400	120	87000	3500	25	79900	1300	0.4	49	820	310	4.2	< 0.8	< 0.7	0.9	250	2200	0.26	0.14	150	4.5	91
2010-HR-095	0.49	22000	1.0	8.7	0.40	< 0.09	49000	0.26	84	1400	120	89000	600	19	81000	1300	0.4	31	820	310	6.0	< 0.8	< 0.7	1.2	250	2700	0.03	0.14	160	5.3	95
2010-HR-096	0.53	82000	< 0.5	320	0.80	< 0.09	18000	0.30	4.9	140	8.9	20000	19000	6	3700	280	2.0	24000	6.1	400	4.8	< 0.8	< 0.7	1.7	110	1200	0.24	0.93	20	7.5	43
2010-HR-098	0.40	84000	< 0.5	240	0.85	< 0.09	28000	0.26	11	120	25	29000	11000	13	9800	410	0.3	25000	17	340	7.1	< 0.8	< 0.7	1.4	280	2500	0.13	1.1	58	11	49
2010-HR-103	0.50	78000	< 0.5	490	0.84	< 0.09	19000	0.28	4.8	170	32	19000	20000	8	4100	280	0.6	20000	6.5	330	7.1	< 0.8	< 0.7	1.6	110	1100	0.25	0.99	21	6.3	44
2010-HR-104	0.67	81000	< 0.5	470	0.85	< 0.09	22000	0.27	5.0	150	76	20000	20000	12	4300	250	0.5	21000	7.6	320	5.6	< 0.8	< 0.7	1.8	120	1100	0.23	1.1	18	6.7	42
Minimum	*0.2*	*22000*	*< 0.5*	*8.7*	*0.4*	*< 0.09*	*15000*	*0.11*	*3.5*	*120*	*2.5*	*17000*	*600*	*3*	*3100*	*200*	*0.2*	*31*	*4.9*	*240*	*3*	*< 0.8*	*< 0.7*	*0.9*	*110*	*1100*	*0.03*	*0.14*	*17*	*4.5*	*22*
Maximum	*1.6*	*91000*	*2.1*	*490*	*0.89*	*0.13*	*49000*	*0.47*	*84*	*1400*	*120*	*89000*	*28000*	*25*	*81000*	*1300*	*2*	*33000*	*820*	*730*	*21*	*1.1*	*0.8*	*2*	*320*	*3100*	*0.32*	*1.7*	*160*	*12*	*95*
Average	*0.50*	*75000*	*0.72*	*341*	*0.74*	*0.10*	*25313*	*0.25*	*17*	*304*	*36*	*32500*	*16631*	*11*	*15775*	*468*	*0.59*	*20818*	*112*	*428*	*6.6*	*0.83*	*0.71*	*1.5*	*174*	*1819*	*0.21*	*0.99*	*50*	*7.1*	*51*
CHLORITIC GRANITE n=31																															
2010-HR-007	0.40	73000	1.5	440	0.70	< 0.09	19000	0.24	4.3	170	23	18000	17000	7	3500	300	0.3	22000	4.2	300	7.5	< 0.8	< 0.7	1.4	140	1500	0.25	1.3	21	9.1	45
2010-HR-008	0.26	78000	< 0.5	240	0.85	< 0.09	11000	0.12	2.1	110	3.3	12000	18000	< 2	2000	220	0.4	27000	1.8	180	5.7	< 0.8	< 0.7	3.1	110	610	0.27	1.3	8	7.2	32
2010-HR-010	0.36	78000	< 0.5	310	0.87	< 0.09	15000	0.27	4.1	220	8.6	18000	20000	5	3800	280	3.8	23000	5.2	280	5.5	< 0.8	< 0.7	2.2	130	960	0.32	1.5	15	7.3	61
2010-HR-012	0.38	76000	< 0.5	380	0.90	< 0.09	20000	0.16	4.3	130	25	18000	20000	6	3900	340	0.7	23000	5.1	340	4.5	< 0.8	< 0.7	2.1	140	800	0.36	1.3	20	8.3	37
2010-HR-036	0.42	64000	< 0.5	240	0.43	< 0.09	29000	0.07	12	180	7.6	32000	15000	11	8400	390	2.2	15000	12	1000	2.5	< 0.8	< 0.7	1.6	130	3100	0.22	0.55	62	9.7	67
2010-HR-040	0.33	75000	0.6	240	0.70	< 0.09	25000	0.17	6.9	140	10	26000	11000	16	5500	300	0.4	23000	6.4	530	5.9	< 0.8	< 0.7	1.5	210	1800	0.12	1.2	35	10	43
2010-HR-041	0.30	73000	< 0.5	200	0.88	< 0.09	16000	0.14	3.2	190	10	13000	13000	6	2900	160	0.4	24000	5.4	230	6.2	< 0.8	< 0.7	2.1	150	730	0.14	1.7	13	8.0	20
2010-HR-045	0.24	78000	0.6	730	0.62	< 0.09	11000	0.13	2.2	200	4.0	10000	19000	< 2	1600	130	0.7	24000	5.1	130	6.6	< 0.8	< 0.7	0.8	150	490	0.20	1.3	5	3.2	23
2010-HR-049	0.58	77000	< 0.5	510	0.67	< 0.09	15000	0.30	3.9	240	9.2	19000	22000	5	3500	210	1.0	19000	5.5	410	3.9	< 0.8	< 0.7	1.4	120	1200	0.30	1.2	19	5.4	36
2010-HR-058	0.21	75000	1.4	220	0.62	< 0.09	13000	0.20	3.4	180	8.5	15000	17000	6	3000	230	0.4	26000	5.9	230	15	< 0.8	< 0.7	4.2	120	1100	0.20	1.00	16	8.1	31
2010-HR-060	0.21	77000	< 0.5	340	0.71	< 0.09	20000	0.20	5.6	180	7.3	20000	17000	7	4300	300	0.4	23000	7.1	360	5.7	< 0.8	< 0.7	3.2	180	1400	0.24	0.80	23	5.2	47
2010-HR-062	0.30	74000	< 0.5	310	0.50	< 0.09	17000	0.20	5.4	190	4.4	17000	18000	4	3600	200	0.9	23000	5.4	310	6.1	< 0.8	< 0.7	7.6	150	1000	0.22	0.57	19	3.8	35
2010-HR-064	0.55	70000	< 0.5	270	0.58	< 0.09	20000	0.20	4.2	220	23	17000	17000	4	2700	240	0.5	22000	4.7	210	7.5	< 0.8	< 0.7	15	170	670	0.19	1.1	15	5.6	40
2010-HR-066	0.38	71000	< 0.5	380	0.70	< 0.09	34000	0.25	12	140	32	31000	23000	9	11000	480	0.3	14000	22	680	5.9	< 0.8	< 0.7	13	170	1700	0.28	1.1	49	6.3	56
2010-HR-068	0.55	70000	< 0.5	430	0.58	< 0.09	16000	0.32	3.6	160	7.5	17000	22000	3	3600	230	0.3	18000	5.9	280	6.3	< 0.8	< 0.7	2.0	120	1000	0.25	1.1	17	5.0	34
2010-HR-072	0.63	91000	< 0.5	420	0.86	< 0.09	19000	0.33	6.2	180	16	24000	23000	8	6100	250	0.6	25000	7.3	440	5.0	< 0.8	< 0.7	1.4	130	1500	0.29	1.0	27	6.9	40
2010-HR-076	0.49	93000	< 0.5	450	0.84	< 0.09	41000	0.31	3.9	110	4.1	20000	23000	7	3900	390	0.6	28000	4.8	380	6.2	< 0.8	< 0.7	1.7	160	1200	0.23	1.1	21	7.8	40
2010-HR-079	0.54	87000	0.6	390	0.79	< 0.09	18000	0.27	5.6	210	7.2	24000	22000	10	4900	350	0.6	25000	6.0	470	6.1	< 0.8	< 0.7	1.6	120	1240	0.23	1.1	24	7.2	51
2010-HR-080	0.46	85000	0.5	500	0.74	< 0.09	16000	0.23	5.0	130	12	18000	22000	7	4800	260	0.6	24000	6.2	350	4.3	< 0.8	< 0.7	1.2	120	930	0.18	1.1	24	4.1	31
2010-HR-085	0.47	92000	< 0.5	410	0.78	< 0.09	27000	0.31	6.4	210	15	26000	24000	9	4800	290	0.8	25000	6.0	680	6.0	< 0.8	< 0.7	1.4	160	1900	0.25	0.98	28	6.3	56
2010-HR-087	0.57	85000	< 0.5	440	0.82	< 0.09	20000	0.33	4.5	150	8.3	20000	24000	4	3400	250	0.4	23000	4.3	340	6.9	< 0.8	< 0.7	1.2	130	1100	0.24	1.3	20	5.2	39
2010-HR-089	0.49	83000	< 0.5	350	0.69	< 0.09	25000	0.28	5.7	150	13	23000	19000	12	4600	280	0.6	23000	4.9	640	6.3	< 0.8	< 0.7	1.9	180	1900	0.26	0.99	26	5.0	56
2010-HR-091	1.2	78000	< 0.5	590	0.92	0.72	16000	0.24	4.8	160	13	18000	22000	3	3600	260	1.2	21000	5.7	350	20	< 0.8	< 0.7	1.6	150	1100	0.28	1.3	26	4.6	33
2010-HR-101	0.41	88000	< 0.5	530	0.84	< 0.09	25000	0.27	7.6	150	33	25000	22000	10	5900	290	0.6	23000	6.7	710	8.0	< 0.8	< 0.7	1.5	180	1900	0.27	0.97	36	7.6	45
2010-HR-106	0.42	82000	0.5	350	0.90	< 0.09	26000	0.22	10	120	21	29000	16000	26	9500	530	0.4	24000	19	410	6.1	< 0.8	0.9	2.7	150	1500	0.26	1.1	54	8.2	72
2010-HR-112	0.44	85000	< 0.5	390	0.98	< 0.09	16000	0.20	4.4	150	4.6	20000	21000	7	4200	220	0.5	22000	5.4	380	5.6	< 0.8	< 0.7	1.0	140	1400	0.28	0.88	26	4.7	47
2010-HR-114	0.57	84000	< 0.5	480	0.87	< 0.09	20000	0.23	5.9	140	12	20000	22000	6	4200	230	1.8	20000	6.0	370	6.5	< 0.8	< 0.7	*0.5*	130	1700	0.30	0.87	25	3.6	46
2010-HR-116	0.73	83000	< 0.5	550	0.83	< 0.09	16000	0.26	6.1	140	12	20000	20000	6	3900	230	0.4	21000	6.7	320	7.0	< 0.8	< 0.7	1.1	150	1200	0.26	0.99	20	4.9	38
2010-HR-117	0.46	74000	1.6	260	0.57	< 0.09	42000	0.19	26	140	130	64000	8600	11	19000	940	1.0	19000	40	420	2.6	< 0.8	< 0.7	1.0	170	5700	0.06	0.50	170	17	74
2010-HR-118	0.20	81000	< 0.5	420	0.79	< 0.09	26000	0.04	7.3	190	4.7	19000	14000	9	8300	320	0.4	25000	24	270	3.6	< 0.8	< 0.7	0.7	440	1400	0.18	0.36	26	3.1	35
2010-HR-123	0.26	73000	< 0.5	320	0.61	< 0.09	24000	0.08	2.2	140	3.7	10000	13000	3	2400	220	0.4	26000	4.0	140	2.8	< 0.8	< 0.7	1.0	110	690	0.17	0.77	7	5.0	18
Minimum	*0.2*	*64000*	*< 0.5*	*200*	*0.43*	*< 0.09*	*11000*	*0.04*	*2.1*	*110*	*3.3*	*10000*	*8600*	*< 2*	*1600*	*130*	*0.3*	*14000*	*1.8*	*130*	*2.5*	*< 0.8*	*< 0.7*	*0.5*	*110*	*490*	*0.06*	*0.36*	*5*	*3.1*	*18*
Maximum	*1.2*	*93000*	*1.6*	*730*	*0.98*	*0.72*	*42000*	*0.33*	*26*	*240*	*130*	*64000*	*24000*	*26*	*19000*	*940*	*3.8*	*28000*	*40*	*1000*	*20*	*< 0.8*	*0.9*	*15*	*440*	*5700*	*0.36*	*1.7*	*170*	*17*	*74*
Average	*0.45*	*79129*	*0.61*	*390*	*0.75*	*0.11*	*21226*	*0.22*	*6.1*	*165*	*16*	*21387*	*18858*	*7.5*	*5058*	*301*	*0.76*	*22581*	*8.3*	*392*	*6.4*	*< 0.8*	*0.71*	*2.7*	*155*	*1433*	*0.24*	*1.0*	*29*	*6.6*	*43*

Sample ID	Ag	Al	As	Ba	Be	Bi	Ca	Cd	Co	Cr	Cu	Fe	K	Li	Mg	Mn	Mo	Na	Ni	P	Pb	Sb	Se	Sn	Sr	Ti	Tl	U	V	Y	Zn
	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g
TONALITE n=30																															
2010-HR-001	0.29	80000	1.9	230	0.78	< 0.09	20000	0.22	5.4	270	9.0	19000	10000	7	4400	290	0.5	26000	6.3	320	6.1	< 0.8	< 0.7	1.5	190	1700	0.10	1.4	27	9.2	21
2010-HR-005	0.32	78000	1.5	630	0.61	< 0.09	16000	0.18	3.5	240	9.0	15000	19000	5	3000	250	0.2	25000	24	210	9.4	< 0.8	< 0.7	1.4	160	1100	0.21	1.7	14	6.1	34
2010-HR-014	0.47	85000	< 0.5	500	0.77	< 0.09	21000	0.19	6.3	140	42	25000	19000	6	5400	350	0.4	22000	7.4	580	8.4	< 0.8	< 0.7	2.0	260	2400	0.28	1.5	41	11	52
2010-HR-016	0.23	77000	0.6	490	0.68	< 0.09	21000	0.12	7.2	170	10	24000	19000	6	5100	290	0.5	23000	6.8	670	5.3	< 0.8	< 0.7	1.7	160	2200	0.25	1.3	44	8.2	43
2010-HR-018	0.34	78000	< 0.5	700	0.57	< 0.09	20000	0.15	5.6	140	12	21000	22000	6	4900	340	0.3	23000	6.8	410	7.6	< 0.8	< 0.7	1.9	300	1700	0.25	1.1	30	8.5	48
2010-HR-020	0.55	81000	1.0	430	0.71	< 0.09	25000	0.20	8.2	190	28	31000	14000	7	6700	440	0.8	24000	8.9	1100	7.7	< 0.8	< 0.7	2.4	370	2200	0.17	1.5	46	16	59
2010-HR-022	0.32	75000	< 0.5	350	0.68	< 0.09	19000	0.15	5.3	140	18	20000	15000	8	4500	270	0.4	23000	6.0	420	8.5	< 0.8	< 0.7	1.4	240	1700	0.17	1.1	26	6.8	44
2010-HR-025	63	76000	2.4	520	0.65	< 0.09	16000	0.19	4.2	240	9.2	18000	17000	7	3400	270	0.5	25000	6.4	360	7.5	< 0.8	1.0	1.6	180	1300	0.17	1.5	16	7.5	38
2010-HR-027	1.2	81000	< 0.5	420	0.72	< 0.09	23000	0.18	8.7	110	38	35000	20000	8	5400	430	0.3	24000	9.1	920	7.9	< 0.8	< 0.7	2.2	210	1000	0.25	1.2	46	10	55
2010-HR-030	0.39	76000	1.6	500	0.87	< 0.09	14000	0.23	3.7	240	3.7	18000	18000	8	3300	300	1.2	25000	6.2	220	12	< 0.8	< 0.7	2.2	160	1300	0.22	1.8	14	8.3	41
2010-HR-032	0.23	83000	1.5	610	0.50	< 0.09	22000	0.10	7.4	220	9.7	28000	18000	6	5800	310	0.6	24000	6.4	710	6.7	< 0.8	< 0.7	1.6	190	2700	0.21	0.71	42	9.2	48
2010-HR-034	0.32	81000	1.8	410	0.62	< 0.09	22000	0.20	7.5	150	8.0	23000	15000	6	6100	320	0.4	24000	10	290	6.4	< 0.8	< 0.7	1.6	190	2100	0.20	1.4	36	8.2	43
2010-HR-037	0.38	80000	< 0.5	370	0.60	< 0.09	22000	0.20	7.7	120	9.0	26000	15000	6	5600	290	0.6	24000	7.4	620	5.2	< 0.8	< 0.7	1.8	170	2300	0.23	1.2	40	8.5	53
2010-HR-038	0.33	85000	0.7	380	0.64	< 0.09	27000	0.16	14	130	42	36000	14000	12	8500	430	0.4	23000	9.3	1000	5.0	< 0.8	< 0.7	1.9	230	3500	0.23	0.98	65	12	68
2010-HR-039	0.22	79000	< 0.5	400	0.77	< 0.09	19000	0.10	5.5	200	12	20000	14000	6	4600	310	0.3	26000	8.9	320	4.9	< 0.8	< 0.7	1.5	270	1500	0.17	1.1	31	8.8	36
2010-HR-051	0.39	84000	0.7	570	0.79	< 0.09	22000	0.21	5.6	190	33	19000	19000	6	4400	290	3.9	24000	12	310	12	< 0.8	< 0.7	1.9	200	1500	0.24	2.1	21	7.9	41
2010-HR-052	0.43	79000	< 0.5	390	0.63	< 0.09	25000	0.24	7.7	140	11	26000	18000	8	6200	370	0.4	22000	9.9	530	5.7	< 0.8	< 0.7	1.6	170	2700	0.25	1.00	39	9.6	54
2010-HR-054	0.13	75000	< 0.5	530	0.64	0.14	28000	0.14	14	130	35	32000	15000	15	14000	500	0.2	23000	39	680	2.6	< 0.8	< 0.7	3.2	280	2700	0.22	0.48	62	8.3	61
2010-HR-056	0.37	80000	< 0.5	410	0.75	0.10	34000	0.29	13	100	44	35000	25000	16	11000	570	0.4	16000	16	520	6.2	< 0.8	< 0.7	4.5	140	2800	0.36	0.97	75	11	74
2010-HR-073	0.60	92000	< 0.5	560	0.63	< 0.09	20000	0.29	5.8	180	24	27000	16000	7	5400	310	0.4	27000	6.5	400	7.9	< 0.8	< 0.7	1.5	240	2300	0.19	0.71	25	6.0	55
2010-HR-074	0.39	93000	0.6	320	0.83	< 0.09	27000	0.19	7.9	190	20	28000	16000	15	7900	420	3.4	27000	9.5	540	6.6	< 0.8	< 0.7	1.7	230	2300	0.20	0.84	39	10	58
2010-HR-077	0.90	88000	< 0.5	520	0.88	0.19	17000	0.34	7.6	180	35	27000	28000	9	5600	290	0.7	15000	5.9	580	5.5	< 0.8	< 0.7	1.7	84	1500	0.28	0.80	38	5.7	40
2010-HR-083	0.59	88000	1.7	350	0.71	< 0.09	24000	0.36	9.5	270	34	30000	21000	19	8100	370	1.1	25000	14	520	5.1	< 0.8	< 0.7	0.9	120	1700	0.21	1.2	37	6.7	60
2010-HR-097	0.59	87000	< 0.5	270	0.86	< 0.09	23000	0.28	9.9	140	40	35000	14000	16	8600	430	0.3	25000	13	1100	7.8	< 0.8	< 0.7	2.3	210	3600	0.19	1.7	48	14	82
2010-HR-099	0.49	87000	< 0.5	380	0.91	< 0.09	24000	0.29	8.3	140	33	28000	18000	14	8000	390	0.3	25000	13	600	5.9	< 0.8	< 0.7	1.9	230	2400	0.24	1.6	42	9.5	62
2010-HR-107	0.53	88000	0.8	400	0.80	< 0.09	25000	0.30	5.8	220	6.5	23000	12000	7	5100	250	0.4	25000	7.5	380	6.5	< 0.8	< 0.7	1.3	200	2100	0.19	0.98	25	5.7	43
2010-HR-109	0.53	84000	0.6	330	0.77	< 0.09	25000	0.16	7.5	210	25	25000	12000	8	7300	350	0.5	24000	14	450	5.9	< 0.8	< 0.7	1.7	170	2300	0.23	1.0	30	7.4	61
2010-HR-111	0.47	88000	< 0.5	390	0.75	< 0.09	24000	0.20	5.9	190	8.3	24000	12000	6	5200	280	0.7	25000	7.1	450	7.0	< 0.8	< 0.7	1.2	180	2200	0.19	0.71	22	7.4	61
2010-HR-119	0.62	85000	< 0.5	320	0.80	< 0.09	29000	0.32	20	250	12	43000	15000	34	24000	570	0.5	19000	110	990	4.9	< 0.8	< 0.7	1.3	150	2800	0.16	0.97	70	12	76
2010-HR-121	0.53	88000	< 0.5	500	0.87	< 0.09	34000	0.19	13	100	52	36000	21000	23	14000	500	0.2	20000	29	660	9.0	< 0.8	< 0.7	1.1	140	1700	0.25	1.1	64	8.2	70
Minimum	*0.13*	*75000*	*< 0.5*	*230*	*0.5*	*< 0.09*	*14000*	*0.1*	*3.5*	*100*	*3.7*	*15000*	*10000*	*5*	*3000*	*250*	*0.2*	*15000*	*5.9*	*210*	*2.6*	*< 0.8*	*< 0.7*	*0.9*	*84*	*1000*	*0.1*	*0.48*	*14*	*5.7*	*21*
Maximum	*63*	*93000*	*2.4*	*700*	*0.91*	*0.19*	*34000*	*0.36*	*20*	*270*	*52*	*43000*	*28000*	*34*	*24000*	*570*	*3.9*	*27000*	*110*	*1100*	*12*	*< 0.8*	*1*	*4.5*	*370*	*3600*	*0.36*	*2.1*	*75*	*16*	*82*
Average	*2.5*	*82700*	*0.85*	*439*	*0.73*	*0.10*	*22933*	*0.21*	*8.1*	*178*	*22*	*26567*	*17033*	*10*	*7050*	*359*	*0.69*	*23433*	*15*	*562*	*6.9*	*< 0.8*	*0.71*	*1.8*	*201*	*2110*	*0.22*	*1.2*	*39*	*8.9*	*53*
ALTERED GRANITOID n=8																															
2010-HR-024	0.21	75000	< 0.5	200	0.90	< 0.09	5700	0.07	0.94	210	3.7	7300	12000	< 2	700	140	0.5	34000	2.6	100	12	< 0.8	< 0.7	3.8	88	240	0.14	2.4	1	9.7	12
2010-HR-031	4.7	73000	< 0.5	310	0.61	< 0.09	18000	0.09	4.9	140	13	17000	14000	5	4600	330	0.5	26000	11	330	5.8	< 0.8	< 0.7	1.5	170	800	0.15	0.92	23	4.9	38
2010-HR-044	0.39	81000	< 0.5	470	0.72	< 0.09	23000	0.26	5.9	120	29	20000	22000	4	5000	360	1.9	20000	7.8	360	7.1	< 0.8	< 0.7	1.4	160	1300	0.30	0.83	30	3.9	47
2010-HR-046	0.52	76000	< 0.5	450	0.69	< 0.09	18000	0.23	5.5	170	15	18000	20000	5	4200	270	0.4	21000	9.2	340	6.2	< 0.8	< 0.7	1.1	160	1200	0.24	0.99	22	4.6	38
2010-HR-086	0.73	87000	< 0.5	310	0.86	0.11	20000	0.21	5.0	220	6.8	21000	20000	8	4200	280	0.6	27000	5.4	500	12	< 0.8	< 0.7	1.9	140	1500	0.18	1.6	20	7.6	48
2010-HR-092	0.25	79000	< 0.5	210	0.65	< 0.09	2800	0.07	1.7	240	9.9	7000	13000	< 2	1100	80	16	35000	5.2	60	3.2	< 0.8	< 0.7	3.6	68	170	0.13	0.84	< 1	4.5	9.9
2010-HR-093	0.40	77000	2.0	480	0.91	< 0.09	13000	0.26	6.1	140	12	18000	27000	2	5100	250	1.0	18000	11	350	3.6	< 0.8	< 0.7	2.4	52	1100	0.29	1.4	33	6.4	22
2010-HR-115	0.36	87000	< 0.5	240	0.84	< 0.09	26000	0.13	7.3	180	18	27000	14000	14	5500	330	0.4	25000	6.0	760	4.1	< 0.8	< 0.7	1.0	170	2800	0.20	0.90	35	6.5	68
Minimum	*0.21*	*73000*	*< 0.5*	*200*	*0.61*	*< 0.09*	*2800*	*0.07*	*0.94*	*120*	*3.7*	*7000*	*12000*	*< 2*	*700*	*80*	*0.4*	*18000*	*2.6*	*60*	*3.2*	*< 0.8*	*< 0.7*	*1*	*52*	*170*	*0.13*	*0.83*	*< 1*	*3.9*	*9.9*
Maximum	*4.7*	*87000*	*2*	*480*	*0.91*	*0.11*	*26000*	*0.26*	*7.3*	*240*	*29*	*27000*	*27000*	*14*	*5500*	*360*	*16*	*35000*	*11*	*760*	*12*	*< 0.8*	*< 0.7*	*3.8*	*170*	*2800*	*0.3*	*2.4*	*35*	*9.7*	*68*
Average	*0.95*	*79375*	*0.69*	*334*	*0.77*	*0.09*	*15813*	*0.17*	*4.7*	*178*	*13*	*16913*	*17750*	*5.3*	*3800*	*255*	*2.7*	*25750*	*7.3*	*350*	*6.8*	*< 0.8*	*< 0.7*	*2.1*	*126*	*1139*	*0.20*	*1.2*	*21*	*6.0*	*35*
PEGMATITE n=11																															
2010-HR-013	0.15	72000	< 0.5	300	0.60	< 0.09	13000	0.10	1.8	170	1.2	8500	17000	< 2	1400	130	0.4	26000	3.3	110	5.7	< 0.8	< 0.7	1.3	140	580	0.20	0.92	9	2.6	21
2010-HR-017	4.5	81000	0.8	310	0.57	1.2	11000	0.07	3.4	200	46	12000	23000	< 2	2700	210	3.6	30000	5.4	190	44	< 0.8	< 0.7	1.2	160	830	0.22	1.4	16	9.4	25
2010-HR-019	0.19	71000	1.0	930	0.39	< 0.09	7200	0.09	0.91	210	1.7	6200	34000	< 2	700	81	0.4	22000	3.1	57	9.0	< 0.8	< 0.7	0.9	140	230	0.29	0.88	< 1	3.5	14
2010-HR-026	0.20	67000	< 0.5	240	0.44	< 0.09	6700	0.02	1.6	270	4.5	10000	9100	< 2	600	77	1.0	31000	4.9	48	3.6	< 0.8	0.8	1.0	160	160	0.06	0.83	7	1.9	6.8
2010-HR-042	0.23	73000	0.6	250	0.56	< 0.09	12000	0.13	6.7	240	4.7	17000	11000	7	7100	220	1.7	30000	31	290	4.3	< 0.8	< 0.7	1.5	180	540	0.10	1.1	20	3.9	34
2010-HR-055	0.05	80000	< 0.5	690	0.56	< 0.09	15000	0.06	0.70	200	9.2	5100	19000	< 2	500	80	0.6	25000	2.8	25	11	< 0.8	< 0.7	3.2	140	100	0.18	2.1	< 1	3.9	5.9
2010-HR-057	0.28	78000	1.0	340	0.76	< 0.09	16000	0.23	4.6	230	17	17000	14000	7	3400	250	0.9	25000	5.6	350	6.9	< 0.8	< 0.7	2.1	160	1500	0.19	1.6	17	6.3	34
2010-HR-063	1.9	72000	< 0.5	370	0.66	0.10	20000	0.29	5.8	120	10	20000	22000	3	4700	270	0.2	18000	5.3	440	9.1	< 0.8	< 0.7	4.5	140	1400	0.26	0.65	31	4.4	43
2010-HR-065	0.54	70000	0.6	370	0.68	< 0.09	26000	0.21	10	190	7.8	24000	23000	4	11000	420	1.8	16000	29	340	7.4	< 0.8	< 0.7	7.7	150	1000	0.27	1.1	33	4.3	43
2010-HR-105	0.12	74000	< 0.5	120	0.82	< 0.09	18000	0.06	0.79	190	5.3	4000	11000	3	600	82	0.5	28000	3.2	24	5.9	< 0.8	< 0.7	1.8	150	100	0.11	0.78	< 1	12	3.2
2010-HR-108	0.44	84000	< 0.5	260	0.93	< 0.09	17000	0.26	5.6	180	10	23000	18000	7	5500	320	0.5	25000	7.9	960	7.8	< 0.8	< 0.7	1.4	120	2100	0.21	1.3	21	13	47
Minimum	*0.05*	*67000*	*< 0.5*	*120*	*0.39*	*< 0.09*	*6700*	*0.02*	*0.7*	*120*	*1.2*	*4000*	*9100*	*< 2*	*500*	*77*	*0.2*	*16000*	*2.8*	*24*	*3.6*	*< 0.8*	*< 0.7*	*0.9*	*120*	*100*	*0.06*	*0.65*	*< 1*	*1.9*	*3.2*
Maximum	*4.5*	*84000*	*1*	*930*	*0.93*	*1.2*	*26000*	*0.29*	*10*	*270*	*46*	*24000*	*34000*	*7*	*11000*	*420*	*3.6*	*31000*	*31*	*960*	*44*	*< 0.8*	*0.8*	*7.7*	*180*	*2100*	*0.29*	*2.1*	*33*	*13*	*47*
Average	*0.78*	*74727*	*0.64*	*380*	*0.63*	*0.19*	*14718*	*0.14*	*3.8*	*200*	*11*	*13345*	*18282*	*3.7*	*3473*	*195*	*1.1*	*25091*	*9.2*	*258*	*10*	*< 0.8*	*0.71*	*2.4*	*149*	*776*	*0.19*	*1.2*	*14*	*5.9*	*25*

Sample ID	Ag µg/g	Al µg/g	As µg/g	Ba µg/g	Be µg/g	Bi µg/g	Ca µg/g	Cd µg/g	Co µg/g	Cr µg/g	Cu µg/g	Fe µg/g	K µg/g	Li µg/g	Mg µg/g	Mn µg/g	Mo µg/g	Na µg/g	Ni µg/g	P µg/g	Pb µg/g	Sb µg/g	Se µg/g	Sn µg/g	Sr µg/g	Ti µg/g	Tl µg/g	U µg/g	V µg/g	Y µg/g	Zn µg/g
MAFIC DYKE n=9																															
2010-HR-002	0.15	32000	1.2	3.1	0.23	< 0.09	63000	0.18	54	720	64	80000	65	44	36000	1300	0.3	4700	260	340	5.6	< 0.8	< 0.7	1.0	170	5400	*0.02*	0.12	220	10	97
2010-HR-069	0.12	35000	0.6	7.0	0.30	< 0.09	61000	0.17	53	560	110	81000	120	39	33000	1300	0.2	5000	200	390	3.6	< 0.8	< 0.7	1.0	200	7000	*0.02*	0.062	240	12	80
2010-HR-015	3.4	35000	1.4	48	0.54	< 0.09	69000	0.19	32	660	57	44000	630	30	36000	990	0.2	13000	210	1100	7.9	< 0.8	< 0.7	1.4	350	3000	*0.02*	1.0	91	10	94
2010-HR-047	0.35	75000	< 0.5	440	0.65	< 0.09	27000	0.16	9.3	120	15	27000	22000	7	8400	440	0.1	16000	18	480	4.5	< 0.8	< 0.7	1.0	150	1600	0.28	0.72	44	4.6	53
2010-HR-053	0.19	73000	< 0.5	510	0.65	< 0.09	16000	0.09	5.1	160	22	16000	14000	5	4400	240	0.3	24000	13	270	6.5	< 0.8	< 0.7	1.3	280	1300	0.17	0.95	20	6.0	31
2010-HR-061	0.34	77000	< 0.5	520	0.70	< 0.09	15000	0.28	4.9	140	3.8	19000	23000	5	3900	240	0.2	18000	6.0	330	5.0	< 0.8	< 0.7	2.4	130	1200	0.31	3.0	27	4.7	46
2010-HR-071	0.42	34000	0.5	21	0.59	< 0.09	60000	0.27	42	760	25	63000	440	63	52000	850	0.2	2500	290	1500	6.0	0.9	< 0.7	1.8	220	800	*0.02*	0.74	110	8.7	120
2010-HR-100	0.55	54000	0.8	78	0.46	< 0.09	61000	0.45	36	310	7.6	59000	3800	71	39000	970	0.6	8800	250	1300	11	< 0.8	< 0.7	1.1	200	2700	*0.02*	1.2	100	14	160
2010-HR-110	1.8	83000	< 0.5	470	0.85	0.17	21000	0.20	6.2	150	21	24000	21000	13	4600	260	0.6	22000	5.9	470	8.6	< 0.8	< 0.7	1.1	98	2000	0.37	0.91	25	7.0	52
Minimum	*0.12*	*32000*	*< 0.5*	*3.1*	*0.23*	*< 0.09*	*15000*	*0.09*	*4.9*	*120*	*3.8*	*16000*	*65*	*5*	*3900*	*240*	*0.1*	*2500*	*5.9*	*270*	*3.6*	*< 0.8*	*< 0.7*	*1*	*98*	*800*	*0.02*	*0.062*	*20*	*4.6*	*31*
Maximum	*3.4*	*83000*	*1.4*	*520*	*0.85*	*0.17*	*69000*	*0.45*	*54*	*760*	*110*	*81000*	*23000*	*71*	*52000*	*1300*	*0.6*	*24000*	*290*	*1500*	*11*	*0.9*	*< 0.7*	*2.4*	*350*	*7000*	*0.37*	*3*	*240*	*14*	*160*
Average	*0.81*	*55333*	*0.72*	*233*	*0.55*	*0.10*	*43667*	*0.22*	*26.9*	*398*	*36*	*45889*	*9451*	*31*	*24144*	*732*	*0.3*	*12667*	*139*	*687*	*7*	*0.81*	*< 0.7*	*1.3*	*200*	*2778*	*0.14*	*1.0*	*97*	*8.6*	*81*
CHLORITIC GRANITE PORPHYRY n=5																															
2010-HR-067	0.19	76000	< 0.5	450	0.77	< 0.09	21000	0.14	5.3	170	5.8	19000	25000	< 2	6600	290	0.5	18000	15	390	4.6	< 0.8	< 0.7	16	140	1200	0.27	1.1	29	4.6	33
2010-HR-075	0.40	84000	< 0.5	410	0.82	0.14	27000	0.23	5.6	180	32	21000	18000	10	5400	350	0.8	25000	8.0	400	9.2	< 0.8	< 0.7	1.6	130	1400	0.19	1.6	27	7.6	42
2010-HR-088	0.34	78000	< 0.5	390	0.81	0.17	35000	0.25	13	140	19	33000	22000	12	13000	600	0.4	19000	34	490	9.6	1.1	< 0.7	2.3	170	2000	0.32	1.4	66	9.8	80
2010-HR-090	0.35	80000	< 0.5	420	0.80	< 0.09	27000	0.19	9.7	160	28	28000	21000	10	8000	440	0.3	21000	14	510	7.3	< 0.8	< 0.7	2.3	180	2000	0.25	0.81	44	4.8	62
2010-HR-120	0.58	88000	< 0.5	380	0.86	< 0.09	31000	0.22	11	130	24	33000	19000	16	11000	460	0.3	20000	20	670	6.3	< 0.8	< 0.7	1.5	130	2900	0.30	2.2	60	21	71
Minimum	*0.19*	*76000*	*< 0.5*	*380*	*0.77*	*< 0.09*	*21000*	*0.14*	*5.3*	*130*	*5.8*	*19000*	*18000*	*< 2*	*5400*	*290*	*0.3*	*18000*	*8*	*390*	*4.6*	*< 0.8*	*< 0.7*	*1.5*	*130*	*1200*	*0.19*	*0.81*	*27*	*4.6*	*33*
Maximum	*0.58*	*88000*	*< 0.5*	*450*	*0.86*	*0.17*	*35000*	*0.25*	*13*	*180*	*32*	*33000*	*25000*	*16*	*13000*	*600*	*0.8*	*25000*	*34*	*670*	*9.6*	*1.1*	*< 0.7*	*16*	*180*	*2900*	*0.32*	*2.2*	*66*	*21*	*80*
Average	*0.37*	*81200*	*< 0.5*	*410*	*0.81*	*0.12*	*28200*	*0.21*	*8.9*	*156*	*22*	*26800*	*21000*	*10*	*8800*	*428*	*0.46*	*20600*	*18*	*492*	*7.4*	*0.86*	*< 0.7*	*4.7*	*150*	*1900*	*0.27*	*1.4*	*45*	*9.6*	*58*
MINOR UNITS																															
Aplite n=1																															
2010-HR-009	0.23	77000	< 0.5	370	0.70	< 0.09	15000	0.15	2.7	180	9.1	13000	17000	3	3100	200	3.5	26000	2.8	240	5.7	< 0.8	< 0.7	1.2	180	770	0.24	1.0	13	5.9	29
Diorite n=2																															
2010-HR-029	0.48	80000	2.0	420	0.67	< 0.09	19000	0.32	5.1	220	1.5	19000	17000	9	4500	220	0.5	24000	8.0	270	9.7	< 0.8	< 0.7	1.6	160	1500	0.20	1.2	15	7.8	33
2010-HR-033	0.22	88000	2.5	240	0.57	< 0.09	35000	0.12	15	150	28	42000	10000	10	11000	470	3.3	24000	10	1400	5.2	< 0.8	< 0.7	1.8	210	5200	0.15	0.77	95	12	72
Gneiss n=1																															
2010-HR-028	0.35	78000	1.0	370	0.63	< 0.09	26000	0.18	9.2	180	30	29000	14000	12	8600	470	3.5	24000	18	610	9.3	< 0.8	< 0.7	2.4	200	2500	0.21	1.2	49	12	60
Sheared mafic unit n=2																															
2010-HR-102	0.60	46000	0.8	100	0.77	< 0.09	49000	0.35	35	300	27	55000	2700	57	38000	930	0.1	15000	170	1500	7.9	< 0.8	< 0.7	0.9	260	2100	< 0.02	1.1	120	9.7	99
2010-HR-113	0.33	57000	< 0.5	90	0.44	< 0.09	41000	0.13	38	880	80	45000	3900	25	45000	690	0.3	15000	340	240	7.4	< 0.8	< 0.7	0.5	170	1700	0.02	1.0	94	5.6	54
Sheared granitoid n=1																															
2010-HR-122	0.41	92000	< 0.5	330	0.65	< 0.09	37000	0.14	15	150	35	42000	11000	13	13000	570	0.3	22000	26	410	6.1	< 0.8	< 0.7	1.0	210	3800	0.16	0.90	80	11	65
Tectonized-sheared vein zone n=4																															
2010-HR-021	0.79	53000	< 0.5	360	0.54	0.25	12000	0.09	4.5	330	6.8	15000	16000	3	2500	200	2.7	15000	6.7	230	4.3	< 0.8	< 0.7	1.3	110	910	0.22	0.77	16	4.7	25
2010-HR-048	0.51	76000	1.0	380	0.62	< 0.09	27000	0.28	8.4	130	21	28000	21000	8	7200	390	0.3	17000	13	490	5.4	< 0.8	< 0.7	1.7	160	1900	0.26	0.87	41	7.3	60
2010-HR-050	0.45	77000	< 0.5	520	0.64	< 0.09	18000	0.27	3.4	150	7.6	16000	16000	4	2900	250	0.3	24000	4.1	340	4.2	< 0.8	< 0.7	1.4	150	1100	0.24	0.91	14	6.0	33
2010-HR-078	0.83	93000	0.7	430	0.86	< 0.09	9000	0.37	6.7	220	20	25000	21000	11	5400	180	2.5	26000	5.6	480	4.7	< 0.8	< 0.7	1.7	130	1400	0.19	0.92	19	7.6	41
Quartz vein zone n=1																															
2010-HR-035	0.73	25000	0.8	160	0.20	0.23	5600	0.03	6.0	440	8.0	12000	7900	< 2	1200	91	2.4	7300	8.3	110	3.4	< 0.8	< 0.7	0.7	45	400	0.09	0.64	10	2.4	9.1
Intermediate dyke n=1																															
2010-HR-059	0.26	76000	< 0.5	550	0.62	< 0.09	20000	0.26	4.5	160	4.6	19000	21000	6	3900	280	3.1	20000	3.9	400	3.8	< 0.8	< 0.7	4.4	150	1200	0.30	0.58	23	4.3	36
Minimum	*0.22*	*25000*	*< 0.5*	*90*	*0.2*	*< 0.09*	*5600*	*0.03*	*2.7*	*130*	*1.5*	*12000*	*2700*	*< 2*	*1200*	*91*	*0.1*	*7300*	*2.8*	*110*	*3.4*	*< 0.8*	*< 0.7*	*0.5*	*45*	*400*	*< 0.02*	*0.58*	*10*	*2.4*	*9.1*
Maximum	*0.83*	*93000*	*2.5*	*550*	*0.86*	*0.25*	*49000*	*0.37*	*38*	*880*	*80*	*55000*	*21000*	*57*	*45000*	*930*	*3.5*	*26000*	*340*	*1500*	*9.7*	*< 0.8*	*< 0.7*	*4.4*	*260*	*5200*	*0.3*	*1.2*	*120*	*12.0*	*99*
Average	*0.48*	*70615*	*0.91*	*332*	*0.61*	*0.11*	*24123*	*0.21*	*12*	*268*	*21*	*27692*	*13731*	*13*	*11254*	*380*	*1.8*	*19946*	*47*	*517*	*5.9*	*< 0.8*	*< 0.7*	*1.6*	*164*	*1883*	*0.18*	*0.91*	*45*	*7.4*	*47*
TAILINGS n=1																															
SGS Lakefield	0.22	65000	2.5	430	0.80	0.45	24000	0.33	7	65	30	24000	24000	5	6500	370	3.6	18000	27	450	7.6	< 0.8	< 0.7	1.8	130	1300	0.29	1.3	35	5.2	46
Lakehead	< 0.5	---	5.3	505	---	0.39	---	< 0.5	9	70	39	---	---	---	---	---	5.0	---	38	---	7.0	0.2	0.5	3.6	148	---	< 0.5	1.3	43	12.5	64

(1) Typical crustal abundance for continental rocks taken from Price (1997).

>1 x
>5 x
>10 x

Acid Base Accounting (ABA) and Net Acid Generation (NAG) Results

Sample ID	Paste pH	NP	AP	Net NP	NPR	Total Sulphur	Sulphate-S	Sulphide-S	Total Carbon	Carbonate (CO_3)	Carbonate NP	CaNPR	NAG pH
	s.u.	*t $CaCO_3$/1000 t*	*t $CaCO_3$/1000 t*	*t $CaCO_3$/1000 t*	*ratio*	*%*	*%*	*%*	*%*	*%*	*t $CaCO_3$/1000 t*	*ratio*	*s.u.*
FINE GRAINED GRANITE n=16													
2010-HR-003	9.86	43.9	0.31	43.6	142	0.006	< 0.01	< 0.01	0.480	2.01	33	108	10.78
2010-HR-006	9.71	32.4	0.31	32.1	105	*0.005*	< 0.01	< 0.01	0.297	1.16	19	62	10.16
2010-HR-011	9.69	48.3	0.31	48.0	156	0.009	< 0.01	< 0.01	0.558	2.29	38	123	10.86
2010-HR-023	9.57	43.6	0.31	43.3	141	0.005	< 0.01	< 0.01	0.502	2.21	37	118	11.02
2010-HR-043	9.84	22.9	0.31	22.6	73.9	0.018	0.02	< 0.01	0.230	0.945	16	51	9.01
2010-HR-004	9.55	106	2.27	104	46.9	0.110	0.04	0.07	1.51	6.24	104	46	11.15
2010-HR-070	9.60	67.3	0.62	66.7	109	0.033	0.01	0.02	0.925	4.15	69	111	11.19
2010-HR-081	9.63	63.7	0.31	63.4	205	0.023	0.02	< 0.01	0.770	3.42	57	183	11.12
2010-HR-082	9.56	54.6	0.31	54.3	176	0.022	0.02	< 0.01	0.643	2.85	47	153	11.12
2010-HR-084	9.47	63.6	0.31	63.3	205	0.045	0.04	< 0.01	0.838	3.90	65	209	10.93
2010-HR-094	9.11	235	1.25	234	188	0.068	0.03	0.04	4.02	15.0	249	199	9.54
2010-HR-095	9.03	242	1.56	241	155	0.089	0.04	0.05	3.88	15.2	252	162	9.14
2010-HR-096	9.68	45.5	0.31	45.2	147	0.012	0.01	< 0.01	0.536	2.41	40	129	10.95
2010-HR-098	9.63	29.9	0.31	29.6	96.5	0.025	0.02	< 0.01	0.315	1.33	22	71	10.78
2010-HR-103	9.43	49.9	0.31	49.6	161	0.019	0.02	< 0.01	0.596	2.67	44	143	10.95
2010-HR-104	9.48	56.4	0.31	56.1	182	*0.005*	< 0.01	< 0.01	0.687	3.20	53	171	10.98
Minimum	*9.03*	*22.9*	*0.31*	*22.6*	*47*	*0.005*	*< 0.01*	*< 0.01*	*0.23*	*0.945*	*16*	*46*	*9.01*
Maximum	*9.86*	*242*	*2.27*	*241*	*205*	*0.11*	*0.04*	*0.07*	*4.02*	*15.2*	*252*	*209*	*11.19*
Average	*9.5*	*75*	*0.59*	*75*	*143*	*0.03*	*0.02*	*0.02*	*1.0*	*4.3*	*72*	*127*	*11*
CHLORITIC GRANITE n=31													
2010-HR-007	9.78	37.8	0.62	37.2	61.0	0.028	< 0.01	0.02	0.409	1.57	26	42	10.72
2010-HR-008	9.76	31.0	0.31	30.7	100.0	0.025	0.01	0.01	0.356	1.48	25	79	10.74
2010-HR-010	9.73	40.2	0.31	39.9	130	0.012	0.01	< 0.01	0.456	1.97	33	105	10.85
2010-HR-012	9.67	55.9	0.94	55.0	59.5	0.046	0.01	0.03	0.669	3.03	50	54	10.82
2010-HR-036	9.47	66.4	0.31	66.1	214	0.019	0.02	< 0.01	0.754	3.30	55	177	11.16
2010-HR-040	9.63	51.8	0.31	51.5	167	0.006	< 0.01	< 0.01	0.577	2.50	42	134	11.09
2010-HR-041	9.80	41.1	0.31	40.8	133	*0.005*	< 0.01	< 0.01	0.472	1.97	33	105	11.10
2010-HR-045	9.80	32.4	0.31	32.1	105	0.018	0.02	< 0.01	0.372	1.49	25	80	11.07
2010-HR-049	9.32	41.7	0.31	41.4	135	*0.005*	< 0.01	< 0.01	0.489	2.03	34	109	11.08
2010-HR-058	9.38	22.1	0.31	21.8	71.3	0.014	0.01	< 0.01	0.236	0.997	17	53	10.16
2010-HR-060	9.69	55.7	0.31	55.4	180	0.020	0.02	< 0.01	0.736	2.80	46	150	11.17
2010-HR-062	9.69	51.1	0.94	50.2	54.4	0.050	0.02	0.03	0.639	2.67	44	47	11.16
2010-HR-064	9.61	59.0	1.25	57.8	47.2	0.061	0.02	0.04	0.739	3.11	52	41	11.19
2010-HR-066	9.49	125	3.40	122	36.8	0.148	0.04	0.11	1.66	7.21	120	35	11.28
2010-HR-068	9.73	52.7	0.31	52.4	170	0.023	0.01	0.01	0.704	3.26	54	175	11.16
2010-HR-072	9.60	44.7	0.31	44.4	144	*0.005*	< 0.01	< 0.01	0.526	2.30	38	123	11.20
2010-HR-076	9.60	102	0.31	102	330	0.006	< 0.01	< 0.01	1.25	5.71	95	306	11.22
2010-HR-079	9.61	44.8	0.31	44.5	145	0.035	0.02	0.01	0.515	2.23	37	119	10.99
2010-HR-080	9.61	42.9	0.31	42.6	138	0.025	0.03	< 0.01	0.534	2.43	40	130	11.04
2010-HR-085	9.42	69.2	0.31	68.9	223	0.025	0.03	< 0.01	0.898	4.04	67	216	11.18
2010-HR-087	9.54	53.9	0.31	53.6	174	0.041	0.03	0.01	0.751	3.40	56	182	11.03
2010-HR-089	9.60	65.3	0.31	65.0	211	0.011	0.01	< 0.01	0.811	3.87	64	207	11.05
2010-HR-091	9.70	47.2	4.51	42.7	10.5	0.196	0.05	0.14	0.603	2.67	44	10	11.04
2010-HR-101	9.61	61.3	0.94	60.4	65.2	0.052	0.03	0.03	0.735	3.25	54	57	11.06
2010-HR-106	9.47	65.8	0.31	65.5	212	*0.005*	< 0.01	< 0.01	0.805	3.66	61	196	10.99
2010-HR-112	9.54	43.3	0.31	43.0	140	0.007	< 0.01	< 0.01	0.536	2.36	39	126	10.94
2010-HR-114	9.46	55.4	0.31	55.1	179	0.032	0.03	< 0.01	0.730	3.14	52	168	11.04
2010-HR-116	9.68	45.0	3.72	41.3	12.1	0.192	0.07	0.12	0.557	2.41	40	11	10.98
2010-HR-117	9.66	50.6	0.31	50.3	163	0.012	0.01	< 0.01	0.597	2.68	44	144	11.07
2010-HR-118	9.13	71.8	0.31	71.5	232	0.010	0.01	< 0.01	0.826	3.92	65	210	11.15
2010-HR-123	9.68	47.1	0.31	46.8	152	0.026	0.03	< 0.01	0.556	2.41	40	129	11.09
Minimum	*9.13*	*22.1*	*0.31*	*21.8*	*10.5*	*0.005*	*< 0.01*	*< 0.01*	*0.236*	*0.997*	*17*	*9.8*	*10.16*
Maximum	*9.8*	*125*	*4.51*	*122*	*330*	*0.196*	*0.07*	*0.14*	*1.66*	*7.21*	*120*	*306*	*11.28*
Average	*9.6*	*54*	*0.76*	*53*	*135.3*	*0.04*	*0.02*	*0.02*	*0.7*	*2.9*	*48*	*120*	*11*
TONALITE n=30													
2010-HR-001	10.23	11.9	0.31	11.6	38.4	0.005	< 0.01	< 0.01	0.060	0.151	3	8.1	7.44
2010-HR-005	9.86	14.3	0.31	14.0	46.1	*0.005*	< 0.01	< 0.01	0.124	0.403	7	22	7.83
2010-HR-014	9.57	15.8	0.31	15.5	51.0	0.009	< 0.01	< 0.01	0.129	0.539	9	29	8.01
2010-HR-016	9.66	27.0	0.62	26.4	43.5	0.022	< 0.01	0.02	0.256	1.01	17	27	8.73
2010-HR-018	9.69	28.6	0.31	28.3	92.3	0.010	0.01	< 0.01	0.300	1.31	22	70	10.72
2010-HR-020	9.50	19.0	1.56	17.4	12.2	0.088	0.03	0.05	0.126	0.337	6	3.6	8.10
2010-HR-022	9.47	32.1	0.31	31.8	104	0.012	0.01	< 0.01	0.352	1.54	26	82	10.72
2010-HR-025	9.59	21.8	0.31	21.5	70.3	0.006	< 0.01	< 0.01	0.202	0.723	12	39	8.80
2010-HR-027	9.39	62.5	10.0	52.5	6.24	0.375	0.05	0.32	0.730	3.29	55	5.5	10.96
2010-HR-030	9.90	26.6	0.31	26.3	85.8	0.018	0.02	< 0.01	0.257	0.956	16	51	9.83
2010-HR-032	9.85	15.7	0.31	15.4	50.6	0.010	< 0.01	< 0.01	0.103	0.329	5	18	7.97
2010-HR-034	9.71	8.3	0.31	7.99	26.8	*0.005*	< 0.01	< 0.01	0.052	0.153	3	8.2	7.20
2010-HR-037	9.69	24.4	0.31	24.1	78.7	0.011	0.01	< 0.01	0.241	1.09	18	58	10.20
2010-HR-038	9.69	33.9	2.50	31.4	13.6	0.130	0.05	0.08	0.326	1.20	20	8.0	10.82
2010-HR-039	9.77	31.0	0.31	30.7	100	0.016	0.02	< 0.01	0.342	1.42	24	76	10.96
2010-HR-051	9.56	42.3	0.31	42.0	136.5	0.040	0.03	0.01	0.485	1.97	33	105	11.08
2010-HR-052	9.56	51.1	0.31	50.8	165	0.018	0.02	< 0.01	0.594	2.57	43	138	11.15
2010-HR-054	9.44	76.9	0.31	76.6	248	0.045	0.05	< 0.01	0.893	3.97	66	213	11.31
2010-HR-056	9.40	98.6	2.50	96.1	39.4	0.174	0.10	0.08	1.19	5.13	85	34	11.34
2010-HR-073	9.82	15.0	0.31	14.7	48.4	*0.005*	< 0.01	< 0.01	0.138	0.574	10	31	8.30
2010-HR-074	9.58	44.6	0.31	44.3	144	0.008	< 0.01	< 0.01	0.548	2.11	35	113	11.12
2010-HR-077	9.41	44.0	2.19	41.8	20.1	0.114	0.05	0.07	0.526	2.16	36	16	11.01
2010-HR-083	9.22	59.0	0.31	58.7	190	0.008	< 0.01	< 0.01	0.688	3.04	50	163	11.10
2010-HR-097	9.53	26.7	0.62	26.1	43.1	0.048	0.03	0.02	0.250	1.03	17	28	8.94
2010-HR-099	9.63	45.8	0.94	44.9	48.7	0.092	0.06	0.03	0.520	2.25	37	40	11.10
2010-HR-107	9.51	10.1	0.31	9.79	32.6	*0.005*	< 0.01	< 0.01	0.057	0.190	3	10	7.39
2010-HR-109	9.52	13.3	0.31	13.0	42.9	*0.005*	< 0.01	< 0.01	0.093	0.327	5	18	7.91
2010-HR-111	9.57	12.1	0.31	11.8	39.0	*0.005*	< 0.01	< 0.01	0.087	0.277	5	15	7.67
2010-HR-119	9.69	50.8	0.31	50.5	164	0.006	< 0.01	< 0.01	0.575	2.61	43	140	11.09
2010-HR-121	9.65	28.7	0.31	28.4	92.6	0.024	0.02	< 0.01	0.280	1.27	21	68	10.15
Minimum	*9.22*	*8.3*	*0.31*	*7.99*	*6.24*	*0.005*	*< 0.01*	*< 0.01*	*0.052*	*0.151*	*3*	*3.6*	*7.2*
Maximum	*10.23*	*98.6*	*10*	*96.1*	*248*	*0.375*	*0.1*	*0.32*	*1.19*	*5.13*	*85*	*213*	*11.34*
Average	*9.6*	*33*	*0.93*	*32*	*76*	*0.04*	*0.02*	*0.03*	*0.35*	*1.5*	*24*	*55*	*10*

Sample ID	Paste pH *s.u.*	NP *t $CaCO_3$/1000 t*	AP *t $CaCO_3$/1000 t*	Net NP *t $CaCO_3$/1000 t*	NPR *ratio*	Total Sulphur *%*	Sulphate-S *%*	Sulphide-S *%*	Total Carbon *%*	Carbonate (CO_3) *%*	Carbonate NP *t $CaCO_3$/1000 t*	CaNPR *ratio*	NAG pH *s.u.*
ALTERED GRANITOID n=8													
2010-HR-024	9.82	17.6	0.31	17.3	56.8	0.034	0.02	0.01	0.172	0.540	9	29	10.38
2010-HR-031	9.65	55.8	0.31	55.5	180	0.019	0.02	< 0.01	0.741	3.35	56	179	10.98
2010-HR-044	9.56	73.4	0.31	73.1	237	0.017	0.02	< 0.01	1.01	4.71	78	252	11.00
2010-HR-046	9.41	55.4	0.62	54.8	89.4	0.056	0.03	0.02	0.694	2.85	47	76	10.99
2010-HR-086	9.61	52.5	0.62	51.9	84.7	0.068	0.05	0.02	0.681	2.80	46	75	11.02
2010-HR-092	10.02	11.7	0.62	11.1	18.9	0.057	0.03	0.02	0.124	0.301	5	8.1	7.91
2010-HR-093	9.57	49.7	0.31	49.4	160	0.030	0.03	< 0.01	0.769	3.18	53	170	10.57
2010-HR-115	9.79	42.2	0.31	41.9	136	0.020	0.02	< 0.01	0.458	1.98	33	106	10.96
Minimum	*9.41*	*11.7*	*0.31*	*11.1*	*18.9*	*0.017*	*0.02*	*< 0.01*	*0.124*	*0.301*	*5*	*8.1*	*7.91*
Maximum	*10.02*	*73.4*	*0.62*	*73.1*	*237*	*0.068*	*0.05*	*0.02*	*1.01*	*4.71*	*78*	*252*	*11.02*
Average	*9.6*	*45*	*0.43*	*44*	*120*	*0.04*	*0.03*	*0.01*	*0.58*	*2.5*	*41*	*112*	*10*
PEGMATITE n=11													
2010-HR-013	9.82	40.1	0.31	39.8	129	0.008	< 0.01	< 0.01	0.488	1.98	33	106	10.91
2010-HR-017	9.87	20.0	0.31	19.7	64.5	0.008	< 0.01	< 0.01	0.182	0.685	11	37	8.76
2010-HR-019	9.98	15.3	0.31	15.0	49.4	*0.005*	< 0.01	< 0.01	0.144	0.551	9	30	7.99
2010-HR-026	9.82	20.6	1.56	19.0	13.2	0.079	0.03	0.05	0.206	0.671	11	7.1	8.68
2010-HR-042	9.86	46.7	1.25	45.4	37.4	0.066	0.03	0.04	0.579	2.35	39	31	10.90
2010-HR-055	9.66	40.2	0.31	39.9	130	*0.005*	< 0.01	< 0.01	0.480	1.99	33	107	11.20
2010-HR-057	9.62	25.5	0.31	25.2	82.3	0.043	0.04	< 0.01	0.251	0.968	16	52	11.01
2010-HR-063	9.50	70.4	1.88	68.5	37.4	0.090	0.02	0.06	0.993	4.40	73	39	11.18
2010-HR-065	9.54	112	1.88	111	59.8	0.104	0.05	0.06	1.57	7.25	120	64	11.09
2010-HR-105	9.78	44.4	0.31	44.1	143	*0.005*	< 0.01	< 0.01	0.532	2.43	40	130	10.99
2010-HR-108	9.45	10.5	0.31	10.2	33.9	0.006	< 0.01	< 0.01	0.030	0.058	1	3.1	7.17
Minimum	*9.45*	*10.5*	*0.31*	*10.2*	*13.2*	*0.005*	*< 0.01*	*< 0.01*	*0.03*	*0.058*	*1*	*3.1*	*7.17*
Maximum	*9.98*	*112*	*1.88*	*111*	*143*	*0.104*	*0.05*	*0.06*	*1.57*	*7.25*	*120*	*130*	*11.2*
Average	*9.7*	*41*	*0.79*	*40*	*71*	*0.04*	*0.02*	*0.03*	*0.50*	*2.1*	*35*	*55*	*10*
MAFIC DYKE n=9													
2010-HR-002	8.66	190	2.14	188	89.0	0.117	0.05	0.07	2.10	9.75	162	76	11.00
2010-HR-069	8.83	137	0.62	137	221	0.032	0.02	0.02	1.60	7.74	128	207	11.11
2010-HR-015	8.93	185	0.62	184	298	0.015	< 0.01	0.02	2.01	9.49	158	254	11.12
2010-HR-047	9.03	97.8	0.62	97.2	158	0.052	0.03	0.02	1.36	6.31	105	169	11.17
2010-HR-053	9.66	25.1	0.31	24.8	81.0	0.010	< 0.01	< 0.01	0.251	1.12	19	60	10.95
2010-HR-061	9.74	45.8	0.31	45.5	148	0.006	< 0.01	< 0.01	0.540	2.36	39	126	11.13
2010-HR-071	8.62	157	0.31	157	507	*0.005*	< 0.01	< 0.01	1.81	8.94	148	479	11.38
2010-HR-100	8.75	168	0.31	168	542	0.006	< 0.01	< 0.01	1.95	9.44	157	505	11.42
2010-HR-110	9.73	38.4	3.12	35.3	12.3	0.282	0.18	0.10	0.424	1.51	25	8.0	10.87
Minimum	*8.62*	*25.1*	*0.31*	*24.8*	*12.3*	*0.005*	*< 0.01*	*< 0.01*	*0.251*	*1.12*	*19*	*8.0*	*10.87*
Maximum	*9.74*	*190*	*3.12*	*188*	*542*	*0.282*	*0.18*	*0.1*	*2.1*	*9.75*	*162*	*505*	*11.42*
Average	*8.9*	*116*	*0.93*	*115*	*228*	*0.06*	*0.04*	*0.03*	*1.3*	*6.3*	*105*	*209*	*11*
CHLORITIC GRANITE PORPHYRY n=5													
2010-HR-067	9.63	77.2	0.31	76.9	249	0.026	0.03	< 0.01	1.08	4.52	75	242	11.15
2010-HR-075	9.61	66.4	0.62	65.8	107	0.044	0.03	0.02	0.796	3.53	59	95	11.19
2010-HR-088	9.33	128	0.31	128	413	0.014	0.01	< 0.01	1.82	8.35	139	447	11.16
2010-HR-090	9.38	91.9	1.56	90.3	58.9	0.097	0.05	0.05	1.29	5.56	92	59	11.18
2010-HR-120	9.48	90.9	0.62	90.3	147	0.065	0.04	0.02	1.09	5.21	86	139	11.21
Minimum	*9.33*	*66.4*	*0.31*	*65.8*	*58.9*	*0.014*	*0.01*	*< 0.01*	*0.796*	*3.53*	*59*	*59*	*11.15*
Maximum	*9.63*	*128*	*1.56*	*128*	*413*	*0.097*	*0.05*	*0.05*	*1.82*	*8.35*	*139*	*447*	*11.21*
Average	*9.5*	*91*	*0.68*	*90*	*195.0*	*0.05*	*0.03*	*0.02*	*1.2*	*5.4*	*90*	*196*	*11*
MINOR UNITS													
Aplite n=1													
2010-HR-009	9.79	43.2	0.31	42.9	139	0.010	< 0.01	< 0.01	0.499	2.12	35	114	10.87
Diorite n=2													
2010-HR-029	9.50	35.2	0.31	34.9	114	0.017	0.02	< 0.01	0.373	1.54	26	82	10.53
2010-HR-033	9.78	15.8	0.31	15.5	51.0	0.015	0.02	< 0.01	0.069	0.175	3	9.4	7.74
Gneiss n=1													
2010-HR-028	9.46	43.2	0.31	42.9	139	0.020	0.02	< 0.01	0.458	1.90	32	102	11.04
Sheared mafic unit n=2													
2010-HR-102	8.71	158	0.31	158	510	0.012	0.01	< 0.01	1.89	9.12	151	488	11.08
2010-HR-113	8.98	196	0.31	196	633	0.036	0.02	0.01	2.50	12.2	203	653	10.92
Sheared granitoid n=1													
2010-HR-122	9.55	60.3	0.31	60.0	195	0.011	0.01	< 0.01	0.738	3.56	59	191	11.10
Tectonized-sheared vein zone n=4													
2010-HR-021	9.35	33.3	3.33	30.0	10.00	0.124	0.02	0.11	0.367	1.36	23	6.8	10.75
2010-HR-048	9.08	89.0	0.31	88.7	287	0.013	0.01	< 0.01	1.16	5.23	87	280	11.24
2010-HR-050	9.56	41.7	0.31	41.4	135	*0.005*	< 0.01	< 0.01	0.477	2.20	37	118	11.07
2010-HR-078	9.25	21.5	0.31	21.2	69.4	0.011	0.01	< 0.01	0.206	0.876	15	47	10.61
Quartz vein zone n=1													
2010-HR-035	9.11	20.0	11.7	8.27	1.70	0.485	0.11	0.38	0.204	0.588	10	0.83	8.21
Intermediate dyke n=1													
2010-HR-059	9.79	54.6	0.31	54.3	176	*0.005*	< 0.01	< 0.01	0.665	2.95	49	158	11.21
Minimum	*8.71*	*15.8*	*0.31*	*8.27*	*1.7*	*0.005*	*< 0.01*	*< 0.01*	*0.069*	*0.175*	*2.905*	*0.83*	*7.7*
Maximum	*9.79*	*196*	*11.7*	*196*	*633*	*0.485*	*0.11*	*0.38*	*2.5*	*12.2*	*202.52*	*653*	*11.24*
Average	*9.4*	*62*	*1.4*	*61*	*189*	*0.06*	*0.02*	*0.05*	*0.74*	*3.4*	*56*	*173*	*10*
TAILINGS n=1													
SGS Lakefield	9.03	77	2.85	74	27	0.175	0.08	0.09	1.05	4.84	80	28	11.14
Lakehead	---	---	---	---	---	0.260	---	---	1.10	---	---	---	---

Sample ID	Final pH	Alk.	Cond.	Cl	SO_4	Hg	Ag	Al	As	B	Be	Bi	Ca	Cd	Co	Cr	Cu	Fe	K	Li	Mg	Mn	Mo	Na	Ni	Pb	Sb	Se	Sn	Sr	Ti	Tl	U	V	W	Y	Zn
	---	mg/L [8]	µS/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
PWQO	6.5 to 8.5					0.0002	0.0001	0.015, 0.075 [1, 4]	0.005 [4]	0.2		0.011, 1.1 [2]		0.0001, 0.0005 [2, 4]	0.0009	0.001 [3]	0.001, 0.005 [2, 4]	0.3					0.04		0.025	0.001, 0.003, 0.005 [2, 4]	0.02	0.1					0.005	0.006 [4]			0.02 [4]
CCME Aquatic Life	6.5 to 9.0					0.000026	0.0001	0.005, 0.1 [1]	0.005					0.000017		0.001 [3]	0.002 - 0.004 [2]	0.3							0.025 - 0.15 [2]	0.001 - 0.007 [2]		0.001									0.03
MISA	6 to 9.5								1								0.6								1	0.4											1
FINE GRAINED GRANITE n=6																																					
2010-HR-003	***9.89***	34	70	2.2	0.4	< 0.0001	< 0.00001	**0.91**	0.0013	0.0063	< 0.00002	< 0.00001	4.09	< 0.000003	0.000022	< 0.0005	0.0005	0.006	3.65	< 0.001	0.431	0.00023	0.00123	8.85	0.0002	< 0.00002	0.0004	< 0.001	< 0.00001	0.0204	< 0.0001	< 0.00002	0.000119	0.00845	0.00028	0.000002	< 0.001
2010-HR-006	***10.08***	33	78	2.2	0.5	< 0.0001	< 0.00001	**0.93**	0.0038	0.0049	< 0.00002	< 0.00001	4.26	< 0.000003	0.000029	< 0.0005	0.0007	0.029	6.32	< 0.001	0.506	0.00051	0.00020	8.47	0.0003	0.00006	0.0004	< 0.001	< 0.00001	0.0105	0.0017	< 0.00002	0.000111	0.00973	0.00385	0.000007	< 0.001
2010-HR-004	***9.62***	48	109	0.6	1.0	< 0.0001	< 0.00001	**0.78**	0.0013	0.0061	< 0.00002	< 0.00001	6.82	< 0.000003	0.000034	< 0.0005	< 0.0005	< 0.002	10.3	< 0.001	2.40	0.00186	0.00051	4.83	0.0003	< 0.00002	0.0006	< 0.001	< 0.00001	0.0357	0.0001	< 0.00002	0.000410	0.00281	0.00135	0.000003	< 0.001
2010-HR-084	***9.74***	45	91	0.5	0.3	< 0.0001	< 0.00001	**0.60**	0.0006	0.0040	< 0.00002	< 0.00001	5.63	< 0.000003	0.000022	< 0.0005	< 0.0005	< 0.002	9.65	< 0.001	1.56	0.00131	0.00091	4.41	0.0002	< 0.00002	0.0004	< 0.001	< 0.00001	0.0242	0.0003	< 0.00002	0.000064	0.00197	0.00053	0.000001	< 0.001
2010-HR-095	***9.79***	33	82	0.7	2.0	< 0.0001	< 0.00001	**1.03**	0.0011	0.0055	< 0.00002	< 0.00001	4.50	< 0.000003	0.000022	< 0.0005	< 0.0005	< 0.002	9.13	< 0.001	0.452	0.00036	0.00034	5.22	0.0002	< 0.00002	0.0005	< 0.001	< 0.00001	0.0311	< 0.0001	< 0.00002	0.000071	0.00377	0.00359	0.000002	< 0.001
2010-HR-096	***9.95***	27	58	2.1	< 0.2	< 0.0001	< 0.00001	**1.15**	0.0038	0.0027	< 0.00002	< 0.00001	4.00	< 0.000003	0.000115	< 0.0005	< 0.0005	0.162	2.93	< 0.001	0.306	0.00192	0.00031	5.57	0.0002	0.00011	0.0004	< 0.001	< 0.00001	0.0065	0.0059	< 0.00002	0.000191	0.00384	0.00086	0.000079	< 0.001
Minimum	9.62	27	58	0.5	< 0.2	< 0.0001	< 0.00001	0.6	0.0006	0.0027	< 0.00002	< 0.00001	4	< 0.000003	0.000022	< 0.0005	< 0.0005	< 0.002	2.93	< 0.001	0.306	0.00023	0.0002	4.41	0.0002	< 0.00002	0.0004	< 0.001	< 0.00001	0.0065	< 0.0001	< 0.00002	0.000064	0.00197	0.00028	0.000001	< 0.001
Maximum	10.08	48	109	2.2	2	< 0.0001	< 0.00001	1.15	0.0038	0.0063	< 0.00002	< 0.00001	6.82	< 0.000003	0.000115	< 0.0005	0.0007	0.162	10.3	< 0.001	2.4	0.00192	0.00123	8.85	0.0003	0.00011	0.0006	< 0.001	< 0.00001	0.0357	0.0059	< 0.00002	0.00041	0.00973	0.00385	0.000079	< 0.001
Average	9.8	37	81	1.4	0.73	< 0.0001	< 0.00001	0.90	0.002	0.005	< 0.00002	< 0.00001	4.9	< 0.000003	0.00004	< 0.0005	0.0005	0.03	7.0	< 0.001	0.94	0.001	0.0006	6.2	0.0002	0.00004	0.0005	< 0.001	< 0.00001	0.02	0.001	< 0.00002	0.0002	0.005	0.002	0.00002	< 0.001
CHLORITIC GRANITE n=11																																					
2010-HR-008	***9.92***	39	97	3.6	0.9	< 0.0001	< 0.00001	**0.78**	0.0030	0.0082	< 0.00002	< 0.00001	4.26	0.000008	0.000022	< 0.0005	0.0006	0.032	8.78	< 0.001	0.531	0.00102	0.00644	11.7	0.0002	0.00004	0.0005	0.003	< 0.00001	0.0200	0.0005	< 0.00002	0.00134	0.00282	0.00148	0.000018	< 0.001
2010-HR-045	***9.76***	39	84	1.0	1.3	< 0.0001	< 0.00001	**0.96**	0.0013	0.0062	< 0.00002	< 0.00001	5.19	< 0.000003	0.000025	< 0.0005	< 0.0005	0.004	9.70	< 0.001	0.588	0.00080	0.00046	6.37	0.0002	< 0.00002	0.0006	< 0.001	< 0.00001	0.0248	0.0002	< 0.00002	0.000368	0.00208	0.00074	0.000002	< 0.001
2010-HR-060	***9.93***	33	71	1.0	0.3	< 0.0001	< 0.00001	**1.20**	0.0009	0.0058	< 0.00002	< 0.00001	5.07	0.000003	0.000021	< 0.0005	< 0.0005	0.003	7.35	< 0.001	0.337	0.00063	0.00115	5.90	0.0002	< 0.00002	0.0005	< 0.001	< 0.00001	0.0175	0.0002	< 0.00002	0.000164	0.00245	0.00801	< 0.000001	< 0.001
2010-HR-076	***9.84***	33	74	0.6	0.3	< 0.0001	< 0.00001	**1.12**	0.0010	0.0072	< 0.00002	< 0.00001	4.10	< 0.000003	0.000023	< 0.0005	< 0.0005	< 0.002	7.41	< 0.001	0.273	0.00054	0.00089	6.03	0.0002	< 0.00002	0.0003	< 0.001	< 0.00001	0.0187	< 0.0001	< 0.00002	0.000342	0.00287	0.00222	0.000004	< 0.001
2010-HR-080	***9.83***	38	81	1.3	0.3	< 0.0001	< 0.00001	**0.88**	0.0014	0.0042	< 0.00002	< 0.00001	5.15	< 0.000003	0.000026	< 0.0005	< 0.0005	0.010	7.95	< 0.001	0.539	0.00059	0.00055	5.69	0.0002	< 0.00002	0.0005	< 0.001	< 0.00001	0.0150	0.0003	< 0.00002	0.000394	0.00347	0.00048	0.000012	< 0.001
2010-HR-085	***9.84***	30	70	0.6	0.3	< 0.0001	< 0.00001	**0.95**	0.0012	0.0038	< 0.00002	< 0.00001	4.58	< 0.000003	0.000020	< 0.0005	< 0.0005	0.006	5.70	< 0.001	0.450	0.00041	0.00068	5.18	0.0002	< 0.00002	0.0006	< 0.001	0.00001	0.0154	0.0006	< 0.00002	0.000136	0.00355	0.00230	0.000004	< 0.001
2010-HR-091	***9.86***	24	70	0.7	0.3	< 0.0001	< 0.00001	**0.93**	0.0012	0.0039	< 0.00002	< 0.00001	4.30	< 0.000003	0.000020	< 0.0005	< 0.0005	0.003	5.60	< 0.001	0.397	0.00028	0.00065	5.65	0.0002	< 0.00002	0.0005	< 0.001	< 0.00001	0.0148	0.0004	< 0.00002	0.000188	0.00404	0.00237	0.000006	< 0.001
2010-HR-101	***9.94***	28	61	1.8	0.3	< 0.0001	< 0.00001	**1.01**	0.0003	0.0036	< 0.00002	< 0.00001	4.43	< 0.000003	0.000061	< 0.0005	< 0.0005	0.127	2.90	< 0.001	0.360	0.00172	0.00079	5.09	0.0003	0.00007	0.0004	< 0.001	0.00003	0.0084	0.0047	< 0.00002	0.000252	0.00379	0.00215	0.000058	< 0.001
2010-HR-117	***9.99***	30	68	1.4	0.3	< 0.0001	< 0.00001	**0.73**	0.0008	0.0040	< 0.00002	< 0.00001	4.08	< 0.000003	0.000013	< 0.0005	< 0.0005	< 0.002	4.40	< 0.001	0.373	0.00015	0.00030	6.44	0.0002	< 0.00002	0.0002	< 0.001	< 0.00001	0.182	0.0002	< 0.00002	0.000022	0.00334	0.00187	0.000003	< 0.001
2010-HR-118	***9.78***	28	60	0.6	0.3	< 0.0001	< 0.00001	**0.51**	0.0005	0.0051	< 0.00002	< 0.00001	5.24	< 0.000003	0.000016	< 0.0005	< 0.0005	< 0.002	3.74	< 0.001	0.452	0.00006	0.00024	3.87	0.0002	< 0.00002	0.0003	< 0.001	< 0.00001	0.0180	< 0.0001	< 0.00002	0.000002	0.00318	0.01735	0.000001	< 0.001
2010-HR-123	***9.93***	26	54	0.9	0.3	< 0.0001	< 0.00001	**0.89**	0.0009	0.0017	< 0.00002	< 0.00001	5.35	< 0.000003	0.000025	< 0.0005	< 0.0005	< 0.002	2.70	< 0.001	0.254	0.00018	0.00121	3.27	0.0002	< 0.00002	0.0003	< 0.001	< 0.00001	0.0101	0.0002	< 0.00002	0.000111	0.00171	0.00151	0.000004	< 0.001
Minimum	9.76	24	54	0.6	0.3	< 0.0001	< 0.00001	0.51	0.0003	0.0017	< 0.00002	< 0.00001	4.08	< 0.000003	0.000013	< 0.0005	< 0.0005	< 0.002	2.7	< 0.001	0.254	0.00006	0.00024	3.27	0.0002	< 0.00002	0.0002	< 0.001	< 0.00001	0.0084	< 0.0001	< 0.00002	0.000002	0.00171	0.00048	< 0.000001	< 0.001
Maximum	9.99	39	97	3.6	1.3	< 0.0001	< 0.00001	1.2	0.003	0.0082	< 0.00002	< 0.00001	5.35	0.000008	0.000061	< 0.0005	0.0006	0.127	9.7	< 0.001	0.588	0.00172	0.00644	11.7	0.0003	0.00007	0.0006	0.003	0.00003	0.182	0.0047	< 0.00002	0.00134	0.00404	0.01735	0.000058	< 0.001
Average	9.9	32	72	1.2	0.45	< 0.0001	< 0.00001	0.91	0.001	0.005	< 0.00002	< 0.00001	4.7	0.000003	0.00002	< 0.0005	0.0005	0.02	6.0	< 0.001	0.41	0.0006	0.0012	5.9	0.0002	0.00003	0.0004	0.001	0.00001	0.03	0.0007	< 0.00002	0.0003	0.003	0.004	0.00001	< 0.001
TONALITE n=10																																					
2010-HR-005	***10.01***	35	78	3.4	0.3	< 0.0001	< 0.00001	**1.03**	**0.0190**	0.0057	< 0.00002	< 0.00001	4.75	0.000003	0.000079	< 0.0005	< 0.0005	0.135	6.07	< 0.001	0.470	0.00223	0.00027	7.98	0.0003	0.00016	0.0004	< 0.001	< 0.00001	0.0155	0.0040	< 0.00002	0.00118	0.00662	0.00030	0.000102	< 0.001
2010-HR-014	***9.90***	28	64	1.0	0.3	< 0.0001	< 0.00001	**1.20**	0.0018	0.0319	< 0.00002	< 0.00001	5.03	< 0.000003	0.000089	< 0.0005	0.0014	0.161	6.53	< 0.001	0.276	0.00176	0.00062	5.52	0.0002	0.00011	0.0005	< 0.001	< 0.00001	0.0065	0.0058	< 0.00002	0.000500	0.00699	0.00157	0.000075	< 0.001
2010-HR-025	***10.01***	30	66	1.5	0.3	< 0.0001	< 0.00001	**0.89**	**0.0069**	0.0055	< 0.00002	< 0.00001	4.93	0.000003	0.000040	< 0.0005	< 0.0005	0.059	5.35	< 0.001	0.485	0.00101	0.00238	6.71	0.0002	0.00007	0.0003	< 0.001	< 0.00001	0.0175	0.0019	< 0.00002	0.000485	0.00373	0.00476	0.000046	< 0.001
2010-HR-027	***9.80***	34	81	0.8	0.3	< 0.0001	0.00001	**1.11**	0.0009	0.0056	< 0.00002	0.00002	5.59	< 0.000003	0.000025	< 0.0005	< 0.0005	0.007	8.24	< 0.001	0.383	0.00162	0.00035	6.43	0.0002	< 0.00002	0.0004	< 0.001	< 0.00001	0.0267	0.0002	< 0.00002	0.000072	0.00384	0.00144	0.000009	< 0.001
2010-HR-054	***10.00***	29	62	0.4	0.3	< 0.0001	< 0.00001	**0.81**	0.0005	0.0048	< 0.00002	< 0.00001	4.21	< 0.000003	0.000013	< 0.0005	< 0.0005	0.004	4.18	< 0.001	0.410	0.00012	0.00022	6.20	0.0002	< 0.00002	0.0003	< 0.001	< 0.00001	0.0332	0.0002	< 0.00002	0.000015	0.00501	0.00091	0.000001	< 0.001
2010-HR-074	***9.55***	44	92	0.5	0.3	< 0.0001	< 0.00001	**0.60**	0.0006	0.0042	< 0.00002	< 0.00001	5.42	< 0.000003	0.000023	< 0.0005	< 0.0005	< 0.002	9.35	< 0.001	1.45	0.00128	0.00098	4.70	0.0002	< 0.00002	0.0003	< 0.001	< 0.00001	0.0230	< 0.0001	< 0.00002	0.000069	0.00218	0.00070	0.000003	< 0.001
2010-HR-077	***9.64***	35	83	0.9	0.3	< 0.0001	< 0.00001	**0.75**	0.0008	0.0040	< 0.00002	< 0.00001	5.76	0.000004	0.000028	< 0.0005	< 0.0005	0.007	9.02	< 0.001	0.512	0.00083	0.00284	3.76	0.0003	< 0.00002	0.0005	< 0.001	< 0.00001	0.0130	0.0006	< 0.00002	0.000076	0.00263	0.00242	0.000013	< 0.001
2010-HR-099	***9.91***	23	59	2.3	0.3	< 0.0001	< 0.00001	**1.02**	0.0032	0.0024	< 0.00002	< 0.00001	4.09	0.000003	0.000122	< 0.0005	< 0.0005	0.195	3.31	< 0.001	0.428	0.00297	0.00082	6.48	0.0003	0.00014	0.0003	< 0.001	< 0.00001	0.0058	0.0057	< 0.00002	0.000198	0.00315	0.00097	0.000268	0.001
2010-HR-107	***9.48***	49	105	0.9	0.3	< 0.0001	< 0.00001	0.10	0.0004	0.0023	< 0.00002	< 0.00001	8.04	< 0.000003	0.000032	< 0.0005	< 0.0005	< 0.002	1.26	< 0.001	5.74	0.00040	0.00336	2.37	0.0004	< 0.00002	0.0002	< 0.001	< 0.00001	0.0513	< 0.0001	< 0.00002	< 0.000001	0.00088	0.00044	0.000001	< 0.001
2010-HR-111	***9.93***	27	62	1.8	0.3	< 0.0001	< 0.00001	**1.05**	0.0005	0.0036	< 0.00002	< 0.00001	4.70	< 0.000003	0.000061	< 0.0005	< 0.0005	0.141	2.98	< 0.001	0.372	0.00174	0.00072	5.29	0.0003	0.00008	0.0003	< 0.001	0.00008	0.0097	0.0050	< 0.00002	0.000254	0.00408	0.00323	0.000060	< 0.001
Minimum	9.48	23	59	0.4	0.3	< 0.0001	< 0.00001	0.1	0.0004	0.0023	< 0.00002	< 0.00001	4.09	< 0.000003	0.000013	< 0.0005	< 0.0005	< 0.002	1.26	< 0.001	0.276	0.00012	0.00022	2.37	0.0002	< 0.00002	0.0002	< 0.001	< 0.00001	0.0058	< 0.0001	< 0.00002	< 0.000001	0.00088	0.0003	0.000001	< 0.001
Maximum	10.01	49	105	3.4	0.3	< 0.0001	0.00001	1.2	0.019	0.0319	< 0.00002	0.00002	8.04	0.000004	0.000122	< 0.0005	0.0014	0.195	9.35	< 0.001	5.74	0.00297	0.00336	7.98	0.0004	0.00016	0.0005	< 0.001	0.00008	0.0513	0.0058	< 0.00002	0.00118	0.00699	0.00476	0.000268	0.001
Average	9.8	33	75	1.4	0.30	< 0.0001	0.00001	0.86	0.003	0.007	< 0.00002	0.00001	5.3	0.000003	0.00005	< 0.0005	0.0006	0.07	5.6	< 0.001	1.1	0.0014	0.0013	5.5	0.0003	0.00007	0.0004	< 0.001	0.00002	0.02	0.0024	< 0.00002	0.0003	0.004	0.002	0.00006	0.001
ALTERED GRANITOID n=2																																					
2010-HR-086	***9.92***	37	75	1.0	0.3	< 0.0001	< 0.00001	**0.93**	0.0011	0.0036	< 0.00002	< 0.00001	4.26	< 0.000003	0.000027	< 0.0005	< 0.0005	0.002	7.28	< 0.001	0.318	0.00039	0.00133	5.78	0.0002	< 0.00002	0.0004	< 0.001	< 0.00001	0.0123	0.0002	< 0.00002	0.000185	0.00281	0.00105	0.000003	< 0.001
2010-HR-093	***9.66***	28	62	1.7	0.3	< 0.0001	< 0.00001	**0.30**	0.0004	0.0050	< 0.00002	< 0.00001	6.56	< 0.000003	0.000024	< 0.0005	< 0.0005	< 0.002	1.91	< 0.001	1.40	0.00020	0.00058	2.22	0.0003	< 0.00002	0.0003	< 0.001	< 0.00001	0.0916	< 0.0001	< 0.00002	< 0.000001	0.00081	0.00136	< 0.000001	< 0.001
PEGMATITE n=3																																					
2010-HR-019	***10.12***	29	66	1.0	0.3	< 0.0001	< 0.00001	**1.07**	0.0038	0.0036	< 0.00002	< 0.00001	4.55	0.000003	0.000064	< 0.0005	0.0006	0.064	7.59	< 0.001	0.201	0.00141	0.00093	5.14	0.0002	0.00032	0.0003	< 0.001	< 0.00001	0.0141	0.0012	< 0.00002	0.000934	0.00081	0.00323	0.000082	< 0.001
2010-HR-065	***9.85***	34	76	0.7	0.3	< 0.0001	< 0.00001	**1.28**	0.0010	0.0080	< 0.00002	< 0.00001	4.49	0.000003	0.000024	< 0.0005	< 0.0005	0.004	8.83	< 0.001	0.309	0.00049	0.00125	6.73	0.0002	< 0.00002	0.0004	< 0.001	< 0.00001	0.0222	< 0.0001	< 0.00002	0.000408	0.00296	0.00218	0.000002	< 0.001
2010-HR-108	***9.96***	30	68	1.6	0.3	< 0.0001	< 0.00001	**0.66**	0.0011	0.0042	< 0.00002	< 0.00001	4.12	< 0.000003	0.000014	< 0.0005	< 0.0005	< 0.002	4.72	< 0.001	0.412	0.00014	0.00034	5.73	0.0002	< 0.00002	0.0002	< 0.001	< 0.00001	0.235	< 0.0001	< 0.00002	0.000026	0.00343	0.00188	0.000003	< 0.001
Minimum	9.85	29	66	0.7	0.3	< 0.0001	< 0.00001	0.66	0.001	0.0036	< 0.00002	< 0.00001	4.12	< 0.000003	0.000014	< 0.0005	< 0.0005	< 0.002	4.72	< 0.001	0.201	0.00014	0.00034	5.14	0.0002	< 0.00002	0.0002	< 0.001	< 0.00001	0.0141	< 0.0001	< 0.00002	0.000026	0.00081	0.00188	0.000002	< 0.001
Maximum	10.12	34	76	1.6	0.3	< 0.0001	< 0.00001	1.28	0.0038	0.008	< 0.00002	< 0.00001	4.55	0.000003	0.000064	< 0.0005	0.0006	0.064	8.83	< 0.001	0.412	0.00141	0.00125	6.73	0.0002	0.00032	0.0004	< 0.001	< 0.00001	0.235	0.0012	< 0.00002	0.000934	0.00343	0.00323	0.000082	< 0.001
Average	10	31	70	1.1	0.30	< 0.0001	< 0.00001	1.00	0.002	0.005	< 0.00002	< 0.00001	4.4	0.000003	0.00003	< 0.0005	0.0005	0.02	7.0	< 0.001	0.3	0.0007	0.0008	5.9	0.0002	0.00012	0.0003	< 0.001	< 0.00001	0.09	0.0005	< 0.00002	0.0005	0.002	0.002	0.00003	< 0.001
MAFIC DYKE n=3																																					
2010-HR-069	***9.74***	26	55	0.5	0.3	< 0.0001	< 0.00001	**0.65**	0.0002	0.0048	< 0.00002	< 0.00001	7.50	< 0.000003	0.000024	< 0.0005	< 0.0005	0.002	0.218	< 0.001	1.52	0.00027	0.00076	1.54	0.0003	< 0.00002	0.0004	< 0.001	< 0.00001	0.0716	< 0.0001	< 0.00002	< 0.000001	0.00093	0.00039	0.000001	< 0.001
2010-HR-100	***9.95***	32	76	0.8	0.3	< 0.0001	< 0.00001	**1.13**	0.0004	0.0046	< 0.00002	< 0.00001	4.09	0.000003	0.000020	< 0.0005	< 0.0005	0.032	9.04	< 0.001	0.228	0.00061	0.00036	4.52	0.0002	< 0.00002	0.0003	< 0.001	< 0.00001	0.0069	0.0016	< 0.00002	0.000387	0.00448	0.00430	0.000018	< 0.001
2010-HR-110	***9.74***	26	59	0.7	0.3	< 0.0001	< 0.00001	**0.46**	0.0005	0.0042	< 0.00002	< 0.00001	5.48	< 0.000003	0.000018	< 0.0005	< 0.0005	< 0.002	3.29	< 0.001	0.473	0.00006	0.00027	3.19	0.0002	< 0.00002	0.0003	< 0.001	< 0.00001	0.0189	0.0001	< 0.00002	0.000003	0.00280	0.0147	0.000002	< 0.001
Minimum	9.74	26	55	0.5	0.3	< 0.0001	< 0.00001	0.46	0.0002	0.0042	< 0.00002	< 0.00001	4.09	< 0.000003	0.000018	< 0.0005	< 0.0005	< 0.002	0.218	< 0.001	0.228	0.00006	0.00027	1.54	0.0002	< 0.00002	0.0003	< 0.001	< 0.00001	0.0069	< 0.0001	< 0.00002	< 0.000001	0.00093	0.00039	0.000001	< 0.001
Maximum	9.95	32	76	0.8	0.3	< 0.0001	< 0.00001	1.13	0.0005	0.0048	< 0.00002	< 0.00001	7.5	0.000003	0.000024	< 0.0005	< 0.0005	0.032	9.04	< 0.001	1.52	0.00061	0.00076	4.52	0.0003	< 0.00002	0.0004	< 0.001	< 0.00001	0.0716	0.0016	< 0.00002	0.000387	0.00448	0.0147	0.000018	< 0.001
Average	10	28	63	0.7	0.30	< 0.0001	< 0.00001	0.75	0.000	0.005	< 0.00002	< 0.00001	5.7	0.000003	0.00002	< 0.0005	< 0.0005	0.01	4.2	< 0.001	0.7	0.0003	0.0005	3.1	0.0002	< 0.00002	0.0003	< 0.001	< 0.00001	0.03	0.0006	< 0.00002	0.0001	0.003	0.006	0.000007	< 0.001
CHLORITIC GRANITE PORPHYRY n=1																																					
2010-HR-067	***9.68***	50	101	1.3	0.3	< 0.0001	< 0.00001	**0.95**	0.0017	0.0080	< 0.00002	< 0.00001	5.59	< 0.000003	0.000024	< 0.0005	< 0.0005	< 0.002	11.8	< 0.001	1.59	0.00095	0.00252	4.38	0.0003	< 0.00002	0.0007	< 0.001	< 0.00001	0.0188	< 0.0001	< 0.00002	0.00126	0.00291	0.00143	0.000005	< 0.001
MINOR UNITS																																					
Diorite n=1																																					
2010-HR-029	***10.06***	33	64	0.7	0.3	< 0.0001	< 0.00001	**0.99**	**0.0120**	0.0046	< 0.00002	< 0.00001	4.68	< 0.000003	0.000019	< 0.0005	< 0.0005	0.005	6.02	< 0.001	0.340	0.00022	0.00083	6.15	0.0002	< 0.00002	0.0004	< 0.001	< 0.00001	0.0113	0.0001	< 0.00002	0.000293	0.00221	0.00076	0.000007	< 0.001
Sheared mafic unit n=1																																					
2010-HR-113	***9.53***	40	109	0.9	0.3	< 0.0001	< 0.00001	0.09	0.0004	0.0023	< 0.00002	< 0.00001	8.15	0.000003	0.000033	< 0.0005	< 0.0005	< 0.002	1.30	< 0.001	6.22	0.00050	0.00314	2.62	0.0004	< 0.00002	0.0003	< 0.001	< 0.00001	0.0544	< 0.0001	< 0.00002	< 0.000001	0.00089	0.00081	0.000001	< 0.001
Tectonized-sheared vein zone n=1																																					
2010-HR-021	***9.87***	29	74	1.6	0.3	< 0.0001	< 0.00001	**0.63**	0.0017	0.0068	< 0.00002	< 0.00001	5.94	< 0.000003	0.000044	< 0.0005	< 0.0005	0.035	7.21	< 0.001	0.672	0.00094	0.00120	4.60	0.0002	0.00002	0.0003	**0.003**	< 0.00001	0.0234	0.0013	< 0.00002	0.000241	0.00350	0.0134	0.000015	< 0.001
Quartz vein zone n=1																																					
2010-HR-035	***9.59***	27	88	2.2	0.3	< 0.0001	0.00012	**0.37**	0.0018	0.0049	< 0.00002	0.00004	10.1	0.000004	0.000071	< 0.0005	< 0.0005	0.019	6.08	< 0.001	0.360	0.00278	0.00296	3.23	0.0004	0.00003	0.0003	**0.016**	< 0.00001	0.0351	0.0009	< 0.00002	0.00140	0.00293	0.00185	0.000014	< 0.001
Intermediate dyke n=1																																					
2010-HR-059	***10.03***	33	70	0.5	0.3	< 0.0001	< 0.00001	**1.21**	0.0007	0.0052	< 0.00002	< 0.00001	4.47	0.000021	0.000022	< 0.0005	< 0.0005	0.014	7.79	< 0.001	0.252	0.00039	0.0215	5.99	0.0002	< 0.00002	0.0005	< 0.001	< 0.00001	0.0116	0.0003	< 0.00002	0.000315	0.00308	0.00162	0.000002	< 0.001
TAILINGS																																					
SGS Lakefield	8.65	51	216	1.1	55.0	< 0.0001	< 0.00001	**0.14**	0.001	0.0038	< 0.00002	< 0.00001	22.1	0.000005	0.000241	< 0.0005	0.0013	0.065	8.03	< 0.001	6.49	0.0271	0.00969	7.83	0.0005	0.00007	0.0013	< 0.001	< 0.00001	0.0986	---	< 0.00002	0.00198	0.00005	0.00018	0.000009	< 0.001

Notes:
1. Guideline is dependent on pH
2. Guideline is dependent on hardness
3. Criteria for hexavalent chromium used.
4. Denotes a PWQO interim guideline

0.1	- value that does not meet MISA guidelines.
0.1	- value that does not meet PWQO guidelines.
0.1	- value that does not meet CCME guideline for aquatic life

Sample ID	pH	Alk.	Cond.	Cl	SO_4	Cr(VI)	Hg	Ag	Al	As	B	Be	Bi	Ca	Cd	Co	Cr	Cu	Fe	K	Li	Mg	Mn	Mo	Na	Ni	Pb	Sb	Se	Sn	Sr	Ti	Tl	U	V	W	Y	Zn
	---	mg/L [8]	µS/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
PWQO	6.5 to 8.5					0.001	0.0002	0.0001	0.015, 0.075 [1, 4]	0.005 [4]	0.2	0.011, 1.1 [2]			0.0001, 0.0005 [2, 4]	0.0009	0.001 [3]	0.001, 0.005 [2, 4]	0.3					0.04		0.025	0.001, 0.003, 0.005 [2, 4]	0.02	0.1					0.005	0.006 [4]			0.02 [4]
CCME Aquatic L	6.5 to 9.0					0.001	0.000026	0.0001	0.005, 0.1 [1]	0.005					0.000017		0.001 [3]	0.002 - 0.004 [2]	0.3							0.025 - 0.15 [2]	0.001 - 0.007 [2]		0.001									0.03
MISA	6 to 9.5									1								0.6								1	0.4											1
FINE GRAINED GRANITE n=6																																						
2010-HR-003	9.77	64	137	2.3	< 2	---	< 0.0001	< 0.00001	5.54	0.0002	0.258	< 0.00002	< 0.00001	32.0	< 0.000003	0.000098	0.0214	< 0.0005	< 0.002	9.54	0.001	0.006	0.00008	0.00133	9.71	< 0.0001	< 0.00002	0.0006	< 0.001	0.00005	0.115	0.0004	< 0.00002	0.000005	0.0133	0.00058	0.000002	0.003
2010-HR-006	9.46	65	127	< 2	< 2	---	< 0.0001	< 0.00001	2.41	0.0007	0.0368	< 0.00002	< 0.00001	23.9	< 0.000003	0.000077	0.0213	< 0.0005	0.007	7.34	0.001	0.008	0.00049	0.00040	5.62	< 0.0001	< 0.00002	0.0005	< 0.001	0.00005	0.0270	0.0010	< 0.00002	0.000037	0.0250	0.00074	0.000003	< 0.001
2010-HR-004	10.4	69	177	< 2	8.6	---	< 0.0001	< 0.00001	3.85	< 0.0002	0.218	< 0.00002	< 0.00001	36.9	< 0.000003	0.000124	0.0222	< 0.0005	< 0.002	18.4	0.001	0.004	< 0.00001	0.00383	6.31	< 0.0001	< 0.00002	0.0004	< 0.001	0.00014	0.235	0.0001	0.00003	0.000001	0.00712	0.00115	0.000001	0.002
2010-HR-084	10.3	52	127	< 2	5.9	---	< 0.0001	< 0.00001	2.67	< 0.0002	1.19	< 0.00002	< 0.00001	34.0	< 0.000003	0.000115	0.0205	< 0.0005	0.005	6.33	0.001	0.004	0.00006	0.00122	4.55	< 0.0001	< 0.00002	0.0004	< 0.001	0.00006	0.132	< 0.0001	< 0.00002	0.000002	0.00179	0.00024	0.000001	0.003
2010-HR-095	8.91	52	118	< 2	5.4	---	< 0.0001	< 0.00001	< 0.01	0.0003	3.49	< 0.00002	< 0.00001	18.8	< 0.000003	0.000064	< 0.0005	< 0.0005	< 0.002	4.11	< 0.001	0.043	< 0.00001	0.00272	3.30	< 0.0001	< 0.00002	0.0003	< 0.001	0.00002	0.287	< 0.0001	0.00008	< 0.000001	0.00329	0.00042	0.000001	< 0.001
2010-HR-096	10.8	113	267	< 2	3.1	---	< 0.0001	< 0.00001	5.52	< 0.0002	0.559	< 0.00002	< 0.00001	42.3	0.000005	0.000057	0.0119	< 0.0005	< 0.002	6.94	0.002	0.006	0.00027	0.0137	5.62	0.0003	< 0.00002	0.0003	< 0.001	0.00002	0.0913	< 0.0001	< 0.00002	< 0.000001	0.00270	0.00029	< 0.000001	< 0.001
Minimum	*8.91*	*52*	*118*	*< 2*	*< 2*	---	*< 0.0001*	*< 0.00001*	*< 0.01*	*< 0.0002*	*0.0368*	*< 0.00002*	*< 0.00001*	*18.8*	*< 0.000003*	*0.000057*	*< 0.0005*	*< 0.0005*	*< 0.002*	*4.1*	*< 0.001*	*0.004*	*< 0.00001*	*0.0004*	*3.3*	*< 0.0001*	*< 0.00002*	*0.0003*	*< 0.001*	*0.00002*	*0.027*	*< 0.0001*	*< 0.00002*	*< 0.000001*	*0.00179*	*0.00024*	*< 0.000001*	*< 0.001*
Maximum	*10.80*	*113*	*267*	*2.3*	*8.6*	---	*< 0.0001*	*< 0.00001*	*5.54*	*0.0007*	*3.49*	*< 0.00002*	*< 0.00001*	*42.3*	*0.000005*	*0.000124*	*0.0222*	*< 0.0005*	*0.007*	*18*	*0.002*	*0.043*	*0.00049*	*0.01*	*9.7*	*0.0003*	*< 0.00002*	*0.0006*	*< 0.001*	*0.0001*	*0.29*	*0.001*	*0.00008*	*0.000037*	*0.025*	*0.00115*	*0.000003*	*0.003*
Average	*9.5*	*69*	*159*	*2.1*	*4.50*	---	*< 0.0001*	*< 0.00001*	*3.33*	*0.000*	*0.959*	*< 0.00002*	*< 0.00001*	*31.3*	*0.000003*	*0.00009*	*0.02*	*< 0.0005*	*0.003*	*8.8*	*0.001*	*0.01*	*0.0002*	*0.004*	*5.9*	*0.0001*	*< 0.00002*	*0.0004*	*< 0.001*	*0.00006*	*0.15*	*0.0003*	*0.00003*	*0.000008*	*0.009*	*0.0006*	*0.000002*	*0.002*
CHLORITIC GRANITE n=11																																						
2010-HR-008	9.31	60	119	< 2	6.4	---	< 0.0001	< 0.00001	3.93	0.0003	0.417	< 0.00002	< 0.00001	27.9	< 0.000003	0.000093	0.0197	< 0.0005	0.002	5.92	0.002	0.004	0.00014	0.00107	5.35	< 0.0001	< 0.00002	0.0004	< 0.001	0.00004	0.0725	0.0002	< 0.00002	0.000003	0.00177	0.00046	0.000001	0.002
2010-HR-045	9.68	64	151	< 2	6.0	---	< 0.0001	< 0.00001	7.85	< 0.0002	0.149	< 0.00002	< 0.00001	31.2	< 0.000003	0.000097	0.0208	< 0.0005	0.002	14.6	0.001	0.005	0.00011	0.00225	7.35	< 0.0001	< 0.00002	0.0004	< 0.001	0.00002	0.116	0.0002	< 0.00002	0.000004	0.00213	0.00076	< 0.000001	< 0.001
2010-HR-060	10.1	75	174	< 2	3.8	---	< 0.0001	< 0.00001	9.66	0.0002	0.386	< 0.00002	< 0.00001	32.7	< 0.000003	0.000097	0.0125	< 0.0005	0.007	13.0	0.002	0.005	0.00024	0.00088	9.60	< 0.0001	< 0.00002	0.0004	< 0.001	0.00004	0.144	0.0001	< 0.00002	0.000025	0.00359	0.00135	0.000001	< 0.001
2010-HR-076	11.2	126	365	< 2	< 2	---	< 0.0001	< 0.00001	13.8	0.0003	0.654	< 0.00002	< 0.00001	50.3	< 0.000003	0.000154	0.0053	< 0.0005	0.006	19.3	0.003	0.003	0.00031	0.00192	9.44	< 0.0001	< 0.00002	0.0005	< 0.001	0.00005	0.177	< 0.0001	0.00005	0.000002	0.00282	0.00065	0.000001	< 0.001
2010-HR-080	10.2	62	159	< 2	6.4	---	< 0.0001	< 0.00001	3.18	< 0.0002	0.727	< 0.00002	< 0.00001	39.4	< 0.000003	0.000140	0.0239	< 0.0005	< 0.002	5.47	0.001	0.004	0.00007	0.00109	4.37	< 0.0001	< 0.00002	0.0005	< 0.001	0.00015	0.137	< 0.0001	< 0.00002	0.000001	0.00167	0.00037	0.000001	0.004
2010-HR-085	11.1	109	339	< 2	2.6	---	< 0.0001	< 0.00001	7.92	0.0003	0.728	< 0.00002	< 0.00001	51.0	< 0.000003	0.000174	0.0137	< 0.0005	0.005	13.4	0.002	0.003	0.00004	0.00090	7.99	< 0.0001	< 0.00002	0.0004	< 0.001	0.00004	0.208	< 0.0001	< 0.00002	< 0.000001	0.00347	0.00074	0.000001	< 0.001
2010-HR-091	10.6	63	204	< 2	24	---	< 0.0001	< 0.00001	2.81	0.0002	0.767	< 0.00002	< 0.00001	45.8	0.000005	0.000154	0.0261	< 0.0005	< 0.002	6.06	< 0.001	0.005	< 0.00001	0.00746	4.63	< 0.0001	0.00015	0.0004	< 0.001	0.00003	0.232	0.0003	< 0.00002	< 0.000001	0.00157	0.00050	0.000001	< 0.001
2010-HR-101	11.2	137	402	< 2	7.4	---	< 0.0001	< 0.00001	7.11	< 0.0002	0.300	< 0.00002	< 0.00001	51.8	< 0.000003	0.000058	0.0074	0.0009	0.006	8.61	0.001	0.003	0.00061	0.00226	6.03	0.0004	0.00004	0.0003	< 0.001	0.00023	0.205	< 0.0001	< 0.00002	< 0.000001	0.00299	0.00063	0.000001	< 0.001
2010-HR-117	11.0	125	280	< 2	2.6	---	< 0.0001	< 0.00001	6.05	< 0.0002	0.700	< 0.00002	< 0.00001	42.1	< 0.000003	0.000053	0.0259	< 0.0005	0.003	6.18	< 0.001	0.002	0.00043	0.00046	9.10	0.0003	< 0.00002	0.0003	< 0.001	0.00008	0.236	< 0.0001	< 0.00002	< 0.000001	0.00184	0.00028	0.000001	< 0.001
2010-HR-118	11.2	130	396	< 2	2.2	---	< 0.0001	< 0.00001	5.14	< 0.0002	0.765	< 0.00002	< 0.00001	56.2	< 0.000003	0.000062	0.0348	< 0.0005	0.006	4.65	< 0.001	0.002	0.00031	0.00083	5.10	0.0004	0.00002	0.0003	< 0.001	0.00009	0.199	< 0.0001	< 0.00002	0.000005	0.00552	0.00152	0.000001	< 0.001
2010-HR-123	11.0	110	291	< 2	4.5	---	< 0.0001	< 0.00001	6.25	< 0.0002	0.476	< 0.00002	< 0.00001	42.5	0.000003	0.000051	0.0169	< 0.0005	0.004	6.45	0.001	0.003	0.00033	0.00992	7.52	0.0003	< 0.00002	0.0002	< 0.001	0.00005	0.0777	< 0.0001	< 0.00002	< 0.000001	0.00218	0.00063	< 0.000001	< 0.001
Minimum	*9.31*	*60*	*119*	*< 2*	*< 2*	---	*< 0.0001*	*< 0.00001*	*2.81*	*< 0.0002*	*0.149*	*< 0.00002*	*< 0.00001*	*27.9*	*< 0.000003*	*0.000051*	*0.0053*	*< 0.0005*	*< 0.002*	*4.7*	*< 0.001*	*0.002*	*< 0.00001*	*0.00046*	*4.37*	*< 0.0001*	*< 0.00002*	*0.0002*	*< 0.001*	*0.00002*	*0.0725*	*< 0.0001*	*< 0.00002*	*< 0.000001*	*0.00157*	*0.00028*	*< 0.000001*	*< 0.001*
Maximum	*11.2*	*137*	*402*	*< 2*	*24*	---	*< 0.0001*	*< 0.00001*	*13.8*	*0.0003*	*0.767*	*< 0.00002*	*< 0.00001*	*56.2*	*0.000005*	*0.000174*	*0.0348*	*0.0009*	*0.007*	*19*	*0.003*	*0.005*	*0.0006*	*0.00992*	*9.6*	*0.0004*	*0.00015*	*0.0005*	*< 0.001*	*0.00023*	*0.236*	*0.0003*	*0.00005*	*0.000025*	*0.00552*	*0.00152*	*0.000001*	*0.004*
Average	*10.1*	*96*	*262*	*< 2*	*6.2*	---	*< 0.0001*	*< 0.00001*	*6.7*	*0.000*	*0.552*	*< 0.00002*	*< 0.00001*	*43*	*0.000003*	*0.0001*	*0.02*	*0.0005*	*0.004*	*9.4*	*0.001*	*0.004*	*0.0002*	*0.003*	*7.0*	*0.0002*	*0.00003*	*0.0004*	*< 0.001*	*0.00007*	*0.16*	*0.0001*	*0.00002*	*0.000004*	*0.003*	*0.0007*	*0.000001*	*0.001*
TONALITE n=10																																						
2010-HR-005	8.05	116	202	2.4	< 2	---	< 0.0001	< 0.00001	0.75	0.0049	0.0362	< 0.00002	< 0.00001	34.2	0.000003	0.000147	0.0447	0.0005	0.003	6.91	0.003	0.924	0.0134	0.00100	6.22	0.0002	< 0.00002	0.0007	< 0.001	0.00010	0.0453	0.0063	< 0.00002	0.00145	0.00763	0.00109	0.000005	< 0.001
2010-HR-014	8.07	111	214	< 2	3.2	---	< 0.0001	< 0.00001	0.83	0.0013	0.0856	< 0.00002	< 0.00001	39.6	0.000010	0.000157	0.0296	0.0036	0.005	4.80	0.002	0.542	0.0195	0.00074	2.56	0.0002	< 0.00002	0.0005	< 0.001	0.00012	0.0345	0.0062	< 0.00002	0.000388	0.00780	0.00092	0.000004	0.002
2010-HR-025	8.75	172	301	< 2	2.4	---	< 0.0001	< 0.00001	0.72	0.0061	0.0450	< 0.00002	< 0.00001	62.5	< 0.000003	0.000225	0.0375	0.0010	0.005	8.56	0.004	0.535	0.0248	0.00120	6.66	< 0.0001	< 0.00002	0.0003	< 0.001	0.00005	0.0607	0.0048	< 0.00002	0.000498	0.00841	0.00170	0.000002	< 0.001
2010-HR-027	9.89	68	205	< 2	43	---	< 0.0001	< 0.00001	5.43	0.0003	0.620	< 0.00002	< 0.00001	55.5	< 0.000003	0.000189	0.0137	0.0008	0.005	6.51	0.002	0.004	0.00041	0.00103	5.84	< 0.0001	0.00003	0.0004	< 0.001	0.00007	0.236	0.0007	< 0.00002	0.000008	0.00169	0.00062	0.000001	0.002
2010-HR-054	10.7	102	257	< 2	5.3	---	< 0.0001	< 0.00001	8.19	0.0002	0.533	< 0.00002	< 0.00001	54.4	< 0.000003	0.000189	0.0227	0.0007	0.013	10.1	< 0.001	0.003	0.00024	0.00076	8.81	< 0.0001	< 0.00002	0.0004	< 0.001	0.00011	0.248	0.0001	0.00003	0.000196	0.00424	0.00094	0.000001	0.004
2010-HR-074	10.8	79	201	< 2	2.2	---	< 0.0001	< 0.00001	7.99	< 0.0002	0.365	< 0.00002	< 0.00001	39.2	< 0.000003	0.000126	0.0235	< 0.0005	0.003	10.9	0.002	0.005	0.00008	0.00111	9.34	< 0.0001	0.00008	0.0004	< 0.001	0.00002	0.0899	< 0.0001	< 0.00002	0.000001	0.00533	0.00035	< 0.000001	< 0.001
2010-HR-077	10.9	80	246	< 2	15	---	< 0.0001	< 0.00001	5.70	0.0002	0.0750	< 0.00002	< 0.00001	47.6	< 0.000003	0.000152	0.0131	< 0.0005	< 0.002	13.3	< 0.001	0.002	0.00003	0.00197	2.97	< 0.0001	< 0.00002	0.0005	< 0.001	0.00004	0.137	0.0002	< 0.00002	0.000001	0.00709	0.00071	0.000001	< 0.001
2010-HR-099	11.0	117	317	< 2	15	---	< 0.0001	< 0.00001	5.69	< 0.0002	0.656	< 0.00002	< 0.00001	53.4	< 0.000003	0.000068	0.0160	< 0.0005	0.002	6.08	0.001	0.006	0.00025	0.00105	6.45	0.0004	0.00016	0.0003	< 0.001	0.00016	0.106	< 0.0001	< 0.00002	< 0.000001	0.00459	0.00119	0.000002	0.003
2010-HR-107	7.46	53	102	< 2	< 2	---	< 0.0001	0.00003	0.26	0.0035	0.0967	< 0.00002	< 0.00001	13.5	< 0.000003	0.000039	0.0469	< 0.0005	0.008	3.83	< 0.001	1.07	0.00605	0.00123	4.59	0.0002	< 0.00002	0.0007	< 0.001	0.00018	0.0175	0.0158	< 0.00002	0.000552	0.00755	0.00178	0.000004	< 0.001
2010-HR-111	7.73	66	123	< 2	3.1	---	< 0.0001	0.00001	0.53	0.0009	0.0617	< 0.00002	< 0.00001	19.5	< 0.000003	0.000039	0.0367	< 0.0005	0.005	3.24	< 0.001	0.962	0.00675	0.00413	4.00	0.0002	< 0.00002	0.0004	< 0.001	0.00011	0.0180	0.0088	< 0.00002	0.000327	0.00662	0.00079	0.000002	< 0.001
Minimum	*7.46*	*53*	*102*	*< 2*	*< 2*	---	*< 0.0001*	*< 0.00001*	*0.26*	*< 0.0002*	*0.0362*	*< 0.00002*	*< 0.00001*	*13.5*	*< 0.000003*	*0.000039*	*0.0131*	*< 0.0005*	*< 0.002*	*3.24*	*< 0.001*	*0.002*	*0.00003*	*0.00074*	*2.56*	*< 0.0001*	*< 0.00002*	*0.0003*	*< 0.001*	*0.00002*	*0.0175*	*< 0.0001*	*< 0.00002*	*< 0.000001*	*0.00169*	*0.00035*	*< 0.000001*	*< 0.001*
Maximum	*11.00*	*172*	*317*	*2.4*	*43*	---	*< 0.0001*	*0.00003*	*8.19*	*0.0061*	*0.656*	*< 0.00002*	*< 0.00001*	*62.5*	*0.00001*	*0.000225*	*0.0469*	*0.0036*	*0.013*	*13.3*	*0.004*	*1.07*	*0.0248*	*0.00413*	*9.34*	*0.0004*	*0.00016*	*0.0007*	*< 0.001*	*0.00018*	*0.248*	*0.0158*	*0.00003*	*0.00145*	*0.00841*	*0.00178*	*0.000005*	*0.004*
Average	*8.1*	*96*	*217*	*2.0*	*9.3*	---	*< 0.0001*	*0.00001*	*3.6*	*0.002*	*0.26*	*< 0.00002*	*< 0.00001*	*42*	*0.000004*	*0.0001*	*0.03*	*0.0009*	*0.005*	*7.4*	*0.002*	*0.41*	*0.007*	*0.001*	*5.7*	*0.0002*	*0.00004*	*0.0005*	*< 0.001*	*0.0001*	*0.10*	*0.004*	*0.00002*	*0.0003*	*0.006*	*0.001*	*0.000002*	*0.002*
ALTERED GRANITOID n=2																																						
2010-HR-086	10.3	71	179	< 2	7.5	---	< 0.0001	< 0.00001	7.73	< 0.0002	0.152	< 0.00002	< 0.00001	33.1	< 0.000003	0.000106	0.0143	< 0.0005	0.003	12.1	0.002	0.005	0.00003	0.00118	9.00	< 0.0001	< 0.00002	0.0005	< 0.001	0.00004	0.151	0.0001	< 0.00002	0.000002	0.00348	0.00047	< 0.000001	< 0.001
2010-HR-093	10.2	73	161	< 2	4.2	---	< 0.0001	< 0.00001	1.14	0.0005	0.889	< 0.00002	< 0.00001	28.2	< 0.000003	0.000096	0.0244	< 0.0005	0.003	12.4	< 0.001	0.004	< 0.00001	0.00478	5.87	< 0.0001	< 0.00002	0.0004	< 0.001	0.00022	0.0977	< 0.0001	< 0.00002	0.000002	0.00461	0.00104	0.000001	< 0.001
PEGMATITE n=3																																						
2010-HR-019	8.06	141	264	2.3	< 2	---	< 0.0001	< 0.00001	0.76	0.0017	0.0466	< 0.00002	< 0.00001	46.1	< 0.000003	0.000181	0.0385	0.0021	0.002	11.6	0.002	0.401	0.0452	0.00090	5.81	0.0002	< 0.00002	0.0005	< 0.001	0.00026	0.0648	0.0036	< 0.00002	0.001005	0.00137	0.00349	0.000003	0.002
2010-HR-065	11.1	82	270	< 2	11	---	< 0.0001	< 0.00001	1.26	0.0002	1.18	< 0.00002	< 0.00001	47.4	< 0.000003	0.000187	0.0289	< 0.0005	0.003	6.77	0.001	0.008	0.00001	0.00159	4.78	0.0001	< 0.00002	0.0004	< 0.001	0.00002	0.221	0.0002	< 0.00002	0.000009	0.00047	0.00075	0.000001	< 0.001
2010-HR-108	7.22	32	70	< 2	4.0	---	< 0.0001	0.00005	0.16	0.0022	0.0776	< 0.00002	< 0.00001	6.01	0.000003	0.000044	0.0433	< 0.0005	0.009	4.00	< 0.001	1.28	0.00807	0.00139	4.64	0.0001	< 0.00002	0.0006	< 0.001	0.00013	0.0106	0.0097	< 0.00002	0.000798	0.00857	0.00150	0.000015	< 0.001
Minimum	*7.22*	*32*	*70*	*< 2*	*< 2*	---	*< 0.0001*	*< 0.00001*	*0.16*	*0.0002*	*0.0466*	*< 0.00002*	*< 0.00001*	*6.01*	*< 0.000003*	*0.000044*	*0.0289*	*< 0.0005*	*0.002*	*4*	*< 0.001*	*0.008*	*0.00001*	*0.0009*	*4.64*	*0.0001*	*< 0.00002*	*0.0004*	*< 0.001*	*0.00002*	*0.0106*	*0.0002*	*< 0.00002*	*0.000009*	*0.00047*	*0.00075*	*0.000001*	*< 0.001*
Maximum	*11.10*	*141*	*270*	*2.3*	*11*	---	*< 0.0001*	*0.00005*	*1.3*	*0.0022*	*1.18*	*< 0.00002*	*< 0.00001*	*47.4*	*0.000003*	*0.000187*	*0.0433*	*0.0021*	*0.009*	*11.6*	*0.002*	*1.28*	*0.0452*	*0.00159*	*5.81*	*0.0002*	*< 0.00002*	*0.0006*	*< 0.001*	*0.00026*	*0.221*	*0.0097*	*< 0.00002*	*0.001005*	*0.00857*	*0.00349*	*0.000015*	*0.002*
Average	*7.6*	*85*	*201*	*2.1*	*5.7*	---	*< 0.0001*	*0.00002*	*0.73*	*0.001*	*0.435*	*< 0.00002*	*< 0.00001*	*33*	*0.000003*	*0.00014*	*0.04*	*0.001*	*0.005*	*7.5*	*0.001*	*0.56*	*0.02*	*0.001*	*5.1*	*0.0001*	*< 0.00002*	*0.0005*	*< 0.001*	*0.0001*	*0.10*	*0.0045*	*< 0.00002*	*0.0006*	*0.003*	*0.002*	*0.000006*	*0.001*
MAFIC DYKE n=3																																						
2010-HR-069	10.3	68	184	35	5.8	---	< 0.0001	< 0.00001	1.97	0.0002	0.556	< 0.00002	< 0.00001	54.7	< 0.000003	0.000190	0.0659	0.0007	0.003	0.428	< 0.001	0.002	0.00005	0.00177	1.47	0.0001	< 0.00002	0.0005	< 0.001	0.00009	0.182	0.0002	< 0.00002	< 0.000001	0.00748	0.00031	0.000001	0.003
2010-HR-100	11.4	169	548	< 2	< 2	---	< 0.0001	< 0.00001	3.77	< 0.0002	1.18	< 0.00002	< 0.00001	77.1	< 0.000003	0.000079	0.0484	< 0.0005	0.008	2.20	< 0.001	0.003	0.00033	0.00348	3.60	0.0006	0.00007	0.0003	< 0.001	0.00020	0.409	< 0.0001	< 0.00002	< 0.000001	0.00446	0.00069	0.000001	< 0.001
2010-HR-110	10.8	126	430	< 2	78	---	< 0.0001	< 0.00001	5.10	< 0.0002	0.0700	< 0.00002	< 0.00001	82.8	< 0.000003	0.000106	0.0217	< 0.0005	< 0.002	10.6	0.003	0.003	0.00018	0.00191	4.07	0.0005	< 0.00002	0.0004	< 0.001	0.00006	0.0769	0.0005	< 0.00002	0.000023	0.00733	0.00194	0.000001	< 0.001
Minimum	*10.30*	*68*	*184*	*< 2*	*< 2*	---	*< 0.0001*	*< 0.00001*	*1.97*	*< 0.0002*	*0.07*	*< 0.00002*	*< 0.00001*	*54.7*	*< 0.000003*	*0.000079*	*0.0217*	*< 0.0005*	*< 0.002*	*0.428*	*< 0.001*	*0.002*	*0.00005*	*0.00177*	*1.47*	*0.0001*	*< 0.00002*	*0.0003*	*< 0.001*	*0.00006*	*0.0769*	*< 0.0001*	*< 0.00002*	*< 0.000001*	*0.00446*	*0.00031*	*0.000001*	*< 0.001*
Maximum	*11.40*	*169*	*548*	*35*	*78*	---	*< 0.0001*	*< 0.00001*	*5.1*	*0.0002*	*1.18*	*< 0.00002*	*< 0.00001*	*82.8*	*< 0.000003*	*0.00019*	*0.0659*	*0.0007*	*0.008*	*10.6*	*0.003*	*0.003*	*0.00033*	*0.00348*	*4.07*	*0.0006*	*0.00007*	*0.0005*	*< 0.001*	*0.0002*	*0.409*	*0.0005*	*< 0.00002*	*0.000023*	*0.00748*	*0.00194*	*0.000001*	*0.003*
Average	*11*	*121*	*387*	*13*	*29*	---	*< 0.0001*	*< 0.00001*	*3.6*	*0.000*	*0.60*	*< 0.00002*	*< 0.00001*	*72*	*< 0.000003*	*0.00013*	*0.05*	*0.0006*	*0.004*	*4.4*	*0.002*	*0.003*	*0.0002*	*0.0024*	*3.0*	*0.0004*	*0.00004*	*0.0004*	*< 0.001*	*0.00012*	*0.22*	*0.0003*	*< 0.00002*	*0.000008*	*0.006*	*0.001*	*0.000001*	*0.002*
CHLORITIC GRANITE PORPHYRY n=1																																						
2010-HR-067	10.6	62	178	< 2	3.2	---	< 0.0001	< 0.00001	4.39	0.0003	0.171	< 0.00002	< 0.00001	28.7	< 0.000003	0.000086	0.0275	< 0.0005	< 0.002	22.4	< 0.001	0.004	0.00002	0.00120	5.05	< 0.0001	< 0.00002	0.0004	< 0.001	0.00003	0.175	< 0.0001	0.00002	0.000004	0.00712	0.00078	0.000001	0.001
MINOR UNITS																																						
Diorite n=1																																						
2010-HR-029	9.39	73	162	< 2	5.4	---	< 0.0001	< 0.00001	2.12	0.0046	0.0432	< 0.00002	< 0.00001	27.4	< 0.000003	0.000092	0.0283	< 0.0005	0.004	8.39	0.002	0.019	0.00688	0.00177	3.99	< 0.0001	< 0.00002	0.0004	< 0.001	0.00006	0.0439	0.0007	< 0.00002	0.000054	0.00486	0.00112	0.000002	0.001
Sheared mafic unit n=1																																						
2010-HR-113	10.6	100	246	< 2	5.2	---	< 0.0001	< 0.00001	1.24	< 0.0002	0.784	< 0.00002	< 0.00001	49.1	< 0.000003	0.000062	0.189	< 0.0005	< 0.002	2.33	< 0.001	0.009	0.00004	0.00174	5.37	0.0003	< 0.00002	0.0003	< 0.001	0.00011	0.241	< 0.0001	< 0.00002	0.000001	0.00047	0.00025	0.000001	< 0.001
Tectonized-sheared vein zone n=1																																						
2010-HR-021	10.1	64	206	< 2	26	---	< 0.0001	< 0.00001	3.71	0.0002	0.1000	< 0.00002	< 0.00001	48.4	0.000009	0.000162	0.0547	< 0.0005	< 0.002	11.2	0.002	0.005	0.00012	0.0144	4.28	< 0.0001	< 0.00002	0.0003	0.002	0.00002	0.108	0.0004	< 0.00002	0.000009	0.00550	0.00234	0.000001	< 0.001
Quartz vein zone n=1																																						
2010-HR-035	7.67	37	397	< 2	150	---	< 0.0001	< 0.00001	0.55	0.0008	0.0521	< 0.00002	< 0.00001	70.7	0.000004	0.000262	0.189	< 0.0005	0.007	7.09	< 0.001	0.687	0.00125	0.0105	3.26	0.0003	< 0.00002	0.0003	0.006	0.00004	0.171	0.0101	< 0.00002	0.000339	0.00418	0.00093	0.000002	< 0.001
Intermediate dyke n=1																																						
2010-HR-059	10.3	81	165	< 2	< 2	---	< 0.0001	< 0.00001	8.38	0.0002	0.106	< 0.00002	< 0.00001	38.4	< 0.000003	0.000125	0.0113	< 0.0005	0.003	12.0	0.002	0.004	0.00010	0.00264	5.12	< 0.0001	< 0.00002	0.0004	< 0.001	0.00004	0.126	< 0.0001	< 0.00002	0.000070	0.00468	0.00054	< 0.000001	< 0.001
TAILINGS n=1																																						
SGS Lakefield	11.1	62	130	2.8	19	0.02	< 0.0001	0.00033	1.60	0.0006	0.801	< 0.00002	< 0.00001	56.1	< 0.000003	0.000107	0.0209	< 0.0005	< 0.003	3.5	< 0.001	0.007	0.00384	0.02630	3.56	0.0013	< 0.00002	0.0005	< 0.001	0.00027	0.244	0.0002	< 0.00002	0.000038	0.00059	0.00251	0.000003	< 0.001
Lakehead	11.4	200	841	0.72	---	---	---	< 0.01	2.31	< 0.025	---	---	---	60.7	< 0.005	---	0.0240	< 0.005	< 0.01	10.1	< 0.001	< 0.001	< 0.001	< 0.05	2.77	---	< 0.025	< 0.05	< 0.05	< 0.05	0.220	< 0.01	< 0.05	< 0.08	< 0.01	0.025	---	0.048

Notes:
1. Guideline is dependent on pH
2. Guideline is dependent on hardness
3. Criteria for hexavalent chromium used.
4. Denotes a PWQO interim guideline

0.1	- value that does not meet MISA guidelines.
0.1	- value that does not meet PWQO guidelines.
0.1	- value that does not meet CCME guideline for aquatic life

Appendix B-6
Osisko Hammond Reef Gold Project
Tailings Aging Test Results

Parameter	Units	PWQO	CCME Aquatic Life	MISA	SGS Lakefield								Lakehead							
					Day 0		Day 7		Day 15		Day 30		Day 0		Day 7		Day 15		Day 30	
Final pH	---	6.5 to 8.5	6.5 to 9.0	6 to 9.5	8.46		8.39		8.36		8.31		7.956		7.931		7.702		0.001[3]	
Alk.	mg/L [8]				144		150		162		174		172.3		178.7		275.4		0.001[3]	
Cond.	µS/cm				760		724		872		985		908		931		1003		971	
Cl	mg/L				16		17		24		22		11.81		21.9		30.98		23.03	
SO_4	mg/L				210		240		240		280		159.9		256.2		275.3		269.8	
NO_2	as N mg/L	0.06			< 0.06		< 0.06		< 0.06		< 0.06		0.445		0.416		0.102		0.009	
NO_3	as N mg/L	13	13		< 0.05		< 0.05		< 0.05		< 0.05		0.019		0.047		0.095		0.104	
Thiosalts	as S_2O_3 mg/L				< 10		< 10		< 10		< 10		< 0.5		< 0.5		< 0.5		< 0.5	
NH_3+NH_4	as N mg/L				6.8		5.7		5.2		4.1		8.2		8.236		8.85		9.335	
					TOTAL	**DISSOLVED**	**TOTAL**	**DISSOLVED**	**TOTAL**	**DISSOLVED**	**TOTAL**	**DISSOLVED**	**TOTAL**	**DISSOLVED**	**TOTAL**	**DISSOLVED**	**TOTAL**	**DISSOLVED**	**TOTAL**	**DISSOLVED**
Cr (VI)	µg/L	1	1		< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	---	---	---	---	---	---	---	---
Hg	mg/L	0.0002	0.000026		< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.00000145	0.0000013	0.0000016	---	0.00000176	---	0.00000078	---
Ag	mg/L	0.0001	0.0001		bb	< 0.00001	0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.05	< 0.01	< 0.05	---	< 0.05	---	< 0.05	---
Al	mg/L	0.015, 0.075 [1, 4]	0.005, 0.1 [1]		**0.44**	0.04	0.04	0.02	0.01	< 0.01	0.04	0.04	**0.483**	0.017	**0.745**	---	**0.179**	---	**0.271**	---
As	mg/L	0.005[4]	0.005	1	0.0014	0.0015	0.0014	0.0015	0.0014	0.0014	0.0013	0.0013	< 0.005	< 0.025	< 0.005	---	< 0.005	---	< 0.005	---
B	mg/L	0.2			< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.0001	< 0.001	< 0.0001	---	< 0.0001	---	< 0.0001	---
Be	mg/L				0.0233	0.0231	0.0277	0.026	0.025	0.0244	0.0262	0.0276	---	---	---	---	---	---	---	---
Bi	mg/L	0.011, 1.1[2]			0.00004	< 0.00001	0.00001	< 0.00001	0.00003	< 0.00001	0.00001	< 0.00001	---	---	---	---	---	---	---	---
Ca	mg/L				24.8	24.7	28.4	28.2	32.4	32.6	39.4	40.1	32.276	30.44	33.357	---	35.35	---	27.976	---
Cd	mg/L	0.0001, 0.0005[2, 4]	0.000017		0.000012	0.000009	0.000016	0.000026	< 0.000003	< 0.000003	**0.000051**	**0.000028**	< 0.0002	< 0.0002	0.0002	---	< 0.0002	---	< 0.0002	---
Co	mg/L	0.0009			0.00277	0.00266	0.0029	0.00284	0.00286	0.00283	0.00301	0.00311	0.0027	< 0.005	0.0025	---	0.0028	---	0.0029	---
Cr	mg/L				0.0008	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	0.002	< 0.005	0.0055	---	0.0012	---	0.001	---
Cu	mg/L	0.001, 0.005[2, 4]	0.002 - 0.004[2]	0.6	**0.0047**	**0.0027**	**0.0152**	**0.0155**	**0.0093**	**0.0091**	**0.0045**	**0.0044**	**0.0193**	**0.012**	**0.0572**	---	**0.1584**	---	**0.1595**	---
Fe	mg/L	0.3	0.3		0.472	0.046	0.022	0.01	0.01	< 0.003	0.018	0.011	0.8976	0.104	1.9176	---	0.5556	---	0.3929	---
K	mg/L				36.1	36.3	40	39.7	39	39	45.7	46.6	29.774	28.414	30.532	---	34.311	---	35.471	---
Li	mg/L				0.002	0.002	0.002	0.002	0.002	0.002	0.003	0.003	< 0.05	< 0.001	< 0.05	---	< 0.05	---	< 0.05	---
Mg	mg/L				13.5	13.5	15.3	15	17.3	17.5	23.2	23.6	9.993	9.444	10.563	---	11.279	---	11.204	---
Mn	mg/L				0.00572	0.052	0.0516	0.0518	0.0458	0.0457	0.0194	0.0192	0.0872	0.069	0.1253	---	0.1432	---	0.0861	---
Mo	mg/L	0.04			0.0762	0.0724	0.0857	0.0832	0.0801	0.0794	0.0865	0.0914	0.065	0.06	0.062	---	0.06	---	0.058	---
Na	mg/L				104	96.5	101	98.6	107	101	122	129	79.38	75.099	78.263	---	82.125	---	85.867	---
Ni	mg/L	0.025	0.025 - 0.15[2]	1	0.0077	0.007	0.0077	0.0078	0.0067	0.0066	0.0073	0.0079	0.0116	0.011	**0.0292**	---	**0.0385**	---	**0.0342**	---
Pb	mg/L	0.001, 0.003, 0.005[2, 4]	0.001 - 0.007[2]	0.4	0.00089	0.00006	**0.0032**	0.00008	0.00024	0.00004	0.00062	0.00044	< 0.0025	< 0.025	< 0.0025	---	**0.0026**	---	< 0.0025	---
Sb	mg/L	0.02			0.0023	0.0024	0.0024	0.0026	0.002	0.0021	0.0021	0.0022	< 0.01	< 0.05	< 0.01	---	< 0.01	---	< 0.01	---
Se	mg/L	0.1	0.001		< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.001	0.001	0.001	< 0.05	< 0.05	< 0.05	---	< 0.05	---	< 0.05	---
Sn	mg/L				0.0189	0.018	0.0429	0.0423	0.0362	0.0354	0.0341	0.0354	< 0.05	< 0.05	< 0.05	---	< 0.05	---	< 0.05	---
Sr	mg/L				0.264	0.268	0.29	0.287	0.318	0.319	0.394	0.394	0.249	0.231	0.255	---	0.265	---	0.233	---
Ti	mg/L				0.0012	0.0002	0.0004	0.0002	0.0021	0.002	0.0005	0.0004	< 0.005	< 0.01	< 0.005	---	< 0.005	---	< 0.005	---
Tl	mg/L				< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.05	< 0.05	< 0.05	---	< 0.05	---	< 0.05	---
U	mg/L	0.005			0.0065	0.0063	0.00615	0.00604	0.00735	0.00723	0.00836	0.00861	< 0.05	< 0.08	< 0.05	---	< 0.05	---	< 0.05	---
V	mg/L	0.006[4]			0.00038	0.00014	0.00013	0.0003	0.0001	0.00009	0.00016	0.00014	< 0.006	< 0.01	< 0.006	---	< 0.006	---	< 0.006	---
W	mg/L				0.00014	0.00011	0.0001	0.00008	0.00027	0.00013	0.00009	0.00009	< 0.05	0.011	< 0.05	---	< 0.05	---	< 0.05	---
Y	mg/L				0.000074	0.000006	0.000012	0.000007	0.000004	0.000002	0.000003	0.000002	---	---	---	---	---	---	---	
Zn	mg/L	0.02[4]	0.03	1	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.002	0.002	**0.032**	---	**0.031**	---	**0.0427**	---	**0.0513**	---

Notes:
1. Guideline is dependent on pH
2. Guideline is dependent on hardness
3. Criteria for hexavalent chromium used.
4. Denotes a PWQO interim guideline

- ***0.1*** - value that does not meet MISA guidelines.
- 0.1 (shaded) - value that does not meet PWQO guidelines.
- **0.1** (underlined) - value that does not meet CCME guideline for aquatic life

APPENDIX 2.IV

Tabulated Kinetic Testing Results

Analyte	Unit	Provincial Water Quality	CCME Water Quality Guidelines for the Protection	MISA[3]	Wk#0	Wk#1	Wk#2	Wk#3	Wk#4	Wk#5	Wk#6	Wk#7	Wk#8	Wk# 9	Wk#10	Wk#11	Wk#12	Wk#13	Wk#14	Wk#15	Wk#16	Wk#17	Wk#18	Wk#19	Wk#20
Acidity	mg/L as CaCO3				<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	<1	1	<1	<1	<1	<1	<1	<1
Alkalinity	mg/L as CaCO3				53.2	55.3	39.6	53.4	36.7	36.6	43.3	40.7	37.4	54.5	43.2	48.8	185.1	59	43.8	34.1	43.4	42.6	83.4	72.8	78.9
Conductivity	uS/cm				536	348	142.1	139	206	119.9	131.2	129.8	121.5	169	117.6	135.4	131.2	126.2	91.6	71.5	82.7	84.6	180.9	159.4	139.8
pH	no unit	6.5 - 8.5	6.5 - 9	6 - 9.5	8.237	7.878	7.469	7.425	7.744	8.219	7.376	8.103	7.805	7.542	8.301	6.683	6.538	7.457	7.537	7.758	7.422	7.46	8.048	7.977	8.066
Bromide	mgL				0.06	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.58	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Chloride	mg/L				10.11	1.66	0.3	0.15	0.14	0.3	0.21	0.18	0.22	0.22	0.16	0.69	0.16	0.16	0.21	0.16	0.08	<DL	0.37	0.15	0.25
Nitrite (as nitrogen)	mg/L		0.06		0.018	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	**0.18**	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
Nitrate (as nitrogen)	mg/L				0.11	0.029	0.02	0.192	0.836	0.026	0.019	0.014	0.016	0.019	0.016	0.021	0.017	0.021	0.04	<0.01	0.01	0.19	0.017	0.015	0.011
Tot.Reactive Phos.	mg/L				<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Sulphate	mg/L				269.8	101.01	24.33	23.98	17.52	50.13	18.04	19.82	18.9	25.3	13.76	13.85	6.44	4.22	0.19	3.69	2.95	3.36	11.78	6.8	6.58
Mercury	mg/L	0.0002			1.33	0.85	<0.5	<0.5	<0.5	<0.5	---	---	---	---	<0.5	---	---	---	---	<0.5	---	---	---	---	<0.5
Calcium	mg/L				27.93	22.82	11.24	6.86	13.37	10.8	---	---	---	---	8.66	---	---	---	---	5.6	---	---	---	---	12.3
Potassium	mg/L				16.606	9.839	2.96	1.696	3.139	2.067	---	---	---	---	2.487	---	---	---	---	0.677	---	---	---	---	1.183
Magnesium	mg/L				9.137	9.86	4.006	2.861	7.577	3.53	---	---	---	---	5.32	---	---	---	---	2.656	---	---	---	---	7.051
Sodium	mg/L				31.088	9.099	1.573	0.622	1.483	0.744	---	---	---	---	1.06	---	---	---	---	0.316	---	---	---	---	0.591
Silver	mg/L	0.0001	0.0001		<0.01	<0.01	<0.01	**0.012**	<0.01	<0.01	---	---	---	---	<0.01	---	---	---	---	<0.01	---	---	---	---	**0.016**
Aluminum	mg/L	0.075(5)	0.1		0.081	0.084	0.04	0.023	0.058	0.067	---	---	---	---	0.068	---	---	---	---	0.023	---	---	---	---	0.026
Arsenic	mg/L	0.005	0.005	1	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	---	---	---	---	<0.025	---	---	---	---	<0.025	---	---	---	---	<0.025
Barium	mg/L				0.014	0.01	<0.01	<0.01	<0.01	<0.01	---	---	---	---	<0.01	---	---	---	---	<0.01	---	---	---	---	<0.01
Beryllium	mg/L	0.011(4)			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	---	---	---	---	<0.001	---	---	---	---	<0.001	---	---	---	---	<0.001
Cadmium	mg/L	0.0001(4)	0.000017		<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	---	---	---	---	<0.004	---	---	---	---	<0.004	---	---	---	---	<0.004
Cobalt	mg/L	0.0009			<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	---	---	---	---	<0.005	---	---	---	---	<0.005	---	---	---	---	<0.005
Chromium	mg/L				<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	---	---	---	---	<0.005	---	---	---	---	<0.005	---	---	---	---	<0.005
Copper	mg/L	0.001(4)	0.002(4)	0.6	**0.013**	**0.006**	<0.005	<0.005	<0.005	<0.005	---	---	---	---	<0.005	---	---	---	---	<0.005	---	---	---	---	<0.005
Iron	mg/L	0.3	0.3		0.033	0.042	0.019	0.013	0.039	0.033	---	---	---	---	**0.351**	---	---	---	---	0.09	---	---	---	---	0.114
Lithium	mg/L				<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	---	---	---	---	<0.001	---	---	---	---	<0.001	---	---	---	---	<0.001
Manganese	mg/L				0.044	0.039	0.027	0.022	0.028	0.025	---	---	---	---	0.009	---	---	---	---	0.015	---	---	---	---	0.02
Molybdenum	mg/L	0.04			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	---	---	---	---	<0.05	---	---	---	---	<0.05	---	---	---	---	<0.05
Nickel	mg/L	0.025	0.025(4)	1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	---	---	---	---	<0.01	---	---	---	---	<0.01	---	---	---	---	<0.01
Lead	mg/L	0.001(4)	0.001(4)	0.4	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	---	---	---	---	<0.025	---	---	---	---	<0.025	---	---	---	---	<0.025
Sulphur	mg/L				55.317	30.067	7.533	4.332	13.992	5.395	---	---	---	---	4.417	---	---	---	---	1.082	---	---	---	---	1.771
Antimony	mg/L	0.02			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	---	---	---	---	<0.05	---	---	---	---	<0.05	---	---	---	---	<0.05
Selenium	mg/L	0.1	0.001		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	---	---	---	---	<0.05	---	---	---	---	<0.05	---	---	---	---	<0.05
Tin	mg/L				<0.05	<0.05	<0.05	<0.05	0.1233	0.1851	---	---	---	---	<0.05	---	---	---	---	<0.05	---	---	---	---	<0.05
Strontium	mg/L				0.162	0.128	0.051	0.032	0.069	0.043	---	---	---	---	0.041	---	---	---	---	0.024	---	---	---	---	0.062
Titanium	mg/L				<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	---	---	---	---	<0.01	---	---	---	---	<0.01	---	---	---	---	<0.01
Thallium	mg/L				<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	---	---	---	---	<0.05	---	---	---	---	<0.05	---	---	---	---	<0.05
Uranium	mg/L	0.005			<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	---	---	---	---	<0.08	---	---	---	---	<0.08	---	---	---	---	<0.08
Vanadium	mg/L	0.006			<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	---	---	---	---	<0.01	---	---	---	---	<0.01	---	---	---	---	<0.01
Tungsten	mg/L	0.03			0.01	0.009	<0.005	<0.005	<0.005	<0.005	---	---	---	---	<0.005	---	---	---	---	<0.005	---	---	---	---	<0.005
Zinc	mg/L	0.02	0.03	1	<0.005	0.005	**0.038**	0.017	0.029	0.03	---	---	---	---	0.024	---	---	---	---	0.02	---	---	---	---	<0.005

0.5	Parameter exceeds the Provincial Water Quality Objective[1]
0.5	Parameter exceeds the CCME Water Quality Guidelines[2]
0.5	Parameter exceeds MISA[3]

(1) Provincial Water Quality Objectives (PWQO) (MOEE, 1999)
(2) Canadian Environmental Quality Guidelines. Canadian Council of Ministers of the Environment (CCME, 2007).
(3) Municipal/Industrial Strategy for Abatement (MISA): Effluent Monitoring and Effluent Limits — Metal Mining Sector (O.Reg. 560/94).
(4) Parameter is dependant on hardness. The minimum value was selected.
(5) Aluminum guideline applies to water with pH > 6.5

Appendix C-1
Osisko Hammond Reef Gold Project
2010-HR-004 - Fine-Grained Granite

Analyte	Unit	Provincial Water Quality	CCME Water Quality Guidelines for the	MISA[3]	Wk#0	Wk#1	Wk#2	Wk#3	Wk#4	Wk#5	Wk#6	Wk#7	Wk#8	Wk# 9	Wk#10	Wk#11	Wk#12	Wk#13	Wk#14	Wk#15	Wk#16	Wk#17	Wk#18	Wk#19	Wk#20	Wk#21
					26-Apr-11	3-May-11	10-May-11	17-May-11	24-May-11	31-May-11	7-Jun-11	14-Jun-11	21-Jun-11	28-Jun-11	5-Jul-11	12-Jul-11	19-Jul-11	26-Jul-11	2-Aug-11	9-Aug-11	16-Aug-11	23-Aug-11	30-Aug-11	6-Sep-11	13-Sep-11	20-Sep-11
Leachate Volume Added (mL)	mL				1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Leachate Volume Recovered (mL)	mL				764	922	876	904	861	873	941	925	869	866	865	860	868	849	877	862	844	868	872	856	864	930
pH	no unit	6.5 - 8.5	6.5 - 9	6 - 9.5	8.34	8.79	8.59	8.16	8.64	8.29	7.74	8.6	8.76	8.12	8.46	8.6	7.87	8.68	8.63	8.51	7.87	8.96	8.45	8.31	7.62	7.34
Alkalinity	mg/L as $CaCO_3$				23	24	17	21	17	23	20	16	15	15	16	13	13	14	13	13	13	13	12	23	13	11
Acidity	mg/L as $CaCO_3$				< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Conductivity	uS/cm				7	48	32	42	38	43	37	34	30	32	35	28	28	32	28	25	22	26	26	25	28	20
Sulphate	mg/L				0.5	0.9	0.8	0.9	1	0.8	0.8	0.7	0.8	0.6	0.7	0.7	0.7	0.6	0.6	0.6	0.5	0.5	0.5	0.6	0.5	0.4
Chloride	mg/L				0.8	1.1	0.5	0.3	< 0.2	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---
Nitrate (as nitrogen)	mg/L				< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	---	---	---	---	< 0.05	---	---	---	---	< 0.05	---	---	---	---	< 0.05	---
Ammonia+Ammonium (N)	mg/L				< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	---	---	---	---	< 0.1	---	---	---	---	< 0.1	---	---	---	---	< 0.1	---
Tot.Reactive Phos.	mg/L				< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	---	---	---	---	< 0.03	---	---	---	---	< 0.03	---	---	---	---	< 0.03	---
Chromium III	mg/L	0.0089	0.0089		< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	<0.0005	---	---	---	---	<0.0005	---
Chromium VI	µg/L	1	1		0.6	0.7	0.2	< 0.2	< 0.2	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---
Mercury	mg/L	0.0002			< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---
Silver	mg/L	0.0001	0.0001		< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---
Aluminum	mg/L	0.075[5]	0.1		0.08	0.08	0.09	0.08	0.09	0.06	---	---	---	---	0.07	---	---	---	---	0.05	---	---	---	---	0.05	---
Arsenic	mg/L	0.005	0.005	1	0.0004	< 0.0002	< 0.0002	< 0.0002	< 0.0002	0.0002	---	---	---	---	< 0.0002	---	---	---	---	< 0.0002	---	---	---	---	< 0.0002	---
Barium	mg/L				0.00304	0.00366	0.00241	0.00255	0.0018	0.00217	---	---	---	---	0.00139	---	---	---	---	0.00113	---	---	---	---	0.0011	---
Beryllium	mg/L	0.011[4]			< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---
Boron	mg/L	0.2			0.0041	0.0063	0.0025	0.0042	0.0057	0.0109	---	---	---	---	0.0019	---	---	---	---	0.0006	---	---	---	---	0.0009	---
Bismuth	mg/L				< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---
Calcium	mg/L				6.17	5.84	4.88	5.09	4.46	4.86	---	---	---	---	4.28	---	---	---	---	3.93	---	---	---	---	4.04	---
Cadmium	mg/L	0.0001[4]	0.000017		< 0.000003	< 0.000003	**0.000051**	0.000011	0.000003	< 0.000003	---	---	---	---	**0.00004**	---	---	---	---	0.000007	---	---	---	---	**0.000097**	---
Cobalt	mg/L	0.0009			0.000036	0.000035	0.000105	0.000035	0.000024	0.000027	---	---	---	---	0.000056	---	---	---	---	0.000072	---	---	---	---	0.000062	---
Chromium	mg/L				0.0005	0.0006	< 0.0005	< 0.0005	< 0.0005	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---
Copper	mg/L	0.001[4]	0.002[4]	0.6	0.0007	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---
Iron	mg/L	0.3	0.3		< 0.002	< 0.002	< 0.002	< 0.002	0.013	< 0.002	---	---	---	---	< 0.002	---	---	---	---	< 0.002	---	---	---	---	0.002	---
Potassium	mg/L				0.489	0.49	0.316	0.324	0.25	0.2	---	---	---	---	0.122	---	---	---	---	0.093	---	---	---	---	0.079	---
Lithium	mg/L				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---
Magnesium	mg/L				0.558	1.22	0.934	1.1	0.871	0.942	---	---	---	---	0.67	---	---	---	---	0.716	---	---	---	---	0.688	---
Manganese	mg/L				0.00236	0.00811	0.00938	0.00949	0.00865	0.0112	---	---	---	---	0.0117	---	---	---	---	0.0106	---	---	---	---	0.0118	---
Molybdenum	mg/L	0.04			0.00059	0.0014	0.00107	0.00061	0.00057	0.00036	---	---	---	---	0.00031	---	---	---	---	0.00009	---	---	---	---	0.0003	---
Sodium	mg/L				0.77	1.19	0.66	0.56	0.5	0.27	---	---	---	---	0.11	---	---	---	---	0.06	---	---	---	---	0.05	---
Nickel	mg/L	0.025	0.025[4]	1	< 0.0001	0.0002	0.0003	< 0.0001	< 0.0001	0.0002	---	---	---	---	0.0003	---	---	---	---	0.0001	---	---	---	---	0.0001	---
Phosphorus	mg/L				0.047	0.013	< 0.009	< 0.009	0.014	0.039	---	---	---	---	< 0.009	---	---	---	---	< 0.009	---	---	---	---	< 0.009	---
Lead	mg/L	0.001[4]	0.001[4]	0.4	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	---	---	---	---	0.00004	---	---	---	---	0.00021	---	---	---	---	< 0.00002	---
Antimony	mg/L	0.02			0.0007	0.0006	0.0003	0.0002	< 0.0002	0.0003	---	---	---	---	0.0003	---	---	---	---	0.0002	---	---	---	---	0.0002	---
Selenium	mg/L	0.1	0.001		< 0.001	< 0.001	< 0.001	**0.002**	< 0.001	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---
Silica	mg/L				0.17	0.25	0.2	0.24	0.14	0.17	---	---	---	---	0.12	---	---	---	---	0.14	---	---	---	---	0.15	---
Tin	mg/L				0.001	0.0009	0.00034	0.00041	0.00022	0.00027	---	---	---	---	0.00023	---	---	---	---	0.00006	---	---	---	---	0.00003	---
Strontium	mg/L				0.023	0.0286	0.0201	0.0223	0.0168	0.0181	---	---	---	---	0.0131	---	---	---	---	0.0109	---	---	---	---	0.0112	---
Titanium	mg/L				< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0001	< 0.0001	---	---	---	---	0.0001	---	---	---	---	0.0001	---	---	---	---	< 0.0001	---
Thallium	mg/L				< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	0.00008	---	---	---	---	< 0.00002	---
Uranium	mg/L	0.005			0.000004	0.000009	0.000013	0.000001	0.000013	0.000009	---	---	---	---	0.000014	---	---	---	---	0.000035	---	---	---	---	0.000016	---
Vanadium	mg/L	0.006			0.0003	< 0.00003	0.00036	0.00041	0.00041	0.00023	---	---	---	---	0.00032	---	---	---	---	0.00023	---	---	---	---	0.00022	---
Zinc	mg/L	0.02	0.03	1	< 0.001	< 0.001	0.007	0.002	0.001	< 0.001	---	---	---	---	< 0.001	---	---	---	---	0.017	---	---	---	---	< 0.001	---

0.5	Parameter exceeds the Provincial Water Quality Objective[1]
0.5	Parameter exceeds the CCME Water Quality Guidelines[2]
0.5	Parameter exceeds MISA[3]

(1) Provincial Water Quality Objectives (PWQO) (MOEE, 1999)
(2) Canadian Environmental Quality Guidelines. Canadian Council of Ministers of the Environment (CCME, 2007).
(3) Municipal/Industrial Strategy for Abatement (MISA): Effluent Monitoring and Effluent Limits — Metal Mining Sector (O.Reg. 560/94).
(4) Parameter is dependant on hardness. The minimum value was selected.
(5) Aluminum guideline applies to water with pH > 6.5

Analyte	Unit	Provincial Water Quality	CCME Water Quality Guidelines for the	MISA[3]	Wk#22	Wk#23	Wk#24	Wk#25	Wk#26	Wk#27	Wk#28	Wk#29	Wk#30	Wk#31	Wk#32	Wk#33	Wk#34	Wk#35	Wk#36	Wk#37	Wk#38	Wk#39	Wk#40	Wk#41	Wk#42	Wk#43	Wk#44
					27-Sep-11	4-Oct-11	11-Oct-11	18-Oct-11	25-Oct-11	1-Nov-11	8-Nov-11	15-Nov-11	22-Nov-11	29-Nov-11	6-Dec-11	13-Dec-11	20-Dec-11	28-Dec-11	3-Jan-12	10-Jan-12	17-Jan-12	24-Jan-12	31-Jan-12	7-Feb-12	14-Feb-12	21-Feb-12	28-Feb-12
Leachate Volume Added (mL)	mL				1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Leachate Volume Recovered (mL)	mL				918	930	879	872	877	855	867	824	827	908	850	858	834	838	889	854	858	860	865	897	864	874	861
pH	no unit	6.5 - 8.5	6.5 - 9	6 - 9.5	7.71	8.22	7.44	7.75	7.48	7.33	7.39	7.9	7.98	7.24	8.17	7.51	7.65	7.71	7.88	7.4	7.53	7.76	7.33	7.64	7.33	7.27	7.42
Alkalinity	mg/L as $CaCO_3$				26	14	12	12	12	11	11	10	12	11	11	10	15	11	12	10	10	11	10	11	10	10	11
Acidity	mg/L as $CaCO_3$				< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Conductivity	uS/cm				159	5	30	27	20	27	15	26	21	24	4	18	34	25	19	23	18	24	18	24	23	24	24
Sulphate	mg/L				0.5	0.4	0.4	0.5	0.4	0.5	0.5	0.5	0.6	0.6	0.5	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Chloride	mg/L				---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---
Nitrate (as nitrogen)	mg/L				---	---	---	< 0.05	---	---	---	---	< 0.05	---	---	---	---	< 0.05	---	---	---	---	< 0.05	---	---	---	---
Ammonia+Ammonium (N)	mg/L				---	---	---	< 0.1	---	---	---	---	< 0.1	---	---	---	---	0.1	---	---	---	---	< 0.1	---	---	---	---
Tot.Reactive Phos.	mg/L				---	---	---	< 0.03	---	---	---	---	0.13	---	---	---	---	< 0.03	---	---	---	---	< 0.03	---	---	---	---
Chromium III	mg/L	0.0089	0.0089		---	---	---	< 0.0005	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Chromium VI	µg/L	1	1		---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---
Mercury	mg/L	0.0002			---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---
Silver	mg/L	0.0001	0.0001		---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---
Aluminum	mg/L	0.075[5]	0.1		---	---	---	0.05	---	---	---	---	0.04	---	---	---	---	0.05	---	---	---	---	0.04	---	---	---	---
Arsenic	mg/L	0.005	0.005	1	---	---	---	< 0.0002	---	---	---	---	< 0.0002	---	---	---	---	0.0003	---	---	---	---	< 0.0002	---	---	---	---
Barium	mg/L				---	---	---	0.00105	---	---	---	---	0.00082	---	---	---	---	0.00083	---	---	---	---	0.00082	---	---	---	---
Beryllium	mg/L	0.011[4]			---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---
Boron	mg/L	0.2			---	---	---	0.0004	---	---	---	---	0.0004	---	---	---	---	0.0006	---	---	---	---	0.0003	---	---	---	---
Bismuth	mg/L				---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---
Calcium	mg/L				---	---	---	4.01	---	---	---	---	3.65	---	---	---	---	3.36	---	---	---	---	3.57	---	---	---	---
Cadmium	mg/L	0.0001[4]	0.000017		---	---	---	< 0.000003	---	---	---	---	< 0.000003	---	---	---	---	< 0.000003	---	---	---	---	< 0.000003	---	---	---	---
Cobalt	mg/L	0.0009			---	---	---	< 0.000002	---	---	---	---	0.000008	---	---	---	---	0.000008	---	---	---	---	0.000008	---	---	---	---
Chromium	mg/L				---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---
Copper	mg/L	0.001[4]	0.002[4]	0.6	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---
Iron	mg/L	0.3	0.3		---	---	---	< 0.002	---	---	---	---	< 0.003	---	---	---	---	< 0.003	---	---	---	---	< 0.003	---	---	---	---
Potassium	mg/L				---	---	---	0.059	---	---	---	---	0.052	---	---	---	---	0.048	---	---	---	---	0.039	---	---	---	---
Lithium	mg/L				---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---
Magnesium	mg/L				---	---	---	0.632	---	---	---	---	0.567	---	---	---	---	0.599	---	---	---	---	0.438	---	---	---	---
Manganese	mg/L				---	---	---	0.0103	---	---	---	---	0.00953	---	---	---	---	0.00798	---	---	---	---	0.0101	---	---	---	---
Molybdenum	mg/L	0.04			---	---	---	0.00012	---	---	---	---	0.00008	---	---	---	---	0.00011	---	---	---	---	0.00005	---	---	---	---
Sodium	mg/L				---	---	---	0.04	---	---	---	---	0.05	---	---	---	---	0.04	---	---	---	---	0.03	---	---	---	---
Nickel	mg/L	0.025	0.025[4]	1	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---
Phosphorus	mg/L				---	---	---	< 0.009	---	---	---	---	< 0.009	---	---	---	---	< 0.009	---	---	---	---	< 0.009	---	---	---	---
Lead	mg/L	0.001[4]	0.001[4]	0.4	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---
Antimony	mg/L	0.02			---	---	---	< 0.0002	---	---	---	---	< 0.0002	---	---	---	---	< 0.0002	---	---	---	---	< 0.0002	---	---	---	---
Selenium	mg/L	0.1	0.001		---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---
Silica	mg/L				---	---	---	0.13	---	---	---	---	0.12	---	---	---	---	0.15	---	---	---	---	0.11	---	---	---	---
Tin	mg/L				---	---	---	0.00007	---	---	---	---	0.00006	---	---	---	---	< 0.00001	---	---	---	---	0.00006	---	---	---	---
Strontium	mg/L				---	---	---	0.0107	---	---	---	---	0.0098	---	---	---	---	0.0087	---	---	---	---	0.0088	---	---	---	---
Titanium	mg/L				---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	0.0001	---	---	---	---	< 0.0001	---	---	---	---
Thallium	mg/L				---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---
Uranium	mg/L	0.005			---	---	---	0.000026	---	---	---	---	0.000009	---	---	---	---	0.00001	---	---	---	---	0.000012	---	---	---	---
Vanadium	mg/L	0.006			---	---	---	0.00027	---	---	---	---	0.00026	---	---	---	---	0.00014	---	---	---	---	0.00019	---	---	---	---
Zinc	mg/L	0.02	0.03	1	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---

0.5	Parameter exceeds the Provincial Water Quality Objective[1]
0.5	Parameter exceeds the CCME Water Quality Guidelines[2]
0.5	Parameter exceeds MISA[3]

(1) Provincial Water Quality Objectives (PWQO) (MOEE, 1999)
(2) Canadian Environmental Quality Guidelines. Canadian Council of Ministers of the Environment (CCME, 2007).
(3) Municipal/Industrial Strategy for Abatement (MISA): Effluent Monitoring and Effluent Limits — Metal Mining Sect
(4) Parameter is dependant on hardness. The minimum value was selected.
(5) Aluminum guideline applies to water with pH > 6.5

Analyte	Unit	Provincial Water Quality	CCME Water Quality Guidelines for the	MISA[3]	Wk#0 26-Apr-11	Wk#1 3-May-11	Wk#2 10-May-11	Wk#3 17-May-11	Wk#4 24-May-11	Wk#5 31-May-11	Wk#6 7-Jun-11	Wk#7 14-Jun-11	Wk#8 21-Jun-11	Wk# 9 28-Jun-11	Wk#10 5-Jul-11	Wk#11 12-Jul-11	Wk#12 19-Jul-11	Wk#13 26-Jul-11	Wk#14 2-Aug-11	Wk#15 9-Aug-11	Wk#16 16-Aug-11	Wk#17 23-Aug-11	Wk#18 30-Aug-11	Wk#19 6-Sep-11	Wk#20 13-Sep-11	Wk#21 20-Sep-11	Wk#22 27-Sep-11
Leachate Volume Added (mL)	mL				1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Leachate Volume Recovered (mL)	mL				794	970	956	955	899	884	897	922	920	913	919	932	906	938	973	836	875	878	916	881	874	862	913
pH	no unit	6.5 - 8.5	6.5 - 9	6 - 9.5	7.51	7.61	7.51	7.53	7.56	7.8	7.72	7.7	7.68	7.28	7.65	6.96	7.73	7.09	7.04	8	7.8	8.74	7.68	8.47	7.57	7.18	7.35
Alkalinity	mg/L as $CaCO_3$				15	26	14	14	12	14	12	10	11	9	9	8	11	7	10	11	10	10	8	12	11	9	11
Acidity	mg/L as $CaCO_3$				< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Conductivity	uS/cm				6	41	26	33	29	33	26	23	23	18	19	21	23	16	23	21	18	20	17	21	23	22	20
Sulphate	mg/L				0.5	0.8	1.6	0.9	1.2	1	0.8	0.5	0.5	0.3	0.3	0.3	0.5	< 0.2	0.3	0.4	0.3	0.3	0.2	0.2	< 0.2	< 0.2	< 0.2
Chloride	mg/L				0.6	0.7	0.3	< 0.2	< 0.2	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---
Nitrate (as nitrogen)	mg/L				0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	---	---	---	---	< 0.05	---	---	---	---	< 0.05	---	---	---	---	< 0.05	---	---
Ammonia+Ammonium (N)	mg/L				< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	---	---	---	---	< 0.1	---	---	---	---	< 0.1	---	---	---	---	< 0.1	---	---
Tot.Reactive Phos.	mg/L				< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	---	---	---	---	< 0.03	---	---	---	---	< 0.03	---	---	---	---	< 0.03	---	---
Chromium III	mg/L	0.0089	0.0089		< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	---	---	---	---	< 0.0005	---	---	---	---	<0.0005	---	---	---	---	<0.0005	---	---
Chromium VI	µg/L	1	1		0.2	0.2	< 0.2	< 0.2	< 0.2	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---
Mercury	mg/L	0.0002			< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---
Silver	mg/L	0.0001	0.0001		< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---
Aluminum	mg/L	0.075[5]	0.1		0.02	< 0.01	0.02	< 0.01	0.02	< 0.01	---	---	---	---	< 0.01	---	---	---	---	0.01	---	---	---	---	< 0.01	---	---
Arsenic	mg/L	0.005	0.005	1	0.0005	0.0007	0.0006	0.0007	0.0005	0.0005	---	---	---	---	< 0.0002	---	---	---	---	0.0002	---	---	---	---	0.0002	---	---
Barium	mg/L				0.0112	0.00846	0.00602	0.00591	0.00387	0.00393	---	---	---	---	0.00211	---	---	---	---	0.00253	---	---	---	---	0.00227	---	---
Beryllium	mg/L	0.011[4]			< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---
Boron	mg/L	0.2			0.0019	0.0035	0.0012	0.0012	0.0018	0.0016	---	---	---	---	0.0011	---	---	---	---	0.0002	---	---	---	---	0.0004	---	---
Bismuth	mg/L				< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---
Calcium	mg/L				3.28	2.96	2.08	2.29	1.71	1.82	---	---	---	---	1.26	---	---	---	---	1.51	---	---	---	---	1.4	---	---
Cadmium	mg/L	0.0001[4]	0.000017		< 0.000003	< 0.000003	< 0.000003	< 0.000003	< 0.000003	< 0.000003	---	---	---	---	< 0.000003	---	---	---	---	0.000009	---	---	---	---	0.000004	---	---
Cobalt	mg/L	0.0009			0.000027	0.000043	0.000027	0.000024	0.000025	0.000027	---	---	---	---	0.000012	---	---	---	---	0.000008	---	---	---	---	0.000007	---	---
Chromium	mg/L				< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---
Copper	mg/L	0.001[4]	0.002[4]	0.6	0.0006	0.0006	< 0.0005	< 0.0005	< 0.0005	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---
Iron	mg/L	0.3	0.3		< 0.002	< 0.002	< 0.002	< 0.002	0.01	< 0.002	---	---	---	---	< 0.002	---	---	---	---	< 0.002	---	---	---	---	0.003	---	---
Potassium	mg/L				1.42	1.73	1.31	1.23	1.15	1.09	---	---	---	---	0.427	---	---	---	---	0.553	---	---	---	---	0.667	---	---
Lithium	mg/L				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---
Magnesium	mg/L				1.55	2.29	1.68	1.88	1.7	2.03	---	---	---	---	1.19	---	---	---	---	1.68	---	---	---	---	1.61	---	---
Manganese	mg/L				0.00253	0.00394	0.00283	0.00327	0.00209	0.00197	---	---	---	---	0.0023	---	---	---	---	0.00145	---	---	---	---	0.00179	---	---
Molybdenum	mg/L	0.04			0.00066	0.00154	0.00074	0.00053	0.00059	0.00033	---	---	---	---	0.00008	---	---	---	---	0.00006	---	---	---	---	0.00005	---	---
Sodium	mg/L				0.54	0.68	0.35	0.27	0.23	0.16	---	---	---	---	0.02	---	---	---	---	0.01	---	---	---	---	< 0.01	---	---
Nickel	mg/L	0.025	0.025[4]	1	0.0002	0.0003	0.0002	< 0.0001	< 0.0001	0.0001	---	---	---	---	0.0002	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---
Phosphorus	mg/L				0.054	< 0.009	0.018	< 0.009	0.012	0.015	---	---	---	---	< 0.009	---	---	---	---	0.012	---	---	---	---	< 0.009	---	---
Lead	mg/L	0.001[4]	0.001[4]	0.4	< 0.00002	0.00007	< 0.00002	< 0.00002	0.00004	< 0.00002	---	---	---	---	0.00003	---	---	---	---	0.00012	---	---	---	---	< 0.00002	---	---
Antimony	mg/L	0.02			0.0008	0.0007	0.0004	0.0003	0.0002	0.0004	---	---	---	---	0.0003	---	---	---	---	0.0002	---	---	---	---	0.0003	---	---
Selenium	mg/L	0.1	0.001		< 0.001	< 0.001	< 0.001	**0.002**	< 0.001	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---
Silica	mg/L				0.41	0.48	0.4	0.38	0.24	0.27	---	---	---	---	0.14	---	---	---	---	0.18	---	---	---	---	0.19	---	---
Tin	mg/L				0.00131	0.00104	0.00055	0.00071	0.00032	0.00025	---	---	---	---	0.00017	---	---	---	---	0.00019	---	---	---	---	0.00006	---	---
Strontium	mg/L				0.0223	0.0246	0.0175	0.0191	0.0149	0.0163	---	---	---	---	0.0089	---	---	---	---	0.0112	---	---	---	---	0.0089	---	---
Titanium	mg/L				< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0001	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---
Thallium	mg/L				< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---
Uranium	mg/L	0.005			0.000003	0.000059	0.000062	0.000029	0.000035	0.000046	---	---	---	---	0.000025	---	---	---	---	0.000017	---	---	---	---	0.000015	---	---
Vanadium	mg/L	0.006			0.00131	0.002	0.00189	0.00199	0.00208	0.0017	---	---	---	---	0.00094	---	---	---	---	0.00093	---	---	---	---	0.0008	---	---
Zinc	mg/L	0.02	0.03	1	< 0.001	0.001	< 0.001	< 0.001	< 0.001	< 0.001	---	---	---	---	< 0.001	---	---	---	---	0.002	---	---	---	---	< 0.001	---	---

0.5 (shaded)	Parameter exceeds the Provincial Water Quality Objective[1]
0.5	Parameter exceeds the CCME Water Quality Guidelines[2]
0.5 (underlined)	Parameter exceeds MISA[3]

(1) Provincial Water Quality Objectives (PWQO) (MOEE, 1999)
(2) Canadian Environmental Quality Guidelines. Canadian Council of Ministers of the Environment (CCME, 2007).
(3) Municipal/Industrial Strategy for Abatement (MISA): Effluent Monitoring and Effluent Limits — Metal Mining Sector (O.Reg. 560/94).
(4) Parameter is dependant on hardness. The minimum value was selected.
(5) Aluminum guideline applies to water with pH > 6.5

Analyte	Unit	Provincial Water Quality	CCME Water Quality Guidelines for the	MISA[3]	Wk#23 4-Oct-11	Wk#24 11-Oct-11	Wk#25 18-Oct-11	Wk#26 25-Oct-11	Wk#27 1-Nov-11	Wk#28 8-Nov-11	Wk#29 15-Nov-11	Wk#30 22-Nov-11	Wk#31 29-Nov-11	Wk#32 6-Dec-11	Wk#33 13-Dec-11	Wk#34 20-Dec-11	Wk#35 28-Dec-11	Wk#36 3-Jan-12	Wk#37 10-Jan-12	Wk#38 17-Jan-12	Wk#39 24-Jan-12	Wk#40 31-Jan-12	Wk#41 7-Feb-12	Wk#42 14-Feb-12	Wk#43 21-Feb-12	Wk#44 28-Feb-12
Leachate Volume Added (mL)	mL				1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Leachate Volume Recovered (mL)	mL				916	896	933	938	921	914	896	905	918	906	916	912	919	936	916	920	923	928	944	937	930	929
pH	no unit	6.5 - 8.5	6.5 - 9	6 - 9.5	7.6	7.18	6.85	6.99	6.98	6.86	6.81	6.7	6.85	7.65	7.21	7.38	7.41	7.07	7.26	7.79	7.08	6.78	6.8	6.98	6.93	6.86
Alkalinity	mg/L as $CaCO_3$				12	14	7	6	9	8	9	10	16	9	7	10	7	6	6	7	6	6	6	6	7	6
Acidity	mg/L as $CaCO_3$				< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Conductivity	uS/cm				21	21	15	13	21	10	16	18	19	15	12	27	15	3	14	11	13	3	12	23	13	13
Sulphate	mg/L				< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	0.3	0.2	0.2	0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Chloride	mg/L				---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---
Nitrate (as nitrogen)	mg/L				---	---	< 0.05	---	---	---	---	< 0.05	---	---	---	---	< 0.05	---	---	---	---	< 0.05	---	---	---	---
Ammonia+Ammonium (N)	mg/L				---	---	< 0.1	---	---	---	---	< 0.1	---	---	---	---	< 0.1	---	---	---	---	< 0.1	---	---	---	---
Tot.Reactive Phos.	mg/L				---	---	< 0.03	---	---	---	---	0.07	---	---	---	---	< 0.03	---	---	---	---	< 0.03	---	---	---	---
Chromium III	mg/L	0.0089	0.0089		---	---	< 0.0005	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Chromium VI	µg/L	1	1		---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---
Mercury	mg/L	0.0002			---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---
Silver	mg/L	0.0001	0.0001		---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---
Aluminum	mg/L	0.075[5]	0.1		---	---	< 0.01	---	---	---	---	< 0.01	---	---	---	---	0.01	---	---	---	---	< 0.01	---	---	---	---
Arsenic	mg/L	0.005	0.005	1	---	---	< 0.0002	---	---	---	---	< 0.0002	---	---	---	---	0.0002	---	---	---	---	< 0.0002	---	---	---	---
Barium	mg/L				---	---	0.00154	---	---	---	---	0.00118	---	---	---	---	0.00107	---	---	---	---	0.00094	---	---	---	---
Beryllium	mg/L	0.011[4]			---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---
Boron	mg/L	0.2			---	---	< 0.0002	---	---	---	---	< 0.0002	---	---	---	---	< 0.0002	---	---	---	---	< 0.0002	---	---	---	---
Bismuth	mg/L				---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---
Calcium	mg/L				---	---	1.27	---	---	---	---	1.11	---	---	---	---	1.1	---	---	---	---	1	---	---	---	---
Cadmium	mg/L	0.0001[4]	0.000017		---	---	< 0.000003	---	---	---	---	< 0.000003	---	---	---	---	< 0.000003	---	---	---	---	< 0.000003	---	---	---	---
Cobalt	mg/L	0.0009			---	---	< 0.000002	---	---	---	---	0.000005	---	---	---	---	0.000011	---	---	---	---	0.000004	---	---	---	---
Chromium	mg/L				---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---
Copper	mg/L	0.001[4]	0.002[4]	0.6	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---
Iron	mg/L	0.3	0.3		---	---	< 0.002	---	---	---	---	< 0.003	---	---	---	---	0.005	---	---	---	---	< 0.003	---	---	---	---
Potassium	mg/L				---	---	0.234	---	---	---	---	0.248	---	---	---	---	0.177	---	---	---	---	0.133	---	---	---	---
Lithium	mg/L				---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---
Magnesium	mg/L				---	---	0.88	---	---	---	---	1.42	---	---	---	---	1.05	---	---	---	---	0.802	---	---	---	---
Manganese	mg/L				---	---	0.00344	---	---	---	---	0.00228	---	---	---	---	0.0024	---	---	---	---	0.0029	---	---	---	---
Molybdenum	mg/L	0.04			---	---	0.00003	---	---	---	---	0.00004	---	---	---	---	0.00005	---	---	---	---	0.00002	---	---	---	---
Sodium	mg/L				---	---	< 0.01	---	---	---	---	< 0.01	---	---	---	---	0.01	---	---	---	---	< 0.01	---	---	---	---
Nickel	mg/L	0.025	0.025[4]	1	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	0.0001	---	---	---	---	< 0.0001	---	---	---	---
Phosphorus	mg/L				---	---	< 0.009	---	---	---	---	< 0.009	---	---	---	---	0.014	---	---	---	---	< 0.009	---	---	---	---
Lead	mg/L	0.001[4]	0.001[4]	0.4	---	---	0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---
Antimony	mg/L	0.02			---	---	< 0.0002	---	---	---	---	< 0.0002	---	---	---	---	< 0.0002	---	---	---	---	< 0.0002	---	---	---	---
Selenium	mg/L	0.1	0.001		---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---
Silica	mg/L				---	---	0.11	---	---	---	---	0.13	---	---	---	---	0.13	---	---	---	---	0.1	---	---	---	---
Tin	mg/L				---	---	0.00011	---	---	---	---	0.00024	---	---	---	---	0.00012	---	---	---	---	0.0001	---	---	---	---
Strontium	mg/L				---	---	0.0065	---	---	---	---	0.0061	---	---	---	---	0.0052	---	---	---	---	0.0044	---	---	---	---
Titanium	mg/L				---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---
Thallium	mg/L				---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---
Uranium	mg/L	0.005			---	---	0.000044	---	---	---	---	0.000007	---	---	---	---	0.000008	---	---	---	---	0.000004	---	---	---	---
Vanadium	mg/L	0.006			---	---	0.0004	---	---	---	---	0.00062	---	---	---	---	0.00041	---	---	---	---	0.00036	---	---	---	---
Zinc	mg/L	0.02	0.03	1	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---

0.5	Parameter exceeds the Provincial Water Quality Objective[1]
0.5	Parameter exceeds the CCME Water Quality Guidelines[2]
0.5	Parameter exceeds MISA[3]

(1) Provincial Water Quality Objectives (PWQO) (MOEE, 1999)
(2) Canadian Environmental Quality Guidelines. Canadian Council of Ministers of the Environment (CCME, 2007).
(3) Municipal/Industrial Strategy for Abatement (MISA): Effluent Monitoring and Effluent Limits — Metal Mining Secto
(4) Parameter is dependant on hardness. The minimum value was selected.
(5) Aluminum guideline applies to water with pH > 6.5

Analyte	Unit	Provincial Water Quality	CCME Water Quality Guidelines for the	MISA(3)	Wk#0 26-Apr-11	Wk#1 3-May-11	Wk#2 10-May-11	Wk#3 17-May-11	Wk#4 24-May-11	Wk#5 31-May-11	Wk#6 7-Jun-11	Wk#7 14-Jun-11	Wk#8 21-Jun-11	Wk# 9 28-Jun-11	Wk#10 5-Jul-11	Wk#11 12-Jul-11	Wk#12 19-Jul-11	Wk#13 26-Jul-11	Wk#14 2-Aug-11	Wk#15 9-Aug-11	Wk#16 16-Aug-11	Wk#17 23-Aug-11	Wk#18 30-Aug-11	Wk#19 6-Sep-11	Wk#20 13-Sep-11	Wk#21 20-Sep-11	Wk#22 27-Sep-11	Wk#23 4-Oct-11
Leachate Volume Added (mL)	mL				1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Leachate Volume Recovered (mL)	mL				778	975	988	963	983	981	987	972	279	987	933	835	837	825	863	878	869	897	968	905	875	904	912	898
pH	no unit	6.5 - 8.5	6.5 - 9	6 - 9.5	8.93	7.84	8.39	7.96	8.33	7.94	7.55	8.23	8.56	7.25	7.97	8.79	8.11	8.46	8.74	7.84	8.04	8.57	8.29	7.9	7.76	7.68	7.84	8.34
Alkalinity	mg/L as $CaCO_3$				33	24	26	24	20	20	18	17	21	11	16	13	14	12	13	14	13	14	16	14	15	14	15	15
Acidity	mg/L as $CaCO_3$				< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Conductivity	uS/cm				74	49	43	46	40	40	36	36	36	34	33	27	27	29	27	31	23	29	34	36	32	31	5	25
Sulphate	mg/L				1	1.2	0.8	0.6	0.5	0.4	0.4	0.4	0.2	0.2	0.2	0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Chloride	mg/L				7.2	2.7	0.9	0.2	< 0.2	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---
Nitrate (as nitrogen)	mg/L				0.10	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	---	---	---	---	< 0.05	---	---	---	---	< 0.05	---	---	---	---	< 0.05	---	---	---
Ammonia+Ammonium (N)	mg/L				< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	---	---	---	---	< 0.1	---	---	---	---	0.1	---	---	---	---	< 0.1	---	---	---
Tot.Reactive Phos.	mg/L				< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	---	---	---	---	< 0.03	---	---	---	---	< 0.03	---	---	---	---	< 0.03	---	---	---
Chromium III	mg/L	0.0089	0.0089		< 0.2	---	< 0.2	< 0.2	< 0.2	< 0.2	---	---	---	---	< 0.0005	---	---	---	---	<0.0005	---	---	---	---	<0.0005	---	---	---
Chromium VI	µg/L	1	1		0.4	1	< 0.2	< 0.2	< 0.2	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---
Mercury	mg/L	0.0002			< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---
Silver	mg/L	0.0001	0.0001		< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---
Aluminum	mg/L	0.075(5)	0.1		**0.15**	0.03	**0.25**	**0.25**	**0.23**	**0.2**	---	---	---	---	**0.12**	---	---	---	---	**0.14**	---	---	---	---	**0.19**	---	---	---
Arsenic	mg/L	0.005	0.005	1	**0.0108**	0.0006	**0.0346**	**0.0274**	**0.0189**	**0.0145**	---	---	---	---	0.005	---	---	---	---	0.0038	---	---	---	---	0.0045	---	---	---
Barium	mg/L				0.00225	0.00308	0.00262	0.0025	0.002	0.00196	---	---	---	---	0.00145	---	---	---	---	0.00144	---	---	---	---	0.00168	---	---	---
Beryllium	mg/L	0.011(4)			< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---
Boron	mg/L	0.2			0.0333	0.0067	0.0198	0.0129	0.009	0.0082	---	---	---	---	0.0025	---	---	---	---	0.0009	---	---	---	---	0.001	---	---	---
Bismuth	mg/L				< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---
Calcium	mg/L				4.56	5.24	4.99	5.43	5.03	5.39	---	---	---	---	4.79	---	---	---	---	4.4	---	---	---	---	5.34	---	---	---
Cadmium	mg/L	0.0001(4)	0.000017		< 0.000003	< 0.000003	**0.000018**	0.00001	< 0.000003	< 0.000003	---	---	---	---	0.000004	---	---	---	---	0.000003	---	---	---	---	0.000012	---	---	---
Cobalt	mg/L	0.0009			0.000045	0.000057	0.000068	0.000042	0.000036	0.000039	---	---	---	---	0.000025	---	---	---	---	0.000035	---	---	---	---	0.00003	---	---	---
Chromium	mg/L				< 0.0005	0.0011	< 0.0005	< 0.0005	< 0.0005	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---
Copper	mg/L	0.001(4)	0.002(4)	0.6	0.0017	**0.0027**	0.0013	0.0009	0.0006	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	0.0007	---	---	---	---	< 0.0005	---	---	---
Iron	mg/L	0.3	0.3		< 0.002	< 0.002	< 0.002	< 0.002	0.01	< 0.002	---	---	---	---	< 0.002	---	---	---	---	0.004	---	---	---	---	0.007	---	---	---
Potassium	mg/L				4.27	4.09	2.3	1.93	1.41	1.17	---	---	---	---	0.681	---	---	---	---	0.682	---	---	---	---	0.58	---	---	---
Lithium	mg/L				< 0.001	0.001	< 0.001	< 0.001	< 0.001	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---
Magnesium	mg/L				0.369	1.23	0.387	0.369	0.286	0.264	---	---	---	---	0.213	---	---	---	---	0.218	---	---	---	---	0.181	---	---	---
Manganese	mg/L				0.00127	0.0152	0.00514	0.00446	0.00409	0.0045	---	---	---	---	0.00803	---	---	---	---	0.00912	---	---	---	---	0.00845	---	---	---
Molybdenum	mg/L	0.04			0.00047	0.00573	0.00033	0.00013	0.00009	0.00005	---	---	---	---	0.0001	---	---	---	---	0.00004	---	---	---	---	0.00012	---	---	---
Sodium	mg/L				8.86	2.01	3.78	2.57	1.51	1.09	---	---	---	---	0.44	---	---	---	---	0.39	---	---	---	---	0.33	---	---	---
Nickel	mg/L	0.025	0.025(4)	1	0.0001	0.0007	0.0003	< 0.0001	< 0.0001	0.0002	---	---	---	---	0.0002	---	---	---	---	0.0002	---	---	---	---	0.0001	---	---	---
Phosphorus	mg/L				0.053	0.025	0.047	< 0.009	0.013	0.052	---	---	---	---	< 0.009	---	---	---	---	< 0.009	---	---	---	---	< 0.009	---	---	---
Lead	mg/L	0.001(4)	0.001(4)	0.4	< 0.00002	< 0.00002	< 0.00002	< 0.00002	0.00003	< 0.00002	---	---	---	---	0.00004	---	---	---	---	0.00015	---	---	---	---	0.00005	---	---	---
Antimony	mg/L	0.02			0.0011	0.001	0.0008	0.0005	0.0002	0.0003	---	---	---	---	0.0003	---	---	---	---	< 0.0002	---	---	---	---	0.0002	---	---	---
Selenium	mg/L	0.1	0.001		< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---
Silica	mg/L				1.59	0.6	1.66	1.63	1.26	1.19	---	---	---	---	0.63	---	---	---	---	0.75	---	---	---	---	0.93	---	---	---
Tin	mg/L				0.00142	0.0015	0.00125	0.00104	0.00088	0.00059	---	---	---	---	0.00026	---	---	---	---	0.00014	---	---	---	---	0.00008	---	---	---
Strontium	mg/L				0.0153	0.0258	0.0172	0.0178	0.0149	0.0146	---	---	---	---	0.0116	---	---	---	---	0.0103	---	---	---	---	0.0121	---	---	---
Titanium	mg/L				0.0001	0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	---	---	---	---	0.0002	---	---	---	---	0.0004	---	---	---	---	0.0005	---	---	---
Thallium	mg/L				< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	0.00003	---	---	---	---	< 0.00002	---	---	---
Uranium	mg/L	0.005			0.000242	0.00181	0.00727	0.00657	0.00481	0.00384	---	---	---	---	0.00269	---	---	---	---	0.00209	---	---	---	---	0.00175	---	---	---
Vanadium	mg/L	0.006			0.00274	< 0.00003	0.0041	0.00368	0.00253	0.00193	---	---	---	---	0.0007	---	---	---	---	0.00062	---	---	---	---	0.0007	---	---	---
Zinc	mg/L	0.02	0.03	1	< 0.001	< 0.001	0.002	0.002	0.003	< 0.001	---	---	---	---	< 0.001	---	---	---	---	0.004	---	---	---	---	< 0.001	---	---	---

0.5	Parameter exceeds the Provincial Water Quality Objective(1)
0.5	Parameter exceeds the CCME Water Quality Guidelines(2)
0.5	Parameter exceeds MISA(3)

(1) Provincial Water Quality Objectives (PWQO) (MOEE, 1999)
(2) Canadian Environmental Quality Guidelines. Canadian Council of Ministers of the Environment (CCME, 2007).
(3) Municipal/Industrial Strategy for Abatement (MISA): Effluent Monitoring and Effluent Limits — Metal Mining Sector (O.Reg. 560/94).
(4) Parameter is dependant on hardness. The minimum value was selected.
(5) Aluminum guideline applies to water with pH > 6.5

Analyte	Unit	Provincial Water Quality	CCME Water Quality Guidelines for the	MISA[3]	Wk#24 11-Oct-11	Wk#25 18-Oct-11	Wk#26 25-Oct-11	Wk#27 1-Nov-11	Wk#28 8-Nov-11	Wk#29 15-Nov-11	Wk#30 22-Nov-11	Wk#31 29-Nov-11	Wk#32 6-Dec-11	Wk#33 13-Dec-11	Wk#34 20-Dec-11	Wk#35 28-Dec-11	Wk#36 3-Jan-12	Wk#37 10-Jan-12	Wk#38 17-Jan-12	Wk#39 24-Jan-12	Wk#40 31-Jan-12	Wk#41 7-Feb-12	Wk#42 14-Feb-12	Wk#43 21-Feb-12	Wk#44 28-Feb-12
Leachate Volume Added (mL)	mL				1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Leachate Volume Recovered (mL)	mL				932	988	983	991	983	982	986	993	992	991	994	984	993	992	984	982	989	989	989	988	986
pH	no unit	6.5 - 8.5	6.5 - 9	6 - 9.5	7.45	7.78	7.98	8.6	7.69	8.23	7.73	7.36	8.02	7.74	7.49	7.92	7.8	7.75	7.78	7.95	7.53	7.52	7.61	7.41	7.6
Alkalinity	mg/L as $CaCO_3$				17	22	16	15	16	14	16	13	15	14	16	14	12	12	13	14	12	13	14	12	13
Acidity	mg/L as $CaCO_3$				< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Conductivity	uS/cm				38	34	35	5	20	33	26	29	5	23	34	5	4	24	21	26	4	26	23	23	28
Sulphate	mg/L				< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	<0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Chloride	mg/L				---	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---
Nitrate (as nitrogen)	mg/L				---	< 0.05	---	---	---	---	< 0.05	---	---	---	---	< 0.05	---	---	---	---	< 0.05	---	---	---	---
Ammonia+Ammonium (N)	mg/L				---	< 0.1	---	---	---	---	< 0.1	---	---	---	---	0.1	---	---	---	---	< 0.1	---	---	---	---
Tot.Reactive Phos.	mg/L				---	< 0.03	---	---	---	---	0.14	---	---	---	---	< 0.03	---	---	---	---	< 0.03	---	---	---	---
Chromium III	mg/L	0.0089	0.0089		---	< 0.0005	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Chromium VI	µg/L	1	1		---	< 0.2	---	---	---	---	0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---
Mercury	mg/L	0.0002			---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---
Silver	mg/L	0.0001	0.0001		---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---
Aluminum	mg/L	0.075[5]	0.1		---	**0.2**	---	---	---	---	**0.21**	---	---	---	---	**0.23**	---	---	---	---	**0.17**	---	---	---	---
Arsenic	mg/L	0.005	0.005	1	---	0.0042	---	---	---	---	0.0039	---	---	---	---	0.0035	---	---	---	---	0.0023	---	---	---	---
Barium	mg/L				---	0.00163	---	---	---	---	0.00118	---	---	---	---	0.00116	---	---	---	---	0.001	---	---	---	---
Beryllium	mg/L	0.011[4]			---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---
Boron	mg/L	0.2			---	0.0007	---	---	---	---	0.0004	---	---	---	---	0.0004	---	---	---	---	0.0003	---	---	---	---
Bismuth	mg/L				---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---
Calcium	mg/L				---	6.26	---	---	---	---	5.55	---	---	---	---	5.22	---	---	---	---	4.57	---	---	---	---
Cadmium	mg/L	0.0001[4]	0.000017		---	< 0.000003	---	---	---	---	< 0.000003	---	---	---	---	< 0.000003	---	---	---	---	0.000003	---	---	---	---
Cobalt	mg/L	0.0009			---	0.00001	---	---	---	---	0.000014	---	---	---	---	0.000015	---	---	---	---	0.000013	---	---	---	---
Chromium	mg/L				---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---
Copper	mg/L	0.001[4]	0.002[4]	0.6	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---
Iron	mg/L	0.3	0.3		---	< 0.002	---	---	---	---	< 0.003	---	---	---	---	< 0.003	---	---	---	---	< 0.003	---	---	---	---
Potassium	mg/L				---	0.431	---	---	---	---	0.353	---	---	---	---	0.285	---	---	---	---	0.247	---	---	---	---
Lithium	mg/L				---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---
Magnesium	mg/L				---	0.152	---	---	---	---	0.099	---	---	---	---	0.075	---	---	---	---	0.062	---	---	---	---
Manganese	mg/L				---	0.00953	---	---	---	---	0.00586	---	---	---	---	0.00502	---	---	---	---	0.00504	---	---	---	---
Molybdenum	mg/L	0.04			---	0.00006	---	---	---	---	0.00002	---	---	---	---	0.00006	---	---	---	---	< 0.00001	---	---	---	---
Sodium	mg/L				---	0.22	---	---	---	---	0.18	---	---	---	---	0.15	---	---	---	---	0.13	---	---	---	---
Nickel	mg/L	0.025	0.025[4]	1	---	0.0001	---	---	---	---	0.0001	---	---	---	---	0.0001	---	---	---	---	< 0.0001	---	---	---	---
Phosphorus	mg/L				---	< 0.009	---	---	---	---	< 0.009	---	---	---	---	< 0.009	---	---	---	---	< 0.009	---	---	---	---
Lead	mg/L	0.001[4]	0.001[4]	0.4	---	0.00003	---	---	---	---	0.00003	---	---	---	---	0.00003	---	---	---	---	0.00004	---	---	---	---
Antimony	mg/L	0.02			---	< 0.0002	---	---	---	---	< 0.0002	---	---	---	---	< 0.0002	---	---	---	---	< 0.0002	---	---	---	---
Selenium	mg/L	0.1	0.001		---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---
Silica	mg/L				---	1.08	---	---	---	---	1	---	---	---	---	1.09	---	---	---	---	0.74	---	---	---	---
Tin	mg/L				---	0.00016	---	---	---	---	0.00015	---	---	---	---	0.00009	---	---	---	---	0.00013	---	---	---	---
Strontium	mg/L				---	0.0132	---	---	---	---	0.0111	---	---	---	---	0.0096	---	---	---	---	0.0086	---	---	---	---
Titanium	mg/L				---	0.0003	---	---	---	---	0.0002	---	---	---	---	0.0002	---	---	---	---	0.0002	---	---	---	---
Thallium	mg/L				---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---
Uranium	mg/L	0.005			---	0.00133	---	---	---	---	0.000764	---	---	---	---	0.000727	---	---	---	---	0.000665	---	---	---	---
Vanadium	mg/L	0.006			---	0.0007	---	---	---	---	0.00071	---	---	---	---	0.00058	---	---	---	---	0.0004	---	---	---	---
Zinc	mg/L	0.02	0.03	1	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---

0.5	Parameter exceeds the Provincial Water Quality Objective[1]
0.5	Parameter exceeds the CCME Water Quality Guidelines[2]
0.5	Parameter exceeds MISA[3]

(1) Provincial Water Quality Objectives (PWQO) (MOEE, 1999)
(2) Canadian Environmental Quality Guidelines. Canadian Council of Ministers of the Environment (CCME, 2007).
(3) Municipal/Industrial Strategy for Abatement (MISA): Effluent Monitoring and Effluent Limits — Metal Mining Secto
(4) Parameter is dependant on hardness. The minimum value was selected.
(5) Aluminum guideline applies to water with pH > 6.5

Analyte	Unit	Provincial Water Quality	CCME Water Quality Guidelines for the Protection	MISA[3]	Wk#0 26-Apr-11	Wk#1 3-May-11	Wk#2 10-May-11	Wk#3 17-May-11	Wk#4 24-May-11	Wk#5 31-May-11	Wk#6 7-Jun-11	Wk#7 14-Jun-11	Wk#8 21-Jun-11	Wk# 9 28-Jun-11	Wk#10 5-Jul-11	Wk#11 12-Jul-11	Wk#12 19-Jul-11	Wk#13 26-Jul-11	Wk#14 2-Aug-11	Wk#15 9-Aug-11	Wk#16 16-Aug-11	Wk#17 23-Aug-11	Wk#18 30-Aug-11	Wk#19 6-Sep-11	Wk#20 13-Sep-11	Wk#21 20-Sep-11	Wk#22 27-Sep-11
Leachate Volume Added (mL)	mL				1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Leachate Volume Recovered (mL)	mL				829	968	800	991	911	916	916	909	960	910	922	934	877	894	913	897	889	895	912	911	898	952	903
pH	no unit	6.5 - 8.5	6.5 - 9	6 - 9.5	8.82	8.04	7.76	7.85	7.77	8.14	8.16	8.48	7.88	7.72	8.46	7.67	7.53	7.59	7.49	7.66	7.76	8.23	7.75	7.5	7.38	7.16	7.34
Alkalinity	mg/L as $CaCO_3$				28	23	15	21	13	17	15	11	12	12	12	11	10	10	9	9	10	10	9	16	10	10	9
Acidity	mg/L as $CaCO_3$				< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Conductivity	uS/cm				8	55	36	44	32	38	31	27	27	27	26	22	21	24	21	18	17	20	21	20	22	22	15
Sulphate	mg/L				2.5	3.1	1.2	1.6	1.2	1.2	1.2	0.9	0.8	0.8	0.6	0.6	0.6	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.3	0.3
Chloride	mg/L				2	1.3	< 0.2	< 0.2	< 0.2	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---
Nitrate (as nitrogen)	mg/L				0.06	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	---	---	---	---	< 0.05	---	---	---	---	< 0.05	---	---	---	---	< 0.05	---	---
Ammonia+Ammonium (N)	mg/L				< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	---	---	---	---	< 0.1	---	---	---	---	< 0.1	---	---	---	---	< 0.1	---	---
Tot.Reactive Phos.	mg/L				< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	---	---	---	---	< 0.03	---	---	---	---	< 0.03	---	---	---	---	< 0.03	---	---
Chromium III	mg/L	0.0089	0.0089		< 0.2	---	< 0.2	< 0.2	< 0.2	< 0.2	---	---	---	---	< 0.0005	---	---	---	---	<0.0005	---	---	---	---	<0.0005	---	---
Chromium VI	µg/L	1	1		< 0.2	0.2	< 0.2	< 0.2	< 0.2	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---
Mercury	mg/L	0.0002			< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---
Silver	mg/L	0.0001	0.0001		< 0.00001	0.00003	< 0.00001	0.00001	< 0.00001	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---
Aluminum	mg/L	0.075[5]	0.1		**0.12**	0.03	0.06	0.05	0.07	0.06	---	---	---	---	0.06	---	---	---	---	0.06	---	---	---	---	0.06	---	---
Arsenic	mg/L	0.005	0.005	1	0.0005	< 0.0002	0.0007	0.0004	0.0006	0.0004	---	---	---	---	< 0.0002	---	---	---	---	0.0002	---	---	---	---	0.0002	---	---
Barium	mg/L				0.0022	0.00269	0.00179	0.00246	0.00385	0.00148	---	---	---	---	0.00101	---	---	---	---	0.00085	---	---	---	---	0.00087	---	---
Beryllium	mg/L	0.011[4]			< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---
Boron	mg/L	0.2			0.0058	0.0118	0.0036	0.0041	0.0026	0.0034	---	---	---	---	0.0015	---	---	---	---	0.0004	---	---	---	---	0.0005	---	---
Bismuth	mg/L				< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---
Calcium	mg/L				4.9	5.19	4.24	5.65	4.12	4.49	---	---	---	---	3.96	---	---	---	---	3.31	---	---	---	---	3.33	---	---
Cadmium	mg/L	0.0001[4]	0.000017		< 0.000003	< 0.000003	0.000005	0.000004	< 0.000003	< 0.000003	---	---	---	---	0.000006	---	---	---	---	**0.00009**	---	---	---	---	0.000005	---	---
Cobalt	mg/L	0.0009			0.000044	0.000053	0.000038	0.000043	0.000026	0.000037	---	---	---	---	0.000016	---	---	---	---	0.000016	---	---	---	---	0.000012	---	---
Chromium	mg/L				< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---
Copper	mg/L	0.001[4]	0.002[4]	0.6	**0.0059**	**0.009**	**0.0025**	**0.0022**	< 0.0005	0.0011	---	---	---	---	0.0006	---	---	---	---	0.0009	---	---	---	---	< 0.0005	---	---
Iron	mg/L	0.3	0.3		0.005	0.003	< 0.002	< 0.002	0.011	< 0.002	---	---	---	---	< 0.002	---	---	---	---	< 0.002	---	---	---	---	0.003	---	---
Potassium	mg/L				3.94	3.32	1.58	1.62	0.985	0.869	---	---	---	---	0.439	---	---	---	---	0.323	---	---	---	---	0.249	---	---
Lithium	mg/L				< 0.001	0.001	< 0.001	< 0.001	< 0.001	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---
Magnesium	mg/L				0.365	0.723	0.424	0.569	0.32	0.319	---	---	---	---	0.187	---	---	---	---	0.129	---	---	---	---	0.101	---	---
Manganese	mg/L				0.00939	0.0193	0.0167	0.0197	0.00204	0.0204	---	---	---	---	0.0198	---	---	---	---	0.0174	---	---	---	---	0.0194	---	---
Molybdenum	mg/L	0.04			0.00059	0.0014	0.00022	0.00015	0.00057	0.00005	---	---	---	---	0.00007	---	---	---	---	0.00003	---	---	---	---	0.00004	---	---
Sodium	mg/L				2.92	2.89	0.82	0.76	0.38	0.31	---	---	---	---	0.13	---	---	---	---	0.09	---	---	---	---	0.07	---	---
Nickel	mg/L	0.025	0.025[4]	1	< 0.0001	0.0001	0.0002	< 0.0001	< 0.0001	0.0002	---	---	---	---	0.0002	---	---	---	---	0.0001	---	---	---	---	< 0.0001	---	---
Phosphorus	mg/L				0.051	< 0.009	0.028	< 0.009	0.017	0.044	---	---	---	---	< 0.009	---	---	---	---	< 0.009	---	---	---	---	< 0.009	---	---
Lead	mg/L	0.001[4]	0.001[4]	0.4	0.00004	0.00004	< 0.00002	< 0.00002	0.00003	< 0.00002	---	---	---	---	0.00002	---	---	---	---	0.00017	---	---	---	---	< 0.00002	---	---
Antimony	mg/L	0.02			0.001	0.0008	0.0002	0.0003	0.0002	0.0002	---	---	---	---	0.0003	---	---	---	---	< 0.0002	---	---	---	---	< 0.0002	---	---
Selenium	mg/L	0.1	0.001		< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---
Silica	mg/L				0.52	0.65	0.51	0.65	0.4	0.4	---	---	---	---	0.28	---	---	---	---	0.27	---	---	---	---	0.27	---	---
Tin	mg/L				0.00143	0.0013	0.00091	0.00114	0.00036	0.0007	---	---	---	---	0.00027	---	---	---	---	0.00012	---	---	---	---	0.00008	---	---
Strontium	mg/L				0.0293	0.0448	0.029	0.0399	0.0244	0.0249	---	---	---	---	0.0179	---	---	---	---	0.0138	---	---	---	---	0.0137	---	---
Titanium	mg/L				< 0.0001	0.0002	< 0.0001	< 0.0001	< 0.0001	< 0.0001	---	---	---	---	0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---
Thallium	mg/L				< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---
Uranium	mg/L	0.005			0.000126	0.000412	0.000463	0.000595	0.000057	0.000498	---	---	---	---	0.000395	---	---	---	---	0.000303	---	---	---	---	0.000297	---	---
Vanadium	mg/L	0.006			0.00047	< 0.00003	0.00043	0.00036	0.0021	0.00013	---	---	---	---	0.00024	---	---	---	---	0.00018	---	---	---	---	0.00017	---	---
Zinc	mg/L	0.02	0.03	1	< 0.001	0.001	0.001	0.002	< 0.001	< 0.001	---	---	---	---	< 0.001	---	---	---	---	0.008	---	---	---	---	< 0.001	---	---

0.5 (shaded)	Parameter exceeds the Provincial Water Quality Objective[1]
0.5	Parameter exceeds the CCME Water Quality Guidelines[2]
0.5 (underlined)	Parameter exceeds MISA[3]

(1) Provincial Water Quality Objectives (PWQO) (MOEE, 1999)
(2) Canadian Environmental Quality Guidelines. Canadian Council of Ministers of the Environment (CCME, 2007).
(3) Municipal/Industrial Strategy for Abatement (MISA): Effluent Monitoring and Effluent Limits — Metal Mining Sector (O.Reg. 560/94).
(4) Parameter is dependant on hardness. The minimum value was selected.
(5) Aluminum guideline applies to water with pH > 6.5

Analyte	Unit	Provincial Water Quality	CCME Water Quality Guidelines for the Protection	MISA[3]	Wk#23 4-Oct-11	Wk#24 11-Oct-11	Wk#25 18-Oct-11	Wk#26 25-Oct-11	Wk#27 1-Nov-11	Wk#28 8-Nov-11	Wk#29 15-Nov-11	Wk#30 22-Nov-11	Wk#31 29-Nov-11	Wk#32 6-Dec-11	Wk#33 13-Dec-11	Wk#34 20-Dec-11	Wk#35 28-Dec-11	Wk#36 3-Jan-12	Wk#37 10-Jan-12	Wk#38 17-Jan-12	Wk#39 24-Jan-12	Wk#40 31-Jan-12	Wk#41 7-Feb-12	Wk#42 14-Feb-12	Wk#43 21-Feb-12	Wk#44 28-Feb-12
Leachate Volume Added (mL)	mL				1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Leachate Volume Recovered (mL)	mL				937	935	925	989	943	921	934	916	896	998	926	938	937	960	938	924	930	943	936	945	952	944
pH	no unit	6.5 - 8.5	6.5 - 9	6 - 9.5	7.59	6.71	7.32	7.38	7.36	7.25	7.33	7.39	6.76	7.55	7.51	7.16	7.47	7.62	7.46	7.3	7.3	7.1	7.05	7.21	7.13	7.25
Alkalinity	mg/L as $CaCO_3$				10	18	12	12	10	9	9	9	7	12	9	8	9	9	9	9	8	9	8	9	9	9
Acidity	mg/L as $CaCO_3$				< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Conductivity	uS/cm				4	22	24	21	17	12	16	4	18	20	4	4	20	16	19	15	19	4	18	22	21	21
Sulphate	mg/L				0.3	0.3	0.3	0.4	0.3	0.4	0.4	0.3	0.3	0.4	0.3	0.3	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Chloride	mg/L				---		< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---
Nitrate (as nitrogen)	mg/L				---		< 0.05	---	---	---	---	< 0.05	---	---	---	---	< 0.05	---	---	---	---	< 0.05	---	---	---	---
Ammonia+Ammonium (N)	mg/L				---		< 0.1	---	---	---	---	< 0.1	---	---	---	---	< 0.1	---	---	---	---	< 0.1	---	---	---	---
Tot.Reactive Phos.	mg/L				---		< 0.03	---	---	---	---	0.13	---	---	---	---	< 0.03	---	---	---	---	< 0.03	---	---	---	---
Chromium III	mg/L	0.0089	0.0089		---		< 0.0005	---	---	---	---	***	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Chromium VI	µg/L	1	1		---		< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---
Mercury	mg/L	0.0002			---		< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---
Silver	mg/L	0.0001	0.0001		---		< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---
Aluminum	mg/L	0.075[5]	0.1		---		0.04	---	---	---	---	0.05	---	---	---	---	0.04	---	---	---	---	0.04	---	---	---	---
Arsenic	mg/L	0.005	0.005	1	---		< 0.0002	---	---	---	---	< 0.0002	---	---	---	---	< 0.0002	---	---	---	---	< 0.0002	---	---	---	---
Barium	mg/L				---		0.00087	---	---	---	---	0.00072	---	---	---	---	0.00086	---	---	---	---	0.00082	---	---	---	---
Beryllium	mg/L	0.011[4]			---		< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---
Boron	mg/L	0.2			---		0.0003	---	---	---	---	0.0003	---	---	---	---	0.0004	---	---	---	---	0.0003	---	---	---	---
Bismuth	mg/L				---		< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---
Calcium	mg/L				---		3.65	---	---	---	---	3.27	---	---	---	---	3.67	---	---	---	---	3.45	---	---	---	---
Cadmium	mg/L	0.0001[4]	0.000017		---		0.000006	---	---	---	---	< 0.000003	---	---	---	---	< 0.000003	---	---	---	---	< 0.000003	---	---	---	---
Cobalt	mg/L	0.0009			---		< 0.000002	---	---	---	---	0.000009	---	---	---	---	0.000011	---	---	---	---	0.00001	---	---	---	---
Chromium	mg/L				---		< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---
Copper	mg/L	0.001[4]	0.002[4]	0.6	---		0.0008	---	---	---	---	0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---
Iron	mg/L	0.3	0.3		---		< 0.002	---	---	---	---	< 0.003	---	---	---	---	< 0.003	---	---	---	---	< 0.003	---	---	---	---
Potassium	mg/L				---		0.217	---	---	---	---	0.171	---	---	---	---	0.184	---	---	---	---	0.152	---	---	---	---
Lithium	mg/L				---		< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---
Magnesium	mg/L				---		0.093	---	---	---	---	0.072	---	---	---	---	0.081	---	---	---	---	0.065	---	---	---	---
Manganese	mg/L				---		0.0198	---	---	---	---	0.0192	---	---	---	---	0.0183	---	---	---	---	0.019	---	---	---	---
Molybdenum	mg/L	0.04			---		0.00003	---	---	---	---	0.00002	---	---	---	---	0.00005	---	---	---	---	0.00001	---	---	---	---
Sodium	mg/L				---		0.07	---	---	---	---	0.06	---	---	---	---	0.06	---	---	---	---	0.05	---	---	---	---
Nickel	mg/L	0.025	0.025[4]	1	---		< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---
Phosphorus	mg/L				---		< 0.009	---	---	---	---	< 0.009	---	---	---	---	< 0.009	---	---	---	---	< 0.009	---	---	---	---
Lead	mg/L	0.001[4]	0.001[4]	0.4	---		< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---
Antimony	mg/L	0.02			---		< 0.0002	---	---	---	---	< 0.0002	---	---	---	---	< 0.0002	---	---	---	---	< 0.0002	---	---	---	---
Selenium	mg/L	0.1	0.001		---		< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---
Silica	mg/L				---		0.27	---	---	---	---	0.24	---	---	---	---	0.34	---	---	---	---	0.27	---	---	---	---
Tin	mg/L				---		0.00005	---	---	---	---	0.00006	---	---	---	---	0.00001	---	---	---	---	0.00009	---	---	---	---
Strontium	mg/L				---		0.0149	---	---	---	---	0.0131	---	---	---	---	0.0151	---	---	---	---	0.0139	---	---	---	---
Titanium	mg/L				---		< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---
Thallium	mg/L				---		< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---
Uranium	mg/L	0.005			---		0.000303	---	---	---	---	0.000183	---	---	---	---	0.000258	---	---	---	---	0.000229	---	---	---	---
Vanadium	mg/L	0.006			---		0.00018	---	---	---	---	0.00021	---	---	---	---	0.00018	---	---	---	---	0.00016	---	---	---	---
Zinc	mg/L	0.02	0.03	1	---		< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---

0.5	Parameter exceeds the Provincial Water Quality Objective[1]
0.5	Parameter exceeds the CCME Water Quality Guidelines[2]
0.5	Parameter exceeds MISA[3]

(1) Provincial Water Quality Objectives (PWQO) (MOEE, 1999)
(2) Canadian Environmental Quality Guidelines. Canadian Council of Ministers of the Environment (CCME, 2007).
(3) Municipal/Industrial Strategy for Abatement (MISA): Effluent Monitoring and Effluent Limits — Metal Mining Sector (O.F
(4) Parameter is dependant on hardness. The minimum value was selected.
(5) Aluminum guideline applies to water with pH > 6.5

Analyte	Unit	Provincial Water Quality	CCME Water Quality Guidelines for the Protection	MISA[3]	Wk#0 26-Apr-11	Wk#1 3-May-11	Wk#2 10-May-11	Wk#3 17-May-11	Wk#4 24-May-11	Wk#5 31-May-11	Wk#6 7-Jun-11	Wk#7 14-Jun-11	Wk#8 21-Jun-11	Wk# 9 28-Jun-11	Wk#10 5-Jul-11	Wk#11 12-Jul-11	Wk#12 19-Jul-11	Wk#13 26-Jul-11	Wk#14 2-Aug-11	Wk#15 9-Aug-11	Wk#16 16-Aug-11	Wk#17 23-Aug-11	Wk#18 30-Aug-11	Wk#19 6-Sep-11	Wk#20 13-Sep-11	Wk#21 20-Sep-11	Wk#22 27-Sep-11
Leachate Volume Added (mL)	mL				1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Leachate Volume Recovered (mL)	mL				829	968	800	991	911	916	916	909	960	910	922	934	877	894	913	897	889	895	912	911	898	952	903
pH	no unit	6.5 - 8.5	6.5 - 9	6 - 9.5	8.82	8.04	7.76	7.85	7.77	8.14	8.16	8.48	7.88	7.72	8.46	7.67	7.53	7.59	7.49	7.66	7.76	8.23	7.75	7.5	7.38	7.16	7.34
Alkalinity	mg/L as $CaCO_3$				28	23	15	21	13	17	15	11	12	12	12	11	10	10	9	9	10	10	9	16	10	10	9
Acidity	mg/L as $CaCO_3$				< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Conductivity	uS/cm				8	55	36	44	32	38	31	27	27	27	26	22	21	24	21	18	17	20	21	20	22	22	15
Sulphate	mg/L				2.5	3.1	1.2	1.6	1.2	1.2	1.2	0.9	0.8	0.8	0.6	0.6	0.6	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.3	0.3
Chloride	mg/L				2	1.3	< 0.2	< 0.2	< 0.2	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---
Nitrate (as nitrogen)	mg/L				0.06	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	---	---	---	---	< 0.05	---	---	---	---	< 0.05	---	---	---	---	< 0.05	---	---
Ammonia+Ammonium (N)	mg/L				< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	---	---	---	---	< 0.1	---	---	---	---	< 0.1	---	---	---	---	< 0.1	---	---
Tot.Reactive Phos.	mg/L				< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	---	---	---	---	< 0.03	---	---	---	---	< 0.03	---	---	---	---	< 0.03	---	---
Chromium III	mg/L	0.0089	0.0089		< 0.2	---	< 0.2	< 0.2	< 0.2	< 0.2	---	---	---	---	< 0.0005	---	---	---	---	<0.0005	---	---	---	---	<0.0005	---	---
Chromium VI	µg/L	1	1		< 0.2	0.2	< 0.2	< 0.2	< 0.2	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---
Mercury	mg/L	0.0002			< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---
Silver	mg/L	0.0001	0.0001		< 0.00001	0.00003	< 0.00001	0.00001	< 0.00001	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---
Aluminum	mg/L	0.075[5]	0.1		**0.12**	0.03	0.06	0.05	0.07	0.06	---	---	---	---	0.06	---	---	---	---	0.06	---	---	---	---	0.06	---	---
Arsenic	mg/L	0.005	0.005	1	0.0005	< 0.0002	0.0007	0.0004	0.0006	0.0004	---	---	---	---	< 0.0002	---	---	---	---	0.0002	---	---	---	---	0.0002	---	---
Barium	mg/L				0.0022	0.00269	0.00179	0.00246	0.00385	0.00148	---	---	---	---	0.00101	---	---	---	---	0.00085	---	---	---	---	0.00087	---	---
Beryllium	mg/L	0.011[4]			< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---
Boron	mg/L	0.2			0.0058	0.0118	0.0036	0.0041	0.0026	0.0034	---	---	---	---	0.0015	---	---	---	---	0.0004	---	---	---	---	0.0005	---	---
Bismuth	mg/L				< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---
Calcium	mg/L				4.9	5.19	4.24	5.65	4.12	4.49	---	---	---	---	3.96	---	---	---	---	3.31	---	---	---	---	3.33	---	---
Cadmium	mg/L	0.0001[4]	0.000017		< 0.000003	< 0.000003	0.000005	0.000004	< 0.000003	< 0.000003	---	---	---	---	0.000006	---	---	---	---	**0.00009**	---	---	---	---	0.000005	---	---
Cobalt	mg/L	0.0009			0.000044	0.000053	0.000038	0.000043	0.000026	0.000037	---	---	---	---	0.000016	---	---	---	---	0.000016	---	---	---	---	0.000012	---	---
Chromium	mg/L				< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---
Copper	mg/L	0.001[4]	0.002[4]	0.6	**0.0059**	**0.009**	**0.0025**	**0.0022**	< 0.0005	0.0011	---	---	---	---	0.0006	---	---	---	---	0.0009	---	---	---	---	< 0.0005	---	---
Iron	mg/L	0.3	0.3		0.005	0.003	< 0.002	< 0.002	0.011	< 0.002	---	---	---	---	< 0.002	---	---	---	---	< 0.002	---	---	---	---	0.003	---	---
Potassium	mg/L				3.94	3.32	1.58	1.62	0.985	0.869	---	---	---	---	0.439	---	---	---	---	0.323	---	---	---	---	0.249	---	---
Lithium	mg/L				< 0.001	0.001	< 0.001	< 0.001	< 0.001	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---
Magnesium	mg/L				0.365	0.723	0.424	0.569	0.32	0.319	---	---	---	---	0.187	---	---	---	---	0.129	---	---	---	---	0.101	---	---
Manganese	mg/L				0.00939	0.0193	0.0167	0.0197	0.00204	0.0204	---	---	---	---	0.0198	---	---	---	---	0.0174	---	---	---	---	0.0194	---	---
Molybdenum	mg/L	0.04			0.00059	0.0014	0.00022	0.00015	0.00057	0.00005	---	---	---	---	0.00007	---	---	---	---	0.00003	---	---	---	---	0.00004	---	---
Sodium	mg/L				2.92	2.89	0.82	0.76	0.38	0.31	---	---	---	---	0.13	---	---	---	---	0.09	---	---	---	---	0.07	---	---
Nickel	mg/L	0.025	0.025[4]	1	< 0.0001	0.0001	0.0002	< 0.0001	< 0.0001	0.0002	---	---	---	---	0.0002	---	---	---	---	0.0001	---	---	---	---	< 0.0001	---	---
Phosphorus	mg/L				0.051	< 0.009	0.028	< 0.009	0.017	0.044	---	---	---	---	< 0.009	---	---	---	---	< 0.009	---	---	---	---	< 0.009	---	---
Lead	mg/L	0.001[4]	0.001[4]	0.4	0.00004	0.00004	< 0.00002	< 0.00002	0.00003	< 0.00002	---	---	---	---	0.00002	---	---	---	---	0.00017	---	---	---	---	< 0.00002	---	---
Antimony	mg/L	0.02			0.001	0.0008	0.0002	0.0003	0.0002	0.0002	---	---	---	---	0.0003	---	---	---	---	< 0.0002	---	---	---	---	< 0.0002	---	---
Selenium	mg/L	0.1	0.001		< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---
Silica	mg/L				0.52	0.65	0.51	0.65	0.4	0.4	---	---	---	---	0.28	---	---	---	---	0.27	---	---	---	---	0.27	---	---
Tin	mg/L				0.00143	0.0013	0.00091	0.00114	0.00036	0.0007	---	---	---	---	0.00027	---	---	---	---	0.00012	---	---	---	---	0.00008	---	---
Strontium	mg/L				0.0293	0.0448	0.029	0.0399	0.0244	0.0249	---	---	---	---	0.0179	---	---	---	---	0.0138	---	---	---	---	0.0137	---	---
Titanium	mg/L				< 0.0001	0.0002	< 0.0001	< 0.0001	< 0.0001	< 0.0001	---	---	---	---	0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---
Thallium	mg/L				< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---
Uranium	mg/L	0.005			0.000126	0.000412	0.000463	0.000595	0.000057	0.000498	---	---	---	---	0.000395	---	---	---	---	0.000303	---	---	---	---	0.000297	---	---
Vanadium	mg/L	0.006			0.00047	< 0.00003	0.00043	0.00036	0.0021	0.00013	---	---	---	---	0.00024	---	---	---	---	0.00018	---	---	---	---	0.00017	---	---
Zinc	mg/L	0.02	0.03	1	< 0.001	0.001	0.001	0.002	< 0.001	< 0.001	---	---	---	---	< 0.001	---	---	---	---	0.008	---	---	---	---	< 0.001	---	---

0.5	Parameter exceeds the Provincial Water Quality Objective[1]
0.5	Parameter exceeds the CCME Water Quality Guidelines[2]
0.5	Parameter exceeds MISA[3]

(1) Provincial Water Quality Objectives (PWQO) (MOEE, 1999)
(2) Canadian Environmental Quality Guidelines. Canadian Council of Ministers of the Environment (CCME, 2007).
(3) Municipal/Industrial Strategy for Abatement (MISA): Effluent Monitoring and Effluent Limits — Metal Mining Sector (O.Reg. 560/94).
(4) Parameter is dependant on hardness. The minimum value was selected.
(5) Aluminum guideline applies to water with pH > 6.5

Analyte	Unit	Provincial Water Quality	CCME Water Quality Guidelines for the Protection	MISA[3]	Wk#23 4-Oct-11	Wk#24 11-Oct-11	Wk#25 18-Oct-11	Wk#26 25-Oct-11	Wk#27 1-Nov-11	Wk#28 8-Nov-11	Wk#29 15-Nov-11	Wk#30 22-Nov-11	Wk#31 29-Nov-11	Wk#32 6-Dec-11	Wk#33 13-Dec-11	Wk#34 20-Dec-11	Wk#35 28-Dec-11	Wk#36 3-Jan-12	Wk#37 10-Jan-12	Wk#38 17-Jan-12	Wk#39 24-Jan-12	Wk#40 31-Jan-12	Wk#41 7-Feb-12	Wk#42 14-Feb-12	Wk#43 21-Feb-12	Wk#44 28-Feb-12	Wk#45 6-Mar-12
Leachate Volume Added (mL)	mL				1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Leachate Volume Recovered (mL)	mL				937	935	925	989	943	921	934	916	896	998	926	938	937	960	938	924	930	943	936	945	952	944	
pH	no unit	6.5 - 8.5	6.5 - 9	6 - 9.5	7.59	6.71	7.32	7.38	7.36	7.25	7.33	7.39	6.76	7.55	7.51	7.16	7.47	7.62	7.46	7.3	7.3	7.1	7.05	7.21	7.13	7.25	
Alkalinity	mg/L as $CaCO_3$				10	18	12	12	10	9	9	9	7	12	9	8	9	9	9	9	8	9	8	9	9	9	
Acidity	mg/L as $CaCO_3$				< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	
Conductivity	uS/cm				4	22	24	21	17	12	16	4	18	20	4	4	20	16	19	15	19	4	18	22	21	21	
Sulphate	mg/L				0.3	0.3	0.3	0.4	0.3	0.4	0.4	0.3	0.3	0.4	0.3	0.3	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	
Chloride	mg/L				---		< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---	
Nitrate (as nitrogen)	mg/L				---		< 0.05	---	---	---	---	< 0.05	---	---	---	---	< 0.05	---	---	---	---	< 0.05	---	---	---	---	
Ammonia+Ammonium (N)	mg/L				---		< 0.1	---	---	---	---	< 0.1	---	---	---	---	< 0.1	---	---	---	---	< 0.1	---	---	---	---	
Tot.Reactive Phos.	mg/L				---		< 0.03	---	---	---	---	0.13	---	---	---	---	< 0.03	---	---	---	---	< 0.03	---	---	---	---	
Chromium III	mg/L	0.0089	0.0089		---		< 0.0005	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	
Chromium VI	µg/L	1	1		---		< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---	
Mercury	mg/L	0.0002			---		< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	
Silver	mg/L	0.0001	0.0001		---		< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	
Aluminum	mg/L	0.075[5]	0.1		---		0.04	---	---	---	---	0.05	---	---	---	---	0.04	---	---	---	---	0.04	---	---	---	---	
Arsenic	mg/L	0.005	0.005	1	---		< 0.0002	---	---	---	---	< 0.0002	---	---	---	---	< 0.0002	---	---	---	---	< 0.0002	---	---	---	---	
Barium	mg/L				---		0.00087	---	---	---	---	0.00072	---	---	---	---	0.00086	---	---	---	---	0.00082	---	---	---	---	
Beryllium	mg/L	0.011[4]			---		< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	
Boron	mg/L	0.2			---		0.0003	---	---	---	---	0.0003	---	---	---	---	0.0004	---	---	---	---	0.0003	---	---	---	---	
Bismuth	mg/L				---		< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	
Calcium	mg/L				---		3.65	---	---	---	---	3.27	---	---	---	---	3.67	---	---	---	---	3.45	---	---	---	---	
Cadmium	mg/L	0.0001[4]	0.000017		---		0.000006	---	---	---	---	< 0.000003	---	---	---	---	< 0.000003	---	---	---	---	< 0.000003	---	---	---	---	
Cobalt	mg/L	0.0009			---		< 0.000002	---	---	---	---	0.000009	---	---	---	---	0.000011	---	---	---	---	0.00001	---	---	---	---	
Chromium	mg/L				---		< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	
Copper	mg/L	0.001[4]	0.002[4]	0.6	---		0.0008	---	---	---	---	0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	
Iron	mg/L	0.3	0.3		---		< 0.002	---	---	---	---	< 0.003	---	---	---	---	< 0.003	---	---	---	---	< 0.003	---	---	---	---	
Potassium	mg/L				---		0.217	---	---	---	---	0.171	---	---	---	---	0.184	---	---	---	---	0.152	---	---	---	---	
Lithium	mg/L				---		< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	
Magnesium	mg/L				---		0.093	---	---	---	---	0.072	---	---	---	---	0.081	---	---	---	---	0.065	---	---	---	---	
Manganese	mg/L				---		0.0198	---	---	---	---	0.0192	---	---	---	---	0.0183	---	---	---	---	0.019	---	---	---	---	
Molybdenum	mg/L	0.04			---		0.00003	---	---	---	---	0.00002	---	---	---	---	0.00005	---	---	---	---	0.00001	---	---	---	---	
Sodium	mg/L				---		0.07	---	---	---	---	0.06	---	---	---	---	0.06	---	---	---	---	0.05	---	---	---	---	
Nickel	mg/L	0.025	0.025[4]	1	---		< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	
Phosphorus	mg/L				---		< 0.009	---	---	---	---	< 0.009	---	---	---	---	< 0.009	---	---	---	---	< 0.009	---	---	---	---	
Lead	mg/L	0.001[4]	0.001[4]	0.4	---		< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	
Antimony	mg/L	0.02			---		< 0.0002	---	---	---	---	< 0.0002	---	---	---	---	< 0.0002	---	---	---	---	< 0.0002	---	---	---	---	
Selenium	mg/L	0.1	0.001		---		< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	
Silica	mg/L				---		0.27	---	---	---	---	0.24	---	---	---	---	0.34	---	---	---	---	0.27	---	---	---	---	
Tin	mg/L				---		0.00005	---	---	---	---	0.00006	---	---	---	---	0.00001	---	---	---	---	0.00009	---	---	---	---	
Strontium	mg/L				---		0.0149	---	---	---	---	0.0131	---	---	---	---	0.0151	---	---	---	---	0.0139	---	---	---	---	
Titanium	mg/L				---		< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	
Thallium	mg/L				---		< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	
Uranium	mg/L	0.005			---		0.000303	---	---	---	---	0.000183	---	---	---	---	0.000258	---	---	---	---	0.000229	---	---	---	---	
Vanadium	mg/L	0.006			---		0.00018	---	---	---	---	0.00021	---	---	---	---	0.00018	---	---	---	---	0.00016	---	---	---	---	
Zinc	mg/L	0.02	0.03	1	---		< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	

0.5	Parameter exceeds the Provincial Water Quality Objective[1]
0.5	Parameter exceeds the CCME Water Quality Guidelines[2]
0.5	Parameter exceeds MISA[3]

(1) Provincial Water Quality Objectives (PWQO) (MOEE, 1999)
(2) Canadian Environmental Quality Guidelines. Canadian Council of Ministers of the Environment (CCME, 2007).
(3) Municipal/Industrial Strategy for Abatement (MISA): Effluent Monitoring and Effluent Limits — Metal Mining Sector (O.F
(4) Parameter is dependant on hardness. The minimum value was selected.
(5) Aluminum guideline applies to water with pH > 6.5

Analyte	Unit	Provincial Water Quality	CCME Water Quality Guidelines for the Protection	MISA[3]	Wk#0	Wk#1	Wk#2	Wk#3	Wk#4	Wk#5	Wk#6	Wk#7	Wk#8	Wk# 9	Wk#10	Wk#11	Wk#12	Wk#13	Wk#14	Wk#15	Wk#16	Wk#17	Wk#18	Wk#19	Wk#20	Wk#21
					26-Apr-11	3-May-11	10-May-11	17-May-11	24-May-11	31-May-11	7-Jun-11	14-Jun-11	21-Jun-11	28-Jun-11	5-Jul-11	12-Jul-11	19-Jul-11	26-Jul-11	2-Aug-11	9-Aug-11	16-Aug-11	23-Aug-11	30-Aug-11	6-Sep-11	13-Sep-11	20-Sep-11
Leachate Volume Added (mL)	mL				1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Leachate Volume Recovered (mL)	mL				829	968	800	991	911	916	916	909	960	910	922	934	877	894	913	897	889	895	912	911	898	952
pH	no unit	6.5 - 8.5	6.5 - 9	6 - 9.5	8.82	8.04	7.76	7.85	7.77	8.14	8.16	8.48	7.88	7.72	8.46	7.67	7.53	7.59	7.49	7.66	7.76	8.23	7.75	7.5	7.38	7.16
Alkalinity	mg/L as $CaCO_3$				28	23	15	21	13	17	15	11	12	12	12	11	10	10	9	9	10	10	9	16	10	10
Acidity	mg/L as $CaCO_3$				< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Conductivity	uS/cm				8	55	36	44	32	38	31	27	27	27	26	22	21	24	21	18	17	20	21	20	22	22
Sulphate	mg/L				2.5	3.1	1.2	1.6	1.2	1.2	1.2	0.9	0.8	0.8	0.6	0.6	0.6	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.3
Chloride	mg/L				2	1.3	< 0.2	< 0.2	< 0.2	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---
Nitrate (as nitrogen)	mg/L				0.06	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	---	---	---	---	< 0.05	---	---	---	---	< 0.05	---	---	---	---	< 0.05	---
Ammonia+Ammonium (N)	mg/L				< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	---	---	---	---	< 0.1	---	---	---	---	< 0.1	---	---	---	---	< 0.1	---
Tot.Reactive Phos.	mg/L				< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	---	---	---	---	< 0.03	---	---	---	---	< 0.03	---	---	---	---	< 0.03	---
Chromium III	mg/L	0.0089	0.0089		< 0.2	---	< 0.2	< 0.2	< 0.2	< 0.2	---	---	---	---	< 0.0005	---	---	---	---	<0.0005	---	---	---	---	<0.0005	---
Chromium VI	µg/L	1	1		< 0.2	0.2	< 0.2	< 0.2	< 0.2	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---
Mercury	mg/L	0.0002			< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---
Silver	mg/L	0.0001	0.0001		< 0.00001	0.00003	< 0.00001	0.00001	< 0.00001	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---
Aluminum	mg/L	0.075[5]	0.1		**0.12**	0.03	0.06	0.05	0.07	0.06	---	---	---	---	0.06	---	---	---	---	0.06	---	---	---	---	0.06	---
Arsenic	mg/L	0.005	0.005	1	0.0005	< 0.0002	0.0007	0.0004	0.0006	0.0004	---	---	---	---	< 0.0002	---	---	---	---	0.0002	---	---	---	---	0.0002	---
Barium	mg/L				0.0022	0.00269	0.00179	0.00246	0.00385	0.00148	---	---	---	---	0.00101	---	---	---	---	0.00085	---	---	---	---	0.00087	---
Beryllium	mg/L	0.011[4]			< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---
Boron	mg/L	0.2			0.0058	0.0118	0.0036	0.0041	0.0026	0.0034	---	---	---	---	0.0015	---	---	---	---	0.0004	---	---	---	---	0.0005	---
Bismuth	mg/L				< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---
Calcium	mg/L				4.9	5.19	4.24	5.65	4.12	4.49	---	---	---	---	3.96	---	---	---	---	3.31	---	---	---	---	3.33	---
Cadmium	mg/L	0.0001[4]	0.000017		< 0.000003	< 0.000003	0.000005	0.000004	< 0.000003	< 0.000003	---	---	---	---	0.000006	---	---	---	---	**0.00009**	---	---	---	---	0.000005	---
Cobalt	mg/L	0.0009			0.000044	0.000053	0.000038	0.000043	0.000026	0.000037	---	---	---	---	0.000016	---	---	---	---	0.000016	---	---	---	---	0.000012	---
Chromium	mg/L				< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---
Copper	mg/L	0.001[4]	0.002[4]	0.6	**0.0059**	**0.009**	**0.0025**	**0.0022**	< 0.0005	0.0011	---	---	---	---	0.0006	---	---	---	---	0.0009	---	---	---	---	< 0.0005	---
Iron	mg/L	0.3	0.3		0.005	0.003	< 0.002	< 0.002	0.011	< 0.002	---	---	---	---	< 0.002	---	---	---	---	< 0.002	---	---	---	---	0.003	---
Potassium	mg/L				3.94	3.32	1.58	1.62	0.985	0.869	---	---	---	---	0.439	---	---	---	---	0.323	---	---	---	---	0.249	---
Lithium	mg/L				< 0.001	0.001	< 0.001	< 0.001	< 0.001	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---
Magnesium	mg/L				0.365	0.723	0.424	0.569	0.32	0.319	---	---	---	---	0.187	---	---	---	---	0.129	---	---	---	---	0.101	---
Manganese	mg/L				0.00939	0.0193	0.0167	0.0197	0.00204	0.0204	---	---	---	---	0.0198	---	---	---	---	0.0174	---	---	---	---	0.0194	---
Molybdenum	mg/L	0.04			0.00059	0.0014	0.00022	0.00015	0.00057	0.00005	---	---	---	---	0.00007	---	---	---	---	0.00003	---	---	---	---	0.00004	---
Sodium	mg/L				2.92	2.89	0.82	0.76	0.38	0.31	---	---	---	---	0.13	---	---	---	---	0.09	---	---	---	---	0.07	---
Nickel	mg/L	0.025	0.025[4]	1	< 0.0001	0.0001	0.0002	< 0.0001	< 0.0001	0.0002	---	---	---	---	0.0002	---	---	---	---	0.0001	---	---	---	---	< 0.0001	---
Phosphorus	mg/L				0.051	< 0.009	0.028	< 0.009	0.017	0.044	---	---	---	---	< 0.009	---	---	---	---	< 0.009	---	---	---	---	< 0.009	---
Lead	mg/L	0.001[4]	0.001[4]	0.4	0.00004	0.00004	< 0.00002	< 0.00002	0.00003	< 0.00002	---	---	---	---	0.00002	---	---	---	---	0.00017	---	---	---	---	< 0.00002	---
Antimony	mg/L	0.02			0.001	0.0008	0.0002	0.0003	0.0002	0.0002	---	---	---	---	0.0003	---	---	---	---	< 0.0002	---	---	---	---	< 0.0002	---
Selenium	mg/L	0.1	0.001		< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---
Silica	mg/L				0.52	0.65	0.51	0.65	0.4	0.4	---	---	---	---	0.28	---	---	---	---	0.27	---	---	---	---	0.27	---
Tin	mg/L				0.00143	0.0013	0.00091	0.00114	0.00036	0.0007	---	---	---	---	0.00027	---	---	---	---	0.00012	---	---	---	---	0.00008	---
Strontium	mg/L				0.0293	0.0448	0.029	0.0399	0.0244	0.0249	---	---	---	---	0.0179	---	---	---	---	0.0138	---	---	---	---	0.0137	---
Titanium	mg/L				< 0.0001	0.0002	< 0.0001	< 0.0001	< 0.0001	< 0.0001	---	---	---	---	0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---
Thallium	mg/L				< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---
Uranium	mg/L	0.005			0.000126	0.000412	0.000463	0.000595	0.000057	0.000498	---	---	---	---	0.000395	---	---	---	---	0.000303	---	---	---	---	0.000297	---
Vanadium	mg/L	0.006			0.00047	< 0.00003	0.00043	0.00036	0.0021	0.00013	---	---	---	---	0.00024	---	---	---	---	0.00018	---	---	---	---	0.00017	---
Zinc	mg/L	0.02	0.03	1	< 0.001	0.001	0.001	0.002	< 0.001	< 0.001	---	---	---	---	< 0.001	---	---	---	---	0.008	---	---	---	---	< 0.001	---

0.5	Parameter exceeds the Provincial Water Quality Objective[1]
0.5	Parameter exceeds the CCME Water Quality Guidelines[2]
0.5	Parameter exceeds MISA[3]

(1) Provincial Water Quality Objectives (PWQO) (MOEE, 1999)
(2) Canadian Environmental Quality Guidelines. Canadian Council of Ministers of the Environment (CCME, 2007).
(3) Municipal/Industrial Strategy for Abatement (MISA): Effluent Monitoring and Effluent Limits — Metal Mining Sector (O.Reg. 560/94).
(4) Parameter is dependant on hardness. The minimum value was selected.
(5) Aluminum guideline applies to water with pH > 6.5

Analyte	Unit	Provincial Water Quality	CCME Water Quality Guidelines for the Protection	MISA(3)	Wk#22 27-Sep-11	Wk#23 4-Oct-11	Wk#24 11-Oct-11	Wk#25 18-Oct-11	Wk#26 25-Oct-11	Wk#27 1-Nov-11	Wk#28 8-Nov-11	Wk#29 15-Nov-11	Wk#30 22-Nov-11	Wk#31 29-Nov-11	Wk#32 6-Dec-11	Wk#33 13-Dec-11	Wk#34 20-Dec-11	Wk#35 28-Dec-11	Wk#36 3-Jan-12	Wk#37 10-Jan-12	Wk#38 17-Jan-12	Wk#39 24-Jan-12	Wk#40 31-Jan-12	Wk#41 7-Feb-12	Wk#42 14-Feb-12	Wk#43 21-Feb-12	Wk#44 28-Feb-12
Leachate Volume Added (mL)	mL				1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Leachate Volume Recovered (mL)	mL				903	937	935	925	989	943	921	934	916	896	998	926	938	937	960	938	924	930	943	936	945	952	944
pH	no unit	6.5 - 8.5	6.5 - 9	6 - 9.5	7.34	7.59	6.71	7.32	7.38	7.36	7.25	7.33	7.39	6.76	7.55	7.51	7.16	7.47	7.62	7.46	7.3	7.3	7.1	7.05	7.21	7.13	7.25
Alkalinity	mg/L as $CaCO_3$				9	10	18	12	12	10	9	9	9	7	12	9	8	9	9	9	9	8	9	8	9	9	9
Acidity	mg/L as $CaCO_3$				< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Conductivity	uS/cm				15	4	22	24	21	17	12	16	4	18	20	4	4	20	16	19	15	19	4	18	22	21	21
Sulphate	mg/L				0.3	0.3	0.3	0.3	0.4	0.3	0.4	0.4	0.3	0.3	0.4	0.3	0.3	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Chloride	mg/L				---	---		< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---
Nitrate (as nitrogen)	mg/L				---	---		< 0.05	---	---	---	---	< 0.05	---	---	---	---	< 0.05	---	---	---	---	< 0.05	---	---	---	---
Ammonia+Ammonium (N)	mg/L				---	---		< 0.1	---	---	---	---	< 0.1	---	---	---	---	< 0.1	---	---	---	---	< 0.1	---	---	---	---
Tot.Reactive Phos.	mg/L				---	---		< 0.03	---	---	---	---	0.13	---	---	---	---	< 0.03	---	---	---	---	< 0.03	---	---	---	---
Chromium III	mg/L	0.0089	0.0089		---	---		< 0.0005	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Chromium VI	µg/L	1	1		---	---		< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---
Mercury	mg/L	0.0002			---	---		< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---
Silver	mg/L	0.0001	0.0001		---	---		< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---
Aluminum	mg/L	0.075(5)	0.1		---	---		0.04	---	---	---	---	0.05	---	---	---	---	0.04	---	---	---	---	0.04	---	---	---	---
Arsenic	mg/L	0.005	0.005	1	---	---		< 0.0002	---	---	---	---	< 0.0002	---	---	---	---	< 0.0002	---	---	---	---	< 0.0002	---	---	---	---
Barium	mg/L				---	---		0.00087	---	---	---	---	0.00072	---	---	---	---	0.00086	---	---	---	---	0.00082	---	---	---	---
Beryllium	mg/L	0.011(4)			---	---		< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---
Boron	mg/L	0.2			---	---		0.0003	---	---	---	---	0.0003	---	---	---	---	0.0004	---	---	---	---	0.0003	---	---	---	---
Bismuth	mg/L				---	---		< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---
Calcium	mg/L				---	---		3.65	---	---	---	---	3.27	---	---	---	---	3.67	---	---	---	---	3.45	---	---	---	---
Cadmium	mg/L	0.0001(4)	0.000017		---	---		0.000006	---	---	---	---	< 0.000003	---	---	---	---	< 0.000003	---	---	---	---	< 0.000003	---	---	---	---
Cobalt	mg/L	0.0009			---	---		< 0.000002	---	---	---	---	0.000009	---	---	---	---	0.000011	---	---	---	---	0.00001	---	---	---	---
Chromium	mg/L				---	---		< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---
Copper	mg/L	0.001(4)	0.002(4)	0.6	---	---		0.0008	---	---	---	---	0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---
Iron	mg/L	0.3	0.3		---	---		< 0.002	---	---	---	---	< 0.003	---	---	---	---	< 0.003	---	---	---	---	< 0.003	---	---	---	---
Potassium	mg/L				---	---		0.217	---	---	---	---	0.171	---	---	---	---	0.184	---	---	---	---	0.152	---	---	---	---
Lithium	mg/L				---	---		< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---
Magnesium	mg/L				---	---		0.093	---	---	---	---	0.072	---	---	---	---	0.081	---	---	---	---	0.065	---	---	---	---
Manganese	mg/L				---	---		0.0198	---	---	---	---	0.0192	---	---	---	---	0.0183	---	---	---	---	0.019	---	---	---	---
Molybdenum	mg/L	0.04			---	---		0.00003	---	---	---	---	0.00002	---	---	---	---	0.00005	---	---	---	---	0.00001	---	---	---	---
Sodium	mg/L				---	---		0.07	---	---	---	---	0.06	---	---	---	---	0.06	---	---	---	---	0.05	---	---	---	---
Nickel	mg/L	0.025	0.025(4)	1	---	---		< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---
Phosphorus	mg/L				---	---		< 0.009	---	---	---	---	< 0.009	---	---	---	---	< 0.009	---	---	---	---	< 0.009	---	---	---	---
Lead	mg/L	0.001(4)	0.001(4)	0.4	---	---		< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---
Antimony	mg/L	0.02			---	---		< 0.0002	---	---	---	---	< 0.0002	---	---	---	---	< 0.0002	---	---	---	---	< 0.0002	---	---	---	---
Selenium	mg/L	0.1	0.001		---	---		< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---
Silica	mg/L				---	---		0.27	---	---	---	---	0.24	---	---	---	---	0.34	---	---	---	---	0.27	---	---	---	---
Tin	mg/L				---	---		0.00005	---	---	---	---	0.00006	---	---	---	---	0.00001	---	---	---	---	0.00009	---	---	---	---
Strontium	mg/L				---	---		0.0149	---	---	---	---	0.0131	---	---	---	---	0.0151	---	---	---	---	0.0139	---	---	---	---
Titanium	mg/L				---	---		< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---
Thallium	mg/L				---	---		< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---
Uranium	mg/L	0.005			---	---		0.000303	---	---	---	---	0.000183	---	---	---	---	0.000258	---	---	---	---	0.000229	---	---	---	---
Vanadium	mg/L	0.006			---	---		0.00018	---	---	---	---	0.00021	---	---	---	---	0.00018	---	---	---	---	0.00016	---	---	---	---
Zinc	mg/L	0.02	0.03	1	---	---		< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---

0.5	Parameter exceeds the Provincial Water Quality Objective(1)
0.5	Parameter exceeds the CCME Water Quality Guidelines(2)
0.5	Parameter exceeds MISA(3)

(1) Provincial Water Quality Objectives (PWQO) (MOEE, 1999)
(2) Canadian Environmental Quality Guidelines. Canadian Council of Ministers of the Environment (CCME, 2007).
(3) Municipal/Industrial Strategy for Abatement (MISA): Effluent Monitoring and Effluent Limits — Metal Mining Sector (O.F
(4) Parameter is dependant on hardness. The minimum value was selected.
(5) Aluminum guideline applies to water with pH > 6.5

Analyte	Unit	Provincial Water Quality	CCME Water Quality Guidelines for the Protection	MISA[3]	Wk#0 26-Apr-11	Wk#1 3-May-11	Wk#2 10-May-11	Wk#3 17-May-11	Wk#4 24-May-11	Wk#5 31-May-11	Wk#6 7-Jun-11	Wk#7 14-Jun-11	Wk#8 21-Jun-11	Wk# 9 28-Jun-11	Wk#10 5-Jul-11	Wk#11 12-Jul-11	Wk#12 19-Jul-11	Wk#13 26-Jul-11	Wk#14 2-Aug-11	Wk#15 9-Aug-11	Wk#16 16-Aug-11	Wk#17 23-Aug-11	Wk#18 30-Aug-11	Wk#19 6-Sep-11	Wk#20 13-Sep-11	Wk#21 20-Sep-11	Wk#22 27-Sep-11
Leachate Volume Added (mL)	mL				1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Leachate Volume Recovered (mL)	mL				830	944	965	954	895	867	886	887	912	908	909	919	909	899	906	901	895	901	907	908	858	936	935
pH	no unit	6.5 - 8.5	6.5 - 9	6 - 9.5	8.13	7.76	8.46	7.62	8.02	8.18	7.81	8.11	7.32	7.49	7.42	7.13	7.5	7.54	7.63	7.5	7.69	**6.2**	7.52	7.32	7.09	7.13	7.26
Alkalinity	mg/L as $CaCO_3$				21	17	14	14	13	16	11	12	13	11	11	9	8	9	9	8	10	17	7	14	7	8	8
Acidity	mg/L as $CaCO_3$				< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Conductivity	uS/cm				7	42	28	31	28	33	24	25	64	21	22	17	16	20	20	16	17	16	16	16	18	18	3
Sulphate	mg/L				0.7	0.8	0.6	0.5	0.7	0.2	0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Chloride	mg/L				2.1	1.3	0.6	0.3	0.3	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---
Nitrate (as nitrogen)	mg/L				< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	---	---	---	---	< 0.05	---	---	---	---	< 0.05	---	---	---	---	< 0.05	---	---
Ammonia+Ammonium (N)	mg/L				< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	---	---	---	---	< 0.1	---	---	---	---	< 0.1	---	---	---	---	< 0.1	---	---
Tot.Reactive Phos.	mg/L				< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	---	---	---	---	< 0.03	---	---	---	---	< 0.03	---	---	---	---	< 0.03	---	---
Chromium III	mg/L	0.0089	0.0089		< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	---	---	---	---	< 0.0005	---	---	---	---	<0.0005	---	---	---	---	<0.0005	---	---
Chromium VI	µg/L	1	1		< 0.2	0.2	< 0.2	< 0.2	< 0.2	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---
Mercury	mg/L	0.0002			< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---
Silver	mg/L	0.0001	0.0001		< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---
Aluminum	mg/L	0.075[5]	0.1		0.09	0.03	0.05	0.04	0.08	0.06	---	---	---	---	0.05	---	---	---	---	0.03	---	---	---	---	0.04	---	---
Arsenic	mg/L	0.005	0.005	1	0.0009	< 0.0002	0.0002	0.0003	0.0002	0.0003	---	---	---	---	< 0.0002	---	---	---	---	< 0.0002	---	---	---	---	< 0.0002	---	---
Barium	mg/L				0.00177	0.00181	0.0018	0.00131	0.0011	0.00108	---	---	---	---	0.00059	---	---	---	---	0.00057	---	---	---	---	0.0005	---	---
Beryllium	mg/L	0.011[4]			< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---
Boron	mg/L	0.2			0.0042	0.0057	0.003	0.0021	0.0032	0.002	---	---	---	---	0.001	---	---	---	---	< 0.0002	---	---	---	---	0.0003	---	---
Bismuth	mg/L				< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---
Calcium	mg/L				4.53	4.4	3.78	3.77	2.87	3.02	---	---	---	---	2.44	---	---	---	---	2.35	---	---	---	---	2.37	---	---
Cadmium	mg/L	0.0001[4]	0.000017		< 0.000003	< 0.000003	< 0.000003	< 0.000003	< 0.000003	< 0.000003	---	---	---	---	< 0.000003	---	---	---	---	**0.000022**	---	---	---	---	< 0.000003	---	---
Cobalt	mg/L	0.0009			0.000035	0.000047	0.000047	0.000026	0.000019	0.000026	---	---	---	---	0.00001	---	---	---	---	0.000012	---	---	---	---	0.000011	---	---
Chromium	mg/L				< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---
Copper	mg/L	0.001[4]	0.002[4]	0.6	**0.0025**	**0.0031**	0.0018	0.001	0.0012	0.0009	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---
Iron	mg/L	0.3	0.3		0.003	0.002	0.005	0.003	0.012	< 0.002	---	---	---	---	< 0.002	---	---	---	---	< 0.002	---	---	---	---	0.003	---	---
Potassium	mg/L				3.12	2.35	1.8	1.4	1.45	1.09	---	---	---	---	0.321	---	---	---	---	0.405	---	---	---	---	0.259	---	---
Lithium	mg/L				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---
Magnesium	mg/L				0.272	0.476	0.461	0.437	0.443	0.431	---	---	---	---	0.304	---	---	---	---	0.466	---	---	---	---	0.346	---	---
Manganese	mg/L				0.00576	0.0123	0.0113	0.0117	0.00738	0.00858	---	---	---	---	0.0089	---	---	---	---	0.00745	---	---	---	---	0.00895	---	---
Molybdenum	mg/L	0.04			0.00174	0.00298	0.00141	0.0008	0.00098	0.00022	---	---	---	---	0.00007	---	---	---	---	0.00005	---	---	---	---	0.00001	---	---
Sodium	mg/L				1.8	1.78	1.11	0.76	0.91	0.44	---	---	---	---	0.06	---	---	---	---	0.08	---	---	---	---	0.06	---	---
Nickel	mg/L	0.025	0.025[4]	1	< 0.0001	0.0001	0.0003	< 0.0001	< 0.0001	< 0.0001	---	---	---	---	0.0002	---	---	---	---	0.0001	---	---	---	---	< 0.0001	---	---
Phosphorus	mg/L				0.012	0.055	0.044	< 0.009	0.011	< 0.009	---	---	---	---	< 0.009	---	---	---	---	< 0.009	---	---	---	---	< 0.009	---	---
Lead	mg/L	0.001[4]	0.001[4]	0.4	< 0.00002	0.00003	0.00019	< 0.00002	< 0.00002	< 0.00002	---	---	---	---	0.00002	---	---	---	---	0.00009	---	---	---	---	< 0.00002	---	---
Antimony	mg/L	0.02			0.0008	0.0009	0.0006	0.0004	0.0002	0.0003	---	---	---	---	0.0003	---	---	---	---	0.0002	---	---	---	---	0.0002	---	---
Selenium	mg/L	0.1	0.001		< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---
Silica	mg/L				0.46	0.42	0.41	0.32	0.26	0.28	---	---	---	---	0.15	---	---	---	---	0.2	---	---	---	---	0.16	---	---
Tin	mg/L				0.00167	0.00122	0.00124	0.0011	0.0006	0.00046	---	---	---	---	0.00022	---	---	---	---	0.00013	---	---	---	---	0.00006	---	---
Strontium	mg/L				0.0156	0.018	0.0154	0.0149	0.0119	0.0118	---	---	---	---	0.0087	---	---	---	---	0.0088	---	---	---	---	0.008	---	---
Titanium	mg/L				0.0002	< 0.0001	< 0.0001	< 0.0001	0.0001	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---
Thallium	mg/L				< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---
Uranium	mg/L	0.005			0.0008	0.00187	0.00288	0.00294	0.00308	0.0024	---	---	---	---	0.00155	---	---	---	---	0.0015	---	---	---	---	0.000885	---	---
Vanadium	mg/L	0.006			0.00022	0.00012	0.00014	0.00012	0.00013	< 0.00003	---	---	---	---	0.00005	---	---	---	---	< 0.00003	---	---	---	---	< 0.00003	---	---
Zinc	mg/L	0.02	0.03	1	< 0.001	< 0.001	0.004	< 0.001	< 0.001	< 0.001	---	---	---	---	< 0.001	---	---	---	---	0.003	---	---	---	---	< 0.001	---	---

0.5	Parameter exceeds the Provincial Water Quality Objective[1]
0.5	Parameter exceeds the CCME Water Quality Guidelines[2]
0.5	Parameter exceeds MISA[3]

(1) Provincial Water Quality Objectives (PWQO) (MOEE, 1999)
(2) Canadian Environmental Quality Guidelines. Canadian Council of Ministers of the Environment (CCME, 2007).
(3) Municipal/Industrial Strategy for Abatement (MISA): Effluent Monitoring and Effluent Limits — Metal Mining Sector (O.Reg. 560/94).
(4) Parameter is dependant on hardness. The minimum value was selected.
(5) Aluminum guideline applies to water with pH > 6.5

Appendix C-7
Osisko Hammond Reef Gold Project
2010-HR-086 - Altered Granitoid

Analyte	Unit	Provincial Water Quality	CCME Water Quality Guidelines for the Protection	MISA[3]	Wk#23 4-Oct-11	Wk#24 11-Oct-11	Wk#25 18-Oct-11	Wk#26 25-Oct-11	Wk#27 1-Nov-11	Wk#28 8-Nov-11	Wk#29 15-Nov-11	Wk#30 22-Nov-11	Wk#31 29-Nov-11	Wk#32 6-Dec-11	Wk#33 13-Dec-11	Wk#34 20-Dec-11	Wk#35 28-Dec-11	Wk#36 3-Jan-12	Wk#37 10-Jan-12	Wk#38 17-Jan-12	Wk#39 24-Jan-12	Wk#40 31-Jan-12	Wk#41 7-Feb-12	Wk#42 14-Feb-12	Wk#43 21-Feb-12	Wk#44 28-Feb-12
Leachate Volume Added (mL)	mL				1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Leachate Volume Recovered (mL)	mL				928	924	909	898	917	910	900	917	911	954	920	913	906	943	917	915	914	939	913	916	926	916
pH	no unit	6.5 - 8.5	6.5 - 9	6 - 9.5	7.44	**6.48**	6.93	7.2	6.81	7.15	7.32	7.27	7.03	7.25	7.19	7.1	7.29	7.22	7.23	7.4	7.16	7.01	7.05	7.11	7.14	6.89
Alkalinity	mg/L as $CaCO_3$				8	11	8	7	7	8	8	7	7	8	7	10	7	9	7	7	7	7	7	7	7	7
Acidity	mg/L as $CaCO_3$				< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Conductivity	uS/cm				4	17	16	13	17	2	14	3	15	4	12	24	16	14	16	11	15	12	14	11	22	15
Sulphate	mg/L				< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Chloride	mg/L				---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---
Nitrate (as nitrogen)	mg/L				---	---	< 0.05	---	---	---	---	< 0.05	---	---	---	---	< 0.05	---	---	---	---	< 0.05	---	---	---	---
Ammonia+Ammonium (N)	mg/L				---	---	< 0.1	---	---	---	---	< 0.1	---	---	---	---	< 0.1	---	---	---	---	< 0.1	---	---	---	---
Tot.Reactive Phos.	mg/L				---	---	< 0.03	---	---	---	---	0.07	---	---	---	---	< 0.03	---	---	---	---	< 0.03	---	---	---	---
Chromium III	mg/L	0.0089	0.0089		---	---	< 0.0005	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Chromium VI	µg/L	1	1		---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---
Mercury	mg/L	0.0002			---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---
Silver	mg/L	0.0001	0.0001		---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---
Aluminum	mg/L	0.075[5]	0.1		---	---	0.04	---	---	---	---	0.03	---	---	---	---	0.03	---	---	---	---	0.03	---	---	---	---
Arsenic	mg/L	0.005	0.005	1	---	---	< 0.0002	---	---	---	---	< 0.0002	---	---	---	---	0.0002	---	---	---	---	< 0.0002	---	---	---	---
Barium	mg/L				---	---	0.00045	---	---	---	---	0.00045	---	---	---	---	0.00037	---	---	---	---	0.00038	---	---	---	---
Beryllium	mg/L	0.011[4]			---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---
Boron	mg/L	0.2			---	---	< 0.0002	---	---	---	---	< 0.0002	---	---	---	---	< 0.0002	---	---	---	---	< 0.0002	---	---	---	---
Bismuth	mg/L				---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---
Calcium	mg/L				---	---	2.39	---	---	---	---	2.13	---	---	---	---	2.06	---	---	---	---	2.16	---	---	---	---
Cadmium	mg/L	0.0001[4]	0.000017		---	---	< 0.000003	---	---	---	---	< 0.000003	---	---	---	---	< 0.000003	---	---	---	---	< 0.000003	---	---	---	---
Cobalt	mg/L	0.0009			---	---	< 0.000002	---	---	---	---	0.000037	---	---	---	---	0.000008	---	---	---	---	0.000005	---	---	---	---
Chromium	mg/L				---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---
Copper	mg/L	0.001[4]	0.002[4]	0.6	---	---	0.0008	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---
Iron	mg/L	0.3	0.3		---	---	< 0.002	---	---	---	---	< 0.003	---	---	---	---	< 0.003	---	---	---	---	< 0.003	---	---	---	---
Potassium	mg/L				---	---	0.226	---	---	---	---	0.158	---	---	---	---	0.162	---	---	---	---	0.138	---	---	---	---
Lithium	mg/L				---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---
Magnesium	mg/L				---	---	0.38	---	---	---	---	0.334	---	---	---	---	0.392	---	---	---	---	0.378	---	---	---	---
Manganese	mg/L				---	---	0.00942	---	---	---	---	0.00826	---	---	---	---	0.00712	---	---	---	---	0.00775	---	---	---	---
Molybdenum	mg/L	0.04			---	---	0.00003	---	---	---	---	0.00003	---	---	---	---	0.00004	---	---	---	---	0.00001	---	---	---	---
Sodium	mg/L				---	---	0.05	---	---	---	---	0.05	---	---	---	---	0.05	---	---	---	---	0.04	---	---	---	---
Nickel	mg/L	0.025	0.025[4]	1	---	---	< 0.0001	---	---	---	---	0.0002	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---
Phosphorus	mg/L				---	---	< 0.009	---	---	---	---	< 0.009	---	---	---	---	0.012	---	---	---	---	< 0.009	---	---	---	---
Lead	mg/L	0.001[4]	0.001[4]	0.4	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---
Antimony	mg/L	0.02			---	---	< 0.0002	---	---	---	---	< 0.0002	---	---	---	---	< 0.0002	---	---	---	---	< 0.0002	---	---	---	---
Selenium	mg/L	0.1	0.001		---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---
Silica	mg/L				---	---	0.15	---	---	---	---	0.13	---	---	---	---	0.17	---	---	---	---	0.14	---	---	---	---
Tin	mg/L				---	---	0.00005	---	---	---	---	0.00005	---	---	---	---	< 0.00001	---	---	---	---	0.00005	---	---	---	---
Strontium	mg/L				---	---	0.008	---	---	---	---	0.0071	---	---	---	---	0.0066	---	---	---	---	0.0068	---	---	---	---
Titanium	mg/L				---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---
Thallium	mg/L				---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---
Uranium	mg/L	0.005			---	---	0.000878	---	---	---	---	0.000559	---	---	---	---	0.000615	---	---	---	---	0.000561	---	---	---	---
Vanadium	mg/L	0.006			---	---	0.00003	---	---	---	---	0.00005	---	---	---	---	< 0.00003	---	---	---	---	< 0.00003	---	---	---	---
Zinc	mg/L	0.02	0.03	1	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---

0.5	Parameter exceeds the Provincial Water Quality Objective[1]
0.5	Parameter exceeds the CCME Water Quality Guidelines[2]
<u>0.5</u>	Parameter exceeds MISA[3]

(1) Provincial Water Quality Objectives (PWQO) (MOEE, 1999)
(2) Canadian Environmental Quality Guidelines. Canadian Council of Ministers of the Environment (CCME, 2007).
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(4) Parameter is dependant on hardness. The minimum value was selected.
(5) Aluminum guideline applies to water with pH > 6.5

Appendix C-8
Osisko Hammond Reef Gold Project
2010-HR-091 - Chloritic Granite

Analyte	Unit	Provincial Water Quality	CCME Water Quality Guidelines for the Protection	MISA[3]	Wk#0 26-Apr-11	Wk#1 3-May-11	Wk#2 10-May-11	Wk#3 17-May-11	Wk#4 24-May-11	Wk#5 31-May-11	Wk#6 7-Jun-11	Wk#7 14-Jun-11	Wk#8 21-Jun-11	Wk# 9 28-Jun-11	Wk#10 5-Jul-11	Wk#11 12-Jul-11	Wk#12 19-Jul-11	Wk#13 26-Jul-11	Wk#14 2-Aug-11	Wk#15 9-Aug-11	Wk#16 16-Aug-11	Wk#17 23-Aug-11	Wk#18 30-Aug-11	Wk#19 6-Sep-11	Wk#20 13-Sep-11	Wk#21 20-Sep-11	Wk#22 27-Sep-11
Leachate Volume Added (mL)	mL				1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Leachate Volume Recovered (mL)	mL				816	951	978	987	924	890	902	900	931	954	987	928	920	933	923	905	895	919	923	907	927	938	936
pH	no unit	6.5 - 8.5	6.5 - 9	6 - 9.5	8.84	7.77	8.08	7.63	7.96	7.96	7.67	8.05	7.76	7.57	7.5	7.32	7.52	7.66	7.42	7.46	7.54	7.61	7.49	7.57	7.24	7.17	7.16
Alkalinity	mg/L as $CaCO_3$				28	22	21	18	12	17	11	9	11	12	15	10	9	11	9	10	9	9	8	21	9	8	8
Acidity	mg/L as $CaCO_3$				< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	19	< 2	< 2	< 2	< 2	< 2
Conductivity	uS/cm				7	47	38	41	29	39	25	23	23	25	33	21	19	25	20	19	15	17	18	18	19	20	15
Sulphate	mg/L				1.7	3	1.9	1.5	1.2	1.1	0.9	0.7	0.6	0.5	0.6	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.3
Chloride	mg/L				1.5	1.2	0.3	< 0.2	< 0.2	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---
Nitrate (as nitrogen)	mg/L				< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	---	---	---	---	< 0.05	---	---	---	---	< 0.05	---	---	---	---	< 0.05	---	---
Ammonia+Ammonium (N)	mg/L				< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	---	---	---	---	< 0.1	---	---	---	---	< 0.1	---	---	---	---	< 0.1	---	---
Tot.Reactive Phos.	mg/L				< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	---	---	---	---	< 0.03	---	---	---	---	< 0.03	---	---	---	---	< 0.03	---	---
Chromium III	mg/L	0.0089	0.0089		< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	---	---	---	---	< 0.0005	---	---	---	---	<0.0005	---	---	---	---	<0.0005	---	---
Chromium VI	µg/L	1	1		< 0.2	0.3	< 0.2	< 0.2	< 0.2	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---
Mercury	mg/L	0.0002			< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---
Silver	mg/L	0.0001	0.0001		< 0.00001	0.00003	0.00002	< 0.00001	0.00003	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---
Aluminum	mg/L	0.075[5]	0.1		0.09	0.04	0.04	0.05	0.06	0.06	---	---	---	---	0.03	---	---	---	---	0.04	---	---	---	---	0.04	---	---
Arsenic	mg/L	0.005	0.005	1	0.0008	0.0003	0.0003	< 0.0002	0.0002	0.0002	---	---	---	---	< 0.0002	---	---	---	---	< 0.0002	---	---	---	---	< 0.0002	---	---
Barium	mg/L				0.00373	0.00671	0.01015	0.0124	0.0066	0.00751	---	---	---	---	0.00999	---	---	---	---	0.00746	---	---	---	---	0.00964	---	---
Beryllium	mg/L	0.011[4]			< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---
Boron	mg/L	0.2			0.0032	0.0069	0.0035	0.0026	0.0021	0.002	---	---	---	---	0.0016	---	---	---	---	< 0.0002	---	---	---	---	0.0004	---	---
Bismuth	mg/L				< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---
Calcium	mg/L				4.24	4.27	4.83	4.99	3.5	3.75	---	---	---	---	4.02	---	---	---	---	2.68	---	---	---	---	2.95	---	---
Cadmium	mg/L	0.0001[4]	0.000017		0.000003	< 0.000003	0.00001	0.000003	< 0.000003	< 0.000003	---	---	---	---	0.000003	---	---	---	---	0.000008	---	---	---	---	< 0.000003	---	---
Cobalt	mg/L	0.0009			0.000047	0.000049	0.000047	0.000041	0.000027	0.00003	---	---	---	---	0.000014	---	---	---	---	0.000013	---	---	---	---	0.000009	---	---
Chromium	mg/L				< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---
Copper	mg/L	0.001[4]	0.002[4]	0.6	**0.0021**	**0.0038**	0.0017	0.0008	0.0006	0.0006	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---
Iron	mg/L	0.3	0.3		< 0.002	< 0.002	< 0.002	< 0.002	0.007	< 0.002	---	---	---	---	< 0.002	---	---	---	---	< 0.002	---	---	---	---	0.002	---	---
Potassium	mg/L				3.9	3.72	2.45	1.81	1.17	1.04	---	---	---	---	0.512	---	---	---	---	0.297	---	---	---	---	0.289	---	---
Lithium	mg/L				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---
Magnesium	mg/L				0.346	0.779	0.801	0.793	0.447	0.495	---	---	---	---	0.52	---	---	---	---	0.272	---	---	---	---	0.313	---	---
Manganese	mg/L				0.00634	0.0151	0.0169	0.018	0.0138	0.0153	---	---	---	---	0.018	---	---	---	---	0.0142	---	---	---	---	0.015	---	---
Molybdenum	mg/L	0.04			0.00109	0.00222	0.00097	0.00052	0.00037	0.0003	---	---	---	---	0.0002	---	---	---	---	0.00013	---	---	---	---	0.0001	---	---
Sodium	mg/L				2.62	3.1	1.49	0.89	0.52	0.43	---	---	---	---	0.15	---	---	---	---	0.09	---	---	---	---	0.08	---	---
Nickel	mg/L	0.025	0.025[4]	1	< 0.0001	0.0001	0.0002	< 0.0001	< 0.0001	0.0001	---	---	---	---	0.0002	---	---	---	---	0.0001	---	---	---	---	< 0.0001	---	---
Phosphorus	mg/L				0.044	0.014	< 0.009	0.011	0.02	0.028	---	---	---	---	< 0.009	---	---	---	---	0.014	---	---	---	---	< 0.009	---	---
Lead	mg/L	0.001[4]	0.001[4]	0.4	0.00005	0.00015	0.00013	0.00011	0.00014	0.00018	---	---	---	---	0.00011	---	---	---	---	0.00022	---	---	---	---	0.00008	---	---
Antimony	mg/L	0.02			0.0009	0.0009	0.0006	0.0004	< 0.0002	0.0003	---	---	---	---	0.0004	---	---	---	---	< 0.0002	---	---	---	---	0.0002	---	---
Selenium	mg/L	0.1	0.001		< 0.001	< 0.001	< 0.001	0.001	< 0.001	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---
Silica	mg/L				0.63	0.55	0.6	0.52	0.27	0.32	---	---	---	---	0.32	---	---	---	---	0.2	---	---	---	---	0.25	---	---
Tin	mg/L				0.00099	0.00072	0.00046	0.00036	0.00016	0.00012	---	---	---	---	0.00017	---	---	---	---	0.00002	---	---	---	---	0.00001	---	---
Strontium	mg/L				0.025	0.0413	0.0437	0.0442	0.0251	0.026	---	---	---	---	0.0283	---	---	---	---	0.0164	---	---	---	---	0.0181	---	---
Titanium	mg/L				0.0002	0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	0.0002	---	---	---	---	< 0.0001	---	---
Thallium	mg/L				< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---
Uranium	mg/L	0.005			0.000305	0.00263	0.00235	0.00204	0.00136	0.00133	---	---	---	---	0.00138	---	---	---	---	0.000598	---	---	---	---	0.000588	---	---
Vanadium	mg/L	0.006			0.00023	< 0.00003	0.00022	0.00012	0.0001	< 0.00003	---	---	---	---	0.00005	---	---	---	---	0.00004	---	---	---	---	< 0.00003	---	---
Zinc	mg/L	0.02	0.03	1	< 0.001	< 0.001	< 0.001	0.001	< 0.001	0.001	---	---	---	---	< 0.001	---	---	---	---	0.002	---	---	---	---	< 0.001	---	---

0.5	Parameter exceeds the Provincial Water Quality Objective[1]
0.5	Parameter exceeds the CCME Water Quality Guidelines[2]
0.5	Parameter exceeds MISA[3]

(1) Provincial Water Quality Objectives (PWQO) (MOEE, 1999)
(2) Canadian Environmental Quality Guidelines. Canadian Council of Ministers of the Environment (CCME, 2007).
(3) Municipal/Industrial Strategy for Abatement (MISA): Effluent Monitoring and Effluent Limits — Metal Mining Sector (O.Reg. 560/94).
(4) Parameter is dependant on hardness. The minimum value was selected.
(5) Aluminum guideline applies to water with pH > 6.5

Analyte	Unit	Provincial Water Quality	CCME Water Quality Guidelines for the Protection	MISA(3)	Wk#23 4-Oct-11	Wk#24 11-Oct-11	Wk#25 18-Oct-11	Wk#26 25-Oct-11	Wk#27 1-Nov-11	Wk#28 8-Nov-11	Wk#29 15-Nov-11	Wk#30 22-Nov-11	Wk#31 29-Nov-11	Wk#32 6-Dec-11	Wk#33 13-Dec-11	Wk#34 20-Dec-11	Wk#35 28-Dec-11	Wk#36 3-Jan-12	Wk#37 10-Jan-12	Wk#38 17-Jan-12	Wk#39 24-Jan-12	Wk#40 31-Jan-12	Wk#41 7-Feb-12	Wk#42 14-Feb-12	Wk#43 21-Feb-12	Wk#44 28-Feb-12
Leachate Volume Added (mL)	mL				1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Leachate Volume Recovered (mL)	mL				934	940	933	970	963	989	991	992	991	993	992	990	993	988	990	993	982	988	988	987	992	992
pH	no unit	6.5 - 8.5	6.5 - 9	6 - 9.5	7.54	6.58	7.11	7.29	6.87	7.24	7.47	7.49	7.16	7.37	7.3	7.06	7.37	7.29	7.25	7.88	7.23	7.12	7.04	7.17	7.14	7.28
Alkalinity	mg/L as $CaCO_3$				9	17	10	10	9	11	11	11	11	11	10	11	10	10	10	10	10	10	10	10	10	10
Acidity	mg/L as $CaCO_3$				< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Conductivity	uS/cm				4	20	19	18	22	15	19	19	22	19	17	30	22	4	17	18	17	18	21	23	20	4
Sulphate	mg/L				0.2	0.3	0.2	0.2	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.3	0.2	0.2	0.2	< 0.2	0.2	0.2	0.2	< 0.2	0.2
Chloride	mg/L				---		< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---
Nitrate (as nitrogen)	mg/L				---		< 0.05	---	---	---	---	< 0.05	---	---	---	---	< 0.05	---	---	---	---	< 0.05	---	---	---	---
Ammonia+Ammonium (N)	mg/L				---		< 0.1	---	---	---	---	< 0.1	---	---	---	---	< 0.1	---	---	---	---	0.1	---	---	---	---
Tot.Reactive Phos.	mg/L				---		< 0.03	---	---	---	---	0.07	---	---	---	---	< 0.03	---	---	---	---	< 0.03	---	---	---	---
Chromium III	mg/L	0.0089	0.0089		---		< 0.0005	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Chromium VI	µg/L	1	1		---		< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---
Mercury	mg/L	0.0002			---		< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---
Silver	mg/L	0.0001	0.0001		---		< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---
Aluminum	mg/L	0.075(5)	0.1		---		0.05	---	---	---	---	0.03	---	---	---	---	0.02	---	---	---	---	0.03	---	---	---	---
Arsenic	mg/L	0.005	0.005	1	---		< 0.0002	---	---	---	---	< 0.0002	---	---	---	---	< 0.0002	---	---	---	---	< 0.0002	---	---	---	---
Barium	mg/L				---		0.00992	---	---	---	---	0.0144	---	---	---	---	0.015	---	---	---	---	0.0158	---	---	---	---
Beryllium	mg/L	0.011(4)			---		< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---
Boron	mg/L	0.2			---		< 0.0002	---	---	---	---	0.0002	---	---	---	---	< 0.0002	---	---	---	---	< 0.0002	---	---	---	---
Bismuth	mg/L				---		< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---
Calcium	mg/L				---		3.09	---	---	---	---	3.66	---	---	---	---	3.46	---	---	---	---	3.68	---	---	---	---
Cadmium	mg/L	0.0001(4)	0.000017		---		< 0.000003	---	---	---	---	< 0.000003	---	---	---	---	< 0.000003	---	---	---	---	< 0.000003	---	---	---	---
Cobalt	mg/L	0.0009			---		< 0.000002	---	---	---	---	0.00001	---	---	---	---	0.00001	---	---	---	---	0.000007	---	---	---	---
Chromium	mg/L				---		< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---
Copper	mg/L	0.001(4)	0.002(4)	0.6	---		< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---
Iron	mg/L	0.3	0.3		---		< 0.002	---	---	---	---	< 0.003	---	---	---	---	< 0.003	---	---	---	---	< 0.003	---	---	---	---
Potassium	mg/L				---		0.219	---	---	---	---	0.182	---	---	---	---	0.169	---	---	---	---	0.154	---	---	---	---
Lithium	mg/L				---		< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---
Magnesium	mg/L				---		0.272	---	---	---	---	0.346	---	---	---	---	0.308	---	---	---	---	0.301	---	---	---	---
Manganese	mg/L				---		0.0175	---	---	---	---	0.0241	---	---	---	---	0.0204	---	---	---	---	0.0235	---	---	---	---
Molybdenum	mg/L	0.04			---		0.0001	---	---	---	---	0.00012	---	---	---	---	0.00015	---	---	---	---	0.0001	---	---	---	---
Sodium	mg/L				---		0.06	---	---	---	---	0.06	---	---	---	---	0.06	---	---	---	---	0.05	---	---	---	---
Nickel	mg/L	0.025	0.025(4)	1	---		< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	0.0001	---	---	---	---	< 0.0001	---	---	---	---
Phosphorus	mg/L				---		< 0.009	---	---	---	---	< 0.009	---	---	---	---	< 0.009	---	---	---	---	< 0.009	---	---	---	---
Lead	mg/L	0.001(4)	0.001(4)	0.4	---		0.00008	---	---	---	---	0.00005	---	---	---	---	0.00004	---	---	---	---	0.00005	---	---	---	---
Antimony	mg/L	0.02			---		< 0.0002	---	---	---	---	< 0.0002	---	---	---	---	< 0.0002	---	---	---	---	< 0.0002	---	---	---	---
Selenium	mg/L	0.1	0.001		---		< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---
Silica	mg/L				---		0.22	---	---	---	---	0.27	---	---	---	---	0.32	---	---	---	---	0.27	---	---	---	---
Tin	mg/L				---		0.00003	---	---	---	---	0.00007	---	---	---	---	0.00008	---	---	---	---	0.00016	---	---	---	---
Strontium	mg/L				---		0.0173	---	---	---	---	0.0221	---	---	---	---	0.0189	---	---	---	---	0.0195	---	---	---	---
Titanium	mg/L				---		< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---
Thallium	mg/L				---		< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---
Uranium	mg/L	0.005			---		0.000504	---	---	---	---	0.000516	---	---	---	---	0.000531	---	---	---	---	0.000457	---	---	---	---
Vanadium	mg/L	0.006			---		0.00005	---	---	---	---	0.00005	---	---	---	---	0.00004	---	---	---	---	0.00004	---	---	---	---
Zinc	mg/L	0.02	0.03	1	---		< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---

0.5	Parameter exceeds the Provincial Water Quality Objective(1)
0.5	Parameter exceeds the CCME Water Quality Guidelines(2)
0.5	Parameter exceeds MISA(3)

(1) Provincial Water Quality Objectives (PWQO) (MOEE, 1999)
(2) Canadian Environmental Quality Guidelines. Canadian Council of Ministers of the Environment (CCME, 2007).
(3) Municipal/Industrial Strategy for Abatement (MISA): Effluent Monitoring and Effluent Limits — Metal Mining Sector (O.F
(4) Parameter is dependant on hardness. The minimum value was selected.
(5) Aluminum guideline applies to water with pH > 6.5

Analyte	Unit	Provincial Water Quality	CCME Water Quality Guidelines for the Protection	MISA[3]	Wk#0 26-Apr-11	Wk#1 3-May-11	Wk#2 10-May-11	Wk#3 17-May-11	Wk#4 24-May-11	Wk#5 31-May-11	Wk#6 7-Jun-11	Wk#7 14-Jun-11	Wk#8 21-Jun-11	Wk# 9 28-Jun-11	Wk#10 5-Jul-11	Wk#11 12-Jul-11	Wk#12 19-Jul-11	Wk#13 26-Jul-11	Wk#14 2-Aug-11	Wk#15 9-Aug-11	Wk#16 16-Aug-11	Wk#17 23-Aug-11	Wk#18 30-Aug-11	Wk#19 6-Sep-11	Wk#20 13-Sep-11	Wk#21 20-Sep-11	Wk#22 27-Sep-11
Leachate Volume Added (mL)	mL				1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Leachate Volume Recovered (mL)	mL				771	863	818	854	839	870	922	917	856	860	859	851	872	846	876	852	866	855	877	854	857	925	897
pH	no unit	6.5 - 8.5	6.5 - 9	6 - 9.5	8.61	8.26	7.94	7.69	7.74	7.86	7.14	7.63	7.81	7.53	7.96	7.19	7.52	7.84	7.41	7.88	7.77	7.49	7.57	7.31	7.17	7.59	7.64
Alkalinity	mg/L as $CaCO_3$				24	17	13	14	12	15	14	13	11	11	12	10	10	10	10	11	10	10	10	9	10	10	9
Acidity	mg/L as $CaCO_3$				< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Conductivity	uS/cm				8	46	37	32	28	34	29	29	22	25	25	21	22	24	22	30	19	12	21	20	21	20	4
Sulphate	mg/L				1.7	2.2	1.7	0.8	0.6	0.3	0.3	0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Chloride	mg/L				2.8	1.9	0.9	< 0.2	< 0.2	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---
Nitrate (as nitrogen)	mg/L				< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	---	---	---	---	< 0.05	---	---	---	---	< 0.05	---	---	---	---	< 0.05	---	---
Ammonia+Ammonium (N)	mg/L				< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	---	---	---	---	< 0.1	---	---	---	---	< 0.1	---	---	---	---	< 0.1	---	---
Tot.Reactive Phos.	mg/L				< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	---	---	---	---	< 0.03	---	---	---	---	< 0.03	---	---	---	---	< 0.03	---	---
Chromium III	mg/L	0.0089	0.0089		< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	---	---	---	---	< 0.0005	---	---	---	---	<0.0005	---	---	---	---	<0.0005	---	---
Chromium VI	µg/L	1	1		< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---
Mercury	mg/L	0.0002			< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---
Silver	mg/L	0.0001	0.0001		< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	---	---	---	---	0.00002	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---
Aluminum	mg/L	0.075[5]	0.1		0.1	0.03	0.03	0.04	0.06	0.04	---	---	---	---	0.05	---	---	---	---	0.05	---	---	---	---	0.04	---	---
Arsenic	mg/L	0.005	0.005	1	0.0007	0.0005	0.0007	0.0005	0.0006	0.0005	---	---	---	---	< 0.0002	---	---	---	---	< 0.0002	---	---	---	---	0.0002	---	---
Barium	mg/L				0.02439	0.0124	0.01017	0.01001	0.00793	0.00903	---	---	---	---	0.00644	---	---	---	---	0.00562	---	---	---	---	0.0054	---	---
Beryllium	mg/L	0.011[4]			< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---
Boron	mg/L	0.2			0.0262	0.0207	0.0125	0.0075	0.0054	0.0036	---	---	---	---	0.0017	---	---	---	---	0.0004	---	---	---	---	0.0006	---	---
Bismuth	mg/L				< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---
Calcium	mg/L				4.96	4.2	3.76	3.66	3.25	3.74	---	---	---	---	3.25	---	---	---	---	3.22	---	---	---	---	3.33	---	---
Cadmium	mg/L	0.0001[4]	0.000017		< 0.000003	< 0.000003	0.000004	< 0.000003	< 0.000003	< 0.000003	---	---	---	---	< 0.000003	---	---	---	---	0.000003	---	---	---	---	0.000004	---	---
Cobalt	mg/L	0.0009			0.000035	0.000028	0.000027	0.00002	0.000024	0.000025	---	---	---	---	0.000009	---	---	---	---	0.000009	---	---	---	---	0.00001	---	---
Chromium	mg/L				< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---
Copper	mg/L	0.001[4]	0.002[4]	0.6	**0.0028**	**0.0032**	0.002	0.0013	0.001	0.0007	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---
Iron	mg/L	0.3	0.3		0.002	0.002	0.002	0.002	0.01	< 0.002	---	---	---	---	< 0.002	---	---	---	---	< 0.002	---	---	---	---	0.003	---	---
Potassium	mg/L				2.42	1.79	1.58	1.25	1.01	0.844	---	---	---	---	0.466	---	---	---	---	0.374	---	---	---	---	0.292	---	---
Lithium	mg/L				< 0.001	0.001	< 0.001	< 0.001	< 0.001	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---
Magnesium	mg/L				0.317	0.445	0.39	0.385	0.325	0.364	---	---	---	---	0.283	---	---	---	---	0.283	---	---	---	---	0.232	---	---
Manganese	mg/L				0.0051	0.011	0.00829	0.00903	0.00844	0.0101	---	---	---	---	0.00922	---	---	---	---	0.00859	---	---	---	---	0.00972	---	---
Molybdenum	mg/L	0.04			0.00124	0.00209	0.00128	0.00038	0.00021	0.00008	---	---	---	---	0.00005	---	---	---	---	0.00002	---	---	---	---	< 0.00001	---	---
Sodium	mg/L				2.81	2.83	2.1	1.08	0.74	0.47	---	---	---	---	0.18	---	---	---	---	0.14	---	---	---	---	0.1	---	---
Nickel	mg/L	0.025	0.025[4]	1	0.0004	0.0003	0.0003	< 0.0001	< 0.0001	0.0002	---	---	---	---	0.0002	---	---	---	---	0.0001	---	---	---	---	< 0.0001	---	---
Phosphorus	mg/L				0.026	0.019	0.024	< 0.009	0.014	0.039	---	---	---	---	< 0.009	---	---	---	---	0.01	---	---	---	---	< 0.009	---	---
Lead	mg/L	0.001[4]	0.001[4]	0.4	0.00002	0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	---	---	---	---	0.00002	---	---	---	---	0.00007	---	---	---	---	< 0.00002	---	---
Antimony	mg/L	0.02			0.0011	0.0008	0.0005	0.0004	< 0.0002	0.0004	---	---	---	---	0.0004	---	---	---	---	0.0002	---	---	---	---	0.0003	---	---
Selenium	mg/L	0.1	0.001		< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---
Silica	mg/L				0.58	0.51	0.46	0.48	0.35	0.41	---	---	---	---	0.31	---	---	---	---	0.33	---	---	---	---	0.34	---	---
Tin	mg/L				0.00246	0.00148	0.00131	0.00154	0.001	0.0009	---	---	---	---	0.00036	---	---	---	---	0.00015	---	---	---	---	0.00007	---	---
Strontium	mg/L				0.27	0.338	0.275	0.288	0.235	0.261	---	---	---	---	0.179	---	---	---	---	0.162	---	---	---	---	0.131	---	---
Titanium	mg/L				< 0.0001	0.0001	0.0001	< 0.0001	< 0.0001	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---
Thallium	mg/L				< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---
Uranium	mg/L	0.005			0.000072	0.000208	0.0003	0.000407	0.000472	0.00064	---	---	---	---	0.000861	---	---	---	---	0.000799	---	---	---	---	0.000721	---	---
Vanadium	mg/L	0.006			0.00041	< 0.00003	0.00038	0.00036	0.0003	0.00008	---	---	---	---	0.00021	---	---	---	---	0.00016	---	---	---	---	0.00012	---	---
Zinc	mg/L	0.02	0.03	1	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	---	---	---	---	0.001	---	---	---	---	0.001	---	---	---	---	< 0.001	---	---

0.5	Parameter exceeds the Provincial Water Quality Objective[1]
0.5	Parameter exceeds the CCME Water Quality Guidelines[2]
0.5	Parameter exceeds MISA[3]

(1) Provincial Water Quality Objectives (PWQO) (MOEE, 1999)
(2) Canadian Environmental Quality Guidelines. Canadian Council of Ministers of the Environment (CCME, 2007).
(3) Municipal/Industrial Strategy for Abatement (MISA): Effluent Monitoring and Effluent Limits — Metal Mining Sector (O.Reg. 560/94).
(4) Parameter is dependant on hardness. The minimum value was selected.
(5) Aluminum guideline applies to water with pH > 6.5

Analyte	Unit	Provincial Water Quality	CCME Water Quality Guidelines for the Protection	MISA[3]	Wk#23	Wk#24	Wk#25	Wk#26	Wk#27	Wk#28	Wk#29	Wk#30	Wk#31	Wk#32	Wk#33	Wk#34	Wk#35	Wk#36	Wk#37	Wk#38	Wk#39	Wk#40	Wk#41	Wk#42	Wk#43	Wk#44
					4-Oct-11	11-Oct-11	18-Oct-11	25-Oct-11	1-Nov-11	8-Nov-11	15-Nov-11	22-Nov-11	29-Nov-11	6-Dec-11	13-Dec-11	20-Dec-11	28-Dec-11	3-Jan-12	10-Jan-12	17-Jan-12	24-Jan-12	31-Jan-12	7-Feb-12	14-Feb-12	21-Feb-12	28-Feb-12
Leachate Volume Added (mL)	mL				1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Leachate Volume Recovered (mL)	mL				880	880	869	873	853	854	817	844	858	848	857	845	849	881	858	855	853	860	887	858	870	844
pH	no unit	6.5 - 8.5	6.5 - 9	6 - 9.5	7.71	6.6	7.05	7.26	6.87	7.22	7.46	7.53	7.42	7.51	7.39	7.32	7.51	7.38	7.47	7.33	7.47	6.99	7.15	7.19	7.13	7.09
Alkalinity	mg/L as $CaCO_3$				9	9	10	9	9	9	9	9	9	9	9	6	8	9	8	9	9	8	9	8	8	8
Acidity	mg/L as $CaCO_3$				< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Conductivity	uS/cm				4	22	19	16	20	3	16	15	19	15	4	27	18	15	18	13	17	3	19	14	17	19
Sulphate	mg/L				< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Chloride	mg/L				---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---
Nitrate (as nitrogen)	mg/L				---	---	< 0.05	---	---	---	---	< 0.05	---	---	---	---	< 0.05	---	---	---	---	< 0.05	---	---	---	---
Ammonia+Ammonium (N)	mg/L				---	---	< 0.1	---	---	---	---	< 0.1	---	---	---	---	0.2	---	---	---	---	< 0.1	---	---	---	---
Tot.Reactive Phos.	mg/L				---	---	< 0.03	---	---	---	---	0.08	---	---	---	---	< 0.03	---	---	---	---	< 0.03	---	---	---	---
Chromium III	mg/L	0.0089	0.0089		---	---	< 0.0005	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Chromium VI	µg/L	1	1		---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---
Mercury	mg/L	0.0002			---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---
Silver	mg/L	0.0001	0.0001		---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---
Aluminum	mg/L	0.075[5]	0.1		---	---	0.04	---	---	---	---	0.05	---	---	---	---	0.05	---	---	---	---	0.05	---	---	---	---
Arsenic	mg/L	0.005	0.005	1	---	---	< 0.0002	---	---	---	---	< 0.0002	---	---	---	---	0.0003	---	---	---	---	< 0.0002	---	---	---	---
Barium	mg/L				---	---	0.00454	---	---	---	---	0.00383	---	---	---	---	0.00384	---	---	---	---	0.00348	---	---	---	---
Beryllium	mg/L	0.011[4]			---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---
Boron	mg/L	0.2			---	---	0.0002	---	---	---	---	0.0003	---	---	---	---	0.0002	---	---	---	---	0.0002	---	---	---	---
Bismuth	mg/L				---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---
Calcium	mg/L				---	---	3.2	---	---	---	---	3.02	---	---	---	---	2.72	---	---	---	---	2.99	---	---	---	---
Cadmium	mg/L	0.0001[4]	0.000017		---	---	0.000008	---	---	---	---	< 0.000003	---	---	---	---	< 0.000003	---	---	---	---	< 0.000003	---	---	---	---
Cobalt	mg/L	0.0009			---	---	< 0.000002	---	---	---	---	0.000006	---	---	---	---	0.000007	---	---	---	---	0.000005	---	---	---	---
Chromium	mg/L				---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---
Copper	mg/L	0.001[4]	0.002[4]	0.6	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	0.0006	---	---	---	---	< 0.0005	---	---	---	---
Iron	mg/L	0.3	0.3		---	---	< 0.002	---	---	---	---	< 0.003	---	---	---	---	0.004	---	---	---	---	0.004	---	---	---	---
Potassium	mg/L				---	---	0.217	---	---	---	---	0.183	---	---	---	---	0.169	---	---	---	---	0.153	---	---	---	---
Lithium	mg/L				---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---
Magnesium	mg/L				---	---	0.179	---	---	---	---	0.179	---	---	---	---	0.154	---	---	---	---	0.148	---	---	---	---
Manganese	mg/L				---	---	0.0094	---	---	---	---	0.00943	---	---	---	---	0.00756	---	---	---	---	0.00848	---	---	---	---
Molybdenum	mg/L	0.04			---	---	0.00003	---	---	---	---	0.00001	---	---	---	---	0.00003	---	---	---	---	< 0.00001	---	---	---	---
Sodium	mg/L				---	---	0.08	---	---	---	---	0.08	---	---	---	---	0.11	---	---	---	---	0.07	---	---	---	---
Nickel	mg/L	0.025	0.025[4]	1	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---
Phosphorus	mg/L				---	---	< 0.009	---	---	---	---	0.011	---	---	---	---	< 0.009	---	---	---	---	< 0.009	---	---	---	---
Lead	mg/L	0.001[4]	0.001[4]	0.4	---	---	0.00003	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---
Antimony	mg/L	0.02			---	---	< 0.0002	---	---	---	---	< 0.0002	---	---	---	---	< 0.0002	---	---	---	---	< 0.0002	---	---	---	---
Selenium	mg/L	0.1	0.001		---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---
Silica	mg/L				---	---	0.28	---	---	---	---	0.28	---	---	---	---	0.32	---	---	---	---	0.27	---	---	---	---
Tin	mg/L				---	---	0.0001	---	---	---	---	0.00009	---	---	---	---	0.00004	---	---	---	---	0.00012	---	---	---	---
Strontium	mg/L				---	---	0.103	---	---	---	---	0.089	---	---	---	---	0.0697	---	---	---	---	0.0658	---	---	---	---
Titanium	mg/L				---	---	< 0.0001	---	---	---	---	0.0001	---	---	---	---	0.0002	---	---	---	---	< 0.0001	---	---	---	---
Thallium	mg/L				---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---
Uranium	mg/L	0.005			---	---	0.000551	---	---	---	---	0.000438	---	---	---	---	0.000402	---	---	---	---	0.000355	---	---	---	---
Vanadium	mg/L	0.006			---	---	0.00015	---	---	---	---	0.00017	---	---	---	---	< 0.00003	---	---	---	---	0.00012	---	---	---	---
Zinc	mg/L	0.02	0.03	1	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---

0.5	Parameter exceeds the Provincial Water Quality Objective[1]
0.5	Parameter exceeds the CCME Water Quality Guidelines[2]
0.5	Parameter exceeds MISA[3]

(1) Provincial Water Quality Objectives (PWQO) (MOEE, 1999)
(2) Canadian Environmental Quality Guidelines. Canadian Council of Ministers of the Environment (CCME, 2007).
(3) Municipal/Industrial Strategy for Abatement (MISA): Effluent Monitoring and Effluent Limits — Metal Mining Sector (O.F
(4) Parameter is dependant on hardness. The minimum value was selected.
(5) Aluminum guideline applies to water with pH > 6.5

Analyte	Unit	Provincial Water Quality	CCME Water Quality Guidelines for the Protection	MISA[3]	Wk#0	Wk#1	Wk#2	Wk#3	Wk#4	Wk#5	Wk#6	Wk#7	Wk#8	Wk# 9	Wk#10	Wk#11	Wk#12	Wk#13	Wk#14	Wk#15	Wk#16	Wk#17	Wk#18	Wk#19	Wk#20	Wk#21	Wk#22	Wk#23
					1276-OCT1	1277-OCT1	0057-NOV1	0086-NOV1	0146-NOV1	0202-NOV1	793-NOV	0013-DEC1	0075-DEC1	1049-DEC1	10272-DEC11	0022-JAN1	0105-JAN1	1055-JAN1	0195-JAN1	0255-JAN1	0054-FEB1	0117-FEB1	0175-FEB1	0220-FEB1	0017-MAR1	0087-MAR1	0129-MAR1	194-MAR1
Leachate Volume (mL)	mL				710	995	972	986	963	974	947	977	962	981	966	967	984	985	954	983	931	1013	976	964	964	968	948	934
pH	no unit	6.5 - 8.5	6.5 - 9	6 - 9.5	7.9	7.64	7.81	7.5	7.5	7.45	7.34	7.43	7.33	7.2	6.97	7.38	7.35	7.42	7.35	7.27	7.46	7.25	7.44	7.3	7.3	7.51	7.19	7.43
Conductivity	uS/cm				404	269	122	102	37	8	40	58	38	61	52	51	58	58	45	54	50	60	59	64	53	45	42	35
Acidity	mg/L as CaCO3				<2	<2	<2	<2	<2	<2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Alkalinity	mg/L as CaCO3				44	55	43	32	12	18	9	15	11	14	16	17	21	22	16	22	23	22	22	23	25	22	16	13
Sulphate	mg/L				150	79	32	15	8.5	1.3	8	10	9.2	12	12	12	14	13	8.9	11	9.5	8	7.2	6.5	5.4	5.3	3.6	2.8
Chloride	mg/L				2.9	0.7	< 0.2	< 0.2	< 0.2	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---	---	< 0.2	---	---	---
Mercury	mg/L	0.0002			< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---
Silver	mg/L	0.0001	0.0001		< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---
Aluminum	mg/L	0.075[5]	0.1		0.02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	---	---	---	---	< 0.01	---	---	---	---	0.01	---	---	---	---	0.01	---	---	---
Arsenic	mg/L	0.005	0.005	1	0.0008	0.0005	0.0003	< 0.0002	< 0.0002	< 0.0002	---	---	---	---	0.0004	---	---	---	---	< 0.0002	---	---	---	---	< 0.0002	---	---	---
Boron	mg/L	0.2			0.0067	0.0055	0.0032	0.0016	0.0012	0.001	---	---	---	---	0.0007	---	---	---	---	0.0009	---	---	---	---	0.0007	---	---	---
Barium	mg/L				0.0179	0.0129	0.0055	0.00284	0.00114	0.00189	---	---	---	---	0.00151	---	---	---	---	0.0016	---	---	---	---	0.00108	---	---	---
Beryllium	mg/L	0.011[4]			< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---
Bismuth	mg/L				< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---	---	< 0.00001	---	---	---
Calcium	mg/L				32.7	29.5	17.7	10.9	4.75	6.99	---	---	---	---	5.76	---	---	---	---	6.53	---	---	---	---	5.02	---	---	---
Cadmium	mg/L	0.0001[4]	0.000017		0.000013	0.000009	**0.00103**	0.000006	< 0.000003	< 0.000003	---	---	---	---	< 0.000003	---	---	---	---	**0.000026**	---	---	---	---	0.000003	---	---	---
Cobalt	mg/L	0.0009			0.000429	0.000539	0.000257	0.000173	0.000061	0.000119	---	---	---	---	0.000098	---	---	---	---	0.000102	---	---	---	---	0.00007	---	---	---
Chromium	mg/L				< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	< 0.0005	---	---	---
Copper	mg/L	0.001[4]	0.002[4]	0.6	0.0018	0.0015	0.001	0.0006	< 0.0005	< 0.0005	---	---	---	---	< 0.0005	---	---	---	---	0.0008	---	---	---	---	< 0.0005	---	---	---
Iron	mg/L	0.3	0.3		< 0.002	< 0.003	0.002	< 0.003	< 0.003	< 0.003	---	---	---	---	< 0.003	---	---	---	---	0.004	---	---	---	---	0.003	---	---	---
Potassium	mg/L				13.9	7.76	3.29	1.66	0.872	1.08	---	---	---	---	0.769	---	---	---	---	0.789	---	---	---	---	0.598	---	---	---
Lithium	mg/L				0.002	0.001	< 0.001	< 0.001	< 0.001	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---
Magnesium	mg/L				13.3	10.7	6.03	3.38	1.72	2.92	---	---	---	---	2.91	---	---	---	---	3.51	---	---	---	---	2.78	---	---	---
Manganese	mg/L				0.108	0.12	0.0732	0.0521	0.0134	0.0286	---	---	---	---	0.0194	---	---	---	---	0.0204	---	---	---	---	0.0125	---	---	---
Molybdenum	mg/L	0.04			0.0161	0.00951	0.00472	0.00256	0.00125	0.00174	---	---	---	---	0.00161	---	---	---	---	0.00214	---	---	---	---	0.0017	---	---	---
Sodium	mg/L				20.4	7.14	1.96	0.81	0.38	0.51	---	---	---	---	0.35	---	---	---	---	0.36	---	---	---	---	0.27	---	---	---
Nickel	mg/L	0.025	0.025[4]	1	0.0025	0.0019	0.0013	0.0006	0.0001	0.0003	---	---	---	---	0.0004	---	---	---	---	0.0003	---	---	---	---	0.0002	---	---	---
Lead	mg/L	0.001[4]	0.001[4]	0.4	0.00007	< 0.00002	0.00006	< 0.00002	< 0.00002	< 0.00002	---	---	---	---	< 0.00002	---	---	---	---	0.00003	---	---	---	---	0.00002	---	---	---
Phosphorus	mg/L				< 0.009	< 0.009	< 0.009	< 0.009	< 0.009	< 0.009	---	---	---	---	< 0.009	---	---	---	---	< 0.009	---	---	---	---	< 0.009	---	---	---
Antimony	mg/L	0.02			0.0014	0.0006	0.0003	< 0.0002	0.0002	< 0.0002	---	---	---	---	< 0.0002	---	---	---	---	< 0.0002	---	---	---	---	< 0.0002	---	---	---
Sulphur	mg/L				59.2	29.6	12.6	5.46	2.91	4.56	---	---	---	---	4.3	---	---	---	---	3.93	---	---	---	---	1.92	---	---	---
Selenium	mg/L	0.1	0.001		0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---	---	< 0.001	---	---	---
Tin	mg/L				0.00062	0.00021	0.00008	0.00009	0.00009	0.0001	---	---	---	---	0.00023	---	---	---	---	0.00051	---	---	---	---	0.00018	---	---	---
Strontium	mg/L				0.193	0.148	0.081	0.0452	0.0202	0.0319	---	---	---	---	0.0253	---	---	---	---	0.0289	---	---	---	---	0.0219	---	---	---
Titanium	mg/L				< 0.0001	< 0.0001	< 0.0001	0.0001	< 0.0001	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---	---	< 0.0001	---	---	---
Thallium	mg/L				< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	---	---	---	---	0.00004	---	---	---	---	< 0.00002	---	---	---	---	< 0.00002	---	---	---
Uranium	mg/L	0.005			0.00281	0.0027	0.0014	0.000841	0.000315	0.000532	---	---	---	---	0.00062	---	---	---	---	0.000844	---	---	---	---	0.000652	---	---	---
Vanadium	mg/L	0.006			< 0.00003	0.00006	< 0.00003	0.00003	< 0.00003	0.00004	---	---	---	---	< 0.00003	---	---	---	---	< 0.00003	---	---	---	---	< 0.00003	---	---	---
Tungsten	mg/L	0.03			0.00057	< 0.00003	< 0.00003	< 0.00003	< 0.00003	< 0.00003	---	---	---	---	< 0.00003	---	---	---	---	< 0.00003	---	---	---	---	0.00006	---	---	---
Yttrium	mg/L				0.000015	0.000007	0.000001	0.000002	0.000001	0.000001	---	---	---	---	0.000015	---	---	---	---	0.000001	---	---	---	---	0.000001	---	---	---
Zinc	mg/L	0.02	0.03	1	0.002	0.002	**0.043**	< 0.001	0.002	0.002	---	---	---	---	0.002	---	---	---	---	0.002	---	---	---	---	0.002	---	---	---

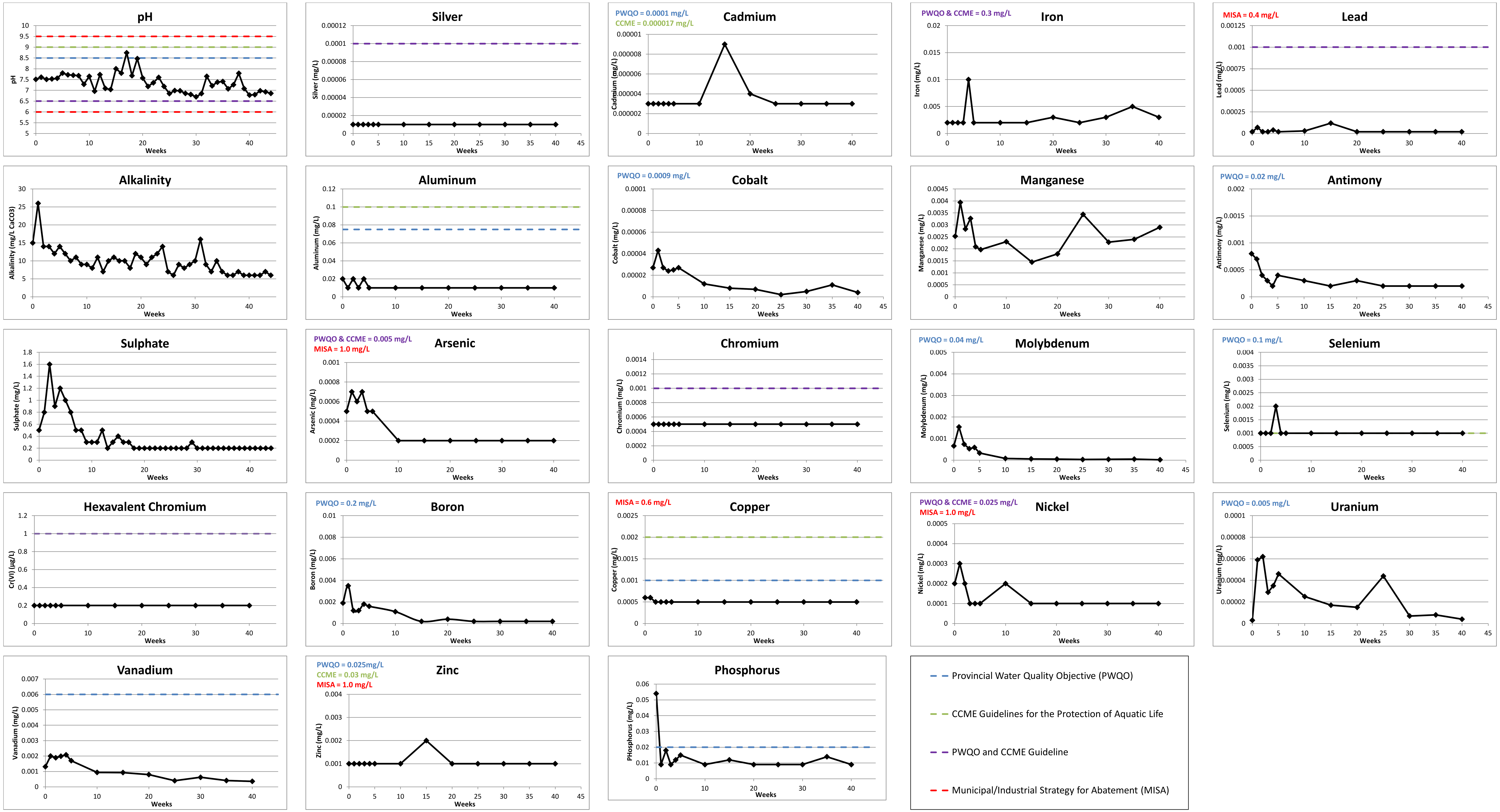
0.5	Parameter exceeds the Provincial Water Quality Objective[1]
0.5	Parameter exceeds the CCME Water Quality Guidelines[2]
0.5	Parameter exceeds MISA[3]

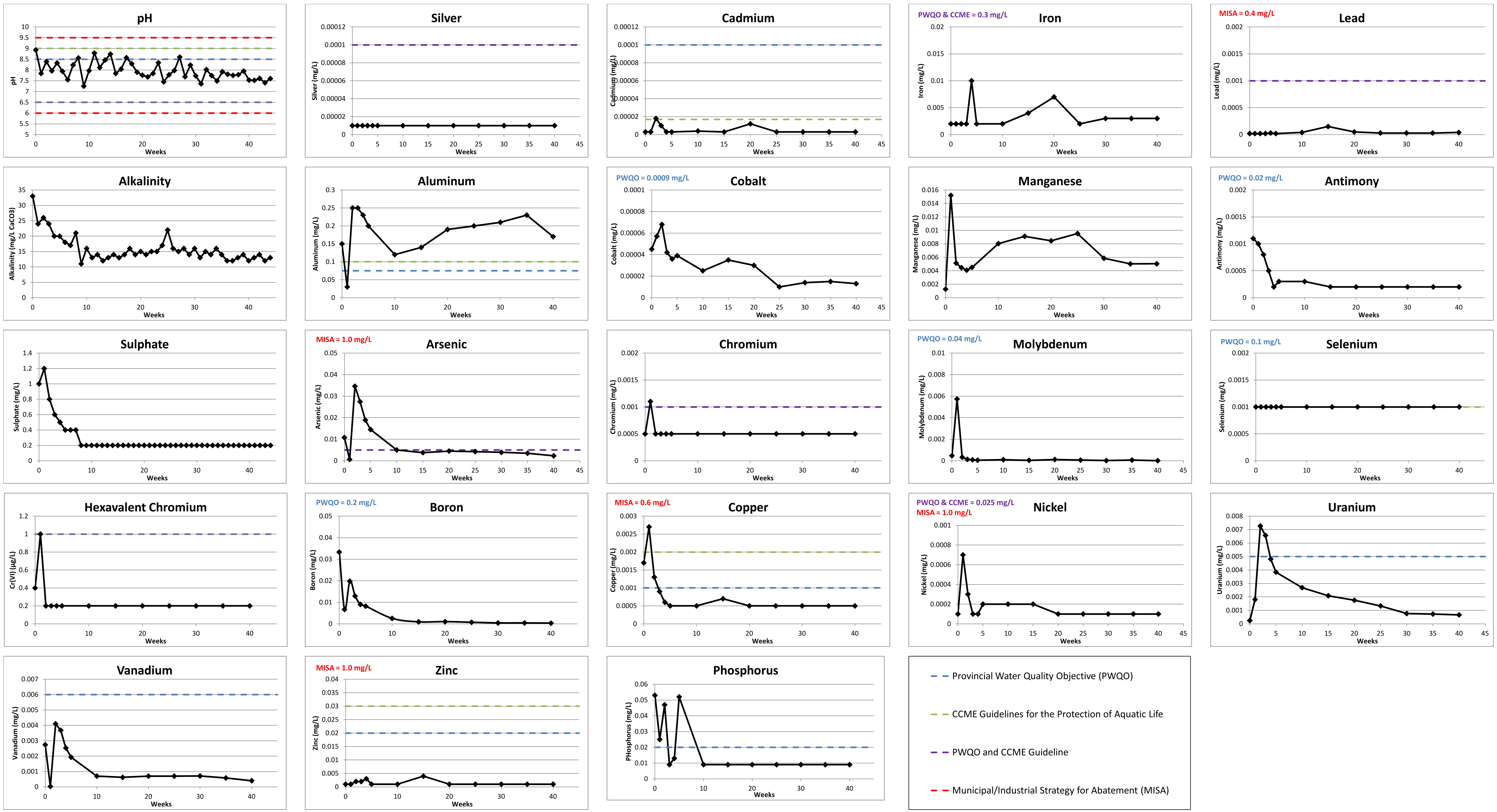
(1) Provincial Water Quality Objectives (PWQO) (MOEE, 1999)
(2) Canadian Environmental Quality Guidelines. Canadian Council of Ministers of the Environment (CCME, 2007).
(3) Municipal/Industrial Strategy for Abatement (MISA): Effluent Monitoring and Effluent Limits — Metal Mining Sector (O.Reg. 560/94).
(4) Parameter is dependant on hardness. The minimum value was selected.
(5) Aluminum guideline applies to water with pH > 6.5

APPENDIX 2.V

Kinetic Testing Results Figures


pH
Silver
Silver (mg/L)
Cadmium
Cadmium (mg/L)
PWQO & CCME = 0.3 mg/L
Iron
Iron (mg/L)
MISA = 0.4 mg/L
Lead
Lead (mg/L)
Alkalinity
Alkalinity (mg/L CaCO3)
Aluminum
Aluminum (mg/L)
PWQO = 0.0009 mg/L
Cobalt
Cobalt (mg/L)
Manganese
Manganese (mg/L)
PWQO = 0.02 mg/L
Antimony
Antimony (mg/L)
Sulphate
Sulphate (mg/L)
PWQO & CCME = 0.005 mg/L
MISA = 1.0 mg/L
Arsenic
Arsenic (mg/L)
Chromium
Chromium (mg/L)
PWQO = 0.04 mg/L
Molybdenum
Molybdenum (mg/L)
PWQO = 0.1 mg/L
Selenium
Selenium (mg/L)
Hexavalent Chromium
Cr(VI) (µg/L)
PWQO = 0.2 mg/L
Boron
Boron (mg/L)
MISA = 0.6 mg/L
Copper
Copper (mg/L)
PWQO & CCME = 0.025 mg/L
MISA = 1.0 mg/L
Nickel
Nickel (mg/L)
PWQO = 0.005 mg/L
Uranium
Uranium (mg/L)
PWQO = 0.006 mg/L
Vanadium
Vanadium (mg/L)
MISA = 1.0 mg/L
Zinc
Zinc (mg/L)
Phosphorus
PHosphorus (mg/L)
Weeks
Provincial Water Quality Objective (PWQO)
CCME Guidelines for the Protection of Aquatic Life
PWQO and CCME Guideline
Municipal/Industrial Strategy for Abatement (MISA)


pH
Silver
PWQO = 0.0001 mg/L
CCME = 0.000017 mg/L
Cadmium
PWQO & CCME = 0.3 mg/L
Iron
MISA = 0.4 mg/L
Lead
Alkalinity
Aluminum
PWQO = 0.0009 mg/L
Cobalt
Manganese
PWQO = 0.02 mg/L
Antimony
Sulphate
PWQO & CCME = 0.005 mg/L
MISA = 1.0 mg/L
Arsenic
Chromium
PWQO = 0.04 mg/L
Molybdenum
PWQO = 0.1 mg/L
Selenium
Hexavalent Chromium
PWQO = 0.2 mg/L
Boron
MISA = 0.6 mg/L
Copper
PWQO & CCME = 0.025 mg/L
MISA = 1.0 mg/L
Nickel
PWQO = 0.005 mg/L
Uranium
Vanadium
PWQO = 0.025mg/L
CCME = 0.03 mg/L
MISA = 1.0 mg/L
Zinc
Phosphorus
Weeks
Provincial Water Quality Objective (PWQO)
CCME Guidelines for the Protection of Aquatic Life
PWQO and CCME Guideline
Municipal/Industrial Strategy for Abatement (MISA)


pH
Silver
Cadmium
PWQO & CCME = 0.3 mg/L
Iron
MISA = 0.4 mg/L
Lead
Alkalinity
Aluminum
PWQO = 0.0009 mg/L
Cobalt
Manganese
PWQO = 0.02 mg/L
Antimony
Sulphate
MISA = 1.0 mg/L
Arsenic
Chromium
PWQO = 0.04 mg/L
Molybdenum
PWQO = 0.1 mg/L
Selenium
Hexavalent Chromium
PWQO = 0.2 mg/L
Boron
MISA = 0.6 mg/L
Copper
PWQO & CCME = 0.025 mg/L
MISA = 1.0 mg/L
Nickel
Uranium
Vanadium
MISA = 1.0 mg/L
Zinc
Phosphorus
Weeks
Provincial Water Quality Objective (PWQO)
CCME Guidelines for the Protection of Aquatic Life
PWQO and CCME Guideline
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pH
Silver
Cadmium
PWQO & CCME = 0.3 mg/L
Iron
MISA = 0.4 mg/L
Lead
Alkalinity
Aluminum
PWQO = 0.0009 mg/L
Cobalt
Manganese
PWQO = 0.02 mg/L
Antimony
Sulphate
PWQO & CCME = 0.005 mg/L
MISA = 1.0 mg/L
Arsenic
Chromium
PWQO = 0.04 mg/L
Molybdenum
PWQO = 0.1 mg/L
Selenium
Hexavalent Chromium
PWQO = 0.2 mg/L
Boron
MISA = 0.6 mg/L
Copper
PWQO & CCME = 0.025 mg/L
MISA = 1.0 mg/L
Nickel
PWQO = 0.005 mg/L
Uranium
PWQO = 0.006 mg/L
Vanadium
MISA = 1.0 mg/L
Zinc
Phosphorus
Weeks
Provincial Water Quality Objective (PWQO)
CCME Guidelines for the Protection of Aquatic Life
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pH
Weeks
Silver
Silver (mg/L)
Cadmium
Cadmium (mg/L)
PWQO & CCME = 0.3 mg/L
Iron
Iron (mg/L)
MISA = 0.4 mg/L
Lead
Lead (mg/L)
Alkalinity
Alkalinity (mg/L CaCO3)
Aluminum
Aluminum (mg/L)
PWQO = 0.0009 mg/L
Cobalt
Cobalt (mg/L)
Manganese
Manganese (mg/L)
PWQO = 0.02 mg/L
Antimony
Antimony (mg/L)
Sulphate
Sulphate (mg/L)
MISA = 1.0 mg/L
Arsenic
Arsenic (mg/L)
Chromium
Chromium (mg/L)
PWQO = 0.04 mg/L
Molybdenum
Molybdenum (mg/L)
PWQO = 0.1 mg/L
Selenium
Selenium (mg/L)
Hexavalent Chromium
Cr(VI) (µg/L)
PWQO = 0.2 mg/L
Boron
Boron (mg/L)
MISA = 0.6 mg/L
Copper
Copper (mg/L)
PWQO & CCME = 0.025 mg/L
MISA = 1.0 mg/L
Nickel
Nickel (mg/L)
Uranium
Uranium (mg/L)
Vanadium
Vanadium (mg/L)
MISA = 1.0 mg/L
Zinc
Zinc (mg/L)
Phosphorus
PHosphorus (mg/L)
Provincial Water Quality Objective (PWQO)
CCME Guidelines for the Protection of Aquatic Life
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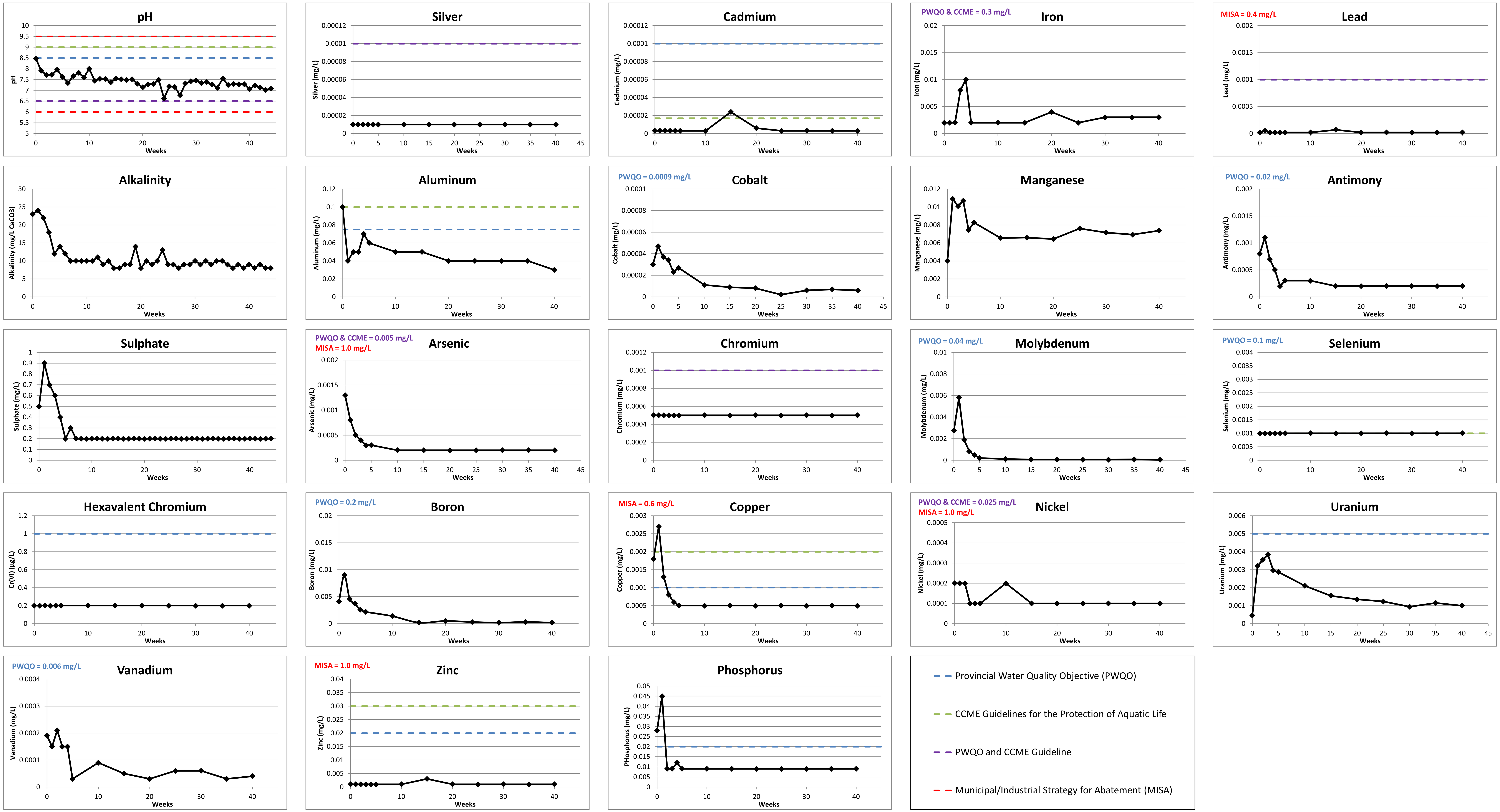
pH
Silver
Cadmium
PWQO & CCME = 0.3 mg/L
Iron
MISA = 0.4 mg/L
Lead
Alkalinity
Aluminum
PWQO = 0.0009 mg/L
Cobalt
Manganese
PWQO = 0.02 mg/L
Antimony
Sulphate
PWQO & CCME = 0.005 mg/L
MISA = 1.0 mg/L
Arsenic
Chromium
PWQO = 0.04 mg/L
Molybdenum
PWQO = 0.1 mg/L
Selenium
Hexavalent Chromium
PWQO = 0.2 mg/L
Boron
MISA = 0.6 mg/L
Copper
PWQO & CCME = 0.025 mg/L
MISA = 1.0 mg/L
Nickel
Uranium
PWQO = 0.006 mg/L
Vanadium
MISA = 1.0 mg/L
Zinc
Phosphorus
Weeks
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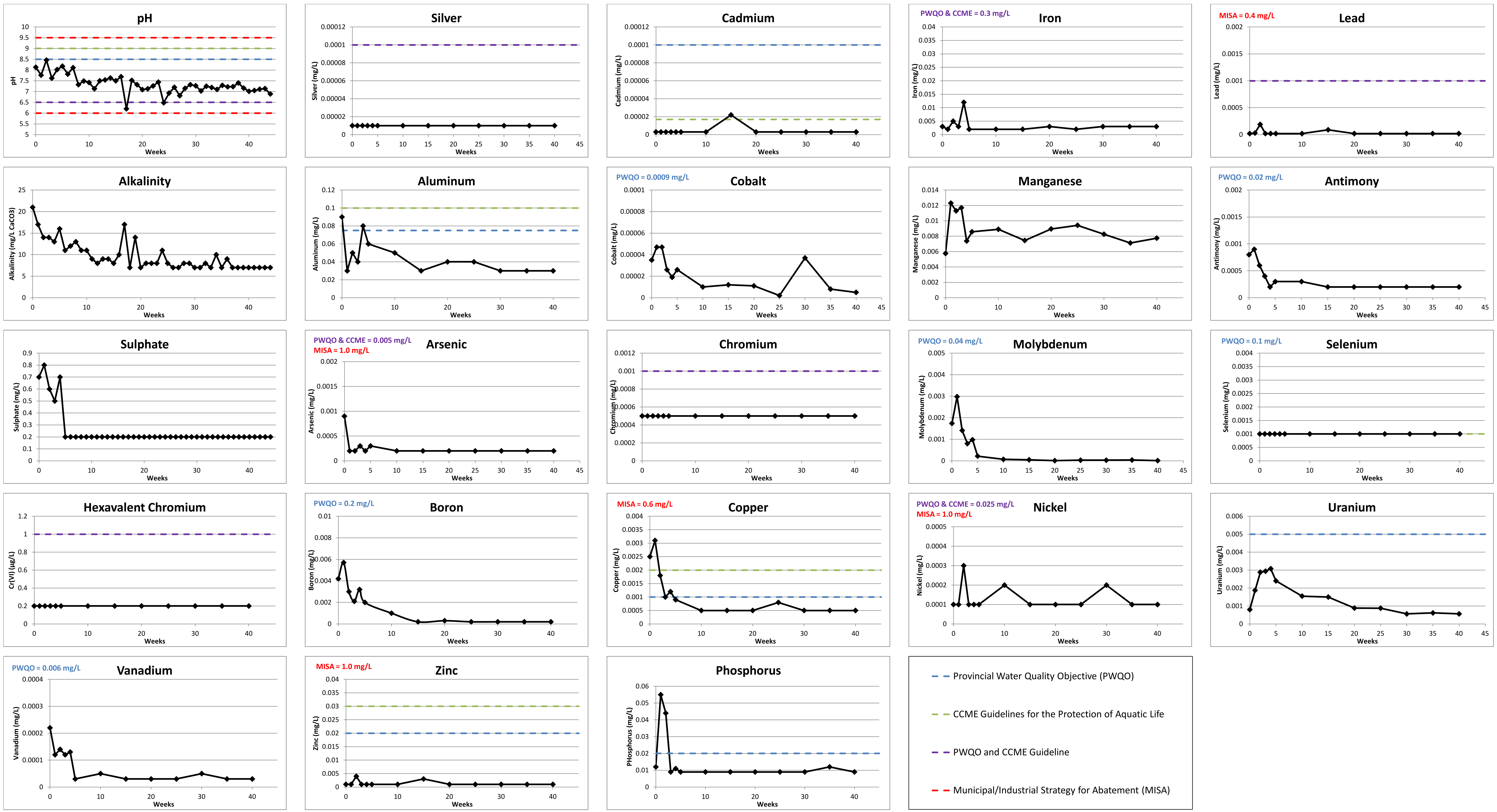
PWQO and CCME Guideline
Municipal/Industrial Strategy for Abatement (MISA)


pH
Silver
Cadmium
PWQO & CCME = 0.3 mg/L
Iron
MISA = 0.4 mg/L
Lead
Alkalinity
Aluminum
PWQO = 0.0009 mg/L
Cobalt
Manganese
PWQO = 0.02 mg/L
Antimony
Sulphate
PWQO & CCME = 0.005 mg/L
MISA = 1.0 mg/L
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Chromium
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PWQO = 0.1 mg/L
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Copper
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MISA = 1.0 mg/L
Nickel
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Vanadium
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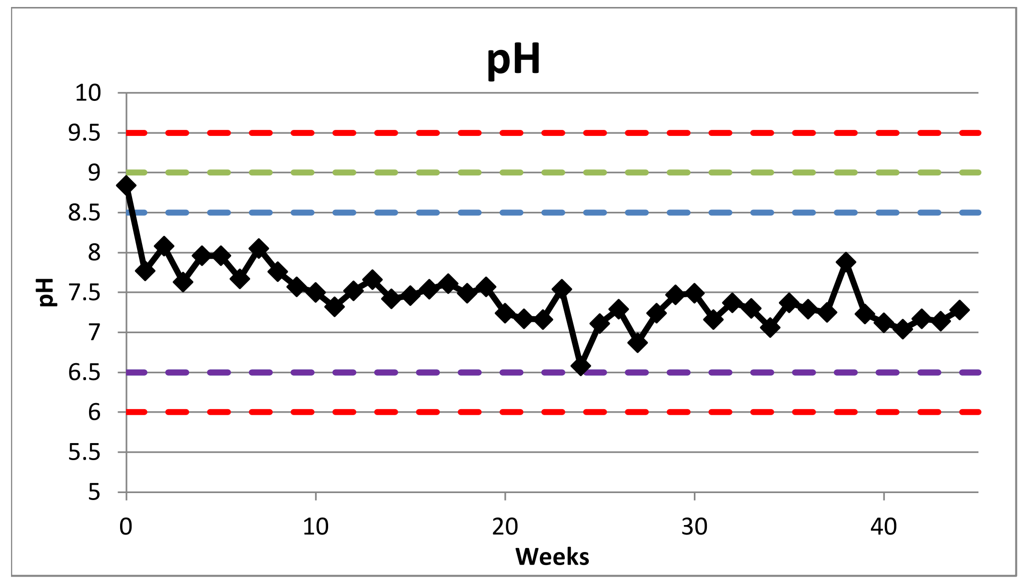

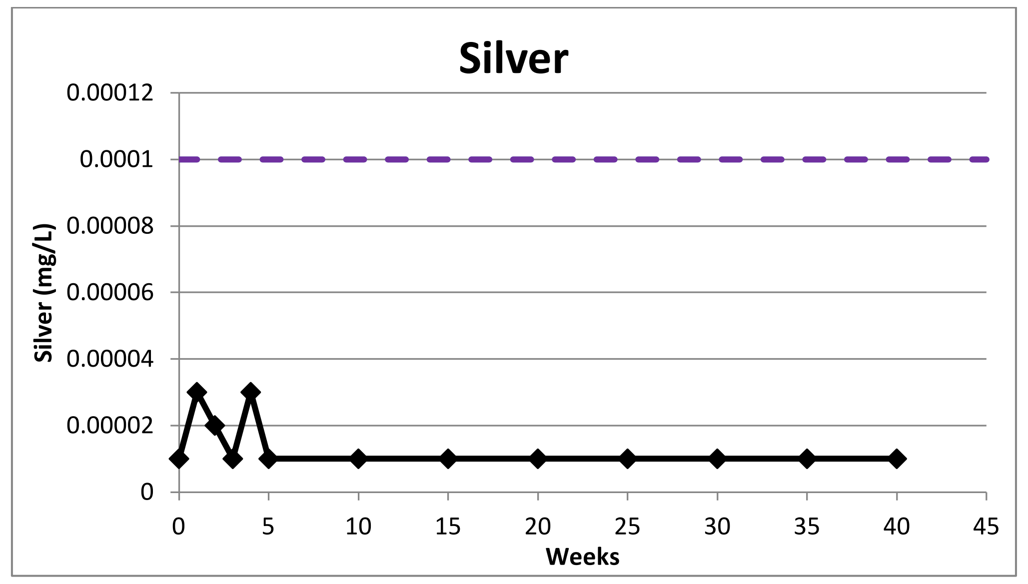

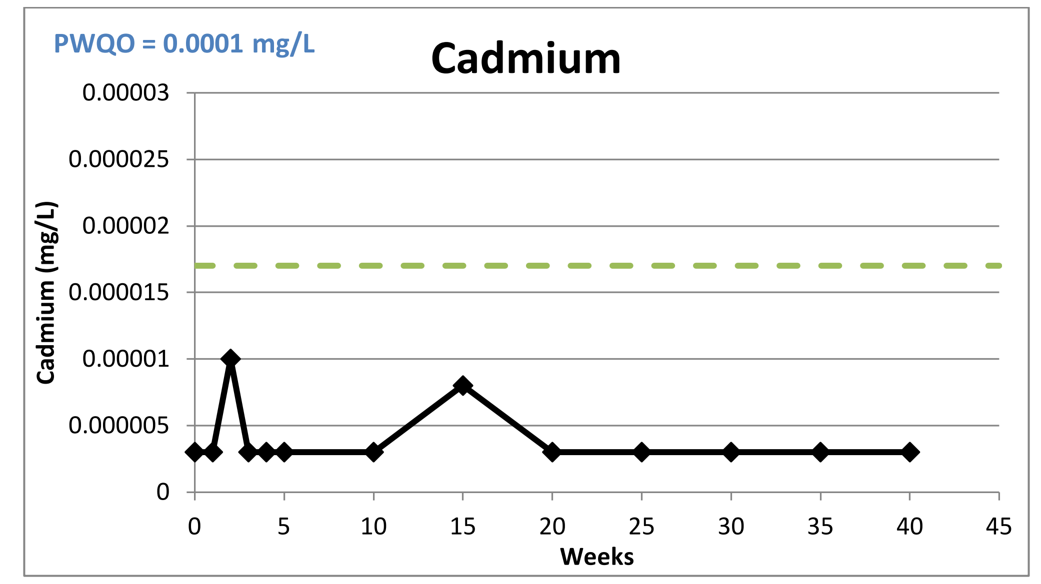

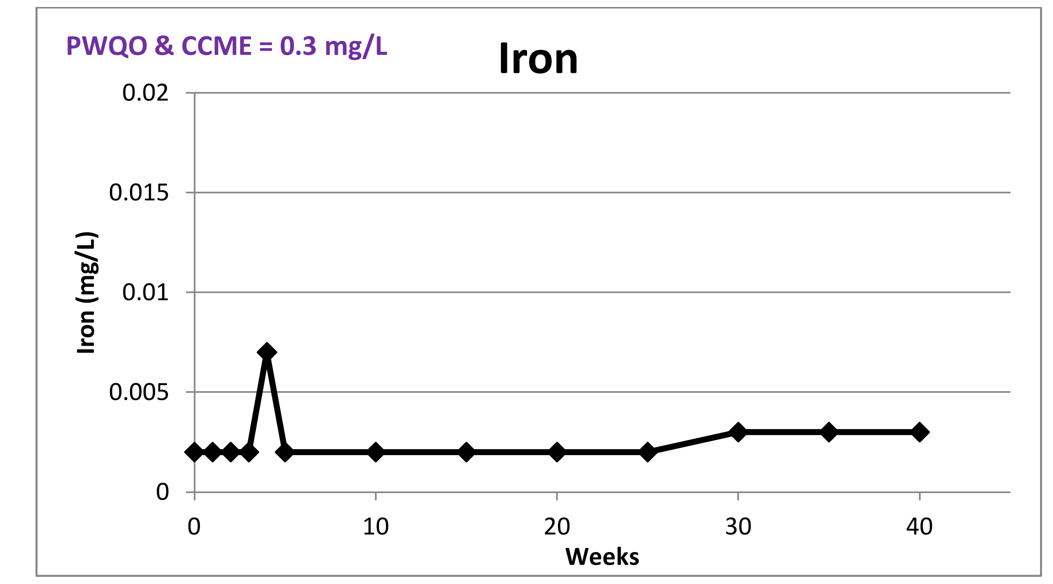

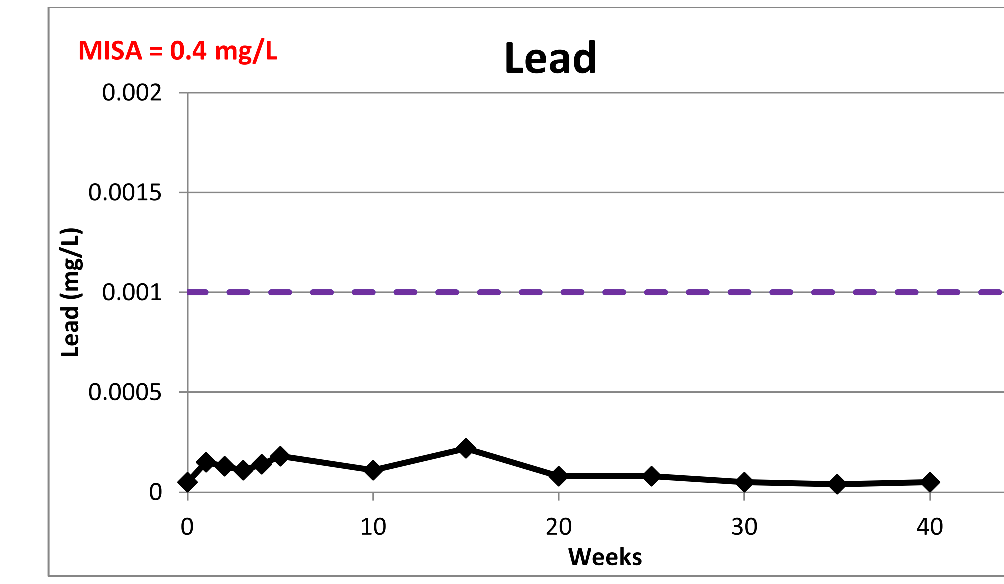

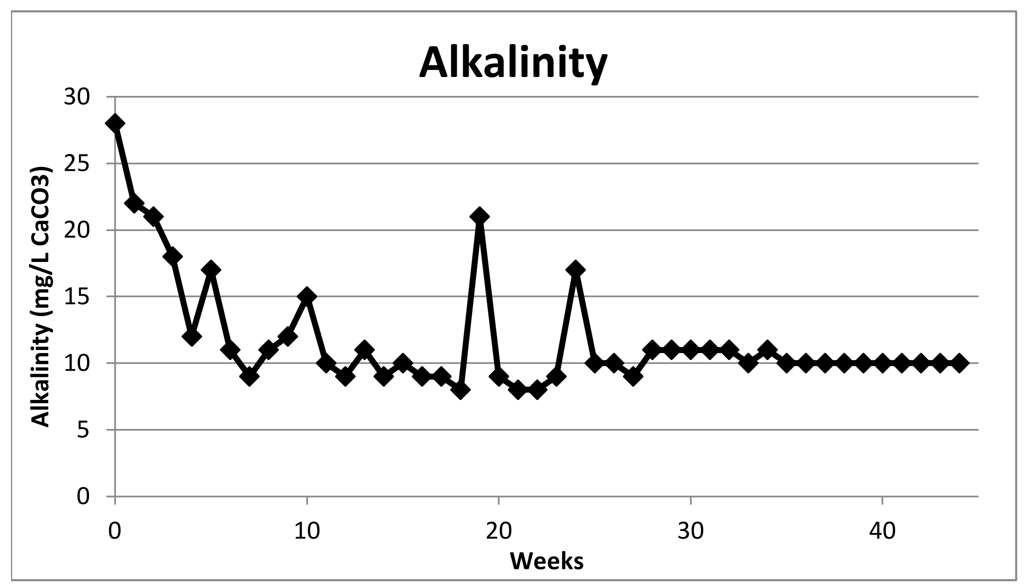

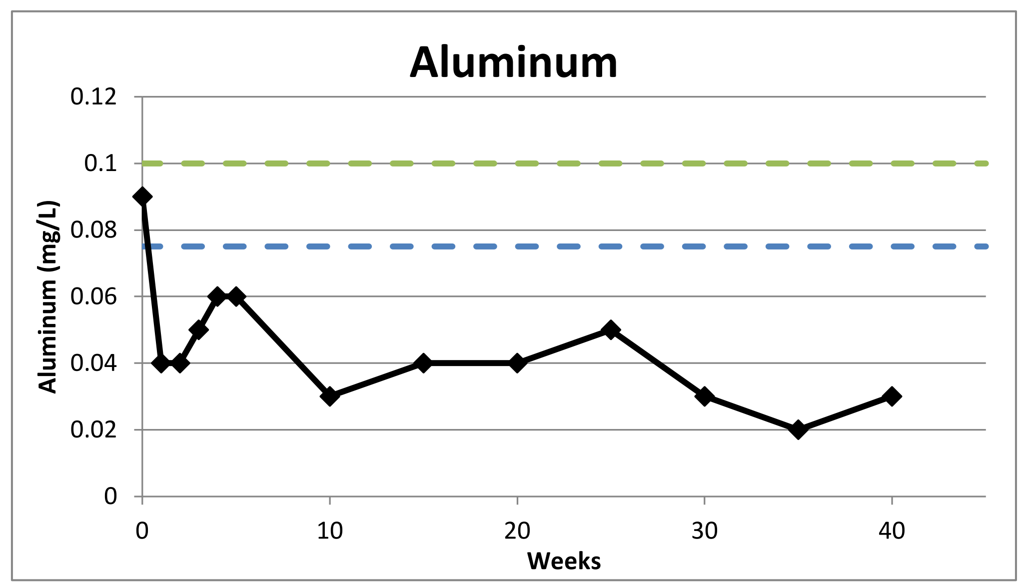

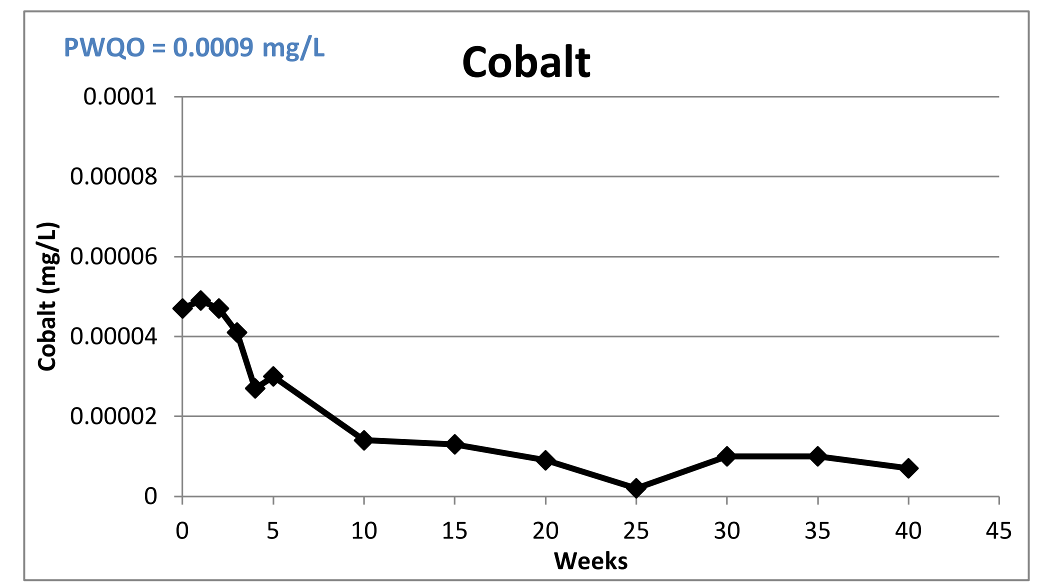

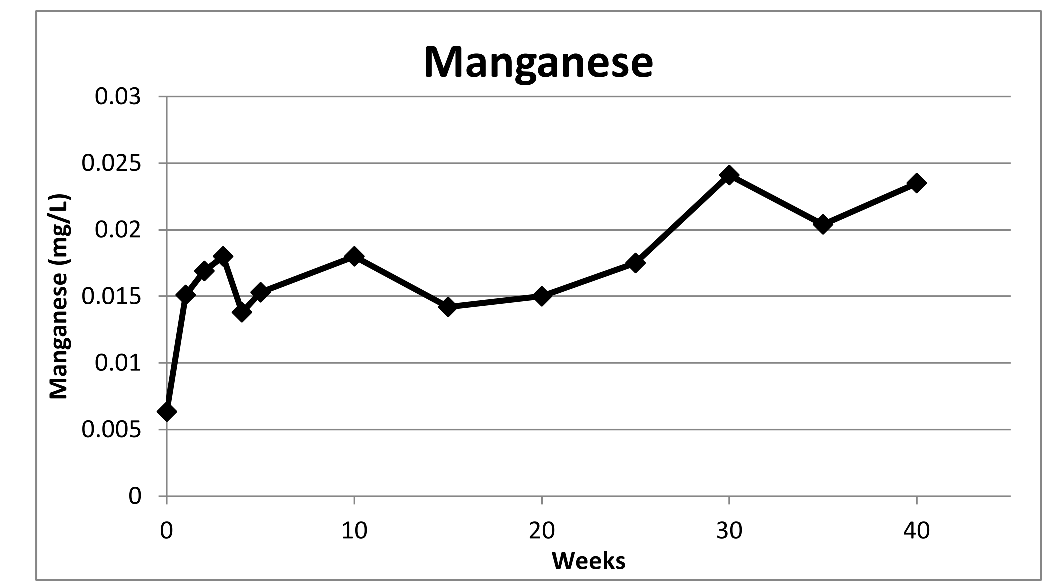

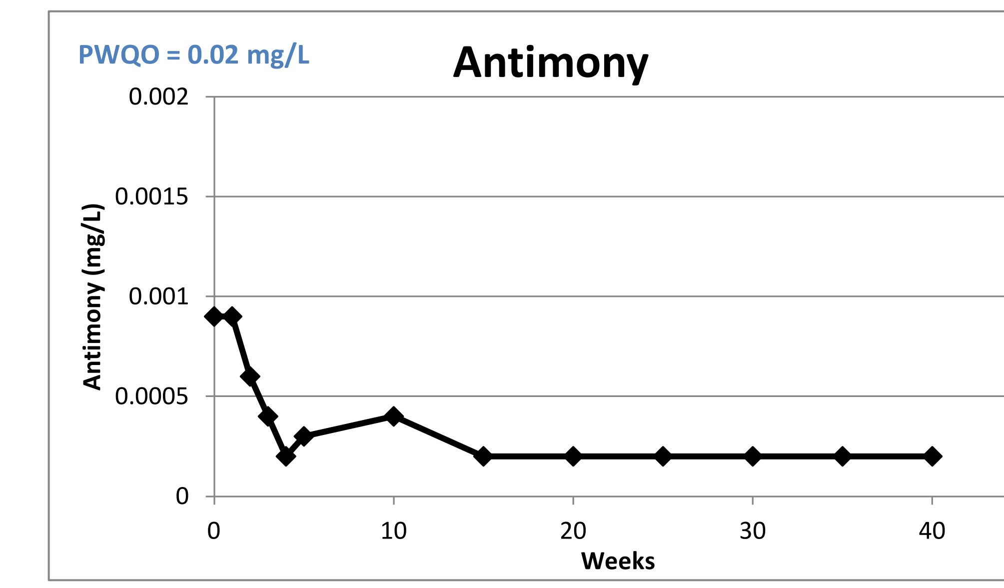

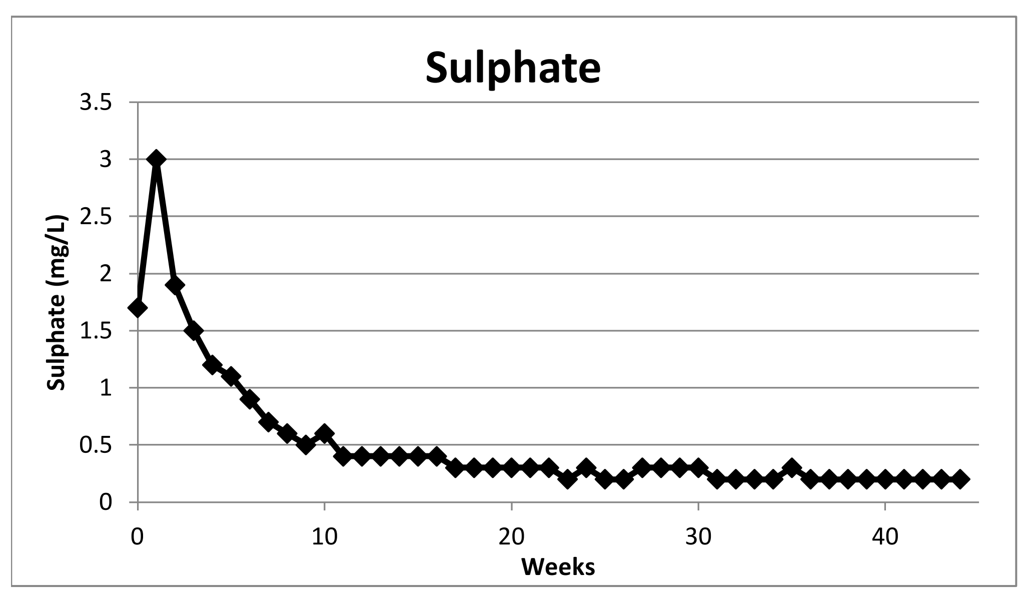

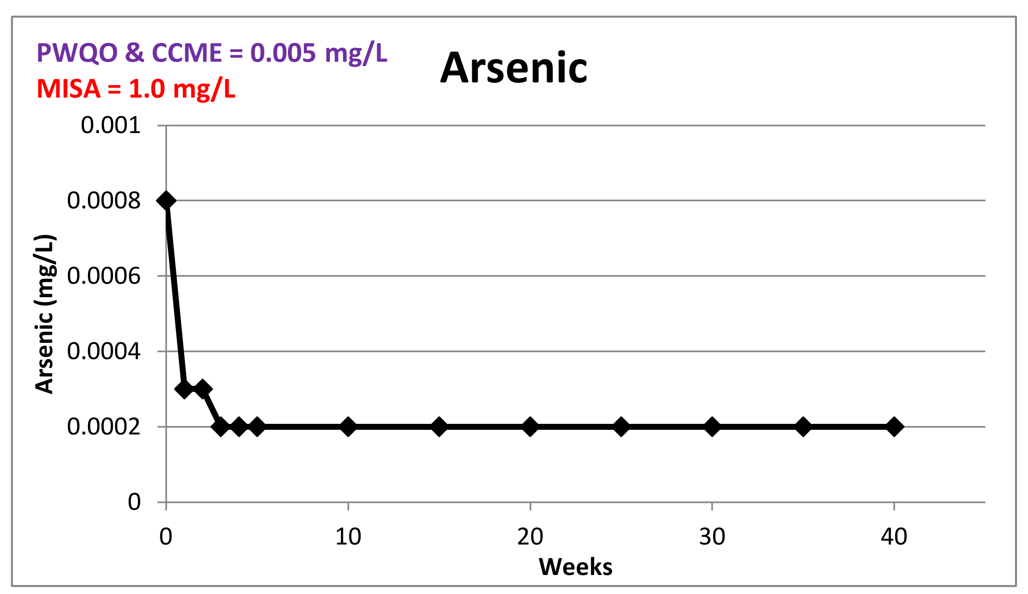

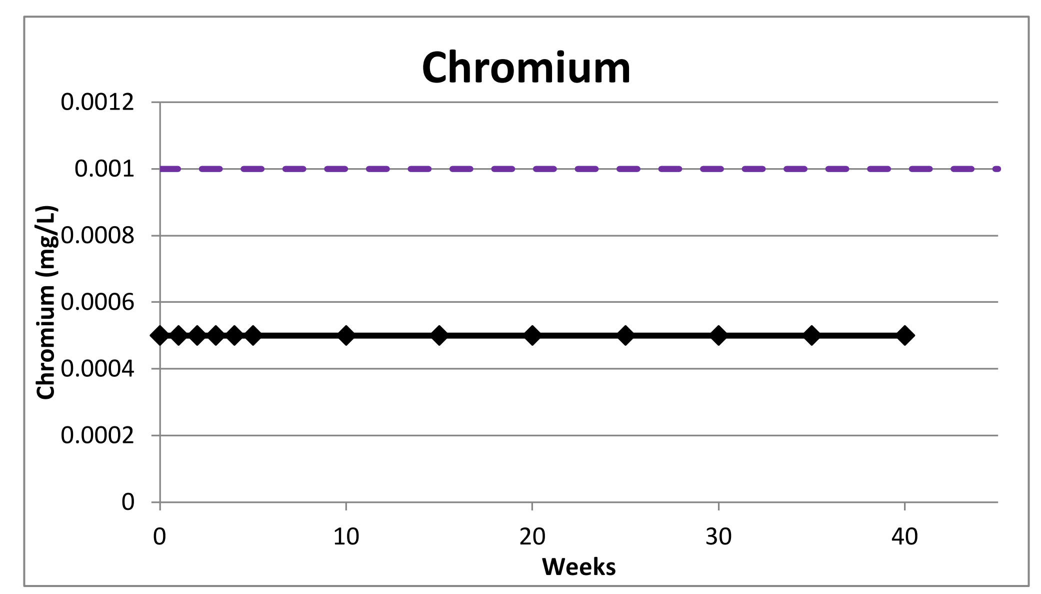

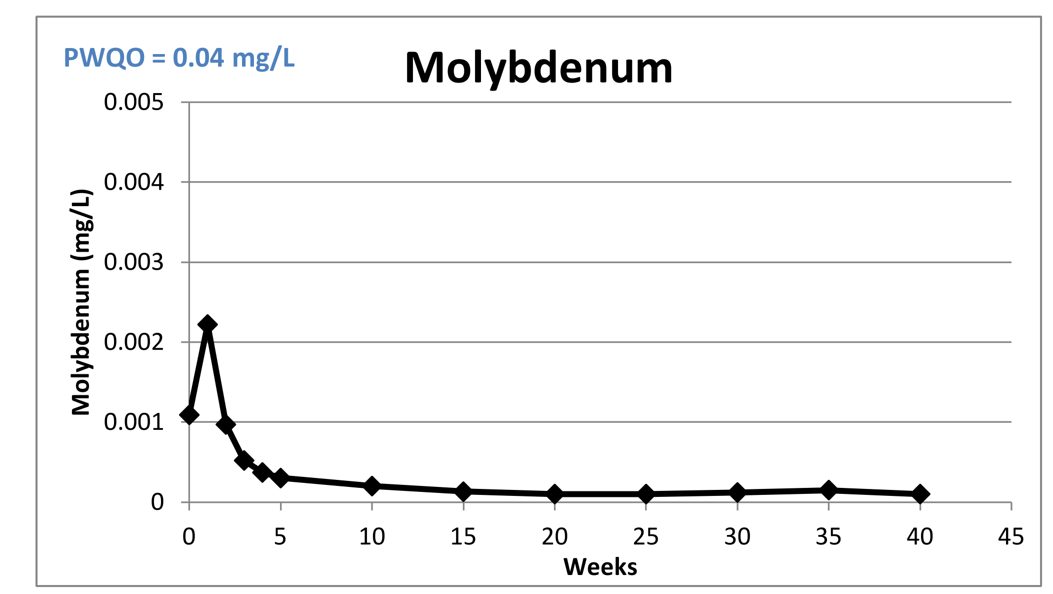

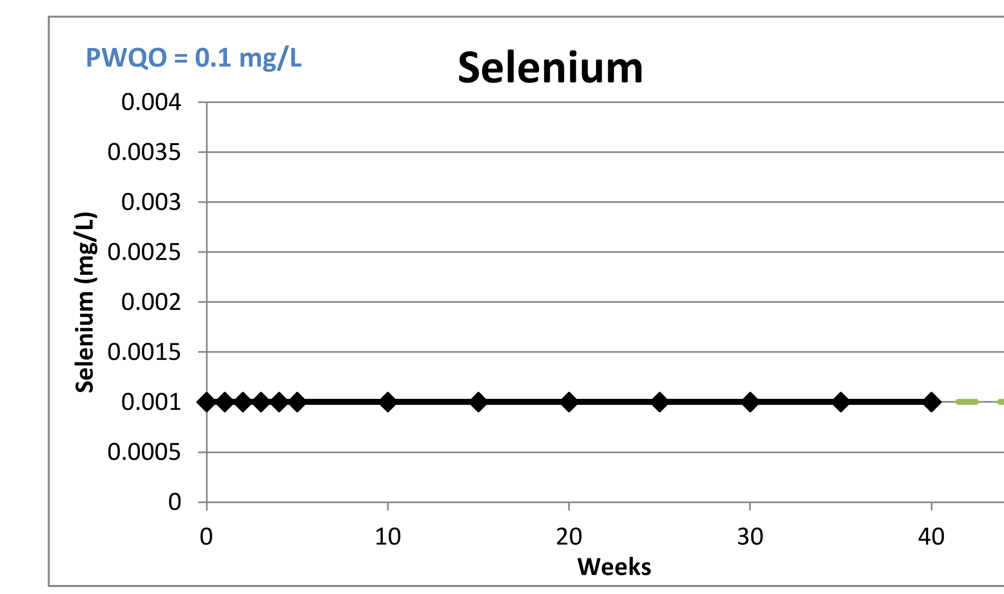

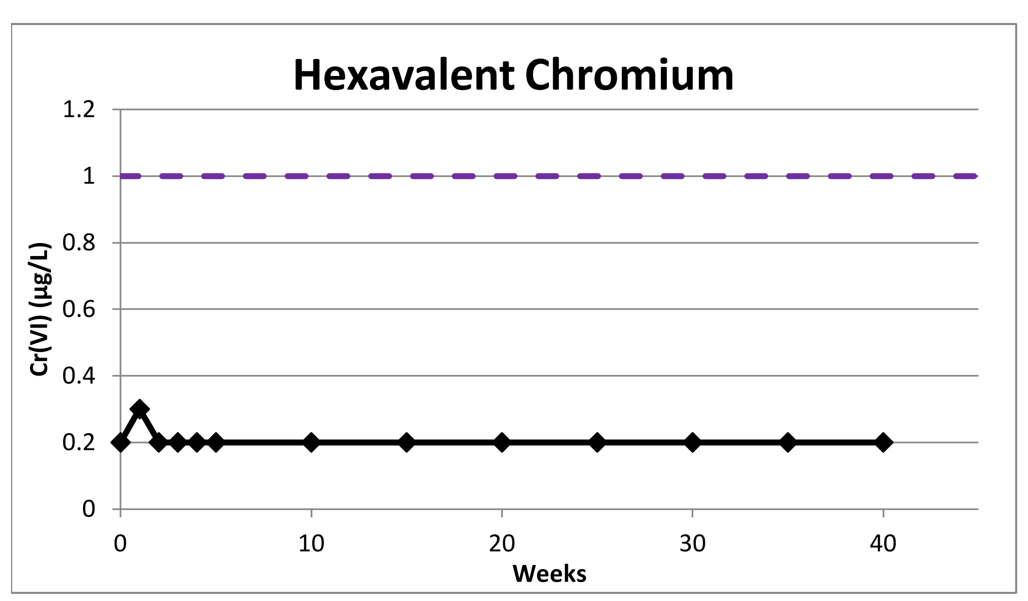

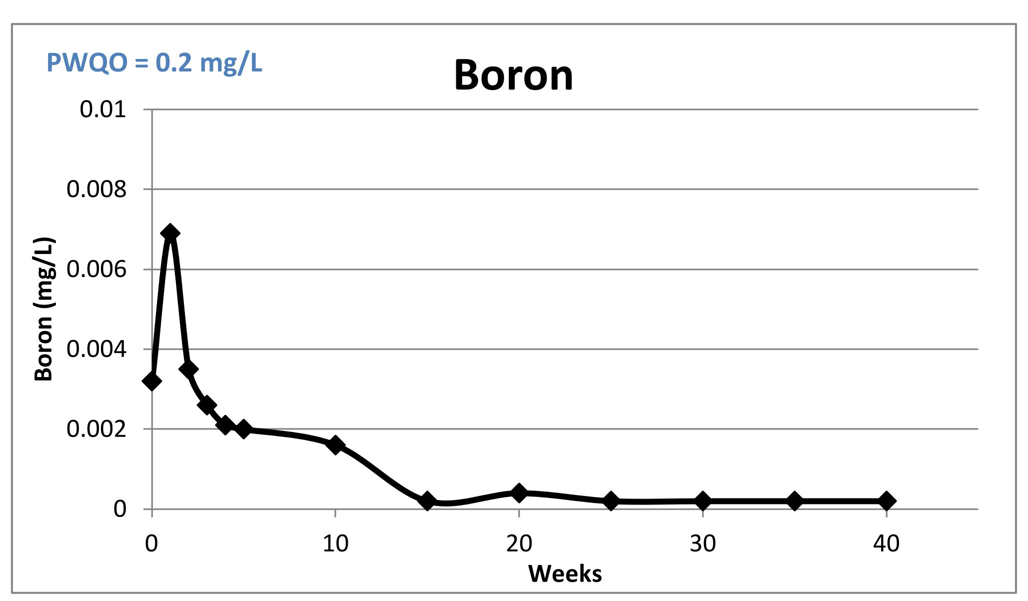

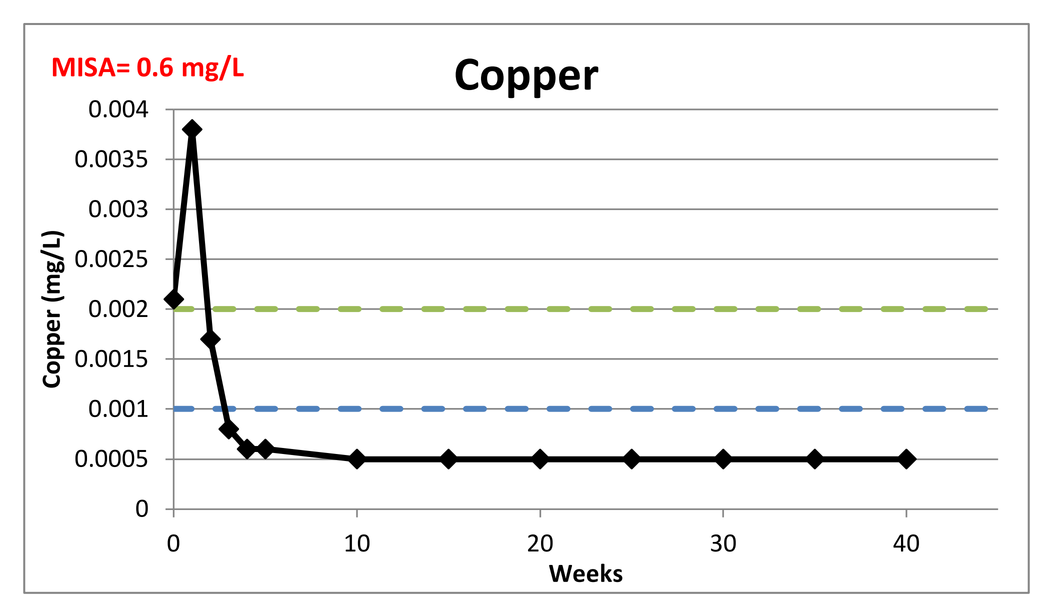

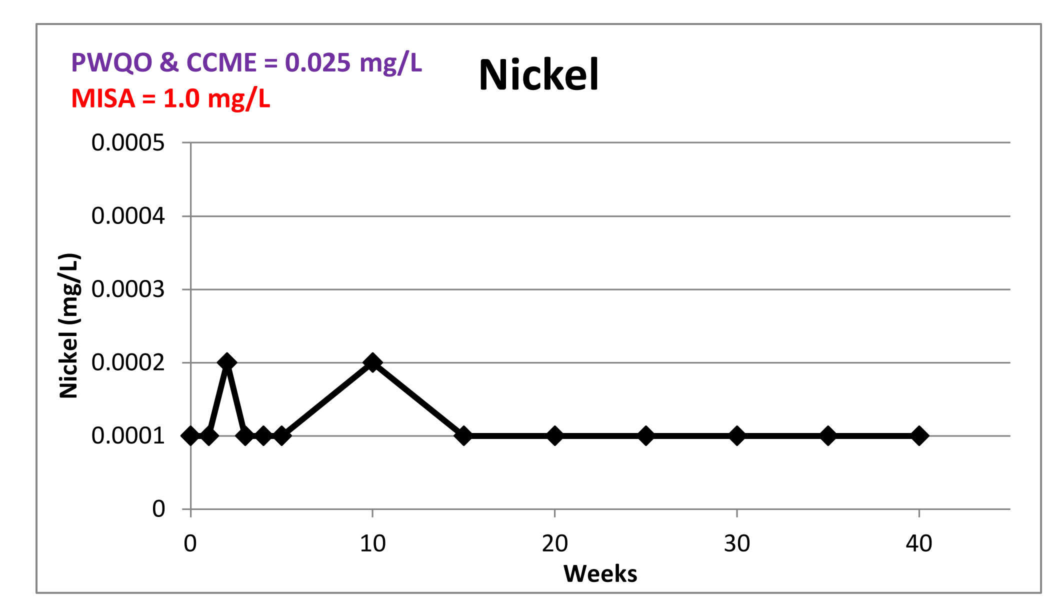

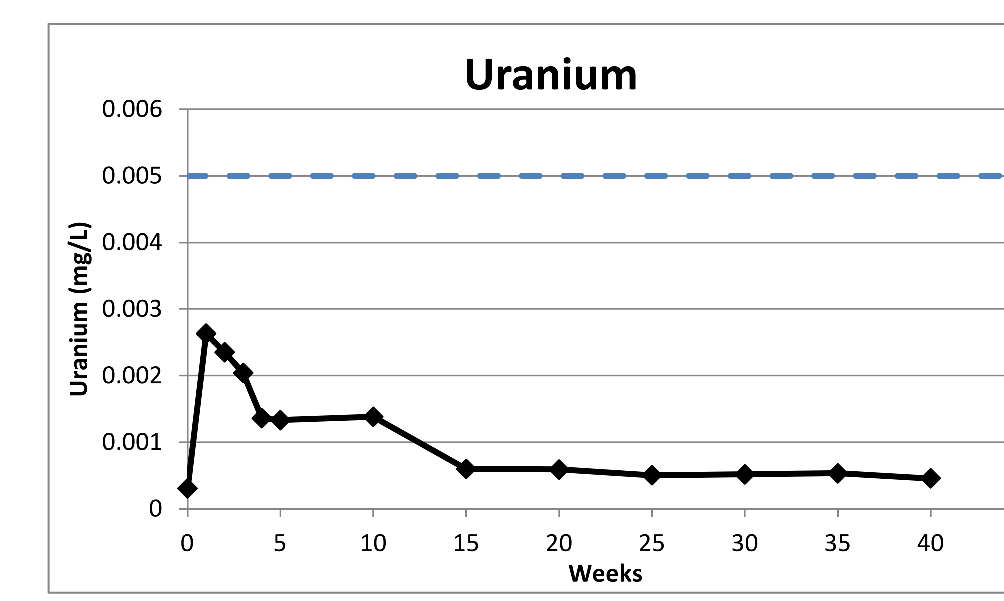

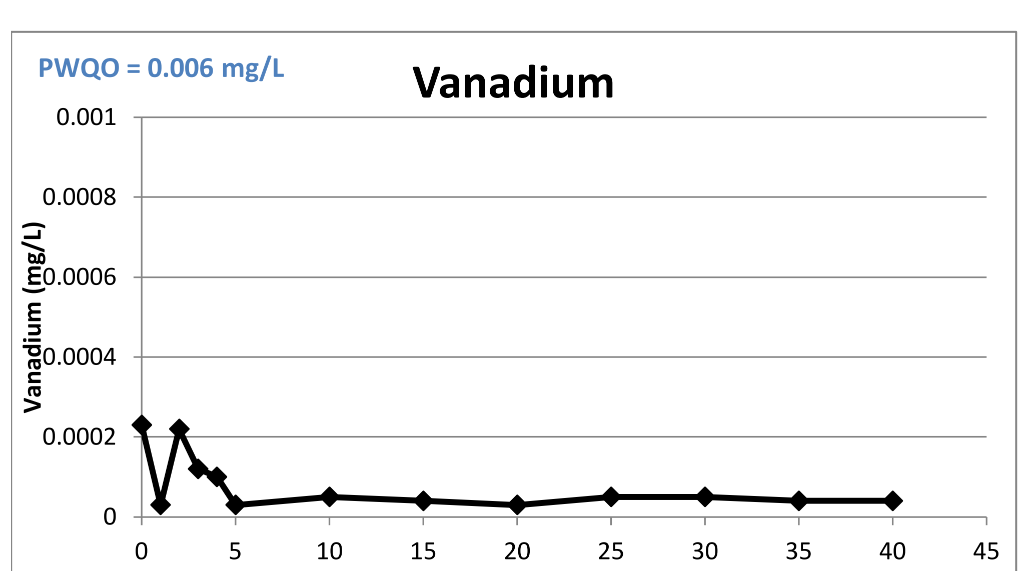

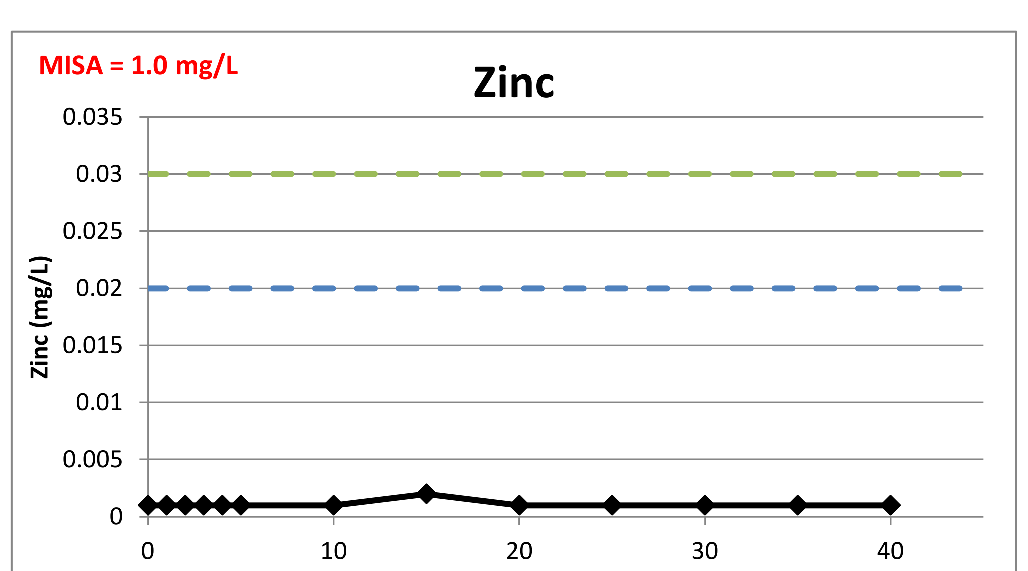

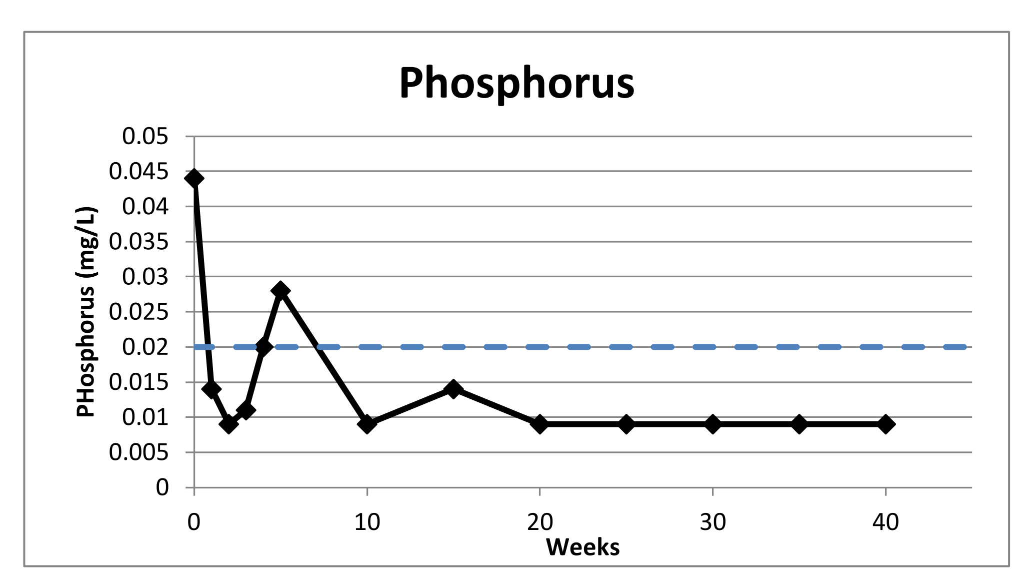

- Provincial Water Quality Objective (PWQO)
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- PWQO and CCME Guideline
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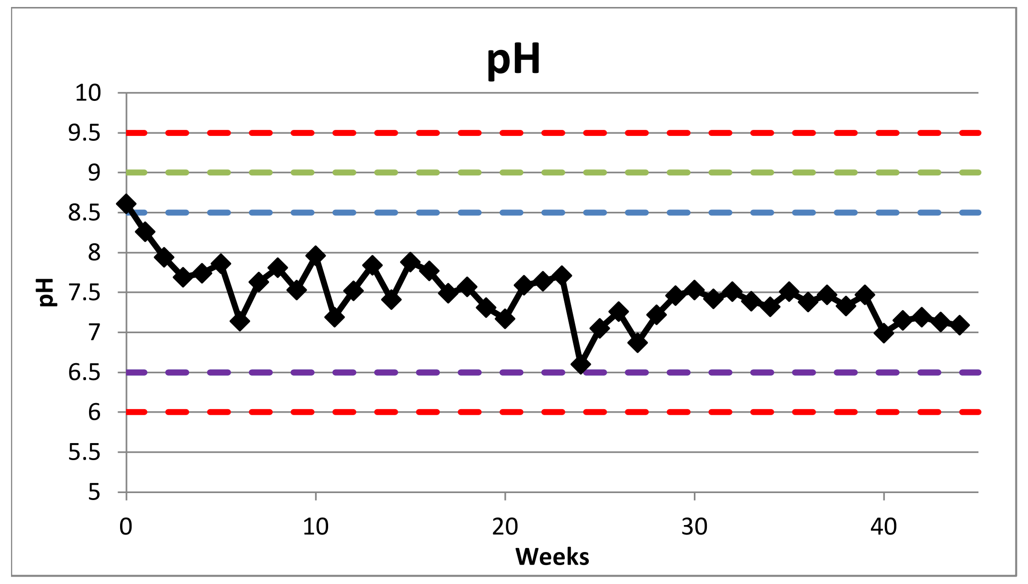

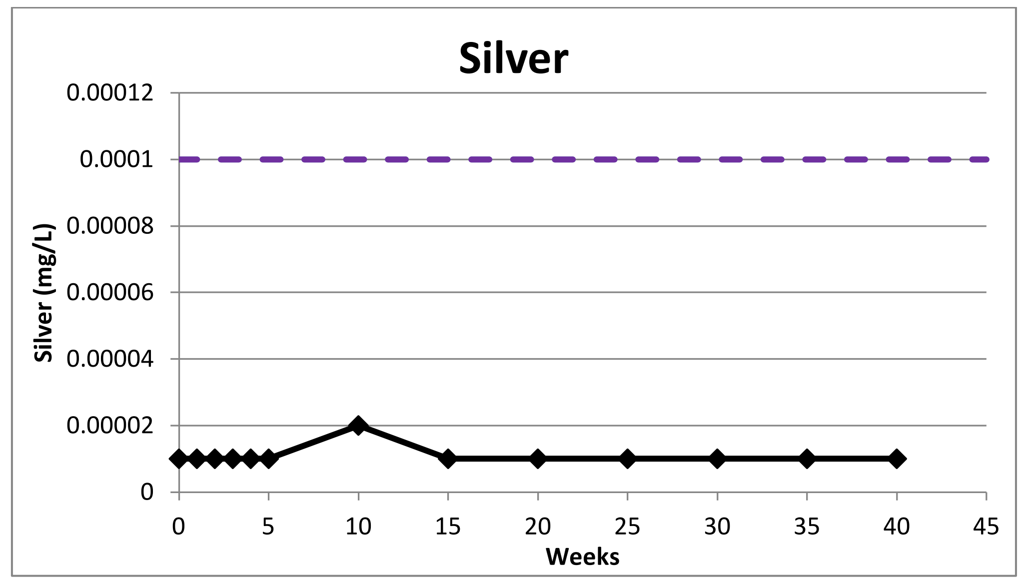

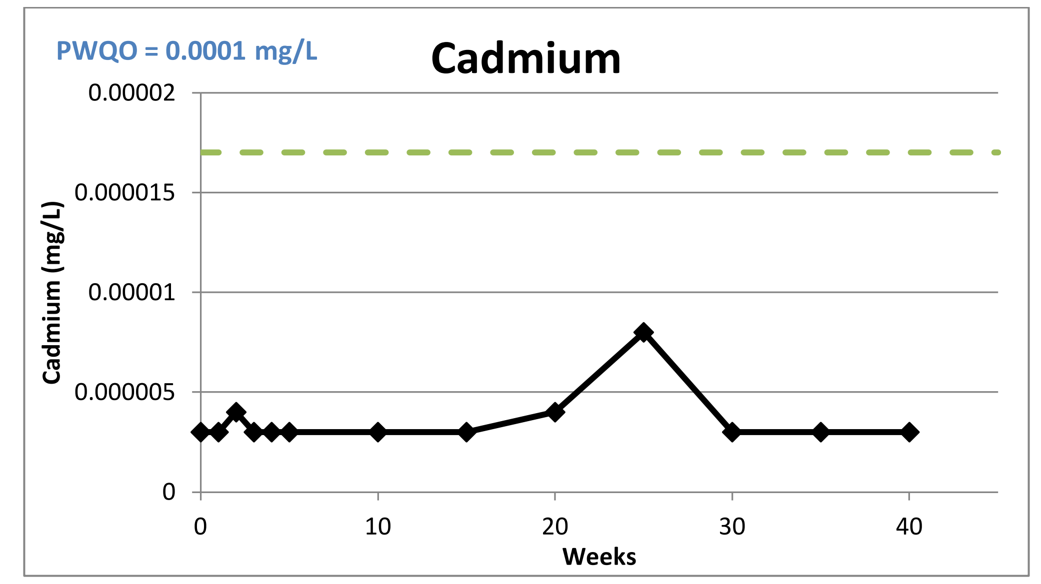

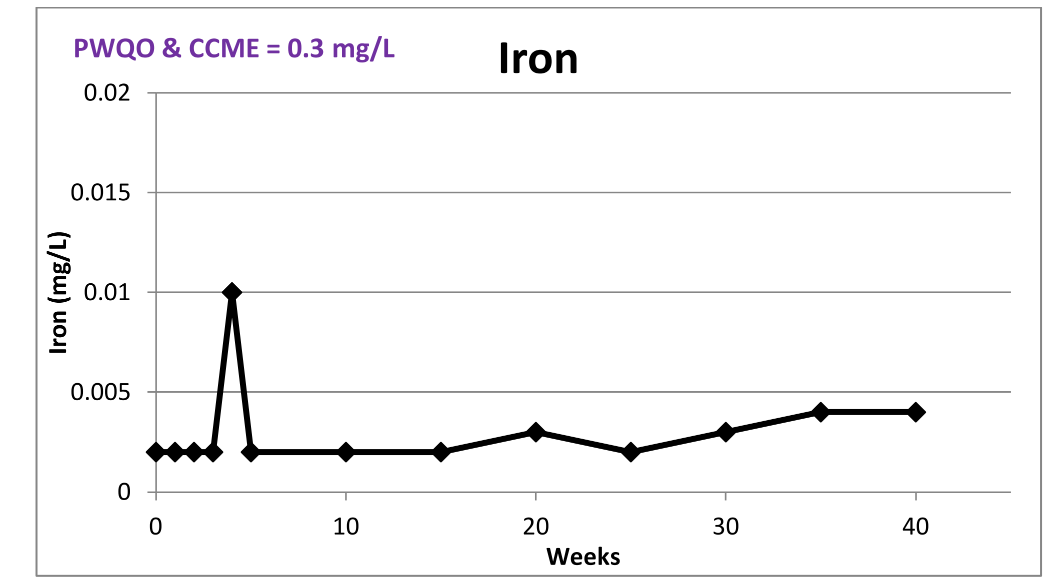

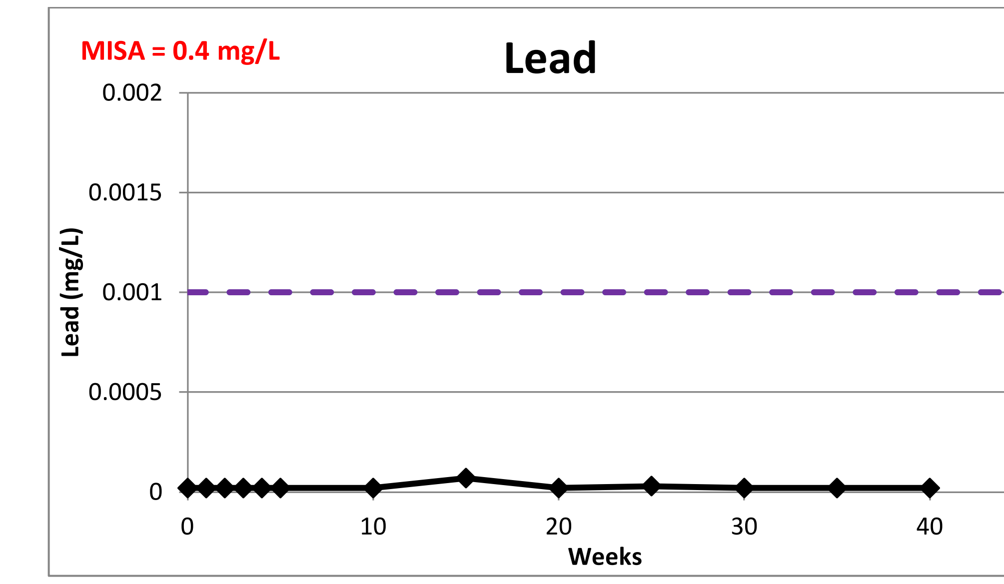

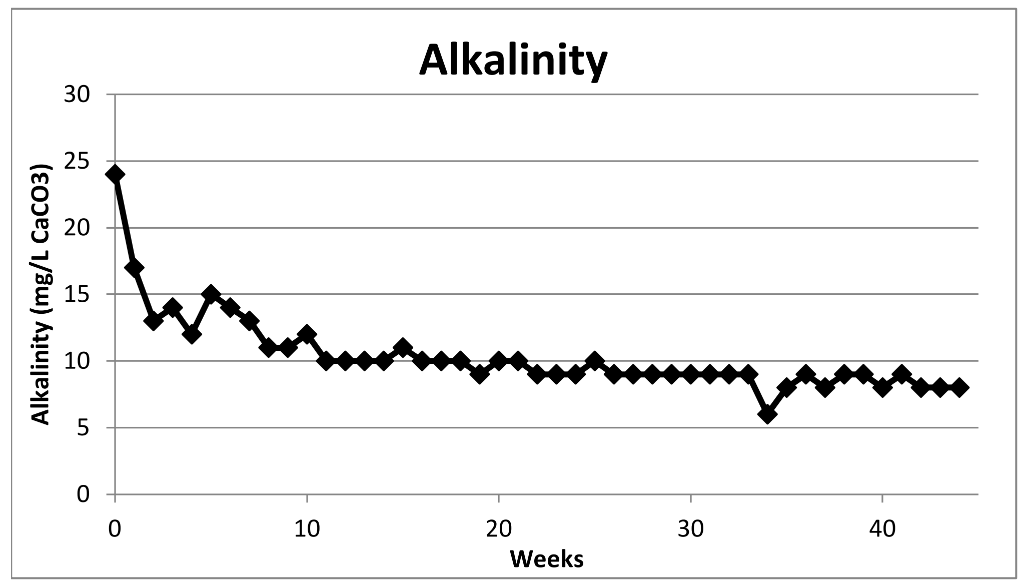

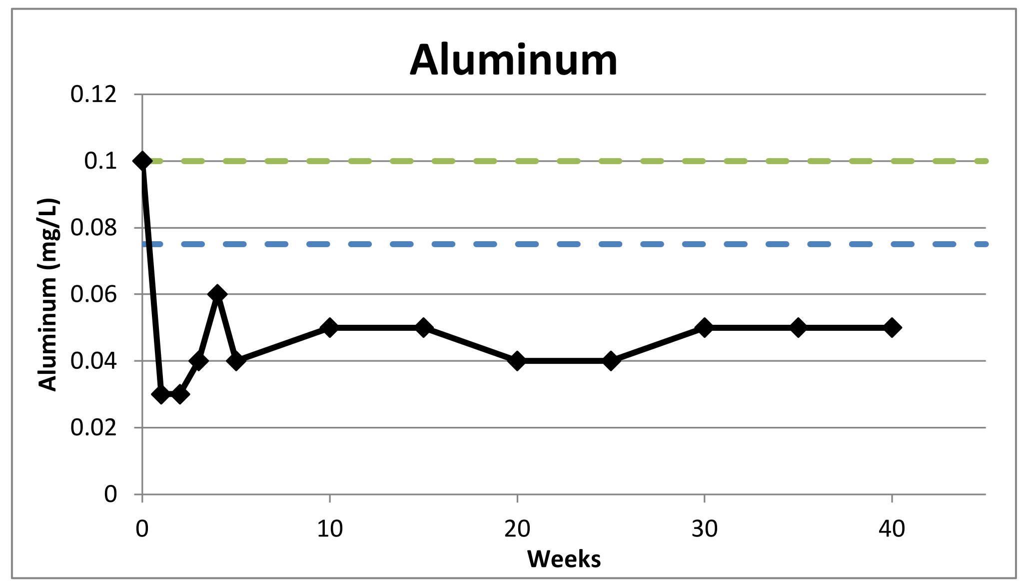

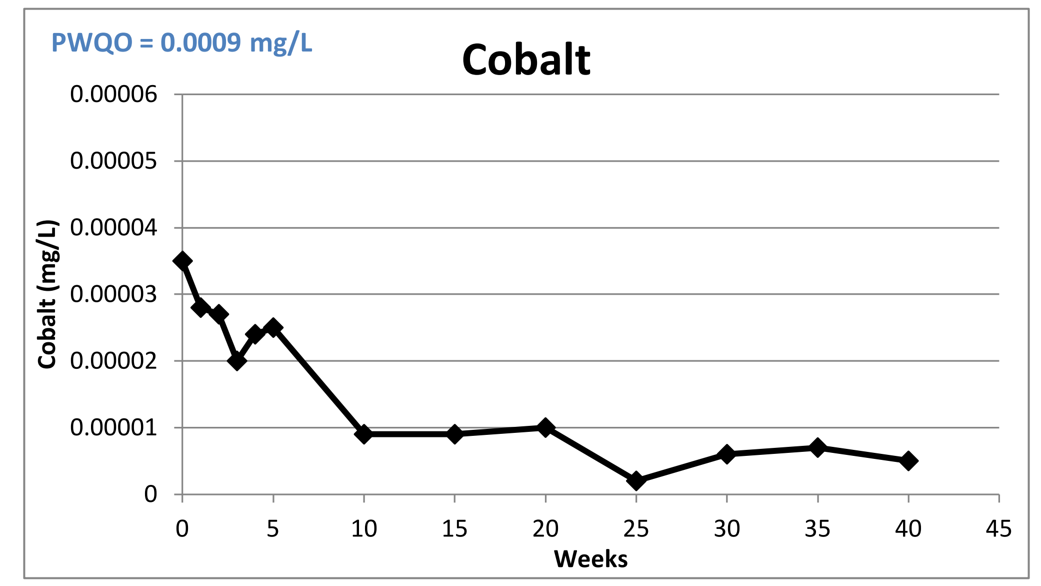

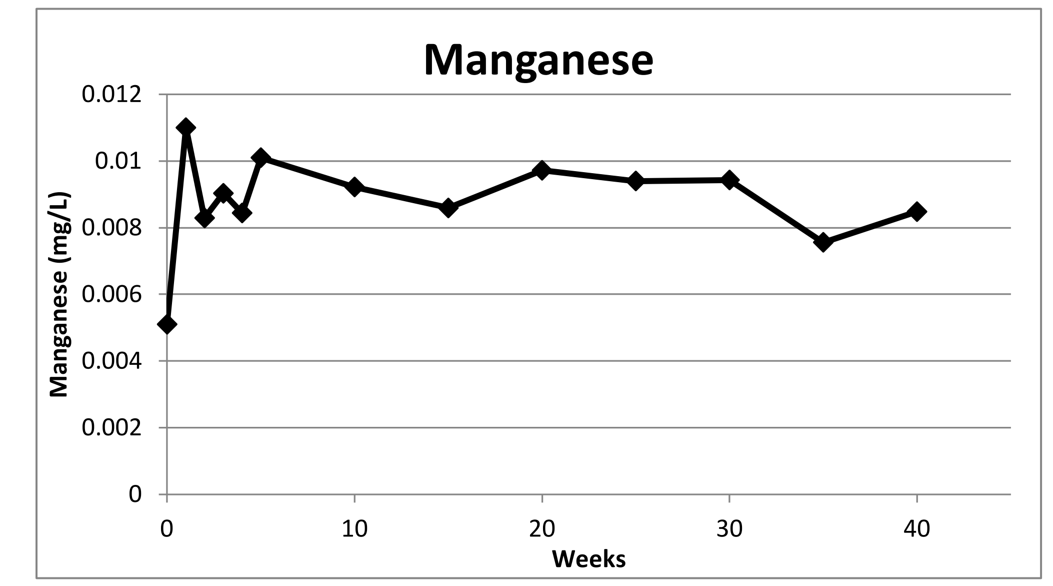

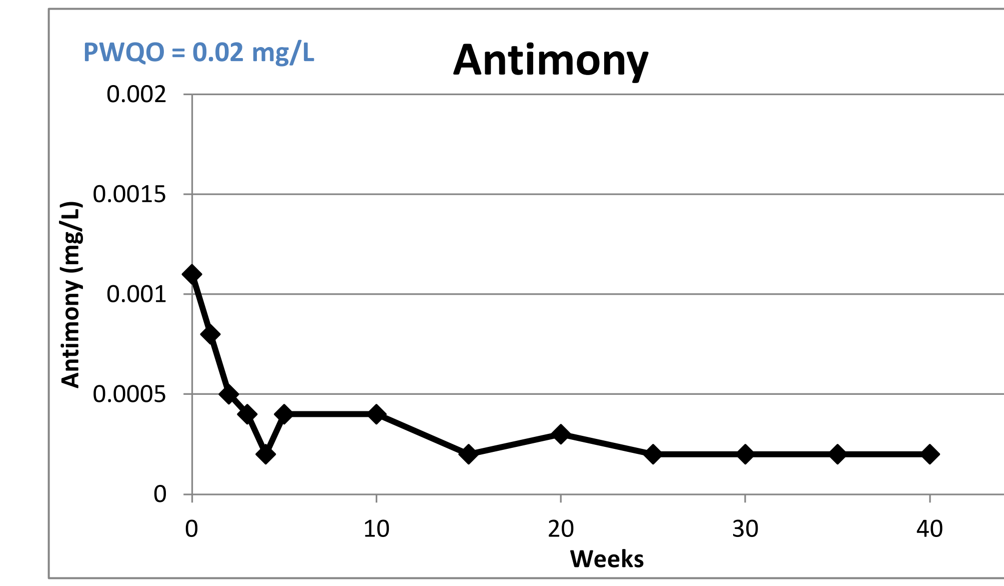

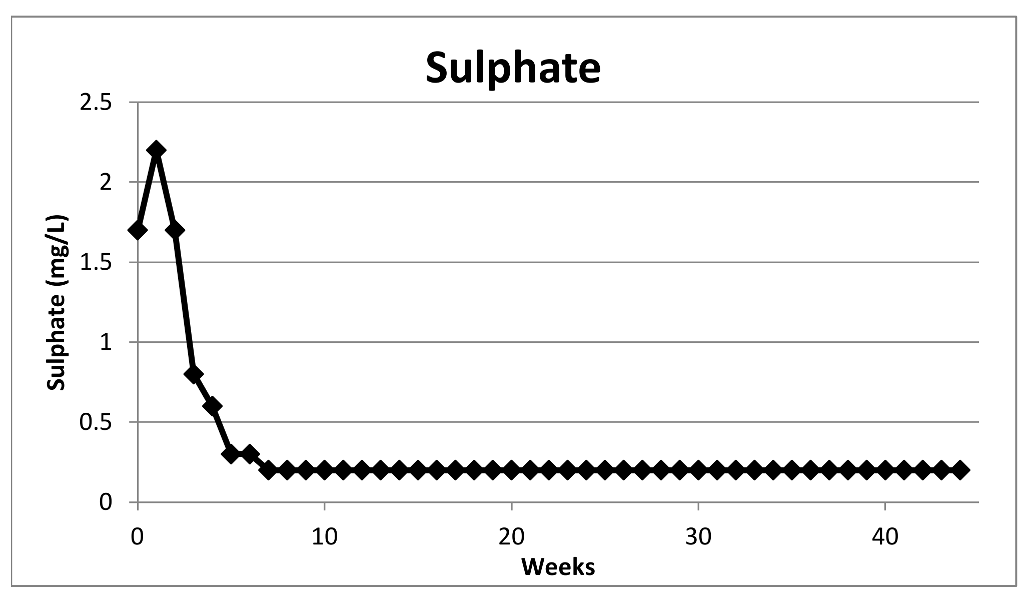

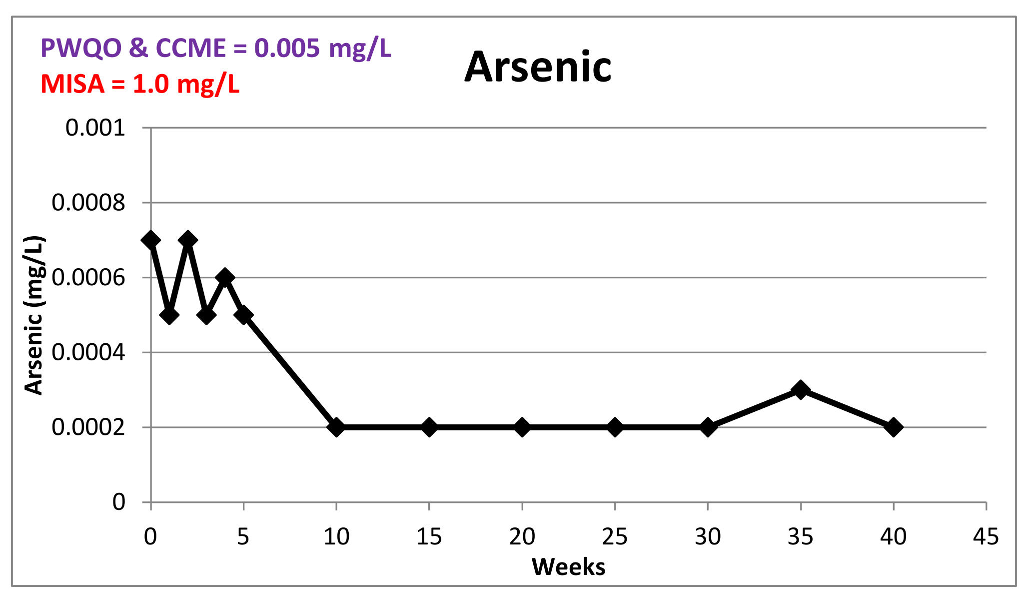

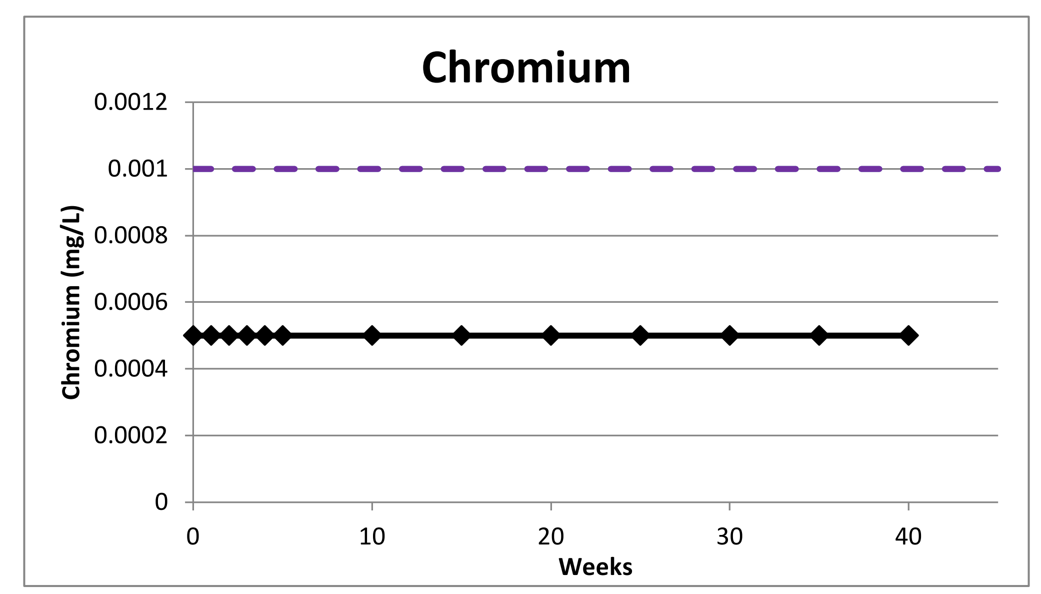

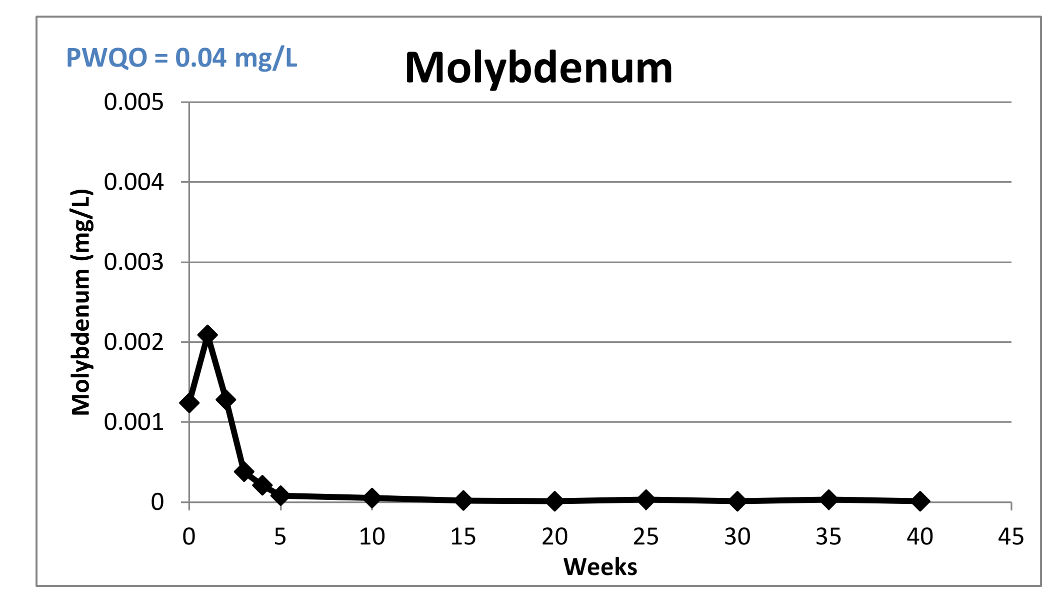

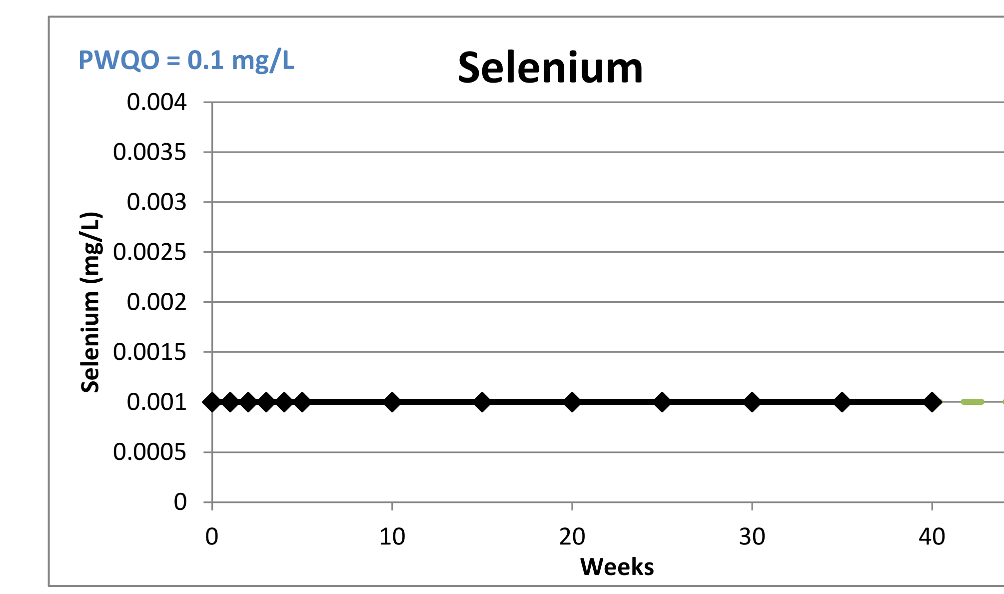

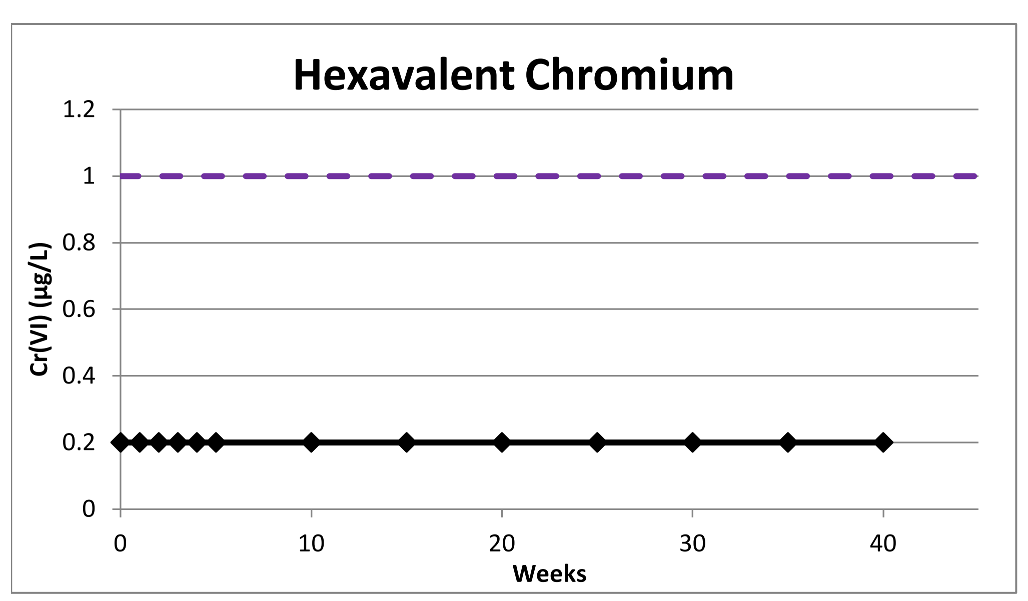

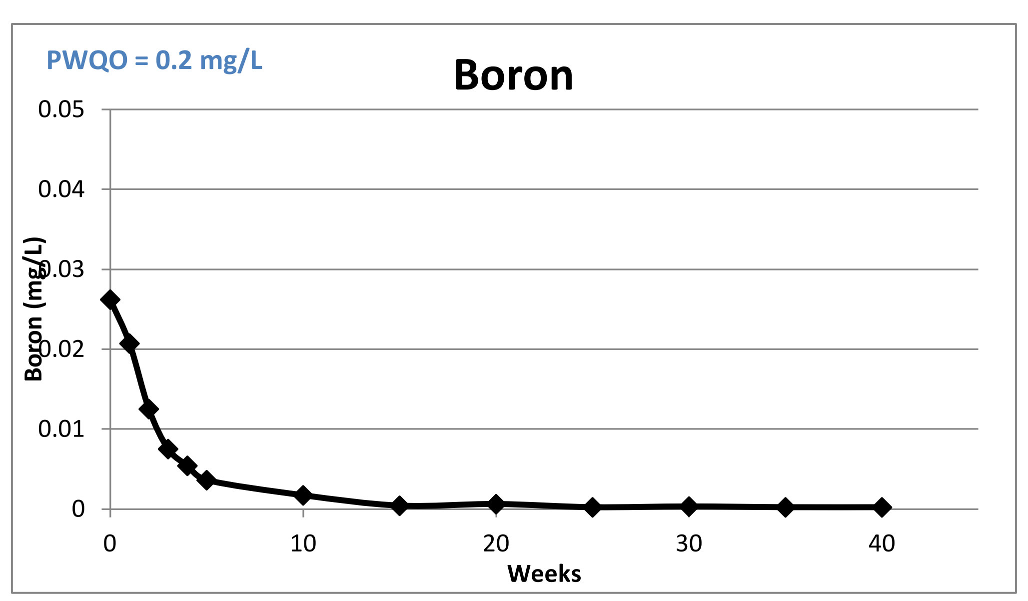

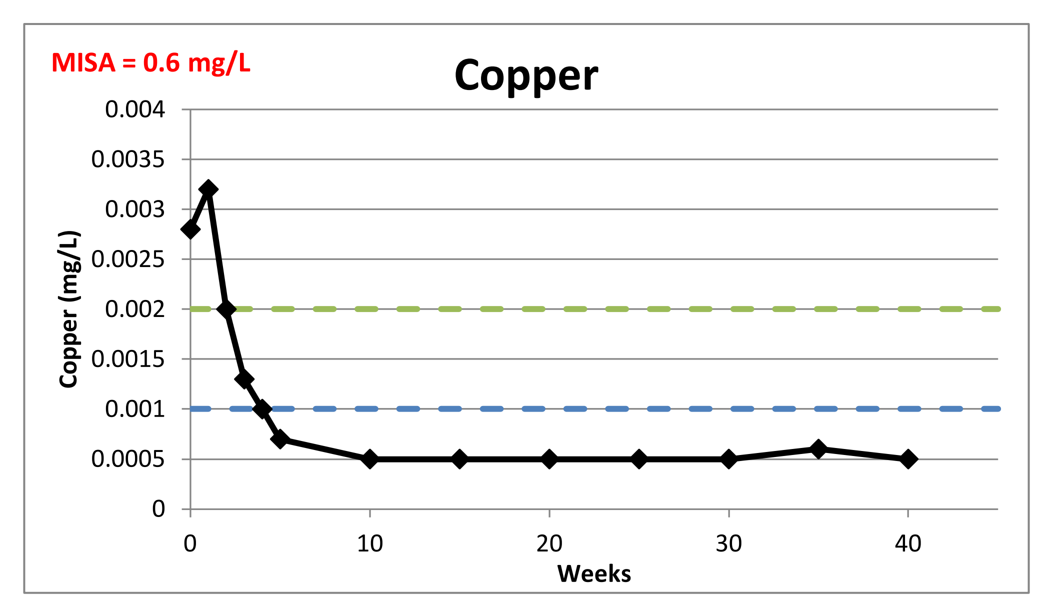

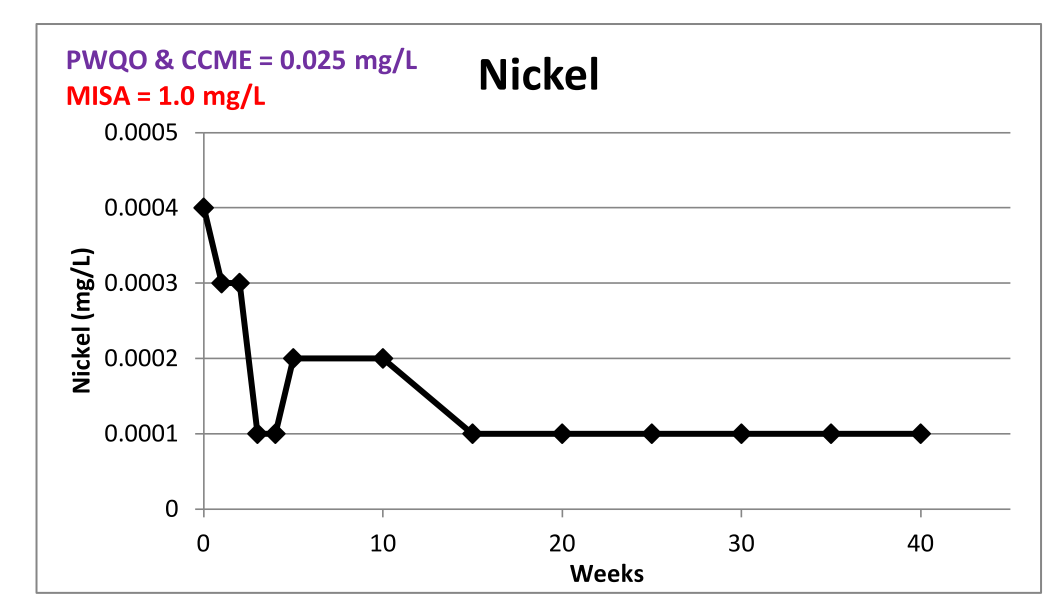

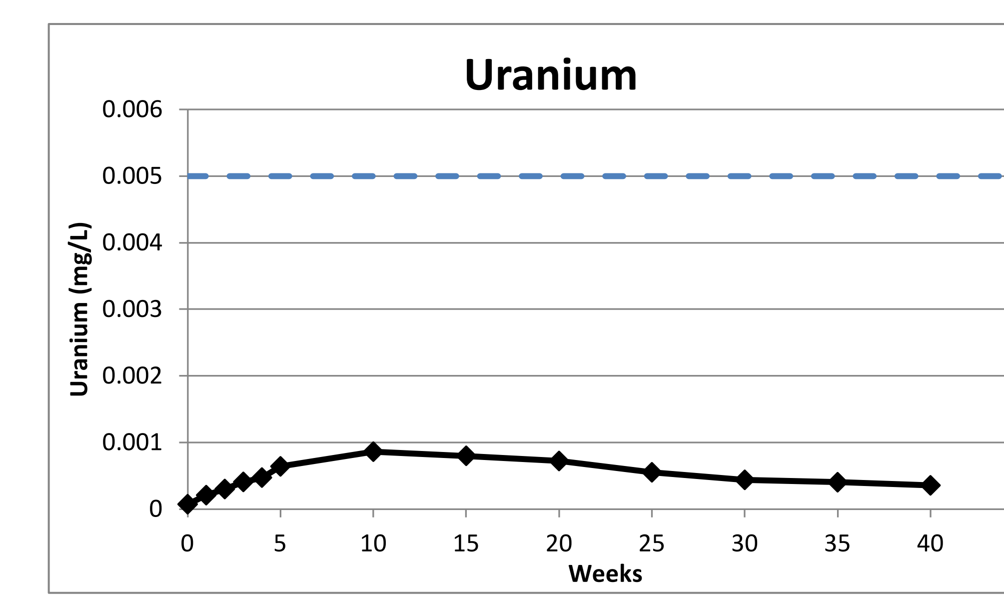

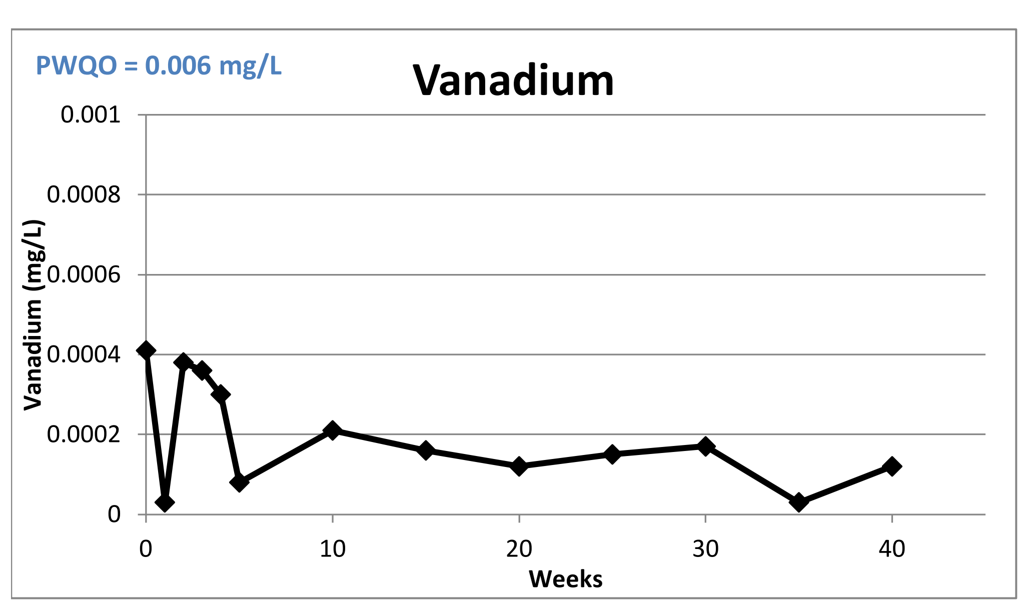

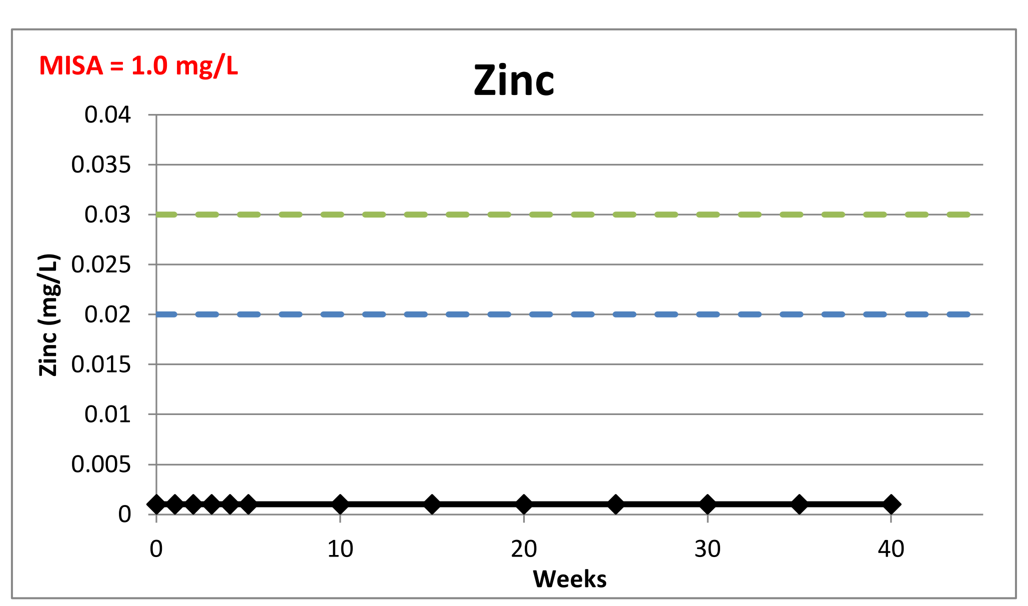

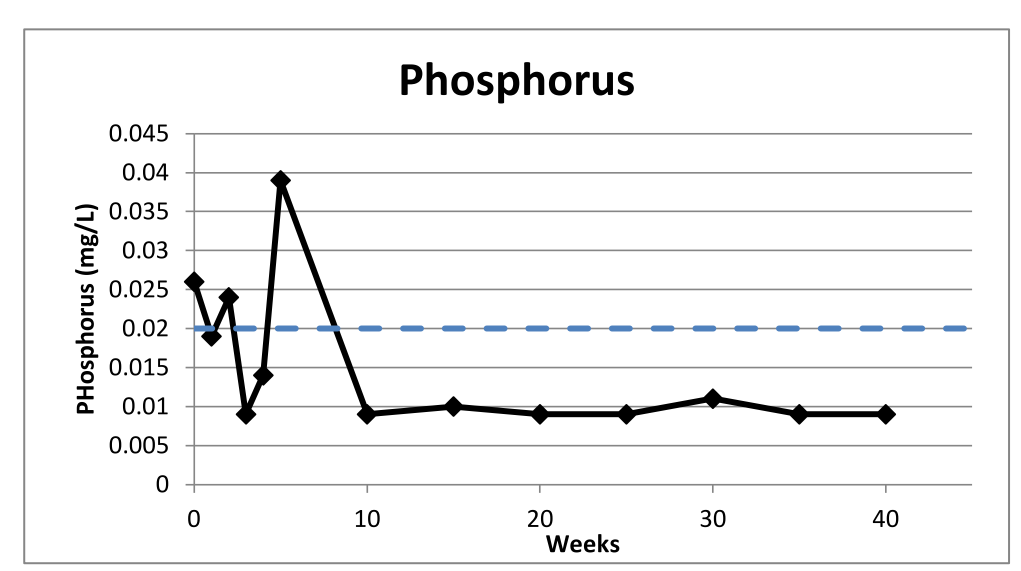

- - Provincial Water Quality Objective (PWQO)
- - CCME Guidelines for the Protection of Aquatic Life
- - PWQO and CCME Guideline
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pH
Silver
Cadmium
Iron
Lead
Alkalinity
Aluminum
Cobalt
Manganese
Antimony
Sulphate
MISA = 1.0 mg/L
Arsenic
Chromium
Molybdenum
Selenium
PWQO = 0.2 mg/L
Boron
MISA = 0.6 mg/L
Copper
MISA = 1.0 mg/L
Nickel
Uranium
Vanadium
MISA = 1.0 mg/L
Zinc
Phosphorus
Weeks
Provincial Water Quality Objective (PWQO)
CCME Guidelines for the Protection of Aquatic Life
PWQO and CCME Guideline
Municipal/Industrial Strategy for Abatement (MISA)
SGS Data
Lakehead Data

APPENDIX 2.VI

Mineralogical Results

Attachment 2.VI.1

Final Data Report: Tailings Mineralogy, Geochemistry and Grain Size – Hammond Reef Gold Project – April 2012

FINAL DATA REPORT: TAILINGS MINERALOGY, GEOCHEMISTRY AND GRAIN SIZE – HAMMOND REEF GOLD PROJECT

PREPARED FOR

Ms. Alexandra Drapack

Osisko Mining Corporation
155 University Avenue Suite 1440
Toronto ON M5H 3B7

Report #: MX12-003A
April 17, 2012

PREPARED BY:

LUMINX

Lakehead University Mineralogy& Experimental Laboratory
955 Oliver Road, Thunder Bay, ON, P7B 5E1

Dr. Andrew G. Conly, PhD
Director

1. Introduction and Scope of Work

1.1 Introduction

Lakehead University Mineralogy and Experimental Laboratory ("LUMINX") was retained by Osisko Mining Corporation ("Osisko") to conduct a mineralogical and geochemical testing program of tailings solids from the Hammond Reef gold project.

1.2 Basis of the Report

This report summarizes the results from mineralogical, geochemical and grain size analysis (sieve + hydrometer) of Hammond Reef tailings solids made available to LUMINX by Osisko. Test results are representative only of material submitted for analysis.

1.3 Statement of Qualifications

LUMINX is a member facility of Lakehead University Centre for Analytical Services ("LUCAS"). Through LUCAS, clients have access to the university's analytical testing labs that combine experienced technical staff, internationally recognized researchers and unique technology of the university, offering a wide range of testing, training and consulting services in a single location. All proceeds from LUCAS testing laboratories are used for the non-profit activities of research and teaching at Lakehead University.

LUMINX is designed to serve as a bridge between the minerals industry and university researchers by providing mineralogical and geochemical services that are not routinely available from commercial firms. LUMINX seeks to promote and develop mineralogical-based research in the north, as well as keeping industrial-based funding and highly qualified personnel in northwestern Ontario. LUMINX offers applied mineralogical and geochemical services on a contractual and research basis, including:

- Petrographic analysis of geological samples and synthetic materials
- Characterization of precious metal (Au, Ag, PGE)-bearing phases, sulphides, diamond indicator minerals and metal-oxide species
- Fluid inclusion petrography and microthermometry
- Quantitative and qualitative phase and chemical composition analysis (XRD, SEM-EDS, FTIR) of geological samples and industrial by-products
- Solubility testing of natural and synthetic materials
- Mineralogical and geochemical studies of mine waste materials
- Static and kinetic testing of mine waste materials in accordance with ASTM protocols

The analyst and author of this report is Dr. Andrew Conly, who is the Director of LUMINX and is an Associate Professor in the Department of Geology at Lakehead University, where he has been on staff since 2003. Dr. Conly has more than 18 years of experience in conducting mineralogical and geochemical studies for both research- and consultant-based projects in the mining and exploration sector.

2. Disclaimer

2.1 Disclaimer

This report or portions of this report are not to be reproduced or used for any purpose other than to assist with Rainy River's exploration activities without LUMINX's prior written permission in each specific instance. LUMINX does not assume any responsibility or liability for losses occasioned by any party as a result of the circulation, publication or reproduction or use of this report contrary to the provisions of this paragraph.

The contents of this report supersede results from any preliminary reports.

Test results are representative only of material submitted for analysis.

Although LUMINX operates from the Thunder Bay campus of Lakehead University, the services provided by LUMINX are independent to the activities of Lakehead University. Therefore, Lakehead University does not assume any responsibility or liability for losses occasioned by any party as a result of the circulation, publication or reproduction or use of this report.

3. Methods and Procedures

3.1 Analytical Methods

3.1.1 General Handling

Tailings solids were stored as submitted to LUMINX by SGS Lakefield on behalf of Osisko. The tailings solids were collected and stored in the same container in order to maintain saturated conditions. Tailings solids were extracted after completion of the tailings process water study (see report MX12-003B). Bulk, unsorted tailings material was dried at ambient room temperature (20-23°C) in a nitrogen gas-filled desiccating cabinet. The nitrogen flow was sufficient to ensure that no room air would entre the cabinet; expect upon opening, where the flow was increase to ensure complete evacuation of the air from the cabinet in less than one hour. Once dried, all tailings solids were continually stored in a nitrogen gas-filled desiccating cabinet until analysis. This procedure was to limit the extent of oxidation of the tailings once removed from the process water.

3.1.2 Optical Mineralogy

A single 1-inch round polished section was prepared by embedding unsorted tailings solids in epoxy. Prior to optical analysis the section was cleaned with 0.2 µm Al_2O_3 and acetone prior examination with an Olympus BX2M transmitted-reflected light microscope.

3.1.3 X-Ray Diffraction

Approximately 5 g of dried and unsorted tailings solids were milled to a fineness of <75µm using an agate puck mill. The milled solids were loaded into back-loading sample holders and then analyzed using a Pananalytical Xpert Pro x-ray diffractometer at Lakehead University. In addition to the use of back-loading sample holders, a spinning state (rotating at 8 rpm) was used to limited the effects of preferred orientation. Analyses were conducted using CuKa radiation at an operating voltage and current of 45 kV and 40 mA, respectively, scanning in continuous mode from a 2θ of 5° to 110° with a step size of 0.013° 2θ and a rate of 300 seconds per step, and a PIXCEL solid-state detector. Diffraction patterns were processes using Panalytical Highscore Plus search/match software and the ICDD PDF-4 database. Modal mineral abundances were determined using Rietveld refinement option in Highscore Plus and the current ICSD structure database.

3.1.4 Whole-Rock Geochemistry

Approximately 50g of dried bulk of dried and unsorted tailings solids were milled to a fineness of <75µm using an agate puck mill. Prior to milling, the agate mill was cleaned with silica sand and acetone. Both the agate mill and cleansing procedure were used to limit contamination of the tailings solids.

A 30 g aliquot of milled solids was submitted to ALS Minerals (Vancouver) for whole-rock analysis. The following methods were used (ALS method codes given in parentheses):

- **Major oxides:** Lithium metaborate fusion with inductively coupled plasma-atomic emission spectroscopy (ME-ICP06)
- **Loss on ignition (LOI):** Thermal decomposition furnace with gravimetric determination (OA-GRA05)
- **Total carbon:** LECO thermal decomposition with infrared analysis (C-IR07)
- **Total sulphur:** LECO thermal decomposition with infrared analysis (S-IR08)
- **Trace elements:** Lithium metaborate fusion with inductively coupled plasma-mass spectroscopy (ME-MS81)
- **Metalloids/volatile metals (As, Bi, Hg, Sb, Se and Te):** Aqua regia digestion with inductively coupled plasma-mass spectroscopy (ME-MS42)

- **Base metals (Ag, Cd, Co, Cu, Mo, Ni, Pb and Zn):** Four (4) acid (perchloric, nitric, hydrofluoric and hydrochloric) digestion with inductively coupled plasma-mass spectroscopy (ME-4ACD81)

3.1.5 Grain Size

Grain size analysis was conducted in strict accordance to ASTM method D422 – 63 (reapproved 2007). The distribution of particle sizes larger than 75 µm (retained on the No. 200 sieve) was determined by sieving (using No. 4, 10, 20, 40 60, 140 and 200 sieves), while the distribution of particle sizes smaller than 75 µm was determined by a sedimentation process using an ASTM certified 152H hydrometer. For the hydrometer analysis, the specific gravity of the dried tailings was determined using ASTM D 854-00 – Standard Test for Specific Gravity of Soil Solids by Water Pycnometer.

4. Results

4.1 Tailings Solids Mineralogy

4.1.1 Mineralogical Composition

The bulk mineralogical composition of the tailings solids was determined by quantitative (Rietveld refinement) powder X-ray diffraction analysis. This method is suitable for determining modal abundances of phases that occur in amounts greater than 1 modal%. The major (>10 modal%) and minor (1-10 modal%) minerals present in Hammond Reef tailings solids are provided below and are also summarized in Figures 1 (phase identification) and 2 (Rietveld refinement).

Modal composition:

- Quartz – 43.4%
- Albite – 27.3%
- Ankerite – 4.8%
- Calcite – 2.4%
- Phengite (muscovite) – 17.1%
- Clinochlore (chlorite) – 4.9%

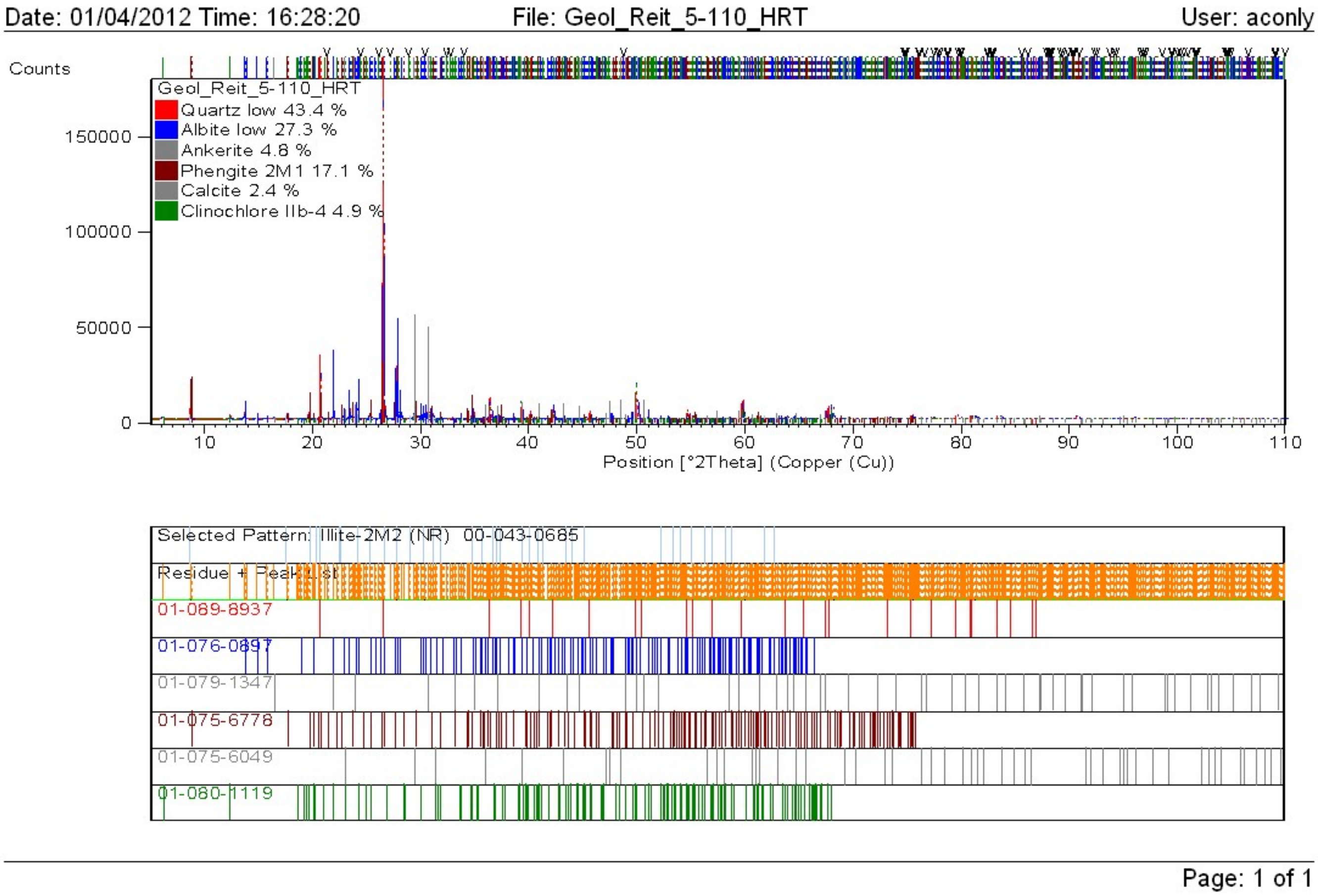

Figure 1: Background corrected XRD pattern for Hammond Reef tailings solids (top) with reference peak positions (bottom). Reference peaks are: 01-089-893 – quartz; 01-076-0897- ablite; 01-079-1347 – ankerite; 01-075-6778 – phengite (muscovite); 01-075-6049 – calcite; 01-080-1119 – clinoclore (chlorite-group).

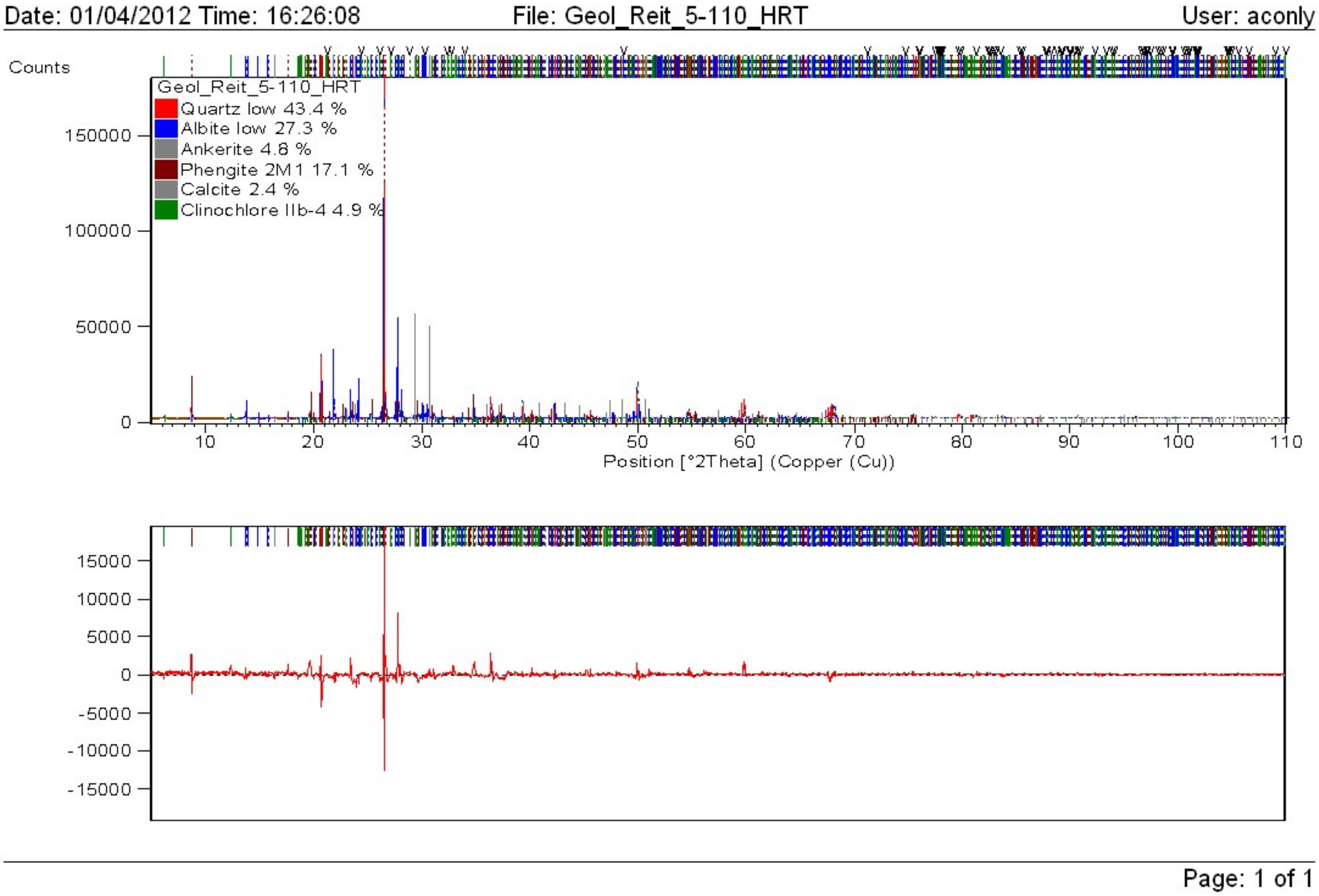

Figure 2: Background corrected XRD pattern for Hammond Reef tailings solids (top) with residual pattern following Rietveld refinement (bottom).

The modal abundances of the Rietveld refinement are based on a moderately good fit of the calculate profile to the measured profile. The agreement indices for the Rietveld refinement are:

- $R_{expected}$: 3.251
- $R_{profile}$: 6.387
- Weighted $R_{profile}$: 8.716
- Goodness of Fit (GOF): 7.184

Ideally a GOF value of <2 is desired. However, higher GOF values are commonly achieved with polymineralic samples, in particular for samples that contain solid-solution series. The Hammond Reef tailings contains three such phases: 1) albite corresponds to pure end-member Na-albite, for which possible K or Ca substitutions for Na are not accounted for; 2) clinochlore is the Mg-rich end-member of the chlorite group, for which possible Mg-Fe substitutions are not accounted for; and 3) carbonate phases in which calcite may have minor amounts of Mg, Mn and Fe, and ankerite may contain minor amounts of Mg and Mn and variable Ca:Fe ratios. In addition, the identification of phengite corresponds to a muscovite with a Si:Al ratio of >3:1 and Mg and/or Fe^{2+} substitution for Al in octahedral sites. Both the possibilities for solid-solution series and structural variances of muscovite are inferred to be the primary cause for the higher than ideal GOF value. As precise mineral chemical compositions of these phases where not known, no pattern refinements were conducted that involve elemental substitutions and corresponding structural variances. Performing such refinements in the absence of mineral chemical data would produce spurious results. While mineral compositional analysis (SEM-EDS or EMP) could assist in improving the agreement indices, such work is deemed unnecessary as any changes in modal abundances are expected to be minor.

4.1.2 Trace Minerals and Textural Features

Petrographic observations support Rietveld determined modal abundances for major and mineral minerals. Figure 3 shows the typical texture of the major and minor phases. The tailings solids consist of angular to subangular crystals of quartz and albite (both twinned and untwined) with minor amounts of euhedral to subhedral carbonate (varieties not differentiated by optical microscopy), sericitic to acicular to feathery muscovite and acicular chlorite.

Quartz, albite and carbonate typically occur as discrete crystals, with the occasional aggregated fragments being comprised of relatively few numbers of crystals. Grain size ranges of these phases are represented by the grain size analysis (section 4.3).

Although discrete crystals do occur, both muscovite and chlorite typically occur as a replacement of albite. The extent of replacement is variable, ranging from unaltered albite crystals to pervasive. Muscovite is the more common alteration phase, where it typically has a sericitic texture. Discrete crystals of muscovite are slightly coarser grained and more lath shaped rather than acicular to feathery. Both muscovite and chlorite have rare crystals that approach 100 µm in size, but typical grain sizes are <10 µm.

Pyrite and magnetite are the only trace phases (Fig. 4) that were not identified by XRD but were observed petrographically. The total abundance for either phase is <1 modal%, with pyrite being the more abundant phase. Both phases form subhedral to euhedral crystals that vary in size from < 10 µm to 50 µm. The degree of euhedralness generally increases with crystal size. While discrete crystal do occur, and these tend to constitute the larger size fraction, crystals typically occur as fine disseminations in altered polymineralic fragments.

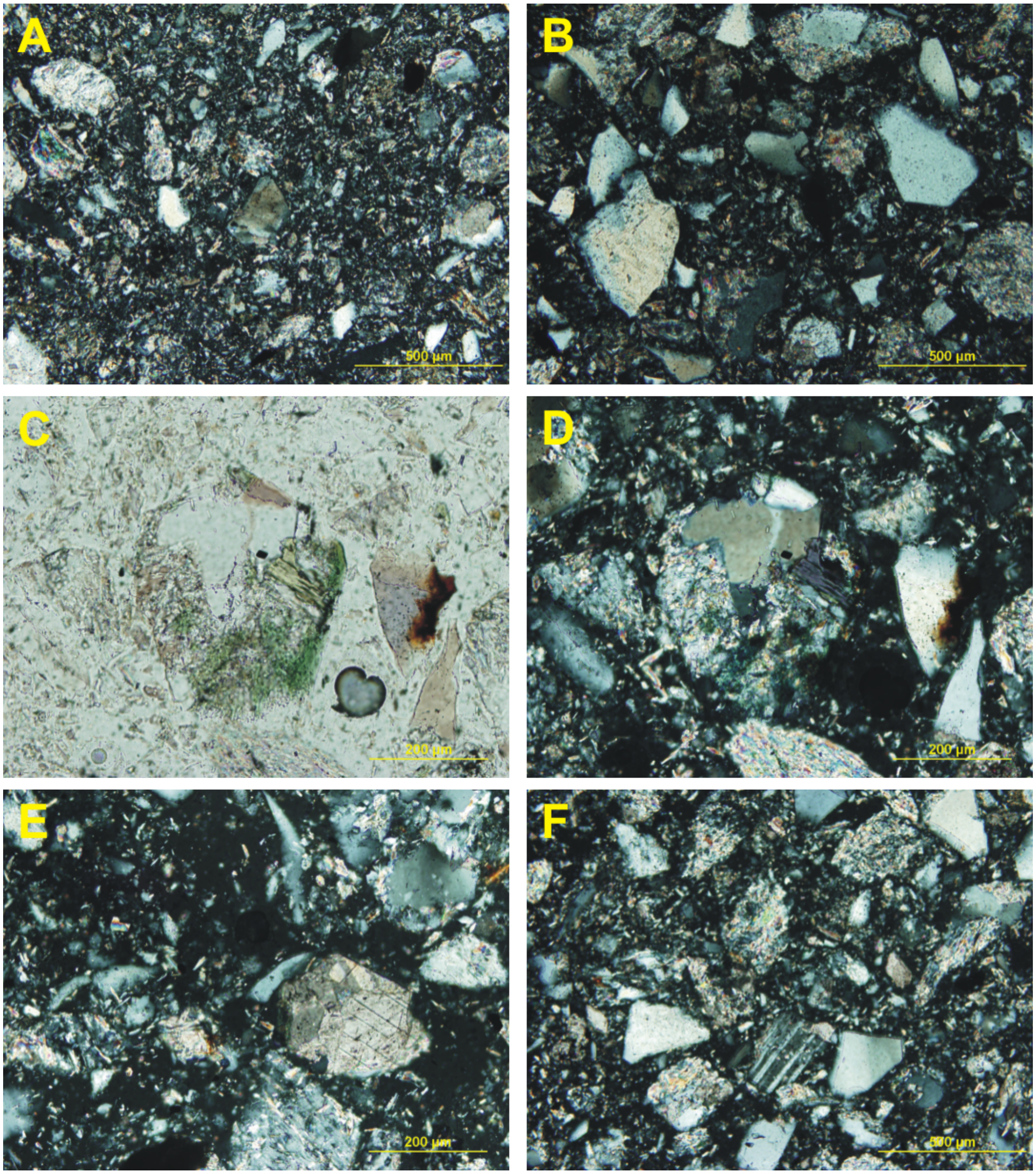

Figure 3: Representative cross-polarized (unless otherwise noted), transmitted light photomicrographs of Hammond Reef tailings solids. A) Finer-grain size range of tailings solids showing abundant quartz and albite with sericite (muscovite) alteration of albite. B) Coarse-grained tailings solids that show varying degrees of sericite (muscovite) alteration of albite. C and D) Plane polarized and crossed-polarized photomicrographs, respectively, showing chlorite replacement of albite. Note discrete crystals lath-shaped muscovite adjacent to sericite altered albite. E) Large euhedral carbonate crystal intermixed with quartz-albite. F) Albite crystals with varying degrees of sericite alteration.

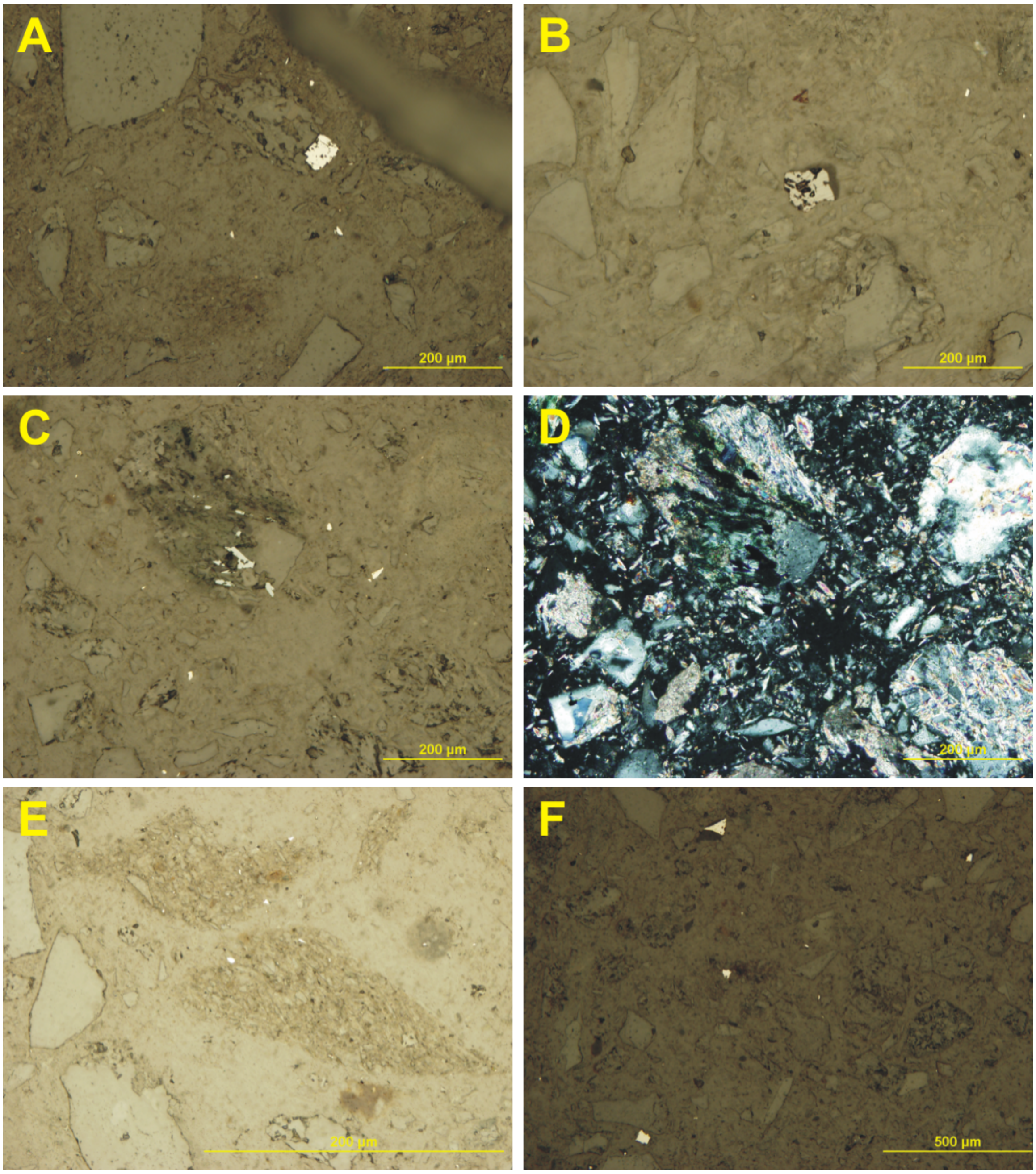

Figure 4: Representative plane-polarized, reflected light (unless otherwise noted) photomicrographs of Hammond Reef tailings solids. A) Discrete pyrite crystals with large euhedral pyrite crystal adjacent to an altered albite crystal. B) Relatively large euhedral magnetite crystal. C and D) Reflected light and cross-polarized, transmitted light photomicrographs, respectively, of subhedral magnetite crystals within chlorite + sericite altered fragment. E) Finely disseminated pyrite within sericite altered fragment. F) Discrete crystals of relatively coarse-grained euhedral to subhedral pyrite.

4.2 Tailings Geochemistry

Table 1: Major oxide, carbon and sulphur abundances.

	Method	Units	HRT	*mdl*	*MDL*
Major Oxides					
SiO_2	LMF/ICP	%	**67.40**	*0.01*	*100*
Al_2O_3	LMF/ICP	%	**13.45**	*0.01*	*100*
Fe_2O_3	LMF/ICP	%	**3.65**	*0.01*	*100*
CaO	LMF/ICP	%	**3.73**	*0.01*	*100*
MgO	LMF/ICP	%	**1.11**	*0.01*	*100*
Na_2O	LMF/ICP	%	**2.83**	*0.01*	*100*
K2O	LMF/ICP	%	**2.93**	*0.01*	*100*
Cr_2O_3	LMF/ICP	%	**0.01**	*0.01*	*100*
TiO_2	LMF/ICP	%	**0.34**	*0.01*	*100*
MnO	LMF/ICP	%	**0.06**	*0.01*	*100*
P_2O_5	LMF/ICP	%	**0.12**	*0.01*	*100*
SrO	LMF/ICP	%	**0.02**	*0.01*	*100*
BaO	LMF/ICP	%	**0.06**	*0.01*	*100*
LOI	TDF-grav	%	**5.58**	*0.01*	*100*
Total		%	**101.29**		
Total Carbon and Sulphur					
C	LECO	%	**1.10**	*0.01*	*50*
S	LECO	%	**0.26**	*0.01*	*50*

Explanation

LMF/ICP: Lithium metaborate fusion with inductively coupled plasma-atomic emission spectroscopy
TDF-grav: Thermal decomposition furnace with gravimetric determination
LECO: LECO thermal decomposition with infrared analysis
mdl: Minimum detection limit (in wt%)
MDL: Maximum detection limit (in wt%)

Table 2: Trace element, metalloid and metal abudndances (next page).

Explanation

HRT: Hammond Reef tailings solids
LMF/ICP-MS: Lithium metaborate fusion with inductively coupled plasma-mass spectroscopy
AR/ICP-MS: Aqua regia digestion with inductively coupled plasma-mass spectroscopy
4A/ICP-MS: Four (4) acid (perchloric, nitric, hydrofluoric and hydrochloric) digestion with inductively coupled plasma-mass spectroscopy
mdl: Minimum detection limit (in ppm)
MDL: Maximum detection limit (in ppm)

	Method	Units	**HRT**	*mdl*	*MDL*
Trace elements					
Ag	4A/ICP-MS	ppm	**<0.5**	*1*	*1000*
As	AR/ICP-MS	ppm	**5.3**	*0.1*	*25*
Ba	LMF/ICP-MS	ppm	**505**	*0.05*	*10000*
Bi	AR/ICP-MS	ppm	**0.39**	*0.01*	*10000*
Cd	4A/ICP-MS	ppm	**<0.5**	*0.2*	*1000*
Ce	LMF/ICP-MS	ppm	**49**	*0.05*	*10000*
Co	4A/ICP-MS	ppm	**9**	*0.1*	*10000*
Cr	LMF/ICP-MS	ppm	**70**	*10*	*10000*
Cs	LMF/ICP-MS	ppm	**1.21**	*0.01*	*10000*
Cu	4A/ICP-MS	ppm	**39**	*0.2*	*10000*
Dy	LMF/ICP-MS	ppm	**2.24**	*0.05*	*10000*
Er	LMF/ICP-MS	ppm	**1.21**	*0.03*	*1000*
Eu	LMF/ICP-MS	ppm	**0.82**	*0.03*	*1000*
Ga	LMF/ICP-MS	ppm	**20.2**	*0.1*	*1000*
Gd	LMF/ICP-MS	ppm	**2.88**	*0.05*	*1000*
Hf	LMF/ICP-MS	ppm	**4.1**	*0.02*	*1000*
Hg	AR/ICP-MS	ppm	**0.006**	*0.01*	*10000*
Ho	LMF/ICP-MS	ppm	**0.42**	*0.01*	*1000*
La	LMF/ICP-MS	ppm	**24.7**	*0.05*	*10000*
Lu	LMF/ICP-MS	ppm	**0.17**	*0.01*	*1000*
Mo	4A/ICP-MS	ppm	**5**	*0.05*	*10000*
Nb	LMF/ICP-MS	ppm	**7.5**	*0.2*	*10000*
Nd	LMF/ICP-MS	ppm	**19.5**	*0.1*	*10000*
Ni	4A/ICP-MS	ppm	**38**	*0.2*	*10000*
Pb	4A/ICP-MS	ppm	**7**	*0.5*	*10000*
Pr	LMF/ICP-MS	ppm	**5.42**	*0.03*	*1000*
Rb	LMF/ICP-MS	ppm	**79.7**	*0.2*	*10000*
Sb	AR/ICP-MS	ppm	**0.2**	*0.05*	*10000*
Se	AR/ICP-MS	ppm	**0.5**	*0.2*	*1000*
Sm	LMF/ICP-MS	ppm	**3.62**	*0.03*	*1000*
Sn	LMF/ICP-MS	ppm	**5**	*1*	*10000*
Sr	LMF/ICP-MS	ppm	**148**	*0.1*	*10000*
Ta	LMF/ICP-MS	ppm	**0.7**	*0.1*	*10000*
Tb	LMF/ICP-MS	ppm	**0.39**	*0.01*	*1000*
Te	AR/ICP-MS	ppm	**0.35**	*0.01*	*500*
Th	LMF/ICP-MS	ppm	**5.52**	*0.05*	*1000*
Tl	LMF/ICP-MS	ppm	**<0.5**	*0.5*	*1000*
Tm	LMF/ICP-MS	ppm	**0.17**	*0.01*	*1000*
U	LMF/ICP-MS	ppm	**1.25**	*0.05*	*1000*
V	LMF/ICP-MS	ppm	**43**	*5*	*10000*
W	LMF/ICP-MS	ppm	**6**	*1*	*10000*
Y	LMF/ICP-MS	ppm	**12.5**	*0.05*	*10000*
Yb	LMF/ICP-MS	ppm	**1.11**	*0.03*	*1000*
Zn	4A/ICP-MS	ppm	**64**	*2*	*10000*
Zr	LMF/ICP-MS	ppm	**153**	*2*	*10000*

4.3 Grain Size Analysis

4.3.1 Sieve Analysis

Table 3: Sieve analysis results

Mass of container (g):	26.2
Mass of container + dry sample (g):	288.4
Mass of dry sample (g):	262.2

Sieve Number	Diameter	Mass of Empty Sieve	Mass of Sieve + Sample	Mass Sample Retained	% Retained	% Passing
	mm	g	g	g		
4	4.750	377.4	377.4	0.0	0.0	100.0
10	2.000	495.1	495.2	0.1	0.0	100.0
20	0.840	348.4	348.4	0.0	0.0	100.0
40	0.425	399.6	399.8	0.2	0.1	99.9
60	0.250	273.1	309.5	36.4	13.9	86.0
140	0.106	371.5	488.1	116.6	44.6	41.4
200	0.075	363.5	391.4	27.9	10.7	30.7
Pan	-	563.8	644.2	80.4	30.7	0.0
			Total:	**261.6**	**100.0**	

4.3.2 Specific Gravity Determination

Specific Gravity Determination (<0.075 mm grain size fraction)

Mass of pycnometer (g):	34.6937
Mass of pycrnometer + dry sample (g):	44.8457
Mass of pycnometer + dry sample + water (g):	91.8032
Mass of pycnometer + water (g):	85.4727
Specific Gravity:	2.6565

4.3.3 Hydrometer Analysis

Table 4: Hydrometer analysis results.

Hydrometer Type:			152H				Mass of sample (g):		49.1		
Specific Gravity:			2.66				Zero Correction:		5		
Dispersing Agent:			Na-hexmetaphosphate				Meniscus Correction:		1		
Elaspsed Time	**Temperature**	**Hydrometer Reading**	**Mensiscus Corrected Reading**	**L value**	**k value**	**D**	**C_T**	**a**	**Corrected Hydrometer Reading**	**% Finer**	**% Adjusted Finer**
min	**°C**					**mm**					
0	23.5	43	44	9.1	0.01317	-	0.70	1.00	-	-	
2	23.5	38	39	9.9	0.01317	0.02930	0.70	1.00	33.7	68.6	21.1
5	23.5	31	32	11.1	0.01317	0.01962	0.70	1.00	26.7	54.4	16.7
8	23.5	28	29	11.5	0.01317	0.01579	0.70	1.00	23.7	48.3	14.8
15	23.5	22	23	12.5	0.01317	0.01202	0.70	1.00	17.7	36.0	11.1
30	23.5	16	17	13.5	0.01317	0.00883	0.70	1.00	11.7	23.8	7.3
60	23.0	12	13	14.2	0.01317	0.00641	0.70	1.00	7.7	15.7	4.8
1440	23.0	6	7	15.2	0.01317	0.00135	0.70	1.00	1.7	3.5	1.1

Explanation

L value - effective depth
k value - temperature-specific gravity constant for particle diameter
CT - temperature correction factors
a - correction factor for unit weight of solids

4.3.4 Grain Size Distribution Curve

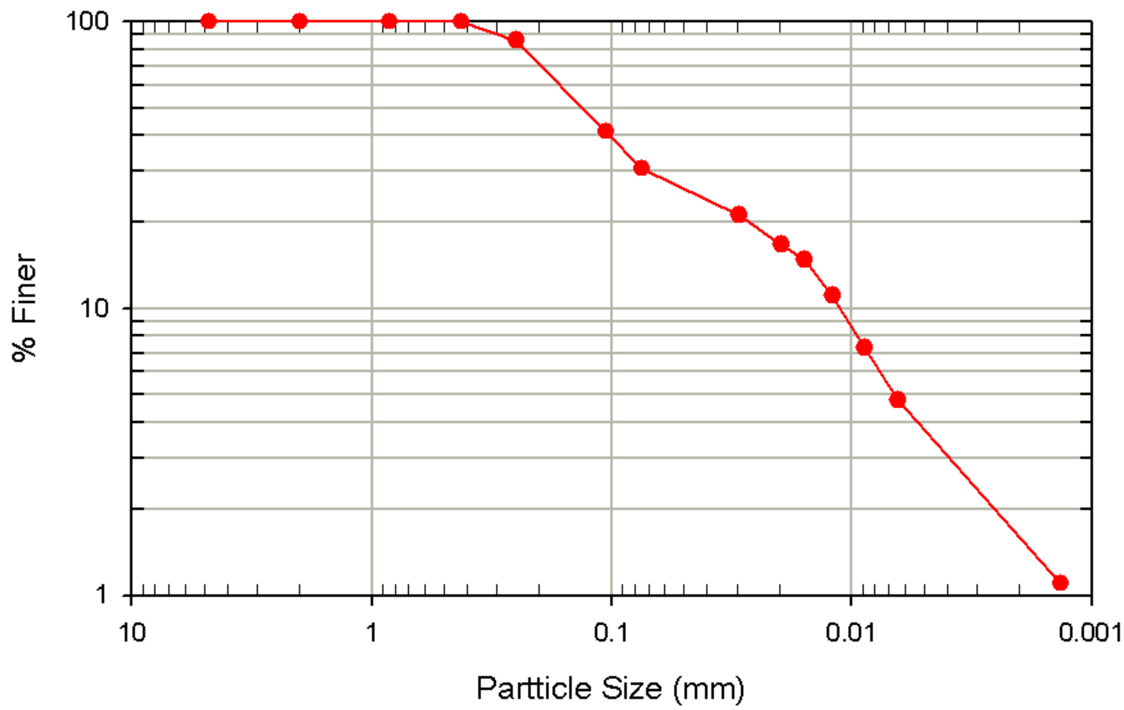

Figure 5. Grain size distribution curve showing combined results of sieve and hydrometer analyses of Hammond Reef tailings.

Attachment 2.VI.2

An Investigation by High Definition Mineralogy into the Mineralogical Characteristics of Mine Waste Rock Samples – September 2011

An Investigation by High Definition Mineralogy into

THE MINERALOGICAL CHARACTERISTICS OF NINE WASTE ROCK SAMPLES

prepared for

GOLDER ASSOCIATES LTD.

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Introduction

This summary report describes a high definition mineralogical test program using QEMSCAN technology (Quantitative Evaluation of Materials by Scanning Electron Microscopy), optical microscopy and X-ray diffraction analysis (XRD) conducted on nine waste rock samples from the Hammond Reef gold project. The samples were submitted to the SGS Advanced Mineralogy Facility by Brian Graham of SGS Analytical Services on behalf of Golder Associates Ltd.

The main purpose of this test program was to identify the bulk mineral assemblage and textural characteristics of the mineral species in the samples. The samples were also investigated for their acid generation (AG) and/or neutralization potential (NP) based on the proportion of sulphide and carbonate minerals and their respective textural associations in each sample. As well, the samples were examined for any evidence of oxidation on the surfaces of the sulphide minerals.

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	Amie Brock - QEMSCAN Operation
	Kathryn Sheridan - Mineralogy
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Reviewed by:	*Stephanie Downing and Kim Gibbs*

Testwork Summary

1. Procedures

Nine waste rock samples from the Hammond reef gold project (labelled 2010-HR-004, 2010-HR-005, 2010-HR-027, 2010-HR-065, 2010-HR-067, 2010-HR-086, 2010-HR-091, 2010-HR-095 and 2010-HR-117) were received by the Mineralogy Department from the Analytical Department at SGS Minerals Services on behalf of Golder Associates Ltd., and assigned LIMS number MI5049-APR11. Each sample was air-dried, stage-ground to 80% passing 150 µm and sub-sampled with a micro-riffler. Each sample was originally submitted for whole rock analyses (XRF by borate fusion) by Brian Graham under LIMS reference number CA11198-APR11. These assay results were used herein for mineralogical data validation purposes. The assays are presented in the reconciliation portion of this report and the Certificates of Analyses are appended (Appendix B). X-ray diffraction (XRD) and chemical analyses were used as part of the QEMSCAN project setup, in order to calibrate the mineral database, known as a Species Identification Programme (SIP), to the particular ore type. A summary of the XRD results are presented in Section 2.1 and full results are appended (Appendix C).

Sub-samples of each micro-riffled sample were prepared into polished sections. A total of nine graphite-impregnated polished epoxy grain mounts were prepared with replicate sections prepared for QA/QC procedures. The graphite-impregnated polished grain mounts were submitted for quantitative modal analysis using the Particle Mineral Analysis (PMA) mode of QEMSCAN technology and were also examined optically with reflected light microscopy. Photomicrographs were taken of various minerals of interest and are presented in Appendix D.

2. Mineralogical Results

2.1. X-ray Diffraction Results

The nine samples were analyzed qualitatively by X-ray diffraction (XRD) in order determine the main crystalline mineral components in each sample. A summary of the results are shown in Table 1, with full results presented in Appendix C.

For the majority of samples, quartz and plagioclase are the dominant crystalline mineral phases. Sample 2010-HR-095 is unique in that dolomite is dominant instead of plagioclase. Calcite, dolomite, mica and chlorite are typically found in minor concentrations (2-10%). Magnetite and magnesite are also present in minor to moderate amounts but are unique only to 2010-HR-095. Other crystalline mineral phases detected by XRD occur in trace abundance and include K-feldspar, ilmenite, epidote and pyrite.

Table 1. Summary of Qualitative XRD Results

Crystalline Mineral Assemblage (relative proportions based on peak height)

Sample	Major	Moderate	Minor	Trace
(1) 2010-HR-004	quartz	chlorite, calcite	plagioclase, dolomite, epidote, titanite	*potassium feldspar
(2) 2010-HR-005	quartz	plagioclase	potassium feldspar, chlorite, dolomite, mica	*calcite, *epidote
(3) 2010-HR-027	quartz	plagioclase	calcite, mica, chlorite	*pyrite
(4) 2010-HR-065	quartz	plagioclase	dolomite, mica chlorite, calcite	*potassium feldspar
(5) 2010-HR-067	quartz	plagioclase	dolomite, mica, calcite	*potassium feldspar, *chlorite
(6) 2010-HR-086	quartz	plagioclase	calcite, chlorite, mica	*potassium feldspar
(7) 2010-HR-091	quartz	plagioclase	calcite, chlorite, mica, dolomite	*potassium feldspar, *pyrite
(8) 2010-HR-095	quartz, dolomite	magnesite	chlorite, talc, magnetite	*potassium feldspar, *ilmenite, *rutile
(9) 2010-HR-117	quartz, plagioclase	-	calcite, mica, chlorite	-

** tentative identification due to low concentrations, diffraction line overlap or poor crystallinity*

2.2. QEMSCAN Operation Modes and Quality Control

QEMSCAN Particle Mineral Analysis (PMA) was performed on all polished sections. PMA is a two-dimensional mapping analysis aimed at resolving liberation and locking characteristics of a generic set of particles. A pre-defined number of particles are mapped at a point spacing selected in order to spatially resolve and describe mineral textures and associations. A full description of this method is appended (Appendix A).

For each sample, roughly 60,000 particles were analyzed using the PMA mode of operation, generating over 600,000 X-ray data points per sample, from which the mineralogical information has been derived. The operational statistics of these analyses are presented in Table 2.

Table 2. Summary of QEMSCAN Operational Statistics

Sample	Fraction	Pixel Size (µm)	Section ID	No. Particles	No. X-ray Points
2010-HR-004	-600/+3um	3	11A	30,897	694,919
			11B	30,344	699,612
2010-HR-005	-600/+3um	3	21A	30,666	714,463
			21B	30,644	854,210
2010-HR-027	-600/+3um	3	31A	30,528	689,649
			31B	30,549	683,531
2010-HR-065	-600/+3um	3	41A	30,203	832,156
			41B	30,399	633,634
2010-HR-067	-600/+3um	3	51A	30,148	586,145
			51B	30,392	703,361
2010-HR-086	-600/+3um	3	61A	30,978	878,499
			61B	31,391	597,939
2010-HR-091	-600/+3um	3	71A	30,413	828,236
			71B	31,487	897,053
2010-HR-095	-600/+3um	3	81A	30,171	612,373
			81B	31,157	425,628
2010-HR-117	-600/+3um	3	91A	30,419	724,120
			91B	30,071	664,568

Key QEMSCAN calculated mineralogical assays have been regressed with the direct chemical assays (Figure 1). Values are shown in Figure 1 and Table 3. Overall correlation, as measured by R-squared criteria, is 1.0. R^2 values above 0.98 are considered to be acceptable.

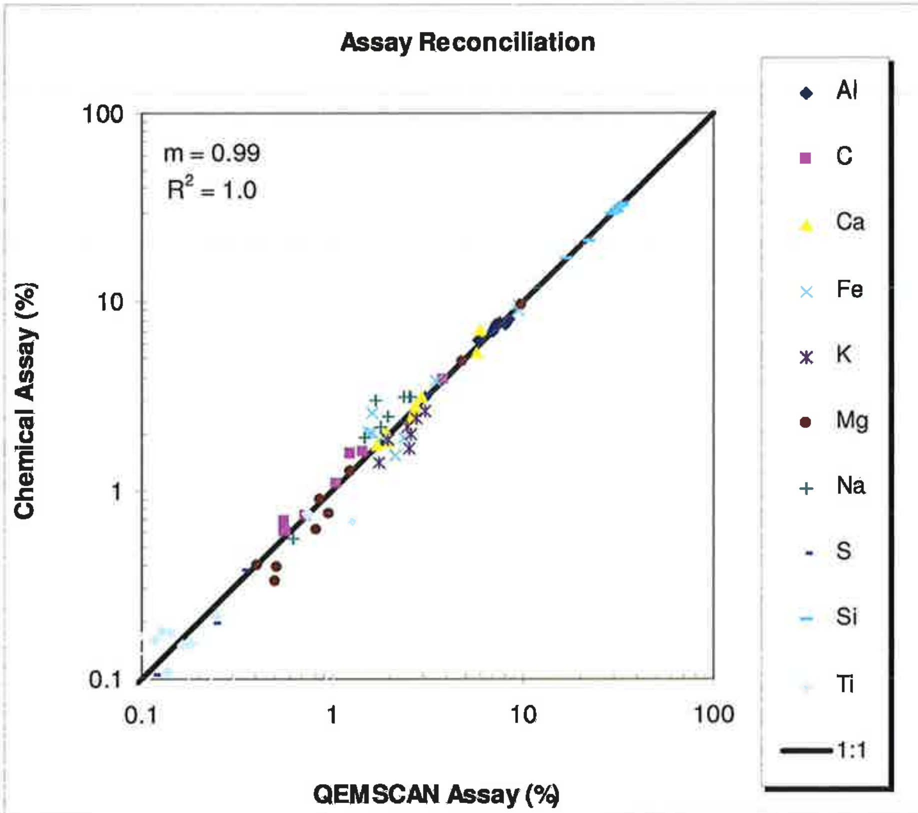


Figure 1. QEMSCAN Calculated and Direct Chemical Assay Reconciliation

	2010-HR-004	2010-HR-005	2010-HR-027	2010-HR-065	2010-HR-067	2010-HR-086	2010-HR-091	2010-HR-095	2010-HR-117
	-600/+3um	-600/+3um	-600/+3um	-600/+3um	-600/+3um	-600/+3um	-600/+3um	-600/+3um	-600/+3um
Al (QEMSCAN)	5.84	7.61	8.35	7.01	8.04	7.06	7.13	3.09	7.24
Al (Chemical)	6.25	7.73	8.04	6.99	7.62	7.36	7.25	3.10	7.62
C (QEMSCAN)	1.43	0.09	0.73	1.25	1.04	0.55	0.57	3.76	0.56
C (Chemical)	1.60	0.12	0.73	1.57	1.08	0.68	0.60	3.88	0.60
Ca (QEMSCAN)	6.02	1.96	2.70	2.92	2.58	1.90	1.73	5.75	2.74
Ca (Chemical)	7.12	1.82	2.67	3.14	2.39	2.01	1.76	5.41	2.89
Fe (QEMSCAN)	9.43	2.10	3.46	1.62	1.55	1.59	1.85	9.42	2.35
Fe (Chemical)	9.02	1.53	3.84	2.57	2.04	2.01	1.89	9.72	1.89
K (QEMSCAN)	0.50	1.94	2.60	2.72	3.05	2.54	2.48	0.02	1.76
K (Chemical)	0.01	1.85	1.98	2.40	2.63	1.68	2.17	0.05	1.40
Mg (QEMSCAN)	4.82	0.51	0.82	1.24	0.96	0.40	0.52	9.78	0.86
Mg (Chemical)	4.84	0.33	0.62	1.25	0.74	0.40	0.39	9.71	0.89
Na (QEMSCAN)	0.62	2.60	2.53	1.48	1.78	1.69	1.96	0.01	2.34
Na (Chemical)	0.56	3.16	3.13	1.90	2.15	2.97	2.48	0.01	3.12
S (QEMSCAN)	0.15	0.01	0.34	0.12	0.01	0.15	0.24	0.08	0.04
S (Chemical)	0.03	0.01	0.38	0.10	0.03	0.07	0.20	0.09	0.01
Si (QEMSCAN)	22.2	33.5	29.2	31.0	30.6	33.6	33.2	16.7	32.0
Si (Chemical)	21.0	33.4	29.4	29.8	30.7	32.4	33.0	17.1	31.5
Ti (QEMSCAN)	0.74	0.13	0.25	0.14	0.12	0.13	0.16	1.25	0.18
Ti (Chemical)	0.74	0.11	0.22	0.17	0.16	0.18	0.15	0.69	0.16

Table 3. QEMSCAN Calculated and Direct Chemical Assay Reconciliation

2.3. Modal Analyses

QEMSCAN analysis of the nine samples identified the bulk modal attributes that are summarized in Table 4 and shown graphically in Figure 2.

In all samples except 2010-HR-004 and 2010-HR-095, quartz (28-45 wt%), plagioclase (18-36 wt%) and muscovite (10-28 wt%) are the predominant mineral phases. Calcite levels vary from 1 to 6 wt% while dolomite levels vary from 0 to 7 wt%. Minor levels (1-10 wt%) of K-feldspar and chlorite are typically present. Fe-sulphides are present in the form of pyrite and appear in trace quantities (0.01 – 0.6 wt%). Chalcopyrite and other sulphides are rare (<0.1%)

Samples 2010-HR-004 and 2010-HR-095 are typified by major chlorite (~39 wt%) and moderate quartz (18-25 wt%). Calcite is present in high abundance in 2010-HR-004 (10 wt%) while only trace amounts (<0.3%) occur in sample 2010-HR-095. Dolomite is present mainly in 2010-HR-095 (24 wt%), as opposed to only 1 wt% in 2010-HR-004. Fe-magnesite is only present in sample 2010-HR-095 at 3 wt%. These two samples also contain minor quantities (2-10 wt%) of plagioclase, muscovite, epidote, titanite, talc and Fe/Ti/Cr-oxides. Pyrite is present at trace levels (0.1 – 0.3 wt%).

Table 4. Bulk Modal Analysis and Average Grain Size Data by QEMSCAN

Survey		**Golder**								
Project		**13057-001 / MI5049-APR11**								
Sample		**2010-HR-004**	**2010-HR-005**	**2010-HR-027**	**2010-HR-065**	**2010-HR-067**	**2010-HR-086**	**2010-HR-091**	**2010-HR-095**	**2010-HR-117**
Fraction		**-600/+3um**	**-600/+3um**	**-600/+3um**	**-600/+3um**	**-600/+3um**	**-600/+3um**	**-600/+3um**	**-600/+3um**	**-600/+3um**
Mass Size Distribution (%)		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Calculated ESD Particle Size		27	32	27	28	26	28	31	23	27
		Sample	**Sample**	**Sample**	**Sample**	**Sample**	**Sample**	**Sample**	**Sample**	**Sample**
Mineral Mass (%)	Pyrite	0.27	0.01	0.63	0.21	0.02	0.27	0.44	0.12	0.07
	Chalcopyrite	0.02	0.00	0.02	0.01	0.00	0.01	0.02	0.05	0.01
	Other Sulphides	0.00	0.01	0.01	0.02	0.01	0.00	0.01	0.01	0.00
	Fe/Ti/Cr-Oxides	0.24	0.03	0.94	0.15	0.26	0.15	0.63	4.72	0.23
	Quartz	25.1	36.7	27.5	40.8	35.9	45.2	42.7	17.5	37.7
	Plagioclase	7.78	35.5	30.8	18.0	21.6	20.5	23.8	0.09	29.0
	K-Feldspar	0.16	6.80	2.25	1.14	1.17	1.04	1.43	0.00	1.22
	Epidote	6.91	4.21	0.10	0.04	0.05	0.19	0.03	0.02	3.61
	Titanite	3.87	0.72	0.47	0.48	0.44	0.45	0.30	1.04	0.74
	Talc	0.23	0.00	0.01	0.01	0.00	0.02	0.00	8.89	0.02
	Chlorite	38.7	5.02	7.39	2.82	2.46	2.90	2.61	38.6	6.28
	Muscovite	4.32	9.74	22.3	24.6	28.3	23.9	22.5	0.03	15.7
	Other Micas/Clays	0.56	0.31	1.12	1.73	1.34	0.65	0.86	0.24	0.62
	Calcite	10.5	0.75	6.07	3.20	3.24	4.17	3.09	0.28	4.63
	Dolomite	1.27	0.00	0.00	6.64	4.99	0.41	1.50	24.3	0.07
	Magnesite	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.93	0.00
	Apatite	0.09	0.13	0.35	0.22	0.19	0.18	0.12	0.16	0.13
	Other	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.02	0.01
	Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Mean Grain Size by Frequency (µm)	Pyrite	37	7	28	30	10	34	27	30	32
	Chalcopyrite	7	5	7	6	5	10	18	11	8
	Other Sulphides	5	5	5	5	7	5	5	6	5
	Fe/Ti/Cr-Oxides	7	6	12	7	10	6	12	10	9
	Quartz	16	34	29	39	35	37	38	13	35
	Plagioclase	16	25	23	24	25	23	24	5	21
	K-Feldspar	6	20	7	7	6	7	7	6	7
	Epidote	18	19	6	5	5	5	5	5	19
	Titanite	9	8	5	5	5	5	5	5	7
	Talc	4	5	5	5	5	17	4	10	5
	Chlorite	14	19	13	11	14	12	14	12	15
	Muscovite	14	10	12	12	11	12	12	7	11
	Other Micas/Clays	5	5	5	6	5	5	5	7	5
	Calcite	19	12	16	14	13	15	17	8	18
	Dolomite	16	9	7	17	15	7	14	20	7
	Magnesite	4	4	4	6	4	11	6	20	5
	Apatite	7	14	20	26	18	21	14	13	16
	Other	5	7	6	7	5	5	6	6	6

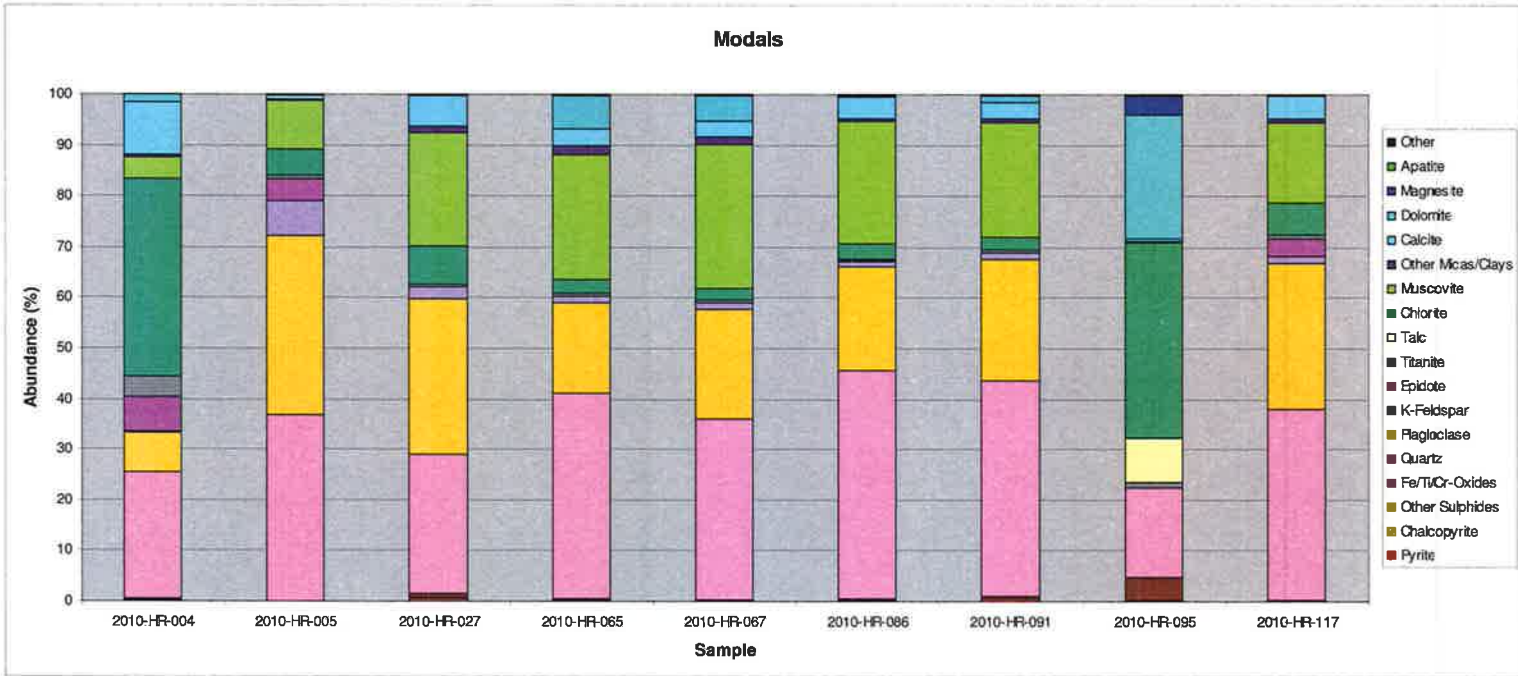


Figure 2. Bulk Modal Analysis by QEMSCAN

2.4. Mineral Occurrence

2.4.1. Carbonates

The main carbonate minerals present in the samples are dolomite and calcite. Fe-magnesite is present in significant abundance only in 2010-HR-095 (4 wt%). Dolomite is present at 24 wt% in 2010-HR-095, 7 wt% in 2010-HR-065 and 5 wt% in 2010-HR-067 and is found only in trace quantities (≤2 wt%) in the other samples. Calcite is present between 3 and 10 wt% for all samples with the exception of 2010-HR-005 and 2010-HR-095 in which calcite is present only in trace quantities (≤1 wt%).

A breakdown of the types of carbonate minerals and their relative proportions and distribution in each sample is presented in Table 5.

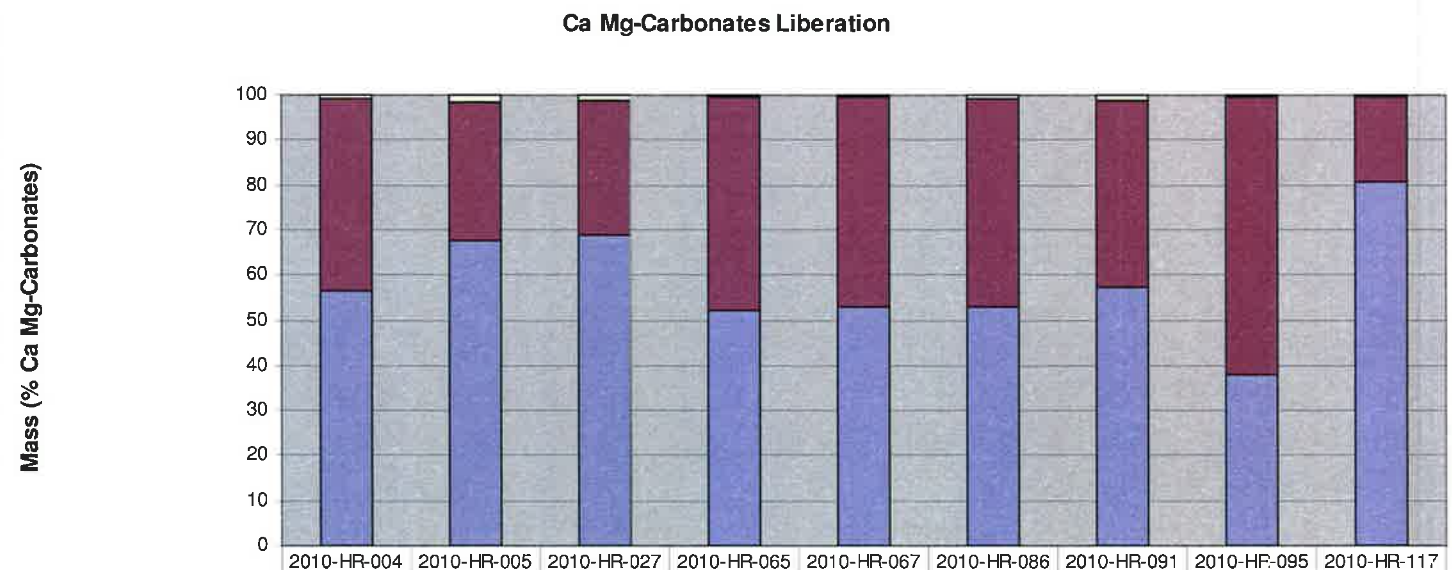
Although the chemistry will dictate the carbonate neutralization potential (NP), carbonate association will also have an impact on its availability for neutralization. A graphical representation of the neutralizing carbonate minerals (calcite, dolomite and magnesite), shown by liberation class, is presented in Figure 3.

In all samples, the majority of Ca-Mg carbonates occur either as liberated or exposed grains (representing over 98% of the overall carbonate surface area per sample), and thus are amenable to dissolution and neutralization.

Figure 4 and Figure 5 show representative particle images grouped by Ca-Mg carbonate liberation categories for the nine samples.

Table 5. Carbonate Mineral Species Distribution

	Sample	2010-HR-004		2010-HR-005		2010-HR-027		2010-HR-065		2010-HR-067		2010-HR-086		2010-HR-091		2010-HR-095		2010-HR-117	
		Wt.%	Dist'n.%	Wt.%	Dist'n.%	Wt.%	Dist'r.%	Wt.%	Dist'n.%	Wt.%	Dist'n.%	Wt.%	Dist'n.%	Wt.%	Dist'n.%	Wt.%	Dist'n.%	Wt.%	Dist'n.%
Calcite	$CaCO_3$	10.5	89.2	0.75	99.7	6.07	99.9	3.20	32.5	3.24	39.3	4.17	90.9	3.09	67.3	0.28	0.99	4.63	98.5
Dolomite	$CaMg(CO_3)_2$	1.27	10.8	0.00	0.24	0.00	0.07	6.64	67.5	4.99	60.7	0.41	9.02	1.50	32.7	24.3	85.2	0.07	1.50
Magnesite	MgCO3	0.00	0.02	0.00	0.02	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.03	0.00	0.00	3.93	13.8	0.00	0.02
	Total Carbonates	11.8	100.0	0.75	100.0	6.07	100.0	9.83	100.0	8.23	100.0	4.59	100.0	4.60	100.0	28.5	100.0	4.70	100.0



	2010-HR-004	2010-HR-005	2010-HR-027	2010-HR-065	2010-HR-067	2010-HR-086	2010-HR-091	2010-HR-095	2010-HR-117
Ca-Mg Carbs Locked	0.61	1.67	1.35	0.28	0.52	0.84	1.17	0.26	0.50
Ca-Mg Carbs Exposed	42.7	30.6	29.8	47.4	46.4	46.1	41.4	61.8	18.7
Ca-Mg Carbs Liberated	56.7	67.8	68.9	52.3	53.0	53.1	57.4	37.9	80.8

Figure 3. Ca-Mg Carbonate Liberation

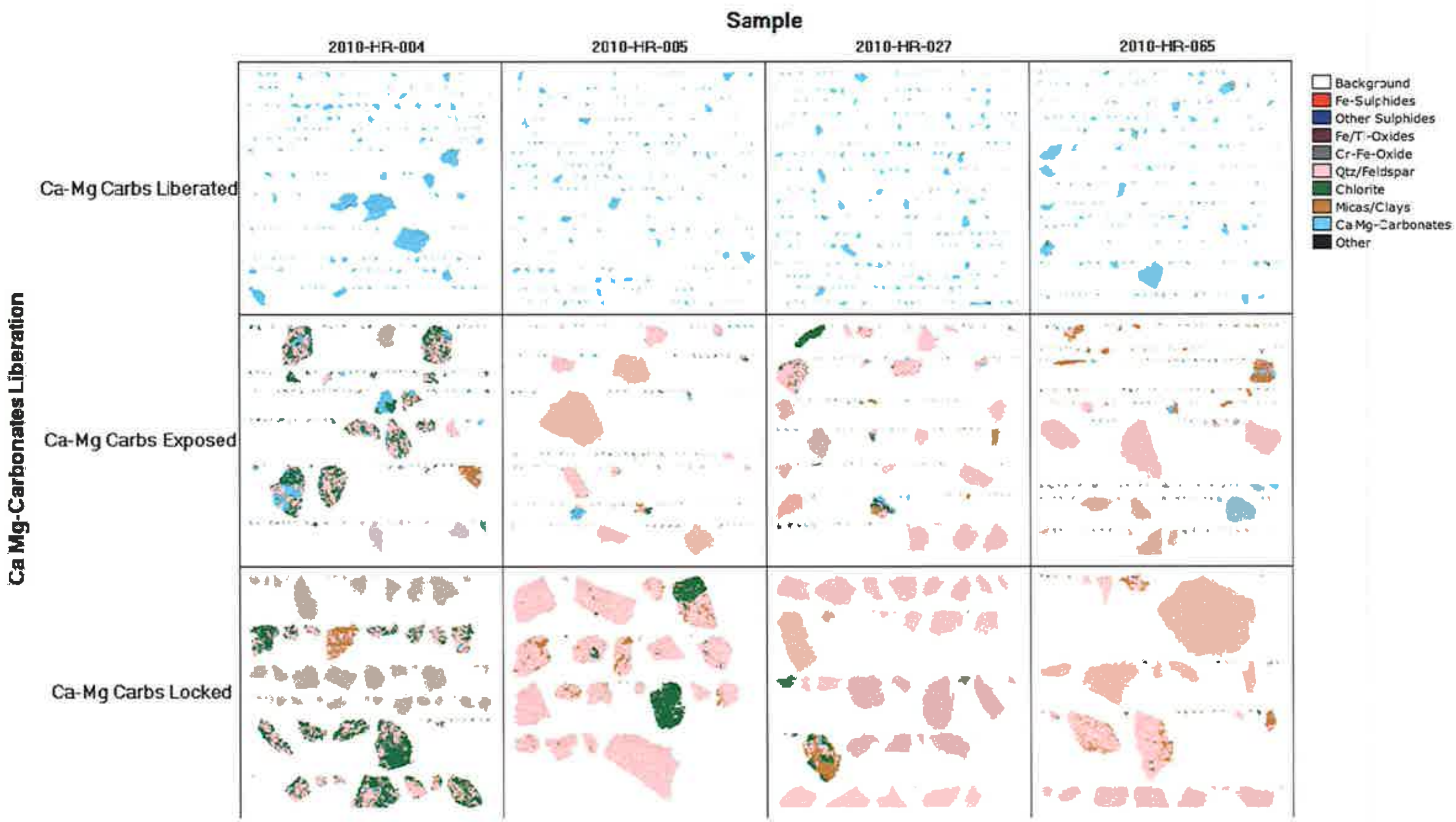


Figure 4: Image Grid of Ca-Mg Carbonates by Liberation Category for 2010-HR-004 to 065

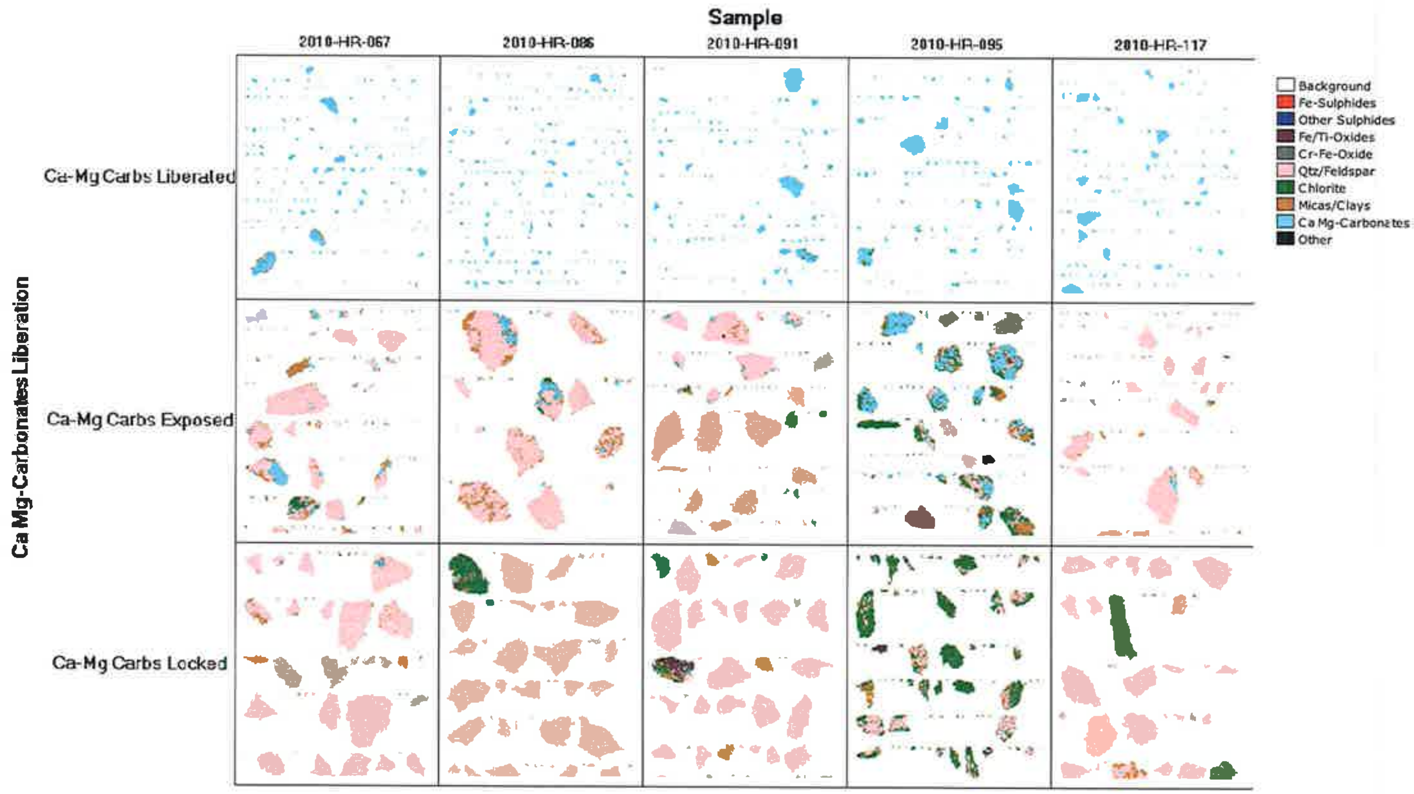


Figure 5: Image Grid of Ca-Mg Carbonates by Liberation Category for 2010-HR-067 to 117

2.4.2. Sulphides

Fe-sulphides are comprised only of pyrite which is present in trace quantities (< 0.6 wt%) in all samples. The sulphide mineral abundance and distribution are presented in Table 6.

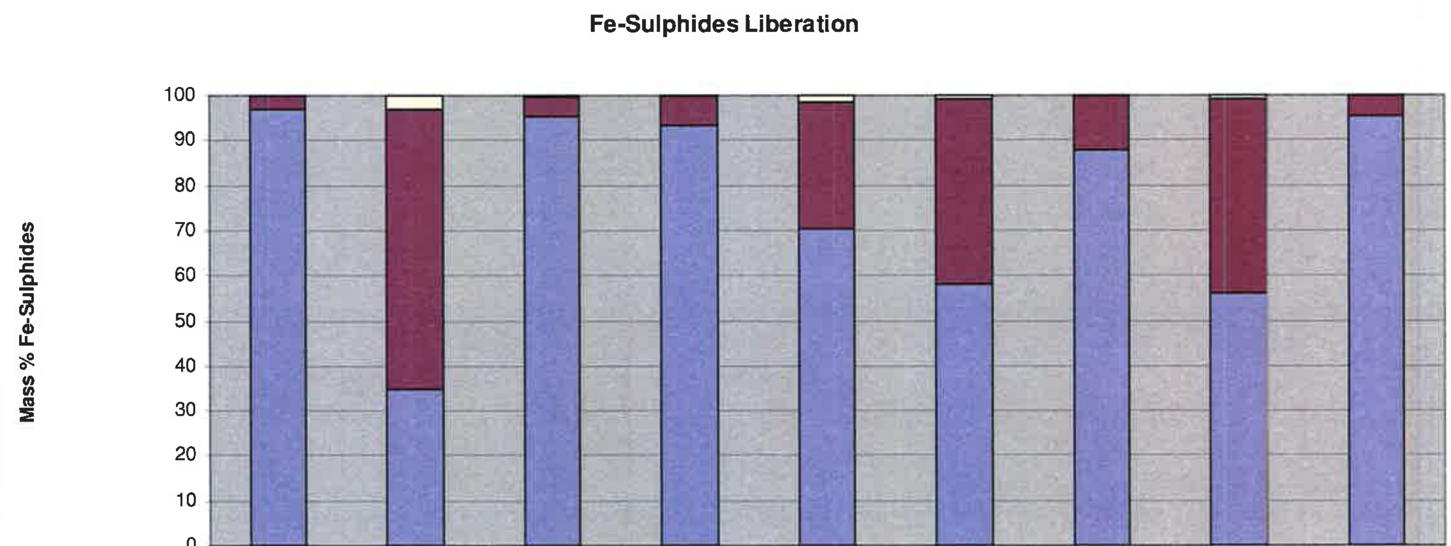
Since Fe-sulphides (in this case, pyrite) may contribute to acidity under oxidizing conditions, their textural associations were examined. Optically, the only sample that shows possible signs of oxidation is 2010-HR-117 (see photomicrographs in Appendix D).

Figure 6 shows a summary liberation graph of Fe-sulphides amongst the samples. Over 96% of the Fe-sulphides occur as liberated and exposed grains, which suggests high availability under oxidizing environments. For those samples in which the Fe-sulphide content is less than 0.5 wt%, additional polished section analysis is required in order to provide more quantitative liberation data.

Figure 7 shows representative particle images grouped by Fe-sulphide liberation classes for the nine samples.

Table 6. Sulphide Mineral Species Distribution

	Sample	2010-HR-004		2010-HR-005		2010-HR-027		2010-HR-065		2010-HR-067		2010-HR-086		2010-HR-091		2010-HR-095		2010-HR-117	
		Wt.%	Dist'n.%	Wt.%	Dist'n.%	Wt.%	Dist'n.%	Wt.%	Dist'n.%	Wt.%	Dist'n.%	Wt.%	Dist'n.%	Wt.%	Dist'n.%	Wt.%	Dist'n.%	Wt.%	Dist'n.%
Pyrite	FeS_2	0.27	91.5	0.01	55.6	0.63	97.2	0.21	96.7	0.02	91.4	0.27	95.7	0.44	95.0	0.12	71.4	0.07	92.0
Chalcopyrite	$CuFeS_2$	0.02	8.52	0.00	44.4	0.02	2.82	0.01	3.33	0.00	8.61	0.01	4.28	0.02	5.00	0.05	28.6	0.01	7.98
	Total Sulphides	0.29	100.0	0.01	100.0	0.65	100.0	0.22	100.0	0.02	100.0	0.28	100.0	0.46	100.0	0.15	100.0	0.07	100.0



	2010-HR-004	2010-HR-005	2010-HR-027	2010-HR-065	2010-HR-067	2010-HR-086	2010-HR-091	2010-HR-095	2010-HR-117
FeS= Locked	0.19	3.36	0.31	0.03	1.56	0.87	0.18	0.74	0.00
FeS= Exposed	3.06	61.9	4.43	6.77	28.1	40.9	12.0	43.1	4.85
FeS= Liberated	96.7	34.7	95.3	93.2	70.3	58.2	87.8	56.2	95.2

Figure 6. Fe-Sulphide Liberation

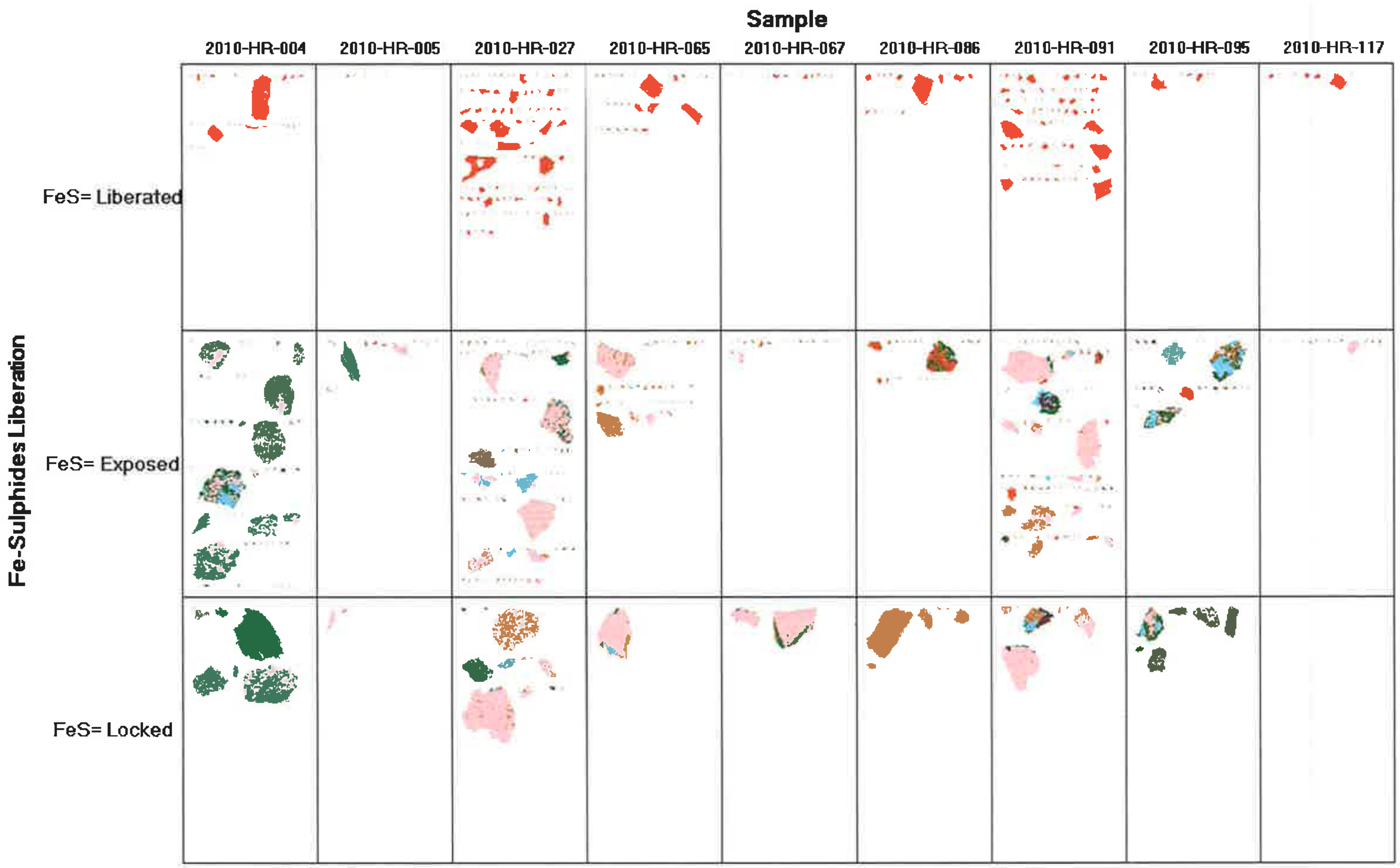


Figure 7. Image Grid of Fe-Sulphides by Liberation Category

2.5. Neutralization Potential

A carbonate/sulphide ratio > 2 indicates probable net neutralizing conditions. Only net acid consuming carbonates (Ca-Mg carbonates) are used for the mineralogical neutralization potential (NP) determination. Only Fe-sulphides are used for the mineralogical acid generation potential (AGP) as they are the main sulphides to contribute to net acidity.

The mineralogical NP calculations employed in this study suggest that for all samples, there is sufficient neutralization potential available. A summary of the mineralogically calculated neutralization potential (NP) for each sample is presented below in Table 7.

Table 7. Summary of Mineralogical Neutralization Potential

	2010-HR-004	2010-HR-005	2010-HR-027	2010-HR-065	2010-HR-067	2010-HR-086	2010-HR-091	2010-HR-095	2010-HR-117
NP from Ca-Mg	11.8	0.75	6.07	9.83	8.23	4.59	4.60	28.5	4.70
AGP from Fe-Sulphide	0.27	0.01	0.63	0.21	0.02	0.27	0.44	0.12	0.07
Ca-Mg Carbonate/ Fe-Sulphide ratio	44	138	10	47	433	17	11	244	72

NP (Neutralization Potential), AGP (Acid Generation Potential)
Note: All values are irrespective of sulphide/carbonate liberation. In cases of low carbonate and sulphide abundance (typically <0.5 wt.% of each), values are only semi-quantitative due to low particle statistics for study. More replicate analyses are recommended to properly quantify the NP/AGP potential of these samples.

Summary of Results

The high definition mineralogical study of the nine waste rock samples identified the following characteristics:

- In the majority of samples, quartz, plagioclase and muscovite are the predominant mineral phases. Calcite levels vary from 0.8 to 6 wt% while dolomite levels vary from 0 to 7 wt%. Fe-sulphides are present in the form of pyrite and appear in trace quantities (0.01 – 0.6 wt%).

- Samples 2010-HR-004 and 2010-HR-095 are different than the others in that chlorite and quartz are the dominant minerals. Of these two samples, calcite is the predominant carbonate in 2010-HR-004 (10 wt%), while dolomite is predominant in 2010-HR-095 (20 wt%). Pyrite is present at trace levels (0.3 and 0.1 wt%, respectively).

- Calcite and dolomite are the main carbonate minerals in these samples. However, sample 2010-HR-095 also contains 4 wt% magnesite. Over 98% of the carbonates occur as either liberated or exposed grains and are amenable to dissolution and neutralization reactions.

- Pyrite was the only Fe-sulphide found in any of the samples. Over 96% of the Fe-sulphides occur as liberated and exposed grains, which suggests that they might be readily oxidized under appropriate conditions. Optical mineralogy indicates that 2010-HR-117 is the only sample in which pyrite shows initial oxidation.

- Based on the QEMSCAN results, all samples show high NP values, suggesting that any acidity produced under oxidizing environments will be sufficiently neutralized in all samples.

Appendix A – QEMSCAN Modes of Operation

QEMSCAN Modes of Operation

QEMSCAN is an acronym for Quantitative Evaluation of Materials by Scanning Electron Microscopy, a system which differs from image analysis systems in that it is configured to measure mineralogical variability based on chemistry at the micrometer-scale. QEMSCAN utilizes both the back-scattered electron (BSE) signal intensity as well as an Energy Dispersive X-ray Signal (EDS) at each measurement point. It thus makes no simplifications or assumptions of homogeneity based on the BSE intensity, as many mineral phases show BSE overlap. EDS signals are used to assign mineral identities to each measurement point by comparing the EDS spectrum against a mineral species identification program (SIP) or database.

There are two general types of measurement: those using the linear intercept and those based on particle mapping. Bulk mineral analysis (BMA) is performed using the linear intercept method, and is used to provide statistically abundant data for speciation and mineral distribution. Particle mapping modes, including Particle Mineral Analysis (PMA), Specific Mineral Search (SMS) analysis and Trace Mineral Search (TMS) analysis provide information on spatial relationships of minerals, including liberation and association data and provide a visual representation of mineral textures. The particle mapping modes of measurement also allow for advanced analysis of the minerals of interest, including grade vs. recovery relationships and mineral release curves. Specific details of the measurement modes are presented below, while visual examples of these two measurement classes are presented in Figures A and B.

Bulk Mineral Analysis, or BMA, is performed by the linear intercept method, in which the electron beam is rastered at a pre-defined point spacing (nominally 3 micrometers, but variable with particle size) along several lines per field, and covering the entire polished section at any given magnification. An example of a BMA measurement image is shown in Figure A. This measurement provides a robust data set for determination of the bulk mineralogy, with mineral identities and proportions, along with grain size measurements.

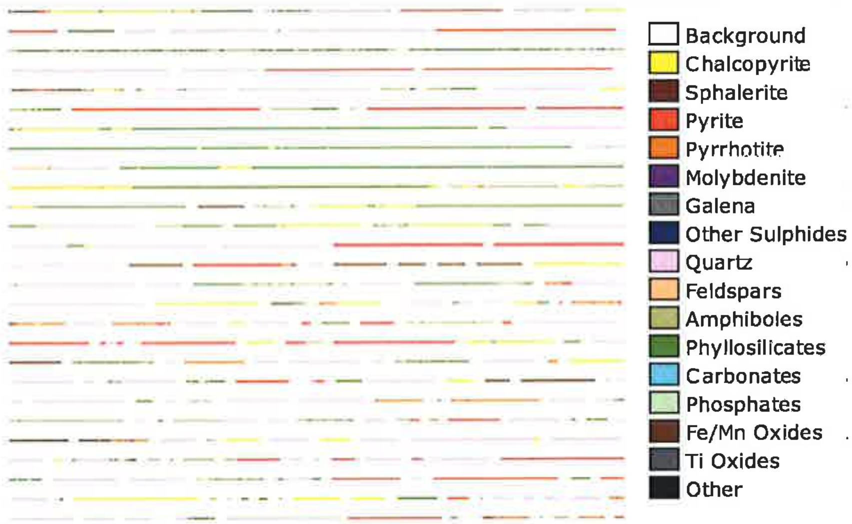


Figure A. BMA Measurement Mode

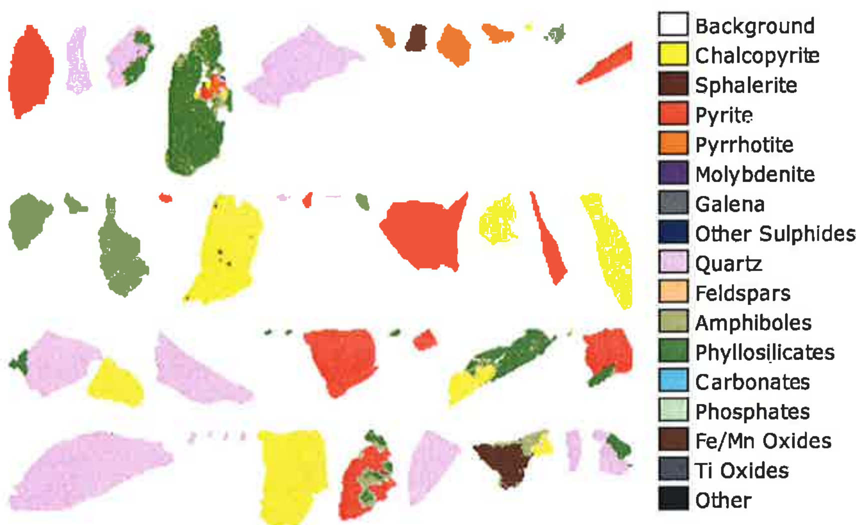


Figure B. Particle Mapping (PMA, SMS or TMS) Measurement Mode

Particle Mineral Analysis (PMA) is a two-dimensional mapping analysis aimed at resolving liberation and locking characteristics of a generic set of particles. A pre-defined number of particles are mapped at a point spacing selected in order to spatially resolve and describe mineral textures and associations. This mode is often selected to characterize concentrate products, as both gangue and value minerals report in statistically abundant quantities to be resolved.

Specific Mineral Search, or SMS, is a modified Particle Mineral Analysis (PMA) routine. However, in an SMS routine, a phase reports as a low-grade constituent and can be located by thresholding of the back-scattered electron intensity. Any accompanying phases of similar and higher brightness are also mapped. For example, this mode of measurement would be selected in ores of low sulphide grade, searching specifically for particles containing sulphide minerals.

Trace Mineral Search (TMS) is an additional mapping routine, where a phase reports as a trace constituent and can be located by thresholding of the back-scattered electron intensity. The objective of this routine is to reject barren fields and increase analysis efficiency. The outputs are otherwise identical to the SMS routine. This mode of measurement is often used for advanced studies of PGE ore types, or trace minerals of interest such as molybdenite.

It is important to note that with regards to SMS and TMS modes, results pertain only to the target minerals. PMA must be selected if quantitative gangue characterization is required. For example, in some sulphide ores, it may be more efficient to reject barren pyrites in favour of copper-bearing minerals. However, it must be noted that data captured in this manner will not reflect the true characteristics of pyrite, as only the pyrite associated with the copper-bearing minerals will be represented.

Appendix B – Certificates of Analysis

SGS

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

Wednesday, April 27, 2011

Golder Associates Limited
Attn : Mallory Drysdale

6700 Century Ave
Mississauga, ON
L5N 6A4,

Phone: 905-567-4444
Fax:905-567-6561

Date Rec. : 11 April 2011
LR Report: CA11192-APR11
Reference: Whole Rock Analysis-Gowest-09-1118-6 010

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Sample ID	SiO2 %	Al2O3 %	Fe2O3 %	MgO %	CaO %	Na2O %	K2O %	TiO2 %	P2O5 %	MnO %	Cr2O3 %	V2O5 %	LOI %	Sum %
5: 11-GW-001	50.9	12.0	15.0	3.91	5.86	2.68	0.19	2.00	0.17	0.24	< 0.01	0.07	7.05	100.0
6: 11-GW-003	50.7	12.6	11.1	3.18	8.56	3.69	0.10	2.11	0.17	0.28	0.01	0.08	6.05	98.6
7: 11-GW-005	47.0	12.5	16.0	4.58	5.73	3.31	0.51	1.77	0.14	0.21	< 0.01	0.06	8.31	100.1
8: 11-GW-007	44.7	8.09	12.1	7.20	12.4	0.65	0.63	1.03	0.07	0.20	0.10	0.04	12.8	100.0
9: 11-GW-009	45.3	11.8	15.7	4.65	6.08	3.27	0.13	1.85	0.13	0.23	0.01	0.08	10.2	99.4
10: 11-GW-011	43.8	11.3	15.8	7.21	7.60	2.05	0.61	1.25	0.10	0.21	0.07	0.04	9.03	99.1
11: 11-GW-013	36.9	7.87	20.3	2.40	7.61	2.35	0.35	0.56	0.07	0.08	0.02	0.02	17.2	95.7
12: 11-GW-015	43.5	11.9	14.7	4.41	7.33	3.05	0.85	1.78	0.11	0.20	0.01	0.09	9.88	97.8
13: 11-GW-016	42.9	11.8	15.6	4.36	5.32	3.09	1.48	1.87	0.11	0.20	< 0.01	0.07	12.4	99.3
14: 11-GW-017	41.1	7.00	10.2	21.7	9.72	0.08	0.02	0.39	0.03	0.18	0.32	0.02	9.61	100.4
15: 11-GW-020	48.0	11.4	15.6	6.87	8.10	3.28	0.55	1.39	0.11	0.19	0.04	0.05	3.44	99.0
16: 11-GW-026	29.3	4.98	27.3	4.08	6.88	0.89	1.35	0.66	0.05	0.22	0.04	0.03	19.1	94.9
17: 11-GW-028	40.8	11.2	14.9	4.83	8.17	2.44	1.22	1.79	0.12	0.23	0.02	0.00	12.1	97.0
18: 11-GW-030	53.5	12.6	15.0	4.41	1.72	5.30	1.18	1.67	0.15	0.50	< 0.01	0.07	4.47	100.6
19: 11-GW-032	49.3	12.3	15.8	5.55	5.70	2.01	0.22	1.93	0.13	0.20	< 0.01	0.08	6.60	99.9
20: 11-GW-038	53.3	12.7	11.7	2.86	6.54	3.30	0.48	2.01	0.15	0.33	< 0.01	0.08	6.26	99.7
21: 11-GW-043	51.9	12.4	11.8	2.92	5.38	3.99	0.75	1.96	0.14	0.23	< 0.01	0.08	7.47	99.0
22: 11-GW-050	43.4	11.1	15.7	3.99	8.88	3.28	0.26	1.65	0.13	0.47	0.02	0.07	9.85	98.9
23: 11-GW-052	43.4	11.1	16.3	3.50	10.2	2.23	0.21	1.75	0.14	0.48	< 0.01	0.07	9.56	98.8
24: 11-GW-054	51.1	7.45	11.8	8.35	8.51	0.01	< 0.01	0.92	0.07	0.24	0.09	0.04	8.17	96.8
25: 11-GW-056	47.8	12.2	16.2	6.80	5.70	2.03	0.40	1.47	0.11	0.23	0.01	0.04	6.33	99.4
26: 11-GW-058	34.5	11.7	10.6	5.63	11.5	5.19	0.12	1.38	0.05	0.29	< 0.01	0.03	16.3	97.3
27: 11-GW-062	44.1	10.6	14.6	3.47	9.97	2.34	0.46	1.64	0.13	0.46	0.03	0.07	10.8	98.7
28: 11-GW-063	41.3	11.2	14.3	4.18	8.60	4.43	0.04	1.68	0.11	0.41	< 0.01	0.07	12.7	98.9
29: 11-GW-066	48.3	13.2	16.0	6.58	5.85	3.24	0.55	1.46	0.12	0.21	0.04	0.04	3.98	99.5
30: 11-GW-067	50.2	12.5	14.8	5.21	7.57	2.91	0.47	1.37	0.11	0.19	0.04	0.04	3.90	99.4
31: 11-GW-068	46.1	12.8	16.0	4.75	6.72	4.33	0.76	1.58	0.14	0.21	< 0.01	0.04	6.01	99.4
32: 11-GW-069	42.1	4.25	14.5	21.7	4.39	0.06	0.16	0.53	0.03	0.15	0.33	0.02	10.9	99.1
33: 11-GW-072	49.3	12.6	14.2	4.55	5.89	3.78	0.08	1.80	0.13	0.16	0.05	0.09	7.68	100.3
34: 11-GW-073	43.6	11.9	15.2	5.24	8.98	2.49	0.45	1.38	0.11	0.20	0.02	0.05	10.0	99.6
35: 11-GW-075	43.0	10.9	12.9	4.37	6.92	5.38	0.55	1.17	0.06	0.18	< 0.01	0.04	9.0	94.4
36: 11-GW-076	31.5	8.23	13.9	4.58	6.38	3.73	0.26	0.39	0.03	0.07	0.05	0.01	30.0	99.1

OnLine LIMS

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LR Report : CA11192-APR11

Sample ID	SiO2 %	Al2O3 %	Fe2O3 %	MgO %	CaO %	Na2O %	K2O %	TiO2 %	P2O5 %	MnO %	Cr2O3 %	V2O5 %	LOI %	Sum %
37: 11-GW-079	48.6	11.9	14.3	2.36	5.30	4.35	0.40	1.95	0.19	0.22	0.01	0.03	9.22	98.8
38: 11-GW-083	43.5	11.4	14.3	8.23	8.62	1.25	0.13	1.25	0.10	0.20	0.06	0.04	9.85	98.9
39: 11-GW-085	10.5	1.44	51.4	0.58	3.23	0.30	0.43	0.05	0.01	0.02	0.02	< 0.01	30.6	98.6
40: 11-GW-086	40.7	5.50	12.7	19.7	9.45	< 0.01	< 0.01	0.66	0.05	0.20	0.46	0.03	9.12	98.6
41: 11-GW-088	48.7	13.5	16.8	4.69	6.70	3.91	0.56	1.65	0.14	0.22	0.01	0.05	3.64	100.5
42: 11-GW-094	50.6	9.64	13.1	1.98	6.13	5.13	0.30	0.82	0.09	0.31	0.02	0.03	7.27	95.4
43: 11-GW-095	50.5	12.6	15.8	4.63	4.88	3.25	0.25	2.02	0.15	0.23	< 0.01	0.08	5.79	100.1
44: 11-GW-097	44.5	10.8	15.6	3.58	5.53	4.99	0.09	1.81	0.14	0.22	0.01	0.06	12.6	99.9

Brian Graham B.Sc.
Project Specialist
Environmental Services, Analytical

OnLine LIMS

Appendix C – X-Ray Diffraction Results

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Qualitative X-Ray Diffraction

Report Prepared for:	*Golder Associates Ltd.*
Project Number/ LIMS No.	*13057-001/MI5049-APR11*
Reporting Date:	*May 19, 2011*

Instrument:	BRUKER AXS D8 Advance Diffractometer
Test Conditions:	Co radiation, 40 kV, 35 mA Regular Scanning: Step: 0.02°, Step time:0.2s, 2θ range: 3-70°
Interpretations:	PDF2/PDF4 powder diffraction databases issued by the International Center for Diffraction Data (ICDD). DiffracPlus Eva software.
Detection Limit:	0.5-2%. Strongly dependent on crystallinity.

Contents:

1) Method Summary
2) Summary of Mineral Asemblages
3) XRD Pattern(s)

Bernie C. Yeung, B. Sc.
Mineralogist

Huyun Zhou, Ph.D
Senior Mineralogist

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P.O. Box 4300, 185 Concession Street, Lakefield, Ontario, Canada K0L 2H0
Tel: (705) 652-2000 Fax: (705) 652-6365 www.sgs.com www.sgs.com/met
Member of the SGS Group (SGS SA)

SGS

Method Summary

Mineral Identification and Interpretation:

Mineral identification and interpretation involve matching the diffraction pattern of an unknown material to patterns of single-phase reference materials. The reference patterns are compiled by the Joint Committee on Powder Diffraction Standards - International Center for Diffraction Data (JCPDS-ICDD) database and released on software as Powder Diffraction Files (PDF).

Interpretations do not reflect the presence of non-crystalline and/or amorphous compounds. Mineral proportions are based on relative peak heights and may be strongly influenced by crystallinity, structural group or preferred orientations. Interpretations and relative proportions should be accompanied by supporting petrographic and geochemical data (Whole Rock Analysis, Inductively Coupled Plasma - Optical Emission Spectroscopy, etc.).

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13057-001/MI5049-APR11
05/19/2011

Summary of Qualitative X-ray Diffraction Results

Crystalline Mineral Assemblage (relative proportions based on peak height)

Sample	Major	Moderate	Minor	Trace
(1) 2010-HR-004	quartz	chlorite, calcite	plagioclase, dolomite, epidote, titanite	*potassium feldspar
(2) 2010-HR-005	quartz	plagioclase	potassium feldspar, chlorite, dolomite, mica	*calcite, *epidote
(3) 2010-HR-027	quartz	plagioclase	calcite, mica, chlorite	*pyrite
(4) 2010-HR-065	quartz	plagioclase	dolomite, mica chlorite, calcite	*potassium feldspar
(5) 2010-HR-067	quartz	plagioclase	dolomite, mica, calcite	*potassium feldspar, *chlorite
(6) 2010-HR-086	quartz	plagioclase	calcite, chlorite, mica	*potassium feldspar
(7) 2010-HR-091	quartz	plagioclase	calcite, chlorite, mica, dolomite	*potassium feldspar, *pyrite
(8) 2010-HR-095	quartz, dolomite	magnesite	chlorite, talc, magnetite	*potassium feldspar, *ilmenite, *rutile
(9) 2010-HR-117	quartz, plagioclase	-	calcite, mica, chlorite	-

** tentative identification due to low concentrations, diffraction line overlap or poor crystallinity*

Mineral	Composition
Calcite	$CaCO_3$
Chlorite	$(Fe,(Mg,Mn)_5,Al)(Si_3Al)O_{10}(OH)_8$
Dolomite	$CaMg(CO_3)_2$
Epidote	$Ca_2(Al,Fe)Al_2O(SiO_4)(Si_2O_7)(OH)$
Ilmenite	$FeTiO_3$
Magnesite	$MgCO_3$
Magnetite	Fe_3O_4
Mica	$K(Mg,Fe)Al_2Si_3AlO_{10}(OH)_2$
Plagioclase	$(NaSi,CaAl)AlSi_2O_8$
Potassium Feldspar	$KAlSi_3O_8$
Pyrite	FeS_2
Quartz	SiO_2
Rutile	TiO_2
Talc	$Mg_3Si_4O_{10}(OH)_2$
Titanite	$CaTiSiO_5$

The Qualitative XRD method (METH # 8-8-1) used by SGS Minerals Services, P.O. Box 4300, 185 Concession Street, Lakefield, Ontario, Canada K0L 2H0
Tel: (705) 652-2000 Fax (705) 652-6365 Mini-method available upon request.

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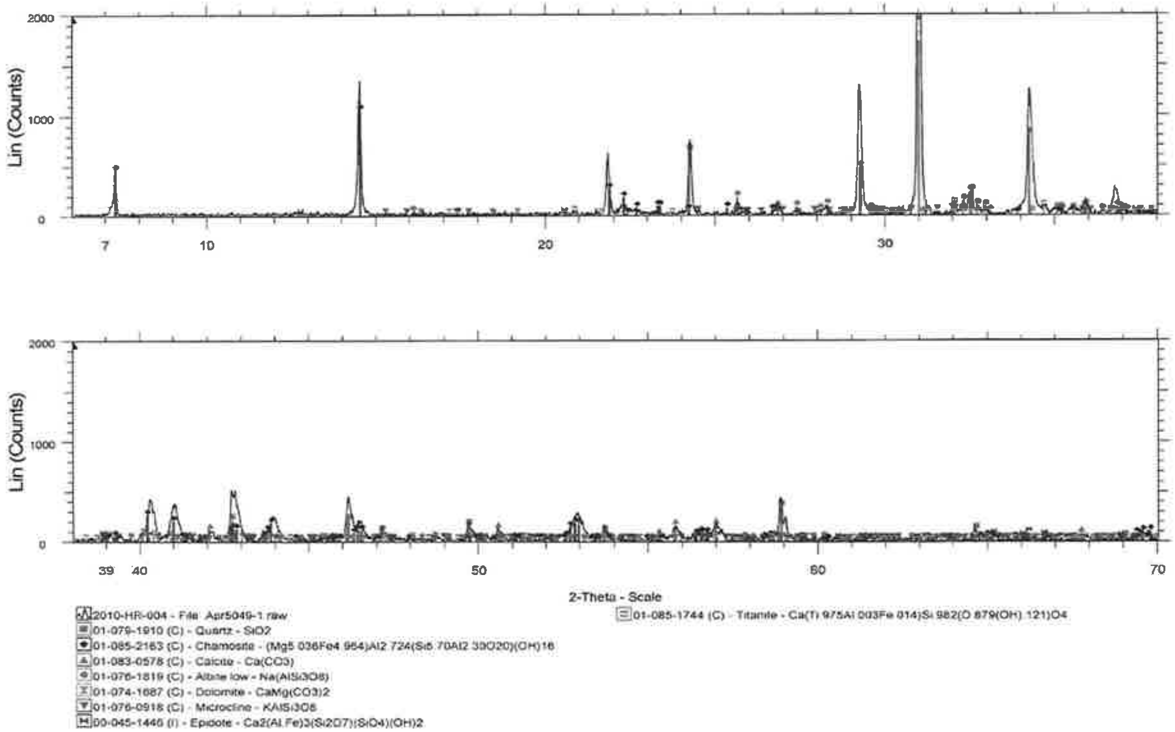
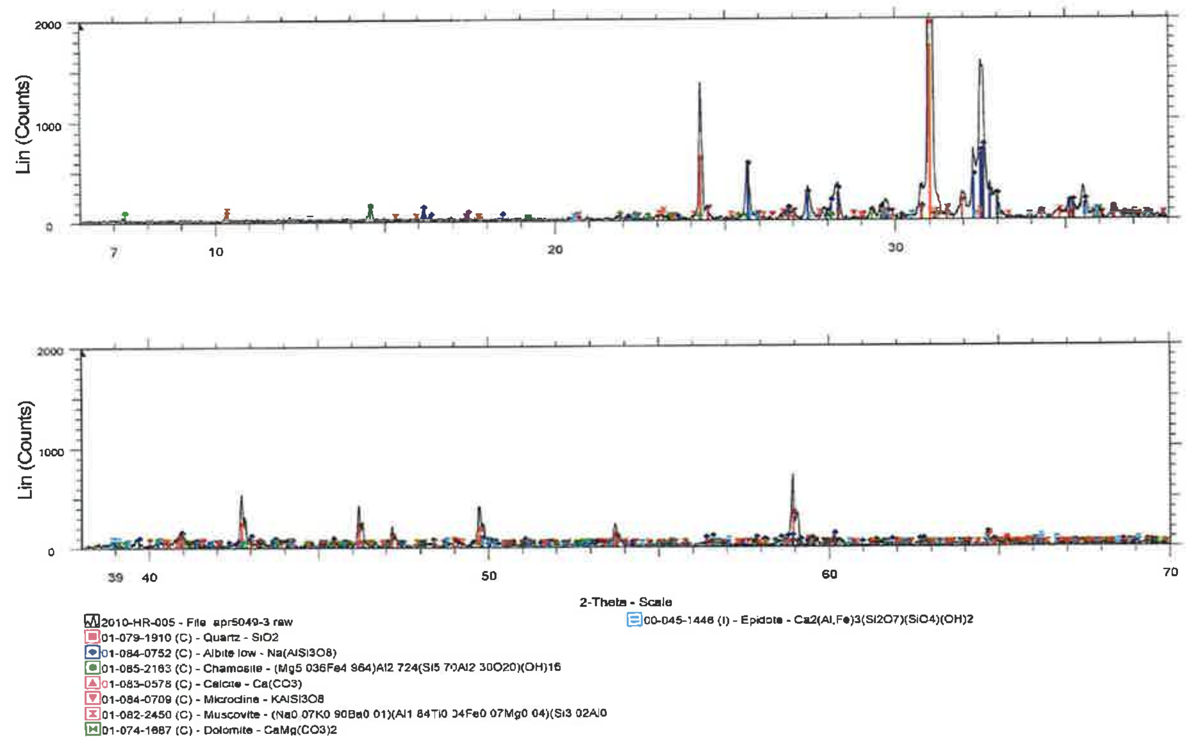
05/19/2011

2010-HR-004

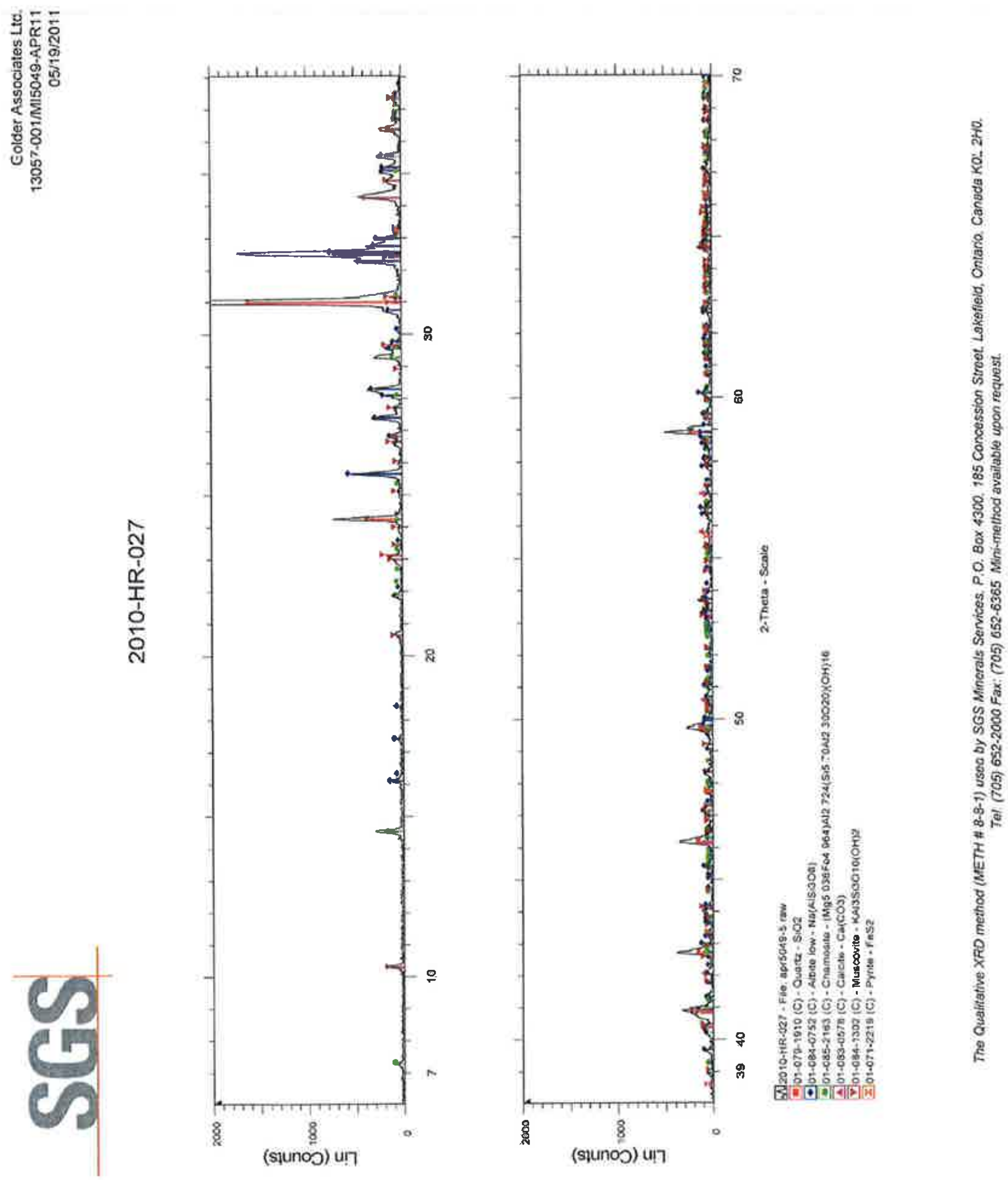


The Qualitative XRD method (METH # 8-8-1) used by SGS Minerals Services, P.O. Box 4300, 185 Concession Street, Lakefield, Ontario, Canada K0L 2H0.
Tel: (705) 652-2000 Fax: (705) 652-6365 Mini-method available upon request.

2010-HR-005



The Qualitative XRD method (METH # 8-8-1) used by SGS Minerals Services, P.O. Box 4300, 185 Concession Street, Lakefield, Ontario, Canada K0L 2H0.
Tel: (705) 652-2000 Fax: (705) 652-6365 Mini-method available upon request.


Golder Associates Ltd.
13057-001/MI5049-APR11
05/19/2011
2010-HR-027
Lin (Counts)
2-Theta - Scale
2010-HR-027 - File: apr5049-5.raw
01-079-1910 (C) - Quartz - SiO2
01-084-0752 (C) - Albite low - Na(AlSi3O8)
01-085-2163 (C) - Chamosite
01-083-0578 (C) - Calcite - Ca(CO3)
01-084-1302 (C) - Muscovite - KAl3Si3O10(OH)2
01-071-2219 (C) - Pyrite - FeS2
The Qualitative XRD method (METH # 8-8-1) used by SGS Minerals Services, P.O. Box 4300, 185 Concession Street, Lakefield, Ontario, Canada K0L 2H0.
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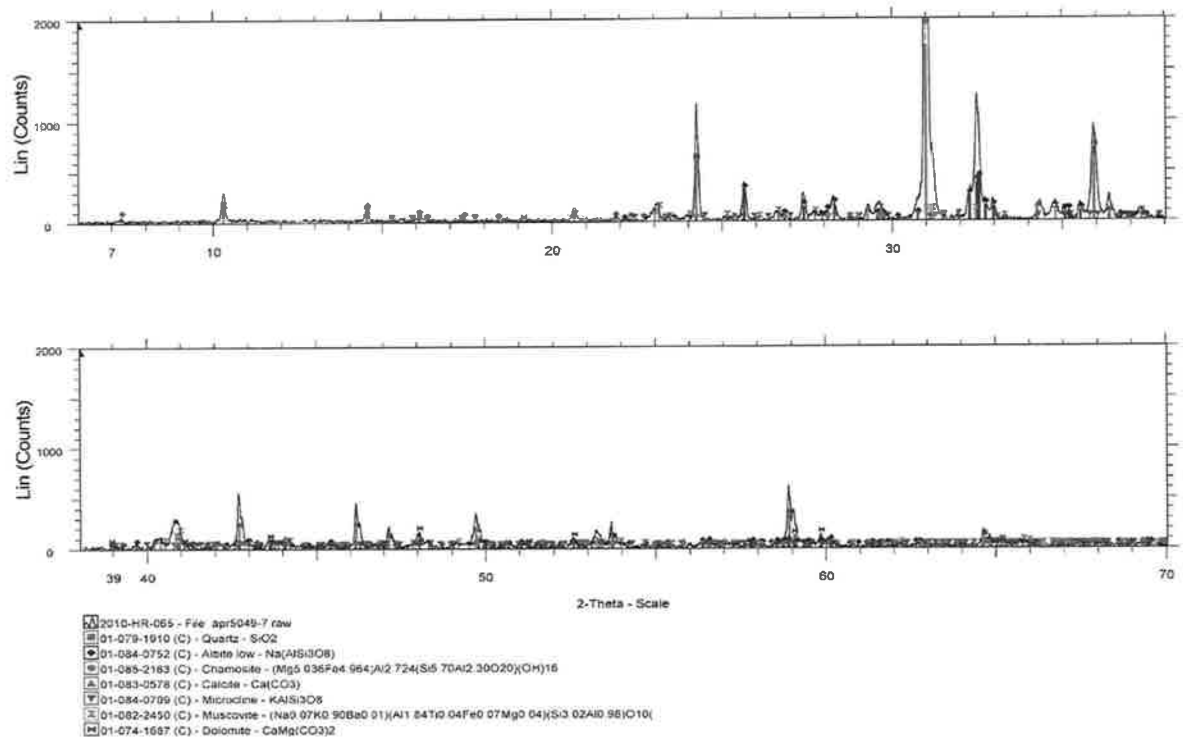
2010-HR-065



The Qualitative XRD method (METH # 8-8-1) used by SGS Minerals Services, P.O. Box 4300, 185 Concession Street, Lakefield, Ontario, Canada K0L 2H0.
Tel: (705) 652-2000 Fax: (705) 652-6365 Mini-method available upon request.

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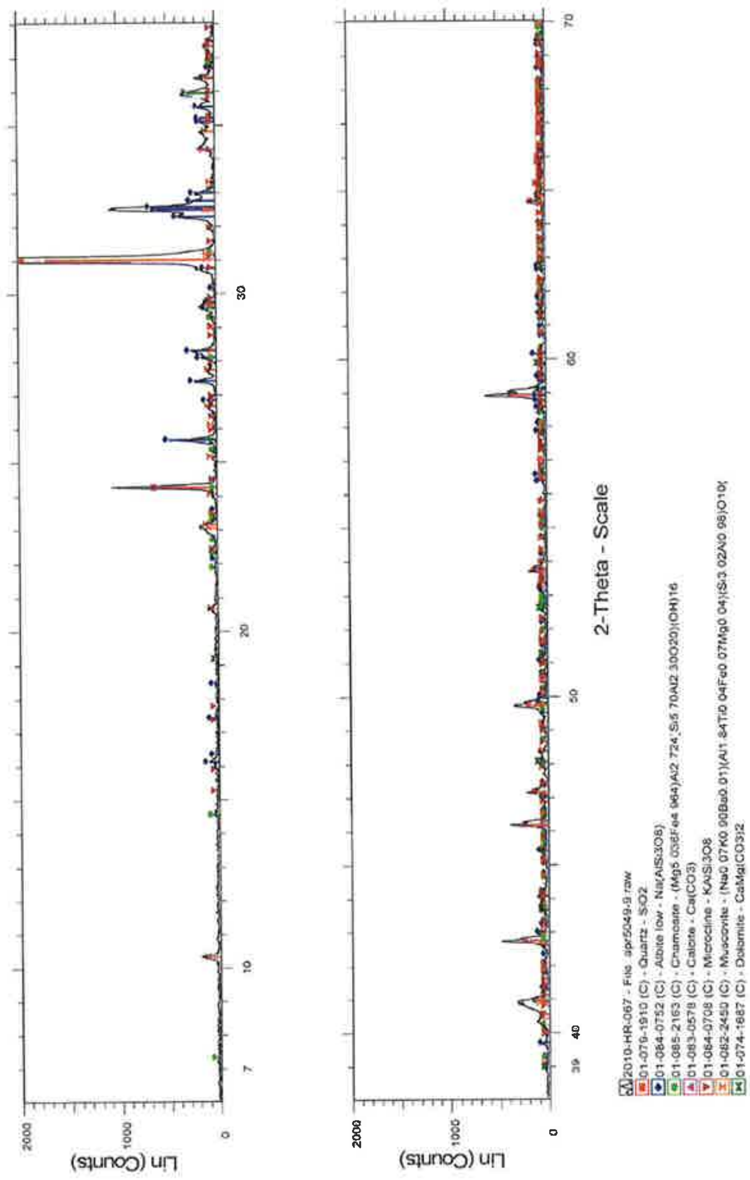
2010-HR-067



The Qualitative XRD method (METH # 8-8-1) used by SGS Minerals Services, P.O. Box 4300, 185 Concession Street, Lakefield, Ontario, Canada K0L 2H0.
Tel: (705) 652-2000 Fax: (705) 652-6365 Mini-method available upon request.

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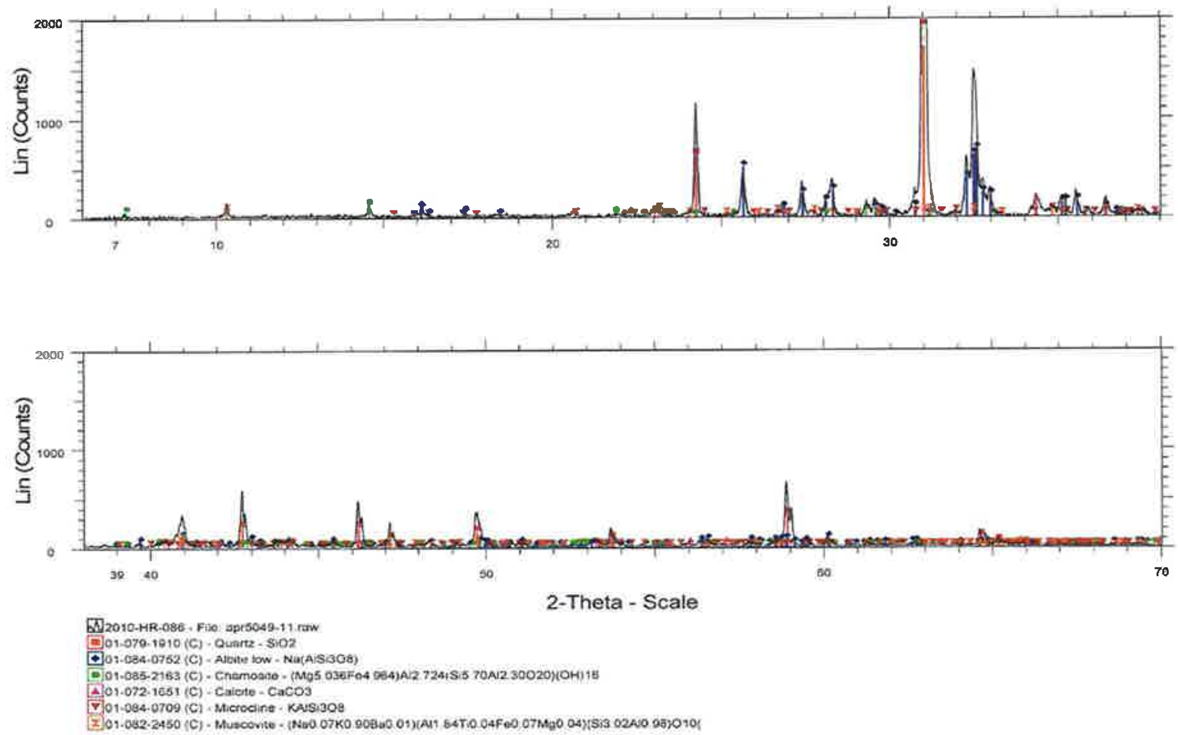
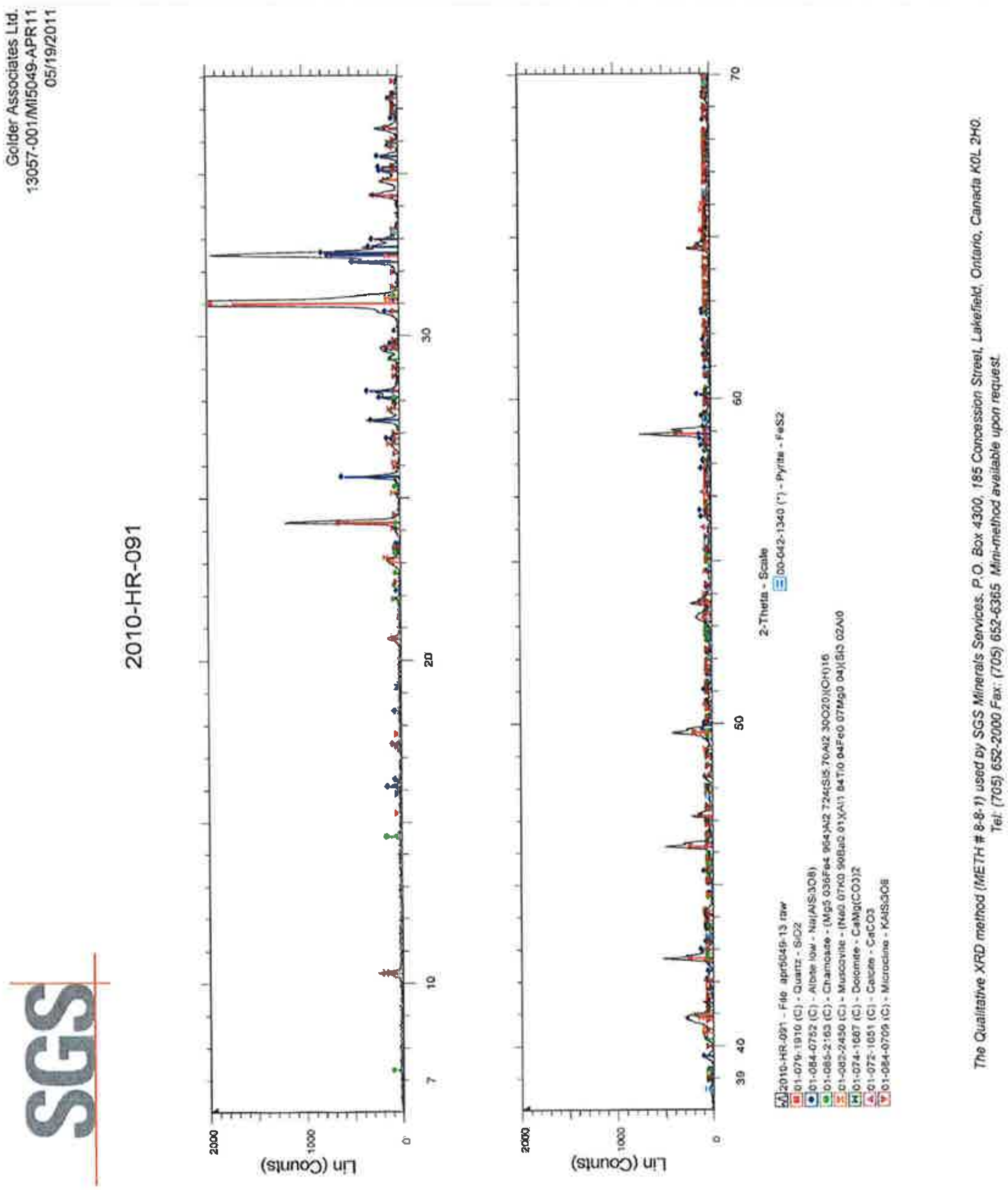
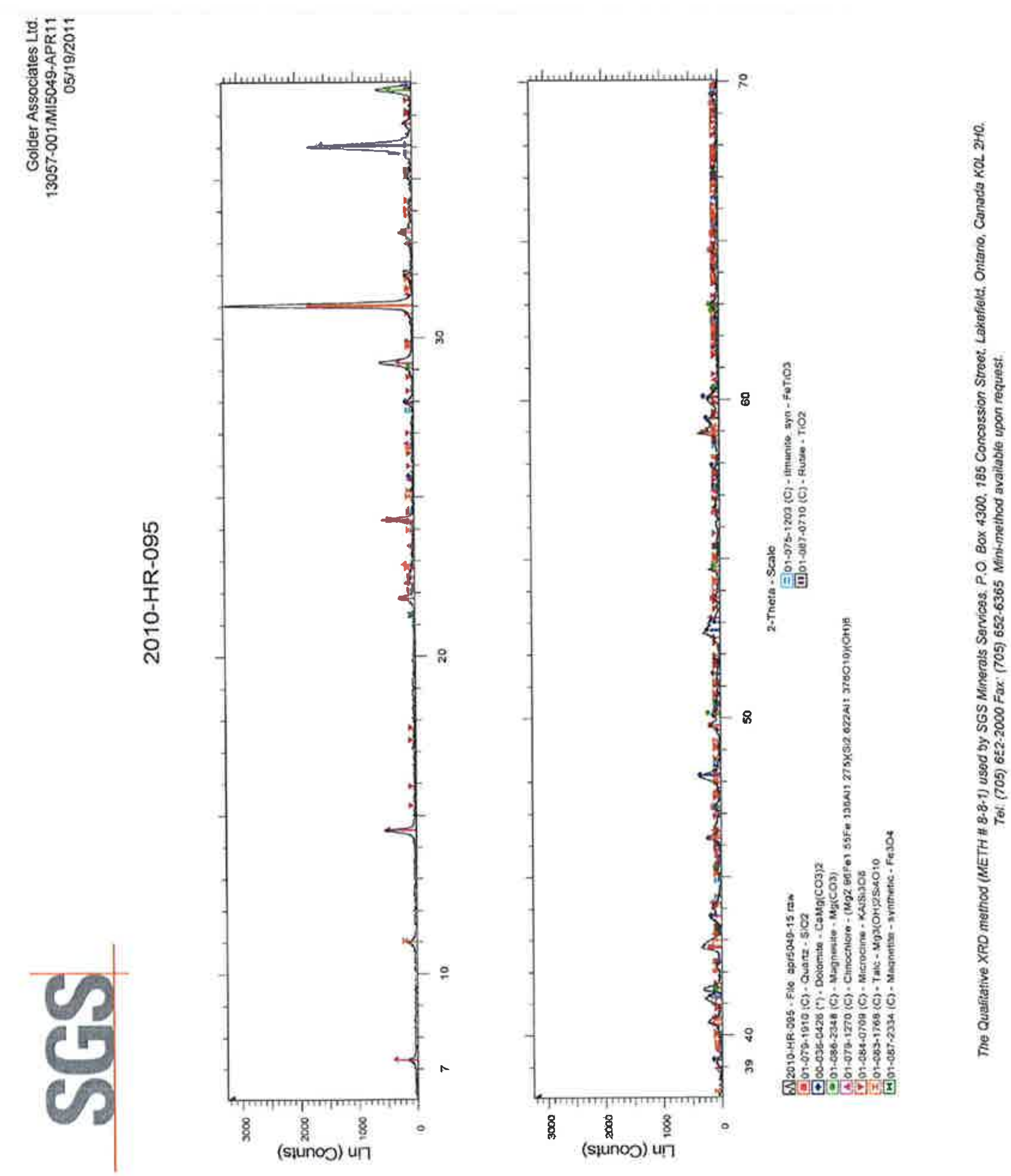
13057-001/MI5049-APR11
05/19/2011

2010-HR-086



The Qualitative XRD method (METH # 8-8-1) used by SGS Minerals Services, P.O. Box 4300, 185 Concession Street, Lakefield, Ontario, Canada K0L 2H0.
Tel: (705) 652-2000 Fax: (705) 652-6365 Mini-method available upon request.


Golder Associates Ltd.
13057-001/MI5049-APR11
05/19/2011
2010-HR-091
Lin (Counts)
2-Theta - Scale
The Qualitative XRD method (METH # 8-8-1) used by SGS Minerals Services, P.O. Box 4300, 185 Concession Street, Lakefield, Ontario, Canada K0L 2H0.
Tel: (705) 652-2000 Fax: (705) 652-6365 Mini-method available upon request.


SGS
Golder Associates Ltd.
13057-001/MI5049-APR11
05/19/2011
2010-HR-095
Lin (Counts)
2-Theta - Scale
2010-HR-095 - File: apr5049-15.raw
01-079-1910 (C) - Quartz - SiO2
00-036-0426 (*) - Dolomite - CaMg(CO3)2
01-086-2348 (C) - Magnesite - Mg(CO3)
01-084-0709 (C) - Microcline - KAlSi3O8
01-083-1768 (C) - Talc - Mg3(OH)2Si4O10
01-087-2334 (C) - Magnetite - synthetic - Fe3O4
01-075-1203 (C) - Ilmenite, syn - FeTiO3
01-087-0710 (C) - Rutile - TiO2
The Qualitative XRD method (METH # 8-8-1) used by SGS Minerals Services, P.O. Box 4300, 185 Concession Street, Lakefield, Ontario, Canada K0L 2H0.
Tel: (705) 652-2000 Fax: (705) 652-6365 Mini-method available upon request.

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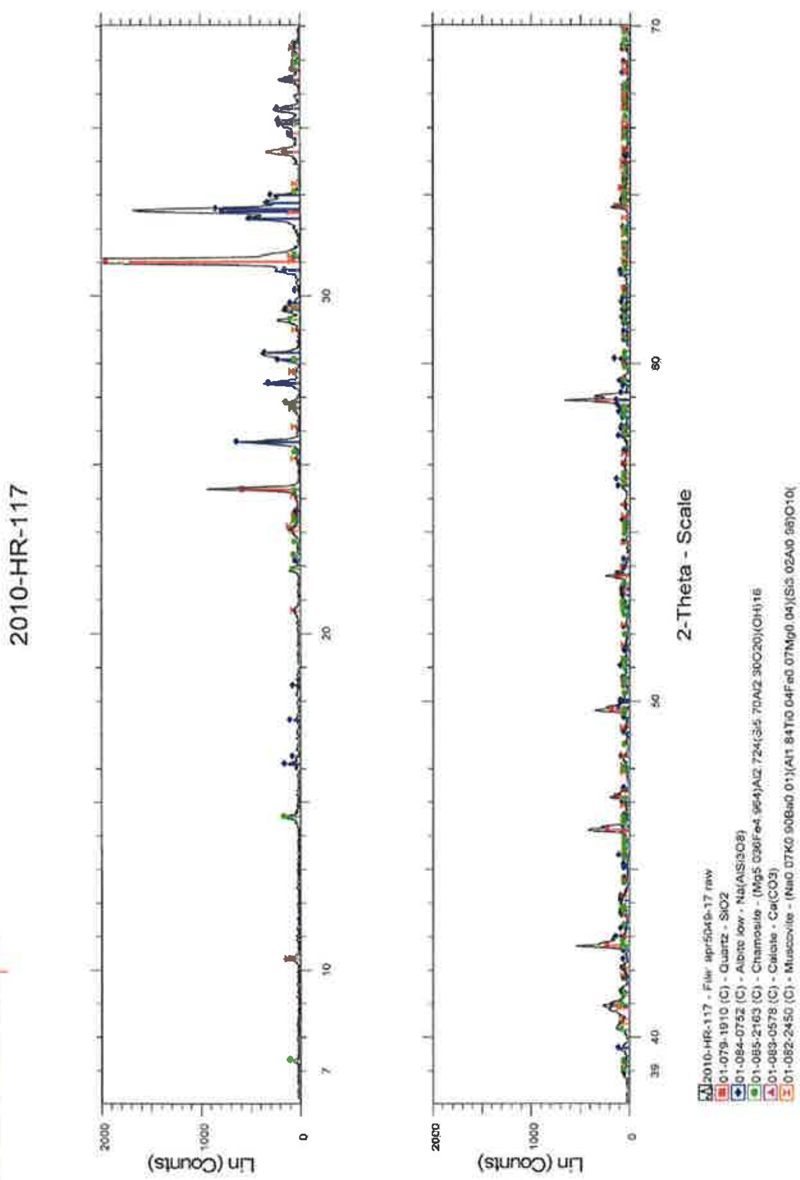

The Qualitative XRD method (METH # 8-8-1) used by SGS Minerals Services, P.O. Box 4300, 185 Concession Street, Lakefield, Ontario, Canada K0L 2H0.
Tel: (705) 652-2000 Fax: (705) 652-6365 Mini-method available upon request.

Appendix D – Photomicrographs

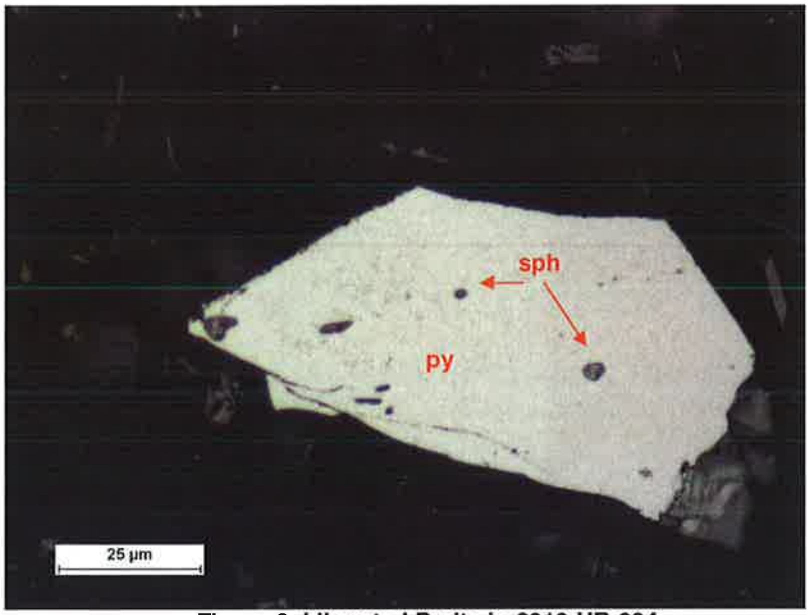

Figure 8. Liberated Pyrite in 2010-HR-004

Plane-polarized reflected light (PPRL) photomicrograph of a liberated grain of pyrite (py) with fine inclusions of sphalerite (sph).

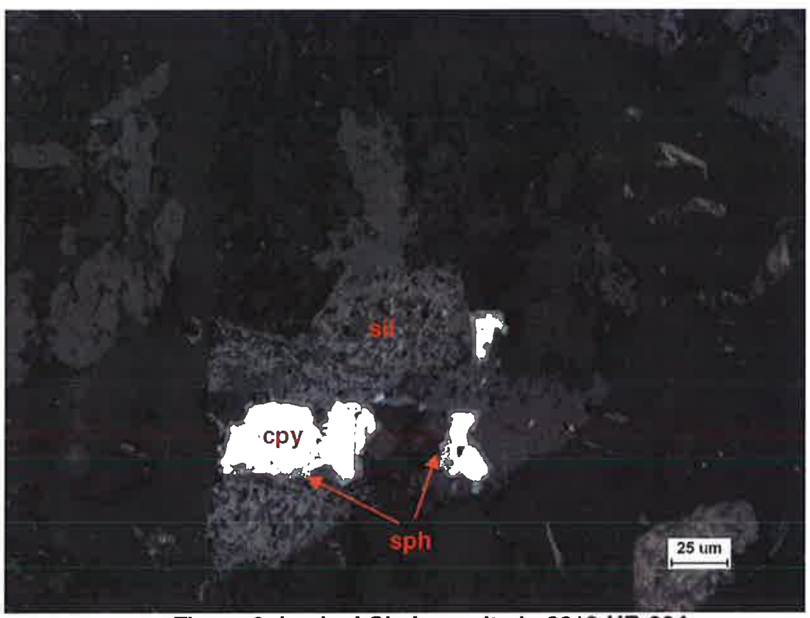

Figure 9. Locked Chalcopyrite in 2010-HR-004

PPRL photomicrograph of silicate (sil) particles enclosing chalcopyrite (cpy) grains. The chalcopyrite grains are rimmed by sphalerite (sph).

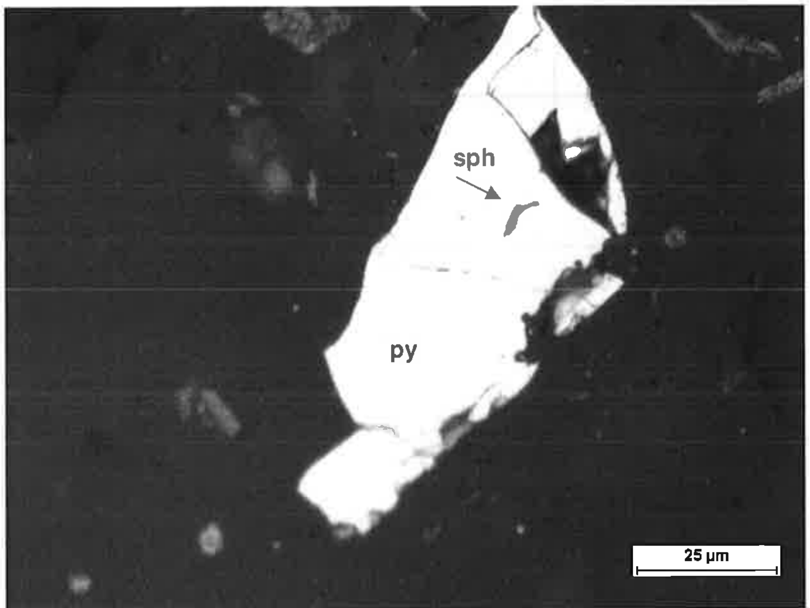

Figure 10. Liberated Pyrite in 2010-HR-005

PPRL photomicrograph of liberated pyrite (py) containing a fine inclusion of sphalerite (sph).

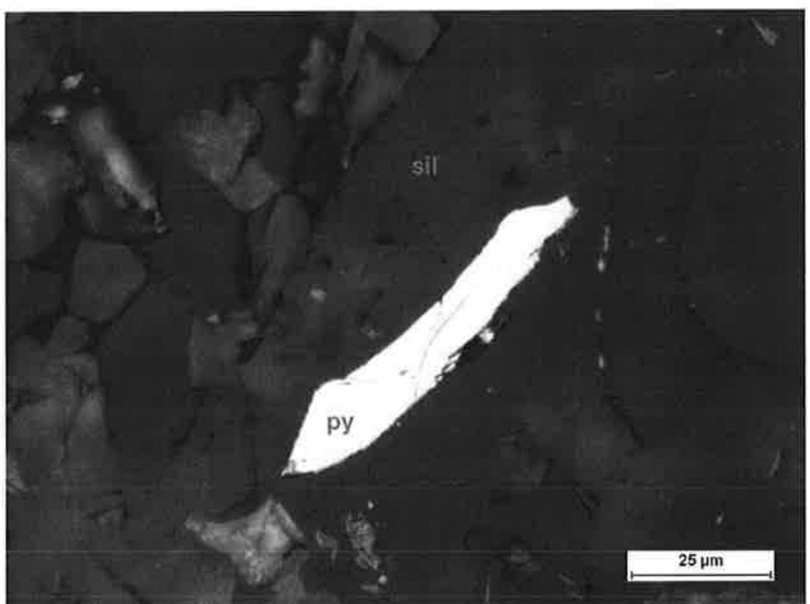

Figure 11. Locked Pyrite in 2010-HR-005

PPRL photomicrograph of pyrite (py) locked in silicate (sil).

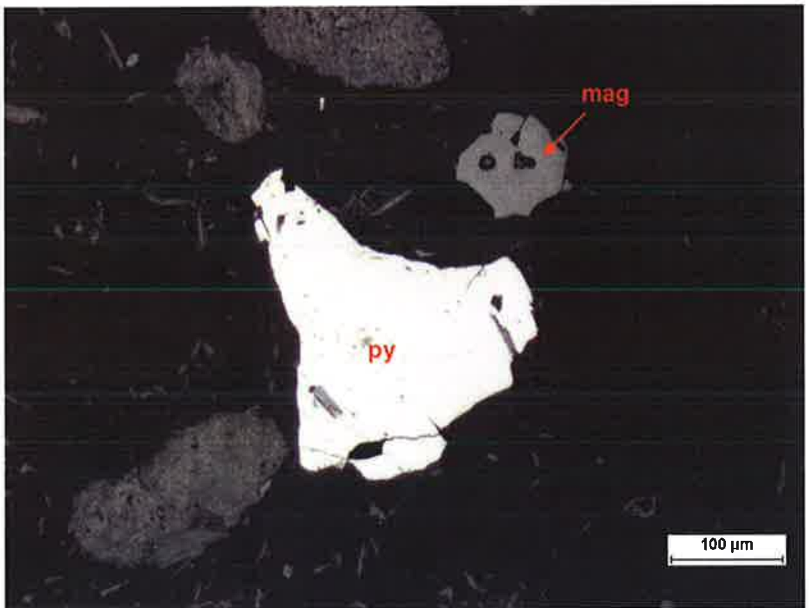

Figure 12. Liberated Pyrite in 2010-HR-027

PPRL photomicrograph of liberated pyrite (py) and adjacent magnetite (mag).

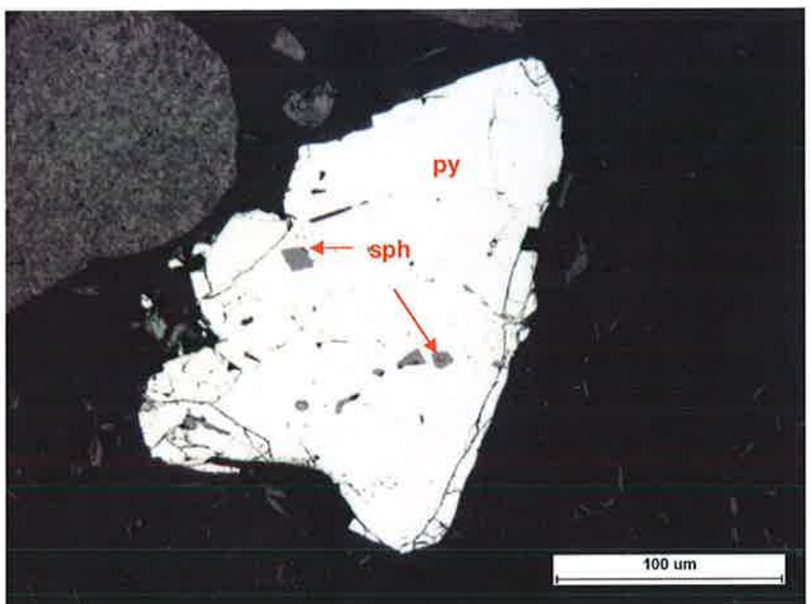

Figure 13. Liberated Pyrite in 2010-HR-027

PPRL photomicrograph of liberated pyrite (py) containing fine inclusions of sphalerite (sph).

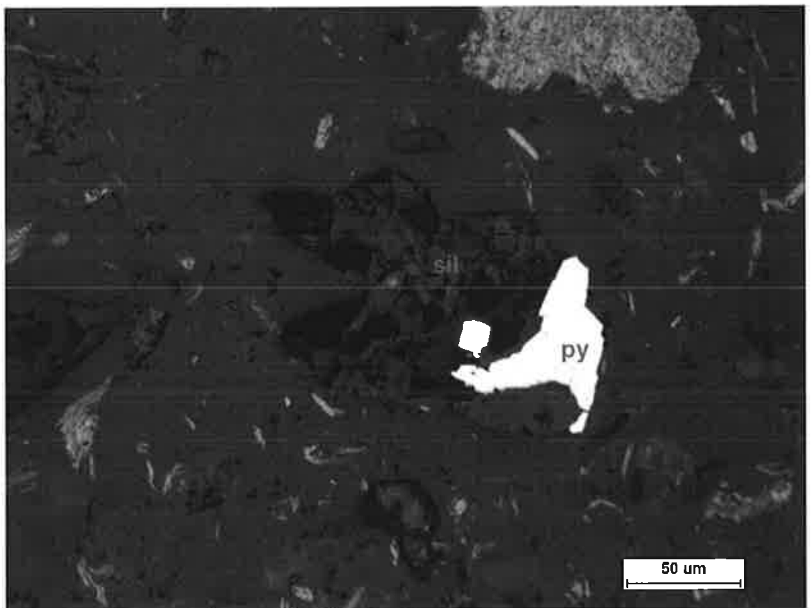

Figure 14. Attached Pyrite in 2010-HR-065

PPRL photomicrograph of a grain of pyrite (py) attached to silicate (sil).

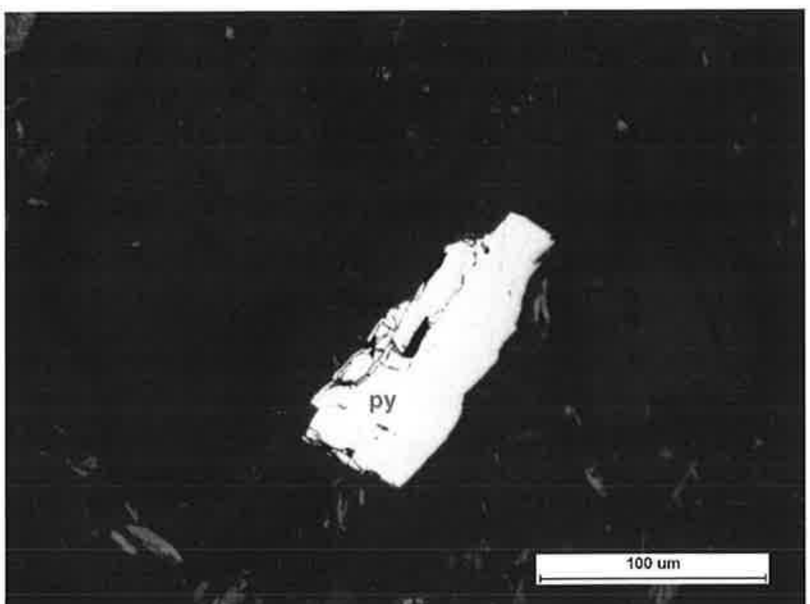

Figure 15. Liberated Pyrite in 2010-HR-065

PPRL photomicrograph of liberated pyrite (py).

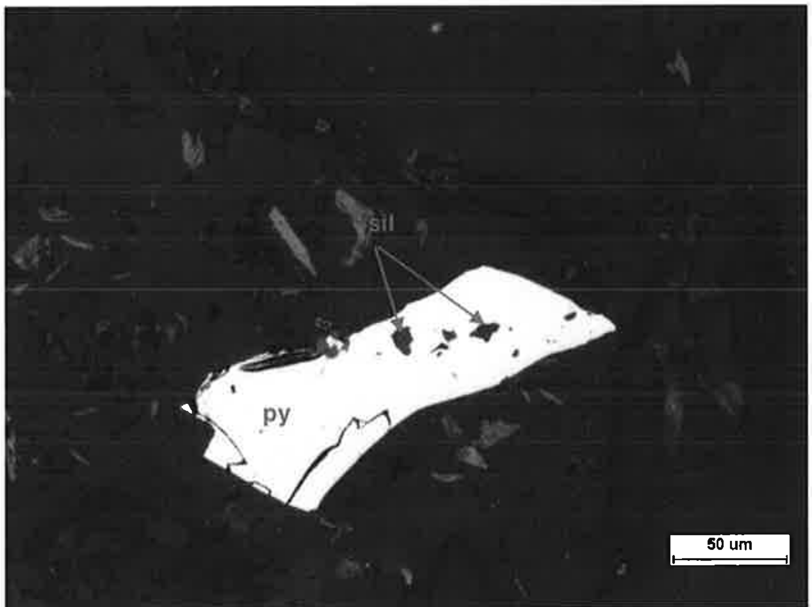

Figure 16. Liberated Pyrite in 2010-HR-067

PPRL photomicrograph of liberated particle of pyrite (py) with locked silicate (sil) grains.

Figure 17. Binary Pyrite in 2010-HR-067

PPRL photomicrograph of binary pyrite-silicate particle.

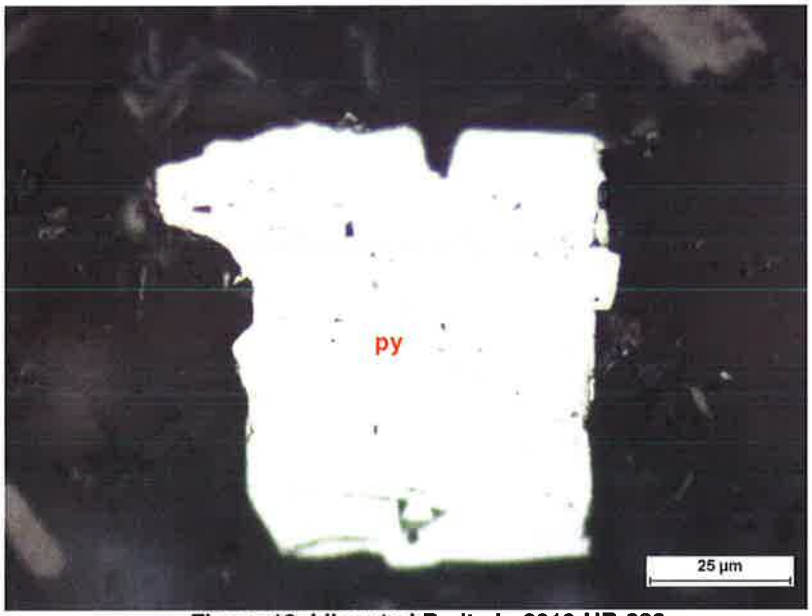

Figure 18. Liberated Pyrite in 2010-HR-086

PPRL photomicrograph of a liberated particle of pyrite.

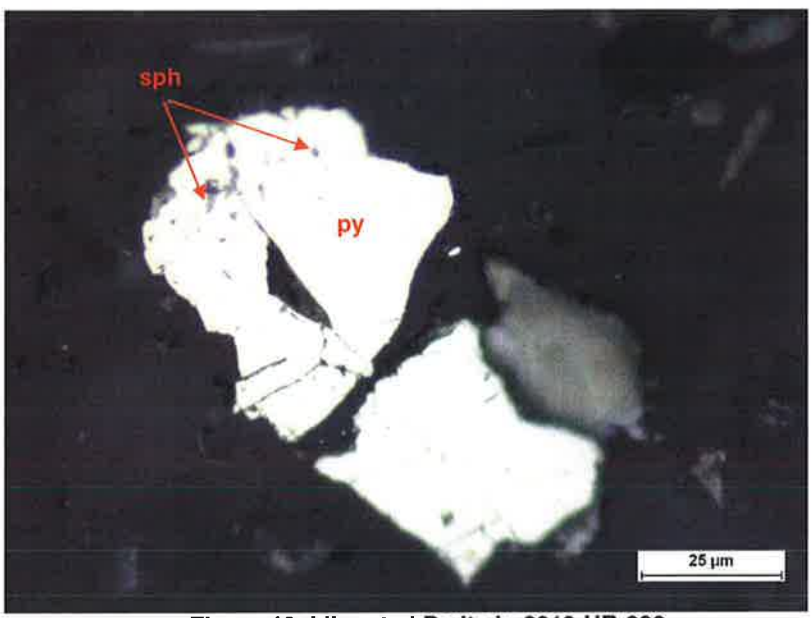

Figure 19. Liberated Pyrite in 2010-HR-086

PPRL photomicrograph of liberated pyrite (py) containing small grains of sphalerite (sph).

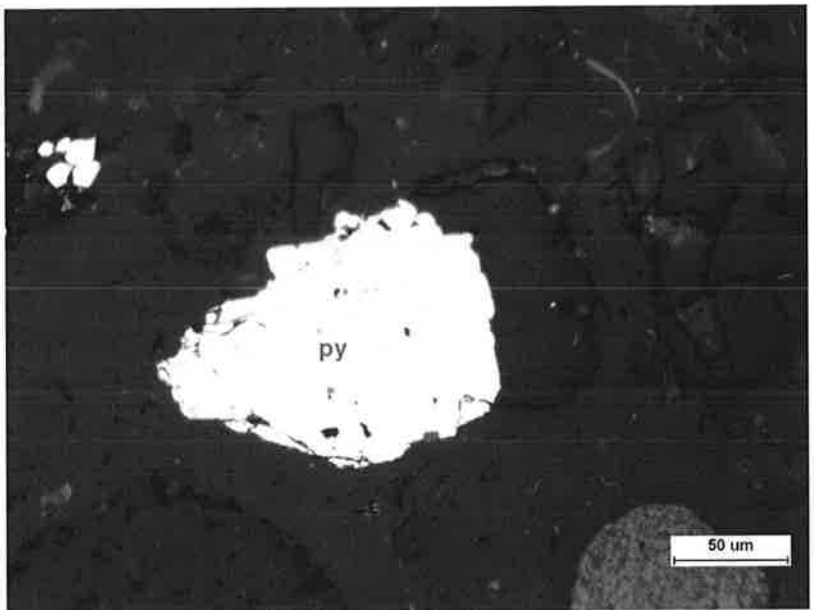

Figure 20. Liberated Pyrite in 2010-HR-091

PPRL photomicrograph of a liberated particle of pyrite.

Figure 21. Liberated Pyrite in 2010-HR-091

PPRL photomicrograph of a liberated particle of pyrite.

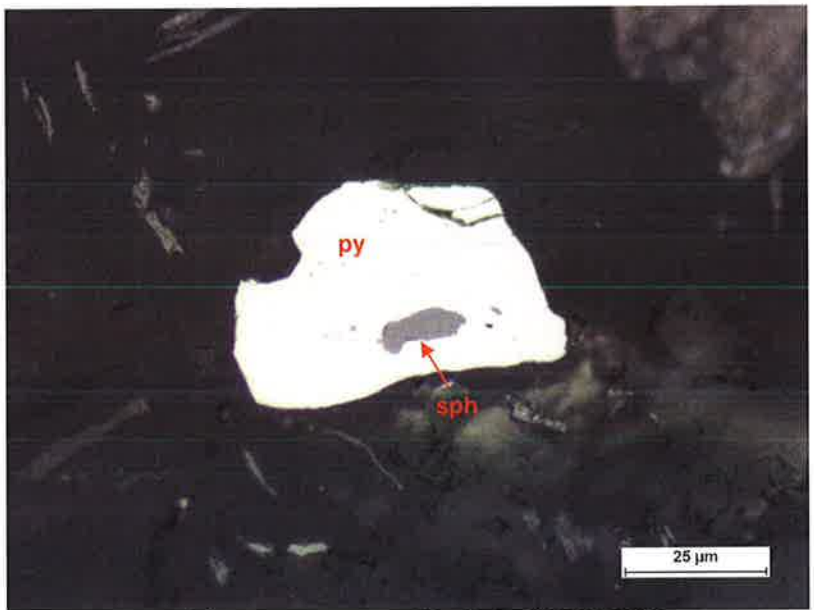

Figure 22. Liberated Pyrite in 2010-HR-095

PPRL photomicrograph of liberated particle of pyrite (py) with locked sphalerite (sph).

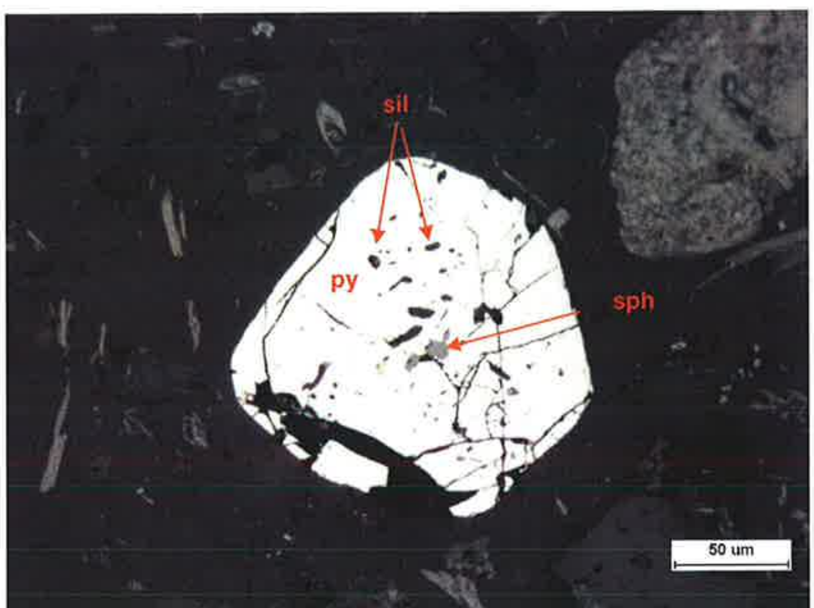

Figure 23. Liberated Pyrite in 2010-HR-095

PPRL photomicrograph of liberated particle of pyrite (py) with locked silicates (sil) and sphalerite (sph).

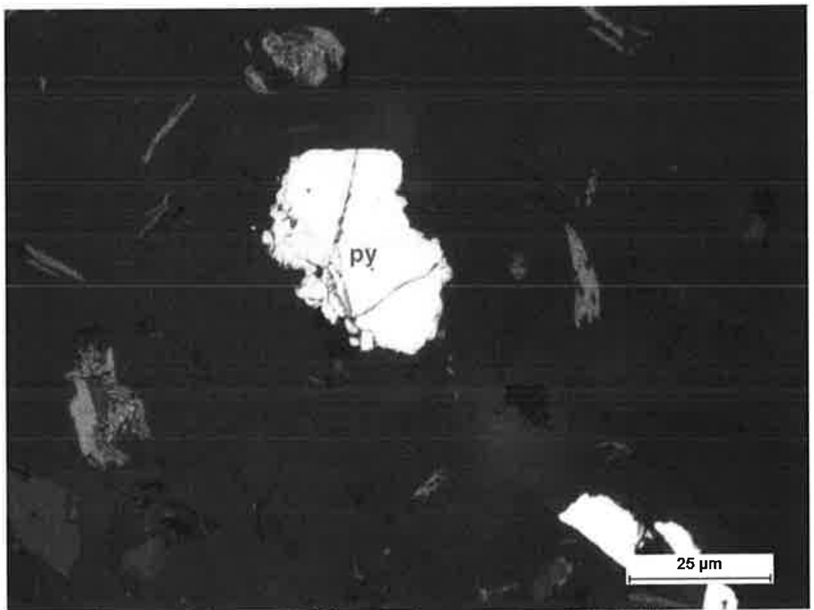

Figure 24. Liberated Pyrite in 2010-HR-117

PPRL photomicrograph of liberated particle of pyrite showing uneven edges which may be indicative of oxidation.

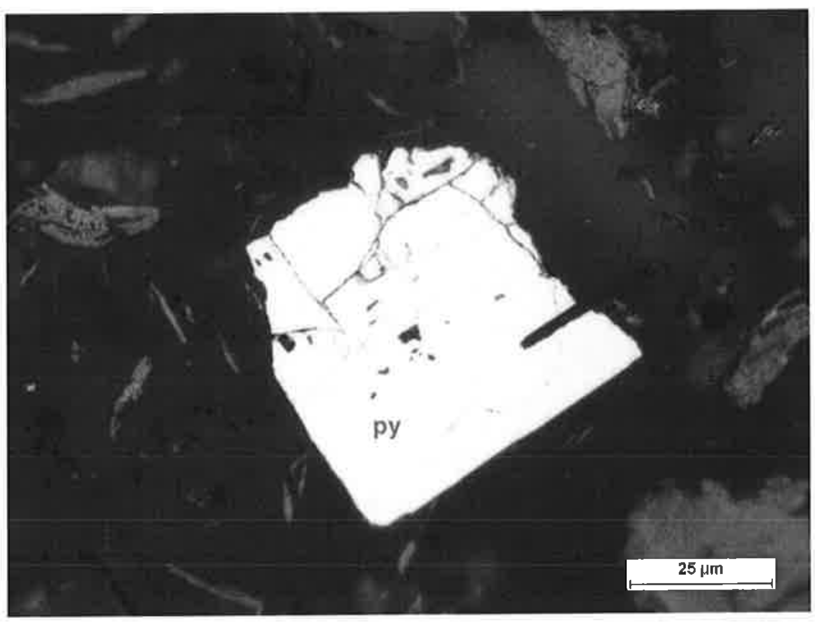

Figure 25. Liberated Pyrite in 2010-HR-117

PPRL photomicrograph of liberated particle of pyrite showing uneven edges which may be indicative of oxidation.