Geochemical Characterization in Support of the Final Environmental Impact Statement (FEIS) for the Back River Project, Nunavut

Prepared for

Sabina Gold & Silver Corp.

Prepared by

SRK Consulting (Canada) Inc.
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November 2015

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Executive Summary

Detailed geochemical characterization studies were completed to determine the metal leaching/acid rock drainage (ML/ARD) potential of the overburden, quarry rock, waste rock, tailings, and mine workings. The results are summarized as follows:

Overburden

The overburden test program included acid base accounting (ABA) and trace element analyses (static tests) on 21 samples from the Goose Property, and a shake flask extraction (SFE) test and mineralogical characterization on one of those samples.

The results indicate that overburden samples from the Goose Property have a negligible potential for ML/ARD.

Quarry Rock at the Goose Property

Construction rock for infrastructure development at the Goose Property will be sourced from the existing quarry near the Goose airstrip (Airstrip quarry) and/or from within the footprint of the Umwelt open pit (Umwelt quarry). This Airstrip quarry is within the current Quarry Permit Boundary KTP11Q001.

Geochemical characterization of quarry rock included ABA and trace element analyses on 40 samples from the Airstrip quarry, and 16 samples representing the Umwelt quarry.

The Airstrip quarry is comprised mainly of a series of turbiditic meta-sedimentary rocks (greywacke and mudstone) with minor amounts of banded iron formation, large intrusive gabbro dykes, and smaller felsic to intermediate dykes. Results indicate that rock from the Airstrip quarry has a variable potential for ARD. Gabbro is generally non-potentially acid generating (NPAG), iron formation is potentially acid generating (PAG), and the other rock types (mainly greywacke and mudstone) include a mixture of material that is PAG, NPAG, or that has an uncertain potential for ARD. Based on these results, Sabina has committed to complete further testing within the existing quarry footprint to further delineate PAG materials in advance of or concurrent with sourcing additional material from this quarry. Similar findings were made for other excavation areas at the Property. However, the volume of material from those areas is expected to be very small.

The Umwelt quarry areas were selected to be entirely within the upper greywacke unit. The majority of these unit samples are classified as NPAG or low sulfide (S) material with a limited potential for ARD. Therefore, no special management measures are required.

Based on analogous samples tested as part of the waste rock characterization program (Section 5.4.2), contact water associated with quarry rock from both the Airstrip quarry and the Umwelt quarry area is expected to contain slightly elevated levels of arsenic, and arsenic loading from this material has been considered in the overall assessment of environment effects. Results from the water and load balance indicate that infrastructure constructed using this material is a relatively minor source of arsenic loading in comparison to the WRSAs or the tailings storage

facility (TSF), and that no specific water management will be required to control arsenic loading from the quarry rock.

Quarry Rock at the MLA

Preliminary geochemical characterization was completed on surface outcrop samples representing quarry rock that will be excavated during construction of the MLA Fuel Storage Farm. These samples were described as weathered quartzite conglomerate and quartz arenite/quartzite (sandstone). The test results showed that these materials have a negligible potential for ML/ARD. It is recommended that additional sampling and testing be completed in advance of development to represent materials from greater depths.

Waste Rock

Testing of waste rock included ABA and trace element analyses on a total of 676 samples representing the Goose Property deposits. Mineralogical characterization, net acid generation (NAG) tests, and humidity cell tests and field barrel tests (kinetic tests) were also completed on a representative subset of these samples.

Figure A shows the distribution of waste rock samples classified as PAG, uncertain, NPAG, or low S in each of the main stratigraphic units by deposit. The results indicate that an appreciable proportion of the waste rock is PAG or has an uncertain potential for ARD. The Umwelt, Llama, and Echo deposits have the highest proportion of PAG and uncertain material, while the Goose Main deposit has the lowest proportion. PAG and uncertain waste rock is found in all of the stratigraphic units, but tends to be more common in the lower iron formation (LIF) and the upper iron formation (UIF) units, and is less common in the gabbro (GAB). The LIF and UIF units also tended to have higher concentrations of sulphides. The humidity cell tests indicate that ML is greatly enhanced when acidic conditions are allowed to develop. Therefore, specific measures will be required to control ML/ARD potential in the PAG waste rock. For management purposes, waste rock that is PAG or has an uncertain potential for ARD will be treated as PAG material, and waste rock that is NPAG or has a low S content will be treated as NPAG material. Estimates of PAG/NPAG waste rock quantities were developed for use in the Back River Feasibility Study (the Project) and are presented in Table A.

- Preliminary calculations indicate that acidic conditions are not expected to develop in the majority (>95%) of the waste rock during the approximately 10-year freeze back period. Although acidic conditions could occur more rapidly in some of the waste rock, average pH conditions in seepage and runoff would be expected to remain buffered until WRSA freeze back conditions develop.

Table A: Quantities and Proportions of Waste Rock by ARD Classification*

Area	Pit	Quantity (tonnes)		Distribution %	
		PAG	NPAG	PAG	NPAG
Goose Property*	Umwelt	13,053,000	5,600,000	70%	30%
	Llama	10,548,000	4,421,000	70%	30%
	Main	10,101,000	14,255,000	41%	59%
	Echo	584,000	389,000	60%	40%
	Total	**34,286,000**	**24,665,000**	**58%**	**42%**

Notes: * Based on 75% segregation efficiency in all units except 0% in the LIF, and 50% in the Umwelt/Llama UIF.

Overburden quantities are not included in this table.

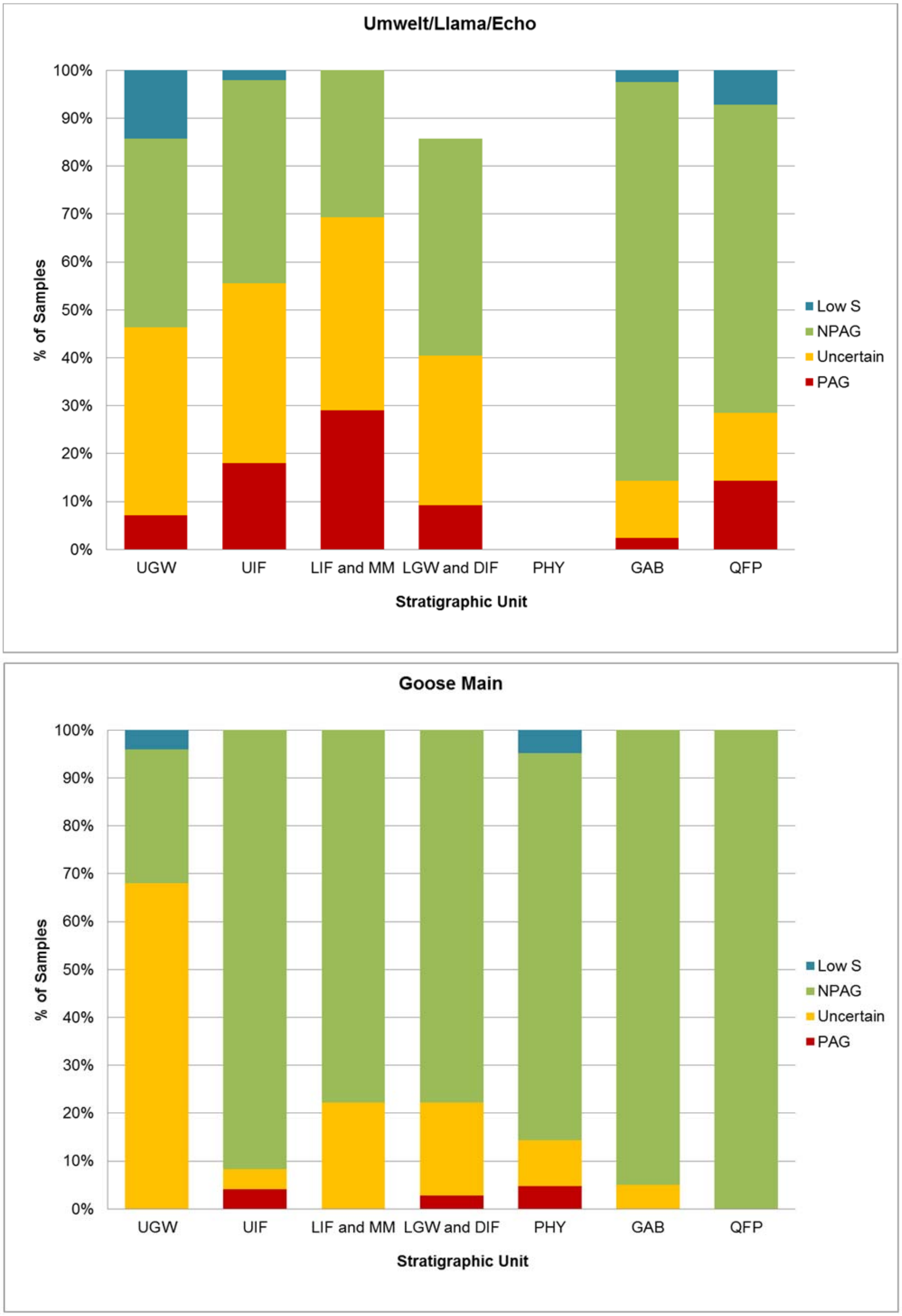

Figure A: Distribution of PAG, Uncertain, NPAG and Low S Waste Rock According to Stratigraphic Unit and Deposit Groupings

Legend: UGW = upper greywacke, UIF = upper iron formation, LIF = lower iron formation, LGW = lower greywacke, DIF = deep iron formation, PHY = phyllite, GAB = gabbro, QFP = quartz feldspar porphyry.

Tailings

Two phases of testing were completed on tailings samples. The first phase included ABA, trace element analyses, and mineralogy on seven samples. Five of these samples represented tailings from the Umwelt open pit, Umwelt underground, Llama open pit, Goose Main open pit, and the George deposits[1]. The two remaining samples were master composite samples representing the overall blend of tailings expected over the mine life. One of the master composites was subjected to cyanide detoxification and the resulting slurry sample was subjected to aging tests. The other master composite tailings sample was subjected to humidity cell testing – including one standard humidity cell test and one test conducted under refrigeration.

The second phase of testing included ABA and trace element analyses on 23 variability composites from the Goose deposits, and one composite sample representing typical tailings from Goose Main. This latter composite sample was subjected to cyanide detoxification; solids from that test were submitted for mineralogical characterization and humidity cell tests, and the detoxified slurry was submitted for aging tests. Process water from the fresh detoxification solutions was also tested for a full suite of water quality parameters. Tailings from the second phase of characterization reflected improvements to the metallurgical process to include a finer grind size, reduced amounts of cyanide, and improved detoxification procedures. However, the ABA and trace element data, mineralogical results, and humidity cell test results from both phases of work are considered to be representative for most parameters.

The results indicate that, with the exception of some samples from the Goose Main deposit, tailings are potentially acid generating (PAG). Acidic conditions developed in one of the humidity cell tests that was operated under standard room temperature conditions (i.e. the master composite sample), but remained neutral in the refrigerated test and in the test completed on tailings from the Main deposit. Sulphate and arsenic concentrations were elevated in all three humidity cell tests. Concentrations of cadmium, cobalt, nickel, and zinc increased in response to decreasing pH conditions that occurred in the room temperature test on the master composite. These findings suggest that the tailings will need to be managed to prevent metal leaching and acid rock drainage.

Preliminary calculations indicate that the delay in the onset of acidic conditions (lag times) in exposed tailings from Umwelt, Llama, and Goose Main would be on the order of 2 to 31 years under field conditions. The difference in lag times is due primarily to differences in the amount of neutralization potential (NP) present in the different types of tailings. However, based on the current production schedules, the majority of exposed tailings on the surface of the TSF are likely to be a blend of Goose Main and Llama ore, and therefore lag times are expected to be on the order of 10 to 20 years. The deposition of fresh tailings is also expected to help maintain neutral pH conditions in the tailings during operations. Similarly, the deposition of waste rock from the Goose Main open pit on top of the TSF once it’s no longer active will contribute alkalinity, which will help to maintain neutral pH conditions until freezing conditions develop in the TSF. The TSF will be fully capped by the end of Year 6. Tailings in the Umwelt and Goose tailings facilities (TFs) will be flooded at closure which will prevent acidic conditions from developing.

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[1] The George deposits are no longer part of the project, but the results of the tailings tests are considered to be analogous to the results for the Goose deposits, and are therefore included in this report.

Process water and aging test data from the more representative second phase of metallurgical and cyanide detoxification testing indicate that tailings process water, shortly after generation, will have neutral pH and elevated concentrations of ammonia (51 mg/L), cyanate (34 mg/L), thiocyanate (94 mg/L), sulphate (1010 mg/L), aluminum (0.68 mg/L), antimony (0.15 mg/L), arsenic (0.17 mg/L), copper (1.4 mg/L), and iron (3.2 mg/L) concentrations. Over time, as indicated by preliminary results from the aging tests, all of these parameters show either decreasing or stable concentrations. However, depending on the residence time and actual rates of degradation occurring in the tailings facilities, there is a possibility that this water may need to be treated to remove these parameters.

Water Quality Estimates

Results from the geochemical characterization program were used to estimate the chemistry of process water and seepage and runoff that will be directly in contact with the WRSAs, ore stockpiles, pads, exposed pit walls, and exposed tailings, prior to dilution from local runoff in undisturbed areas of the catchments. The estimates were based on a combination of scale-up calculations, geochemical modelling, and extrapolation of monitoring data from geologically similar mine sites in the area. The results were a key input to the water and load balance used to predict discharge and receiving water quality from the Property for use in the effects assessment.

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1 Introduction

SRK Consulting (Canada) Inc. (SRK) was been retained by Sabina Gold & Silver Corp. (Sabina) to complete geochemical characterization studies to assess the metal leaching/acid rock drainage (ML/ARD) potential of overburden, quarry rock, waste rock, tailings, and mine workings associated with the Back River Project (the Project). The studies were completed in support of the Final Environmental Impact Statement (FEIS) for the Back River Property (the Property). The characterization program was intended to supplement previous work by Rescan Environmental Services Ltd. entitled Back River Project 2013 Geochemistry Baseline Report (Rescan 2014) that was presented in the draft EIS (DEIS), and included additional test work and further data interpretation.

This report, prepared in support of the FEIS, presents the methods and results of both the previous work and the supplemental testing, an updated interpretation of the test results, and water quality predictions for each of the source areas. The report fully supercedes Rescan 2014 from the DEIS.

The report is structured as follows:

- Section 2 summarizes background information for the Property, including descriptions of the geology, mine plan, previous ML/ARD studies, and an overview of the supplemental program completed in 2014;
- Section 3 describes the methods used to complete the characterization program;
- Sections 4, 5, and 6 provide the results and discussion for overburden and quarry rock, waste rock, and tailings respectively;
- Section 7 presents the source concentrations that were developed for use in the water and load balance for the Property (SRK 2015); and
- Section 8 presents an overall summary and conclusions, including a discussion of potential management implications.

This report is intended as a supporting document or appendix to the FEIS.

2 Background

2.1 Geology

A detailed description of the regional and local geology is provided in the Project Report and in Rescan (2014a). A summary is provided as context for the geochemical studies.

Regional Geology

The George and Goose deposits are located within the Yellowknife Supergroup of the Slave Geological Province. This group of rock is mainly comprised of a series of Precambrian clastic metasediments classified as volcanic-turbidite series rocks (VTS). Iron formations are locally abundant in VTS rocks of the Slave Province, with turbidite-hosted banded iron formations (BIFs) hosting most of the stratiform and stratabound gold prospects in the northeastern Slave Province. The George and Goose deposits are located within the Beechey Lake Group turbidites which host oxide and silicate BIFs.

Three main periods of deformation occurred in this region, resulting in large-scale folding, foliation, and thermal alteration. The abundance of chlorite, clinochlore, actinolite and grunerite are all consistent with greeenschist to amphibolite facies metamorphic grades.

The deposit areas are variably overlain by glacial sediments, including ground moraines, terminal moraines, drumlins, eskers and kames, with the majority of the material comprising sediments deposited during glacial retreat.

The Marine Laydown Area (MLA) is within the Kilohigok Basin of the Bear Geologic Province, and is comprised of Proterozoic aged conglomerates, sandstones, siltstones, breccias, and minor quantities of carbonates. Surficial materials at the MLA include a number of remnant beach deposits overlying marine sediments of variable thickness. Bedrock outcrops were observed at the top of the prominent hill at the Property.

Local Geology

The Goose Property includes the Llama, Umwelt, Goose Main, and Echo deposits, and is underlain by folded turbiditic meta-sediments, including subordinate oxide and silicate banded iron formation (Figure 2-1). This sequence is cut by felsic dykes and gabbroic dykes. From oldest to youngest, the sequence is composed of lower greywacke, deep iron formation, lower iron formation, middle mudstone, upper iron formation, phyllite, upper greywacke, and upper sediments. Gold mineralization tends to be hosted in the lower greywacke, lower iron formation, and upper iron formation units. A narrow (3 to 5 m) felsic dyke is located along the axial plane of the major antiform at the Goose Main deposit. Multiple, thin (0.5 to 5 m) felsic dykes trend nearly parallel to the synform/antiform structures at the Llama and Umwelt deposits. At Echo, a single felsic dyke cross-cuts the mineralization. All units are cross-cut by gabbroic dykes.

Table 2-1 provides a brief description of each of the stratigraphic units. More detailed descriptions of each of the rock types (lithologies) are provided in Appendix A.

Gold mineralization is hosted in both chemical and clastic sedimentary lithologies as well as quartz ± feldspar porphyry dykes. Late gabbro dykes are known to post-date the timing of gold mineralization and are not host to economic concentrations of gold. Banded oxide facies iron formation, consisting of chert + grunerite + magnetite, hosts the majority of the known gold mineralization. Silicate facies iron formation, consisting of actinolite + chert + grunerite and locally interbedded clastic sediments, hosts relatively lesser gold mineralization. Clastic sediments, consisting of greywacke, siltstone, and mudstone, are noted to be mineralized but typically return low levels of gold, with isolated elevated gold assays. In some cases, felsic dykes have been proven to host gold; however, the abundance of such is considered relatively insignificant to date.

Gold mineralization is best characterized as an event of widespread quartz ± carbonate veining and sulphidization related to brittle faulting and folding. Mineralization consisting of pyrite ± arsenopyrite ± pyrrhotite, rare chalcopyrite, and free gold is observed to occur within quartz ± carbonate veining of all lithology types with the exception of gabbro. Gold-mineralized quartz veining occurs commonly within the interpreted structural corridor with local concentrations. Replacement sulphidization of host lithology is also recognized within the Llama deposit, where pyrrhotite ± arsenopyrite (including loellingite) ± pyrite replace magnetite and grunerite to varying degrees.

Table 2-1: Descriptions of Intrusive and Stratigraphic Units

Group	Stratigraphic Unit	Description
Intrusive Rocks	GAB (Gabbro)	Coarse-grained variably magnetic post-deformational mafic dykes
	Intermediate dyke	Porphyritic intermediate to felsic post-mineralization dykes
	QFP (quartz-feldspar porphyry)	Porphyritic felsic dykes; spatially associated with gold mineralization
Sedimentary Rocks (from youngest to oldest)	UGWK (Upper Greywacke)	Coarse wacke/sandstone with rare & discontinuous thin mudstone or iron formation horizons
	PHY (Phyllite)	Foliated silty mudstone
	UIF (Upper Iron Formation)	Silicate and oxide iron formation horizons interbedded with wacke/sandstone, mudstone; minor mineralization host
	MM (Middle Mudstone)	
	LIF (Lower Iron Formation)	Massive oxide iron formation, with minor silicate iron formation, mudstone, or quartz veining; main mineralization host
	DIF (Deep Iron Formation)	Coarse wacke/sandstone hosting minor iron formation horizons with quartz veining; major mineralization host at Goose Main only
	LGWK (Lower Greywacke)	Coarse wacke/sandstone with rare thin mudstone horizons

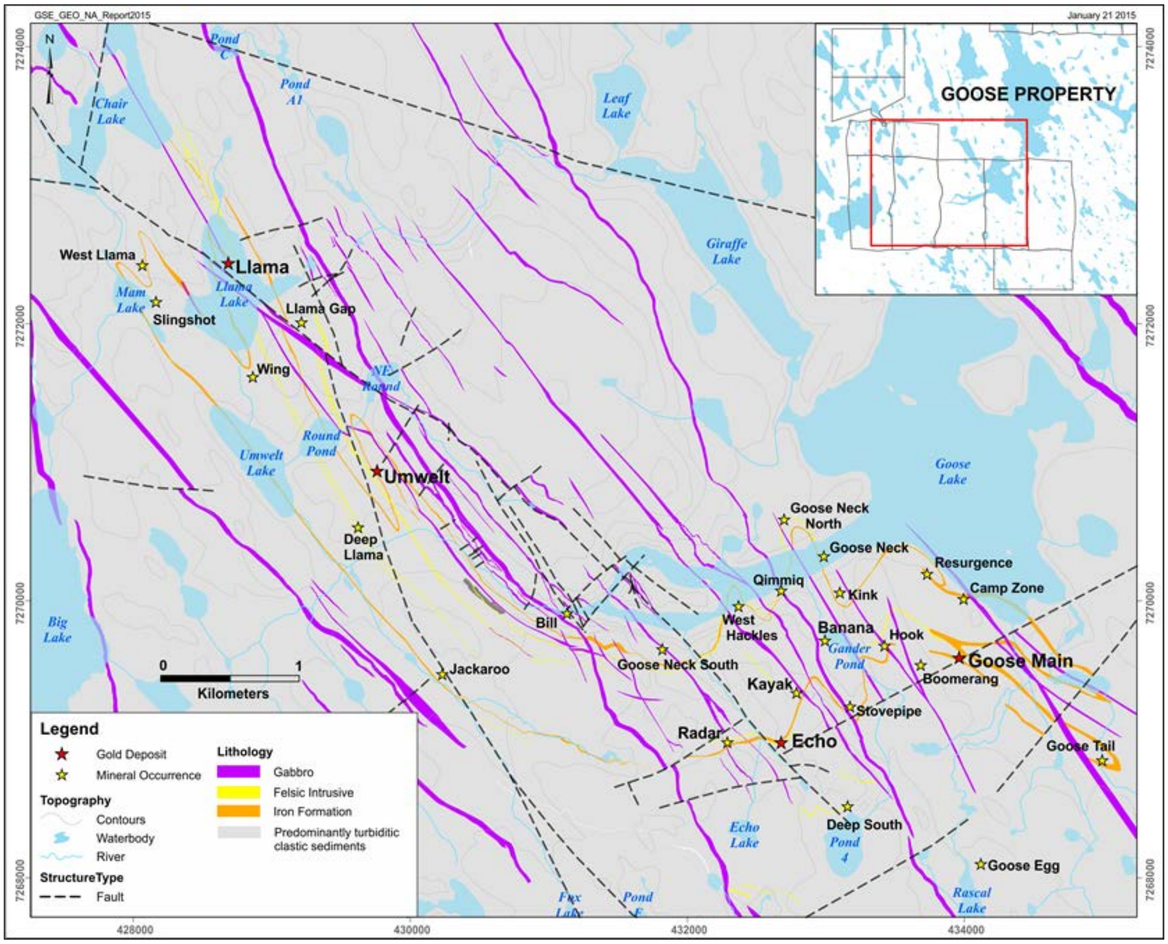

Figure 2-1: Goose Property Geology

2.2 Mine Plan

Details on the mine plan are provided Volume 2: Project Description and Alternatives. Mining will occur over an estimated ten year period based on currently known resources, with total ore production of 19.8 Mt.

The Project includes four deposit areas at the Goose Property: Umwelt, Llama, Echo, and Goose Main. Annual resupply will be completed using the Marine Laydown Area (MLA), located in Bathurst Inlet, and winter ice roads will be utilized to interconnect these areas. Although mining of the George Property was included in the DEIS, it is no longer part of the Project. However, where appropriate, some of the results are included in this report.

Ore will be mined using conventional open pit and underground methods and trucked to the Process Plant located at the Goose Property for processing using standard gravity and leach recovery processes. The ore will be stockpiled in an ore stockpile located adjacent to the plant site prior to processing. It is expected that some of the ore will remain on the ore stockpile until the end of operations, at which time it will be processed.

Waste rock will be stored in one of several designated waste rock storage areas (WRSAs) on the surface, or backfilled in mine workings. Tailings from the Process Plant will be stored in a single constructed Tailings Storage Facility (TSF), as well as backfilled in mined out open pits (Umwelt and Goose Tailings Facilities (TF)). The TSF is designed to contain 3.1 Mm^3 of tailings, while the Umwelt TF and Goose TF have capacity for 7.1 Mm^3 and 6.2 Mm^3 respectively.

Under the current mine plan, all pits and TFs are expected to fill by Year 18, which is the end of the Passive Closure stage (SRK 2015). In developing water quality predictions for the open pits (Section 7), it was conservatively assumed that acidic conditions would develop in any PAG rock exposed on the pit walls.

In the context of the geochemical characterization program, the quantities of each of the different types of waste rock that will be produced from each of the deposit areas are important for understanding the relative importance of each of these units. A summary of the waste rock quantities from each of the open pits is provided in Table 2-2. Waste rock from the underground workings will be used as backfill, and will remain in the underground mine.

Table 2-2: Waste Rock Quantities by Model Unit – Goose Deposits (JDS 2014)

Pit	OVB tonnes	PHYL tonnes	UGWK tonnes	LGWK tonnes	UIF tonnes	MM&LIF tonnes	GAB tonnes	QFP tonnes	DIF tonnes	Total Waste tonnes
Umwelt	1,289,000	0	6,280,000	1,528,000	8,802,000	1,181,000	143,000	539,000	179,000	19,942,000
Llama	1,037,000	0	2,725,000	1,015,000	8,367,000	1,092,000	774,000	995,000	0	16,005,000
Goose	2,755,000	2,590,000	867,000	0	11,546,000	2,176,000	1,756,000	291,000	5,130,000	27,111,000
Echo	250,000	21,000	0	740,000	138,000	56,000	7,000	12,000	0	1,224,000
Total	**5,331,000**	**2,611,000**	**9,873,000**	**3,283,000**	**28,853,000**	**4,504,000**	**2,681,000**	**1,837,000**	**5,309,000**	**64,281,000**

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2.3 Previous ML/ARD Studies

A chronological summary of previous geochemical characterization studies, as described by Rescan (2014a) is provided as follows:

- 2007: Initial screening program carried out on waste rock drill core samples from the Goose and George properties (Lorax Environmental Services Ltd. 2007)
- 2010: Discovery of the Llama Deposit prompted Sabina to collect drill core samples representative of potential waste rock from the deposit (Rescan 2011)
- 2011: Additional drill core samples were collected from Llama and Umwelt deposits to characterize the potential waste rock (Rescan 2011)
- 2012:
  - The Goose Property underwent intense sampling focusing on exploration holes in the open pits for the Llama, Umwelt, and Goose Main deposits (Rescan 2013)
  - Kinetic test work was initiated for the Goose Property deposits (Rescan 2013)
- 2013:
  - Additional mine workings and waste rock drill core and assay pulp samples were collected to reflect changes in the mine plan
  - Drill core was sampled from the Locale 2, Locale 1, LCP North, and LCP South deposits at the George Property to reflect proposed open pit mining methods
  - Drill core samples from the Wing and Echo zones at the Goose Property were collected but not analyzed
  - Characterization of tailings solids and process water on cyanide detoxified tailings samples
  - Additional ore and low grade ore drill core and assay pulp samples were collected from the Goose Property deposits to characterize ore stockpiles

The results from these programs were compiled and presented in Rescan (2014a), which was prepared in support of the Draft Environmental Impact Statement (DEIS) for the Project. Earlier versions of this report were subjected to a peer review and gap analysis by Golder Associates (Golder 2014).

2.4 Supplemental Studies (2014/2015)

As part of the Project, SRK completed a detailed review of the available information and provided recommendations for supplemental studies and data interpretation to address critical data gaps for the FEIS. The recommendations, which were addressed as part of the supplemental studies completed in 2014 and 2015, are described as follows:

- Further testing, including:
    - Additional static tests to understand downhole variability through each of the main stratigraphic units
    - Tests to further understand the reactivity and availability of neutralization potential (NP), including additional determination of NP by alternative methods and net acid generation (NAG) tests
    - Continuation of several of the ongoing kinetic tests, and additional kinetic tests on materials that were under-represented in the earlier programs, notably more typical greywackes and mudstones from the George deposits, and more typical waste grade iron formation samples from both properties; note that the George Property is not part of the FEIS mine plan.
    - Ongoing sampling and analysis of field barrel tests
    - Additional mineralogical characterization, including QEMSCAN analysis on kinetic test samples
    - Static testing and leach extraction tests on overburden from the Goose Property
    - Static testing and leach extraction tests on bedrock outcrop samples from the MLA
    - Characterization of tailings solids and process water on samples that more closely represent the current process and cyanide destruction flow sheets for the Project, and
    - Sampling and analysis of seepage from the Goose Airstrip
- Further data interpretation, including:
    - An assessment of potential bias in the sampling
    - An updated interpretation of the new and pre-existing static test results that more thoroughly examines the forms and reactivity of NP, and assessment of downhole continuity, and stratigraphy to determine whether segregation of PAG/NPAG rock is feasible
    - An updated interpretation of kinetic test data that includes standard calculations of sulphide oxidation and metal release rates, trend analysis, and additional calculations to assess lag times to the onset of ARD, and availability and reactivity of NP
    - Estimate the quantities of PAG/NPAG materials that could be achieved through segregation, and
    - Revise source concentration estimates as required to reflect expected geochemical performance and concentrations limits, including consideration of analogs to establish concentration limits

3 Methods

3.1 Sampling

3.1.1 Overburden

Previous Studies

In 2011, 37 overburden samples were collected from the Goose Property from shallow geotechnical drill holes (n = 29) in the vicinity of the Goose Main deposit and airstrip, and surface grab samples from within the pit boundaries of the Llama (n = 4) and Umwelt (n = 4) deposits. Sample locations are shown in Appendix B.1.

Muskeg was avoided whenever possible to limit the influence of organic material and organic acids on test results; however, roots were occasionally noted in samples. The majority of the samples consisted of poorly sorted till material that appeared highly weathered and contained mostly refractory minerals.

2014/2015

In 2015, 23 overburden samples were collected from a series of geotechnical drill holes on the Goose Property. Eight of these samples were located in close proximity to the open pits, and the remainder were located in various infrastructure areas on the Goose Property. The overburden is comprised of glacial sediments that have been transported far from the original bedrock from which they are derived. Therefore, all of the overburden samples are considered to be representative of the material that will be excavated from the open pits during mining. Sample locations are shown in Appendix B.2

3.1.2 Quarry and Other Excavation Areas

Previous Studies

The proposed airstrip rock quarry was assessed in 2011 (Rescan 2011). Most samples (n = 36) were collected from diamond drill core; the remaining samples (n=4) were outcrop samples. Sample locations are shown in Appendix B.1

2014/2015

In 2015, 13 shallow bedrock samples were collected from a series of geotechnical drill holes on the Goose Property. The majority of these were in the vicinity of the plant site or other areas where infrastructure development will occur. In some of these areas, there may be some disturbance of the shallow bedrock resulting from construction activities. Therefore, these samples were subjected to geochemical characterization. Sample locations are shown in Appendix B.2.

Eight bedrock outcrop samples, three surface grab samples of gravel-rich sand, and four shallow drill core samples also comprised of gravel to cobble sized material were collected in the vicinity of the proposed quarry area at the MLA. The sample locations are shown in Appendix B.3.

The Umwelt pit has also been identified as a potential source of quarry material for construction of site infrastructure. Drill core samples from the waste rock characterization program were used to represent materials from this location.

The Goose Airstrip was constructed in 2012/2013 using rock from the Airstrip quarry. In June 2015, a seep survey was completed around the Goose Airstrip to characterize seepage water quality associated with the quarry rock. Two seeps were sampled and submitted to ALS Environmental for analysis of a full suite of water quality parameters. Sample locations are provided in Appendix O.

3.1.3 Waste Rock

Previous Studies

Between 2007 and 2013, a total of 675 samples were collected from the Goose Property. Sampling procedures were described as follows for the majority of these samples (Rescan 2014):

- Drill collar locations were compared relative to the current open pit outline from ongoing mine planning and drill holes were selected that were inside pit boundaries or within 50 m of the pit boundary (noting that the pit designs have since changed)
- Exploration drill logs were consulted for the selected exploration drill holes and intervals matching the desired lithology were selected based on lithology thickness and log descriptions
- Drill core samples were collected; typical sample weights of NQ size diamond drill holes were 2 to 4 kg representing between 1 and 3 m of drill core
- Targeted intervals were laid out, respecting any existing sample intervals generated by Sabina during exploration assaying
- Where possible, each sample was composed of one lithology
- The core was then submitted to Sabina personnel for splitting with a diamond saw. After the drill core was split, half of the available core was returned to the core box (for example, if previously cut in half for exploration assaying half of the remaining core, i.e., one quarter of the total core, was collected and the other portion was placed back in the core box), and
- Sabina personnel arranged shipment of the samples to Maxxam Analytics through their Yellowknife expeditor, Discovery Mining Services

In some instances, coarse reject was selected from Sabina’s warehouse in order to reduce sample preparation times and reduce consumption of exploration drill core.

In 2012, an alternative procedure was used for sampling seven drill holes from the Llama deposit. For these, continuous downhole sampling was completed, with sample intervals on the order of 10 m in length.

2014/2015

In 2014 the sample coverage was expanded to provide a better understanding of the downhole continuity, which was required to support segregation plans. A stratigraphic approach was used for sampling, with continuous downhole samples collected at intervals of approximately 10 m in length (equivalent to a typical bench height), or where there were major changes in the stratigraphy. Drill holes were selected to provide a minimum of one complete cross section through the stratigraphy in each of the deposit areas - in most cases this included sampling from 2 or 3 additional drill holes per deposit.

An additional 168 waste rock samples were collected from the Goose Property. The sample locations and key sample results were imported into the Leapfrog models for the Project for visualization purposes. A series of cross sections showing the sample locations and corresponding geology are provided in Appendix B4.

3.1.4 Tailings

Previous Studies

As described in Rescan (2014), preliminary, bench-scale, development testing and metallurgical characterization of ore material was undertaken by ALS Metallurgy in 2012 (ALS Metallurgy 2013). ALS Metallurgy created five variability composites of ore material as outlined in Table 3-1 , and one master composite (MK400: MC01) for use in the geochemical characterization program.

Table 3-1: Deposit Composite Material Used for Master Ore Composites

Sample ID	MK417: George Property*	MK416: Main Open Pit	MK418: Llama Open Pit	MK415: Umwelt Underground	MK414: Umwelt Open Pit	Total
MK400: MC-01	8	3	7	8	4	30

Notes: * MK417 was a composite of available samples from the George Property with no distinction given to different deposits.

After ore compositing was complete, splits of the MK400, MK414, MK415, MK416, MK417, and MK418 were sent to ALS Metallurgy in Perth, Australia (ALS Metallurgy 2013). The composites were subjected to direct cyanidation as per process flowsheets generated by ALS Metallurgy in Kamloops, British Columbia (BC). The tailings slurry from the cyanidation test work then underwent cyanide detoxification testing.

The cyanide destruction method tested was the sulphur dioxide/air (SO_2/air) oxidation process catalyzed by copper sulphate pentahydrate. The target for the cyanide detoxification testing was to produce tailings with less than 5 parts per million (ppm) weak acid dissociable (WAD) cyanide in the supernatant. This target was not achieved in some of the test work variability samples (ALS Metallurgy 2013) due to elevated iron concentrations, particularly in MK415 (Umwelt underground). The detoxified tailings were shipped to Maxxam Analytics in Burnaby, BC for geochemical characterization.

All of the samples were subjected to static testing. The master composite (MK400: MC-01) was split to produce samples for humidity cell testing – and subsequently identified as BR-Tail-02 and BR-Tail-03. Additionally, a composite of the individual tailings samples (MK414 to MK418) was prepared for use in the aging tests.

2014/2015

Additional metallurgical and detoxification testing was completed on a sample composite from the Goose Main deposit (KM 4030-147). Three samples were provided, including:

- A detoxified process water sample;
- A dry filter cake prepared from detoxified tailings; and
- A detox tailings slurry sample.

The process water sample was sent to Rescan for water quality analysis and toxicity testing. The dry filter cake was sent to Maxxam for geochemical characterization.

3.2 Analytical

3.2.1 Mineralogy

Previous Studies

One overburden sample, 10 quarry rock samples, and 49 waste rock samples were subjected to mineralogical characterization by x-ray diffraction (XRD) analysis with Reitveld refinement (Reitveld XRD) (Rescan 2014).

2014/2015

In the more recent testing program, samples from all of the kinetic tests were submitted for QEMSCAN analysis at SGS Laboratories in Burnaby, BC to determine the modal mineralogy. Additionally, seven samples from a series of kinetic tests initiated as part of the current program were submitted for Reitveld XRD – also at SGS.

3.2.2 Static Tests

Previous Studies

Static testing methods include acid base accounting (ABA) tests, and trace element analyses.

The analytical methods used in previous phases of ABA testing are outlined in Table 3-2 (Rescan 2014). The data interpretation methods, specifically calculation of the acid potential (AP), and adjustments made to the neutralization potential (NP) have changed slightly since this work was first documented (Rescan 2014), and are described in the following section.

Table 3-2: ABA Parameters, Analytical Methods and Uses (after Rescan 2014)

Measured Parameter	Acronym	Units	Analytical Method
Paste pH	-	pH units	pH of a slurry of solid sample and de-ionized water.
Total sulphur	S	% S	Leco furnace.
Sulphide sulphur	S_2	% S	React with nitric acid to remove sulphide and sulphate and measure residue (insoluble sulphur) by Leco furnace.
Sulphate sulphur	SO_4	% S	React with hydrochloric acid to remove soluble sulphate minerals and measure residue by Leco furnace.
Total carbon	C	% C	Leco furnace.
Inorganic carbon	TIC	% C or % CO_2 or kg $CaCO_3$/t	React with hydrochloric acid to remove carbonate and measure residue by Leco furnace. Inorganic carbon is calculated from the difference between total carbon and the residual (organic) carbon.
Sobek bulk NP	NP	kg $CaCO_3$/t	React with hydrochloric acid at near boiling for 2-4 hours.
Modified Sobek bulk NP	Mod NP	kg $CaCO_3$/t	React with hydrochloric acid at 20°C for 24 hours.

In the earlier work, trace element analyses were completed using either aqua regia (hydrochloric and nitric acid) digestion method or four-acid (hydrochloric, nitric, sulphuric, and hydrofluoric acid) digestion methods. X-ray fluorescence (XRF) was also used to measure the proportion of major elements in some samples.

2014/2015

For consistency with the earlier work, ABA tests were completed following the methods used by Rescan (2014a). The only significant difference is that NP was determined using the siderite corrected NP method (MEND 2009), rather than the standard Sobek method used in most of the previous work. This was to ensure that any buffering provided by iron carbonate minerals was not overestimated. The siderite corrected NP method is almost identical to the standard Sobek method, and is thought to yield similar results except in instances where siderite is abundant. As indicated by the mineralogical characterization, there was relatively little siderite present in these samples. To assess for differences in NP resulting from different testing methodologies and to provide greater insight into the reactivity and availability of the NP, the samples that were subjected to kinetic testing were also characterized using the Modified Sobek NP method.

In both the earlier and the more recent testing, direct analysis of sulphide was completed using a modified version of ASTM 2492 (MEND 2009), which involved a nitric acid digestion of the sample to oxidize and remove the sulphide minerals. The residues were then analyzed for insoluble sulphur, and the difference between the total sulphur and the sum of the insoluble sulphur was inferred to be the sulphide sulphur. The sulphide sulphur results for most samples were significantly less than the results calculated as the difference between total sulphur and sulphate sulphur, and also the sulphur results from the ICP analyses (which are also indicative of the sulphide+sulphate sulphur). One interpretation of this finding is that a considerable proportion of the sulphur is present as insoluble sulphur, likely in the form of organic sulphur, which does not contribute to the AP. However, mineralogical data indicated that the majority of the sulphur could be accounted for by sulphide minerals. Therefore, since use of the direct sulphide results could underestimate AP, they were not used in the interpretation of the ABA results for this Project. Instead, AP was calculated using the total sulphur content.

The ARD potential was classified based on a combination of the NP/AP ratios and AP results. Samples with NP/AP ratios of greater than 3 were classified as NPAG; samples with NP/AP ratios of less than 3 and AP less than 5 (total sulphur content of less than 0.16%) were classified as “low-S”; samples with NP/AP ratios of less than 3, but greater than 1 were classified as having an uncertain potential for ARD; and samples with NP/AP ratios of less than 1 were classified as PAG. There were no adjustments to account for the availability or reactivity of NP or sulphide. However, the NP/AP ratio of 3 that was used to define the “uncertain classification” considers the potential uncertainties in the availability and reactivity of the NP. Further refinement of the ARD classification, as discussed in Sections 5.1.5 and 5.1.6 shows that these classifications are somewhat conservative, suggesting that further refinement can be considered in future.

Trace metal analysis completed in the 2014/2015 program were by ICP following aqua regia digestion.

3.2.3 NAG Tests (2014/2014)

Net acid generation (NAG) tests were completed on all of the samples from the kinetic testing program. Single addition NAG tests were completed on samples with less than 1% total sulphur, while sequential NAG tests were completed on samples with greater than 1% total sulphur. NAG tests are completed by adding hydrogen peroxide to pulverized samples, which results in oxidation of the sulphides and neutralization by other minerals that are present in the samples. The pH is measured and used to assess whether acidic conditions are likely to develop over time.

3.2.4 Shake Flask Extraction (SFE) Tests

Previous Studies

As described in Rescan 2014, a sub-set of overburden, quarry and waste rock samples was subjected to shake flask extraction (SFE) testing to assess for the presence of soluble elements (MEND 2009). The SFE tests were completed using a water to solids ratio of 3:1. Leachates were analyzed for pH, EC, sulphate, acidity, alkalinity, fluoride, chloride, bromide, nitrate, nitrite, ammonia, phosphorus, and a multi-element suite of trace elements by ICP-MS.

SRK considers the use of SFE tests to be inappropriate for fresh drill core samples because they do not account for the time dependent release of soluble elements originating from the oxidation of sulphide minerals. Therefore, only results from surficial samples (overburden), and weathered rock samples are included in this report.

2014/2015

Overburden samples from the Goose Property and the MLA, and quarry samples from bedrock outcrops at the MLA were subjected to SFE tests, as described above.

3.2.5 Humidity Cell Tests

Previous Studies

Humidity cell kinetic tests were constructed from 1 kg of crushed material (80% of material passing 6 mm sieve) in accordance with the MEND procedure (MEND 2009).

In the previous studies, a total of 38 laboratory humidity cells were initiated and operated to assess the ML/ARD properties of potential waste rock, pit wall rock, and tailings from deposits at both the Goose and George properties. Although the Project no longer includes mining at the George Property, kinetic test data for samples from the George deposits (LCP North, LCP South, Local1 and Locale 2) are included in this report because many of the samples are representative of materials found at the Goose Property.

Humidity cell samples were selected to represent different rock types, excluding the narrow veins, at a variety of ML/ARD potentials. Where a cell was targeted to contain material that was likely to be acid-generating, a sample with low NP was selected to try and reduce the lag time to the onset of acidic drainage conditions. In general, this has resulted in a conservative bias in the sample set.

2013/2014

An additional eight humidity cell tests were initiated in the more recent testing program, including seven waste rock tests and one tailings test, resulting in a total of 43 waste rock tests and three tailings tests. Results from the earlier program were reviewed at the start of the Project and again in November 2014, and 18 of the waste rock tests were terminated – either because concentrations were stable, or because the samples were not considered to be representative.

A list of the humidity cell tests completed on waste rock, including the sample intervals, the rock type, and the current status of the tests as of August 2015 is summarized in Table 3-3. Two of the tailings tests have been continued.

3.2.6 Field Barrels

A total of eight field barrels tests were constructed on site using split samples of drill core. In general, the material is very coarse grained. Seven of these tests were constructed in 2007 by Lorax Environmental Services Ltd. and one was constructed in 2013 by Rescan Environmental Services Ltd. The rock types and their ARD classification are listed as follows:

- Barrel 1 – Main Deposit gabbro (NPAG);
- Barrel 2 – Main Deposit greywacke (NPAG);
- Barrel 3 – Main Deposit mudstone (NPAG);
- Barrel 4 – Main Deposit greywacke (NPAG);
- Barrel 5 – George Property iron formation (NPAG);

- Barrel 6 – George Property greywacke (uncertain ARD potential);
- Barrel 7 – Field blank; and
- Barrel 8 – Llama and Umwelt deposit iron formation (PAG).

The barrels have been sampled one to two times/year since 2007, except for 2008. In 2014, the barrels were sampled twice: leachate that had accumulated as of July 2014 was sampled on July 12, 2014, and then the barrels were flushed with 4 L of deionized water and sampled again on July 15, 2014 to simulate rainfall and to obtain a sample that would not have been compromised by long residence time in the collection container.

3.2.7 Analysis of Seepage Samples

Field and laboratory measurements completed on the two samples collected from the Airstrip quarry included field pH, electrical conductivity, oxidation reduction potential ORP, temperature, acidity, alkalinity, sulphate, chloride, fluoride, ammonia, nitrate, nitrite, orthophosphate, total dissolved solids (TDS), hardness, calcium, magnesium, sodium, potassium, and a full suite of metals by ICP-MS.

3.2.8 Aging Tests

Previous Studies

Oxic aging tests were completed on a tailings slurry sample prepared by combining the five variability composites from the metallurgical testing program. The tests were intended to characterize the evolution of process water in contact with tailings over time. Samples were split into glass beakers and covered with a parafilm seal to minimize evaporation. The beakers were left in direct sunlight for a set number of days and then the supernatant was analyzed.

2014/2015

Oxic and anoxic aging tests were also completed on the Goose Main sample composite (KM 4030-147). The samples were each split into 11 - 1.5 L aliquots and placed in 2 L beakers. Five of the samples were subjected to anoxic aging tests, and five were subjected to oxic aging tests. The remaining sample was filtered and submitted for chemical analysis. The anoxic test was completed in a glove box in a nitrogen atmosphere. Samples were allowed to sit for 1, 2, 4, 6, and 8 months prior to analysis. The oxic tests were covered with a parafilm seal and placed in a window where they were exposed to natural light, and were allowed to sit for 0.5, 1, 2, 3, and 4 months before analysis.

Table 3-3: Summary of Waste Rock Humidity Cells

Humidity Cell	Drill hole ID	Depths From m	Depths To m	Deposit	Lithology	Cycles	Status
HC-25	12GSE168	269.5	273.3	Llama	Felsic Dike	119	Operating
HC-24	10GSE32	132.85	137.08	Llama	Felsic Dike	79	Terminated
HC-05	10GSE89	53.6	56.6	Goose Main	Felsic Dike	83	Terminated
HC-14	10GSE127	86	87.62	Umwelt	Felsic Dike	100	Terminated
HC-26	12GSE168	172.26	182.26	Llama	Gabbro	112	Operating
HC-08	08GSE008	210	212	Goose Main	Gabbro	100	Terminated
HC-16	10GSE106	66	67	Umwelt	Gabbro	119	Operating
HC-27	12GSE168	254.7	260.25	Llama	Gabbro	79	Terminated
HC-07	08GSE006	350	352	Goose Main	Gabbro	83	Terminated
HC-06	08GSE006	265	267	Goose Main	Gabbro	83	Terminated
HC-11	10GSE104	66.85	69.85	Umwelt	Iron Formation	118	Operating
HC-46	13GRL131	45.5	47	Locale 2	Iron Formation (ore)	35	Operating
HC-31	13GRL131	28.2	29.2	Locale 2	Iron Formation (ore)	58	Terminated
HC-20	12GSE168	260.25	268.4	Llama	Iron Formation (ore)	132	Operating
HC-41	12GSE159B	217.75	227.75	Llama	Iron Formation (ore)	35	Operating
HC-37	12GRL069	188	189	LCP North	Iron Formation (ore)	58	Terminated
HC-34	12GRL085	62.71	63.5	Locale 1	Iron Formation (ore)	58	Terminated
HC-43	12GRL067	48	49	LCP North	Greywacke	35	Operating
HC-19	10GSE32	112.66	122.66	Llama	Greywacke	132	Operating
HC-18	12GSE144	307.1	317.1	Llama	Greywacke	79	Terminated
HC-02	08GSE006	30	32	Goose Main	Greywacke	83	Terminated
HC-45	10GSE104	86	89	Umwelt	Greywacke	35	Operating
HC-09	12GSE163	625	626	Umwelt	Greywacke	83	Terminated
HC-35	13GRL118	40	41.5	LCP North	Greywacke	85	Terminated
HC-44	13GRL110	26	27.5	Locale 2	Greywacke	35	Operating
HC-10	10GSE127	87.62	169.5	Umwelt	Greywacke	118	Terminated
HC-40	12GSE168	151.9	155.1	Llama	Greywacke	35	Operating
HC-33	13GRL115	21.5	23	Locale 1	Greywacke	58	Terminated
HC-17	12GSE144	241.25	245.3	Llama	Greywacke	132	Operating
HC-36	12GRL071	195	197	LCP North	Greywacke	94	Operating
HC-01	09GSE17	28.9	31	Goose Main	Greywacke	119	Terminated
HC-30	13GRL131	33.7	35.4	Locale 2	Greywacke (ore)	42	Terminated
HC-15	11GSE128	123.9	125	Umwelt	Greywacke/Gabbro	119	Operating
HC-22	12GSE159B	246.46	248	Llama	Greywacke/Mudstone	117	Operating
HC-04	10GSE89	154	157	Goose Main	Mudstone	83	Terminated
HC-13	11GSE019	91.4	94	Umwelt	Mudstone	83	Terminated
HC-38	12GRL069	67	68	LCP North	Mudstone	58	Terminated
HC-23	12GSE168	224	226.45	Llama	Mudstone	120	Terminated
HC-21	10GSE52	236.25	237.6	Llama	Mudstone	117	Terminated
HC-32	12GRL089	175	176	Locale 2	Mudstone	94	Operating
HC-03	08GSE008	336	338	Goose Main	Mudstone	136	Operating
HC-12	10GSE127	43.23	45	Umwelt	Mudstone	83	Terminated
HC-42	12GRL071	143.5	145	LCP North	Mudstone	35	Operating

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4 Overburden and Quarry Rock

4.1 Overburden at the Goose Property

4.1.1 Overview

As discussed previously, there is approximately 5.3 Mt of overburden associated with proposed open pit mining at the Goose Property. Overburden will be placed within the frozen zone of the WRSAs, or used as a portion of capping material if geotechnically suitable.

ABA and trace element analyses were completed on total of 60 overburden samples from the Goose Property, including 6 samples in the vicinity of the Llama pit, 11 in the vicinity of the Umwelt pit, 29 in the vicinity of the Goose Main pit, 4 in the vicinity of the Echo pit, 9 in the vicinity of the plant and ore stockpile, and 2 at the TSF. 24 of these samples were subjected to SFE test and one was subjected to mineralogical characterization by Reitveld XRD. All 23 samples from the 2015 program were also subjected to NAG tests.

Sample depths ranged from near surface to 18 m, with the deepest holes occurring in the vicinity of the Goose Main deposit. Samples from the 2014/2015 sampling program included a wide range of textures, from silty clay to gravel, and some boulders.

4.1.2 Results

Overburden test results are provided in Appendix C1. The results of the ABA tests indicate generally neutral paste pH values, generally low concentrations of total sulphur (75th percentile values of 0.05%, maximum values of 0.16%), and low but detectable levels of NP (median values of 9.7 kg $CaCO_3$ eq). Total inorganic carbon (TIC) levels are also low but detectable in all samples except those collected close to the ground surface, and are consistent with the presence of calcite and dolomite in the Reitveld XRD results. The near-surface samples also tend to have slightly acidic paste pHs, (as low as pH 5.1), indicating they provide essentially no buffering in deionized water. The low paste pH and lack of TIC in the near surface material are attributed to depletion of carbonate minerals resulting from carbonic acid in precipitation and naturally occurring organic acids in runoff. There are no other differences in the results from the different deposit areas. The NP/AP ratios are greater than 3 in all but three samples (5% of the sample set), indicating the majority of the overburden samples are non-potentially acid generating (NPAG). Two of the three exceptions were classified as low-S samples, and one was classified as having an uncertain potential for ARD (Figure 4-1). NAG test results indicated near neutral pHs for all samples.

A comparison between the trace element content of the overburden samples and five times (5x) the average crustal abundance for shale indicates that trace elements were not enriched in any of the overburden samples, with the exception of 4 samples that showed anomalously high silver and tungsten concentrations. Tungsten is commonly used as a hardener in steel, and it is suspected that these samples may have been contaminated during the drilling process. Results from the SFE tests indicate low concentrations of sulphate and other soluble trace elements, but an elevated chloride concentrations (median of 123 mg/L, maximum of 4720 mg/L). Calcium was the major cation in the samples with high chloride. Both sodium and calcium chloride were used in drilling fluids used to collect these samples. Therefore, it is likely that the chloride was introduced to the sample during drilling. Due to differences between lab and field conditions, the SFE results do not provide a direct indication of contact water quality. However, for screening purposes, soluble trace element concentrations were compared to a screening criteria based on 10x CCME guidelines for aquatic life. The results were consistently below those limits with the exception of one sample which exceeded the screening criteria for chloride.

4.1.3 Discussion

Overall, the results indicate that the overburden has a negligible potential for ML/ARD.

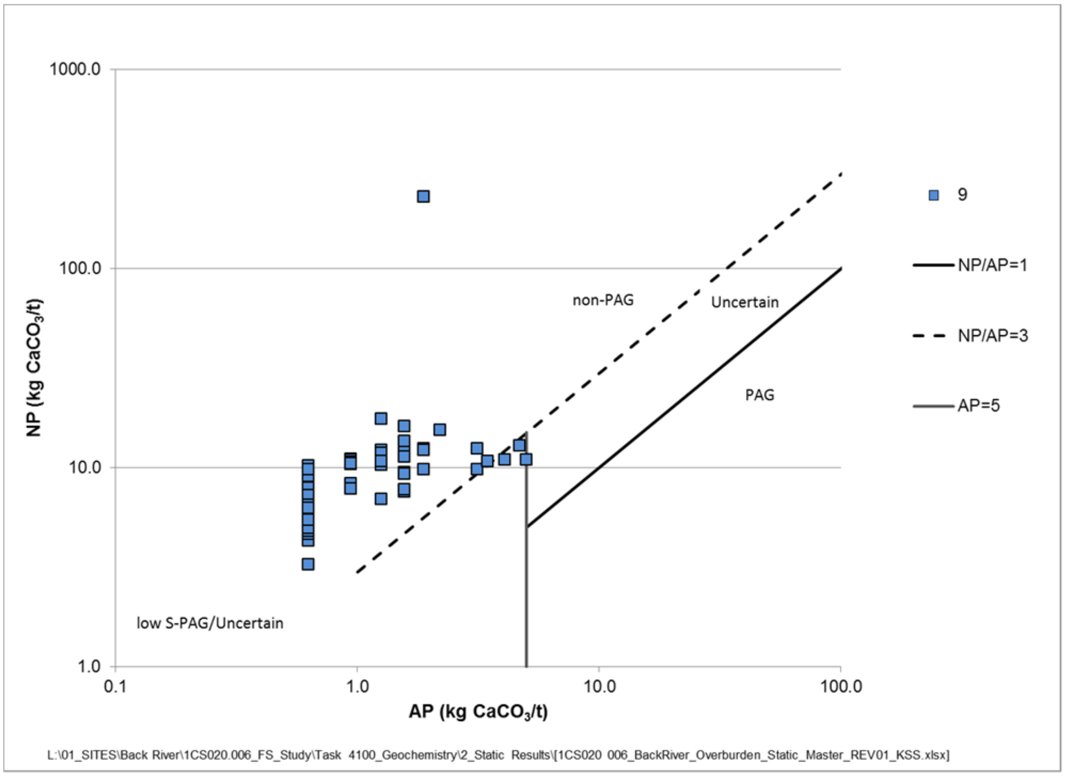

Figure 4-1: NP versus AP for Samples from the Goose Overburden

(Legend: 9 = overburden sample)

4.2 Airstrip Quarry

4.2.1 Overview

The Construction phase will require a total of 550,000 m^3 of quarry rock, which would be obtained from the current quarry west of the existing Goose exploration camp (the Airstrip quarry) and/or the proposed Umwelt quarry. The relative amount of material from each of these quarries will be determined by operational logistics. However, up to 550,000 m^3 could be sourced from either of these locations.

40 samples from quarries in the vicinity of the airstrip at the Goose Property were subjected to ABA and trace element analyses. Of the 40 samples from the airstrip quarries, 8 samples were subjected to Reitveld XRD, and 6 samples were subjected to SFE tests.

In June 2015, two seep samples were collected from the Goose Airstrip and submitted for water quality analyses. Since the Goose Airstrip was constructed from the Airstrip quarry, these samples provide an indication of water quality associated with quarry rock. The seepage results are presented and discussed in Appendix O.

4.2.2 Results

Testing results from the Airstrip quarry are presented in Appendix C2. The ABA results indicate that the Airstrip quarry samples have a wide range of sulphur and NP contents, resulting in variable ARD classifications, as shown in Figure 4-2. Mineralogical characterization indicated that 4 of the 8 samples submitted for Reitveld XRD contained pyrite and/or pyrrhotite, and that 6 of the 8 samples contained calcite or dolomite.

Rescan (2014a) reported the percentage of samples that are PAG, uncertain, or NPAG, according to rock type, but these were based on alternative interpretation methods based on subtracting “unavailable NP” from the measured NP. For consistency with the methods used for the interpretation of waste rock data (Section 5.1.4), these values were recalculated. The revised classifications, grouped by rock type are presented in Table 4-1. Consistent with the findings presented in Rescan 2014, it is concluded that the gabbro is consistently NPAG, and is therefore suitable for construction. Additionally, two of the greywacke/mudstone samples and two of the iron formation samples were PAG, and a number of samples from these and other units had an uncertain potential for ARD.

A comparison between the trace element content of the quarry samples and 5x the average crustal abundance for basalt (gabbro and QFP samples) and shale (meta-sediments). Rescan 2014 suggests that some of the gabbo and QFP samples are elevated in arsenic, bismuth and selenium concentrations, and that some of the metasedimentary samples are elevated in arsenic concentrations. Selenium concentrations were close to detection limits, limiting the usefulness of this comparison. However, the elevated arsenic concentrations (with average concentrations of 48 ppm compared to crustal averages of 2 and 13 for basalt and shale, respectively), may be indicative of potential for metal leaching under neutral pH conditions.

4.2.3 Discussion

Overall, results from the quarry characterization indicate rock from the Airstrip quarry has a variable potential for ARD. Gabbro is generally NPAG, while iron formation is generally PAG, and the other rock types contain a mixture of materials with PAG, NPAG, or uncertain potential for ARD. Based on these findings, SRK has recommended further testing, either on-site or off-site, in advance of quarry development to delineate PAG materials before or during construction phases. Any PAG quarry rock that is encountered during quarry operations would be stockpiled until it can be incorporated in the PAG area of the WRSAs. Based on water quality predictions for analogous samples tested as part of the waste rock characterization program (Sections 5.1.6 and 7.2.1), contact water is expected to contain slightly elevated levels of arsenic.

Table 4-1: Summary of ARD Classifications for Airstrip Quarry Samples

Rock Type	# of Samples	NPAG/ Low S	Uncertain	PAG
Gabbro	6	83%	17%	0%
Greywacke/Mudstone	25	36%	56%	8%
QFP	3	33%	67%	0%
IF	3	33%	0%	67%
Quartz Veins	3	33%	67%	0%

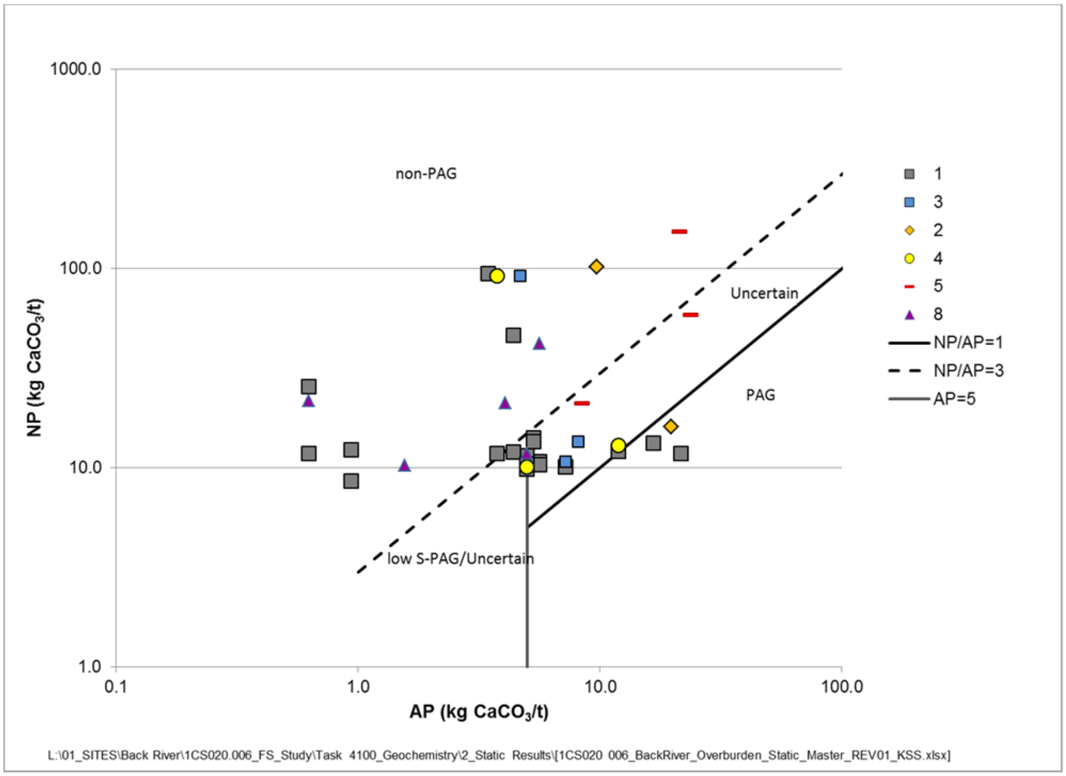

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Figure 4-2: NP versus AP for Samples from the Airstrip Quarry

(Legend: 1 = greywacke, 2 = iron formation, 3 = mudstone, 4 = QFP, 5 = qtz veins, 8 = gabbro)

4.3 Umwelt Quarry

4.3.1 Overview

As discussed previously, the Project Construction phase will require a total of 550,000 m^3 of quarry rock, which would be obtained from the current quarry west of the existing Goose exploration camp (i.e. Airstrip quarry) and/or the proposed Umwelt quarry areas.

Geochemical characterization of the Umwelt quarry areas was completed as part of the waste rock characterization program, as described in Section 5. A separate memo on samples in the quarry areas was also prepared to support a site preparation work application (SRK 2014b).

Data from the waste rock program was uploaded into geological modelling and visualization software (Leapfrog™) to identify samples that were representative of the potential quarry material within the ultimate Umwelt open pit. Samples were considered representative if they were located within the upper greywacke, within or in close proximity to the pit, and outside of the trend of the gold mineralization. Other samples from within the upper greywacke from both the Umwelt and Llama deposit areas were also considered in the assessment. However, it is noted that some of these are within the trend of the mineralization and may have been affected by mineralization processes. The quarry areas within the upper greywacke were selected specifically to avoid those areas. Altogether, there were 73 samples from the upper greywacke unit, of which 16 were representative of the material within the potential quarry areas. ABA and trace element analyses are available for this material.

4.3.2 Results

Relevant static testing data from the Umwelt quarry areas are summarized in Appendix C3. Figure 4-3 is a plot of the neutralization potential (NP) versus acid potential (AP) for the upper greywacke showing results for all of the samples from the Umwelt and Llama deposit areas, with circles depicting the samples that are specifically representative of the potential quarry areas located on either side of the Umwelt mineralization trend.

The results for the upper greywacke indicate that in general, this unit contains very little sulphide (estimated based on total sulphur content and reported as AP), with average AP values of 6.5 kg $CaCO_3$ eq/t[2], and only 10% of the samples having an AP of greater than 10 kg $CaCO_3$ eq/t. The generally low AP suggests that this material is not likely to be an appreciable source of acidity. NPs were also very low indicating limited pH buffering capacity. Based on these results, approximately 67% of samples are classified as NPAG or as having a low sulphur content (AP <5 kg $CaCO_3$ eq/t), 27% are classified as having an uncertain potential for ARD (NP/AP=1 to 3), and 5% are classified as PAG (PAG; NP/AP<1).

As stated previously, 16 of the upper greywacke samples are considered to be representative of the potential quarry areas. The majority of these are classified as NPAG or low sulphur material, and three samples are classified as having an uncertain potential for ARD. Only one of these

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[2] The units for NP and AP are normalized to units of $CaCO_3$ equivalent/tonne (eq/t). For reference, pure calcite would theoretically have an NP of 1,000 kg $CaCO_3$ eq/t (100% $CaCO_3$).

samples has an AP greater than 10 kg $CaCO_3$ eq/t, again, indicating that this material is unlikely to be an appreciable source of acidity.

Samples representing the quarry areas had solid phase arsenic concentrations consistently less than 50 ppm (with a median of 11 ppm), indicating a relatively limited potential for metal leaching.

4.3.3 Discussion

Overall, these results indicate that the majority of the upper greywacke samples representing the proposed quarry areas within the Umwelt pit are classified as NPAG or low S material with a limited potential for ARD. Additionally, based on low solid phase arsenic concentrations, metal leaching is unlikely to be an issue. For these reasons, upper greywacke from the proposed Umwelt quarry areas is considered suitable for use in construction and does not require special management procedures.

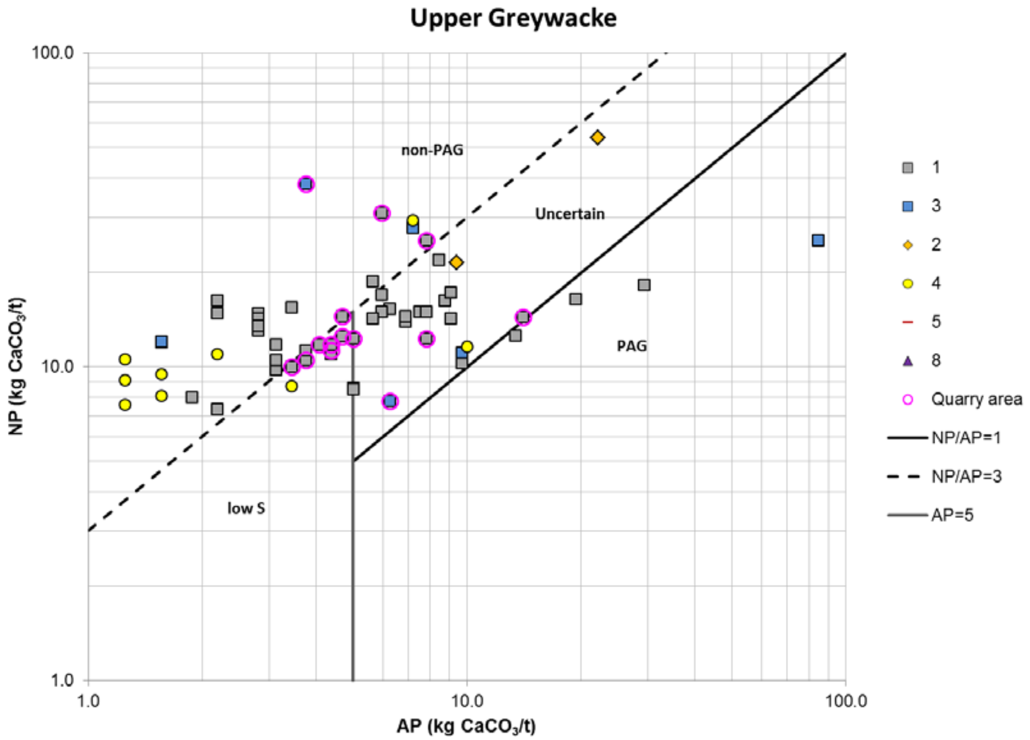

Figure 4-3: NP versus AP for Upper Greywacke Samples

Note: Samples circled in pink are considered to be representative of material from the proposed quarry areas on either side of the mineralization trend

(Legend: 1 = greywacke, 2 = iron formation, 3 = mudstone, 4 = QFP, 5 = qtz veins, 8 = gabbro)

4.4 Other Excavation Areas at the Goose Property

4.4.1 Overview

A limited amount of bedrock excavation may be required as part of construction activities at the Goose Property, primarily in the plant site area. Thirteen near-surface bedrock samples were collected from the various infrastructure areas for geochemical characterization, and were subjected to ABA, NAG tests, and trace element analyses.

4.4.2 Results

Relevant static testing data from the other excavation areas are summarized in Appendix C4 and Figure 4-4. The ABA results indicate that these samples contain low to moderate levels of sulphide, and relatively low NP, with five samples classified as NPAG, and two as low-S, five as uncertain, and one as PAG (Figure 4-4). NAG test results showed acidic pHs for all of the PAG and uncertain samples, but none of the NPAG or low-S samples.

A comparison between the trace element concentrations to 5x the average crustal abundance for basalt (gabbro samples) and shale (meta-sediments) suggests a few of the samples elevated with respect to arsenic, bismuth or selenium concentrations. Again, selenium concentrations were close to detection limits, limiting the usefulness of this comparison.

4.4.3 Discussion

Overall, results from the other excavation area characterization indicate rock from the excavation areas have a variable potential for ML/ARD. The volumes of material that are expected to be disturbed as a result of cut and fill construction activities is expected to be very small.

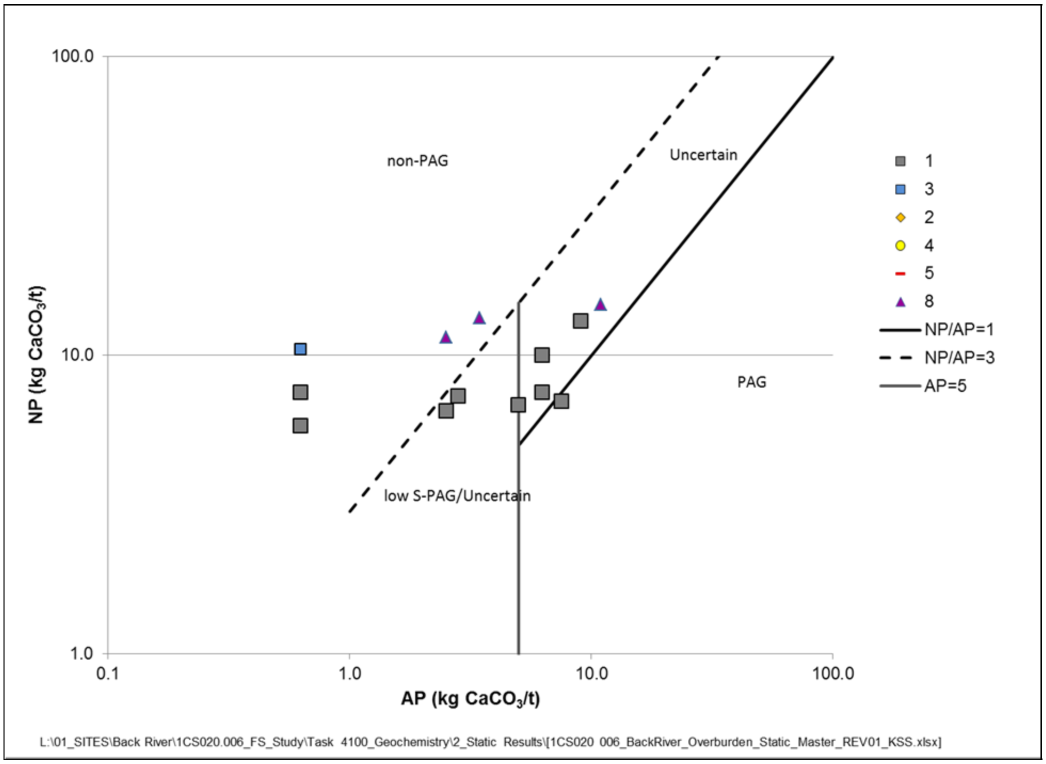

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Figure 4-4: NP versus AP for Excavation Areas

(Legend: 1 = greywacke, 2 = iron formation, 3 = mudstone, 4 = QFP, 5 = qtz veins, 8 = gabbro)

4.5 Quarry Materials at the MLA

4.5.1 Overview

Approximately 362,000 m^3 (in-situ volume) of rock will be excavated from the proposed Fuel Storage Farm at the MLA and will be used to construct pads and other local infrastructure.

A total of eight bedrock outcrop samples and seven gravelly sand samples were collected in the vicinity of the MLA Fuel Storage Farm, and were subjected to ABA, NAG tests, trace element analyses, whole rock analyses, and SFE tests. Both of these materials are expected to be used as quarry material at the MLA.

4.5.2 Results

Sample descriptions and testing results are provided in Appendix C5.

All of the bedrock samples are described as weathered quartzite conglomerate and quartz arenite/quartzite (sandstone). Sample photographs show these are generally a light buff to pink colour. Clasts within the gravelly sand samples are similar in appearance.

The ABA results indicate that sulphur concentrations in all but two of the samples are below the detection limit of 0.02%, and those two samples had concentrations of 0.03 and 0.04% respectively, indicating that there are essentially no sulphides present. Similarly, NP and TIC are very low, with NP ranging from 0.8 to 4.3 kg $CaCO_3$ eq/t, and TIC ranging from <0.5 to 2.7 kg $CaCO_3$ eq/t. Paste pHs are mildly acidic, ranging from 4.6 to 7.3, with median values of 5.6. The mildly acidic pH conditions reflect the limited buffering capacity of these samples when in contact with deionized water.

Trace element concentrations in most samples were within a factor of 5x average crustal values for sandstones.

The SFE results indicated mildly acidic pH consistent with the paste pH results. Sulphate concentrations were also very low, which is consistent with the low sulphide content of the solids. To provide an indication of the metal leaching potential, trace element concentrations were compared to a screening criterion based on 10x CCME guidelines. All of the results were below this threshold.

4.5.3 Discussion

Overall, the results indicate a negligible potential for ML/ARD in quarry materials extracted from the MLA Fuel Storage Farm. However, all of the samples available for testing were weathered bedrock or gravelly sand samples from close to the ground surface. Although there is no evidence that significant concentrations of carbonate or sulphides are likely, materials at depth could contain small amounts of these minerals. Additional sampling and testing should be completed in advance of, or concurrent with construction at the MLA, and the results will be used to verify these findings.

5 Waste Rock

5.1 Results

5.1.1 Sample Coverage

The spatial and geological coverage of samples was assessed as part of the supplemental sampling program. For each of the deposit areas, there was at least one section with continuous downhole samples representing a complete stratigraphic section through the deposit, plus a number of other shorter intervals distributed throughout the deposit area.

At the Goose Property, a total of 841 ore and waste rock samples were collected for complete ABA and metal analyses. Due to various changes in the mine plan, the sample coverage extends beyond the limits of the mine workings in a number of areas. As such, some waste rock samples were excluded from use in any statistical summaries presented in this report. Excluded sampled included those that were more than 20 m off strike from the ultimate open pit boundary, as well as those that were along strike, but more than half the diameter of the pit shell outside of the pit shell outside of the pit shell. Additionally, ore grade samples were not considered in the waste rock evaluation.

In total 676 waste rock samples from the Goose Property were included in the geochemical evaluation. More detailed summaries by deposit area and rock type are provided in Table 5-1. The sample coverage is considered adequate for the purposes of the Project and the FEIS. During mining, additional sampling and testing will be required to segregate PAG and NPAG waste rock.

Table 5-1: Distribution of Samples by Deposit and Stratigraphic Unit – Goose Deposits

Model Unit	Goose Main	Echo	Llama	Umwelt	Totals	% of Total Waste Rock Mass
UGW	25	3	31	22	81	17%
UIF	48	3	115	26	192	49%
LIF and MM	9	-*	50	12	71	8%
LGW and DIF	36	13	138	32	219	15%
PHY	21	-*	-*	-*	21	4%
GAB	20	-*	35	7	62	5%
QFP	2	-*	19	9	30	3%
Total	161	19	388	108	676	

Notes: * unit is minor or absent in these deposits

5.1.2 Mineralogy

In the previous work by Rescan, a total of 81 waste rock samples were subjected to mineralogical analysis by Reitveld XRD (Rescan 2014). SRK completed an additional 7 Reitveld XRD analyses as part of the kinetic testing program and also completed QEMSCAN analysis on all of the samples from the kinetic testing program, as presented in Appendix D of this report. Detailed interpretation of these results will be completed as part of the FEIS. Some key findings of the mineralogical work are summarized as follows:

- Chlinochlore (chloride), amphibole group minerals, biotite and/or plagioclase were a major component (defined as >10%) of samples from all units except veins. These are expected to contribute significantly to buffering capacity, especially when sulphur content is relatively low (Jambor 2002, Day and Kennedy. 2015).
- Pyrrhotite, and pyrite were the most abundant sulphide minerals and were present at trace to minor quantities in most samples. Lesser amounts of arsenopyrite and trace amounts of chalcopyrite were found in many of the samples, while trace amounts of lollingite were found in one sample, trace amounts of scheelite were found in one sample, and trace amounts of sphalerite were found in a few samples. The average sulphide mineral contents of samples representative of the Felsic Dike, Gabbro, Greywacke, Iron Formation, and Mudstone lithologies were, 0.4%, 0.4%, 2%, 5.4%, and 1%, respectively.
- Minor to trace amounts of calcite were present in many of the samples, and lesser amounts of iron dolomite, ankerite, and siderite were present in some samples. Where present, ankerite tended to be the more abundant type of iron carbonate. There were no clear relationships between the presence of iron carbonate minerals and rock type or deposit area.

Results from the QEMSCAN analyses were used to calculate the total carbonate content of the samples, and these were compared to TIC results from the ABA testing (Section 5.1.4). The comparisons indicate there is a strong correlation between the mineralogical results and the analytical results (Figure 5-1), indicating that they can be used in a quantitative manner. Plots of total carbonate content versus calcite, and total carbonate content versus iron carbonate minerals (i.e. sum of ferroan dolomite, ankerite, and siderite), indicate that calcite is the dominant form of carbonate in most samples, but that iron carbonates are the dominant forms in some samples (Figure 5-2 and Figure 5-3). Additionally, they indicate that iron carbonates tend to be the more dominant form of carbonate in samples with more appreciable amounts of carbonate. Plots of NP versus calcite (not shown) indicate that NP is generally higher than the calcite content, suggesting that calcite is not a significant component of the NP.

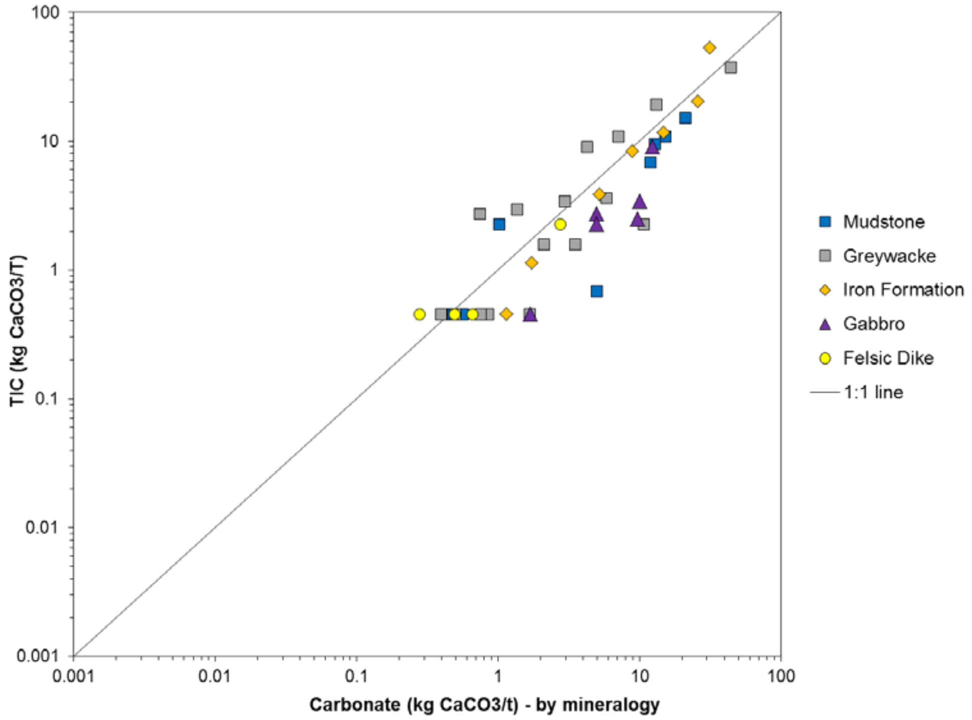

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Figure 5-1: TIC versus Carbonate Content by Mineralogy

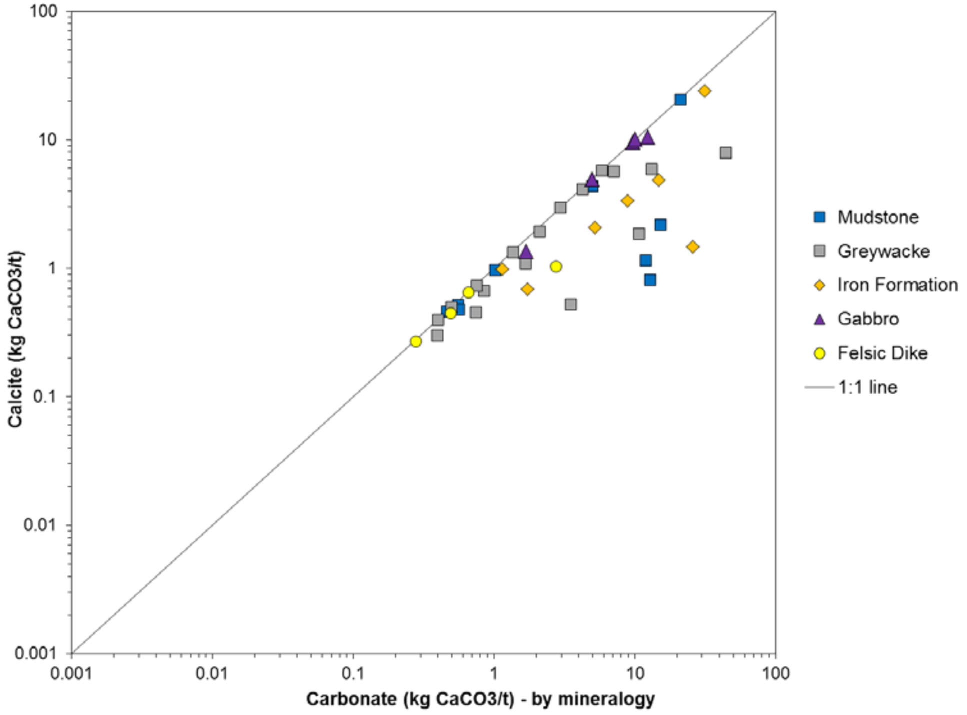

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Figure 5-2: Calcite by Mineralogy versus Total Carbonate Content by Mineralogy

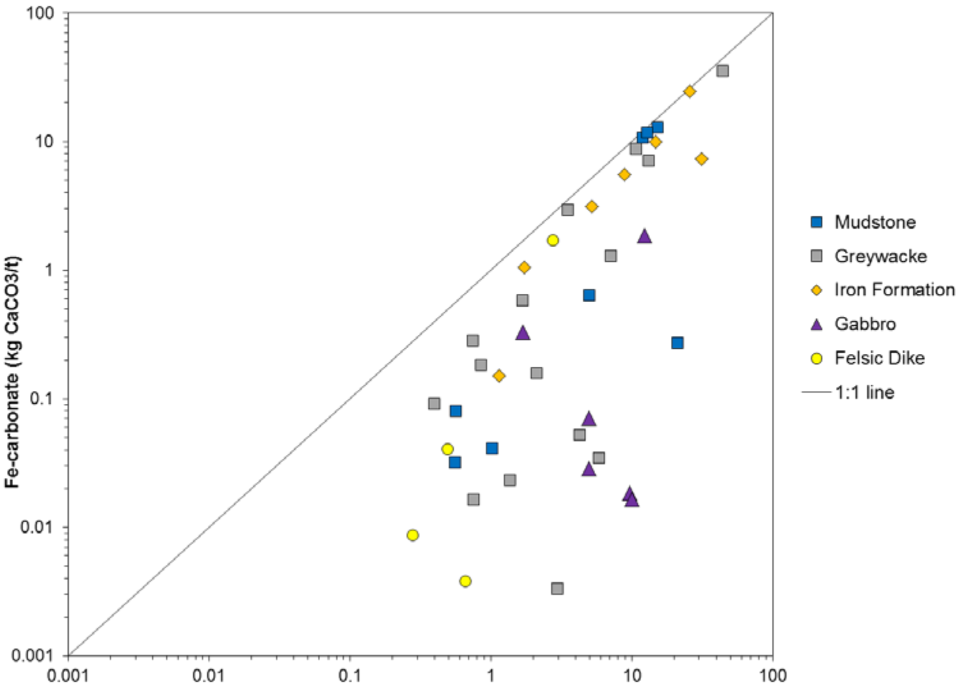

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Figure 5-3: Fe-carbonate by Mineralogy versus Total Carbonate Content by Mineralogy

5.1.3 Trace Elements

Complete results of the trace element analyses, including a statistical summary, are provided in Appendix E. Table 5-2 provides a summary of results for key parameters of interest. The results are compared to 5x the average crustal abundance (CA) values to assess for enrichment which may be indicative of increased potential for metal leaching. The sedimentary units (all units except Gabbro and QFP) were compared to 5x the average CAs for shale and sandstone, gabbro was compared to 5x average CA for basalt, and QFP was compared to the 5x average CA for calcium-rich granites.

The results for the Goose sedimentary samples indicate that median concentrations of arsenic, cobalt, copper, molybdenum, and nickel were enriched relative to sandstone in all units. Median concentrations of arsenic were elevated in the QFP, and median concentrations of selenium were enriched relative to gabbro. The 75th percentile concentrations of arsenic were also enriched relative to shale in the LGW.

The results for the George sedimentary samples (all units except QFP and Intermediate Volcanics) indicate that arsenic was enriched relative to sandstone, and that median concentrations of cobalt, copper, molybdenum, and nickel were enriched relative to sandstone in most units. Median concentrations of arsenic and chromium were also enriched in the QFP.

5.1.4 ABA

Complete results of the ABA tests are provided in Appendix F. Plots showing the relationships between paste pH and NP/AP ratios, NP and TIC, total sulphur versus sulphide sulphur, total sulphur versus sulphate sulphur, and sulphide sulphur versus ICP-S are provided in Figure 5-4 to Figure 5-8.

As shown in Figure 5-4, the vast majority of samples had alkaline paste pHs between 8 and 10. Only 6 samples had paste pHs of less than 7, and all of these were clearly PAG with NP/AP ratios of less than 0.2. Three of the acidic samples were iron formation samples from the mineralized zones of the deposit.

NP[3] was generally low to moderate, typically ranging from approximately 10 to 50 kg $CaCO_3$ eq/t. Samples with higher NP values showed a broad correlation between NP and TIC, but at lower concentrations, TIC was unrelated to NP (Figure 5-5). In general, NP was higher than TIC, indicating that silicate minerals are an important component of the NP. This is consistent with the presence of clinochlore (chlorite), amphiboles, plagioclase, and biotite (calcium/magnesium silicate minerals) that were identified in the mineralogical tests. A very small proportion of the samples had TIC greater than NP, consistent with the finding that iron carbonates are present in the deposit. As discussed previously (Section 5.1.2), calcium carbonates were the dominant type of carbonate mineral in most samples.

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[3] Unless otherwise stated, NP refers to the standard Sobek or Siderite corrected Sobek NP results.

Table 5-2: Summary of Trace Element Analyses (Median Concentrations by Rock Type)

Area	Rock Type	As ppm	Cd ppm	Co ppm	Cr ppm	Cu ppm	Mo ppm	Ni ppm	Pb ppm	Se ppm	Zn ppm
Goose	GAB	4.1	0.10	34	47	147	0.5	48	2.1	0.30	65
	LIF	18	0.010	6.6	60	18	0.5	16	2.2	0.10	11
	UIF	10	0.030	14	94	35	1.0	39	4.6	0.10	44
	LGW	25	0.070	20	99	45	1.6	63	7.0	0.10	69
	UGW	13	0.090	21	101	50	1.5	61	9.2	0.10	72
	PHY	16	0.10	24	95	48	1.7	75	7.0	0.10	88
	QFP	164	0.050	1.0	53	4.0	0.8	3	3.9	0.10	27
5x Crustal Averages	*basalt*	*10*	*1.1*	*240*	*850*	*435*	*7.5*	*650*	*30*	*0.25*	*525*
	high Ca Granite	*9.5*	*0.65*	*35*	*110*	*150*	*5*	*75*	*75*	*0.25*	*300*
	shale	*65*	*1.5*	*95*	*450*	*225*	*13*	*340*	*100*	*3*	*475*
	sandstone	*5*	*0.25*	*1.5*	*175*	*25*	*1*	*10*	*35*	*0.25*	*80*

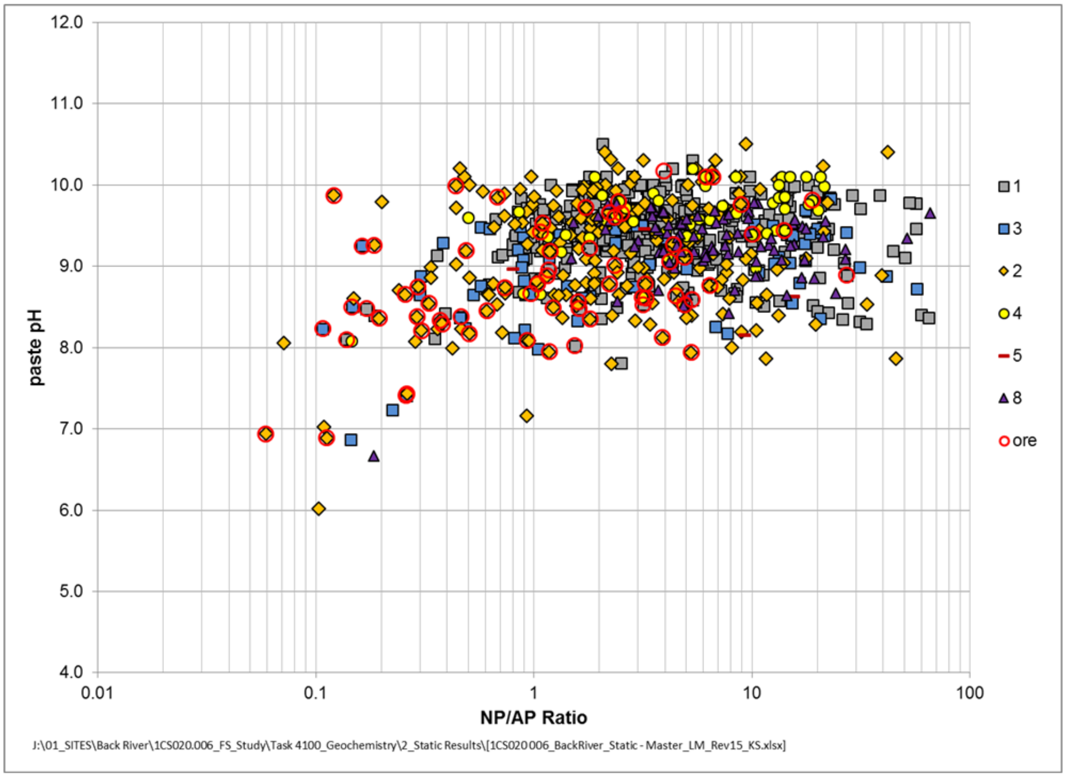

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Figure 5-4: Paste pH versus NP/AP Ratio – Waste Rock and Ore Samples
(Legend: 1 = greywacke, 2 = iron formation, 3 = mudstone, 4 = QFP, 5 = qtz veins, 8 = gabbro)

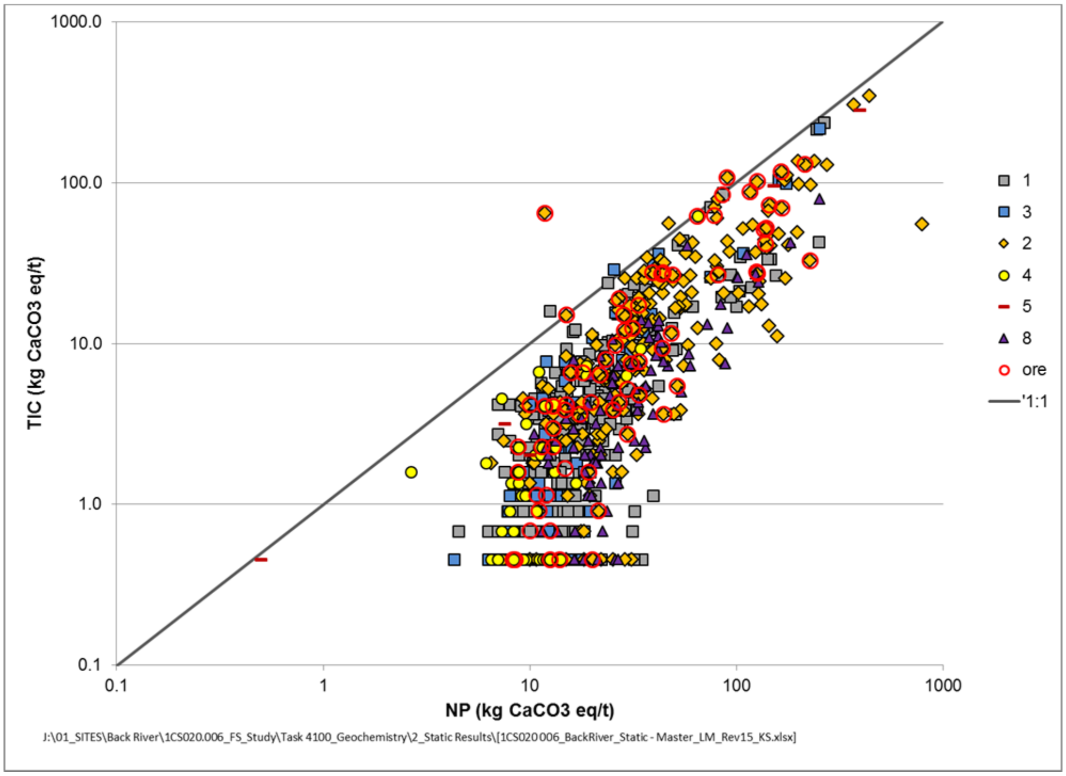

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Figure 5-5: TIC versus NP – Waste Rock and Ore Samples

Sulphide was the dominant form of sulphur in most of the samples (Figure 5-6), consistent with the findings of the mineralogical analyses. However, sulphate was identified in a number of samples, and was the dominant form of sulphur in some of those (Figure 5-7). Sulphate minerals were not identified in any of the mineralogical analyses. As discussed in Section 3.2.2, most of the samples tested as part of this program were also analyzed for pyritic sulphur using a direct measurement technique (ASTM 2492). However, the pyritic sulphur results were generally much lower than expected based on the mineralogical results, and were not considered to be valid for this reason. Therefore, the pyritic sulphur results were excluded from this interpretation. It is noted that the pyritic sulphur data would have resulted in significant underestimation of the sulphide content of these samples. Sulphur measured by ICP (ICP-S) was considered to be a reasonable alternative for establishing the inorganic or “soluble” forms of sulphur (sulphide and sulphate). The ICP-S was strongly correlated with sulphide sulphur calculated based on total sulphur minus sulphate sulphur (Figure 5-8), suggesting that insoluble forms of sulphur (i.e. that associated with organic carbon) are not an appreciable component of the samples. The variability observed at lower values is likely due to analytical uncertainties.

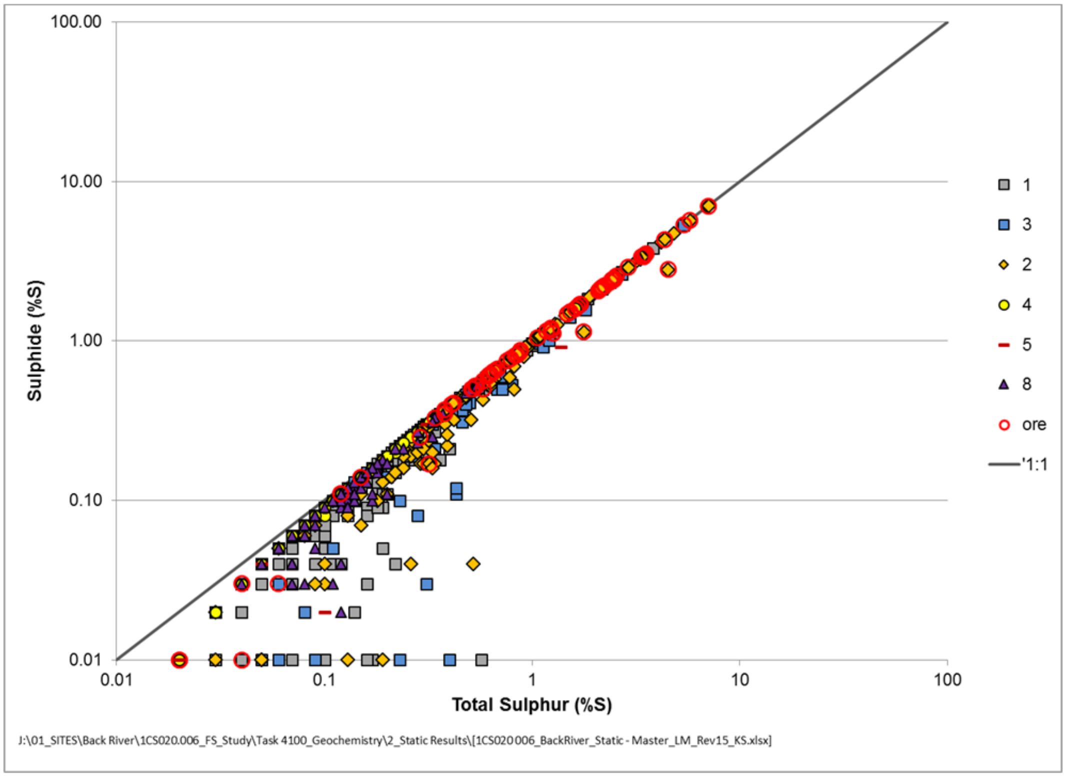

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Figure 5-6: Sulphide Sulphur (calculated) versus Total Sulphur – Waste Rock and Ore Samples

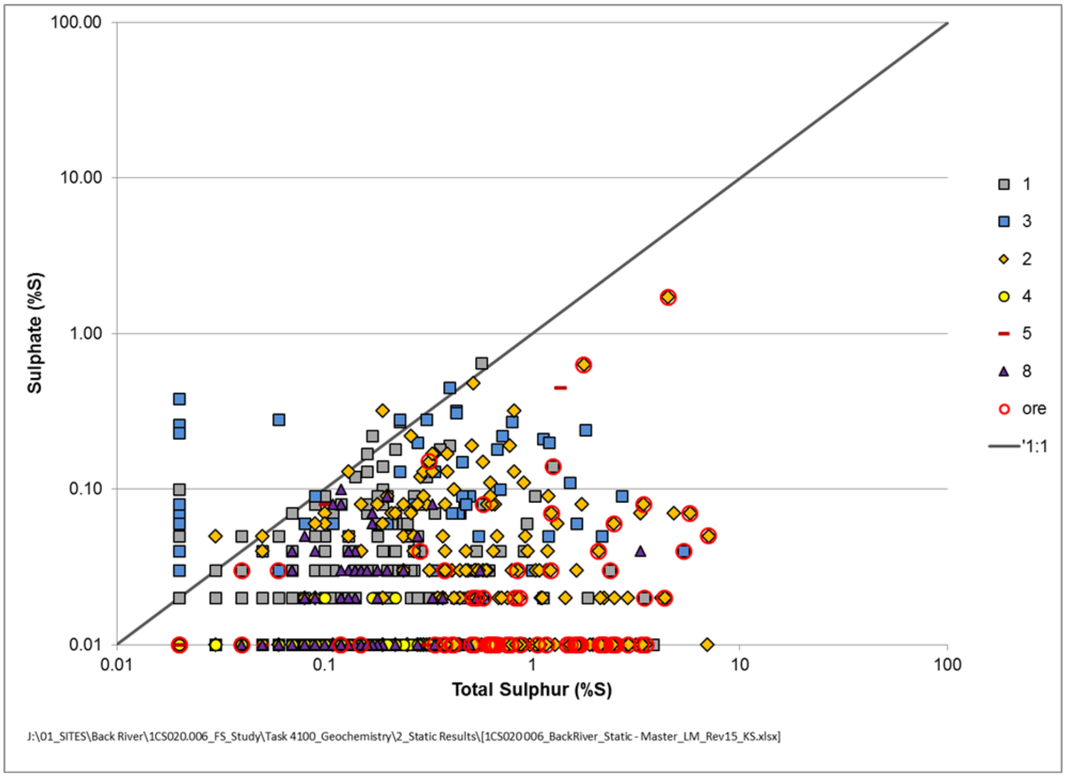

Figure 5-7: Sulphate Sulphur versus Total Sulphur – Waste Rock and Ore Samples

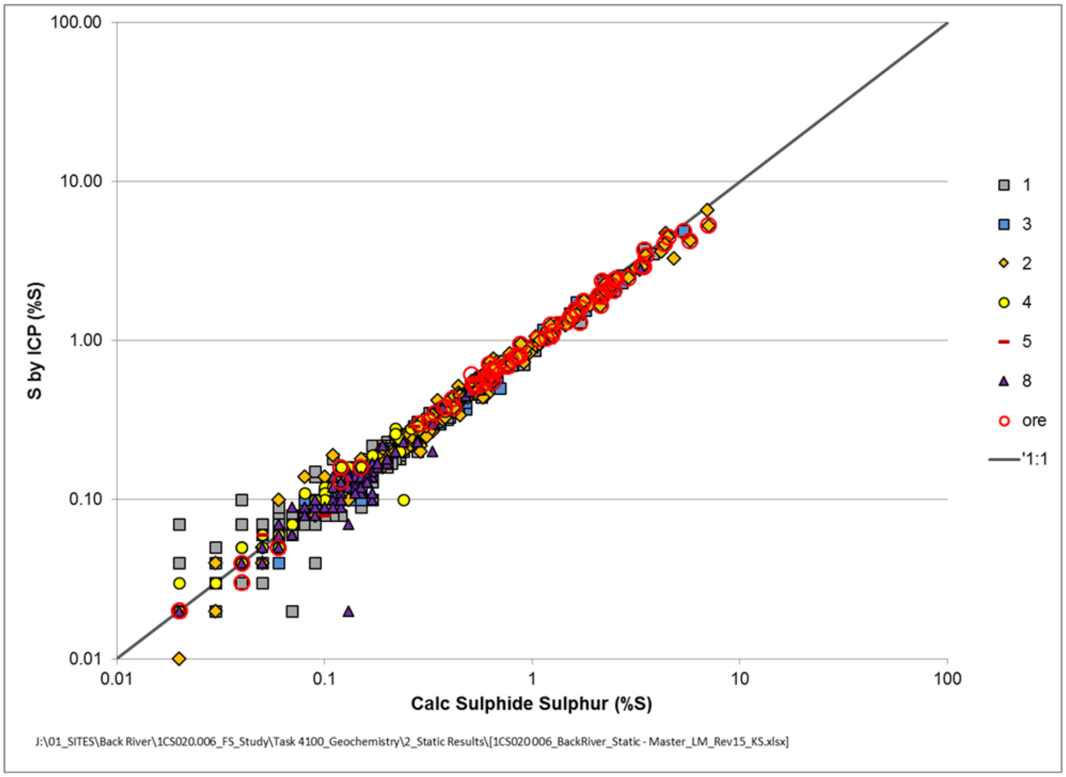

Figure 5-8: ICP S versus Calculated Sulphide Sulphur – Waste Rock and Ore Samples

For the purposes of the Project, the total sulphur content of the samples was used to calculate the acid potential (AP). This is a conservative assumption for those samples that contained appreciable amounts of sulphate. However, since those samples represent a relatively small proportion of samples in this dataset, it is not considered to be an overly conservative assumption. The ARD potential was classified based on a combination of the NP/AP ratios and AP results, as shown in Figure 5-9. Samples with NP/AP ratios of greater than 3 were classified as NPAG; samples with NP/AP ratios of less than 3 and AP less than 5 (total sulphur content of less than 0.16%) were classified as “low-S”; samples with NP/AP ratios of less than 3, but greater than 1 were classified as having an uncertain potential for ARD; and samples with NP/AP ratios of less than 1 were classified as PAG. There were no adjustments to account for the availability or reactivity of NP or sulphide. However, the NP/AP ratio of 3 that was used to define the “uncertain classification” considers the potential uncertainties in the availability and reactivity of the NP. Further refinement of the ARD classification, as discussed in Sections 5.1.5 and 5.1.6 shows that these classifications are somewhat conservative, suggesting that further refinement can be considered in future.

Figure 5-9 shows NP versus AP for each of the major stratigraphic and intrusive units at the Goose Property. In each of these plots, different symbols are used to distinguish the different rock types found in each stratigraphic unit. Additionally, samples within the ore zones are identified. Figure 5-10 and Table 5-3 show the proportions of waste rock samples classified as PAG, uncertain, NPAG, or low S for each unit for geochemically similar deposits at the Goose Property.

Some key observations are summarized as follows:

- Lower Iron Formation (LIF), Middle Mudstone – Results for these units at both deposit areas show a wide range of variation in NP and AP, with the highest AP values found in ore and low grade ore samples. In general, these units have the highest amount of AP (sulphide), indicating that the rate of sulphide oxidation could be more rapid in comparison to other units. There are no clear differences between the samples logged as IF versus mudstone.
- Upper Iron Formation (UIF) – Results for this unit at deposit areas show a similar range of variability in NP and AP to that of the LIF unit. However, proportions of PAG/uncertain material in the UIF are lower than the proportions observed in the LIF.
- Lower Greywacke (LGW) including Deep Iron Formation (DIF) – Results for these two units at both deposit areas indicate that the majority of the samples are NPAG or have very low sulphur concentrations. However, there are a modest number of samples classified as uncertain, and a small number classified as PAG. The Goose Main deposit tended to have a higher portion of NPAG material (78%, n=36) in comparison to the Umwelt/Llama/Echo deposits (59%, n=183). In general, the AP (sulphide content) is less than that of the iron formation units, possibly indicating that the rate of sulphide oxidation and metal release could be lower than rates from the iron formations.
- Upper Greywacke (UGW) – Approximately half of the Goose samples were NPAG or have very low sulphur contents. In general, the AP is less than that of the iron formation units,

again suggesting that rates of sulphide oxidation and metal release could be lower than rates from the iron formations.

- Phyllite (PHY) – Phyllite was present in the Goose Main deposit and the Echo deposit. The majority of the phyllite samples were NPAG or low-S.
- Quartz Feldspar Porphyry (QFP) –QFP typically forms narrow dykes through the other primary units, and is unlikely to be segregated during mining. Most samples are NPAG or have very low sulphur. Additionally, most samples had low AP, indicating that even if small amounts of PAG or uncertain QFP are mixed with other rock units, they would not adversely affect the blend.
- Gabbro – Gabbro dykes tend to be large enough that they could be segregated during mining. The Gabbro is predominantly NPAG (or has a low sulphur content, with a minor portion of samples classified as uncertain (11%)), and one sample classified as PAG.

The results show that there is significant variability within each of the stratigraphic units. Previous work by Rescan indicates that similar levels of variability are present in the different lithological units. The current waste rock management plans will require segregation of PAG and NPAG waste rock. Therefore, based on these findings, it is expected that segregation will need to rely on more intensive sampling and testing of blast hole cuttings to classify the ARD potential of waste rock during mining operations. The sampling density will depend to some extent on the spatial continuity of the different parameters governing ARD potential. To illustrate the spatial continuity, plots of all drill holes that were continuously sampled were prepared (Appendix F4). The results show few clear patterns other than an expected spike in sulphur content and ARD potential in the LIF, and increased sulphur content and ARD potential in the lower half of the UIF. Further work, including geostatistical analysis of these results is required to establish an appropriate sampling density for the segregation program. This work can be completed during the Construction and Operations phases.

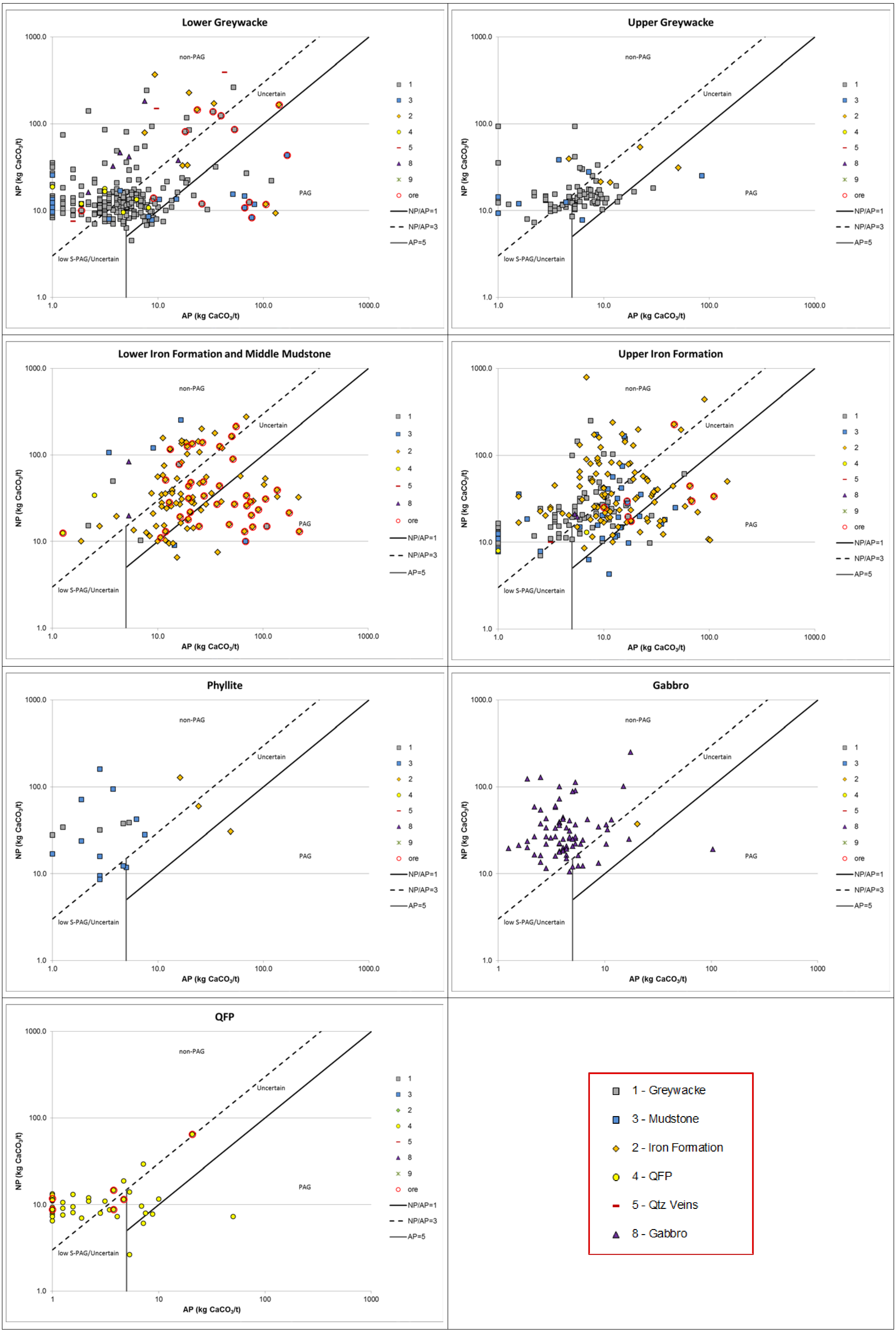

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Figure 5-9: NP versus AP by Stratigraphic Unit

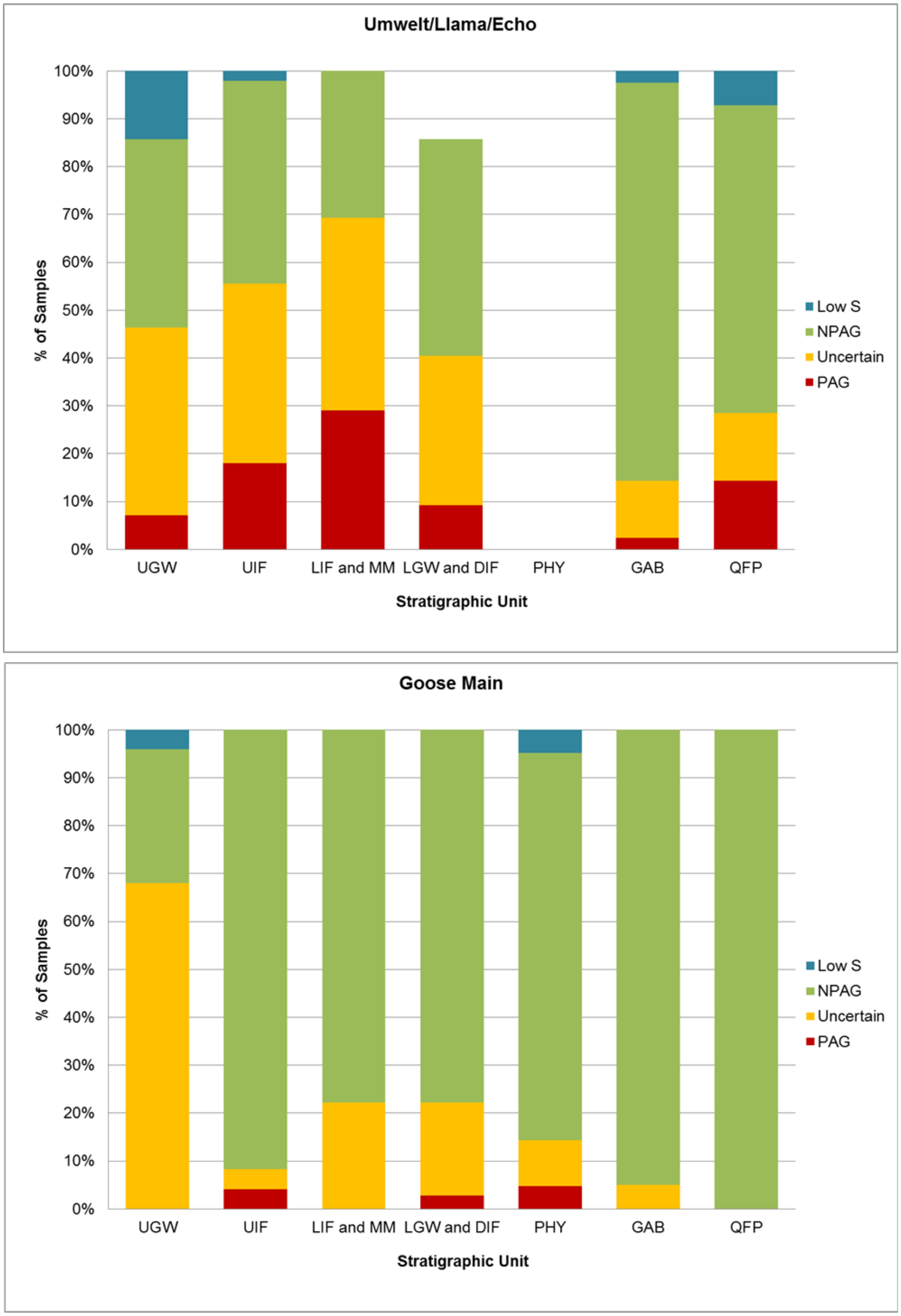

Figure 5-10: Proportions of PAG, Uncertain and NPAG Waste Rock by Stratigraphic Unit - Goose Deposits

Legend: UGW = upper greywacke, UIF = upper iron formation, LIF = lower iron formation, LGW = lower greywacke, DIF = deep iron formation, PHY = phyllite, GAB = gabbro, QFP = quartz feldspar porphyry.

Table 5-3: Quantities and Proportions of Waste Rock by ARD Classification – Goose Deposits

Group	**Classification**	**Goose Main**		**Echo/Llama/Umwelt**	
		number of samples	%	number of samples	%
LIF (includes MM)	PAG	0	0%	18	29%
	uncertain	2	22%	25	40%
	NPAG	7	78%	19	31%
	low S	0	0%	0	0%
	total	9		62	
UIF	PAG	2	4%	26	18%
	uncertain	2	4%	54	38%
	NPAG	44	92%	61	42%
	low S	0	0%	3	2%
	total	48		144	
LGW (includes DIF)	PAG	1	3%	17	9%
	uncertain	7	19%	57	31%
	NPAG	28	78%	83	45%
	low S	0	0%	26	
	total	36	0%	183	
UGW	PAG	0	0%	4	7%
	uncertain	17	68%	22	39%
	NPAG	7	28%	22	39%
	low S	1	4%	8	14%
	total	25		56	
PHY	PAG	1	5%		
	uncertain	2	10%		
	NPAG	17	81%		
	low S	1	5%		
	total	21			
GAB	PAG	0	0%	1	2%
	uncertain	1	5%	5	12%
	NPAG	19	95%	35	83%
	low S	0	0%	1	2%
	total	20		42	
QFP	PAG	0	0%	4	14%
	uncertain	0	0%	4	14%
	NPAG	2	100%	18	64%
	low S	0	0%	2	7%
	total	2		28	

5.1.5 NAG Tests

Results of the net acid generation (NAG) tests are provided in Appendix G and summarized in Figure 5-11 to Figure 5-13. Samples with a NAG pH of less than 5 were considered to be potentially acid generating.

The NAG test results indicate neutral pH conditions in all samples with NP/AP ratios greater than 2.4, acidic pH conditions in most samples with NP/AP ratios between 1 and 2.4, and acidic pH conditions in all but one of the samples with NP/AP ratios of less than 1 (Figure 5-11). These data are generally in agreement with the ABA test results, but suggest that the generic criteria for defining NPAG waste rock (NP/AP ratios of greater than 3) are conservative. Further discussion on the criteria for defining ARD potential is presented in Section 5.1.6.

A comparison of NAG pH and total sulphur content suggested that acidic conditions are unlikely to develop in samples with a sulphur content of less than 0.19% (Figure 5-12).

Comparison of the NAG test results to TIC/AP ratios (Figure 5-13) indicated a more complex relationship, and need to be considered along with the results of the sulphur content. All of the samples with acidic NAG pHs had TIC/AP ratios of less than 1.5, and most had ratios of less than 1. However, there were also many samples with TIC/AP ratios less than 1 that had near neutral NAG pH. Most of the neutral pH samples had sulphur concentrations of less than 0.19%, and suggest that other forms of NP (silicate minerals) are responsible for maintaining neutral pH conditions in these samples.

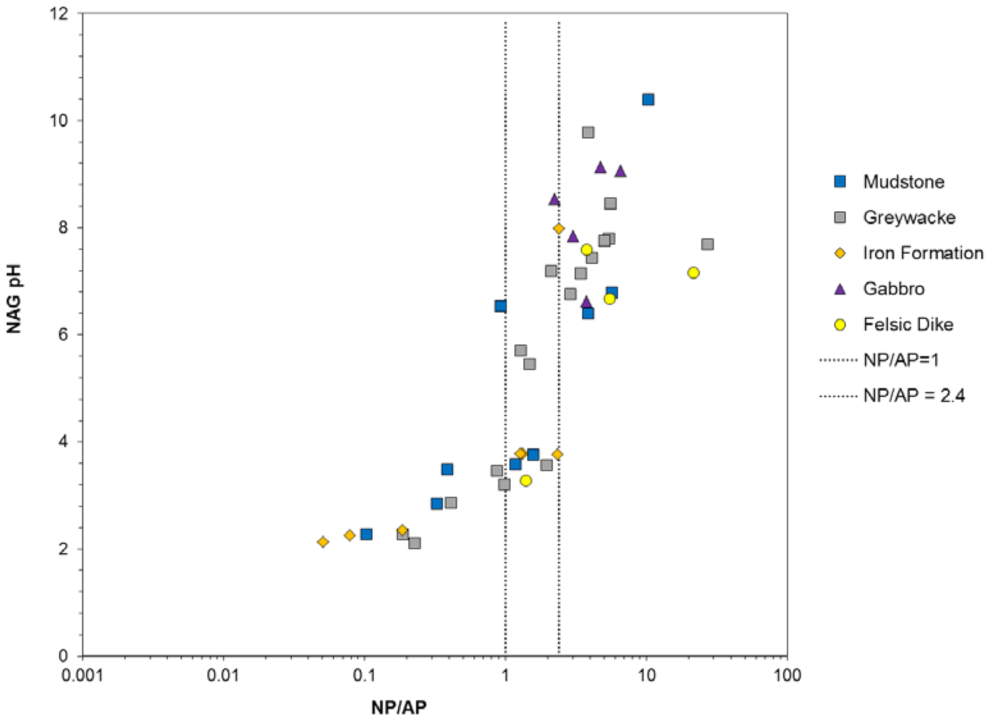

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Figure 5-11: NAG pH versus NP/AP Ratios

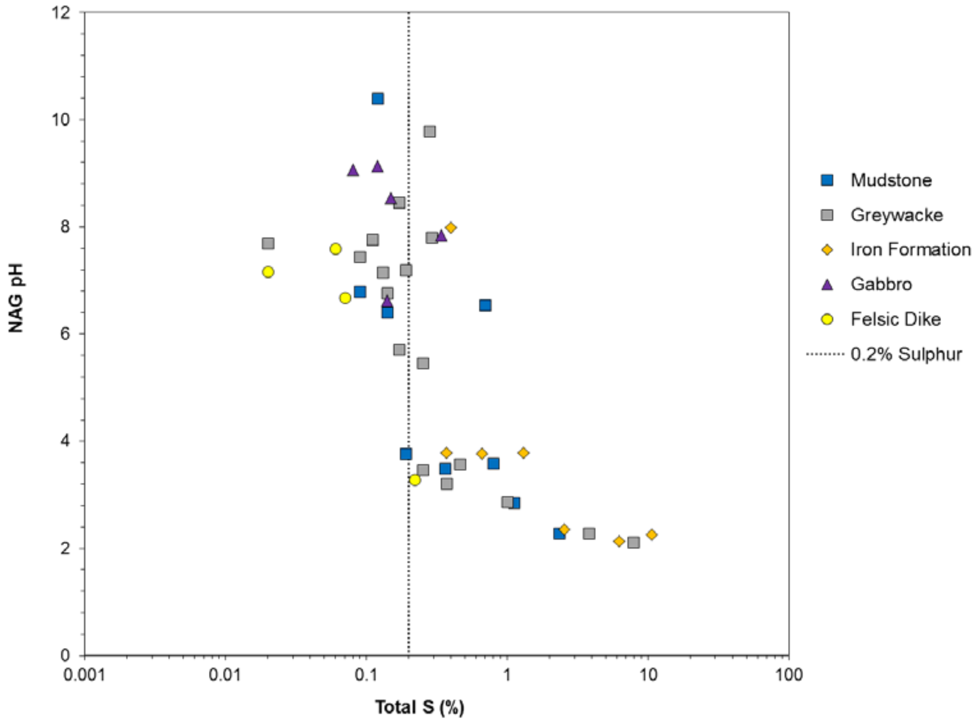

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Figure 5-12: NAG pH versus Total S Content

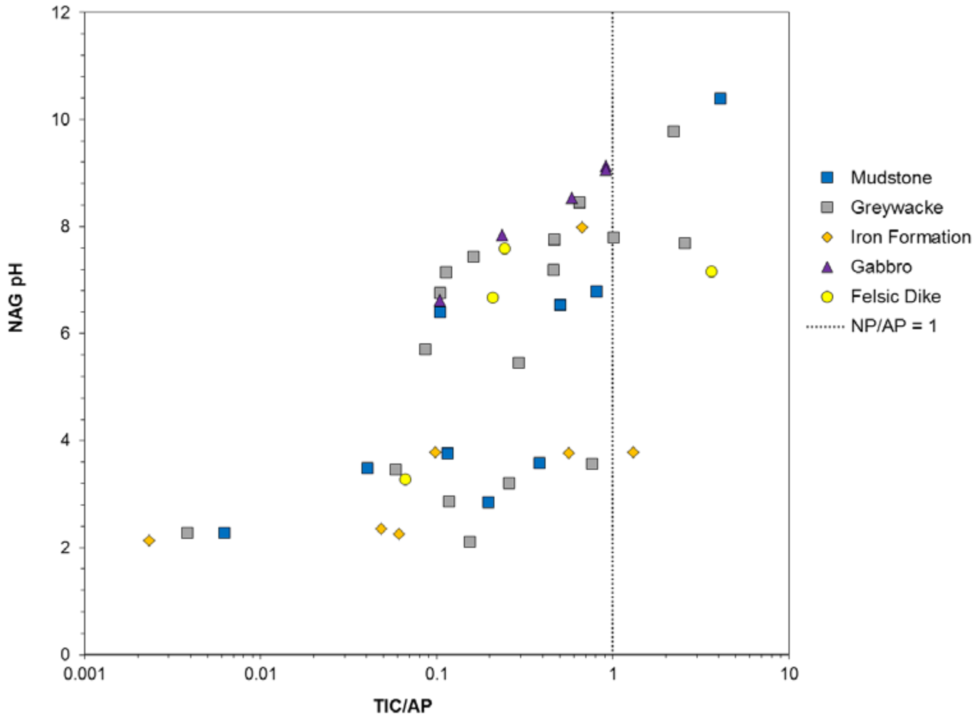

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Figure 5-13: NAG pH versus TIC/AP Ratios

5.1.6 Kinetic Tests

Sample Characteristics

As described in Section 3.2.5, a total of 43 waste rock humidity cells tests were completed as part of the geochemical characterization program.

The geochemical characteristics of the samples subjected to humidity cell tests were assessed through the analysis of mineralogy, trace elements, ABA, and NAG tests. The results of the mineralogy and static testing are presented below.

Mineralogy

As discussed previously, all of the kinetic test samples were subjected to mineralogical analyses using Reitveld XRD and QEMSCAN. Mineralogical results are presented in Appendix D. In general, the results from the kinetic test samples were comparable to that of the full dataset (see Section 5.1.2).

Trace Elements

Trace element data for the humidity cells are presented in Table 5-4 and Appendix E, along with a comparison to 75th percentile statistics from the larger static test dataset. The intent of the comparison was to assess whether the trace element content of the samples was typical or elevated in comparison to the larger and more representative static dataset.

Trace element concentrations for most of the QFP and gabbro samples were below the 75th percentile statistics for those units, indicating that they were within the range of typical samples. However, trace element concentrations exceeded the 75th percentile statistic in more than half of the iron formation, greywacke and mudstone samples – particularly for arsenic, suggesting that the kinetic tests were biased to include material with atypically high trace element concentrations, which suggests that results for these samples may be somewhat conservative with respect to ML/ARD potential. Humidity cells with trace element concentrations greater than the 75th percentile for their respective rock type also tended to have total sulphur and sulphide-sulphur contents that were above the 75th percentile, again suggesting that they may provide a conservative indication of ML/ARD potential.

Table 5-4: Summary of Selected ABA and Aqua Regia Digestion Results

Rock Type	Humidity Cell	Sample ID	Total Sulphur %	As mg/kg	Cd mg/kg	Cu mg/kg	Pb mg/kg	Ni mg/kg	Se mg/kg	Zn mg/kg
Felsic Dike	HC-25	12GSE168-47	0.06	280	0.11	11	7.7	2.3	0.1	32
Felsic Dike	HC-24	10GSE32-16	0.07	560	0.06	14	3.9	19	0.2	44
Felsic Dike	HC-05	12BR010055	0.02	12	0.06	2.3	6.5	3.8	0.1	26
Felsic Dike	HC-14	12BR030010	0.22	2700	1.5	14	3.8	11	0.3	160
Gabbro	HC-26	12GSE168-28	0.15	5	0.13	220	1.3	45	0.5	56
Gabbro	HC-08	12BR010043	0.34	7	0.3	150	5.7	58	-	120
Gabbro	HC-16	12BR030036	0.14	20	0.1	250	0.86	39	0.5	60
Gabbro	HC-27	12GSE168-44	0.12	21	0.11	120	2.7	54	0.1	87
Gabbro	HC-07	12BR010026	0.08	13	0.12	210	2.1	43	0.1	46
Gabbro	HC-06	12BR010024	0.17	5	0.2	130	7.3	68	-	120
Iron Formation	HC-11	12BR030003	0.66	360	0.03	52	3.4	35	0.3	44
Iron Formation (ore)	HC-46	629335	0.40	57	0.01	10	0.84	8.9	0.1	3.5
Iron Formation (ore)	HC-31	629334	6.30	7400	0.01	48	7.5	16	1.6	47
Iron Formation (ore)	HC-20	12GSE168-45	2.60	1800	0.03	20	2.4	7.1	0.2	7.5
Iron Formation (ore)	HC-41	12GSE159B-40	0.37	14	0.01	12	2	9.2	0.1	9.1
Iron Formation (ore)	HC-37	629346	11.00	20	0.01	130	4.7	20	1.7	10
Iron Formation (ore)	HC-34	629364	1.30	2800	0.04	46	1.4	7.7	0.5	28
Greywacke	HC-43	629359	0.17	10	0.03	57	3.8	55	0.1	61
Greywacke	HC-19	10GSE32-13	0.14	67	0.01	48	2.2	61	0.2	62
Greywacke	HC-18	12GSE144-42	0.13	21	0.08	30	8.1	79	0.1	80
Greywacke	HC-02	12BR010028	0.28	15	0.2	51	10	69	-	84
Greywacke	HC-45	12BR030001	0.29	3.8	0.01	27	6.1	34	0.1	36
Greywacke	HC-09	12BR030045	0.17	19	0.28	49	8.1	76	0.2	85
Greywacke	HC-35	629322	0.02	310	0.01	0.39	1.2	380	0.2	86
Greywacke	HC-44	629374	0.19	22	0.21	54	19	70	0.1	94
Greywacke	HC-10	12BR030011	3.80	140	0.04	170	5.1	150	2.4	54
Greywacke	HC-40	12GSE168-22	0.25	2.4	0.01	39	4.1	46	0.1	38
Greywacke	HC-33	629309	1.00	29	0.05	55	5	57	0.4	75
Greywacke	HC-17	12GSE144-33	0.25	2400	0.14	6.4	21	1.5	0.1	50
Greywacke	HC-36	629343	0.37	15	0.15	54	16	56	0.4	66
Greywacke	HC-01	433403	0.46	49	0.47	45	19	63	0.5	110
Greywacke (ore)	HC-30	629333	7.90	10000	0.02	88	9.8	140	2.7	40
Greywacke/Gabbro	HC-15	12BR030025	0.11	700	0.05	140	3	49	0.2	56
Greywacke/Mudstone	HC-22	12GSE159B-44	0.10	5.2	0.06	35	6	69	0.1	84
Mudstone	HC-04	12BR010054	0.09	35	0.15	53	10	100	0.1	88
Mudstone	HC-13	12BR030029	0.12	42	0.06	30	19	110	0.1	86
Mudstone	HC-38	629350	2.30	47	0.01	50	16	140	0.2	68
Mudstone	HC-23	12GSE168-34	0.36	45	0.06	89	8.2	72	0.2	100
Mudstone	HC-21	12BR020007	0.15	31	0.1	43	12	100	0.1	100
Mudstone	HC-32	629383	1.10	26	0.02	47	3.7	60	0.4	63
Mudstone	HC-03	12BR010035	0.70	10	0.1	45	12	62		97
Mudstone	HC-12	12BR030009	0.80	17	0.01	42	2.2	58	0.3	63
Mudstone	HC-42	629341	0.19	45	0.03	62	5.6	99	0.1	80

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Red- Data above 75th percentile for similar rock types in full dataset

ABA and NAG Tests

Results from the acid-base-accounting tests are shown in Figure 5-14. As with the larger static test dataset, the ARD potential of the samples was initially classified based on the NP/AP ratios (Figure 5-14). Samples with NP/AP ratio in excess of 3 were considered NPAG, while samples with NP/AP below 1 were considered PAG. Samples with NP/AP in the range of 1 to 3 were considered uncertain with respect to their acid generation potential. The majority of felsic dyke and gabbro samples were NPAG, with the exception of HC-14 and HC-26. For the greywacke and mudstone, 8 samples were NPAG, 5 samples were uncertain, and 4 samples were PAG.

Total sulphur concentrations in the humidity cell tests were compared to the 75th percentile statistics from the larger static test dataset (Table 5-4) to assess whether the sulphide content of these samples was typical or elevated in comparison to the larger and more representative static dataset. As discussed previously, sulphur concentrations exceeded the 75th percentile in more than half of the iron formation, greywacke and mudstone samples suggesting that the humidity cell samples were biased to include material with atypically high sulphide concentrations, and therefore may provide a somewhat conservative indication of ML/ARD potential.

Each of the humidity cell samples were subjected to NAG tests, as described in Section 5.1.5.

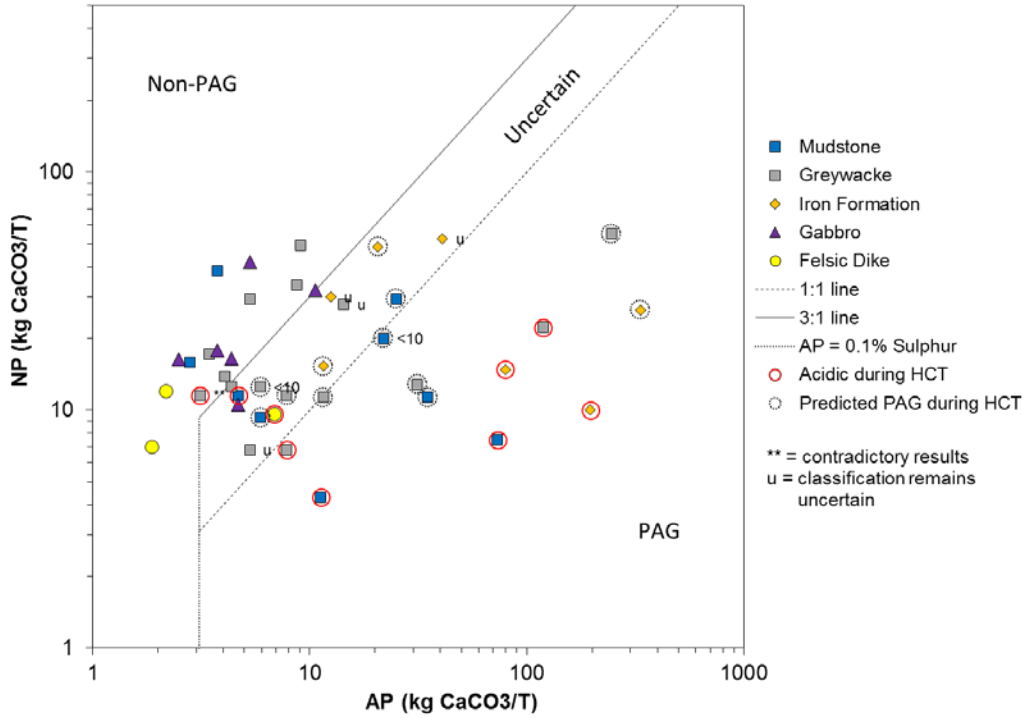

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Figure 5-14: NP versus AP for Humidity Cell Samples – Showing ARD Classification of Waste Rock

Concentrations and Trends

Complete results of the humidity cell tests, including plots of concentrations over time are provided in Appendix H. In the majority of tests, pH conditions remained neutral to alkaline. In these tests, maximum sulphate and trace element concentrations were generally observed during the first 10 to 15 weeks of testing, after which values declined and eventually stabilized.

Acidic conditions, defined by pH values of less than 5, developed in nine of the tests, including: HC-10, 14, 17, 20, 21, 22, 23, 31, and 38. These included six mudstone/greywacke samples, one felsic dyke, and two of the iron formation samples. In these samples, sulphate and trace element concentrations generally increased in response to decreasing pH concentrations.

Sulphate release rates were strongly related to total sulphur content (Figure 5-15). Stable sulphate release rate varied considerably from sample to sample, ranging from 0.64 to 61 mg/kg/week. However, 30 of 43 tests had sulphate release rates below 10 mg/kg/week.

The (Ca+Mg)/SO_4 ratios (carbonate molar ratio or CMR) provide an indication of the relative rates of NP versus sulphate release, which are used to evaluate and refine the projections of ARD potential. However, it is important to recognize that in samples with low sulphate release rates, some of the calcium and magnesium is flushed from the samples through dissolution by deionized water, rather than in response to sulphide oxidation processes. In this dataset, a plot of CMR versus sulphate release rates (Figure 5-16) indicates that excessive dissolution of calcium and magnesium is occurring in many of the samples with sulphate release rates less than 8.5 mg/kg/week, as indicated by wide scatter in CMR values below this threshold. All but one of the samples with sulphate release rates of greater than 8.5 mg/kg/week had CMR values less than 1.5, indicating that acidic conditions are unlikely to develop in samples with NP/AP ratios of greater than 1.5. This is slightly lower than the value of 2.4 indicated by the NAG tests, and may reflect increased utilization of the NP under the slower and more realistic rates of reaction simulated by the humidity cell tests.

To provide an indication of the metal leaching potential, maximum trace element concentrations in the humidity cell test leachates were compared to a screening criterion based on 10x CCME guidelines (Table 5-5). It is noted that these comparisons are not intended to provide an indication of whether leachate from the WRSAs will exceed discharge criteria, but rather to provide an indication as to whether specific parameters are of interest for this Project. Out of 43 humidity cells, 15 had aluminum concentrations exceeding these screening criteria, and 27 had arsenic concentrations exceeding these criteria. Several samples – notably those with acidic pH, also showed exceedances for cadmium (nine tests - 3 with neutral pH), copper (3 tests), iron (7 tests), nickel (4 tests), and zinc (1 test). No humidity cells had maximum lead or selenium concentrations in excess of the screening criterion. Metal release rates from the humidity cell tests were a key input to the water quality predictions described in Section 7. A summary of trace element release rates is provided in Table 5-6.

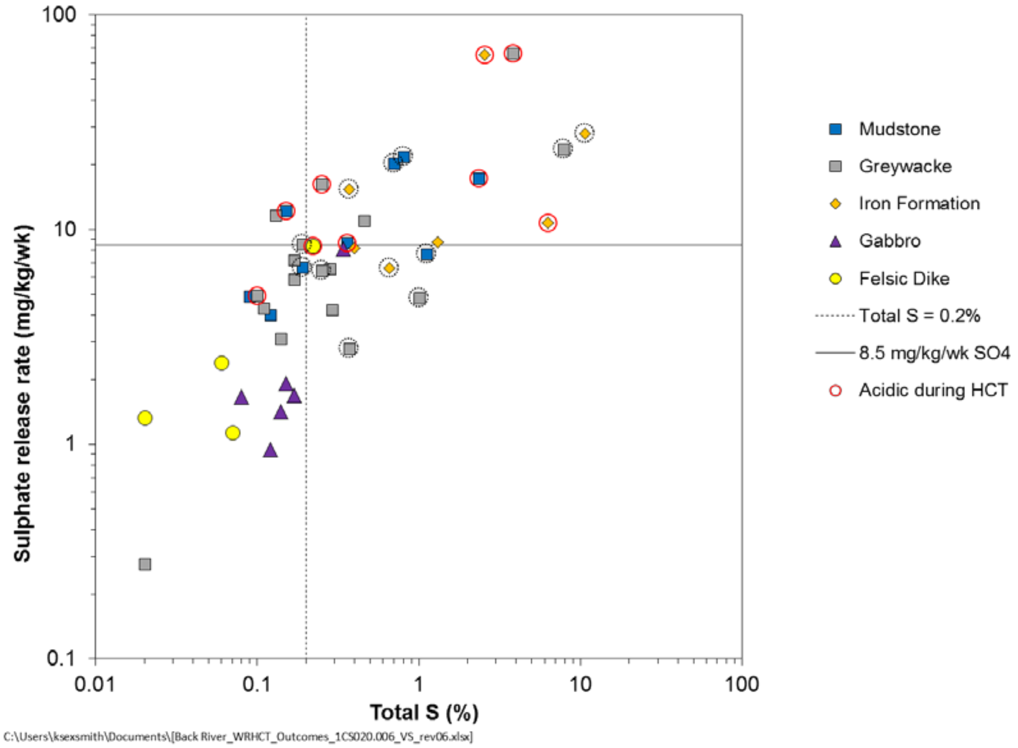

Figure 5-15: Comparison of Total Sulphur and Average Sulphate Release Rate

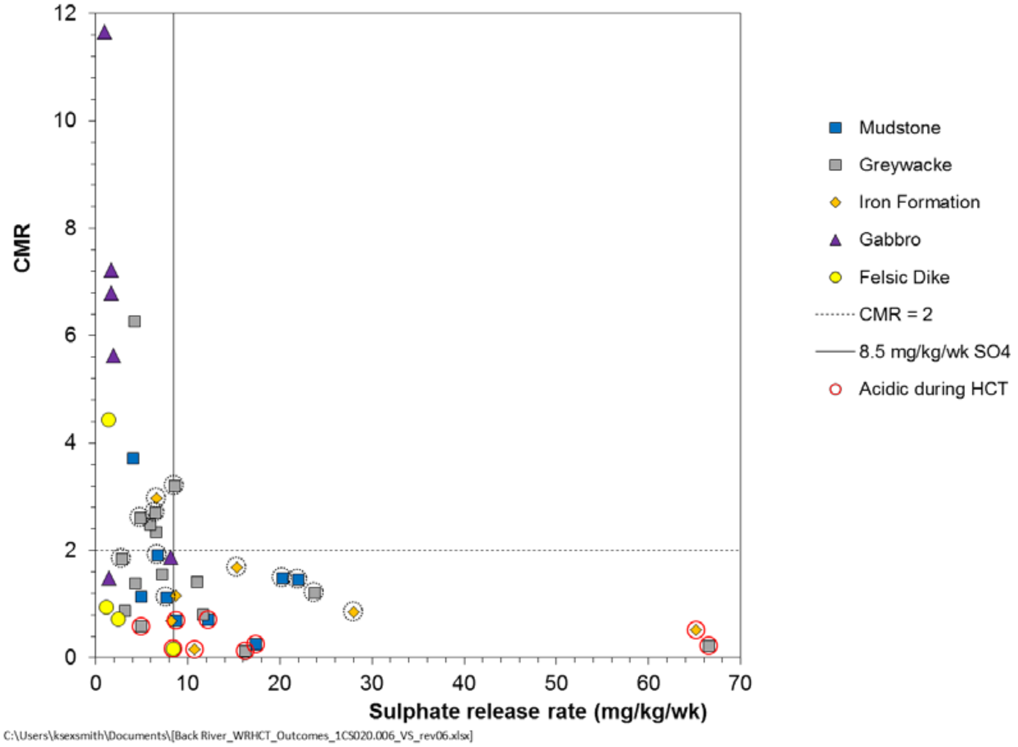

Figure 5-16: Comparison of Sulphate Release Rate and CMR

Table 5-5: Maximum Concentrations in HCTs – Compared to Screening Criteria

Rock type	Humidity Cell	pH	SO4 (mg/L)	Al (mg/L)	As (mg/L)	Cd (mg/L)	Co (mg/L)	Cu (mg/L)	Fe (mg/L)	Pb (mg/L)	Ni (mg/L)	Se (mg/L)	Zn (mg/L)
Felsic Dike	HC-25	5.4	7.2	0.42	0.15	0.00052	0.00058	0.001	0.75	0.00039	0.007	0.00023	0.035
Felsic Dike	HC-24	6.3	14	0.36	0.44	0.000006	0.00023	0.00081	0.13	0.00047	0.0016	0.00051	0.0012
Felsic Dike	HC-05	7.5	7.9	0.63	0.072	0.00003	0.00013	0.002	0.24	0.00055	0.0051	0.0017	0.0025
Felsic Dike	HC-14	3.9	45	1.9	2.5	0.015	0.036	0.017	14	0.0039	0.11	0.00098	1.9
Gabbro	HC-26	7.6	18	0.35	0.019	0.0016	0.00016	0.0015	0.17	0.00012	0.0015	0.00094	0.003
Gabbro	HC-08	7.5	22	0.23	0.01	0.000005	0.00078	0.0021	0.11	0.0013	0.0015	0.00039	0.0018
Gabbro	HC-16	6.6	15	0.19	0.011	0.000008	0.0011	0.00098	0.064	0.0003	0.00091	0.00062	0.0015
Gabbro	HC-27	7.6	13	0.69	0.062	0.000031	0.00031	0.0088	0.71	0.00057	0.002	0.0013	0.014
Gabbro	HC-07	7.7	23	0.63	0.11	0.00019	0.00021	0.011	0.31	0.001	0.0014	0.0015	0.012
Gabbro	HC-06	7.6	12	0.27	0.007	0.000005	0.000095	0.0014	0.074	0.00055	0.0018	0.00067	0.0009
Iron Formation	HC-11	7.6	120	0.23	0.075	0.000013	0.00025	0.013	0.18	0.00021	0.001	0.0013	0.0036
Iron Formation (ore)	HC-46	9.1	28	0.22	0.14	0.000006	0.000031	0.0053	0.5	0.00037	0.001	0.00064	0.0009
Iron Formation (ore)	HC-31	3.7	110	4.4	0.67	0.00013	0.049	0.51	18	0.00027	0.075	0.0015	0.035
Iron Formation (ore)	HC-20	3.8	170	0.27	0.19	0.000016	0.0015	0.0016	33	0.00029	0.0063	0.0005	0.0048
Iron Formation (ore)	HC-41	7.6	29	0.19	0.017	0.000098	0.000036	0.0025	0.29	0.000084	0.00034	0.00028	0.0048
Iron Formation (ore)	HC-37	6.9	220	0.15	0.02	0.000013	0.00005	0.0076	0.17	0.000071	0.0007	0.0005	0.0012
Iron Formation (ore)	HC-34	7.2	77	0.16	0.14	0.000005	0.000026	0.0032	0.21	0.000091	0.00054	0.00034	0.0019
Greywacke	HC-43	7.1	64	0.19	0.015	0.000013	0.00082	0.0036	0.047	0.00013	0.0025	0.0051	0.0015
Greywacke	HC-19	5.9	35	0.2	0.089	0.000027	0.0022	0.00097	0.054	0.000049	0.011	0.0012	0.0022
Greywacke	HC-18	5.3	29	0.61	0.19	0.00032	0.066	0.0056	2.1	0.00021	0.095	0.00041	0.021
Greywacke	HC-02	7.4	16	0.24	0.057	0.000064	0.0017	0.015	0.017	0.0016	0.0011	0.00045	0.006
Greywacke	HC-45	8.0	43	0.49	0.016	0.000005	0.000018	0.002	0.075	0.000095	0.00041	0.00081	0.0018
Greywacke	HC-09	7.6	22	0.32	0.16	0.000048	0.00077	0.0028	0.024	0.0012	0.0018	0.00042	0.0025
Greywacke	HC-35	7.4	29	0.18	12	0.00037	0.0059	0.0045	0.055	0.0051	0.12	0.0008	0.021
Greywacke	HC-44	7.8	44	0.4	0.21	0.000021	0.00043	0.00051	0.018	0.00018	0.004	0.0025	0.0013
Greywacke	HC-10	3.3	1300	7.2	0.0082	0.00079	1.9	0.018	310	0.0099	3.4	0.0037	0.087
Greywacke	HC-40	7.6	11	0.36	0.0052	0.000018	0.00007	0.0033	0.4	0.000059	0.0007	0.00027	0.0013
Greywacke	HC-33	7.5	44	0.24	0.096	0.000005	0.00017	0.00053	0.031	0.000099	0.0013	0.00079	0.007
Greywacke	HC-17	4.8	38	0.64	3.3	0.00063	0.0013	0.0091	17	0.0013	0.0086	0.0015	0.16
Greywacke	HC-36	7.2	12	0.22	0.044	0.000051	0.0011	0.0003	0.052	0.000089	0.0039	0.00043	0.0045
Greywacke	HC-01	7.2	82	0.14	0.067	0.00025	0.0012	0.0041	0.035	0.0035	0.0066	0.0016	0.015
Greywacke (ore)	HC-30	7.0	200	0.022	0.27	0.000022	0.025	0.0036	0.074	0.00021	0.068	0.0092	0.0095
Greywacke/Gabbro	HC-15	7.2	15	0.37	1.3	0.00021	0.0054	0.0015	0.9	0.00027	0.0097	0.0045	0.017
Greywacke/Mudstone	HC-22	4.5	20	0.52	0.0086	0.00056	0.077	0.015	4.1	0.0037	0.17	0.00018	0.066
Mudstone	HC-04	6.3	15	0.35	1.6	0.00011	0.0052	0.011	0.078	0.004	0.026	0.0021	0.009
Mudstone	HC-13	7.6	24	0.34	1	0.00003	0.00024	0.0029	0.027	0.00031	0.0044	0.0016	0.003
Mudstone	HC-38	3.5	55	3.9	0.0033	0.00012	0.46	1.2	1.7	0.0029	0.41	0.002	0.094
Mudstone	HC-23	4.0	85	1.5	0.18	0.00074	0.59	0.023	18	0.003	0.29	0.0015	0.13
Mudstone	HC-21	4.4	44	0.51	0.44	0.00085	0.16	0.017	1.6	0.0022	0.51	0.0013	0.061
Mudstone	HC-32	7.1	46	0.21	0.0095	0.000043	0.00039	0.0014	0.056	0.000034	0.0025	0.0005	0.0051
Mudstone	HC-03	7.1	51	0.21	0.0052	0.00005	0.00017	0.00085	0.02	0.011	0.0017	0.00057	0.004
Mudstone	HC-12	7.5	120	0.17	0.018	0.00001	0.00026	0.0011	0.056	0.000084	0.0015	0.00079	0.0008
Mudstone	HC-42	7.3	52	1.1	0.55	0.000011	0.0004	0.00081	0.017	0.0012	0.001	0.0014	0.003

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Notes: Red text indicates that concentrations exceeded screening criteria based on 10x CCME FAL guidelines (hardness dependent values calculated based on average hardness in HC tests).

Table 5-6: Stable Trace Element Release Rates (mg/kg/week) from Humidity Cell Tests

Rock Type	Humidity Cell	Sulfate mg/kg/wk	Ca mg/kg/wk	Mg mg/kg/wk	Al mg/kg/wk	As mg/kg/wk	Cd mg/kg/wk	Co mg/kg/wk	Cu mg/kg/wk	Fe mg/kg/wk	Pb mg/kg/wk	Ni mg/kg/wk	Se mg/kg/wk	Zn mg/kg/wk
Felsic Dike	HC-25	2.4	0.46	0.16	0.0071	0.0042	0.00012	0.00014	0.00013	0.16	0.000064	0.00018	0.000018	0.007
Felsic Dike	HC-24	1.1	0.15	0.19	0.0043	0.045	2.4E-06	0.000057	0.000061	0.0018	4.2E-06	0.00017	0.000023	0.0002
Felsic Dike	HC-05	1.3	1.6	0.55	0.088	0.017	6.3E-06	0.000003	0.000053	0.00086	0.00009	0.000057	0.000019	0.0003
Felsic Dike	HC-14	8.4	0.15	0.28	0.5	0.14	0.0031	0.0041	0.0058	1.3	0.00065	0.01	0.00016	0.31
Gabbro	HC-26	1.9	4.2	0.21	0.12	0.0044	2.4E-06	0.000035	0.00018	0.012	5.6E-06	0.00011	0.000054	0.000083
Gabbro	HC-08	8.1	6.1	0.16	0.057	0.0019	2.4E-06	0.00029	0.00016	0.0016	0.000075	0.00036	0.000062	0.00011
Gabbro	HC-16	1.4	0.41	0.28	0.003	0.00041	2.4E-06	0.00045	0.00022	0.00059	2.7E-06	0.00032	0.000057	0.00021
Gabbro	HC-27	0.95	4.1	0.28	0.12	0.023	2.4E-06	0.000053	0.00014	0.0069	2.8E-06	0.000081	0.000094	0.000095
Gabbro	HC-07	1.7	4.7	0.18	0.17	0.037	0.000005	0.000032	0.00011	0.0017	2.5E-06	0.000054	0.000065	0.000065
Gabbro	HC-06	1.7	4.3	0.3	0.076	0.0029	2.4E-06	0.000041	0.0001	0.0022	6.7E-06	0.000089	0.000061	0.000076
Iron Formation	HC-11	6.6	6.4	1.1	0.052	0.017	2.3E-06	0.000029	0.000058	0.012	4.2E-06	0.000083	0.00003	0.00045
Iron Formation (ore)	HC-46	8.2	1.4	0.62	0.063	0.0038	0.000005	9.5E-06	0.00033	0.058	0.000021	0.000093	0.00004	0.00027
Iron Formation (ore)	HC-31	11	0.11	0.36	0.63	0.036	4.9E-06	0.002	0.033	2.7	0.000016	0.0017	0.00021	0.0013
Iron Formation (ore)	HC-20	65	9.2	2.9	0.11	0.0014	3.6E-06	0.00046	0.00053	14	0.000054	0.0016	0.00012	0.0015
Iron Formation (ore)	HC-41	15	10	0.46	0.15	0.0016	5.5E-06	0.000014	0.00017	0.051	0.000013	0.00012	0.00004	0.00063
Iron Formation (ore)	HC-37	28	5.1	3	0.0018	0.000031	1.1E-06	8.5E-06	0.000043	0.00051	1.7E-06	0.00008	0.000046	0.000072
Iron Formation (ore)	HC-34	8.7	3.7	0.31	0.0031	0.00031	1.1E-06	2.6E-06	0.000071	0.0004	1.3E-06	0.000032	0.000009	0.000033
Greywacke	HC-43	7.2	2.6	1.3	0.032	0.012	6.8E-06	0.00058	0.00029	0.007	0.000017	0.00025	0.0002	0.00035
Greywacke	HC-19	3.1	0.33	0.49	0.0012	0.00083	2.7E-06	0.00099	0.00013	0.0026	6.1E-06	0.0048	0.000036	0.00039
Greywacke	HC-18	12	2.2	1.1	0.0075	0.00048	0.0001	0.019	0.00042	0.53	0.000054	0.029	0.000092	0.0058
Greywacke	HC-02	6.6	5.5	0.57	0.026	0.0041	8.9E-06	0.00051	0.00012	0.00066	0.000099	0.00032	0.000033	0.00076
Greywacke	HC-45	4.2	8.5	1.5	0.46	0.0084	0.000005	8.7E-06	0.00029	0.0098	0.000008	0.00012	0.00013	0.00027
Greywacke	HC-09	5.9	5.9	0.095	0.086	0.026	5.2E-06	0.00013	0.0002	0.002	0.000015	0.00016	0.000034	0.00011
Greywacke	HC-35	0.28	1.3	0.69	0.049	0.25	3.9E-06	0.000048	0.000027	0.00084	2.4E-06	0.00031	0.000024	0.00069
Greywacke	HC-44	8.6	11	0.54	0.16	0.16	5.8E-06	0.00038	0.00023	0.0072	0.000049	0.00046	0.00062	0.00058
Greywacke	HC-10	67	1.3	3	1.9	0.00025	0.000018	0.023	0.0045	18	0.00035	0.04	0.00013	0.0091
Greywacke	HC-40	6.5	4.5	1.7	0.17	0.0041	8.5E-06	0.000024	0.00015	0.043	0.000022	0.00014	0.000073	0.00067
Greywacke	HC-33	4.8	5	0.16	0.052	0.016	2.4E-06	0.000032	0.000076	0.0043	2.8E-06	0.00011	0.000029	0.000048
Greywacke	HC-17	16	0.71	0.12	0.1	0.0085	0.00021	0.00051	0.00034	7	0.00052	0.00056	0.000054	0.067
Greywacke	HC-36	2.8	1.9	0.14	0.029	0.0021	0.000015	0.00044	0.00005	0.00061	5.8E-06	0.00073	0.000021	0.0011
Greywacke	HC-01	11	5.9	0.38	0.0087	0.0012	7.3E-06	0.00028	0.000067	0.00071	9.8E-06	0.00058	0.000032	0.00024
Greywacke (ore)	HC-30	24	9.3	1.6	0.0065	0.1	2.4E-06	0.00043	0.00049	0.0016	7.3E-06	0.0007	0.00026	0.001
Greywacke/Gabbro	HC-15	4.3	2	0.29	0.077	0.016	2.4E-06	0.000031	0.000073	0.0022	2.5E-06	0.0001	0.000047	0.00016
Greywacke/Mudstone	HC-22	4.9	0.43	0.48	0.16	0.000027	0.00011	0.014	0.007	0.077	0.0015	0.05	0.000034	0.017
Mudstone	HC-04	4.9	1.1	0.74	0.0011	0.0031	0.000042	0.0017	0.00069	0.00094	0.000054	0.0098	0.000046	0.00044
Mudstone	HC-13	4	5.7	0.27	0.089	0.017	3.8E-06	0.00004	0.000072	0.0069	0.000045	0.00011	0.000045	0.00016
Mudstone	HC-38	17	0.93	0.56	1.5	0.00017	0.000016	0.076	0.2	0.38	0.0011	0.073	0.00019	0.01
Mudstone	HC-23	8.7	1.3	0.76	0.26	0.00005	0.000068	0.017	0.0054	0.34	0.00074	0.017	0.000052	0.014
Mudstone	HC-21	12	0.98	1.6	0.18	0.00011	0.00022	0.049	0.0063	0.59	0.00069	0.15	0.00012	0.021
Mudstone	HC-32	7.7	1.9	1	0.0035	0.00014	3.2E-06	0.000061	0.000032	0.00055	1.6E-06	0.000064	0.000018	0.00046
Mudstone	HC-03	20	7	3.4	0.0064	0.000052	2.6E-06	0.000027	0.000048	0.00082	5.5E-06	0.000087	0.000084	0.00018
Mudstone	HC-12	22	6.8	4	0.018	0.00041	2.4E-06	0.000084	0.000042	0.0034	2.8E-06	0.00011	0.000052	0.000068
Mudstone	HC-42	6.7	2.6	1.6	0.082	0.2	0.000006	0.00033	0.000097	0.0023	0.000009	0.00044	0.00024	0.00093

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Factors Controlling Trace Element Release

Plots of trace element concentrations in the HCT leachate versus pH, corresponding solids concentrations, and sulphur content are provided in Appendix H3. The results are summarized in Table 5-7. For most parameters, pH was by far the dominant control on leachate concentrations. For arsenic, sulphur content showed a weak negative relationship, likely due to the release of iron during sulphide oxidation and subsequent precipitation of iron oxyhydroxides which are an important control for arsenic concentrations. For cobalt and nickel, there was a weak relationship with solids concentrations, and for nickel, there was also a weak relationship with sulphur content. Overall, the results show that control of pH conditions will provide the greatest benefit in terms of controlling metal concentrations. However, for arsenic, some sulphide oxidation may be beneficial in controlling concentrations.

Table 5-7: Summary of Relationships between Trace Element Concentrations and Other Variables

Parameter	Correlation with pH	Correlation with Same Element in Solids	Correlation with Sulphur content of Solids
Aluminum	strong (complex)*	absent	absent
Arsenic	absent	absent	weak negative
Cadmium	moderate negative	absent	absent
Cobalt	strong negative	weak positive	absent
Copper	strong negative	absent	absent
Iron	strong negative	absent	absent
Lead	moderate negative	absent	absent
Manganese	moderate negative	absent	absent
Nickel	strong negative	weak positive	weak positive
Zinc	strong negative	absent	absent

Notes: Relationships are based on a qualitative evaluation by examining figures in Appendix H3.
* Relationship is consistent with solubility curves for aluminium with increasing concentrations at both low and high pH.

Long-term Projections of ARD

Long-term projections of acid generation potential for each of the humidity cell tests were developed using a combination of results from humidity cell tests, acid-base accounting, and NAG test results. Experimental limitations, such as the relatively short duration of humidity cell tests and the effects of flushing frequency, were considered in the interpretation, as were other differences between laboratory and field conditions.

As discussed previously, the (Ca+Mg)/SO_4 ratio (also referred to as the carbonate molar ratio or CMR) provides an indication of the relative rates of NP versus sulphate release, which are used to evaluate and refine the projections of ARD potential. As described previously, a plot of CMR versus sulphate release rates (Figure 5 16) indicates that excessive dissolution of calcium and magnesium is occurring in many of the samples with sulphate release rates less than 8.5 mg/kg/week, indicating that it is not appropriate to base long-term projections of ARD on the humidity cell test results from those samples. All but one of the samples with sulphate release rates above this threshold had CMR values less than 1.5, indicating that acidic conditions are unlikely to develop in samples with NP/AP ratios of less than 1.5.

In interpreting the long-term ARD potential for each of the humidity cell tests, the CMR calculated for each individual sample is compared to the NP/AP ratio of the sample. Where the NP/AP ratio is greater than the CMR, the samples are considered likely to remain at neutral pH, and where the NP/AP ratio is less than the CMR, the samples are considered to be PAG.

The results of the ARD projections based on the humidity cell tests as well as ABA and NAG test results are presented in Table 5-8 along with the ABA and NAG test results. The humidity cell results for samples with sulphate release rates less than 8.5 are prefaced with a question mark and are highlighted in grey, indicating that they should not be considered in the interpretation. The final column of Table 5-8 shows the overall interpretation of ARD potential for each of these samples based on the combination of results from all three tests.

Acidic conditions developed in nine of the humidity cell tests (HC-10, 14, 17, 20, 21, 22, 23, 31, and 38) during the testing period (a maximum of 136 weeks), indicating they were acid generating, with relatively short lag times to the onset of acidic conditions. Most of the acidic humidity cells were distinguished from other samples in the testing program by relatively high sulphur contents and very low initial amounts of TIC, calcite, and buffering silicates such as amphiboles. Lag time to the onset of acidic conditions varied, with acidic conditions developing in four of the tests within 30 weeks, one within 45 weeks, and four others between 89 and 121 weeks. Stable sulphate release rates were above 8.5 mg/kg/week for all of the acidic humidity cells except for HC-14, HC-22 and HC-23. In these tests, sulphate release rates were initially low, increased for a brief period of time when acidic conditions developed, and then dropped off to less than 10 mg/kg/week). Eight of the nine acidic cells were predicted to be PAG or uncertain on the basis of their ABA results (i.e. NP/AP values were below 3 or TIC/AP ratios were below 1.5 or residual S content remaining after carbonate depletion was less than 0.2%), and seven of the nine acidic cells also had acidic NAG test results. However, one acidic test (HC-22) was expected to be NPAG according to ABA and neutral pH NAG test results (NP/AP ratio for these this samples was 3.68, and sulphur content was 0.1%), and one acidic test (HC-21) had a neutral pH NAG test result. The differences in the findings of the these test results may be attributed to analytical uncertainties with respect to the sample's sulphur content and NP, and appears to be an isolated anomaly in the dataset.

Table 5-8: Long-term Projections of ARD Based on Static and Kinetic Testing Results

Sample ID	Humidity Cell	Lithology Description	Lithology Code	HCT Interp	ABA (NP/AP ratios)	TIC/NP>1.5 or Residual S<0.15	NAG	Overall
BR02-09	HC-25	Felsic Dike	4a	?nPAG	nPAG	nPAG	neutral	nPAG
BR02-08	HC-24	Felsic Dike	mixed: 4a(76%); 1a;	?nPAG	nPAG	nPAG	neutral	nPAG
BR01-05	HC-05	Felsic Dike	4a	?nPAG	nPAG	nPAG	neutral	nPAG
BR03-06	HC-14	Felsic Dike	mixed: 4a(97%); 1c;	Acidic in test	uncertain	PAG	acidic	Acidic in test
BR02-10	HC-26	Gabbro	8	?PAG	low S	nPAG	neutral	nPAG
BR01-08	HC-08	Gabbro	8	?nPAG	nPAG	PAG	neutral	nPAG
BR03-08	HC-16	Gabbro	8	?nPAG	nPAG	uncertain	neutral	nPAG
BR02-11	HC-27	Gabbro	8	?PAG	nPAG	nPAG	neutral	nPAG
BR01-07	HC-07	Gabbro	8	?PAG	nPAG	nPAG	neutral	nPAG
BR01-06	HC-06	Gabbro	8	?nPAG	nPAG	nPAG	neutral	nPAG
BR03-03	HC-11	Iron Formation	2ca	?PAG	uncertain	PAG	acidic	PAG
LF5502	HC-46	Iron Formation (ore)	2c	?nPAG	uncertain	PAG	neutral	uncertain
BR04-02	HC-31	Iron Formation (ore)	2ca	Acidic in test	PAG	PAG	acidic	Acidic in test
BR02-04	HC-20	Iron Formation (ore)	2ca	Acidic in test	PAG	PAG	acidic	Acidic in test
LF5504	HC-41	Iron Formation (ore)	#N/A	Likely Acidic after 10 yrs	uncertain	PAG	acidic	PAG
BR06-03	HC-37	Iron Formation (ore)	2da	Likely Acidic after 10 yrs	PAG	PAG	acidic	PAG
BR05-02	HC-34	Iron Formation (ore)	2da	Possibly NPAG	uncertain	uncertain	acidic	uncertain
LF5506	HC-43	Greywacke	1a	?PAG	uncertain	uncertain	neutral	uncertain
BR02-03	HC-19	Greywacke	1c	?nPAG	low S	uncertain	neutral	nPAG
BR02-02	HC-18	Greywacke	1a	Possibly nPAG	nPAG	uncertain	neutral	nPAG
BR01-02	HC-02	Greywacke	1a	?nPAG	nPAG	nPAG	neutral	nPAG
LF5508	HC-45	Greywacke	mixed: 1c(87%); 2d;	?PAG	nPAG	nPAG	neutral	nPAG
BR03-01	HC-09	Greywacke	1a	?nPAG	nPAG	nPAG	neutral	nPAG
BR06-01	HC-35	Greywacke	1a	?nPAG	nPAG	nPAG	neutral	nPAG
LF5507	HC-44	Greywacke	1a	Acidic within 10 yrs	uncertain	uncertain	neutral	PAG
BR03-02	HC-10	Greywacke	#N/A	Acidic in test	PAG	PAG	acidic	Acidic in test
LF5503	HC-40	Greywacke	#N/A	?PAG	uncertain	PAG	acidic	PAG
BR05-01	HC-33	Greywacke	1c	?PAG	PAG	PAG	acidic	PAG
BR02-01	HC-17	Greywacke	1a	Acidic in test	PAG	PAG	acidic	Acidic in test
BR06-02	HC-36	Greywacke	1c	?PAG	PAG	PAG	acidic	PAG
BR01-01	HC-01	Greywacke	1a	Possibly nPAG	uncertain	PAG	acidic	uncertain
BR04-01	HC-30	Greywacke (ore)	1c	Likely Acidic after 10 yrs	PAG	PAG	acidic	PAG
BR03-07	HC-15	Greywacke/Gabbro	mixed: 1c(50%); 1c;	?nPAG	nPAG	nPAG	neutral	nPAG
BR02-06	HC-22	Greywacke/Mudstone	mixed: 1c(62%); 3c;	Acidic in test	nPAG	nPAG	neutral	Acidic in test*
BR01-04	HC-04	Mudstone	3a	?nPAG	nPAG	nPAG	neutral	nPAG
BR03-05	HC-13	Mudstone	3c	?nPAG	nPAG	nPAG	neutral	nPAG
BR06-04	HC-38	Mudstone	3a	Acidic in test	PAG	PAG	acidic	Acidic in test
BR02-07	HC-23	Mudstone	3c	Acidic in test	PAG	PAG	acidic	Acidic in test
BR02-05	HC-21	Mudstone	3a	Acidic in test*	uncertain	uncertain	neutral	Acidic in test
BR04-03	HC-32	Mudstone	3a	?PAG	PAG	PAG	acidic	PAG
BR01-03	HC-03	Mudstone	3a	Acidic within 10 yrs	PAG	PAG	neutral	PAG
BR03-04	HC-12	Mudstone	3	Possibly Acidic after 10 yrs	uncertain	PAG	acidic	PAG
LF5505	HC-42	Mudstone	3	?PAG	uncertain	uncertain	acidic	PAG

Notes: * acidic conditions developed, but were not expected based on ABA, sulphur content and NAG test results.

Nine other humidity cell tests had sufficient sulphide oxidation rates to support an assessment of ARD potential. Based on the humidity cell test results, six of these tests were predicted to be PAG (HC-03, 12, 30, 37, 41 and 44) and three were predicted to be NPAG (HC-01, 18 and 34). All of the samples predicted to be PAG were classified as PAG or uncertain by ABA, but NAG tests on two of these had neutral pH (HC-03 and 44). One of the samples predicted to be NPAG was also classified as NPAG according to ABA and NAG test results, while two others (both uncertain by ABA) had acidic NAG test results, indicating that their classification remains uncertain.

The remaining 25 humidity cell test samples were classified on the basis of their ABA and NAG test results. Six were classified as PAG (three of these had uncertain ABA results and acidic NAG pH), 17 were classified as NPAG (all NPAG or low S by ABA and neutral NAG pHs), and 2 remained uncertain (with uncertain ABA results and neutral NAG pHs).

Overall, the results of the humidity cell tests indicate that ARD classifications based on ABA results, coupled with the ARD classification criteria defined previously (Section 5.1.4), are a reasonable basis for identifying and classifying waste rock. In developing management plans, all of the material that is classified as PAG or as having an uncertain potential for ARD, with NP/AP ratios of less than 3 and sulphur content of greater than 0.15% will be managed as though it is PAG, and all of the material with NP/AP ratios of greater than 3, or sulphur content of less than 0.15% will be managed as NPAG.

Estimates of Lag Time

The PAG waste rock encapsulated within the WRSAs is expected to freeze within approximately ten years of exposure, essentially limiting any further interaction between infiltrating water and this material. Therefore, lag times to the onset of ARD were also of interest for this Project. Lag times were determined based on the estimated times of NP and TIC depletion in these samples following the methods described in Sexsmith *et al*. (2015).

Lags time to the onset of acidic conditions in the PAG humidity cell tests were calculated based on TIC depletion times, as follows:

$$Time\ to\ TIC\ depletion\ =\ \frac{TIC}{SO_4\ release\ \ rate}$$

Where:

- TIC is in units of kg $CaCO_3$ eq/t.
- SO_4 release rates are the average non-acidic release rate from the humidity cell tests (i.e. prior to onset of acidic conditions) in units of kg $CaCO_3$ eq/t/year.

Lag time estimates based on TIC were compared to actual lag times in the nine samples where acidic conditions developed, as shown in Figure 5-17. The comparisons indicate that the calculations based on TIC are correlated with actual lag times; indicating that TIC and sulphate release rates can be used to predict lag times for PAG samples in this dataset. However, as shown in Figure 5-17, calculated lag times were higher than actual lag times for a number of the samples. This is attributed to the fact that many of these samples did not contain detectable levels of TIC, and the TIC value used for the calculations was at the method detection limit.

The relationship between sulphate release rates and sulphur content (e.g. Figure 5-15) was to be used to convert sulphate release rates to sulphur content and therefore AP, making it possible to calculate a range of lag times that reflect results from for the larger more representative static testing dataset.

Calculations based on 5th percentile TIC/AP results for UGW, LGW, LIF, and UIF from the static dataset indicate that minimum lag times (for the 5% of samples with the lowest TIC/AP ratios) would be on the order of 1.7 to 2,4 years under laboratory conditions. Lag times for this material is expected to be on the order of 5x slower in the field, i.e. 9 to 12 years. Therefore, acidic conditions are not expected to develop for in the majority (~95%) of the waste rock during the approximately 10-year freeze back period.

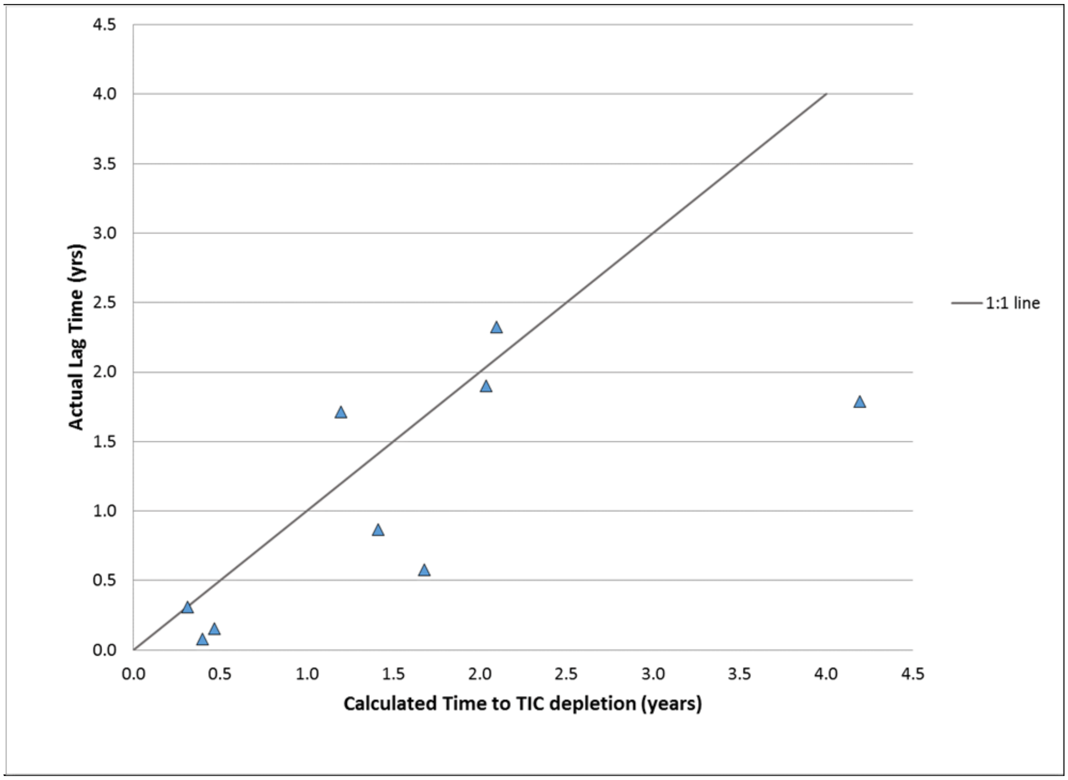

Figure 5-17: Calculated versus Actual Lag Times in Humidity Cell Tests

5.1.7 Field Barrel Tests

Field barrel tests were completed on 7 samples representing gabbro, greywacke, mudstone, and iron formation samples from the Goose and George deposits. Five of these samples were classified as NPAG, and one was uncertain (Bin 6) and one (Bin 8) was PAG. Bin 7 was a field blank. Solid phase arsenic concentrations were low to moderate in all of these samples. Plots showing concentration trends over time are provided in Appendix I.

The results indicate there have been no consistent trends over time in any of these tests. The pH conditions remained neutral in all of the tests, and sulphate concentrations were low, typically ranging from 2 to 20 mg/L in all samples except Bin 3 (an NPAG mudstone sample).

A summary showing median leachate concentrations from the barrel tests is provided in Table 5-9. Concentrations were below screening criteria based on 10x CCME guidelines for freshwater aquatic life with the exception of arsenic in one sample, and copper in one sample.

Table 5-9: Median Concentrations in Barrel Tests

Bin #	Rock Type	ARD Classification	pH	Total Alkalinity mg $CaCO_3$ eq/L	SO_4 mg/L	Ca mg/L	Mg mg/L	Al mg/L	As mg/L	Cd mg/L	Cu mg/L	Pb mg/L	Ni mg/L	Se mg/L	Zn mg/L
Bin 1	Gabbro	NPAG	8.0	45	7.1	17	1.7	0.046	0.0022	0.000010	0.014	0.000050	0.0022	0.00040	0.0030
Bin 2	Greywacke	NPAG	7.8	35	9.2	15	1.5	0.035	0.053	0.000015	0.0096	0.000095	0.0060	0.00048	0.0030
Bin 3	Mudstone	NPAG	7.7	18	24	12	3.2	0.015	0.015	0.000018	0.0064	0.000091	0.019	0.00051	0.0030
Bin 4	Greywacke	NPAG	7.9	35	8.5	16	0.9	0.041	0.019	0.000012	0.0069	0.000050	0.0023	0.00018	0.0030
Bin 5	Iron Fm	NPAG	8.2	88	7.9	4.6	0.3	0.050	0.0069	0.000029	0.024	0.00010	0.0015	0.00014	0.0033
Bin 6	Greywacke	Uncertain	7.4	14	9.5	11	1.2	0.028	0.027	0.000018	0.013	0.00010	0.0038	0.00075	0.0030
Bin 8	Iron Fm	PAG	6.1	2	1.0	1.2	0.4	0.030	0.00078	0.000027	0.0020	0.000063	0.00072	0.00010	0.010
Screening Criteria based on 10x CCME								*0.05*	*0.05*	*0.0009*	*0.02*	*0.01*	*0.25*	*0.01*	*0.3*

Notes: 🟥 indicates concentrations exceed screening criteria

5.2 Discussion

5.2.1 Implications for Waste and Water Management

The results of the geochemical characterization indicate that an appreciable proportion of the waste rock is PAG or has an uncertain potential for ARD. PAG and uncertain waste rock is found in all of the stratigraphic units except for the gabbro dykes, but is more common in the LIF and to a lesser extent in the UIF units. The kinetic tests indicate that metal leaching is greatly enhanced when acidic conditions are allowed to develop. Therefore, specific measures will be necessary to control ML/ARD potential in the PAG waste rock. For management purposes, rock that is PAG or has an uncertain potential for ARD will be treated as PAG, and material that is NPAG or has a low S content will be treated as NPAG.

The proposed waste management plan is to segregate PAG and NPAG waste rock during mining and to encapsulate the PAG rock under a cover of NPAG rock. It is expected that permafrost will aggrade into the PAG rock, which will greatly reduce the rates of oxidation and eliminate interaction with seepage. The relative quantities of PAG and NPAG rock were critical inputs in the design of the WRSAs, and were reported in SRK 2014a. A summary of these estimates is presented in Section 5.2.2.

The distribution of PAG and NPAG waste rock is not closely linked to stratigraphy or to lithology. Therefore, segregation of these materials will require a dedicated blast hole monitoring program similar to the procedures that are used to identify and segregate ore in the mining operation. The testing to support segregation will likely include a combination of sulphur analyses (using a Leco furnace), and NAG tests.

Waste rock will be exposed for a period of time before freezing conditions develop. Current projections indicate that freezing conditions will develop within approximately 10 years. As discussed in Section 5.1.6, lag times to the onset of acidic conditions in the waste rock are expected to be greater than 10 years in field. Therefore, in developing water quality predictions for the PAG waste rock, it was assumed that acidic conditions would not develop during this period. The water quality predictions are presented in Section 7 of this report. Separate predictions are provided for the more mineralized PAG portion of the WRSAs, and for the less mineralized NPAG cover material. Trace element release rates from the humidity cell tests were used to support these predictions.

5.2.2 PAG/NPAG Quantities

The proportions of PAG and NPAG materials from each deposit area are an important input to the waste management plans for the Project. PAG/NPAG quantities were determined based on the proportion of PAG plus uncertain, and NPAG plus low-sulphur material present in each of the modelled stratigraphic and intrusive units, as summarized in Section 5.1.4. This information was combined with quantities of waste rock from within each of the pit limits, based on waste production schedules provided by JDS (pers. comm. November 3) to estimate in-situ quantities of PAG and NPAG material, and then adjusted to reflect inefficiencies in the segregation process –

which were assumed to be 75% all units except LIF and Umwelt/Llama/Echo UIF based on recommendations provided by JDS. The results are summarized in Table 5-10.

- The results indicate that there is a total of 63 Mt of waste rock and overburden associated with the Goose deposits. The quantity of overburden is approximately 5 Mt. This is considered to be NPAG. However, its use in construction may be limited due to its physical properties. Overburden suitability will be assessed during early construction phases.
- The estimates of in-situ quantities indicate that approximately 38 Mt of NPAG waste rock (65%) and 21 Mt of PAG waste rock (35%) are present within the limits of the open pits. The proportions of PAG/NPAG in-situ waste rock vary by pit, with approximately 50% PAG/50% NPAG in the Umwelt and Llama open pits, 45% PAG/55% NPAG in the Echo open pit, and 15% PAG/85% NPAG in the Goose Main open pit. When segregation is taken into account, it is estimated that approximately 25 Mt of NPAG and 34 Mt of PAG waste rock would be produced, which is equivalent to a recoverable ratio of 58% PAG and 42% NPAG.

5.2.3 PAG/NPAG Characteristics

The criteria used to classify the ARD potential of samples is based on the thresholds defined previously. To show the full range of characteristics present in samples classified as NPAG/low S or PAG/uncertain, summary statistics were calculated for each of these groups, and for the Main versus Umwelt/Llama/Echo deposit areas. The statistics are presented in Table 5-11.

Table 5-10: Quantities and Proportions of Waste Rock by ARD Classification – Goose Deposits

Scenario	Pit	Quantity (tonnes)			Distribution %	
		PAG	NPAG	OVB	PAG	NPAG
In-situ Quantities	Umwelt	9,490,000	9,163,000	1,289,000	51%	49%
	Llama	7,479,000	7,490,000	1,037,000	50%	50%
	Main	3,663,000	20,693,000	2,755,000	15%	85%
	Echo	192,000	782,000	250,000	20%	80%
	Total	**20,823,000**	**38,127,000**	**5,331,000**	**35%**	**65%**
75% of NPAG recovered except 0% in LIF and 50% in Umwelt/Llama UIF	Umwelt	13,053,000	5,600,000	1,289,000	70%	30%
	Llama	10,548,000	4,421,000	1,037,000	70%	30%
	Main	10,101,000	14,255,000	2,755,000	41%	59%
	Echo	584,000	389,000	250,000	60%	40%
	Total	**34,286,000**	**24,665,000**	**5,331,000**	**58%**	**42%**

Table 5-11: Summary of ABA Results for NPAG/Low S and PAG/Uncertain Waste Rock

ARD Classification	Deposit	Statistic	Paste pH	Total S%	SO4-S %	AP kg CaCO3/t	NP kg CaCO3/t	TIC-NP	NP/AP	TIC/AP	As ppm
NPAG/low S	Main Deposit	Average	9.1	0.31	0.04	9.8	86.6	37.9	8.8	3.9	118
		Min	7.9	0.02	0.01	0.6	8.6	0.5	2.6	0.2	0.4
		5th percentile	8.2	0.02	0.01	0.6	11.0	0.9	3.2	0.3	3.5
		25th percentile	8.6	0.09	0.01	2.8	29	5.2	5.2	1.5	10
		Median	9.1	0.17	0.01	5.3	57	20	9.4	2.7	18
		75th percentile	9.6	0.35	0.05	11	118	41	18	6	38
		95th percentile	10.1	1.1	0.13	34	239	130	39	15	193
		Max	10.5	2.9	0.63	90	791	348	115	37	5120
		N	140	140	140	140	140	140	140	140	140
	Umwelt/Llama/Echo Deposits	Average	9.5	0.13	0.03	4.2	24.8	5.6	7.8	1.3	78
		Min	7.8	0.02	0.01	0.3	0.5	0.5	0.8	0.1	0.1
		5th percentile	8.7	0.02	0.01	0.6	8.0	0.5	2.5	0.1	1
		25th percentile	9.2	0.06	0.01	1.9	11.1	0.5	3.4	0.3	5
		Median	9.5	0.11	0.01	3.4	14.0	1.5	5.0	0.7	13
		75th percentile	9.7	0.15	0.03	4.7	24.0	4.8	8.7	1.2	32
		95th percentile	10.0	0.41	0.08	12.8	82.1	21.2	21.7	4.1	379
		Max	10.3	1.12	0.38	35.0	253	216	65.8	34.2	2340
		N	286	286	286	286	286	286	286	286	286
PAG/Uncertain	Main Deposit	Average	9.1	0.92	0.07	28.7	30.1	15.6	1.7	0.5	283
		Min	6.9	0.16	0.01	5.0	8.3	0.5	0.1	0.006	3
		5th percentile	8.0	0.17	0.01	5.3	9.4	0.7	0.1	0.1	6
		25th percentile	8.6	0.21	0.01	6.5	12.6	1.6	1.2	0.2	14
		Median	9.4	0.34	0.02	10.5	15.9	2.7	1.7	0.3	23
		75th percentile	9.6	0.85	0.03	26.5	39.3	16.8	2.3	0.6	116
		95th percentile	9.9	4.08	0.18	127	89.5	69.0	2.6	1.5	1148
		Max	10.0	5.36	1.71	168	166	108	2.9	2.2	5120
		N	44	44	44	44	44	44	44	44	44
	Umwelt/Llama/Echo Deposits	Average	9.2	0.76	0.04	23.9	18.9	4.8	1.4	0.3	547
		Min	6.0	0.16	0.01	5.0	2.7	0.5	0.1	0.004	0.1
		5th percentile	8.1	0.17	0.01	5.3	7.8	0.5	0.2	0.02	1
		25th percentile	8.8	0.23	0.01	7.2	11.8	0.9	0.8	0.1	7
		Median	9.3	0.38	0.01	11.9	15.3	2.5	1.4	0.2	20
		75th percentile	9.6	0.76	0.04	23.8	24.2	5.9	2.0	0.4	92
		95th percentile	10.0	2.79	0.17	87.1	38.4	18.3	2.6	0.9	2524
		Max	10.5	7.06	0.65	221	61.1	36.4	3.0	1.8	23000
		N	273	273	273	273	273	273	273	273	273

6 Tailings

6.1 Results

6.1.1 Sample Coverage

Two phases of geochemical characterization have been completed on the tailings.

- The first phase, reported in Rescan (2014a), included static testing (ABA and trace element analyses) and mineralogy by Reitveld XRD on 5 samples representing tailings from the George deposits, Umwelt open pit, Umwelt underground, Llama open pit, and Goose Main open pit, and two master composite samples representing the overall blend of ore expected over the mine life. One of the master composites was subjected to cyanide detoxification and the resulting slurry sample was subjected to aging tests, while the other was subjected to kinetic testing.
- The second phase, which is still in progress, included static testing of 23 variability composites from the Goose deposits, and one composite sample representing ore from Goose Main. The composite sample was subjected to cyanide detoxification. Solids from that test were submitted for mineralogical characterization and kinetic tests, and the detoxified slurry was submitted for aging tests. Process water from the fresh detoxification solutions was also tested for a full suite of water quality parameters (Rescan 2014b).

Tailings from the second phase of characterization reflect improvements to the metallurgical process, including a finer grind size, reduce amounts of cyanide, and improved detoxification procedures. However, the static data, mineralogical results, and kinetic test results from both phases of work are considered to be representative for most parameters.

6.1.2 Mineralogy

All of the tailings samples from Rescan (2014a) were subjected to Reitveld XRD. SRK completed an additional Reitveld XRD analysis on the Goose Main tailings composite and QEMSCAN analyses BR-Tail-2 and the Goose Main Composite, as presented in Appendix D of this report. Some key findings of the mineralogical work are summarized as follows:

- Chlinochlore (chloride) and/or amphibole group minerals were a major component (defined as >10%) of the tailings, while biotite and/or plagioclase were present in most samples. These minerals are expected to contribute to the buffering capacity, especially when sulphur content is relatively low (Jambor 2002, Day and Kennedy. 2015).
- Pyrrhotite, pyrite, and arsenopyrite were the most abundant sulphide minerals, with concentrations of pyrrhotite of over 5% in one of the samples. Trace amounts of chalcopyrite were found in many of the samples, while trace amounts of lollingite were found in one sample, and trace amounts of scheelite were found in one sample.
- Calcite, Fe-dolomite, ankerite and siderite were present in most of the samples. Calcite was typically the most abundant carbonate mineral, but ferroan-dolomite and ankerite were more abundant in the Goose Main composite that was subjected to kinetic testing.

6.1.3 Trace Elements

Complete results of the trace element analyses for tailings, are provided in Appendix J. The results are compared to 5x the average crustal abundance (CA) values for shale and sandstone to assess for enrichment which may be indicative of increased potential for metal leaching.

Concentrations of silver and arsenic were elevated in comparison to that of typical shales in most samples, and concentrations of cobalt, chromium, copper, molybdenum, nickel, antimony, and selenium were elevated in comparison to typical sandstone in most samples, indicating that there is increased potential for leaching of these elements from the tailings. Order of magnitude differences in concentrations of chromium, copper, molybdenum, and nickel between the 2013 and 2014 samples were observed, but it is not clear why these were present. The testing laboratory has indicated that the same methods were used for preparation and analysis of these samples.

6.1.4 ABA

Complete results of the ABA tests on tailings are provided in Appendix K. Plots showing the relationships between paste pH and NP/AP ratios, NP and TIC, and total sulphur versus sulphide sulphur are provided in Figure 6-1 to Figure 6-4.

As shown in Figure 6-1, all of the samples had neutral to alkaline paste pHs between 7 and 9.5. The NP was low to moderate in samples prepared from Umwelt and Llama ores, and NP was moderate to high in ores from the Goose Main deposit and the various composite samples. In this latter group, there was a reasonable correlation between NP and TIC, but at lower NP concentrations, NP was generally higher than TIC (Figure 6-2) indicating that silicate minerals are likely an important component of the NP. This is consistent with the presence of clinochlore (chloride) and amphiboles (calcium/magnesium silicate minerals) that were identified in the mineralogical tests. One sample had TIC greater than NP, consistent with the finding that iron carbonates are present in some samples. As discussed previously (Section 6.1.2), calcium carbonates were the dominant carbonate mineral in most samples.

Sulphide, calculated from total sulphur minus sulphate sulphur, was the dominant form of sulphur in all of the samples (Figure 6-3), consistent with the findings of the mineralogical analyses. Sulphur measured by ICP (ICP-S) was strongly correlated with, but generally less than, total sulphur. This difference has been attributed to incomplete digestion of the sample prior to ICP analysis.

The acid rock drainage (ARD) potential was classified according to the same system used for the waste rock except that the cut off for defining NPAG material was based on an NP/AP ratio of 2 to account for the more uniform characteristics of the tailings. Figure 6-4 shows NP versus AP for each of the tailings samples and sample composites. Based on these results, most of the tailings samples were classified as PAG, but several of the variability samples from the Goose Main deposit had an uncertain potential for ARD, and a few were NPAG.

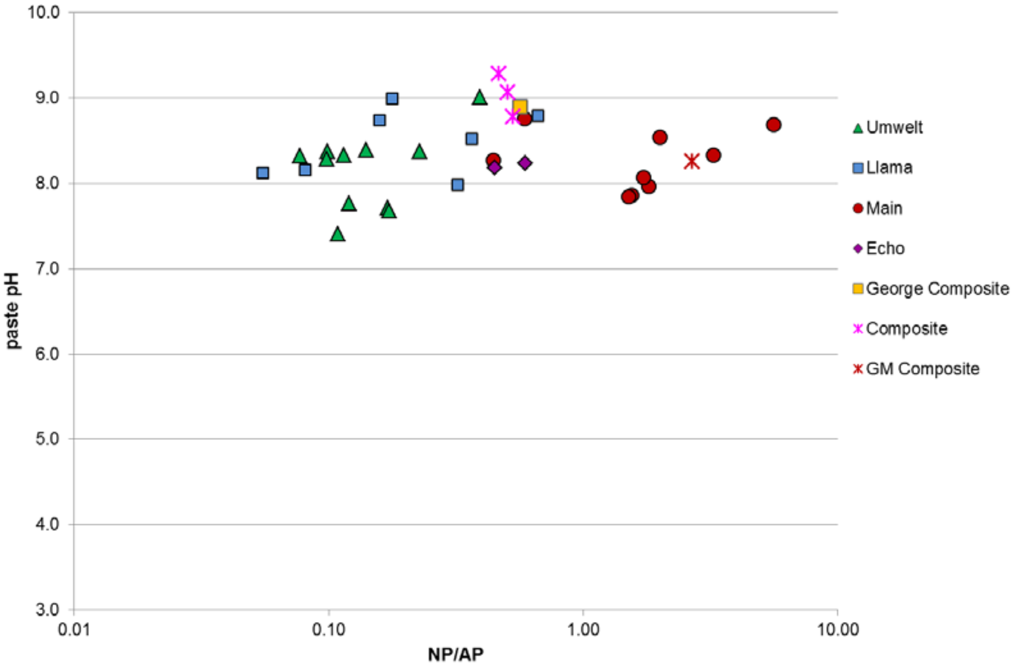

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Figure 6-1: Paste pH versus NP/AP Ratio in Tailings Samples

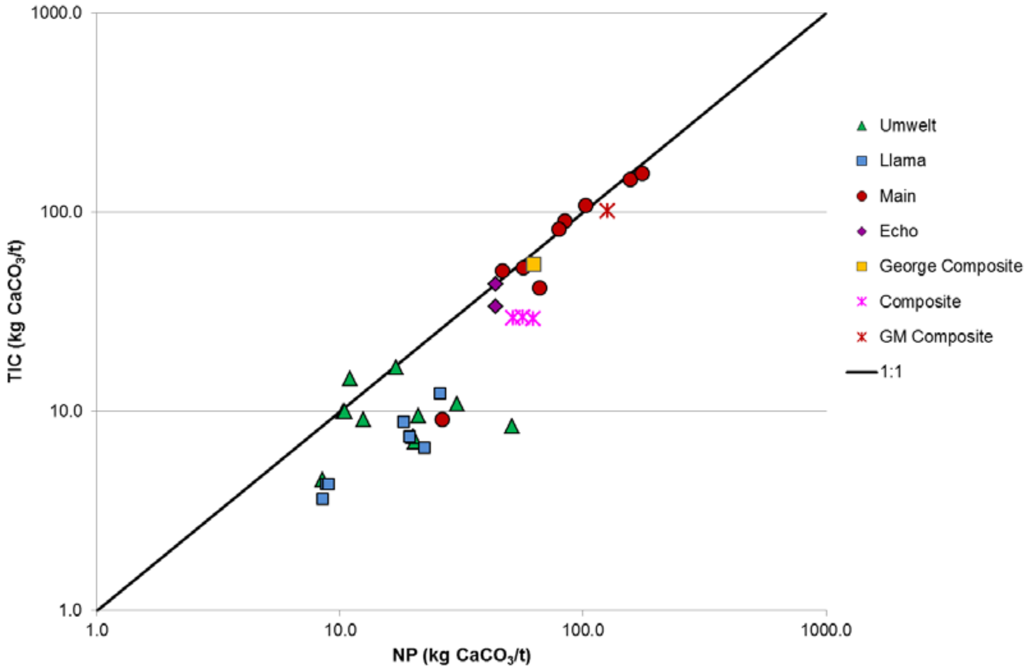

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Figure 6-2: TIC versus NP in Tailings Samples

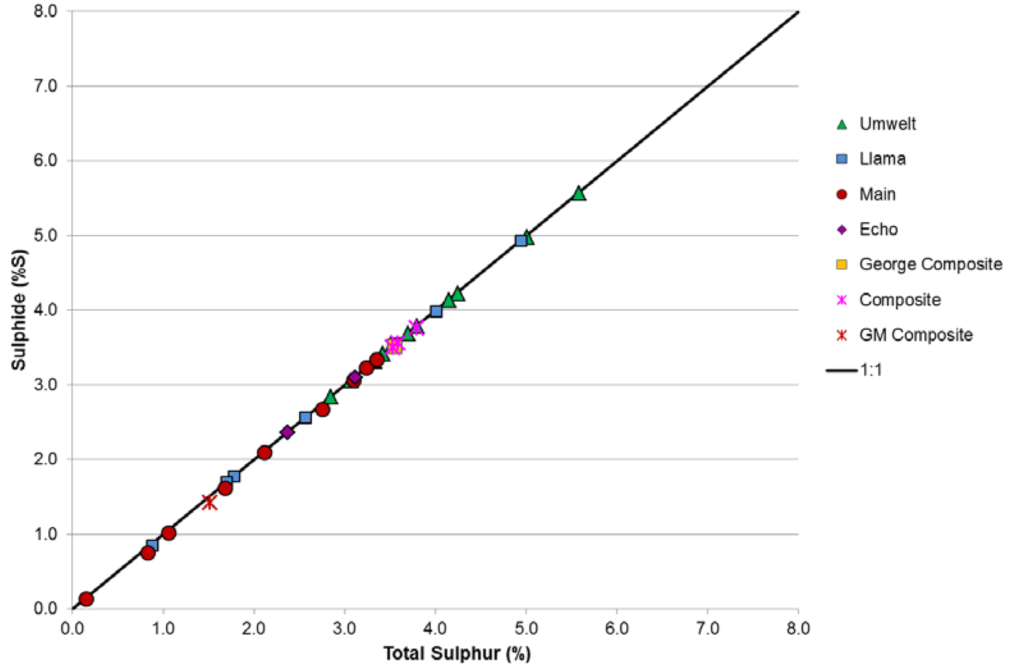

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Figure 6-3: Sulphide versus Total Sulphur in Tailings Samples

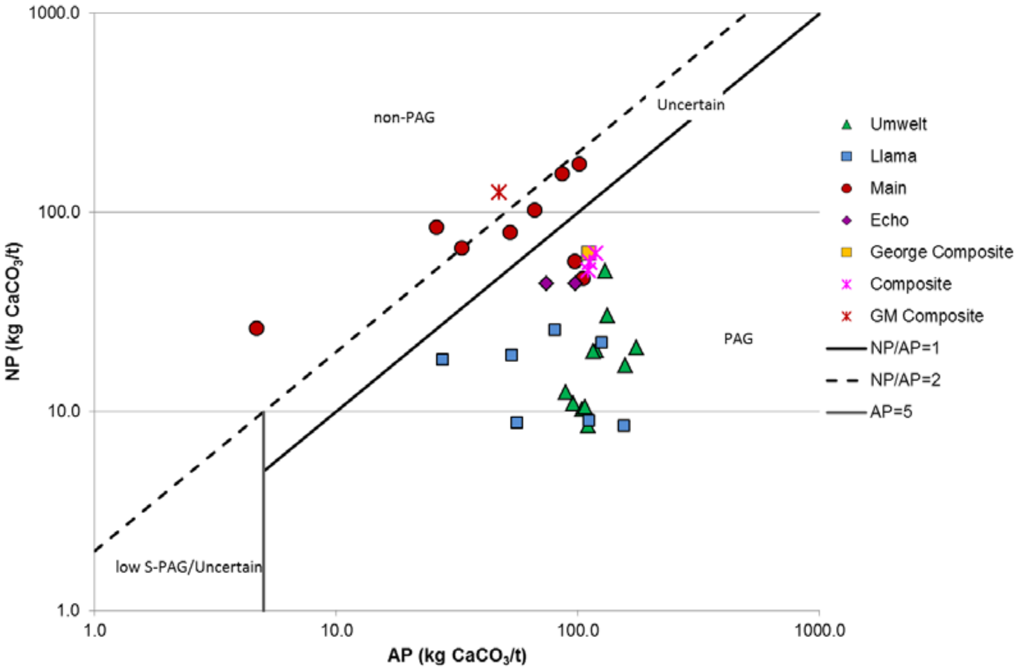

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Figure 6-4: NP versus AP in Tailings Samples

6.1.5 NAG Tests

A NAG test was performed on sample HC-39. The results indicated a circum-neutral pH of 7.68, consistent with the results of ABA tests for this sample.

6.1.6 Kinetic Tests

Sample Characteristics

Two composite tailings samples were subjected to kinetic testing after cyanide detoxification. The first (BR-Tail-2) was representative of the overall blend of ore expected over the mine life. Two humidity cells, HC-28 and HC-29 were completed on this sample, one that was operated at room temperature and one at 4°C. The second tailings composite, was representative of ore from the Goose Main deposit. HC-39 was completed on this sample at room temperature. Further detail on these samples is provided in Section 6.1.1. Based on their geochemical properties, the tailings composites selected for the humidity cell samples represent the range of characteristics found in the overall tailings dataset.

The mixed composition of the blended ore composite was apparent in the geochemical characterization, which tended to yield intermediate values relative to the overall tailings dataset. As with the majority of tailings samples tested, the blended ore composite was classified as PAG.

The Goose Main composite was typical of the overall tailings dataset for Goose Main, and was classified as NPAG.

Concentrations and Trends

Complete results of the tailings humidity cell tests, including plots of concentrations over time, are provided in Appendix L. A summary of leachate concentrations is provided in Table 6-1.

The humidity cell test on the blended ore composite, HC-28, showed a decline in pH after 64 weeks of testing, dropping below pH 6 at week 84, and pH 5 at week 90. The current pH is 4.0 Concentrations of several parameters, notably cadmium, cobalt, nickel, and zinc, increased in response to decreasing pH conditions. HC-29, which contained the same blended ore composite operated at a lower temperature, remained neutral, with a final pH of 7.51 at week 122. Humidity cell operation for the Goose Main composite is ongoing, and pH for the cell is neutral (7.61) as of week 40 of testing.

The results of trace element analyses on the humidity cell leachates were compared to a screening criterion based on 10x CCME guidelines. Aluminum and copper concentrations exceeded the screening criterion in one of the samples. Arsenic, and iron concentrations were higher than the screening criteria in leachates from HC-28 and HC-29.

Table 6-1: Summary of Trace Element Concentrations (Maximum Values) in Humidity Cell Leachates, Including Comparisons to Screening Criteria

Humidity Cell	Sample ID	Al mg/L	As mg/L	Cd mg/L	Cu mg/L	Fe mg/L	Pb mg/L	Ni mg/L	Se mg/L	Zn mg/L
HC-28	BR-TAIL-02	0.48	3.9	0.00010	0.030	23	0.0081	0.0060	0.0046	0.0077
HC-29	BR-TAIL-03	0.41	3.2	0.00026	0.030	23	0.0085	0.0027	0.0044	0.0075
HC-39	KM4030-147 TAILS	0.15	0.04	0.00010	0.0013	0.46	0.0016	0.0006	0.0006	0.010

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Red- Maximum concentration above screening criteria based on 10x CCME FAL guidelines (hardness dependent values calculated based on average hardness in HC tests.

Long-term Projections

Procedures and rationale used for the development of long-term projections of ARD potential are described in Section 5.1.6. For tailings samples, acidic conditions (under pH 5) developed in HC-28 by week 94 of the humidity cell testing period, indicating that relatively rapid onset of acidic conditions under laboratory conditions. This agreed closely with calculated lag times to onset of acidic conditions, which were on the order of 83 weeks or 1.6 years. For HC-29, the test that was operated under cooler temperatures, projected lag times to the onset of acidic conditions were approximately seven to eight years. The interpretation that HC-28 and HC-29 are potentially acid generating is supported by NP/AP ratio of 0.32 and 0.3, respectively (Figure 6-4). HC-39 was uncertain with respect to its acid generating potential, based on a NP/AP of 1.88. However, comparison of ratios and projected depletion times indicate that NP and TIC will outlast AP.

The sulphate release rates from HC-29 were used to estimate field lag times for average tailings from each of the deposits. The results indicate that lag times could range from approximately 2.4 years in the Llama tailings to 31 years in tailings from the Goose Main deposit. Assuming that the exposed tailings on the surface of the TSF are a blend of Goose Main and Llama ore, as is anticipated based on the current production schedule, lag times are expected to be on the order of 10 to 20 years.

6.1.7 Process Water and Aging Tests

Concentrations and Trends

A summary of the process water characterization and aging tests is provided in Table 6-2, with complete results provided in Appendix M. Key observations are summarized as follows:

- The results showed neutral to alkaline pH and elevated sulphate concentrations (~1,100 mg/L) in all of the post-detox samples.
- Concentrations of total cyanide were initially 0.3 mg/L. In the oxic tests, total cyanide concentrations decreased to 0.039 mg/L, likely due to degradation reactions. In the anoxic tests they increased and then levelled off at approximately 2.8 mg/L, likely due to dissolution of sparingly soluble cyanide complexes from the tailings solids. Concentrations of cyanide degradation products (thiocyanate and total ammonia) increased and then levelled off in both the oxic and anoxic tests, whereas cyanate concentrations decreased over time. The decrease in cyanate concentrations suggests that rates of cyanate degradation exceed that of cyanate production.
- Stable or decreasing trends in concentrations were evident for a number of trace elements. Decreasing trends in concentrations are consistent with the degradation of cyanide-metal complexes, precipitation of secondary minerals, and sorption reactions. Nickel concentrations were an exception with a substantial increase and then decrease in concentrations in the anoxic tests. This may be due to dissolution of sparingly soluble nickel cyanide complexes from the tailings solids, and then subsequent degradation reactions.

Trace element results from oxic and anoxic aging tests were compared to 10x screening criteria based on CCME guidelines for the Protection of Aquatic Life (CCME 2014), as shown in Table 6-2. Concentrations of copper exceeded the screening criteria in several of the samples, concentrations of arsenic exceeded the screening criteria in two samples, and concentrations of iron exceeded the screening criteria in one sample.

Table 6-2: Summary of Process Water and Aging Test Data, Including Comparisons to Screening Criteria

Sample	**Sampling Date**	**pH** pH Units	**SO_4** mg/L	**Total Alk** mg/L	**Total CN** mg/L	**WAD CN** mg/L	**CNO** mg/L	**SCN** mg/L	**NH4** mg/L	**Ca** mg/L	**Mg** mg/L	**Al** mg/L	**As** mg/L	**Cd** mg/L	**Cu** mg/L	**Fe** mg/L	**Pb** mg/L	**Ni** mg/L	**Se** mg/L	**Zn** mg/L
Initial Detox Results	20-Jun-14	7.74	706	79	1.1	0.01		43	51.1	109	2.8	0.11	0.17	0.00012	0.0243	0.41	0.0018	0.0049	0.0021	0.0095
Toxicity test results	26-Jun-14	7.72	808	56	0.026	0.005		45	49	134	2.9	0.0024	0.003	0.00002	1.4	0.03	0.0002	0.0131	0.0018	0.019
Initial	30-Oct-14	7.81	1010	66	0.37	-0.2	27	75	1.68	193	33	0.68	0.038	0.000005	0.16	3.2	0.0010	0.00393	0.0035	0.0032
OXIC 1 - 14-NOV-2014	14-Nov-14	7.95	996	73	0.12	-0.2	34	94	2.31	179	43	0.013	0.044	0.000019	0.34	0.026	0.000012	0.00226	0.0041	0.0005
OXIC 2 - 28-NOV-2014	28-Nov-14	8.07	1160	80	0.12	-0.2	34	105	3.41	172	38	0.019	0.042	0.000005	0.26	0.039	-0.00003	0.0014	0.0046	0.0031
OXIC 3 - 29-DEC-2014	29-Dec-14	8.03	1030	84	0.079	-0.2	33	113	3.91	173	38	0.010	0.027	0.000015	0.10	0.011	0.000013	0.00117	0.0040	0.0018
OXIC 4 - 28-JAN-2015	28-Jan-15	8.03	1080	87	0.066	-0.2	19	120	4.73	181	45	0.0089	0.022	0.000027	0.045	0.007	0.000043	0.00135	0.0037	0.0024
OXIC 5 - 27-FEB-2015	27-Feb-15	7.92	1140	105	0.039	-0.2	14	129	5.66	177	47	0.012	0.024	0.000018	0.025	0.008	0.00002	0.00163	0.0031	0.0006
ANOXIC 1 - 28-NOV-2014	28-Nov-14	8.1	1140	55	2.7	-0.2	21	115	4.0	161	34	0.02	0.021	0.000005	4.0	0.32	-0.00003	0.15	0.003	0.0007
ANOXIC 2 - 29-DEC-2014	29-Dec-14	8.15	1040	45	4.3	2	28	129	4.7	173	33	0.016	0.020	0.000005	0.29	0.17	0.000009	0.52	0.0039	-0.0001
ANOXIC 3 27 FEB 2015	27-Feb-15	8.13	1090	63	2.5	0.4	17	139	5.2	159	37	0.022	0.021	0.000011	0.015	0.70	0.000028	0.21	0.0032	0.0003
ANOXIC 4 27 APR 2015	27-Apr-15	8.03	1070	59	2.0	0.2	6.8	139	5.7	150	39	0.0063	0.021	0.000005	0.0015	0.66	0.000005	0.0010	0.0027	0.0001
ANOXIC 5 JUN 26 2015	26-Jun-15	7.97	1050	45	2.8	0.2	2.7	132	5.1	166	44	0.027	0.089	0.000009	0.0027	0.42	0.00004	0.0015	0.0015	0.015
Highlighted values indicate exceedance of Screening Criteria based on 10x CCME												*1*	*0.05*	*0.009*	*0.04*	*3*	*0.07*	*1.5*	*0.01*	*0.3*

6.2 Discussion

6.2.1 Implications for Tailings and Water Management

The findings of the geochemical characterization program suggest that the tailings will need to be managed to prevent metal leaching and acid rock drainage. Exposed tailings beaches are likely to be an ongoing source of sulphate and arsenic leaching. If the tailings beaches are left exposed for an extended period of time (on the order of 10 to 20 years assuming that at least 30% of the tailings are from the Goose Main deposit), pH changes may result in increased concentrations of other trace elements.

During Operations, it is likely that the process water will initially contain elevated concentrations of ammonia, arsenic, copper, and iron. Over time, these are expected to decrease. However, depending on the residence time and actual rates of degradation occurring in the tailings facilities, there is a possibility that this water may need to be treated to remove these parameters.

7 Water Quality Estimates

7.1 Overview

Dissolution of soluble minerals in the ore, and oxidation and weathering of the waste rock, exposed pit walls, and exposed tailings are expected to contribute to the release of soluble components into process water and seepage and runoff from the various mine components. Soluble components include major ions such as alkalinity, sulphate, calcium, and magnesium, and trace elements such as arsenic, copper, iron, nickel, selenium, and zinc.

One of the primary objectives of the testing programs for the Project was to estimate the chemistry of process water and seepage and runoff that will be directly in contact with the WRSAs, ore stockpiles, pads, exposed pit walls, and exposed tailings, prior to dilution from local runoff in undisturbed areas of the catchments. The chemistry of contact water from each of these areas is referred to as the “source concentration”.

The approach used to predict the source concentrations was based on a combination of scale-up calculations, geochemical modelling, and extrapolation of monitoring data from geologically similar mine sites in the area. In brief:

1. The laboratory testing data was used to calculate mass loadings and potential concentrations for the pits and WRSAs.
2. Monitoring data and field scale kinetic testing data from the other mine sites were used to establish concentration limits.

The following sections of the report provide details of the calculation steps and assumptions used to develop the source concentrations for each of the mine components. It is noted that these predictions reflect dissolved metal concentrations. They do not account for additional loading, particularly for aluminum and iron that may result from total suspended sediments, or for nutrient loadings that may arise from blasting residues or cyanide degradation.

7.2 Calculation Methods and Assumptions

7.2.1 Process Water Quality

Process water quality estimates were based on the results of the process water analyses and aging tests described in Section 6.1.7. Based on the expectation that process water will be stored within the tailings facilities for an extended period of time prior to discharge (several years), trends in concentrations were considered in the selection of results. In general, source terms for parameters with an increasing trend over time were based on the maximum concentrations observed in either the oxic or the anoxic tests, source terms for parameters with stable concentrations were based on the median concentration observed in the oxic tests, and source terms for parameters with decreasing concentrations were based on the 25th percentile results for the oxic aging tests.

7.2.2 Waste Rock Storage Areas, Ore Stockpiles, and Pads

Source concentration estimates were made for each of the WRSAs, ore stockpiles, and pads at the Goose Property. A list of these sources and some of the specific considerations is provided in Table 7-1.

Key steps and assumption in the calculations were:

1. Estimate Waste Rock Tonnages, Pile Configuration, and Hydrology Inputs:
    - The footprint areas, volumes and mass of rock within the WRSAs, ore stockpiles, and pads were provided by the mine planners, and are summarized in Table 7-2.
    - Infiltration rates into the unfrozen and frozen piles were assumed to be 124 and 247 mm/year based on the total average precipitation of 412 mm/year and runoff coefficients of 0.3 for unfrozen rock and 0.6 for frozen rock (SRK 2015). The total flows from each pile were calculated by multiplying the footprint areas by these values.
2. Estimate Geochemical Release Rates:
    - The kinetic test results were used to calculate laboratory release rates for PAG and NPAG samples from each of the major rock types.
    - Average laboratory release rates were calculated by weighting the above release rates by the percent distribution of rock types (Table 7-3 and Table 7-4).
    - Correction factors were applied to account for differences in temperature, grain size, and contact effects between the test and the run-of-mine rock, as follows:
        - Temperatures within each of the facilities were assumed to be approximately 5°C, while laboratory temperatures were in the range of 20°C. The effects of temperature on sulphide oxidation rates were determined using the Van't Hoff–Arrhenius equation, assuming an activation energy of 70,000 J/mole. The calculations indicated that release rates could be reduced by a factor of five to account for the differences in temperature.
        - Weathered waste rock at other northern open pit mine sites is typically very coarse. Therefore, it was assumed that approximately 80% percent of the waste rock was coarser than the material used in the kinetic tests. The laboratory release rates were reduced by a factor of five to account for the approximately 80% oversize material that does not contribute significantly to contaminant release.
        - Contact effects such as flow channelling vary according to the particle size distribution and infiltration rates, with relatively more contact occurring at sites with fine grain size distributions and higher infiltration rates. Based on experience at other sites, a reduction factor of two was applied to account for contact effects.

    - The overall effect of the above adjustments was to reduce the laboratory release rates by a factor of 50.

3. Calculate Potential Concentrations:

    - Potential concentrations were calculated by multiplying the average laboratory release rate by the total tonnage and dividing by the total flows infiltrating through the WRSAs.

4. Establish Upper Limits by Comparison to Data from Similar Mine Sites and Field Barrel Tests:

    - The concentrations of several trace elements from Step 3 were significantly higher than those observed in the seepage at geologically similar mines in the region. The relatively low concentrations of trace elements at other sites are likely due to attenuation reactions occurring within the WRSAs. The most accurate means of establishing attenuation controls is to use data from geologically analogous sites. Potential data sources included seepage from the Lupin, Meliadine (Tiriganiak), and Meadowbank. Data from the field barrel tests at the Property, and large column tests from Meliadine were also considered.

    - Two sets of concentration limits (best judgement limits and upper bound limits) were selected from the analog data base described above. Scatterplots of these data are provided in Appendix N. A summary of the best judgement and upper-bound limits is provided in Table 7-5.

        - The best judgment limits are considered to be conservative selections that represent the upper limits of concentrations from full scale facilities and large scale field tests. Typically, trace metal concentration limits reflect the 75th percentile of seeps from the dataset with the highest concentrations, while major ions are set at median values from the most geologically analogous site (i.e. Meliadine).

        - The upper-bound limit concentrations are highly conservative selections based on valid maximum or 90th percentile concentrations from the scatterplots. Most of these reflect field or laboratory test results on specific materials. The higher concentrations in these tests may be due to a lack of beneficial interactions such as attenuation and neutralization that occur in larger scale facilities. Clear outliers were not considered in this assessment. Specific sources of each value are evident in the plots in Appendix N.

    - Scaled concentrations from Step 3 were compared to the analog limits. For each parameter, the lesser of the modelled concentration and the best judgment analog limit was taken to represent a best judgment modelled concentration corrected for attenuation. Similarly, the lesser of Step 3 concentrations and upper-bound analog limits were selected to represent upper-bound concentrations corrected for attenuation.

In June 2015, SRK completed a seep survey around the Goose Airstrip. The seepage results, provided in Appendix O, were compared to the predictions as a means of validation. Based on those results, SRK has recommended adjusting the regional limits for cobalt and manganese. However, the results were not available until July 2015, which was too late to make these adjustments and include them in the subsequent water and load balance calculations. For the Water Licence application, SRK has recommended additional sensitivity analyses to assess how these changes would affect discharge and receiving concentrations for these two parameters.

7.2.3 Pit Walls

Calculations for the pit walls followed the same general calculation steps as for the WRSAs. Key assumptions for the pits walls were as follows:

- Infiltration rates were assumed to be 247 mm/year based on the total average precipitation of 412 mm/year and a runoff coefficient of 0.6 (SRK 2015). The total flows associated with the pit walls were calculated by multiplying the footprint areas by these values.
- Maps showing the extent of each of the rock units on the final pit walls were provided by the mine planners (see example Figure 7-1) and used to calculate the exposed areas during operations, and post-flooding, as summarized in Table 7-6 and Table 7-7.
- The exposed pit walls were assumed to have a 1 m thick rubbly surface with a reactive mass of 5% by volume. A correction factor of 0.2 was applied to account for differences in temperature between the laboratory and field. Correction factors to account contact effects were not taken into consideration due to the near surface exposure of this material.
- It was further assumed that acidic conditions would develop in any PAG materials that are exposed during flooding. Therefore, trace element release rates for samples that were already acid generating were compiled and used in these calculations.
- The analog limits used for the WRSAs were also used for the pit walls.
- Runoff associated with exposed overburden in the pit walls was assumed to have concentrations equivalent to that of runoff from undisturbed areas, and were mixed based on the relative proportions of rock versus overburden exposed in the pit wall.

7.2.4 Exposed Tailings

Calculations for the exposed tailings followed the same general calculation steps as for the WRSAs. Key assumptions for the tailings were as follows:

- Infiltration rates were assumed to be 247 mm/year based on the total average precipitation of 412 mm/year and a runoff coefficient of 0.6 (SRK 2015). The total flows associated with the exposed tailings were calculated by multiplying the footprint areas by these values.
- The upper 0.1 m of tailings are expected to be fully exposed to oxidation and weathering. Tailings below that depth were not expected to contribute to metal loading from the facility during the brief period of time that they will be exposed to oxidizing conditions.

- A correction factor of 0.2 was applied to account for differences between field and laboratory temperatures. Other contact effects were not taken into consideration due to fine particle size and near surface exposure of this material.
- The calculation results were typically less than concentrations found in the tailings process water, therefore analog limits were not required to develop realistic estimates. However, to ensure a sufficient level of conservatism, where the calculated values were less than process water quality results, process water results were used for the final tailings runoff estimates.

7.3 Prediction Results

Best estimate and upper-bound source concentrations for each of the main site components are provided in Table 7-8 and Table 7-9.

- The best estimate results are recommended for use in the downstream effects assessment. These results incorporate a reasonable degree of conservatism in all steps of the calculations and reflect the beneficial interactions that have been observed in other large waste rock piles in the area.
- The upper-bound source concentrations reflect more conservative assumptions, particularly in establishing the upper limits on concentrations from the analog data. Values of this magnitude are unlikely to occur in the WRSAs.

Table 7-1: Source Areas

Component	Subcomponents	Phase	Key Inputs
WRSAs	PAG rock	Operations through to onset of freezing conditions	Metal release rates from PAG HCT (prior to onset of acidity), blended to reflect specific mixture of PAG rock types in each location, and pile geometry.
	NPAG cover	Post-closure – after onset of freezing conditions	Metal release rates from NPAG HCT, blended to reflect specific mixture of NPAG rock types in each location. Calculations assume the active layer within the cover is 5 m thick.
Goose Plant Site	Cut and fill area	Development through to post-closure	As per NPAG cover above, but adjusted to reflect average thickness of cut and fill area.
Ore Stockpile	NPAG pad	Development	As per NPAG cover above, but adjusted to reflect the average thickness of the pad.
	Ore	Operations	Metal release rates from HCT tests on ore, including a mixture of PAG and NPAG results, average results.
	Frozen NPAG pad	Post-closure	As per the NPAG pad, but adjusted to reflect a 5 metre thick active layer.
Other Pad Areas and Dykes	NPAG pad	Development through to post-closure	As per NPAG cover above, but adjusted to reflect the average thickness of these pads (typically 2 m thick).
Open Pits	Fully exposed pit walls	Operations – prior to flooding	Metal release rates from PAG (prior to onset of acidity) and NPAG HCT blended to reflect the specific mixture of rock types exposed on the pit wall. Assumes a rubble zone of 1 m thick.
	Exposed high walls	Operations to post-closure – after flooding	Metal release rates from PAG (after onset of acidity), and NPAG HCT blended to reflect the mixture of rock types exposed on the high wall.
	Exposed overburden	Development through to post-closure	Baseline runoff concentrations.
TSF	Beach areas	Operations	Metal release rates from the tailings HCTs.

Table 7-2: Areas, Volumes, and Mass of Material within Each Facility

Facility	Footprint Area (m^2)	Volume (m^3)	Mass (tonnes)
Umwelt WRSA	380,000	6,515,000	13,031,000
Llama WRSA	350,000	5,266,000	10,532,000
TSF WRSA	561,000	5,053,000	10,105,000
Echo WRSA	60,000	294,000	588,000
Ore Pad	139,000	2,136,000	4,272,000
Ore Stockpile	139,000	1,000,000	2,000,000
Goose Plant Site	482,000	303,000	606,000

Table 7-3: Percent Distribution of PAG Rock Types within WRSAs

Rock Type	Umwelt	Llama	Goose Main	Echo
Felsic	2%	4%	1%	1%
Gabbro	0%	3%	5%	0%
GW/Mudstone	36%	21%	37%	70%
UIF	53%	62%	36%	18%
LIF and MM	9%	10%	22%	9%

Table 7-4: Percent Distribution of NPAG Rock Types within Covers

Rock Type	Umwelt/Llama/Echo	Goose Main
Felsic	8%	2%
Gabbro	6%	9%
GW/Mudstone	50%	34%
UIF	37%	56%

Table 7-5: Regional Limits on WRSA Concentrations

Parameter	Unit	Best Estimate	Upper Bound
Alk	mg $CaCO_3$/L	120	120
Ca*	mg/L	73	73
Mg*	mg/L	11	11
Ag	mg/L	0.000040	0.0010
Al	mg/L	0.39	0.76
As**	mg/L	0.22	0.54
Cd	mg/L	0.00010	0.00036
Co***	mg/L	0.00077	0.0020
Cu	mg/L	0.0110	0.053
Fe	mg/L	0.42	2.40
Hg	mg/L	0.000050	0.00010
Mn***	mg/L	0.069	1.3
Mo	mg/L	0.0052	0.037
Ni	mg/L	0.058	0.03
Sb	mg/L	0.0025	0.012
Se	mg/L	0.0020	0.0050
Zn	mg/L	0.016	0.036

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Notes:

* An upper bound was not considered appropriate or necessary for these major ions.

** A separate regional limit was developed for arsenic concentrations from the cover material, with best estimate of 0.096 mg/L and upper bound of 0.14 mg/L.

*** Data from the seep survey indicates that the regional limits for cobalt and manganese may be underestimated. Sensitivity analyses have been recommended to evaluate the effect of higher concentrations on downstream water quality; see Section 7.2.2 for details.

Table 7-6: Exposed Area and Percent by Rock Type on Open Pit Walls – During Operations

Group	Rock Type	Umwelt	Llama	Goose Main	Echo
Total Area (m^2)		140,993	112,970	158,538	24,507
PAG	Felsic	1%	1%	0%	0%
	Gabbro	0%	1%	1%	0%
	GW/Mudstone	23%	14%	15%	27%
	UIF	18%	26%	3%	10%
	MM&LIF	11%	14%	11%	7%
NPAG	Felsic	1%	3%	1%	1%
	Gabbro	1%	3%	8%	2%
	GW/Mudstone	31%	18%	34%	44%
	UIF	14%	20%	28%	8%

Table 7-7: Exposed Area and Percent by Rock Type on Open Pit Walls – Post Flooding

Group	Rock Type	Umwelt	Llama	Goose Main	Echo
Total Area (m^2)		1,635	4,850	142	1,836
PAG	Felsic	0%	1%	0%	0%
	Gabbro	1%	1%	1%	0%
	GW/Mudstone	9%	14%	15%	27%
	UIF	35%	26%	3%	10%
	MM&LIF	9%	14%	11%	7%
NPAG	Felsic	0%	3%	1%	1%
	Gabbro	7%	3%	8%	2%
	GW/Mudstone	12%	18%	34%	44%
	UIF	28%	20%	28%	8%

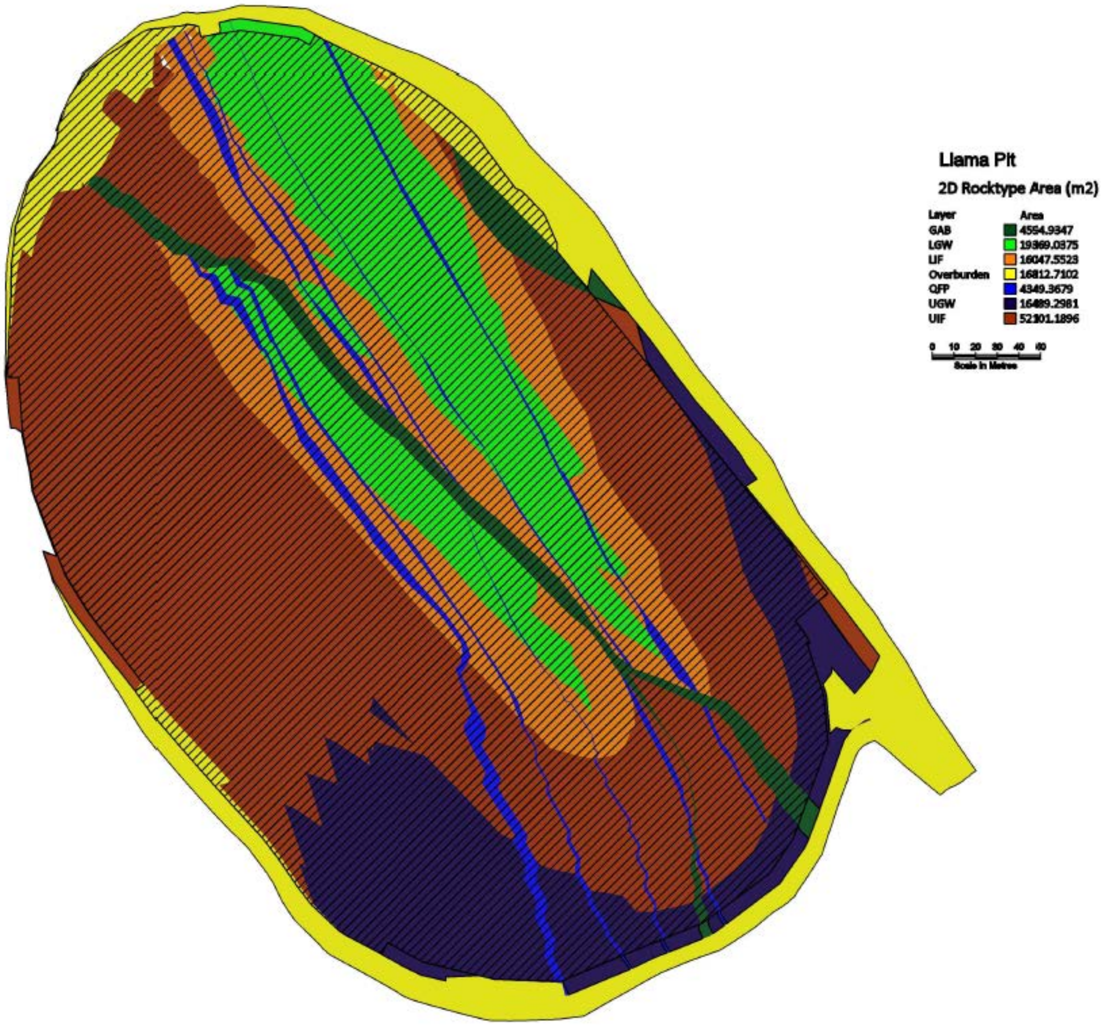

Figure 7-1: Distribution of Rock Types on Exposed Pit Wall – Llama Pit (Hatched area indicates the area that will be flooded upon closure)

Table 7-8: Best Estimates of Source Concentrations for Each of the Mine Components – Goose Property

Feature	Area	Phase	Predicted Concentrations																	
			SO_4 (mg/L)	As (mg/L)	Alk (eq/L)	Ca (mg/L)	Mg (mg/L)	Ag (mg/L)	Al (mg/L)	Cd (mg/L)	Co* (mg/L)	Cu (mg/L)	Fe (mg/L)	Hg (mg/L)	Mn* (mg/L)	Mo (mg/L)	Ni (mg/L)	Sb (mg/L)	Se (mg/L)	Zn (mg/L)
Tailings Process Water	Tailings Ponds	Operations	1055	0.025	82	178	47	0.000063	0.013	0.000017	0.060	0.059	0.019	0.00001	0.15	0.083	0.0015	0.002	0.0036	0.0032
Industrial Site Runoff	Cut and Fill Area	All	36	0.043	25	16	4.1	0.000013	0.21	0.00010	0.00077	0.0027	0.42	0.0000072	0.069	0.00079	0.058	0.0010	0.00033	0.014
Ore Stockpile	Pad	Pre-operations	1732	0.096	120	73	11	0.000040	0.39	0.00010	0.00077	0.011	0.42	0.000050	0.069	0.0052	0.058	0.0025	0.0020	0.016
	Ore and Pad	Operations	1700	0.22	120	73	11	0.000040	0.39	0.00010	0.00077	0.011	0.42	0.000050	0.069	0.0052	0.058	0.0025	0.0020	0.016
	Frozen Pad	Post Closure	283	0.096	120	73	11	0.000040	0.39	0.00010	0.00077	0.011	0.42	0.000050	0.069	0.0052	0.058	0.0025	0.0020	0.016
Tailings Beach Runoff	TSF	TSF operations	1122	0.52	40	40	5.7	0.000055	0.071	0.000020	0.00678	0.0017	0.078	0.0000078	0.091	0.063	0.0015	0.00050	0.0017	0.0016
WRSAs	Umwelt	Operations (until frozen)	1700	0.22	120	73	11	0.000040	0.39	0.00010	0.00077	0.011	0.42	0.000050	0.069	0.0052	0.058	0.0025	0.0020	0.016
	Llama	Operations (until frozen)	1700	0.22	120	73	11	0.000040	0.39	0.00010	0.00077	0.011	0.42	0.000050	0.069	0.0052	0.058	0.0025	0.0020	0.016
	Goose (PAG)	Operations (until frozen)	1700	0.22	120	73	11	0.000040	0.39	0.00010	0.00077	0.011	0.42	0.000050	0.069	0.0052	0.058	0.0025	0.0020	0.016
	Goose (Mix)	Operations (until frozen)	751	0.14	120	73	11	0.000040	0.39	0.00010	0.00077	0.011	0.42	0.000050	0.069	0.0052	0.058	0.0025	0.0020	0.016
	Echo	Operations (until frozen)	1365	0.22	120	73	11	0.000040	0.39	0.00010	0.00077	0.011	0.42	0.000050	0.069	0.0052	0.058	0.0025	0.0020	0.016
Pit Walls	Umwelt	Operations (when exposed)	51	0.090	17	15	4.9	0.000012	0.34	0.00009	0.00068	0.010	0.36	0.0000054	0.060	0.00063	0.041	0.00043	0.00034	0.014
	Llama	Operations (when exposed)	57	0.091	18	16	5.3	0.000012	0.34	0.00009	0.00068	0.010	0.37	0.0000053	0.060	0.00057	0.035	0.00032	0.00037	0.014
	Goose	Operations (when exposed)	36	0.052	17	13	3.7	0.000011	0.30	0.00008	0.00061	0.009	0.32	0.0000063	0.052	0.00051	0.039	0.00041	0.00028	0.0085
	Echo	Operations (when exposed)	38	0.073	15	12	4.0	0.000011	0.29	0.00008	0.00060	0.009	0.31	0.0000061	0.052	0.00058	0.040	0.00047	0.00028	0.012
Pit High Walls	Umwelt	Post Closure	14	0.0082	3.3	3.8	1.8	0.000010	0.06	0.000021	0.00020	0.0026	0.07	0.000009	0.010	0.000089	0.011	0.000081	0.00018	0.0046
	Llama	Post Closure	26	0.021	4.3	5.5	2.5	0.000011	0.12	0.000035	0.00030	0.0041	0.13	0.0000085	0.021	0.00013	0.019	0.00013	0.00028	0.007
	Goose	Post Closure	4.6	0.0006	2.1	2.2	1.3	0.000010	0.015	0.000011	0.00013	0.0015	0.018	0.000010	0.003	0.000054	0.0043	0.000054	0.00010	0.0031
	Echo	Post Closure	23	0.012	4.6	4.8	2.3	0.000011	0.12	0.000036	0.00031	0.0042	0.13	0.0000085	0.021	0.00016	0.019	0.00020	0.00024	0.0067
Covered Areas	ULE	Post Closure	283	0.096	120	73	11	0.000040	0.39	0.00010	0.00077	0.011	0.42	0.000050	0.069	0.0052	0.058	0.0025	0.0020	0.016
	Main		304	0.096	120	73	11	0.000040	0.39	0.00010	0.00077	0.011	0.42	0.000050	0.069	0.0052	0.058	0.0025	0.0020	0.016

Notes: * Data from the seep survey indicates that the regional limits for cobalt and manganese may be underestimated. Sensitivity analyses have been recommended to evaluate the effect of higher concentrations on downstream water quality; see Section 7.2.2 for details.

Table 7-9: Upper Bound Estimates of Source Concentrations for Each of the Mine Components – Goose Property

Feature	**Area**	**Phase**	**Predicted Concentrations**															
			SO$_4$ (mg/L)	**As (mg/L)**	**Alk (eq/L)**	**Ca (mg/L)**	**Mg (mg/L)**	**Ag (mg/L)**	**Al (mg/L)**	**Cd (mg/L)**	**Co* (mg/L)**	**Cu (mg/L)**	**Fe (mg/L)**	**Hg (mg/L)**	**Mn* (mg/L)**	**Mo (mg/L)**	**Ni (mg/L)**	**Sb (mg/L)**	**Se (mg/L)**	**Zn (mg/L)**
Tailings Process Water	Tailings Ponds	Operations	2110	0.049	164	356	94	0.00013	0.025	0.000033	0.12	0.12	0.037	0.000020	0.30	0.17	0.0030	0.0040	0.0071	0.0064
Industrial Site Runoff	Cut and Fill Area	All	44	0.065	25	16	4.1	0.000013	0.21	0.00024	0.0020	0.0027	0.57	0.0000072	0.14	0.00079	0.030	0.0010	0.00033	0.014
Ore Stockpile	Pad	Pre-operations	2143	0.14	120	73	11	0.00062	0.76	0.00036	0.0020	0.049	2.4	0.00010	1.3	0.037	0.030	0.012	0.0050	0.036
	Ore and Pad	Operations	2000	0.54	120	73	11	0.00096	0.76	0.00036	0.0020	0.049	2.4	0.00010	1.3	0.037	0.030	0.012	0.0050	0.036
	Frozen Pad	Post Closure	350	0.14	120	73	11	0.00010	0.76	0.00036	0.0020	0.021	2.4	0.000057	1.1	0.0061	0.030	0.0070	0.0026	0.036
Tailings Beach Runoff	TSF	TSF operations	1122	0.52	40	40	5.7	0.000055	0.07	0.00001	0.0068	0.0017	0.08	0.0000078	0.09	0.06288	0.001	0.0005	0.00172	0.002
WRSAs	Umwelt	Operations (until frozen)	2000	0.54	120	73	11	0.00095	0.76	0.00036	0.0020	0.049	2.4	0.00010	1.3	0.037	0.030	0.011	0.0050	0.036
	Llama	Operations (until frozen)	2000	0.54	120	73	11	0.00080	0.76	0.00036	0.0020	0.049	2.4	0.00010	1.3	0.037	0.030	0.010	0.0050	0.036
	Goose (PAG)	Operations (until frozen)	2000	0.54	120	73	11	0.00049	0.76	0.00036	0.0020	0.049	2.4	0.00010	1.3	0.027	0.030	0.0052	0.0050	0.036
	Goose (Mix)	Operations (until frozen)	906	0.27	120	73	11	0.00022	0.76	0.00036	0.0020	0.029	2.4	0.00007	1.1	0.013	0.030	0.0056	0.0034	0.036
	Echo	Operations (until frozen)	1704	0.54	120	73	11	0.00028	0.76	0.00036	0.0020	0.049	2.4	0.000066	1.1	0.019	0.030	0.0032	0.0050	0.036
Pit Walls	Umwelt	Operations (when exposed)	51	0.090	17	15	4.9	0.000012	0.34	0.00009	0.0007	0.010	0.36	0.0000054	0.060	0.00063	0.041	0.00043	0.00034	0.014
	Llama	Operations (when exposed)	57	0.091	18	16	5.3	0.000012	0.34	0.00009	0.0007	0.010	0.37	0.0000053	0.060	0.00057	0.035	0.00032	0.00037	0.014
	Goose	Operations (when exposed)	36	0.052	17	13	3.7	0.000011	0.30	0.00008	0.0006	0.009	0.32	0.0000063	0.052	0.00051	0.039	0.00041	0.00028	0.0085
	Echo	Operations (when exposed)	38	0.073	15	12	4.0	0.000011	0.29	0.00008	0.0006	0.009	0.31	0.0000061	0.052	0.00058	0.040	0.00047	0.00028	0.012
Pit High Walls	Umwelt	Post Closure	14	0.0082	3.3	3.8	1.8	0.000010	0.06	0.000021	0.0002	0.0026	0.07	0.000009	0.010	0.000089	0.011	0.000081	0.00018	0.0046
	Llama	Post Closure	26	0.021	4.3	5.5	2.5	0.000011	0.12	0.000035	0.0003	0.0041	0.13	0.0000085	0.021	0.00013	0.019	0.00013	0.00028	0.007
	Goose	Post Closure	4.6	0.0006	2.1	2.2	1.3	0.000010	0.015	0.000011	0.0001	0.0015	0.018	0.000010	0.0025	0.000054	0.0043	0.000054	0.00010	0.0031
	Echo	Post Closure	23	0.012	4.6	4.8	2.3	0.000011	0.12	0.000036	0.0003	0.0042	0.13	0.0000085	0.021	0.00016	0.019	0.00020	0.00024	0.0067
Covered Areas	ULE	Post Closure	350	0.14	120	73	11	0.00010	0.76	0.00036	0.0020	0.021	2.4	0.000057	1.06	0.0061	0.030	0.0070	0.0026	0.036
	Main		391	0.14	120	73	11	0.00010	0.76	0.00036	0.0020	0.020	2.4	0.000057	1.07	0.0062	0.030	0.0057	0.0026	0.036

Notes: *Data from the seep survey indicates that the regional limits for cobalt and manganese may be underestimated. Sensitivity analyses have been recommended to evaluate the effect of higher concentrations on downstream water quality.

8 Summary and Conclusions

Detailed geochemical characterization studies were completed to determine the ML/ARD potential of the overburden, quarry rock, waste rock, tailings, and mine workings. The results are summarized as follows:

Overburden and Quarry Rock

- Overburden samples from the Goose Property have a negligible potential for ML/ARD.
- Quarry rock from the Airstrip quarry has a variable potential for ARD and recommendations have been made to either complete further off-site testing in advance of quarry development, or to complete on-site NAG testing to identify and segregate out PAG rock during quarry excavation.
- Quarry rock from the Umwelt quarry has a limited potential for ARD, and does not require special management procedures.
- Rock associated with other excavation areas at the Goose Property has a variable potential for ARD. However, the volumes of material that are expected to be disturbed as a result of cut and fill activities are expected to be very small.
- Contact water associated with quarry rock from both the Airstrip quarry and the Umwelt quarry areas is expected to contain slightly elevated levels of arsenic, and arsenic loading from this material has been considered in the overall assessment of environment effects.
- Quarry rock from the MLA has a negligible potential for ML/ARD. However, because the samples were already weathered, additional sampling and testing should be completed in advance of construction to verify these findings.

Waste Rock

- Testing results indicate that an appreciable proportion of the waste rock is PAG or has an uncertain potential for ARD. The Umwelt, Llama, and Echo deposits have the highest proportion of PAG and uncertain material, while the Goose Main deposit has the lowest proportion.
- PAG and uncertain waste rock is found in all of the stratigraphic units, but tends to be more common in the lower iron formation (LIF) and the upper iron formation (UIF) units, and is less common in the gabbro (GAB). The LIF and UIF units also tended to have higher concentrations of sulphides.
- The humidity cell tests indicate that metal leaching is greatly enhanced when acidic conditions are allowed to develop. Therefore, specific measures will be necessary to control ML/ARD potential in the PAG waste rock.
- Preliminary calculations indicate that acidic conditions are not expected to develop in the majority (>95%) of the waste rock during the 10-year freeze back period. Although acidic conditions could occur more rapidly in some of the waste rock, average pH conditions in

seepage and runoff would be expected to remain buffered until WRSA freeze back conditions develop.

- PAG/NPAG quantities were determined based on the proportion of PAG plus uncertain, and NPAG plus low-sulphur material present in each of the modelled stratigraphic and intrusive units.
    - The estimates of in-situ quantities indicate that approximately 38 Mt of NPAG waste rock (65%) and 21 Mt of PAG waste rock (35%) are present within the limits of the open pits.
    - The proportions of PAG/NPAG in-situ waste rock vary by pit, with approximately 50% PAG/50% NPAG in the Umwelt and Llama open pits, 20% PAG/80% NPAG in the Echo open pit, and 15% PAG/85% NPAG in the Goose Main open pit.
    - When segregation is taken into account, it is estimated that approximately 25 Mt of NPAG and 34 Mt of PAG waste rock would be produced, which is equivalent to a recoverable ratio of 58% PAG and 42% NPAG.
- The proposed waste management plan is to segregate PAG and NPAG waste rock during mining and to encapsulate the PAG rock under a cover of NPAG rock. It is expected that permafrost will aggrade into the PAG rock, which will greatly reduce the rates of oxidation and eliminate interaction with seepage.
- The distribution of PAG and NPAG waste rock is not closely linked to stratigraphy or to lithology. Therefore, segregation of these materials will require a dedicated blast hole monitoring program similar to the procedures that are used to identify and segregate ore in the mining operation. The testing to support segregation will likely include a combination of sulphur analyses (using a Leco furnace), and NAG tests.

Tailings

- With the exception of some samples from the Goose Main deposit, tailings are potentially acid generating (PAG).
- Acidic conditions developed in one of the humidity cell tests that was operated under standard room temperature conditions (i.e. the master composite sample), but remained neutral in the refrigerated test, and neutral in the test completed on tailings from the Goose Main deposit. The humidity cell tests indicate that sulphate and arsenic concentrations were elevated in all three tailings samples. Concentrations of cadmium, cobalt, nickel, and zinc increased in response to decreasing pH conditions that occurred in the master composite. These findings suggest that the tailings will need to be managed to prevent metal leaching and acid rock drainage.
- Preliminary calculations indicate that the delay in the onset of acidic conditions (lag times) in exposed tailings from Umwelt, Llama, and Goose Main would be on the order of 2 to 31 years under field conditions. Assuming that the exposed tailings on the surface of the TSF are a blend of Goose Main and Llama ore (with at least 30% Goose Main ore), as is anticipated based on the current production schedule, lag times are expected to be on the order of 10 to 20 years. It is expected that the TSF will be fully covered by Year 6 of operations.

- Tailings in the Umwelt and Goose TFs will be flooded at Closure which will prevent acidic conditions from developing.
- Process water and aging test data indicate that tailings process water, shortly after generation, will have neutral pH and elevated concentrations of ammonia (51 mg/L) , cyanate (34 mg/L), thiocyanate (94 mg/L), sulphate (1,010 mg/L), aluminum (0.68 mg/L), antimony (0.15 mg/L), arsenic (0.17 mg/L), copper (1.4 mg/L), and iron (3.2 mg/L) concentrations. Over time, as indicated by preliminary results from the aging tests, all of these parameters show either decreasing or stable concentrations. However, depending on the residence time and actual rates of degradation occurring in the tailings facilities, there is a possibility that this water may need to be treated to remove these parameters.

Water Quality Estimates

Results from the geochemical characterization program were used to estimate the chemistry of process water and seepage and runoff that will be directly in contact with the WRSAs, ore stockpiles, pads, exposed pit walls, and exposed tailings, prior to dilution from local runoff in undisturbed areas of the catchments. The estimates were based on a combination of scale-up calculations, geochemical modelling, and extrapolation of monitoring data from geologically similar mine sites in the area. The results were a key input to the water and load balance used to predict discharge and receiving water quality from the site, for use in the in the effects assessment.

This report, “Geochemical Characterization in Support of the Final Environmental Impact Statement (FEIS) for the Back River Project, Nunavut”, was prepared by SRK Consulting (Canada) Inc.

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All data used as source material plus the text, tables, figures, and attachments of this document have been reviewed and prepared in accordance with generally accepted professional engineering and environmental practices.

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The opinions expressed in this report have been based on the information available to SRK at the time of preparation. SRK has exercised all due care in reviewing information supplied by others for use on this project. Whilst SRK has compared key supplied data with expected values, the accuracy of the results and conclusions from the review are entirely reliant on the accuracy and completeness of the supplied data. SRK does not accept responsibility for any errors or omissions in the supplied information, except to the extent that SRK was hired to verify the data.

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Appendix A Lithological Descriptions