APPENDIX 5-E

Evaluation of the Geochemical Properties of Waste Rock, Ore, Tailing, Overburden and Sediment from the Whale Tail Pit and Road Aggregate Materials

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REPORT ON

Evaluation of the Geochemical Properties of Waste Rock, Ore, Tailing, Overburden and Sediment from the Whale Tail Pit and Road Aggregate Materials
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Golder Associates

Executive Summary

Agnico Eagle Mines Limited – Meadowbank Division (Agnico Eagle) is proposing to develop Whale Tail Pit (Project), a satellite deposit located on the Amaruq Exploration property. Agnico Eagle is proposing to continue mine operations and milling at the Meadowbank Mine and gain approval to extend Meadowbank Mine to include development of resources from Whale Tail Pit. Concurrent with the reconsideration of the Project Certificate by the NIRB, Agnico Eagle is seeking an amendment to the Meadowbank Mine Type A Water Licence (No. 2AM-MEA1525) to include mining of Whale Tail Pit and the construction and operations of associated infrastructure from the Nunavut Water Board (NWB).

The Amaruq property is a 408 square kilometre (km^2) site located on Inuit Owned Land approximately 150 kilometres (km) north of the hamlet of Baker Lake and approximately 50 km northwest of Meadowbank Mine in the Kivalliq Region of Nunavut. The deposit will be mined as an open pit (i.e., Whale Tail Pit), and ore will be hauled to the approved infrastructure at Meadowbank Mine for milling.

Mining facilities include accommodation buildings, two ore stockpiles, one overburden stockpile, one rock storage facility area planned to receive waste rock and waste overburden, a water management system that includes collection ponds, water diversion channels, and retention dikes/berms, and a Water Treatment Plant.

The proposed open pit mine, mined by truck-and-shovel operation, will produce 8.3 million tonnes (Mt) of ore, 46.1 Mt of waste rock, and 5.6 Mt of overburden waste. There are four phases to the development: one year of construction, three to four years of mine operation, seven years of closure, and the post-closure period.

Agnico Eagle mandated Golder to evaluate the geo-environmental properties of geological materials that will be disturbed by mining of the Whale Tail Pit; namely, waste rock, ore, tailings produced by milling of the ore, overburden and Whale Tail Lake sediments in the footprint of the proposed open pit. Potential road construction materials (esker material and Vault waste rock) were also evaluated (Golder 2015; Appendix A) and results are included in this report. This study investigates the potential of these materials to generate acidic rock drainage (ARD) and to release metals (metal leaching, or ML) to the receiving environment in the short and long term, within the context of the site climate and proposed mine management plans.

This report presents the results of the geochemical characterization program completed to date. The tests include chemical analyses and kinetic weathering tests. Kinetic tests are on-going on samples of waste rock and ore from the deposit. A kinetic weathering test on the one waste rock sample and one tailings sample was stopped after 44 weekly cycles of leaching.

Site Geology

The main lithological units that will be mined include: ultramafic komatiites, sedimentary rocks (greywacke, iron formation and chert), mafic volcanic rocks and felsic to intermediate intrusive rocks. The Whale Tail deposit mineralization is low sulphur but the sulphur carries arsenic which is enriched in all waste rock types along with antimony and bismuth. In addition to arsenic, chromium and nickel enrichment is observed in ultramafic, iron formation and mafic volcanic waste rock.

Waste rock

The majority (73%) of waste rock to be generated by mining is low sulphur and not potentially acid generating (non PAG), including: ultramafic, iron formation, mafic volcanic, southern greywacke and intermediate intrusive waste rock. This is from low sulphur content and excess carbonate-mineral (reactive) buffering capacity. A limited number of samples from the ultramafic and iron formation units are PAG but the bulk of these lithologies carry sufficient reactive carbonate buffering capacity to neutralize any acidity that could be generated from these samples.

Arsenic is the principal element of environmental interest in Whale Tail mining wastes. No other element is systematically released in leachate from any rock type, tailings, ore or sediments at concentrations that exceed the Meadowbank effluent limits. Arsenic is released at concentrations that exceed the Meadowbank effluent limits from the non PAG rock ultramafic and iron formation lithologies, which comprise approximately 46% of the waste rock to be generated by mining, or 63% of the non PAG waste rock at Whale Tail Pit. The mafic volcanic lithology can leach elevated arsenic at the contact with the ultramafic and greywacke units, but the bulk of the samples are low arsenic. The exceedances noted in static and kinetic leaching tests do not necessarily mean that water contacting this rock at site will necessarily exceed the comparative criteria because conditions at site differ substantially from the aggressive leaching conditions of the laboratory tests. This does suggest, however, that arsenic is likely to be released from this rock upon contact with water and that this drainage should be captured and monitored before discharge to the receiving environment. The ore and lithologies that host to the ore, namely central greywacke and chert waste rock, are PAG. They represent 27% of waste rock to be generated by mining. The central greywacke samples (within the mineralized zone) are more silicified than the southern greywacke unit (outside the mineralized zone). Based on results to date, a total sulphur content of 0.1 wt% appears to be a suitably conservative cut-off criteria below which chert and greywacke waste rock are non PAG. Samples above 0.8 wt% are PAG. The ARD potential of samples having 0.1 to 0.8wt% sulphur is uncertain.

Kinetic leaching tests performed on 1-kg samples and on large bulk lithological samples corroborate results of static testing. Only one of the three PAG greywacke samples generated acid rock drainage (ARD) during testing. This sample represents a high-tier ARD potential end-member of this unit (high sulphur, low buffering capacity). Theoretical mineral depletion calculations and consideration of the field time equivalency of laboratory kinetic tests infers the PAG rock will not begin to generate ARD at site for more than a decade, as a minimum, if no ARD control mechanisms were put in place. This period of time is substantially longer than the 4 years of mine construction and operations. Accordingly, ARD control mechanisms will be implemented at the end of mining operations, during the closure period. The possible exception being the upper tier high sulphur – low buffering capacity greywacke or chert rock, which may require ARD or metal leaching control during operations. Existing operations at Vault Pit, a satellite deposit currently in operation at the Meadowbank Mine show little to no drainage or seepage from the Vault waste rock storage facility, thus Whale Tail Waste Rock Storage Facility drainage control is not expected to be an issue.

Mine Site Construction Rock

Early mine development rock from the Whale Tail deposit (intermediate intrusive, southern greywacke waste rock and mafic volcanic rock away from the greywacke and ultramafic units) is being considered for use as infrastructure construction material on the mine site. These units are non PAG and leach relatively low levels of arsenic. These materials appear suitable for use in construction based on testing completed as part of this study. As a precaution, monitoring will continue to evaluate the sulphur content of the south greywacke waste rock and Agnico Eagle will avoid rock that contains more than 0.1 wt% sulphur. Mafic volcanic rock proximal to the ultramafic and greywacke contacts will also be avoided.

Based on the aggressive laboratory leaching tests completed to date, the ultramafic and iron formation waste rock may not be suitable for construction in areas where the rock will be in contact with water because of the potential to release arsenic in leachate. The actual leachability of these materials will be verified under site conditions prior to use.

Ore and Tailings

The ore and tailings are enriched in arsenic, antimony, bismuth, selenium and silver, and are slightly enriched in chromium. Copper is elevated in tailings but given its low levels in ore and waste rock, this may reflect copper sulphate addition during the cyanide destruction process. Process water quality exceeds the Meadowbank effluent limits for ammonia, arsenic and total cyanide.

Ore and tailings are PAG due to their elevated sulphur content and low buffering capacity; however, kinetic leaching tests showed sustained buffering capacity over 10 to 44 weeks of leaching. Both ore samples leached concentrations that exceeded one or both Meadowbank effluent limits for arsenic. No other exceedances are noted. Mineralogical depletion calculations indicate a fairly long delay to the possible initiation of ARD. Given that ore storage at the Whale Tail site is temporary (it will be transported to the Meadowbank mill and ultimately report to tailings at the Meadowbank area), ARD is not expected to require control during mine construction and operations. However, for this reason Agnico Eagle has planned to stockpile or store ore at the Whale Tail Pit site in areas within the drainage area of the attenuation pond. If ore were to be stockpiled permanently; the material would require means to control oxidation and ARD in the long term.

The tailings sample showed neutral pH, low conductivity and sulphate concentrations over 44 weeks of accelerated kinetic weathering test. Metal and arsenic concentrations remained below both the Portage and Vault effluent criteria throughout testing. The cell was terminated after 44 weeks having reported steady state conditions and exceeded the anticipated exposure period of tailings at site. The maintenance of neutral pH despite the solid sample having no buffering capacity may be due to the presence of lime added to the tailings slurry in metallurgical processing. It is expected that this added buffering capacity will eventually be consumed, after which the tailings may start to oxidize and develop acidic conditions, as suggested based on mineral depletion calculations.

Tailings are expected to require ARD control in the long term. Consideration will be given to avoiding the prolonged exposure of the tailings to prevent the development of localized acidification. The Medowbank TSF is designed with such long term controls, namely the placement of a capping layer to isolate the underlying tailings from exposure to the surrounding environment.

Whale Tail tailings contact water and process water is likely to require capture and monitoring of quality prior to discharge if the Whale Tail ore is processed by itself (not mixed with ore from other deposits).

Overburden and Lake Sediment

The shallow overburden is non PAG based on the low sulphide sulphur content. The arsenic content is low, and its leachable arsenic content is below CCME aquatic life in laboratory tests. This material has a suitable chemistry for use as construction materials; however, the fines portion of the samples could be amenable to erosion and transport as suspended solids in contact water. This, along with the chemistry and leachability of deep overburden, will be monitored prior to its use where it would be exposed to runoff.

The five lake sediment samples tested are non-acid generating. However, the lake sediment samples are enriched in arsenic, and the arsenic is somewhat leachable; three of the five samples have short term test leachate concentrations that are above the effluent limit for Vault.

Exploration Road Construction Materials

All esker samples tested from potential borrow sources show no potential to generate ARD and all release low concentrations of chemical constituents (within one order of magnitude of the CCME aquatic life criteria).

Vault Pit waste rock has variable ARD potential, depending on the sulphur content of the sample analyzed. The current operational sampling plan is effective at defining the ARD potential of waste rock being extracted from the open pit and as such, can be relied upon to identify non PAG rock for construction use. Furthermore, grab samples from the existing non PAG waste rock stockpile adjacent to the Vault Pit confirm that this material is non PAG and suitable for construction use. However, one sample from the non PAG area was identified as having an uncertain ARD potential due to its higher sulphur content. Using both the total sulphur and CaNPR segregation criteria will help to optimize the effectiveness of the on-going segregation program.

Arsenic leaching from Vault Pit waste rock is not expected to pose a risk to the environment because of the small quantity of rock that will be exposed along the road corridor, especially considering that the majority of the top layer will be sourced from natural eskers. The quality of road contact water will be monitored during road construction.

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1.0 INTRODUCTION

Agnico Eagle Mines Limited – Meadowbank Division (Agnico Eagle) is proposing to develop Whale Tail Pit (Project), a satellite deposit located on the Amaruq Exploration property. Agnico Eagle is proposing to continue mine operations and milling at the Meadowbank Mine and gain approval to extend Meadowbank Mine to include development of resources from Whale Tail Pit. Concurrent with the reconsideration of the Project Certificate by the NIRB, Agnico Eagle is seeking an amendment to the Meadowbank Mine Type A Water Licence (No. 2AM-MEA1525) to include mining of Whale Tail Pit and the construction and operations of associated infrastructure from the Nunavut Water Board (NWB).

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Mining facilities include accommodation buildings, two ore stockpiles, one overburden stockpile, one rock storage facility area planned to receive waste rock and waste overburden, a water management system that includes collection ponds, water diversion channels, and retention dikes/berms, and a Water Treatment Plant.

The proposed open pit mine, mined by truck-and-shovel operation, will produce 8.3 million tonnes (Mt) of ore, 46.1 Mt of waste rock, and 5.6 Mt of overburden waste. There are four phases to the development: one year of construction, three years of mine operation, seven years of closure, and the post-closure period.

As part of baseline data collection in support of the Environmental Review for the Project, Agnico Eagle mandated Golder Associates (Golder) to carry out an evaluation of the geochemical properties of geological materials that will be displaced by mining of the Whale Tail Pit; namely, waste rock, ore, tailings produced by milling of the ore, overburden and Whale Tail Lake sediments within the footprint of the pit. Potential road construction materials (esker material and Vault waste rock) were also evaluated (Golder 2015; Appendix A) and results are included in this report. This study investigates the potential of these materials to generate acidic rock drainage (ARD) and to release metals (metal leaching, or ML) to the receiving environment in the short and long term, within the context of the site climate and anticipated mine management plans.

This study was completed in a phased approach. Phase 1 consisted of the collection of core samples by Agnico Eagle staff from existing exploration boreholes drilled mostly within the west part of the Whale Tail Pit. Phase 2 included the analysis of assay reject materials from an analytical laboratory, including samples that originated mostly from the eastern part of the Whale Tail Pit, and the collection of a tailings sample from mineral processing tests directed by Agnico Eagle. The Phase 3 investigation consisted of collecting waste rock and available ore samples from existing exploration boreholes, overburden, and lake sediment samples from within the footprint of the Whale Tail Pit. The third stage of sampling targeted spatial and lithological data gaps from the first two stages, and was completed by Golder personnel, except for lake sediment samples which were collected by Azimuth Consulting.

This report describes the geology of the deposit, the sampling and analytical methods used to characterize the geochemical properties of the mined and borrow materials, and presents the results the static tests and on-going kinetic leaching tests on tailings, ore and waste rock. The results serve to identify the predominant geo-environmental trends of the materials, on the basis of which appropriate mine waste and water management plans will be developed.

1.1 Information Reviewed

Background information on the geology, mineralogy, and chemistry of rock types present at the site was extracted from the following documentation provided by Agnico Eagle:

- Project Description, Whale Tail Deposit, Nunavut (Agnico Eagle 2015);
- Whale Tail Ore Types & Lithology Summary;
- Mine plan provided by Agnico Eagle - *6108_PJS-002_R3.xlsx* received by Golder on February 22, 2016; and,
- Geological cross-sections, borehole logs and maps.

A previous report on the geochemical characterization program of potential road fill materials for the Whale Tail access road (Golder 2015) is referenced in this study and excerpts are included in this report for completeness. The full report on the geochemical characterization program of potential road fill materials for the Whale Tail access road is included in Appendix A.

Other information on mine planning, mineral processing and mine waste management was collected via discussions and email exchanges with Agnico Eagle staff and Whale Tail Project team members during this study.

1.2 Regional and Site Geology

The following summary is adapted from the Agnico Eagle lithology summary provided by Agnico Eagle staff.

1.2.1 Regional Geology

The Amaruq property is underlain by Archean supra crustal rocks of the metamorphosed Woodburn Lake Group; the same sequence as at the Meadowbank Mine. These rocks are believed to have been deposited in a continental rift setting. They are comprised of mafic to ultramafic volcanic and volcaniclastic rocks interlayered with clastic sedimentary units that include greywacke, siltstone, mudstone, banded iron formation, and chert. This rock sequence has been intruded by granitoid rocks and lamprophyres, and underwent multiple deformation events and metamorphism to the upper greenschists facies. There are four Paleo-Proterozoic aged events of deformation recognised, two of which have significant effects on the geometry of the deposit.

1.2.2 Site Geology

The main lithological units associated with the Whale Tail deposit include: ultramafic komatiites, clastic sedimentary rocks, mafic volcanic rocks and felsic to intermediate intrusive rocks. These lithologies are briefly described as follows:

Ultramafic (V4a) – Komatiite – There are two main units that are grouped into this lithology: komatiite (geological code 0a) and a transitional komatiite (0b); for the basis of this report both are referred to as ultramafic rocks. The 0a unit can host mineralization and bounds the deposit on the northern part of the open pit, while the 0b unit is on the south side of the open pit. Both units are commonly altered with a talc-chlorite-carbonate package and are often deformed. The transitional ultramafic rock is distinguished based on whole rock chemistry, which is intermediate between the calc-alkaline and tholeiite units.

Clastic Sedimentary (3b) – Greywacke and Mudstone (S3) – This unit is dominantly comprised of greywacke (S3) that is dominantly present in the southern portion of the deposit (S3S) and centrally between the two ultramafic units mentioned above (S3C). There is a small northern unit (S3N), but this unit falls outside the pit outline and was not a part of this study. The S3C unit has varying amounts of silica, which was noted during sample collection by Golder but is not defined in the geological model.

Chemical Sediments (3b) - Chert (S10) – Predominantly located within or proximal to the ore zones and is sometimes interbedded with greywacke. This unit has some graphitic lenses, mostly associated with mudstone lenses. The chert unit is host to some of the economical mineralization which is noted by an increase in quartz veining and general silicification. In rocks related to the mineralization, the host sedimentary fabric is no longer distinguishable.

Chemical Sediments (3b) - Iron Formation (S9) – This is a hard, dense and banded unit comprised of two sub units: a sulfide facies Iron Formation (S9E) and a silicate facies Iron Formation (S9D), which cannot be distinguished chemically. The formation of this rock is interpreted as the subaqueous deposition of sediments associated with the V4_0a unit. The iron formation commonly contains many alteration-related minerals (calcite, amphiboles and chlorite) and can sometimes be harder than the ultramafic unit due to silicification. This unit can also be weakly to strongly magnetic closer to the mineralized zones because of the minerals present as part of the alteration package. Carbonate veins and veinlets, which sometimes contain pyrrhotite, are often present within this unit.

Mafic Volcanic (V3; 1b) – This basalt unit has a very similar colour and texture to greywacke (S3). The contact between the two units is diffuse and gradational; whole rock analyses are needed to properly distinguish these two units.

Intermediate Intrusive (I2; 8b) – This unit is located in the southern and eastern part of the development. It consists mostly of diorite, which is commonly porphyritic with medium sized grains of plagioclase that are often sheared and flattened. It is non-altered and non-mineralized.

1.2.3 Overburden Composition

Overburden in the Whale Tail Pit area is expected to be similar to that of the Meadowbank Mine. At the Meadowbank Mine, overburden consists of glacial till having an average thickness of 2.75 m, with local deposits over 10 m thick (CRL 2003). The glacial till varies from silty sand to gravel with minor boulders (Golder 2002). In a previous report (Golder 2005), overburden is described as silty to sand-sized with 25 to 50% pebble to boulder-sized particles. These data have been confirmed during the construction of the Meadowbank Mine from 2008 to 2010. Where sampled at Whale Tail Pit (in July), the overburden was frozen below 1 meter depth, and samples were collected in the surficial unfrozen zone only.

1.2.4 Whale Tail Mineralization

Three different mineralization styles are present at the Whale Tail deposit. The first style is associated with pyrrhotite-amphibole-carbonate layers, lenses or disseminations within the silicate-sulfides iron formation (S9E). The second style is characterized by silica flooding with presence of pyrrhotite, arsenopyrite and local pyrite, contained in chert-rich levels within a sediment sequence. The third style is associated with decimeter to several meters, quartz-galena-sphalerite-chalcopyrite-native gold veins cutting through the entire Whale Tail rock sequence. Mineralization within the Whale Tail deposit is widely dispersed in the western part, where multiple chert horizons are distinguished. Toward the east, the ore zones merge together. In all three style of mineralization, gold is associated with pyrrhotite or arsenopyrite, as inclusions or grains along fractures, or as free gold in a quartz-rich matrix.

1.3 Whale Tail Mine Plan

This section describes the mine plan at the time of report preparation. Approximately 8.3 million tonnes (Mt) of ore will be extracted from the Whale Tail Pit, producing approximately 46.1 Mt of waste rock and resulting in the removal of 5.6 Mt of overburden from the open pit footprint (Table 1). The geochemical characterization study and sampling plan for the Project were designed based on an open pit scenario generating 51.7 Mt of waste and 8.3 Mt of ore (*6108_PJS-002_R3.xlsx* dated February22, 2016, from Agnico Eagle).

Table 1: Proportions of Waste Rock and Overburden to be Mined from the Whale Tail Pit

Lithology	Chemical Code	Rock Code	Waste (t)[a]	Waste %
Ultramafic	V4a	0a	7,839,953	17%
Transitional Ultramafic	V3-V4	0b	6,292,816	14%
		Sum of Ultramafic	**14,132,768**	**31%**
Greywacke	3b	S3C	3,167,882	7%
	3b	S3S	9,707,441	21%
		Sum of Greywacke	**12,875,323**	**28%**
Chert	3b	S10	9,069,203	20%
Iron Formation	3b	S9E	7,080,011	15%
Mafic Volcanic	V3	1b	2,324,150	5%
Intermediate Intrusive	I2	8b	622,937	1%
		Sub Total	**46,104,394**	**100%**
Overburden			5,618,359	-
		Total	**51,722,752**	-

Note: [a] Individual tonnages may not sum to the total due to rounding
Source: Agnico Eagle, personal communication, February 2016.

1.3.1 Mining Schedule and Technique

The Whale Tail deposit will be mined by open pit. The life of mine for the Whale Tail Pit is expected to be eleven (11) years including one (1) year of construction, three (3) to four (4) years of operations, and seven (7) years of closure (Volume 1, Section 1.4). Mining is expected to begin in June 2018 with the first ore being extracted in Q4 2018. A summary of the expected mine life materials balance for the purposes of the assessment is provided in Table 2.

Table 2: Summary of Mine Life Materials Balance (February 2016)

Year	Ore Mined	Waste Mined*	Ore Stockpiled	Ore Stockpile Balance
	tonnes			
2018	160,020	2,899,672	160,020	160,020
2019	2,289,976	17,916,444	647,476	807,495
2020	3,352,314	21,585,794	67,314	874,809
2021	2,476,834	9,320,843	- 808,166	66,644
2022			- 66,644	-
Total	**8,279,144**	**51,722,753**	-	-

Note: * Includes overburden. Individual tonnages may not sum to the total due to rounding.
Source: Agnico Eagle, personal communication, February 2016.

1.3.2 Management of Mine Waste Materials

It is expected that waste rock and overburden will be co-disposed in the Whale Tail Waste Rock Storage Facility adjacent to the north-west of the Whale Tail Pit. A smaller stockpile of esker material will be located west of the Attenuation Pond for possible use as construction material.

Ore will be temporarily stockpiled on three ore pads located north-east and west of the proposed Attenuation Pond. It will be trucked to the Meadowbank milling facility for processing. Tailings will be deposited in the Meadowbank Tailings Storage Facility (TSF).

1.3.3 Waste Rock for Use as Construction and Closure Material

During the first year of operations, Agnico Eagle plans on developing one quarry (Quarry 2) from which they will obtain suitable construction rock (i.e. non PAG and non-leachable). This quarry is located within the west side of the deposit and is part of the ultimate open pit outline.

Lithologies anticipated to be used for construction and closure include southern greywacke (S3S or 3bS), mafic volcanic (V3 or 1b) and intermediate intrusive (I2 or 8b).

1.3.4 Access Road Construction Materials

Agnico Eagle proposes to expand the 64-km exploration access road from the Meadowbank Mine to the Whale Tail Pit to accommodate hauling of ore to the Meadowbank Mill. Fill and road surface materials will continue to be sourced from esker materials along the road alignment and from Meadowbank Mine Vault Pit waste rock, which is non-acid-generating (non PAG).

The amount of material (both from eskers and the Vault Pit) required to build the exploration access road is estimated at 718,229 tonnes (Agnico Eagle, 2015b). The expansion of the access road will be sourced from the same locations and within the same footprint. Vault Pit waste rock will continue to be used for the road base and possibly for the surface for the 16 km segment closest to the Vault Pit.

2.0 SAMPLE COLLECTION AND TEST METHODS

2.1 Sample Selection and Collection

This section summarizes the sampling and analytical programs completed for the geo-environmental characterization study, which was completed in three phases. The geology of the deposit was re-interpreted between Phase 2 and Phase 3 sampling rounds, and some borehole intervals already collected were re-logged as different lithologies; mostly between chert and central greywacke but also for two samples of mafic volcanic (one laboratory reject sample which was originally logged as greywacke and another now substantially closer to the UM 0b contact than previously defined). The lithology of each sample discussed in this report reflects the new geological interpretation. Cross-sections illustrating the location of borehole sample intervals are included in Appendix B. The sections show some differences between the apparent lithology of some samples on cross-section and the lithology stated in the tables for the same sample. This is an artefact of projecting lithological contacts and borehole intervals on the cross-section. The tabulated lithologies are considered to be more accurate than the graphical interpretations on sections.

2.1.1 Waste Rock and Ore Samples

The sampling plan for Whale Tail Pit waste rock considered MEND (2009) guidance, which recommends that the number of samples collected and analyzed be volumetrically representative of each lithology of waste rock to be mined.

Agnico Eagle personnel completed the sample collection for Phases 1 and 2 under the guidance of Golder. Samples were sent to the laboratory directly without viewing by Golder. Phase 3 sampling of waste rock and overburden was completed by Golder during a site visit in July 2015. An additional 10 ore and 2 waste rock samples were subsequently collected by Golder in December 2015. The Golder personnel that developed the sampling plan and collected the samples are registered professional geologists in Nunavut.

For Phase 3, Golder geochemists reviewed geological cross-sections through the Whale Tail Pit to target sample intervals that represent each lithological unit to be removed and exposed by mining. Sampling of waste rock was focused on obtaining spatial and compositional representation of each lithology. Overall, samples were collected from areas within the open pit footprint, just below the pit outline, and along the planned open pit walls. Table 3 presents the number of waste rock and ore samples collected compared to the total tonnage of waste materials expected to be generated by mining.

Table 3: Anticipated Tonnage of Tailings and Mined Materials and Sample Count

Rock Name	Rock Code	Estimated Tonnage[a]	Proportion of Total Tonnage (%)	# of Samples Collected			% of Samples Collected
				Phases 1 and 2	Phase 3	Total All Phases	
Ultramafic	0a	7,839,953	17%	12	9	21	13%
	0b	6,292,816	14%	10	4	14	9%
Iron Formation	S9E	7,080,011	15%	10	12	22	13%
Greywacke	S3C	3,167,882	7%	20	23	43	26%
	S3S	9,707,441	21%	10	13	23	14%
Chert	S10	9,069,203	20%	-	14	14	9%
Mafic Volcanic	1b	2,324,150	5%	5	3	8	5%
Intermediate Intrusive	8b	622,937	1%	2	3	5	3%
Ore	various	8,279,144	-	1	12	13	8%
Tailing	mixed		-	1	-	1	-
	Total	**54,383,538**	100%	**71**	**93**	**164**	100%

Note: [a] Individual tonnages may not sum to the total due to rounding

Each sample of waste rock and ore collected by Golder was described in terms of rock type, estimated sulphide content and mineralogy, alteration, and staining associated with sulphide mineral oxidation. For samples collected as part of Phase 3, each sample consisted of a composite of 3 to 5 kilograms of core (whole or split) collected from previously drilled diamond drill core over an interval of up to 10 metres. The total length of the sample interval was intended to represent a nominal bench height, and to circumvent the effect of mineral clusters, particularly sulphide minerals and calcite or silica veins.

All waste rock and ore samples were sent to SGS Canada Inc. (SGS) in Lakefield Ontario for geochemical testing, as summarized in Appendix C.

2.1.2 Tailings and Process Water Samples

One sample of metallurgical processing wastes (tailings) and its process water were retained from test work conducted by Agnico Eagle. The ore used to generate a representative composite of the Whale Tail Pit tailings material analyzed in this study is presented in Table 4.

Table 4: Summary of Ore Zones Used to Generate a Representative Composite of Tailings Material

Host Rock	Description	Major Ore Zone[1]	Total Ore Removed over LOM (t)	Total Ore Removed over LOM (%)	Proportion of Ore Zone Used to Generate Tailings Sample
S10	Reflects mineralization associated with quartz veining and silica flooding hosted in greywacke and chert within the western part of the Whale Tail deposit	S3-QZ	3,322,778	40%	50%
V4a/S9E	Associated with pyrrhotite and carbonate veining in chert (silicate-rich greywacke) and iron formation, centrally located within the Whale Tail deposit	V4_Alt	4,186,347	51%	25%
Various – East Part of Deposit	Mineralization associated with high grade quartz veining in the eastern part of the Whale Tail deposit	HGZ	770,019	9%	25%
		Total	***8,279,144***	***100%***	

Source: 1 - Agnico Eagle, personal communication, November 2015.
LOM = Life of Mine; HGZ – High Grade Zone

2.1.3 Overburden and Lake Sediment Samples

Table 5 presents the number of overburden and lake sediment samples collected, as well as the total tonnage of overburden expected to be excavated for mining of the Whale Tail Pit.

Table 5: Overburden and Lake Sediment Sample Count

Rock Name	Estimated Tonnage to be Removed[1]	Estimated Proportion of Total Tonnage of Waste (%)[2]	# of Samples Collected
Overburden	5,618,359	10%	12
Lake Sediment			5
Total	**5,618,359**	**10%**	**17**

Notes:

[1] Tonnage of Lake Sediment is not available but expected to be a minimal proportion compared with the overburden, with which it will be removed during operations.

[2] Based on the total tonnage of all waste types reporting to the Whale Tail Waste Rock Storage Facility.

Overburden samples were collected in 2015, with sampling locations shown on Map 2. Samples were collected by Golder using a metal shovel to a depth that was limited by the presence of large boulders and/or frozen ground conditions. Each overburden sample consisted of approximately 5 kg of material, and was described in terms of texture, colour and water/ice content.

Five lake sediment samples were collected in 2015 from within the footprint of the proposed open pit, in the north basin of Whale Tail Lake (Map 2). Samples were collected in 125 mL glass sample jars by Azimuth Consulting personnel from a boat using a Petite Ponjar instrument. Each sediment sample consisted of a homogenized composite sample of two Ponjar grabs from approximately the top 0.10 m of sediment. The top 3 to 5 cm of sediment from each grab was retained, homogenized in a stainless steel bowl and analyzed for total metals, total organic carbon (TOC), grain size, moisture content, and pH at ALS Environmental in Vancouver, BC under the direction of Azimuth Consulting. The lower portion of the sample (below ~ 5 cm) was retained, homogenized and subject to analysis at ALS and SGS for chemical composition, acid-base accounting (ABA) and static metal leaching tests (SFE) at Golder's request.

2.1.4 Road Construction Material Samples

A study was completed to assess the chemical characteristics of the esker material and the Vault waste rock that are targeted for use in road construction to the Whale Tail Pit. The study report is included in Appendix A. A summary description of the report is provided hereafter.

Twenty four (24) samples were collected from six eskers by Agnico Eagle staff with input from Golder. Five samples each were collected from Esker 1 and 3, four samples each were collected from Esker 2, 5, and 6, and two samples were collected from Esker 4. All samples were described as sand to gravel with sand based on grain size analysis (Agnico Eagle, personal communication, November 10, 2014).

Existing geochemistry data from the Vault Pit operational database were used for this assessment. The data included results on sulphur and carbon content for approximately 11,200 blast hole samples obtained by Agnico Eagle from Leco furnace analysis at the Meadowbank Mine. Database information is described in the report included in Appendix A. These results were complemented by test results from confirmatory duplicate samples submitted to an external laboratory (SGS) by Agnico Eagle as part of their quality control - quality assurance (QA/QC) program over the period of Q4-2014 to Q1-2015. In addition, 17 grab samples were collected from the non PAG and PAG Vault waste rock stockpiles adjacent to the Vault Pit, from which some of the construction rock may be sourced.

Esker samples were packaged by Agnico Eagle staff and shipped to SGS for geochemical testing, which included chemical composition, ABA and SFE.

2.2 Test Methods

The test program incorporated standard geochemical test methods to characterize the chemical composition and ARD/ML potential of the different material types expected to be generated from mining. The testing program included the following analyses:

- Mineralogical identification: by X-ray diffraction and Rietveld pattern analysis on a subset of greywacke waste rock samples, and by Scanning Electron Microscopy (SEM) and optical mineralogy on a subset of iron formation and ultramafic rock.
- Chemical composition through whole rock (XRF) analysis for major elements, and through inductively coupled plasma-mass spectroscopy (ICP-MS) for trace element chemistry preceded by 4-acid digestion.
- ARD potential through ABA testing by the Modified Sobek method (MEND 2009).
- Sequential Net Acid Generation (NAG) pH tests on a subset of waste rock samples and on the tailings sample (Amira 2002 Method).

- The following leaching tests on solids:
  1. i) readily leachable metals through short-term leach testing by a modified version of the shake flask extraction test (SFE; Modified ASTM D3987).
  2. ii) Sequential NAG leaching tests. Samples selected for this testing are the same as selected for the Sequential NAG pH testing mentioned above.
  3. iii) Kinetic leaching tests, including:
     - (a) eight 1-kg humidity cell tests (HCTs; ASTM method D5744) on waste rock samples.
     - (b) two 1-kg humidity cell tests (HCTs; ASTM method D5744) on ore samples.
     - (c) one 1-kg humidity cell test (HCTs; ASTM method D5744) on the tailings sample.
     - (d) seven 26-kg to 60-kg large column leaching tests on single lithology bulk composite samples.
     - (e) one 41.5 kg submerged leaching column on a bulk composite sample of the ultramafic and iron formation lithologies.
- Metallurgical process water chemistry:
  - pH, alkalinity, carbonate and bicarbonate, conductivity, cyanide (total, free and WAD), cyanate (CNO) and thiocyanate (CNS).
  - Anions: chloride (Cl), sulphate (SO_4), nitrite (NO_2), nitrate (NO_3), bromide (Br), ortho-phosphate (P), fluoride (F), total ammonia (NH_3+NH_4).
  - Dissolved Metals: silver (Ag), aluminum (Al), arsenic (As), boron (B), barium (Ba), beryllium (Be), bismuth (Bi), calcium (Ca), cadmium (Cd), cobalt (Co), chromium (Cr), chromium VI [Cr(VI)], copper (Cu), iron (Fe), potassium (K), lithium (Li), magnesium (Mg), manganese (Mn), molybdenum (Mo), sodium (Na), nickel (Ni), phosphorus (P), lead (Pb), antimony (Sb), selenium (Se), silicon (Si), tin (Sn), strontium (Sr), titanium (Ti), thallium (Tl), uranium (U), vanadium (V), zinc (Zn), and mercury (Hg).

All chemical tests and analyses were performed at the SGS laboratory, except for the tests on lake sediment samples, which were performed at ALS. Geochemical test methods are discussed in the next sections.

2.2.1 Mineralogical Analyses

Five (5) samples of greywacke and two (2) samples of chert waste rock were selected for mineralogical analysis by X-Ray Diffraction (XRD) and XRD pattern interpretation by Rietveld method at SGS Minerals in Lakefield, ON. Rietveld interpretation allows for a quantitative evaluation of the crystalline mineral phases to approximately 1%. Mineral phases present in concentration between 1% and 0.5% can be identified but quantification is imprecise. XRD does not detect amorphous mineral phases.

This analysis was used to identify and quantify minerals that provide buffering capacity and acidification potential to the samples in order to help define the propensity for acid generation from the lithologies tested. Samples were selected based on their sulphur content and on the difference between the carbonate mineral buffering capacity and bulk buffering capacity, which includes non-carbonate buffering minerals such as alumino-silicates (Section 2.2.3).

Two samples of iron formation waste rock and one sample of ultramafic rock were observed by SEM, which focussed on identifying arsenic-bearing mineral phases and mapping arsenic content in the different mineral phases. Unlike XRD, this is not a quantitative mineralogical assessment. Samples were selected based on their elevated leachable arsenic content relative to (lower) total arsenic content. Optical mineralogy was also completed at the Université du Québec en Abitibi-Témiscamingue (UQAT) on these three samples to assist in the identification of major mineral phases prior to SEM observation.

2.2.2 Chemical Composition of Solids

The chemical composition of all solid materials was determined through whole rock and trace element analysis to determine the content of major rock forming elements and trace metals, respectively. This information is used to assess the variation in chemical composition by lithology, and to identify parameters of potential environmental concern with respect to leachability. Trace metal results for waste rock and overburden are compared to typical elemental abundances in continental crust (Price 1997). The following components were included in the chemical analyses:

- Metals (including arsenic and selenium) by ICP-MS, with samples extracted using a concentrated strong acid solution of perchloric, nitric, hydrochloric and hydrofluoric acids. The digestion of the solids is not complete but does provide a better insight into the parameters that may be environmentally available within each sample.
- Mercury by cold vapour atomic absorption spectroscopy (CVAAS), EPA245.1 methodology.
- Whole rock analysis for major metals by borate fusion / x-ray fluorescence (XRF).

2.2.3 Potential for Acid Rock Drainage

The potential of geologic material to oxidize and generate acidic drainage was evaluated through acid-base accounting (ABA). This test was conducted following the Modified Sobek method (MEND 2009) and included determination of the following parameters:

- paste pH;
- total sulphur by LECO furnace (ASTM E 1915 method);
- sulphate sulphur by acid digestion and sulphide sulphur by difference from the total sulphur content;
- total carbon (TC as %C), graphitic carbon (as %C) and carbonate (as %C) by LECO furnace; and,
- bulk neutralization potential (NP; by the 1996 Modified NP procedure; MEND 2009).

A subset of waste rock samples and the tailings sample were subjected to sequential NAG tests (AMIRA 2002) to provide additional information on the ARD potential of samples.

Neutralization Potential (NP)

Neutralization potential (NP) is a bulk measurement of the acid-buffering capacity of a sample provided by various minerals of different reactivities and effective neutralization capacity. Neutralization potential was evaluated using two different analytical techniques:

***1996 Modified NP Procedure*:** Represents the bulk NP of the sample, including contributions from carbonate minerals and some reactive aluminosilicate minerals, where present. It is calculated from the amount of base consumed to neutralize (to pH 8.3) the acid remaining from the acid-digested sample at room temperature.

***Carbonate NP (CaNP)*:** Represents the NP available from calcite, dolomite, and other carbonate minerals only. This also includes siderite, ankerite and any other divalent metal carbonates, as well as graphite, all of which provide less to no net neutralization compared with calcite and dolomite. The carbonate NP was calculated from the carbonate content of the sample (as %C), less any graphitic carbon when it was detected in the sample. The reported carbonate NP values are corrected for the graphite content.

Acid Potential (AP)

Acid potential (AP) is a measure of the total potential acidity of a sample, and assumes that all sulphur is in the form of available pyrite. For waste rock and ore, AP is calculated from the total sulphur content of the samples (rather than sulphide content) on the basis that there are no sulphate minerals present in any lithologies based on the geology of the deposit.

For tailings, overburden, lake sediment and esker material samples, AP was determined based on the sulphide content (the difference between total sulphur and sulphate sulphur) because these materials have been exposed to oxidizing conditions and can contain secondary sulphate phases that would not generate acid.

Values of AP, NP and CaNP are reported as kg equivalent calcium carbonate per tonne of rock.

2.2.3.1 Sequential Net Acid Generation (NAG) Test

Sequential net acid generation (NAG) tests are used in combination with ABA to assess the ARD potential of a sample. The NAG test (Amira 2002) uses hydrogen peroxide to induce complete oxidation of sulphide minerals, with the sulfuric acid (H_2SO_4) produced being buffered concurrently by any available neutralizing minerals in the sample. Unlike ABA results, NAG tests do not provide an estimate of NP relative to AP, but rather indicate the net effect of sulphide oxidation and buffering reactions within a sample. Of note, this test may not successfully oxidize all sulphide sulphur into sulphate under certain circumstances (such as, but not limited to, too much sulphur or the presence of carbonates, iron and copper, and organic material). To monitor for this situation, the total amount of sulphate captured over the four sequences of leaching during the NAG test was calculated and compared against the total sulphur content of the sample measured in the ABA test.

When the NAG test is successful (when all the sulphide is oxidized to sulphate), it can be used to define the ARD potential of samples considered uncertain (having a CaNPR between 1 and 2) and those containing low AP and low NP. The NAG leachate chemical composition can be used to assess the total metal load that would be generated upon complete oxidation of sulphide minerals and consumption of buffering capacity, and to compare the rate of release of metals in kinetic leaching tests.

Sequential NAG tests were conducted on 38 samples of waste rock and on the tailings sample. Waste rock samples were selected for sequential NAG pH testing based on their low CaNPR and NPR values, generally on samples having an uncertain ARD potential (CaNPR between 1 and 2 or conflicting results between CaNPR and NPR), and on some PAG samples identified during Phase 1.

2.2.3.2 ARD Screening Criteria

The ABA results were compared to Canadian guidelines outlined in MEND (2009). The suggested screening criteria for inferring ARD potential are summarized in Table 6. For this study the carbonate mineral NPR (CaNPR) was used to quantify the reactive carbonate buffering capacity in the sample (CaNPR excludes the less reactive silicate minerals).

Table 6: Acid-Base Accounting Screening Criteria

Potential for ARD	Initial Screening Criteria	Description
Likely	CaNPR < 1	Likely to generate acidity, unless sulphide minerals are non-reactive
Uncertain	1≤ CaNPR <2	Neither clearly acid-generating nor acid consuming
None	CaNPR ≥ 2	Acid consuming, low acid generating potential

Note: Based on MEND (2009) but conservatively uses CaNPR rather than NPR.

Samples with CaNPR values greater than or equal to 2 are considered to have no ARD potential since there is no preferential exposure of sulphides along fracture planes, nor very reactive sulphides, and buffering capacity is in the form of carbonate minerals (see Section 3.3.1).

Results of NAG pH tests were compared to the criteria presented in Table 7.

Table 7: Net Acid Generation Criteria (AMIRA, 2002)

NAG pH	NAG Acidity (to pH 7) kg H_2SO_4/t[1]	Potential for Acid Generation
≥ 4.5	0	Non-acid generating
< 4.5	≤ 5 [2]	Low potential to be acid-generating
< 4.5	> 5 [2]	Potentially acid-generating.

Note: [1] kg sulfuric acid (H_2SO_4)/t
[2] The NAG criteria used may vary from site to site with a cut-off up to 10 kg H_2SO_4/t (Source: AMIRA 2002).

2.2.4 Leaching Tests

Leaching tests are used to assess the potential of waste rock to release readily-soluble metals to the receiving environment by simulating interaction between water and solids. The leach tests completed in this study are outlined in Table 8 and discussed hereafter.

Table 8: Summary of Leaching Tests

Test Type	Test Method	Location	Number of Samples	Status
Short-Term Leach Test	Shake Flask Extraction	laboratory	181	Completed
	NAG Leachate	laboratory	15	Completed
Long-term Leach Test	Humidity Cell Tests	laboratory	11	Ongoing[1]
	Large Column Tests	laboratory	8	Ongoing

Note: [1] Tailings HCT was terminated at 40 weeks.

Short-term leach tests are an initial screening tool in the identification of potential constituents of concern at neutral pH (outside of the potential for acid generation), in view of mine site water management and potential water treatment requirements. However, these test methods do not consider the kinetics of weathering reactions. To this end, kinetic leaching tests were initiated on a select subset of samples to provide a more representative assessment of likely chemical release rates in a controlled laboratory setting. Still, laboratory kinetic tests have limited ability to represent the effect of field conditions (climate, hydrology) on the weathering behaviour of materials in the field, and contact water quality. Short-term and kinetic leach tests are discussed in Sections 2.2.4.1 and 2.2.4.2, respectively.

2.2.4.1 Short-Term Leaching Tests (Shake Flask Extraction – SFE)

Samples were subjected to short-term leach tests using a modified version of shake flask extraction (SFE, Modified ASTM D3987). Crushed samples (<9.5 mm; reject samples are <2mm) of waste rock and ore were mixed with distilled water (4:1 solution to solid ratio), placed in a flask, and shaken for 24 hours using a variable speed shaker table. Leachate was collected from a pump through a 0.45-μm filter and analyzed for pH, sulphate, chloride and dissolved metals. Tailings, overburden, lake sediments and esker materials were tested at the grain size received (not crushed).

2.2.4.2 Kinetic Leaching Tests

Kinetic leaching tests are a repetitive leach test meant to simulate accelerated weathering conditions on a specific charge material (e.g., waste rock, tailings, etc.) by promoting sulphide mineral oxidation and dissolution of acid-buffering minerals over the duration of the testing period. Kinetic leach tests are being carried out on different quantities of charge material to verify the effect of scale and water contact on the rate of chemical releases; specifically 1-kg humidity cell tests (HCTs), 20- to 60-kg large columns, and one 40-kg submerged leach column.

Humidity Cell Test Method (HCTs)

The HCT method is based on the standard method ASTM D5744 where a 1-kg sub sample of crushed (<9.5 mm) waste rock, ore or tailings (as-is) is placed in a cylindrical vessel and subjected to a seven-day cycle of leaching, which includes three days of dry air circulation followed by three days of humid air circulation, and a subsequent flushing with 1 litre (L) of distilled water (1:1 liquid to solid ratio by weight) on the seventh day. Approximately 1 L of leachate was collected each week for analysis of short- and long-suite groups of parameters as follows:

- short suite parameter group with weekly analysis from Cycle 0, including:
  - volume of leachate recovered, pH, conductivity, alkalinity, acidity, sulphate, and calcium;

- long suite group of parameters analyzed at Cycle 0-5, 10, 15, 20, 25, 30, 35 and 40 including:
    - chloride and fluoride;
    - dissolved Ag, Al, Sb, As, Ba, Be, Bi, B, Cd, Cr, Co, Cu, Fe, Hg, K, Li, Mg, Mn, Mo, Na, Ni, Pb, Se, Sn, Sr, Th, Ti, U, V, Zn; and
    - tailings only: bromide, chromium VI, cyanide (total and WAD), cyanate (CNO) and thicyanate (CNS), total ammonia (NH_3+NH_4 as N), nitrate (NO_3 as N), and nitrite (NO_2 as N).

Results from humidity cells are used to assess the oxidation rate and the release rates of chemical constituents from mine wastes upon exposure to water. However, these leachates may not be direct analogues of expected water quality because the testing does not consider the scale (size, shape) of the mine waste infrastructure, nor the effect of climate (moisture content, temperature) on drainage quality, such as freshet conditions and frozen winter conditions.

HCT Sample Selection Rationale

Humidity cell test sample selection was designed to represent the dominant waste rock groups that will generate the largest volume of waste, and to capture the effect of specific compositional characteristics on leachate chemistry; namely, that of the average and high-end or upper quartile concentration ranges of constituents of interest, including NP, CaNP and sulphide content for the greywacke lithology, and arsenic content for ultramafic lithology.

Table 9 summarizes the sample selection rationale and the ARD designation for each HCT sample based on static testing. The composite ore sample consists of two 500 gram samples: 1) iron formation ore; and 2) ultramafic ore. Note that greywacke sample AMQ-ENV-28 was subjected to a re-assay on a riffle split sample from the crushed portion, and was found to have high heterogeneity in composition (Sections 2.3 and 3.6).

Table 9: HCT Sample Selection Rationale

Rock Type	Rock Code	Sample Information		Concentration and Percentile Ranking of the Sample based on Static Results per Rock Type (Concentration $^{\text{Percentile Ranking}}$)						Selection Rationale
		Sample ID	ARD Potential[1]	Total As (mg/kg)	Leachable As[2] (mg/L)	Total Sulphur (wt. %)	NP (kg $CaCO_3$/ t)[3]	NPR	CaNPR	
Ultramafic	V4 - 0a	AMQ-ENV-32	Non PAG	440 $^{\text{45th}}$	0.98 $^{\text{45th}}$	0.028 $^{\text{35th}}$	124 $^{\text{75th}}$	142 $^{\text{70th}}$	145 $^{\text{75th}}$	Median As leaching
Iron Formation	S9E – 3b	AMQ-ENV-43	Non PAG	820 $^{\text{55th}}$	4.0 $^{\text{75th}}$	0.033 $^{\text{20th}}$	290 $^{\text{max}}$	281 $^{\text{95th}}$	302 $^{\text{95th}}$	High quartile As leaching
Greywacke	S3C – 3b	AMQ-ENV-37	Non PAG	33 $^{\text{50th}}$	0.12 $^{\text{85th}}$	0.16 $^{\text{35th}}$	23 $^{\text{75th}}$	4.7 $^{\text{80th}}$	3.6 $^{\text{80th}}$	Non PAG, sulphur less than 0.2 %
Greywacke	S3C – 3b	AMQ-ENV-18	**PAG**	33 $^{\text{50th}}$	0.084 $^{\text{80th}}$	0.31 $^{\text{55th}}$	14 $^{\text{30th}}$	1.5 $^{\text{50th}}$	0.68 $^{\text{60th}}$	Uncertain ARD Potential (NPR vs PAG CaNPR), median sulfur, high quartile As leaching.
Greywacke	S3C – 3b	AMQ-ENV-28	**PAG**	90 $^{\text{80th}}$	0.031 $^{\text{30th}}$	0.56 $^{\text{70th}}$	8.9 $^{\text{<5th}}$	0.51 $^{\text{25th}}$	0.16 $^{\text{20th}}$	PAG (NPR and CaNPR), high quartile sulphur content
Greywacke	S3C – 3b	AMQ-ENV-40	**PAG**	280 $^{\text{90th}}$	0.074 $^{\text{10th}}$	1.3 $^{\text{75th}}$	14 $^{\text{30th}}$	0.34 $^{\text{20th}}$	0.38 $^{\text{45th}}$	PAG, high quartile sulphur content
Chert	S10 – 3b	AMQ-ENV15-133	**PAG**	970 $^{\text{max}}$	0.056 $^{\text{40th}}$	2.8 $^{\text{75th}}$	13 $^{\text{10th}}$	0.15 $^{\text{10th}}$	0.024 $^{\text{10th}}$	PAG, high quartile sulphur content, high As
Intermediate Intrusive	I2 – 8b	AMQ-ENV-114	Non PAG	8.7 $^{\text{min}}$	0.029 $^{\text{75th}}$	0.046 $^{\text{min}}$	17 $^{\text{min}}$	12 $^{\text{50th}}$	4.5 $^{\text{50th}}$	Median NPR and CaNPR
Ore	S3C – ALTV41	AMQ-ENV15-144	**PAG**	1100 $^{\text{90th}}$	0.90 $^{\text{75th}}$	3.9 $^{\text{90th}}$	41 $^{\text{60th}}$	0.34 $^{\text{15th}}$	0.19 $^{\text{10th}}$	PAG, high quartile As leach
Ore Composite[4]	SE9 and 0b	AMQ-ENV15-089 and 076	**PAG**	735 $^{\text{65th}}$	1.7 $^{\text{75th}}$	3.6 $^{\text{75th}}$	72 $^{\text{85th}}$	0.63 $^{\text{35th}}$	0.38 $^{\text{35th}}$	High As leach, high S^{2-}
Tailings	Mixed	RE-13872/ RE-13874	**PAG**	3200	0.023	3.3	-6.8	-0.08	0.22	Available sample

Notes:

[1] Based on results of static testing

[2] Based on results of SFE static leaching test

[3] kg calcium carbonate ($CaCO_3$)/t

[4] Results presented represent the average from the two samples used to create the composite sample

Column Leaching Tests

Larger scale kinetic weathering tests consisting of leaching columns are being carried out on bulk lithological samples to measure the effects of accelerated wetting and drying on sulphide mineral oxidation and chemical leaching rates from a larger quantity of material for a given lithology. The large column test uses a lower leaching water to solid ratio than the 1-kg HCT tests and thus provides a closer approximation of likely contact water quality under field conditions at the Project site than the smaller scale tests HCT.

Four large scale leaching columns (Columns C-1 to C-4) were initiated on September 30th, 2015. Columns 5 (C-5) and 6 (C-6) were initiated on October 9th, 2015 and column 7 was initiated on January 6th, 2016 (Figure 1). The charge material for these columns consists of crushed (<9.5 mm) waste rock samples left over from the static testing program (Figure 2) with known chemical characteristics (Table 10). Rock samples of similar lithologies were mixed together prior to charging the columns. The mass of the charge material used in each column was defined by the amount of static test reject rock available for use. An equal mass of sample was used to make up each composite to avoid biasing the charge material with any one particular sample.

The crushed rock material was placed in PVC columns of 91 cm height by 25 cm diameter for columns C-1 to C-4, and 20 cm diameter for columns C-5 to C-7. The columns are trickle leached (slow rain-like precipitation of water at the top) on a weekly basis with laboratory grade de-ionized water at a 10:1 solid to liquid ratio (i.e., the 20 kg column is leached with 2 litres of water). The solid to liquid ratio was selected in order to approximate the monthly precipitation in the Project region.

A valve is fitted at the bottom of the columns to release leachate. Unlike the standard HCT, the leaching columns were not subjected to 3 days of dry air circulation and 3 days of humid air circulation between weekly leaching cycles. Leachate was collected on the seventh day for analysis following the same analytical suite and schedule as described for the HCTs above.

Figure 1: Six Waste Rock Columns Currently Underway.

Figure 2: Typical Grain Size (< 9.5 mm) of the Large Column Charge Material

For three cycles[1], the amount of distilled water added to each column was decreased to 750 ml. This was followed by a larger flush volume on March 9th, 2016 in which sufficient water was added to each column so that the charge material was completely submerged. This was done to simulate dry summer conditions followed by an intense rain fall conditions. After this, the regular 10:1 solid to liquid ratio continued. Results from this process are used to assess the effect of varying the infiltrated water volume on waste rock leachate quality.

Table 10: Leaching Column Charge Material Properties

Column	Rock Type	Test Material Mass (kg)	Water Leaching Volume (L)	Total Arsenic (mg/kg)	Leachable Arsenic (mg/L)	Total Sulphur (wt.%)	CaNPR (ratio)	ARD Potential
C-1	Ultramafic (0a)	40	4.0	682	0.89	0.13	23	Non PAG
C-2	Iron Formation(S9E)	42.5	4.25	689	1.4	0.69	2.9	Non PAG
C-3	Greywacke (S3C)	45	4.5	163	0.057	1.0	0.25	**PAG**
C-4	Greywacke (S3C and S3S)	60	6.0	41	0.053	0.31	1.7	Uncertain
C-5	Ultramafic (0b)	26.4	2.64	71	0.20	0.084	29	Non PAG
C-6	Chert; (S10)	28.8	2.88	222	0.065	2.2	0.12	**PAG**
C-7	Mafic Volcanic (1b)	20.3	2.03	30	0.15*	0.046	32	Non PAG
Submerged Leaching Column								
C-8	0b + S9E	41.5	4.15	543	0.91	0.34	801	Non PAG

Note: * The average leachable arsenic content is influenced by one sample having 10x higher leachable arsenic content than the other samples used as test material.

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[1] columns C-1 to C-4 (cycles 20, 21 and 22), C-5 and C-6 (cycles 16, 17, 18), and C-7 (cycles 6, 7 and 8)

The rationale for running four different ultramafic and iron formation columns (Columns 1, 2, 5 and 8) is to verify the arsenic leaching properties of composites having differing total and leachable arsenic content.

Columns 3 and 4 represent greywacke waste rock from two different locales in the Whale Tail deposit. Column 3 contains silicified PAG greywacke from the central unit (S3C) exclusively. The charge material has a higher sulphur content than the south greywacke, and samples that make up the S3C charge material are within 25 m of the ore zone. Column 4 represents the less silicified, lower total sulphur greywacke from both the central and southern greywacke units. The charge material in Column 4 represents the greywacke that would be exposed along the south pit wall and potentially used as construction material. The C-4 charge material is a conservative representation of the low sulphur greywacke because the average sulphur content (0.31%) of the charge material is higher than that of the static database average (0.07%, see Section 3.3.1) for the south greywacke (S3S).

Column 6 represents PAG chert material and is intended to verify the propensity and time of this material to onset of ARD, and to determine metal release rates before and after the onset of ARD.

Column 7 is composed of non PAG mafic volcanic material and is intended to verify the general leaching properties of this bulk material.

Column 8 is a submerged column and is discussed in the section below.

Submerged Column Leaching Test

A submerged leaching column (Column 8) was initiated on January 13th, 2016. The column is a bulk sample of the lithologies identified during static leaching tests as having high leachable arsenic concentrations; namely, ultramafic (0a and 0b) and iron formation (S9E). These units will be exposed in the pit wall and in the open pit lake. The objective of the test was to assess the chemical load that may report from these lithologies in fully flooded conditions, simulating the exposure of the open pit wall in the flooded pit lake in post-closure.

The charge material consists of sample reject left over from the static testing program and includes samples from the ultramafic (0a and 0b) and iron formation lithologies. All material is crushed to the same size as the subaerial columns (<9.5mm). A total of 46 equal-weighted samples were used to charge the submerged column from the ultramafic (16 samples), transitional ultramafic (10 samples), and the iron formation (17 samples) units.

The charge material was placed in a custom-built leaching column consisting of a PVC pipe (91 cm high by 34 cm diameter) that is closed with a valve at the bottom and open at the top. Approximately 40 kg of charge material was placed in the column. Three water-sampling ports were installed at specific depths above and below the water/rock interface: two locations within the waste rock charge material and one location above it in the water column (Figure 3). Port 1 is located 5 cm below the water/rock interface and is sampled using a porous cup
(Figure 4). Port 2 is located 5 cm above the water/rock interface and in the water column, while Port 3 is located 25 cm above the water rock interface. The column was filled with distilled water so that the height of the water (61cm) within the column was over twice the height of the charge material (28 cm).

The water sample collection process for Port 2 and Port 3 requires the use of a small pump attached to the port to collect the pre-determined volume of water. Once both the charge material and distilled water was added, the submerged column was left for 24 hrs before the initial sampling event was initiated. Sample collection from each port occurs on days 1, 3, 6, 10, 15, 20, 27, 35 (week 5), 49 (week 7), 70 (week 10), 105 (week 15) and 140 (week 20).

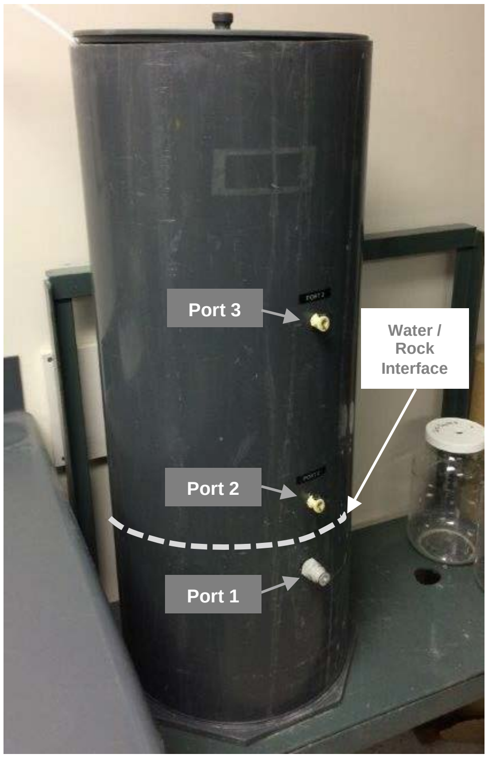

Figure 3: Submerged Column with Three Sampling Ports

Figure 4: View of the Porous Cup Sampler (Port 1)

Actual Time Equivalency of Kinetic Leaching Tests

The 1-kg HCT is an accelerated weathering test meant to speed up the process of sulphide mineral oxidation in order to facilitate the measurement of weathering and its products on a shorter time scale than might occur in reality. This is achieved by forcing a rapid succession of alternating wet and dry cycles, and by actively flushing out the weathering products through the use of a high liquid to solid ratio (1:1 water to rock proportion by weight). The HCT test method (ASTM D 5744-07) states a 10-fold acceleration of the weathering rate compared to field conditions.

In practice, many factors will influence weathering characteristics of the exposed mined materials and the rate of chemical release at site. Of importance are site climate and pile hydrology which affect the water to solid contact and the rate of chemical reactions.

The Whale Tail waste rock will be piled and will be exposed to far less precipitation than both HCT and leaching columns. The average annual rainfall is 145 mm over 4 frost-free months (average of 36 mm/month), while each of the HCTs receive the equivalent of 127mm/week (508 mm/month), and the leaching columns receive the equivalent of between 63 and 122 mm/week (254 and 488 mm/month[2]). Each weekly cycle represents more

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[2] Based on the different column diameters.

flushing than one average summer month at site. Thus conservatively, one leaching cycle can be said to represent 1 month of leaching at site. Comparatively, a 10-fold weathering rate acceleration (per ASTM) equates to 1 weekly cycle of leaching representing 2.5 months of weathering in the field.

In addition, as observed at Meadowbank, freezing conditions prevail for 8 months of the year in the surficial active thaw depth of the rock storage facility. The deeper portion of the pile remains frozen. The frozen winter conditions are not represented in laboratory leaching cycles. Laboratory tests simulate frost-free periods only (the four summer months). Consequently, 4 leaching cycles can be considered to represent the four months of active water ingress into the waste rock pile, or one year at site, insofar as 4 months in the field constitutes the frost-free summer period where water can seep through the waste rock pile. By extension, a 20-cycle kinetic test would represent approximately 5 years at site.

2.2.4.3 Water Quality and Leachate Screening Criteria

Leachates and ore processing liquids were screened against effluent limits for the Meadowbank Mine (NWB, 2AM-MEA1525, July 2015). The maximum monthly mean limits for the Vault and Portage effluents are shown in Table 11.

Table 11: Meadowbank Effluent Quality Criteria (July 2015)

Parameter	Unit	Portage Effluent Criteria (maximum monthly mean)	Vault Effluent Criteria (maximum monthly mean)
pH	no unit	6-9	6-9
TSS	mg/L	15	15
TDS	mg/L	1400	1400
Turbidity	NTU	15	15
Total Aluminum	mg/L	1.5	1.5
Dissolved Aluminum	mg/L	1.0	1.0
Total Arsenic	mg/L	0.3	0.1
Total Cadmium	mg/L	0.002	0.002
Total Chloride	mg/L	1000	500
Total Cyanide	mg/L	0.5	(no value)
Total Copper	mg/L	0.1	0.1
Total Mercury	mg/L	0.0004	0.004
Ammonia (NH_3 as N)	mg/L	16	20
Total Nickel	mg/L	0.2	0.2
Total Nitrate (as N)	as N mg/L	20	50
Total Lead	mg/L	0.1	0.1
Total Phosphorus	mg/L	1.0	1.5
Total Zinc	mg/L	0.4	0.2

2.3 Quality Assurance and Quality Control

The objective of a quality assurance/quality control (QA/QC) program is to assess sample representativeness and defensibility of reported results based on the analytical precision achieved during the study. Samples of core and overburden collected by Golder were obtained using a consistent sampling procedure and sample size. Sampled material was bagged individually to avoid cross-contamination, provided unique sample identification and sent to the analytical laboratory with chain-of-custody records. Similar analytical methods were used on all solid samples (rock, ore, overburden, lake sediments and tailings) to allow direct comparison of results.

Results for the duplicate samples were analyzed following EPA Guidelines for Inorganic Data Review (USEPA, 1994) and are included in Appendix D. In keeping with this guideline, the relative percent difference (RPD) was calculated and compared with an RPD of 20% (aqueous analyses) and 35% (solid material analyses) for each parameter. If the RPD value is greater than the guideline value (20% and 35%, respectively), the analytical precision for that parameter is considered unacceptable.

When rock and overburden samples arrive at the laboratory, all of the material collected and placed in the bag during sample collection is crushed (<9.5 mm), homogenized, and placed back into the sample bag. A riffle split of roughly 1kg is collected using a sample splitter to ensure that a representative sample is collected. From this riffle split, 300 g is split off for use in the SFE test, while the remaining 700 g is pulverized (passing 200 µm) for ABA, whole rock analysis (WRA) and total metal analysis.

To assess laboratory analytical precision, analyses were performed on approximately 10% of the samples analyzed. Two groups of analyses were completed as follows:

- Duplicate analyses collected from the riffle splits of sample material to assess the analytical repeatability. Completed for ABA, whole rock, total metals, and SFE analyses.
- Replicate analyses using various sub-samples collected from the bulk crushed sample material, then pulverized individually prior to analysis (with the exception of SFE, which is not pulverized). This was completed to assess sample heterogeneity at the crushed size fraction.

Results of this QAQC program are presented in Section 3.6.

Grain Size Effect on Chemistry

Samples of waste rock and ore were collected from existing and new exploration drill core and from assay reject material. The main difference between these two source materials is grain size. The reject material was received at SGS as fine samples (< 2mm), while core samples were crushed by SGS to <9.5mm. The grain size does not affect the ABA or chemical composition analyses since these require pulverized material; however, it could have affected the SFE test because it uses crushed material (< 9.5 mm). In order to verify the effect of the smaller grain size, and thus, larger surface area per unit weight of assay results, replicates of four assay reject samples were collected during Phase 3 from core collected from the same interval as the assay reject. These ‘replicate’ core samples were crushed to <9.5 mm and subjected to the same suite of testing as their replicated assay intervals.

Results indicate that the variance due to differences in grain size is minor since only 30 out of the 115 (26%) parameters tested showed a difference larger than an order of magnitude. Furthermore, in some instances it was the crushed core sample that exhibited higher concentrations than the pulverized reject sample. This trend is likely due to the heterogeneity of the samples targeted within the duplicated interval, which was confirmed through further QA/QC testing completed and presented in Section 3.6.

Because of their small grain size, no reject sample was submitted for kinetic testing.

3.0 RESULTS OF GEOCHEMICAL CHARACTERIZATION

Tabulated static test results and figures are presented in Appendix E. Kinetic test results are presented in Appendix F as time series graphs. Laboratory analytical certificates for the static tests and kinetic tests are included in Appendices G and H, respectively.

For the purposes of data analysis, samples were sorted based on the lithological classification provided by Agnico Eagle, as described in Section 1.2 and presented in Table 1.

3.1 Mineralogical Analyses

Mineralogical results from X-ray diffraction analysis and SEM observations are tabulated in Appendix E.1 and summarized below.

3.1.1 Greywacke and Chert Waste Rock Samples

This analysis focussed on identifying minerals that contribute to acidification and buffering capacity to assist in the interpretation of the ARD potential of central greywacke and chert.

The central greywacke samples (S3C) have variable mineralogical assemblages but overall consist primarily of quartz (32 to 73 weight percent or wt%), albite (1.5 to 28 wt%), chlorite (1.7 to 20 wt%), cummingtonite (3.2 to 15 wt%), and muscovite (2.9 to 22 wt%) with lesser almandine (2.0 to 3.9 wt%) and biotite (2.7 to 6.0 wt%).

All samples contain calcite which ranges from 0.8 to 7.2 wt%. One of the 5 samples also contained trace ankerite at 1.2 wt%. Pyrrhotite is the only sulphide mineral identified in two of the 5 samples: at 3.7 wt% in the uncertain ARD sample and 5.6 wt% in the PAG sample. No sulphide minerals are identified in the other two central greywacke samples; their sulphur content being less than 0.21 wt%. Sphalerite (0.2 wt%) is the only sulphide mineral present in the one southern greywacke sample.

The two chert samples primarily contain quartz (25 to 47 wt%), phlogopite (4.4 to 18 wt%), chlorite (11 to 14 wt%), albite (3.3 to 13 wt%), biotite (2.7 to 13 wt%) with lesser orthoclase (0.7 to 2.7 wt%) and stilpnomelane (2.0 to 3.5 wt%). Carbonate minerals include calcite (2.7 to 5.5 wt%) and siderite (0.3 to 3.1 wt%). Pyrite (2.4 wt%) is present in one sample and pyrrhotite (2.1 wt%) in the other.

The XRD analyses corroborate with the results of ABA (Section 3.3) and chemical composition (Section 3.2) tests for these samples. Mineralogy shows that the two samples with higher silica content also had the highest sulphide mineral content, which would support the observation that silicified greywacke more frequently tends to be PAG than samples from the less silicified greywacke, such as in the south greywacke unit.

3.1.2 Ultramafic and Iron Formation Waste Rock Samples

The two samples of iron formation waste rock (AMQ-ENV-43 and AMQ-ENV-125) and one sample of ultramafic rock (AMQ-ENV-31) contain the following sulphide minerals: pyrrhotite and pyrite, sometimes with traces of pentlandite ($(Fe,Ni)_9S_8$) and chalcopyrite ($CuFeS_2$), all of which are arsenic-free according to microprobe analyses. The nickel arsenide mineral gersdorffite (NiAsS) is present in all samples, and traces of nickeline (NiAs) are present in the ultramafic sample as identified by SEM. The sulphide minerals identified are generally of small grain size (less than 500 µm).

Gersdorffite is in a solid solution series with cobaltite, often referred to as (Ni,Fe,Co)AsS. The gersdorffite identified contains between 45 and 50 wt% arsenic, 1 to 22 wt% cobalt and 5 to 31% nickel. It can be reactive and may be a source of labile arsenic, nickel and cobalt from its potentially rapid oxidation kinetics (Jackson *et al*. 2003; MEND 2004).

No silicate gangue minerals were found to contain arsenic.

3.2 Chemical Composition

3.2.1 Waste Rock, Ore, and Tailings

The chemical composition of samples is presented in the tables and figures included in Appendix E.2. Summary statistics are provided for each sample type, including: minimum, maximum, average, median, 75th percentile and standard deviation. Results are summarized in Table 12.

Table 12: Compositional Enrichment in Waste Rock, Ore and Tailings

Rock Type	Rock Unit	Number of Samples Collected	Parameter Concentrations Greater than Five Times Typical Crustal Abundance (Price 1997)
Ultramafic	V4a – 0a	21	Ag(2), As(21), Bi(6), Cr(20), Ni(11), Sb(14)
	V4a – 0b	14	Ag(1), As(12), Bi(4), Cr(10), Se(1)
Iron Formation	S9E – 3b	22	Ag(5), As(22), Bi(13), Cr(20), Ni(17), Sb(16)
Greywacke	S3C – 3b	43	Ag(3), As(41), Bi(40), Cr(3), Mo(3), Sb(5), Se(2)
	S3S – 3b	23	As(11), Bi(14), Cr(8), Pb(1)
Chert	S10 – 3b	14	Ag(4), As(14), Bi(10), Cr(1), Ni(1), Sb(7), Se(2)
Mafic Volcanic	V3 – 1b	8	As(5), Ba(1), Bi(2), Cr(4), Li(1), P(1)
Intermediate Intrusive	I2 – 8b	5	As(4), Bi(3), Pb(1)
Ore	Various	13	Ag(6), As(13), Bi(5), Cr(5), Ni(3), Pb(1), Sb(6), Se(5)
Tailings	Mixed	1	Ag, As, Bi, Cu, Sb, Se

Note: Number in parenthesis represents the number of samples that are enriched relative to typical crustal abundance.

Major constituents in all rock types, ore and the tailings sample are silica, aluminum and iron, but also include magnesium in ultramafic and mafic volcanic rocks. Minor constituents in all rock types are calcium and potassium, with the addition of sodium in both greywacke units (S3C and S3S) and intermediate intrusive lithologies. Major constituents show little variation within each lithological group as demonstrated by low standard deviation values.

Trace element concentrations that are greater than five times the typical crustal abundance (Price, 1997) are considered to be significantly enriched in Whale Tail deposit materials. Enrichment is observed for arsenic and bismuth in all waste rock lithologies; antimony for 0a ultramafic, chert and iron formation; as well as chromium and nickel in many but not all ultramafic, iron formation and mafic volcanic waste rock samples.

Two of the mafic volcanic samples have an arsenic content that is 10 times higher than the other six (6) samples: sample AMQ-ENV-01 is located near the contact with UM 0b lithology, while sample AMQ-ENV-51 was previously logged as a greywacke sample. This may explain the apparent variability of arsenic content in this lithology.

Ore and tailings are enriched in selenium in addition to antimony, arsenic, bismuth, chromium and silver. Tailings also contain elevated copper, but given that copper content is very low in this deposit, this likely reflects copper sulphate addition in the cyanide destruction process. The milling process is not yet finalized and copper content may differ in actual tailings.

3.2.1.1 Arsenic Content in Waste Rock, Ore, and Tailings

Arsenic has been identified as a parameter of environmental interest because of its association with gold mineralization and its enrichment in most mine wastes.

Arsenic concentrations are above five times typical crustal abundance (9 mg/kg) in samples from all rock types, including the median concentration for most rock groups.

A strong correlation does not exist between the total arsenic concentration and the samples' proximity to the ore zone for most rock groups, ore and tailings (Figure 5).

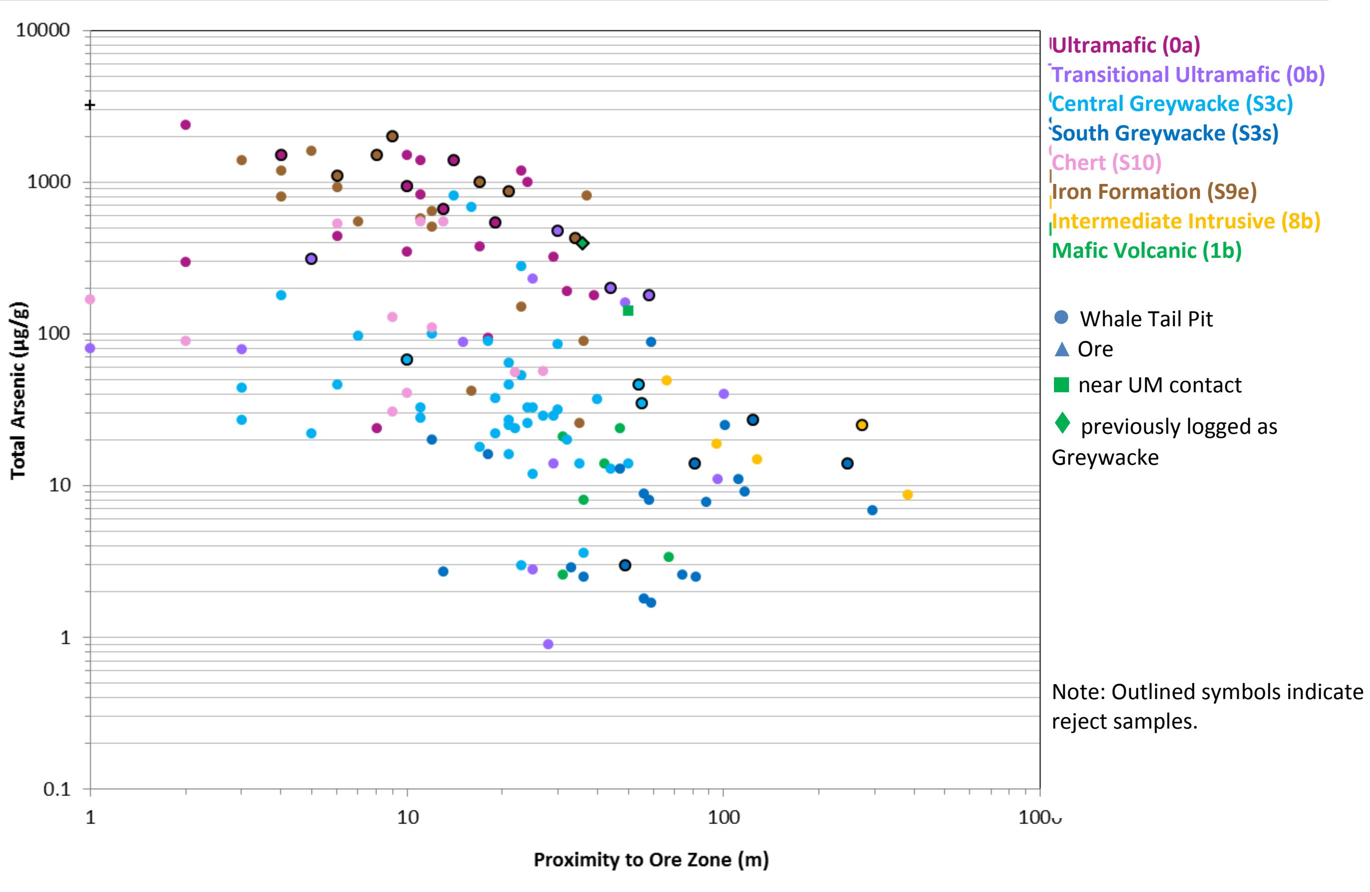

Figure 5: Proximity to the Ore Zone vs Total Arsenic Content

Figure 6 illustrates the relationship between the arsenic and the sulphur content in waste rock, ore and tailings samples.

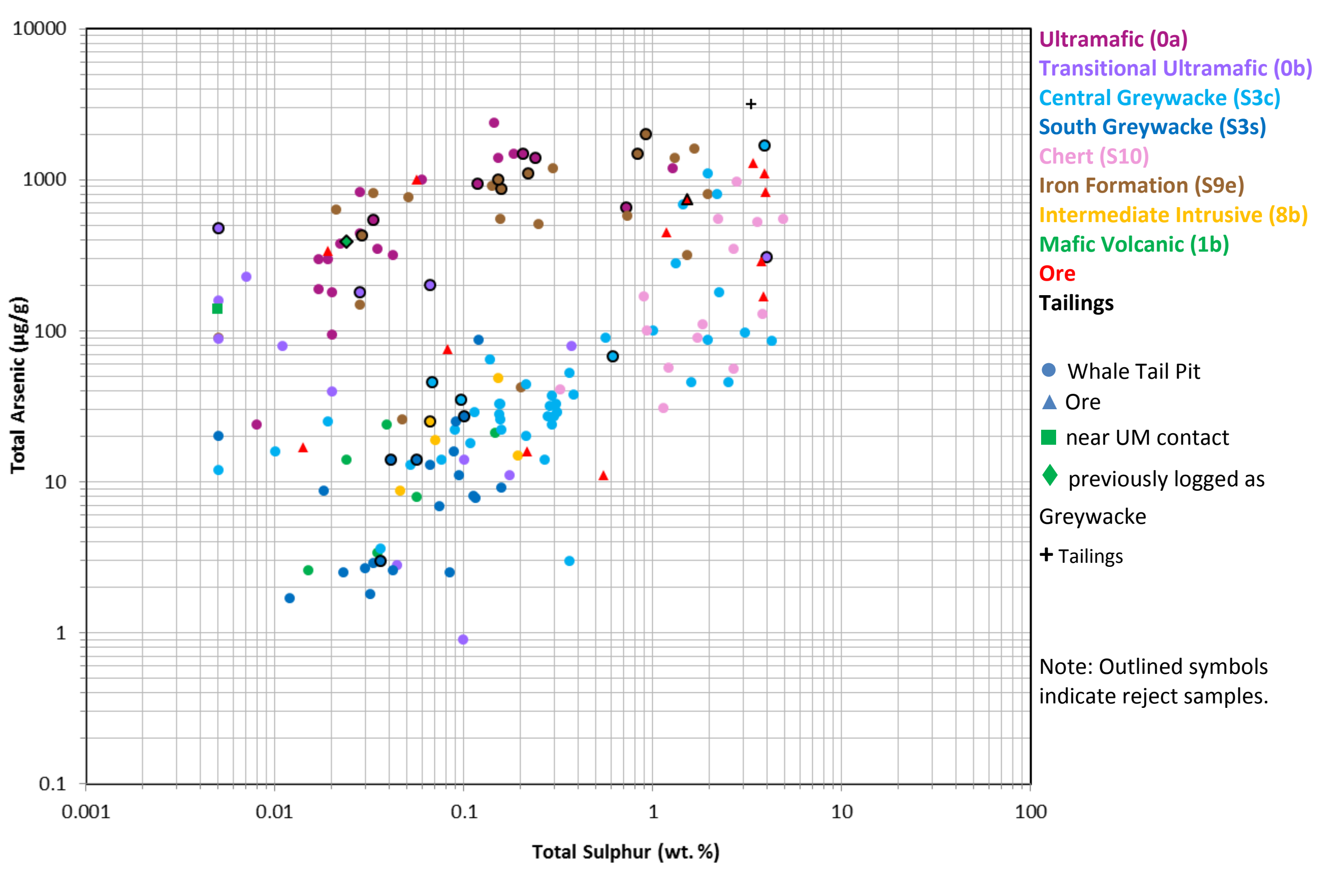

Figure 6: Total Sulphur vs Total Arsenic

The highest arsenic concentrations (Table 13) are associated with the ultramafic and iron formation lithologies, which also have a relatively low sulphur content compared to greywacke and chert. Mineralogical observations suggest that arsenic occurs as nickel arsenide minerals gersdorffite and nickeline in these lithologies. There was no arsenic in pyrite in three samples of these lithologies observed under SEM and analyzed by microprobe. Gersdorffite and nickeline are documented to be reactive (fast oxidation kinetics) and a source of labile arsenic (MEND 2004, Jackson et al. 2003). These minerals may not be the only source of labile arsenic in iron formation or ultramafic rock.

Ore has a moderately high arsenic content, while the tailings have the highest content of arsenic and sulfur and are also highly leachable. In ore and tailings, arsenic is likely associated with arsenopyrite (FeAsS) and possibly with arsenical pyrite (FeS_2) since they are documented to be present in the mineralized zone of the Whale Tail deposit (Agnico Eagle, 2014). Other trace minerals could be present, including gersdorffite and nickeline given that some of the ore is hosted in iron formation and ultramafic rock.

The correlation between arsenic and sulphur was evaluated for each lithological group. Results of this analysis indicate a moderate correlation between these two parameters in central greywacke (R^2 =0.37). A similar correlation exists in chert (R^2 =0.40. This relationship is weaker in south greywacke (R^2 =0.25), ore (R^2 =0.26), and intermediate intrusive (R^2 =0.22) waste rock samples. There is no such correlation in samples of ultramafic and transitional ultramafic waste rock, in iron formation, or in mafic volcanic waste rock samples (R^2 <0.2 for each).

Parametric correlation analysis suggests that arsenic content is likely associated with sulphide minerals in chert and central greywacke, but not in ultramafic and iron formation waste rock where leachable arsenic is highest (Table 13). This may be explained by the presence of sulphide mineral phases that do not contain arsenic.

Table 13: Average Arsenic and Sulphur Content of Waste Rock, Ore and Tailings

Rock Type	Rock Unit	Average Total Arsenic (mg/kg)	Average Total Sulphur (wt. %)
Ultramafic	V4a – 0a	759	0.16
	V4a – 0b	134	0.35
Iron Formation	S9E – 3b	787	0.49
Greywacke	S3C – 3b	143	0.79
	S3S – 3b	14	0.066
Chert	S10 – 3b	267	2.2
Mafic Volcanic	V3 – 1b	75	0.043
Intermediate Intrusive	I2 – 8b	23	0.11
Ore	-	488	1.7
Tailings	-	3200	3.3

3.2.2 Overburden and Lake Sediments

Major constituents are similar for both the overburden and the lake sediments and include silica, aluminum and iron. Minor constituents include calcium, magnesium, potassium and sodium. Bismuth is enriched in most overburden samples compared to typical crustal abundance (Table 14).

In the lake sediment samples, arsenic, bismuth, and selenium concentrations are enriched in all samples, while manganese and molybdenum are enriched in 3 of 5 samples.

Table 14: Compositional Enrichment in Overburden and Lake Sediment

Material Type	Number of Samples Collected	Parameter Concentrations Greater than Five Times Typical Crustal Abundance (Price 1997)
Overburden	12	Bi(12), Mo(3)
Lake Sediment	5	As(5), Bi(5), Mn(3), Mo(3), Se(5)

Note: Number in parenthesis represents the number of samples that are enriched relative to typical crustal abundance.

3.2.2.1 Arsenic Content in Overburden and Lake Sediments

Overburden samples reported an average total arsenic concentration of 4.3 mg/kg, while lake sediments reported an average concentration of 1007 mg/kg; the latter is substantially enriched compared to typical crustal abundance and higher than observed average concentrations in the waste rock (Table 13).

3.2.3 Access Road Construction Materials

The major element and trace metal content of esker materials targeted for potential road construction are fairly homogeneous with few exceptions (Appendix A). Major constituents include silica and aluminum with minor iron, potassium, sodium, magnesium, and calcium. Arsenic, chromium, nickel, and copper naturally exceed CCME soil guidelines in esker samples.

No new assessment of Vault Pit waste rock was completed in this study. Compositional information is presented in a previous report (Golder 2005; Appendix A) where it is shown that the average arsenic content of Vault Pit waste rock samples collected at the time of the report was 148 ppm based on 36 samples. The Vault waste rock consists almost exclusively of intermediate volcanic rock. This arsenic content is at or slightly higher than the average for mafic volcanic, intermediate intrusive and non-chert greywacke waste rock of the Whale Tail deposit, but lower than the Whale Tail chert and ultramafic waste rock, ore and tailings.

3.3 Acid Generation Potential

3.3.1 Waste Rock, Ore and Tailings

The results of ABA and NAG testing are presented as tables and figures in Appendix E.3. The results provide information on the ARD potential of each sample as determined based on total sulphur content, the net potential ratio (CaNPR (CaNP/AP) and NAG pH. Presented with the data are results of statistical analyses and the calculated bulk characteristics for each lithological group using the sum of AP (calculated from total sulphur) and sum of CaNP from all the samples of a given lithology.

In some lithologies, carbonate minerals account for the bulk of the NP, and as such, the use of CaNP and CaNPR is considered more suitable to define non-PAG samples.

A summary of the ARD potential of all samples and the designated ARD potential for each sample group is presented in Table 15 and is illustrated in Figure 7 to Figure 9.

Table 15: Summary of ABA Results for Waste Rock, Ore and Tailings

Rock Type	Rock Codes	Quantity of Waste (tonnes)	Number of Samples	Sample Count			Bulk Potential by Rock Type		
				non-PAG	un-certain	PAG	Average Sulphur (wt.%)	Bulk CaNPR[1]	Bulk ARD Designation
Ultramafic	V4a – 0a	7,839,953	21	21	0	0	0.16	17	non PAG
	V4a – 0b	6,292,816	14	13	0	1	0.35	7.7	non PAG
Iron Formation	S9E – 3b	7,080,011	22	14	2	6	0.49	4.4	non PAG
Greywacke	S3C – 3b	3,167,882	43	10	6	27	0.79	**0.43**	**PAG**
	S3S – 3b	9,707,441	23	23	0	0	0.066	12	non PAG
Chert	S10 – 3b	9,069,203	14	0	0	14	2.2	**0.15**	**PAG**
Mafic Volcanic	V3 – 1b	2,324,150	8	8	0	0	0.007	32	non PAG
Intermediate Intrusive	I2 – 8b	622,937	5	4	1	0	0.10	4.9	non PAG
Ore	various	8,279,144	13	4	2	7	1.7	**0.66**	**PAG**
Tailings	mixed		1	0	0	1	3.3	**0.22**	**PAG**

Note: [1] Calculated as the Sum of CaNP/Sum of AP from all samples in each lithology

Waste rock samples collected from the central greywacke and chert lithologies, as well as the ore and tailings samples, are PAG. All other lithologies (ultramafic, southern greywacke, iron formation, mafic volcanic and intermediate intrusive waste rock) are non PAG. The non PAG lithologies have a combination of lower sulphur content and excess available carbonate buffering capacity to neutralize any acidity generated should all sulphides oxidize (Figure 7).

Non PAG rock represents a total of 33.9 million tonnes of rock, or 73% of the waste rock produced during mine life. The PAG chert waste rock represents 20% of the waste rock, while the PAG central greywacke lithology represents 7%.

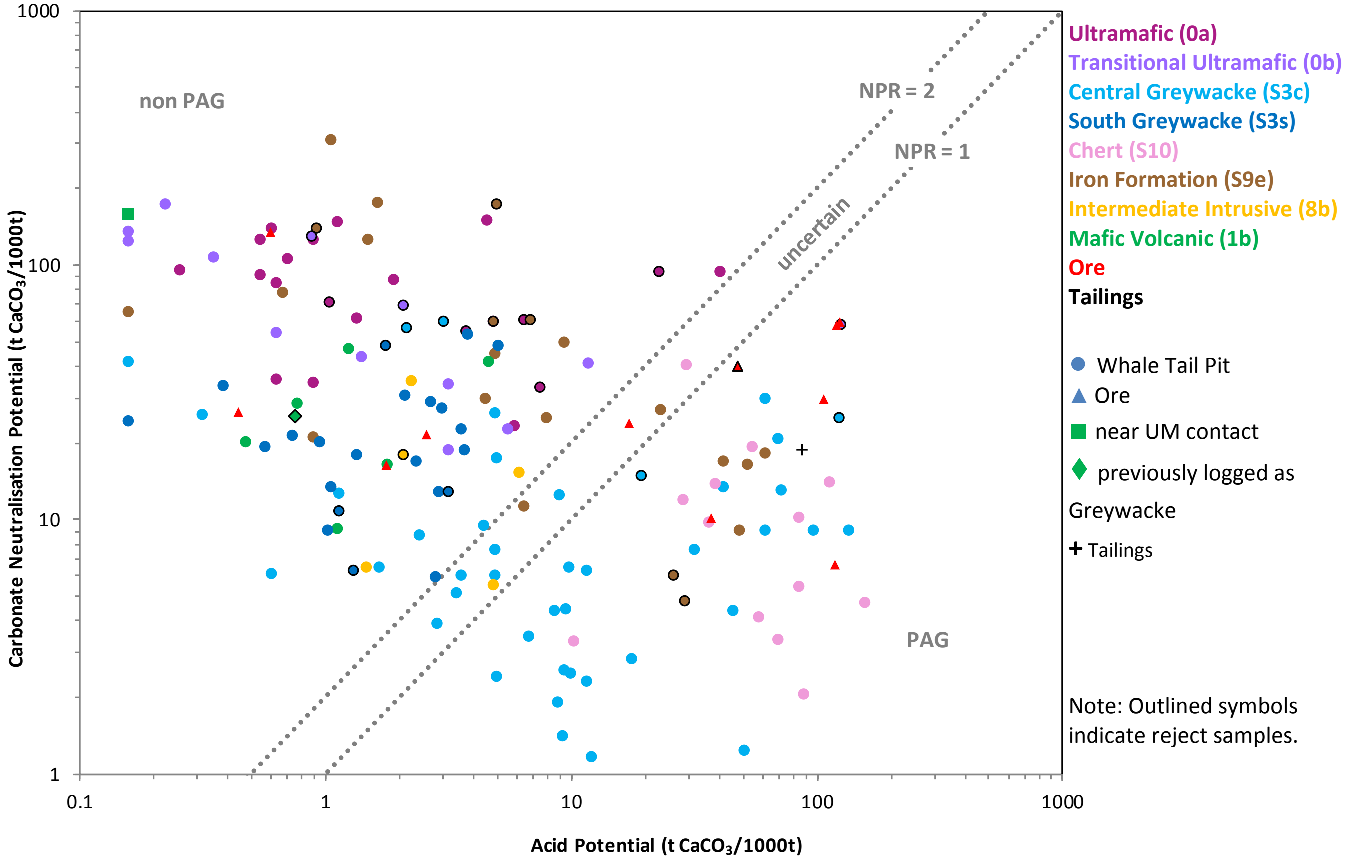

Figure 7: Acid Potential (AP) vs Carbonate Neutralization Potential (CaNP)

Waste rock total sulphur concentrations range from 0.11 to 4.9 wt%. The dominant sulphur species in most samples is sulphide sulphur, which is the source of acidity (Appendix E, Figure E.3-1). Total sulphur is highest in ore, tailings and chert waste rock, and lowest in the south greywacke and mafic volcanic lithologies (Table 15).

Buffering capacity (or neutralization potential) is typically highest in the ultramafic (0a and 0b) and iron formation lithologies. Two samples of the mafic volcanic unit (AMQ-ENV-01 near the contact with UM 0b and AMQ-ENV-51 previously logged as greywacke) have substantially higher CaNP than the other samples of the lithology. These are likely uncharacteristic of the overall mafic volcanic unit.

Overall, the central greywacke (S3C) and chert lithologies exhibit lower buffering capacities than the other waste rock lithologies, ore and tailings (Figure 8). Paste pH values range from 5.9 to 10.2, indicating there is some readily available buffering capacity in most samples. The bulk NP is similar to the Carbonate NP (Figure 8) in most lithologies except central and south greywacke waste rock, where non carbonate (less reactive) minerals provide some of the bulk buffering capacity measured in the laboratory test. The non-carbonate minerals are typically insufficiently reactive to buffer acidity under field conditions. Thus for these lithologies, it is more prudent to use CaNP to designate available buffering capacity. For ore and all other lithologies, carbonate minerals are the primary source of NP.

Consequently in this study, CaNP and CaNPR are used to evaluate acid generation potential of mine wastes.

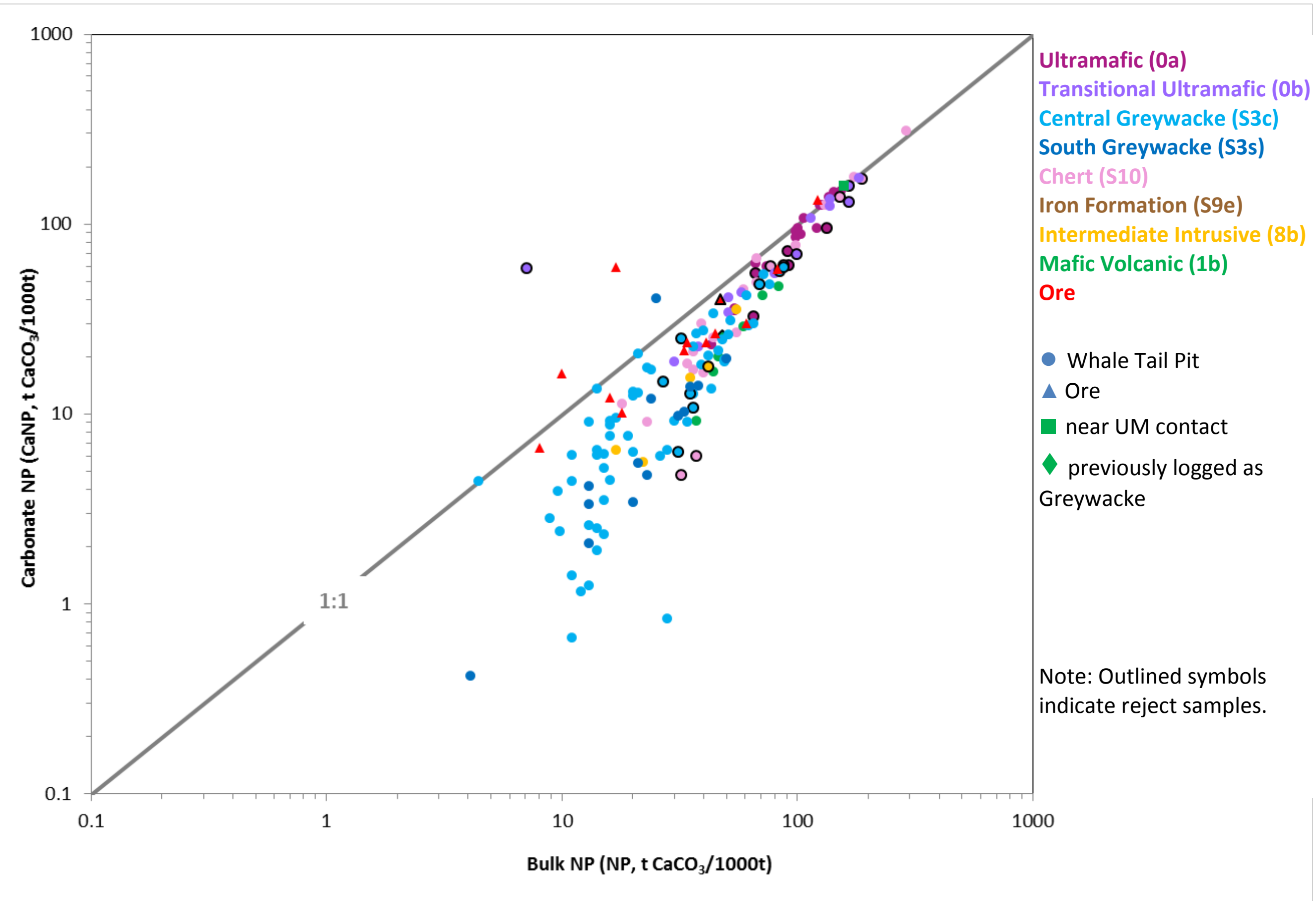

Figure 8: Bulk Neutralization Potential vs Carbonate Neutralization Potential (CaNP)

Figure 9 illustrates the relationship between sulphur content and the ARD potential of samples.

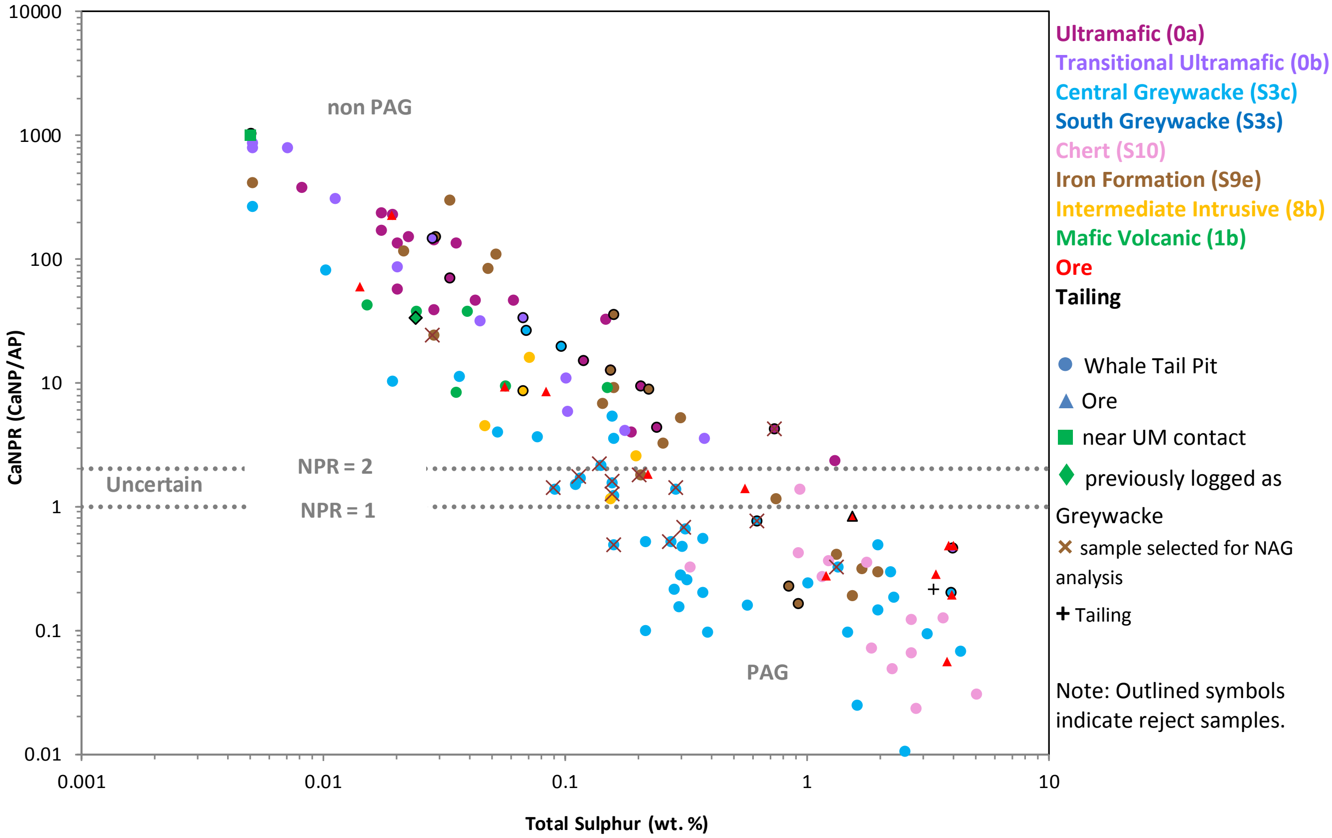

Figure 9: Total Sulphur vs Carbonate Neutralization Potential Ratio (CaNPR)

All samples that have a sulphur content less than 0.1 wt% are non PAG, while most of those above 0.8 wt% are PAG. The tailings sample and all ore samples contain more than 0.1% sulphur and most are PAG, except for two of the 13 samples of ore.

For PAG lithologies of central greywacke and chert, samples with a sulphur content above 0.1% are PAG. Based on the data to date, this sulphur content (0.1 wt%) appears to be a suitably conservative cut-off to define non PAG waste rock for these PAG lithologies.

ARD Potential by Waste Type and Lithology

The following discussion focuses on ARD classification (MEND 2009) for each lithology of waste rock. Figures E-3.3 to E-3.5 illustrate the ARD potential of all samples.

Non PAG Waste Rock

Ultramafic Lithologies (V4a) – Unaltered (Oa) and Transitional (0b): The bulk of these units is non PAG, with bulk CaNPR values of 17and 7.7, respectively. The average sulphur content (wt%) of these units is low (0.16 and 0.35, respectively).

The only PAG sample within the transitional ultramafic unit had a sulphur content of 4.0 wt% and was located within 5 m of an ore zone. All other samples have a total sulphur content of less than 0.4 wt%.

Iron Formation (S9E – 3b): This unit is non PAG with a bulk CaNPR of 4.4 and moderately low sulphur content. Six (6) out of the 22 samples collected are PAG, and have a total sulphur content greater than 0.8 wt% and a carbonate content less than 1.1 wt%. These samples were located within 5 to 10 m of the ore zone. Two samples have an uncertain ARD potential based on CaNPR but the NPR values are above 2. The non PAG samples have a total sulphur content of less than 0.3 wt% and a carbonate content greater than 1.5 %. The bulk CaNPR and generally low sulphur content suggest there is excess buffering capacity to neutralize any acid that may be generated from this lithology

South Greywacke (S3S – 3b): this unit is non PAG with a bulk CaNPR value of 12. All 23 samples tested are non PAG and report a low total sulphur content that ranges from <0.005 to 0.16 wt%.

Mafic Volcanics (V3 – 1b): All eight (8) samples are non PAG. Samples have a low average sulphur content of 0.043 wt% and a bulk CaNPR value of 32.

Intermediate Intrusive (I2 – 8b): Four (4) of the five (5) samples are non PAG while one sample is uncertain. Overall, these samples also have a low average sulphur content of 0.11 wt% and a bulk CaNPR value of 4.9.

PAG Waste Rock

Central Greywacke (S3C – 3b): Overall the central greywacke unit has a PAG bulk ARD potential. The average sulphur content is 0.79 wt% and the bulk CaNPR is 0.46. Samples that are PAG have an average sulphur content of 1.2 wt%. Those with an uncertain ARD potential have an average sulphur content of 0.15 wt%, and non PAG samples average 0.08 wt% sulphur.

Greywacke samples with a total sulphur content of less than 0.1 wt% are non PAG (Figure 9). Those above 2 wt% are all PAG, while those in between are uncertain or PAG.

The lower CaNPR values in the uncertain and PAG samples are related to both the higher total sulphur content (higher AP) and the lower carbonate content (lower CaNP), which may be related to the silicic alteration of the deposit. Silicification was observed in the central greywacke samples collected by Golder in Phase 3 (Figure 10), most of which are PAG. These are highlighted with an 'X' in Figure 9.

Figure 10: Photo showing the different appearance of (a) silicified greywacke and (b) non or less silicified greywacke

Chert (S10 – 3b): The chert lithology is PAG. The low bulk CaNPR value of 0.15 is attributed to a combination of an average total sulphur content of 2.2 wt. % and a low overall buffering capacity (NP and CaNP).

Ore

The ore shows a bimodal ARD potential largely due to variability in sulphur content. Seven of 13 samples are PAG and have a high sulphur content (between 1.2 wt% and 3.8 wt%), while the 4 non PAG samples have a sulphur content less than 0.55 wt%. The paste pH of all samples is alkaline, attesting to the presence of some immediately available buffering capacity; however, the carbonate content (and CaNP) values are low suggesting that the buffering capacity is likely to be short lived.

Tailings

The tailings sample is PAG with a CaNPR value of 0.22. It has a sulphide sulphur content of 2.8 wt%, and a sulphate sulphur content of 0.54 wt% indicating that some of the sulphur has oxidized, possibly in the metallurgical process. Although the NP value of -22 t $CaCO_3$/1000 t equivalent indicates there is stored acidity in the sample, the paste pH value is alkaline. The sample contains a small amount of carbonate buffering capacity, attesting to the presence of some immediately available buffering capacity in the sample, but the buffering capacity could be short-lived.

3.3.2 NAG Test Results on Waste Rock and Tailings

Results of the Sequential NAG tests are reported in Appendix E.4. The NAG test results confirmed the 0.1% sulphur content cut-off below which samples are non PAG.

The sulphate analysis completed at each NAG step suggests that most of the sulphur content of the samples was oxidized to sulphate (from 70 to 133 %) during the NAG test. It can be inferred that where the NAG test consumed more than 90% of the sulphur of a given sample, the test was largely successful in oxidizing its sulphide mineral content. The variation of sulphur consumed relative to initial sulphur content could reflect residual unoxidized sulphur; however, given that some of the values report over 100% of sulphur oxidation, it could also reflect heterogeneity of the individual subsamples from which sulphur was measured (Total S from the ABA analysis subsample and sulphate-S from the NAG test subsample).

Ten (10) samples returned a sulphur removal of less than 90%: thee (3) iron formation, three (3) chert and three (3) greywacke samples, all of which have a sulphur content above 0.9 wt%; and (1) ultramafic sample, which had a sulphur removal of 70% and the highest CaNP of all samples subjected to the NAG test. For most of these samples, the NAG pH returned an alkaline pH and low acidity most likely reflecting the incomplete oxidation of all sulphide minerals. Thus, the result for these samples is not conclusive; the test would have required more than 4 steps of NAG leaching (AMIRA 2002). Figure 11 presents a summary of NAG pH vs NAG acidity results.

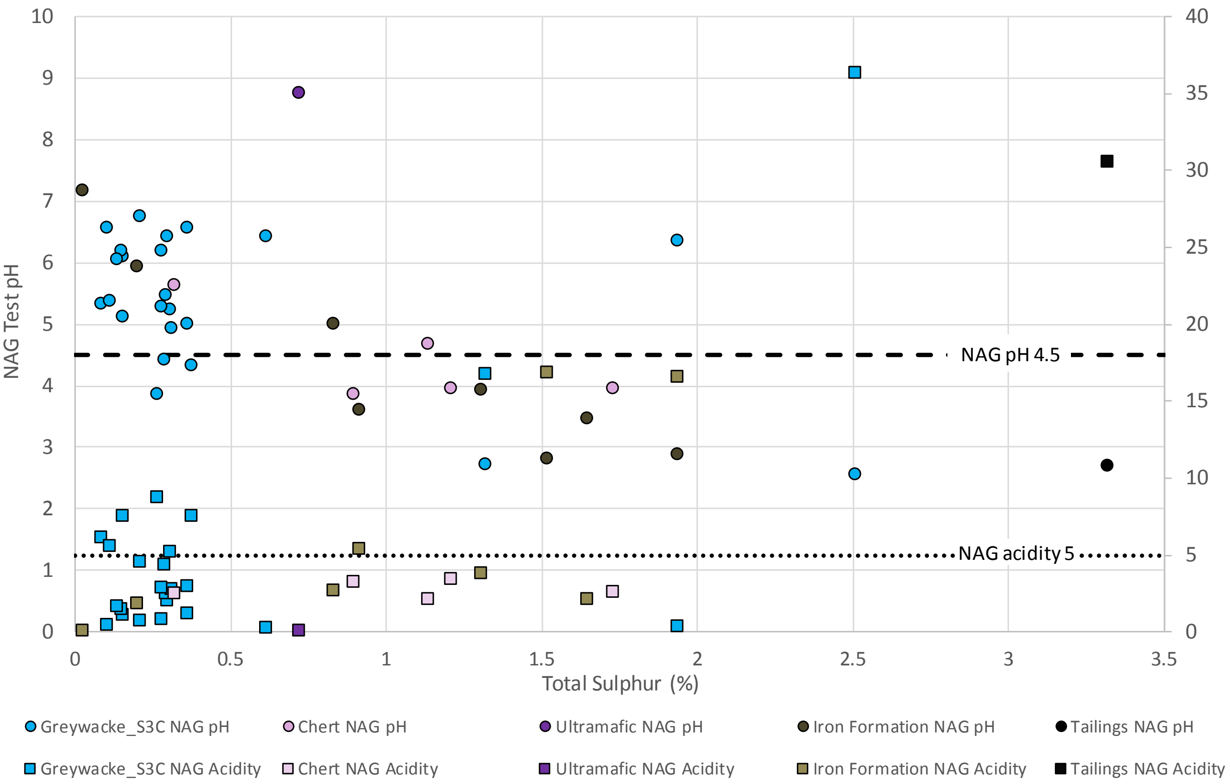

Figure 11: NAG test pH (circle) and corresponding NAG test acidity (square) compared to sulphur content.

Waste rock samples of **central greywacke (S3C)** having a sulphur content above 0.1wt% are shown to be mostly PAG. Some exceptions are observed where the NAG pH value is less than 4.5 but NAG acidity is greater than 5 kg H_2SO_4/t. These could be false negatives caused by the presence of carbonate in these samples, which is preferentially consumed by the peroxide solution (over sulphide mineral oxidation) and can result in an over-buffered pH of the NAG solution (AMIRA 2002). Given that most S3C samples have low CaNP, the NAG test confirms a cut off of 0.1% below which samples from this lithology are non PAG.

The **iron formation** and **chert** waste rock samples with a sulphur content of above 0.2wt% and 0.3wt% respectively are PAG, but for all chert and many iron formation samples (4 of 6), sulphide oxidation released low levels of acidity. This would classify them as *low capacity PAG* samples (low metal release). Samples with a sulphide content of between 0.1% and 0.3 wt% are non PAG according to the NAG test. This trend should be verified with additional samples.

The NAG test on the **0a ultramafic** (non PAG) waste rock sample (AMQ-ENV-49) was completed to confirm that this samples in non PAG and to verify whether all the arsenic would be released upon sulphide oxidation. This sample has one of the highest sulphur contents (660 ppm) of the lithology, but also has an elevated CaNP. The NAG pH did confirm the non PAG character of the sample. For arsenic release, only 3% of the total arsenic content of the sample (660 ppm) was released upon 70% oxidation of the sulphides. This could mean that much of the arsenic is not associated with sulphide minerals in this sample or that arsenic was retained (adsorbed) within the NAG-leached sample.

The tailings sample is PAG according to the NAG test and the ABA test. It released a substantial amount of metal acidity upon oxidation of the sulphide minerals, suggesting that upon ARD development, tailings could be an elevated source of metal release to receiving waters.

3.3.3 ARD Potential of Overburden and Lake Sediments

A summary of the ARD potential for overburden and lake sediments is provided in Table 16. Results are detailed in Appendix E.

Table 16: ARD Potential for Overburden and Lake Sediments

Rock Type	Number of Samples Collected	Sample Count			Average Sulphide (wt.%)	Bulk ARD Designation
		non PAG	uncertain	PAG		
Overburden	12	12	0	0	<0.005	Non PAG
Lake Sediment	5	5	0	0	0.04	Non PAG

Sulphide sulphur concentrations in overburden are all below detection limit, and are present but in low concentrations in lake sediments where they range from 0.03 to 0.07 wt%. The carbonate buffering capacity is low to below detection limits in most samples. Paste pH values of the overburden samples are circum-neutral, ranging from 6.2 to 8.5, corroborating the low amount of buffering capacity in some of the samples. Despite their lack of buffering capacity, the overburden and lake sediments are non PAG given their very low sulphide content.

3.3.4 ARD potential of Road Construction Materials

All esker samples tested show no potential to generate ARD (Appendix A). This stems from the low sulphide content and sufficient buffering capacity, and is corroborated by neutral to alkaline paste pH, NAG pH and SFE pH values.

Vault Pit waste rock has a variable ARD potential, largely defined by the sulphur content. The Agnico Eagle operational dataset and results of additional testing correlate well together (Figure 12). Results show that in general, material with a total sulphur content below 0.2% reports a CaNPR > 2, and thus is designated as non PAG as previously proposed (Golder 2005). Material with total sulphur content between 0.2% and 0.3% could also be non PAG depending on the CaNP (Figure 12).

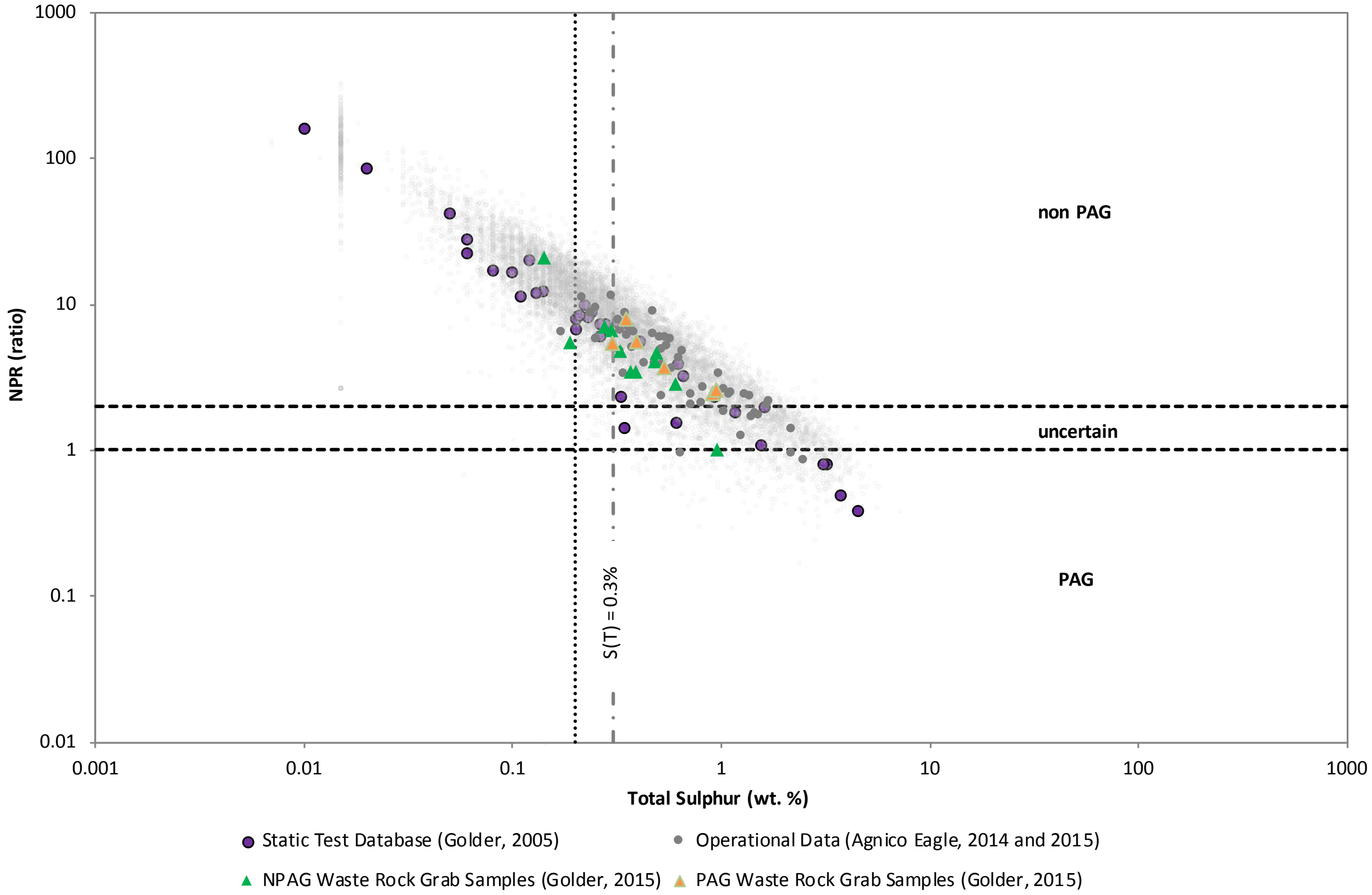

Figure 12: Comparison of the Vault WRSF grab samples (Golder, 2015), the Vault operational sample database (Agnico Eagle, pers. commun. 2014 and 2015), and the Vault waste rock geochemical characterization results (Golder, 2005)

3.4 Metal Leaching Potential

3.4.1 Short-Term Leach Tests (SFE)

3.4.1.1 Waste Rock, Ore and Tailing

Leachate quality results for waste rock, ore and tailings samples are presented in Appendix E.5. Results are compared to Meadowbank Effluent Limits for the Vault and Portage areas as outlined in Water License #2AM-MEA1525 (NWB, July 2015). Table 17 summarizes parameters that exceed the screening criteria.

Table 17: Summary of SFE Leachate Exceedances to Screening Criteria

Rock Type	Rock Unit	Number of Samples Collected	Average Final pH	Average As (mg/L)	Parameters in Exceedance of Effluent Quality Criteria[1]	
					Portage Criteria	Vault Criteria
Ultramafic	V4a – 0a	21	9.5	1.8	As(14), P(4)	As(17), P(4)
	V4a – 0b	14	9.4	0.32	As(6)	As(8)
Iron Formation	S9E – 3b	22	9.5	2.2	Al(1), As(18), P(4)	Al (1), As(19), P(8)
Greywacke	S3C – 3b	43	9.2	0.057	Al(19)	Al (19), As(8),
	S3S – 3b	23	9.8	0.055	As(1)	As(2)
Chert	S10 – 3b	14	8.7	0.072	Al(2), Cd(1)	Al (2), As(5), Cd(1)
Mafic Volcanic	V3 – 1b	8	9.7	0.37	As(2)	As(2)
Intermediate Intrusive	I2 – 8b	5	9.5	0.027	Al (3)	Al (3)
Ore	various	13	9.1	1.1	As(5), P(1)	As(9), P(1)
Tailings	mixed	1	8.2	0.02	n.e.	n.e.

Note: [1] Number in parenthesis represents the number of samples that exceed their respective effluent limit.
n.e. no exceedances.

The final pH values of the SFE leachates are circum-neutral to alkaline with values ranging from 6.4 to 10.0, corroborating the presence of some available buffering capacity to neutralize acid in the short term in all samples.

For all rock types investigated, the concentrations of almost all leachate parameters are below Portage and Vault mine effluent criteria (NWB 2015), except for arsenic which is elevated in ore and in a number of samples from most waste rock types (except Intermediate Intrusive); aluminum in some samples of central greywacke, chert and intermediate intrusive waste rock; and phosphorous in some ultramafic and iron formation waste rock samples.

Total versus leachable arsenic for all waste rock and ore samples is illustrated in Figure 13.

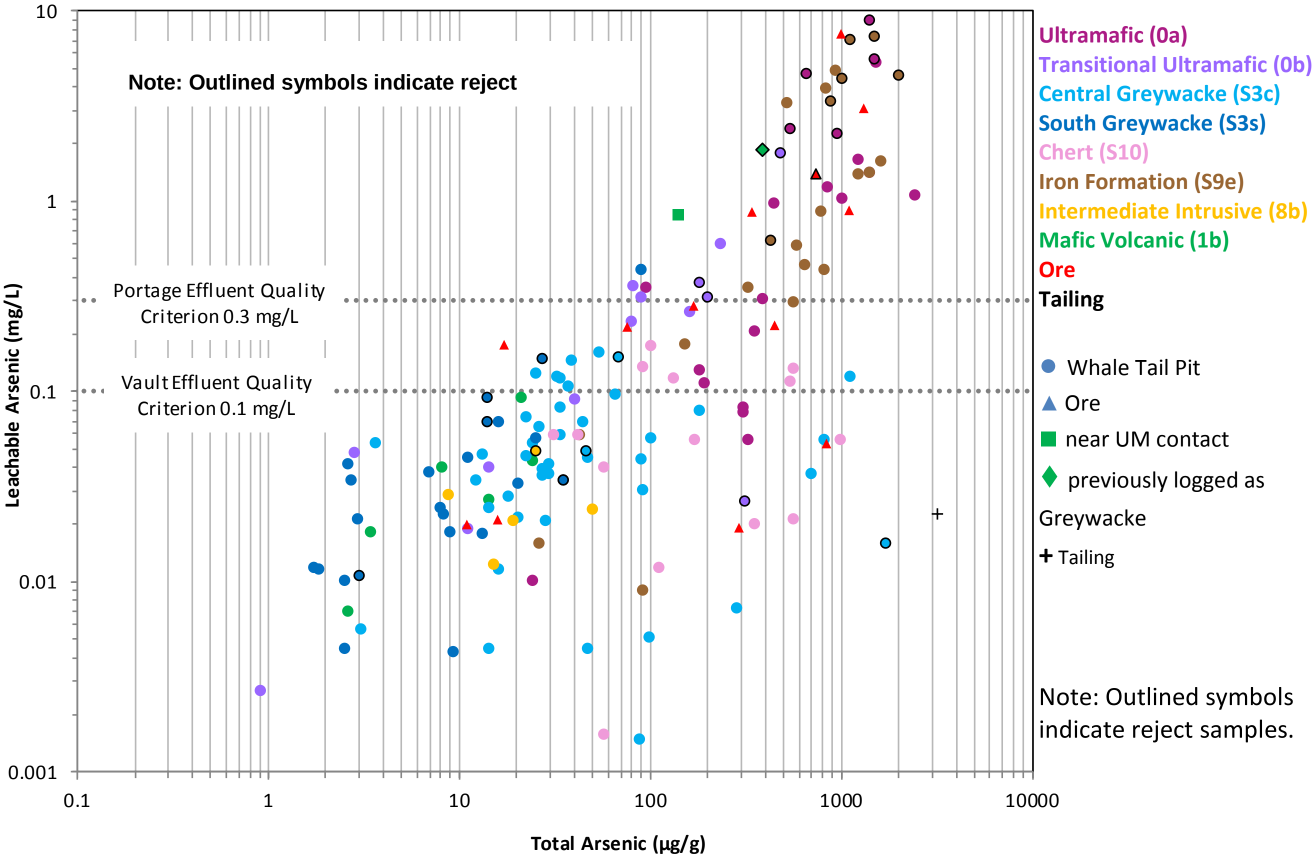

Figure 13: Total Arsenic vs Leachable Arsenic in Waste Rock, Ore, and Tailings

Arsenic is leached at concentrations that are within one order of magnitude or above the Meadowbank effluent limits (0.1 mg/L for Vault and 0.3 mg/L for Portage) in many samples. The average arsenic concentration in leachates of samples from both greywacke units (central and south), chert and intermediate intrusive waste rock units is below the effluent limits, but the average leachable arsenic in ultramafic and iron formation waste rock, as well as in ore, exceeds these limits. The leachate in most samples of ultramafic and iron formation waste rock and in ore exceeds the criteria by more than one order of magnitude.

There is a good correlation between total and leachable arsenic in ultramafic, iron formation and south greywacke waste rock (R^2 >0.50). The correlation is weaker in ore (R^2=0.35), and absent in the other rock types.

The large majority of greywacke (S3C and S3S) and mafic volcanic samples, as well as all chert and intermediate intrusive samples, do not show elevated leachable arsenic in the SFE leaching tests; most concentrations meet the Portage effluent criterion for arsenic regardless of their initial arsenic concentration, although most samples do have less than 100 µg/g (ppm) total arsenic. A few of these samples exceed the Vault effluent criterion. Two (2) of the eight (8) samples of mafic volcanic waste rock take exception; their leachable arsenic exceeds both Portage and Vault effluent criteria. One sample having 0.85mg/L arsenic in leachate is proximal to the contact with 0b ultramafic rock. It has similar compositional characteristics, most prominently, it has a CaNP value that falls in the much higher range of those of ultramafic rock. The other mafic volcanic rock was previously logged as greywacke and has an anomalously high total and leachable arsenic content for the mafic volcanic lithology.

Samples that exhibit higher leachable arsenic (iron formation and ultramafic samples as well as the two mafic volcanic samples discussed previously) tend to have a total arsenic content that is greater than 100 µg/g (ppm), and almost all of these samples leach arsenic at concentrations that exceed the Portage effluent criterion. Samples with less than 60 ppm total arsenic leach concentrations meet the Vault effluent criteria. Of note, however, is that exceedances to the effluent criterion in these aggressive laboratory leaching tests do not necessarily infer that contact water quality will also exceed this criterion.

The only other parameters that show exceedances to Portage effluent criteria are aluminum and phosphorous in multiple samples, and one marginal exceedance of the cadmium criterion in a chert sample (0.0032 mg/L compared to the criterion of 0.002 mg/L for both Portage and Vault effluent).

Concentrations of aluminum in leachate are exceeded in samples of central greywacke, chert, iron formation and intermediate intrusive waste rock, while phosphorous is exceeded in ultramafic and iron formation rock. Aluminum and phosphorous concentrations are only slightly higher than the Meadowbank effluent limits.

Aluminum exceedances in short-term leach tests are often an artefact of the test protocol itself resulting from vigorous shaking and passing of very fine aluminum-bearing colloids through the filter rather than an occurrence in true soluble form.

Phosphorous is exceeded in all samples where arsenic concentrations are leached at concentrations above 3.0 mg/L.

The actual leachability of phosphorous, aluminum, arsenic and all other elements are verified though kinetic testing, discussed in Section 3.5 of this report.

3.4.1.2 Overburden and Lake Sediments

Leachate quality results for overburden and lake sediment samples are presented in Appendix E.3, and parameters exceeding screening criteria are summarized in Table 18.

Table 18: Summary of SFE Leachate Results

Rock Type	Number of Samples Collected	Average Final pH	Average As (mg/L)	Parameters in Exceedance of Portage Effluent Quality Criteria	Parameters in Exceedance of Vault Effluent Quality Criteria
Overburden	12	5.7	0.0036	Al (1)	Al (1)
Lake Sediment	5	5.0	0.17	Al(1), As(1), Ni (2)	Al (1), As(3), Ni (2)

Note: the number in parenthesis represents the number of samples that exceed the effluent limit

The final average pH values of the SFE leachates are 5.7 and 5.0 for the overburden and lake sediment samples respectively, attesting to the lack of available buffering capacity in these samples.

Most samples report leachate parameter concentrations that meet Portage and Vault effluent criteria with few exceptions; namely, aluminum in overburden and lake sediments, as well as marginal exceedances of arsenic and nickel in lake sediments only.

Leachate aluminum concentrations marginally exceed the Portage and Vault effluent criterion (of 1.0 mg/L dissolved aluminum) for one lake sediment sample and one overburden sample. Overburden concentrations range from 0.3 to 1.1 mg/L, while lake sediment aluminum concentrations range from 0.009 to 1.0 mg/L.

Total versus leachable arsenic for all overburden and lake sediment is illustrated in Figure 14.

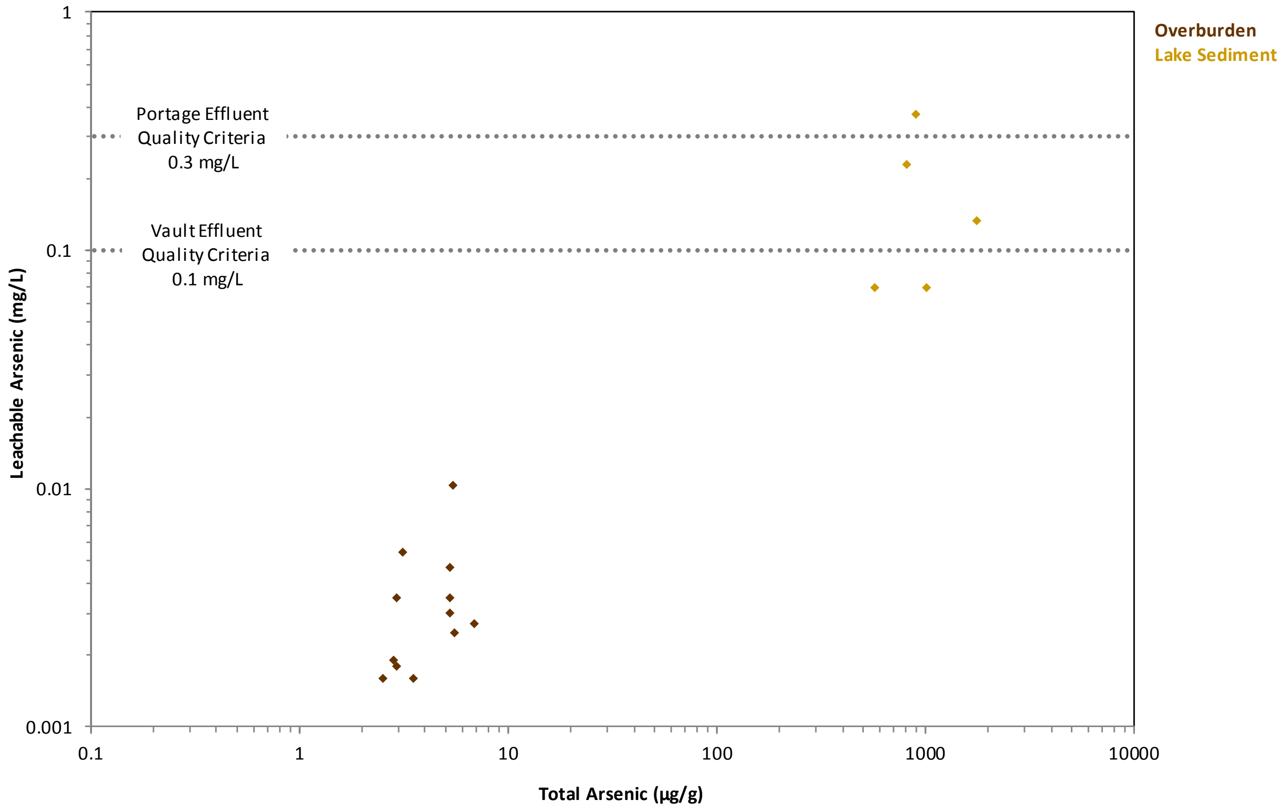

Figure 14: Total Arsenic vs Leachable Arsenic in Overburden and Lake Sediments

Arsenic concentrations range from 0.07 to 0.37 mg/L in the lake sediment samples. Leachate nickel concentrations exceed the 0.2 mg/L Portage and Vault effluent limit for nickel in two lake sediment samples, but the average concentration for all lake sediment samples (0.12 mg/L) is below the effluent limit. No other parameters exceed the Meadowbank effluent limits.

3.4.1.3 Road Construction Materials

Some esker samples report metal leachate concentrations that are naturally above the CEQG guideline for the protection of aquatic life (CCME 2007); namely arsenic, copper, and lead (Appendix A). However, leachate concentrations are within the same order of magnitude as the respective CEQG guideline, and thus are not expected to be a concern to receiving water quality. Iron concentrations reported for all esker samples exceed the CCME criterion (0.3 mg/L) by two to three orders of magnitude, but given the neutral pH values of the test leachates, it is likely that elevated iron concentrations are related to colloidal iron (total iron) rather than dissolved.

Based on these results, the Vault waste rock leachate chemistry was not required to be further assessed in this or the Amaruq Exploration Access road materials study.

3.4.1.4 Process Water

Chemical analysis results for the process water are presented in Appendix E.6. For the purposes of this assessment, the results are compared to both the Portage and Vault effluent limits; however, the water will either be reclaimed or mixed with natural lake water during closure of the Meadowbank Mine and therefore not discharged directly to the receiving environment. For more details on modelling closure refer to the Tailings Management Plan in Volume 8 Appendix 8.A-1. The limits apply to the attenuation pond discharge rather than direct, unrecycled mill effluent, which this sample emulates.

For comparative purposes, the process water quality from the one tailings sample tested meets the Portage average monthly effluent limits for most of the regulated parameters except:

- arsenic at 0.33 mg/L exceeds the limit of 0.3 mg/L;
- ammonia at 69 mg/L exceeds the limit of 16 mg/L; and
- total cyanide at 2.02 mg/L exceeds the limit of 0.5 mg/L.

It should be noted that the cyanide destruction process and cyanide dosage used for the generation of this sample may not necessarily reflect the final mill effluent total cyanide content at Meadowbank Mine. Agnico Eagle will use the current cyanide destruction circuit at Meadowbank Mine.

All other parameter concentrations are below Portage and Vault effluent limits.

3.5 Kinetic Leaching Tests

All but one kinetic leaching tests on waste rock and ore are on-going, and the tailings HCT has been stopped. The HCT for the central greywacke PAG sample AMQ-ENV-28 (cycle 24) was terminated because ARD developed and stable leaching rates occurred. The tailings sample (cycle 44) was terminated because the test time extended beyond anticipated tailings exposure time and stable leaching trends were observed.

Leachate concentrations in time-series graphs are presented in Appendix F.1. The results are presented up to the cycles identified in Table 19. Results are compared to Portage and Vault Effluent Limits.

3.5.1 Leaching Tests on Waste Rock and Ore

Based on the kinetic leaching test results, most leachates from the waste rock and ore samples are circum-neutral (values ranging from 6.7 to 8.1), including two PAG greywacke samples, one PAG chert sample and both ore samples. These samples have maintained a leachate with low conductivity and sulphate content throughout the test period to date. The other PAG greywacke sample AMQ-ENV-28 was acid from the first cycle onward, at a pH of around 4.2. Sulphate content and conductivity for this sample are moderately high. A re-analysis of the sample source for this HCT using a replicate riffle split of the sample (Sections 2.3 and 3.6) yielded a much higher sulphur content (1.2 wt% compared to the 0.56 wt% initially reported for the sample), but similar metal content, NP and SFE values for parameters of interest. At 1.2 wt% sulphur, this sample has the 75th percentile sulphur content of the central greywacke lithology but the 20th percentile carbonate buffering capacity. At the latter sulphur content, it represents a high ARD potential end member of this unit.

The PAG greywacke and chert samples remained neutral, corroborating the immediately-available buffering capacity in these samples (Table 19).

Almost all parameter concentrations in HCT and column test leachates are below Vault and Portage effluent criteria except for the PAG greywacke sample AMQ-ENV-28 (Table 19) which, because of its acidic drainage, has higher parameter concentrations than leachate from the other HCT and columns.

One exception is arsenic, which exceeds both Meadowbank effluent limits by more than one order of magnitude in the HCT and leaching columns of ultramafic and iron formation waste rock. In ore, only the first few cycles of leaching exceed the effluent criteria but concentrations decreased to below these levels thereafter. In all other waste rock types arsenic meets both Meadowbank effluent criteria for arsenic. The bulk mafic volcanic column, which contains the one sample located proximal to the contact with ultramafic rock (and reported an elevated static test leachate arsenic content), also released arsenic concentrations that slowly rose to slightly exceed the Portage effluent criterion after 8 weeks of testing.

In ultramafic and iron formation rock, arsenic shows stable leaching rates from the beginning of testing in both HCT and columns; no decreases were observed over the test period so far. Arsenic leaching is on a slight decreasing trend for greywacke, chert and intermediate intrusive.

These different arsenic leaching behaviours suggests a different mineralogical occurrence of arsenic in ultramafic and iron formation rock compared to greywacke, chert and intermediate intrusive rock.

Table 19: Summary of Kinetic Weathering Test Results to Date

Kinetic Test	Rock Type	Rock Code	Sample Information		Kinetic Results			
			Sample ID	**ARD Potential (ABA)**	**Last Leaching Cycle Analyzed**	**pH at Last Leach Cycle**	**Parameters in Exceedance of Portage Effluent Quality Criteria**	**Parameters in Exceedance of Vault Effluent Quality Criteria**
HCT	Ultramafic	V4a - 0a	AMQ-ENV-32	Non PAG	28	7.1	As	As
	Iron Formation	S9E – 3b	AMQ-ENV-43	Non PAG	28	7.0	As	As
	Greywacke	S3C – 3b	AMQ-ENV-37	Non PAG	28	7.0	n.e.	n.e.
	Greywacke	S3C – 3b	AMQ-ENV-18	PAG	28	6.7	n.e.	n.e.
	Greywacke	S3C – 3b	AMQ-ENV-28	PAG	24	4.1	pH(<6.0), Ni	pH(<6.0), Ni
	Chert	S10 – 3b	AMQ-ENV15-133	PAG	9	7.1	n.e.	n.e.
	Greywacke	S3C – 3b	AMQ-ENV-40	PAG	28	6.2	n.e.	n.e.
	Intermediate Intrusive	I2 – 8b	AMQ-ENV-114	Non PAG	28	6.8	n.e.	n.e.
	Ore	S3C – 3b	AMQ-ENV15-144	PAG	9	7.7	As	As
	Ore	SE9 and 0b	Composite	PAG	25	6.7	n.e.	As
	Tailing	mixed	RE-13872/ RE-13874	PAG	40	7.4	n.e.	n.e.
Leaching Column	Ultramafic	V4a - 0a	C-1	Non PAG	24	8.1	As	As
	Iron Formation	S9E – 3b	C-2	Non PAG	24	7.8	As	As
	Greywacke	S3C – 3b	C-3	PAG	24	7.8	n.e.	n.e.
	Greywacke	S3C[1] and S3S	C-4	Uncertain	24	7.7	n.e.	n.e.
	Ultramafic	V4a - 0b	C-5	Non PAG	20	8.1	As	As
	Chert	S10 - 3b	C-6	PAG	20	7.7	n.e.	n.e.
	Mafic Volcanic	V3 - 1b	C-7	Non PAG	10	8.0	As	As
	Ultramafic and Iron Formation	0b and S9E	C-8	Non PAG	Day 75	7.7[2]	As (all 3 ports)	As (all 3 ports)

Notes:

[1] Contains samples of S3C located farther than 10 m away from the ore zone

[2] Represents the average pH over the 3 sampling ports

In addition to arsenic, the following trends were observed for both HCT and column tests:

- Sulphate concentrations and conductivity are generally stable inferring low oxidation rates of sulphide minerals in PAG samples even under accelerated weathering conditions in the laboratory. In ultramafic, iron formation and mafic volcanic rock, the low sulphate content and slightly higher conductivity may reflect low sulphur content rather than slow oxidation rate since the reactive gersdorffite sulphide mineral was identified as the likely source of labile arsenic.
- Alkalinity, and the major ions that are released from its consumption (calcium, magnesium), are low and have a stable trend.
- Trace metal concentrations (Co, Cu, Fe, Mn, Ni, Pb) in leachates are low and on a stable to slightly decreasing trend in most HCT samples and columns except for the acidic AMQ-ENV-28 sample, in which metal concentrations are up to two orders of magnitude higher than in other HCTs. Nickel concentration in this sample exceeds the Portage and Vault effluent limit in the first cycle, while the other metals meet the limits.

The liquid to solid ratio of the leaching tests has an effect on parameter concentrations. In leaching columns where the solid to liquid ratio is higher than in HCTs (10:1 vs 1:1 respectively), higher concentrations are noted for major ions (alkalinity, SO_4, Ca, K, Mg, Na) and a number of trace elements (As, Ba, B, Co, F, Li, Mo, Ni, Sb, Se, Sr, Tl, Sb, U and V) in most lithologies for which there are HCTs and columns, as well as Cd, Mn and P in greywacke only.

The effect of liquid to solid ratio was further demonstrated, (i.e., showing similar trends) in leaching column cycles where the amount of leaching water was modified to simulate 3 dryer cycles, where concentrations increased, and one wet flushing cycle where concentrations decreased. Concentrations differed by approximately the same factor as the liquid to solid ratio difference.

Submerged Column Leaching Test on Waste Rock

The data for submerged leaching columns are tabulated and illustrated in time-series graphs included in Appendix F-2.

After 75 days (2.5 months) of submergence, the waste rock charge material consisting of mixed iron formation and ultramafic waste rock shows relatively stable contact water quality for most parameters.

The water collected from Port 1, located in the waste rock pore space 5 cm down from the rock-water interface, had consistently higher parameter concentrations than water in the column above the rock surface where water quality was similar at both ports (5 cm and 25 cm above the rock-water interface). Concentrations in the pore space were initially up to two orders of magnitude higher than in the water column, but in time, trended toward similar concentrations.

For some parameters, pore space concentration decreased with time (for Sb, Cl, Cr, Li, Mo, Ni, Pb, Se, V), while for others, pore space concentrations remained steady (major ions: Al, Ca, Mn, Na, K, SO_4, conductivity and alkalinity, and some trace elements including: As, Be, Bi, B, Cd, Co, Cu, F, P, Si, Sn, Th, Tl, U). The stable pore-water concentrations for these parameters suggests an occurrence in soluble minerals; their concentration in the pore space being solubility controlled rather than related to sulphide mineral oxidation, which would be arrested upon submergence (concentrations would go down in time as chemicals diffuse out of the pore space into the water column). This corroborates the mineralogical observation and supporting literature review suggesting that gersdorffite, which is present in ultramafic and iron formation rock samples, is a source of labile arsenic upon flooding (MEND 2004).

Notwithstanding these trends, the water quality from all three ports continues to meet Vault and Portage effluent levels for most parameters except arsenic. Arsenic concentrations in the pore space (Port 1) remained steady since the beginning of testing at 1.5 to 2.4 mg/L, while concentrations in the water column above increased from 0.02 mg/L to 0.6 mg/L, or twice the Portage effluent limit of 0.3 mg/L.

3.5.1.1 Mineral Consumption Rates and Evaluation of ARD Potential from Kinetic Tests

Mineral depletion calculations provide an estimate of time to depletion of acid generating (sulphide) minerals and acid-consuming minerals (carbonates), and thus can be used to evaluate the likelihood of the generation of ARD and approximate time to onset of ARD. Theoretical mineral depletion calculations for pyrite and buffering capacity were completed based on the MEND (2009) guidance using the static ABA data, the measured sulphate and alkalinity release rates, and the leachate volumes. The calculations were completed for all kinetic test samples. Depletion calculations are theoretical in nature and assume that the sulphide oxidation and buffering mineral dissolution rates observed in the tests will remain stable in the future, which may not be the case when active ARD is initiated (sulphide oxidation rates are substantially higher at acidic pH where oxidation is bacterially-mediated). Based on this assumption, and testing results to date, the estimated maximum number of years to full depletion of sulphide and buffering minerals are summarized in Table 20.

Depletion calculation results are in general agreement with the static ABA results indicating that the ultramafic, iron formation, mafic volcanic and intermediate intrusive lithologies will remain buffered with carbonate minerals, and largely outlast the time required for complete oxidation of sulphide minerals in these samples.

Conversely, the chert samples could acidify in the HCT in another year, and in 2 years in the leaching column. The PAG greywacke leaching column would be amenable to acidification in more than 4 years. This time frame for the laboratory leaching columns (1.5 to 5 years or 78 to 260 weeks) represents more than a decade in the field (Section 2.2.4.2). This period of time is likely underestimated because it does not consider 1) the buffering capacity afforded by the other waste rock with which it will be mixed in the pile, 2) slower sulphide mineral oxidation kinetics at lower site temperatures and 3) the 8 months of freezing conditions and lower rock to liquid ratio in the field that slows the rate of buffering mineral dissolution (consumption). In summary, the calculated delay to the onset of ARD in PAG samples is substantially longer than the 7 years of mine construction, operations and closure, with the possible exception of the upper tier high sulphur – low buffering capacity greywacke or chert rock.

Table 20: Mineral Depletion Calculations

Cell	Rock Type	Sample	Rock Code	S(T) %	NP	CaNP	CaNPR	NPR	ARD (CaNPR)	Depletion Calculations					
										Years to Depletion				ARD (Kinetic Test)	Effective ARD Potential
										S_T	S^{2-}	CaNP	NP		
HCT	Ultramafic	AMQ-ENV-32	V4a – 0a	0.03	124	127	145	142	Non PAG	5.7	1.7	233	227	Non-PAG	non-PAG
	Iron Formation	AMQ-ENV-43	S9E – 3b	0.03	290	312	302	281	Non PAG	7.6	1.9	577	536	non-PAG	non-PAG
	Greywacke	AMQ-ENV-37	S3C – 3b	0.16	23	18	3.6	4.7	Non PAG	64	41	62	81	PAG	uncertain
	Greywacke	AMQ-ENV-18	S3C – 3b	0.31	14	6.5	0.68	1.5	PAG	80	50	21	46	PAG	PAG
	Greywacke	AMQ-ENV-28	S3C – 3b	0.6	8.9	2.8	0.16	0.51	PAG	20	18	2.5	8.8	PAG	PAG
	Greywacke	AMQ-ENV-40	S3C – 3b	1.3	14	14	0.33	0.34	PAG	100	86	36	33	PAG	PAG
	Chert	AMQ-ENV15-133	S10 – 3b	2.8	13	2.1	0.02	0.15	PAG	60	50	1.0	7.0	PAG	PAG
	Intermediate Intrusive	AMQ-ENV-114	I2 – 8b	0.05	17	6.5	4.5	12	non PAG	13	9	37	98	non-PAG	non-PAG
	Ore	AMQ-ENV15-144	S3C – 3b	3.9	41	24	0.19	0.34	PAG	907	643	31	54	PAG	PAG
	Ore - UM / IF	AMQ-ENV15-076/ -089 composite	Ob / S9E	3.6	72	44	0.38	0.63	PAG	86	79	43	70	PAG	PAG
	Tailing	RE-13872/RE-13874	-	3.3	-6.8	19	0.22	-0.08	PAG	13	11	2.6	-2.1	PAG	PAG
Leaching Column	Ultramafic	C-1	V4a – 0a	0.13	100	92	23	25	Non PAG	21	16	246	267	non-PAG	non-PAG
	Iron Formation	C-2	S9E – 3b	0.69	75	62	2.9	3.5	Non PAG	66	59	118	142	non-PAG	non-PAG
	Greywacke	C-3	S3C – 3b	1.0	19	8	0.2	0.6	PAG	19	14	4.5	9.7	PAG	PAG
	Greywacke	C-4	S3C1 and S3S	0.31	31	16	1.7	3.3	Uncertain	22	17	26	50	Non-PAG	non-PAG
	Ultramafic	C-5	V4a – 0b	0.08	88	76	29	34	Non PAG	7	5	121.6	151.2	non-PAG	non-PAG
	Chert	C-6	S10 – 3b	2.2	25	8	0.1	0.4	PAG	24	16	2.2	7.7	PAG	PAG
	Mafic Volcanic	C-7	V3 – 1b	0.05	71	46	32	50	Non PAG	2.1	1.2	55	84	non-PAG	non-PAG

3.5.2 Humidity Test Cells on Tailings

Although the tailings sample is PAG with relatively elevated sulphur and sulphide content and little mineral buffering capacity, the sample remained neutral after 44 cycles of accelerated weathering,. This was likely due, at least in part, to the added lime at the time of processing. The concentrations of all parameters analyzed were below both Vault and Portage Effluent limits after 44 cycles, with the following general trends observed:

- The leachate pH remained neutral, ranging between 7.0 and 8.2.
- Sulphate concentrations decreased from 720 mg/L at cycle 0 to 130 mg/L at cycle 5 and remained steady since cycle 5 at around 90 mg/L. This consistent release of sulphate could reflect low level sulphide oxidation.
- Conductivity steadily decreased from an initial concentration of 1620 us/cm to 222 us/cm at cycle 21, where it remained stable to cycle 44.
- Arsenic concentrations remained stable since the beginning of testing, where leachate concentrations were slightly below the Vault effluent criteria of 0.1 mg/L.
- Chloride concentrations were above 100 mg/L, yet below Meadowbank effluent criteria for the first 5 cycles, then decreased to below method detection limit at cycle 10 where concentrations remained until HCT termination.
- Copper concentrations rose above the Portage and Vault Effluent Limits at cycles 3 and 5, but decreased thereafter to below Effluent Limits. From cycle 15 to cycle 44, concentrations remained steady at around 0.0004 mg/L.
- Silver showed peak concentrations at cycles 2 and 3 but continually and substantially decreased thereafter.
- The cyanide and nitrate concentrations declined steadily during the first 4 weeks of testing. This reflects the process water being flushed out of the sample. Cyanide analyses were stopped after 5 weeks.

3.6 Laboratory QA/QC Results

To assess laboratory analytical precision, both duplicate and replicate analyses were performed on approximately 15% of the samples analyzed. Eight duplicates were used to assess the analytical repeatability, while the remaining replicate samples were collected after riffling to assess sample heterogeneity. Relative percent differences (RPDs) were calculated and evaluated following USEPA guidelines (USEPA, 1994), and are included in Appendix D.

The type of quality assurance/quality control (QA/QC) conducted, rationale for analysis and number of samples analyzed as part of the QA/QC program are described in Table 21.

Table 21: Summary of the QA/QC Program

Analysis or Sample Type	Number of Samples	Rationale
Duplicate analysis of same subsample (after riffle split)	9	Analytical repeatability
Riffle split duplicate samples from same crushed core	18	Assess sample homogeneity
Duplicate mineralogical analysis by XRD	2	Analytical precision

All QA/QC analytical results are presented in Appendix D with the exception of duplicate mineralogical analysis, which are included in the results table in Appendix E.1. Relative percent differences (RPD) between analytical results for each parameter were calculated following USEPA Guidelines for Inorganic Data Review (USEPA, 1994). In keeping with this guidance, the aqueous metal leach data were compared to an RPD of 20%, while results from chemical analysis and ABA for the waste rock and soil samples were compared to an RPD of 35%. This differentiation between water and soil/rock material is to compensate for increased sample heterogeneity, and thus difficulty in obtaining truly representative duplicates (USEPA, 1994).

Duplicates

Results suggest that the precision of the analytical results for constituents of environmental interest is acceptable for the purpose of evaluating potential environmental impacts. Although several parameters have RPD values greater than 20% for one or two samples, none of the parameters had consistently elevated RPD values. Furthermore, many RPD differences occurred at lower concentrations, and according to Fritz (1994), this is acceptable considering higher sample variability at low concentrations, and therefore no systematic error is suspected. The analytical data from SFE tests is therefore considered to have adequate repeatability.

Riffle Split Replicates

Eighteen (18) riffle split replicate samples were prepared and analyzed to provide an assessment on the heterogeneity of the samples, with a focus on the variability of the ABA within a sample. Some samples were also submitted for WRA and bulk metal parameters.

Overall, there was good agreement between the replicates and the original data in the solid portion of testing parameters. Out of the 63 parameters tested, most samples reported RPD differences less than 35% for more than 47 parameters. The ability of the acids used to digest the material precision does not completely dissolve all of the silicon in the sample which explains why this parameter was consistently showing RPD of greater than 60%.

There were two replicate samples which reported noticeable RPD differences; sample AMQ-ENV-28 and AMQ-ENV15-025. The replicate of sample AMQ-ENV15-025 reported an RPD of greater than 35% for almost half of the parameters tested. However, during sample collection Golder personnel noted that this sample was distinctively banded and contained numerous, thin calcite veins. This heterogeneity in geology likely explains the differences noted in the total metals, while the presence of the calcite veins may explain the large difference in the carbonate content (80% RPD). Meanwhile sample AMQ-ENV-28 also showed a noticeable difference between the replicate and the original sample in the ABA testing, but not in the total metals nor SFE leachate. This sample was collected by Agnico Eagle staff and no descriptions are available to assist in explaining the high

RPDs. However, because most other replicate samples reported low RPD differences, it is expected that the difference noted in the RPD for this sample is based on sample heterogeneity and not on laboratory methods.

Results of SFE parameters for the replicate samples show variability in the number of parameters with an RPD difference greater than 20%. Some samples report less than 10 parameters with an RPD greater than 20%, while others report 20 or more. No correlation exists between the samples with numerous RPD exceedances and its respective lithology. Sample AMQ-ENV15-027 (iron formation) was the only sample that showed a noticeable difference in the leachable arsenic content between the original sample and its replicate. During sample collection Golder personnel noted that this sample contained numerous, thin quartz and calcite veins, as well as a variable amount of disseminated sulphides; the latter of which could explain the variability of the arsenic content.

Overall, results of the replicate samples indicate that geochemical variability within a sample is possible, which based on visual observations in the field during sample collection, is not unexpected. Even though some geochemical variability is expected, results reported for all lithologies are considered representative and the results of the QAQC program do not change the ABA classification for the lithologies. Results further strengthen the position that during sample collection, caution must be taken to ensure that the material collected represent the lithology as much as possible; geological anomalies within the core samples (e.g., pockets of minerals (vugs), veins, zones of weathering, etc.) may skew testing results.

4.0 CONCLUSIONS

4.1 Summary of Geo-Environmental Properties of Mine Wastes

This report presents the results of the geochemical characterization program conducted to date on mining wastes that are expected to be produced from the exploitation of the Whale Tail Pit, and on materials planned to be used to build the exploration road to the deposit from the Meadowbank Mine. The tests completed to date include static geochemical tests and kinetic weathering tests to evaluate the chemical composition, acid-generation and metal leaching potentials and relative reactivity of ore, tailings, mine wastes and construction materials. Kinetic weathering tests are still on-going on samples of waste rock and ore from the deposit. The kinetic weathering test on the one tailings sample was stopped after 44 weekly cycles of leaching.

The following presents a summary of the results of the geochemical characterization program completed to date.

4.1.1 Waste Rock

Sulphide mineralization of the Whale Tail deposit carried arsenic, which is enriched in all waste rock types along with antimony and bismuth. In addition to arsenic, chromium and nickel enrichment is observed in ultramafic, iron formation and mafic volcanic waste rock. The Whale Tail deposit mineralization is low in sulphur.

The majority (73%) of waste rock is non PAG based on the low sulphur content and presence of excess carbonate buffering capacity, including: ultramafic, iron formation, mafic volcanic, southern greywacke and intermediate intrusive waste rock. Only a few samples from the ultramafic units are PAG. Given that the bulk of these lithologies contain ample excess carbonate-mineral (reactive) buffering capacity, they are not expected to require means to control ARD.

Sulphur is generally contained within the ore and waste rock host to ore including the chert central greywacke units. These units are PAG and represent 27% of waste rock to be generated by mining. The central greywacke samples are more silicified than the southern greywacke unit, which is associated with higher sulphide content and lower buffering capacity. Based on results to date, a total sulphur content of 0.1 wt% appears to be a suitably conservative theoretical cut-off criteria below which chert and greywacke waste rock are non PAG. NAG test results suggest this cut off could potentially be higher for iron formation and chert (0.2 wt% and 0.3 wt% respectively) but this needs to be verified with additional samples in this sulphur range.

Kinetic leaching tests performed on 1-kg samples and on large, bulk lithological samples corroborate results of static testing. One of the three PAG greywacke samples generated acidic drainage from initiation of testing and released elevated metal concentrations, while the other two samples continue to be buffered to pH values of 6.2 and 6.7 after 29 weeks of testing, slowly decreasing from a pH near 8 when the kinetic tests were initiated. The acidic greywacke represents a high ARD potential (high sulphur, low buffering capacity) end-member of this unit. None of the other PAG samples developed acidic conditions during the kinetic leaching testing completed to date (chert HCT, chert leaching column and central greywacke leaching column). Mineral depletion calculations together with consideration of the field time equivalency of laboratory kinetic tests infers the PAG rock will not generate ARD at site for more than a decade, as a minimum, if no ARD control mechanisms were put in place. This period of time is substantially longer than the 4 years of mine construction and operations. Accordingly, ARD control mechanisms will be implemented at the end of mining operations, with the possible exception of the upper tier high sulphur – low buffering capacity greywacke or chert rock, which will be managed during operations.

Arsenic is the principal element of environmental interest. It is released at concentrations that exceed the Meadowbank Mine effluent limits from ultramafic and iron formation waste rock in the static and kinetic leaching tests and in submerged leaching tests completed to date. The mafic volcanic lithology has an overall low leachability except for one anomalous sample (initially logged as greywacke), and another sample near the contact with ultramafic rock. The latter was included in the column material, while the former was a pulverized reject and not included in the column charge material. This near ultramafic sample is likely to contribute most of the leachable arsenic from the mafic volcanic bulk column because all other samples included in the column contain low total and leachable arsenic. No other element is systematically released in leachate from any rock type, tailings, ore or sediments at concentrations that exceed the Vault or Portage effluent limits.

The amount of arsenic released by leaching is generally proportional to the total arsenic content of the sample. There is a moderate to weak correlation between total arsenic and sulphide sulphur in lithologies that leach lower concentrations of arsenic (central greywacke, chert and intermediate intrusive waste rock), but no such correlation is apparent in ultramafic and iron formation waste rock, tailings or ore. Mineralogical observations suggest that in ultramafic and iron formation waste rock, some of the arsenic is present as nickel arsenides. Nickel arsenides are documented to be reactive and can be sources of labile arsenic. No other sources of arsenic have been identified in these units based on the limited mineralogical studies completed to date on waste rock. Arsenopyrite is documented to be present in greywacke and in the ore but this mineral was not detected by X-ray diffraction in the samples analyzed in this study.

4.1.2 Ore and Tailings

The ore and tailings are enriched in arsenic, antimony, bismuth, selenium and silver, and are slightly enriched in chromium. Copper is elevated in tailings but given its low levels in ore and waste rock, this may reflect copper sulphate addition during the cyanide destruction process. Process water quality exceeds the Meadowbank effluent limits for ammonia, arsenic and total cyanide; however cyanide and ammonia concentrations will reflect the current practices at Meadowbank Mine.

Ore and tailings are PAG due to their elevated sulphur content and low buffering capacity. Ore storage at the Whale Tail site will be temporary and runoff will be directed into the attenuation pond; ore will ultimately report to tailings after processing at the Meadowbank Mill.

Kinetic testing on ore reports neutral pH conditions over the duration of testing to date, but the composite ore HCT (of iron formation and ultramafic ore) reports an arsenic concentration in leachate that exceeds the Vault effluent criteria (of 0.1 mg/L), while the other ore HCT reports arsenic concentrations above both Meadowbank effluent criteria. No other exceedances were noted.

The tailings sample showed neutral pH, low conductivity and sulphate concentration over 44 weeks of accelerated kinetic weathering testing. Metal and arsenic concentrations remained below both the Portage and Vault effluent criteria throughout testing. The cell was terminated after 44 weeks having reported steady state conditions and exceeded the anticipated exposure period of tailings at site. The maintenance of neutral pH, despite the solid sample having no buffering capacity, may be due to the presence of lime added to the tailings slurry in metallurgical processing. It is expected that this added buffering capacity will eventually be consumed, after which the tailings may start to oxidize and develop acidic conditions, as suggested based on mineral depletion calculations.

4.1.3 Overburden and Lake Sediment

The overburden is non PAG based on the low sulphide sulphur content. The leachable arsenic content in these samples was low, below CCME aquatic life. However the fines content may be amenable to transport as suspended solids in runoff.

All lake sediment samples tested were non-acid generating based on the low sulphide content. The lake sediment samples are enriched in arsenic and the arsenic is somewhat leachable; three of the five samples had short term test leachate arsenic concentrations above the effluent limit for Vault, one sample was above the limit for Portage. The average leachate arsenic concentration for all five samples (0.15 mg/L) was also above the Vault effluent limit but meets the Portage limit for arsenic.

4.1.4 Haul Road Expansion Construction Materials

All esker samples tested from potential borrow sources showed no potential to generate ARD and all released low concentrations of chemical constituents (within one order of magnitude of the CCME aquatic life criteria).

Vault Pit waste rock has variable ARD potential, depending on the sulphur content of the sample analyzed. The current operational sampling plan is effective at defining the ARD potential of waste rock being extracted from the open pit and as such, can be relied upon to identify non PAG rock for construction use. Furthermore, grab samples from the existing non PAG waste rock stockpile adjacent to the Vault Pit confirmed that this material is non PAG and suitable for construction use. Using both the total sulphur and CaNPR segregation criteria will help to optimize the effectiveness of the on-going segregation program.

4.2 Mine Waste Management Considerations

The following mine waste management considerations are preliminary and subject to re-evaluation upon completion of additional studies, further sampling, and/or modification/finalization of the mining plan and mine waste management plans.

4.2.1 Waste Rock

The chert lithology (20% of waste rock) and the central greywacke (7% or less of the waste rock) will require means to prevent oxidation of sulphides to control ARD in the long-term, after the currently projected operations phase of the Project. Central greywacke waste rock can be further split into PAG and non PAG rock by sulphur content. Samples having less than 0.1 wt% are non PAG, while those having more than 0.8 wt% sulphur are PAG. The ARD potential of samples having 0.1 to 0.8wt% sulphur is uncertain; a larger database of results would be needed to define a higher than 0.1 wt% sulphur cut-off. On-going kinetic testing suggests that the delay to onset of ARD for PAG waste rock is likely to be much longer than the construction, operations and closure phases of the Project combined. Thus, ARD control measure will be implemented after mining operations are complete, with the possible exception of chert samples with higher tier ARD potential, which may need to be managed separately or have ARD control measures implemented during operations.

All other waste rock lithologies (73% of the waste rock) do not require means to control ARD. However, 63% of the non PAG rock at Whale Tail Pit (the ultramafic and iron formation lithologies; 46% of the total waste rock tonnage) leaches arsenic at concentrations that exceed Meadowbank effluent limits in aggressive laboratory testing. This does not necessarily mean that water contacting this rock will exceed the comparative effluent criteria because conditions at site differ substantially from the aggressive leaching conditions of the laboratory tests; however, this suggests that arsenic is likely to be released from this rock upon contact with water, and drainage will be captured and monitored before discharge to the receiving environment.

4.2.2 Construction Materials

Mine Site

Early mine development rock from the Whale Tail deposit (intermediate intrusive, southern greywacke (S3S) and mafic volcanic) is being considered for use as infrastructure construction material on the mine site. The intermediate intrusive, southern greywacke, and mafic volcanic waste rock are non PAG and the leachate quality from kinetic tests meet the Portage and Vault effluent criteria for all parameters including arsenic. Based on laboratory data obtained in this study, these materials are suitable for use in construction. As a precaution, monitoring will continue to evaluate the sulphur content of the south greywacke waste rock and Agnico Eagle will avoid rock that contains more than 0.1 wt% sulphur. Similarly for mafic volcanic, a precaution will be taken to avoid using the rock located at or very near the lithological contact with greywacke and ultramafic rock.

Based on laboratory observations obtained in this study, ultramafic and iron formation waste rock may not be suitable for construction in areas where the rock will be in contact with water owing to the potential to release arsenic in leachate.

Access Road Construction Materials

There is no ARD or metal leaching concern from the esker material tested. This material can be used for road construction. The current waste rock monitoring program being followed by Agnico Eagle is effective at identifying non PAG waste rock being mined from the Vault Pit. The surface material being stored in the non PAG Vault waste rock stockpile is indeed non PAG and is suitable for use as road construction material. Although not tested as part of this study, previous studies (Golder 2005) have identified that the Vault Pit waste rock leaches relatively low concentrations of metals. Arsenic leaching from Vault Pit waste rock is not expected to pose a risk to the environment because of the small quantity of rock that will be exposed along the road corridor, especially considering that the majority of the top layer will be sourced from natural eskers. The quality of road contact water will be monitored during road construction.

4.2.3 Whale Tail Waste Rock Storage Facility

The use of the non PAG and non-leachable lithologies for construction material (approximately 4.5% of the waste) will leave a slightly greater proportion of PAG and leachable waste rock to be managed in the Whale Tail Waste Rock Storage Facility. Nevertheless, approximately 10.4 Mt of non PAG and non-leachable lithologies will be available to complete the closure of this facility. The tonnage proportions of waste rock that will report to the rock storage facility are presented in Table 22 along with a summary of their key geochemical properties.

Table 22: Proportion of Waste Rock to be Stored in the Whale Tail Waste Rock Storage Facility

Lithology	Lithology Code	Proportion (by weight) Reporting to WRSF[1]	Bulk ARD Designation (based on bulk CaNPR)	Arsenic Leachability
Ultramafic	V4a – 0a	23%	Non PAG	High
Transitional Ultramafic	V4a – 0b	19%	Non PAG	Moderate
Central Greywacke	S3C – 3b	9%	PAG	Low
Chert	S10 – 3b	27%	PAG	Low
Iron Formation	S9E – 3b	21%	Non PAG	High

Note: [1] Individual proportions may not sum to 100% due to rounding.

4.2.4 Tailings and Ore

Should some of the ore remain stockpiled permanently, the material will require means to control oxidation and ARD in the long term, however it is important to note that no long term storage of ore at the Whale Tail site is planned.

Tailings are also expected to require ARD control in the long term. Through design structures and closure planning, consideration has been given to avoiding the prolonged exposure of the tailings to prevent the development of localized acidification. The current closure plan for the Meadowbank TSF is to cover tailings at closure to minimize contact with the surrounding environment.

Whale Tail tailings contact water and process water will be captured and the water quality monitored prior to discharge according to standards currently approved for operation of the Meadowbank TSF.

4.2.5 Overburden and Lake Sediments

The shallow overburden has a suitable chemistry for use as construction materials; however, the fines portion of the samples could be amenable to erosion and transport as suspended solids in contact water. This will be monitored if overburden is used where it will be exposed to runoff. The chemistry and leachability of the deep overburden will be verified prior to its use.

Lake sediments may not be used in construction because of their potential for arsenic leaching, albeit not high levels of arsenic. If lake sediments are to be used for construction, these assumptions will be verified with additional samples prior to construction.

5.0 LIMITATIONS

This report was prepared for the exclusive use of Agnico Eagle Mines Limited (Agnico Eagle). The report, which specifically includes all tables, figures and attachments, is based on samples, data and information collected by Golder Associates Ltd. (Golder) and Agnico Eagle staff, and is based solely on the conditions of the properties at the time of sampling. It is supplemented by a previous investigation completed by Golder and Agnico Eagle as well as information and planned operational data provided by Agnico Eagle at the time of this report. Many of the mine design parameters and management plans are being developed concurrently and may change in the future.

Except where specifically stated to the contrary, the information contained in these reports was provided to Golder by others and has not been independently verified or otherwise examined by Golder to determine its accuracy or completeness. Golder has relied in good faith on this information and does not accept responsibility for any deficiency, misstatements, or inaccuracies contained in the reports as a result of omissions, misinterpretation, fraudulent acts or the persons interviewed or contacted or errors or omissions in the reviewed documentation.

The assessment of geochemical characteristics for mine wastes and potential borrow sites for the Project has been made using the results of chemical analysis of discrete samples from a limited number of locations, collected by the Agnico Eagle, Azimuth Consulting and Golder. Sample locations and borehole intervals collected by others were not observed or visited by Golder. Subsurface conditions may vary from these sample locations. Additional study, including further surface and subsurface investigation, can reduce the inherent uncertainties associated with this type of study. However, it is never possible even with exhaustive sampling and testing to dismiss the possibility that part of a site, of an ore zone, tailings or waste rock may have considerably different characteristics than the average properties identified by the sampling and analyses completed as part of this study.

The services performed as described in this report were conducted in a manner consistent with that level of care and skill normally exercised by other members of the geoscience profession currently practising under similar conditions, subject to the time limits and financial and physical constraints applicable to the services. Any use which a third party makes of this report, or any reliance on, or decisions to be made based of it, are the responsibilities of such third parties. Golder accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

The content of this report is based on information collected during our investigation, our present understanding of the site conditions, and our professional judgement in light of such information at the time of this report. This report provides a professional opinion and therefore no warranty is expressed, implied, or made as to the conclusions, advice and recommendations offered in this report. This report does not provide a legal opinion regarding compliance with applicable laws. With respect to regulatory compliance issues, it should be noted that regulatory statutes and the interpretation of regulatory statutes are subject to change.

The findings and conclusions of this report are valid only as of the date of this report. If new information is discovered in future work, including excavations, borings, or other studies, Golder should be requested to re-evaluate the conclusions of this report, and to provide amendments as or if required.

6.0 CLOSURE

We trust this report meets your current needs. Should you have any questions regarding this report, please contact the undersigned.

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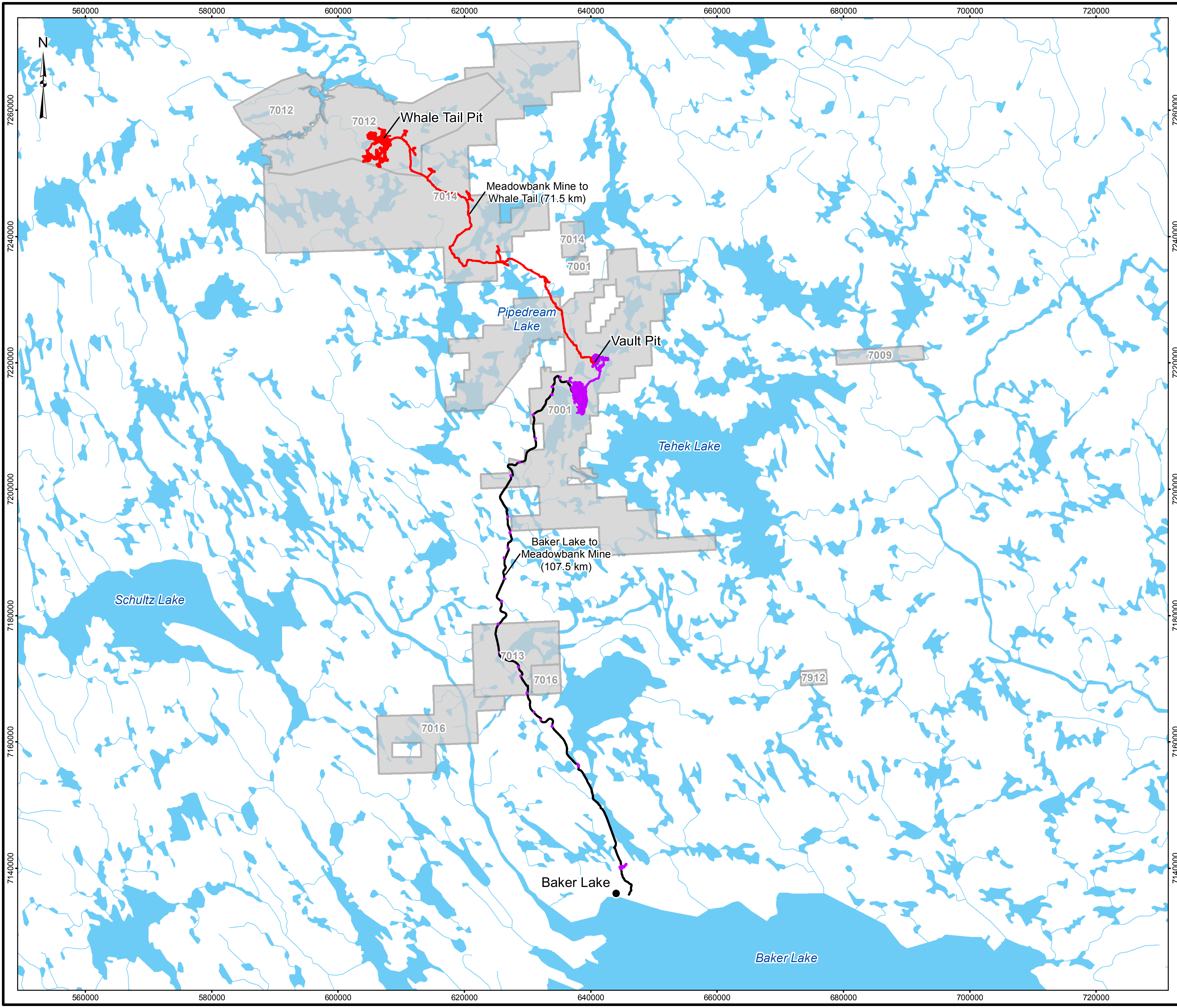
MAPS

Map 1: Site Location
Map 2: Locations of Overburden and Lake Sediment Samples



Y:\burnaby\CAD-GIS\Client\Agnico_Eagle_Mines_Ltd\Whale_Tail\99_PROJECTS\1541520_FEIS\02_PRODUCTION\FEIS\MXD\1300_Documentation\1340_Project_Description\Report\1541520_FIG_1.1-1_PROJECT_LOCATION.mxd

LEGEND

- ● COMMUNITY
- — PROPOSED HAUL ROAD
- — ALL WEATHER ROAD
- 🟥 WHALE TAIL PIT
- 🟪 MEADOWBANK OPERATION AND INFRASTRUCTURE
- ▨ CLAIM BOUNDARY
- — WATERCOURSE
- 🟦 WATERBODY

REFERENCE

1. HAUL ROAD OBTAINED FROM AGNICO EAGLE MINES LIMITED. 2015-10-14
FROM 6103-117-230-200_R0.dwg
2. CLAIM BOUNDARIES OBTAINED FROM AGNICO EAGLE MINES LIMITED.
3. WATERCOURSE AND WATERBODY DATA OBTAINED FROM CANVEC © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
4. INSET MAP DATA OBTAINED FROM ESRI.

DATUM: NAD 83 CSRS PROJECTION: UTM ZONE 14

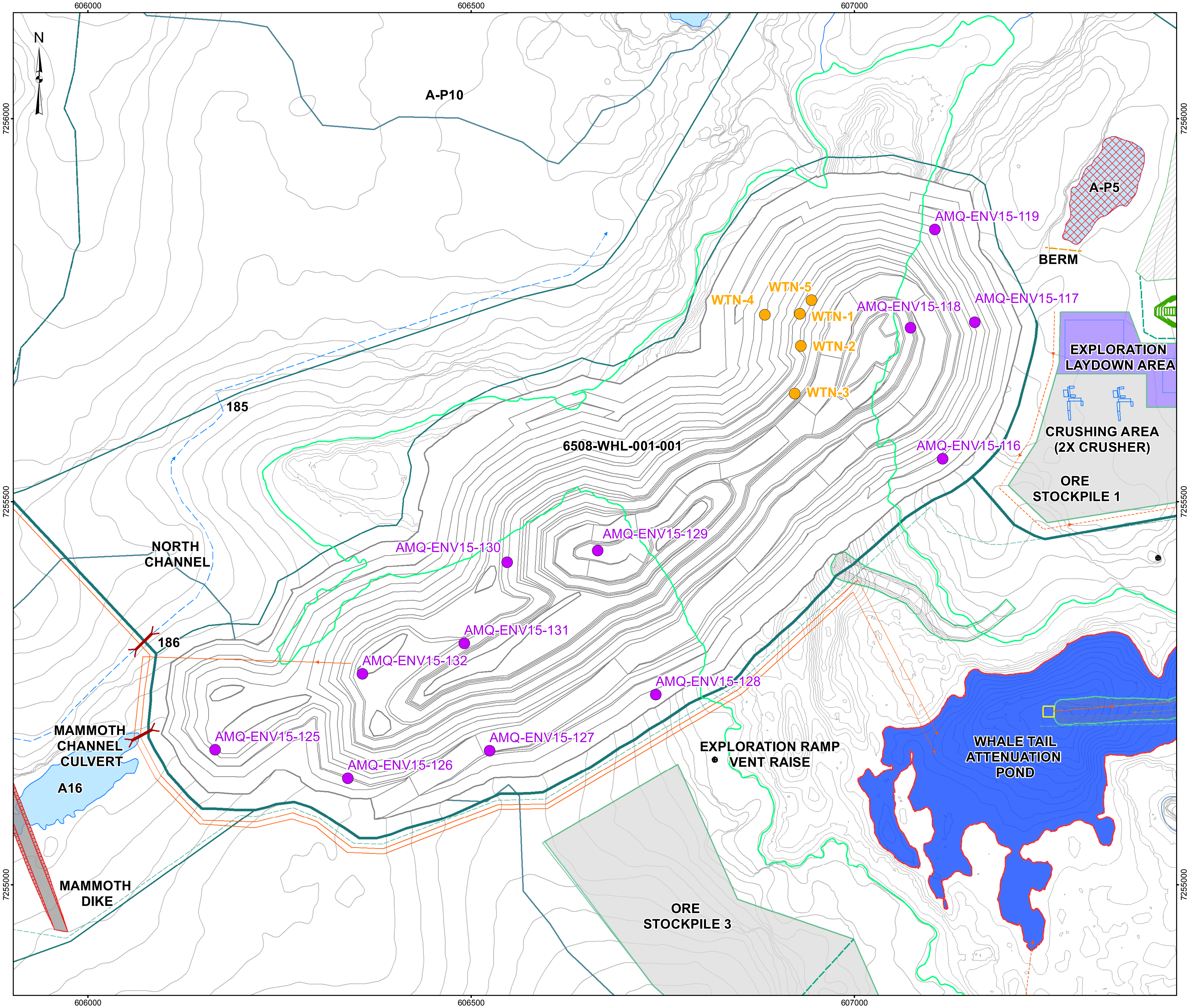
12 0 12
KILOMETRES

PROJECT
AGNICO EAGLE MINES LIMITED:
MEADOWBANK DIVISION
WHALE TAIL PIT PROJECT

TITLE

SITE LOCATION

PROJECT		1541520	FILE No.	
DESIGN	JR	24 Mar. 2016	SCALE AS SHOWN	REV. 0
GIS	CDB	24 Mar. 2016	MAP 1	
CHECK	JR	09 May 2016		
REVIEW	LY	09 May 2016		



LEGEND

- ● LAKE SEDIMENT SAMPLE LOCATION
- ● OVERBURDEN SAMPLE LOCATION
- ▨ EXPLORATION LAYDOWN AREA
- ▨ ORE STOCKPILE
- ▨ STORM WATER STORAGE POND
- ▨ ATTENUATION POND
- ▨ DIKE
- ☐ NATURAL WATERSHED
- — ROAD
- - - TEMPORARY ROAD
- — DIVERSION CHANNEL
- → COLLECTION CHANNEL
- — CULVERT
- ← INTAKE WATER PIPE
- — CONTACT WATER PIPE
- - - FRESHWATER PIPE
- — WATERCOURSE
- ▨ WATERBODY

REFERENCE

1. INFRASTRUCTURE OBTAINED FROM AGNICO EAGLE MINES LIMITED FROM 6108-600-210-002_R2(2019)s.dwg.
2. WATERCOURSE AND WATERBODY DATA OBTAINED FROM PHOTOSAT

DATUM: NAD 83 CSRS PROJECTION: UTM ZONE 14

100 0 100

METRES

PROJECT

AGNICO EAGLE

AGNICO EAGLE MINES LIMITED:
MEADOWBANK DIVISION
WHALE TAIL PIT PROJECT

TITLE

LOCATIONS OF OVERBURDEN AND LAKE SEDIMENT SAMPLES

Golder Associates

PROJECT		1541520	FILE No.	
DESIGN	JR	24 Mar. 2016	SCALE AS SHOWN	REV. A
GIS	MH	09 May. 2016	MAP 2	
CHECK	JC	10 Jun. 2016		
REVIEW	VB	10 Jun. 2016		

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APPENDIX A

Geochemical Assessment of Proposed Construction Material for the Road to the Amaruq Deposit, Meadowbank Mine, Nunavut

TECHNICAL MEMORANDUM

DATE	23 December 2014	**PROJECT No.**	14-12623
TO	Ryan Vanengen Agnico-Eagle Mines Ltd. (AEM)		
CC	Erika Voyer, AEM		
FROM	Jennifer Cole and Valérie Bertrand	**EMAIL**	jcole@golder.com vbertrand@golder.com

GEOCHEMICAL ASSESSMENT OF PROPOSED CONSTRUCTION MATERIAL FOR THE ROAD TO THE AMARUQ DEPOSIT, MEADOWBANK MINE, NUNAVUT

1.0 INTRODUCTION

Agnico-Eagle Mines Ltd. (AEM) proposes to construct and operate an exploration road to the Amaruq Project site located 50 km north of the Meadowbank Mine. In September 2014, AEM and Golder Associates Ltd. (Golder) initiated a geochemical study of materials proposed for use in construction of the road that included the following:

a) A geochemical characterization program for the proposed road construction material collected from a number of borrow source locations (eskers), and,

b) An overview of available data from the Meadowbank Vault deposit, an additional proposed material borrow source location for road construction proximal to the Meadowbank mine.

The geochemical characterization was carried out following methods that apply to mining wastes for comparative purposes only (MEND, 2009).

The objective of the program is to evaluate the chemical characteristics of the esker material and the Vault waste rock that is targeted for use in road construction. Static testing methods were used to assess the chemical composition of the esker material, its potential to generate acid rock drainage (ARD) and its potential to leach metals (ML) to the receiving environment upon exposure to ambient conditions. Results of this static testing program are meant to guide the selection of appropriate material for use as road fill, with particular emphasis on potential ARD/ML that could affect water quality in nearby water courses, in order to minimize potential effects to nearby lakes and streams.

This report discusses the static test results for the esker material, describes the methods utilized as part of the static testing program, and presents the interpreted test results.

1.1 Regional and Site Geology

The local geology of the Meadowbank mine area is part of the Rae subprovince of the Canadian Shield Churchill Province (AMEC 2005), and consists of folded and variably metamorphosed Archean sedimentary rocks, quartzites, iron formation, and felsic to ultramafic volcanic rocks. Specifically, the deposits themselves consist of metasedimentary quartzite (QTZ group), banded iron formation of oxide-facies (IF group), felsic to intermediate sericitized and chloritized volcaniclastic tuffs and agglomerates (IV group), and mafic to ultramafic amphibolites and komatiites (UM group) (Sherlock et al., 2000; CRL, 2003).

The Vault deposit is located at the southern end of the road alignment and is currently being mined. It is mostly comprised of IV group rocks. These rocks contain massive lava flows and interbedded volcaniclastic sediments. Major mineral constituents are quartz and feldspar, with minor epidote, biotite, chlorite, and muscovite (Sherlock et al., 2000; CRL, 2003). The stratigraphy of the Vault deposit also includes fine-grained, feldspar-quartz-chlorite-sericite schists, oxide-facies iron formation, and medium-grained quartz-feldspar-sericite-chlorite schist (AMEC 2005). The chlorite-sericite alteration of the Vault deposit geology is thought to either reflect the original composition of the rocks pre-metamorphism, or be the product of local alteration caused by the mineralization process.

Overburden in the Meadowbank mine area consists of glacial till with an average thickness of 2.75 m; however local deposits have been noted to be over 10 m thick (CRL 2003). The glacial till varies from silty sand to gravel with minor boulders (Golder 2002). In the Golder (2005), sampled overburden is described as silty to sand-sized with between 25 to 50% pebble to boulder-sized particles.

1.2 Vault Deposit Operations ARD Database

AEM is considering the use of waste rock from the Vault deposit for construction of the southern portion of the road which will start at the Vault deposit. Data collected for internal control during operations at Vault was provided by AEM for comparison with the Vault geochemical database (Golder, 2005) to evaluate which Vault material might be appropriate for use in road construction. The Vault database from AEM included results for 11198 samples analyzed at the on-site laboratory for total sulphur, buffering capacity (NP), acid potential (AP), the ratio of NP to AP (NPR) and total carbon. The focus of the evaluation of these data was to define the minimum sulphur concentration below which Vault waste rock has no ARD potential. Note that metal leaching potential was not evaluated as relevant information was not available in the Vault operations database. Results of the ARD evaluation are reported in Section 3.2.

1.3 Sample Collection

A total of 24 samples were collected from six eskers by AEM staff with input from Golder. Five samples were collected from Esker 1 and 3, four samples were collected from Esker 2, 5, and 6, and two samples were collected from Esker 4. All samples were described as sand to gravel with sand based on grain size analysis (E. Voyer, pers. commun. November 10, 2014).

Samples were packaged by AEM staff and shipped from Meadowbank to SGS Canada Ltd. (SGS) of Lakefield, Ontario for geochemical testing.

2.0 ANALYTICAL METHODS

The test program incorporated a comprehensive set of standard geochemical methods to characterize the ARD and ML potential of the Esker samples collected by AEM. The static testing program included the following components:

- Potential to generate acidic drainage analyzed through acid base accounting (ABA) by the Modified Sobek method and the net acid generation test (NAG);
- Whole rock and trace element chemical composition; and,
- Readily leachable metals through short-term metal leach testing by a modified version of the shake flask extraction (SFE; Modified ASTM D3987).

All analyses were performed at SGS. Methods are discussed briefly in the following sections.

2.1 Potential for Acid Rock Drainage

The potential of geologic material to oxidize and generate acidic drainage was evaluated through acid-base accounting (ABA) and net acid generation (NAG) tests.

2.1.1 Acid Base Accounting (ABA)

ABA tests were conducted following the Modified Sobek method and included determination of the following parameters:

- Paste pH;
- Total sulphur and total carbon by induction furnace, (ASTM E 1915-01 methodology);
- Acid leachable sulphate sulphur and sulphide sulphur by difference;
- Carbonate (as %C) by pyrolysis; and,
- Bulk neutralization potential (NP; by the 1996 Modified NP method (MEND 2009)).

The following sections describe neutralization potential (NP) and acid potential (AP) in terms of acid rock drainage prediction.

Neutralization Potential (NP)

The NP is a bulk measurement of the acid-buffering capacity of a sample provided by various minerals of different reactivity and effective neutralization capacities. It is measured by digestion of a pulverized portion of the sample using a strong acid. This process consumes all minerals affected by the acid, including minerals that may not normally be reactive under ambient conditions and minerals that would not neutralize to pH-neutral conditions (such as silicate minerals; Blowes and Ptacek 1994). Because the type and occurrence of neutralizing minerals present in the sample will have a determining effect on whether the ARD potential of a sample will be realized, NP was evaluated using two different analytical techniques to more accurately determine the amount of available NP:

***1996 Modified NP Determination*:** Represents the bulk NP of the sample, including contributions from some reactive aluminosilicate minerals, if present. It is calculated from the amount of base consumed to neutralize acid remaining from the sample acid-digested at room temperature. This test method is modified from the Standard (Sobek) NP method which more aggressively dissolves neutralization minerals and may thus overestimate NP because of the higher digestion temperature (boiling).

Carbonate NP: Represents the NP available from reactive carbonate minerals, including siderite and other divalent metal carbonates (which provide no net neutralization). It was calculated based on the carbonate (%CO_3) content of the sample, assuming all carbonate is in the form of carbonate minerals.

Acid Potential (AP)

The AP is calculated from the sulphide sulphur content of the sample, on the basis that the entire sulphide content of the rock will oxidize to generate acid. The sulphide content of the sample is calculated as the difference between laboratory-measured total sulphur and sulphate sulphur.

Values of AP, NP and CaNP are reported as kg equivalent calcium carbonate per tonne of material.

2.1.2 Net Acid Generation (NAG)

Net acid generation (NAG) tests are used in combination with ABA to assess the ARD potential of a sample. The NAG test (Amira, 2002) uses hydrogen peroxide to induce complete oxidation of sulphide minerals and concurrent buffering by available minerals in the sample. Unlike ABA results, NAG tests do not provide an estimate of NP relative to AP, but rather the net effect of sulphide oxidation and buffering reactions within a sample. This test is particularly useful for samples containing low AP and low NP or where results from other tests yield conflicting predictions. Results of NAG pH are used to verify ARD potential, while NAG leachate chemical composition can be used to assess the potential degree of metal release upon sulphide oxidation.

2.1.3 ARD Screening criteria

For this study, ABA results were compared to the federal guidance Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials (MEND, 2009). The suggested screening criteria for inferring ARD potential is based on the net potential ratio (NPR) which is the ratio of NP to AP (or CaNP to AP for CaNPR). The screening criteria are summarized in Table 1.

Table 1: Acid-Base Accounting Screening Criteria (MEND 2009)

Potential for ARD	Initial Screening Criteria	Description	Classification
Likely	NPR < 1	Likely to generate acidity, unless sulphide minerals are non-reactive	PAG: Potentially Acid Generating
Uncertain	1 ≤ NPR ≤2	Neither clearly acid-generating nor acid consuming	Uncertain
Low	NPR > 2	Acid consuming	Non-PAG: non Potentially Acid Generating

According to MEND (2009), samples with NPR values less than 1 are considered potentially acid generating (PAG). Samples with NPR values between 1 and 2 are considered “possibly acid generating” if NP is insufficiently reactive or is depleted at a rate faster than the sulphide oxidation rate. Samples with NPR values greater than 2 have low potential to generate acid unless there is a significant preferential exposure of sulphide minerals along fracture planes, or extremely reactive sulphides in combination with insufficiently reactive NP.

Results of NAG tests were compared to criteria defined by AMIRA (2002) to identify the ARD potential of the test material, as summarized in the following table.

Table 2: Net Acid Generation Criteria (AMIRA, 2002)

NAG pH	NAG Acidity (to pH 4.5) kg H_2SO_4/t	Potential for Acid Generation
≥ 4.5	0	Non acid-generating.
< 4.5	≤ 5 [1]	Low potential to be acid-generating.
< 4.5	> 5 [1]	Potentially acid-generating.

Note: The NAG criteria used may vary from site to site with a cut-off up to 10 kg H_2SO_4/t (Source: AMIRA 2002).

2.2 Chemical Composition

The chemical composition of each sample was determined through whole rock and trace element analysis to establish the content of major rock-forming elements and trace metals, respectively. The following components were included in the chemical analyses:

- Metals, arsenic and selenium by inductively coupled plasma-mass spectroscopy (ICP-MS), with samples extracted using a concentrated strong acid solution of perchloric, nitric, hydrochloric and hydrofluoric acids; and,
- Whole rock analysis for major metals by borate fusion / x-ray fluorescence (XRF).

This information is used to assess the variation in chemical composition and to identify parameters for which concentrations are considered enriched compared with values that are considered to be representative of background (CCME guidelines). Results for the Esker material are compared against Canadian Soil Quality Guidelines (CEQG) for the Protection of Environmental and Human Health (industrial land use) (CCME 2007).

2.3 Metal Leaching Potential

Metal leaching tests are used to assess the potential of the waste rock to release readily-soluble metals to the receiving environment by simulating interaction between water and solids.

Samples were subjected to short-term leach tests using a modified version of the shake flask extraction (Modified ASTM D3987). Crushed samples (< 9.5 mm) were mixed with distilled water (4:1 solution to solid ratio) and the pulp was placed in a flask and shaken for 24 hours using a variable speed shaker table. Leachate was collected from the pump through a 0.45-µm filter and analyzed for pH, sulphate, and dissolved metals. The pH reported herein was measured after the shaking was complete and prior to filtration of the sample.

The results of the short-term leach tests were compared to Metal Mining Effluent Regulations (MMER) (DFO 2006) and Canadian Environmental Quality Guidelines (CEQG) for the Protection of Freshwater Aquatic Life (CCME 2007). These comparisons are an initial screening tool in the identification of potential constituents of concern. Short-term leach tests provide an estimate of which metals have a potential to leach from a particular material. However, actual drainage chemistry at site will almost certainly differ from short-term leach test results due to the inability of short-term leach tests to accurately simulate natural conditions, in particular transient processes such as sulphide oxidation. Short term leach test results are therefore only considered as indicators of potential constituents of interest rather than accurate representations of future drainage compositions.

2.4 Quality Assurance / Quality Control (QA/QC)

The objective of a quality assurance/quality control (QA/QC) program is to assess analytical precision and defensibility of reported results. A total of 10 sample splits were prepared by SGS and submitted for duplicate analysis for the SFE test.

To assess analytical precision, the relative percent difference (RPD) was calculated for each duplicate and its original sample based on USEPA Guidelines for Inorganic Data Review (USEPA, 1994). In keeping with this guidance, the results are compared to an RPD of 35%.

3.0 RESULTS

Static test results for samples collected from the proposed borrow source locations (eskers) are discussed in the following sections, followed by a summary of the evaluation of ABA data from the Vault deposit. Tabulated results and figures are presented in Attachment A, the QA/QC assessment is provided in Attachment B, and laboratory analytical certificates are included in Attachment C. The results tables include summary statistics for each esker sample group, including: minimum, maximum, average, median, 75th percentile and standard deviation.

3.1 Esker Material

3.1.1 Acid Generation Potential

The results provide information on the ARD potential of each sample as determined based on sulphide content, net neutralization potential (NNP = NP - AP), net potential ratio (NPR = NP/AP), and Carbonate NPR (CaNPR = CaNP/AP). The bulk ARD characteristics were calculated for each esker group, including bulk NNP (sum NP – sum AP), bulk NPR (sum NP / sum AP), and the resulting bulk ARD potential.

A summary of the ARD potential for each sample group is presented in Table 3.

Table 3: Summary of Esker Material ARD Potential

Proposed Location	Sample Count	Sample Count		Median Paste pH	Median NAG pH	Average Sulphide Sulphur (%)	Overall ARD Designation
		Non PAG	PAG				
Esker 1	5	5	0	7.6	6.6	0.01	Non PAG
Esker 2	4	4	0	7.2	6.2	<0.01	Non PAG
Esker 3	5	5	0	7.7	6.7	0.012	Non PAG
Esker 4	2	2	0	8.2	7.5	<0.01	Non PAG
Esker 5	4	4	0	7.5	6.5	<0.01	Non PAG
Esker 6	4	4	0	7.2	6.4	0.018	Non PAG

The esker samples show no potential to generate acid drainage. The low ARD potential stems from the low sulphide content and sufficient buffering capacity of the sample material. Sulphide sulphur content ranges from <0.01 to 0.018% and total sulphur ranges from <0.005 to 0.068%. The dominant species in most samples is sulphide sulphur as sulphate is almost always below the analytical method detection limit (MDL) (<0.01%), with the exception of one sample from Esker 6 which is contains equal amounts of sulphide sulphur and sulphate.

Paste pH is circum-neutral to alkaline and ranges from 6.7 to 8.9, suggesting the presence of a limited amount of natural buffering capacity. Bulk buffering capacity (NP) ranges from 2.3 to 8 tonnes $CaCO_3$ /100 tonnes, while carbonate buffering capacity (CaNP) ranges from 0.17 to 5.3. NP values are mostly greater than CaNP values, suggesting that buffering capacity is comprised of reactive carbonate minerals as well as less reactive aluminosilicates.

ARD classification (MEND 2009) is shown graphically for all samples in Figure 1. Based on the low sulphide sulphur content and high NPR values, all samples are classified as non acid generating (non PAG).

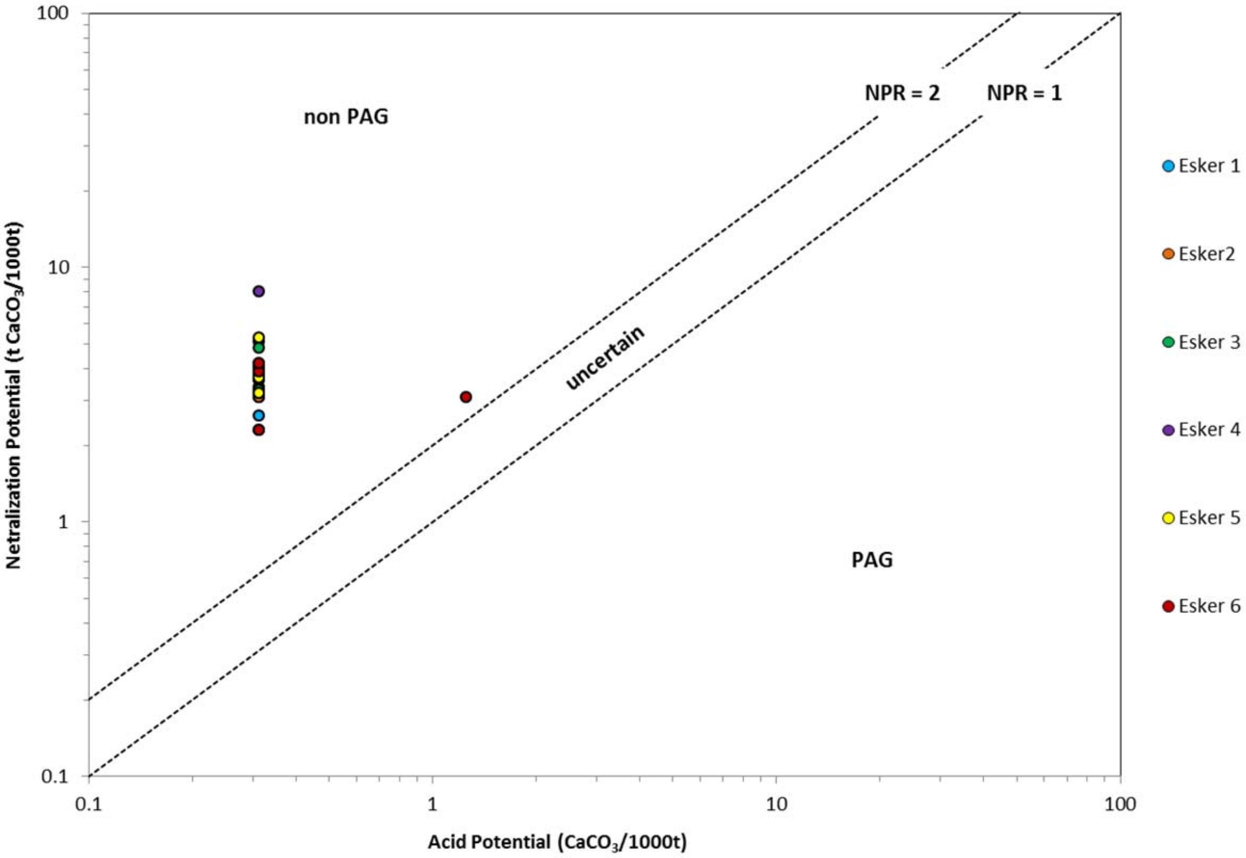

Figure 1: AP versus NP for Esker Samples

NAG pH values are circum-neutral and range from 6.1 to 8.3, with the exception of one sample from Esker 6 that reports a NAG pH of 4.3, however, this Esker 6 sample still has a low potential to generate acid based on its NAG acidity (to pH 4.5) value being less than 5 kg H_2SO_4/t.

3.1.2 Chemical Composition

Major constituents are similar for all esker samples and include silica and aluminum with minor iron, potassium, sodium, magnesium, and calcium. Major oxides show little variation within each sample group as demonstrated by the low standard deviation values, suggesting that the materials in the eskers have a relatively homogeneous chemical composition.

Trace element composition was evaluated against CEQG Soil Quality Guidelines for the Protection of Environmental and Human Health, Industrial Land Use (CCME, 2007). The results of these comparisons are summarized in Table 4. Trace metal content is also fairly homogeneous across samples and eskers with few exceptions. Arsenic, chromium, nickel, and copper naturally exceed CCME soil guidelines in some of the eskers.

Table 4: Summary of Trace Element Composition

Proposed Location	Sample Count	Parameter Concentrations Above CCME Industrial Soil Guideline [1,2]
Esker 1	5	**As,** Cr
Esker 2	4	As
Esker 3	5	**Cr, Ni**
Esker 4	2	**Cr, Ni**
Esker 5	4	**Cr, Ni**
Esker 6	4	Cu, Ni

Notes: [1] Where at least one sample exceeds CCME soil guidelines; and,
[2] bold values indicate parameters where median concentration exceeds CCME soil guidelines.

3.1.3 Metal Leaching Potential

Leach test results are compared with effluent regulations (MMER; DFO 2006) and CEQG guidelines for the protection of aquatic life (CCME 2007). Results are summarized in Table 3 below and include a summary of parameters exceeding screening criteria.

Exceedances in leachates from laboratory tests do not necessarily imply non-compliance of contact water quality. The quality of drainage water will depend on a number of factors that are difficult to reproduce in static leach tests such as the SFE test, including, but not necessarily limited to, material exposure, drainage patterns and site climate which affect the ratio of leaching solution to solid material and water-rock contact time. Rather, results discussed below underline the propensity of the till material to release metals in dissolved form when in contact with water.

Table 5: Summary of SFE Parameters Exceeding Screening Criteria

Proposed Location	Sample Count	Median Final pH	CEQG[1]	MMER[2]
Esker 1	5	7.2	pH (<6.5), As, Cu, Fe, Pb	n.e.
Esker 2	4	6.5	pH (<6.5), Cu[3], Fe, Pb[3]	n.e
Esker 3	5	7.1	Cu[3], Fe, Pb[3]	n.e.
Esker 4	2	7.8	As, Cu, Fe	n.e.
Esker 5	4	7.1	Cu[3], Fe[3]	n.e.
Esker 6	4	7.0	pH (<6.5), Cu, Fe	n.e

Notes: [1] Canadian Environmental Quality Guidelines for the protection of aquatic life (CCME 2007);
[2] Metal Mining Effluent Regulations (DFO 2006); and,
[3] Exceedance not observed in all duplicate samples
n.e. = no exceedances

The SFE pH values are below the CEQG range (pH<6.5) for some samples from eskers 1, 2 and 6. Values for all samples range from 6.2 to 8.7. For most samples, the neutral to alkaline pH values corroborate the available buffering capacity. Four samples reporting mildly acidic pH values (pH<6.5) may reflect either less available buffering capacity or the release of some stored metal acidity.

Arsenic, copper, iron, and lead concentrations naturally exceed CEQG guidelines. Arsenic concentrations are above the CEQG guidance (0.005 mg/L) in two samples from Esker 1 (0.0057 mg/L) and Esker 4 (0.0063 mg/L). Copper and lead report average concentrations above CEQG guidelines for some eskers; however, the averages are only slightly higher than CEQG and as such, these parameters are not expected to be of concern to receiving water quality. Further, not all duplicate pairs both report concentrations above criteria for copper and lead, further supporting the marginality of exceedances.

Iron presents average values two to three times higher than CEQG and exceeds the CEQG guidance (0.3 mg/L) in all samples. Chemical principles dictate that the dissolved iron concentration should be lower in the pH range of the SFE tests. In neutral to slightly alkaline pH conditions, the reported elevated concentrations of iron are likely to include a portion of colloidal (particulate) iron in the leachate sample. Colloidal particles are typically smaller than the 0.45-µm filter pore size used to collect leach test water for analysis and thus this solid-phase fraction can be reported as a dissolved phase concentration.

All parameters meet mine effluent criteria (MMER; DFO 2006) with the exception of pH in samples from Eskers 3 and 5.

3.2 Quality Assurance / Quality Control (QA/QC) Assessment

A total of 10 samples were analyzed as duplicates as described in Section 2.4. The QA/QC assessment results are presented in Attachment B.

Analytical precision was assessed through calculated relative percent differences (RPD) following USEPA Guidelines for Inorganic Data Review (USEPA, 1994). The USEPA guidance suggests that duplicates from solid samples be compared to an RPD of 35% and duplicates from liquid samples be compared to an RPD of 20% where both samples are above 5 times the method detection limit. Aqueous metal leach data from the SFE test are compared to an RPD of 35% since the duplicates are generated from solid sample splits rather than duplicates of the leachate water. Where one or both samples is not within 5 times the detection limit, these samples are compared with respect to whether they are within the detection limit of each other, and designated as “> MDL” where they are not.

Six or more (>50%) duplicates show RPD values above 35% or >MDL for arsenic, barium, calcium, cobalt, lithium, magnesium, manganese, lead, titanium, and zinc. The variability in concentration between the duplicate pairs is likely attributable to the low detected concentrations (Fritz 1994), where analytical precision is typically lower at lowest concentrations. Notwithstanding this, this variability does not alter the interpretation of the results. Therefore, although some parameters show relatively low analytical precision (below USEPA guidelines), no systematic error is suspected, nor does this affect the interpretation of results.

3.3 Vault Data Analysis

Operational data from the Vault deposit provided by AEM (“Vault Operational Data (AEM, 2014)”) was compared to static test database collected by Golder during project start-up (“Vault Static Test Database (Golder, 2005)”) in order to recommend a minimum sulphur cut-off concentration to be used to identify material that is non PAG. The NPR values for both datasets were compared to test the fit of both data sets and to determine the total sulphur content at which material may be considered as potentially acid generating per MEND (2009).

NPR values are plotted against total sulphur in Figure 2. The datasets correlate and in general, material with a total sulphur content below 0.2% reports an NPR > 2 and thus, is designated as non PAG. Therefore, <0.2% is recommended as an appropriate criterion for selecting non PAG Vault material for use in road construction.

With regards to the leaching potential of the Vault material, leachable parameters from the Vault Operational Data (AEM, 2014) database include aluminum, arsenic, and copper. When comparing the solid and leachable concentrations of these parameters against total sulphur, no correlation can be found that would serve as useful selection criteria in terms of metal leaching potential.

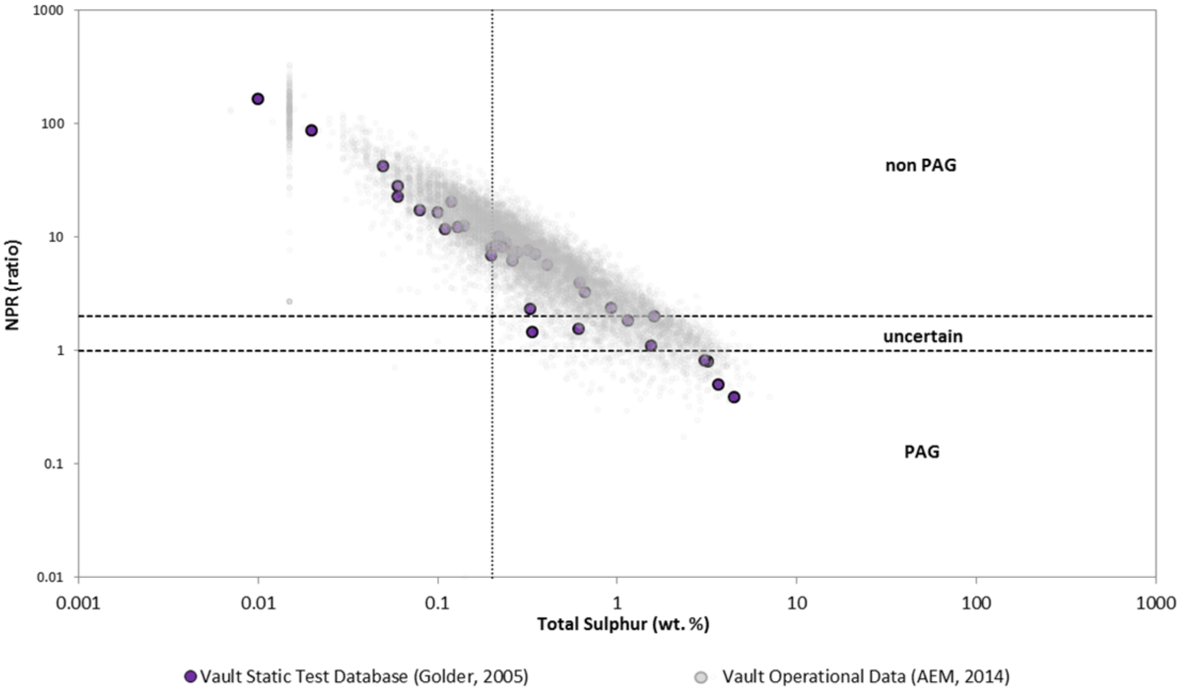

Figure 2: Comparison of Vault Static Test Database (Golder, 2005) and Vault Operational Data (AEM, 2014)

4.0 SUMMARY AND RECOMMENDATIONS

The geochemical characterization program conducted to date is limited to the use of static tests. With these results, it is possible to develop observations with regards to the general chemical characteristics of the materials tested. The following considerations are preliminary and are subject to re-evaluation upon further sampling if warranted, should the size or quantity of material extracted from a borrow area be substantially larger than anticipated. Observations include:

- All esker samples tested show no potential to generate ARD. This stems from the low sulphide content and sufficient buffering capacity, and is corroborated by neutral to alkaline paste pH, NAG pH and SFE pH values. As such, there is no concern for ARD generation from similar esker material used for road construction.
- For Vault waste rock, an appropriate selection criterion of total sulphur <0.2% is recommended to identify non PAG waste rock material to be used for road construction. Vault waste rock material with total sulphur less than 0.2% consistently shows NPR values above 2 and is thus this material would not be likely to generate ARD.
- Metal concentrations in leaching tests for the esker samples are below MMER (DFO 2006) criteria. However, some samples report metal leachate concentrations that are naturally above the CEQG guideline for the protection of aquatic life (CCME 2007), namely arsenic, copper, and lead. Concentrations are within

the same order of magnitude as the respective CEQG guideline and thus are not expected to be a concern to receiving water quality. Road material and borrow area contact water quality monitoring should be carried out post construction to verify this.

- Iron concentrations reported for all esker samples exceed the CCME criterion (0.3 mg/L) by two to three orders of magnitude. Given the neutral pH values of the test leachates, it is likely that elevated iron concentrations are related to colloidal iron (total iron) rather than in dissolved form.
- Based on a comparison of the two Vault datasets, no correlation was found between total sulphur and metal concentrations. Therefore, a selection criterion could not be developed with respect to metal leaching from Vault waste rock. Actual contact water quality from Vault waste rock and open pit could be considered to evaluate the leaching potential of this rock.

A strategy should be adopted whereby esker locations on higher topographic features are favoured over potential locations in low-lying areas. This strategy would utilize locations where the material can be stripped to the surrounding ground elevation rather than digging below grade and minimize the potential for water to accumulate at these locations. This strategy would reduce the requirement for future water management at the quarry locations.

5.0 LIMITATIONS

This report was prepared for the exclusive use of Agnico-Eagle Mines Ltd. (AEM). The report, which specifically includes all tables, figures and appendices, is based on samples, data and information collected by AEM and is based solely on the conditions of the properties at the time of sampling. It is supplemented by a previous investigation completed by Golder Associates Ltd. as well as information and operational data provided by AEM.

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The assessment of geochemical characteristics for potential borrow sites for this project has been made using the results of chemical analysis of discrete till samples from a limited number of surface locations, collected by the client but not visited by Golder. Subsurface conditions may vary from these sample locations. Additional study, including further surface and subsurface investigation, can reduce the inherent uncertainties associated with this type of study. However, it is never possible, even with exhaustive sampling and testing, to dismiss the possibility that part of a site may have considerably different characteristics, such as different lithologies at depth.

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