Attachment 9.3

2017 Geochemical Evaluation

(7 Pages)

Project Memo

H353004

September 11, 2017

To: M Weaver

From: W Hoyle

cc:

BIM
T Atiba
F Pittman
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Hatch
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S Heiner
S Hinchberger
J Howes
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Baffinland Iron Ore Mines LP
Mary River Project

Geotechnical Investigations - Acid Rock Drainage Assessment

1. Introduction

Hatch Ltd. (Hatch) was retained by Baffinland Iron Mines (BIM) to complete an assessment of bedrock materials that will potentially be used as construction materials associated with the proposed railway from Mary River to Milne Port on Baffin Island, Nunavut. Testing was carried out on three rock samples, representative of the likely materials available during the construction of the railway. Hatch's objective was to assess the suitability of rock materials for use as construction materials.

Acid Rock Drainage (ARD) occurs when minerals containing sulphide and elemental sulphur are exposed to the weathering effects of oxygen and water. Acidity is generated from the oxidation of sulphur and precipitation of ferric iron. ARD occurs when the resulting acidity is entrained by water. High metal solubility and sulphide weathering occur under acidic conditions. Metal Leaching (ML) is typically associated with acid rock drainage. Although a neutral pH does not necessarily prevent metal leaching, in many environments, metal leaching will only be significant if the drainage pH is less than 5.5 or 6 (Price and Errigton 1998).

The Fizz Rating test is another aspect of the acid-base accounting testing program. This test is carried out by adding 1 to 2 drops of 25 % HCL to a prepared sample. The 'fizz' is rated on a scale for 0 to 3, with 0 for no reaction, 1 for a slight reaction, 2 for a moderate reaction and 3 for a strong reaction. There should be a correlation between NP and Fizz Rating. As an example, for a Fizz Rating of 3, there would likely be a highly positive NP and for a Fizz Rating of 0, a likely very low positive or negative NP.

An assessment of the potential of acid generating potential of excavated bedrock is typically required as part of the regulatory permitting and approvals process for facilities where imported natural materials will be potentially exposed to weathering.

During the geotechnical investigation program, a number of bedrock samples were collected, including samples of granitic gneiss, limestone and diabase that are located along the alignment of the proposed railway.

2. Testing Methodology

The rock samples were considered to be representative of the bedrock encountered along the railway. The samples were shipped to SGS Lakefield Research Limited for static laboratory analysis. The analysis procedure utilized was the acid-base accounting which included measurement of sulphur species, total carbon and carbonate, Neutralization Potential (NP), pH, acid potential (AP), and the NP/AP ratio. Testing was carried out as per Government of British Columbia Technical Circular T-04/13.

3. Results

The bedrock samples included:

- granitic gneiss sampled at approximately Km 3; medium to coarse, fresh, comprised mostly of plagioclase, quartz and mafic minerals
- diabase sampled at approximately Km 95; fine to medium, fresh, blackish green comprised of mostly mafic minerals, some quartz
- limestone sampled at approximately Km 62; fine to medium, fresh, light yellowish grey.

The results of the ABA testing are summarized in Table 1 and the laboratory test reports are attached. The ABA test includes several components that provide an indicator of the acid—generating potential of the materials sampled, including paste pH, the sulphide sulphur component (%), neutralization potential (NP): acid potential (AP) ratio and net neutralization potential (NP-AP) (tonnes $CaCO_3$/1000 tonnes). The AP is calculated based on the sulphide sulphur concentration, and the NP is measurement of the amount of neutralizing base minerals, including carbonate in the samples. The net NP is the difference between the NP and the AP and the NP/AP ratio is the NP divided by the AP.

Table 1: Results of ABA Testing

Laboratory Sample Number	Description	Paste pH	NP/AP Ratio	Net NP (tonnes $CaCO_3$/ 1000 tonnes)	Total Sulphur (%)	Sulphide Sulphur (%)	Fizz Rate	Carbonate (%)
NF17-07	Granitic Gneiss	9.89	9.10	5.43	0.035	<0.02	1	0.110
NF17-08	Diabase	8.89	16.9	10.6	0.042	<0.02	1	<0.025
NF17-09	Limestone	8.24	1608	1077	0.029	<0.02	3	54.1

While there is a very low concentration of total sulphur in the samples, the majority of the sulphur in the sample is likely sulphide sulphur. The samples had a paste pH near or over 9, which indicates that neutralization potential will be available immediately under leaching conditions. Based on results from ARD studies in the Appalachian coal mines (Brady et al. 1994), a net NP value that exceeds 15 tonnes $CaCO_3$/tonne was considered to be non-acid generating, a net NP value less than or equal to 0 tonnes $CaCO_3$/tonne was considered to be acid generating, and a net NP value between 0 and 15 tonnes $CaCO_3$/tonne represented a grey zone that was potentially acid generating, but for which prediction was difficult.

Based on this classification system, the limestone sample (NF17-09) with a net NP value at 1077 is classified as non-acid generating and the diabase (NF17-08) at a net NP value of 10.6 is likely non-acid generating. The granitic gneiss (NF17-07) with a net NP value of 5.4 falls in the zone that is difficult to predict, however likely closer to the non-acid generating classification as there is a very low percentage of sulphides (sulphur) present. The ABA screening criteria developed by the BC Ministry of Energy and Mines, (Price 1997) (Table 6.4), are described in Table 2.

Table 2: **Acid-Base Accounting Screening Criteria (Price 1997)**

Potential for ARD	Initial Screening Criteria	Comments
Likely	NPR < 1	Likely ARD-generating unless sulphide minerals are non-reactive.
Possible	1 < NPR < 2	Possibly ARD-generating if NP is insufficiently reactive or is depleted at a faster rate than sulphides.
Low	2 < NPR < 4	Not potentially ARD-generating unless there is significant preferential exposure of sulphides along fracture planes or extremely reactive sulphides in combination with an insufficiently reactive NP.
None	NPR > 4	

The results of the ABA testing indicated that for the tested rock samples from the BIM site, the Net NP was more than or slightly less than 15 tonnes $CaCO_3$ and the NP/AP ratio was greater than 4. Therefore the rock is unlikely to be acid-generating. Given the high paste pH for the sample, metal leaching is unlikely to be an issue since most metals are not soluble under alkaline conditions.

4. Recommendations

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Based on the results, no further testing is recommended if rock material is consistent with the samples of rock that were collected during the geotechnical investigation program. Since the excavated bedrock is unlikely to be acid-generating, there is very little concern, with respect to ARD, with its use as a source of construction material.

5. References

Brady, K.B., Perry, E.F., Beam, R.L., Bisko, D.C., Gardner, M.D. and Tarantino, J.M. (1994). Evaluation of Acid-Base Accounting to Predict the Quality of Drainage at Surface Coal Mines in Pennsylvania, USA, Proc. International Land Reclamation and Mine Drainage Conference and 3rd International Conference on the Abatement of Acidic Drainage, Pittsburgh, PA; USBM SP 06A-94, v1, p138-146.

Government of British Columbia (2013). Technical Circular T-04/13, Evaluating The Potential For Acid Rock Drainage and Metal Leaching at Quarries, Rock Cut Sites and From Stockpiles Rock or Talus Materials Used by MOTI, September 15, 2013.

Price, W.A. 1997. Draft Guidelines and Recommended Methods for the Prediction of Metal Leaching and Acid Rock Drainage at Mine sites in British Columbia. British Columbia Ministry of Employment and Investment.

Price, W.A. and Errington, J.C. (1998): Guidelines for Metal Leaching and Acid Rock Drainage at Minesites in British Columbia.

W Hoyle

WH:kf

Attachments:
Attachment A: C of C CA13857-JUN17
Attachment B: Report CA13857-JUN17

Jun 13857
06/27/17 JB

HATCH

GEOTECHNICAL LABORATORY

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GEOTECHNICAL LABORATORY SAMPLE - CHAIN OF CUSTODY

SAMPLE I.D	QUANTITY	TESTS REQUIRED	
NF17-07	1 Bag 350 g	Test for Acid Rock Drainage Potential / ABA	(Granitic Gneiss)
NF17-08	1 Bag 350 g	Test for Acid Rock Drainage Potential / ABA	(Diabase)
NF17-09	1 Bag 350 g	Test for Acid Rock Drainage Potential / ABA	(Limestone)

Samples Relinquished By:	R Serluca	Samples Recieved By:	Jeanette Barker
Date:	June 26th 2017	Date:	Jun 27/17
Time:	3:00 PM	Time:	15:00
Signature:		Signature:	Jeanette Barker
Reciving Labs Address:	185 Concession St. P.O Box 4300		
	Lakefield Ontario, K0L 2H0		
	1-705-652-2000 Attention Mr. Chris Sullivan		

FedEx

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

10-July-2017

Hatch LTD
Attn : Ralph Serluca

4342 Queen St Suite500
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Phone: 905-374-5200
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Date Rec. : 27 June 2017
LR Report: **CA13857-JUN17**

Copy: #1

CERTIFICATE OF ANALYSIS

Partial Report

Analysis	5: NF17-07	6: NF17-08	7: NF17-09
Sample Date & Time	Date:N/A	Date:N/A	Date:N/A
Paste pH	9.89	8.89	8.24
Fizz Rate [---]	1	1	3
Sample weight [g]	2.05	1.99	2.00
HCl Added [mL]	20.00	20.00	540.00
HCl [Normality]	0.10	0.10	0.10
NaOH [Normality]	0.10	0.10	0.10
NaOH to [pH=8.3 mL]	17.48	15.50	109
Final pH	1.14	1.73	1.68
NP [t CaCO3/1000 t]	6.1	11	1077
AP [t CaCO3/1000 t]	0.67	0.67	0.67
Net NP [t CaCO3/1000 t]	5.43	10.6	1077
NP/AP [ratio]	9.10	16.9	1608
Sulphur (total) [%]	0.035	0.042	0.029
Acid Leachable SO4-S [%]	0.04	0.04	0.03
Sulphide [%]	< 0.02	< 0.02	< 0.02
Carbon (total) [%]	0.044	0.061	11.1
Carbonate [%]	0.110	< 0.025	54.1

Brian Graham B.Sc.
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OnLine LIMS

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LR Report : **CA13857-JUN17**

*NP (Neutralization Potential)

$$= \frac{50 \times (\text{N of HCL} \times \text{Total HCL added} - \text{N NaOH} \times \text{NaOH added})}{\text{Weight of Sample}}$$

*AP (Acid Potential) = % Sulphide Sulphur x 31.25
*Net NP (Net Neutralization Potential) = NP-AP
NP/AP Ratio = NP/AP
*Results expressed as tonnes CaCO3 equivalent/1000 tonnes of material
Samples with a % Sulphide value of <0.02 will be calculated using a 0.02 value.