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via email at: licensing@nwb-oen.ca

Assol Kubeisinova
Technical Advisor
Nunavut Water Board
P.O. Box 119
Gjoa Haven, NU X0B 1J0

Dear Assol Kubeisinova:

RE: 2AM-MRY1325 – Baffinland Iron Mines Corporation – Mary River Project – Water Licence Amendment Application – Phase 1 Waste Rock Management Plan

Baffinland Iron Mines Corporation ('the proponent') submitted their Phase 1 Waste Rock Management Plan on January 6, 2020 to the Nunavut Water Board (NWB) in support of its Amendment Application for water licence 2AM-MRY1325. ECCC has reviewed this information, and is providing technical comments by way of this letter.

ECCC's specialist advice is based on our mandate pursuant to the *Canadian Environmental Protection Act,* the pollution prevention provisions of the *Fisheries Act*, the *Migratory Bird Convention Act* and the *Species at Risk Act*.

ECCC-1: Potentially Acid Generating Rock Definition

References

- Baffinland Iron Mines Corporation. 2019. Phase 1 Waste Rock Management Plan Rev 2, Section 3 Definitions.

Proponent's Conclusion(s)

The proponent has provided the following definition for Potentially Acid Generating (PAG) rock:

> "*Potentially acid generating (PAG): rock-containing minerals, which potentially can produce acid or acidic water, with a total sulphur content greater than 0.2 wt % as S [Sulphur]*."

ECCC's Conclusion(s)

The generally accepted definition of PAG rock does not contain the percentage of sulphide minerals content (wt % as S). PAG rock is defined as a rock that, when oxidized by surface weathering, may form acid that can then leach metals. PAG rock can also be defined as rock with a neutralization potential/acid potential (NP/AP) ratio of less than 2, determined by static tests, as defined by Mine Environment Neutral Drainage (2009). PAG rock can also be defined operationally based on the results of static testing such as Acid Base Accounting (ABA) and Non-Acid Generating (NAG) testing.

ECCC's Recommendation(s)

ECCC recommends that the proponent revise the definition of PAG rock.

ECCC-2 Waste Rock Characterization

References:

- Baffinland Iron Mines Corporation. 2019. Phase 1 Waste Rock Management Plan Rev 2, Section 6 Waste Rock Characterization, 6.1 and 6.2 Deposit Geology and Geochemical Sampling Program.

- Golder Associates. 2019. Phase 1 Waste Rock Management Plan Rev 2, Appendix A : Waste Rock Management Plan Report for 2020 to 2021, Section 4.0 Waste Rock Characterization and Geochemistry Review.

Proponent's Conclusion(s)

The proponent included samples of drill cuttings from the boreholes used for blasting ("blastholes") in the open pit in order to expand the geochemical database for samples with total sulphur slightly above and below 0.2 wt % as S in the 2019 geochemistry program. The inclusion of the borehole drill cuttings was done to assess the presence of soluble sulphate minerals in material with low total sulphur to inform the current waste rock segregation criteria.

The proponent goes on to state that the geochemical results suggest that the overall existing waste rock pile design and placement, as presented in the December 2018 WRMP, remains valid for the purpose of reducing potential for acid rock drainage (ARD) and metal leaching (ML), provided that the non-acid generating (Non-AG) material does not contain stored acidity.

However, the proponent also recognizes that stored acidity within the waste rock pile is related to localized conditions in the ore currently mined in Deposit 1:

> *"The geochemistry of the current WRF may be localized within the current area of Deposit 1. Stored acidity, particularly within material currently classified as Non-AG waste rock, appears to be primarily within the current Deposit 1 area and the potential appears to decrease based on available historical data*".

The proponent also indicated that

> "*7% of the 2019 geochemical samples with less than 0.20 wt % as S total sulphur had acidic pH values (<6) in either the paste pH from ABA or final pH from SFE*."

In appendix A of the WRMP, it is stated that:

> "*when applied to the current dataset, the addition of paste pH to the PAG classification criteria would reduce the amount of low sulphur, Non-AG waste rock with potential to release stored acidity to less than 2% of the samples tested (1 of 55 samples)".*

ECCC's Conclusion(s)

The proponent's above conclusions suggest that based on the classification method selected and the test conducted on potential samples, between 2 and 7% of the non-AG materials placed into the waste rock pile could be PAG.

ECCC suggests that the proponent consider assessing all samples rather than using the 0.2 wt % S criteria to segregate waste rocks samples as stated in section 6.2. This would alleviate potential bias caused by using only samples near the 0.2 wt % as S.

ECCC has concluded that stored acidity and localized ARD and ML activities within the current waste rock facility is due to misclassification of PAG as non-AG rock. ECCC notes that even when the quantities of soluble sulphate to produce ARD and ML are predominately constrained to material with a total sulphur content greater than 0.20 wt % as S, this does not mean that materials with less than 0.2 wt % of S will not produce ARD/ML. This is the case where there is not enough neutralization potential (materials) to neutralize the acid. The fact that 7% of the 2019 geochemical samples with less than 0.20 wt % as S total sulphur had acidic pH values (<6) in either the paste pH from ABA or final pH from SFE, means that the 0.2 wt % as S cut off for Sulphur is not adequately segregating materials that have potential to general acid.

A wider range of samples could be assessed to alleviate the possibility that up to 7% of samples could be misclassified using the 0.2 wt % as S cutoff and therefore reduce the risk for stored acidity hotspots within the waste rock facility.

Table 1 from Appendix A, Waste Rock Management Plan Rev 2 also indicates that even with the additional paste pH test, 1 out of 55 samples may be misclassified as non-AG rock. Hence, even with the addition of the paste pH test, about 2% of the entire waste rock could have been misclassified as non-AG. There is also no indication what the results (% misclassification) would be if the cut off is reduced to 0.1 wt % as S or less.

ECCC supports the recommendation by Golder Associates Ltd, submitted by the proponent, that:

> "*In addition to altering the PAG classification criteria, it is also recommended that supplemental blast hole samples of both PAG and Non-AG material be submitted for ABA and SFE testing on an ongoing basis opposed to the current practices of ABA analysis of PAG samples only*"

and

> *"The supplemental samples should be representative of the material mined, including a representative range of sulphide content. A frequency of 10 samples per month (five of each PAG and Non-AG) is recommended through 2020 with the results and sample frequency reviewed on a six-month basis."*

The adoption of these recommendations would allow the proponent to develop a comprehensive geochemical database for the waste rock, and to diminish or eliminate the risk of PAG rock misclassification.

ECCC's Recommendation(s)

ECCC recommends that:

- the proponent assess all samples with Acid Base Accounting (ABA) and Shake Flask Extraction (SFE);
- the proponent assess a wide range of samples without relying on the 0.2 wt % S cut off, in order to ensure that no PAG rock is misclassified as non-AG rock and
- the Proponent adopt Golder's recommendation that all samples be submitted for ABA and SFE testing on an ongoing basis.

ECCC-3: Thermal Assessment of the Waste Rock Pile

References

- Baffinland Iron Mines Corporation. 2019. Phase 1 Waste Rock Management Plan Rev 2, Section 7 Thermal Assessment

- Golder Associates. 2019. Phase 1 Waste Rock Management Plan Rev 2, Appendix A : Waste Rock Management Plan Report for 2020 to 2021, Section 5.0 Thermal Assessment

Proponent's Conclusion(s)

A thermal assessment was undertaken to characterize the freezing patterns of deposited waste rock and to assess the Waste Rock Facility (WRF) thermal performance. A thermal model was run to assess the time that it takes for waste rock placed during summer and the subsequent winter to freeze back. The proponent's main conclusions from the thermal assessment are as follows:

- "*Review of data obtained from the site thermistors indicate that the WRF is almost entirely frozen, with exception of a 2- 3m thick active zone subject to seasonal freeze and thaw cycles.*
- *Temperatures within the WRF are affected not only by air temperature, but also potentially by airflow, air convection and by internal heat generation connected to airflow through the WRF and variation in the geochemical behavior of the waste rock. Progressive increase in air temperatures slowly impacts ground temperature, while airflow and/or internal heat generation lead to sudden, localized and temporary variations in temperatures.*
- *Results from thermal models suggest that between 5 m and 7m of waste rock could be placed in summer and the entire thickness of material would freeze during the following winter, assuming the summer placed material was not covered over during the winter. However, depending on the existence of heat sources within the WRF, a 7 m thick waste rock summer deposition could cause the development of a thawed zone in portions of waste rock previously deposited. Limiting the thickness of summer placed waste rock to 5 m would reduce the risk of creating a thawed zone at depth within the WRF.*
- *If no internal heat source is present, the models indicate that the entire waste rock layer deposited in summer would freeze within a year, with or without additional deposition of waste rock in winter and the extent of the thawed zone in the interior of the pile would be very limited.*"

As part of their modelling, the proponent conducted field work and installed thermistors inside the waste rock pile to obtain temperatures measurements. The readings from the thermistors showed that abrupt and localized temperatures changes were observed in the waste rock pile.

ECCC's Conclusion(s)

The proponent's conclusions from modelling and thermistor readings would indicate that internally, some portions of the WRF are not frozen due to possible hot spots within the WRF. These hot spots could have arisen because of misclassification of PAG as non-AG by using the 0.2 wt % as S cut-off. Sulphide oxidation is an exothermic reaction that generates heat. The generation of heat within the waste rock facility occurs when PAG rock is misclassified as non-AG rock. ECCC assumes that this is likely what was meant by the proponent when they referred to "*existence of heat sources within the WRF*".

ECCC's Recommendation(s)

ECCC recommends that the proponent:

- not use sulphide content only to classify Potentially Acid Generation and non-Acid Generating rock;
- verify whether there are layers of the lifts that are not frozen within the Waste Rock Facility.

ECCC-4 Waste Rock Facility Closure

Reference:

- Golder Associates. 2019. Phase 1 Waste Rock Management Plan Rev 2, Appendix A : Waste Rock Management Plan Report for 2020 to 2021, Section 10.3 WRF Closure

Proponent's Conclusion(s)

In section 10.0 WRF Development Strategy, the proponent noted that stockpile exterior faces would have PAG waste rock placed at a minimum 4 m under a non-AG rock cover. The placement of PAG rock under 4 m of non-AG cover was recommended by Golder until more data points are obtained to define the permafrost active zone. Section 10.3, of the WRF Development Strategy mentions that the non-AG out layer during closure could be up to 50 m thick to ensure that the interior of the WRF remains frozen year-round.

ECCC's Conclusion(s)

Given the statements in sections 10.0 and 10.3 of the WRF Development Strategy, it is not clear whether the proposed cover thickness over PAG rock would be 4 m or 50 m.

ECCC's Recommendation(s)

ECCC recommends that the proponent provide clarification on the thickness of the cover proposed in the waste rock facility closure.

ECCC-5 Sulphate concentrations in discharge

References

- Baffinland Iron Mines Corporation. 2019. Phase 1 Waste Rock Management Plan Rev 2, Appendix A4 Water Quality Memorandum & Appendices A-E – Water Quality Data

Proponent's Conclusion(s)

The proponent provided water quality data measurements from 2019 in table format in Appendices A-D, and Water Quality Modeling Results in Appendix E. Measured values for sulphate were as high as 72,187 mg/L in waste rock facility runoff, and up to 3654 mg/L in the pond. Sulphate concentrations are modeled to average 3429 mg/L in 2019/2020 in the effluent. Appendix E presents predictions, but the table does not have a title which indicates what the predictions represent. Based on the text on page 11 of Appendix A4 Water Quality Memorandum, it appears that these numbers represent runoff quality from the WRF with precipitation of metals taken into account. It's unclear if they are post-treatment, given that they are compared to the *Metal and Diamond Mining Effluent Regulations* (MDMER).

ECCC's Conclusion(s)

Current water quality measured in the ditch, pond and runoff have high levels of sulphate which for some species could be considered high enough to cause acute toxicity. Clarification on potential treatment and mitigation options for sulphate are required, as well as clarification on the predictions table from Appendix E.

ECCC's Recommendation(s)

ECCC recommends that the proponent provide clarification on potential treatment or mitigation measures for high sulphate, given the high levels of sulphate measured in the Waste Rock Facility in 2019 and given the use of ferric sulphate in the currently used treatment process.

If you would like more information, please contact Senior Environmental Coordinator Gabriel Bernard-Lacaille at (867) 669-4746 or Gabriel.Bernard-Lacaille@Canada.ca.

Sincerely,

Margaret Fairbairn
Manager – Environmental Assessment

cc: John Olyslager, Acting Head, Environmental Assessment North (NT and NU)