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March 25, 2020

File: W2015L2-0001

Gord Macdonald
Diavik Diamond Mines (2012) Inc.
P.O. Box 2498
Suite 300, 5201-50th Avenue
Yellowknife, NT X1A 2P8

Dear Gord Macdonald,

Re: DDMI Request for Waste Rock Storage Area Cover Modification

The Wek'èezhìi Land and Water Board (WLWB or the Board) met on March 24, 2020 and considered Diavik Diamond Mines' (2012) Inc. (DDMI) request to approve a Modification to the cover for the North Waste Rock Storage Area (WRSA). As described in the attached Reasons for Decision, the Board did not approve DDMI's request.

Sincerely,

A handwritten signature in blue ink, appearing to read "Joe Mackenzie".

Joe Mackenzie
Chair, Wek'èezhìi Land and Water Board

Copied: Diavik Distribution List



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Reasons for Decision

Reference/File Number:	W2015L2-0001
Licensee:	Diavik Diamond Mines (2012) Inc.
Subject:	Request to Approve a Modification to the Waste Rock Storage Area Cover Design

Decision from the Wek'èezhìi Land and Water Board Meeting of March 24, 2020

1.0 Decision

On March 24, 2020, the Wek'èezhìi Land and Water Board (WLWB or the Board) considered Diavik Diamond Mines' (2012) Inc. (DDMI) request to approve a Modification to the North Waste Rock Storage Area (WRSA) cover design.¹ This request was submitted under Part G, Condition 2 of DDMI's Water Licence W2015L2-0001 (the Licence). The Board made the following decisions:

1. The Board did not approve DDMI's proposed modification to the WRSA cover.
2. The Board requires DDMI to submit confirmation from Tetra Tech that the lakebed sediments have similar thermal properties and similar water retention to those used in the model, or commit to testing the lakebed sediment properties to verify that they are within the range of properties used in the model. DDMI must submit a letter within 45 days of the date of this Reasons for Decision with this information. If lakebed sediments lab testing is required, DDMI must indicate when the results and conclusions will be reported to the Board.

¹ See WLWB Online Registry for [Diavik - Modification - WRSA-NCRP Cover Modification Request - Jan 9 20.pdf](#).

2.0 Background

The Board approved the North WRSA cover design on February 9, 2018.² On January 9, 2020, DDMI submitted a request to modify the approved design for the North WRSA cover. DDMI proposed to reduce the till thickness cover from 1.5 meters to 1.0 meters for the top surface of the WRSA when the material contains greater than 10% gravimetric water content (GWC).

DDMI's submission was distributed for public review on January 16, 2020. Reviewers were asked to provide comments by February 13, 2020. Comments were received from Environment and Climate Change Canada (ECCC), the Environmental Monitoring Advisory Board (EMAB), and the Government of the Northwest Territories – Environment and Natural Resources (GNWT-ENR). The Wek'èezhii Renewable Resources Board (WRRB) and Fisheries and Oceans Canada (DFO) indicated that they had no comments. Board staff also submitted questions. Proponent responses were submitted by the deadline of February 20, 2020. Reviewer comments and recommendations, as well as and proponent responses are available on the WLWB Online Registry.³

SRK Consulting (SRK) provided expert input on DDMI's submission.

3.0 Reasons for Decision

The proposed modification is discussed in Section 3.1. In addition, an issue related to lakebed sediments arose during review of the proposed modification and is discussed in Section 3.2.

3.1 Proposed Cover Modification

In its approval of the WRSA cover design, the Board stated the following:

While DDMI has adequately demonstrated through thermal modelling, field tests, and design that their freeze encapsulation cover is plausible, the Board is not convinced that the till layer construction and associated QA/QC plan will ensure consistent performance through all areas of the cover as predicted.⁴

Similarly, the Board stated the following:

Although the test pile data is informative, the incomplete information presented does not allow the Board to reach the same level of certainty regarding the test pile data as has been reached by DDMI. As a result, due to the significant heterogeneity of the till material, coupled with the placement methods and the limited QA/QC, the Board concludes that there could be portions of the cover that do not attain the necessary minimum moisture

² See WLWB Online Registry for [Diavik - Closure and Reclamation Plan - WRSA - Directive and Reasons for Decision - Feb 9 18.pdf](#).

³ See WLWB Online Registry for [Diavik - Modification - WRSA-NCRP Cover Modification Request - Review Summary and Attachments - Feb 20 20](#).

⁴ See WLWB Online Registry for [Diavik - Closure and Reclamation Plan - WRSA - Directive and Reasons for Decision - Feb 9 18.pdf](#).

content, and as a result the active layer thickness as modelled would not materialize in those areas.⁵

The Board also emphasized the importance of applying engineering judgement because climate change modeling is only feasible to the year 2100, yet the cover must perform well beyond that time. The Board required DDMI to install instrumentation clusters and increase the construction quality assurance/quality control (QA/QC) sampling frequency, and determined that a security holdback would be required. These measures help to address the uncertainty, and in combination with the other reasons expressed in the Board's February 9, 2018 Reasons for Decision,⁶ allowed the Board to approve the cover design such that progressive reclamation could begin. Nonetheless, significant uncertainty in performance of the cover system remains.

DDMI predicts that the requested thinner till layer would mean that the active layer penetrates to essentially the bottom of the till layer, leaving no buffer, as noted by EMAB (comment 4). The Board has previously noted that thawing of some of the Type III rock has not been demonstrated to be acceptable.⁷ ECCC pointed to the potential for thawing of the PAG rock during warmer years, and indicated that the previously approved cover thickness is a more conservative approach to ensure thawing does not penetrate into the PAG rock (ECCC comment 1). The Board agrees with ECCC and is of the view that a design that brings the cover right up to the edge of performance while not addressing significant uncertainties, is not adequate. Similarly, the GNWT-ENR noted (comment 2) that the uncertainties expressed by the Board with the approval of the cover remain, and yet DDMI has proposed a potentially less conservative cover design. The Board notes that DDMI has not indicated that there is insufficient till for the approved cover. Even if till quantities were low for the approved cover, DDMI should propose a cover design modification that provides adequate certainty that the cover will perform over 100 plus years.

Further, as part of its Modification request, DDMI submitted a memo from Tetra Tech regarding additional thermal modelling (using the same model that was used for the approved cover design) to determine whether the proposed design change is acceptable. Tetra Tech determined that when the material contains greater than 10% moisture content, the thawing front would be at depths between 3.90 m to 4.00 m after 100 years under the projected mean climate change scenario.⁸ DDMI was asked whether the company could provide Tetra Tech's opinion on the adequacy of the reduced till thickness (WLWB staff comment 1). In response, DDMI referred to the memo it submitted from Tetra Tech, however, the memo does not include an opinion from Tetra Tech that the reduced till thickness is adequate. The memo stated

⁵ See WLWB Online Registry for [Diavik - Closure and Reclamation Plan - WRSA - Directive and Reasons for Decision - Feb 9 18.pdf](#).

⁶ See WLWB Online Registry for [Diavik - Closure and Reclamation Plan - WRSA - Directive and Reasons for Decision - Feb 9 18.pdf](#).

⁷ See WLWB Online Registry for [Diavik - Closure and Reclamation Plan - WRSA - Directive and Reasons for Decision - Feb 9 18.pdf](#).

The Board presented an estimate of the effects of thawing 0.6 meters of PAG rock.

⁸ Board staff asked why the predicted thaw depth is reported as a range, (WLWB staff comment 1), however, DDMI's response did not clarify why the model output a range, rather than a single thickness. Nonetheless the lower end of the range is very close to the proposed 4-meter cover thickness, and the upper end is right at the cover thickness, so there is virtually no buffer even when considering the predicted thaw depth as a range of values.

that Tetra Tech concluded that “[t]he thermal results demonstrate that the thawing front would be at depths between 3.90 m to 4.00 m after 100 years under the projected mean climate change scenario, which is still within the cover system, but nearly penetrates to Type III rock layer underneath.” The lack of an opinion from Tetra Tech is in contrast to the other memo DDMI submitted to support the cover design modification, which was from Golder Associates Ltd. (Golder) and addressed stability. In that memo, Golder stated: “Based on the results presented above, Golder can confirm that a reduction in till thickness on the top surface of the NCRP will not affect the overall stability of the cover system.” A professional opinion from Tetra Tech on the adequacy of the reduced till layer would have better supported DDMI’s proposed Modification to the cover.

The Board concluded that DDMI’s proposal to reduce the till layer, leaving no buffer, is not acceptable. It does not demonstrate the level of engineering judgement the Board was referring to when it stated that appropriate engineering judgement must be applied. There should be reasonable confidence that the design will perform as required. Although DDMI proposed that if the areas with thinner till do not perform as the company anticipates, the company will add additional non-PAG rock to the cover, the Board finds that this is not a sufficiently conservative approach. The initial cover design should be developed to meet performance expectations, with allowances for uncertainty in the modeling, underlying assumptions, and construction methods. It may be possible to propose an alternate design that achieves this, however, the Board is of the view that DDMI’s proposed modification does not.

The reasons presented above on their own support a Board decision to deny DDMI’s proposed cover design Modification request. In addition, new uncertainties are apparent from DDMI’s submission:

- As noted by EMAB (comment 5), much of the till that has already been placed has a moisture content below the design specification of 10% moisture content.
- As noted by EMAB (comment 3), much of the till that has been placed to date is below the design thickness of 1.5 m. Further, settling or impingement of till into the underlying rock could result in thicknesses below 1.5 meters after rock placement. The Board currently does not require DDMI to seek approval prior to placement of the rock layer on top of the till. The Board advises DDMI that the company must ensure that the till is placed such that it will remain at a minimum of 1.5 meters thick post-closure. DDMI should ensure that the documentation submitted in its Reclamation Completion Report (RCR) demonstrates that the till and rock thickness was achieved and will be maintained. This should include till and rock isopach maps generated from surface grade measurements that follow industry best practice for development of as-built documentation, preferably with sign-off from the professional engineer responsible for cover construction.
- DDMI referenced a memo by Leslie Smith to support its conclusions but did not provide the memo to the Board as supporting evidence, and provided a redacted version to EMAB, which raised concerns for EMAB (EMAB comment 7).

The Board also has concerns with DDMI's proposed method for determining where the till can be thinner and where instrumentation will be placed for future monitoring:

- The proposed sampling is not sufficient to account for potential vertical and lateral variability in till properties, as noted by EMAB (comment 6). Although DDMI indicated that samples are taken at a minimum depth of 0.3 meters and that the company collects a profile of the till layer (response to WLWB staff comment 5), data showing a vertical profile was not presented to support the proposed cover design. As noted by EMAB (comment 6), "it is almost certain that the water content of the till will not be uniform with depth. It is also expected that the water content near the bottom of the layer could be reduced due to drainage into the Type III waste rock. This certainly will be the case in the early period after placement."
- DDMI proposed in its request for approval of the cover Modification that the criteria for determining where till can be thinner should be 10% GWC. DDMI did not identify a criteria for the fines content of the till. Although in its response to comments, DDMI indicated that fines content will also be measured and considered, the company made contradictory statements regarding what the criteria for thinner till placement would be:

A conservative approach will be used to determine if the till thickness can be reduced based on the results of the two quality control testing (grain size and moisture content). If the area contains a moisture content great than 10% GWC (gravimetric water content), the till thickness will be deemed acceptable if >1.0m thick (response to WLWB staff comment 2).

For clarity, use of moisture content alone to determine areas where the cover can be thinner, without considering fines content, is not sufficient to select locations for the modified cover. The fines content (at multiple depths) will indicate water retention over the long term, as noted by the GNWT-ENR (comment 4).

- DDMI has not demonstrated that the instrumentation it has proposed to monitor the areas of reduced till thickness (a single vertical thermistor in the thinnest area, with no ability to collect moisture content) is enough to verify the performance of those areas.

➤ **Decision #1: The Board did not approve DDMI's proposed modification to the WRSA cover.**

The Board requires DDMI to continue constructing the cover in accordance with the approved design.

3.2 Lakebed Sediments

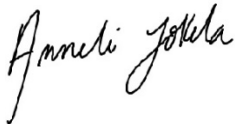
DDMI's request to approve a cover design modification indicated that some of the till layer contains lakebed sediments (LBS). In its response to WLWB staff comment 11, DDMI noted that 23% of the cover placed to date on the top of the WRSA is a natural mixture of till and LBS from A21 pit. DDMI explained that "avoiding any till material which included a proportion of lakebed sediments would have significantly reduced material availability and negatively impacted progressive reclamation activities." The material was placed on the top of the WRSA because lakebed sediments on the slopes could flow downwards, and

reduce the cover thickness. DDMI also indicated that “Golder completed a stability analysis on the LBS material and the results showed that the LBS material gains strength when loaded with rockfill. This documentation is in preparation and will be submitted with the 2019 Reclamation Completion Report.”

The Board reviewed the thermal modeling documentation that supports the cover design and could not confirm that the modeling accounted for the properties of lakebed sediments. Lakebed sediments may have different thermal properties and long-term water retention when compared to the till, and it is important that modeled conditions are similar to actual conditions in the field. This should be confirmed, in order to ensure that the cover is built to perform as modeled.

- ***Decision #2: The Board requires DDMI to submit confirmation from Tetra Tech that the lakebed sediments have similar thermal properties and similar water retention to those used in the model, or commit to testing the lakebed sediment properties to verify that they are within the range of properties used in the model. DDMI must submit a letter within 45 days of the date of this Reasons for Decision with this information. If lakebed sediments lab testing is required, DDMI must indicate when the results and conclusions will be reported to the Board.***

Signed the 25th day of March 2020, on behalf of the Wek’èezhii Land and Water Board



Witness



Joseph Mackenzie
Chair, Wek’èezhii Land and Water Board