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Memo

To:	Karyn Lewis, Project Manager Lupin Project Mandalay Resources Corporation, Suite 330, 76 Richmond Street Toronto, ON M5C 1P1	From:	Alvin Tong. P.Eng. Stantec Consulting Ltd., 1100 – 111 Dunsmuir Street Vancouver, BC V6B 6A3
File:	Lupin Gold Project - 129500081	Date:	June 8, 2020

Reference: 2 AM-LUP2032 Technical Memorandum on Exposed Tailings Preliminary Cover Design

INTRODUCTION

Lupin Mine Incorporated (LMI), a wholly owned subsidiary of Mandalay Resources Corporation, was issued a Type "A" Water License (No: 2AM-LUP2032 (License)) in support of the Closure and Reclamation of the Lupin Mine (Lupin) by the Nunavut Water Board (NWB or Board) on April 9th, 2020. Stantec Consulting Ltd. (Stantec) was retained by LMI to support the execution of certain Licence commitments, including the response to Licence Part E Item 27. Licence Part E Item 27 states:

> *The Licensee shall, within sixty (60) days following the approval of the License, submit to the Board for review, a Technical Memorandum that provides rationale and detailed designs of cover construction for tailings that becomes exposed, including but not limited to the following:*
>
> *a. Further rationale supporting in-situ cover as a contingency measure;*
>
> *b. Preliminary detail designs;*
>
> *c. Typical cross sections; and,*
>
> *d. Long-term erosion control measures."*

This memorandum summarizes Stantec's proposed approach to address the required conditions above.

DESIGN RATIONALE

At this time there is no indication that tailings will be exposed after the water levels are lowered, outside of a small area in the northern corner of the Tailings Containment Area (TCA) Cell 4. The currently approved Closure Plan for the Tailings Containment Area (Kinross 2005) uses an esker cover to reduce ARD/ML potential from placed tailings. In addition, subsequent to the TCA closure plan's approval under the water license renewal in 2016, a TCA ecological risk assessment was conducted in 2004 (Golder 2004) and determined that covering the exposed tailings with esker sand is effective in mitigating offsite environmental impacts.

The proposed cover in place method will place a minimum of 1 m of esker cover over any significant amount of tailings found in areas that are exposed above the closure water levels of the TCA ponds. Based on available information, summarized below, it is believed that an esker cover over the potentially exposed tailings would perform in a similar manner as the approved cover in the tailings cells with the following rationale:

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- The existing instrumentation data indicates that esker cover only entirely thaws between the months of July and September and would be partially frozen for the remainder of the year. Thus, the window for oxidation is quite short.

- During the thaw period, instrument data also suggests that the lowest parts of the cover would remain at a high degree of saturation (>85% by volume) during the driest months (Stantec 2019). The tailings permeability is low (between 1E-05 cm/s to 5E-05 cm/s) and is not readily free draining. The overall water balance for the site is positive, where there is more precipitation than evaporation, which will ensure the tailings and the cover will be rehydrated between the seasons (Holubec 2006). The MEND Guideline outlines that a zone of cover material at or above 85% by volume saturation would effectively limit oxidation of the material below (MEND 2004). Given the existing data and analytical results, it is concluded that a sufficient thickness of esker material would mitigate potential acid rock drainage concerns from the potentially exposed tailings.

- Covering the tailings in place would eliminate the risk of destabilizing the existing dam structures. If tailings are found within a horizontal distance of 1.5x the height of the dam from the dam toe, the excavation associated with the tailings removal could jeopardize the stability of the existing dams. The existing material at the toe of the dam is effectively providing support to the structure, and excavation, even temporary, could cause sloughing or slumping to a stable structure. Cover the tailings in place would prevent potential instability caused by excavation. Plus, the additional cover placed effectively adding more buttress and support to the dams.

- Covering the tailings found in bedrock outcrops would prevent potential downstream impact. The bedrock found around the site is typically uneven with deep narrow crevices. These features would make complete removal of tailings impractical with conventional earthwork equipment. Conventional removal of the material in small inaccessible areas would typically involve some type of hydraulic equipment. The risks associated with hydraulic removal are downstream impact to undisturbed ground from construction runoff, and agitation of tailings affecting downstream waterbodies. It would be more prudent to cover the tailings in place then risk disturbing additional ground and waterbodies.

- Covering thick tailings in place would mitigate the risks associated with deep excavation and long-term erosion. A typical excavator can dig down to approximately 4m depth. However, the typical excavator cannot “bucket” compact loose material below an approximate depth of 2.5m. Loose material place below the depth of 2.5m might not get compact sufficiently and risk of creating differential settlements. It is assumed that the excavator would utilize the 1m thick esker as a working platform. Therefore, the approximate depth of tailings removal would be 1.5m due to the difference between the excavator limitation and the cover thickness. Deeper excavation would also be associated with water management risks (ponding water from rain) and construction health and safety risks. Separately if thick pockets of tailings are found, material found around 2m or deeper below ground surface would eventually be encapsulated by permafrost thus mitigation ARD potential.

- Depending on the depositional environment of the tailings, they could be mixed with soft lakebed sediments. These materials could be highly saturated and contain significant amounts of free-flowing water. Excavating these materials in a soft, saturated environment will incur significant health and safety risks, in addition to the risk of spreading highly saturated (sludge like) tailings to nearby environs during excavation and haulage. It is considered safer to cover these soft tailings in place as the cover would provide dry, firm and even ground for equipment.

Design with community in mind

- Covering potential exposed tailings in place would mitigate the risks associated with construction scheduling and uncertainties. LMI has entered into an agreement with a contractor to execute the closure works in a two-year timeframe. Northern climatic considerations will limit the timing and duration of activities and there is a related risk to the contactor's schedule if unproven mitigation measures are utilized. By using the proven cover and construction method would mitigate the risk associated with schedule and constructability uncertainties.

PRELIMINARY DESIGN

The preliminary design and typical cross sections showing long-term erosion control measures have been presented herein based on the only know area of exposed tailings, which is found in the northwest corner of Cell 4. Figure 1 shows the location of the exposed tailings in Cell 4. Typical sections location is shown in Figure 2. The preliminary cover design cross section is shown on Figure 3 and long section is shown on Figure 4. Typical shoreline protection details, specifically for Cell 4 exposed tailings cover, is shown in Figure 5.

The preliminary design applies a 1m thick cover over the exposed tailings, with minimum 1m offset around the tailings boundaries. The cover will be compacted by dozer track-pack to minimize the erosion potential. While the downstream limit of the Cell 4 exposed tailings has not been confirmed, it is assumed that it extends down below the closure water level. The cover is designed to extend into the water along the closure shoreline to ensure the 1m coverage. The cover shoreline will be armored with boulders to prevent wave erosion. Preliminary plan, section and shoreline details are provided in the figures below.

Figure 1: Cell 4 Exposed Tailings Location

Reference: **2 AM-LUP2032 Technical Memorandum on Exposed Tailings Preliminary Cover Design**

Figure 2: Typical Sections Location

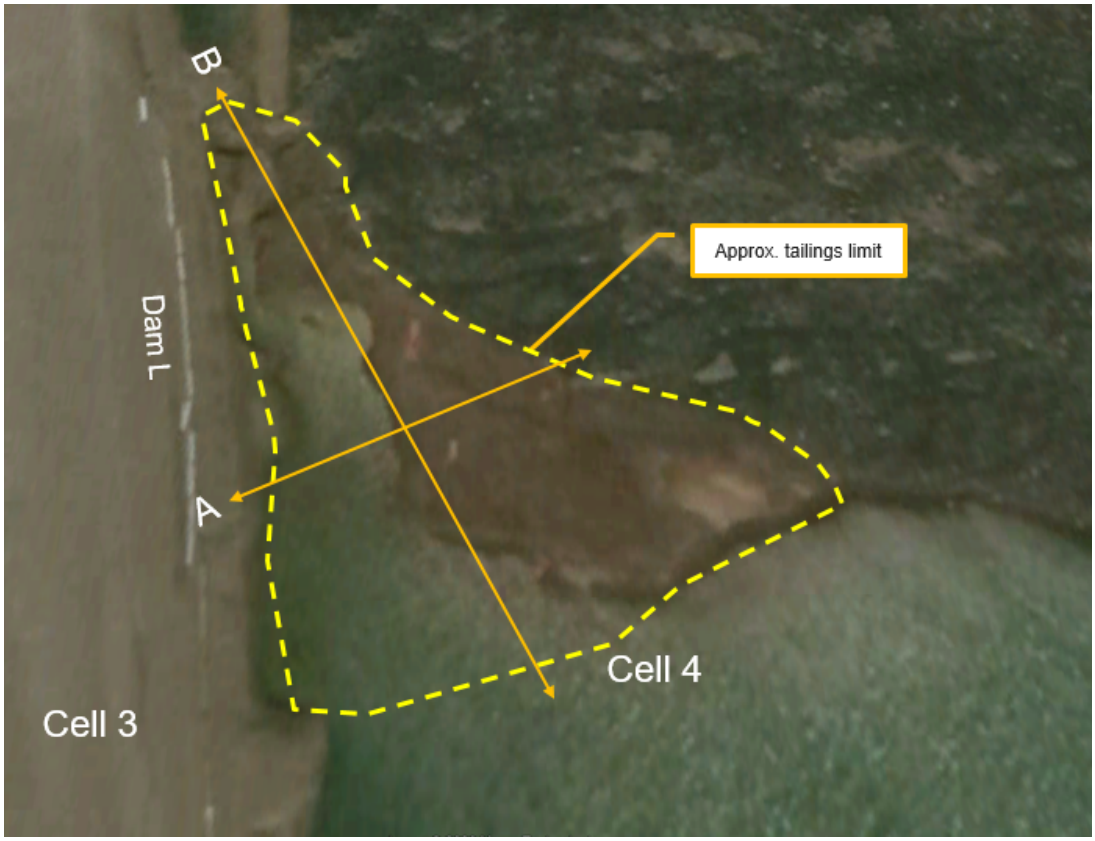

Figure 3: Typical Section A

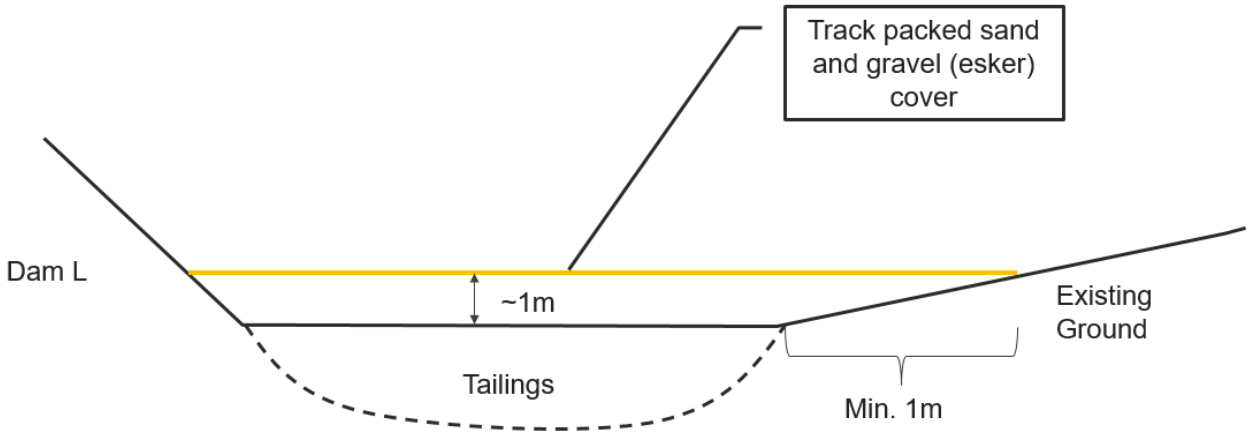

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Figure 4: Typical Section B

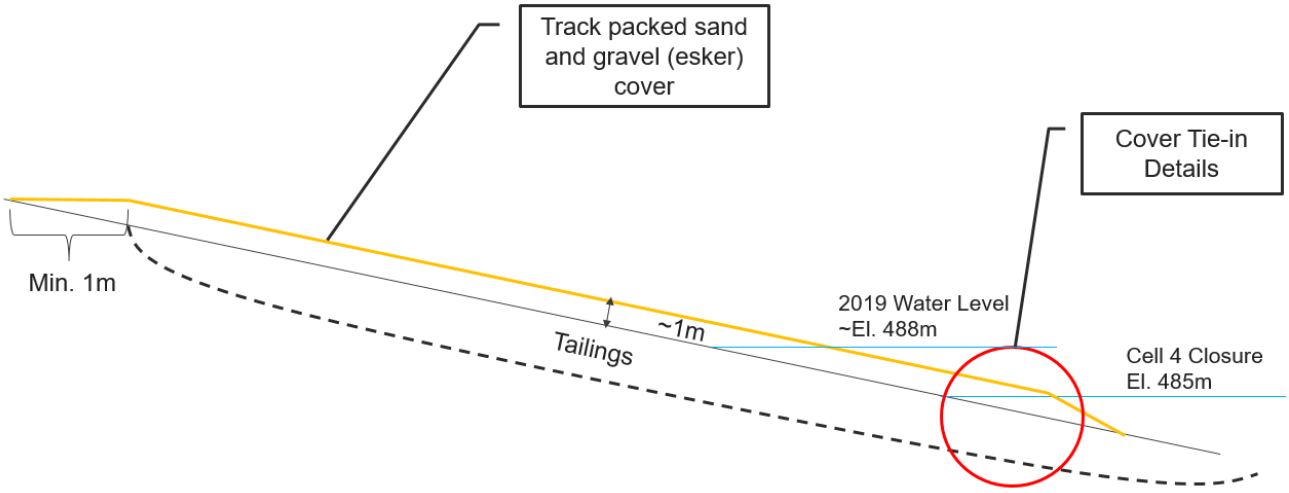
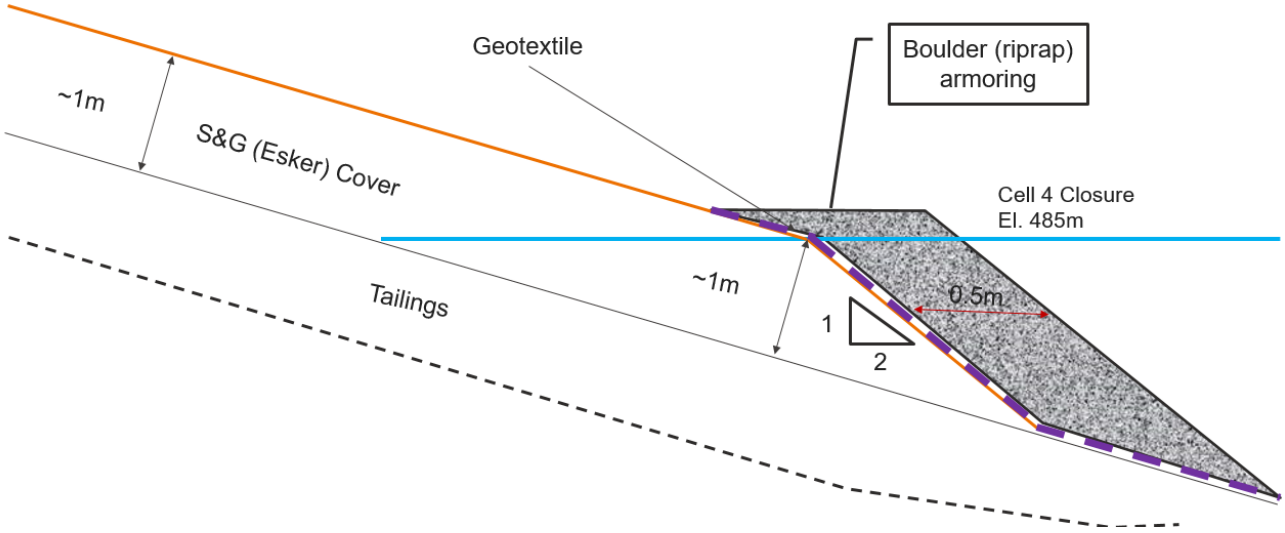


Figure 5: Typical Cell 4 Exposed Tailings Cover Shoreline Tie-in Protection



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The following general criteria will be used to cover encountered exposed tailings:

- Exposed tailings will be covered with a minimum of 1m of sand and gravel (esker) material.
- The cover will be offset minimum 1m outside of the identified exposed tailings boundary.
- The sand and gravel will be track compacted and constructed to provide an even free draining surface to minimize erosion.
- Tied into existing topography in such a way to minimize uncontrolled surface drainage along the cover edges.
- Minimum 0.5 m thick armoring will be placed across shoreline, where needed, at closure water level of the pond, underlain with geotextile for material separation.

If other exposed tailings are found, outside of the identified Cell 4 area, specific design will be done according to specific site conditions. The general criteria above will apply, along with specific design feature(s) as needed once site condition and specifics are identified.

CLOSURE

As currently planned, cover on any potentially exposed tailings in place within the dewatered former pond areas will be the most prudent measure to mitigate ARD risks. The preliminary design presented herein addresses provided the rationale, plans and section, and long-term erosion mitigation. The cover effectiveness will be monitored to ensure that there is no significant detriment to the environment prior to breaching the TCA to allow for passive drainage.

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Attachment: N/A

c. Karyn Lewis; Jim McKinley; Sara Wilkins

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Reference

Holubec 2006. Geotechnical, Seepage and Water Balance. Report prepared for Kinross Gold Corporation by Holubec Consulting Inc., March 2006.

MEND 2004. Design, Construction and Performance monitoring of Cover Systems for Waste Rock and Tailings, Volume 1 and 2. MEND 2.21.4a. July 2004.

Stantec 2019. 2019 Lupin Mine Tailings Area Inspection Report. Report prepared for LMI by Stantec Constructing Ltd., October 2019.

Golder 2004. Final Report Ecological Risk Assessment for the Lupin Mine Tailings Containment Area. December 2004.

Kinross 2005. Closure Plan for Tailings Containment Area. January 2005.