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Memo

To:	Karyn Lewis	From:	Alvin Tong
	Lupin Mine Incorporated		Stantec Consulting Ltd.
File:	Supporting information to the Contingency Contaminants Management Decision Matrix	Date:	January 9, 2020

Reference: Supporting Information to the Contingency Contaminants Management Decision Matrix

INTRODUCTION

Lupin Mine Incorporated (LMI), a wholly owned subsidiary of Mandalay Resources is requesting the renewal and amendment of their existing Type “A” Water License No. 2AM-LUP1520, to allow for Final Closure and Reclamation of the Lupin Mine Project (Lupin). The Nunavut Water Board (NWB or Board) Water License Application No. 2AM-LUP1520 Technical Meeting was held June 6-7th, 2019 in Kugluktuk and Appendix D of the June 18, 2018 Pre-Hearing Conference Decision Report outlines the agreed upon List of Commitments (Commitments). Stantec Consulting Ltd. (Stantec) was retained by LMI to support the responses to select commitments and this technical memo provides the responses to fulfill Commitment No. 8.

The original response to the commitment was provided on October 15, 2019. Follow up comments and a meeting with CIRNAC on January 7th, 2020 identified that additional information is needed to provide clarification and reasoning behind the decision matrix. The decision matrix provided herein is revised from the original submission in October 2019, and this technical memorandum provides supporting details regarding cover performance and risk evaluation. The goal of the decision matrix is to provide a set of determining criteria to decide which one of two mitigation options is most appropriate. The two mitigation options are cover exposed contaminants in place or excavate and relocate to consolidate them within existing tailings cells.

OPTION 1 – EXCAVATE, RELOCATE AND CONSOLIDATE

While excavation and relocation of all exposed contaminants to existing cells would consolidate contaminants within approved storage areas, there are number of risks that are associated with this mitigation option that should be considered. These risks are the determining criteria to drive the selection of the appropriate mitigation option. The subsections below highlight cases where relocation of contaminants may incur significant risks, and cover in place should be considered.

CONTAMINANTS FOUND NEAR DAM TOES

If contaminants are found within a horizontal distance of 1.5x the height of the dam from the dam toe, the excavation associated with the contaminant 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. It would be more prudent to cover the contaminant in place, thus effectively adding more buttress and support to the dams.

CONTAMINANTS FOUND OVER LARGE AREAS AND REQUIRING LONG ACCESS ROADS

A stepped approach is needed to allow equipment to access and relocate exposed contaminants. New access roads must be built over clean areas to the edge of the exposed contaminants. Then only the contaminants within the operable reach (~4m) of the equipment can be removed and then replaced with clean material to advance the access. Thus, the relocation work can only occur in ~4m increments. During the construction, two separate sets of equipment must be used to prevent cross contamination. LMI has a planned construction schedule to facilitate the closure work. The additional steps will significantly increase the risks of spreading contaminants to nearby environs during excavation and haulage, and will significantly decrease productivity, thus jeopardizing LMI's planned schedule that is tailored to northern climate conditions. If contaminant is found in isolated upland areas, there are also risks associated with adverse downstream impact of undisturbed ground due to construction runoff.

CONTAMINANTS FOUND IN THICKNESS IN EXCESS OF 1.5M

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. It is assumed that a construction access road would be constructed from at least 1m thick esker material. Therefore, the approximate depth of contaminant removal would be 1.5m due to the difference between the excavator limitation and the access road thickness. Loose material place below the depth of 2.5m might not get compact sufficient and risk of creating differential settlements. Deeper excavation would also be associated with water management risks (ponding water from rain) and construction health and safety risks. If thick pockets of contaminant are found, material found around 2m or deeper below ground surface would eventually be encapsulated by permafrost. The risks associated with deep excavation and removal are deemed more significant than covering in place.

CONTAMINANTS FOUND ON BEDROCK

The bedrock found around the site is typically uneven with deep narrow crevices. These features would make complete removal of contaminants 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 contaminant affecting downstream waterbodies. It would be more prudent to cover the contaminants in place then risk disturbing additional ground and waterbodies.

CONTAMINANTS FOUND WITHIN SOFT LAKEBED SEDIMENTS

Depending on the depositional environment of the contaminant, 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) contaminant to nearby environs during excavation and haulage. It is considered safer to place a constructed cover over the soft contaminants as this would provide dry, firm and even ground for equipment.

TAILINGS CELL COVERS ARE NOT YET COMPLETED

Depending on the actual length of the construction and discharge season, the tailings cell covers could be completed prior to reaching closure water levels in the TCA. LMI has a planned construction schedule to facilitate the closure work. Any changes due to northern climate conditions (i.e. longer freeze, larger freshet) could impact the water discharge schedule. If contaminants are found after completion of the tailings cell covers, reopening of cover(s) could compromise the quality of work and the overall completion of the TCA closure in accordance with LMI's schedule. It is also not advisable to leave portions of the cell cover incomplete as a contingency to accommodate potential exposed contaminants. Incomplete cell cover will create risks associated with water management and quality, as well as overall closure schedule risks to LMI's planned schedule.

OPTION 2 – COVER IN PLACE

The proposed cover in place mitigation option will utilize the same esker cover that has been approved for the TCA. Sufficient thickness of esker, similar to the approved cover, will be placed over any significant amount of contaminant if found in areas above the closure water level. Based on available information, summarized below, it is believed that an esker cover over the potentially exposed contaminants would perform in a similar manner as the approved cover in the tailings cells.

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 rest of the year. 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 contaminants 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 contaminants.

ACTIVE MONITORING

The performance of either option would be monitored according to the final closure monitoring plan. LMI's schedule would allow a period of performance monitoring post construction, prior to opening the TCA system to the environment. Any residual risks associated with the options will be identified, monitored and tracked during this period. The monitoring would demonstrate the TCA closure has been completed in accordance with the design and will not be detrimental to environment prior to opening the TCA to the environment.

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Attachment: Contingency Contaminants Management Decision Matrix

c. Jim McKinley; Sara Wilkins

Reference

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

Reference: Supporting Information to the Contingency Contaminants Management Decision Matrix

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.

Contingency Contaminants Management Decision Matrix