Acres International Limited
500 Portage Avenue, 6th Floor
Winnipeg, Manitoba, Canada ▪ R3C 3Y8
Tel: 204•786•8751 ▪ Fax: 204•786•2242
www.acres.com

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Nunavut Water Board
P.O. Box 119
Gjoa Haven, NU
X0E 1J0

Attention: Ms. Dionne Filiatrault, P.Eng.,
Manager of Technical Services

Dear Dionne:

Lupin Gold Mine
Tailings Containment Area (TCA)
Review of TCA's 2005 Abandonment and Restoration Plan
NWB Water License NWB1LUP0008

At the request of Nunavut Water Board (NWB), Acres International Limited (Acres) has conducted an independent review on the Abandonment and Restoration Plan (A&R Plan) for the Lupin Mine's Tailings Containment Area (TCA). The document was submitted by Kinross Gold Corporation (Kinross) on June 2005. The Lupin Mine is owned by Echo Bay Mines Limited (Echo Bay), a subsidiary of Kinross. Echo Bay is the registered holder of the Nunavut Water Board Water Licence No. NWB1LUP0008 (Water Licence).

Background

Part I of the Water Licence describes the Conditions Applying to Abandonment and Restoration. Item 3 of Part I specifically makes reference for the Lupin Mine's Final A&R Plan. Particular details related to the A&R Plan are also mentioned in the Interim A&R Plan, and was described as Item 1, Part I of the Water License. As indicated in the Water License, the A&R Plan shall include detailed information on the restoration activities, schedule, and details regarding the follow-up monitoring program.

The Interim A&R Plan, as required by Item 1, Part I was submitted on April 29, 2001. The Final A&R Plan, as required by Item 3, Part I for the TCA was submitted on June 29, 2005. Kinross indicated that this report was derived from the 2004 Final A&R Plan, submitted to the NWB on February 2005. The 2004 A&R Plan was prepared from the Interim A&R Plan, and was intended to contain both the mine site and the TCA. Following this submission, Kinross requested the NWB and Indian and Northern Affairs Canada (INAC) to consider the mine site and the TCA as separate entities for the remediation permitting process. This request was submitted so that a decision on the TCA remediation activities can be expedited more quickly, as the progress of the TCA reclamation work is in a more advanced state than the reclamation activities at the mine site.

Lupin's TCA was developed in a rolling topography site, approximately 6 km south of the mine and mill complex. Historically, the TCA was created in 1981 by the construction of four small dams and two smaller divider dykes. The mine started its operation in 1982, and the TCA was operated as a

contained water facility until 1985. Progressive reclamation was started in 1988. Temporary suspensions of activities occurred between January 1998 and April 2000, and between August 2003 and March 2004. The operation has produced over 3.3 million ounces of gold from 12.8 million tons of mined ore. Mining has now been suspended at Lupin indefinitely, as existing developed ore has reportedly been depleted.

Acres' Review and Comments

Acres' review on the TCA's Abandonment and Restoration Plan included a number of technical papers and background studies, which are related to the geotechnical and geo-environmental aspects of the TCA. These documents were referenced in the A&R Plan.

Acres major comments on the TCA's A&R Plan are related to (i) the saturated esker material cover concept for the tailings, and its application for the remaining reclamation activities at Lupin, and (ii) the details of the proposed reclamation activities. There are a few other details in the A&R Plan, which require minor corrections, clarifications or modifications; and these are also included in this review report. The two major issues, which would require further discussion and/or considerations in the A&R Plan are presented as follows:

1. Saturated Esker Material Cover Concept

It is understood that a number of studies have been carried out since the tailings cover program was initiated in 1988. In 2002, the use of saturated esker material cover as a concept for the tailings cover was pursued as a potential reclamation measure at Lupin. This concept is different from the encapsulating tailings concept in permafrost. The encapsulating tailings concept utilizes a thick granular cover material, placed over the tailings to promote permafrost aggradation, so that the tailings will remain frozen below the anticipated maximum thaw depths of the cover. This concept, however, would require a thicker cover due to the potential increase of thaw depths as a result of global warming. The studies that are provided in the two appendices (Appendices A and B) both supported the use of a saturated cover which consisted of a 1 m thick esker materials over the tailings. Two technical papers, referenced in the A&R Plan: Holubec and Hohnstein (2003), and Li, Aube and St-Arnaud (1997), as well as studies that were prepared by Golder Associates (2004) as presented in Appendix 3 also described favourably for the use of a saturated granular cover concept for tailings in the arctic environment. However, all of these documents cautiously indicated that the concept would work for tailings situated in areas, which are relatively flat, and its benefit are site specific. This site specific properties include tailings and cover conditions (including thickness, physical properties, etc.), local terrain factors (slopes, vegetation, etc), and local climatic and hydrological conditions. In other words, the local environment within the tailings area should be supportive to ensure that, during thaw/summer periods, there must be a saturated zone present within the cover materials and over the tailings to inhibit the oxidation process that may result in the leaching process of the tailings.

Section 5 of the A&R Plan provides a summary of the studies related to the saturated granular zone cover as detailed in Appendices 2 and 3 of the A&R Plan. The studies were prepared in 2004, and

contain detailed descriptions of the various activities carried out between 1988 and 2004 at Lupin. These activities included:

- data collections from existing instrumentations,
- installation of water sampling pipes in 1995, 2002 and 2003,
- 2003 test pad installation in the northwest corner of Cell 1,
- test pit excavation at several locations in Cells 1a, 1, 2 and 3 in September 2004
- studies of the potential interaction between covered cells and flooded areas of the TCA
- potential pore water expulsion from TCA,
- material suitability assessment for tailings cover,
- climate and hydrology study to maintain oxidation barrier.

Saturation Zone Depth of the Esker Material Cover

Field tests have proven that the depth of the saturation zone within the esker material cover varied considerable from 0.16 m to 1.17 m. These depths were dependant on cover location (center of cells, near perimeter of dam, etc.), cover thickness, time of the year, as well as stratigraphy and thickness of the tailings and its cover at the site. The reports did not establish how the saturation zone depths were estimated from the various conditions and parameters. The field observations indicated that the saturation thickness depends on all of the above parameters and is site-specific.

The A&R Plan established that the saturation zone depth should be maintained at 0.3 m above the cover/tailings interface to ensure that it will act as an oxidation barrier. No discussion or explanation was provided on what would happen to the tailings if the saturation depth is less than 0.3 m. It is also not known whether this saturation zone depth can be maintained for an indefinite amount of time, i.e. when the TCA will be abandoned and returned to its natural environment. No information is provided on the sensitivity of the 0.3 m zone depth, such as whether it is sufficient to allow for future changes as a result of climatic change, global warming, or extreme weather conditions.

Potential for Lateral Pore Water Flow Through the Active Layer and Over the Crest of the Frozen Dam Core

Section 5.4 of the A&R Plan, p. 23, indicated that there is a potential for lateral pore water flow through the active layer and over the crest of the frozen dam core. The A&R Plan further mentioned two remediation strategies to avoid this problem: (i) raising the crest of the dam, or (ii) raising the thickness of the esker material cover in tailings area adjacent to the periphery of the tailings cells. Preliminary estimates, as provided in Appendix 3 of the A&R Plan, suggest that the crest of the dam should be raised so that it is 3 m higher than the top of the adjacent cell cover. The studies further suggested that an additional 1 m to 1.5 m of esker cover may be required to sufficiently maintain the active layer within the cover material at the periphery of the tailings cells. However, there is no further discussion on the implementation of any of these two options in the proposed reclamation activities.

Potential Drainage of Thawed Water Within the Relatively Porous Esker Material Cover, Resulting in Reduced Saturation Zone Depth

The measured thaw depth or active layer over 7 year of observations revealed that depths vary depending on the physical characteristics of the cover and tailings, time of placement (winter or summer), climatic and hydrologic conditions, and many other factors which are site-specific. Consequently, the active layer beneath the covered TCA is difficult to estimate without actual field measurements through test pits, field sampling pipes or thermistor readings. The field measurements indicated that the tailings/cover interface is not relatively flat, but may have various depressions, undulations or slopes, depending on site conditions and how the tailings were deposited.

The esker material cover is described as clean gravelly sand to sand and gravel. Permeability of the cover material is estimated to be relatively high, i.e. in the order of 10^{-1} to 10^{-2} cm/sec during thaw conditions (estimated from gradation of the esker material and using Hazen's formula). During this period, it is possible that lateral movement of thawed water within the cover material occurs, leaving some areas of the tailings to have thinner or thicker saturation zone depth, as observed during the test pitting program in 2004.

This issue has not been discussed in the A&R Plan as to whether it will have any impact on determining whether a minimum 0.3 m saturation zone depth can be assured throughout the life of the tailings area after the TCA is returned to its natural environment conditions.

Climatic and Hydrologic Conditions

Section 5.5 of the A&R Plan (pp. 24-25) discussed the implication from the climate and hydrology studies. It indicated that the probability of moisture deficit from the water balance analysis will not likely vary more than 50 mm. The study was based on a monthly water balance prepared from the 21-year series of monthly precipitation and evaporation data derived from the study area. Based on this study, site specific climatic and hydrologic conditions resulted in a water balance in which the tailings TCA will always be submerged with a column of saturated water during the thaw periods in the summer.

The report did not provide a detail analysis in regards to the minimum depth of the saturated water zone that would occur at the site. Is an estimate of 0.3 m derived from an analysis for the site? Appendix 2 of the A&R Plan reported that between 2002 and 2004, the measured saturation zone depths varied between 0.16 m and 1.17 m at the various field sampling pipes within Cell 1. The 2004 test pits indicated measured saturation zone thickness to vary from tailings/esker cover interface (i.e. wetness at the interface) to 0.2 m.

Some saturation zone depths measured during the field tests were less than 0.3 m, although it is assumed that the depths would change monthly based on the fluctuation of the hydrologic data at the site. What would be the long-term effect on tailings material if the saturation zone depth falls below 0.3 m? How frequent, and what portion areas of the TCA would this occur?

Discussion and analysis which are provided in the A&R Plan and its supporting document have not clearly provided definite answers regarding the depth of the saturation zone thickness, critical depths

of the cover material, as well as how potential future changes in climatic and hydrological conditions will affect the oxidation barrier to the underlying tailings material. Therefore, it is critical that the saturated cover concept is cautiously implemented and that thorough monitoring of site conditions during reclamation work is carried out. A follow-up monitoring program needs to be established to ensure that the cover design will function as predicted during the initial portion of the long term monitoring program at the site. In addition, the A&R plan needs to include the tentative long term strategy to remediate, rehabilitate or modify the field program, so that adequate attention can be provided prior to final closure and abandonment of the site, where the TCA will be returned to its natural environment indefinitely and without any further human interventions.

Erosion Protection for the Cover Materials

Available site photos on the perimeter dams inspection report showed that some erosion gullies were developed along the slope of the dams after some severe rainfall events. There is no detail discussion made in the A&R Plan in regards to potential erosion of the cover materials, except for a statement made in Appendix 2 (Section 10.5) that no sign of erosion by surface water was observed on the esker cover. The esker material is identified as clean gravelly sand to sand and gravel, with maximum particle sizes in the order of 75 mm (3 in.). Even at flat slopes, erosion by surface water run-off can occur on clean, gravelly sand materials. In addition, the A&R Plan has not definitely provided a clear strategy for re-vegetation of the TCA during the reclamation work. Consequently, considerations should be made for potential erosion of the gravelly sand esker materials during summer rainfalls, when the cover is thawed. Will the same cover material also be subjected to wind erosion during the summer months? It should be noted that once the reclamation work is completed and the site is abandoned, no further reclamation work will be anticipated. Therefore, considerations should be made whether there will be long-term potential erosion of the cover materials, and whether an erosion protection blanket is required over the esker material cover.

2. Detail of Reclamation Activities

Construction Details Showing the Extent of the Reclamation Activities

A list of missing information related to the proposed reclamation activities are provided in the following.

- Details on the design and construction of spillway at Dam 1A and J Dam are not provided in the A&R Plan.
- What will be the final grade of the covered tailings? Will the final surface be sloped, crowned or flat? What criteria are used for placement of esker material cover? Would uniform thickness criteria (1 m) over existing tailings be used, or should the final grade of the covered tailings meet a certain slope or grades requirements, with minimum of 1 m thickness? The latter would mean that thickness of the cover material may exceed 1 m in areas where existing tailings are depressed or lower than the surrounding area.
- No details and typical section(s) are provided in regards to the thickness of cover materials adjacent to the periphery dams, if required.
- No details and typical section(s) are provided in regards to any additional work to raise the crest of the periphery dams, if required.

- No details and typical section(s) are shown for the installation of rockfill slope protection along the downstream toe of some of the dams, or flattening of the downstream slopes and adding rockfill material for erosion slope protection.
- No details are provided for any external, natural drainage system and final landscaping details for the long term condition of the TCA.
- No selected strategy for re-vegetation option, if any, is provided in the A&R Plan.

Some of the above construction details may, however, be added into the TCA's A&R Plan, as the reclamation activities draw to a close. It is understood that some of the construction activities, such as breaching of the dams, construction of spillway structures, etc. will not be carried out in the first year of the reclamation activities at Lupin.

Reclamation Schedule

No definite schedule is presented in the A&R Plan. A schedule of activities or a bar chart with mile-stones dates would be useful to oversee all of the proposed reclamation activities. This schedule would also be helpful for Kinross to plan and organize their own work force to meet datelines or milestones outlined in the schedule.

Water Quality, Breaching of Dams and Spillway Construction

It is understood that the breaching of Dam 1A and J Dam will not be carried out until the second year of the reclamation program. However, the A&R Plan should provide a detailed analysis on how the two dams will be breached and how the spillway constructions be carried out while ensuring that the quality of water released from Pond 2 into the surrounding environment will meet the guidelines specified in the Water License after closure. Were analyses for the design of the spillway's crests presented under separate reports? If the design of the spillway has been completed previously, a reference to the document should be made in the A&R Plan.

The design analyses would also include the water balance at the TCA site after closure, in which water would flow naturally through the spillway, while ensuring that adequate residency time occurs within the ponds and final outflow from the spillway to the environment will meet the water quality requirements.

Post Monitoring

In addition to the proposed closure monitoring plan indicated in Section 8 of the A&R Plan, monitoring stations to ensure that saturated zone depths are maintained above the tailings and within the esker material cover will be required.

Cost of Reclamation Activities

The cost of the reclamation activities, as shown in Section 9, Table 11 needs to be separated between cost items related to the TCA activities, and other cost items for activities for the remaining of the mine site. It would be useful if two tables were provided in Section 9: one is a table which is similar to Table 11 and contains the reclamation cost for the whole site, and a second table which only contains cost items which directly related to the TCA reclamation activities.

No sources and/or detailed cost analysis, including methods and assumptions used in the calculations were provided for the reclamation cost budget. Was the cost estimate derived from the 2001 estimate prepared by Nuna Logistics Limited, and modified to reflect changes in the A&R Plan, including the reclamation cover strategy from encapsulation concept to the saturated zone cover concept?

3. Other Minor Issues

Some other minor issues related to the TCA's A&R Plan are listed as follows. Most of these are minor deficiencies found throughout the document and need to be corrected.

- Section 6.1 of the Plan, p. 28 – Location of dump stations were not shown on the map in Figure 5.
- Section 7.0 of the Plan, p. 39 - The quarry location is referred to Figure 3 – 2004 Lupin TCA. However, the location was not marked or identified in the Figure.
- Section 8.2 of the Plan, p. 41 – There are no Figures 9 and 10 in Appendix 1. Figure 9 should be changed to Figure 6 (water quality monitoring stations), and Figure 10 should be change to Figure 7 (location of thermistors).
- Section 8.3 of the Plan, p. 42 – There is no Figure 9 in Appendix 1. Figure 9 should be changed to Figure 6 (water quality monitoring stations).

Review Summary

The TCA's A&R Plan has been prepared to follow the condition requirements as stipulated in the Water License, Part I. This plan focuses specifically on the TCA at the Lupin mine, and was based on the 2004 general A & R Plan submitted in February 2005. The A&R plan submitted in February 2005 covers both the TCA and the mine site and its infrastructures. Using the guidelines laid out in the 2001 Interim A&R document, the A&R Plan for the TCA has been expanded to include new data obtained from the various studies as presented in the three appendices. This is to reflect the additional activities which have been carried out since the issuance of the Interim A&R Plan in 2001.

The A&R plan contains detailed background information and technical references related to the mine development at Lupin. The mining operation history, the site geology, and the local environment, as well as requirements for the A&R plan, its background and objectives have generally been satisfactorily presented in sufficient details. The document also provided a summary of the TCA reclamation studies, references to the previous major reports related to the closure plan (Appendix 2), other studies related to the water license requirements and support for the reclamation plan (Appendix 3), as well as ecological risk assessment for the Lupin's TCA (Appendix 3). However, the document still falls short in terms of providing detail descriptions and discussions on the critical issues of the saturated esker material cover concept as presented in this review report, and in the actual execution of the reclamation activities for the Lupin's TCA. The activities which are described in the A&R Plan are generally provided in concept, with no actual details on execution, schedule, and detail activities to be carried out in the Plan.

Recommendations

Based on the review and findings as stated in the previous section, Acres recommends that the following issues are to be addressed and integrated as part of, or as a follow-up, to the submitted 2005 TCA's A&R Plan:

- Further address the issue of ensuring that saturation zone depth above the esker material cover and tailings interface will not be impaired as a result of poor construction activities (grades, degree of compaction, thickness of cover, etc.), or as a result of water draining away from the esker material cover zone during thawing periods, creating lateral flow above the frozen zones or above the tailings and within the thawed zone. No detailed design or further discussions were made in the Plan for potentially raising the periphery dam's crest, or increasing the thickness of the esker material cover along the periphery of the tailings cells so that the depth to the frozen zones is raised and acts as a barrier to lateral water flow.

- Further address the issue of potential erosion of the esker material cover under the long term conditions after the closure of the mine, where the TCA will be returned to its natural environment. Will there be a concern that localized and/or progressive erosion by wind and/or surface water run-off affects the functioning of the cover to provide continuous saturated protection above the tailings? Will future climatic change, extreme weather conditions (such as prolonged droughts) result in circumstances where the tailings may not have adequate protection of an overlying saturated cover?

- A site survey prior to reclamation activities to identify and map the existing ground elevation of the tailings including areas which require reclamation work, existing ground surface for the tailings in the various cells, dams, and ponds, existing ground surface in areas which have been reclaimed and covered with waste rock, and /or with esker granular fill materials. This work may not necessary be a field activity, but may involve gathering existing survey data from the various reports for the TCA, including the annual inspection reports for the dams. It is understood that in some areas of the tailings, esker material cover is over 1 m thick, but there are also some areas which have less than 1 m thickness. In order to construct an adequate cover thickness during the reclamation, the existing site conditions need to be defined and mapped properly.

- Provision of plan details for the reclamation activities for covering the remaining exposed tailings areas. Typical sections and drawings should be provided in regards to thickness of cover, final slopes of the tailings area, final grading and provision of natural drainage system, placements of additional fill materials on the perimeter and interior dams to promote slope stability. Detail drawings of the spillway outlet at J Dam and at Dam 1A shall also be included in the Plan, as this will become an integral part of the reclamation activities.

- Installation of monitoring and sampling stations to ensure that the saturated cover will have adequate thickness, saturation requirements, adequate permafrost depths, etc.

- A detailed schedule for all of the activities outlining the reclamation work at the TCA.

Should you have any further questions or concerns regarding the above, please do not hesitate to contact me.

Yours very truly,

RAH:sep

R. A. Halim, P.Eng.
Senior Geotechnical Engineer

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