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Our File:

Your File:

October 26, 2005

Nunavut Water Board  
P.O. Box 119  
Gjoa Haven, NU  
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Dear P. Dipizzo :

**Re: Lupin Mine Tailings Containment Area Abandonment and Restoration Plan**

On behalf of Indian and Northern Affairs Canada (INAC), I would like to thank the Nunavut Water Board (NWB) for the opportunity to provide comment on the "2005 Abandonment and Restoration Plan, Lupin Mine Tailings Containment Area", prepared by Kinross Gold Corporation ("Kinross") dated June 2005 (the "A&R Plan"). The 2005 Abandonment and Restoration Plan was submitted by Kinross Gold Corporation on behalf of Echo Bay Mines Limited (The Licencee) in accordance with NWB Water Licence NWB1LUP0008 and INAC Land Lease 76E/14-1-9.

INAC previously provided comments to the Nunavut Water Board on the Lupin A&R plan on May 9, 2005 stating:

1. Final approval of Tailing Containment Area (TCA) A&R requires a holistic evaluation of TCA site. The Licensee must demonstrate that all areas and aspects of TCA A&R employ methodology appropriate for permanent TCA closure. This information encompasses, but is not limited to:
  - a. proposed reclamation activities
  - b. progressive reclamation already completed in the TCA
  - c. future monitoring and contingency planning
2. Separate approval of the TCA A&R plan should proceed only if the Licencee can demonstrate that TCA reclamation can be undertaken and completed as an independent A&R component. Following TCA reclamation, interactions with other site components, or the reclamation thereof, should not remain. The Licencee will be required to clearly delineate the geographic boundaries to be encompassed in the TCA A&R.

INAC has reviewed the June 2005 document with the understanding that the A&R Plan is intended to address only the Tailings Containment Area (TCA) for the purpose of allowing review of the proposed reclamation work for the TCA ahead of other areas of the mine property, for which discussions of possible on-going use are underway.

Our review was assisted by the technical consulting firm of Gartner Lee Limited and this review addresses the following fundamental questions:

1. Is the A&R Plan complete with respect to current requirements and best practices such as INAC's Mine Reclamation Policy for Nunavut and other recent, Northern mine reclamation plans;
2. Is the A&R Plan technically sound with respect to thoroughness of study, consideration of alternatives and predicted performance of reclamation measures; and
3. What specific requests, suggestions or recommendations might address any identified technical concerns?

### **1. Approach to the A&R Plan**

Kinross has assumed, in their proposed A&R Plan, that permafrost will be lost in the Lupin Mine area due to climate change within 100 years. With this assumption, a thermal barrier cover over exposed tailings was not considered as a long-term reclamation measure. INAC will provide comment on Kinross' assumption later in this note, but agrees that this approach to managing under proposed climate change in the A&R Plan is conservative.

If permafrost is assumed not to continue occur at the mine site, reclamation of the Lupin TCA will be approached from the same "perspective" as a southern site for prevention and mitigation of acid rock drainage, including measures to securely contain tailings (by unfrozen dams and dykes), to minimize oxidation of tailings (often through water cover) and to prevent, minimize or control the transport of contaminants from tailings (such as through low permeability soil covers, diversion ditches, water treatment systems and groundwater interception systems). Kinross has described assessments of dam stability (based on fully-thawed conditions in the dams) and cover design (which relies on low permeability of the tailings to maintain a perched water table in the cover material).

### **2. Concerns**

INAC has attached a listing of initial concerns and questions related to the A&R Plan, but has described several immediate concerns below, primarily on the long-term performance of the proposed water retention cover. INAC suggests that these immediate concerns need to be resolved by Kinross before approval of the A&R Plan.

INAC's technical reviewers have identified:

- a substantive error in the site water balance;
- the assessment of contaminated porewater seepage is based on continued permafrost conditions which is in contradiction with other aspects of the A&R Plan;
- a lack of scientific validation of the soil cover design for long-term performance;
- a lack of design detail regarding the proposed water cover, which covers approximately 50% of the TCA-disturbed area; and
- an absence of contingency planning and risk analysis.

### **3. Water Balance**

An inadvertent error may have been made in the development of the water balance that could affect the A&R Plan. Specifically, the development of the "Operating Case" water balance appears to misapply the total area of the TCA to estimate runoff over land rather than the (intended) area of land only, excluding water bodies. Correction of this error could change the "Operating Case" from a net positive water balance to a net negative water balance in Pond 2 which, in turn, could substantively affect the predicted "Closure Case" water balance. Further discussion is provided in the attached listing of comments.

Related to the water balance are some concerns regarding the water quality information. A typographic error may be carried through the A&R Plan with the values for two parameters being identical (a rare occurrence). Also, water quality in the receiving environment is not discussed.

### **4. Porewater Seepage**

Kinross' assessment of porewater seepage appears to be based on the continued presence of permafrost in the tailings, which is contradictory to the fundamental approach in the A&R Plan that climate change will cause permafrost to be lost within 100 years. For example, the basis of the cover design and the assessment of dam stability assume fully-thawed conditions whereas the assessment of possible mechanisms of seepage loss appears to be based on continued frozen conditions in the tailings. These differences will have implications for the A&R Plan since thawing of the tailings could release the assumed contaminated porewater to the environment.

One of the measures proposed by Kinross for reducing the risk of "lateral seepage" from the TCA is to increase the thickness of the granular cover along the upstream sides of some dams such that permafrost aggrades upwards into the cover to serve as a seepage barrier. This concept is at odds with the fundamental assumption of the loss of permafrost within a 100-year time frame.

## **5. Soil Cover Design**

Water-retention within the granular cover to serve as an oxygen-barrier, as is described by Kinross in the A&R Plan, is not a new concept for reclamation of acid generating tailings, however few case studies exist where such covers have been constructed and monitored. In the case of the Lupin TCA, Kinross proposes that the low permeability of the tailings will maintain perched, saturated conditions in the granular cover. Kinross suggests that this approach has been demonstrated effective by the results of their on-site test programs, which have been undertaken since 1995. Several concerns with this approach are not addressed in the A&R Plan such as:

- the on-site tests are not adequate validation for long-term performance. A level of “science”, possibly including permeability and gradient testing and water balance sensitivity analyses, is necessary to demonstrate that the results of the on-site tests can reasonably be extrapolated over the long-term closure time frame;
- the results of the observed field test programs, conducted under permafrost conditions, have not been reconciled with the assumed loss of permafrost in the future (i.e., are current and recent results applicable to thawed conditions?);
- Under thawed conditions, as assumed by Kinross’ A&R Plan for the minesite, the tailings will allow some level of infiltration by runoff and precipitation water and this water will displace existing porewater or simply emerge elsewhere, likely as contaminated porewater seepage. The A&R Plan has not assessed what amount of runoff and precipitation water could infiltrate into the tailings and the effects on the receiving environment.

INAC’s concern over the proposed soil cover design is that, under thawed conditions, contaminated seepage could occur from the TCA if the base of the cover does not remain saturated and oxygen penetrates to the tailings and acid rock drainage occurs. Some of the “older” southern mine sites that provided the initial examples of lag times and the general seriousness of acid generation issues were configured with relatively flat-lying acid generating tailings under a cover of local, high permeability soil. In our view, the A&R Plan does not adequately validate the cover design for long-term performance under either thawed or permafrost conditions nor does it provide sufficient risk analysis. Further discussion is provided in the attached listing of comments.

## **6. Water Cover Design**

Approximately 50% of the area to be reclaimed is proposed to be reclaimed under a water cover. Kinross provides only a conceptual description of what depth of water is proposed and provides no discussion of how shoreline areas are proposed to be reclaimed to prevent the physical movement of tailings through mechanisms such as ice plucking and

wave erosion. Further, the A&R Plan does not provide a detailed water balance sensitivity assessment of possible changes in the depth of water cover due to dry or wet years.

This omission in the A&R Plan is a substantive and should be addressed. INAC agrees that water cover, in theory, is an acceptable approach as a long term reclamation measure. However, the explanation is inadequate on the for achieving and maintaining of the water cover over the long term for this site.

## **7. Contingency Planning**

The contingency plans in the A&R Plan are not adequate. These plans should explain how potentially problematic occurrences can be managed appropriately according to pre-authorized approaches without the need for time-consuming re-designs, reviews and approvals. Contingency plans should be linked to an appropriate monitoring program to provide action thresholds. The topic areas to be included could consider:

- Localized drying of the cover;
- Widespread drying of the cover;
- Emergence of greater than anticipated tailings porewater seepage;
- Emergence of poorer quality than anticipated tailings porewater seepage;
- Onset of increased acid generation/metal release within the tailings;
- Complete or partial failure of one of the perimeter dams; and
- Erosion of the cover soils due to channelization of surface flows.

## **8. Monitoring Program**

A fundamental commitment of the monitoring program should be that no changes to the intensity or other aspects of the program will be implemented until they have been approved. Changes to the monitoring program, whether an increase or decrease in intensity, should be based on the results of the monitoring program to date and should not be pre-set at the outset of the reclamation work.

The A&R Plan anticipates changes to the monitoring program but should explicitly state this commitment, as has been the case for other, recent, Northern A&R Plans.

Further, based on the proposed cover design, the monitoring program should include a more intensive effort for monitoring water content within the cover and tailings throughout the TCA and also monitoring of ground thermal conditions throughout the cover and tailings.

## **9. Climate Change**

Although INAC believes that climate change theory should be taken into account within the A&R plan, Kinross has not provided adequate robustness in the plan if the climate predictions are incorrect. In its annual reports to the Nunavut Water Board, Kinross has indicated that permafrost has come into the tailings that have already been covered. Kinross should provide better justification for its assumption of loss of permafrost and its contingencies if the assumption is incorrect. The local data should be reconciled with published scientific knowledge regarding climate change in polar regions, especially the Canadian Arctic.

## **10. Overall Conclusions**

With reference to the three fundamental questions in this review:

- I. The A&R Plan is incomplete with respect to current requirements and best practices such as INAC's Mine Reclamation Policy for Nunavut and other recent, northern mine reclamation plans. Specific examples would be the areas of reclamation cost estimating and demonstration of long term environmental protection with a reasonable level of confidence;
- II. The A&R Plan is not technically sound in all areas; specific examples would be the water balance for the "Operating Case" and the assessment of porewater seepage under thawed conditions; and
- III. Specific requests, suggestions and recommendations that might address the identified technical concerns are provided herein.

## **11. Overall Recommendations**

The Lupin TCA is an existing site that has been undergoing progressive reclamation measures. Further reclamation should be implemented in order to minimize further environmental degradation (oxidation or wind dispersion of tailings, for example). However, the proposed long-term reclamation measures should be demonstrated and understood to provide reasonably confident means of providing long-term environmental protection before they are approved or implemented.

For this A&R Plan, further technical work should be conducted before it is approved because the A&R Plan contains substantive errors and omissions and does not provide a reasonable level of study and confidence in the long-term performance of the proposed covers (soil and water).

An efficient means of addressing and resolving the concerns outlined in this letter would be direct communications between Kinross and our technical experts, possibly through a technical meeting, similar to the model of a meeting of technical experts (proponent, their technical consultants, technical consultants for the NWB, and technical consultants for INAC) used at an early stage of the Reclamation Plan for the Nansivik Mine.

Finally, INAC recognizes that Kinross has invested time and resources into progressive reclamation and has covered a significant portion (~60%) of the TCA with approximately one meter (1 m) of granular esker material. This work has immediate and positive benefits of helping to eliminate wind dispersion of tailings. This progressive reclamation work should form a part of the ultimately approved A&R Plan. However, Kinross should acknowledge the risk that the currently constructed cover may not correspond with the ultimate cover design. For example, one approach to water retention covers requires a coarser-grained material at the base of the cover to create a capillary break and, in this case, the esker granular soil may not be able to serve this function in the event that this type of cover is necessary. Therefore, INAC is raising this issue so follow up technical work can proceed as quickly as possible.

For additional comments on specific topics see the attached document. If you have any questions or concerns contact Spencer Dewar, Land Administrator Specialist at (867) 975-4283, or myself at (867) 975-4550.

Jim Rogers  
Manager, Water Resources  
Nunavut Region

## **Comments, Concerns and Suggestions Regarding the Lupin TCA A&R Plan**

These comments are organized according to the following topics:

Ownership and Management;  
Reclamation Objectives;  
Operating History;  
A&R Planning Background;  
Climate Change;  
Dam Stability;  
Soil Cover Design;  
Water Cover Design;  
Design of Spillways and Other Earthworks;  
Links to Reclamation of Other Mine Components;  
Environmental Site Assessment of TCA;  
Revegetation;  
Water Quality Criteria;  
Receiving Environment;  
Risk Assessment;  
Contingency Planning;  
Reclamation and Closure Monitoring;  
Reclamation Schedule;  
Reclamation Costing; and  
Miscellaneous Editing Comments.

### **1. Ownership and Management**

Section 1.1.2 describes a corporate “Reclamation Operations Business Unit” within Kinross Gold Corporation but does not explain whether, or how, this management structure may apply to reclamation of the TCA. The A&R Plan should describe the general corporate management structure and key management positions within Kinross Gold Corporation and any relevant subsidiaries. This should include general areas of accountability relevant to reclamation of the TCA.

In it’s most direct form, the question, “Who, by job position and corporate entity, is accountable for reclamation of the TCA?” should be answered.



## **2. Reclamation Objectives**

“Objectives for the Abandonment and Restoration Plan” are described in Section 3.1, summarized in the A&R Plan primarily in the form of 5 bulleted statements. Several comments apply to these statements as follows:

re. bullet 1, ‘the wording “...no danger to...” should be amended to “...an acceptable level of risk that is consistent with the natural environment...”, or similar, in recognition that risk/danger can not be completely eliminated at any site;

re. bullet 2, we simply suggest that the wording “...is minimal or nil;” be amended to “... is minimized.”, or similar, as a more clear statement of the objective; and

re. bullet 3, the wording “.. minimized or prevented;” is not appropriate for this objective regarding the release of contaminants to the environment; the release of contaminants must be managed to meet an appropriate standard that either stems from accepted references such as the Canadian Environmental Quality Guidelines or that is derived specifically for this site based on the assimilative capacity of the receiving environment; “minimizing” contaminant releases is not an acceptable objective because it could provide an “open-door” for degradation of the receiving environment based on an undefined determination of “minimiz ed”; *in fact, the A&R Plan (post Section 3.1) adopts the continued use of the current water licence Effluent Quality Criteria (EQC) as a specific criterion for water quality exiting the TCA.*

Further to Section 3.1 of the A&R Plan, the final paragraph suggests that “...exposed tailings in the TCA will ultimately be covered by a 1-metre thickness of esker material.” (line 2/3). This statement should be amended to recognize that the 1-metre cover of esker material for the purpose of long-term reclamation of the exposed tailings is a proposal before the Nunavut Water Board and INAC that has not yet been approved.

The first paragraph of Section 6.0 also expresses that “The goal of the restoration practices in the TCA is to minimize or preferably eliminate degradation of disturbed areas and to initiate, encourage and accelerate the natural recovery. ”. This stated goal is not completely complementary to the objectives stated in Section 3.1 and should be amended accordingly. INAC also suggests that usage of the terms “objective” and “goal” be re-considered according to common and consistent usage of these terms.

## **3. Operating History**

The “metallurgical processing” process is described in Section 2.4. Of particular relevance to the A&R Plan is an understanding of the processing reagents that were used and their instantaneous and cumulative addition rates. This understanding would be greatly enhanced if the A&R Plan included a clearly-illustrative flowsheet of the processing circuits

that clearly identified typical reagent addition points and rates. For example, an understanding of cyanide levels in the tailings and associated waters would be enhanced by an illustrative description of the origin of the cyanide in the metallurgical process. A summary listing of reagents used would also be helpful.

The physical distribution of tailings in the TCA is also an important component of a description of current conditions. A figure(s) should be provided that clearly illustrates the locations and thicknesses of tailings (both exposed and underwater) and that identifies the significant “generations” of tailings placement based on years or changing processing parameters. This would provide a necessary description of current conditions to serve as the “starting point” for assessing the proposed reclamation activities.

#### **4. A&R Planning Background**

Section 4 of the A&R Plan provides a summary of the history of A&R Planning as regards regulatory submissions that is very helpful to understanding the current A&R Plan. Following are several suggestions that would make this section more useful:

Re. 1985, what were the alternatives for reclamation of the TCA that were discussed at that time?;

Re. 1995-2000 para. 1, what was the proposed approach to reclamation of the TCA at that time?; and

Re. 2005 (new), add the submission of the January 2005 A&R Plan, subsequent discussions around isolating the TCA and the subsequent submission of the current (June 2005) A&R Plan for the TCA.

#### **5. Climate Change**

The approach to managing climate change is described in Section 5.1 of the A&R Plan. In short, the A&R Plan is based on the assumption that the TCA area will not be continuous permafrost within a timeframe in the order of 30 to 110 years. This is based on an extrapolation of temperature trends measured at or local to the Lupin mine site since around 1960.

This is a critical assumption on the part of the A&R Plan because it leads to the proposed strategy of constructing a saturated soil cover instead of a thermal barrier cover as has been implemented at other Northern sites, primarily in the High Arctic.

While this is a conservative approach to managing climate change in some respects, INAC suggests that the local data needs to be reconciled with the larger body of scientific knowledge that has been published regarding climate change in the Canadian Arctic. This is necessary to ensure that the selection and design of long term reclamation measures

is based on a thorough and complete assessment of all available, relevant data.

## **6. Dam Stability**

The A&R Plan assesses the long term stability of residual dams under fully thawed conditions and uses the Canadian Dam Association Guidelines for relevant minimum factors of safety. Further, the A&R Plan states that all downstream slopes will be reduced to 2.5:1 with rip rap rock. INAC agrees that this approach is adequate for dam stability analysis.

INAC notes that a number of minor concerns have been raised from time to time under the professional annual geotechnical inspections. INAC note that these concerns should continue to be identified and responded to on an on-going basis and that any implications regarding long term stability should be incorporated into the A&R Plan.

## **7. Soil Cover Design**

### **7.1 General**

As a point of clarification, INAC notes that the “two parts” to the proposed soil cover (Section 5.1, para. 7) are both proposed to be constructed with the same material, esker gravel. The total (combined) proposed design thickness of the cover is 1.0 m, which includes both “layers” and which is entirely constructed of esker gravel.

INAC makes the following comments regarding the stated advantages of a saturated granular cover as stated Section 5.1 para. 8:

Re. sensitivity to climate change, INAC agrees that the design is not sensitive to thawing or loss of permafrost conditions in the tailings, however, has the proponent considered other possible aspects of climate change such as increased evaporation/evapotranspiration?;

Re. the ability of the saturated granular cover to support vegetation, the positive inferences in Section 5.1 appear to be at odds with subsequent, less favourable inferences re. revegetation (Section 6.6);

Re. the reduced development of esker deposits, this is true but we suggest that this is not a “driving” factor in the selection of cover design.

### **7.2 Porewater Expulsion**

The assessment of potential talik formation beneath the (currently) frozen dams was conducted for a 20-year timeframe (Section 5.4, para. 4). A rationale needs to be provided as to how representative the assessed 20-year timeframe is of the much longer timeframes that are typically assessed for final mine reclamation.

The assessment of consolidation of tailings as a mechanism for porewater expulsion appears to be based on current thermal conditions (i.e., that the depth of thaw in tailings is 2 m). There needs to be an assessment under long term thermal conditions wherein the depth of thaw might increase due to the extrapolations of progressive climate change that were described in Section 5.1 of the A&R Plan. In short, the A&R Plan should describe how the rates of MATT warming and other extrapolated climate change factors could affect the potential for porewater expulsion. This would correspond to the conservative approach taken for dam stability (i.e., thawed conditions in dams) and soil cover design (i.e., loss of permafrost in tailings).

Re. the assessment of lateral flow in the active layer, this assessment is based on an assumption of continued frozen conditions in the dams and in the tailings, which is at odds with the approach taken for assessment of dam stability and cover design. The A&R Plan should assess the implications on porewater seepage from warming of the MATT and other extrapolated climate change factors.

Re. the proposed means of reducing the risk of lateral seepage, we feel that the proposed approach requires further discussion and design. For example, the thickness of esker gravel that would be required to raise permafrost into the cover material is inferred to be +1m (i.e., 2 m total thickness); however, there is no justification that 2 m thickness is adequate and no design as to what “width” of tailings should be covered to provide a meaningful reduction of risk. Further, there is a concern whether the proposed means of reducing the risk of lateral seepage may create a larger risk of creating a “pool” of unfrozen water situated within frozen boundaries created at the dams and that this pool of unfrozen water would promote increased thawing of tailings and other resultant concerns. The A&R Plan should more thoroughly investigate the effectiveness and implications of the proposed means of reducing the risk of lateral seepage.

### 7.3 Water Balance

There is an error in operations water balance outlined in Section 6.4 and Table 6.4 of Holubec (2005). Essentially, the water balance applies the total TCA area of 616 ha for the land area instead of 281 ha. Corrected, this gives an average land runoff value of 511,785.3 m<sup>3</sup>, less than half of what the A&R Plan predicts (1,122,000 m<sup>3</sup>). This results in an average loss of water in Pond 2 of 398,116 m<sup>3</sup> versus the predicted 212,000 m<sup>3</sup>.

This incorrect land area is carried through the operational water balance and therefore this error subsequently results in an incorrect estimation of the final accumulated volume in Pond 2 of 4,900,000 m<sup>3</sup>. This volume is then carried over and used as the volume of water that will have to be discharged before Pond 2 is restored to its original level and Dam 1a breached.

The concern with respect to this error is that the water balance does not reconcile and

therefore the statement on page 37 of Holubec (2005) is incorrect, "...water balance assumptions and parameters that were used in the before and after TCA water balance are realistic".

The operational water balance should be corrected and reconciled with the changes in water level seen in Pond 2. The A&R Plan then should discuss the implications of changes in the revised water balance on present and future water management at the site.

It is also quite unclear how the water balance work carried out by Golder and discussed in Section 6 of Studies Related to Water Licence Requirements is, if at all, incorporated into the overall TCA water balance.

#### 7.4 Water Quality

The A&R Plan presents a limited amount of water quality data that is not adequate to assess the trends in water quality at the site, and specifically Pond 2 the ultimate discharge water. Only 2 years of data are presented for Pond 1 and Pond 2. The A&R Plan should also summarize any SNP data that might be useful and available.

There may be an error in either the zinc or nickel concentrations in Holubec Table 9.5, Water Quality in Cell 1 Ponded Water. Both zinc and nickel concentrations are exactly the same which is extremely rare. The values for these parameters should be clarified and corrected, if necessary. This same error is carried through to Table 4 of the A&R Plan.

#### 7.5 Ability to Maintain Saturated Conditions

The A&R Plan states that "...it is considered likely that partial saturation can be maintained within the cover..." (Section 5.5, para. 6). However, the A&R Plan does not define the term "likely" and its implications nor does the A&R Plan provide any scientific backup for the statement.

Water-retention covers to serve as an oxygen-barrier are not a new concept for reclamation of acid generating tailings, as is described by Kinross in the A&R Plan. However, there are very few case studies where such covers have been constructed and monitored. The studies of water retention covers are typically founded on one of two principles:

the principle of a "capillary break" to retain water in a finer-grained soil that directly overlies a coarser-grained soil with a physical and evaporation-protection layer on surface; or

in arid areas, a soil with high moisture-retention properties is selected and placed in sufficient thickness to prevent net evaporative losses.

In the case of the Lupin TCA, Kinross proposes simply that the low permeability of the tailings will be sufficient to maintain perched, saturated conditions in the granular cover. Kinross suggests that this approach has been demonstrated effective by the results of their on-site test programs, which have been undertaken in some form since about 19xx. Gartner Lee has several fundamental concerns regarding this approach that are not addressed in the A&R Plan such as:

the on-site tests are not adequate validation for long-term performance; a level of “science”, possibly including permeability and gradient testing and water balance sensitivity analyses, is necessary to demonstrate that the results of the on-site tests can reasonably be extrapolated over the long-term closure timeframe;

the results of the observed field test programs, which have been conducted entirely under permafrost conditions, have not been reconciled with the assumed loss of permafrost in the future (i.e., are current and recent results applicable to thawed conditions?);

Under thawed conditions, as are assumed by Kinross for the minesite, the tailings will allow some level of infiltration of runoff and precipitation water and this water will displace existing porewater or simply emerge elsewhere, likely as contaminated porewater seepage; the A&R Plan has not assessed what amount of runoff and precipitation water could infiltrate into the tailings and what implications this would have for the receiving environment; and

The geochemical assessment of the tailings is not provided in the A&R Plan but is referenced as having been completed in 1991 to 1993 by Klohn-Crippen Consultants Ltd. (Section 6.3); Gartner Lee simply notes that there have been advances in the methods for testing and interpretation for geochemical characterization and predictive geochemistry related to mine tailings; therefore, a technical review of the 1993 information would be of interest to either validate the previous conclusions or, possibly, to suggest new interpretations and options for managing acid rock drainage; this will be particularly relevant to the development of groundwater seepage quality predictions as recommended above.

In short, our primary apprehension regarding the cover design is that, under thawed conditions, the TCA could become a serious environmental problem wherein the cover does not remain saturated and acid rock drainage occurs as has been observed for many years at southern, unmitigated sites. In fact, many of the “older” southern mine sites that provide some of the initial examples of lag times and general seriousness of acid generation issues were configured with relatively flat-lying acid generating tailings under a cover of local, high permeability soil. In our view, the A&R Plan does not adequately validate the cover design for long-term performance under either thawed or permafrost conditions.

Our specific suggestions for the initial steps to addressing this concern include:

- a) Re-assess the water balance with corrections as necessary;
- b) Re-assess the field monitoring results in the context of the future loss of permafrost;  
develop (and provide) engineering estimates of tailings permeability, focussed primarily on surficial tailings;
- c) Re-assess (and provide) the predictive geochemical testing of the tailings in the context of thawed conditions
- d) Assess the rates, quality and discharge locations for porewater seepage under thawed conditions;
- e) Develop a water balance for the receiving environment that predicts water quality;
- f) Assess the 100-year climate change scenario based on local observations in the context of the general scientific knowledge regarding climate change in the central Arctic to cross reference with wider-based studies; and
- g) Assess, as an alternative cover design, the thickness of a thermal barrier cover that would be required to maintain permafrost in tailings under alternate climate change scenarios.

#### **7.6 Alternatives**

Section 6.6 of the A&R Plan briefly describes alternative forms of covers that were considered.

Paragraph 2 describes an approach that would incorporate an ice lens at the base of the cover. The A&R Plan states that this approach is not desired because it would require winter construction and awkward quarrying of granular soil in the winter. This approach might also require a soil cover that is thicker than 1.0 m in order to ensure that the ice lens at the base of the cover remains frozen. However, we feel that this approach would offer the advantage of providing a possible “dual approach” wherein the saturated layer oxygen barrier may exist in conjunction with frozen conditions in the tailings. We suggest that this approach be further investigated because of its potential benefits in reducing risk over the long term.

#### **8. Water Cover Design**

Section 6.4 of the A&R Plan states that water cover will be maintained “over areas that are currently used for water retention and low elevation tailings deposition (ponds)” (para.2, bullet no.1). Table 8 of the A&R Plan indicates that Ponds 1 & 2 combined account for approximately 50% (~1.8 million m<sup>2</sup>) of the TCA-disturbed area and makes no mention of whether there are other “low” areas.

The A&R Plan provides a conceptual description of what depth of water is proposed. However, the A&R Plan provides no design for the depth of water cover, no drawings of the tailings surface to be covered, nor any discussion of how shoreline areas are proposed to be reclaimed to prevent the physical movement of tailings through mechanisms such as ice plucking and wave erosion. Further, the A&R Plan does not provide a detailed water balance sensitivity assessment of possible changes in the depth of water cover due to flood or drought years.

This is a substantive omission of the A&R Plan that should be addressed. We agree that water cover, in theory, is an acceptable approach as a long term reclamation measure. However, adequate thought has not been provided to justify how a water cover will be achieved and maintained over the long term for this site.

### **9. Design of Spillways**

The A&R Plan provides a conceptual level description of permanent discharge spillways related to the TCA. The spillways should not be approved except, possibly, in a conceptual sense based on the current A&R Plan.

Prior to the commencement of any construction activities related to the spillways, a detailed engineering design report(s) should be provided and reviewed. These should include, at a minimum, fully documented geotechnical investigations of surface and subsurface conditions (permafrost, soils, rock) along the alignments, evaluation of alternative alignments and alternative designs, review and rationale for selected hydraulic (flood) design parameters, detailed engineering design drawings and specifications, monitoring plan, maintenance plan, contingency plan, and schedule.

### **10. Links to Reclamation of Other Mine Components**

Construction steel, cleaned scum or plastic pipe and other salvage items should be stockpiled at the mine site proper until the determination of possible on-going use has been resolved. These types of materials could be useful to other, future uses of the site.

### **11. Environmental Site Assessment of TCA**

An Environmental Site Assessment (“ESA”) of the TCA should be undertaken. The specific areas of potential environmental concern would include: the tailings line (possible historic breaks and spills), tailings dump ponds (possible historic leakage or overflows), any historic fuel storage or dispensing locations (possible spills), and possible dispersion of wind-blown tailings.



An ESA is the recognized means of following a standard and accepted protocol to document and investigate these types of environmental concerns.

## **12. Revegetation**

Section 6.7 of the A&R Plan states that “the harsh environments associated with the area can make it difficult, if not impossible, to carry out a successful revegetation program”. The A&R Plan goes on to reference experience reported by others in Alberta regarding a “high alpine” environment. Notwithstanding that case studies of revegetation in the central Arctic are few, we feel that reference to experience in a high alpine (i.e., mountainous) environment is not relevant or helpful to the Lupin TCA.

Further, Section 1.5.3 of the A&R Plan suggests that the area is “...typified as having a generous amount of low lying vegetation extremely tolerant and well adapted to the climatic conditions” and that “Plentiful and diverse amounts of vegetation can be found everywhere...”. We suggest, therefore, that stronger consideration should be given to revegetation of the TCA.

The A&R Plan states, in fact, that test cover areas from 1998 and 1995 have both started to re-vegetate on their own. This is in spite of the stated poor qualities of the esker granular soil as regards providing a growth medium.

The A&R Plan described two methods of encouraging colonization with natural species: sod transplanting; and surface preparation through addition of “heavy” material, surface scarification and contouring to avoid erosion and ponding. The A&R Plan does not, however clearly indicate whether these measures are planned to be undertaken and, if so, by what means and in what level of effort.

A revegetation plan should be prepared that thoroughly assesses the potential for enhanced colonization by natural species and that clearly states what enhancement measures are proposed to be implemented. This is of particular interest regarding sod transplanting which is stated as being a “viable method of revegetation” that “has been successful on Cell 1A” (Section 6.7, para. 6).

## **13. Water Quality Criteria**

The implied criteria in the A&R Plan for water quality exiting the TCA is the current water licence effluent quality criteria (“EQC”).

There should be some discussion in the A&R Plan of water quality in the receiving environment, both current and predicted. The predictions should then be taken forward

into the risk assessment.

#### **14. Receiving Environment**

Section 1.5, Local Environment, provides only a cursory mention of the downstream aquatic environment (Section 1.5.4, para. 2, line 7/8). A thorough description of the aquatic environment, including a clearly illustrative figure, is important and should be provided. Aquatic resources are an integral component of the local environment and the information is necessary to allow an understanding of the level of environmental protection and risk reduction provided by the proposed reclamation measures.

There is no discussion on the receiving water environment. Although, Kinross mentions the EEM study plan, INAC feels a better summary should be provided in the main document basically providing a cursory assessment of the water quality and aquatic habitat conditions presently existing in the downstream receiving environment.

#### **15. Risk Assessment**

Parts of the Ecological Risk Assessment may require amendment depending on the possible resolution of some of the concerns and questions described above. If this is the case, then the ERA should be thoroughly reviewed at that time.

We understand the ERA to identify a potential risk to individual shorebirds and of possible metal uptake in vegetation. However, no specific monitoring or mitigation plans are proposed for these items.

A Human Health Risk Assessment was not deemed necessary. This assumption is questionable given that human health risks have been the clear driver over and above ecological risk in two recent, Northern mine reclamation case studies, Polaris and Nanisivik. This assumption and the omission of an HHRA should be more thoroughly justified, with particular emphasis on the implications on human health risk related to possible on-going use of the mine site.

#### **16. Contingency Planning**

The A&R Plan does not provide adequate contingency planning. These plans are an essential part of a mine reclamation plan because they attempt to making sure that potentially problematic occurrences can be managed appropriately according to pre-authorized approaches without the need for time consuming designs, reviews and approvals.

Contingency plans should be provided that are linked directly to an appropriate monitoring program to provide action thresholds. The topic areas to be included could consider:

- a) Localized drying of the cover;
- b) Widespread drying of the cover;
- c) Emergence of greater than anticipated tailings porewater seepage;
- d) Emergence of poorer quality than anticipated tailings porewater seepage;
- e) Onset of increased acid generation/metal release within the tailings;
- f) Complete or partial failure of one of the perimeter dams; and
- g) Erosion of the cover soils due to channelization of surface flows.

### **17. Reclamation and Closure Monitoring**

A fundamental commitment of the monitoring program should be that no changes to the intensity or other aspects of the program will be implemented until they have been approved. Changes to the monitoring program – whether increasing or decreasing in intensity – should be based on the results of the monitoring program to date and should not be pre-set at the outset of the reclamation work.

The A&R Plan anticipates changes to the monitoring program but should explicitly state this commitment, as has been the case for other, recent, Northern A&R Plans.

Based on the proposed cover design, the monitoring program should include a more intensive effort for monitoring water content within the cover and tailings throughout the TCA and also monitoring of ground thermal conditions throughout the cover and tailings.

### **18. Reclamation Schedule**

A schedule should be provided that shows the anticipated sequence and duration of events from present through the proposed monitoring periods.

### **19. Reclamation Costing**

The “Reclamation Budget” (Section 9 of the A&R Plan) provides summary cost estimates but no breakdown of those cost estimates according to unit costs and material quantities. The cost estimate as provided does not allow for a review or discussion of the reasonableness of the proposal.

### **20. Miscellaneous Other Comments**

Both Bathurst Inlet and Umingmaktok are closer to the mine site than is Kugluktuk (executive summary, para. 3, line 2).

Section 6.1 of the A&R Plan describes that the tailings line will be “flushed thoroughly with clean water” (para. 3). The A&R Plan should describe how the contaminated flush water will be disposed.

Section 6.1 of the A&R Plan describes that roads will have culverts removed and that road surfaces will be “ripped/scarified to provide microclimate sites for seed deposition” (para. 5). The A&R Plan should discuss the scheduling of such work for some roads that would allow access to the TCA for both short and long term monitoring and maintenance activities. Some or all of the roads will be required to provide monitoring and maintenance access for some time into the future or an alternate means of access needs to be provided.