ATTACHMENT #1

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MEMORANDUM

To:	**INAC-CARD**	**Fax No.:**	**Via email**
Attention:	**Emma Pike**	**CC:**	
From:	**Geoff Claypool**	**Date:**	**June 9, 2008**
Subject:	**Damage Criteria Assessment, Discovery Mine Airstrip, Access Road and Apron**		
No. of Pages (including this page): 16		**Project No:**	**0131-056-01**

1.0 INTRODUCTION

The Discovery Mine airstrip, access road and apron area are currently utilized by Tyhee NWT Corporation (Tyhee) to support their ongoing, nearby mineral exploration activities. The ongoing use of these structures is considered to have the potential to impact, and affect the performance of, the underlying cover in these specific areas. Thus, a method of determining if the cover has been compromised or damaged through ongoing use of these structures is required for ongoing monitoring purposes. As such, it has been proposed that damage criteria for the cover in these areas be developed. The purpose of developing damage criteria is to develop a clear and transparent method of identifying and assessing the significance of impacts to the cover materials beneath the airstrip, access road and apron area associated with ongoing use of these structures.

A preliminary list of potential damage criteria was developed by BGC and provided to INAC in a memo dated May 9, 2008. These preliminary damage criteria were reviewed in a meeting held in the EBA Engineering Consultants Ltd. office in Edmonton, Alberta on May 14, 2008. The meeting was attended by the following people:

- Emma Pike – Contaminants and Remediation Directorate – Indian and Northern Affairs Canada (INAC)
- Tony Brown – Contaminants and Remediation Directorate – INAC
- Clint Ambrose – Resource Management Officer – INAC
- Nahum Lee – Resource Management Officer – INAC
- Geoff Claypool – BGC Engineering Inc. (BGC)
- Ed Hoeve – EBA Engineering Consultants Ltd. (EBA)
- Hugh R. Wilson – Tyhee NWT Corp (Tyhee)

During the meeting, the preliminary damage criteria, and the method by which they were developed, were reviewed. The damage criteria were developed by undertaking the following tasks:

- A general review of previous studies and observations related to the physical integrity of the cover along the airstrip, access road and apron area.
- A screening level Failure Modes and Effects Analysis (FMEA) was undertaken to determine the potential failure modes for the cover in specific areas and assess the potential effects of each failure mode with respect to cover performance.
- A list of potential qualitative and quantitative assessment methods was developed to assess the failure modes identified during the FMEA.
- A list of damage criteria that could subsequently be used to assess the significance of inspection observations was developed.
- A list of potential contingency measures that could be implemented should the damage criteria be exceeded was developed.

As a result of the meeting, the final damage criteria for the Discovery Mine airstrip, access road and apron area were selected, with input from the various participants. This memorandum documents the results of the damage criteria assessment and provides context and rational associated with the development of these criteria on a task by task basis.

2.0 BACKGROUND REVIEW

2.1 Cover Design and Objectives

The Discovery Mine tailings cover was constructed between 1998 and 2000. In the uplands areas, the cover design consists of 300 mm of fine-grained silty clay material overlain by 300 mm of minus 100 mm armour rock. As stated in PWGSC (1997)[1], the objectives of the cover include the following:

- Minimize the potential erosion and physical failure of the reclaimed areas that could result in mechanical or geochemical dispersion of mercury and other metal contaminants into aquatic systems and vegetation; and,
- Reduce mobilization of mercury and other metals into surface and groundwater and uptake of these contaminants by biota.

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1 Public Works and Government Services Canada 1997. Project Brief, Project Number 658990, Discovery Mine, N.W.T., Verification – Capping Design and Environmental Monitoring Program In Reclamation of Mine Tailings and Waste Dump, Dec 4, 1997.

Based on the original design work, the potential transportation of contaminants by physical processes such as erosion by wind and water is considered to be far more likely to impact the receiving environment, should it occur, than transportation of contaminants by groundwater flow. Thus, processes that have the potential to lead to increased infiltration rates are considered to be less significant than processes that may result in exposure and physical transport of tailings. Nonetheless, processes and practices that could promote infiltration are not desired.

2.2 Airstrip, Access Road and Apron

The airstrip is part of the cover. It is founded on tailings and includes an extra 100 mm thickness of minus 20 mm crushed granular material at surface for improved trafficability. The current use of the airstrip includes light aircraft (Buffalo, Twin Otter, Dash 7, Caravan) to support nearby mineral exploration activities conducted by Tyhee and, on a less regular basis, ongoing monitoring activities conducted by INAC. The west edge of the airstrip is also used regularly by light vehicle traffic to support Tyhee's camp activities.

An access road was constructed between the Tyhee camp, located at the West Quarry, and the airstrip to permit vehicle traffic between the camp and the airstrip. The access road currently consists of approximately an extra 300 to 400 mm of coarse armour rock applied to the surface of the original tailings cover (i.e. total armour rock thickness of 600 to 700 mm) which was applied by Tyhee in September 2005. Prior to September 2005, traffic between the camp and the airstrip drove directly on top of the original tailings cover.

The apron area is located near the confluence of Area 7 and Area 9F. The apron area is used as a staging area for supplies loaded onto and from aircraft. No modifications to the original cover design have been implemented to-date in the apron area.

2.3 Annual Inspection Observations

The physical integrity of the airstrip and access road has been inspected annually by BGC for INAC during the annual geotechnical inspection of the tailings cover. More recently, EBA has undertaken additional inspections and monitoring of the airstrip on behalf of Tyhee. In previous years, settlement of specific areas of the airstrip has been noted. No additional observations of impacted physical integrity of the cover along the airstrip have been noted. Along the access road, some rutting and pumping of the silty clay into the armour rock was noted during the annual geotechnical inspections in 2004 and 2005. In 2005 and 2006, the armour rock thickness along the access road was increased by Tyhee to prevent additional damage to the cover materials. No additional pumping of materials along this route has been observed since 2005.

On the remainder of the cover, additional issues related to physical integrity have been previously identified. They include the development of small sinkholes, the formation of silt boils which expose the silty clay material at the surface of the cover, settlement of the cover in areas of limited aerial extent, the development of frost jacking boulders through the cover materials and the development of vegetation on the surface of the cover. Additional remediation measures were undertaken by INAC-CARD in 2005 to address some of the noted concerns. It should also be noted that physical characteristics (i.e. hydraulic conductivity and SWCC) of the cover are likely evolving over time in response to natural phenomena (i.e., development of vegetation on the surface of the cover and freeze/thaw cycles experienced by the cover). It is likely that the change in these physical characteristics of the cover materials over time, in response to these natural phenomena, may influence some aspects of cover performance.

EBA implemented an instrumentation and monitoring program along the airstrip in 2005. Standpipe piezometers were installed to monitor ground water levels and thermistors were installed to monitor ground temperatures along the airstrip. The instruments have been monitored regularly in 2006 and 2007. The results of the monitoring program have been included in an annual inspection report for the airstrip and access roads. In general, the results of the instrumentation and monitoring program are summarized by the following:

- No permafrost is present beneath the airstrip.
- Frost penetration beneath the airstrip is generally greater than it is at areas off of the airstrip (likely related to snow clearing activities in the winter).
- Ground temperatures at depth beneath the airstrip are cooler than ground temperatures at depth off the airstrip.
- The groundwater table is generally greater than 1 m below the tailings/silty clay interface (with the exception being the area where settlement of the airstrip has been historically noted).

It should also be noted that EBA has undertaken an engineering assessment of the load capacity of the current airstrip and access road configuration. The results of the assessment suggest that the current configuration of the airstrip and access roads is sufficient for the current usage. Additionally, EBA have completed preliminary engineering design of a modified airstrip design should the airstrip need to be upgraded to accommodate larger, heavier aircraft traffic. It is understood that this information has been submitted by Tyhee to the Mackenzie Valley Land and Water Board as required by Tyhee's current and use permit and water license.

3.0 FAILURE MODES AND EFFECTS ANALYSIS

3.1 Objectives and Criteria

The objective of the Failure Modes and Effects Analysis (FMEA) is to identify the potential failure modes of the cover along the airstrip, access road and apron associated with continued use of these areas and the potential effects of each failure mode on the performance of the cover in these areas. The failure modes were identified if they met one or more of the following criteria:

- Does the potential failure mode reduce the likelihood of the cover achieving its original design objectives?
- Is the potential failure mode associated, in whole or in part, with continued use of the airstrip, access roads or apron?

The list of potential failure modes is provided in Table 1. Also provided in Table 1 are the potential failure mechanisms associated with each failure mode and the potential effect of the failure mode on the performance of the underlying cover. For example, rutting of the surface of the airstrip, access road or apron was identified as a potential failure mode. The possible failure mechanism was identified to be traffic with excessive weight or traffic during wet periods when the strength of the subgrade is reduced. The potential effects of rutting were identified to be increased potential of surface exposure and subsequent erosion of silty clay and tailings. Also, localized ponding may occur which could result in increased infiltration of surface water into the cover materials and underlying tailings. These potential effects would be considered in contradiction to the original design objectives of the cover.

Table 1 – Summary of Potential Failure Modes and Resulting Effects

Failure Modes	Potential Failure Mechanisms	Effects
Erosion of Surface	Extreme precipitation events/ Secondary effect of the development of other failure modes.	- Possible erosion of cover materials and exposure/ transportation of underlying tailings.
Rutting of Surface	Traffic (excessive weight/ during periods when subgrade is wet)	- Possible surface exposure of underlying cover materials and tailings. / Increased potential for erosion of cover materials and tailings. - Localized ponding, increased infiltration.
Mixing of Tailings/Clay/Armour Rock	Traffic (excessive weight/during periods when subgrade is extremely wet)/ Natural Phenomena	- Increased risk of surface exposure and subsequent erosion of tailings. - Potential for increased hydraulic conductivity of silty clay possibly resulting in increased infiltration of surface water.
Blocking of Surface Drainage (more applicable to access road)	Blocked drainage path	- Could lead to erosion of cover materials if blockage is suddenly breached. - Localized ponding, increased infiltration.
Settlement of Surface	Traffic/ Natural Phenomena	- Localized ponding, increased infiltration.
Sinkholes	Natural Phenomena	- Increased potential for surface exposure/ erosion of underlying silty clay and tailings materials. - Localized ponding, increased infiltration.
Frost Jacking Boulders	Natural Phenomena	- Increased potential for surface exposure/ erosion of underlying silty clay and tailings materials. - Localized disturbance of cover materials, increased infiltration.
Desiccation of Clay Layer	Snow Clearing (reduction in available moisture, deeper frost penetration)	- Increased hydraulic conductivity potentially resulting in increased infiltration of surface water and increased oxygen ingress into tailings.

3.2 Further Discussion on Failure Modes

Further discussion is provided on each of the identified potential failure modes in the following sections. A physical description of each failure mode is provided along with possible reason for occurrence, if and where the failure modes have been observed in the cover at Discovery Mine, how the operation of the airstrip, access roads and apron could relate to the development of each failure mode and the potential significance of each failure mode with respect to cover performance.

Erosion of Surface

Erosion of the surface of the cover can occur in response to extreme precipitation events or as a secondary effect associated with the development of other failure modes (i.e. if rutting of the surface occurs, the cover materials and underlying tailings could be more susceptible to surface erosion at that location). Due to the coarse nature of the armour rock material on the surface of the cover, and the generally low surface gradient of the cover, no significant erosion of the cover materials has been observed since construction of the cover. Erosion of the surface of the cover, if it were to occur, could result in exposure, and subsequent erosion/ transportation, of the underlying tailings.

Rutting of Surface

As previously noted, vehicle traffic along the surface of the airstrip is generally limited to small planes and light vehicles. To date, no rutting of the surface of the airstrip, access road or the apron area has been noted. Only some minor tracks have been noted along the west side of the airstrip which is used by light vehicle traffic. For the purpose of this study, rutting is considered to be any vertical displacement or breaking of the surface of the airstrip or access road associated with plane or vehicle traffic. Rutting may occur if vehicles exhibiting excessive weight are driven over these areas, or if the area is driven over when the subgrade is weakened due to extremely wet ground conditions. Should rutting develop on the surface of any of these structures, surface exposure of underlying silty clay or tailings materials may result. This would leave these materials susceptible to erosion and subsequent transportation. Additionally, surface water drainage may be impeded, ponding may occur and increased infiltration into the underlying cover materials may result.

Mixing of Tailings, Clay and Armour Rock Materials

Mixing of the cover materials and the underlying tailings has been observed in many areas of the cover. The mixing process can occur in response to a variety of mechanisms including excessive traffic loading at surface and natural phenomena related to freeze/thaw cycling. If the mixing becomes sufficiently advanced, surface exposure of the silty clay and/or tailings can result. Surface exposures of the silty clay material have been observed in many areas of the larger cover and have been termed silt boils. To-date, no silt boils have been observed on the airstrip, although some mixing was observed at the silty clay/ armour rock interface during the EBA investigation of the airstrip in 2005. Additionally, surface exposures of the silty clay material had been observed along the access road between the Tyhee camp and the airstrip prior to the addition of extra armour rock along this route. Mixing of materials along the airstrip, access roads and apron area can occur if vehicles exhibiting excessive weight are driven over these areas, or if the area is driven over when the subgrade is weakened due to extremely wet ground conditions. Mixing of the cover materials is significant due to the possibility that silty clay, and potentially tailings, may become exposed at surface and be susceptible to erosion and subsequent transportation. Additionally, pumping of the silty clay into the armour rock, should it occur, could increase the hydraulic conductivity of the silty clay layer, potentially resulting in increased infiltration rates into the underlying tailings. It should be noted that during the May 14 review meeting, EBA suggested that the effect of mixing of the cover materials on the infiltration rates would likely be depended on the degree of mixing. EBA also suggested that minor amounts of mixing of the cover materials may not have a significantly negative effect on infiltration rates.

Blocking of Surface Drainage

The access road between the Tyhee camp and the airstrip crosses a significant drainage swale along the surface of the cover (transition between Area 8 and Area 9). At the location where the road crosses the drainage swale, a small diameter pipe has been installed at the base of the road fill to permit free drainage and reduce the potential for ponding. The flow capacity of the pipe and the drainage channel are currently unknown. Should the flow capacity of the pipe be exceeded, or should the pipe become temporarily blocked with ice, ponding of surface water may occur behind the access road. This could result in a sudden overtopping or breaching of the road fill, potentially causing erosion of the cover materials down gradient. The ponding may also result in increased infiltration rates into the underlying tailings.

Surface Settlement

Surface settlement has historically been observed in one area of the airstrip, in the vicinity of EBA boreholes BH-12, BH-20 and BH-22. The settlement area was on the order of 200 m^2 and has, in the recent past (post reclamation), exhibited as much as an estimated 300 mm of settlement, based on observations made during the 2005 investigation by EBA. The exact cause of the settlement has not been determined but has possibly been attributed to consolidation of the underlying tailings related to permafrost degradation or internal loss of subgrade materials (tailings) into voids and fractures in the underlying bedrock. Settlement of this area has been noted to slow in recent years, with little to no fill placement being required in 2006 and 2007. Settlement of the surface of the airstrip, access road and apron is thought to be significant due to the potential for ponding of surface water which could result in increased infiltration rates into the underlying tailings. Additionally, surface settlement in these areas would indicate likely deformation of the underlying silty clay materials which may increase the hydraulic conductivity of this layer, also resulting in increased infiltration rates.

Sinkholes

Sinkholes are identified by small diameter (<0.5 m) depressions in the surface of the cover. These sinkholes likely occur in response development of ice lenses within the silty clay during the winter months and the subsequent melting of these ice lenses during the subsequent thaw season. Sinkholes have been observed in many areas of the cover and several of them were remediated in 2005. To-date, sinkholes have not been observed along the airstrip, access road or apron area and their development is not thought to be directly related to use of the airstrip or access roads. The formation of sinkholes in the cover area is thought to be significant due to the potential for exposure of, and subsequent erosion and transportation of, silty clay or tailings materials. Also, the development of sinkholes increases the potential for increased infiltration rates associated with ponding of water in the depression and increased hydraulic conductivity of the disturbed silty clay material.

Frost Jacking Boulders

Frost jacking boulders are identified by large diameter (~1m) boulders that vertically migrate through the cover and become exposed at surface. The vertical displacement of these boulders occurs in response to the frost jacking effect of fine-grained soils on an entrained boulder when the system is exposed to numerous freeze-thaw cycles. Frost jacking boulders have been observed in many areas of the cover, but have not been observed along the airstrip, access road or apron. It should be noted that new boulders continue to become exposed in other areas of the cover every year. The development of the frost jacking boulders is not thought to be directly influenced by operation of the airstrip or access roads. Although the deeper frost penetration along the airstrip associated with snow clearing activities may eventually result in the formation of these features in this area as well. The existence of frost jacking boulders is thought to be significant due to the potential for exposure of, and subsequent erosion and transportation of, silty clay or tailings materials. Additionally, frost jacking boulders indicate areas of the cover where local disturbance of the cover materials has occurred, potentially resulting in increased infiltration of surface water into the underlying tailings. Also, if frost jacking boulders were to occur on the airstrip, operational difficulties would also likely be encountered.

Desiccation of the Clay Layer

Desiccation cracking of clayey soils can occur in response to excessive drying. The area underlying the airstrip is thought to be more susceptible to desiccation cracking due to the fact that the airstrip is located along a drainage divide and the practice of snow removal from the surface of the airstrip during the winter months. Since the airstrip is located along a drainage divide, the only moisture available is antecedent precipitation (i.e. no run off from other areas). Removal of the snow cover essentially acts to decrease the moisture available to maintain a high degree of saturation within the silty clay material. Additionally, the removal of the snow cover permits increased frost penetration along the airstrip, as verified by the instrumentation program. It is likely that the pore water in the underlying tailings also provides moisture to the clay layer, thereby helping maintain a relatively high degree of saturation within the silty clay materials. If the frost penetration is deep along the airstrip, these underlying tailings remain frozen for a longer period of time than other areas off of the airstrip. As such, the availability of moisture from the underlying tailings to maintain hydration within the silty clay is not as readily available. Desiccation is significant because it can lead to the development of shrinkage cracks on a micro or macro scale. This cracking would increase the hydraulic conductivity of the silty clay material resulting in increased infiltration of surface water, and possibly increase the ingress of oxygen, into the underlying tailings.

It should be noted that freeze-thaw effects on fine-grained materials, such as the silty clay layer of the cover, can have similar effects on the hydraulic conductivity on these types of materials. Given the relatively thin thickness of the cover layer, and the relatively cold climate experienced at the Discovery Mine site, it is likely that the hydraulic conductivity of the silty clay has increased over time, regardless of the development of any desiccation cracking that may be attributable to use of the airstrip, access road or apron area.

4.0 ASSESSMENT METHODS

A method of assessment must be established to be able to determine if the failure modes identified during the FMEA have developed. A list of potential assessment methods for each failure mode is provided in Table 2.

Table 2 – Summary of Potential Assessment Methods

Failure Modes	Potential Assessment Methods
Erosion of Surface	- Visual inspection of surface conditions.
Rutting of Surface	- Visual inspection of surface conditions.
Mixing of Tailings/Clay/Armour Rock (Failure of Subgrade)	- Visual inspection of surface conditions. - Classification of exposed materials. - Visual observations from test pitting.
Blocking of Surface Drainage (more applicable to access road)	- Visual inspection of surface conditions.
Settlement of Surface	- Visual inspection of surface conditions.
Sinkholes	- Visual inspection of surface conditions.
Frost Jacking Boulders	- Visual inspection of surface conditions.
Desiccation of Clay Layer	- In-situ sample collection and testing. - In-situ monitoring of moisture conditions, oxygen concentrations, infiltration rates.

For the most part, visual inspection of surface conditions can determine if the failure mode has developed. Additional intrusive investigation would be required to assess mixing of cover materials and the moisture condition of the silty clay. It should be noted that this method would only provide a “snap shot in time” of the moisture condition within the cover materials. The moisture condition would be expected to fluctuate throughout the year in response to various factors. As such, continuous in-situ monitoring would be required to accurately characterize the moisture condition of the cover materials throughout the year. This type of monitoring could require a variety of instrumentation including soil moisture sensors, oxygen sensors and/or lysimeters to monitor infiltration rates. This instrumentation would need to be connected to dataloggers to obtain a continuous data record.

It is recommended that the practice of an annual inspection of the airstrip, access road and apron area, by a qualified geotechnical engineer, continue for a period of time to the expiration of Tyhee’s and INAC’s current land use permits. These inspections should be supplemented by regular inspections by site staff and periodic inspections by regulatory authorities. Identification of any of the failure modes during any inspection should be documented and this information should be forwarded to the INAC/Tyhee for further review.

5.0 PRELIMINARY DAMAGE CRITERIA AND REMEDIAL ACTIONS

In order for the assessment methods in Table 2 to be properly applied, damage criteria must be established to apply significance to the result of the assessment. Additionally, if the damage criteria are found to be exceeded, remedial action plan must be in place to limit the damage to the cover materials. Proposed damage criteria and remedial action plans are provided in Table 3.

Table 3 – Summary of Damage Criteria

Failure Modes	Damage Criteria	Remedial Action Plan
Erosion of Surface	- Visual confirmation of surface erosion.	- Notification of INAC/Tyhee. - Reassess design and review usage and restrictions. - Potential remediation measures may include grading of surface/ placement of additional material.
Rutting of Surface	- Visual confirmation of rutting (breakthrough of surface material).	- Notification of INAC/Tyhee. - Reassess design and review usage and restrictions. - Potential remediation measures may include grading of surface/ placement of additional material.
Mixing of Tailings/Clay/ Armour Rock (Failure of Subgrade)	- Visual confirmation of mixing at surface. - Testing verification of clay (plastic), or visual confirmation of tailings, material at surface.	- Notification of INAC/Tyhee. - Reassess design and review usage and restrictions. - Potential remediation measures may include placement of additional material with an appropriate separator (depending on location), or reconstruction.
Blocking of Surface Drainage (more applicable to access road)	- Visual confirmation of drainage interruption.	- Notification of INAC/Tyhee. - Reassess drainage requirements. - Restore drainage by unplugging pipes or controlled breaching of road.
Settlement of Surface	- Visual confirmation of settlement.	- Notification of INAC/Tyhee. - Geotechnical assessment of settlement severity and impacts. - Minor settlement – potential fill placement and grading or risk management/monitor. - Major settlement – potential reconstruction.
Sinkholes	- Visual confirmation of the existence of sinkholes.	- Notification of INAC/Tyhee. - Repair sinkhole as per 2005 INAC remediation practices.
Frost Jacking Boulders	- Visual confirmation of the existence of frost jacking boulders.	- Notification of INAC/Tyhee. - Potential excavation and removal of boulder and subsequent repair of cover.
Desiccation of Clay Layer	- Visual confirmation of desiccation cracking. - Excessively low moisture content (less than Plastic Limit and Shrinkage Limit of silty clay) or low degree of saturation.	- Notification of INAC/Tyhee. - Further assessment of cause of desiccation and usage, maintenance and design of airstrip/access road. - Assess impacts to receiving environment and monitor. - Potential increase in cover thickness.

As can be seen, the damage criteria primarily consist of the visual confirmation of the occurrence of each individual failure mode. The exception is the moisture condition of the silty clay layer for which conceptual criteria are provided. Various potential remedial action plans are also provided. Common to the remedial action plans is to notify both INAC and Tyhee of the development. As stated earlier, all inspection observations should be documented and forwarded to the INAC and Tyhee for further review. Additionally, any remedial actions undertaken should be documented and this information should be promptly forwarded to both INAC and Tyhee. Considering the joint management required of the airstrip, access road and apron area, decisions regarding any remedial actions in the overlap areas will be mutually agreed to by INAC and Tyhee prior to implementation.

6.0 IMPLEMENTATION

The successful implementation of the plan presented herein is dependent on the open communication between all parties involved in the inspection process. It is currently anticipated that, until at least 2010, regular monitoring of the tailings cover will continue in a formal and informal basis. The current monitoring practices include the following:

- An annual geotechnical inspection of the cover is undertaken by a professional geotechnical engineer, on behalf of INAC.
- An annual geotechnical inspection of the airstrip and access road portion of the cover is undertaken by a professional geotechnical engineer, on behalf of Tyhee.
- An inspection of the site is completed on a regular basis by the INAC Land Use Inspectors.
- Daily informal observations are undertaken by Tyhee site staff during their regular use of the airstrip and access roads.

It is anticipated that monitoring requirements will be revaluated when the current land use permits for both INAC and Tyhee expire, which is expected to be in 2010.

As previously noted, communication of site observations is key to the successful implementation of the damage criteria assessment presented herein. As such, it is recommended that the following practices be implemented with respect to communication:

- Communication should continue on both a formal and informal basis at both operations and management levels.
- Each party should be made aware of potential issues on site within a reasonable time frame.
- The Land Use Inspectors should be notified prior to any work on tailings cap. Depending on the scale of the work, the Mackenzie Valley Land and Water Board may also need to be notified.
- An annual meeting should be held between INAC and Tyhee to review the results of the individual monitoring programs. The meeting should likely occur in spring once annual geotechnical reports are available.

As previously noted, decisions regarding any remedial actions in the overlap areas will be mutually agreed to by INAC and Tyhee prior to implementation.

7.0 SUMMARY

The results of the study identify various potential failure modes and provide additional context as to why the failure modes develop, why they are significant to the performance of the cover and how they may be associated with continued use of the airstrip, access road and apron area. Various assessment methods are proposed for each potential failure mode and damage criteria are provided to assess the significance of the results of the assessment. Finally, potential remedial action plans are provided, should the damage criteria be found to be exceeded. All of the information provided in Section 3, 4 and 5 is further summarized on Table 4.

It should be reiterated that the intention of this study is to provide a clear and transparent means of assessing the impact of the continued use of the airstrip, access road and apron area to the performance of the tailings cover and its ability to achieve its original design objectives. The study is not a quantitative assessment of the impacts to cover performance or a critical review of the assessment work completed to-date.

Table 4 – Summary of Preliminary Damage Criteria Assessment

Failure Modes	Potential Failure Mechanisms	Effects	Potential Assessment Methods	Damage Criteria	Contingency Measures if Damage Criteria Exceeded
Erosion of Surface	Extreme precipitation events/ Secondary effect of the development of other failure modes.	- Possible erosion of cover materials and exposure/ transportation of underlying tailings.	- Visual inspection of surface conditions.	- Visual confirmation of surface erosion.	- Notification of INAC/Tyhee. - Reassess design and review usage and restrictions. - Potential remediation measures may include grading of surface/ placement of additional material.
Rutting of Surface	Traffic (excessive weight/ during periods when subgrade is wet)	- Possible surface exposure of underlying cover materials and tailings. / Increased potential for erosion of cover materials and tailings. - Localized ponding, increased infiltration.	- Visual inspection of surface conditions.	- Visual confirmation of rutting (breakthrough of surface material).	- Notification of INAC/Tyhee. - Reassess design and review usage and restrictions. - Potential remediation measures may include grading of surface/ placement of additional material.
Mixing of Tailings/Clay/Armour Rock	Traffic (excessive weight/during periods when subgrade is extremely wet)/ Natural Phenomena	- Increased risk of surface exposure and subsequent erosion of tailings. - Potential for increased hydraulic conductivity of silty clay possibly resulting in increased infiltration of surface water.	- Visual inspection of surface conditions. - Classification of exposed materials. - Visual observations from test pitting.	- Visual confirmation of mixing at surface. - Testing verification of clay (plastic), or visual confirmation of tailings, material at surface.	- Notification of INAC/Tyhee. - Reassess design and review usage and restrictions. - Potential remediation measures may include placement of additional material with an appropriate separator (depending on location), or reconstruction.
Blocking of Surface Drainage (more applicable to access road)	Blocked drainage path	- Could lead to erosion of cover materials if blockage is suddenly breached. - Localized ponding, increased infiltration.	- Visual inspection of surface conditions.	- Visual confirmation of drainage interruption.	- Notification of INAC/Tyhee. - Reassess drainage requirements. - Restore drainage by unplugging pipes or controlled breaching of road.
Settlement of Surface	Traffic/ Natural Phenomena	- Localized ponding, increased infiltration.	- Visual inspection of surface conditions.	- Visual confirmation of settlement.	- Notification of INAC/Tyhee. - Geotechnical assessment of settlement severity and impacts. - Minor settlement – potential fill placement and grading or risk management/monitor. - Major settlement – potential reconstruction.
Sinkholes	Natural Phenomena	- Increased potential for surface exposure/ erosion of underlying silty clay and tailings materials. - Localized ponding, increased infiltration.	- Visual inspection of surface conditions.	- Visual confirmation of the existence of sinkholes.	- Notification of INAC/Tyhee. - Repair sinkhole as per 2005 INAC remediation practices.
Frost Jacking Boulders	Natural Phenomena	- Increased potential for surface exposure/ erosion of underlying silty clay and tailings materials. - Localized disturbance of cover materials, increased infiltration.	- Visual inspection of surface conditions.	- Visual confirmation of the existence of frost jacking boulders.	- Notification of INAC/Tyhee. - Potential excavation and removal of boulder and subsequent repair of cover.
Desiccation of Clay Layer	Snow Clearing (reduction in available moisture, deeper frost penetration)	- Increased hydraulic conductivity potentially resulting in increased infiltration of surface water and increased oxygen ingress into tailings.	- In-situ sample collection and testing. - In-situ monitoring of moisture conditions, oxygen concentrations, infiltration rates.	- Visual confirmation of desiccation cracking. - Excessively low moisture content (less than Plastic Limit and Shrinkage Limit of silty clay) or low degree of saturation.	- Notification of INAC/Tyhee. - Further assessment of cause of desiccation and usage, maintenance and design of airstrip/access road. - Assess impacts to receiving environment and monitor. - Potential increase in cover thickness.

8.0 CLOSURE

BGC Engineering Inc. (BGC) prepared this report for the account of Indian and Northern Affairs Canada (INAC). The material in it reflects the judgment of BGC staff in light of the information available to BGC at the time of report preparation. Any use which a third party makes of this report, or any reliance on decisions to be based on it are the responsibility of such third parties. BGC accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

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This memorandum presents the results of an assessment of damage criteria for the Discovery Mine airstrip, access road and apron. The damage criteria were reviewed in a meeting attended by representatives from INAC, Tyhee, EBA and BGC.

We trust the information provided herein meets your requirements and expectations. Should you have any questions or comments regarding the information provided herein, please contact the undersigned at your convenience.

Respectfully submitted,
BGC Engineering Inc.
Per:

Geoff Claypool, B.Sc., P.Eng.
Geological Engineer