Memorandum

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Date: July 7, 2016

To: Nicola Banton

From: Jason Rempel, Robyn Pollock

Subject: **IRs 17 and 19 Accidents and Malfunctions**

1. INTRODUCTION

This memorandum responds to comments provided by the Canadian Environmental Assessment Agency (the Agency) on March 21, 2016 with respect to KGHM Ajax Mining Inc.'s (KAM) Application for an Environmental Assessment Certificate (Application) and Environmental Impact Statement (EIS). The response provided below is pertinent to information requests (IRs) 17 and 19 regarding accidents and malfunctions. In response to the Agency, KAM provides an assessment of the potential effects of accidents and malfunction on the valued components (VCs). This memo is a supplement to the Accidents and Malfunctions described in the EIS Section 17.6, and will refer to material already presented in that section.

1.1 IR 17

"Provide a detailed description of environmental effects that may result from this potential open pit highwall failure event, including a description of the temporal and spatial boundaries for loss to fish and wildlife habitat and an estimation of potential mortality. Provide a detailed description of potential losses of recreational and cultural value. Provide a detailed description of effects relating to the other VCs potentially interacting with this potential event.

Provide a detailed description of mitigation measures to prevent highwall pit failure, as well as measures to remediate those effects should the accident/malfunction occur. Provide an assessment of all of the criteria considered in determining significance of environmental effects for the resulting environmental effects of such a failure."

1.2 IR 19

"In relation to the south embankment, provide a description of any non-contact water infrastructure in the inundation area. Clarify whether the inundation area includes any discharges of non-contact water to the receiving environment that could result in a discharge of tailings in the event of a failure of the south embankment.

Provide a detailed description of mitigation measures to prevent failure of the south embankment, as well as measures to remediate those effects should the accident/malfunction occur. Provide an assessment of all of the criteria considered in determining significance of environmental effects for the resulting environmental effects of such a failure."

2. ASSESSMENT OF ACCIDENTS AND MALFUNCTIONS ON VALUED COMPONENTS

2.1 Assessment Approach

The assessment approach for accidents and malfunctions in this memorandum generally follows the methodology described in Chapter 5 of the Application/EIS. This section summarizes the key components of the assessment methodology that have been adapted for the assessment of effects of an unintended accident or malfunction on Valued Components (VCs). These include:

1. **Scoping:** Identifies the interactions between accidents and malfunctions and VCs;
2. **Description of Potential Effects:** Describes the potential effects and their temporal and spatial extent, in the unlikely event of an accident or malfunction for each key (moderate and high) interaction identified in Step 1.
3. **Mitigation, Contingency and Remediation Measures:** Discusses the availability and implementation of mitigation, contingency and remediation measures to avoid, minimize, control, restore on-site conditions, compensate, or offset adverse effects to VCs**.**
4. **Characterization of Residual Effects:** Adverse effects remaining after the implementation of all mitigation, contingency and remediation measures are characterized using the attributes described in the Application/EIS and summarized in Table 2.1-1.
5. **Summary and Conclusion:** A table summarizing potential effects, mitigation and residual effect characterization is provided.

A separate risk assessment methodology was used to determine the risk profile of each failure mode scenario. This assessment methodology included a consequence/severity ranking and a likelihood rating (probability that the identified outcome will occur relative to the defined failure mode) and is outlined in Section 17.6.2.2 of the EIS/Application.

2.2 Spatial and Temporal Boundaries

The memo uses the same spatial boundaries, which are described in detail in the respective sections of the Application/EIS, and are not repeated here. Spatial boundaries are described for each VC in the following sections:

- Assessment of Potential Environmental Effects (EIS Section 6);
- Assessment of Potential Economic Effects (EIS Section 7);
- Assessment of Potential Social Effects (EIS Section 8);
- Assessment of Potential Heritage Effects (EIS Section 9); and
- Assessment of Potential Health Effects (EIS Section 10).

Table 2.1-1. Residual Effect Characterization Attributes

Attribute	Description
Magnitude: This refers to the expected magnitude or severity of the residual effect.	*Negligible*: no or very little detectable change from baseline conditions; *Low*: differing from the average value for baseline conditions to a small degree, but within the range of natural variation and well below a guideline or threshold value; *Medium*: differing from the average value for baseline conditions and approaching the limits of natural variation, but below or equal to a guideline or threshold value; or *High*: differing from baseline conditions and exceeding guideline or threshold values so that there will be a detectable change beyond the range of natural variation.
Duration: the length of time the effect lasts.	*Short-term*: an effect that lasts approximately 1 to 5 years; *Medium-term*: an effect that lasts between 6 to 25 years; *Long-term*: an effect that lasts between 26 and 50 years; or *Far Future*: an effect that lasts more than 50 years.
Frequency: how often the effect occurs.	*Once*: an effect that occurs once during any phase of the Project; *Sporadic*: an effect that occurs at sporadic or intermittent intervals during any phase of the Project; *Regular*: an effect that occurs regularly during any phase of the Project; or *Continuous*: an effect that occurs constantly during any phase of the Project.
Spatial Extent: the spatial scale over which the residual effect is expected to occur.	*Local*: an effect is limited to the Project footprint less than 500m from infrastructure or activity; *Landscape/Watershed*: an effect extends beyond the Project footprint limited to the local study area or one watershed (i.e., sub-area); *Regional*: an effect extends across the regional study area or multiple watersheds; or *Beyond Regional*: an effect that extends possibly across or beyond the province of BC.
Reversibility: the degree to which the effect is reversible.	*Reversible* Short-*term*: an effect that can be reversed relatively quickly; *Reversible Long-term*: an effect that can be reversed within 20 years of Post Closure; or *Irreversible*: an effect cannot be reversed (i.e., is permanent).
Resiliency: the level of resiliency of the receiving environment.	*Low*: the receiving environment or population has a low resilience to imposed stresses, and will not easily adapt to the effect; *Neutral*: the receiving environment or population has a neutral resilience to imposed stresses and may be able to respond and adapt to the effect; or *High*: the receiving environment or population has a high natural resilience to imposed stresses, and can respond and adapt to the effect.
Probability/Likelihood: the likelihood that an adverse effect will occur	*Low*: an effect that is unlikely, but could occur; *Medium*: an effect that is likely, but may not occur; or *High*: an effect that is highly likely to occur.
Confidence: a measure of how well residual effects are understood	*Low* (< 50% confidence): the cause-effect relationships are poorly understood, there are a number of unknown external variables, and data for the Project area are incomplete. High degree of uncertainty and final results may vary considerably; *Medium* (50 to 80% confidence): the cause-effect relationships are not fully understood, there are a number of unknown external variables, or data for the Project area are incomplete. There is a moderate degree of uncertainty; while results may vary, predictions are relatively confident; or *High* (> 80% confidence): there is a good understanding of the cause-effect relationship and all necessary data are available for the Project area. There is a low degree of uncertainty and variation from the predicted effect is expected to be low.

Similarly, the temporal boundaries follow the effects assessment and supporting studies. Potential effects will be considered for each phase of the Project (where relevant), which are:

- **Construction:** 2 years;
- **Operation:** 23 years;
- **Decommissioning and Closure:** 2-5 years (includes project decommissioning, abandonment and reclamation activities as well as temporary closure and care and maintenance); and
- **Post-Closure:** 5+years (includes ongoing reclamation activities and post-closure monitoring).

Boundaries described in sections are the maximum limit within which the effects assessment and supporting studies are conducted.

2.3 Open Pit Highwall Failure

2.3.1 Description of Possible Scenario

Based on the groundwater and water balance modelling completed for the Project (see Sections 6.4 and 6.6 of the Application/EIS and their supporting appendices), it is anticipated that as the open pit develops, the water table will be drawn down, resulting in a hydraulic gradient towards the pit from the surrounding groundwater. Any seepage that may occur from the base of Jacko Lake will flow towards the open pit in groundwater. Fine grained sediments that have settled to the bottom of the lake will act as a low permeability liner and will impeded seepage from the base of the lake. Furthermore, based on observations of current conditions in the historic pit and on detailed geotechnical and hydrogeologic drilling investigation (see Appendix 3-C, and Appendix A of Appendix 6.6-A), no substantial preferential flow paths between the lake and the open pit were identified, and the existing rock shows very low hydraulic conductivity. As a result of the low hydraulic conductivity, the modelling results in an estimated net seepage from the lake to the open pit on the order of < 1.0 L/s (50 m^3/d). However, Jacko Lake is expected to maintain an overall positive water balance, and as a result, this seepage would not cause the normal functioning of the lake to substantially change. During Operation and Post-Closure phases, there is a risk that a highwall failure on the west wall of the open pit could occur and propagate into Jacko Lake. Such an accident/malfunction scenario could cause a wide range of potential effects, from increased rate of seepage, all the way to a catastrophic drainage of Jacko Lake into the pit. It is important to note that this failure mode is considered highly improbable at the start of Operation, when the pit crest is the farthest from Jacko Lake. This risk increases through the first few years of Operation as the pit crest advances toward the lake and mining of the western wall occurs. This will be balanced by a robust system of monitoring the geotechnical and hydrogeological conditions and adjustments to the mining operation based on the results of the monitoring program. The risk will then decrease again during later stages of Operation when the In-pit Mine Rock Storage Facility (IPMRSF) will buttress the west pit wall, producing lower risk conditions carried into Post-Closure.

For the purposes of this assessment of accidents and malfunctions, a worst-case approach has been taken, assuming that the high-wall failure propagates into the lake and results in catastrophic loss of the entire lake. This would result in 4.2 Mm^3 of water flowing into the open pit, and 48.5 ha of lake habitat being temporarily lost.

2.3.2 Characterization of Risk

During the FMEA Workshop (see Appendix 17.6-A of the Application/EIS), it was agreed by all participants that for the worst-case scenario, the likelihood of this failure mode occurring was "Rare" (1 in 10,000 years); this was the lowest defined likelihood descriptor. It was also agreed by all participants that given the importance of Jacko Lake to the SSN and to local recreational users, environmental effects of such an event would be 'catastrophic', which is the highest defined consequence/severity descriptor. Combining the likelihood and consequence, the risk ranking of this failure mode was determined to be 'High'.

2.3.3 Mitigation, Contingency and Remediation Measures

Preventative controls are measures that are inherently part of the Project design to help reduce the likelihood of this failure mode from occurring. They include, but are not limited to the following:

- Detailed geotechnical investigations and design, including a minimum factor of safety of 1.6 (see Appendices 3-D; 6.2-C; 6.2-D);
- De-pressurization of the pit wall during Operation through installation of horizontal drains (see Section 3.5.1);
- Active, continuous monitoring of pit stability (see Section 11.2);
  - Slope stability will be constantly monitored through a combination of Automated Total Station Networks, non-reflective LIDAR (Light Detection and Ranging) scanning, Slope Stability Radar (SSR) and an array of prisms.SSR and prism array systems will provide real-time monitoring of slope stability in conjunction with daily inspections by geotechnical engineering mine staff. Such monitoring will enable any slope instability to be detected and remediated in a timely manner through adaptive management.
- An adaptive response will be implemented based on monitoring observations, which will include escalation as appropriate (e.g., grouting, reconfiguration of slope angles, slowing rate of advance, evacuation of pit, evacuation of Jacko Lake);
- The mine plan will be continuously optimized and refined through Operation to ensure long-term stability; and
- In-pit MRSF (Section 3.9.1) will buttress high-wall and reduce residual risk.

Mitigation responses are measures that will be in place pre-event, but would be implemented post-event to reduce the consequences should the failure mode occur. These will include, but are not limited to the following:

- Implement Emergency Response Plans (Section 11.14) to ensure safe conditions are established as quickly as possible;
- Site investigations:
    - Evaluate the new geotechnical conditions in the immediate vicinity of the failure and of remaining pit wall sections; and
    - Evaluate resultant effects to environmental/cultural resources around the lake.
- Establish temporary water supply for existing water licence holders on Peterson Creek prior to lake re-establishment;
- Evaluate temporarily providing flow to Peterson Creek (from Kamloops Lake) prior to lake re-establishment;
- Re-establishment of Jacko Lake:
    - Construct new dam(s) and grout/seal potential new seepage pathways that were developed;
    - Re-fill lake (with original lake water, or with supply from Kamloops Lake); and
    - Re-establish water supply to downstream users and stocked fish population.
- Re-establishment of stability monitoring to incorporate new site conditions.

Re-establishing the lake would take time. At a high level, it is anticipated that it would take one to two years to complete the necessary site investigations, planning, and construction activities to re-establish the lake, followed by a time of re-filling (4 to 12 months), and fish stocking. Time would be required for water chemistry, invertebrate life, and aquatic plant life to re-establish to a level that would support a fishable lake. In total it should be expected that active fishing on the lake would not be possible for a period of approximately five years.

KAM will have a formal communication plan in place in the event of a failure scenario. A designated media spokesperson will be assigned and lead the dissemination of information, per the Mining Association of Canada's "Towards Sustainable Mining" Crisis Management Planning Assessment Protocol (MAC TSM 2014). KAM will notify all relevant federal, provincial, regional and municipal government agencies, and Aboriginal Groups as soon as practicable after the occurrence and work with agencies to ensure appropriate responsive action is taken, including communication to the public.

KAM will work with Aboriginal Groups to communicate about the failure event, and look for input from Aboriginal Groups into the mitigation response and reclamation efforts. This would help ensure that members practicing traditional land uses near the Project are able to make informed decisions related to the quality of the land to support CULRTP activities.

Follow-up monitoring activities will include monitoring of new dams to support the re-established Jacko Lake and monitoring the success of lake re-establishment (e.g., fish population establishment, fish habitat assessments, and recreational use).

2.3.4 *Description of Interactions and Characterization of Potential Effects*

Table 2.3-1 summarizes the anticipated interactions with Valued Components should this hazard be realised. Potential moderate (yellow) or high (red) interactions are discussed in further detail below. Potential for negligible (white) to minor (green) interactions are not discussed further.

Table 2.3-1. VC Interaction Matrix for Open Pit Highwall Failure

Greenhouse Gases	Terrestrial Invert.	Business	Archaeological Sites
Geology, Landforms	Amphibians	Property Values	Heritage Sites
SW Quantity	Reptiles	Economic Diversification	Air Quality
SW Quality	Migratory Birds	Infrastructure/Services	Domestic Water
GW Quantity	Raptors	Dark Sky	Country Foods
GW Quality	Non-Migratory Birds	Visual Quality	Human Health
Fish & Aquatics	Mammals	Land and Resource Use	Noise
Rare Plants	Economic Growth	CULRTP	Healthy Living
RSEC	Labour/Employment	Outdoor Recreation	Community Health/WB
Grasslands	Income		Aboriginal Economies

2.3.4.1 *Surface Water Quantity*

A complete draining of Jacko Lake due to a highwall failure would result in the reduction of surface water quantity. Based on a worst-case scenario in which the entire volume of Jacko Lake is drained, the magnitude is predicted to be “high”, although the spatial extent is predicted to be “local” as it would only impact Jacko Lake and potentially downstream water users and water licence holders. There are eight (8) water storage licences on Jacko Lake to support downstream irrigation, as well as one conservation licence held by Ministry of Forests, Lands, and Natural Resources Operations (FLNRO) for fish habitat. On Peterson Creek below Jacko Lake there are 15 irrigation licences, 5 domestic water licences, 1 livestock watering licence, and 1 storage licence (Appendix 6.4-C of Application/EIS). The duration and reversibility are predicted to be “short-term” and “reversible short-term”. As part of the emergency response, KAM would work to replace water supply to other users. As mine production would be suspended for a period following the failure event, it would be possible to use the mine water supply from Kamloops Lake to temporarily augment flow in Peterson Creek downstream of the Project. It would be possible to physically re-establish Jacko Lake with time (high resiliency). The confidence is medium, as with all of these failure scenarios, there are a number of unknown external variables that lead to a moderate degree of uncertainty.

2.3.4.2 *Surface Water Quality*

In a worst-case scenario, a complete draining of Jacko Lake would not affect surface water quality of Jacko Lake because there would be no water remaining immediately following the failure. As a temporary measure, water from Kamloops Lake could be used to re-establish water levels. Although the water quality may be different from the original quality of Jacko Lake, water quality would be tested before being brought in to ensure it was suitable for downstream uses. The magnitude is predicted to be “medium” as the water quality is expected to differ from baseline conditions at Jacko Lake, but not exceed water quality guidelines. The spatial extent is predicted to be “local” (Jacko Lake), and the duration “short-term”. The reversibility is expected to be “reversible long-term” as the water quality should return to pre-event quality once the lake has been re-established and runoff from existing drainage contributes to the water quality. The resiliency of the aquatic environment is predicted to be “high”. The likelihood that there are residual effects on surface water quality following mitigation and remediation measures is “low”.

2.3.4.3 *Fish and Fish Habitat*

Jacko Lake has been stocked by the provincial government annually since 1954, except for 1990 when no stocking occurred. In the last two decades, between 6,500 and 16,000 rainbow trout were released annually. The provincial government currently stocks a mix of diploid (fertile) and triploid (sterile) rainbow trout, as well as some all-female strains to improve the recreational and asserted Aboriginal fisheries.

In a worst-case catastrophic failure scenario, all fish and fish habitat could be lost from Jacko Lake. The magnitude is expected to be “high” because in this scenario the entire fish population of Jacko Lake could be affected. Spatial extent is local (Jacko Lake and downstream of lake). Duration is expected to be “medium-term”; however, is predicted to be “reversible long-term”. Once Jacko Lake is re-established, a stocked fishery could be restored through mitigation controls and follow-up monitoring. Resiliency is expected to be “high” as it is likely that a fish population could be re-established. The likelihood that there are residual effects on fish and fish habitat following mitigation and remediation measures is anticipated to be “low”.

2.3.4.4 *Land and Resource Use*

Cattle ranching is the primary agricultural activity in proximity to the Project. An open pit highwall failure scenario that drains all of Jacko Lake could lead to a reduction in access to sufficient water quantities to support ranching operations. The magnitude of this is “low”, as KAM would work to provide a temporary water supply to downstream water users prior to lake re-establishment. The duration is “short-term” and spatial extent would be “local” (Jacko Lake and downstream of lake). It is predicted that it would be “reversible long-term” as the lake could be physically re-established, and for this reason, the resiliency is considered “high”. The likelihood that there are residual effects on land and resource use following mitigation and remediation measures is anticipated to be “low”.

2.3.4.5 *Current Use of Lands and Resources for Traditional Purposes*

SSN have indicated that Jacko Lake is a keystone cultural place, which supports many activities including fishing, hunting, gathering, and ceremonial practices. Any open pit highwall failure scenario that impacts Jacko Lake may affect perceptions of the suitability of using the area for conducting traditional practices (e.g., fishing) and lead to a loss of cultural value. It is predicted that the effects to CULRTP would be “high” magnitude, of “local” extent, but would have a duration of "far-future" based on the "irreversible" nature of effects to the cultural use of the lake. Due to the cultural value of the lake, the likelihood that residual effects will manifest following mitigation measures is "high". However, KAM would work closely with SSN in the planning and execution of mitigation response to help reduce this likelihood.

2.3.4.6 Outdoor Recreation

Jacko Lake is a popular outdoor recreation area in large part due to its relatively close proximity to the City of Kamloops (approximately 1 km south of the Kamloops southern boundary and about 2 km east of Lac Le Jeune Road). Angling is currently the most common recreational use of Jacko Lake, which has been stocked annually by the Ministry of Environment since 1954. An open pit highwall failure will reduce the availability of natural resources (e.g., fish, wildlife) for anglers and other outdoor recreationalists (e.g., boaters), and reduce the recreational area of Jacko Lake. The predicted magnitude is "low", with a "medium-term" duration, "local" extent (Jacko Lake) and is "reversible long-term" because it is possible to physically re-establish the lake and stock it with fish again, returning outdoor recreation opportunities to before-event levels. The likelihood that there are residual effects on outdoor recreation following mitigation and remediation measures is anticipated to be "low".

2.3.4.7 Archaeological and Heritage Sites

Jacko Lake has been identified as an important area for traditional and current practices of the Secwépmec people. There are currently six known archaeological sites near Jacko Lake (EdRc-1, EdRc-5, EdRc-6, EdRc-7, and EdRc-8, EdRc-19), four of which are located along the shores of Jacko (Pípsell) Lake, which is associated with the Trout Children Story (CEAA 2015). These sites consist of lithic scatters. The magnitude of effect is predicted to be "low", and the duration "short-term" as draining of Jacko Lake is unlikely to disturb archaeological or heritage sites on the shores of Jacko Lake. However, prior to the lake level being re-established, planning will need to take place to ensure that construction activities do not disturb these sites, and that re-established water levels do not flood these existing sites. The likelihood that there are residual effects on archaeological or heritage sites following mitigation and remediation measures is anticipated to be "low".

2.3.4.8 Domestic Water

A complete draining of Jacko Lake due to a highwall failure could result in the reduction of surface water quantity available for existing water licence holders, including 10 domestic water use licences on Peterson Creek. The magnitude of the effect would be "high" and the duration would be "medium-term" until the lake was re-established. The duration could be reduced to "short-term" if flow to Peterson Creek (from Kamloops Lake) is implemented prior to re-establishment of Jacko Lake. The spatial extent is "local" (Jacko Lake and downstream) and considered "reversible long-term" because water would be temporarily made available for downstream users until the lake level is sufficiently restored. The likelihood that there are residual effects on domestic water following mitigation and remediation measures is anticipated to be "low".

2.4 South Embankment Failure

2.4.1 Description of Possible Scenario

As described in EIS Section 17.6.3.5, a South Embankment failure would mean a large catastrophic failure triggered by a seismic event and/or high pore pressures leading to deep-seated foundation failure and subsequent breach and a release of tailings downstream (see Potential Failure Modes Risk Profile Case #5). It is assumed that the tailings will liquefy and flow as a fluid with very low strength. A South Embankment failure could result in tailings inundation covering an area close to 32 ha, the majority of which would be within the mine property boundary (24 ha), while 8 ha would be outside the mine property boundary. The area of inundation is expected to be controlled by topography, such that tailings would not be carried to other catchments through surface runoff. Inundation could extend as far as 300 m from the toe of the South Embankment.

Note that the potential for structural failure is unlikely due to the large consolidated tailings mass upstream that provides structural support and also due to the foundation being relatively compact to very dense. However the dam is not buttressed with mine rock, so was therefore considered for the dam breach evaluation.

A dam breach of the South Embankment would release tailings only, as the supernatant pond is located a safe distance away from the dam crest. The maximum inundation extent downstream of the embankments was estimated to be the same tailings elevation stored within the TSF, as the topography will contain any tailings and water that are released in the event of a dam breach. See Section 17.6.4 – Downstream Effects of Dam Breach Scenarios.

Two sumps and a contact water collection ditch are located downstream of the South Embankment. The seepage collection ponds and water management ditch will likely be buried.

Surface runoff from subsequent precipitation events, which could conceivably re-mobilize exposed tailings, would be contained within the TSF catchment, and would not connect to the local stream network.

2.4.2 Characterization of Risk

A Potential Failure Modes Analysis (PFMA) and risk evaluation was completed for the TSF (see Section 17.6.3 and Appendix 17.6-B of Application/EIS). Specifically, PFM #18 – Case #5 (South Embankment Failure at End of Year 20) was considered to be 'critical' and considered in detail in the PFMA. Case #5 was assigned a Category II Consequence – PFM with potential for a breach with inundation zone likely to be maintained within the property or results in limited impacts beyond the property boundary. A summary of the risk characterization is in Table 2.4-1.

Table 2.4-1. Risk Characterization of Case #5 – South Embankment Failure at End of Year 20

Positive Factors	• Factor of Safety exceeds design criteria. • Very long seepage path that minimizes flow velocities that reduces internal erosion and potential for piping. • Rock fill material is not susceptible to erosion and piping. • Spatial and limited time of contact over a relatively small area. Startup pond has limited contact with the upstream face of the starter embankment.
Adverse Factors	• Limited by seasonal construction period. • Borrow areas are not well defined. • Rapid construction of till blanket that may lead to increased pore pressures and differential settlement.
Mitigation Opportunity	• Use geotechnical instruments and construction monitoring to monitor performance, prior to filling of the TSF. • QA/QC of material construction specification of processed engineered fill. • Use additional seepage control, thicker upstream blanket, and internal core zone as a design contingency.
Consequence Category (I to IV)	Category II – Potential Failure Mode with potential for a breach with inundation zone likely to be maintained within the property or results in limited impacts beyond the property boundary (see section 17.6.3.2 of Application/EIS for more details).

2.4.3 *Mitigation, Contingency and Remediation Measures*

Preventive controls are measures that are inherently part of the Project design to help reduce the likelihood of this failure mode from occurring. They will include, but are not limited to the following:

- Review of TSF design by Independent Engineering Review Board, and regulatory bodies.
- Construction and operation of the TSF will be implemented in accordance with an Operation, Maintenance and Surveillance (OMS) manual.
- Visual and instrumentation monitoring program for the TSF:
    - inspection of the dam crests and sloes for signs of cracking, slumping, settlement, seepage or piping;
    - inspection of pumps and piping systems;
    - inspection of surface water diversion channels and structures to identify sections where repairs may be required;
    - inspection of diversion channels to identify damage or blockages attributable to snow accumulation, and to identify excessive erosion during spring runoff;
    - installation of piezometers to measure pore water pressures in the dams and dam foundations and establishment of limits and action plans based on allowable variations in pore water pressures;

  - installation of survey monuments to measure dam fill settlement and surface displacement and establishment of limits and action plans based on allowable variations in displacements;
  - monitoring of pond water levels;
  - monitoring of tailing beach widths;
  - monitoring of seepage water quantity and quality downstream of the dams and establishment of limits and action plans based on allowable variations in seepage rates;
  - monitoring of flows in the diversion channels; and
  - monitoring of geohazards.

- Regular Dam Safety Reviews (DSRs) carried out over the life of the Project.
- Use Quantitative Performance Objectives (QPO) to establish adequate limits of measurable indicators that define the TSF performance (i.e., filling schedule, trigger levels for response to instrumentation, performance data gathering intervals).
- Evaluate opportunities to add rock buttress or reduce overall downstream slopes to improve stability.
- Provide performance monitoring program to monitor to confirm no movements within the foundation.

Mitigation responses are measures that will be in place pre-event, but would be implemented post-event to reduce the consequences should the failure mode occur. These will include, but are not limited to the following:

- Implementation of Emergency Response Plan (see Section 11.14).
- Ensure safety for personnel and the public.
- Implement interim measures to minimize potential environmental effects (e.g., sediment and erosion control, dust control).
- Review the stability of the resultant runout, and identify appropriate remediation measures (e.g., return material to the TSF and re-construct the embankment, or reclaim the runout in place).
- Reclamation activities.

KAM will have a formal communication plan in place in the event of a failure scenario. A designated media spokesperson will be assigned and lead the dissemination of information, per the Mining Association of Canada's "Towards Sustainable Mining" Crisis Management Planning Assessment Protocol. KAM will notify all relevant federal, provincial, regional, and municipal government agencies, and Aboriginal Groups, as soon as practicable after the occurrence and work with agencies to ensure appropriate responsive action is taken, including communication to the public.

KAM will work with Aboriginal Groups to communicate about the failure event, the mitigation response and the results of reclamation efforts. This would help ensure that members practicing traditional land uses near the Project are able to make informed decisions related to the quality of the land to support CULRTP activities.

Follow up monitoring will include monitoring the success of clean-up and subsequent reclamation activities.

2.4.4 Description of Interactions and Characterization of Potential Effects

Table 2.4-2 summarizes the anticipated interactions with Valued Components should this potential failure mode occur. Potential moderate (yellow) or high (red) interactions are discussed in further detail below. Potential for negligible to minor (green) interactions are not discussed further.

Table 2.4-2. VC Interaction Matrix for South Embankment Failure

Greenhouse Gases	Terrestrial Invert.	Business	Archaeological Sites
Geology, Landforms	Amphibians	Property Values	Heritage Sites
SW Quantity	Reptiles	Economic Diversificaiton	Air Quality
SW Quality	Migratory Birds	Infrastructure/Services	Domestic Water
GW Quantity	Raptors	Dark Sky	Country Foods
GW Quality	Non-Migratory Birds	Visual Quality	Human Health
Fish & Aquatics	Mammals	Land and Resource Use	Noise
Rare Plants	Economic Growth	CULRTP	Healthy Living
RSEC	Labour/Employment	Outdoor Recreation	Community Health/WB
Grasslands	Income		Aboriginal Economies

2.4.4.1 Geology, Landforms and Soils

Overall, the area of inundation would increase the direct footprint of the Project (assessed as 1,705 ha; see EIS Section 3.17) by less than 2%. Some unavoidable losses of would be incurred, such as the loss of soil resources in this 32 ha area as a result of burial by tailings. The magnitude of the effect is "low" and duration is predicted to be "far-future" as the loss would be permanent or "irreversible". The spatial extent would be "local" because it would be confined to the inundation area. The likelihood that there are residual effects on geology, landforms and soils following mitigation and remediation measures is "high" because the loss of soils in the zone of inundation is permanent.

2.4.4.2 Amphibians

Some direct mortality may be incurred for individual amphibians or other small animals that may not be able to escape inundation. Northern Pacific treefrog has been observed in the vicinity of the inundation area (Chapter 6.12 of the EIS/Application). However, given the relatively small area of inundation, this would not be anticipated to affect local or regional populations. The magnitude of the effect is predicted to be "low" from a population perspective and "short-term". The spatial extent would be "local" because it would be confined to the inundation area, and would be "reversible short-term" because on-going breeding would make up for the direct mortality of those individuals. The likelihood that there are residual effects on the local or regional amphibian population following mitigation and remediation measures is "low".

2.4.4.3 Land and Resource Use

It is acknowledged that a portion (8 ha) of the predicted inundated land is associated with grazing licence RAN 077241 and Trapline TR0320T001; however, it is anticipated that there will be limited trapping or ranching activity due to the natural topography and close proximity to the Project. Effects to other land uses/users are anticipated to be negligible, particularly after reclamation measures are implemented. The magnitude of this effect is "low" and the spatial extent is "local" (limited to the inundation area). The duration of the effect is predicted to be "short-term" and is "reversible short-term". The likelihood that there are residual effects on land and resource use following mitigation and remediation measures is "low".

2.4.4.4 CULRTP

There is potential for some loss of available habitat for hunted species or traditional use plant species, as well as potential ceremonial use sites. A dam breach scenario could also cause effects associated with the perceived quality of land in the proximity of the Project to support CULRTP, although the specific area of inundation is anticipated to see limited CULRTP activity due to the natural topography and close proximity to the Project. The inundation area, at the upstream end of the TSF, is not known to contain particularly unique habitat or ceremonial features, therefore the magnitude of the effect is predicted to be "low", and confined to a "local" spatial extent. Effects would be "long-term" and it is "reversible long-term", as the area will be reclaimed as per the TSF. KAM would work closely with SSN in the planning and execution of mitigation response to help reduce this likelihood of residual effects on CULRTP. As such, following mitigation and remediation measures the likelihood of residual effects on CULRTP is "low".

2.5 Summary of Effects and Conclusion

Consistent with the requirements outlined in the AIR/EIS Guidelines, an evaluation of accidents and malfunctions was completed to support the environmental assessment process (Chapter 17.6 of the Application/EIS). The characterization of the potential effects to VCs, mitigation and contingency measures are outlined in Table 2.5-1 for each of the three failure scenarios (open pit highwall failure and South Embankment failure) identified by the Agency as requiring further information (IR 17 and 19).

Table 2.5-1. Summary of the Characterization of Environmental Effects of Open Pit Highwall Failure, or South Embankment Failure

Accident and Malfunction Scenario	Valued Components with Moderate or High Interaction	Potential Effects	Description of Mitigation, Contingency, and Remediation Measures	Magnitude	Duration	Frequency	Spatial Extent	Reversibility	Resiliency	Likelihood	Confidence
Open Pit Highwall Failure	Surface Water Quantity	Reduction in surface water quantity in Jacko Lake, effects to downstream water users and license holders	• Detailed geotechnical investigations and design, including a minimum factor of safety of 1.6 (see Appendices 3-D; 6.2-C; 6.2-D); • De-pressurization of the pit wall during Operation through installation of horizontal drains (see Section 3.5.1); • Active, continuous monitoring of pit stability (see Section 11.2); o Slope stability will be constantly monitored through a combination of Automated Total Station Networks, Non reflective LIDAR (Light Detection and Ranging) scanning, Slope Stability Radar (SSR) and/or Global Positioning System (GPS). Monitoring will be done on a daily basis to allow for real-time identification of stability issues that can be rectified in a timely manner through adaptive management. • An adaptive response will be implemented based on monitoring observations, which will include escalation as appropriate (e.g., reinforcement of wall, evacuation of pit, evacuation of Jacko Lake); • The mine plan will be continuously optimized and refined through Operation to ensure long-term stability; and • In-pit MRSF (Section 3.9.1) will buttress high-wall and reduce residual risk. • Implement Emergency Response Plans (Section 11.14) to ensure safe conditions are established as quickly as possible; • Implement Spill Prevention and Response Plan (Section 11.6); • Site investigations: o Evaluate the new geotechnical conditions in the immediate vicinity of the failure and of remaining pit wall sections; and o Evaluate resultant effects to environmental/cultural resources around the lake. • Establish temporary water supply for existing water licence holders on Peterson Creek prior to lake re-establishment; • Evaluate temporarily providing flow to Peterson Creek (from Kamloops Lake) prior to lake re-establishment; • Re-establishment of lake: o Construct new dam(s) and grout/seal potential new seepage pathways that were developed; o Re-fill lake (with original lake water, or with supply from Kamloops Lake); and o Re-establish water supply to downstream users and stocked fish population. • Re-establishment of stability monitoring to incorporate new site conditions.	High	Short-term	Once	Local	Reversible Short-Term	High	High	Medium
	Surface Water Quality	Reduction in surface water quality		Medium	Short-term	Once	Local	Reversible Long-Term	High	Low	Medium
	Fish Populations and Fish Habitat	Loss of fish and aquatic habitat (extending downstream of the lake)		High	Medium-term	Once	Local	Reversible Long-Term	High	Low	Medium
	Land and Resource Use	Reduction in access to sufficient water quantities to support ranching operations		Low	Short-term	Once	Local	Reversible Long-Term	High	Low	Medium
	CULRTP	Loss of spiritual and cultural value of Jacko Lake; loss of lake area for fishing		High	Far Future	Once	Local	Irreversible	High	High	Medium
	Outdoor Recreation	Loss of recreational area; reduced availability of natural resources for fishing		Low	Medium-term	Once	Local	Reversible Long-Term	High	Low	Medium
	Archaeological Sites	Disturbance of archaeological sites on shores of Jacko Lake		Low	Short-term	Once	Local	Irreversible	High	Low	Medium
	Heritage Sites	Disturbance of heritage sites on shores of Jacko Lake		Low	Medium-term	Once	Local	Irreversible	High	Low	Medium
	Domestic Water	Reduction in water quantity available for existing water licence holders, including 10 for domestic water use licenses on Peterson Creek		High	Medium-term	Once	Local	Reversible Long-Term	High	Low	Medium
South Embankment Failure	Geology, Landforms and Soils	Loss of soil	• Construction and operation of the TSF will be implemented in accordance with an Operation, Maintenance and Surveillance (OMS) manual. • Visual and instrumentation monitoring program for the TSF. • Regular Dam Safety Reviews (DSRs) over the life of the Project. • Use of Quantitative Performance Objectives (QPO) to establish adequate limits of measurable indicators that define the TSF performance (i.e., filling schedule, trigger levels for response to instrumentation, performance data gathering intervals) • Evaluate opportunities to add rock buttress or reduce overall downstream slopes to improve stability; • Provide performance monitoring program to monitor to confirm no movements within the foundation. • Emergency Response Plan (see Section 11.14). • Ensure safety for personnel and the public. • Interim measures to minimize potential environmental effects (e.g., sediment and erosion control, dust control). • Review the stability of the resultant runout, and identify appropriate remediation measures (e.g., return material to the TSF and re-construct the embankment, or reclaim the runout in place). • Reclamation activities.	Low	Far-future	Once	Local	Irreversible	Low	High	Medium
	Amphibians	Direct mortality of amphibians or other small animals		Low	Short-term	Once	Local	Reversible Short-term	High	Low	Medium
	Land and Resource Use	Inundation of grazing land		Low	Short-term	Once	Local	Reversible Short-term	High	Low	Medium
	CULRTP	Loss of habitat for CULRTP (e.g. for hunting, gathering)		Low	Short-term	Once	Local	Reversible Short-term	High	Low	Medium

REFERENCES

CEAA. 2015. *Consideration of the Stk' emlupsemc to Secwepemc Nations's Trout Children Story in the Environmental Assessment of the Ajax Mine Project*. Letter from CEAA to KAM dated August 4, 2015.