# 4.0 ACCIDENTS AND MALFUNCTIONS

## 4.1 Background

The Project is located within with the Kenora Mining Division in northwestern Ontario. The Project site is approximately 4 km northwest of the village of Wabigoon, 20 km east of Dryden and 2 km north of the TransCanada Highway 17 and within the Hartman and Zealand townships.

A major component of the EIS process is the identification and assessment of potential accidents and malfunctions that could occur throughout all phases of the Project. Treasury Metals understands the risks associated with the Project and is committed to operate the Project to the highest standards for operation, security and health and safety. The assessment of the potential accidents and malfunctions of the Project have been completed in accordance with the EIS Guidelines (Appendix Y) issued by the Canadian Environmental Assessment Agency (the Agency).

The proponent will identify the probability of potential accidents and malfunctions related to the Project, including:

- An explanation of how the potential accidents and malfunctions were identified;
- Potential consequences (including the environmental effects);
- The methodology for assessing potential risks;
- Definitions of assessment characterization criteria (e.g., likelihood and severity);
- The plausible worst case scenarios and the effects of these scenarios;
- Identification of the magnitude of an accident and/or malfunction, including the quantity, mechanism, rate, form and characteristics of the contaminants and other materials likely to be released into the environment during the accident and malfunction events;
- Identification of the safeguards that have been established to protect against such occurrences; and
- Contingency/emergency response procedures in place if accidents and/or malfunctions do occur.

The process for identification of potential accidents and malfunctions, potential environmental effects, methodology for assessing potential risks, assessment characterization criteria, worst case scenarios, preventative procedures, and contingency procedures are included in this section.

## 4.2 Approach

Accidents and malfunctions were identified using a Failure Mode and Effects Analysis (FMEA) methodology. An FMEA is a risk analysis procedure used to identify and characterize accidents and malfunctions (i.e., failure) based on the likelihood of occurring and the severity/magnitude of the failure. Through the FMEA process, a total of 463 failure modes were identified and analyzed, as described in the following sections.

The FMEA process for this Project assessed the likelihood of a potential failure and the consequences of the failure in three main categories:

- Environment;
- Safety and health; and
- Production.

The FMEA process was completed in four general phases:

- Data input;
- Summary of risks and risk matrices;
- Likelihood and severity assessment; and
- Analysis of controls.

### 4.2.1 Data Input

A team of experts involved with the Project (Table 4.2.1-1) was assembled and an FMEA workshop was conducted from January 30, 2015 to February 1, 2015 under the facilitation of Dave Ireland of Tetra Tech.

The potential environmental risks were identified, including potential consequences of the occurrence. The likelihood and magnitude of an accident and/or malfunction were also identified. Once the accidents and malfunctions were identified, control measures were established to protect against such occurrences as well as emergency response procedures if accidents or malfunctions failures occur. The FMEA data were gathered and input to a worksheet that uses a structured approach to identify and assess potential risks.

**Table 4.2.1-1: FMEA Workshop Participants**

| Name | Company | Role | 01/30/2015 | 01/31/2015 | 02/01/2015 |
|---|---|---|---|---|---|
| D. Ireland | Tetra Tech | Facilitator | √ | √ | √ |
| M. Rutherford | Tetra Tech | Scribe/Team Member | √ | √ | √ |
| J. Jones | Tetra Tech | Team Member | √ | √ | √ |
| M. Grégoire | Tetra Tech | Team Member | √ | √ | √ |
| M. Herrera | Tetra Tech | Team Member | √ | √ | |
| N. Bush | Treasury | Team Member | √ | √ | √ |
| M. Wheeler | Treasury | Team Member | √ | √ | √ |
| M. Potter | Treasury | Team Member | √ | √ | √ |
| A. Cluegh | Orway Mineral Consultant | Team Member | √ | √ | |

#### 4.2.1.1 Activity / Step / Area or Category

Potential accidents and malfunctions are organized into categories and each category is further divided into sub-categories or items.

The major categories evaluated are:

- General development;
- Mine underground;
- Mine open pit;
- Mine site process;
- Mine site utilities;
- Mine site facilities;
- Mine site tailings;
- Mine site temporary facilities; and
- Off-site infrastructure.

#### 4.2.1.2 Hazard / Aspect or Threat

The Hazard/Aspect or Threat describes the potential risk or type of failure being evaluated. A failure mode can occur naturally, by an engineering system failure, or operational failure due to inadequate control measures or operator error. For example, the clearing of vegetation (site preparation category) requires heavy equipment and releases from equipment failure are a potential hazard or threat. Since there may be several hazards in one category, the FMEA only includes the most significant or likely hazards that may potentially occur.

#### 4.2.1.3 Unwanted Event

The Unwanted Event describes the adverse effects or outcome of the hazard / threat occurring, whether it relates to the environment, safety and health, or reputation. For example, potential unwanted events that could occur when clearing vegetation with heavy equipment include accidents, collisions, spills, air emissions, injury to humans or wildlife, and habitat removal.

#### 4.2.1.4 Life of Mine

The Life of Mine refers to the phase(s) of the Project the potential hazard / threat may occur in. Depending on the type of failure identified, it may be a potential threat at only one Project phase or multiple Project phases. The six phases of the Project are: exploration, study, site preparation and construction, operation, closure, and post-closure. As the exploration and study phases of the Project are either complete or currently underway, they are not considered in the FMEA. During the post-closure phase, there will be little or no activity at the Project site, and thus post-closure was not included in the FMEA. The FMEA focuses on the site preparation and construction, operations, and closure phases of the Project when activities will be occurring at the site. Some potential failures may have a different severity or likelihood of occurring depending on the phase.

#### 4.2.1.5 Existing Controls and Contributing Factors

Within the Existing Controls and Contributing Factors category, there are six sub-sections that provide information on:

- Factors contributing to the unwanted event;
- Current controls in place (i.e., elimination, substitution, separation, administrative, engineering, personal protective equipment, and emergency response);
- Effectiveness of controls (i.e., effective, limited, or partial);
- The total effectiveness of controls for each category based on a combination of effectiveness ratings for each control; and
- Reasons why the controls are either effective or not effective.

#### 4.2.1.6 Impact Categories

As indicated in Section 4.2, the impact categories are:

- Environment;
- Safety and health; and
- Reputation.

#### 4.2.1.7 Residual and Inherent Risks

The Residual and Inherent Risks describe the overall level or rank of each hazard / threat. Residual risk is defined as the amount of risk remaining once the controls have been applied and inherent risk is defined as the risk associated with a hazard / threat where no controls have been implemented. The level of both the residual risk and inherent risk are determined as a function of likelihood and severity. The likelihood is the expected frequency of occurrence and the severity is the consequence expected as a result of the occurrence.

There are no mathematically or statistically derived formulas for determining the actual risk of a hazard / threat. Therefore, likelihood and severity are based on experience and judgment of qualified professionals involved in the Project (i.e., FMEA workshop participants). However, the FMEA incorporates a semi-quantitative method for estimating the likelihood and severity based on a five-category scale.

**Likelihood**

Likelihood is described as the possibility that the identified failure will occur for each of the impact categories. The likelihood ratings range from “almost certain” to “rare” and are coded A to E, respectively (Table 4.2.1.7-1).

**Table 4.2.1.7-1: Ratings for Likelihood of Failure Modes**

| Code | Description | Definition |
|---|---|---|
| A | Almost Certain (i.e., the event will occur) | 90% to 100% |
| B | Expected (i.e., the event will probably occur in most circumstances) | 55% to 90% |
| C | Likely (i.e., the event could occur at some time) | 30% to 55% |
| D | Unlikely (i.e., the event may occur at some time) | 5% to 30% |
| E | Rare (i.e., the event may occur only in exceptional circumstances) | < 5% |

**Severity**

Severity is the degree of consequence expected as a result of a failure mode. That is, the greater the severity, the more negative the consequence. Severity, unlike likelihood, is assessed separately for each impact category. The severity rating applied to the Project uses a scale of “limited” to “severe” and are coded 1 to 5, respectively (Table 4.2.1.7-2).

**Table 4.2.1.7-2: Rating for Severity of Failure Modes**

| Severity Rating | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Safety & Health | First aid -or- minor reversible health effects of no concern | Medical treatment -or- reversible health effect of concern (no disability) | Lost time injury / illness -or- severe, reversible health effect resulting from acute, short-term exposure -or- progressive chronic condition, infectious disease | Single fatality -or- permanent disability -or- exposure resulting in irreversible health effect of concern | Multiple fatalities or health effects resulting in multiple disabling illnesses leading to early mortality |
| Environment | Limited environmental impact<br>• restricted to the Project site<br>• no regulatory reporting<br>• Unlikely to affect closure and operations schedule | Minor environmental impacts<br>• restricted to the Project site<br>• reportable to regulators<br>• Unlikely to affect closure and operations schedule | Moderate environmental impacts<br>• extending beyond site boundary<br>• regulatory violations with fines<br>• significant potential delays of closure up to 10 years (still required to monitor and maintain) | Serious environmental impacts<br>• extends beyond the site boundary<br>• major regulatory violations (operations continue but with significant fines)<br>• significant potential delays of closure greater than 10 years (still required to monitor and maintain) | Severe environmental impacts<br>• extends beyond the site boundary<br>• severe breach of regulations (significant fines and / or charges)<br>• operations suspended and significant potential delays of closure greater than 10 years (still required to monitor and maintain) |
| Stakeholder Relations and Reputation | No impact on stakeholder confidence in management of company | Limited impact on stakeholder confidence in management of company | Medium impact on stakeholder confidence in management of company | High impact on stakeholder confidence in management of company | Loss of stakeholder confidence in management of company |

#### 4.2.1.8 Rank and Risk Level

The rank and risk levels are determined using the likelihood and severity categories for each failure mode. The combination of likelihood and severity for a failure mode assigns a rank ranging from 1 to 25 (Table 4.2.1.8-1). The greater the likelihood and/or severity, the lower the rank (i.e., smaller ranks represent greater risk). For example, a failure mode that has a high likelihood (i.e., likelihood rating of A - almost certain to occur) and high severity (i.e., severity rating of 5) would be considered the highest rank (i.e., rank = 1).

The risk level is based on ordering the 25 ranks into three risk management categories: low, medium, and high (Table 4.2.1.8-1). Each cell in the matrix has two values: the first is whether the failure mode is low (L, green), medium (M, yellow), or high (H, red) and the second is the rank.

**Table 4.2.1.8-1: Criteria for Risk Matrix**

| Likelihood Rating | Severity Rating 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| A | $L_{18}$ | $M_{11}$ | $H_{6}$ | $H_{3}$ | $H_{1}$ |
| B | $L_{20}$ | $M_{14}$ | $M_{10}$ | $H_{4}$ | $H_{2}$ |
| C | $L_{22}$ | $L_{19}$ | $M_{12}$ | $H_{7}$ | $H_{5}$ |
| D | $L_{24}$ | $L_{21}$ | $M_{15}$ | $M_{13}$ | $H_{8}$ |
| E | $L_{25}$ | $L_{23}$ | $M_{17}$ | $M_{16}$ | $H_{9}$ |

The high-risk level (i.e., red, ranks 1 to 9) indicate failure modes with a severity rating of greater than 3 and a likelihood rating of A to C. The medium-risk level (i.e., yellow, ranks 10 to 17) indicate failure modes with a severity rating of 2 to 4 and broad range of likelihood. The low-risk level (i.e., green, ranks 18 to 25) indicate failure modes with a severity rating of 1 to 2 and a broad range of likelihood.

#### 4.2.1.9 Recommended Action

The Recommended Actions column of the FMEA worksheet provides a list of methods that were identified during the FMEA workshop for improving existing controls and implementing new controls for each failure mode.

### 4.2.2 Risk Registers and Risk Matrices

#### 4.2.2.1 Risk Across all Impact Categories

Treasury has committed to a wide-range of control measures designed to reduce inherent risk in all facets of the Project development, operation, and closure (Appendix HH). As a result, the remainder of this section will focus on the characterization and discussion of residual environmental risk. Across the three impact categories, there are 463 potential failure modes. One (0.2%) of the failure modes are considered high-residual risk, 69 (14.9%) are medium-residual risk, and 393 (84.9%) are low-residual risk (Table 4.2.2.1-1).

**Table 4.2.2.1-1: Summary of Residual Risk Ranks**

| Likelihood Rating | | | | | | |
|---|---|---|---|---|---|---|
| | A | 0 | 3 | 0 | 0 | 0 |
| | B | 6 | 0 | 0 | 0 | 0 |
| | C | 15 | 6 | 0 | 0 | 0 |
| | D | 81 | 58 | 10 | 7 | 0 |
| | E | 211 | 16 | 28 | 21 | 1 |
| | | 1 | 2 | 3 | 4 | 5 |
| Severity Rating | | | | | | |

The summary of the residual risk categories indicates that the majority of medium and high risk categories are due to the potential impact of failure modes on environment (14) and safety and health (47), whereas only nine were associated with reputation (i.e., one high-risk and eight medium-risk) (Table 4.2.2.1-2).

**Table 4.2.2.1-2: Risk Level by Impact Category**

| Impact Category | Low Risk | Medium Risk | High Risk | Total |
|---|---|---|---|---|
| Environment | 123 | 14 | 0 | 137 |
| Safety & Health | 174 | 47 | 0 | 221 |
| Reputation | 96 | 8 | 1 | 105 |
| **Total** | **393** | **69** | **1** | **463** |

#### 4.2.2.2 Evaluation of Environmental Failure Modes

To evaluate the environmental residual risks, the following steps were taken:

- Filtering from the FMEA worksheet the failure modes exclusive to the environment category;
- Selecting the failure modes in the environment category that had risk rankings (both residual and inherent) of high- or medium-risk levels (i.e., yellow or red on risk matrix); and
- Documenting the rationale behind their rank and subsequent risk level assignment.

The environment impact category has a total of 137 failure modes. 123 of these failure modes are considered low-residual risk (green) and 14 are considered medium-residual risk (yellow). There were no high-residual risk (red) environmental failure modes identified during the FMEA process as shown on the risk matrix (Table 4.2.2.2-1).

**Table 4.2.2.2-1: Summary of Identified Environmental Residual Risks**

| Likelihood Rating | Severity Rating: 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| A | 0 | 3 | 0 | 0 | 0 |
| B | 2 | 0 | 0 | 0 | 0 |
| C | 2 | 6 | 0 | 0 | 0 |
| D | 41 | 15 | 4 | 0 | 0 |
| E | 50 | 7 | 7 | 0 | 0 |

#### 4.2.2.3 Low Environmental Risks

All of the 123 low residual risk environmental failure modes were considered to have a low severity rating with limited to minor potential environmental effects (i.e., severity rating of 1 or 2). There were no environmental low-residual risk failure modes with a severity of greater than 3. Of the low-residual risk environmental failure modes, two were determined to be “expected” to occur (i.e., likelihood rating B), eight were found to be “likely” to occur (i.e., likelihood rating C), 56 were determined to be “unlikely” to occur (i.e., likelihood rating D), and 57 were found to be “rare” (i.e., likelihood rating E). It should be noted that the environmental failures considered to be “expected” and “likely” all involve spills that would occur only on site (e.g. minor spills from equipment failure or break of a water pipeline on-site) Treasury Metals has committed to good housekeeping practices and regular clean-up of spills, as well as to construct a perimeter ditch surrounding the active operations area during the site preparation and construction phase. This ditch which would effectively provide a means to capture all spills from reaching the receiving environment if for some reason they were not detected or occurred near the active area boundary. Accordingly, there are no predicted environmental effects as a result of these "expected" or "likely" failures.

Further information regarding low-residual risk environmental failure modes including a description / consequence, area of impact, phase, severity, likelihood, risk level/rank, and controls and applicable management/monitoring plans for low environmental risk failure modes is included in Appendix HH.

#### 4.2.2.4 Medium Environmental Risks

Fourteen of the failure modes are considered medium environmental risks. Of the 14 medium residual risk environmental failure modes, three were considered to have a severity rating of 2 (i.e., minor environmental effects) and the remaining 11 were considered to have a severity rating of 3 (i.e., moderate environmental effects). Of all the medium-risk environmental failure modes, three were determined to be "almost certain" to occur (i.e., likelihood rating A), four were considered to be "unlikely" to occur (i.e., likelihood rating D), and seven were considered to be "rare" (i.e., likelihood rating E). It should be noted that the environmental failures considered to be "almost certain" all involve spills from earth works, vegetation clearing and road development that would occur only on site, within the active operations area. Treasury Metals has committed to constructing a perimeter ditch surrounding the active operations area during the site preparation and construction phase. This would effectively capture all spills from reaching the surrounding environment. There are no predicted environmental effects as a result of the "expected" or "likely" failures.

Further information regarding medium-risk environmental failure modes including a description / consequence, area of impact, phase, severity, likelihood, risk level / rank, and controls and applicable management / monitoring plans for medium environmental risk failure modes is included in Appendix HH.

## 4.3 Effects of Medium Risk Failure Modes

### 4.3.1 Identification of Medium Risk Failure Modes

The medium risks identified within the environment category were selected for further analysis and categorized into three failure modes for further environmental assessment (Table 4.3.1-1):

1. Failure of the tailings storage facility (TSF);
2. Spills and releases; and
3. Uncontrolled Cyanide Release.

**Table 4.3.1-1: Description, Prevention, and Responses to Potential Medium Environmental Residual Risk Failure Modes**

| Potential Failure Mode | Potential Environmental Effects | Control Measures and Preventative Procedures | Emergency Response and Contingency Procedures | Follow-up Monitoring |
|---|---|---|---|---|
| Failure of tailings storage facility | The potential primary effects would be to soil, terrain, and surface water in the vicinity of the release with potential secondary effects on aquatic resources and fish and fish habitat. | 1.0 Dam Safety Management Plan<br>2.0 CDA Dam Safety Guidelines<br>3.0 MNRF Best Management Practices<br>4.0 Provincial Lakes and Rivers Improvement Act<br>5.0 Operational and storm water management<br>6.0 Existing site conditions and historical climatic data incorporated into the predictive hydrological modelling<br>7.0 The spillway will be designed to route flows resulting from the Inflow Design Flood as prescribed by the HPC of the dam.<br>8.0 The embankment heights will also be designed with the required freeboard allowances, for normal and minimum freeboard, as prescribed by the guidelines listed above.<br>9.0 The embankments will be designed with zoned earth fill raises and meet the standards set forth by the applicable guidelines. The embankments will be designed to be stable and meet the required minimum Factors of Safety under the required conditions.<br>10.0 A qualified Engineer will inspect the system as part of the annual Dam Safety Inspections and routine Dam Safety Review.<br>11.0 Operations, Maintenance and Surveillance (OMS) Plan will be developed for the TSF. The OMS will include items such as<br>o Operational pond levels will be established and an allowance to hold the volume of water resulting from the EDS will be developed.<br>o Dam inspections will be completed as required by guidelines and best managements practices.<br>o The seepage collection system will be inspected as part of the daily visual inspections to identify early potential problems or concerns.<br>o Ground movement sensors will be used to detect any early movement on TSF<br>12.0 Emergency Preparedness Plan (EPP) will be prepared to include the proper procedure for dealing with a failure of the TSF. This Plan will be updated as required by the current operating plan.<br>13.0 A compliance monitoring program will be developed prior to construction to assess the performance of the TSF and collection | In the event of a dam breach, the following must occur as outlined in the EPP:<br>14.0 The seepage reclaim system would be shut down to prevent water from being routed to the containment area.<br>15.0 The reclaim system would be re-routed to transfer water back to the plant site if capacity is available, or alternatively it could be pumped to the open pit for temporary storage if worker safety is not compromised.<br>16.0 In the event of a pump failure, a temporary pump can be installed during repairs. The standby pump can also be diesel-powered in the event of power loss at the site.<br>17.0 In the event that water breaches the seepage collection system; the area would be cleaned up by removal and proper disposal of the potentially impacted material into the TSF. | 18.0 If the TSF was to fail an in-depth review will be conducted which may warrant design changes, procedure changes, or need for additional measures.<br>19.0 A compliance monitoring program would be developed to ensure that cleanup activities are effective. |
| Spills/Releases | Primary effects would be to the soil, snow and surface water. Potential secondary effects on aquatic resources, fish and fish habitat and wildlife habitat. | 20.0 OMS Plan will be developed mine operations. The OMS will include items such as<br>o Regular maintenance of fuel trucks;<br>o Speed limits are to be strictly adhered to, to be posted and enforced by Treasury security personnel;<br>o Strict adherence to national trucking hour limits and other applicable requirements;<br>o Drivers will be required to meet all applicable regulatory training requirements, be trained in spill response procedures for the materials they transport, and carry the appropriate MSDS;<br>o Right-of-way procedures will be defined and haul trucks and loaded vehicles will be given preference;<br>o Traffic will be required to yield to wildlife as observed;<br>o Where possible, heavy traffic will be limited to site haul roads and other traffic limited to site access roads;<br>o Transportation of material (i.e., fuel) during times of limited visibility will be avoided where possible;<br>o All vehicles transporting fuel to site will be required to maintain a supply of basic emergency response equipment, including communication equipment, first aid materials and a fire extinguisher; and<br>o Penalties for infractions.<br>21.0 All materials will be stored and handled according to manufacture specification or MSDS<br>22.0 All liquid containments will be designed to include a secondary containment area which will hold 150% the contained volume.<br>23.0 All personnel on the project site will be trained in the proper handling of chemicals.<br>24.0 Spill Management Plan (SMP) will be prepared to include the proper procedures for handling spills to land and water, locations of spill containment equipment, safe areas to access spills, disposal of spill contaminated material and reporting requirements. This plan will be updated as required by the current operating plan.<br>25.0 EPP will include the proper procedure for dealing with spills. This Plan will be updated as required by the current operating plan. | The emergency response protocols will be followed as outlines in the ERP and SMP in the event of a worst-case scenario fuel release include the following:<br>26.0 Identify immediate hazards to human life and health;<br>27.0 Identify source of spill and control source;<br>28.0 Contain the released material;<br>29.0 Notify appropriate personnel and reporting to applicable government agencies;<br>30.0 Conduct clean-up area impacted by release;<br>31.0 Incident investigation; and<br>32.0 Further assessment of effected environment, including surface water bodies in vicinity of the release. | 33.0 Review of reported spill will be conducted periodically which may warrant design changes, procedure changes, or need for additional measures.<br>34.0 Compliance monitoring programs would be implemented to assess clean-up requirements and disposal of impacted soil/snow, if required. |

**Table 4.3.1-1: Description, Prevention, and Responses to Potential Medium Environmental Residual Risk Failure Modes (continued)**

| Potential Failure Mode | Potential Environmental Effects | Control Measures and Preventative Procedures | Emergency Response and Contingency Procedures | Follow-up Monitoring |
|---|---|---|---|---|
| Cyanide | Primary effects would be to the terrain and soil, as well as surface water if the release occurs near a surface water body. Potential secondary effects on aquatic resources, fish and fish habitat and wildlife habitat. | 35.0 Cyanide, cyanide compounds and related chemicals will each have an MSDS in order to comply with the best practices in the industry for health and safety, and to provide relevant regulatory standards for the safe use of these materials. All materials will be stored and handled according to manufacture specification or MSDS<br>36.0 All liquid containments will be designed to include a secondary containment area which will hold 150% the contained volume.<br>37.0 All personnel on the project site will be trained in the proper handling of cyanide chemicals and associated PPE.<br>38.0 Regular inspections of holding tanks and operational procedures will be carried out. This program will have continual reviews and updates to remain current. These will also be used in the training programs conducted by the health and safety department personnel.<br>39.0 Operations and designs for hazardous materials, such as cyanide transport, will comply with applicable regulatory requirements for the transportation of dangerous goods.<br>40.0 Operational safeguards for compressed gases will be enforced, operations personnel will be trained to use appropriate health and safety safeguards, and infrastructure will be regulatory maintained and inspected as per standard operating procedures.<br>41.0 Operations and designs for hazardous materials, such as cyanide transport, will comply with applicable regulatory requirements for the transportation of dangerous goods.<br>42.0 Specific remediation measures are implemented and followed including:<br>o All vehicles and drivers involved with transport will be licensed, trained, and inspected for competency.<br>o Proper transportation containers and proper transport vessels (appropriate vehicle) will be used. If liquid cyanide must be transported, containers will have appropriate hydraulically controlled internal valves.<br>o All trucks will have their needed MSDS, will be properly maintained to company and Transport Canada standards, and will have all safety equipment on hand (including medical and spill response material).<br>o All incidents and near-misses will be reported, and regular audits will be conducted.<br>o Drivers will maintain constant communication and/or GPS tracking during the transportation of cyanide.<br>o SMP will be prepared to include the proper procedures for handling CN spills to land and water, locations of spill containment equipment, safe areas to access spills, disposal of spill contaminated material and reporting requirements. This plan will be updated as required by the current operating plan.<br>o EPP will include the proper procedure for dealing with cyanide. This Plan will be updated as required by the current operating plan. | The contingency and emergency response plan for transport related emergencies will ensure the following:<br>43.0 Best route for access to incident site, including an evaluation of transportation route condition<br>44.0 Specific remediation measures are implemented and followed including:<br>o Recovery and treatment of contaminated soil;<br>o Decontamination or management of soil and other contaminated material;<br>o Disposal of clean-up debris; and<br>o If possibility of contamination to drinking water, appropriate emergency response measures will be enforced to protect drinking water users.<br>Emergency response plans for $SO_2$-Air cyanide destruction process failure:<br>45.0 Ore processing plant will be shut down and all pumping outputs and inputs to the plant will cease.<br>46.0 Body and eye wash stations will be established at the ore processing plant as a first response measure.<br>47.0 Personnel and the ore processing plant area will be equipped with HCN gas sensors with an alarm system, should gas reach unacceptable ambient levels.<br>48.0 All workers will be provided notification and cease all work and be evacuated as per established emergency response procedures.<br>49.0 Any gas plume present will be allowed to dissipate to ensure worker safety. Notification to workers downwind of the incident and ore processing plant shutdown may be required in order to secure the area.<br>50.0 $SO_2$-Air cyanide destruction process will remain closed until full operational ability is restored. | 51.0 After any major release or accident from cyanide use, transport, storage or handling an in-depth review will be conducted which may warrant design changes, procedure changes, or need for additional measures.<br>52.0 Compliance monitoring programs would be implemented to assess clean-up requirements and disposal of impacted materials, if required. |

After the FMEA process was complete and failure modes identified, the next phase of the accidents and malfunctions analysis is the identification of the effects of potential failure modes on valued components (VCs). VCs are those aspects of the environment that are particularly notable or valued because of their ecological, scientific, resource, socio-economic, cultural, health, aesthetic, or spiritual importance, and which have a potential to be adversely affected by project development or have the potential to have an effect on the Project. The potential to be affected means there has to be some interaction, either directly or indirectly, between the environmental component and some component or activity associated with the Project during all phases. In this way, the assessment becomes focused on the identification and management of potential adverse effects.

### 4.3.2 Failure of Tailing Storage Facility

#### 4.3.2.1 Tailing Storage Facility Description

The TSF is expected to have a final footprint area of approximately 88 ha. It will be constructed in stages to provide containment for the tailings solids, along with operational and storm water management. The final crest is anticipated to have an elevation of approximately 420 masl and the maximum dam height is anticipated at approximately 22 m. The slopes of the embankments have been preliminarily assigned at 2.25H:1V to 2.5H:1V and will be dependent on the final design. The TSF will include an emergency spillway, a downstream seepage collection and pump-back system, a tailings delivery and deposition pipeline to deposit the tailings into the facility and a water reclaim pipeline to route water back to the process plant for reuse in processing operations. Approximately 9.07 million dry tonnes of tailings solids are anticipated to be directed to the TSF during the planned years of operations. During operations, the tailings will be deposited into the TSF in a way that allows for continuous saturation to minimize acid generating potential.

The TSF embankments will be designed as zoned earth fill structures to control potential seepage flows through the embankments. A seepage collection and pump-back system will also be utilized to capture and return potential seepage from the embankments back into the containment facility. The seepage collection ditches will be designed with sufficient capacity to accommodate the anticipated seepage rate and runoff from the upstream catchment that will include the downstream slopes of the TSF.

The design of the embankment heights will include allowances for operating pond levels, containment of the Environmental Design Storm (EDS), a spillway designed to pass expected flows (in accordance with the Inflow Design Flood [IDF]) and the required freeboard as identified in the CDA Dam Safety Guidelines and the *Lakes and Rivers Improvement Act* Best Management Practices. Water pond levels and embankment heights will be designed for each embankment stage for operational and storm water management:

- Maximum Operating Level – Required to contain runoff from average and wet precipitation conditions considering the volume of water being removed from the facility (evaporation and water transferred to treatment and process) while maintaining tailings saturation;
- Emergency Spillway Invert Level – Pond level providing storage capacity between the invert of the spillway and Maximum Operating Water Level to contain the EDS, currently assigned as the volume of water resulting from the 1:1,000 year, 24-hour precipitation event; and
- Embankment Height – Sufficient to maintain freeboard above the invert of the spillway for each embankment stage to prevent water from overtopping the dam during the occurrence of the prescribed IDF that will be determined once the dam's hazard potential classification (HPC) has been established during final design.

It should also be noted that the design of the Project as it is being advanced by Treasury Metals allows for the emergency spillway located on the west dam of the TSF to be directed into the open pit in an emergency circumstance. This design approach ensures in an emergency and before an overtopping event (i.e. the water levels are extremely high and flow over the dam) could occur, excess water will be directed through the emergency spillway for complete containment within the open pit. In order to re-open the pit, this water would be treated as needed prior to discharge to the environment, or potentially would be returned to the TSF once it had been stabilized. Raising of water levels even under extreme storm conditions, would allow a sufficient amount of time that all operation personnel will be evacuated from the open pit.

#### 4.3.2.2 Control Measures and Preventative Procedures

The TSF will be designed using sound engineering principles and accepted standards to ensure protection of the environment during all phases of the Project. Designs will be in accordance with the latest version of the CDA Dam Safety Guidelines (2007), the MNRF Best Management Practices (2011) and the Provincial *Lakes and Rivers Improvement Act*. The TSF will be designed for operational and storm water management based on hydrological modelling using historical climatic data. Operational pond levels will be established and an allowance to hold the volume of water resulting from the EDS will be developed. The spillway will be designed to route flows resulting from the IDF as prescribed by the HPC of the dam. The embankment heights will also be designed with the required freeboard allowances, for normal and minimum freeboard, as prescribed by the guidelines listed above. The embankments will be designed with zoned earth fill raises and meet the standards set forth by the applicable guidelines. The embankments will be designed to be stable and meet the required minimum Factors of Safety under the required conditions (Table 4.3.2.2-1).

**Table 4.3.2.2-1: Minimum Factors of Safety**

| Loading Conditions | Minimum Factor of Safety | Slope |
|---|---|---|
| End of construction (before reservoir filling) | 1.3 | Downstream and upstream |
| Long-term (steady state seepage, normal reservoir level) | 1.5 | Downstream and upstream |
| Full or partial rapid drawdown | 1.2 to 1.3 | Upstream |
| Pseudo-static | 1.0 | Downstream and upstream |
| Post-earthquake | 1.2 to 1.3 | Downstream and upstream |

A Dam Safety Management Plan will be developed and finalized prior to the start of the first dam construction on site. A further description of the Dam Safety Management plan is provided in Section 12.14, and will consist of the following:

- At least daily visual inspection during operational processes of all embankments and berms, pipelines, pumps, culverts and spillways to identify any visible problems such as pipeline damage, blockage, embankment seepage, and slope instabilities;
- A more detailed inspection of these same facilities and others, will be conducted on a monthly basis to look for any less obvious signs of potential problems;
- During and following any high potential precipitation events and spring melt, a more detailed inspection will be conducted to ensure the integrity of the TSF and related structures;
- The facility will be inspected by a qualified geotechnical engineer on an annual basis (Dam Safety Inspection) to verify that the embankments are performing as designed. The inspections will likely be carried out during or shortly after the spring melt under snow free conditions. A full Dam Safety Review will also be completed at the prescribed time intervals, but most likely on a 5-year basis;
- Ground movement sensors will be install on the TSF to detect any early movement on embankments, berms and dams; and
- If any stability-related issues are identified during dam inspections or during other site reviews, a qualified geotechnical engineer will be brought to site to assess the issue and provide guidance on the appropriate path forward including remedial actions if appropriate.

The perimeter seepage collection ditches will be designed to contain the potential volume of water from seepage through the embankment and upstream runoff. All seepage will be collected and routed to a collection point to allow for pumping and return to the TSF containment area. The ditches will also be designed with sufficient freeboard to ensure that water overflows do not occur. The ditches will be lined with a low permeability material (such as geotextile) to ensure that seepage is contained within the ditch and that erosion damage does not occur.

A compliance monitoring program will be developed prior to construction to assess the performance of the TSF and collection. Surface and groundwater monitoring programs will also be used to ensure that seepage flows are not leaving the containment system.

#### 4.3.2.3 TSF Failure Modeling

The EIS Guidelines require that Treasury Metals identify "…potential consequences (including the environmental effects), the plausible worst case scenarios and the effects" associated with accidents and malfunctions. In the highly unlikely case of a failure of the TSF, the consequences associated with a failure of the TSF were modelled as described in Appendix GG. That modelling was conducted to simulate worst-case credible conditions of a hypothetical catastrophic failure, but are not a reflection of the actual safety conditions of the TSF after it is designed and built. The modelled consequences in the highly unlikely event of a TSF failure are summarized below. The modelling allowed Treasury Metals to describe the environmental effects likely to occur in the highly unlikely event of a TSF failure, described in Section 4.3.2.4, and to also develop measures to reduce or mitigate potential effects impacts to the environment and/or human health should such a highly improbable event take place.

There have been further refinements of the Project design since the TSF failure modeling was completed, including the replacement of the seepage collection pond used in the original EIS with a larger minewater pond, located to the south of the TSF. This minewater pond would provide additional storage downstream of the TSF that would absorb some of the energy of a TSF failure. In the highly unlikely event of a breach of the south TSF dam, the supernatant water and tailings from the TSF would flow into the minewater pond, prior to flowing into Blackwater Creek (the same outcome of the TSF failure model completed without the minewater pond). The minewater pond would be expected to capture some of the tailings, preventing them from reaching Blackwater Creek. This could reduce the effects on Blackwater Creek and would require less intrusive remediation of the spilled tailings by Treasury Metals, as compared to the current TSF failure model. Accordingly, effects predicted by the TSF failure model are more conservative without the inclusion of the minewater pond. Treasury Metals decided to retain this conservatism, rather than reassess the design.

**TSF Failure Modeling Summary**

The TSF failure model presented in Appendix GG included the following steps:

- Dam breach assessment, to determine the release hydrograph from the TSF failure;
- Hydraulic routing, to determine the extent of the released materials from the TSF after the failure;
- Geochemical modelling, to determine concentrations of selected water quality parameters from the supernatant, pore water and tailings; and
- Water quality modelling of Wabigoon Lake to determine the extent of the contamination and changes in parameter concentrations in the lake.

For the selection of a credible worst-case scenario two failure modes were considered: piping (sunny-day failure) and overtopping. Overtopping was considered to be more critical for the receiving environment as the volume of released materials from the TSF would be larger, and the anticipated flows in Blackwater Creek would not provide enough dilution to alleviate the contaminant loads.

The dam breach and initial flood hydrograph was conducted to evaluate breach opening, time of dam failure and the subsequent breach flow into Blackwater Creek (Figure 4.3.2.3-1). The peak outflow from the breach was calculated to be 78 m³/s, and the total spill volume was calculated at 1,695,958 m³, which is made-up of 753,480 m³ of settled tailings solids, 880,000 m³ of supernatant water, and 62,478 m³ of storm water, corresponding to the 100-year storm inflow. Worst case conditions were assumed where all of the supernatant stored in the TSF is released.

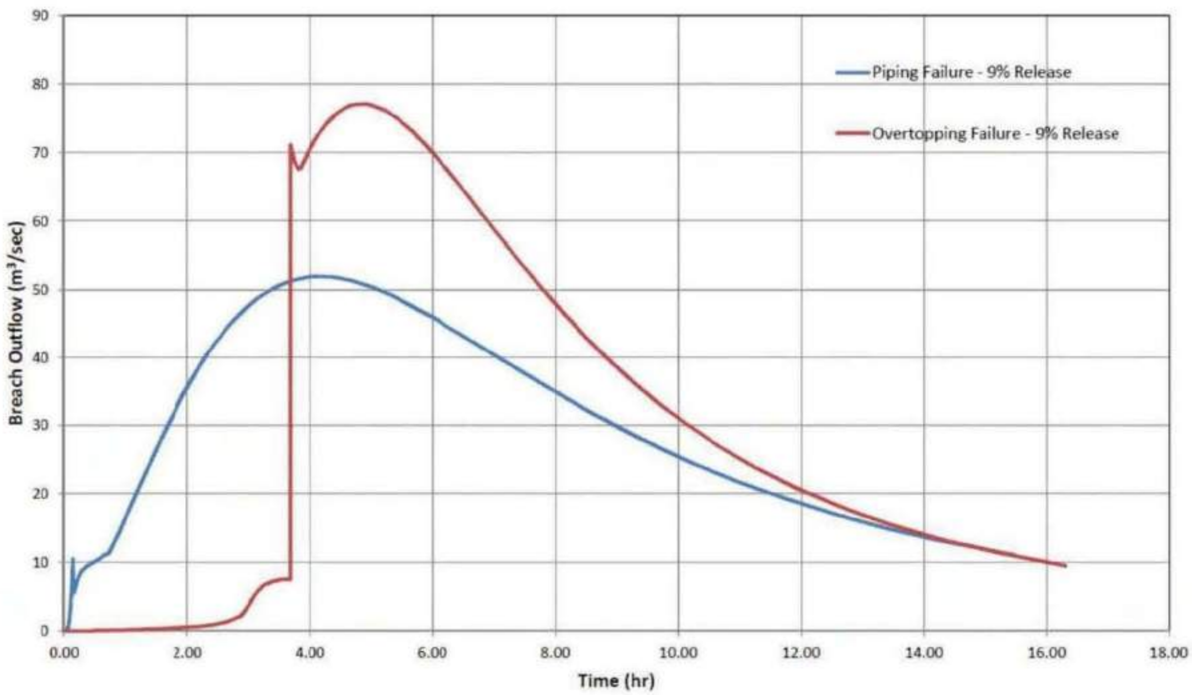



**Figure 4.3.2.3-1: Breach Hydrograph**

In order to better assess the quality of the released fluids, a preliminary geochemical model was conducted. Results from the modelling provided concentrations of the various components of the effluent, including supernatant, pore water and tailings. Concentrations of all parameters in the released fluids remain below the Metal Mining Effluent Regulations (MMER) limits, with the exception of lead which may increase to roughly 1.5-times the limit of 0.2 mg/L after acid generating conditions are established in the tailings material. This assumption adds further conservatism to the model. In the event the TSF is overtopped, aluminum, cadmium, cobalt, copper, iron, lead, mercury, selenium, silver, thallium, uranium, and cyanide concentrations in the TSF outflow water may exceed the respective Provincial Water Quality Objectives (PWQO) for protection of aquatic life. The predicted TSF overflow quality for an overtopping of the tailings dam is listed in Table 4.3.2.3-1, and does not take into consideration any dilution effects from the receiving waters. The sulphate concentrations decrease after the initial flushing of readily soluble material to a local minimum. The pH of any release is predicted to remain circumneutral.

**Table 4.3.2.3-1: TSF Overflow Concentrations and Relevant Water Quality Criteria**

| Parameter (1) | TSF Overflow Concentration (mg/L) | Water Quality Criteria | | |
|---|---|---|---|---|
| | | PWQO (mg/L) | Ontario Drinking Water Standards (mg/L) | MMER (Max Monthly Mean) (mg/L) |
| pH | 5.0616 | 6.5 – 8.5 | — | 6.5 – 9.0 |
| Al | 0.1985 | 0.075 | — | — |
| Cd | 0.0010 | 0.0002 | 0.005 | — |
| Co | 0.0030 | 0.0006 | — | — |
| Cu | 0.0652 | 0.005 | — | 0.3 |
| Fe | 0.3428 | 0.3 | — | — |
| Pb | 0.3046 | 0.005 | 0.01 | 0.2 |
| Hg | 0.0126 | 0.0002 | 0.001 | — |
| Se | 1.1748 | 0.1 | 0.01 | — |
| Ag | 0.0004 | 0.0001 | — | — |
| Tl | 0.3789 | 0.0003 | — | — |
| U | 0.0115 | 0.005 | 0.02 | — |
| Cyanide (2) | 0.2025 | 0.005 | 0.2 | 1 |

Notes:

(1) Only those parameters where the TSF overflow quality exceed the PWQO are listed.

(2) Total cyanide.

Wabigoon Lake is a large body of water with a surface area of 104 km². The water level of the lake is controlled by the dam located in Dryden, approximately 18 km west of the TSF. Blackwater Creek enters Wabigoon Lake in Kelpyn Bay. A two-dimensional numerical model was created to simulate the hydrodynamic conditions in Wabigoon Lake. The failure inflow hydrograph (see Figure 4.3.2.3-1) corresponds to TSF overtopping failure with a maximum discharge of 64.6 m³/s a total hydrograph volume of 1.2 hm³ at the point of discharge into the lake. As noted above, tailings solids are not predicted to reach, or enter Wabigoon Lake.

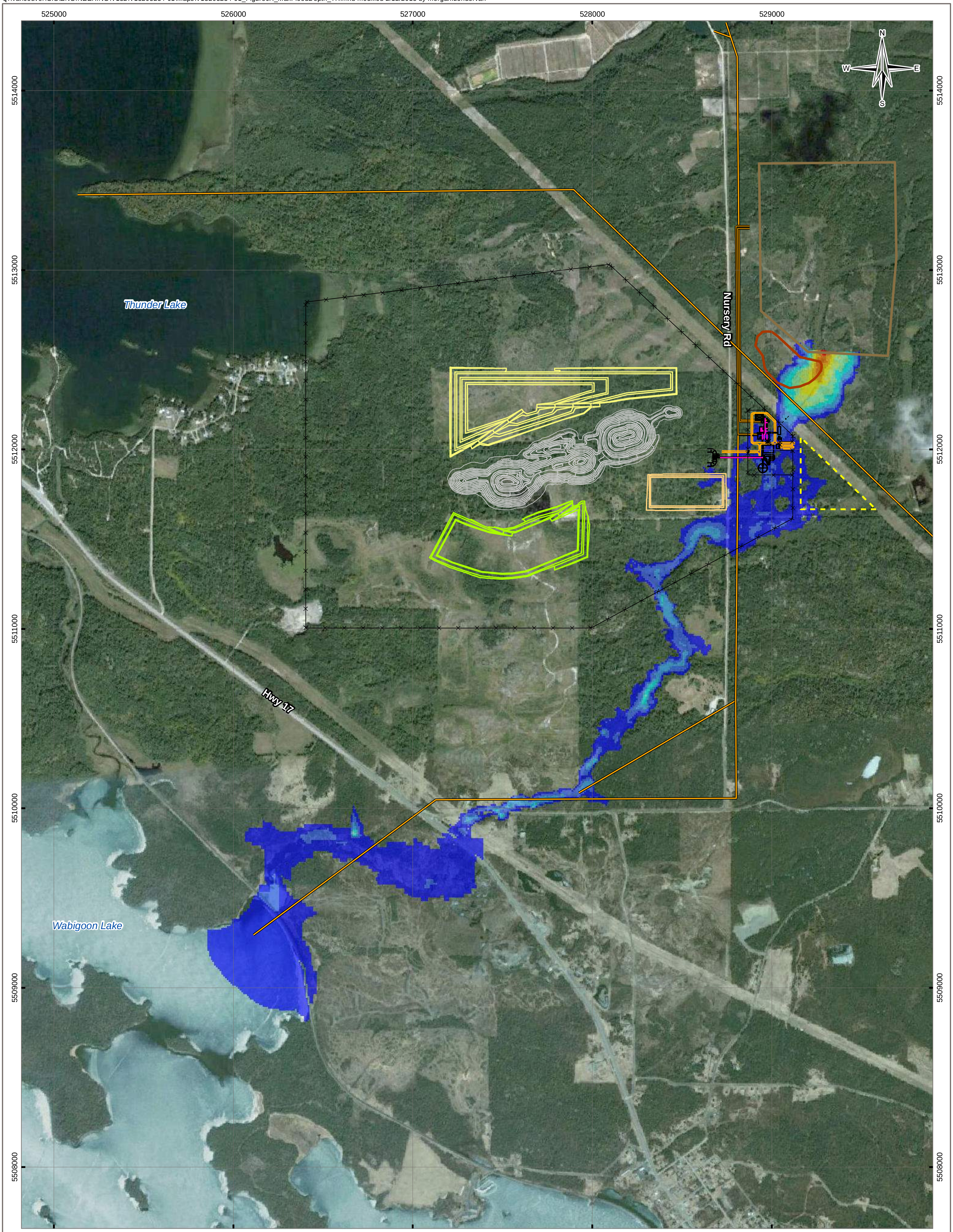
Using the output from the breach analysis, a two-dimensional hydraulic model was used to produce the inundation map shown in Figure 4.3.2.3-2. The results from the model indicate that all of the released supernatant would reach Wabigoon Lake, as well as the pore water from the tailings. However, the released tailings solids would remain on the land and within Blackwater Creek immediately downstream of the Project, as shown in Figure 4.3.2.3-3. None of the tailings released were predicted to reach, or enter Wabigoon Lake. This is predominantly a result of the relatively flat terrain and wide floodplain of Blackwater Creek over which the tailings solids would spread out, along with the viscous properties of the tailings solids.

A tailings breach occurring during winter months, when conditions are below freezing, is anticipated to have a lesser effect compared to a breach occurring during non-frozen conditions. Tailings released from the facility in winter would be contained by snow cover that would aid in facilitating cleanup activities. In addition, minimum flow would be occurring in the streams and therefore water released would potentially freeze up before traveling a significant distance from the facility and into existing water bodies. All TSF solids deposited on the ground and within Blackwater Creek would be removed in accordance with the spill management plan to ensure no further environmental damage to Blackwater Creek and Wabigoon Lake. As the cleanup and removal of any tailings deposited into Blackwater Creek would occur during the winter month, deposited tailings would not be exposed long enough for acidification and metals leaching (ML) to occur.

The contaminant concentration of the water entering Wabigoon Lake at Blackwater Creek is set to 1.0 (unity) in the calculations, assuming a conservative constituent that changes concentrations only by dilution effects. The model results in a concentration factor that can then be applied to each water quality parameter. Water quality projections for Wabigoon Lake (maximum instantaneous projections) are shown in Figure 4.3.2.3-4. The concentration values shown in Figure 4.3.2.3-4 are relative to the concentration of water that would be released from the tailings dam. The 0.01 “red” concentration factor zone on Figure 4.3.2.3-4, for example, indicates that the maximum concentration within this zone would be 1% (0.01) of the TSF outflow concentration (see Table 4.3.2.3-1). The model shows that the greatest effects to water quality are limited to Keplyn Bay, and are diluted to 0.1% of the TSF outflow concentrations before reaching the community of Dryden. The modelling indicates that effects on water quality in Wabigoon Lake in the highly unlikely event of a TSF failure would be restricted to the areas between the mouth of Blackwater Creek (i.e., Keplyn Bay) and Dryden, and would avoid the community of Wabigoon, as well as the south eastern portion of Wabigoon Lake towards the reserve lands of the Wabigoon Lake Ojibway Nation.

Table 4.3.2.3-2 presents the simulation results at five control points in Wabigoon Lake: the fish sanctuary at Christie’s Island; the spawning habitat at the mouth of Thunder Creek; the fishing camp at Bonny Bay; the City of Dryden water intake; and the outlet of Wabigoon Lake in the City of Dryden. The table provided the UTM coordinates for each of these control points, along with the distance from the mouth of Blackwater Creek. Additionally, the table lists the dilution of the TSF overflow for the predicted maximum concentration ($C_{max}$), along with the predicted time after failure to reach the maximum concentrations ($C_{max}$).

Q:\Vancouver\GIS\ENGINEERING\V132\V13203234-01\Maps\V13203234-01_Figure0X_MaxFloodDepth_TR.mxd modified 2/12/2015 by morgan.zondervan




## LEGEND

- Low-Grade Stockpile
- Overburden
- Ultimate Pit
- Waste Rock Dump
- Effluent Pipe
- Electrical
- Fenceline
- Gate
- Laydown Area
- M25
- Plant
- Seapage Collection
- Tailings Area
- Tailings Pipe
- Traffic

**Maximum Flood Depth (m)**

- 0.0 - 1.3
- 1.4 - 2.5
- 2.6 - 3.8
- 3.9 - 5.1
- 5.2 - 6.4
- 6.5 - 7.6
- 7.7 - 8.9
- 9.0 - 10.2
- 10.3 - 11.5
- 11.6 - 12.7

**NOTES**
Base data source:
Imagery from Google; CNES/SPOT (2013)

**STATUS**
FOR INTERNAL USE ONLY

# TREASURY METALS TSF FAILURE MODELLING

## Maximum Flood Water Depth Release

| PROJECTION | DATUM | CLIENT |
|---|---|---|
| UTM Zone 15 | NAD83 | Treasury Metals |

Scale: 1:20,000
400 200 0 400
Metres

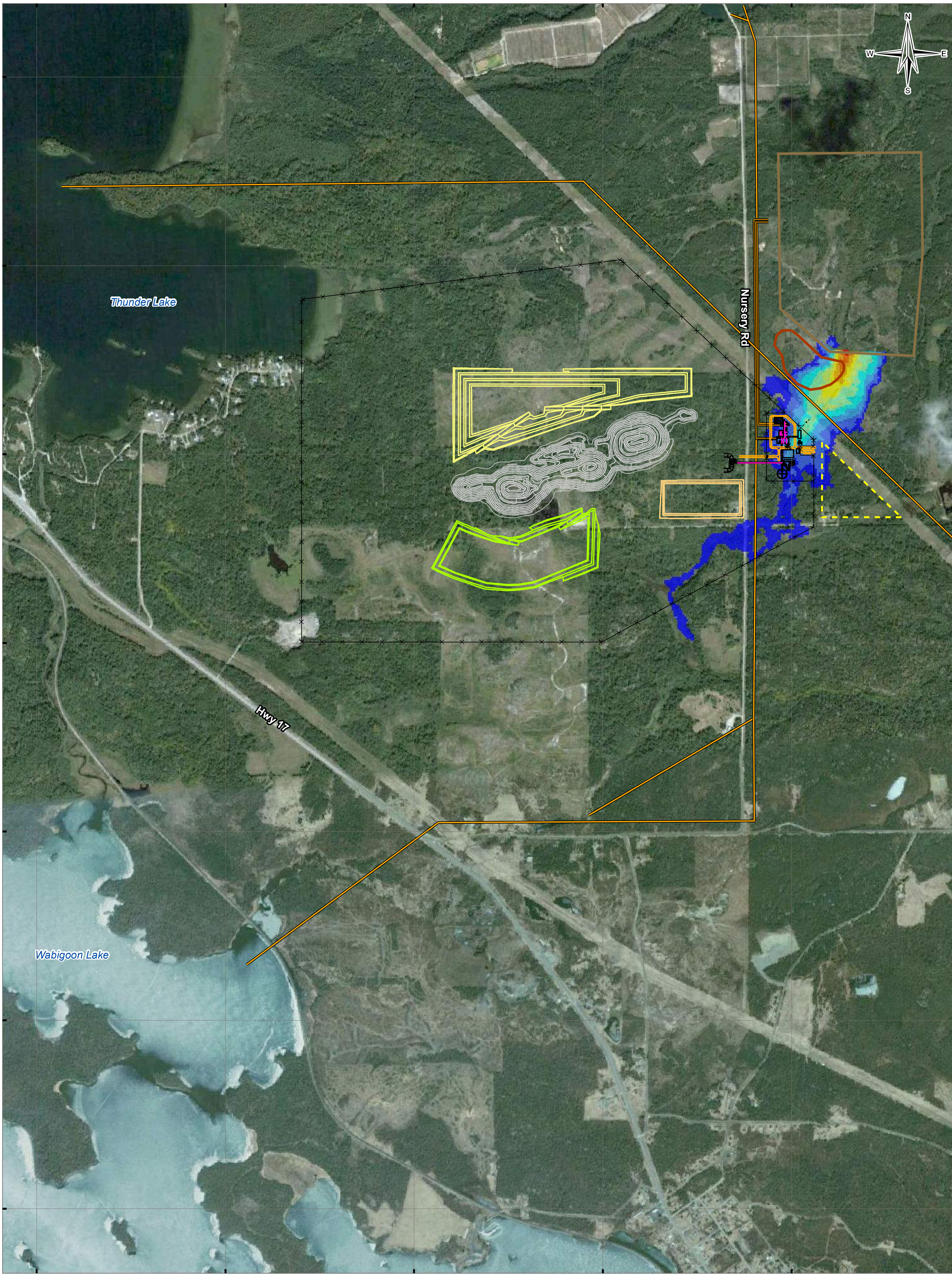
TETRA TECH EBA

**FILE NO.**
V13203234-01_Figure0X_MaxFloodDepth_TR.mxd

| PROJECT NO. | DWN | CKD | APVD | REV |
|---|---|---|---|---|
| V13203234-01 | MEZ | - | EL | 0 |

| OFFICE | DATE |
|---|---|
| Tt EBA-VANC | February 12, 2015 |

**Figure 4.3.2.3-2**




## LEGEND

- Low-Grade Stockpile
- Overburden
- Ultimate Pit
- Waste Rock Dump
- Effluent Pipe
- Electrical
- Fenceline
- Gate
- Laydown Area
- M25
- Plant
- Seapage Collection
- Tailings Area
- Tailings Pipe
- Traffic

**Maximum Flood Depth (m)**

- 0.0 - 1.3
- 1.4 - 2.5
- 2.6 - 3.8
- 3.9 - 5.1
- 5.2 - 6.4
- 6.5 - 7.6
- 7.7 - 8.9
- 9.0 - 10.2
- 10.3 - 11.5
- 11.6 - 12.7

**NOTES**
Base data source:
Imagery from Google; CNES/SPOT (2013)

**STATUS**
FOR INTERNAL USE ONLY

# TREASURY METALS
# TSF FAILURE MODELLING

## Depth and Extent of Tailings Deposition

| PROJECTION | DATUM | CLIENT |
|---|---|---|
| UTM Zone 15 | NAD83 | Treasury Metals |

Scale: 1:20,000
400 200 0 400
Metres

TETRA TECH EBA

| FILE NO. | | | | |
|---|---|---|---|---|
| V13203234-01_Figure0X_MaxFloodDepth_TRST.mxd | | | | |
| PROJECT NO. | DWN | CKD | APVD | REV |
| V13203234-01 | MEZ | - | EL | 0 |
| OFFICE | DATE | | | |
| Tt EBA-VANC | February 12, 2015 | | | |

Figure 4.3.2.3-3

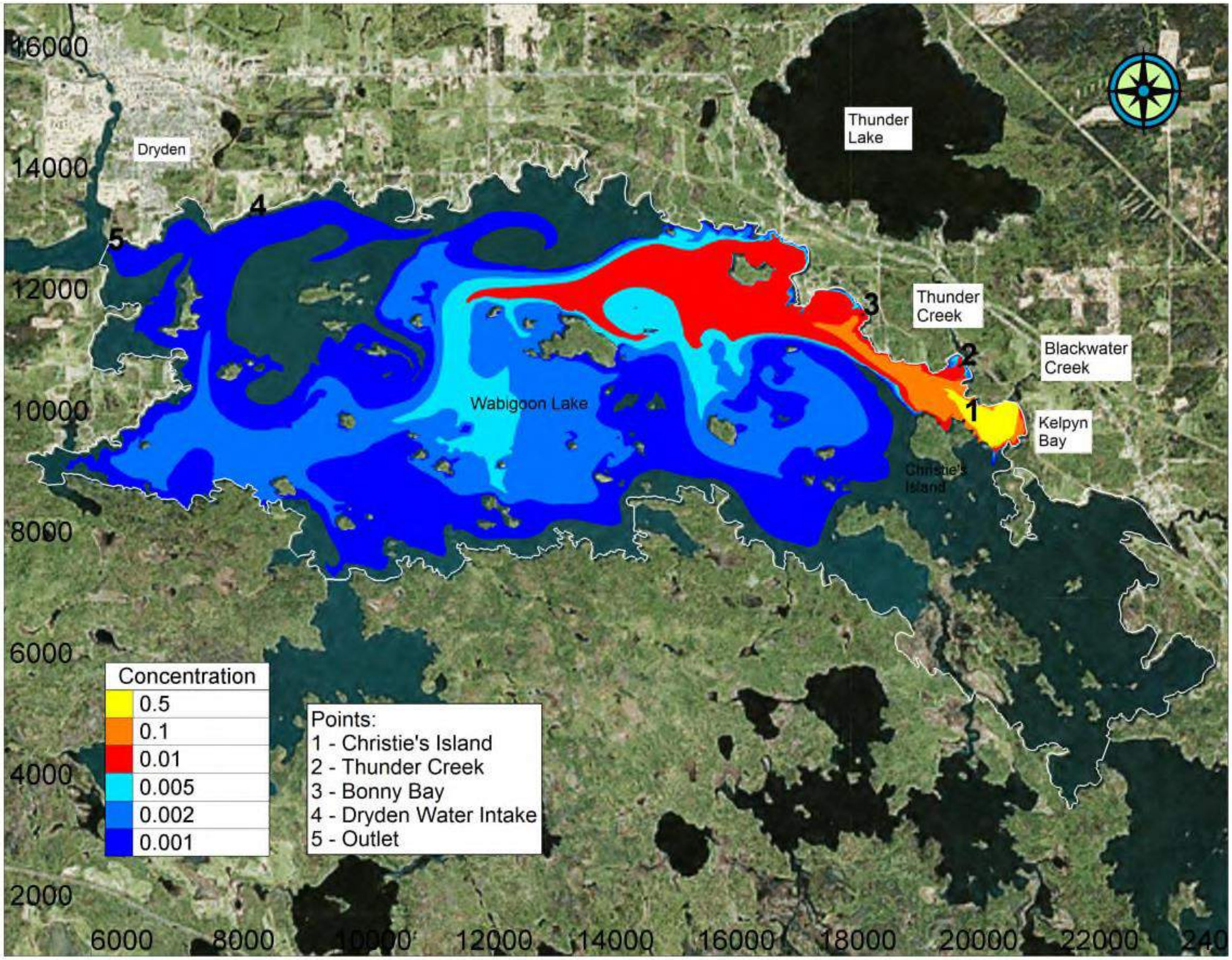



**Figure 4.3.2.3-4: Depth and Extent of Tailings Deposition**

**Table 4.3.2.3-2: Results at Five Control Points in Wabigoon Lake**

| Point | Description | Coordinates (1) | | Distance (2) (km) | Dilution Factor $C_{max}$ (3) | Time to $C_{max}$ (day) |
|---|---|---|---|---|---|---|
| | | X | Y | | | |
| 1 | Christie's Island (fish sanctuary) | 525,406.2 | 5,509,088.1 | 0.74 | 0.37 | 1.6 |
| 2 | Thunder Creek (spawning habitat) | 525,343.5 | 5,509,999.8 | 0.92 | 0.021 | 3.6 |
| 3 | Bonny Bay (fishing camp) | 523,738.2 | 5,510,836.4 | 2.72 | 0.051 | 5.3 |
| 4 | Dryden Water Intake | 513,621.0 | 5,512,466.0 | 12.81 | 0.00095 | 23.8 |
| 5 | Lake Outlet | 511,277.5 | 5,511,910.6 | 15.00 | 0.001 | 25.3 |

Notes:
(1) NAD 1983 UTM Zone 15N
(2) Distance is measured from the mouth of Blackwater Creek
(3) The Dilution Factor $C_{max}$ represents the maximum concentration at each control location as a fraction of the TSF overflow concentration as provided in Table 4.3.2.6-2.

By combining the TSF outflow concentrations (see Table 4.3.2.3-1) with the model predictions of dilution factors listed in Table 4.3.2.3-2 and shown in Figure 4.3.2.3-4, the maximum predicted concentrations ($C_{max}$) for each of the constituents at the control locations can be determined, as presented in Table 4.3.2.3-3. The table shows that, with the exception of thallium, the maximum concentrations ($C_{max}$) at Dryden (either the water intake or lake outflow), exceed the drinking water standards. In fact, the only locations where the maximum concentrations ($C_{max}$) are predicted to exceed the drinking standards are: the fish sanctuary at Christie's Island (lead, mercury and selenium); the spawning habitat at the mouth of Thunder Creek (selenium); and the fishing camp at Bonny Bay (lead and selenium).

**Table 4.3.2.3-3: Predicted Maximum Concentrations in Wabigoon Lake**

| Parameter (1) | Predicted Maximum Concentrations at Control Locations in Wabigoon Lake (2) | | | | |
|---|---|---|---|---|---|
| | Christie's Island | Thunder Creek | Bonny Bay | Dryden Water Intake | Lake Outlet |
| | *0.37 (3)* | *0.021 (3)* | *0.051 (3)* | *0.00095 (3)* | *0.001 (3)* |
| Al | 0.0734 | 0.0042 | 0.0101 | 0.0002 | 0.0002 |
| Cd | 0.0004 (4) | 0.0000 | 0.0001 | 0.0000 | 0.0000 |
| Co | 0.0011 | 0.0001 | 0.0002 | 0.0000 | 0.0000 |
| Cu | 0.0241 | 0.0014 | 0.0033 | 0.0001 | 0.0001 |
| Fe | 0.1268 | 0.0072 | 0.0175 | 0.0003 | 0.0003 |
| Pb | **0.1127** | 0.0064 | **0.0155** | 0.0003 | 0.0003 |
| Hg | **0.0047** | 0.0003 | 0.0006 | 0.0000 | 0.0000 |
| Se | **0.4347** | **0.0247** | **0.0599** | 0.0011 | 0.0012 |
| Ag | 0.0001 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

**Table 4.3.2.3-3: Predicted Maximum Concentrations in Wabigoon Lake (continued)**

| Parameter (1) | Predicted Maximum Concentrations at Control Locations in Wabigoon Lake (2) | | | | |
|---|---|---|---|---|---|
| | Christie's Island | Thunder Creek | Bonny Bay | Dryden Water Intake | Lake Outlet |
| | *0.37 (3)* | *0.021 (3)* | *0.051 (3)* | *0.00095 (3)* | *0.001 (3)* |
| Tl | 0.1402 | 0.0080 | 0.0193 | 0.0004 | 0.0004 |
| U | 0.0043 | 0.0002 | 0.0006 | 0.0000 | 0.0000 |
| Cyanide (6) | 0.0749 | 0.0043 | 0.0103 | 0.0002 | 0.0002 |

Notes:

(1) Only those parameters where the TSF overflow quality exceed the PWQO are listed.
(2) The maximum concentrations are calculated by multiplying the TSF outflow concentrations are presented in Table 4.3.2.3-1 by the maximum dilution factors ($C_{max}$) listed in Table 4.3.2.3-2.
(3) These numbers represent the predicted dilution factors ($C_{max}$) listed in Table 4.3.2.3-2.
(4) The results highlighted with grey shading indicates where the predicted $C_{max}$ concentrations of a compound exceed the corresponding PWQO.
(5) The results highlighted with **grey shading and bold-faced type** indicates where the predicted $C_{max}$ concentrations of a compound exceed the corresponding Drinking Water Standards.
(6) Total cyanide.

As shown in Table 4.3.2.3-4, elevated concentrations within Wabigoon Lake are predicted to dissipate over a relatively short time period. The longest lasting effects are predicted at Christie's Island, which is expected given its proximity to the mouth of Blackwater Creek. At the most distant location (i.e., City of Dryden water intake and the outlet of Wabigoon Lake), the maximum concentrations ($C_{max}$) do not exceed the PWQO, or in the case of thallium, exceed for a period much less than a day.

**Table 4.3.2.3-4: Duration of Predicted Concentration in Excess of PWQO**

| Parameter (1) | Number of Days with Concentrations Predicted above PWQO | | | | |
|---|---|---|---|---|---|
| | Christie's Island | Thunder Creek | Bonny Bay | Dryden Water Intake | Lake Outlet |
| Al | 0 | 0 | 0 | 0 | 0 |
| Cd | 1 (2) | 0 | 0 | 0 | 0 |
| Co | 1 | 0 | 0 | 0 | 0 |
| Cu | 3 | 0 | 0 | 0 | 0 |
| Fe | 0 | 0 | 0 | 0 | 0 |
| Pb | 10 | 1 | 5 | 0 | 0 |
| Hg | 10 | 1 | 9 | 0 | 0 |
| Se | 4 | << 1 (3) | << 1 | 0 | 0 |
| Ag | 1 | 0 | 0 | 0 | 0 |
| Tl | 20 | 10 | 12 | << 1 | << 1 |
| U | 0 | 0 | 0 | 0 | 0 |
| Cyanide (5) | 1 | 0 | 2 | 0 | 0 |

Notes:

(1) Only those parameters where the TSF overflow quality exceed the PWQO are listed.
(2) The results highlighted with grey shading indicates where the predicted $C_{max}$ concentrations of a compound exceed the corresponding PWQO.
(3) Although the $C_{max}$ at these locations was predicted to exceed the PWQO, the modelling indicates this situation would last much less than a day.
(5) Total cyanide.

As stated previously, and demonstrated in Figure 4.3.2.3-3, the solid tailings that would be released in the unlikely event of a TSF failure would be deposited on the ground between the TSF and Blackwater Creek, or would be deposited in Blackwater Creek in the vicinity of the Project. The tailings solids would not reach Wabigoon Lake. All TSF solids deposited on the ground and within Blackwater Creek would be removed in accordance with the spill management plan, which would require the cleanup and removal of any tailings deposited into Blackwater Creek would occur during the winter month. However, contaminants that reach Wabigoon Lake with the TSF outflow water could deposit within the water column and affect lake sediments. An analysis of potential contaminant levels within the sediments of Wabigoon Lake and within the aquatic food web following a TSF failure, was completed with a focus on contaminants that persist in the environment, bioaccumulate in fish or are toxic to fish, migratory birds or humans. This was conducted using a worst-case sediment concentration calculation, with the worst case proportional water column concentrations shown in Figure 4.3.2.3-4, where the values in the figure represent fractions of the TSF outflow water concentrations (see Table 4.3.5.3-1). This analysis was completed for cadmium, lead and mercury, which were selected due to their bioaccumulation potential, and as they are known to be the most problematic metals from a biomagnification, as well as for human and wildlife health perspective.

For the modeled catastrophic dam failure scenario (which is not expected to occur), there would be: a slight increase in cadmium concentrations in all zones of Wabigoon Lake; a substantive concentration increase of lead in the yellow zone; and substantive concentration increases for mercury in both the yellow and orange zones (see Figure 4.3.2.3-4). The calculated sediment concentrations for cadmium would meet the PSQG LEL levels in all zones. The calculated lead concentrations would exceed the PSQG LEL within all zones; however, the measured background concentrations of lead in the sediment of Wabigoon Lake suggests the lead levels already exceed the PSQG LEL. The predicted mercury concentrations in sediment will not exceed the PSQG LEL in the orange or red zones, but will exceed in the yellow zone. None of the predicted sediment concentrations are not expected to exceed PSQG Severe Effect Levels (SEL). Metals do not biodegrade or disappear, but over time it would be expected that they would become distributed within a greater depth of the sediment column due to wave action, the actions of sediment burrowing organisms, and as a result of new sediment influx from lake inflow waters. As such, initial metal concentrations observed in the upper 2 cm layer of the lake sediment would become gradually reduced over time. The results of this analysis are presented in Table 4.3.2.3-5, along with the assumptions used.

**Table 4.3.2.3-5: Calculated Change in Lake Sediment Metals Concentrations**

| Condition / Lake Zone | Metal | | |
|---|---|---|---|
| | Cd | Pb | Hg |
| **TSF overflow concentration (mg/L) (1)** | 0.001 | 0.3046 | 0.0126 |
| **Modelled dilution factor (2)** | | | |
| Yellow zone | 0.5 | 0.1 | 0.01 |
| Orange zone | 0.5 | 0.1 | 0.01 |
| Red zone | 0.5 | 0.1 | 0.01 |

**Table 4.3.2.3-4: Calculated Change in Lake Sediment Metals Concentrations (continued)**

| Condition / Lake Zone | Metal | | |
|---|---|---|---|
| | Cd | Pb | Hg |
| **Wabigoon Lake water column concentration ($C_{max}$) in mg/L (or g/m³) (3)** | | | |
| Yellow zone | 0.0005 | 0.1523 | 0.0063 |
| Orange zone | 0.0001 | 0.03046 | 0.00126 |
| Red zone | 0.00001 | 0.003046 | 0.000126 |
| **Weight of metals added from 3 m (a) × 1 m² column of water (g) (4)** | | | |
| Yellow zone | 0.0015 | 0.4569 | 0.0189 |
| Orange zone | 0.0003 | 0.09138 | 0.00378 |
| Red zone | 0.00003 | 0.009138 | 0.000378 |
| **Weight of 2 cm × 1 m² volume of sediment (g) (b)** | 26,000 | 26,000 | 26,000 |
| **Increase in sediment concentration (c) in the top 2 cm (µg/g) (5)** | | | |
| Yellow zone | 0.058 | 17.573 | 0.727 |
| Orange zone | 0.012 | 3.515 | 0.145 |
| Red zone | 0.001 | 0.351 | 0.015 |
| **Background Sediment Concentration (µg/g) (d)** | | | |
| Yellow zone | 0.50 | 34.4 | 0.05 |
| Orange zone | 0.50 | 34.4 | 0.05 |
| Red zone | 0.50 | 34.4 | 0.05 |
| **Effect induced concentration in top 2 cm of sediment (µg/g) (6)** | | | |
| Yellow zone | 0.558 | 57.978 | 0.777 |
| Orange zone | 0.512 | 37.915 | 0.195 |
| Red zone | 0.501 | 34.751 | 0.065 |
| **PSQG LEL for Comparison (µg/g)** | 0.6 | 31 | 0.2 |
| **PSQG SEL for Comparison (µg/g)** | 10 | 250 | 2 |

Assumptions:

(a) Average water column depth in yellow, orange and red zones is 3 m
(b) Average total material density of the upper sediment column is 1.3 g/cm
(c) 100% of waterborne metals settle out and become homogeneously mixed in top 2 cm of the sediment column
(d) Background sediment metal concentration are based on the highest background sediment values measured in Wabigoon Lake (Table 5.8.2.2-1).

Notes:

(1) Values from Table 4.3.2.3-1.
(2) Taken from Figure 4.3.2.3-4.
(3) 1 mg/L is equivalent to 1 g/m³.
(4) Weight of metals added from the water column is calculated by multiplying the “water column concentration” in g/m³ times the depth of water in m times the area considered (1 m²).
(5) The increase in sediment concentration is calculated by dividing the weight of metals deposited by the weight of the top 2 cm of sediment. To avoid using scientific notation, the concentration are presented in units of µg/g. To convert from g/g to µg/g a conversion factor of 1,000,000 is used.
(6) The “effect induced concentration” is the sum of the increase in sediment concentrations d sediment and background sediment concentrations.

### 4.3.2.4 Potential Environmental Effects

The description below is provided for an unmitigated catastrophic failure of the TSF, not considering mitigation during the event, or the addition of a minewater pond to the site design. Hence, the discussion below of potential environmental effects should be considered conservative

**Surface Water Quality**

Based on the TSF failure model, in the unlikely event of a TSF failure, there would be a reduction in water quality in both Blackwater Creek and Wabigoon Lake. The parameters modelled to exceed PWQO are: aluminum, cadmium, cobalt, copper, iron, lead, mercury, selenium, silver, thallium, uranium, and cyanide. In the event of a TSF breach, arsenic and zinc would also be present in concentrations above the PWQO. These temporary exceedances of PWQO are projected to be isolated to Keplyn Bay and the area just north of Keplyn Bay for all parameters with the exception of thallium (primarily the yellow and orange areas shown in Figure 4.3.2.3-4); and water quality would return to PWQO or better within 20 days for all parameters (most parameters would be less than PWQO within a few days). It should be noted that this model conservatively looked at dilution as the only mechanism for constituent concentration changes in the water column, ignoring all additional processes (e.g. precipitation, sorption) which would reduce the temporal extent of the elevated parameters.

**Effects on Fish and Fish Habitat**

There are two potential effects to fish and fish habitat that could result from a catastrophic TSF failure: direct effects on fish as the flood wave passes down Blackwater Creek and changes related to water quality.

With respect to Blackwater Creek, it would be expected that there would be individual fish mortalities from the high kinetic energy associated with the release, and suffocation from the high suspended solids content. A number of individuals could also become stranded on the floodplain as the flood pulse waters receded. The height of the pulse wave expected to flow down Blackwater Creek is between 0 and 5.1 m. This flood wave will also have the potential to damage or destroy plants in its path, as well as cause erosion along Blackwater Creek until the flood wave velocity is attenuated, as it reaches bends and beaver ponds along the creek. The aquatic habitat in the zone affected by the higher velocity of the flood wave could be damaged or destroyed. In addition to the flood wave, the tailings solids could coat the ground surface and sections of Blackwater Creek in the vicinity of the failure and affect the aquatic environment in the short-term. Treasury Metals has committed in the case of a tailings spill into the creek, to remove the tailings solids from Blackwater Creek as soon as reasonable and in consultation with applicable regulatory authorities, such as Fisheries and Oceans Canada. This would likely be completed over the winter following the TSF failure as the frozen conditions would be required for effective cleanup within most portions of the downstream creek environment.

In additional, the water quality released during a TSF failure (see Table 4.3.2.3-1) may or may not be acutely toxic to some forms of aquatic life, depending on the hardness of the water and other exposure-related factors; but based on the modeled concentrations any such toxic effects would be very short-term, if they occur at all.

Tailings would not reach Wabigoon Lake; however, there would be some reduction in water quality in the lake should a catastrophic failure occur. Based on the modelling of the catastrophic failure, the maximum concentrations of some parameters (see Table 4.3.2.3-3) could exceed the PWQO values for the portion of Wabigoon Lake near to the Blackwater Creek inlet (primarily the yellow and orange areas shown in Figure 4.3.2.3-4). Although there are some predicted exceedances of the PWQO, Table 4.3.2.3-4 shows the temporal extent of the exceedance. Most parameters that will be greater than PWQO will only occur for a few days, which is expected to not be long enough to effect fish in Wabigoon Lake.

Thallium is expected to be the only parameter after a TSF failure that would be present in concentrations above PWQO as far as Dryden. For a location at a distance such as the Dryden control point from the mouth of Blackwater Creek elevated thallium concentrations last much less than a day (see Table 4.3.2.3-4), and concentrations near the mouth of Blackwater Creek remaining above the PWQO for as much as 20 days. While thallium concentrations are predicted to be above the PWQO after a catastrophic TSF failure, this does not necessarily mean that there would be a toxic effect on aquatic life. The literature on thallium toxicity is limited and the PWQO value of 0.0003 mg/L is viewed as overly conservative relative to federal and British Columbia accepted guideline for the protection of aquatic organisms 0.0008 mg/L. Therefore, based on multiple lines of evidence the overall risk to aquatic organisms from toxicity is anticipated to be low.

It is also important to note that PWQO values are defined for longer / indefinite exposure, and shorter-term exposures would have more limited effects. It is therefore unlikely that higher trophic level species (e.g., walleye and pike) would accumulate elevated levels of metals from the water column compared to background conditions as a result of a TSF failure. It is recognized; however, that there is some potential for an adverse effect to fish and other aquatic life due to reduced water quality, including the potential for some mortality should a TSF failure occur.

If sediments in mainly the yellow and orange zones of Figure 4.3.2.3-4 were to become contaminated with additional metals as per Table 4.3.2.3-5, it would be expected that benthic organisms would ingest these sediments. Fish that feed upon these organisms would take up additional metal concentrations. In this scenario, it would also be expected that fish that feed upon these fish, such as pike and walleye, would also tend to biomagnify metals such as cadmium, lead and mercury. The extent to which such metal uptake would be expected to occur would depend on the fish species involved and the amount of time they spend feeding in the yellow and orange zones. With the levels of uncertainty, it is not reasonably possible to predict increased body burden concentrations of metals that could occur in the different fish species over time.

It is recognized that metals such as cadmium, lead and mercury biomagnify within aquatic food chains. However, the ecological health risk of sediment contamination in the event of a catastrophic spill is considered to be limited, as the zone of influence is expected to be confined primarily to the yellow and orange zones and tailings solids will not enter the lake. These zones comprise a very small portion of the lake area, and would therefore be expected to have only a limited effect, on fish tissue metal levels as measured on a lake-wide basis.

### Effects on Vegetation

In the highly unlikely scenario of a dam breach or failure, the resulting pulse wave would damage or destroy some or all of the plants in its path. The vegetation directly downstream of the TSF failure point, shown in Figure 4.3.2.3.-2, would have the greatest potential to be affected by the greater velocities and pressure of the pulse wave. Treasury Metals has committed to cleaning up of spilled tailings and revegetation of the affected area as soon as practicable (in discussion with regulatory authorities).

Treasury Metals understands that the mouth of Blackwater Creek is known wild rice habitat used by a number of Indigenous communities. The flood wave is expected to be attenuated to below 1.3 m in depth by the time it reaches Wabigoon Lake and tailings solids will not enter the lake. The expected height and velocity of the water is not anticipated to cause an appreciable physical damage to the wild rice stands in Blackwater Creek. There is the potential that metal constituents in the water that are retained within the lake sediments, could potentially be taken up by plants along Blackwater Creek, including wild rice. However, it is anticipated that the concentration of metals in the sediment and resultant content in the plant tissue would be sufficiently low to not harm human or wildlife if consumed. In the highly unlikely event of a TSF failure, a monitoring program would be developed that would include wild rice samples taken from the mouth of Blackwater Creek and tested for metals against other wild rice stands in Wabigoon Lake (and a control lake outside of the system if practical) in order to provide confidence to potential consumers.

### Effects on Human Health

Humans, other mammals and birds are much less sensitive to the effect of a TSF failure, including indirect effect related to reduced water quality than are aquatic life, which is reflected in the provincial soil, groundwater and surface water guidelines. Drinking water quality standards would continue be met for all parameters in Wabigoon Lake with the exception of total mercury, lead and selenium, which would be mostly isolated to Keplyn Bay (Table 4.3.2.3-2). The water supplies for Dryden, Wabigoon Lake Ojibway Nation and village of Wabigoon are all outside the effect zone shown in Figure 4.3.2.3-2: Dryden draws its municipal water supply from the far western end of the lake; Wabigoon Lake Ojibway Nation draws its water supply from Dinorwic Lake which is upstream of Wabigoon Lake; and that the Village of Wabigoon is also outside of the potential effect zone.

A catastrophic TSF failure would nevertheless be expected to have some potential implications on the food web and remedial effort would be required and is proposed. Irrespective of the Goliath Gold Project, there is already a fish consumption advisory in effect for the area surrounding the Project to address pre-existing concerns regarding the concentration of mercury in fish (as discussed in Section 6.19 of the Revised EIS and Appendix W (the Screening Level Risk Assessment). Given the risk management measures already in place for the protection of human health via the fish ingestion pathway, this would be considered sufficient to ensure exposure risk reduction in the unlikely event of a TSF failure. In the highly unlikely event of a TSF failure, Treasury Metals would implement a fish flesh monitoring program to verify that the effects to contaminant concentrations in fish tissues has not substantively increased as a result of the failure.

Meaningful contaminant uptake by plants, including wild rice, is not anticipated in the event of a catastrophic TSF failure. As previously stated, in the highly unlikely event of a TSF failure, a monitoring program would be developed that would include wild rice samples be taken from the mouth of Blackwater Creek and tested for metals against other wild rice stands in Wabigoon Lake, and likely a control lake outside of the system.

**Effects to Aboriginal Peoples Traditional Land and Resource Use**

Treasury Metals recognizes that Aboriginal people live, work, hunt, fish, trap, drink water, and gather/harvest throughout their lands and rely on them for their individual as well as their community's overall cultural, social, spiritual, physical, and economic well-being. In the highly unlikely event of a TSF failure, potential effects to traditional land and resource use by members of Indigenous communities identified in relations to changes in water quality, effects on fish and fish habitat, and effects on vegetation used for traditional purposes.

As previously stated, drinking water quality standards would continue to be met in Wabigoon Lake for all parameters, with the exception of lead, mercury and selenium in Keplyn Bay, selenium in Thunder Creek, and lead and selenium in Bonny Bay (Table 4.3.2.3-2). The water supplies for Dryden, Wabigoon Lake Ojibway Nation and Village of Wabigoon are all outside the effect zone shown in Figure 4.3.2.3-2; Dryden draws its municipal water supply from the far western end of the lake; Wabigoon Lake Ojibway Nation draws its water supply from Dinorwic Lake which is upstream of Wabigoon Lake; and the Village of Wabigoon is south of the potential effect zone.

Although there has not been any identified bait fish harvesting that occurs in Blackwater Creek downstream of the proposed TSF, it is expected that there would be individual fish mortality in Blackwater Creek from the high kinetic energy associated with the release, and suffocation from the high suspended solids content. Blackwater Creek would not be available for bait fish harvesting until the deposited tailings are remediated and the creek re-established. From a water quality perspective, modelling of a highly unlikely catastrophic failure of the TSF shows that maximum predicted concentrations of some parameters (see Table 4.3.2.3-3) could exceed the PWQO values for the portion of Wabigoon Lake, near to the Blackwater Creek inlet (primarily the yellow and orange areas shown in Figure 4.3.2.3-4). The temporal extent of elevated concentrations (see Table 4.3.2.3-4) are expected not to be long enough to effect fish in Wabigoon Lake. It is also important to note that PWQO values are defined for protecting aquatic life for long-term, indefinite exposures. For shorter-term exposures, elevated concentrations would have more limited effects. It is therefore unlikely that higher trophic level species that are relied on by members of the Indigenous communities (e.g., walleye and pike) would experience mortality or noticeable decreases in the fish abundance or population.

It is recognized that metals such as cadmium, lead and mercury biomagnify within aquatic food chains. However, the ecological health risk of sediment contamination in the event of a catastrophic spill is considered to be limited, as the zone of influence is expected to be confined primarily to the yellow and orange zones and tailings solids will not enter the lake. These zones comprise a very small portion of the lake area, and would therefore be expected to have only a limited effect, on fish tissue metal levels as measured on a lake-wide basis. Additionally, that changes in fish tissue metal levels would not be sufficient to alter the current fish consumption advisory in effect in the regional area to protect human receptors from mercury toxicity.

It is predicted that the kinetic energy from the flood wave would destroy vegetation along Blackwater Creek, which could impact the stand of wild rice located at the mouth of Blackwater Creek. There is also the potential that metal concentrations in the water released in the highly unlikely event of a TSF failure could affect the concentrations of metals within the wild rice at the mouth of Blackwater Creek. However, the concentration anticipated in the plant tissue would likely not be above levels that would affect humans or wildlife consuming this vegetation. In the highly unlike event of a TSF failure, Treasury Metals would develop a monitoring program that would look at the concentration levels in the wild rice at the mouth of Blackwater Creek to verify that the metals concentrations were not elevated to a level harmful to wildlife and humans.

#### 4.3.2.5 Contingency and Emergency Response

The following emergency response and contingency procedures have been identified in the event that a TSF dam breach occurs:

- Processing plant operations would be immediately shut down;
- The seepage reclaim system would be shut down;
- The reclaim system would be re-routed to transfer water to the open pit for temporary storage if worker safety is not compromised;
- In the event of a pump failure, a temporary pump can be installed during repairs; and
- In the event that water breaches the seepage collection system; the area would be cleaned up by removal and proper disposal of the potentially impacted material into the TSF.

After the short-term actions of the Emergency and Spill Response Management Plan (ESRMP) consultation would be initiated immediately with applicable government agencies and a remediation plan would be developed. The damaged TSF embankment would be stabilized and reconstructed to ensure that containment of tailings solids and impacted water is reinstated. Released tailings and impacted natural ground are expected to be removed by excavation and deposited into the reinstated facility. Thereafter remediation efforts will be started, to support habitat recovery, including through seeding and revegetation.

Details of the recovery strategy would be dependent on the extent and nature of the spill. Tailings that were released from the TSF impoundment structure will need to be contained by temporary measures to limit additional spreading and damage to the surrounding environment. As a general strategy, tailings spilled on land between the TSF and the creek would be cleaned up as soon as the TSF could be stabilized to receive the spilled tailings. Tailings that are spilled on land could be cleaned-up within a reasonable timeline (likely one year) using dozers, excavators, loaders and haul trucks, well before the onset of acid mine drainage. Spilled tailings in the creek would need to be cleaned up mainly in winter, where the ground bordering the creek can be frozen, and when creek flows are predictably low. Access to the creek would be provided by an emergency winter road constructed parallel to the creek. Heavy equipment (excavators, loaders, dozers) would operate from off the winter road, and spilled tailings would be excavated and transferred to trucks for transport back to the TSF. Once the spilled tailings have been removed, the creek would be remediated using natural channel restoration strategies, in parallel with, or after tailings removal. Rock check control structures would likely be required at critical points in the system, to reduce creek flow velocities and erosion potentials until the creek banks can be successfully revegetated.

Another primary concern in the event of a dam breach will be to ensure site personnel and worker safety. By shutting down the processing plant, tailings will no longer be routed to the TSF, which will prevent additional tailings solids and water from entering the facility. An ESRMP will be prepared and in-place during the operations of the Project. It will be expected that personnel responsible for the operations of the TSF as well as other site managers, will be familiar with and trained to implement the ESRMP. The ESRMP will be initiated and temporary remedial works implemented to limit environmental effects, once worker safety is no longer compromised.

The effects of a catastrophic TSF failure (however unlikely to occur) on Wabigoon Lake, would be expected to be localized and short-term in nature due to the very large assimilative potential of the lake. The perception of contamination of the lake could potentially be of greater importance than the effects of the failure itself, and it would be up to Treasury Metals to demonstrate that the water, fish, sediments and vegetation in the lake would not be harmful to aquatic life in the longer term through monitoring and the sharing of monitoring data in an interactive environment. Further to the ability to implement mitigation measures in the event of a catastrophic TSF failure and/or remediate such an occurrence, the company will be expected to carry reasonable insurance for operational failures. This is in line with industry standard practice for other mine and mine projects. It is also expected that should the mine project create sufficient value and the decision to proceed to construction and operational phases is made, the company will be in an adequate financial position to cover any such failures.

#### 4.3.2.6 TSF Failure Follow-up Program

In the unlikely event of a TSF failure, an in-depth review will be conducted, which may warrant design changes, procedure changes, or need for additional measures.

A follow-up monitoring program would be developed to ensure that cleanup activities are effective, which is proposed to include water quality, sediments, fish tissue and key vegetation (i.e., wild rice) monitoring.

### 4.3.3 Spills / Releases

#### 4.3.3.1 Issue Description

Diesel fuel and gasoline will be stored at the fuel storage facility in double-walled tanks or other equivalent storage, with secondary containment such as a bermed facility with a petroleum resistant liner. Since these risks have been addressed with secondary containment, they are considered to have a low environmental risk.

Some site activities have the potential for fuel releases from vehicles or heavy equipment, especially during general development of the mine site (i.e., bulk earthworks / site preparation and site road development). However, as part of the developing technical work for the Project, which has been included in this EIS, Treasury Metals has proposed to construct a perimeter ditch around the operations area to contain all runoff from the active mining areas of the Project. Any possible spills associated with the operations of the mine will be wholly contained within this operations area, and within the water management system. Any excess waters not used in the process will be treated to meet PWQO prior to release to the environment.

Since there will be many vehicles operating and traveling both on- and off-site through all phases of the Project, there is the potential for an accident to occur, resulting in a release of fuel to the adjacent environment.

Fuel will be transported to the Project site along the regional road network by tanker trucks. Tanker trucks are generally compartmentalized, such that if there were to be an accident, only a portion of the load will be lost except in a catastrophic incident. The principal type of fuel used at the Project will be diesel for generator power supplementation during the construction phase and heavy equipment fleet operation during site preparation and construction, operations and closure. Fuel is transported routinely and safely throughout the local region and across Canada by licensed and trained drivers, and the risk of incident involving a serious collision where fuel is released into the environment is small.

Smaller quantities of gasoline will be trucked to the Project by tanker truck or container on truck, also using licensed and trained drivers. During the site preparation and construction phase, cement and paints will also be brought to the site.

All chemicals, such as reagents that may pose a potential risk to the environment, will be stored and used within contained areas if practicable (i.e., ore processing plant reagents), with sealed floors and sumps or drains reporting to facilities which will provide for retrieval of the released materials. These measures greatly reduce the release of such materials directly to the environment. Since these risks have been addressed with secondary containment, they are considered to be low environmental risk.

Various chemicals and materials including non-hazardous and hazardous substances will be transported by road to and from the Project site. Access to the site is available via Anderson Road/Tree Nursery Road linking to the Trans-Canada Highway (Highway 17) just to the west of the Village of Wabigoon.

Accidents along public roads and highways may have a higher risk of occurrence than on-site accidents due to other road users and higher speed limits. On-site design and operation procedures will continue to apply on off-site roads along with provincial and national road regulations and laws. The same potential environmental concerns indicated under on-site vehicular accidents will apply for off-site accidents.

#### 4.3.3.2 Control Measures and Preventative Procedures

All shipments will be in compliance with regulatory requirements, including the *Transportation of Dangerous Goods Act* and associated regulations. The need for compliance with the *Transportation of Dangerous Goods Act* and associated regulations will be reinforced in all applicable contracts and vendor agreements.

The potential for environmental effects associated with accidents and malfunctions on the trucking route will be minimized by the following operational procedures, which will be incorporated into the environmental management system, as possible, and into trucking/supply contracts, as reasonable:

- Regular maintenance of fuel trucks;
- Speed limits are to be strictly adhered to, including on-site;
- Strict adherence to national trucking hour limits and other applicable requirements;
- Drivers will be required to meet all applicable regulatory training requirements, be trained in spill response procedures for the materials they transport, and carry the appropriate MSDS;
- All vehicles transporting fuel to site will be required to maintain a supply of basic emergency response equipment, including communication equipment, first aid materials and a fire extinguisher; and
- Penalties for infractions.

The ESRMP (Section 12.13) will address the primary hazardous materials on-site, including procedures for spill response on the trucking route to the Project. Materials to be maintained in vehicles will be identified in the emergency response plan, but are likely to include absorbent materials and equipment to contain released material.

At the Project site, the following additional controls will be put in place to reduce the potential for, or the severity of, accidents involving fuel:

- Drivers will be required to meet all applicable regulatory training requirements;
- Speed limits are to be strictly adhered to, to be posted and enforced by Treasury security personnel;
- Right-of-way procedures will be defined and haul trucks and loaded vehicles will be given preference;
- Traffic will be required to yield to wildlife as observed;
- Where possible, heavy traffic will be limited to site haul roads and other traffic limited to site access roads;
- Transportation of material (i.e., fuel) during times of limited visibility will be avoided where possible;
- All vehicles transporting fuel to site will be required to maintain a supply of basic emergency response equipment, including communication equipment, first aid materials and a fire extinguisher;
- Waste management and littering;
- Regular maintenance of fuel trucks; and
- Penalties for infractions.

#### 4.3.3.3 Potential Environmental Effects

**On-site Spill**

Any spill occurring on-site will be isolated to the operations area and cleaned up as soon as possible. A vehicular accident on-site could happen at any time of the year. On-site accidents are most likely to involve personnel vehicles or haul trucks transporting coarse materials (e.g., ore, mine rock or overburden). Spills of fuel would be captured within the perimeter ditching surrounding the operations area and would be directed to one of the collection ponds on-site, where the water will be pumped to the process plant and treated prior to being discharge from the site. The contaminated soil would be removed and sent to the proper facilities for remediation. Therefore, it is anticipated that the effects of a spill occurring on-site will not cause any environmental effects off-site, or affect Indigenous peoples' traditional land and resource use.

**Off-site Spill**

Reasonable safeguards have been taken into account for the design of the Project, but a small potential for releases along all transport routes from tanker trucks still exists due to possible accidents related to poor weather conditions, collisions and other factors. A release from a tanker truck could potentially contaminate the soil or snow it covers, or enter a nearby water body or at a watercourse crossing. The consequences of any release will depend on the type and quantity of the material released, as well as the location and time of the release. Fuel that does not enter any water body is likely to have low or no environmental effects beyond the immediate footprint of the release. The released fuel and contaminated soil and/or snow can be collected and hauled away for appropriate disposal. A worst-case scenario would be the release of the entire contents of the fuel being transported to the site through a collision.

Effects of this worst-case scenario would typically be limited to the immediate terrestrial environment unless the release occurs during a rainfall event or if in close proximity to a surface water body. Depending on the soil and its hydrological characteristics, a significant fuel release could create a plume in the soil and leach into downstream watercourses resulting in aquatic and riparian effects. Therefore, primary effects would be to the terrain and soil, as well as surface water if the release occurs near a surface water body. Potential secondary effects could be on aquatic resources, groundwater, fish and fish habitat and wildlife habitat.

Diesel fuel and gasoline are toxic to aquatic life and a highly unlikely release in a water body or watercourse that supports aquatic life would affect the environment and would likely cause fish mortality, until the fuel dissipated or was cleaned up. However, this is a potential risk in all fuel transportation and is not unique to this Project. As previously stated, the extent and magnitude of this effect would depend on the type of product spilled and quantity of the spill. It can conservatively be assumed that all of the fish within the watercourse affected would be killed in a major / catastrophic spill into a watercourse. It is difficult to identify potential effects to Indigenous peoples without knowing the traditional uses of the affected stream; however, people would not take fish or drink from waters where a fuel sheen in present, and it can be assumed that traditional practices would cease until the spill had been remediated.

Off-site accidents could also include construction materials and other non-hazardous materials needed for the Project. Accidents strictly involving personnel and the public will have a detrimental effect on the families, communities and on the Project itself, and efforts will be undertaken to enforce safe driving habits on-site, with penalties if required.

Any release of non-hazardous material will not be expected to cause a significant environmental effect, with the exception of the immediate footprint of the accident. Heavy materials such a mine rock could crush vegetation and compact soil. Any effects will be temporary in nature and readily remediated as needed.

#### 4.3.3.4 Contingency and Emergency Response

The following emergency response and contingency procedures will be followed as outlined below in the event of a worst-case scenario release:

- Spill response measures; and

- Incident Specific Remediation action plans.

The affected environment will be rehabilitated as needed. Clean-up and remediation will ensure long-term environmental effects are reduced to the extent practical. After any major environmental release, a review will be conducted to ensure that the required design changes and procedures and appropriate monitoring measures are in place to ensure that the incident will not be repeated.

In general, the emergency response protocols in the event of a worst-case scenario fuel release include the following:

- Identify immediate hazards to human life and health;
- Identify source of release and control source;
- Contain the released material;
- Notify appropriate personnel and reporting to applicable government agencies;
- Conduct clean-up of area affected by the release;
- Incident investigation; and
- Further assessment of effected environment, including surface water bodies in vicinity of release.

Emergency and spill response procedures will be established as part of the environmental management system and include the following: medical response, notification, containment of the release, removal of released material, treatment of affected environment, monitoring of environment and learning from the accident.

Although the environmental effects of a release are very important, another primary goal in any collision resulting in a release will be to ensure public and worker health and safety. Potential ignition sources will be removed in the event of a release of flammable or combustible materials, if possible, and the release will be stopped or slowed using available equipment. Appropriate corporate and external personnel will be notified, and an assessment will be conducted to determine the best means to prevent immediate environmental effects. Counter-measures may include the use of absorbent materials, establishment of a collection trench and setting containment booms on water. When fuel is contained by booms, berms, or other means, it may be pumped, skimmed or mopped with absorbent matting, and disposed of in an approved facility designed to manage such wastes. If a release were to directly enter a fast moving watercourse, it may not be possible to completely contain and remediate the area affected by the release.

#### 4.3.3.5 Follow-up Monitoring

Review of reported spill will be conducted periodically which may warrant design changes, procedure changes, or need for additional measures.

Compliance monitoring programs (water, soil or air) would be implemented to assess clean-up requirements and disposal of impacted materials, if required.

### 4.3.4 Uncontrolled Cyanide Release

#### 4.3.4.1 Issue Description

The Project will extract gold from gold-bearing ore using the industry standard carbon-in-leach (CIL) process (Appendix HH). A cyanide solution will be used as a reagent in this process to recover gold. Cyanide leaching is a technically proven and cost-effective technique for the recovery of gold. Cyanide will occur in the processing plant in both liquid (free cyanide and complexed with heavy metals) and gaseous phases (hydrogen cyanide [HCN] gas).

All aspects of the Project associated with the handling, use and treatment of cyanide are designed to comply with the International Cyanide Code, the recognized standard for best practice in the mining industry worldwide. Cyanide that will be used in the process will be delivered by truck in the preferred form of dry (solid) sodium cyanide pellets or briquettes, to avoid the possibility of liquid spills during transport. All deliveries of cyanide to the site would be done by regulated transport companies, who would be required to comply with relevant federal regulations such as the *Transportation of Dangerous Goods Act*. All carriers would be required under the Act to have detailed emergency response and contingency plans in place in the unlikely event of an accident during transport. Three to five days' worth of cyanide pellets will be stored in the processing plant, with additional storage (two to four days' worth) provided at the existing warehouse at the former Ontario Ministry of Natural Resources and Forestry (MNRF) tree nursery.

With the safety and operational procedures in place, the likelihood that a cyanide release should occur during transport and delivery to the Project is low; however, a worst-case scenario would be an accident involving a vehicle carrying hazardous material (e.g., cyanide), which would result in a release to the environment.

As part of the gold recovery process, ore will be leached with cyanide in agitated leach reactors. The ore processing plant will be designed according to best practice engineering standards for safe operation, with appropriate ventilation systems. As ore processing plant design involving cyanide is common industry practice, including detailed cyanide management plans, there is no reasonable potential for HCN gas to be unintentionally released in the ore processing plant. Appropriate safeguards will be in place to protect the limited number of workers in this area and those that come into contact with the liquid or gaseous cyanide.

Cyanide consumption will be limited through use of a recovery thickener to recycle cyanide, and cyanide concentrations in the effluent and tailings will be reduced using the $SO_2$-Air cyanide destruction (treatment) process prior to discharge to the tailings facility. After treatment using the $SO_2$-Air cyanide destruction process, process water and tailings pumped to the TSF will create a supernatant water within the TSF that intends to meet the 1 mg/L total cyanide effluent discharge limit set out in the federal MMER.This process is technically proven and well-established technology that is unlikely to fail during normal operations such that this standard is not met.

#### 4.3.4.2 Control Measures and Preventative Procedures

With respect to preventative measures, all aspects of the Project associated with the handling, use and treatment of cyanide are designed to comply with the International Cyanide Code requirements. The International Cyanide Code focuses exclusively on the safe management of cyanide that is produced, transported and used for the recovery of gold and silver, and on mill tailings and leach solutions. The Cyanide Code addresses production, transport, storage, and use of cyanide and the decommissioning of cyanide facilities. It also includes requirements related to financial assurance, accident prevention, emergency response, training, public reporting, stakeholder involvement and verification procedures. Cyanide producers and transporters are subject to the applicable portions of the Cyanide Code identified in their respective Verification Protocols.

Designs and operational practices will be prepared to limit worker exposure to cyanide and cyanide compounds in compliance with exposure limits established in Canada, and / or as recommended by the International Cyanide Management Institute.

The $SO_2$-Air cyanide destruction process is an industry standard process designed for safe and responsible management and use of cyanide. Operational safeguards for compressed gases will be enforced, operations personnel will be trained to use appropriate health and safety safeguards, and infrastructure will be regulatory maintained and inspected as per standard operating procedures. Due to design and use of best practices employed at the Project site, there is no reasonable potential for the destruction circuit to fail, or for significant environmental effects.

As per other reagents and chemicals that will be used at the ore processing plant, cyanide, cyanide compounds and related chemicals will each have an SDS in order to comply with the best practices in the industry for health and safety, and to provide relevant regulatory standards for the safe use of these materials. Regular inspections of holding tanks and operational procedures will be carried out. This program will have continual reviews and updates to remain current. These will also be used in the training programs conducted by the health and safety department personnel.

Operations and designs for hazardous materials, such as cyanide transport, will comply with applicable regulatory requirements for the transportation of dangerous goods. All vehicles and drivers involved with transport will be licensed, trained, and inspected for competency.

All containers and trucks will carry SDS of materials being transported, will be properly maintained to company and Transport Canada standards, and will have all safety equipment on hand (including medical and spill response material). Other requirements of the International Cyanide Code will also be met or exceeded.

#### 4.3.4.3 Potential Environmental Effects

Three scenarios were assessed whereby an accident or malfunction related to cyanide could potentially lead to an environmental effect. Although these scenarios are highly unlikely to occur due to the control measures and safeguards put in place, they have been assessed to show the hypothetical environmental effects if they were to occur.

**Vehicular Accident During Transportation**

The primary risk of cyanide related to accidents and malfunctions for the Project, is the potential release of cyanide to the environment due to a vehicular accident during transport to the site. As previously stated, cyanide that will be used in the process will be delivered by truck in the preferred form of dry (solid) sodium cyanide pellets or briquettes, to avoid the possibility of liquid spills during transport. In the highly unlikely event of a spill involving cyanide occurs during transportation to the site, the dry cyanide pellets or briquettes would only impact the soil it came into contact with, and environmental effects would be limited. The greatest risk would be if a cyanide spill occurred at a river crossing and entered a nearby waterbody. Cyanide is toxic to humans and terrestrial and aquatic life. In the highly unlike event that a cyanide spill was to occur into a waterbody or watercourse, the potential for adverse and potentially detrimental effects will vary according to the volume spilled and location. The use and transport of cyanide is only expected to occur during the operations phase of the Project and as such accidents of this type are not expected to occur in any other phase.

It is difficult to identify potential effects to Indigenous peoples without knowing the traditional uses of the affected stream; however, the waterbody or watercourse contaminated with cyanide would be isolated until the spill could be remediated or the elevated concentrations of cyanide dissipate. During this time, all traditional practices would cease until the spill had been remediated for safety reasons.

**$SO_2$-Air Cyanide Destruction Process Failure**

In the event of $SO_2$-air cyanide destruction process failure, the potential environmental concerns include the release of higher concentrations of cyanide and heavy metal effluent discharge to the TSF, and HCN and $SO_2$ releases within the ore processing plant. The weak-acid dissociable (WAD) cyanide concentration that would be discharged into the TSF in the unlikely event of a destruction process failure would be approximately 150 mg/L, compared to the 1 mg/L that would be discharged to the TSF from the operational $SO_2$-air cyanide destruction process failure. Based on literature, concentrations below 50 mg/L WAD are deemed safe to wildlife, and is also considered an interim benchmark for discharge into the TSF (Donato et al. 2007). Although the discharge to the TSF would be temporarily greater than 50 mg/L, based on the estimated quantity of supernatant water in the TSF of 300,000 $m^3$ compared to the 2,913 $m^3$ being discharge to the TSF each day, the change in WAD cyanide concentration within the TSF would only increase by small amount each day. It would take several weeks of discharge to the TSF of 150 mg/L WAD cyanide before the water quality in the TSF would reach levels that are harmful to wildlife.

Treasury Metals would have the $SO_2$-air process fixed prior to water quality in the TSF reaching levels that would be harmful to wildlife (e.g., birds landing on the TSF). If WAD cyanide levels in the TSF were to approach concentrations close to 50 mg/L prior to the $SO_2$-air process being fixed, the processing of ore would cease until the process was fixed. There are therefore no predicted environmental effects due to $SO_2$-air cyanide destruction process failure.

That stated, potential effects to the environment from the $SO_2$-air process failure could occur should it be coupled with TSF dam failure. In this event, discharge would not meet PWQO, which would potentially affect water quality, fish, and aquatic habitat within the Blackwater Creek watershed, and potentially Wabigoon Lake due to limited assimilative capacity of Blackwater Creek. However, it is not reasonably plausible that two highly unlikely failures would occur in sequence.

There are no anticipated effects to traditional land and resource use by Aboriginal people as a result of $SO_2$-Air cyanide destruction process failure. The water in the TSF would be treated until effluent discharge limits are reached and would therefore not have an effect outside the TSF.

**Hydrogen Cyanide Gas Release**

HCN gas can be harmful (i.e., toxic) to humans, wildlife and equipment upon exposure to elevated concentrations also poses a fire hazard. HCN gas release would be limited to the ore processing plant, all operations staff would be notified as per the emergency response plan, and evacuated if needed, HCN gas will be allowed to dissipate and will be removed to allow for sage working conditions for all staff. The HCN gas plume will quickly dissipate once entering the natural environment and no further response/environmental effects will be expected. The special boundary for this type of accident is expected to be limited to the property boundary as much of the HCN gas would likely be contained within the processing plant building and infrastructure. Accidents of this type are only considered during the operations phase as no use of cyanide is expected during the site preparation and construction, closure, and post-closure phases.

There are no anticipated effects to Aboriginal people's traditional land and resource use in the highly unlikely event of an HCN gas release at the process plant.

#### 4.3.4.4 Contingency and Emergency Response

The following emergency response and contingency procedures will be followed as outlined below in the event of a worst-case scenario of cyanide release:

- Spill response measures;
- Emergency response plan and associated Standard Operation Procedures; and
- Incident Specific Remediation action plans.

If the unlikely event of a vehicle accident involving a cyanide-carrying truck, the emergency and spill response plan would be deployed immediately. The incident would be reported to all relevant parties, public and worker safety would be ensured.

In the event of a cyanide spill into a waterway (which would only occur with a cyanide-carrying truck, involved in accident near / in water, where truck and cyanide containment is broken), there are no effective means by which the cyanide spill can be remediated or cleaned up, as per guidance provided in the Implementation Guidance for the International Cyanide Management Code (with the exception of physical removal of the briquettes / pellets). All emphasis must therefore be placed on strategies designed to prevent such an occurrence. In the event the cyanide is spilled on land including near a watercourse, measures are available to prevent it from entering the water and either clean up the spilled material, or render it less toxic (oxidize with hypochlorite or hydrogen peroxide solutions, or chemically binding it with ferrous sulphate). The provision of such actions would be the responsibility of the licensed transporter, supported by Treasury Metals.

The contingency and emergency response plan for transport related emergencies will ensure the following:

- Best route for access to incident site, including an evaluation of transportation route condition
- Specific remediation measures are implemented and followed including:
  - Recovery and treatment of contaminated soil;
  - Decontamination or management of soil and other contaminated material;
  - Disposal of clean-up debris; and
  - If possibility of contamination to drinking water, appropriate emergency response measures will be enforced to protect drinking water users.

After any major release or accident, an in-depth review will be conducted which may warrant design changes, procedure changes, or need for additional measures.

Should the $SO_2$-Air cyanide destruction process fail, the ore processing plant will be shut down and all pumping outputs and inputs to the plant will cease. Body and eye wash stations will also be established at the ore processing plant as a first response measure. Personnel and the ore processing plant area will also be equipped with HCN gas sensors with an alarm system, should gas reach unacceptable ambient levels. All workers will be provided notification and cease all work and be evacuated as per established emergency response procedures. Any gas plume present will be allowed to dissipate to ensure worker safety. Notification to workers downwind of the incident and ore processing plant shutdown may be required in order to secure the area. $SO_2$-Air cyanide destruction process will remain closed until full operational ability is restored.

#### 4.3.4.5 Follow-up Monitoring

After any major release or accident from cyanide use, transport, storage or handling, and in-depth review will be conducted which may warrant design changes, procedure changes, or need for additional measures.

Compliance monitoring programs (water, soil or air) would be implemented to assess clean-up requirements and disposal of impacted materials, if required.

## 4.4 Natural Hazards

Natural hazards that could potentially affect the Project include extreme flooding, natural fires, earthquakes, tornadoes and climate change. Additional items identified in the EIS Guidelines as potential natural events (e.g., ice jams, geohazards) are not likely to occur due to the topographical characteristics of the Project. All facets of the Project have been designed, and will be constructed and operated with consideration for local environmental conditions and the potential for extreme natural hazards.

### 4.4.1 Extreme Floods

Extreme flood events have the potential to cause structural failure of the TSF and flood site facilities particularly the open pit. To protect site infrastructure against the risk of extreme floods, the TSF has been designed to pass extreme flood events without affecting TSF stability, and compromising safety on site.

The design of the TSF embankment heights will include allowances for operating pond levels, containment of the Environmental Design Storm, spillway designed to pass expected flows (in accordance with the Inflow Design Flood [IDF]) and the required freeboard as identified in the CDA Dam Safety Guidelines and the *Lakes and Rivers Improvement Act* Best Management Practices. Water pond levels and embankment heights will be designed for each embankment stage for operational and storm water management as presented below:

- Maximum Operating Level – Required to contain runoff from average and wet precipitation conditions considering the volume of water being removed from the facility (evaporation and water transferred to treatment and process) while maintaining a water cover.
- Spillway Invert Level – Pond level providing storage capacity between the invert of the spillway and Maximum Operating Water Level to contain the Environmental Design Storm (EDS), currently assigned as the volume of water resulting from the 1:1,000 yr, 24-hr. precipitation event.
- Embankment Height – Sufficient to maintain freeboard above the invert of the spillway for each embankment stage to prevent water from overtopping the dam during the occurrence of the prescribed IDF that will be determined once the dam’s Hazard Potential Classification has been established during final design.

Based on proper water management practices that follow the final design requirements, once completed, the TSF should not experience overtopping due to the extreme flooding.

Any water due to an extreme flood event that enters the pit and collection pond system will be pumped out over several days. During this period, the process plant feed would derive from the ore stockpile.

Extreme flood events are not expected to affect the Project except as discussed above, and no resulting environmental effects are expected. This would be similarly true of floods of higher probability, such as the 5-year or 10-year floods, which represent less extreme events.

Treasury Metals, as part of on-going engineering refinements has included a mine dewatering pond, surface water runoff collection ponds and also a perimeter site containment ditch/berm system to provide additional contingency containment of mine contact water to prevent unintended releases to Blackwater Creek. Design of the seepage collection ditch, holding ponds and perimeter site containment system will be advanced to the detailed level of design that will include site investigation data that is planned for completion in the near future. All ditches and ponds will be designed to accommodate the Environmental Design Storm (EDS) for the site and will be submitted for Provincial Approval with Plans and Specifications. All containment or holding ponds, including the TSF, will be designed with contingency containment that will include allowance for the EDS. A comprehensive water balance analysis will be completed as part of detailed design that will be used to assess average, 1:20 year wet and dry precipitation conditions. The assessment will be used to ensure that all facilities can be operated within the prescribed pond limits.

The following Planning, Design and Construction Strategies will be applied to the Project to minimize the potential effects from extreme flood events on the seepage collection system,

**Planning**

- Include a site perimeter ditch / berm to provide additional containment and prevent the release of mine contact water to the environment in the unlikely event that the seepage collection ditches are breached. Ditches will be designed to accommodate the Environmental Design Storm (EDS) for the site.
- Use excavated material from the ditch construction to construct a containment berm, on the downstream site of the seepage collection ditch, to provide additional containment during high flows resulting from significant storm events.
- Runoff can be routed to the open pit for containment if the capacity of the seepage collection ditches is exceeded.
- Complete detailed site investigations to collect site data for use in the design of the ditches and also for construction planning.
- Site surveys along ditch alignments to provide accurate field data for use in the design.

- Collect field information on the culvert at Tree Nursery Road.
- Preparation of a site Operations, Maintenance and Surveillance Manual after completion of detailed engineering for use during operations.

**Design**

- All diches will be designed to accommodate peak flows resulting from the EDS. The EDS will use station data for the area to accurately identify significant storm rainfall events.
- Include freeboard allowances for all ditches.
- Include contingency storage to accommodate the volume of water generated from the EDS in all holding ponds. The EDS allowance will be included in addition to allowances for the operating pond.
- Complete detailed water balance analysis for all containment facilities.
- Include riprap erosion protection to prevent scour and damage to diches.
- Include non-woven geotextile under riprap to aid in prevention of scour.
- Check capacity of culvert on Tree Nursery Road and design upgrade/improvement, as required.

**Construction**

- Prepare design drawings with technical specifications for use during construction.
- Provide full time construction monitoring during construction to ensure that work is being completed in accordance with the design intent and technical specifications.
- Implement a construction Quality Assurance and Quality Control (QA/QC) program for testing to ensure that construction materials meet the technical specifications.

### 4.4.2 Natural Fires

Within the Lake Wabigoon Ecoregion (Ecoregion 4S), where the Project is situated, forest fires are part of the natural regeneration cycle of the area. The forest fire cycle within Ecoregion 4S ranges between 50 and 187 years for upland coniferous forest areas. Mixed forest fires cycle ranged between 63 and 210 years.

Primary Project components that are most vulnerable to natural fire include the processing plant, the Project office, and the 115 kV/230 kV power lines running in parallel though the Project site. Fire suppression systems will be constructed to protect key buildings and help ensure the safety of personnel, and that multiple road and highway accesses would be available to evacuate people from site if needed. Should it be determined in the future that additional fire breaks are required, appropriate approvals will be obtained from the MNRF. The transmission line remains the most vulnerable Project component to fire. If the transmission line were to become damage these portions of the line would need to be repaired, operations would cease due to lack of power.

Fires (natural or man-induced) have the potential to affect the Project; however, they are not expected to result in an additional an additional environmental effect, such as causing an accident or malfunction.

The risk of damage from natural fires to key infrastructure such as the explosives storage facility, fuel storage facility and process plant is assessed to be low / unlikely if the key mitigation measure of maintaining adequate special separation (fire break) between the facility and natural fire hazard is implemented.

Items such as oils, transformers, fuels or reagents will be stored on-site in adequately designed tanks within diked / bounded areas sized to capture 110% of the largest spill plus one hour of fire suppression water from either fixed fire suppression systems or fire hose streams. Coarse gravels will be used to surround these structures and maintain the clear fire break.

Planning, design and construction mitigation strategies to minimize the potential impacts of environmental effects from natural fires on the explosives facility, bulk fuel storage and process plant areas include:

- Clearing sufficient vegetation surrounding these facilities during construction to create an effective fire break, eliminating any potential impact from natural fire and possible flash over;
- Maintaining these fire breaks during plant operation;
- Ensuring the process plant and mine infrastructure fire suppression system is designed and operated in accordance with the National Fire Code of Canada (NFC), the National Fire Protection Agency (NFPA) codes and relevant FM global design guidelines;
- Fuel storage spills will be contained with ignition sources unlikely. Protection within fuel storage areas will be in line with the requirement of NFPA 30;
- The explosives storage facility construction and storage will be in compliance with the requirements of NFPA 495 Explosives Materials Code;
- The bulk fuel and explosive storage facilities will be classified as hazardous areas with potential ignition sources being designed out of these areas, i.e. only intrinsically safe equipment / instrumentation will be installed, etc;
- Onsite fire suppression equipment will be provided to support trained responders in extinguishing and ensuring exposure protection from natural fires. Site hydrants will ensure that cooling water can be applied if threatened by external fire source; and
- Ensuring operations and construction personnel are adequately trained in responding to site natural fires.

The fire water main will be an underground buried HDPE pipe installed at a depth lower than the frost depth. For piping and risers exposed to extreme cold conditions, adequate freeze protection measures such as heat tracing, insulation or stainless-steel wrapping will be used.

The plant fire suppression system equipment will include:

- Fire hydrants installed in accordance with the requirements of NFPA 24 and 14;
- Fire hose reels;
- Automatic fire sprinkler systems used in enclosed conveyor galleries and for hydraulic power packs (as required); and
- Visible and readily accessible portable fire extinguishers.

A system of fire detection and alarm will be installed to ensure very early warning of a fire event and allow early emergency response (and keep water use as low):

- Local fire detections systems including smoke detectors, heat detectors and manual pull stations;
- Fire alarm and emergency warning system to a manned control centre which will ensure response to the alarm of fire; and
- VESDA smoke detection systems for substations.

The following strategies will be implemented to collect the water used to put out fires and prevent it leaving the operations area:

- Fire water used within the process plant will be collected and contained within concrete bunds within the plant area. Fire water can then be treated locally prior to disposal;
- Fire water used from hydrants and external sources outside of the plant will be directed to the site collection / sediment ponds used for storing site groundwater run-off. Water will be managed according to the site-wide water management plan and will ultimately report to the minewater pond, where it can be sampled and treated (if contaminated from a fire event) before it is either pumped back into the process plant or discharged into Blackwater Creek if discharge requirements are met); and
- For plant hazardous areas, i.e. oil filled transformers and the fuel storage area, etc., infrastructure will be located within a diked / bunded area which will be sized to capture 110% of the largest spill plus one hour of fire suppression water from either fixed fire suppression systems or fire hose streams. The contained water/fuel bund can then be treated, collected and disposed according to the specific area spills management plan.

### 4.4.3 Earthquakes

The risk of an earthquake that could have a real effect on the Project is very low at the Project site due to the Low Relative Hazard rating of the area based on the Seismic Hazard Map from the Geological Survey of Canada (Appendix D, Figure 2.3). Seismic data for the site is available from the National Building Code (NBCC) Seismic Hazard Calculation that provides return period ground acceleration values, which was updated in 2015. This latest site data will be used to design stable slopes for the waste rock, overburden and ore stockpiles.

The effects of earthquakes on overburden, ore and waste rock stockpiles result from the potential for liquefaction, which could lead to a loss of strength and displacement of the foundation soils, as well as a loss of support for loads that may be present (i.e. a material stockpile). Loss of support and soil movement can result in a situation where a stockpile will move, decreasing the stability of the stockpile slopes. In the unlikely event of an earthquake, the mobilization of stockpile material into the perimeter runoff and seepage collection ditch system could occur, or alternatively cause damage to the runoff and seepage collection systems adjacent to the stockpiles. These effects are anticipated to have a very low potential for occurrence as well as low environmental impact as the site will have a perimeter containment system consisting of a ditch / berm, which would provide secondary containment if material from the stockpiles were mobilized and were not captured or contained by the individual stockpile collection system.

Site investigation data collected from the stockpile foundations will be used to design stable slopes for all stockpiles. The stability design will be completed for static and pseudo-static conditions, similar to the design for the TSF embankments. Design under seismic conditions will utilize the available data from the NBCC as an input parameter to design stable slopes for the stockpiles. Assessment for potential liquefaction will be based on the results of the site investigation and assessment of the foundation soils to identify if the soils have liquefaction potential. Designing stable slopes under seismic loadings will minimize the potential environmental effects in the unlikely event of an earthquake.

The TSF dam will be designed to withstand the maximum earthquake in accordance with the latest version (2007) of the Canadian Dam Association Dam Safety Guidelines, the Ministry of Natural Resources and Forestry Best Management Practices (2011) and the Provincial *Lakes and Rivers Improvement Act*. Further design specifications can be referenced within Appendix D. All TSF construction will be completed under the supervision of a qualified geotechnical engineer. The risk of TSF failure resulting from an earthquake is taken into consideration and is reflected with dam construction plans and design.

Seismic events are not expected to cause Project-related accidents or malfunctions that would result in environmental effects, due to the mitigation and contingency measures in place. Additional geohazards such as landslides and avalanches, associated with seismic activities and mountainous environments are not expected to affect the Project due to the topographical characteristics of the site.

The following provides the proposed planning, design and construction strategies for minimizing the potential environmental effects of an earthquake:

**Planning**

- Include a site perimeter ditch / berm to provide additional containment and prevent the release of fine material from stockpiles that may become mobilized in the event of loss of containment caused by an earthquake;
- Complete detailed site investigations to collect geotechnical site data for use in the design;
- Collect most recent seismic data from NRCAN for the site for use in design; and
- Review stability when seismic data for the site is updated in future.

**Design**

- Design stockpiles to have stable slopes under seismic conditions utilizing the most recent site data available;
- Design the TSF to withstand the maximum earthquake in accordance with the latest versions (2007) of the Canadian Dam Association Dam Safety Guidelines, the Ministry of Natural Resources and Forestry Best Management Practices (2011) and the Provincial *Lakes and Rivers Improvement Act*; and
- Assess the liquefaction potential of foundation soils. Where soils are found to not be suitable include as part of the design effort identification of option to remove and replace soils that are potentially liquefiable.

**Construction**

- Prepare design drawings with technical specifications for use during construction;
- All TSF construction will be completed under the supervision of a qualified geotechnical engineer; and
- Provide full time monitoring of dam construction by qualified engineers to ensure that work is being completed in accordance with the design intent and technical specifications.
- Implement a construction Quality Assurance and Quality Control (QA/QC) program for testing to ensure that construction materials meet the technical specifications.

### 4.4.4 Tornadoes

Project components and infrastructure are being designed as per best engineering practices to ensure safe operation. Personnel will be trained to take emergency measures as part of the emergency and spill response plan in the unlikely event that a tornado or other wind event that occurs at the Project site. The procedures used as part of the emergency and spill response plan would be used as needed, repair and follow-up inspections would occur to ensure site safety.

Critical plant and mine infrastructure that may be affected by high wind or tornado events are the explosives, reagent and bulk fuel storage facilities. However, these facilities will be designed in accordance with the Ontario Building Code. Therefore, they would not be susceptible to high winds and tornadoes that could otherwise result in damage to the building and possible rupture and spills of the materials they are designed to safely store.

Critical components of the TSF that may be affected by high winds or tornado events consists of the upstream embankment and low-permeable zone as well as the embankment crest. Wave action resulting from wind can result in erosion of low-permeable fill materials (i.e., clay) or loss of protection zones covering low-permeable engineered liners (i.e. HDPE). If not mitigated, exposure of the low-permeable liner by wind and wave erosion could potentially lead to degradation of the liner, leading to reduced containment capacity and increased seepage potential, as well as exposure the low-permeable engineered liners to sun degradation to low-permeable engineered liners. There are greater potential risk to the environment with increase seepage leaving the TSF and migrating off-site to surface watercourses.

Wave action can also result in overtopping of the embankments, causing damage to the embankment crest. The damage to the embankment crest can result in erosion damage that can lead to a loss of containment or instability of embankment. This can impact the environment by having loss of containment of tailings solids or supernatant water. The TSF design basis will address the protection of erodible materials during extreme wave run-up events.

The perimeter runoff and seepage collection ditch that encompasses the entire TSF will contain any water that overtops the dam crest due to wave run-up. The ditch will be a low-permeability structure to provide effective containment in accordance with the requirements of the MMER and will prevent an effect to the environment. The perimeter runoff and seepage collection ditch is described in Section 3.8.

Water that overtops the spillway due to wave run-up will report to the open pit via the low-permeable swale that is described in Sections 3.7.1 and 3.7.4, and illustrated in Figure 3.0.1A. This TSF water will be consolidated with mine water and pumped to the minewater pond where it will be contained, thereby preventing an effect to the environment as a result of this overtopping. During the operations phase of the Project, while the pit is actively dewatered, there will be a net flow of groundwater into the pit and there is no potential for the TSF water to migrate out of the pit.

There is a risk reduction associated with overtopping from wave run-up that is based on operations of the TSF. Containment for tailings solids, operational and storm water management is established with the perimeter embankment and the established crest elevation. The elevation of the crest is raised at strategic times over the life of the facility to accommodate the required storage capacity. The tailings surface elevation increases with the tailings deposition and the tailings rate of rise is established based on the design throughput of the plant. The risk of overtopping from wave run-up is significantly reduced during initial periods of tailings deposition for each embankment stage as significant elevation difference is present between the embankment crest level and the tailings beach level. The engineering design for wave run-up to establish the required crest height is based on the highest tailings beach surface for each stage.

For all process plant and mine infrastructure component design, the design wind loads will be determined in accordance with the Ontario Building Code (based on the Canadian National Building Code) Section 4.1.7. The design wind load is calculated by:

- The reference velocity pressure (q) is based on a probability of being exceeded in any one year of 1-in-50, and the reference velocity pressure design factor used for the Project will be specified in the building code for the Dryden site location;
- The ultimate load combination for a limit state design applies a 1.4 factor to the calculated wind load; and
- An Importance Factor (Iw) is applied and is 1.0 for Normal Importance Category structures, or 1.15 for High Importance Category structures (i.e., storage facilities containing toxic, explosive or other hazardous substances).

The site wind velocity pressure data is determined from wind load data recordings at nearby weather stations and is reported in the building code.

Plant and mine infrastructure structures will be designed, checked and signed-off by licensed professional engineers (P.Eng.) who are certified and in good standing with Professional Engineers Ontario (PEO).

Items such as oils, transformers, fuels or reagents will be stored on-site within diked / bunded areas sized to capture 110% of the largest spill plus one hour of fire suppression water from either fixed fire suppression systems or fire hose streams.

The TSF detailed design will include suitable freeboard for containment of operational, storm water and freeboard. Design for freeboard is completed in accordance with the *Lakes and Rivers Improvement Act* for Provincial approval by the Ontario Ministry of Natural Resources and Forestry (MNRF). Freeboard is determined for each embankment stage to ensure that overtopping from wave run-up is prevented. Determination of required freeboard utilizes computations of wind-generate wave height, set-up and run-up that incorporate a selection of reasonable combined occurrences of reservoir level, wind velocity, wind direction and wind duration based on site specific studies.

Planning, design and construction strategies to minimize potential environmental effects from tornadoes and high wind effects on the TSF are summarized below:

**Planning**

- Include protective covers over low-permeable zones for protection and to prevent erosion;
- Utilize non-woven geotextile in embankment construction to provide additional protection against erosion of protection layers to low-permeable zones;
- Use riprap erosion protection layer on upstream slope of embankment to add additional protection from wave action for the embankment fill that includes the low-permeable zone; and
- Apply freeboard to contain wave run-up for each TSF embankment stage to prevent overtopping and protect the crest and dam.

**Design**

- Protective cover zones for low-permeable zones to properly filter graded and assigned sufficient thickness for protection;
- Non-woven geotextile design to be completed for wave action condition and also properly filter graded to prevent loss of cover material to maintain protection of low-permeable zone;
- Riprap gradation designed to withstand the design wave for the site to prevent embankment erosion; and
- Freeboard design to be completed in accordance with the LRIA and the MNRF Best Management Practices to prevent wave run-up from overtopping the dam. Minimum freeboard design to be assigned under worst case conditions consisting of maximum tailings beach level. Freeboard allowance to be assigned for each TSF embankment stage.

**Construction**

- Preparation of Construction Drawings and Technical Specifications sealed by a Professional Engineer in Ontario and submitted for MNRF approval under the LRIA;
- Construction monitoring to be completed by a qualified engineer to ensure that the construction product meets the requirements of the Construction Drawings and Technical Specifications to ensure the dam embankment and protection achieves the design intent; and
- Implementation of a Quality Assurance and Quality Control Program (QA/QC) to ensure that the embankment zones and engineered products used for construction meet the requirements of the Construction Drawing and Technical Specifications.

### 4.4.5 Climate Change

Climate changes over the life of the Project could potentially result in a shift in weather conditions and/or the frequency of extreme weather events. These changes could increase the risk of environmental effects due to accidents and malfunctions. Climate change events would be minor relative to the life of the proposed Goliath Gold Project.

Various climate change assessments have been developed for northern Ontario. These statements predict an increase in temperature, stable to increasing precipitation, more episodic precipitation and an increased risk of natural fires. The primary effect of climate change on the Project is that of the potential variation to the water balance on site through the life of the Project, and a minor extent through the risk of natural fires.

Due to the short nature of the Project and historical and reference documentation, it would therefore appear that the runoff and water regimes of the area are likely to remain close to the current levels. Water balance determinations used to design the Project are unlikely to change during the life of the Project.

In addition to the requirements set out in the EIS Guidelines, guidance for incorporating climate impacts in environmental assessments can also be found in the current Federal guidance document (FPTCCCEA 2003). This guidance describes how the evaluation of climate impacts should do the following:

- Identify the sensitivities of the Project to variations and changes in climate parameters; and
- Review available information on how regional climate change may affect these parameters.

**Identify Sensitivities of the Project to Climate Change**

Given that the mining activities are planned to have ceased after 13 years, and the closure phase is expected to last two years, the only possible sensitivities of the Project to changing climate in the longer term will be those related to the functioning of the post-closure landscape. The key elements of the post-closure landscape for the Project include the following:

- Open pit mine;
- Underground mine;
- Stockpiles;
- TSF; and
- Site drainage and water structures.

The following sections briefly describe each of the elements of the post-closure landscape, and their potential for susceptibility to longer term changes in climate.

**Open Pit Mine**

As described in the Section 3.14, by closure the open pit mine will be comprised of three interconnected pits. The west pit and part of the central pit will be backfilled with waste rock from the development of the central and east pits. Following mining, the open pits will be prepared for closure and allowed to flood. The operations area will be graded to direct all runoff into the open pit. A passive spillway will be constructed to allow the pit lake to eventually discharge into an existing ephemeral tributary of Blackwater Creek. The elevation of the spillway will be set to ensure the lake level is maintained within the overburden above the backfilled waste and bedrock. This will ensure that the waste rock and pit walls remain underwater during the post-closure phase. As both the pit walls and waste rock are currently classified as potentially acid generating (PAG), placing them under a water cover is a standard practice to prevent acid rock drainage / metal leaching (ARD/ML). The open pit mine closure is intended to leave a functioning aquatic ecosystem while providing secure storage of waste rock underwater.

The water flooding the pit is expected to come from three sources: surface water runoff from the operations area, treated tailings water present in the TSF at closure, and groundwater inflow. The flooding of the open pit is projected to take between 5 and 8 years, depending on climatic conditions.

Changes in climate in the longer term have the potential to affect the open pit mine after operations cease in the following manners:

- Changes in precipitation rates could affect the rate at which the open pit mine is flooded; and
- Changes in the long-term annual water budgets (i.e., precipitation less evapotranspiration) could affect the long-term water levels in the open pits.

**Underground Mine**

As described in Section 3.14, once mining operations cease infrastructure and equipment will be removed from the underground mine, and any spills or waste will be cleaned up and removed. The upper ramp and portal will be sealed using clean, quarried rock backfill, and the area around the portal will then be backfilled, covered with soil, and vegetated. The ventilation raises will be sealed to prevent inadvertent access to the underground mine workings by humans and wildlife. The underground workings will then be allowed to flood, with groundwater levels eventually returning to near pre-development levels.

Changes in climate in the longer term have the potential to affect the underground mine following closure in the following manner:

- Long-term changes in precipitation and annual water budgets (i.e., precipitation less evapotranspiration) could affect the rate at which the underground mine floods.

**Stockpiles**

The three main stockpiles are the waste rock storage area (WSRA), the overburden stockpile and the low-grade ore (LGO) stockpile. The waste rock has been classified as PAG, therefore, the closure and reclamation WSRA will include full encapsulation with a water-shedding cap that is tied into the up-gradient clay layer, as well as placement of soil and vegetation over the cap and disturbed areas. The WRSA will be graded to allow runoff to shed from the surface to runoff collection ditches that will be realigned to direct runoff into the open pits. At closure the material in the overburden stockpile will be used as cover material for the TSF closure as well as other reclamation activities requiring fill. Any material remaining in the overburden stockpile will be graded and vegetated. Finally, the LGO stockpile is expected to be depleted by the end of the underground mining operations. Any residual ore or PAG material on the LGO stockpile pad will be removed and placed in the TSF at closure, and the LGO stockpile pad will then be scarified and re-vegetated.

It is not expected that any longer-term changes in climate will have a potential effect on the stockpile areas following closure.

**Tailings Storage Facility (TSF)**

At closure the water will be withdrawn from the TSF, treated and used to help fill the open pit. The tailings would then be covered with a granular layer to physically isolate the tailings. Finally, the TSF will be covered with either a low-permeability cover or a water cover of non-process water to isolate the tailings from oxygen. It is not expected that longer-term changes in climate will potentially effect on the TSF following closure.

**Groundwater**

During the life of mining activities, dewatering is required in order to safely mine in the open pits and underground mine. At closure, the groundwater drawdown will be at the maximum extent. Once all mining has ceased the underground works will be allowed to flood, with the groundwater elevations eventually returning to pre-development levels (EIS, Section 11.4.3). It is anticipated the drawdown effects will be fully reversed in 20 to 30 years.

Changes in climate in the longer term have the potential to affect groundwater following closure in the following manner:

- Long-term changes in precipitation and annual water budgets (i.e., precipitation less evapotranspiration) could affect the rate of infiltration and the rate at which the underground mine floods, affecting the time to fully reverse drawdown effects.

**Site Drainage and Water Structures**

The pre-development headwater wetland of beaver ponds at the open pit site will be replaced by the pit lake. As described in Section 3.14, the operations area will be graded to drain towards the open pit as part of the closure activities. A passive spillway will be constructed to allow excess water from the open pit to drain to the former channel of Blackwater Creek Tributary 1. In general, the Project site post-closure is expected to experience an increase the amount of runoff as a result of hardening or surfaces. Anticipated flow increases are within the capacity of the existing creek channels.

Changes in climate in the longer-term have the potential to affect the site drainage and water structures following closure in the following manners:

- Changes in precipitation rates and intensities could increase peak flows beyond the capacities of the existing creek channels in Blackwater Creek (but this would also occur in the region irrespective of the Project).

**Projections of Regional Changes in Climate**

Although there are a multitude of sources available that describe the projections for future changes in climate in northwestern Ontario, Treasury Metals has tried to focus on those documents compiled by, or for the Ontario government. The two most heavily relied references were the climate change research reports CCRR-05 (Columbo et al, 2007) and CCRA-44 (McDermid et al, 2015).

The earlier policymaker summary report (Columbo et al, 2007) made use of data from the Canadian Coupled Global Climate Model (CGCM2) forecasts for emission scenarios presented in the Fourth Assessment Report (AR4) from the Intergovernmental Panel for Climate Change (IPCC, 2007). Specifically, Columbo et al (2007) presented the climate projections associated with the A2 emission scenarios, which is one of the four socio-economic scenarios relied on in AR4 (IPCC, 2007). Although the IPCC has not stated which of these scenarios are most likely to occur, the A2 scenario most closely reflects the current global socio-economic situation. In relation to the A2 scenario, scenarios A1, B1 and B2 result in lower long-term GHG emissions over the next century. Climate projections are presented as changes from the 1971 to 2000 baseline period, and are provided for the 2011 to 2040, 2041 to 2070, and 2071 to 2100 time horizons. These projections were used to compile the projected changes in summer and winter temperature and precipitation for the region near the Project.

Generally, the picture presented for future climate in the area is one of increasing temperatures in both the winter and summer periods for all of the forecast horizons. For precipitation, the summer rates are projected to increase for the 2011 to 2040 horizon, changing to a decrease for the 2041 to 2070 and 2071 to 2100 horizons. During the winter, future precipitation is projected to decrease for the 2011 to 2040 and 2041 to 2070 time horizons, but increasing the 2071 to 2100 time horizon. The results Columbo et al., 2007) presented in Table 4.4.5-1 suggest that the future climate for the region will continue to warm, with precipitation decreasing slightly except in the later stages of the century.

**Table 4.4.5-1: Projections for Changes in Climate (relative to 1971 to 2000)**

| Period | Temperature | | Precip[itation | |
|---|---|---|---|---|
| | Summer | Winter | Summer | Winter |
| 2011 to 2040 | +1 to +2°C | +1 to +2°C | 0% to +10% | -10% to 0% |
| 2041 to 2070 | +2 to +3°C | +3 to +4°C | -10% to 0% | -10% to +10% |
| 2071 to 2100 | +4 to +5°C | +5 to +6°C | -10% to 0% | 0% to +20% |

Note: Data derived from Coumbo et al, 2007.

In the updated summary for policymakers (McDermid et al, 2015), use was made of data from the Fifth Assessment Report (AR5) from the IPCC (2013), which replaces the socio-economic emission scenarios relied on in AR4 (IPCC, 2007) with new emission scenarios, but uses four new emission scenarios that better represent climate processes used in the modelling. The updated summary considered the RCP 2.6, RCP 4.5, and RCP 8.5 emission scenarios, and shows the 2011 to 2040, 2041 to 2070, and 2071 to 2100 time horizons. The updated summary also relies on statistically downscaled data from Earth Systems Models rather than data from a single GCM. The data relied on by McDermid et al are described more fully by McKenney et al (2006; 2011; 2013). The results are presented numerically for the three major watersheds in Ontario (i.e., Great Lakes, Hudson Bay, and Nelson River), the most relevant one for this project being the Nelson River watershed.

The updated picture for future climate in the region (McDermid et al, 2015) is one of warming annual, summer and winter temperatures for all of the emission scenarios and forecast horizons. The annual and winter precipitation projections show increasing precipitation for all of the emission scenarios and forecast horizons. In contrast, the projections for summer precipitation show decreases for all of the emission scenarios and forecast horizons (Table 4.4.5-2).

**Table 4.4.5-2: Projections for Mean Changes in Climate (relative to 1971 to 2000)**

| Period | Scenario | Temperatures (°C) | | | Precipitation (mm) | | |
|---|---|---|---|---|---|---|---|
| | | Annual | Summer | Winter | Annual | Summer | Winter |
| 2011 to 2040 | RPC 2.6 | +2.3 | +2.2 | +2.3 | +18.1 | -18.6 | +21.7 |
| | RPC 4.5 | +2.2 | +2.1 | +2.1 | +28.7 | -19.1 | +19.4 |
| | RPC 8.5 | +2.4 | +2.3 | +2.7 | +32.8 | -20.8 | +18.8 |
| 2041 to 2070 | RPC 2.6 | +3.0 | +2.7 | +3.2 | +51.8 | -7.4 | +24.0 |
| | RPC 4.5 | +4.0 | +3.4 | +4.7 | +37.5 | -19.8 | +21.6 |
| | RPC 8.5 | +4.8 | +4.6 | +5.6 | +54.3 | -27.7 | +30.6 |
| 2071 to 2100 | RPC 2.6 | +3.1 | +2.9 | +3.6 | +57.5 | -2.9 | +21.9 |
| | RPC 4.5 | +5.0 | +4.4 | +5.6 | +40.6 | -24.1 | +30.6 |
| | RPC 8.5 | +8.3 | +7.8 | +9.3 | +64.0 | -43.6 | +39.7 |

Note: Data derived from McDermid et al, 2015

**Implications for Regional Changes Climate Projections for the Project**

The primary susceptibilities of the Project to climate change were identified to be the following:

- Changes in precipitation rates could affect the rate at which the open pit mine is filled;
- Changes in the long-term annual water budgets (i.e., precipitation less evapotranspiration) could affect the water levels in the open pits.
- Long-term changes in precipitation and annual water budgets (i.e., precipitation less evapotranspiration) could affect the rate at which the underground mine floods;
- Long-term changes in precipitation and annual water budgets (i.e., precipitation less evapotranspiration) could affect the rate of infiltration and the time to fully reverse drawdown effects from dewatering; and
- Changes in precipitation rates and intensities could increase peak flows beyond the capacities of the existing creek channels in Blackwater Creek.

The filling of the open pit mine is predicted to take a period of nine years after the mining operations cease, which would fall within the 2011–2040 forecast horizon. Moderate increases in temperatures and increasing annual and winter precipitation for this period would suggest that climate change would not significantly alter the rate at which the open pit mine is filled. In addition, the filling of the open pit will not rely on precipitation and surface runoff only (EIS, Table 11.2.1), but will also rely on secondary treatment discharge and groundwater from wells outside of the mine zone of influence.

The longer-term site water budget will be affected by projections of increasing temperatures and annual precipitation rates over the remainder of century. This suggests that water levels will remain sufficient in the open pit mine to maintain a water cover for both the pit walls and waste rock, which are currently classified as PAG. The post-closure water level is anticipated to be above the overburden / bedrock interphase.

With respect to the underground mine, once the dewatering of the mine stops, it is expected to take between 20 to 30 years for the groundwater levels to recover to near pre-development levels. However, the underground workings are expected to fill more quickly as they will be influenced by the filling of the open pit. This would extend into the 2041 to 2070, or even the 2071 to 2100 forecast horizons. The longer-term water budgets that could influence the rates of infiltration into the underground workings will be affected by projections of increasing temperatures and annual precipitation rates over the remainder of century.

Finally, the precipitation rates for the region are projected to steadily increase through the remainder of the century. Although the model projections do not indicate whether intensities will increase, increasing precipitation is likely to increase the downstream peak flows in Blackwater Creek. To mitigate this, surface water collection ponds, diversion ditches, and seepage ponds can be converted into retention ponds (Section 3.8). This will reduce the potential effects of peak flows by slowing down the release to natural watercourses.

In conclusion, the possible Project susceptibilities to climate change were identified, and evaluated considering the projections for future changes in climate for the region. Generally, the relatively short life of the Project (17 years from site preparation through post-closure) means that climate change will be a minor concern for all aspects except those related to the post-closure landscape. Specifically, changes in the longer-term water balances could affects the effectiveness of the closed site. Projections of future climate for the region suggest steady increases in precipitation and temperature over the remainder of the century. As a result, it is expected the closed site will continue to function as proposed in the EIS. There could, however, be changes in the time required to flood the underground workings of the mine, and fully reverse the effects of dewatering on groundwater, with these possibly occurring slightly faster or slower than predicted in the EIS. In either case, there would not be a change to the conclusions reached in the EIS.

## 4.5 Conclusions

Accidents and malfunctions were identified using an FMEA process. The FMEA is a risk analysis procedure used to identify and characterize accidents and malfunctions based on the likelihood of occurring and the severity/magnitude of the failure. Through the FMEA process, a total of 463 failure modes were identified and analyzed within the environment, safety and health, and reputation impact categories.

Once all risks were identified, Treasury focused on the potential effects of accidents and malfunctions identified in the environment impact category. The environment impact category had a total of 137 failure modes; 123 of these failure modes are considered low-risk and 14 are considered medium-risk. There were no high-risk failure modes identified during the FMEA process as shown on the risk matrix.

The medium risks identified within the environment category were selected for analysis and were placed into broader failure modes for further assessment. There were three categories of failure modes considered for further environmental assessment: failure of the TSF, releases to land and water, and cyanide releases to land, water, and air. Potential primary environmental effects of the three categories of failure modes were generally to the terrain and soil and surface water. Potential secondary effects were generally determined to be to aquatic resources, fish and fish habitat, vegetation, and wildlife habitat.

As per the EIS guidelines, preventative procedures were identified to minimize impacts to the identified VCs, as well as contingency/emergency response procedures and follow-up monitoring for each failure mode.

Overall, the residual effects of the failure modes on the environment were determined to be not significant if all preventative procedures are adhered to throughout all phases of the Project.