18. Accidents and Malfunctions

The purpose of **Chapter 18, Accidents and Malfunctions**, of the Environmental Impact Statement (EIS) is to assess the potential accidents and malfunctions that could occur in association with the Project. This chapter describes the identification of the potential accident and malfunction scenarios, mitigation measures, and determines the risk and effects of those potential scenarios.

The assessment of accidents and malfunctions for the Project involves a structured and systematic process to identify and evaluate unplanned events that could result in adverse environmental, health, or safety outcomes. The process includes identifying potential hazards associated with Project activities, followed by an initial qualitative screening based on the likelihood of occurrence and the potential severity of consequences. Existing design features, operational procedures, and mitigation measures are considered to assess whether risks are acceptable or if further analysis is needed. From this screening, bounding scenarios are selected to represent the worst credible events, which are then assessed in detail to determine their potential impacts and the effectiveness of proposed controls. The key steps are:

- **Hazard identification**—systematic review of Project components, materials, and operations to identify potential causes of accidents and malfunctions (e.g., equipment failure, material spills, structural breaches).
- **Initial qualitative screening—**each identified hazard is evaluated using a matrix based on probability and consequence severity with consideration of mitigative measures such as built-in safeguards such as engineering controls, emergency response plans, monitoring systems, and operator training
- **Selection of bounding scenarios—**representative worst-case but credible events are chosen for detailed assessment and these are scenarios with high or medium risk ratings despite mitigation.
- **Assessment of bounding scenarios—**bounding scenarios are analyzed for their potential environmental and safety impacts, pathways of release, exposure to receptors, and the need for further design or procedural improvements.

18.1 Scope and Objective

The scope of this assessment includes all potential Project-related accidents and malfunctions that may occur during any phase of the Project. The assessment of accidents and malfunctions is intended to provide a clear identification of the potential Project-associated hazards that fall outside the range of "typical" day-to-day events.

The objective of this assessment was to evaluate the potential effects on the human health and biophysical environment resulting from accidents and malfunctions with consideration of proposed preventive and mitigative measures.

18.1.1 Assessment Boundaries

Assessment boundaries define the spatial and temporal extents of the assessment. The spatial extent of the evaluation includes the Project site and the associated Project-related access road network and the corridor between the Project site and the local rail load out facility (see Section 18.4, Figure 18-1). The hazard identification (HI) phase of the accidents and malfunctions assessment considered potential hazard sources associated with the operation of the Project. While the operational footprint is located within the site study area, the consequences of certain accidents and malfunctions scenarios could extend into the local study area and or less likely to the regional study area (RSA).

The temporal extent of the evaluation includes all stages, phases and periods associated with the Project lifespan (see Section 18.4).

18.1.2 Definition of Accidents and Malfunctions

For the purposes of the risk assessment, the terminology for accidents and malfunctions is defined as follows.

An accident is defined as any unintended event, including operating errors, equipment failures, and other mishaps, the consequences, or potential consequences of which are significant from the point of view of protection or safety. Examples of accidents include truck roll over, train derailment or landslides.

A malfunction is defined as a failure in the normal functioning of equipment, infrastructure, or systems that could result in potentially significant consequences. Examples of malfunctions include failure of dewatering pumps, failure of tailings management facility (TMF) liner, and tailings thickener tank structural failure.

18.2 Regulatory Context

The accidents and malfunctions assessment has been completed to satisfy Section 6.3 of the Environmental Impact Statement Guidelines issued on December 19, 2024, by the NL Department of Environment and Climate Change.

Other federal and provincial regulatory instruments that may be relevant to the consideration of the individual accident and malfunction scenarios evaluated herein are discussed as appropriate in the section and subsections that follow. This includes but is not limited to:

- NL *Environmental Protection Act* (SNL 2002, c. E-14.2)
- Environmental Assessment Regulations, 2003 (under the NL *Environmental Protection Act*)
- Occupational Health and Safety Regulations (under NL's *OH&S Act*)
- Storage and Handling of Gasoline and Associated Products Regulations (NL)
- Environmental Control Water and Sewage Regulations (under the *Water Resources Act*)

18.3 Incorporation of Indigenous and Local Knowledge

Indigenous and Local Knowledge shared throughout the engagement process was reviewed. One comment was identified that is relevant to the assessment, whereby Labrador City highlighted that water bombers use Duley Lake to collect water for forest fires. This has been considered in the assessment of risks for the accident and malfunctions assessment.

18.4 Project Information

A detailed summary of the Project activities and schedule is provided in Chapter 2, Project Description. The proposed Project would include an open pit mine and surface infrastructure to support the extraction of iron ore from the Kami deposit and the production of high purity iron ore concentrate. The Project includes construction, operation, and closure of the following components:

- an open pit (referred to as the Rose Pit)
- ore processing infrastructure, including conveyors and transfer stations, stockpiles, the process plant, and load-out facilities
- waste management infrastructure, including an overburden stockpile, mine rock stockpile, and TMF
- water management infrastructure that will collect, convey, store, treat, and discharge contact and non-contact water, including dams, dikes, and collection ponds
- supporting infrastructure, including site roads, workforce accommodations, a mine service area, fresh water pumping stations, fuel storage, an emulsion and explosion production plant and explosive storage, a crushing plant, transmission lines for local site distribution, and telecommunication services
- transportation corridors, including access roads and a railway corridor that includes a spur line to connect the mine site to the Québec North Shore and Labrador (QNS&L) Railway

All mining and processing operations will take place within NL provincial boundaries. All Project components will be constructed, operated, and closed in accordance with governing federal, provincial, and municipal regulations, as well as industry regulations and standards.

The Project is segregated into stages, phases and periods. A description of these stages, phases and periods including the key activities associated with each, as well as their estimated durations is summarized below.

- **Permitting and Approvals stage (3 years)**—includes release from the provincial environmental assessment process from the Government of NL and receipt of permits from applicable provincial and regulatory agencies. See Section 2.3 for further information about potentially applicable federal and provincial legislation and regulations.
- **Construction phase (4 years)**—include site preparation, mine, Process Plant and site infrastructure development, commissioning the structures, systems, and components. Construction includes 1 year of pre-development mining (i.e., ramp-up).
- **Operations phase (26 years)**—mining and processing of iron ore, production and shipment of iron ore concentrate and supporting activities. The Operations phase is initiated once the concentrator is commissioned, activated, and is producing iron ore concentrate. The mining rate will peak in Year 15, then slowly ramp down until the end of the life of the mine. The processing rate for the concentrator is planned to ramp up to 26 Mtpa within the first year. The Operations phase concludes when processing is complete.

- **Closure phase (10 years)**—accelerated flooding of the Rose Pit, re-establishment of passive surface water drainage following the pit-flooding period, recontouring and revegetating disturbed areas. Physical infrastructure that is not required during Post-closure monitoring and for other activities required to achieve the Project's decommissioning criteria and to return the Project site to a safe and stable condition will be removed.
- **Post-closure period (40 years)**—transition from Closure to Post-closure involves ongoing dam safety monitoring, water treatment and environmental monitoring to verify that water quality is achievable for passive discharge and decommissioning criteria have been met. The length of the Post-closure period could be further refined through the completion of additional analysis as part of the Feasibility Study.

The accidents and malfunctions assessment considers Project related activities, components and facilities within all Project stages, phases and periods. A total of twenty-six discrete Project related activities, components and facilities have been considered in this assessment, as follows:

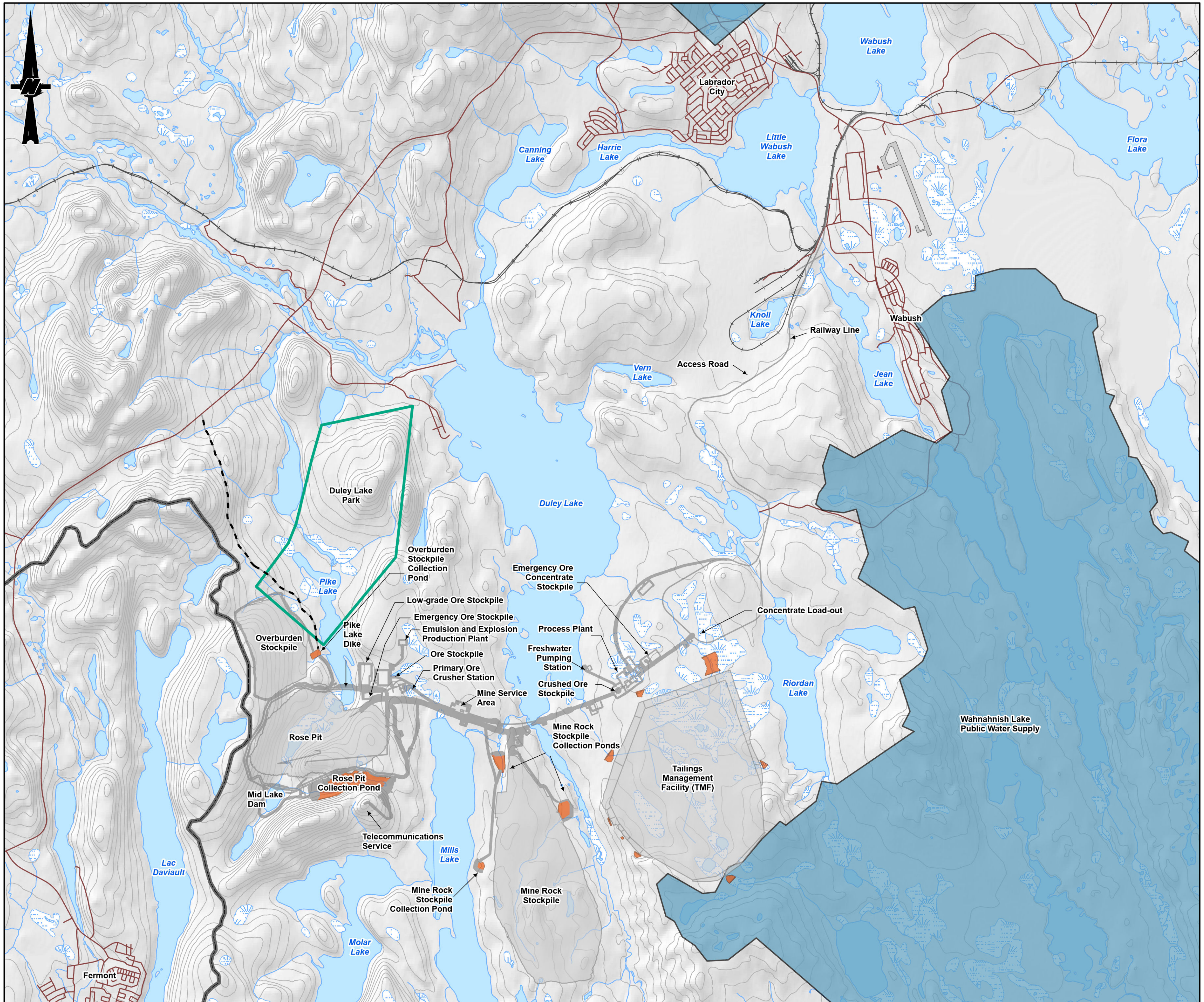
Construction Phase

- land clearing, topsoil stripping and stockpiling, overburden removal and stockpiling, and excavation and preparation of the open pit
- construction of major site infrastructure, including mine rock storage areas, TMF, water management structures, process plant, truck shop, administrative buildings, warehouses, and site access and haul roads
- temporary fuel storage installation
- installation of substations and power distribution
- construction of the rail spur and load-out facility

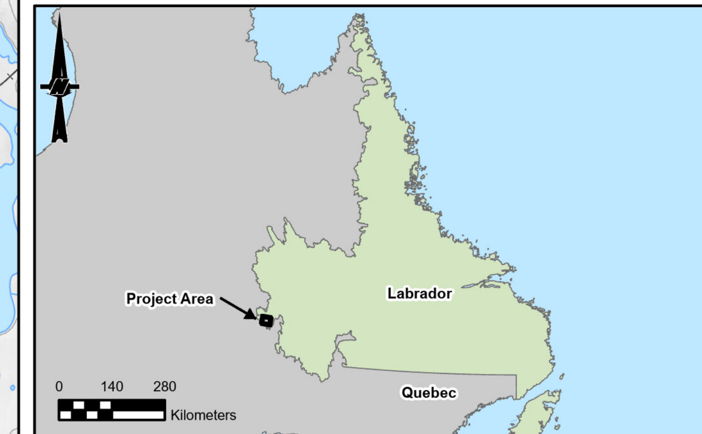
Operations Phase

- Mining
  - drilling and blasting of ore and mine rock
  - haulage of blasted material, including transport of mine rock to mine rock stockpile and loading of ore into the primary crusher
  - pit dewatering (mine water pumping systems)
  - stockpiling of mine rock
  - stockpiling of ore
- Ore processing
  - primary crushing and grinding of ore
  - magnetic separation (low-intensity magnetic separators)
  - concentrate thickening and filtration and storage
- Tailings management
  - tailings thickening
  - tailings pipeline transfer to TMF and deposition
  - TMF Pond management
- Water management
  - water management (Reclaim water recovery from TMF, Mine contact water collection and treatment, stormwater management infrastructure), and ponds
- Transportation and shipping
  - rail transport of concentrate to port
  - trucking of supplies (diesel, explosives, reagents) to site
  - emergency concentrate reclaim system
- Power Supply and Emergency Systems
  - main substation connection to provincial grid
  - on-site transformers and electrical distribution
  - emergency backup diesel generators (2.5 megawatts [MW])

A site plan providing a representation of the Project fully built out during the Operations phase in shown in Figure 18-1.



KEY MAP



SCALE 1:20,000,000

Legend

PROJECT DATA

- Proposed Project Infrastructure
- Proposed Sediment Pond
- Potential Access Road

BASEMAP INFORMATION

- Duley Lake Park
- Railway
- Watercourse
- Contour
- Bog/Wetland
- Waterbody
- Labrador/Quebec Boundary
- Public Water Supply

0 1,000 2,000 4,000

1:71,000 METRES

NOTE(S)
1. ALL LOCATIONS ARE APPROXIMATE

REFERENCE(S)
1. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENCE - NEWFOUNDLAND AND LABRADOR
2. IMAGERY CREDITS:
3. COORDINATE SYSTEM: NAD 1983 UTM ZONE 19N

CLIENT
CHAMPION IRON MINES LTD.

PROJECT
KAMI IRON ORE MINE PROJECT (KAMI PROJECT)
WABUSH, NL

TITLE
PROJECT LOCATION AND SITE LAYOUT

CONSULTANT

Kami

YYYY-MM-DD	2025-06-27
DESIGNED	----
PREPARED	GM/MS
REVIEWED	AF
APPROVED	JMC

PROJECT NO.	CONTROL	REV.	FIGURE
CA0038713.5261	0002	0	18-1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

18.5 Risk Assessment Methodology

The assessment of accidents and malfunctions employed a risk assessment approach to characterize the potential effects on the environment and public safety. Residual effects for accidents and malfunctions and transportation-related events are defined in terms of risk, which can be characterized based on the likelihood of the postulated event and the effect or severity of the potential effects on the environment and public.

The general approach for the assessment of accidents and malfunctions included the following steps:

- hazard identification
- environmental design feature and mitigation evaluation
- risk measurement, as a function of likelihood and consequence
- risk evaluation

This approach differs from that used in effects assessments completed for biophysical, cultural, and socioeconomic VECs, whereby those assessments present predictions that consider the effects from normal operating conditions and/or activities over the lifespan of the proposed Project. In contrast, the effects assessments for accidents and malfunctions present hypothetical outcomes for hazard scenarios that are not part of the normal activity or operation of a project as planned. Therefore, the potential effects on the environment and public safety from accidents and malfunctions considered to be an estimate of the residual risk to VECs and intermediate components.

An overview of the approach taken for each assessment is provided below, with the details presented in the subsections that follow. It is noted that the process by which risk is evaluated is completed with and without mitigations – that is, consequence, likelihood and risk are considered initially without mitigation measures and subsequently with mitigation measures as a means to identify where the mitigation are perceived to reduce overall risk.

For additional reference, the following is noted. The scope of the assessment encompasses all phases of the Project, including Construction, Operations, Closure, and Post-closure, and includes all major Project components such as the open pit, process plant, tailings and water management infrastructure, and site roads. Additionally, the scope of the accidents and malfunctions assessment considers incidents initiated by the Project's structures, components, systems, and activities.

Forest fires are generally considered external natural events, with causes unrelated to mine operations and beyond the control of the mine operation; these events are addressed under Chapter 19, Effects of the Environment on the Project. A postulated forest fire initiated by mine-related activity was included in the hazard screening and was deemed to have a very low probability of occurrence. In any event, the Emergency Response (Annex 5C) includes procedures for responding to such events.

A postulated train derailment and subsequent release of potentially hazardous materials was considered in the accident and malfunctions assessment. Consistent with the EIS guidelines the EIS Guidelines the focus of the assessment of the scenario was long the Project's rail spur that connects the site and QNS&L Railway, approximately 23.2 km from the Project site. While the derailment represents a potential material concern from an operational point of view, the analysis presented herein concluded that it was a low risk scenario in consideration of the unlikely nature of the event and proposed mitigations and emergency response and planning. Hazard Identification

The HI process is a systematic approach to identify possible hazards associated with key Project components and facilities and activities (see Section 18.4) in a work process. A hazard can be defined as a physical event or condition that has the potential for causing damage to people, property, or the environment (e.g., fire, explosion, release of chemicals). HI involved the consideration of the following three elements that, in combination, may present a risk to the human health and biophysical environment:

- the sources of hazard (e.g., presence of hazardous materials)
- hazardous situations (e.g., presence of ignition source)
- initiating events (e.g., natural causes, technical failure, or human error)

The outcome of this process is a comprehensive list of potential Project-related accident and malfunction scenarios for further consideration.

18.5.1 Application of Environmental Design Features and Mitigation

Where potential adverse effects on the environment or public safety were identified from a potential accident scenario, controls are considered as they are presumed to address the hazards and associated effects. Controls included feasible environmental design features and/or mitigation practices that have been implemented to avoid and minimize potential adverse effects. Relevant mitigation actions are identified for each hazard scenario and included prevention measures that would minimize the probability of the scenarios occurring, as well as control measures to mitigate the severity from an accident or malfunction or transportation scenario. These factor into the overall consideration of risk (see Section 18.5.3, Risk Measurement).

18.5.2 Risk Measurement

After identifying hazard scenarios and considering the implementation of environmental design features and/or mitigation practices, a risk measurement process was undertaken to characterize the risk associated with each scenario as a function of the likelihood and consequence.

The likelihood refers to how often a hazard scenario might occur (Table 18-2). On a scale of increasing likelihood, hazard scenarios were categorized as highly unlikely, unlikely, likely, very likely, or almost certain (Table 18-1).

Table 18-1: Likelihood Index

Rating	Likelihood	Description
1	Highly unlikely	<1 occurrence in 1,000 years
2	Unlikely	≤1 occurrence in 100 years and >1 occurrence in 1,000 years
3	Likely	≤1 occurrence in 10 years and >1 occurrence in 100 years
4	Very likely	≤1 occurrence in 1 year and >1 occurrence in 10 years
5	Almost certain	>1 occurrence in 1 year

< = less than; ≤ = less than or equal to; > = greater than.

Consequence refers to the overall magnitude or severity of the potential environmental or public health effects that may occur. The consequence index ranges from negligible to catastrophic (Table 18-2). Consequence includes the consideration of design-based mitigation, proposed management plans, and response plans.

Table 18-2: Consequence Index

Rating	Consequence	Description
1	Negligible	No measurable biophysical environmental effects, or medical treatment not required
2	Minor	Short-term (less than one month in duration) minor effect on small area, or minor first aid injuries with no lost time
3	Moderate	Reversible or repairable (i.e., less than one year in duration) effect off site, or reversible injuries with lost time
4	Major	Extended-range, long-term (i.e., between 1 and 10 years in duration) effect off site, or severe injuries with long-lasting effects and/or disability
5	Catastrophic	Long-lasting (more than 10 years) or irreversible environmental effects, fatalities, or multiple disabilities

18.5.3 Risk Evaluation

The resulting risk level (likelihood x consequence) associated with each hazard scenario was defined according to the risk matrix shown in Table 18-3. Risks were identified as being low (green), moderate (yellow), or high (red). A qualitative description of each risk level is provided in Table 18-4.

Table 18-3: Risk Matrix

Likelihood		Consequence				
		1	2	3	4	5
		Negligible	Minor	Moderate	Major	Catastrophic
5	Almost certain	Low	Moderate	Moderate	High	High
4	Very likely	Low	Low	Moderate	High	High
3	Likely	Low	Low	Moderate	Moderate	High
2	Unlikely	Low	Low	Low	Moderate	High
1	Highly unlikely	Low	Low	Low	Moderate	Moderate

Table 18-4: Risk Levels Description

Risk Level		Description
	High	High-risk scenarios have major to catastrophic consequence with the likelihood ranging from unlikely to almost certain. As the evaluation of the risk at this hazard identification stage was qualitative and subject to some uncertainty, the hazard scenarios identified as high risk were advanced for further detailed assessment so that a more detailed evaluation of risk and potential management activities could be considered.
	Moderate	Moderate-risk scenarios have minor to catastrophic consequence with the likelihood ranging from highly unlikely to almost certain. In many cases, risk-reduction activities would reduce the risk associated with these scenarios to ALARP. Under this condition, the risk may be characterized as tolerable.
	Low	Low-risk scenarios have negligible to moderate consequence with likelihood ranging from highly unlikely to almost certain. The likelihood of these scenarios can be effectively managed through application of planned controls, and/or the severity would be low in magnitude.

ALARP = as low as a reasonably practical.

The risk levels were used to distinguish those scenarios for which no further analysis was needed (that is, it was determined through the screening process that risks were low in consideration of mitigations proposed or the risks were reduced to as low as a reasonably practical (ALARP) from those that further, more detailed assessment was warranted as the risk screening process may have not adequately or fully the risk associated with the scenario (see Section 18.5.5, Identification and Re-consideration of Bounding Scenarios).

18.5.4 Identification and Re-consideration of Bounding Scenarios

Based on the results of the initial screening process undertaken to identify and screen the risk of postulated hazard scenarios (as described above), a subset of the scenarios was selected as the focus of the further, more detailed risk analysis. These hazard scenarios represented the "bounding scenarios"[1] considered in the accidents and malfunctions assessment. The assessment undertaken for each of the identified bounding scenarios was consistent with the general approach to screening. In these cases, both likelihood and consequence were re-visited and considered in a more quantitative manner as necessary to more adequately evaluate the overall risk. The assessment of the bounding scenarios documents a general description of the hypothetical event, characterization of the resulting release (e.g., contaminants, quantities), an assessment of probability (i.e., frequency of occurrence), and a description of the resulting potential effects on biophysical and human health VECs.

Based on the results of the detailed risk analysis for each bounding scenario, a revised risk evaluation that considered the results of the detailed assessment was then completed for each bounding scenario. The detailed assessment of each of the selected bounding scenarios resulted in a more in-depth, quantitative, and representative characterization of the risk associated with each scenario. Based on the detailed analysis, a revised risk rating is provided for each of the selected bounding scenarios per the risk measurement and evaluation matrices shown in Section 18.5.3 (Risk Measurement) and 16.4.4 (Risk Evaluation).

18.6 Assessment of Accidents and Malfunctions

The results of the HI process and screening process, and identification and evaluation of select bounding scenarios is provided below.

18.6.1 Hazard Scenario Identification and Initial Screening Results

As noted above, the accidents and malfunctions assessment considered Project related activities, components and facilities within all Project stages, phases and periods and shown in Section 18.4.

For each of the Project related activities, components and facilities listed in Section 18.4, the corresponding hazard screening evaluation is shown in Appendix A, Table 18A-1 through Table 18A-26. In each case, the evaluation considered the nature of the accident or malfunction (initiating event), the hazard type, potential consequence(s), existing mitigations (safeguards and design features), and the qualitative evaluation of consequence severity and likelihood (per Table 18-2 and Table 18-3) to determine the overall screening level risk (per Table 18-3 and Table 18-4).

The following malfunctions and accidents categories were identified during the HI process:

- mechanical / structural failure
- chemical spill / environmental release
- other operational malfunction
- fire / explosion
- transportation incident
- flooding / overtopping

The above accidents and malfunction may result in worker/public injury / health effects, environmental contamination, and operational damage.

A summary of the key outcomes associated with the potential accident and malfunction hazard screening evaluation is highlighted in the following bullets and depicted in Figure 18-2.

- A total of 133 hazard scenarios within the twenty-six (26) discrete nodes were identified and evaluated.
- Sixty-three of the scenarios evaluated were characterized as low-risk scenarios, based on low likelihood of occurrence and/or consequence in consideration of planned existing safeguards and design features.

[1] A bounding scenario is used to represent an event in which its potential effects are considered to represent those associated with other accident and malfunction scenarios; or, alternatively, the potential effects of scenarios that are bounded by another are expected to fit within the envelope of those associated with the bounding scenario. Utilizing the bounding scenario approach avoids duplication in the evaluation process while confirming the evaluation is completed in a conservative manner.

- Sixty-seven of the scenarios evaluated were characterized as moderate-risk scenarios. Most (43) of the moderate-risk scenarios were deemed to represent a tolerable level of risk in consideration of proposed safeguards and design features that reduce the risk level to a level considered to be ALARP. Two of the scenarios characterized as moderate risk scenarios were recommended for further detailed assessment (Scenarios 16.1 and 16.4; see Appendix 18A, Table 18A-16). Each of the moderate risk scenarios is related to the operation of the TMF Pond, including one event involving a dam breach / failure and the other involving a liner breach. These two moderate risk scenarios that were recommended for further detailed assessment are discussed further below.
- Three of the hazard scenarios were characterized as high-risk. Two of these were related to tailings management, both associated with a tailings pipeline leaks or ruptures but as the result of different initiating events (Scenarios 15.1 and 15.2; Appendix 18A, Table 18A-15). The third high risk event is associated with a spill of petroleum hydrocarbons or chemical reagents to surface water (Scenario 19.1; Appendix 18A, Table 18A-19). The three high-risk scenarios were recommended for further detailed assessment, and these are discussed further below.

A total of five of the 133 potential accident and malfunction scenarios identified and then screened were recommended for further assessment consideration. These five scenarios are discussed below in terms of the rationale for advancement (or not) to assessment as bounding scenarios.

Scenario 15.1 (Appendix 18A, Table 18A-15) involves a tailings pipeline rupture or leak during transfer of tailings from the processing facility to the TMF resulting in localized or widespread release of the tailings slurry to ground or water. This scenario is confirmed to be carried forward for further detailed evaluation as a bounding scenario (Section 18.6.2).

Scenario 15.2 (Appendix 18A, Table 18A-15) involves a pipeline blockage causing pipeline overpressure and rupture resulting in the release of the tailings slurry during transfer of tailings from the processing facility to the TMF resulting in localized or widespread release of the tailings slurry to ground or water. It is envisioned that such an event would be of similar or lesser magnitude than Scenario 15.1; therefore, Scenario 15.2 can be considered to be bounded by Scenario 15.1. Scenario 15.2 was not carried forward for further detailed evaluation as a bounding scenario.

Scenario 16.1 (Appendix 18A, Table 18A-16) involves a catastrophic dam breach at the TMF due to structural failure resulting in massive tailings and water release, potential loss of life, and environmental destruction. It is noted that this scenario is being considered under separate cover as part of a dam breach analysis assessment and is therefore not carried forward for further detailed evaluation as a bounding scenario. Nonetheless, it is noted that the Dam Safety Plan (Annex 5B) demonstrates that significant provisions have been incorporated into the design and management of the TMF to prevent such failures. The TMF is classified as "Very High" consequence under the Canadian Dam Association guidelines, triggering stringent inspection, maintenance, and dam safety review requirements. Failure modes such as structural collapse, overtopping, internal erosion, and foundation instability have been identified and paired with comprehensive mitigation strategies including strict quality assurance and quality control (QA/QC) protocols, staged construction controls, and frequent monitoring (e.g., piezometers, settlement surveys, routine inspections). While not assessed quantitatively in this assessment, the scenario is addressed from a risk-prevention standpoint through the application of recognized best practices and standards, which significantly reduce the probability of failure and support the Project's commitment to safe TMF operation.

Scenario 16.4 (Appendix 18A, Table 18A-16) involves a liner breach at the TMF due to construction defect or degradation resulting in significant seepage of contaminated water into subsurface and groundwater environments. This scenario is confirmed to be carried forward for further detailed evaluation as a bounding scenario (see Section 18.6.2).

Scenario 19.1 (Appendix 18A, Table 18A-19) involves a truck accident and rollover resulting in the spill of petroleum hydrocarbons or reagents to ground or water. This scenario is confirmed to be carried forward for further scrutiny as a bounding scenario (see Section 18.6.2).

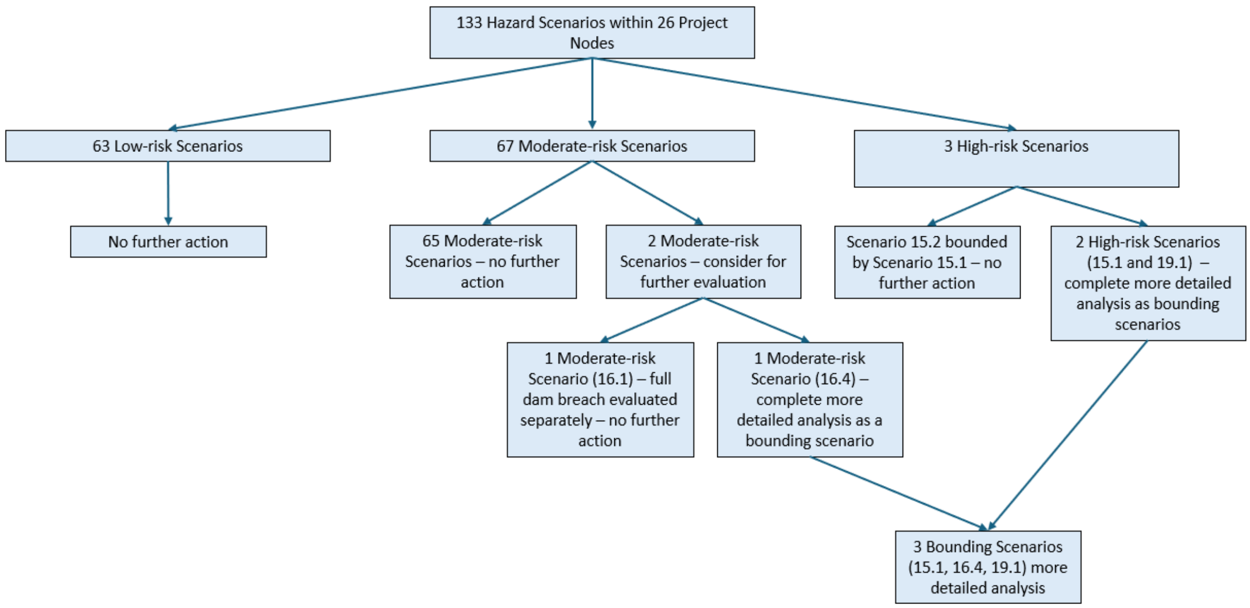


Figure 18-2: Summary of the Potential Accidents and Malfunctions Scenario Screening Evaluation

18.6.2 Mitigation Measures

To evaluate the mitigated risk levels of the identified hazard scenarios across all Project components and activities, a range of preventive and protective measures were compiled and assessed. These mitigation strategies are grounded in Project-specific engineering designs, standard operating procedures, and industry best practices. Each mitigation measure directly targets the specific failure mode or consequence pathway associated with a given hazard scenario, and includes both passive design controls (e.g., liners, containment systems, structural standards) and active operational controls (e.g., maintenance protocols, emergency response plans, communication / public safety protocols for notification, training programs). An Emergency Response Plan which describes the Project emergency response procedures is included in Annex 5C of the EIS.

Table 18-5 summarizes the key categories of mitigation applied throughout the Project and demonstrates how these measures collectively reduce the residual risk (mitigation risk) to levels that are either Tolerable or ALARP, in accordance with the risk matrix and screening framework. These measures include:

Table 18-5: Environmental Design Features and Mitigation Measures

Failure Mode / Consequence Pathway	Environmental Design Features and Mitigation Measures
Health and safety	— Implement and enforce operator training, seatbelt use, safe work procedures, terrain hazard mapping — Implement physical guarding of rotating parts, restricted access, lockout/tagout procedures, health and safety plans — Conduct remote operated equipment where feasible — Implement guarding systems, exclusion zones, and a maintenance program — Implement safe dumping procedures, berms at dumping edges, and restrict access — Implement Emergency Response Plan (Annex 5C) — Implement wildlife management and avoidance procedures, as outlined in the Environmental Protection Plan (Annex 5D)

Failure Mode / Consequence Pathway	Environmental Design Features and Mitigation Measures
Fire / explosion measures	— Conduct blast audits and controlled excavation of misfires. — Implement blast clearance procedures. — Conduct preventative equipment maintenance — Install fire extinguishers on mobile units. — Install fire detection, fire extinguishers, suppression systems and fire suppression kits on buildings and equipment — Implement fire prevention procedures — Conduct fire watch during vegetation clearing — Hot work permits — Implement Emergency Response Plan (Annex 5C)
Chemical spill / environmental release measures	— Mine rock drainage management, including blending of potentially acid generating material with non-potentially acid generation material to achieve sufficient neutralization potential — A leak detection and collection layer may be included between the liner and subgrade in high-risk zones of the TMF (not always continuous across entire TMF) — The upstream slope of the TMF starter dam will be constructed with a high-density polyethylene (HDPE) geomembrane liner — A non-woven geotextile underliner is placed beneath the liner of the TMF starter dam to protect it from puncture by subgrade materials (rocks, roots, sharp objects) — The base below the geotextile is a sand-bedding layer, providing secondary containment and minimizing leakage risk — All pond embankments use non-potentially acid generating (NPAG) compacted rockfill with a seepage collection system. — Design of TMF and other dams following Canadian Dam Association guidelines. — Design includes 1-in-100-year flood protection, with emergency spillways and freeboard to avoid overtopping that could cause liner damage — Design of emergency spillways for extreme events, including probable maximum precipitation events — Design of collection ponds for extreme events, including probable maximum precipitation events — Fuel and chemical storage include double-walled tanks, secondary containment berms and regular tank inspections. — Energy dissipation structures at effluent and sewage discharges — Implement sediment and erosion control measures, as outlined in the Erosion and Sediment Control Plan (Annex 5F) — Use HDPE pipelines with pressure monitoring and pipeline inspections — Installation of pipelines will follow strict QA/QC protocols, including seam testing (both destructive and non-destructive) and field inspections — Piezometers, sumps, and monitoring wells will be installed to detect and collect any potential leakage from the pond base or embankments — Proper design of stockpile slopes — Proper feed control and regular inspections — Proper handling procedures, personal protective equipment use, spill response training, and health and safety plan — Secondary containment for pumps with spill kits available — Implement Emergency Response Plan (Annex 5C)
Operational measures	— Implement progressive reclamation and environmental effects monitoring program — Implement automated feed control systems and operator training — Conduct TMF beach slope monitoring, staged deposition planning, periodic adjustment of spigots and discharge locations — Conduct blast design optimization, use blast mats — Complete certified erection procedures, rigging plans, and inspections — Implement controlled grading plans, geotechnical oversight

Failure Mode / Consequence Pathway	Environmental Design Features and Mitigation Measures
	— Apply exclusion zones to applicable facilities, activities and environmentally sensitive features. — Drying plans based on geotechnical assessments, controlled equipment access — Conduct an engineering assessment prior to decommissioning activities and implement controlled demolition procedures — Implement applicable management plans, including Environmental Protection Plan, Environmental Effects Monitoring Plan and Emergency Response Plan (Annex 5C)
Transportation measures	— Use certified transporters that comply with Transportation of Dangerous Goods — Implement vehicle and rail maintenance program — Conduct proper rail car loading and enforce speed restrictions Controlled rail crossings with signals and barriers, public education, emergency response plan — Coordinate with rail authorities and municipalities — The Project will incorporate vehicle safety and traffic flow considerations into the design of roads, site layout, and haul route planning — Route planning to minimize public exposure, and implement defensive driving training to applicable staff — Develop and implement Traffic Management Plan, including signage, communication, segregation of light and heavy vehicles, training and certification requirement — Implement Emergency Response Plan (Annex 5C)
Mechanical / structural failure measures	— Install automated level control systems with overflow piping to containment areas — Install a backup dosing system with alarms on dosing rates — Install backup power systems (emergency generators), uninterruptible power supplies for critical loads — Install backup pumps with regular maintenance — Use certified crane operators, with lift plans and equipment inspections

18.6.3 Identification and Evaluation of Bounding Scenarios

Based on the potential accident and malfunction scenario screening evaluation process, three potential accident and malfunction scenarios were recommended for further assessment consideration including:

- **Scenario 15.1** – tailings pipeline rupture or leak during transfer of tailings from the processing facility to the TMF resulting in localized or widespread release of the tailings slurry to ground or water
- **Scenario 16.4** – liner breach at the TMF due to construction defect or degradation resulting in significant seepage of contaminated water into subsurface and groundwater environments
- **Scenario 19.1** – truck accident and rollover resulting in the spill of petroleum hydrocarbons or reagents to ground or water

A more detailed re-evaluation of these scenarios is provided below.

18.6.3.1 Bounding Scenario 1 – Tailings Pipeline Rupture or Leak during Transfer of Tailings from the Processing Facility to the Tailings Management Facility (Scenario 15.1)

18.6.3.1.1 Scenario Description

In the event of a breach in the tailings slurry pipeline, there would a risk of soil and groundwater contamination. There would also be the potential for surface water contamination if the released materials make their way to surface water bodies.

The Project's tailings management system is designed to handle the deposition of both coarse and fine iron ore tailings as a slurry into the TMF. The Project is expected to generate approximately 16.55 million tonnes of tailings per year, with a solids content of 55% by weight. This implies that the total mass of the tailings slurry being deposited annually would be approximately 30.1 million tonnes. To convert this mass to a volumetric flow, a bulk slurry density of 1.5 tonnes per cubic metre was assumed, which is typical for tailings streams with similar solids content and mineralogy.

Based on this assumption, the total annual slurry volume would be approximately 20.07 million cubic metres per year. Dividing this volume by the number of hours in a year (8,760 hours) provides an average slurry flow rate of approximately 2,290 cubic metres per hour (m^3/h). This rate assumes continuous operation throughout the year.

Based on the estimated tailings slurry flow rate of approximately 2,290 m^3/h and assuming a design velocity of 2.0 m/s to prevent solids settling and minimize pipe wear, the required internal pipe diameter is calculated to be approximately 636 mm. Accordingly, a nominal 650 mm (26-inch) slurry pipeline would be suitable for transporting tailings to the TMF, consistent with industry standards for similar operations.

Based on site layout information in the Kami Mining Project Pre-Feasibility Study, the TMF is located south of the concentrator, with its location selected to minimize the tailings pumping distance - a conservative estimate of 1 km has been used as the pipeline corridor length. Assuming a 650 mm internal diameter pipeline, the total volume of tailings slurry contained within the full length of the pipeline would be approximately 330 cubic metres. In the event of a pipeline break, it is assumed that the entire contents of the pipeline would be released.

18.6.3.1.2 Mitigation Measures

The Project has incorporated multiple layers of mitigation during the design phase of the tailings pipeline to minimize the risk of environmental releases.

The pipeline design emphasizes QA/QC during Construction. For example, strict installation protocols will be followed, including destructive and non-destructive seam testing, field inspections, and the use of protective bedding materials to reduce the risk of mechanical damage or puncture. Routine inspections will be used to detect potential leaks early and allow for rapid intervention.

In summary the mitigations that would be employed include routine inspections, preventive maintenance, and the availability of spill containment kits and a trained response team. Pipeline routes will be inspected regularly, and operational parameters such as pressure and flow will be monitored to detect anomalies that could indicate leaks. The Project's emergency response plan will enable quick containment and cleanup of any release to prevent effects on soil, groundwater, and nearby surface water bodies.

Collectively, these controls are designed to prevent tailings-laden runoff from entering natural waterways in the event of a surface spill or pipeline breach.

18.6.3.1.3 Assessment of Potential Effects

The potential effects of the release of tailings from the pipeline would primarily affect soil and surface water in the immediate vicinity of the rupture. In summer conditions, when soils are unfrozen and permeable, the released tailings slurry may infiltrate into the upper soil layers, especially in well-drained or sandy terrain. However, the fine fraction of the tailings (silts and clays) can plug soil pores near the surface, slowing vertical percolation and forming a low-permeability seal that may confine most of the slurry near the surface. This can lead to the lateral spread of water and fines, saturating surrounding soils and potentially migrating toward surface depressions or drainage channels. If the water table is shallow, there is a risk of localized turbidity or alteration of groundwater quality, though this would be mitigated by the low mobility and low leaching potential of the tailings.

In winter, the frozen ground prevents any significant infiltration, causing the released slurry to remain at the surface and spread laterally, often following topographic lows or snow-filled depressions. While this prevents immediate subsurface contamination, it increases the risk of wider surface area coverage, particularly if the terrain is sloped or the release occurs during or near thawing conditions.

If the spill were to reach surface water, the effect would largely be physical (e.g., sedimentation and turbidity), as the iron ore concentrate is relatively chemically inert and NPAG. These effects would be localized and reversible, and wildlife or human exposure would be limited due to the remote setting and containment procedures.

The TMF is located to the south of the concentrator, with the tailings pipeline route likely following a direct corridor between these two facilities. The general area contains several surface water features that may act as potential receptors in the event of a pipeline failure, including Duley Lake. If a rupture or failure were to occur along the tailings pipeline, which contains an estimated 330 cubic metres of slurry, these water bodies could be affected, particularly if the release occurs near a drainage pathway, culvert, or uncontained slope.

The tailings slurry, composed of approximately 55% solids, could introduce suspended solids, heavy metals, and changes in pH to receiving waters, thereby posing risks to aquatic ecosystems and downstream water quality. While the design of the TMF and pipeline routing aims to minimize these risks, secondary containment systems, leak detection mechanisms, and emergency spill response protocols are critical to prevent or mitigate such effects.

Considering the Project's planned mitigation measures, the consequence rating for this scenario is assessed as Moderate (rating score of 3).

18.6.3.1.4 Assessment of Likelihood

The piping system would be designed and constructed in compliance with standards such as ASTM F714, PE pipe for sewer and industrial applications, ISO 4437 / ISO 4427, International standards for PE piping. The entire system would be regularly inspected and tested for defects. A maintenance program would be in place to confirm the mechanical integrity of the process components.

According to the Center for Chemical Process Safety of the American Institute of Chemical Engineers (AIChE 1989), the probability of a full-bore failure of a piping system similar to that of the Project is approximately 1x10-04 per year per piping segment. Assuming 10 tailings pipe segment, the probability of full-bore rupture of the tailings pipe will be 1x10-3 per year (1 in 1,000 years). This probability is rated as Highly Unlikely (rating score of 1).

18.6.3.1.5 Overall Risk Characterization

Given a consequence rating of Moderate (3) and an Unlikely likelihood, the overall risk associated with the more detailed analysis of Scenario 15.1, tailings pipeline rupture or leak during transfer of tailings from the processing facility to the TMF, is classified as Low according to the risk matrix. This rating indicates that the risk associated with tailings pipeline rupture or leak is tolerable and would be expected to be effectively managed through planned engineering controls and operational oversight.

The more detailed evaluation has resulted in a reduction of the risk profile as initially estimated in the screening evaluation from High to Low based on both lower ratings of consequence (catastrophic to moderate) and likelihood (unlikely to highly unlikely).

18.6.3.2 Bounding Scenario 2 – Liner Breach at the Tailings Management Facility TMF (Scenario 16.4)

18.6.3.2.1 Scenario Description

Based on the current TMF design, an HDPE geomembrane liner system with seepage control will be installed along the upstream slope of the Stage 1 starter dam. This configuration aligns with best-practice containment approaches in modern tailings storage facility design, where the liner serves as a near-impermeable barrier and the underlying sand bedding layer acts as a secondary containment to attenuate leakage through any liner defects. The details of the liner design and specifications will be further refined during future design stages. One of the potential mechanisms for contaminant release is the migration of solutes through localized flaws in this engineered barrier system. While this liner system is not extended in subsequent dam raises, the starter dam liner is designed to significantly reduce solute migration and seepage during early operational stages, with later containment relying on compacted tailings and natural foundation conditions for continued seepage control.

A leak in the TMF liner has the potential to result in localized seepage of tailings porewater into the underlying subgrade and, potentially, into the shallow groundwater system.

18.6.3.2.2 Mitigation Measures

The Project has incorporated several layered engineering and operational safeguards into the design of the TMF to manage the environmental risks associated with a potential liner leak. The facility is engineered in accordance with best industry practices to enable robust containment and early detection of any loss of integrity in the liner system.

As noted above, a geomembrane liner system with seepage control would be installed along the upstream slope of the Stage 1 starter dam. This configuration aligns with best-practice containment approaches in modern tailings storage facility design, where the liner serves as a near-impermeable barrier and the underlying sand bedding layer acts as a secondary containment to attenuate leakage through any geomembrane defects. To protect the liner from mechanical damage, a non-woven geotextile underliner is used to shield it from puncture by rocks or sharp objects during Construction. This dual-barrier approach significantly reduces the potential for vertical seepage into the subsurface.

Surrounding the TMF, seepage control infrastructure plays a critical role in managing potential liner failures. This includes downstream seepage collection ditches, sumps, and graded filters, all designed to intercept and capture any water escaping the impoundment and return it to the system for treatment or reuse. The outer embankments are constructed from NPAG compacted rockfill, ensuring chemical stability and preventing acid drainage even in the event of seepage contact.

To detect and monitor leakage, the Project includes installation of piezometers, sumps, and groundwater monitoring wells around the TMF footprint. These instruments will provide real-time data to identify any rising trends in seepage volumes or changes in groundwater quality, thereby enabling early intervention.

During the Operations phase, the Project will implement a comprehensive monitoring program, as described in the mitigation summary. This includes regular inspections, maintenance of liner integrity, seam testing during Construction, and emergency response procedures in the event of suspected leakage.

In combination, these engineering controls and monitoring strategies reflect a proactive, risk-based approach to tailings facility design that prioritizes both environmental protection and long-term performance reliability.

18.6.3.2.3 Assessment of Potential Effects

A leak in the TMF liner has the potential to result in localized seepage of tailings porewater into the underlying subgrade and, potentially, into the shallow groundwater system. The consequence of such a failure depends on several factors, including the volume and duration of the leak, hydrogeological conditions, tailings geochemistry, and proximity to sensitive receptors such as surface water bodies or groundwater wells.

Given all design and operational mitigation measures are in place, and considering the inert nature of the tailings, the consequence of a liner leak from the TMF at the Project is considered Minor (rating score 2) in severity. A leak would result in the slow release of tailings porewater into the underlying subgrade and potentially into shallow groundwater. While the tailings are chemically benign, classified as non-acid generating with low metal leaching potential, the physical presence of seepage could lead to localized changes in soil moisture regimes, increased turbidity in groundwater, or migration of fine solids.

If the seepage were to reach a shallow aquifer or natural drainage feature, the resulting effects would be limited in geographic scope and reversible within a timeframe of less than one year, particularly with timely detection and response. Any measurable environmental effects would likely be confined to the immediate vicinity of the TMF and would not pose a widespread risk to surface water bodies or ecological receptors. Consequently, in accordance with the Project’s risk matrix, the consequence rating is assigned as Moderate (rating score 3), reflecting a scenario with off-site but reversible environmental effects that can be addressed through corrective action without resulting in long-term or irreversible damage.

18.6.3.2.4 Assessment of Likelihood

For well-designed and maintained liner systems in stable and controlled environments, the annual probability of liner failure can be very low, possibly in the range of $1x10^{-2}$ (1 in 100) or even lower (1 in 1,000 years) which is rated as Unlikely (rating score 2).

18.6.3.2.5 Overall Risk Characterization

Given a consequence rating of Minor to Moderate and a likelihood rating of Unlikely, the overall risk associated with the more detailed analysis of Scenario 16.4, Liner breach at the TMF, is classified as Low per the risk matrix. This rating indicates that the risk associated with the Liner breach at the TMF is tolerable and would be expected to be effectively managed through planned engineering controls and operational oversight. The more detailed evaluation of this scenario does not affect the overall risk rating which is given as Low.

18.6.3.3 Bounding Scenario 3 – Spill of Petroleum Hydrocarbons or Reagents to Ground or Water (Scenario 19.1)

18.6.3.3.1 Scenario Description

A transportation accident along the Project’s access road or rail spur that connect the site and QNS&L Railway could result in the release of hazardous materials to the ground, surface water, and/or the atmosphere. This includes the potential for soil contamination and subsequent groundwater effects, and releases to nearby surface water bodies along the transportation routes.

The Project's transportation needs during Operations are centred around the shipment of iron ore concentrate by rail and the delivery of diesel fuel and processing reagents by truck. The Project will produce approximately 8.6 million wet metric tonnes (wmt) of iron ore concentrate annually. This concentrate will be transported via a newly constructed 23.2 km rail spur that connects to the QNS&L Railway.

To estimate the volume of train traffic, it is assumed that each train consists of approximately 240 railcars, with each car capable of carrying 100 tonnes of ore. This configuration results in a total train capacity of 24,000 tonnes per shipment. Using these assumptions, an estimated 375 trains per year would be required to handle the total concentrate production, translating to approximately one train per day under continuous operations.

In addition to concentrate shipments, diesel fuel is delivered by truck from Wabush to support the mining fleet and on-site operations. A conservative estimate of 50 million litres per year was applied, which equates to the current peak fuel consumption estimate (Chapter 2, Project Description). Assuming a standard highway fuel tanker has a capacity of 40,000 litres, the Project would require approximately 1,250 truck deliveries per year, or about 3 to 4 trucks per day.

The transportation of processing reagents, including caustic soda, diamine collector, dextrin, and flocculants, is also by truck. Based on reagent consumption rates typical of similar flotation circuits, the total annual reagent volume is estimated at 7,000 tonnes. With an assumed truck capacity of 25 tonnes per load, approximately 280 truck deliveries per year would be needed, corresponding to less than one truck per day.

18.6.3.3.2 Mitigation Measures

The Project has incorporated several risk mitigation measures during the design phase to address potential hazards associated with the transportation of diesel fuel, chemical reagents, and iron ore concentrate. These measures align with best industry practices and regulatory standards, particularly those related to the TDG Regulations (Transport Canada 2023). All transportation-related infrastructure is planned to meet relevant design standards, including the development of roads and the establishment of controlled rail crossings with signals and barriers to enhance safety for both site personnel and the public.

During the Construction and Operations phases, the Project will incorporate vehicle safety and traffic flow considerations into the design of roads, site layout, and haul route planning. This plan includes measures such as segregation of light and heavy vehicle traffic, clearly marked signage, radio communication protocols, and driver competency certification requirements. Transport operators will receive defensive driving training, and a robust emergency response plan will be in place to address potential incidents such as vehicle collisions or material spills.

To further protect the environment, especially soil and surface water resources, the Project includes provisions for spill prevention and response, including the use of certified carriers, containment systems, and adherence to standard spill response procedures. Reagent and fuel handling will follow rigorous safety protocols, including the use of personal protective equipment, routine inspections, and immediate cleanup procedures in the event of an accidental release.

In addition, wildlife would be deterred from spill sites using temporary fencing or deterrents during cleanup.

These layered controls demonstrate the Project's commitment to minimizing environmental effects and protecting worker and public safety through a combination of engineering design features, operational safeguards, and regulatory compliance, consistent with the mitigation strategies outlined in the Project documentation.

18.6.3.3.3 Assessment of Potential Effects

The transportation of diesel fuel, chemical reagents, and iron ore concentrate poses several environmental risks in the event of a release, particularly during truck accidents or train derailments. Typical release volumes could include a truckload of diesel fuel (~40,000 L) or reagents (~25 tonnes), or several train cars of iron ore concentrate (~24,000 tonnes per train). The following paragraphs describe the potential effects to surface soil, groundwater, and surface water:

1. Effects on Soil and Shallow Groundwater (Summer Conditions)

During the summer, when the ground is unfrozen and permeable, a spill of liquid fuel or chemical reagents could infiltrate the soil, leading to localized soil contamination and the potential for shallow groundwater effects. Diesel fuel, depending on the volume and soil texture, can percolate several metres into the unsaturated zone, posing a risk of contaminating shallow aquifers, especially in coarse, well-drained soils. Water-soluble reagents such as caustic soda ($NaOH$) or flocculants can also move vertically into the soil profile, potentially altering soil pH, affecting microbial activity, and mobilizing other contaminants. Contaminated soil may require excavation or in situ treatment to meet regulatory cleanup standards (e.g., Canadian Council of Ministers of the Environment guidelines [CCME 2007]).

Despite these risks, the Project has adopted mitigation strategies including trained personnel, certified TDG-compliant carriers, and availability of spill response kits. Spill response would include containment berms, removal of contaminated soil, and validation against pre-determined risk-based cleanup criteria.

Given the above, the consequence rating for a summer event of Minor (rating score 2) is indicated, due to reversible environmental effects with proper emergency response.

2. Effects on Soil in Winter (Frozen Ground Conditions)

In contrast, during winter months, the frozen ground acts as a temporary barrier to vertical infiltration, resulting in the spilled materials pooling or spreading horizontally across the surface. This can limit initial percolation into the soil and groundwater but increases the potential for surface runoff. Spilled fuel or reagents can be more effectively contained and recovered in these conditions if response is immediate.

With rapid response and winter-specific containment measures, such as snow bunds or sorbent barriers, environmental effect is minimal.

Given the above a consequence rating for a winter event is provided as Minor (rating score 2), due to short-term, localized effects with high containment potential.

3. Potential Effects on Surface Water and Wildlife

If a spill reaches surface water bodies such as Duley Lake or Pike Lake or nearby tributaries, the environmental effects depend on the pollutant type and site conditions. For example:

- **Diesel fuel**—Forms a sheen on water, potentially toxic to fish and aquatic invertebrates. Effects are usually transient if contained quickly.
- **Caustic soda**—Rapidly alters water pH, which can be lethal to aquatic life at high concentrations. Effect is typically short term with sufficient dilution.
- **Flocculants/coagulants**—Can cause turbidity and physical gill irritation in aquatic organisms; toxicity depends on dose.
- **Iron ore concentrate**—Physically smothers benthic habitats and reduces light penetration but is chemically stable and non-toxic.

Given that spills are expected to be localized and managed with immediate response, ecological effects would be short term and unlikely to affect biological populations beyond the immediate area.

Given the above a consequence rating for this event is provided as Minor to Moderate (rating score 2 to 3) depending on the chemical and containment efficiency.

4. Potential Effects on Human Receptors

The Project site is situated entirely in Labrador, approximately 7 km southwest of the Town of Wabush, 10 km southwest of Labrador City, and 5 km northeast of the Town of Fermont, Québec. Duley Lake, located approximately 5 km north of the site and downstream in the regional drainage network, is a popular recreational area with numerous cabins and seasonal activities. While it is acknowledged that Duley Lake forms part of a connected watershed extending to Wabush Lake, the likelihood of a diesel or reagent spill (limited in volume to a single truck or rail car load) reaching the lake is considered very low due to the distance, containment capacity of roadside ditches and terrain, and the rapid implementation of spill response measures. Nonetheless, as a precaution, spill prevention and emergency response protocols would include specific measures for spill containment. In the unlikely event of a spill near a recreational area, prompt containment, signage, temporary access restrictions, and clean-up would be implemented to prevent public exposure and minimize environmental risk.

Given the above a consequence rating for this event is provided as Negligible to Minor (rating score 1 to 2), due to the remote location and robust emergency planning.

18.6.3.3.4 Assessment of Likelihood

Using the Canada-wide commercial vehicle collision rate of 0.74 collisions per million vehicle-kilometres travelled,[2] which includes all reportable incidents, the estimated accident frequency for the Project's access road is approximately 0.021 collisions per year, or one collision every 48 years, based on 1,530 truck trips per year over an 18.5 km access road. However, not all collisions result in a release of transported material; many minor collisions involve only cosmetic or structural vehicle damage without compromising tanks or containers.

Based on conservative industry estimates and spill data, it is reasonable to assume that approximately 10% of truck collisions involving hazardous materials result in a release. Applying this factor, the estimated release frequency becomes 0.0021 releases/year. This equates to one release every ~476 years, corresponding to a likelihood rating of Unlikely (rating score 2) in the Project's risk matrix.

2 https://tc.canada.ca/en/road-transportation/statistics-data/commercial-vehicle-collisions-canada-2012-2021

18.6.3.3.5 Overall Risk Characterization

Given a consequence rating of Negligible to Moderate and a likelihood rating of Unlikely, the overall risk associated with the more detailed analysis of Scenario 19.1, spill of petroleum hydrocarbons or reagents to ground or water (during transportation), is classified as Low per the risk matrix, due to the potential for localized, short-term environmental effects on soil and surface water, which are manageable through rapid containment and cleanup.

The more detailed evaluation has resulted in a reduction of the risk profile as initially estimated in the screening evaluation from High to Low. The consequence rating was revised from catastrophic to negligible to moderate. The likelihood rating was unchanged as unlikely.

18.6.4 Summary

Table 18-6 summarizes the results of the bounding scenario assessment that re-classified the overall risk for the three bounding scenarios identified through the initial hazard scenario screening process. All three bounding scenarios have been re-classified into the Low-Risk category, reflecting the effectiveness of planned engineering design and operational mitigation measures.

Table 18-6: Summary of the Bounding Scenario Assessment

Scenario	Likelihood	Consequence	Risk Rating
Bounding Scenario 1 (ID 15.1) – Tailings pipeline rupture or leak	Highly Unlikely (rating score 1)	Moderate (rating score 3)	Low
Bounding Scenario 2 (ID 16.4) - Liner breach at the TMF	Unlikely (rating score 2)	Minor (rating score 2)	Low
Bounding Scenario 3 (ID 19.1) - Spill of petroleum hydrocarbons or reagents to ground or water (During transportation)	Unlikely (rating score 2)	Minor to Moderate consequence (rating score 2 to 3)	Low

TMF = tailings management facility.

18.7 Key Findings and Conclusions

This accidents and malfunctions assessment considered a range of plausible scenarios, outside the norms of day-to-day operations of the Kami Mining Project, that could result in effects on the environment and public safety. These scenarios were evaluated with respect to consequence and likelihood within the context of consideration of environmental design features and mitigation measures to quantify the overall risk profile for each scenario.

A total of 133 potentially hazardous situations were identified and subsequently assessed in an initial hazard screening process. Of these, three bounding scenarios were carried forward for more detailed analysis and risk evaluation.

Overall, based on the initial hazard scenario screening process and the more detailed consideration of three identified bounding scenarios, it is anticipated that potential risks associated with accidents and malfunctions could largely be addressed through engineering design, and compliance with industry best practices that reduce risks associated with hazard scenarios to ALARP. Under this condition, the risks may be characterized as tolerable.

The previous assessment in the Alderon EIS (2012) focused on four primary scenarios: a train derailment, a forest fire, a polishing pond dam failure, and a chemical release at the port facility; in contrast, the current assessment followed a structured HI risk-based methodology that considered a range of potential accident and malfunction scenarios over all Project activities for the entire mine life. Two of the scenarios evaluated in 2012 were also evaluated in the current assessment, including a train derailment and a forest fire scenario; though the evaluation methodologies between the assessments was different both studies considered the two scenarios to be associated with overall low risk. The polishing pond dam failure previously evaluated was not relevant to the current assessment since the pond is not part of the current Project design. The chemical release at the port facility was not considered herein, as the scenario occurrence was outside the scope of the EIS.

Appendix 18A: Accident and Malfunction Assessment Hazard Identification and Initial Screening Tables

The following tables represent the preliminary hazard screening evaluation for postulated accident and malfunction scenarios. The scenarios have been developed per and consistent with the Project-related information provided in Section 18.4 and the assessment methodology described in Section 18.5.

Table 18A-1: Preliminary Hazard Screening - Site Preparation and Construction - Land Clearing, Topsoil Stripping and Stockpiling, Overburden Removal and Stockpiling, and Excavation and Preparation of the Open Pit

Hazard Number	Project Component / Activity	Potential Accident or Malfunction	Hazard Type	Consequence	Mitigations	Mitigated Consequence Category	Mitigated Likelihood Category	Mitigated Risk Rating	Screening Decision
1.1	Land clearing and topsoil stripping	Equipment roll-over causing serious injury or fatality	Mechanical	Serious injury or fatality of workers	Operator training, seatbelt use, safe work procedures, terrain hazard mapping	Major	Highly unlikely	Moderate	Mitigated risk is tolerable with standard controls; no further action required.
1.2	Land clearing and topsoil stripping	Fire due to vegetation ignition from equipment	Fire	Localized fire affecting vegetation	Fire watch during clearing, fire suppression kits on equipment, emergency response plan	Moderate	Unlikely	Low	Mitigated risk is tolerable; no further action required.
1.3	Land clearing	Wildlife encounters leading to injury	Environmental / Wildlife	Injury due to animal encounter	Wildlife management, avoidance procedures, bear spray training	Moderate	Highly unlikely	Low	Mitigated risk is tolerable; no further action required.
1.4	Topsoil and overburden stockpiling	Slope instability leading to worker injury or sediment release	Geotechnical	Worker injury or environmental sedimentation	Proper design of stockpile slopes, erosion control measures, exclusion zones	Major	Unlikely	Moderate	Mitigated risk is ALARP; no further action required.
1.5	Excavation and pit preparation	Blasting accidents causing injuries or flyrock incidents	Explosive	Severe injury or damage from blast	Licensed blasting contractors, exclusion zones, blast design controls, pre-blast clearance	Major	Highly unlikely	Moderate	Mitigated risk is ALARP; no further investigation required.
1.6	Excavation and pit preparation	Traffic accident involving heavy equipment	Traffic / Mechanical	Severe injury or fatality from equipment collision	Traffic management plan, designated haul routes, signage, driver competency certification	Major	Unlikely	Moderate	Residual risk is ALARP; no further investigation needed. Traffic-related fatalities with mitigation are common ALARP outcomes.
1.7	Excavation and pit preparation	Fuel or lubricant spill leading to soil/water contamination	Chemical Spill	Contamination of soil or water	Spill kits, secondary containment, emergency response procedures	Minor	Unlikely	Low	Mitigated risk is tolerable; no further action required.
1.8	Site preparation (general)	Worker injuries due to slips, trips, and falls	Occupational Safety	Minor injuries to workers	Good housekeeping, proper footwear, safety inspections	Minor	Likely	Low	Mitigated risk is tolerable; no further action required.

ALARP = as low as a reasonably practical.

Table 18A-2: Preliminary Hazard Screening – Site Preparation and Construction - Construction of Major Site Infrastructure, including Mine Rock Storage Areas, Tailings Management Facility, Water Management Structures, Process Plant, Truck Shop, Administrative Buildings, Warehouses, and Site Access and Haul Roads

Hazard Number	Project Component / Activity	Potential Accident or Malfunction	Hazard Type	Consequence	Mitigations	Mitigated Consequence Category	Mitigated Likelihood Category	Mitigated Risk Rating	Screening Decision
2.1	Construction of major site infrastructure	Heavy equipment rollover during MRS, TMF, or road construction	Mechanical	Worker injury or fatality due to equipment rollover	Operator training, seatbelts, site-specific safe work procedures, terrain hazard mapping	Major	Highly unlikely	Moderate	Mitigated risk is tolerable with standard controls; no further action required.
2.2	Construction of major site infrastructure	Slope failure during MRS or TMF construction	Geotechnical	Worker injury and environmental release (sediment/water effect)	Engineering designs, staged construction, slope monitoring, exclusion zones	Major	Unlikely	Moderate	Mitigated risk is ALARP; no further action required.
2.3	Construction of water management structures	Failure of temporary stormwater ponds or ditches during construction	Hydrological / Environmental	Localized flooding, sediment transport to watercourses	Proper pond sizing, staged diversion ditch construction, regular inspections	Minor	Unlikely	Low	Mitigated risk is tolerable; no further action required.
2.4	Construction of process plant and facilities	Structural collapse during steel erection (warehouse, admin buildings, process plant)	Structural	Worker injury or fatality	Certified erection procedures, rigging plans, inspections, exclusion zones	Major	Highly unlikely	Moderate	Mitigated risk is tolerable with mitigation measures implemented; no further action required.
2.5	Construction of truck shop and process plant	Crane failure or dropped load	Mechanical / Lifting	Worker injury, fatality, or equipment damage	Certified crane operators, lift plans, equipment inspections	Major	Highly unlikely	Moderate	Mitigated risk is tolerable with mitigation measures implemented; no further action required.
2.6	General construction activities	Fuel or hydraulic fluid spills during equipment fuelling or maintenance	Chemical Spill	Localized soil and water contamination	Spill kits, secondary containment, spill response plans, trained personnel	Minor	Unlikely	Low	Mitigated risk is tolerable; no further action required.
2.7	Construction of buildings	Fire during hot work (welding, cutting) operations	Fire	Localized fire; worker injury or structural damage	Hot work permits, fire watch personnel, availability of extinguishers	Minor	Unlikely	Low	Mitigated risk is tolerable; no further action required.
2.8	Site-wide construction	Worker injuries due to slips, trips, and falls	Occupational Safety	Minor injuries requiring first aid or medical treatment	Good housekeeping, clear pathways, proper footwear, site safety inspections	Minor	Likely	Low	Mitigated risk is tolerable; no further action required.
2.9	General construction	Traffic collisions within construction zones (light vehicles and heavy equipment)	Traffic / Mechanical	Worker injury or fatality	Traffic management plan, segregation of light and heavy vehicles, signage, training	Major	Unlikely	Moderate	Residual risk is ALARP; no further investigation needed.

ALARP = as low as a reasonably practical; TMF = tailings management facility; MRS = mine rock stockpile.

Table 18A-3: Preliminary Hazard Screening - Site Preparation and Construction - Temporary Fuel Storage Installation

Hazard Number	Project Component / Activity	Potential Accident or Malfunction	Hazard Type	Consequence	Mitigations	Mitigated Consequence Category	Mitigated Likelihood Category	Mitigated Risk Rating	Screening Decision
3.1	Temporary fuel storage installation	Fuel tank leak or rupture	Chemical Spill	Soil and groundwater contamination	Double-walled tanks, secondary containment berms, regular tank inspections	Major	Highly unlikely	Moderate	Mitigated risk is tolerable; no further action required.
3.2	Temporary fuel storage installation	Fire or explosion at temporary fuel storage area	Fire / Explosion	Worker injury/fatality and environmental damage	No smoking zones, grounding and bonding during fuel transfer, emergency response plans	Major	Highly unlikely	Moderate	Mitigated risk is tolerable as ALARP; no further detailed assessment required.
3.3	Temporary fuel storage installation	Small spills during fuel transfer (truck unloading)	Chemical Spill	Localized soil contamination	Spill kits available, drip trays during transfers, trained personnel	Minor	Unlikely	Low	Mitigated risk is tolerable; no further action required.
3.4	Temporary fuel storage installation	Overfill during fuel truck delivery	Operational Error	Spill causing localized soil or stormwater contamination	Level sensors, overfill alarms, attended transfers	Minor	Unlikely	Low	Mitigated risk is tolerable; no further action required.

ALARP = as low as a reasonably practical.

Table 18A-4: Preliminary Hazard Screening - Site Preparation and Construction - Installation of Substations and Power Distribution

Hazard Number	Project Component / Activity	Potential Accident or Malfunction	Hazard Type	Consequence	Mitigations	Mitigated Consequence Category	Mitigated Likelihood Category	Mitigated Risk Rating	Screening Decision
4.1	Installation of substations and power distribution	Electrical shock during installation	Electrical Hazard	Serious injury or fatality of workers	Lockout/tagout procedures, insulated tools, certified electricians	Major	Unlikely	Moderate	Mitigated risk is ALARP; no further action required.
4.2	Installation of substations and power distribution	Arc flash event during substation energization	Electrical Explosion	Severe injury or fatality, equipment damage	Arc flash PPE, restricted access during energization, proper commissioning procedures	Major	Highly unlikely	Moderate	Mitigated risk is ALARP; no further detailed assessment required.
4.3	Installation of substations and power distribution	Transformer oil spill during installation	Chemical Spill	Localized soil or water contamination	Use of drip trays, secondary containment for transformers, emergency response plans	Minor	Highly unlikely	Low	Mitigated risk is tolerable; no further action required.
4.4	Installation of substations and power distribution	Structural failure of transformer platform during installation	Structural	Worker injury and equipment damage	Engineering design checks, load testing, inspection before energization	Major	Highly unlikely	Moderate	Mitigated risk is tolerable with standard controls; no further action required.
4.5	Installation of substations and power distribution	Fire during cable installation (hot work)	Fire	Localized fire and smoke hazard to workers	Hot work permits, fire watch personnel, fire extinguishers on site	Minor	Unlikely	Low	Mitigated risk is tolerable; no further action required.

PPE = personal protective equipment.

Table 18A-5: Preliminary Hazard Screening - Site Preparation and Construction - Construction of the Rail Spur and Load-Out Facility

Hazard Number	Project Component / Activity	Potential Accident or Malfunction	Hazard Type	Consequence	Mitigations	Mitigated Consequence Category	Mitigated Likelihood Category	Mitigated Risk Rating	Screening Decision
5.1	Construction of the rail spur and load-out facility	Heavy equipment rollover during railbed grading	Mechanical	Worker injury or fatality due to equipment overturning	Operator training, seatbelts, safe work procedures, terrain hazard mapping	Major	Highly unlikely	Moderate	Mitigated risk is tolerable with standard controls; no further action required.
5.2	Construction of the rail spur and load-out facility	Train collision with construction equipment	Traffic / Collision	Worker fatality or serious injury	Coordination with rail authorities, track possession during construction, flagging and spotters	Major	Highly unlikely	Moderate	Mitigated risk is ALARP; no further detailed assessment required.
5.3	Construction of the rail spur and load-out facility	Ground disturbance causing sedimentation into nearby watercourses	Environmental	Sediment release affecting aquatic habitats	Erosion and sediment control plans, silt fences, buffer zones near water bodies	Minor	Unlikely	Low	Mitigated risk is tolerable; no further action required.
5.4	Construction of the rail spur and load-out facility	Fuel spill from construction equipment	Chemical Spill	Localized soil and possible water contamination	Use of spill kits, secondary containment, fuelling procedures in place	Minor	Unlikely	Low	Mitigated risk is tolerable; no further action required.

ALARP = as low as a reasonably practical.

Table 18A-6: Preliminary Hazard Screening - Mining Activities - Drilling and Blasting of Ore and Mine Rock

Hazard Number	Project Component / Activity	Potential Accident or Malfunction	Hazard Type	Consequence	Mitigations	Mitigated Consequence Category	Mitigated Likelihood Category	Mitigated Risk Rating	Screening Decision
6.1	Drilling and blasting of ore and mine rock	Flyrock affecting personnel or equipment outside blast exclusion zone	Explosive / Projectile	Severe injury or fatality, equipment damage	Blast design optimization, blast mats, exclusion zones, emergency response plan	Major	Highly unlikely	Moderate	Mitigated risk is ALARP; no further detailed assessment required.
6.2	Drilling and blasting of ore and mine rock	Misfire or undetonated explosive remaining in muckpile	Explosive	Potential detonation hazard during excavation	Blast audit, blast clearance procedures, controlled excavation of misfires, emergency response plan	Major	Highly unlikely	Moderate	Mitigated risk is ALARP; no further detailed assessment required.
6.3	Drilling and blasting of ore and mine rock	Drill rig overturn due to unstable ground	Mechanical / Geotechnical	Worker injury or fatality	Ground condition assessment, drill rig stability controls, terrain hazard mapping	Major	Highly unlikely	Moderate	Mitigated risk is tolerable with standard controls; no further action required.
6.4	Drilling and blasting of ore and mine rock	Spill of fuel or oils from drilling equipment	Chemical Spill	Soil and water contamination	Spill kits, fuelling procedures, spill response plan, health and safety plan	Minor	Unlikely	Low	Mitigated risk is tolerable; no further action required.
6.5	Explosives permanent magazine storage	Fire or explosion at explosives magazine	Fire / Explosion	Worker fatalities and environmental effect	Magazine design to NRCan standards, restricted access, emergency response plan	Major	Highly unlikely	Moderate	Mitigated risk is ALARP; no further detailed assessment required.

ALARP = as low as a reasonably practical.

Table 18A-7: Preliminary Hazard Screening - Hazard Identification Evaluation – Haulage of Blasted Material, including Transport of Mine Rock to Mine Rock Stockpile and Loading of Ore into the Primary Crusher

Hazard Number	Project Component / Activity	Potential Accident or Malfunction	Hazard Type	Consequence	Mitigations	Mitigated Consequence Category	Mitigated Likelihood Category	Mitigated Risk Rating	Screening Decision
7.1	Haulage of blasted material	Truck collision or rollover during haulage to MRSs or crusher	Traffic / Mechanical	Worker fatality or serious injury	Traffic management plan, haul road design to standards, vehicle maintenance program, driver training, emergency response plan	Major	Unlikely	Moderate	Residual risk is ALARP; no further detailed assessment required.
7.2	Haulage of blasted material	Fuel spill from haul trucks during operation	Chemical Spill	Localized soil contamination and water quality effect	Spill kits in trucks, maintenance to avoid leaks, spill response plan, health and safety plan	Minor	Unlikely	Low	Mitigated risk is tolerable; no further action required.
7.3	Loading of ore into primary crusher	Mechanical failure of crusher during loading leading to worker exposure	Mechanical	Worker injury from flying debris or entrapment	Remote operated equipment, guarding systems, exclusion zones, maintenance program	Major	Highly unlikely	Moderate	Mitigated risk is tolerable with standard controls; no further action required.

ALARP = as low as a reasonably practical; MRS = mine rock stockpile.

Table 18A-8: Preliminary Hazard Screening - Mining Activities - Pit Dewatering (mine water pumping systems)

Hazard Number	Project Component / Activity	Potential Accident or Malfunction	Hazard Type	Consequence	Mitigations	Mitigated Consequence Category	Mitigated Likelihood Category	Mitigated Risk Rating	Screening Decision
8.1	Pit dewatering (mine water pumping systems)	Pump failure leading to uncontrolled pit flooding	Mechanical / Operational	Work disruption, access hazard, potential pit wall instability	Redundant pump systems, regular pump maintenance, water level monitoring, emergency response plan	Minor	Highly unlikely	Low	Mitigated risk is tolerable; no further action required.
8.2	Pit dewatering (mine water pumping systems)	Fuel or oil spill from diesel-powered pumps	Chemical Spill	Localized soil and water contamination	Secondary containment for pumps, spill kits available, spill response plan, health and safety plan	Minor	Unlikely	Low	Mitigated risk is tolerable; no further action required.
8.3	Pit dewatering (mine water pumping systems)	Electrical shock during pump maintenance	Electrical Hazard	Worker injury or fatality	Lockout/tagout procedures, maintenance by qualified personnel, PPE usage	Major	Highly unlikely	Moderate	Mitigated risk is tolerable with mitigation measures implemented; no further action required.
8.4	Pit dewatering (mine water pumping systems)	Erosion at discharge point causing sediment release	Environmental	Downstream water quality degradation	Energy dissipation structures at discharge, sediment control measures (e.g., silt fences, sediment ponds)	Minor	Unlikely	Low	Mitigated risk is tolerable; no further action required.

PPE = personal protective equipment.

Table 18A-9: Preliminary Hazard Screening – Mining Activities - Stockpiling of Mine rock

Hazard Number	Project Component / Activity	Potential Accident or Malfunction	Hazard Type	Consequence	Mitigations	Mitigated Consequence Category	Mitigated Likelihood Category	Mitigated Risk Rating	Screening Decision
9.1	Stockpiling of mine rock	Slope failure of mine rock pile	Geotechnical	Worker injury, equipment burial, sediment release	Proper slope design, staged construction, regular geotechnical inspections, exclusion zones, emergency response plan	Major	Highly unlikely	Moderate	Mitigated risk is ALARP; no further detailed assessment required.
9.2	Stockpiling of mine rock	Traffic accident between haul trucks at stockpile	Traffic / Mechanical	Worker injury or fatality	Traffic management plan for stockpile areas, signage, radio communication, training	Major	Unlikely	Moderate	Residual risk is ALARP; no further detailed assessment required.
9.3	Stockpiling of mine rock	Rockfall or flyrock during dumping causing injury	Mechanical / Operational	Worker injury from falling material	Safe dumping procedures, berms at dumping edges, restricted access, emergency response plan	Major	Highly unlikely	Moderate	Mitigated risk is tolerable with mitigation measures implemented; no further action required.
9.4	Stockpiling of mine rock	Equipment fire during stockpiling operations	Fire	Worker injury, fire spread to nearby areas	Fire extinguishers on equipment, equipment maintenance, emergency response plan	Minor	Highly unlikely	Low	Mitigated risk is tolerable; no further action required.
9.5	Stockpiling of mine rock	Fuel or hydraulic fluid spill from haul truck or dozer	Chemical Spill	Localized soil contamination	Spill kits on site, secondary containment, spill response plan, health and safety plan	Minor	Unlikely	Low	Mitigated risk is tolerable; no further action required.
9.6	Stockpiling of mine rock	ARD generation from PAG mine rock	Geochemical / Environmental	Long-term offsite environmental degradation	ARD management plan, segregation of PAG material, progressive reclamation, monitoring, emergency response plan	Major	Highly unlikely	Moderate	Mitigated risk is ALARP; no further detailed assessment required.
9.7	Stockpiling of mine rock	Failure of temporary ARD control structures during storm events	Environmental	Contaminated runoff discharge to surface water	Design of sediment ponds for extreme events, emergency overflow channels, maintenance during storm seasons	Minor	Unlikely	Low	Mitigated risk is tolerable; no further action required.

ALARP = as low as a reasonably practical; ARD = acid rock drainage; HDPE = high-density polyethylene; PAG = potentially acid generating; QA/QC = quality assurance and quality control.

Table 18A-10: Preliminary Hazard Screening - Mining Activities - Stockpiling of Ore

Hazard Number	Project Component / Activity	Potential Accident or Malfunction	Hazard Type	Consequence	Mitigations	Mitigated Consequence Category	Mitigated Likelihood Category	Mitigated Risk Rating	Screening Decision
10.1	Stockpiling of all types of ore	Slope instability of ore stockpiles	Geotechnical	Worker injury, equipment damage, production disruption	Proper stockpile design, staged buildup, slope monitoring, exclusion zones, emergency response plan	Major	Highly unlikely	Moderate	Mitigated risk is ALARP; no further detailed assessment required.
10.3	Stockpiling of all types of ore	Traffic accident during ore hauling to stockpile areas	Traffic / Mechanical	Worker injury or fatality	Traffic management plan, separation of light and heavy vehicles, signage, training, emergency response plan	Major	Unlikely	Moderate	Residual risk is ALARP; no further detailed assessment required.
10.4	Stockpiling of all types of ore	Fuel or oil spills from ore haul trucks	Chemical Spill	Soil and water contamination	Spill kits, secondary containment, maintenance of equipment, spill response plan, health and safety plan	Minor	Unlikely	Low	Mitigated risk is tolerable; no further action required.
10.5	Stockpiling of all types of ore	Fire risk from mobile equipment operating near stockpiles	Fire	Worker injury and equipment damage	Equipment maintenance, fire extinguishers on mobile units, emergency response plan	Minor	Highly unlikely	Low	Mitigated risk is tolerable; no further action required.

ALARP = as low as a reasonably practical.

Table 18A-11: Preliminary Hazard Screening - Ore Processing and Recovery - Primary Crushing and Grinding

Hazard Number	Project Component / Activity	Potential Accident or Malfunction	Hazard Type	Consequence	Mitigations	Mitigated Consequence Category	Mitigated Likelihood Category	Mitigated Risk Rating	Screening Decision
11.1	Primary crushing and grinding	Crusher mechanical failure during operation	Mechanical	Worker injury from debris or entrapment, equipment downtime	Remote crusher operation, protective guarding, maintenance programs, emergency stop systems	Major	Highly unlikely	Moderate	Mitigated risk is tolerable with standard controls; no further action required.
11.2	Primary crushing and grinding	Overload of crusher or grinding circuit leading to equipment trip or downtime	Operational	Disruption of production, potential minor damage	Automated feed control systems, operator training, emergency response plan	Minor	Unlikely	Low	Mitigated risk is tolerable; no further action required.
11.3	Primary crushing and grinding	Spillage of lubricants or hydraulic fluids from crusher or mill systems	Chemical Spill	Localized soil contamination and environmental effect	Secondary containment, spill kits at equipment sites, emergency spill response plan, health and safety plan	Minor	Unlikely	Low	Mitigated risk is tolerable; no further action required.
11.4	Primary crushing and grinding	Hot work (welding/cutting) fire hazard during crusher or mill maintenance	Fire	Worker injury, equipment damage	Hot work permits, fire watch, fire extinguishers, health and safety plan	Minor	Highly unlikely	Low	Mitigated risk is tolerable; no further action required.

Table 18A-12: Preliminary Hazard Screening - Ore Processing and Recovery - Magnetic Separation (low-intensity magnetic separators)

Hazard Number	Project Component / Activity	Potential Accident or Malfunction	Hazard Type	Consequence	Mitigations	Mitigated Consequence Category	Mitigated Likelihood Category	Mitigated Risk Rating	Screening Decision
12.1	Magnetic separation (low-intensity magnetic separators)	Blockage of separator feed resulting in spillage	Operational	Material spillage, housekeeping hazards, minor environmental risk	Proper feed control, regular inspections, immediate cleanup procedures, emergency response plan	Minor	Unlikely	Low	Mitigated risk is tolerable; no further action required.
12.2	Magnetic separation (low-intensity magnetic separators)	Overheating of separator electrical motors	Electrical / Fire	Potential fire hazard and equipment damage	Motor overload protection, temperature monitoring, preventive maintenance, emergency response plan	Minor	Highly unlikely	Low	Mitigated risk is tolerable; no further action required.
12.3	Magnetic separation (low-intensity magnetic separators)	Worker injury due to entanglement with moving parts	Mechanical / Safety	Severe injury or fatality	Physical guarding of rotating parts, restricted access, lockout/tagout procedures, health and safety plan	Major	Highly unlikely	Moderate	Mitigated risk is tolerable with mitigation measures implemented; no further action required.
12.4	Magnetic separation (low-intensity magnetic separators)	Spill of lubricants or hydraulic fluids from separator maintenance	Chemical Spill	Localized soil or water contamination	Secondary containment, use of drip pans during maintenance, spill kits and spill response plan	Minor	Unlikely	Low	Mitigated risk is tolerable; no further action required.

Table 18A-13: Preliminary Hazard Screening - Ore Processing and Recovery - Concentrate Thickening and Filtration and Storage

Hazard Number	Project Component / Activity	Potential Accident or Malfunction	Hazard Type	Consequence	Mitigations	Mitigated Consequence Category	Mitigated Likelihood Category	Mitigated Risk Rating	Screening Decision
13.1	Concentrate thickening and filtration and storage	Thickener overflow due to process upset	Operational / Environmental	Spill of concentrate slurry, potential sediment release to environment	Automated level control systems, overflow piping to containment, emergency response plan	Minor	Unlikely	Low	Mitigated risk is tolerable; no further action required.
13.2	Concentrate thickening and filtration and storage	Failure of storage area containment (bunds or foundations)	Structural / Environmental	Localized soil and groundwater contamination	Properly engineered containment, regular inspections and maintenance, emergency response plan	Major	Highly unlikely	Moderate	Mitigated risk is ALARP; no further detailed assessment required.
13.3	Concentrate thickening and filtration and storage	Fire risk from filter equipment during maintenance (hot work)	Fire	Localized fire, worker injury, equipment damage	Hot work permits, fire watch, fire extinguishers, health and safety plan	Minor	Highly unlikely	Low	Mitigated risk is tolerable; no further action required.

ALARP = as low as a reasonably practical.

Table 18A-14: Preliminary Hazard Screening - Tailings Management - Tailings Thickening

Hazard Number	Project Component / Activity	Potential Accident or Malfunction	Hazard Type	Consequence	Mitigations	Mitigated Consequence Category	Mitigated Likelihood Category	Mitigated Risk Rating	Screening Decision
14.1	Tailings Thickening	Mechanical failure of thickener rake causing process interruption and slurry overflow	Mechanical Failure	Environmental contamination, worker exposure to tailings, potential surface water effects	Regular maintenance of thickener drives and rakes, condition monitoring	Unlikely	Moderate	Moderate	Risk reduced to ALARP through preventive maintenance
14.2	Tailings Thickening	Overloading or overtopping of thickener due to high inflow rates	Process Upset	Environmental contamination, process upset	Flow monitoring and emergency bypass; operator training	Unlikely	Moderate	Moderate	Risk reduced to ALARP through operational controls
14.3	Tailings Thickening	Failure of flocculant dosing system leading to poor settling and overflow	Process Upset	Environmental contamination, process upset	Backup dosing system, alarms on dosing rates	Unlikely	Moderate	Moderate	Risk reduced to ALARP through redundancy and monitoring
14.4	Tailings Thickening	Overflow piping rupture causing uncontrolled discharge of tailings water	Mechanical Failure	Environmental contamination, worker exposure	Regular inspection of piping, secondary containment	Highly Unlikely	Moderate	Low	Risk reduced to tolerable level through inspection and containment
14.5	Tailings Thickening	Tailings thickener tank structural failure leading to tailings slurry release	Structural Failure	Major environmental release, worker safety risk	Structural inspections, design to appropriate standards (e.g., seismic)	Highly Unlikely	Major	Moderate	Further review during detailed design to confirm structural adequacy
14.6	Tailings Thickening	Slip, trip, and fall incidents due to wet surfaces around thickener area	Occupational Safety	Minor worker injuries	Good housekeeping, anti-slip surfaces, safety training	Unlikely	Minor	Low	Risk inherently low with good housekeeping and training
14.7	Tailings Thickening	Electrical failure causing loss of thickener control and overflow	Electrical Failure	Environmental contamination, process upset	Backup power systems, overflow alarms	Highly Unlikely	Moderate	Low	Risk reduced to tolerable level through backup systems

ALARP = as low as a reasonably practical.

Table 18A-15: Preliminary Hazard Screening - Tailings Management - Tailings Pipeline Transfer to Tailings Management Facility and Deposition

Hazard Number	Project Component / Activity	Potential Accident or Malfunction	Hazard Type	Consequence	Mitigations	Mitigated Consequence Category	Mitigated Likelihood Category	Mitigated Risk Rating	Screening Decision
15.1	Tailings pipeline transfer to TMF and deposition	Tailings pipeline rupture or leak during transfer	Mechanical / Environmental	Localized or widespread release of tailings slurry, soil and surface water contamination	HDPE pipeline material selection, pressure monitoring, pipeline inspections, secondary containment measures near sensitive areas	Catastrophic	Unlikely	High	HI Risk, further detailed assessment required
15.2	Tailings pipeline transfer to TMF and deposition	Pipeline blockage causing pipeline overpressure and rupture	Mechanical / Operational	Release of tailings slurry, equipment damage	Regular flushing of pipelines, pressure relief systems, operator training	Catastrophic	Unlikely	High	HI Risk, further detailed assessment required
15.3	Tailings pipeline transfer to TMF and deposition	Erosion at spigot discharge points leading to instability of tailings beach	Geotechnical / Environmental	Increased risk of seepage, loss of containment efficiency	Rotation of spigots, beach monitoring, engineering supervision during deposition	Minor	Unlikely	Low	Mitigated risk is tolerable; no further action required.
15.4	Tailings pipeline transfer to TMF and deposition	Failure of valve or bifurcation control systems	Mechanical / Operational	Uncontrolled tailings deposition, equipment damage	Regular valve inspections, preventive maintenance program, operational protocols	Minor	Highly unlikely	Low	Mitigated risk is tolerable; no further action required.
15.5	Tailings pipeline transfer to TMF and deposition	Excessive deposition leading to tailings pond migration toward dam	Operational / Environmental	Reduction in freeboard, increased dam safety risk	Beach slope monitoring, staged deposition planning, periodic adjustment of spigots and discharge locations	Major	Highly unlikely	Moderate	Mitigated risk is ALARP; no further detailed assessment required.

ALARP = as low as a reasonably practical; HDPE = high-density polyethylene: HI = hazard identification; TMF = tailings management facility.

Table 18A-16: Preliminary Hazard Screening - Tailings Management - Tailings Management Facility

Hazard Number	Project Component / Activity	Potential Accident or Malfunction	Hazard Type	Consequence	Mitigations	Mitigated Consequence Category	Mitigated Likelihood Category	Mitigated Risk Rating	Screening Decision
16.1	TMF management	Catastrophic dam breach due to structural failure	Geotechnical / Structural	Massive tailings and water release, potential loss of life, environmental destruction	Design following Canadian Dam Association guidelines; Very High consequence design basis; routine inspections; monitoring; Operation, Maintenance, and Surveillance manual; emergency preparedness plan	Catastrophic	Highly Unlikely	Moderate	Catastrophic Consequences, further detailed assessment required.
16.2	TMF management	Overtopping of the TMF dam during extreme flood event	Hydrological	Dam integrity compromised, catastrophic failure potential	Design of emergency spillways for probable maximum precipitation, sufficient freeboard, emergency action plans	Major	Highly Unlikely	Moderate	Mitigated risk is ALARP through design to extreme flood standards and robust operational controls.
16.3	TMF management	Localized liner failure (single puncture or seam failure)	Environmental	Seepage of contaminated water to groundwater	HDPE liner with geotextile protection, QA/QC during installation, leak detection monitoring system	Minor	Unlikely	Low	Mitigated risk is tolerable with liner QA/QC and monitoring in place.
16.4	TMF management	Multiple holes or large liner breach from construction defect or degradation	Environmental	Significant seepage of contaminated water into subsoil and groundwater	Secondary containment (cut-off trench), monitoring wells, geotechnical leak detection inspections	Minor to Moderate	Unlikely	Low	Given that the tailings have been classified as NPAG with low metal leaching potential, the environmental toxicity associated with a potential leak from the TMF liner is considered minimal. However, due to the sensitivity of issues related to TMF performance and environmental concern associated with any potential seepage, this scenario was conservatively selected as a bounding scenario.
16.5	TMF management	Failure of reclaim water pump system from TMF pond	Mechanical / Operational	Reduced water reclaim to plant, potential increase in pond levels	Backup pump system, causeway access for pumps, proactive maintenance, emergency response plan	Minor	Unlikely	Low	Mitigated risk is tolerable; no further action required.
16.6	TMF management	Slope failure of tailings beach into pond causing wave overtopping	Geotechnical / Operational	Partial dam overtopping risk, tailings instability	Staged deposition planning, tailings beach monitoring, beach profile control	Major	Highly Unlikely	Moderate	Mitigated risk is ALARP with beach management program and geotechnical inspections.
16.7	TMF management	Failure of seepage collection systems (sumps and pipelines)	Environmental	Localized seepage breakout and surface discharge	Regular inspection and maintenance of seepage systems, redundancy, emergency pumping plans	Minor	Highly Unlikely	Low	Mitigated risk is tolerable; no further action required.

ALARP = as low as a reasonably practical; HDPE = high-density polyethylene; NPAG = non-potentially acid generating; QA/QC = quality assurance and quality control; TMF = tailings management facility.

Table 18A-17: Preliminary Hazard Screening - Water Management – Water Management Infrastructure

Hazard Number	Project Component / Activity	Potential Accident or Malfunction	Hazard Type	Consequence	Mitigations	Mitigated Consequence Category	Mitigated Likelihood Category	Mitigated Risk Rating	Screening Decision
17.1	Water management	Failure of reclaim water pump system	Mechanical / Operational	Reduced water recycling, increased freshwater demand, potential process disruption	Backup pumps installed, regular maintenance program, emergency response plan	Minor	Unlikely	Low	Mitigated risk is tolerable; no further action required.
17.2	Water management	Seepage collection system failure in water management ponds	Structural / Environmental	Leakage of contaminated water to ground and groundwater	Seecondary containment systems, leak detection monitoring, regular inspections, NPAG dam fill, QA/QC, and freeboard design	Major	Highly unlikely	Moderate	Mitigated risk is tolerable; no further action required.
17.3	Water management	Transfer pipe rupture (contact water transfer between ponds)	Mechanical / Environmental	Release of untreated contact water to environment	HDPE piping with fusion-welded joints, pressure monitoring, emergency shutoff valves, spill response plan	Major	Highly unlikely	Moderate	Mitigated risk is ALARP; no further detailed assessment required.
17.4	Water management	Pond overflow during major storm event	Hydrological / Environmental	Discharge of untreated water to natural environment	Spillways sized for 100-year storm events, proactive pond level management with pumping, emergency overflow plans	Major	Highly unlikely	Moderate	Mitigated risk is ALARP; no further detailed assessment required.
17.5	Water management	Blockage or failure of stormwater ditches and culverts	Operational / Environmental	Localized flooding, erosion, and sedimentation	Riprap protection, regular inspection and maintenance, sediment control structures	Minor	Unlikely	Low	Mitigated risk is tolerable; no further action required.
17.6	Water management	Failure of WTP (contact water treatment plant)	Operational / Environmental	Discharge of untreated water, environmental regulatory non-compliance	Plant redundancy, bypass management plans, emergency response procedures, operator training	Major	Highly unlikely	Moderate	Mitigated risk is ALARP; no further detailed assessment required.

ALARP = as low as a reasonably practical; WTP = water treatment plant; HDPE = high-density polyethylene; NPAG = non-potentially acid generating; QA/QC = quality assurance and quality control.

Table 18A-18: Preliminary Hazard Screening - Transportation and Shipping - Rail Transport of Concentrate to Port

Hazard Number	Project Component / Activity	Potential Accident or Malfunction	Hazard Type	Consequence	Mitigations	Mitigated Consequence Category	Mitigated Likelihood Category	Mitigated Risk Rating	Screening Decision
18.1	Rail transport of concentrate to port	Train derailment resulting in concentrate release	Transport / Mechanical	Localized soil contamination, disruption of transport operations	Rail maintenance program, proper rail car loading, speed restrictions, emergency response plan	Major	Highly unlikely	Moderate	Mitigated risk is ALARP; no further detailed assessment required.
18.2	Rail transport of concentrate to port	Spillage of concentrate during loading onto rail cars	Operational	Localized contamination around load-out area, slip hazards	Spill containment under load-out, regular cleanups, covered conveyors where feasible	Minor	Unlikely	Low	Mitigated risk is tolerable; no further action required.
18.3	Rail transport of concentrate to port	Collision with public vehicles at rail crossings	Traffic / Safety	Public injury or fatality	Controlled rail crossings with signals and barriers, public education, emergency response plan	Major	Highly unlikely	Moderate	Mitigated risk is ALARP; no further detailed assessment required.
18.4	Rail transport of concentrate to port	Fire involving concentrate cars due to mechanical failure	Fire	Damage to rail assets, potential worker or public injury	Railcar inspection and maintenance, emergency response preparedness, health and safety plan	Minor	Highly unlikely	Low	Mitigated risk is tolerable; no further action required.

ALARP = as low as a reasonably practical.

Table 18A-19: Preliminary Hazard Screening - Transportation and Shipping - Trucking of Supplies (diesel, explosives, reagents) to Site

Hazard Number	Project Component / Activity	Potential Accident or Malfunction	Hazard Type	Consequence	Mitigations	Mitigated Consequence Category	Mitigated Likelihood Category	Mitigated Risk Rating	Screening Decision
19.1	Trucking of supplies (diesel, explosives, reagents) to site	Truck rollover resulting in spill of diesel or reagents	Transport / Chemical	Surface water contamination, fire hazard, environmental effect	Certified transporters, spill containment kits, emergency response plans, TDG compliance	Catastrophic	Unlikely	High	HI Risk, further detailed assessment required.
19.2	Trucking of supplies (diesel, explosives, reagents) to site	Truck rollover resulting in spill of diesel or reagents	Transport / Chemical	Localized soil contamination, fire hazard, environmental effect	Certified transporters, spill containment kits, emergency response plans, TDG compliance	Major	Unlikely	Moderate	Mitigated risk is ALARP; no further detailed assessment required.
19.3	Trucking of supplies (diesel, explosives, reagents) to site	Traffic collision with public vehicles during transport	Traffic / Safety	Public injury or fatality	Route planning to minimize public exposure, defensive driving training, emergency response plan	Major	Highly unlikely	Moderate	Mitigated risk is ALARP; no further detailed assessment required.
19.4	Trucking of supplies (diesel, explosives, reagents) to site	Loss of containment of explosives during transport	Transport / Explosives	Explosion risk, worker and public injury or fatality	Explosives transport by licensed carriers, compliance with TDG regulations, securement protocols	Major	Highly unlikely	Moderate	Mitigated risk is ALARP; no further detailed assessment required.
19.5	Trucking of supplies (diesel, explosives, reagents) to site	Spillage of minor quantities during routine handling	Operational / Chemical	Localized contamination or worker exposure	Proper handling procedures, PPE use, spill response training, health and safety plan	Minor	Unlikely	Low	Mitigated risk is tolerable; no further action required.
19.6	Trucking of supplies (diesel, explosives, reagents) to site	Mechanical breakdown of transport vehicle on route	Mechanical	Delay in delivery, minor public road obstruction	Regular vehicle maintenance, breakdown response plans, roadside safety protocols	Minor	Unlikely	Low	Mitigated risk is tolerable; no further action required.
19.7	Trucking of supplies (diesel, explosives, reagents) to site	Vehicle – wildlife collision	Traffic/Safety	Wildlife Injury or fatality	Route planning to minimize wildlife exposure, defensive driving training, emergency response plan	Minor	Unlikely	Low	Mitigated risk is tolerable; no further action required.
19.8	Trucking of supplies (diesel, explosives, reagents) to site	Vehicle – Human collision	Traffic/Safety	Public injury or fatality	Route planning to minimize public exposure, defensive driving training, emergency response plan, speed limits	Major	Highly unlikely	Moderate	Mitigated risk is tolerable as ALARP; no further detailed assessment required.

ALARP = as low as a reasonably practical; HI = hazard identification; PPE = personal protective equipment: TDG = Transportation of Dangerous Goods.

Table 18A-20: Preliminary Hazard Screening - Transportation and Shipping - Emergency Concentrate Reclaim System

Hazard Number	Project Component / Activity	Potential Accident or Malfunction	Hazard Type	Consequence	Mitigations	Mitigated Consequence Category	Mitigated Likelihood Category	Mitigated Risk Rating	Screening Decision
20.1	Emergency concentrate reclaim system	Mechanical failure of reclaim equipment during emergency transfer	Mechanical	Delayed concentrate handling, production disruption	Preventive maintenance, redundant reclaim systems where feasible, emergency response procedures	Minor	Unlikely	Low	Mitigated risk is tolerable; no further action required.
20.2	Emergency concentrate reclaim system	Spill of concentrate during emergency transfer	Operational / Environmental	Localized contamination at load-out area, slip hazards	Spill containment infrastructure at reclaim area, quick spill response protocols, health and safety plan	Minor	Unlikely	Low	Mitigated risk is tolerable; no further action required.
20.3	Emergency concentrate reclaim system	Fire hazard from mobile reclaim equipment	Fire	Localized fire hazard, worker injury, equipment damage	Fire extinguishers mounted on mobile reclaim units, fire prevention procedures, emergency response plan	Minor	Highly unlikely	Low	Mitigated risk is tolerable; no further action required.

Table 18A-21: Preliminary Hazard Screening - Power Supply and Emergency Systems - Main Substation Connection to Provincial Grid

Hazard Number	Project Component / Activity	Potential Accident or Malfunction	Hazard Type	Consequence	Mitigations	Mitigated Consequence Category	Mitigated Likelihood Category	Mitigated Risk Rating	Screening Decision
21.1	Main substation connection to provincial grid	Failure of provincial grid supply (outage)	Electrical / Operational	Disruption to mine operations, potential safety effects	Backup power systems (emergency generators), uninterruptible power supplies for critical loads	Minor	Unlikely	Low	Mitigated risk is tolerable; no further action required.
21.2	Main substation connection to provincial grid	Transformer failure at main substation	Electrical / Mechanical	Major disruption of power supply, potential fire	Transformer protection systems, regular maintenance, fire suppression systems, emergency response plan	Major	Highly unlikely	Moderate	Mitigated risk is ALARP; no further detailed assessment required.
21.3	Main substation connection to provincial grid	Electrical arc flash event during maintenance	Electrical Explosion	Severe worker injury or fatality	Strict lockout/tagout procedures, arc flash PPE, restricted access, health and safety plan	Major	Highly unlikely	Moderate	Mitigated risk is ALARP; no further detailed assessment required.
21.4	Main substation connection to provincial grid	Oil spill from transformer (if oil-filled)	Chemical Spill	Localized soil contamination, minor fire risk	Secondary containment for transformers, regular inspections, emergency spill response plan	Minor	Highly unlikely	Low	Mitigated risk is tolerable; no further action required.
21.5	Main substation connection to provincial grid	Fire in electrical substation equipment	Fire	Damage to critical infrastructure, potential worker injury	Fire detection and suppression systems, equipment maintenance, emergency response plan	Major	Highly unlikely	Moderate	Mitigated risk is tolerable with mitigation measures implemented; no further action required.

ALARP = as low as a reasonably practical; PPE = personal protective equipment.

Table 18A-22: Preliminary Hazard Screening - Power Supply and Emergency Systems - On-Site Transformers and Electrical Distribution

Hazard Number	Project Component / Activity	Potential Accident or Malfunction	Hazard Type	Consequence	Mitigations	Mitigated Consequence Category	Mitigated Likelihood Category	Mitigated Risk Rating	Screening Decision
22.1	On-site transformers and electrical distribution	Transformer failure causing power outage	Electrical / Mechanical	Production disruption, potential equipment damage	Routine maintenance and inspections, transformer protection systems, spare parts management	Minor	Unlikely	Low	Mitigated risk is tolerable; no further action required.
22.2	On-site transformers and electrical distribution	Oil leak from transformer leading to environmental contamination	Chemical Spill	Localized soil contamination, minor fire risk	Secondary containment systems (berms or concrete pads), spill response plan, regular inspections	Minor	Highly unlikely	Low	Mitigated risk is tolerable; no further action required.
22.3	On-site transformers and electrical distribution	Electrical arc flash during maintenance activities	Electrical Explosion	Severe worker injury or fatality	Strict lockout/tagout procedures, arc flash PPE, qualified personnel, health and safety plan	Major	Highly unlikely	Moderate	Mitigated risk is ALARP; no further detailed assessment required.
22.4	On-site transformers and electrical distribution	Fire originating from electrical fault	Fire	Damage to site infrastructure, potential worker injury	Fire detection and suppression systems, preventive maintenance, emergency response plan	Major	Highly unlikely	Moderate	Mitigated risk is tolerable with mitigation measures implemented; no further action required.
22.5	On-site transformers and electrical distribution	Electrical shock to worker during operation or maintenance	Electrical Safety	Worker injury or fatality	Lockout/tagout, insulated tools, training, PPE for electrical work	Major	Highly unlikely	Moderate	Mitigated risk is tolerable with mitigation measures implemented; no further action required.

ALARP = as low as a reasonably practical; PPE = personal protective equipment.

Table 18A-23: Preliminary Hazard Screening - Power Supply and Emergency Systems - On-Site Transformers and Electrical Distribution

Hazard Number	Project Component / Activity	Potential Accident or Malfunction	Hazard Type	Consequence	Mitigations	Mitigated Consequence Category	Mitigated Likelihood Category	Mitigated Risk Rating	Screening Decision
23.1	Emergency backup diesel generators (2.5 MW)	Mechanical failure during startup or operation	Mechanical	Loss of emergency power supply, critical system disruptions	Preventive maintenance program, periodic load testing, redundant generator units if possible	Major	Highly unlikely	Moderate	Mitigated risk is ALARP; no further detailed assessment required.
23.2	Emergency backup diesel generators (2.5 MW)	Fuel spill during refueling operations	Chemical Spill	Localized soil and potential water contamination	Spill containment systems, trained operators, spill kits available, spill response plan	Minor	Unlikely	Low	Mitigated risk is tolerable; no further action required.
23.3	Emergency backup diesel generators (2.5 MW)	Fire originating from generator fuel or electrical fault	Fire	Damage to backup systems, potential worker injury	Fire suppression systems, fire extinguishers, fire detection systems, emergency response plan	Major	Highly unlikely	Moderate	Mitigated risk is tolerable with mitigation measures implemented; no further action required.

ALARP = as low as a reasonably practical; MW = megawatt.

Table 18A-24: Preliminary Hazard Screening - Decommissioning and Closure - Dismantling of Process Plant and Equipment and Removal of Temporary Infrastructure (fuel tanks, camps)

Hazard Number	Project Component / Activity	Potential Accident or Malfunction	Hazard Type	Consequence	Mitigations	Mitigated Consequence Category	Mitigated Likelihood Category	Mitigated Risk Rating	Screening Decision
24.1	Dismantling of process plant and equipment	Structural collapse during dismantling activities	Structural / Mechanical	Worker injury or fatality	Engineering assessment prior to dismantling, controlled demolition procedures, exclusion zones, health and safety plan	Major	Highly unlikely	Moderate	Mitigated risk is ALARP; no further detailed assessment required.
24.2	Dismantling of process plant and equipment	Release of residual hazardous materials (e.g., oils, greases, chemicals)	Chemical Spill	Localized soil and water contamination	Pre-dismantling decontamination, spill containment, emergency spill response plan	Minor	Unlikely	Low	Mitigated risk is tolerable; no further action required.
24.3	Removal of temporary infrastructure (fuel tanks, camps)	Fuel spill during tank removal	Chemical Spill	Localized soil contamination	Tank emptying prior to removal, spill containment measures, spill response plan	Minor	Unlikely	Low	Mitigated risk is tolerable; no further action required.
24.4	Dismantling of process plant and equipment	Fire during dismantling (e.g., hot work, cutting torches)	Fire	Localized fire hazard, worker injury, property damage	Hot work permits, fire watch, fire extinguishers, emergency response plan	Major	Highly unlikely	Moderate	Mitigated risk is tolerable with mitigation measures implemented; no further action required.
24.5	Removal of temporary infrastructure	Traffic accidents during removal activities (heavy equipment movement)	Traffic / Mechanical	Worker injury or fatality	Traffic management plan during decommissioning, vehicle spotters, exclusion zones, emergency response plan	Major	Highly unlikely	Moderate	Mitigated risk is ALARP; no further detailed assessment required.

ALARP = as low as a reasonably practical.

Table 18A-25: Preliminary Hazard Screening - Decommissioning and Closure - Regrading and Covering of Mine Rock Storage Areas

Hazard Number	Project Component / Activity	Potential Accident or Malfunction	Hazard Type	Consequence	Mitigations	Mitigated Consequence Category	Mitigated Likelihood Category	Mitigated Risk Rating	Screening Decision
25.1	Regrading and covering of Mine Rock Stockpile	Slope instability during regrading activities	Geotechnical / Mechanical	Equipment rollover, worker injury, environmental sediment release	Controlled grading plans, geotechnical oversight, exclusion zones, trained equipment operators, emergency response plan	Major	Highly unlikely	Moderate	Mitigated risk is ALARP; no further detailed assessment required.
25.2	Regrading and covering of Mine Rock Stockpile	Spill of fuel or hydraulic fluids from heavy equipment	Chemical Spill	Localized soil contamination	Spill kits carried on equipment, fuelling procedures, spill response plan, health and safety plan	Minor	Unlikely	Low	Mitigated risk is tolerable; no further action required.
25.3	Regrading and covering of Mine Rock Stockpile	Failure of temporary erosion and sediment control measures	Environmental	Sediment release to downstream watercourses	Installation of silt fences, sediment ponds, regular inspections, maintenance after rainfall events	Minor	Unlikely	Low	Mitigated risk is tolerable; no further action required.
25.4	Regrading and covering of Mine Rock Stockpile	Long-term settlement or erosion of final cover system	Geotechnical / Environmental	Exposure of underlying waste, potential ARD release	Proper cover design with erosion-resistant materials, monitoring and maintenance program	Major	Highly unlikely	Moderate	Mitigated risk is ALARP; no further detailed assessment required.

ALARP = as low as a reasonably practical; ARD = acid rock drainage.

Table 18A-26: Preliminary Hazard Screening - Decommissioning and Closure - Decommissioning of Tailings Management Facility (drying, covering, revegetation)

Hazard Number	Project Component / Activity	Potential Accident or Malfunction	Hazard Type	Consequence	Mitigations	Mitigated Consequence Category	Mitigated Likelihood Category	Mitigated Risk Rating	Screening Decision
26.1	Decommissioning of TMF (drying, covering, revegetation)	Tailings surface instability during drying	Geotechnical / Operational	Worker injury, equipment entrapment	Drying plans based on geotechnical assessments, controlled equipment access, exclusion zones, emergency response plan	Major	Highly unlikely	Moderate	Mitigated risk is ALARP; no further detailed assessment required.
26.2	Decommissioning of TMF (drying, covering, revegetation)	Failure of final cover system (erosion or settlement)	Geotechnical / Environmental	Exposure of tailings, potential for contaminant release	Robust cover design with erosion-resistant materials, progressive reclamation, monitoring and maintenance	Major	Highly unlikely	Moderate	Mitigated risk is ALARP; no further detailed assessment required.
26.3	Decommissioning of TMF (drying, covering, revegetation)	Spill of fuel or oil from equipment during covering activities	Chemical Spill	Localized soil contamination	Spill kits available, fuelling procedures, equipment maintenance, spill response plan, health and safety plan	Minor	Unlikely	Low	Mitigated risk is tolerable; no further action required.
26.4	Decommissioning of TMF (drying, covering, revegetation)	Failure of temporary stormwater management during reclamation	Environmental	Runoff erosion, sediment release to surrounding environment	Installation of diversion channels, sediment ponds, regular inspections, emergency contingency measures	Minor	Unlikely	Low	Mitigated risk is tolerable; no further action required.

ALARP = as low as a reasonably practical; TMF = tailings management facility.

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19. Effects of the Environment on the Project

The purpose of **Chapter 19, Effects of the Environment on the Project**, of the Environmental Impact Statement (EIS) is to presents an analysis of the environmental changes and hazards within the Project area that could have an effect on the Project. Section 6.5 of the EIS Guidelines requires that the effects that environmental hazards that may occur and may affect the Project be described in the EIS and shall take into account the potential influence of climate change, as well as local knowledge.

The following sections outline the potential effects that the surrounding environment may have on the Project. This includes potential effects from environmental, geophysical, and climatic hazards, including the influence of various climate change scenarios for anticipated future effects. Potential for environmental effects that may occur because of hazard effects on the Project are considered.

19.1 Assessment Approach

The assessment of the effects of the environment on the Project included an assessment of how natural hazards might affect Project infrastructure and activities during different phases of the Project. The general approach for the assessment of effects of the environment on the Project included:

- incorporation of Indigenous and Local Knowledge into the assessment
- identification of natural hazards in the Project region that could interact with the Project (referred to as "relevant hazards" in this report), including geohazards as well as climate hazards and projected climate change
- assessment of effects of the environment on the Project, including:
    - description of existing conditions
    - description of how the existing conditions may affect the Project
    - evaluation of the design and operational features that mitigate the effects of these hazards on the Project
    - identification of potential effects on the surrounding environment that may occur due to hazard effects on the Project and the associated mitigation measures

19.1.1 Incorporating Indigenous and Local Knowledge

Indigenous and Local Knowledge shared throughout the engagement process was reviewed. One comment was identified that is relevant to the assessment of effects of the environment on the Project, particularly the assessment of wildfire. Labrador City highlighted that water bombers use Duley Lake to collect water for forest fires. This has been included in the discussion on wildfires in Section 19.4.4, Droughts and Wildfires.

Based on a review of secondary sources, outside of Project consultation, local knowledge of a recent wildfire from the Le Journal de Montréal was noted and included in the discussion in Section 19.4.4.

The overall approach and methods for the incorporation of Indigenous and Local Knowledge into the EIS is discussed in detail in Chapter 22, Engagement. Issues and concerns related to the effects of the environment on the Project raised by Indigenous groups and community members are identified and addressed in this assessment, where applicable.

19.1.2 Identifying of Relevant Hazards

The EIS Guidelines does not specify the hazards and events that require consideration in the EIS. A range of sources was used to identify potential natural hazards and extreme events that could interact with the Project, including the local conditions, the current and anticipated environmental and geological hazards that have potential to affect the Project (Section 19.4, Assessment of Effects of the Environment), and the following sources:

- Impact Assessment Agency of Canada Registry: past environmental assessments in Newfoundland and Labrador (reviewed for topics considered)
- Canada Disaster Database
    - https://cdd.publicsafety.gc.ca
- Earthquakes in Canada
    - https://www.earthquakescanada.nrcan.gc.ca/historic-historique/caneqmap-en.php
    - https://www.earthquakescanada.nrcan.gc.ca/hazard-alea/simphaz-en.php#ON

- Northern Tornadoes Project:
  - https://westernu.maps.arcgis.com/apps/dashboards/19460b79cf24493680e5792f5247f46d

19.1.3 Assessment of Effects of the Environment

19.1.3.1 Description of Existing Conditions

The existing conditions for each relevant hazard was summarized based on the range of sources outlined in Section 19.1.2, Identification of Relevant Hazards that were used to identify relevant hazards. In addition to the sources noted above, existing conditions were summarized based on the following, including studies previously conducted for the Project:

- Kami Iron Ore Mine Project Hydrogeological Modelling (TSD V)
- Kami Mine Hydrogeological and Water Balance Study – Rose Pit Water Management Infrastructure Design (SNC-Lavalin 2024)
- Kami Iron Ore Project, Pit Slope Design, Rose Pit (Stantec 2012a)
- Canada's Changing Climate Report: Chapter 6 – Changes in Fresh Water Availability Across Canada. (Bonsal et al. 2019)
- "Hurricanes and Climate Change in Atlantic Canada" from ClimateData.ca (Climatedata.ca 2024b)
- "Observed Trends in Canada's Climate and Influence of Low-Frequency Variability Modes" (Vincent et al. 2015)
- Canadian Climate Data Normals from 1991 to 2020 (ECCC 2025)
- news article titled "Feux de forêt: Fermont se prépare à évacuer" (Le journal de Montréal 2014)

19.1.3.2 Assessment of Effects

The sources identified in Section 19.1.2 and Section 19.1.3.1, Description of Existing Conditions were also used to evaluate potential effects on the Project, along with consultation with relevant subject matter experts and design documents. The evaluation includes consideration of climate change. Climate change has the potential to affect and change many of the geohazards that may affect the Project (for example, local groundwater). The effects on the Project from these potential changes are evaluated with each hazard to identify the Project's resilience to climate change.

19.1.3.3 Evaluation of Mitigation Measures

To mitigate the effects of the environment on the Project, there must be adequate planning, design, and operation procedures that consider normal and extreme physical environmental conditions. There must also be adequate monitoring and forecasting of physical environment conditions. Through adequate monitoring and forecasting, Project activities can be managed in a manner that not only mitigates current conditions but can also adapt to changing conditions.

To address the potential effects of climate and climate change on the Project, and in consideration of the potential normal and extreme conditions that might be encountered throughout the life of the Project, proactive design, materials selection, planning, and maintenance are required. Potential effects and mitigation measures were developed in consultation with Project subject matter experts, the Project Description, and information provided in the Environmental Effects Monitoring Program (Annex 5E) and Environmental Protection Plan Table of Contents (Annex 5D).

All engineering design will adhere to national and international standards which provide design criteria that the regulatory agencies consider satisfactory for withstanding the potential physical environmental conditions. These codes consider physical environmental criteria such as temperature, wind, snow and ice loading, and drainage. In addition, the design life is taken into consideration so that materials are chosen with sufficient durability and corrosion resistance for current and future conditions.

Mitigation measures for each identified hazard are discussed in Section 19.4.

19.1.3.4 Identification of Potential Effects on the Environment

An effect on the Project from natural hazard can result in a secondary effect on the surrounding environment (for example, a spill caused by a climate event can in turn have detrimental effects on the surrounding hydrological environment). The identified potential effects on the Project from natural hazards were reviewed and assessed for potential secondary effects on the environment. Relevant technical studies were consulted to identify mitigation measures for these potential effects.

Common mitigation measures include climate-conscious design and standard procedures. For example, designing surface drainage to prevent flooding of stockpile areas mitigates climate change through design controls, whereas monitoring access roads for signs of erosion and repairing them as necessary mitigates climate change through regular monitoring.

These potential effects on the environment and associated mitigation, as well as potential for climate resilience are discussed in Section 19.4.

19.2 Climate and Climate Change Context

To assess effects of natural hazards on the Project, future conditions under a changing climate must also be considered. This section provides an overview of the local climate conditions, and he projected future conditions.

The climate in the area is sub-arctic, characterized by long cold winters and short mild summers. Climate normals for the 1991 to 2020 30-year period were obtained for the Wabush, Newfoundland and Labrador, dataset (ECCC 2025) and documented in the existing conditions sections within Section 19.4. Wabush is a composite dataset representing three stations in the Wabush area which are the nearest Environment and Climate Change Canada meteorological station to the Project. The 1991 to 2020 climate normals for precipitation, air temperature, and wind are provided in the sections below to describe existing conditions.

In addition to temperature, precipitation, and wind, historical snowfall data are presented below. Snowfall accumulation is not provided as part of the climate normals dataset and were therefore obtained from a climate data analysis completed by in 2024 (Lorax 2024). Snow accumulation data were extracted form the Churchill-Wabush station, the only snow station in the vicinity of the Project with long-duration snow water equivalent records. The data for this station were extracted from the Canadian historical snow water equivalent dataset—a compilation of manual and automated pan-Canadian observations of snow water equivalent collected by national, provincial, and territorial agencies as well as hydropower companies and their partners. This climate analysis by Lorax was used to support water balance and quality modelling. This analysis is documented in TSD VIL Site-Wide Water Balance and Water Quality Modelling Report (TSD VI).

Observations of various climate variables since the mid-19th century, using direct measurements, satellites, and other platforms, as well as climate reconstructions and model simulations, have demonstrated variability and changes in the climate system. Atmospheric and oceanic temperatures are rising, snow and ice quantities are decreasing, sea levels are increasing, and greenhouse gas concentrations are also rising (IPCC 2013). Canada has experienced warming at approximately twice the global average (1.0°C) over the past century, with higher rates observed in northern regions (Lulham et al. 2023). Future climate projections indicate that temperatures will continue to rise throughout the current century (CRA 2015).

The Intergovernmental Panel on Climate Change (IPCC) is generally considered to be the definitive source of information related to past and future climate change as well as climate science. The IPCC is a United Nations body dedicated to providing an objective, scientific assessment of climate change information, and the potential natural, political, economic, and human effects of climate change. The IPCC periodically releases Assessment Reports, each of which provides the current state of climate change science, where there is agreement within the scientific community. The Sixth Assessment Report (AR6) was released in 2021. AR6 is the most current, complete synthesis of information regarding climate change that includes general global and regional trends.

When projecting future climate conditions, there needs to be a consideration of future climate scenarios, which are based on assumptions about future greenhouse gas emissions and atmospheric concentrations. In AR6 (IPCC 2021), five scenarios are provided, described as Shared Socioeconomic Pathways (SSPs). The five SSPs are, SSP1-2.6, SSP2-4.5, SSP3-7.0, SSP4-6.0, and SSP5-8.5, where SSP5-8.5 represents the most severe climate change and SSP1-2.6 represents the least severe. They are described for changing climatic conditions until 2100. A description for each SSP is noted in Table 19-1.

Table 19-1: Characterization of Shared Socioeconomic Pathways in the Intergovernmental Panel on Climate Change's Sixth Assessment Report

SSP	Radiative Forcing in 2100[(a)] (W/m^2)	Associated Global Temperature Outcome for 2081–2100 (°C)[(b)]	Characterization
SSP1	1.9 2.6	1.4 1.8	Sustainable development proceeds at a reasonably high pace.
SSP2	4.5	2.7	An intermediate case between SSP1 and SSP3.
SSP3	7.0	3.6	Unmitigated emissions are high due to moderate economic growth.
SSP4	3.4 6.0	–	A mixed world, with relatively rapid technological development in low carbon energy sources in key emitting regions, leading to relatively large mitigative capacity in places where it mattered most to global emissions.
SSP5	8.5	4.4	In the absence of climate policies, energy demand is high and most of this demand is met with carbon-based fuels.

Source: O'Neil et al. 2014.

(a) Radiative forcing is a term in climate science used to depict energy flux in Earth's atmosphere. The higher the radiative forcing value (W/m^2), the more energy remains in Earth's atmosphere, causing increased global temperature change.

(b) These values represent the best estimate of change in average global surface temperature compared to 1850–1900 temperatures. The dash represents a value not provided by source. Source for this column: IPCC 2021.

W/m^2 = watts per square metre; SSP = Shared Socioeconomic Pathway; – = associated global temperature outcome not provided in the IPCC.

Regional climate projections were developed for the Project considering a subset of the available scenarios. Of the scenarios described above, the SPP2-4.5 and SPP5-8.5 scenarios were chosen to provide insight into potential changes in climate in both moderate emission and higher emission scenarios, capturing a range of potential conditions.

Climate projections were developed for the following time horizons:

- Modelled baseline (1991–2020)
- Early century (2021–2050)
- Mid-century (2041–2070)
- End of century (2071–2100)

It should be noted that the modelled baseline presented in this section differs from the climate normals presented throughout Section 19.4. The values provided below for the baseline are not based on measured data but instead are taken from the climate model projections which have climate estimates covering the period 1950 through 2100. This allows for a better capture of the future projected trends as the focus is on the projected change in climate, not on any bias introduced by how an individual model compares to observations.

The time horizons considered help frame climate projections and their influence on the various stages of the Project. These time frames offer insights into the projected climate conditions at different intervals, which is crucial for assessing risks, planning, and sustainability over the long term. The following illustrates how these time horizons correspond to the Project stages:

- **Early-century projections**—The climate projections for this time horizon are important for understanding how climate conditions will affect the construction of infrastructure and early operational activities.
- **Mid-century projections**—This period aligns with the operational phase of the Project, spanning most of the 26 years of expected Operations, and the beginning of decommissioning activities. The climate projections here will help understanding longer-term operational risks, including the stability of the infrastructure and the operational efficiency of the mining and energy systems.
- **End-of-century projections**—This period will cover the final phase of the Project, extending into the post-closure period (which is estimated to last 40 years), to consider the long-term effects of climate change, even after the Project's operational life has ended.

Climate variables (e.g., mean temperature, total precipitation, wind speed) describe the state of the climate system and are contributing factors to climate hazards. Climate hazards refer to climate events that may interact with different components of the Project. Future climate conditions were assessed by projecting changes in key climate variables over the modelled baseline period and early-century, mid-century, and end-of-century future periods using a multi-model ensemble. Table 19-2 provides a summary of climate projections and associated trends for the Project area for relevant climate hazards.

Table 19-2: Regional Climate Projections Representative of the Project Site

Climate Hazard	Climate Variable	Modelled Baseline	SSP2-4.5 Early Century	SSP5-8.5 Early Century	SSP2-4.5 Mid-Century	SSP5-8.5 Mid-Century	SSP2-4.5 End of Century	SSP5-8.5 End of Century	Trend
Extreme heat	Annual number of hot days (days >30°C)[(a)]	0	1	1	2	3	3	12	Increasing
	Average summer maximum temperature (°C)[(a)]	18	19	20	20	21	21	24	Increasing
Extended cold spell	Number of days with minimum temperature below -15°C[(a)]	105	94	93	87	80	78	53	Decreasing
Freezing rain and freeze-thaw[(b)]	Average winter precipitation (mm)[(a)]	178	191	198	201	211	210	239	Increasing
	Total number of winter (Dec–Feb) freeze-thaw cycles (Tmin ≤-1°C and Tmax ≥0°C)[(a)]	63	59	58	58	55	55	52	Decreasing
Major precipitation events	Number of heavy precipitation days (precipitation > 20 mm)[(a)]	3	4	5	5	5	5	7	Increasing
	Annual maximum 1-day precipitation (mm)[(a)]	30	32	33	33	35	34	38	Increasing
Severe snowstorms	Number of days where the coldest day is lower than 0°C (frost days)[(a,c)]	225	214	211	204	198	198	176	Decreasing
Droughts and wildfire	Standardized Precipitation and Evapotranspiration Index (SPEI 3-mth) for warm months[(a,d)]	-0.04	-0.03	-0.06	-0.07	-0.17	-0.10	-0.49	Increasing
	Maximum length of consecutive dry period (days)[(a)]	16	12	12	12	12	12	11	No trend
High winds	Extreme wind gust (km/h)[(e)]	130	n/a	n/a	n/a	n/a	n/a	-2.5% in summer n/a in winter	No trend
	Total days with gusts >90 km/h (days)[(f)]	n/a	n/a	n/a	+60%	+60%	+60%	+60%	Increasing

(a) Source: ClimateData.ca 2024a.
(b) Average winter precipitation and freeze-thaw cycles are used as indicators for the trends for freezing rain as they could relate to the conditions that may result in freezing rain. This is consistent with projected increasing trends in literature (Cannon et al. 2020; Cheng et al. 2011).
(c) The number of frost days (days where the coldest day is lower than 0°C) has been used as a proxy for representing the trend in severe snowstorms.
(d) SPEI 3-mth describes the SPEI between the summer months from June to August. SPEI is a drought index based on the difference between precipitation and potential evapotranspiration; negative (positive) values indicate water deficit (surplus).
(e) Source: ECCC 2025; Seneviratne et al. 2012.
(f) Source: Cheng et al. 2014. The values of percent change in annual total days with gusts exceeding 90 km/h are based on literature review (Cheng et al. 2014). The projected values for mid-century and end of century are based on the periods 2046–2065 and 2081–2100, respectively; the future conditions are compared with the values from the historical baseline period of 1955–2009. The climate scenario used as reference is based on a regionally oriented economic development future with global temperature increases ranging from 2.0°C to 5.4°C; this scenario is relatively similar to the SSP5-8.5 scenario.
SPEI = Standardized Precipitation and Evapotranspiration Index; mth = month; SSP = Shared Socioeconomic Pathway; Tmin = temperature minimum; Tmax = temperature maximum; n/a = not applicable.

Sections 19.4.1 to 19.4.11 describe the climate local climate conditions in more detail and outline potential effects on the Project and associated mitigation.

19.3 Identification of Relevant Hazards

Based on a review of the Project and the external sources identified in Section 19.1.2, the following relevant hazards were identified:

- **Climate and climate change**—extreme heat, extended cold spell, freezing rain, major precipitation events, severe snowstorms, droughts, high winds, and wildfires
- **Physiography**—topography, drainage network
- **Geology**—bedrock and surficial cover stratigraphy as well as the composition and geomechanical properties where major Project infrastructure and earthworks are proposed, including potential for landslides
- **Groundwater**—hydrogeological characteristics of the different geological units (hydraulic conductivities, porosity, storage coefficients); groundwater geochemistry, and groundwater levels for the areas that will be disturbed by major Project components
- **Hydrology**—levels and yields of surroundings lakes, rivers, and brooks
- **Permafrost**—locations, thickness, and melting
- **Seismicity and faulting**—local faults and potential for seismic activity; based on the Project and its location, the following natural hazards not considered relevant hazards to the Project and have been screened out of the assessment: avalanche, major earthquake, major tornado, storm surge, tsunami, or volcanic eruption

19.4 Assessment of Effects of the Environment

The following sections describe the regional natural hazards and potential effects on the Project. Table 19-3 identifies the Project infrastructure being assessed and its presence in each Project phase. While the infrastructure will be essential during the Construction and Operations phases of the Project, the majority of ore processing and supporting infrastructure will no longer be present during the Closure phase. If the infrastructure is still present at the Closure phase, it is likely that in the post-closure period, it will be reclassified or maintained for monitoring purposes. The presence or absence of infrastructure during the various Project phases is important to understand when assessing future effects due to climate change.

Table 19-3: Infrastructure by Project Phase

Category	Infrastructure	Project Phases			
		Construction	Operations	Closure	Post-closure
Open pit – Rose Pit	Open mine pit	Y	Y	Y	Flooded
Ore processing infrastructure	Ore stockpiles	N	Y	Removed/area rehabilitated	N
	Primary ore crusher station	Y	Y	Removed/area rehabilitated	N
	Main overland conveyor	Y	Y	Removed/area rehabilitated	N
	Crushed ore stockpile	N	Y	Removed/area rehabilitated	N
	Process plant (concentrator and mill, water treatment plant, main electrical substation, steam boiler room)	Y	Y	Removed/area rehabilitated	N
	Ore concentrate load-out	Y	Y	Removed/area rehabilitated	N
		Y	Y	Removed/area rehabilitated	N
	Sewage facility	Y	Y	Y	Dismantled/Rehabilitated

Category	Infrastructure	Project Phases			
		Construction	Operations	Closure	Post-closure
Waste management infrastructure	In-pit crushing and conveying system	Y	Y	Removed/area rehabilitated	N
	Mine rock stockpile	N	Y	Y	Contact water pumped to the Rose Pit and area reclaimed
	Overburden stockpile	Y	Y	Y	Progressive regrading and natural revegetation. Run-off directed to the Rose Pit
	TMFs	Y	Y	Y	Rehabilitated
Water management infrastructure to collect contact and non-contact water	TMF Pond	Y	Y	Y	Regraded/breached
	Rose Pit collection pond, End Lake dams (2)	Y	Y	Y	Breached
	Clean water perimeter diversion ditches	Y	Y	Y	Backfilled
	Mid Lake dam (non-contact)	Y	Y	Y	Decommissioned
	Pike Lake dike (non-contact)	Y	Y	Y	Decommissioned
	Overburden stockpile collection pond (contact)	Y	Y	Decommissioned	Breached
	Mine rock stockpile collection ponds (contact)	Y	Y	Y	Y
	Water pumping stations and pipeline	Y	Y	Y	Y
Supporting infrastructure	Electrical infrastructure	Y	Y	Dismantled, removed from site, and area rehabilitated	N
	Emulsion and explosion production plant and explosive storage	Y	Y	Removed/area rehabilitated	N
	Mine service area	Y	Y	Removed/area rehabilitated	N
	Aggregate plant	Y	Y	Removed/area rehabilitated	N
	Workforce accommodations	Y	Y	Removed/area rehabilitated	N
	Temporary construction worker accommodations	Y	Y	Removed/area rehabilitated	N
	Permanent worker accommodations	Y	Y	Removed/area rehabilitated	N
	Fresh water pumping stations (2)	Y	Y	Y	Decommissioned
	Borrow pit	Y	Y	Removed/area rehabilitated	N
	Telecommunication services	Y	Y	Removed/area rehabilitated	N
	Steam boiler room	Y	Y	Removed/area rehabilitated	N
	Fire protection systems	Y	Y	Y	Decommissioned
	Crushing plant	Y	Y	Removed/area rehabilitated	N

Category	Infrastructure	Project Phases			
		Construction	Operations	Closure	Post-closure
Transportation corridors	East access roads	Y	Y	Y	Restricted access for monitoring activities (TMF dam)
	West access road	Y	Y	Decommissioned	N
	On-site roads	Y	Y	Graded, scarified, and revegetated	N
	Railway corridor	Y	Y	Removed, dismantled, and rehabilitated	N
	Waldorf River bridges	Y	Y	Y	N

N = no; TMF = tailings management facility; Y = yes.

It should be noted that Project components will be designed and constructed in accordance with all applicable laws and regulations, industry standards, and codes and will incorporate and accommodate any anticipated effects of the environment. Additionally, various plans developed for the Project include mitigation and monitoring related to potential effects of natural and climate-related hazards on the Project and surrounding environment. These can be found in Annex 5, Management Plans, which includes the Emergency Response Plan (Annex 5C), Environmental Protection Plan Table of Contents (Annex 5D), Environmental Effects Monitoring Program (5E), Sediment and Erosion Control Plan (Annex 5F) and Waste Management Plan (Annex 5H).

The Project will comply with the *Newfoundland Occupational Health and Safety Act*, as well as the requirements of all other relevant municipal, provincial, and federal authorities. In case of a discrepancy, the more rigid requirements shall govern.

19.4.1 Extreme Temperatures

19.4.1.1 Environmental Conditions

The daily average temperatures at the Project site range between -21.7°C and 14.1°C, with the lowest average temperatures occurring in January and the highest occurring in July. Extreme daily minimum and maximum temperatures range between -46.8°C (February 3, 2015) and 32.6°C (July 1, 2002). For additional information on temperature conditions at the Project site, see Chapter 5: Air Quality and Climate.

As described in Section 19.3, Identification of Relevant Hazards these temperature conditions are projected to change in the future. In the Atlantic region of Canada, the annual temperature has increased by 0.7°C, primarily during the summer season (Dietz and Arnold 2021). In Newfoundland and Labrador, air temperature increases are expected to be most pronounced in winter, with smaller increases in summer and autumn (CRA 2015).

In addition to changes in magnitude, the frequency of certain temperature extremes is also expected to change. Extreme hot temperatures are expected to become more frequent, while extreme cold temperatures less frequent. For example, under a high-emission scenario (RCP8.5), the annual highest daily temperature that would currently be attained once every 10 years, on average, will become a once in two-year event by 2050 – a five-fold increase in frequency. The annual highest daily temperature that occurs once every 50 years in the current climate is projected to become a once in five-year event by 2050 – a 10-fold increase in frequency. These projected changes indicate not only more frequent hot temperature extremes, but also relatively larger increases in frequency for more rare events (e.g., 10-year extreme versus 50-year extreme) (Zhang et al. 2019). As seen in Table 19-2, the annual number of hot days (days >30°C) and the average summer maximum temperature are both projected to increase under all emissions scenarios.

In regions that currently experience hot days, the increase may be more than 50 days by the late century under RCP8.5. Areas with hot days will progressively expand northward, depending on the level of global warming. The number of frost days and ice days is projected to decrease, with projections ranging from about 10 fewer days in 2031–2050 under the low-emission scenario (RCP2.6) to more than 40 fewer days in 2081–2100 under the high-emission scenario (RCP8.5) (Zhang et al. 2019). As seen in Table 19-2, the number of days with minimum temperatures below -15°C is also projected to decrease under all emissions scenarios.

19.4.1.2 Potential Effects on the Project

<u>Open Pit – Rose Pit</u>

Temperature fluctuations such as periods of high heat following periods of heavy rain can result in swelling and shrinkage of soils. This can result in cracking, sloughing, and slope instabilities, which has already been observed on embankment slopes around site. Slope issues in the pits can affect safety and production.

Ore Processing Infrastructure

Extreme temperature changes, including extreme heat and extended cold spells, may overwhelm the capacity of the heating, ventilation, and air cooling systems of the buildings needed to support the facility demands, causing thermal discomfort and unsuitable working conditions.

Increased temperatures and extreme heat could cause degradation of buildings and insulation, which would reduce the life expectancy of the buildings. Extreme heat may also overwhelm performance of the electrical and instrumentation equipment and cause overheating of transformers, leading tom equipment breakdowns, plant shutdowns, and environmental risks.

Extreme heat could increase risk of fire in dusty areas (e.g., conveyor fires).

Extreme cold could cause freezing of pipes and equipment that may affect on-site management of water, treated sewage, and tailings. Extreme cold can also cause the breakage of the rock breaker and freezing of garage doors during Operations.

Waste Management Infrastructure

Extreme heat may influence the effectiveness of mine waste management strategies, which may in turn affect water management and treatment needs.

Increased temperatures could lead to algal blooms with associated pH changes and other aquatic and aesthetic risks.

Extreme heat and drought could cause:

- effects on water availability and a site water imbalance,
- a reduction in water resources needed for cooling water affecting Operations or leading to turbine inefficiencies.

Extreme heat and drought could also cause the water stored in the normal storage facilities to be low and therefore require water to be sourced from other storages affecting production (e.g., water needed for mining and metal operations for cooling, crushing, grinding, milling ore, slurry transport, tailings storage, and dust mitigation activities).

Extended cold spells could create a risk of freezing water in lines/pumps/infrastructure.

Extreme temperatures can cause operational disruptions. Extreme cold can lead to longer water treatment processes.

Both extreme heat and cold can cause breakage of filters or samples (used for environmental monitoring), which could lead to regular non-compliance.

Supporting Infrastructure

Extreme heat may increase the demand of the energy system overwhelming the capacity of the production plant. Extreme heat may increase dust generation and affect dust mitigation activities. Extreme heat may affect water availability and cause on-site water imbalance. Reduction in water may affect dust mitigation activities. Extreme temperatures can cause tracks to buckle and tires or brakes to malfunction, beyond unsafe working conditions for workers on site and in construction worker accommodations.

Extreme cold may increase the demand of the energy system overwhelming the capacity of the production plant. During extended cold periods, ice build up could affect ventilation intakes/outtake. Extreme cold may cause physical damage to the production plant causing loss of on-site heat and electricity.

Transportation Corridors

Extreme temperature variations can cause rail failure due to rapid temperature change of 20 degrees in less than 12 hours.

Extreme heat could lead to dustier conditions as the hot weather can dry out the road surface and singular water truck might not keep up. Roads may be vulnerable to the effects of extreme heat as it might cause pavement softening. Roads may be vulnerable to the effects of extreme heat in combination with high winds resulting in dust problems, creating health and safety issues, as well as negatively affecting adjacent communities.

Extreme cold may affect the roads causing cracks or potholes due to temperature fluctuations. Extreme cold can cause difficulties releasing brakes on railcar air systems.

19.4.1.3 Mitigation Measures

Open Pit – Rose Pit

A pumping system will be installed at the bottom of Rose Pit for pit dewatering, management of pit wall run-off and pit infiltration. Two permanent sump pumps located within Rose Pit are proposed to manage the contact water before it is pumped to the Rose Pit collection pond. The Rose Pit collection pond will be built within the existing Elfie Lake and End Lake. This system will be in function continually for 12 months a year to transfer run-off and infiltrated water from the Rose Pit.

Scaling will be implemented to remove loose rocks, radar technology to detect faults or movements, geotechnical data analysis to assess soil and rock stability, adhering to distance standards to maintain safe distances between structures, and pre-cutting stop techniques to manage stress and prevent uncontrolled collapses.

Ore Processing Infrastructure

Mechanical equipment would be inspected for damage after extreme temperature days. The process plant will be designed for the site-specific future climate conditions and load requirements of all seasons, including peak loads during winter months.

Ventilation of critical areas susceptible to overheating may be inspected.

Infrastructure will be inspected for potential damage after major freeze/thaw events in the spring. All dual piping will be designed and installed to standards that are designed for regional weather.

All materials used for construction of site buildings will comply with applicable building codes for anticipated temperatures and will maintain designed structural integrity. The Emergency Response Plan includes responses to extreme weather conditions, including heat.

In the event of a power outage, Champion will access emergency power using diesel-powered gensets. Three 2,500 kW generator sets will provide backup power to the plant and maintenance shop for selected process loads and critical components requiring emergency power in case of a power failure.

Waste Management Infrastructure

Small quantities of hazardous material (drums, cans and other containers under 20 L volume) will be stored in a secure location protected from weather and freezing, as well as vehicle traffic. Daily equipment inspections will be conducted for leaks or damage.

Routine inspection and maintenance of containment and conveyance structures will be conducted. Process water would be recycled as much as possible to minimize the requirements for fresh water.

Collection ponds and pumping systems associated with the overburden stockpile and mine rock stockpile will be brought to their minimal level in the fall, will be shut down during winter and will be started before spring thaw.

Filters will be stored in a temperate place and controlled environment; sampling will be rescheduled in occurrence of extreme temperatures.

The proposed overburden and mine rock stockpiles will be designed for Closure using an ascending benched construction sequence that will integrate progressive rehabilitation activities during Operations and enhance stability.

The stockpiles have been designed with reduced steepness for stability and to meet reclamation requirements for Closure.

The volume of water in the tailings management facility (TMF) pond will be managed to reduce risk of dam instability and seepage, and will require consideration of seasonal influences and contingencies for processing water demands. A monthly water balance, considering climate change, was completed to identify the operational water management requirements for the TMF.

During Operations, a systematic performance monitoring program will be implemented to maintain the physical integrity of the dams and ancillary structures at the TMF. Such a program will include regular visual inspections, engineering inspections and specific inspections following extreme events (Annex 5B).

Supporting Infrastructure

The production plant would be designed for the site-specific climate and load requirements of all seasons. Mechanical equipment, as well as ventilation systems, would be inspected for damage after extreme temperature days.

Process water would be recycled as much as possible to minimize the requirements for fresh water.

Safety procedures would be in place to address worker safety, and would include reducing traffic speeds, addressing road conditions as quickly as possible, and if necessary, issuing work stop orders.

Backup generators would be available to run power to critical systems in the event that power supply is interrupted.

Transportation Corridors

Track instrumentation (fibre optics – continuity detector) will be installed along the track to identify rail breaks.

Routine inspection and maintenance would be conducted for access roads, and repairs would be completed as necessary.

Increased watering would be implemented when needed to combat dust.

Inspection of railcar air systems will be conducted, systematic drainage of air system for winter season.

Standard subgrade construction techniques are expected to be applied taking into consideration the anticipated environmental conditions.

Mitigation measures to prevent derailments include the following:

- Manual inspection of rolling stock will be undertaken before trains are loaded at the mine site to confirm there are no problems with wheels, couplers, car bodies, or brakes. Defective equipment will be removed from the train and kept out of service until repaired.
- Track inspections (both manual and electronic) will be carried out in accordance with Transport Canada regulations to identify track defects that could lead to derailment.

19.4.1.4 Potential Effects on the Environment

With implementation of design standards and codes, combined with engineering best practices as proposed, extreme temperatures are not considered to have the potential to substantively damage Project infrastructure or components during all phases of the Project, or result in a major environmental effect. There are no anticipated secondary effects associated with the effects of extreme temperatures on the Project.

With the mitigation measures outlined above and the development of an adaptative management plan it is expected that the Project will be resilient to major extreme temperatures.

19.4.2 Major Precipitation Events

19.4.2.1 Environmental Conditions

Total annual average precipitation in the Wabush area was 860.1 mm, with 458.9 cm of snow and 526.8 mm of rain. The monthly average precipitation ranged between 38.1 to 119.9 mm, with the least precipitation in February and the most occurring in August. Extreme daily rainfall was 65.4 mm on August 20, 2010, and the extreme daily snowfall was 45.2 cm on February 15, 2007. The precipitation data from the Wabush area stations were considered in the water balance and water quality model technical data report (TSD VI). The mean annual precipitation between 2013 and 2022 at the Wabush Airport 1 and 2 stations is approximately 20% less than the mean annual precipitation over the 1961 to 2012 period (TSD VI). This difference is mostly due to known issues with the measurement of solid phase precipitation (i.e., gauge undercatch for solid precipitation can reach 20% to 35%, depending on meteorological conditions, the precipitation gauge, and the wind shield used). For additional information on precipitation conditions at the Project site, see Chapter 5.

Canada's annual precipitation has increased in all regions since 1948, with relatively larger percentage increases in northern Canada and parts of Atlantic Canada, although there is low confidence in observed regional precipitation trends. In the future, annual and winter precipitation is projected to increase in all regions, with larger relative changes for the North. Daily extreme precipitation (that is, changes in extreme precipitation amounts accumulated over a day or less) is projected to increase; thus, there is potential for a higher incidence of rain-generated local flooding (Cohen et al. 2019).

In the Atlantic region of Canada, annual mean precipitation has increased by 11% from 1948 to 2012, with seasonal trends ranging from 5.1% in winter to 18.2% in fall, although there is low confidence in these trends (Cohen et al. 2019). Annual precipitation for 2031–2050 is projected to increase by 3.8% (−0.8, 9.1) for a low-emission scenario (RCP2.6) to 5.0% (0.6, 9.9) for a high-emission scenario (RCP8.5), and by 4.7% (0.3, 9.0) (RCP2.6) to 12.0% (5.7, 19.3) (RCP8.5) for 2081–2100 (Cohen et al. 2019).

As seen in Table 19-2, the frequency and intensity of heavy precipitation events are projected to increase in the Project area.

19.4.2.2 Potential Effects on the Project

Open Pit – Rose Pit

Extreme precipitation may cause water infiltration into the pit, resulting in:

- wall movement and pit wall failure related to the dewatering of the pit
- a change in dewatering requirements
- flooding of the pit, dewatering pumps, and equipment which in turn can lead to loss of production
- effects on health and safety

Longer-term, increased water quantity can extend the length of "peak" periods of water management and release requirements to address extended durations of pit floor flooding occurrences.

More intense rainfall events will require changes to the design requirements for bench transfer sumps, their respective spillways and also diversion drains.

Ore Processing Infrastructure

Extreme precipitation events may result in structural damage of the structures. Increased precipitation may lead to water retention on the structures and cause potential run-off into walls.

Increased precipitation and snowmelt may cause flooding in the building areas. Precipitation can cause run-off from non-potentially acid generating stockpiles by saturating the material and carrying away sediments and contaminants

Increasing precipitation could cause the collapse of the underground tunnel housing the mill belt conveyor, resulting in safety hazards and financial losses. Increasing precipitation could also lead to water infiltration in tunnels 420/2520, water infiltration in the roof during maintenance and lateral displacement of buffer conveyors during Operations.

Waste Management Infrastructure

Precipitation events may affect the effectiveness of managing peak discharges of run-off from waste storage facilities, such as the stockpiles. An increase in the number of high rainfall days or total rainfall can increase the amount of water on the tailing's facility. More water on the tailings facility can result in a larger pond volume, wetter beaches, and inability of the effluent treatment plant to reduce the volume of water. This in return can result in additional groundwater effects and lower consolidated tailings density, requiring a larger tailings facility for the same tonnage of tailings. Should the effluent treatment plant and/or other decant systems not be able to handle the water volume, it could lead to overtopping and tailings failure, which could have effects on the surrounding environment.

Water Management Infrastructure

More intense rainfall events could affect the design requirements for bench transfer sumps, their respective spillways, and also diversion drains; additionally, it could increase erosion on slopes and affect the slope stability/erosion during Operations.

Extreme precipitation may cause failure of localized slope stability and run-off from the stockpiles.

Extreme precipitation, including snowmelt, rainfall, and freezing rain, can lead to flooding and surface water run-off and overflow, which could affect fish habitat or result in an unauthorized discharge. Changes to the flow of water through the Project site as a result of changes in snowfall may damage water management infrastructure and containment structures. Flooding at the mine can affect tailings and cause damage to equipment such as tunnels, making the site inaccessible. An increase in precipitation could result in risks associated with spillways, discharge siphons, decant system, water treatment, and pumps and piping being too small. It could also affect water quality and can lead to non-compliance of discharge water, resulting in effects on the surrounding environment.

Supporting Infrastructure

Extreme precipitation, including snowmelt, rainfall, and freezing rain, can lead to flooding and surface water run-off. Increasing extreme precipitation may result in structural damage to the structures. Increased precipitation may lead to water retention on the structures and cause potential run-off into walls. Increased precipitation and snowmelt may cause flooding in the building areas. Water accumulation can lead to corrosion and potential leaks, affecting the valve system.

Freezing rain can affect electrical infrastructure and create hazardous, slippery conditions. These events can lead to power outages, reduced heating capacity, and unsafe working conditions, potentially resulting in site closure.

Transportation Corridors

Extreme precipitation, including snowmelt, rainfall, and freezing rain, can lead to flooding and surface water run-off. These events have the potential to disrupt rail services by washing away rails and submerging tracks in low-lying areas. Increased precipitation could cause road washouts, which might limit access to the Project site. Heavy snowfall events and extended freshet could restrict road access to the site.

19.4.2.3 Mitigation Measures

The following sections provide infrastructure-specific mitigation measures for droughts and wildfire. **Chapter 18, Accidents and Malfunctions**, outlines additional mitigation for potential effects from precipitation, such as flooding and overtopping.

Open Pit – Rose Pit

Actions will be taken to reduce the risks of wall movement and failures, including health and safety and production effects. Groundwater levels around the pit will be monitored against the target pore pressures set in the slope stability analysis. An action plan with trigger pore pressures and a contingency plan will be developed to prevent pore pressure increase greater than the set target value. Infiltration into the pit will mainly be run-off, as groundwater level target is set to be 20 m below the base of the pit. The pumps managing run-off will be designed to handle exceptional rainfall. A weather monitoring system will be established to evacuate the pit preventively in the event of an anticipated major deluge.

The design of the pit (including dewatering plans) and associated drainage design take into account future changes to climate.

As part of the Rehabilitation and Closure Plan, the flooding of the Rose Pit will be accelerated with limited recontouring to support stability, while maintain surface flow rates in surrounding water bodies. Temporary access control measures will be in place during the flooding period (anticipated to be approximately 10 years). Passive surface water drainage will be re-established following the pit-flooding period.

The overburden slopes of the Rose Pit area will also be benched and will be designed with consideration for water diversion and collection. Slopes will be designed with a minimum long-term safety factor of 1.5.

The open pit and associated infrastructure will be designed to accommodate estimated mine water inflows based on field hydraulic properties of the overburden materials and bedrock determined from field investigations.

Ore Processing Infrastructure

Ditches have been designed to allow rainwater to flow via gravity into the closest site run-off collection basin, where it would eventually be pumped into the closest collection pond or into the TMF for treatment and further discharge.

As outlined in the Environmental Effects Monitoring Program (Annex 5E), contact water (from mine disturbance areas) and non-contact water will be collected, subjected to treatment and discharged to the receiving water body (i.e., Duley Lake) in compliance with *Metal and Diamond Mining Effluent Regulations* discharge requirements. During Construction and Operations, Champion will collect surface water samples for monitoring purposes according to the associated regulations.

Scaling will be implemented to remove loose rocks, radar technology to detect faults or movements, geotechnical data analysis to assess soil and rock stability, adhering to distance standards to maintain safe distances between structures, and pre-cutting stop techniques to manage stress and prevent uncontrolled collapses.

The process plant and associated facilities including infrastructure such as site buildings, roadways, transmission lines, and sedimentation ponds will be designed and constructed in accordance with all applicable laws and regulations, industry standards, and codes and will incorporate and accommodate any anticipated effects of the environment.

Waste Management Infrastructure

As part of the commitment/monitoring requirements defined in the Environmental Effects Monitoring Program (5E), run-off from stockpiles will be managed as required. Surface drainage is designed to prevent flooding of stockpile areas. Surface water run-off from the overburden stockpile will be collected in the ditches surrounding the landform.

The Emergency Response Plan (Annex 5C) addresses potential flooding under future conditions. Enhanced monitoring systems could be implemented to provide real-time data on water levels and precipitation, allowing for proactive management. Vegetation and soil stabilization techniques could be used to reduce erosion and improve slope stability.

Potential effects on fish and fish habitat and the surrounding environment will be mitigated through measures identified In Chapter 9, Fish and Fish Habitat.

The proposed disposal areas will be designed for Closure using an ascending benched construction sequence that will integrate progressive rehabilitation activities during Operations and enhance stability.

The stockpiles have been designed with reduced steepness for stability and to meet reclamation requirements for Closure.

Placement of the mine rock will begin at the low point of the disposal areas and will proceed in a series of lifts as the development of the mine and mineral processing dictate. Material obtained during the clearing and grubbing will be used to revegetate the bench and slope of the preceding lift as progressive rehabilitation progresses.

The mine rock disposal areas are designed using applicable codes and standards and therefore incorporate and accommodate the potential, predictable effects of the surrounding environmental conditions.

Excess water not required in the process water balance is directed to the water treatment plant prior to discharge to the environment. Excess water from the Rose Pit collection pond and TMF will discharge as effluent into Duley Lake via a diffuser. All effluent will be tested to meet *Metal and Diamond Mining Effluent Regulations* requirements prior to discharge.

The current preliminary design includes rockfill starter dams/dikes with low permeability till cores, and appropriate filter zones for compatibility between the till core and rockfill shell to prevent piping as a result of the seepage gradients. Seepage through the containment dams will be limited and seepage control measures implemented downstream with a combination of ditches and sumps to allow for proper monitoring and pumping back into the TMF. To the extent possible, tailings will be discharged from the dam crests to form an upstream beach that will encourage water drainage away from the perimeter dams.

As outlined in in the Erosion and Sediment Control Plan, sediment and erosion control measures consider seasonal precipitation fluctuations. A monitoring program be implemented to assess the effectiveness of the sediment and control measures. Additional monitoring events will be conducted in anticipation of or after storm events where the risk of erosion and sediment transport is increased.

<u>Water Management Infrastructure</u>

To account for the effects of climate change, the water management infrastructure (i.e., the TMF and water collection basins and ponds) for the Project was developed considering the increase in design rainfall (TSD II). Each collection basin would be located in a natural low point to minimize the number of pumps required to manage precipitation and run-off into the treatment plant. Emergency spillways provide increased stability protection by preventing water from overtopping the dam. Precipitation and snow melt run-off that comes into contact with potentially contaminated areas would be captured, collected, and directed to site run-off ponds or collection areas. Spills in snow will be contained close to the release point and treated in a similar manner used for spill containment within water. Contingency pumps will be installed, rounds of inspections of basins and ditches will be conducted during heavy rainfall.

During Operations, a systematic performance monitoring and inspection program will be implemented to maintain the physical integrity of the dams and ancillary structures at the TMF. Such a program will include regular visual inspections, engineering inspections and specific inspections following extreme events (Annex 5B).

A Dam Safety Plan (Annex 5B) will be implemented in accordance with the Canadian Dam Association Dam Safety Guidelines to mitigate environmental risk caused by extreme precipitation.

Ditches have been designed along the edges of all mine facilities, access roads, and around building pads to allow rainwater to flow via gravity into the closest site run-off collection basin, where it would eventually be pumped into the closest collection pond or into the TMF for treatment and further discharge.

As outlined in in the Erosion and Sediment Control Plan, sediment and erosion control measures consider seasonal precipitation fluctuations. A monitoring program will be implemented to assess the effectiveness of the sediment and control measures. Additional monitoring events will be conducted in anticipation of or after storm events where the risk of erosion and sediment transport is increased. Each fuel storage unit will be fitted with a locking valve system for the elimination of water inside the outer tank. The valve must be closed and locked except to drain precipitation.

<u>Supporting Infrastructure</u>

Safety procedures would be in place to address worker safety, including inspecting infrastructure for potential falling snow hazards, and if necessary, issuing work stop orders.

Electrical equipment would be inspected for damage after freezing rain events. Backup generators would be available to run power to critical systems in the event that power supply is interrupted.

Transportation Corridors

Roads will be adequately ditched so as to allow for good drainage. Routine inspection and maintenance of containment and conveyance structures (i.e., roadside ditches and culverts) would be conducted to limit the risk of road washout.

Standard subgrade construction techniques are expected to be applied taking into consideration the anticipated environmental conditions).

Mitigation measures to prevent derailments include the following:

- Manual inspection of rolling stock will be undertaken before trains are loaded at the mine site to confirm there are no problems with wheels, couplers, car bodies, or brakes. Defective equipment will be removed from the train and kept out of service until repaired.
- Track inspections (both manual and electronic) will be carried out in accordance with Transport Canada regulations to identify track defects that could lead to derailment.

19.4.2.4 Potential Effects on the Environment

With implementation of design standards and codes, combined with engineering best practices as proposed, major precipitation events are not considered to have the potential to substantively damage Project infrastructure or components during all phases of the Project, or result in a major environmental effect. There are no anticipated generational effects associated with the effects of major precipitation events on the Project.

With the mitigation measures outlined above and the development of an Adaptive Management Plan it is expected that the Project will be resilient to major precipitation events.

19.4.3 Severe Storms and High Winds

19.4.3.1 Environmental Conditions

The five-year (2018 to 2022) wind rose for the Wabush Airport station, depicting the wind speed in metres/second (m/s) and wind direction frequency, is provided in Figure 19-1. The prevailing winds are from the west, north, and south, but very rarely from the east. The highest wind speeds occur most frequently from the south and west directions and the lowest wind speeds occur most frequently from the east direction. Average monthly wind speeds range from about 12 to 15 km/h and extreme wind speeds of over 60 km/h can occur in autumn, blowing from the west or from the southwest directions. For additional information on existing wind conditions at the Project site, see **Chapter 5, Air Quality and Climate**.

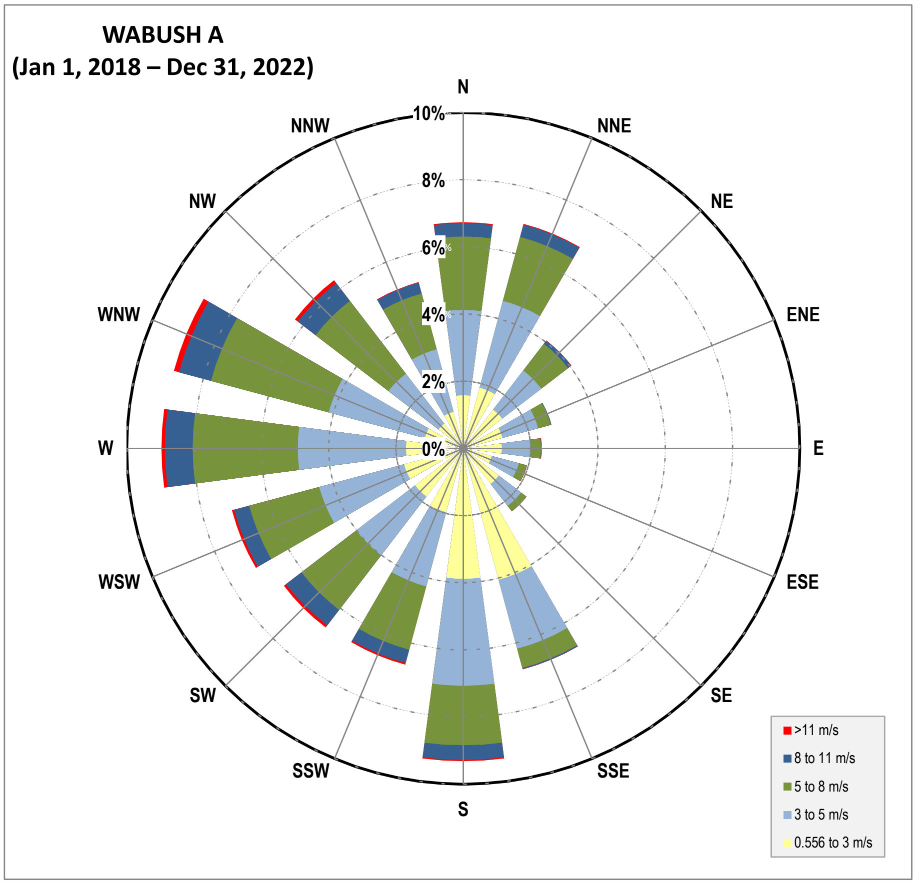

Figure 19-1: Wind Rose for the Wabush Airport (January 1, 2018, to December 31, 2022)

Based on a review of historical hurricanes in the Atlantic region, although the Project is located inland in Newfoundland there is potential for effects from hurricanes or post-tropical storms, which are expected to increase in frequency and intensity (Climatedata.ca 2024b).

As shown in Figure 19-1, the frequency of high winds is projected to increase under future climate scenarios.

19.4.3.2 Potential Effects on the Project

Open Pit – Rose Pit

An increase in droughts and high winds could cause increased dust amounts from the mine pits, leading to visibility and health and safety concerns.

Ore Processing Infrastructure

Severe thunderstorms could cause structural damage to the structures and buildings from strong winds, and result in power outages. Lightning associated with severe storms could damage the infrastructure and/or affect the electrical systems. Increased lightning could also affect production and worker safety.

Waste Management Infrastructure

An increase in high winds could cause physical damage to the structures, for example, the big tops being torn apart. Extreme winds can cause dust generation and deposition. These events can negatively affect site air quality and lead to the deposition of dust from aggregate stockpiles into nearby surface water bodies, affecting the region's water quality. Increased lightning could also affect production and workers' safety.

Extreme weather events, including high winds and storms, may lead to accumulation of debris on the pond, affecting drainage.

Supporting Infrastructure

Projected increase in high wind events could cause structural damage and/or failure of infrastructure, and worker safety due to a tornadoes or severe thunderstorms, including lightning, beyond disruption to energy transmission pathways, affecting operations. Ventilation fans may be vulnerable to extreme weather events, including high winds, tornadoes, and wildfires, that can cause structural damage to the systems. Increased winds may increase the dust generation activities and affect the efficiency of ventilation fans.

Transportation Corridors

Extreme weather events including high winds and storms may lead to accumulation of debris on the roads, affecting access to the facility and visibility. Road access to and from the site could become limited or restricted due to debris. This could lead to health and safety risks, slowing down or stopping operations, risks of equipment breakdown, exposure to silicosis, negative effects on social acceptance of the Project. Extreme wind may also affect the docking and filling of holds.

19.4.3.3 Mitigation Measures

Open Pit – Rose Pit

As part of the Rehabilitation and Closure Plan, the flooding of the Rose Pit will be accelerated with limited recontouring to support stability, while maintaining surface flow rates in surrounding water bodies. The Rehabilitation and Closure Plan will include monitoring of vegetation reclamation success.

Ore Processing Infrastructure

Safety procedures would be in place to address worker safety and, if necessary, work-stop orders would be issued if structural concerns are identified.

Backup generators would be available to run power to critical systems in the event that power supply is interrupted.

Lightning arresters will be installed at several locations on the mine site. electrical energy storage for plants could be considered.

The process plant and associated facilities including infrastructure such as site buildings, roadways, transmission lines, and sedimentation ponds will be designed and constructed in accordance with all applicable laws and regulations, industry standards, and codes and will incorporate and accommodate any anticipated effects of the environment.

All materials used for construction of site buildings will comply with applicable building codes for anticipated winds and will maintain designed structural integrity. All sediment and erosion control measures designed for the mine site will be designed to handle extreme seasonal fluctuations (rainfall, snowfall, and melt). The Emergency Response/ Plan includes responses to severe weather conditions.

In the event of a power outage, Champion will access emergency power using diesel-powered gensets. Three 2,500 kW generator sets will provide backup power to the plant and maintenance shop for selected process loads and critical components requiring emergency power in case of a power failure .

Waste Management Infrastructure

The cover systems for the stockpiles would be vegetated to reduce the potential for soil erosion from wind and water. Dry material will be wetted or covered to prevent blowing dust. Temporarily exposed soil and material stockpiles will be protected against wind erosion. Weather will be monitored for periods of high wind and dust suppression measures and/or control of activities will be implemented to mitigate excess dust generation. Erosion control protocols set out in the Environmental Protection Plan will be followed.

The external slopes of the mine rock stockpile will be constructed with a 3.5H:1V slope to avoid resloping at reclamation. The Rehabilitation and Closure Plan will be developed that will be adaptive to changing site-specific conditions.

Routine inspection and maintenance of containment and conveyance structure will be conducted.

As outlined in in the Erosion and Sediment Control Plan (Annex 5F), sediment and erosion control measures consider seasonal precipitation fluctuations. A monitoring program will be implemented to assess the effectiveness of the sediment and control measures. Additional monitoring events will be conducted in anticipation of or after storm events where the risk of erosion and sediment transport is increased. During Operations, a systematic performance monitoring and inspection program will be implemented to maintain the physical integrity of the dams and ancillary structures at the TMF. Such a program will include regular visual inspections, engineering inspections and specific inspections following extreme events (Annex 5B).

Supporting Infrastructure

Routine inspection and maintenance would be conducted to mitigate damage to the systems. The Emergency Response Plan (Annex 5C) includes responses to severe weather conditions. Fuel storage area will be well ventilated.

Transportation Corridors

Safety procedures would be in place to address worker safety, and would include reducing traffic speeds, addressing road conditions (e.g., snow removal, sanding) as quickly as possible, and if necessary, issuing work stop orders. Any vehicles carrying waste off site will be secured to prevent windblown or other loss of load during transportation. As necessary, the contractor will implement dust suppression measures such as watering the roads (water trucks). Access roads will be monitored for signs of erosion and repaired as necessary. Vegetation clearing will be minimized to maintain existing trees and shrubs where possible to act as windbreaks and natural erosion prevention. In case of extreme wind, loading rate will be adjusted, stacker-reclaimers will be secured by tying them down, or personnel will wait for wind to diminish.

Standard subgrade construction techniques are expected to be applied taking into consideration the anticipated environmental conditions.

Mitigation measures to prevent derailments include the following (Alderon 2012):

- Manual inspection of rolling stock will be undertaken before trains are loaded at the mine site to confirm there are no problems with wheels, couplers, car bodies, or brakes. Defective equipment will be removed from the train and kept out of service until repaired.
- Track inspections (both manual and electronic) will be carried out in accordance with Transport Canada regulations to identify track defects that could lead to derailment.

19.4.3.4 Potential Effects on the Environment

With implementation of design standards and codes, combined with engineering best practices as proposed, severe storms are not considered to have the potential to substantively damage Project infrastructure or components during all phases of the Project, or result in a major environmental effect. There are no anticipated generational effects associated with the effects of severe storms on the Project.

With the mitigation measures outlined above and the development of an adaptative management plan it is expected that the Project will be resilient to severe storms.

19.4.4 Droughts and Wildfires

19.4.4.1 Environmental Conditions

Across Canada, droughts have, for the most part, been variable, with no clear increasing or decreasing trends (Cohen et al. 2019). This variability corresponds to observed year-to-year and multi-year variations in precipitation, which are influenced by naturally occurring large-scale climate variability (Cohen et al. 2019).

Local knowledge and experiences indicate that wildfires occur in the region and have occurred recently. A large fire occurred in the Town of Fermont in July 2024 (Le Journal de Montréal 2024). This wildfire, originating in Labrador and driven by strong winds, grew to a size of 12,000 hectares and crossed into Québec. The fire prompted evacuation alerts and affected air quality due to dense smoke. Although the fire did not cause extensive damage to the town itself, it forced Québec Iron Ore to suspend their operations at Lac Bloom mine site and posed a threat to the region.

The changing frequency of temperature and precipitation extremes can be expected to lead to a change in the likelihood of events such as wildfires and droughts. Higher temperatures in the future will contribute to increased fire risk. The increase in precipitation that would be required to offset warming for most of the Forest Fire Weather Index (FWI) indices exceeds both projected and reasonable precipitation changes. Increases in fire spread days and extreme values of the FWI are projected. Several other studies also project increases in the FWI indices and the length of the fire season in Canada in the future. Although the magnitude of projected changes varied among these studies, most project increases in the FWI indices that correspond to higher fire risk (Zhang et al. 2019).

In a warmer world, most climate models project more frequent, longer-lasting warm spells; overall increased summer dryness in the middle-interior regions of North America; and earlier, less-abundant snowmelt (Trenberth 2011). Since Canada is projected to warm in all seasons under a range of emission scenarios, drought risk is expected to increase in many regions of the country. In summer, higher temperatures cause increased evaporation, including more loss of moisture through plant leaves (transpiration).

This leads to more rapid drying of soils if the effects of higher temperatures are not offset by other changes (such as reduced wind speed or increased humidity). How much summer droughts will increase in frequency and intensity depends on whether future summer precipitation will offset increased evaporation and transpiration. Smaller snowpacks and earlier snow and ice melt associated with warming temperatures could increase drought risk in the many snowmelt-fed basins across Canada that rely on this water source, as well as in regions that depend on glacial meltwater for their main dry-season water supply. Therefore, as temperatures rise, the threat of drought will increase across many regions of Canada (Bonsal et al. 2019). Figure 19-1 indicates there is no trend in the maximum length of consecutive dry period (days) under all emissions scenarios. However, the Standardized Precipitation and Evapotranspiration Index (SPEI 3-mth [month]) for warm months is projected to increase, potentially leading to drier conditions and increased risk of wildfires in the Project area.

19.4.4.2 Potential Effects on the Project

Open Pit – Rose Pit

An increase in droughts and high winds could cause increased dust amounts from the mine pits, leading to visibility and health and safety concerns.

Adequate water availability in reclaimed areas is a key component to successful reclamation, and drought conditions could affect the successful establishment of vegetation used in reclamation of the site. Unsuccessful revegetation activities could result in a delay in reclamation activities, additional costs adjusting or repeating revegetation, and potential for erosion during the period while the revegetation is unsuccessful.

Ore Processing Infrastructure

Drought-like conditions could cause inadequate water availability that is required to meet the demands for cooling, grinding, and milling.

Infrastructure would be vulnerable to damage from wildfires if a wildfire were to occur at or near the site. Wildfires could cause temporary suspension of activities due of danger to worker safety, discomfort, and unhealthy working conditions due to smoke inhalation.

Waste Management Infrastructure

Drought can affect the Project during its Closure phase by preventing the successful establishment of vegetation on rock stockpiles. Drought conditions can provide the opportunity for drier tailings beaches and smaller pond volumes and may also affect erosion protection effectiveness through effects on vegetation. Additionally, an increase in droughts and high winds could cause increased dust amounts from the tailings management, leading to visibility and health and safety concerns. Drought-like conditions may influence the effectiveness of mine waste management strategies, which may in turn affect water management and treatment needs.

Droughts may lead to lack of supply in potable water. Drought could also cause:

- effects on water availability and a site water imbalance
- a reduction in water resources that are needed for cooling water, affecting operations or leading to turbine inefficiencies
- water stored in the normal storage facilities to be low, therefore requiring water to be sourced from other storages affecting production. For example, water is needed for mining and metal operations for cooling, crushing, grinding, milling ore, slurry transport, tailings storage, and dust mitigation activities

Infrastructure would be vulnerable to damage from wildfires if a wildfire were to occur at or near the site. Wildfires could cause temporary suspension of activities due of danger to worker safety, discomfort, and unhealthy working conditions due to smoke inhalation. Infrastructure may be vulnerable to the effects of wildfires.

Wildfire could affect the drainage system constructed of high-density polyethylene. Increase in wildfire conditions could cause melting of high-density polyethylene pipelines, affecting water management on site.

Supporting Infrastructure

Infrastructure may be vulnerable to the effects of wildfires, including:

- temporary suspension of activities because of danger to worker safety, discomfort, reduced visibility, and unhealthy working conditions due to smoke inhalation
- loss of access to the Project site, affecting transportation of materials and staff
- contact with fuel storage tanks and the surface explosives magazine that could cause temporary suspension of operations
- structural damage to the Project infrastructure that could cause temporary suspension of operations

Transportation Corridors

Wildfires have the potential to cause interruption to rail service. These events could cause rail service providers to cancel or delay service. An increase in wildfire events could affect site access due to road blockage, reduced visibility, debris accumulation, and potential effects on the surrounding environment.

19.4.4.3 Mitigation Measures

Through the Project consultation, Labrador City highlighted that water bombers use Duley Lake to collect water for forest fires. This would support mitigation of effects on all infrastructure. The following sections provide infrastructure-specific mitigation measures for droughts and wildfire. Chapter 18, Accidents and Malfunctions, outlines additional mitigation for potential effects from fire.

Open Pit – Rose Pit

As part of the Rehabilitation and Closure Plan, the flooding of the Rose Pit will be accelerated with limited recontouring to support stability, while maintaining surface flow rates in surrounding water bodies. The Rehabilitation and Closure Plan will include monitoring of vegetation reclamation success.

Ore Processing Infrastructure

Process water would be recycled as much as possible to minimize the requirements for fresh water.

As outlined in in the Erosion and Sediment Control Plan (Annex 5F), sediment and erosion control measures consider seasonal precipitation fluctuations. A monitoring program will be implemented to assess the effectiveness of the sediment and control measures.

Fire protection systems will be located across the mine site. Each system contains a water tank and a diesel-powered fire water pump, except for the system covering the process plant, which contains an electrical pump with a diesel pump as backup. The mine rescue team would be trained and certified in effective structural and wildland firefighting techniques. Firefighting equipment will be readily available.

The Emergency Response (Annex 5C) includes responses to severe weather conditions, including wildfires.

Waste Management Infrastructure

The cover systems for the stockpiles would be vegetated to reduce the potential for soil erosion from wind and water. Revegetation of soil stockpiles will be promoted to prevent erosion and promote biological activity. Dry material will be wetted or covered to prevent blowing dust. Temporarily exposed soil and material stockpiles will be protected against wind erosion. Weather will be monitored for periods of high wind and dust suppression measures and/or control of activities will be implemented to mitigate excess dust generation. Erosion control protocols set out in the Sediment and Erosion Control Plan, and the Environmental Protection Plan will be followed.

The external slopes of the mine rock stockpile will be constructed with a 3.5H:1V slope to avoid resloping at reclamation. The Rehabilitation and Closure Plan will be developed that will be adaptive to changing site-specific conditions.

Routine inspection and maintenance of containment and conveyance structure will be conducted. Process water would be recycled as much as possible to minimize the requirements for fresh water.

Fire protection systems will be located across the mine site. Each system contains a water tank and a diesel-powered fire water pump, except for the system covering the process plant, which contains an electrical pump with a diesel pump as backup. Firefighting equipment will be readily available. The mine rescue team would be trained and certified in effective structural and wildland firefighting techniques. Storage of material from clearing and grubbing for future re-use will be established and managed in a manner that minimizes erosion, discharge of affected water, and risk of fire. Firefighting equipment will be readily available. Stockpiles, if required, will be built to allow easy access and inspection of the piles.

During Operations, a systematic performance monitoring program will be implemented to maintain the physical integrity of the dams and ancillary structures at the TMF. Such a program will include regular visual inspections, engineering inspections and specific inspections following extreme events (Annex 5B).

Supporting Infrastructure

Fire protection systems will be located across the mine site. Each system contains a water tank and a diesel-powered fire water pump, except for the system covering the process plant, which contains an electrical pump with a diesel pump as backup. Firefighting equipment will be readily available. The mine rescue team would be trained and certified in effective structural and wildland firefighting techniques.

Transportation Corridors

Fire protection systems will be located across the mine site. Each system contains a water tank and a diesel-powered fire water pump, except for the system covering the process plant, which contains an electrical pump with a diesel pump as backup. The mine rescue team would be trained and certified in effective structural and wildland firefighting techniques. Firefighting equipment will be readily available.

Standard subgrade construction techniques are expected to be applied taking into consideration the anticipated environmental conditions.

19.4.4.4 Potential Effects on the Environment

With implementation of design standards and codes, combined with engineering best practices as proposed, droughts and wildfires are not considered to have the potential to substantively damage Project infrastructure or components during all phases of the Project, or result in a major environmental effect. There are no anticipated generational effects associated with the effects of droughts or wildfires on the Project.

With the mitigation measures outlined above and the development of an adaptative management plan it is expected that the Project will be resilient to droughts and wildfires.

19.4.5 Severe Snowstorms

19.4.5.1 Environmental Conditions

The total annual average snowfall in the Wabush area is 458.9 cm (ECCC 2025). The highest extreme daily snowfall was 45.2 cm recorded on February 15, 2007 (ECCC 2025).

The Churchill-Wabush station, with records from 1972 to 2016, is the only dedicated snow station in the vicinity of the Project that measures snow accumulation. The annual maximum snow water equivalent measured at this station varies from 184 to 470 mm, with an average of 322 mm (TSD VI).

The proportion of precipitation falling as snow (i.e., the ratio of snowfall to total precipitation) is decreasing over southern Canada, particularly during spring and autumn (Vincent et al. 2015). It is likely that snow cover duration will decline to mid-century across Canada due to increases in temperature under all emission scenarios. Projections with a high-emission scenario show continued snow loss after mid-century (high confidence) (Cohen et al. 2019). Seasonal snow accumulation has declined over the period of record (1981–2015) on a country-wide basis (medium confidence) (Cohen et al. 2019). In association with warmer temperatures, seasonal changes in streamflow are expected to continue, including shifts from more snowmelt-dominated regimes toward rainfall-dominated regimes. Shifts toward earlier snowmelt-related floods, including those associated with spring snowmelt, ice jams, and rain-on-snow events, are also anticipated. However, changes to the frequency and magnitude of future snowmelt-related floods are uncertain (Cohen et al. 2019).

19.4.5.2 Potential Effects on the Project

Ore Processing Infrastructure

Heavy snowfall events may result in structural damage of the structures. Increased snowmelt may lead to water retention on the structures and cause potential run-off into walls.

Increased snowmelt may cause flooding in the building areas. Risk of snow sliding off the infrastructure could result in a health and safety risk, as well as access to the buildings.

Increasing snowstorms could cause the collapse of the underground tunnel housing the mill belt conveyor, resulting in safety hazards and financial losses.

Structures may be vulnerable to increased snow loads that may cause structural damage to the foundations and roofs.

Waste Management Infrastructure

Snowmelt can lead to flooding and surface water run-off and overflow, which could affect fish habitat or result in an unauthorized discharge. Changes to the flow of water through the Project site as a result of changes in snowfall may damage water management infrastructure and containment structures. Flooding at the mine can affect tailings and cause damage to equipment such as tunnels, making the site inaccessible. An increase in snowmelt could result in risks associated with spillways, discharge siphons, decant system, water treatment, and pumps and piping being too small. It could also affect water quality and can lead to non-compliance of discharge water, resulting in effects on the surrounding environment.

Water Management Infrastructure

Snowmelt can lead to flooding and surface water run-off with implications for discharge and effects on the surrounding environment, as described above.

Supporting Infrastructure

Increasing heavy snowfall events, may result in structural damage to the structures. Increased snow melt may lead to water retention on the structures and cause potential run-off into walls. Increased snowmelt may cause flooding in the building areas. Risk of snow sliding off the infrastructure could result in a health and safety risk, as well as access to the building. Water accumulation can lead to corrosion and potential leaks, affecting the valve system.

Transportation Corridors

Snowmelt can lead to flooding and surface water run-off. These events have the potential to disrupt rail services by washing away rails and submerging tracks in low-lying areas. Increased snowmelt could cause road washouts, which might limit access to the Project site. Heavy snowfall events and extended freshet could restrict road access to the site.

Severe snowstorms could affect vehicle operation at the site because of reduced traction and visibility and could increase the probability of vehicle accidents. It could also affect access to the site affecting transportation of staff.

Snowstorms may lead to accumulation of debris on the roads, affecting access to the facility and visibility. Road access to and from the site could become limited or restricted due to debris. This could lead to health and safety risks, slowing down or stopping operations, risks of equipment breakdown, exposure to silicosis, and negative effects on social acceptance of the Project.

19.4.5.3 Mitigation Measures

Ore Processing Infrastructure

Risks associated with severe snowstorms and snow loadings to facilities are managed through design criteria for the Project.

Ditches have been designed along the edges of all mine facilities, access roads, and around building pads to allow snowmelt to flow via gravity into the closest site run-off collection basin, where it would eventually be pumped into the closest collection pond or into the TMF for treatment and further discharge.

As part of the commitment/monitoring requirements defined in the Environmental Effects Monitoring Program (5E), run-off from stockpiles will be managed as required. Surface drainage is designed to prevent flooding of stockpile areas.

Scaling will be implemented to remove loose rocks, radar technology to detect faults or movements, geotechnical data analysis to assess soil and rock stability, adhering to distance standards to maintain safe distances between structures, and pre-cutting stop techniques to manage stress and prevent uncontrolled collapses.

Safety procedures would be in place to address worker safety and, if necessary, work-stop orders would be issued if structural concerns are identified.

The process plant and associated facilities including infrastructure such as site buildings, roadways, transmission lines, and sedimentation ponds will be designed and constructed in accordance with all applicable laws and regulations, industry standards and codes and will incorporate and accommodate any anticipated effects of the environment.

All materials used for construction of site buildings will comply with applicable building codes for anticipated temperatures, winds and precipitation (rainfall, snow and ice) and will maintain designed structural integrity. All sediment and erosion control measures designed for the mine site will be designed to handle extreme seasonal fluctuations (rainfall, snowfall and melt).

Waste Management Infrastructure

During Operations, a systematic performance monitoring program will be implemented to maintain the physical integrity of the dams and ancillary structures at the TMF. Such a program will include regular visual inspections, engineering inspections and specific inspections following extreme events (Annex 5B). The current preliminary design includes rockfill starter dams/dikes with low permeability till cores, and appropriate filter zones for compatibility between the till core and rockfill shell to prevent piping as a result of the seepage gradients. Seepage through the containment dams will be limited and seepage control measures implemented downstream with a combination of ditches and sumps to allow for proper monitoring and pumping back into the TMF. To the extent possible, tailings will be discharged from the dam crests to form an upstream beach that will encourage water drainage away from the perimeter dams.

During Operations, a systematic performance monitoring program will be implemented to maintain the physical integrity of the dams and ancillary structures at the TMF. Such a program will include regular visual inspections, engineering inspections and specific inspections following extreme events (Annex 5B).

Water Management Infrastructure

To account for the effects of climate change, the water management infrastructure (i.e., the TMF and water collection basins and ponds) for the Project was developed considering the increase in design rainfall (TSD II). Each collection basin would be located in a natural low point to minimize the number of pumps required to manage precipitation and run-off into the treatment plant. Emergency spillways provide increased stability protection by preventing water from overtopping the dam. Snow melt run-off that comes into contact with potentially contaminated areas would be captured, collected, and directed to site run-off ponds or collection areas. Spills in snow will be contained close to the release point and treated in a similar manner used for spill containment within water. Contingency pumps will be installed.

Supporting Infrastructure

Ditches have been designed along the edges of all mine facilities, access roads, and around building pads to allow snowmelt to flow via gravity into the closest site run-off collection basin, where it would eventually be pumped into the closest collection pond or into the TMF for treatment and further discharge. Each fuel storage unit will be fitted with a locking valve system for the elimination of water inside the outer tank. The valve must be closed and locked except to drain snowmelt.

Safety procedures would be in place to address worker safety, including inspecting infrastructure for potential falling snow hazards, and if necessary, issuing work stop orders.

Transportation Corridors

Ditches have been designed along the edges of all mine facilities, access roads, and around building pads to allow snowmelt to flow via gravity into the closest site run-off collection basin, where it would eventually be pumped into the closest collection pond or into the TMF for treatment and further discharge. Roads will be adequately ditched to allow for good drainage. Routine inspection and maintenance of containment and conveyance structures (i.e., roadside ditches and culverts) would be conducted to limit the risk of road washout.

Safety procedures would be in place to address worker safety, and would include reducing traffic speeds, addressing road conditions (e.g., snow removal, sanding) as quickly as possible, and if necessary, issuing work stop orders. The Emergency Response Plan (Annex 5C) include emergency prevention and response procedures for heavy snowfall events. Equipment used for snow clearing will be inspected at a minimum daily for leaks and damage. The location of all culverts must be marked with a post so they can be located during snow removal operations or if they become covered from debris accumulation.

Standard subgrade construction techniques are expected to be applied taking into consideration the anticipated environmental conditions.

Mitigation measures to prevent derailments include the following (Alderon 2012):

- Manual inspection of rolling stock will be undertaken before trains are loaded at the mine site to confirm there are no problems with wheels, couplers, car bodies, or brakes. Defective equipment will be removed from the train and kept out of service until repaired.
- Track inspections (both manual and electronic) will be carried out in accordance with Transport Canada regulations to identify track defects that could lead to derailment.

19.4.5.4 Potential Effects on the Environment

With implementation of design standards and codes, combined with engineering best practices as proposed, severe snowstorms are not considered to have the potential to substantively damage Project infrastructure or components during all phases of the Project, or result in a major environmental effect. There are no anticipated generational effects associated with the effects of severe snowstorms on the Project.

With the mitigation measures outlined above and the development of an adaptative management plan it is expected that the Project will be resilient to severe snowstorms.

19.4.6 Physiography

19.4.6.1 Environmental Conditions

The Kami Mining Project property is characterized by gentle rolling hills and valleys that vary in trend from northeast–southwest to north–south. The site has extensive lakes and wetlands. The ground elevations on the site range from about 560 to 700 m above sea level (TSD I, Tailings Management Facility Pre-Feasibility Study Report).

The proposed TMF area lies within a comparatively gently undulating terrain situated between the south end of Duley Lake to the west and Riordan Lake to the east. The elevation across the proposed tailings basin area varies from approximately elev. 560 m near Duley Lake rising inland to approximately elev. 600 m with some local rock knobs in the range of elev. 650 m to elev. 700 m. The prominent bedrock knob, located at the southeastern end of the tailings basin, and noted wet and swamp areas along the northern extent of the facility. The property area drains east or north into Duley Lake. A part of the property drains north into the Duley Lake Provincial Park before draining into Duley Lake. The proposed TMF area drains north into Duley Lake (Stantec 2012b). In the central property area, forest fires have helped to expose outcrops and the remainder of the property has poor outcrop exposure. The cover predominantly consists of various coniferous and deciduous trees with alder growth over areas exposed by forest fires. Drainage from the site is northward into Duley Lake. Riordan Lake is located east of the TMF and close to the site although run-off from the site does not drain into it. Riordan Lake also drains into Duley Lake (TSD I).

19.4.6.2 Potential Effects on the Project

Based on a review of the environmental conditions, effects on the Project due to the physiography are not expected, as the Project has been designed to accommodate the site physiography. Potential effects related to local geology, groundwater, and hydrology are described in Sections 19.4.7 to 19.4.9.

19.4.6.3 Mitigation Measures

Impacts on the Project due to the physiography are not expected and therefore mitigation has not been identified.

19.4.6.4 Potential Effects on the Environment

Impacts on the Project due to the physiography are not expected and therefore secondary effects on the environment are not expected.

19.4.7 Geology

19.4.7.1 Environmental Conditions

Surficial Geology

Overburden materials (quaternary sediments), consist of veneers of organic soils overlying sequences of glacial till, and occasional glacio-fluvial and fluvial deposits overlying bedrock (Stantec 2012a; TSD V).

Soil thickness ranges from nil to 90 m. It is interpreted that thicker blankets of overburden deposits are generally encountered in topographic lows and valleys thought to represent geologic structures such as rock fold depressions and faults, while bedrock, exposed or concealed by vegetation or thin overburden veneers are found along the crests of ridges (Alderon 2012).

Based on the variety of depositional environments thought to have occurred in the area (glacial melting, river flow, glacial damming, moraines) it is likely there will be broad range of surficial materials and characteristics, which may include sands and gravels (with varying proportions of silt, cobbles and boulders), bogs; silt deposits and occasional clay deposits (Alderon 2012).

Surficial glacial expressions in the form of eskers, and Rogen moraines have been described in the area. Two Rogen moraine features, typically thicker deposits variably composed of diamicton, gravel, sand and minor amounts of silt and clay, are located to the south of the property boundaries. One esker is located on the Project site, with several others outside and near the Project site. These sinuous, often dissected, elevated glaciofluvial landforms are composed of poorly sorted sands and gravels. Throughout the site are numerous boggy areas containing various thicknesses of peat, often with interconnected drainage gullies, streams, and brooks, with a high concentration in the northeastern portion of the property. Topsoil is assumed to be thin and discontinuous. Glacial erratics composed of large boulders may be encountered in the study area (Alderon 2012).

No landslides or any evidence of slow mass movement were observed from an examination of the existing aerial photographs.

Bedrock and Structural Geology

The Project site is underlain by folded, metamorphosed sequences of the Ferriman Group and includes—from oldest to youngest—Denault (Duley) Formation dolomitic marble (reefal carbonate) and Wishart Formation quartzite (sandstone) as the footwall to the Sokoman Formation. The Sokoman Formation includes iron oxide, iron carbonate, and iron silicate facies and hosts iron oxide deposits. The overlying Menihek Formation resulted from clastic pelitic sediments derived from emerging highlands into a deep-sea basin and marks the end of the chemical sedimentation of the Sokoman Formation (Alderon 2018). The Project site includes two iron oxide hosting basins juxtaposed by thrust faulting. The principal basin, named the Wabush Basin, contains the majority of the known iron oxide deposits on the Project site. Its trend continues north-northeast from the Rose Lake area for 9 km to Rio Tinto's Wabush 3 Open Pit Mine and beyond the Town of Wabush. The second basin, named the Mills Lake Basin, lies south of the Elfie Lake thrust fault and extends southwards, parallel with the west shore of Mills Lake. Each basin has characteristic lithological assemblages and iron formation variants. In some areas of the Project site, the Sokoman Formation is underlain primarily by Denault (Duley) Formation dolomite. In other areas of the Project site, both Denault (Duley) Formation dolomite and Wishart Formation quartzite units are present (Alderon 2018).

19.4.7.2 Potential Effects on the Project

The site geology affects the open pit mine stability and how the pit slopes are designed. Given the nature of this Project, the geology of the site is the basis for the Project and design.

19.4.7.3 Mitigation Measures

Open pit mine slopes are generally designed based on Factor of Safety, which represents the ratio of resisting (stabilizing) forces to those of driving (failure) forces. The ultimate slopes of the Rose Pit area will be designed in accordance with these guidelines and will be based on the anticipated geological and structural condition and behaviour of the pit wall material, determined by review, geotechnical investigations, and stability analysis (Champion 2024).

Slope failures in competent rock masses are generally structurally controlled with a rock block or mass sliding or opening along pre-existing geological discontinuities. For bench-scale failures in competent rock, the orientation (dip/dip direction) of geological discontinuities relative to the bench face angle and azimuth will generally control slope stability. Similar structural control mechanisms of higher slopes generally require a high degree of continuity of structures, such as faults, bedding, and foliation (Alderon 2012).

For the purpose of conceptual slope design, the rock formations within the Kami Property have been classified into two general types (Alderon 2012):

- **Type 1**—massive rock formations (e.g., gneiss, quartzite, dolostone)
- **Type 2**—bedded or foliated formations (e.g., schist and iron formation)

For benches excavated in Type 1 rocks, and for Type 2 rocks in the hanging wall orientation, the key failure mechanisms that control bench geometry and stability include toppling on bedding, stepped-path plane failure, and ravelling. Bench widths are selected to control rock fall hazard and to provide rock fall catchment for ravelling debris (Alderon 2012).

On footwall slopes in Type 2 rocks, the assumed key failure mechanisms are plane failure and stepped planar failure along bedding. Consequently, bedding should not be undercut and the concept level assumption is that the batter angle or bench face angle of bench faces in foot walls will match the dip of the strata. The bench widths are selected to provide catchment for small failures and ravelling debris.

The overburden slopes of the Rose Pit area will also be benched and will be designed with consideration for water diversion and collection. Slopes will be designed with a minimum long-term safety factor of 1.5

The open pit and associated infrastructure will be designed to accommodate estimated mine water inflows based on field hydraulic properties of the overburden materials and bedrock determined from field investigations.

19.4.7.4 Potential Effects on the Environment

Given the design basis for the Project, potential effects on the surrounding environment are not anticipated.

19.4.8 Groundwater

19.4.8.1 Environmental Conditions

Regional hydrogeologic information was obtained from *The Hydrogeology of Labrador* (AECOM 2013). The Project area is characterized by rugged bedrock dominated uplands that have been carved by glacial erosion to form valleys, as a result, both surficial (till) and bedrock aquifers are present throughout the region. The deposits at the Project site are located within or below both surficial and bedrock aquifers which have been classified regionally as distinct hydrostratigraphic units.

It is expected that the surficial aquifers in the area will be largely controlled by topography, surface run-off and local recharge/discharge conditions, while the bedrock aquifers may be influenced by recharge at higher elevations. Groundwater flow in metamorphic and igneous rocks generally occurs through secondary porosity (e.g., fractures, joints and faults) which will become tighter and less frequent with increasing depth. The underlying bedrock aquifer is likely to be under semi-confining conditions due to widespread presence of blanket till. Groundwater flow directions generally follow topography and the surface water flow patters from southwest to northeast along the Churchill River watershed. Locally, groundwater moves from higher topography areas towards lakes, streams, and wetlands distributed across the site.

Groundwater depths vary across the site and generally reflect the topographic relief of the area. Groundwater levels varied from artesian conditions (maximum >2 m above ground) in low-lying and wetland areas to 13.55 m below ground surface (mbgs) at higher elevations. Topographic highs to the west (near Gleeson Lake) and southeast of the pit (near Elfie Lake) act as preferential recharge areas, whereas the centre of the valley represents a local discharge area in alignment with Mid, Rose, and Pike Lake. Groundwater elevations range from approximately 537 metres above sea level (masl) near the Waldorf River crossing to 646 masl at the watershed divide near Gleeson Lake, a difference of approximately 109 m.

Continuous water level monitoring by dataloggers from 2013–2023 show that groundwater fluctuates seasonally, with decreasing water level during low recharge season (fall and winter), and spiking during the spring melt period where water levels remain relatively consistent throughout the summer months.

19.4.8.2 Potential Effects on the Project

Changes in groundwater levels and recharge rates (including those from climate change) may cause water infiltration into the pit, resulting in:

- wall movement and pit wall failure related to the dewatering of the pit
- a change in dewatering requirements
- flooding of the pit, dewatering pumps, and equipment which in turn can lead to loss of production
- effects on health and safety

19.4.8.3 Mitigation Measures

Actions will be taken to reduce the risks of wall movement and failures, including health and safety and production effects. Groundwater levels around the pit will be monitored against the target pore pressures set in the slope stability analysis. An action plan with trigger pore pressures and a contingency plan will be developed to prevent pore pressure increase greater than the set target value. Infiltration into the pit will mainly be run-off, as groundwater level target is set to be 20 m below the base of the pit. The pumps managing run-off will be designed to handle exceptional rainfall. A weather monitoring system will be established on the site to evacuate the pit preventively in the event of an anticipated major deluge.

The design of the pit (including dewatering plans) and associated drainage design take into account future changes to climate.

19.4.8.4 Potential Effects on the Environment

Effects on the Project from groundwater (namely changes in groundwater due to climate change), can have reciprocal effects on the surrounding environment including a disruption to the local hydrology and groundwater from changes in dewatering requirements. To mitigate these potential effects, follow-up and monitoring programs will be used to:

- identify unanticipated negative effects, including possible accidents and malfunctions
- contribute to the overall continual improvement of the Project

- evaluate the effectiveness of reclamation and other mitigation actions, and modify or enhance as necessary through monitoring and developing updated mitigation measures (if needed)

Chapter 18, Accidents and Malfunctions outlines additional mitigation for potential effects on the surrounding environment, including those associated with the pit slopes.

19.4.9 Hydrology

19.4.9.1 Environmental Conditions

The proposed Project would be situated within the existing Rose Pond, south of Pike Lake within the Churchill River watershed headwaters. The drainage pattern within the vicinity of the Project is directed north and east through a network of watercourses, lakes, and wetlands that are part of the Churchill River watershed headwaters. The west portion of the proposed Project site drains into Pike Lake, which then is collected by several lakes and streams connected to the Walsh River and discharging into Duley Lake from the north. The south portion of the proposed Project site follows an in-line lake pattern in the following order: Molar Lake, Mills Lake, and Duley Lake. The Waldorf River and several streams from the south and southeast drain into Duley Lake. One of these streams in the east connects Riordan Lake into Duley Lake. Finally, Duley Lake drains into Canning Lake and northwest into Harrie Lake.

During the 2023–2024 surface water campaigns, water level monitoring at six lake stations showed that water levels were generally observed to gradually decrease from June 2023 to August 2023 (spring to summer), gradually increase from August 2023 to October 2023 (summer to fall) correlating with rain events and again gradually decrease in winter months. The water levels were observed to increase from April 2024 that peaked in May 2024 and were attributed to spring freshest and/or beaver activity. The water levels generally reported a marked response to rain events except at two lake outlets (Duley Lake and Mills Lake) (Annex 2A, Surface Water Baseline Report).

Similar to lake water levels, water level monitoring at 12 watercourses showed that watercourse water levels were generally observed to gradually decrease from June 2023 to August 2023 (spring to summer), gradually increase from August 2023 to October 2023 (summer to fall) and again gradually decrease in winter months of 2023 and 2024. The water levels were observed to increase from April 2024 that peaked in May 2024 and were attributed to spring freshest and/or beaver activity. Flow and/or water level hydrographs at the watercourse and lake stations were in correlation with rain events generating moderate to high flows. Water levels at most of the watercourse stations exhibited a marked, but gradual response to major rain events, except three watercourse stations that exhibited rapid and flashy hydrologic response to precipitation events characterized by higher peaks with steep rising and falling limbs (Annex 2A). Additional information on hydrological conditions in the area of the Project can be found in **Chapter 8, Surface Water**.

19.4.9.2 Potential Effects on the Project

Changes in water levels in Duley Lake and Pike Lake can affect water takings for construction and operation of various infrastructure, including:

- dewatering of excavations for development of roads, facilities, and infrastructure
- dewatering of Rose Pit
- water diversion to create and maintain a dry work area for the construction of waterbody crossings and tailing management facility starter dam, if required
- water for drilling
- water for on-site concrete mixing and earthworks (compaction)
- water for washing concrete mixing equipment, concrete delivery systems, vehicles, and equipment as well as for work sites, and construction worker accommodations
- water for dust suppression at work sites and along access roads
- water for drinking and sanitation at worker accommodations, mine service area, and offices
- water for processing of iron ore

Changes in water levels in Duley Lake and Pike Lake can affect the ability of these resources to accommodate discharge of treated effluent as well as site drainage and run-off. It should be noted that the changes in water elevation in Duley Lake are unlikely to happen due to the size of its watershed and hydrological conditions.

19.4.9.3 Mitigation Measures

Watering taking will be completed in accordance with provincial standards and licence/permit conditions and industry best standards.

Process water will be recycled and reused, to the extent practical, to reduce freshwater intake and release to environment, to the extent practical.

An Environmental Effects Monitoring Program (Annex 5E) has been developed for the Project and includes surface water monitoring to confirm the effectiveness of mitigation measures as well as to maintain compliance with regulatory permits / approvals.

19.4.9.4 Potential Effects on the Environment

Effects on the Project from hydrology (namely changes in hydrology due to climate change), can have reciprocal effects on the surrounding environment including a disruption to the local hydrology and related biological systems from changes in the ability for the lake to accommodate surface run-off and dewatering. To mitigate these potential effects, follow-up and monitoring programs will be used to:

- verify that the water management infrastructure and facilities are operating as designed and evaluate effectiveness of the surface water protection plans
- monitor changes to surface water quantity, surface water, and sediment quality in the receiving environment due to Project activities
- verify the predictions of the EIS and confirm that the aquatic ecosystem in the receiving environment is protected
- contribute to the overall continual improvement of the Project
- evaluate the effectiveness of reclamation and other mitigation actions, and modify or enhance as necessary through monitoring and developing updated mitigation measures (if needed)

Chapter 18, Accidents and Malfunctions outlines additional mitigation for potential effects on the surrounding environment.

19.4.10 Permafrost

19.4.10.1 Environmental Conditions

The Project lies within the isolated patches permafrost zone, where between 0% and 10% of the land area is underlain by permafrost (Heginbottom et al. 1995). In addition, for any areas within this zone where there is permafrost, there is between 0% and less than 10% of ground ice content in the upper 10 to 20 m of the ground (Heginbottom et al. 1995; Annex 3A, Terrain and Soils Baseline Report).

Smith and Burgess (2002) provide a digital database of permafrost thickness in Canada, and within the database one site is located within the Wabush–Labrador City area. The site was initially discussed by Brown (1975) and the following information is from the 1975 publication. Brown (1975) notes that the distribution of permafrost in Québec and Labrador is more complicated than provinces farther west due to the hilly and mountainous relief. Except in areas of higher elevation, Brown (1975) suggests permafrost occurs in scattered islands varying in extent and thickness (Annex 3A).

Peat palsas were noted at the summit of Mont-Wright, Québec, at approximately 762 masl (Brown 1975), and located approximately 36 km southwest of Wabush, Labrador. No permafrost was found in the townsites of Wabush and Labrador City at an elevation of approximately 548 masl; however, permafrost was noted at an elevation of approximately 762 masl in nearby iron mines and found to depths exceeding 60 m (Brown 1975). The details of the permafrost identified in the iron ore mines were provided to Brown (1975) through personal communication, but no other details are given (Annex 3A).

As described in Section 19.3, temperatures are projected to increase in the future. These projected increases in mean air temperature over land underlain with permafrost under all emission scenarios will result in permafrost warming and thawing across large areas of Canada (Bush et al. 2019). Permafrost was not identified as a potential issue in the Alderon Iron Ore Corporation (Alderon) EIS (2012). In addition, it was not identified during the terrain mapping completed for the Project (Annex 3A), and frozen soil was not encountered during field investigations. If encountered it is anticipated that permafrost will be localized to specific landforms, such as topographic highs, where mean annual air temperatures are lower than regional (Annex 3A).

19.4.10.2 Potential Effects on the Project

Based on a review of the environmental conditions described above (Section 19.4.10.1), effects on the Project due to permafrost are not expected.

19.4.10.3 Mitigation Measures

Effects on the Project due to the permafrost are not expected and therefore mitigation has not been identified.

19.4.10.4 Potential Effects on the Environment

Effects on the Project due to the permafrost are not expected and therefore secondary effects on the environment are not expected.

19.4.11 Seismicity and Faulting

19.4.11.1 Environmental Conditions

Western Labrador is one of the lowest risk areas for seismicity in the country. The following sections outline the various faults in the region and their potential effects on the Project.

Katsao-Wishart Fault

The stability analysis carried out by Stantec in 2012a provided an initial characterization of the rock formation quality. Generally, the bedrock in the eastern part of the pit is of good quality, while that in the western part is of good to poor quality, with deep and intense weathering. The most significant area of weathering was noted at NR2 (Stantec 2012a). In this zone, the entire Wishart was observed in some boreholes to be weathered to poorly consolidated sand. In terms of groundwater flow, it appears that the entire Wishart Formation could be considered as a water-bearing structure with an average width of 50 m (TSD V).

Central Fault

Several potential fault intervals have been identified within the pit area. These highly fractured and altered zones feature pulverized rock horizons of varying thicknesses (between 20 and 50 m) and are mainly found within the Sokoman Formation, in the central part of the pit and referred to as the central fault in this report. The true thickness of these fractures has been interpreted between 20 and 40 m, based on boreholes analyses. In terms of groundwater flow, the central fault could be considered as a water-bearing structure with an average width of 30 m (TSD V).

Other Potential Faults

Stantec's Pit Slope Design report (2012a) mentions the presence of a potential fault in the Menihek unit (syncline axis). However, deep exploration holes have not confirmed the existence or location of this fault.

Interpreted sub-vertical dip-slip faults bisect the deposits, trending roughly northwest–southeast. Three of these major features have been interpreted by Alderon; however, it is understood that more structures may be present based on reviews of aerial imagery (TSD V). As a result of directional bias of the exploration boreholes, these structures are rarely intersected and are currently only interpreted through 3D geological interpolation (Stantec 2012a; TSD V).

Cut/Fill Slopes

The Kami iron ore deposit is a stratabound iron formation deposit. The iron formation is assumed to be ductile, medium-strong (or better) rock in which overall rock mass failure may only be a potential concern for slopes where the in situ stress exceeds the rock mass strength, or where the rockmass quality has deteriorated due to secondary leaching or weathering processes (Alderon 2012).

19.4.11.2 Potential Effects on the Project

Seismic activity, such as earthquakes, can trigger natural hazards including ground vibrations, landslides, liquefaction of saturated sediments, and surface rupture. These natural hazards can affect mine workings and surface-engineered structures such as water diversions and mine rock stockpile. Seismic activity can also result in work delays while stability is reassessed for the safety of the employees and continued production. However, given the low risk of seismic activity in the region, effects on the Project are not expected.

19.4.11.3 Mitigation Measures

Effects on the Project due to the seismic activity and faults are not expected; however, the Project infrastructure and features will be designed and constructed in consideration of the risk of seismic activity (Champion 2024).

19.4.11.4 Potential Effects on the Environment

Effects on the Project due to the seismic activity and faults are not expected and therefore secondary effects on the environment are not expected.

19.5 Summary

As described in Section 19.4, there is potential for effects on the Project from climate hazards, including, extreme temperatures, major precipitation events, severe storms, high winds, drought, wildfire, snowstorms, as well as geohazards such as geology, groundwater, and hydrology. As documented in Section 19.4, upon review, it was identified that physiography, permafrost, and seismicity are not anticipated to affect the Project.

A range of mitigation measures are incorporated into the Project, including both design features and operational practices that reduce the potential for effects. Section 19.4 also describes potential effects on the environment that occur as a result of the climate hazards and geohazards interacting with the Project. All Project components will be constructed, operated, and closed in accordance with governing federal, provincial, and municipal regulations, as well as industry regulations and standards. In addition to the mitigation measures outlined in Section 19.4, the Emergency Response Plan, Waste Management Plan, Water Management Plan, the Sediment and Erosion Control Plan, and Environmental Protection Plan, found in Annex 5, provide further mitigation to potential natural and climate-related hazards. With the mitigation identified for these effects, measurable residual effects are not expected.

Due to the uncertainty associated with climate change, the most effective mitigation measure at this time for climate and geohazards may change in the future. Assessing the efficiency of mitigation measures is crucial for decision-making and establishing additional measures. Therefore, mitigation measures must be adapted through continual improvement and an adaptative management plan.

With the mitigation measures outlined above, and the development of an adaptative management plan, it is expected that the Project will be resilient to potential effects of the environment, including the effects of climate change.

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