Appendix 21-A

Accident and Malfunction Assessment

DILLON CONSULTING

NWP COAL CANADA LTD.

Crown Mountain Coking Coal Project

Accident and Malfunction Assessment – Elk Valley, East Kootenay Region

February 2021 – 12-6231

February 10, 2021

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Attention: Michael Allen, P.Eng.
General Manager – Crown Mountain Coking Coal Project

Risk Assessment – Crown Mountain Coking Coal Project

On behalf of Dillon Consulting Limited (Dillon), we are pleased to present the findings of our assessments of the risks to NWP Coal Canada Ltd. (NWP) regarding the Crown Mountain coking coal project.

Within our report, we have included supporting information, reference documents, and have provided conclusions on NWP's risks with respect to safety, environment, operations, and regulatory. If there are any questions, please feel free to contact the undersigned at (403) 215-8885, ext. 4324 or at dpoole@dillon.ca.

Sincerely,

DILLON CONSULTING LIMITED

<Original signed by>

Dave Poole, M.Sc., P.Eng., CRM
Partner

DKT:clm

Our file: 12-6231

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Acronyms, Abbreviations, Definitions

– B –

Barrier: *are the safety measures or controls in a BowTie diagram. Barriers interrupt the scenario so that the threats do not result in the top event when control is lost over the hazard. Barriers can also ensure that the top event does not escalate into an actual impact (the consequences). Barriers in the BowTie appear on both sides of the top event.*[1]

BowTie*: the BowTie method is a risk evaluation method that can be used to analyse and demonstrate causal relationships in high risk scenarios. The method takes its name from the shape of the diagram that you create, which looks like a men's bowtie. A BowTie diagram does two things. First of all, a BowTie gives a visual summary of all plausible accident scenarios that could exist around a certain hazard. Second, by identifying control measures the BowTie displays what a company does to control those scenarios.*[2]

– C –

Consequence: *in BowTie methodology, a consequence is a potential event resulting from the release of the hazard, which results directly in loss or damage.*[3]

Criticality Scores*: a quantitative assessment of the extent to which a threat, top event, barrier, or consequence is effective in causing, resulting, controlling, or imposing negative outcomes respectively.*

– E –

Escalating Factor: *a condition that leads to increased risk by defeating or reducing the effectiveness of a control. For example: the risk of a fire would escalate if you conduct welding (the escalating factor) within proximity of an open pool of gasoline that just spilled from a tank.*

– H –

Hazard: *a chemical, physical, social, or political condition that has the potential to cause damage or any kind of harm to people, property, environment, or business continuity.*

[1] Refer to: https://www.cgerisk.com/knowledgebase/Barriers
[2] Refer to: https://www.cgerisk.com/knowledgebase/The_history_of_bowtie
[3] Section 3.1 – A Brief Description of Bowtie Methodology, BowTieXP Software Manual – for Release 9.2

– I –

Inherent Risk: *1) a risk which is impossible to manage or transfer away is said to be an inherent risk; 2) the risk that exists when no controls have been put in place; 3) the level of raw or untreated risk, that is, the natural level of risk inherent in process or activity without doing anything to reduce the likelihood or mitigate the severity.*

– L –

Level of Concern: *a qualitative assessment of the level of undesirability in accordance to an adverse consequence to safety, environment, operations, and regulatory. This includes both the likelihood and magnitude aspects of assessment.*

Level of Contribution: *a qualitative assessment of threats in terms of their likelihood of occurrence and the extent to which they are capable of triggering an undesired event.*

Level of Criticality: *the extent to which a threat, top event, barrier, or consequence is effective in causing, resulting, controlling, or imposing negative outcomes respectively.*

Level of Service: *Obligations for Canadian Pacific pursuant to s.113(1)(a to e) of the Canadian Transportation Act. A railway company shall, according to its powers, in respect of a railway owned or operated by it,*

> *(a) furnish, at the point of origin, at the point of junction of the railway with another railway, and at all points of stopping established for that purpose, adequate and suitable accommodation for the receiving and loading of all traffic offered for carriage on the railway;*
> *(b) furnish adequate and suitable accommodation for the carriage, unloading and delivering of the traffic;*
> *(c) without delay, and with due care and diligence, receive, carry and deliver the traffic;*
> *(d) furnish and use all proper appliances, accommodation and means necessary for receiving, loading, carrying, unloading and delivering the traffic; and*
> *(e) furnish any other service incidental to transportation that is customary or usual in connection with the business of a railway company*

Likelihood: *chance of something happening*[4]*. Often measured in qualitative terms such as low, medium, or high.*

[4] International Organization for Standardization (ISO) 31000:2018, Risk Management – Guidelines (ISO 31000)

– P –

Probability: *percentage chance of something happening[4].*

– R –

Residual Risk: *the remaining risk associated with a possible Undesired Event after all risk control measures have been taken. This is often contrasted with the inherent risk - the risk that exists before any risk controls have been applied.*

Risk: *the positive or negative level of uncertainty of an event. It is typically measured as the combination of the likelihood (or frequency) of an event with its consequences (or severity).*

Risk Analysis: *the process of understanding the nature of risk and its characteristics including likelihood and consequence.[4]*

Risk Assessment: *the process used to identify, analyze, and evaluate risk.[4]*

Risk Evaluation: *the process of comparing the risk results with the risk tolerance criteria and determining where further actions are required.[4]*

Risk Identification: *process of finding, recognizing, and describing risks.[4]*

Risk Matrix: *a visual tool (matrix) to represent the risk results taking into consideration the likelihood and the consequence.*

Risk Perception: *the subjective judgement regarding the risk of an activity.*

Risk Tolerance: *the degree of risk with which the community/individual is comfortable.*

– S –

Safety: *a judgment of acceptability of risk. A thing is considered "safe" if the risks are judged to be acceptable. An activity is considered "safe" if it has desired level of safety, as required by all stakeholders. There are degrees of risk and, consequently, there are degrees of safety. Higher safety = Lower risk. Safety means protection from danger and any hazards arising from, linked with, or occurring in the course of employment or business operations.*

– T –

Threat: *often there are several factors that could cause the top event. In BowTie methodology, these are called threats. These threats need to be sufficient or necessary: every threat itself should have the ability to cause the top event. For example: corrosion of the pipeline can lead to the loss of containment.*[3]

Top Event: *As long as a hazard is controlled it is in its wanted state. For example: oil in a pipe on its way to shore. However, certain events can cause a deviation of or loss of control over the hazard. In BowTie methodology, such an event is called the top event. The top event is not a catastrophe yet, but the dangerous characteristics of the hazard are now in the open. For example: oil is outside of the pipeline (loss of containment). Not a major disaster, but if not mitigated correctly it can result in more unwanted events (consequences).*

– U–

Undesired Event: *an event that has the potential to cause adverse effects on people, property, environment, productivity, reputation or financial objectives. Examples of undesirable events:*

- *Injuries to employees or other persons;*
- *Collisions, derailments, fires, explosions;*
- *Environmental contamination;*
- *Equipment or structural breakdowns;*
- *Major service disruptions;*
- *Loss of key personnel; and*
- *Market value collapse, price, or currency fluctuations.*

1.0 Introduction

1.1 Background

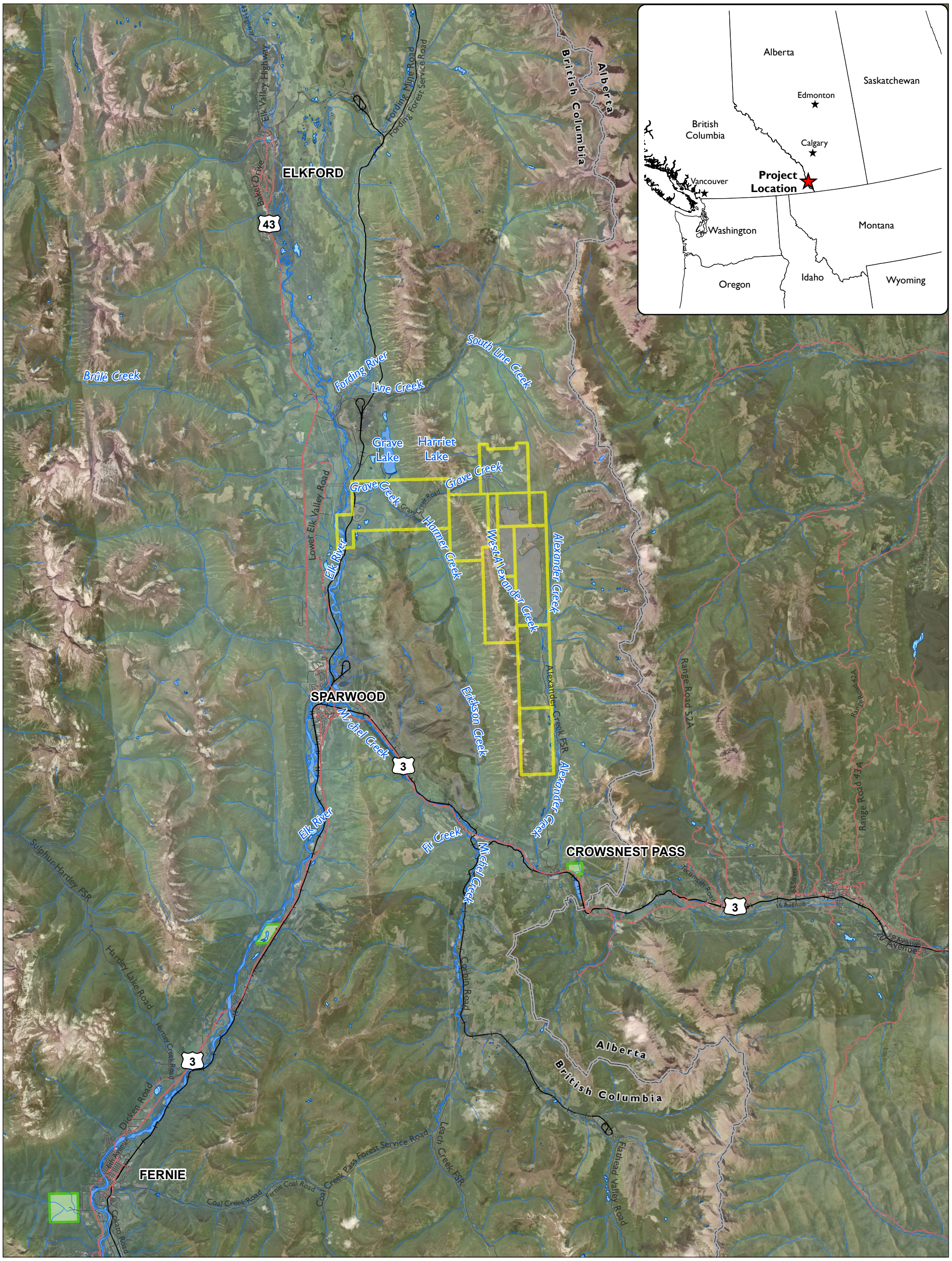
NWP Coal Canada Ltd. (NWP) proposes to develop and operate the Crown Mountain Coking Coal Project (the Project), an open pit steelmaking coal mine located in Elk Valley of the East Kootenay Region of British Columbia (B.C.) – refer to **Figure 1**. The Project comprises ten coal licenses (**Figure 2**) and is located between several existing metallurgical coal mines in the Elk Valley and Crowsnest coal fields. Teck Coal Limited's (Teck) Elkview Operations is located approximately 8 kilometres (km) southwest of the Project area and their Line Creek Operations are located approximately 12 km north of the Project area. NWP's goal is to create a project that is both environmentally responsible and safe for all parties involved.

An Environmental Assessment (EA) for the Project is being prepared and will be submitted to the:

- Impact Assessment Agency of Canada (IAAC) as an Environmental Impact Statement (EIS) pursuant to the *Canadian Environmental Assessment Act* (CEA Act), 2012; and
- B.C. Environmental Assessment Office (EAO) as an Application for an Environmental Assessment Certificate (Application) pursuant to the provincial *Environmental Assessment Act*, (EAA), 2002.

In support of the EA, an Accidents and Malfunctions Assessment (A&M Assessment) is being conducted to ensure that proper risk management and preparedness are in place. The goal of the A&M Assessment is to have sufficient certainty that the material risks associated with the construction, operation, reclamation, and closure of the Project are being appropriately and sufficiently mitigated that align with the outcome of the EA.

As such, a systematic and transparent process to identify, analyze, and evaluate the risks has been implemented. Further, the identified risks and corresponding mitigation measures will be incorporated within the EA regarding interactions with Project Valued Components (VCs), including components of the natural environment.



Crown Mountain Coking Coal Project

FIGURE 1.
Project Location

LEGEND

- Project Footprint
- Coal Licences
- Highways
- Arterial Roads
- Local/Resource Roads
- Railway
- Watercourse
- Waterbody
- Wetland
- Provincial Park
- BC/Alberta Border

0 1 2 3 4 Kilometers

SCALE 1:200,000

Map Drawing Information: Data Provided by Province of British Columbia, NWP Coal Canada Ltd., Dillon Consulting Limited

Map Created By: JFC/RBB
Map Checked By: LKD
Map Projection: NAD 1983 UTM Zone 11N

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PROJECT: 12-6231
STATUS: FINAL
DATE: 2021-01-22

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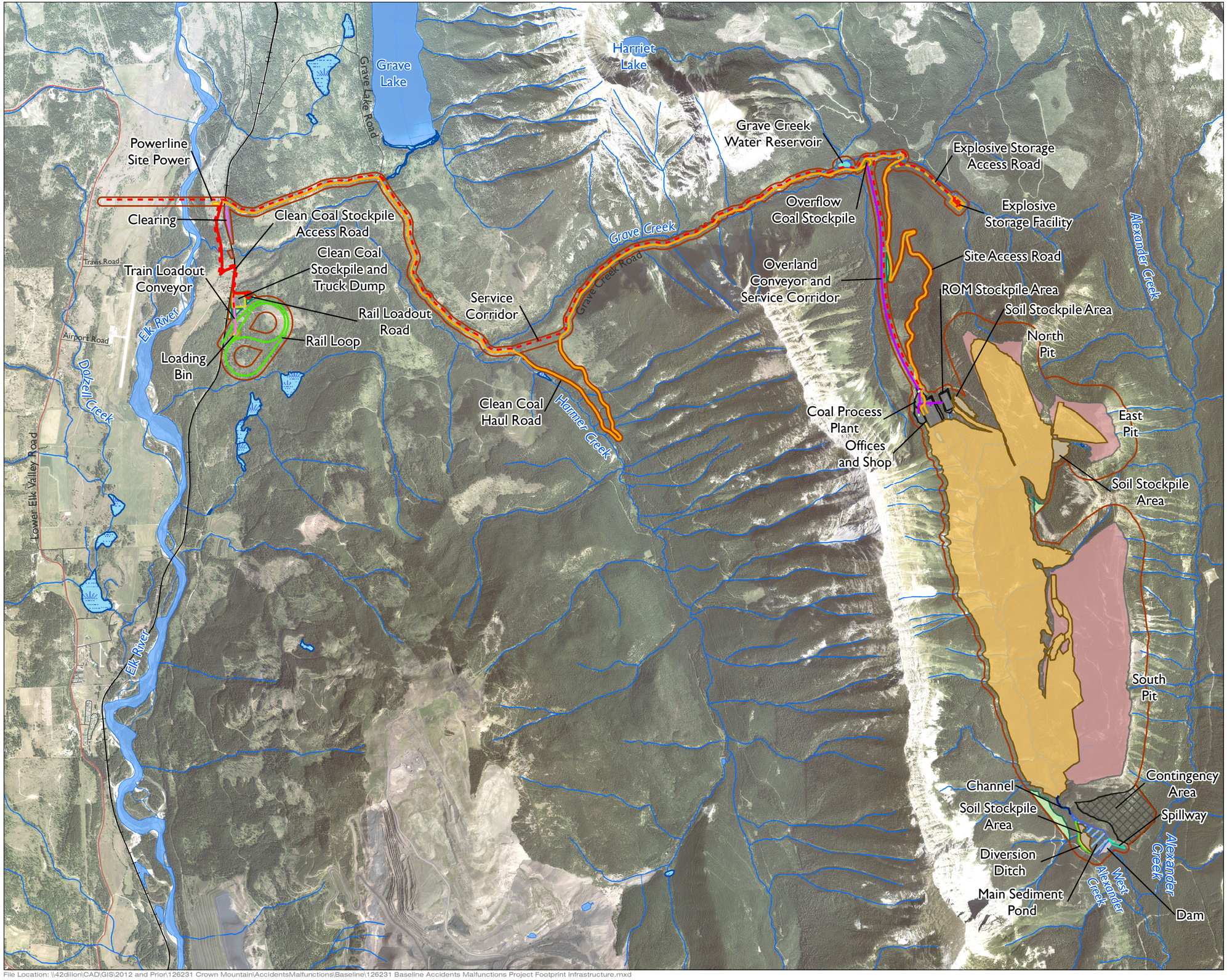
Crown Mountain Coking Coal Project

FIGURE 2
Project Footprint Infrastructure



- Project Footprint
- Channel to Ultimate Pond
- Clean Coal Haul Road\Site Access
- Explosive Storage Access\Facility Road
- Rail Loadout Road
- Rail Loop
- Service Corridor
- Coal Process Plant Conveyor
- Coal Process Plant Duct
- Train Loadout Conveyor
- Waste Dump
- Mined Area
- Clean Coal Stockpile and Truck Dump
- Overflow Coal Stockpile
- Soil Stockpile Area
- Explosive Storage Facility\Pad
- Loading Bin
- Plant Site\ROM Stockpile Area
- Powerline-Site Power
- Water Reservoir
- Main Sediment Pond
- Dam
- Spillway
- Diversion Ditch
- Clearing
- Additional Area
- Contingency Area
- Arterial Roads
- Local/Resource Roads
- Railway
- Watercourse
- Waterbody
- Wetland
- BC/Alberta Border

0 1 2 Kilometers

SCALE 1:42,000

N W E S

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1.2 Scope of the Accidents and Malfunctions Assessment

The purpose of the A&M Assessment is to evaluate the potential effects of accidents and malfunctions of the Project throughout its project cycle – Pre-Construction, Construction, Operation, and Reclamation period. As stipulated in Section 6.6.1 of the EIS Guideline Requirements, the scope of the A&M Assessment covered the following:

- ✓ The failure of certain works caused by human error or exceptional natural events (e.g., flooding, earthquake) could cause major effects. Conduct an analysis of the risks of accidents and malfunctions, determine their effects and present a preliminary emergency measures.
- ✓ Taking into account the lifespan of different project components, identify the probability of potential accidents and malfunctions related to the project, including an explanation of how those events were identified, potential consequences (including the environmental effects as defined in section 5 of CEAA 2012), the plausible worst case scenarios and the effects of these scenarios.
- ✓ Include an identification of the magnitude of an accident and/or malfunction, including the quantity, mechanism, rate, form and characteristics of the contaminants and other materials likely to be released into the environment during the accident and/or malfunction events and would potentially result in an adverse environmental effect as defined in section 5 of CEAA 2012.
- ✓ Describe the safeguards that have been established to protect against such occurrences and the contingency and emergency response procedures in place if such events do occur.

More specifically, the A&M Assessment addressed the following AIR the EIS requirements as presented in **Table 1**.

Table 1: Concordance Table – AIR and EIS Requirements

AIR Requirements (Section 4.7, Page 129) EIS Requirements (Section 6.6.1, Page 35)	A&M Assessment – Report Sections
Include and overall methodology for assessing the potential risk of an event (likelihood and consequence)	Section 2.0 - Accident and Malfunction Assessment Approach and Methodology
Define each category of likelihood	Section 2.2 - Scope, Context, and Criteria
Define each category of consequence	Section 2.2 - Scope, Context, and Criteria
Identify potential accidents and malfunctions	Section 2.0 - Accident and Malfunction Assessment Approach and Methodology Section 4.0 - Accident and Malfunction Assessment Results
Assess the likelihood of the event occurring, based on historical trends and models (applied where appropriate)	Section 4.0 - Accident and Malfunction Assessment Results
Assess the consequences of the event, in a manner consistent with direct effects assessment	Section 4.0 - Accident and Malfunction Assessment Results
Identify proposed measures to reduce the likelihood of the event	Section 4.0 - Accident and Malfunction Assessment Results Section 5.0 - Mitigation Plan
Identify measures to mitigate the consequences to the Valued Components (VCs) and discussion on their	Section 5.8 - Mitigation Measures for Valued Components

AIR Requirements (Section 4.7, Page 129) EIS Requirements (Section 6.6.1, Page 35)	A&M Assessment – Report Sections
expected effectiveness	
Conclude on the potential risk (likelihood multiplied by consequence) of the accident or malfunction	Section 6.0 - Conclusions.

1.3 Accidents and Malfunctions Assessment Team

Dillon Consulting Limited (Dillon) was retained by NWP to complete the A&M Assessment, the findings of which are documented in this report. External to NWP, the A&M Assessment was led by a Certified Risk Manager (CRM) with over 26 years of professional experience, supported by the following subject expertise:

- Geotechnical and mining engineer with 30 years of professional experience;
- Mining operations engineer with 20 years of professional experience; and
- Registered Professional biologist with 34 years of experience.

The combined professional experience is over 100 years and provides a multi-disciplinary and broad-based perspective to ensure that the rigour of the A&M Assessment is sufficient to properly identify the hazards and evaluate and assess the risks of the Project.

1.4 Limitations of the Accidents and Malfunctions Assessment

1.4.1 Potential Accidents and Malfunctions

Consideration was given to the preliminary list of potential accidents and malfunctions in Section 4.7 of the AIR Requirements, with the final list validated by the subject matter experts engaged to support the completion of the A&M Assessment. In many cases, there were uncertainties regarding specific accidents and malfunctions being identified given that detailed design of the Project has not been completed. As such, general categories of accidents and malfunctions were utilized to identify specific outcomes (i.e., consequences) that align with the preliminary list of potential accidents and malfunctions in Section 4.7 of the AIR Requirements.

1.4.2 Uncertainties

Given that detailed design of the Project has not been completed at the time the A&M Assessment was completed, predictive models were not utilized. Instead, experience and professional judgement of the subject matter experts (SMEs) were utilized to quantify the uncertainties related to the likelihood of events occurring, and the corresponding probability of experience specific consequences/impacts. Historical trends were utilized to support the analysis, as required.

1.4.3 Evaluation of the Risks of an Event

The A&M Assessment evaluated the risks of an event, taking into consideration the presence and effectiveness of proposed mitigation measures of the Project that will be in place. As such, the likelihood multiplied by consequence of the accident or malfunction is considered to the "Inherent Risks" from which conclusions will be drawn as to the need for additional mitigation measures so that the "Residual Risks" are considered appropriate.

In other words, the risks of an event, in the absence of any mitigation measures, were NOT assessed. Any exceptions to this are explicitly identified in the A&M Assessment.

2.0 Accident and Malfunction Assessment Approach and Methodology

2.1 Overview

Organizations of all types and sizes face internal and external factors and influences that make it uncertain whether and when they will achieve their objectives. Managing uncertainty in decision-making relies upon identifying, quantifying, and analyzing those factors. More specifically, the A&M Assessment seeks to identify and evaluate the risks (uncertainties) posed by the potential accidents and malfunctions due to the Project, to allow the uncertainties to be characterized and integrated into mitigation measures.

The approach to conducting the A&M Assessment is based upon CAN/CSA-ISO 31000:2018 Risk Management – Guidelines (ISO31000), specifically the Process as illustrated in **Figure 3**.

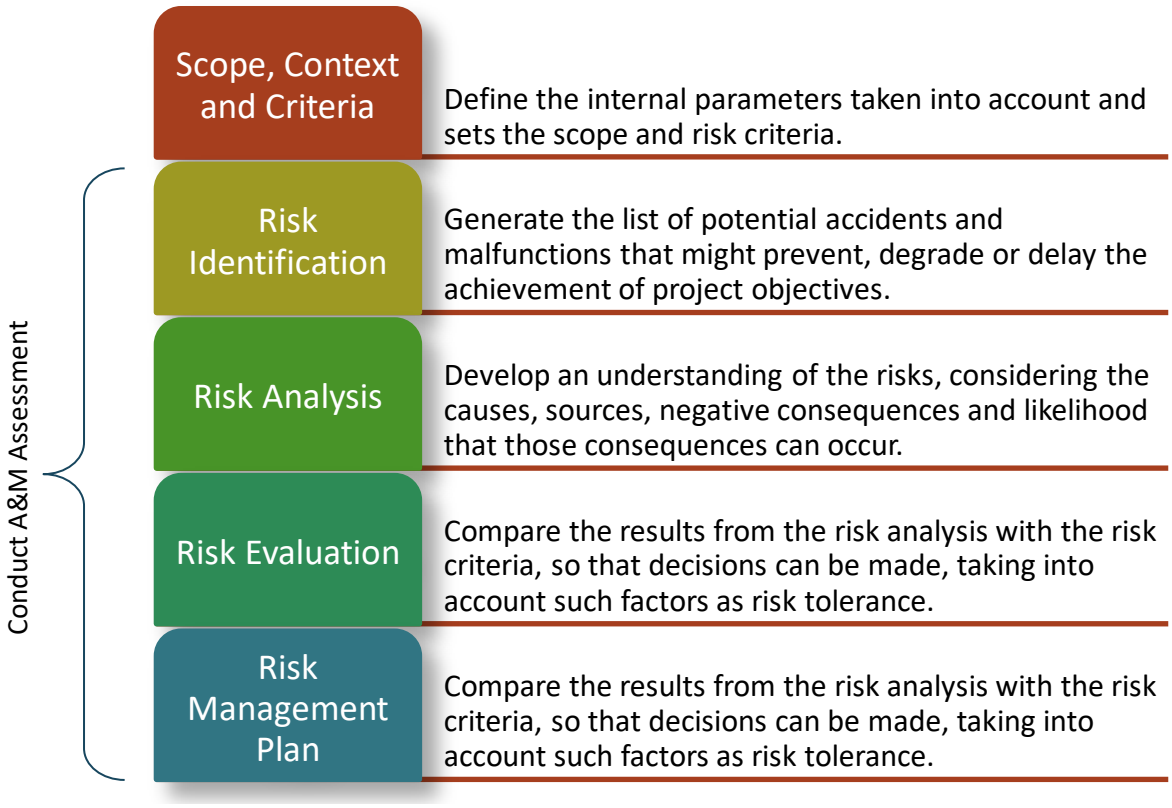


Figure 3: Application of Risk Management Process - ISO31000

2.2 Scope, Context, and Criteria

The purpose of establishing the scope, the context, and criteria is to customize the process to conduct the A&M Assessment, enabling effective assessment of the accidents and malfunctions and an appropriate risk management plan. Scope, context, and criteria involve defining the scope of the process, and understanding the external and internal context.

The scope of the A&M Assessment is to cover the following activities of the Project as shown in **Figure 4**.

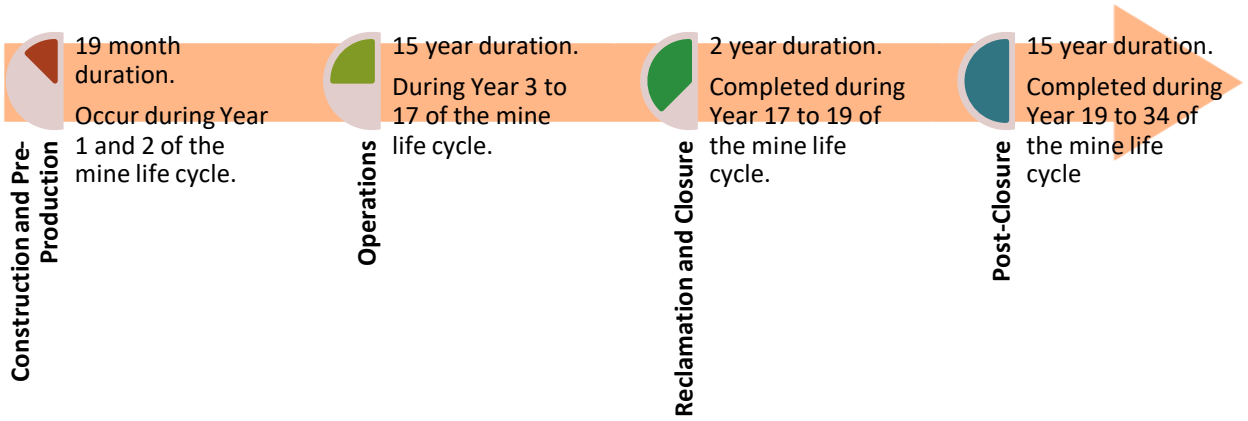


Figure 4: Scope of Accident & Malfunction Assessment – Project Phases

The external context of the A&M Assessment is based on external factors that can lead to accidents and malfunctions in any 1 of the 4 stages of the Project as shown in **Figure 4**. Internally, the focus will be on the presence and effectiveness of proposed mitigation measures to a) prevent or reduce the likelihood of an accident or malfunction; and b) reduce or eliminate any consequences should an accident or malfunction occur.

The criteria utilized for the A&M Assessment will quantify "risk" based on:

Risk = Probability/Likelihood x Consequence

A 5-step scale was utilized for the Probability/Likelihood criteria as shown in **Table 2**. It consists of quantitative criteria (such as probability or frequency), but also qualitative criteria (i.e., may occur but not anticipated) that would be scored based on professional judgement of the SMEs.

Table 2: Probability/Likelihood Criteria

Score	Criteria
A	• 99% probability; or • Impact is occurring now; or • Could occur within "days to weeks"
B	• >50% and <99% probability; or • Balance of probability will occur; or • Could occur within "weeks to months"
C	• >20% and <50% probability; or • May occur shortly but a distinct probability it won't; or • Could occur in "months to years"
D	• >1% and <20% probability; or • May occur but not anticipated; or • Could occur in "years to decades"
E	• <1% probability; or • Occurrence requires exceptional circumstances; or • Exceptionally unlikely, even in the long term future; or • Only occur as a "100 year event"

The primary considerations of the Consequence criteria were a) health and safety and b) the environment. **Table 3** below outlines the rating and Consequence Criteria used in the A&M Assessment.

Table 3: Consequence Criteria

Score	Health and Safety	Environment
1	Multiple fatalities; or significant irreversible effects to 10's of people	An incident that has caused disastrous environmental impact with long term effect requiring major remediation
2	Single fatality; and/or severe irreversible disability to one or more persons	An incident that has caused serious environmental impact with medium term effects requiring significant remediation
3	Extensive injuries or irreversible disability or impairment to one or more persons; lost time	An incident that has cause moderate reversible environmental impact with short term effects requiring moderate remediation
4	Medical treatment	An incident that has caused minor reversible environmental impact requiring minor remediation
5	First aid treatment	An incident that has caused negligible reversible environmental impact requiring very minor or no remediation

In addition to scoring the Probability/Likelihood and Consequence, the Criticality of the proposed risk mitigation measures was scored using a 3-step scoring scheme shown in **Table 4**. This rating criteria allowed for the importance of each risk mitigation measure to be prioritized.

Table 4: Criticality Score for Risk Mitigation Measures

Criticality of Risk Mitigation Measure	Criticality Score
High	3
Medium	2
Low	1

2.3 Conduct the Accident and Malfunction Assessment

BowTie is a visual-based process that was utilized to conduct the A&M Assessment. BowTie is a standard risk assessment approach that complies with ISO31000. A generic BowTie is shown in **Figure 5.**

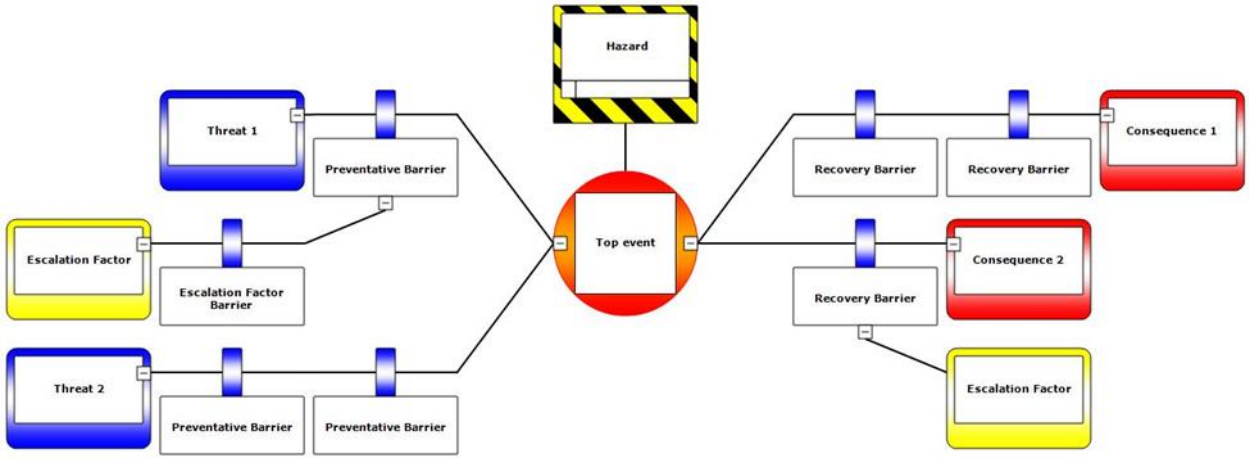


Figure 5: Generic BowTie Diagram

Facilitated by the A&M Assessment Lead over the course of a two-day workshop (November 25/27, 2020) and attended by the SMEs, the 4 Project stages were assessed using the BowTie process to determine/confirm the following as shown in **Figure 6**. A total of 16 BowTies were identified, analyzed, and evaluated with further details provided in **Section 4.0** of this submission. Further details on the BowTie Methodology are provided in **Appendix A**.

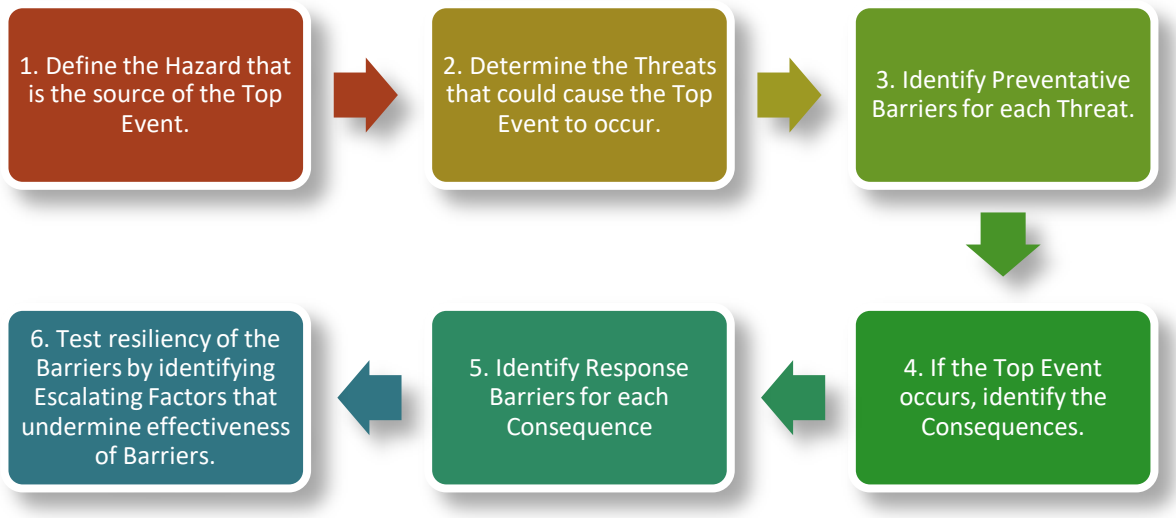


Figure 6: Step-Wise Process to Conduct a Facilitated BowTie Workshop

The analysis of the risks was completed using the Risk Matrices in **Figure 7** for Public/Employee Health and Safety and **Figure 8** for Environment, with the shown colour schemes defined in **Table 5** to evaluate the risks as either being High, Medium, or Low.

	Public or Employee Health & Safety	5 Slight Injury	4 Minor Injury	3 Major Injury	2 Single Fatality	1 Multiple Fatalities
A	99% probability; or impact is occurring now; or could occur within "days to weeks"	5A	4A	3A	2A	1A
B	>50% and <99% probability; or balance of probability will occur; or could occur within "weeks to months"	5B	4B	3B	2B	1B
C	>20% and <50% probability; or may occur shortly but a distinct probability it won't; it could occur in "months to years"	5C	4C	3C	2C	1C
D	>1% and <20% probability; or may occur but not anticipated; or could occur in "years to decades"	5D	4D	3D	2D	1D
E	<1% probability; or occurrence requires exceptional circumstances; or exceptionally unlikely, even in the long term future; or only occur as a "100 year event"	5E	4E	3E	2E	1E

Figure 7: Risk Matrix – Public or Employee Health and Safety

Environment		5 An incident that has caused neglible reversible environmental impact requiring very minor or no remediation.	4 An incident that has caused minor reversible environmental impact requiring minor remediation.	3 An incident that has caused moderate reversible environment impact with short term effect requiring moderate remediation.	2 An incident that has caused serious environmental impact with medium term effect requiring significant remediation.	1 An incident that has caused disasterous environmental impacts with long term effect requiring major remediation.
A	99% probability; or impact is occurring now; or could occur within "days to weeks"	5A	4A	3A	2A	1A
B	>50% and <99% probability; or balance of probability will occur; or could occur within "weeks to months"	5B	4B	3B	2B	1B
C	>20% and <50% probability; or may occur shortly but a distinct probability it won't; it could occur in "months to years"	5C	4C	3C	2C	1C
D	>1% and <20% probability; or may occur but not anticipated; or could occur in "years to decades"	5D	4D	3D	2D	1D
E	<1% probability; or occurrence requires exceptional circumstances; or exceptionally unlikely, even in the long term future; or only occur as a "100 year event"	5E	4E	3E	2E	1E

Figure 8: Risk Matrix – Environment

Table 5: Risk Evaluation Classification

Classification	
High Risk	
Medium Risk	
Low Risk	

3.0 Project Description

3.1 Overview

The Project area is located approximately 30 km by road from Sparwood, B.C. and is accessible by several Forest Service Roads, including Grave Creek Road in the northwest and Alexander Creek Road from the south. The Alberta/B.C. provincial border is approximately 5 km east of the Project, and the United States border between B.C. and Montana is located approximately 90 km south of the Project.

Construction of the Project is anticipated to be completed over 1.5 years. The anticipated production capacity of the Project is up to 4.0 million run-of-mine tonnes (M ROMt) per annum for a duration of approximately 15 years, not including site decommissioning. This equates to a coal production capacity of approximately 10,150 tonnes per day. Exploration activities have indicated that the coal at the Project site is typical of coking coals produced from existing mines in the Elk Valley. The high quality metallurgical coal would be transported by rail to terminals located along the west coast of B.C., where it would be shipped overseas to steel producers.

For the purpose of the A&M Assessment, the Project was broken down into five phases, within which there are a total of 14 Project Components as summarized in **Table 6**.

Table 6: Project Phases and Components – Crown Mountain Coking Coal Project

Project Phase	Project Component
Construction	Water Management Infrastructure
	Mine Infrastructure Facilities
	Linear Infrastructure Facilities
Pre-Production	Pre-Production Mining
Operation	Mine Surface Operations
	Construction of Main Sediment Pond
	Operation of Main Sediment Pond
	Coal Preparation Plant
	Rail Loadout and Rail Siding
	Clean Coal Haul Route
	Explosives Storage
	Sewage Treatment and Waste Management
Reclamation & Closure	Reclamation Activities
Post Closure	Main Sediment Pond Decommissioning

Further breakdown of activities within each of the 14 Project Components are provided in the following sections.

3.2 Project Phase – Construction and Pre-Production

The Construction and Pre-Production Phases of the Project are expected to have a duration of 19 months and occur during Year 1 and 2 of the mine life cycle. The Construction and Pre-Production Phases will include the following activities summarized in **Table 7**.

3.3 Project Phase – Operation

The Operation Phase of the Project is expected to have a duration of 15 years and will be completed during Year 3 to 17 of the mine life cycle. The Operation Phase will include to following activities:

- Production of:
  - 270 million bank cubic metres (BCM) of waste;
  - 57.5 million metric tonnes (Mt) of ROM coal;
  - 26.3 Mt of clean coal; and
  - 31.2 Mt of plant rejects.
- Construction of:
  - An additional shop in Year 1; and
  - Main sediment pond in Year 4

The Operation Phase will include the following activities summarized in **Table 8**.

3.4 Project Phase – Reclamation and Closure

The Reclamation and Closure Phases of the Project are expected to have a duration of two years and will be completed during Year 17 to 19 of the mine life cycle. The Reclamation and Closure Phases will include the following activities:

- Decommissioning of the following infrastructure:
  - Process plant;
  - ROM stockpile;
  - Grave Creek reservoir;
  - Construction water management;
  - Office/shop complex;
  - Linear infrastructure (i.e., gas and power lines); and
  - Explosive manufacturing site.
- Reclamation of the following infrastructure:
  - ROM stockpile;
  - Plant/office complex pad; and
  - Pit and mine rock storage facility areas not reclaimed at end of mine life.

The Reclamation and Closure Phases will include the following activities summarized in **Table 9**.

3.5 Project Phase – Post-Closure

The Post-Closure Phase of the Project is expected to have a duration of 15 years and will be completed during Year 19 to 34 of the mine life cycle. The Post-Closure Phase will include the following activities:

- Environmental effects and geotechnical monitoring; and
- Decommissioning of the main sediment pond.

The Post-Closure Phases will include the following activities summarized in **Table 10**.

Table 7: Project Activities – Construction and Pre-Production Phases

Project Components	Project Activities	Description
Project Phase – Construction		
Water Management Infrastructure	Foundation Preparations	Foundations will be required for much of the on-site infrastructure including the containment dam and main sediment pond. Preparations will relate to geotechnical and engineering design elements.
	Embankment Construction	An embankment will be constructed to ensure to meet the surface water management plan requirements.
	Blasting – Construction of Ditches	Ditches will be required to divert water away from the site during construction. Due to the local geology, blasting will be necessary in many cases. All blasting will be conducted using a certified third party blasting contractor.
Mine Infrastructure Facilities	Accessing Site	Improvements to existing roadways (i.e., widening, improvements to structural integrity) to access the plant site will be completed. New roads will be constructed to access the initial benches of the water management structures, open pits and mine rock storage facilities.
	Foundation Preparations	Foundations will be required for much of the on-site infrastructure including the Main Sediment Pond. Preparations for the foundations will include but are not limited to geotechnical investigation, engineering design and testing during construction.
	Blasting	Due to the local geology, blasting will be required to displace rock during the construction of mine infrastructure facilities.
Linear Infrastructure Facilities	Construction of Rail Line and Loading Facility	A new rail loadout will be constructed which connects to the existing CP Rail line called the Fording Subdivision , located parallel to Elk River on the western site boundary. A Rail Loadout facility, including a rail loop, clean coal stockpile and material handling equipment, will be constructed on the northwest corner of the project footprint.
	Construction of Gas Line	Natural gas services will be required for the operation of the coal dryer and heating the site facilities. A gas line will be constructed and will follow the service corridor.
	Construction of Power Line	Electricity will be required for the operation of the site facilities. A power line will be constructed and follow the service corridor.
	Construction of Coal Haul Route Road	Grave Creek Road will be upgraded for use as the coal haul route. The existing roadway will be upgraded to accommodate highway legal vehicle traffic.
	Construction of Clean Coal Conveyor System	The construction of a clean coal conveyor system will be completed along the service corridor running from the coal processing plant to the overflow coal stockpile.
	Blasting	Due to the local geology, blasting may be required to complete the construction of the linear infrastructure.
Project Phase – Pre-Production		
Pre-Production Mining	Access Road Construction and Upgrade	Improvements to existing roadways (i.e., widening, improvements to structural integrity) as well as the construction of onsite roads will be completed. New roads will be constructed to access the initial benches of the water management structures, open pits and mine rock storage facilities.
	Construct Main ROM Stockpile and Facility Pad Areas	The Run of Mine (ROM) coal stockpiles, and facility pad areas will be constructed to manage the materials removed from the active mining areas prior to processing facility.
	Waste Mine Management Areas	Management areas for mine rock will be constructed to the west of the mining area.
	Surface Extraction Area	The surface extraction area is the area to be mined. This area will be subdivided into the North Pit, East Pit, and South Pit.
	Initial Site Prep	Removal of overburden from mining areas and preparation of site for coal extraction.

Table 8: Project Activities – Operation Phase

Project Components	Project Activities	Description
Project Phase – Operation		
Mine Surface Operations	Mine Rock Management Areas	Designated areas will be constructed in the Pre-Production Phase to store mine rock removed from the mine site.
	Surface Extraction Area	The surface extraction area is the area to be mined. This area will be subdivided into the North Pit, East Pit, and South Pit.
	Site Operations	Site operations including but not limited to health and safety, blasting, waste rock removal, coal removal, and transportation will occur during the Mine Surface Operations.
Construction of Main Sediment Pond	Surface Water Management	Ditches will be completed in the Construction Phase to divert surface water from the site to alternative approved areas.
	Foundation Preparations	Foundations will be required for the main sediment pond. Preparations will relate to geotechnical, engineering design elements, and testing.
	Embankment Construction	An additional embankment will be constructed to ensure to meet the surface water management plan requirements.
	Blasting	Due to the local geology, blasting may be required to complete the construction of the Main Sediment Pond.
Operation of Main Sediment Pond	Operation of Main Sediment Pond	Operation of the Main Sediment Pond includes but is not limited to health and safety, foundation and embankment integrity monitoring, water quality monitoring, and routine maintenance.
Coal Preparation Plant	Coal Stockpile	A coal stockpile will be completed adjacent to the coal preparation plant for accessibility purposes.
	Steam Emissions from Coal Dryer	Emissions from the coal dryer will be monitored and the dryer will undergo routine maintenance as required to ensure it is working appropriately.
	Kerosene Tank Storage	Kerosene will be required for the operation of the mine site. All kerosene will be stored in a regulatory compliant storage area in approved storage tanks.
	Kerosene Tanking Loading Area	Kerosene will be trucked to the mine site. To ensure the health and safety of all mine personnel and trades personnel a designated tank loading area will be completed.
	Public Grade Level Crossing	There is one public grade level crossing of the CP Fording Subdivision that will be managed on the mine site. The grade crossing will be upgraded to Federal Grade Crossing Standards and maintained as such based on anticipated future train and vehicle traffic.
	Private Grade Level Crossing	There is one private grade level crossing of the CP Fording Subdivision that will be managed on the mine site. The grade crossing will be upgraded to Federal Grade Crossing Standards and maintained as such based on anticipated future train and vehicle traffic.
	Train Crew Exchange	NWP will have their own train crew that will manage the engine and rail cars on-site. CP will have a designated train crew exchange area where responsibilities will be transferred.
Rail Loadout and Rail Siding	Loading of Hopper Rail Cars	Hopper rail cars will be loaded in the loadout facility by NWP personnel. The railcars will advance along the loadout facility to allow for the coal to be distributed in each of the hopper cars.
	Coal Truck Delivery	Clean coal will be delivered to the loadout facility by highway legal trucks using the Clean Coal Haul Route.
	Coal Stockpile	A stockpile of clean coal will be completed adjacent to the loadout facility for accessibility purposes.
	Fuel Storage	Fuels (i.e., gasoline and diesel) will be required for the operation of the loadout facility and the locomotives. Fuels will be stored in regulatory compliant tanks and in a designated fuel storage area. Locomotive refueling will be conducted by Direct-to-Locomotive (DTL) methods that are consistent with those utilized by CP.
Clean Coal Haul Route	Coal Haul Truck Traffic	Clean coal will be delivered to the loadout facility by highway legal trucks using the Clean Coal Haul Route.
	Light Vehicle Mine Related Traffic	Light vehicles will be required for many of the mine operations and will often share the access roads and clean coal haul route with heavier vehicle traffic.
Explosives Storage	Ammonium Nitrate and Emulsion Silo Storage	Ammonium Nitrate (AN) and Emulsion will be contained within a designated explosives storage area. This area and all explosives containers will be compliant with the Federal Explosives Regulations.
	Magazine Storage	Magazines will be stored on-site for the use in blasting activities and will comply with the Explosives Magazine Storage and Use Permit Application For Mining Purposes outlined by the Ministry of Energy, Mines and Petroleum Resources Mining and Minerals Division in British Columbia.
	Handling and Transportation of Explosives to Explosive Storage Site	A designated explosives storage area will be constructed on the mine site. To ensure that all regulatory and health and safety measures are followed, trained third party explosives personnel and select trained NWP personnel will manage the handling and transportation of explosives to the storage site.
	Disposal of Off-Spec Explosives Off-Site	A third party explosives contractor will manage the removal and disposal of explosive wastes off-site.
Sewage Treatment and Waste Management	Storage and Handling of Wash Water from ANFO Trucks	ANFO trucks will be used to distribute the ANFO around the blasting areas of the site. Any wash water collected from the ANFO trucks will be stored and disposed of off-site by a third party explosives contractor.
	Septic Field	A septic field will be constructed to manage the on-site sewage.
	Non-Hazardous Waste Collection	All non-hazardous solid waste will be collected and transported off-site for disposal by a waste management contractor.
	Hazardous Waste Generation	Any hazardous waste generated on-site will be properly stored and removed from the site for disposal by a hazardous waste management contractor.

Table 9: Project Activities – Reclamation and Closure Phases

Project Components	Project Activities	Description
Project Phase – Reclamation and Closure Phases		
Reclamation Activities	Reclaim Access Road	All non-municipal roadways will be reclaimed which will include but is not limited to re-contouring, re-sloping and re-vegetating.
	Reclaim Mine Rock Piles	Any remaining mine rock piles will be reclaimed by re-contouring, re-sloping, and re-vegetating. Waste rock piles will be reclaimed progressively during the mine life cycle to meet reclamation objectives.
	Reclaim Site Facilities	Site facilities will be removed and the remaining land re-graded and re-vegetated.
	Reclaim Surface Extraction Area	Remaining reclamation material is re-handled from stockpiles and placed on the designated dump surfaces for reclamation and revegetation.
	Reclaim Utility Services	Utility infrastructure will be removed and the area re-graded and re-vegetated.
	Restore Coal Haul Route	The Grave Creek Road will be returned to its previous state for use as a municipal roadway.
	Reclaim Rail Loadout Area	The equipment and the Crown-built rail line will be removed and the loadout areas will be re-graded and re-vegetated.
	Reclaim Grave Creek Reservoir	Once all process and site water has been removed or properly diverted the Grave Creek Reservoir will be dismantled, re-sloped, and re-vegetated.

Table 10: Project Activities – Post-Closure Phase

Project Components	Project Activities	Description
Project Phase – Post-Closure		
Main Sediment Pond Decommissioning	Decommissioning Main Sediment Pond	Following the completion of the reclamation of the mine site, the main sediment pond water will be removed and the pond infrastructure dismantled. The land will then be re-sloped, re-contoured, and re-vegetated.

4.0 Accident and Malfunction Assessment Results

A total of 16 individual BowTies were identified and analyzed in support of the A&M Assessment, as shown in **Table 11**. Further details are provided in the subsequent sections, grouped by each Project Phase.

Table 11: Number of BowTies – A&M Assessment

Project Phase	Number of BowTies
Construction	3
Pre-Production	1
Operation	8
Reclamation and Closure	1
Post-Closure	2
General Project Risks	1

4.1 Project Phase – Construction

4.1.1 Top Event – Unforeseen Site Conditions

Project Components – "Water Management Infrastructure" and "Linear Infrastructure Facilities" were identified as Hazards that could result in the Top Event – "Unforeseen Site Conditions", which is meant to define what could go wrong during the Construction Phase as distinct Consequences. Detailed breakdown of each BowTie, including the Preventative and Response Barriers, and Escalating Factors are provided in **Appendix B**, with a summary of the Activities/Threats and Consequences provided in **Table 12**. Included in **Table 12** are the High, Medium, and Low Risks that were evaluated for each of the Consequences, using the evaluation classification from **Table 5**.

Table 12: Summary of Top Event – Unforeseen Site Conditions (Construction Phase)

Activity or Threat	Top Event	Consequences	Description	Risk Ranking Health and Safety Risks	Risk Ranking Environmental Risks
Project Component – Water Management Infrastructure					
Foundation Preparations Embankment Construction Blasting – Construction of Ditches	Unforeseen Site Conditions	Embankment/Foundation Failure During Construction	An embankment and/or foundation failure during construction could cause major injury and reversible impact to the surrounding environment. A failure could result in sediments and debris falling downslope into Alexander Creek.	3D	3D
		Partial Failure of Embankment During Construction	A partial embankment failure could result in injury and reversible environmental impact. A partial failure could result in sediments and debris falling downslope into Alexander Creek.	4D	4D
		Overtopping of Embankment During Construction	Overtopping of the embankment during construction could result in slight injury and is likely to have a reversible impact on the surrounding environment. Water and any suspended sediment is likely to flow downslope into Alexander Creek.	5E	3D
Project Component – Linear Infrastructure Facilities					
Construction of Rail Line and Loading Facility Construction of Gas Line Construction of Power Line Construction of Coal Haul Route Road Construction of Clean Coal Conveyor System Blasting	Unforeseen Site Conditions	Archaeology Site	Disturbance and/or the destruction of cultural artifacts and/or burial grounds.	-	2A
		Geotech Unstable Areas	A geotechnical unstable area could cause events such as significant subsidence (among other problems) that could lead to the partial or full failure of the linear infrastructure (i.e., downed power lines, damaged natural gas pipelines). These effects would have health and safety as well as environmental impacts.	3C	3D

Notes:
- No inherent risks identified.

4.1.2 Top Event – Disruption to Construction Resulting in Safety Risk and/or Environmental Damage

Project Component – "Mine Infrastructure Facilities" was identified as the Hazard that could result in the Top Event – "Disruption to Construction Resulting in Safety Risk and/or Environmental Damage", which is meant to define what could disrupt construction activities as distinct Consequences. Detailed breakdown of the BowTie, including the Preventative and Response Barriers, and Escalating Factors are provided in **Appendix B**, with a summary of the Threats and Consequences provided in **Table 13**. Included in **Table 13** are the High, Medium, and Low Risks that were evaluated for each of the Consequences, using the evaluation classification from **Table 5**.

Table 13: Summary of Top Event – Disruption to Construction Resulting in Safety Risk and/or Environmental Damage (Construction Phase)

Activity or Threat	Top Event	Consequences	Description	Risk Ranking Health and Safety Risks	Risk Ranking Environmental Risks
Project Component – Mine Infrastructure Facilities					
Accessing Site Foundation Preparations Blasting	Disruption to Construction Resulting in Safety Risk and/or Environmental Damage	Unable to Utilize Road during Evacuation	In the event that access roads are unusable during an emergency there is increased potential for minor injury.	4C	-
		Archaeology Site	Disturbance and/or the destruction of cultural artifacts and/or burial grounds.	-	2E
		Geotechnical Unstable Areas	A geotechnical unstable area could cause events such as significant subsidence (among other earth works failures) that could lead to the partial or full failure of the foundations of the mine infrastructure facilities. These could result in major injury as well as reversible environmental impacts.	3D	4E
		Vehicular Accident on Access Road	A vehicular accident on an access road could result in a single fatality and disastrous impact to the surrounding environment (i.e., spill).	1E	2E

Notes:
- No inherent risks identified.

4.2 Project Phase – Pre-Production

4.2.1 Top Event – Unforeseen Site Conditions

Project Component – "Pre-Production Mining" was identified as the Hazard that could result in the Top Event – "Unforeseen Site Conditions", which is meant to define what could go wrong during the Pre-Production Phase as distinct Consequences. Detailed breakdown of the BowTie, including the Preventative and Response Barriers, and Escalating Factors are provided in **Appendix B**, with a summary of the Threats and Consequences provided in **Table 14**. Included in **Table 14** are the High, Medium, and Low Risks that were evaluated for each of the Consequences, using the evaluation classification from **Table 5**.

Table 14: Summary of Top Event – Unforeseen Site Conditions (Pre-Production Phase)

Activity or Threat	Top Event	Consequences	Description	Risk Ranking Health and Safety Risks	Risk Ranking Environmental Risks
Project Component – Pre-Production Mining					
Access Road Construction and Upgrade Construct Main ROM Stockpile and Facility Pad Areas Waste Rock Management Areas Surface Extraction Area Initial Site Prep	Unforeseen Site Conditions	Geotechnical Unstable Areas – Access Road	A geotechnical unstable area could result in the failure of the structural integrity of the access road and could result in a single fatality.	2C	4C
		Heavy/Light Vehicle Interaction	The interaction of light and heavy vehicles on-site could result in a single fatality.	2C	4B
		Geotechnical Unstable Areas – Mine Rock Storage Facility	A geotechnical unstable area could result in the failure of the mine rock storage facility foundation. This could result in major injury and could cause serious impacts the surrounding environment (i.e., mine rock released to the surrounding environment).	3C	2D
		Geotechnical Unstable Areas – Pit Wall	A geotechnical unstable area could result in the failure of the pit wall. This could result in major injury and reversible impacts to the surrounding environment.	3C	5D
		Archaeology Site	Disturbance and/or the destruction of cultural artifacts and/or burial grounds.	-	2E
		Unable to Utilize Road during Evacuation	In the event that access roads are unusable during an emergency there is increased potential for minor injury.	4C	-

Notes:
- No inherent risks identified.

4.3 Project Phase – Operation

4.3.1 Top Event – Unforeseen Site Conditions

A total of three Project Components were identified that were linked to the Top Event – "Unforeseen Site Conditions", which is meant to define what could go wrong during the Operation Phase as distinct Consequences. Detailed breakdown of each BowTie, including the Preventative and Response Barriers, and Escalating Factors are provided in **Appendix B**, with a summary of the Threats and Consequences provided in **Table 15**. Included in **Table 15** are the High, Medium, and Low Risks that were evaluated for each of the Consequences, using the evaluation classification from **Table 5**.

Table 15: Summary of Top Event – Unforeseen Site Conditions (Operation Phase)

Activity or Threat	Top Event	Consequences	Description	Risk Ranking Health and Safety Risks	Risk Ranking Environmental Risks
Project Component – Mine Surface Operations					
Waste Rock Management Areas Surface Extraction Area Site Operations Surface Water Management	Unforeseen Site Conditions	Geotechnical Unstable Areas – Access Road	A geotechnical unstable area could result in the failure of the structural integrity of the access road. This could result in a single fatality.	2C	4C
		Heavy/Light Vehicle Interaction	The interaction of light and heavy vehicles on-site could result in single fatality.	2C	4B
		Geotechnical Unstable Area – Mine Rock Storage Facility	A geotechnical unstable area could result in the failure of the mine rock storage facility foundation. This could result in major injury and could cause serious impacts the surrounding environment (i.e., mine rock released to the surrounding environment).	3C	2D
		Geotechnical Unstable Area – Pit Wall	A geotechnical unstable area could result in the failure of the pit wall. This is could result in major injury and reversible impacts to the surrounding environment.	3C	5D
		Archaeology Site	Disturbance and/or the destruction of cultural artifacts and/or burial grounds.	-	2E
		Unable to Utilize Road during Evacuation	In the event that access roads are unusable during an emergency there is increased potential for minor injury.	4C	-
Project Component – Construction of Main Sediment Pond (Water Management Infrastructure)					
Foundation Preparations Embankment Construction Blasting	Unforeseen Site Conditions	Embankment/Foundation Failure during Construction	An embankment and/or foundation failure during construction could cause minor injury and reversible impact to the surrounding environment. A failure could result in sediments and debris falling downslope into Alexander Creek.	4E	3E
		Partial Failure of Embankment during Construction	A partial embankment failure could result in minor injury and reversible environmental impact. A partial failure could result in sediments and debris falling downslope into Alexander Creek.	4E	4E
		Overtopping of Embankment during Construction	Overtopping of the embankment during constructions could result in slight injury and is likely to have a reversible impact on the surrounding environment. Water and any suspended sediment is likely to flow downslope into Alexander Creek.	5E	4E
Project Component – Operation of Main Sediment Pond (Water Management Infrastructure)					
Heavy Precipitation Event Internal Erosion or Piping Seismic Event Slope Instability Landslide Going into Pond Drought Conditions	Unforeseen Site Conditions	Embankment/Foundation Failure	An embankment and/or foundation failure could result in a single fatality and reversible impact to the surrounding environment. A failure could result in sediments and debris falling downslope into Alexander Creek.	2E	3E
		Partial Failure of Embankment	A partial embankment failure could result in minor injury and reversible environmental impact. A partial failure could result in sediments and debris falling downslope into Alexander Creek.	4E	4E
		Overtopping of Embankment	Overtopping of the embankment during constructions could result in slight injury and is likely to have a reversible impact on the surrounding environment. Water and any suspended sediment is could flow downslope into Alexander Creek.	5E	4E
		Rapid Drawdown of Pond Resulting in Significant Flow in Alexander Creek	The rapid drawdown on the main sediment pond resulting in significant flow into Alexander Creek could result in minor injury and negligible environmental impacts.	4D	5D

Notes:

- No inherent risks identified.

4.3.2 Top Event – Unforeseen Events

Project Components – "Coal Preparation Plant" and "Rail Loadout and Rail Siding" were identified as the Hazard that could result in the Top Event – "Unforeseen Events", which is meant to define what could go wrong during the Operation Phase as distinct Consequences. Detailed breakdown of the BowTie, including the Preventative and Response Barriers, and Escalating Factors are provided in **Appendix B**, with a summary of the Threats and Consequences provided in **Table 16**. Included in **Table 16** are the High, Medium, and Low Risks that were evaluated for each of the Consequences, using the evaluation classification from **Table 5**.

Table 16: Summary of Top Event – Unforeseen Events (Operation Phase)

Activity or Threat	Top Event	Consequences	Description	Risk Ranking Health and Safety Risks	Risk Ranking Environmental Risks
Project Component – Coal Preparation Plant					
Coal Stockpile Steam Emissions from Coal Dryer Kerosene Tank Kerosene Tank Loading Area	Unforeseen Events	Kerosene Spill	A kerosene spill could result in minor injury and negligible environmental impact.	4D	5D
		Fugitive Dust from Coal Stockpile	Fugitive dust emissions from the coal stockpile could result in negligible environmental impact.	-	5C
		Uncontrolled Release of Process Water	An uncontrolled release of process water could result in minor injury and negligible environmental impact.	5E	5E
Project Component – Rail Loadout and Rail Siding					
Public Grade Level Crossing Private Grade Level Crossing Train Crew Exchange Loading of Hopper Rail Cars Coal Truck Delivery Coal Stockpile Fuel Storage	Unforeseen Events	Crossing Accident at Public Crossing	An accident at a public rail crossing could result in multiple fatalities.	1D	4D
		Crossing Accident at Private Crossing	An accident at a private rail crossing could result in a single fatality and reversible environmental impact.	2E	4D
		Derailment on the Fording Spur	A derailment on the fording spur could result in minor injury.	5E	-
		Derailment on the Loadout Siding	A derailment on the loadout siding is not expected to pose inherent risk to health and safety or the environment.	-	-
		Fugitive Dust Emissions	Fugitive dust emissions from the rail loadout is could result in negligible environmental impact.	-	5C
		Coal Spill at Loadout Area	A coal spill at the loadout area could result in negligible environmental impact.	-	5C
		Fuel Spill	A fuel spill in the rail loadout or rail siding could result in slight injury and reversible environmental impact.	5E	4E
		Coal Dust Explosion	A coal dust explosion on the rail loadout or rail siding could result in single fatality.	2E	-
		Wildlife Strike by Train	A wildlife strike by train could result in reversible environmental impact.	-	3C

Notes:
- No inherent risks identified.

4.3.3 Top Event – Interaction of Coal Haul Traffic and Public Traffic/Wildlife

Project Components – "Clean Coal Haul Route" was identified as the Hazard that could result in the Top Event – "Interaction of Coal Haul Traffic and Public Traffic/Wildlife", which is meant to define what could go wrong during the Operation Phase as distinct Consequences. Detailed breakdown of the BowTie, including the Preventative and Response Barriers, and Escalating Factors are provided in **Appendix B**, with a summary of the Threats and Consequences provided in **Table 17**. Included in **Table 17** are the High, Medium and Low Risks that were evaluated for each of the Consequences, using the evaluation classification from **Table 5**.

Table 17: Summary of Top Event – Interaction of Coal Haul Traffic and Public Traffic/Wildlife (Operation Phase)

Activity or Threat	Top Event	Consequences	Description	Risk Ranking Health and Safety Risks	Risk Ranking Environmental Risks
Project Component – Clean Coal Haul Route					
Coal Haul Truck Traffic Public Vehicle Traffic on Public Road	Interaction of Coal Haul Traffic and Public Traffic/Wildlife	Coal Haul/Public Vehicle Accident	An accident involving coal hauling vehicles and a public vehicle could result in single fatality.	2C	5C
Light Vehicle Mine Related Traffic Wildlife on Road Terrain Hazards		Vehicle Striking Wildlife	Wildlife struck by a vehicle could result in major injury and reversible environmental impact.	3C	3D
Public Vehicle Trespassing on Private Road Hikers/Hunters Trespassing		Pedestrian Struck by Vehicle	A pedestrian struck by a vehicle could result in single fatality.	2D	-

Notes:

- No inherent risks identified.

4.3.4 Top Event – Improper Storage and Handling

Project Component – "Explosives Storage" was identified as the Hazard that could result in the Top Event – "Improper Storage and Handling", which is meant to define what could go wrong during the Operation Phase as distinct Consequences. Detailed breakdown of the BowTie, including the Preventative and Response Barriers, and Escalating Factors are provided in **Appendix B**, with a summary of the Threats and Consequences provided in **Table 18**. Included in **Table 18** are the High, Medium, and Low Risks that were evaluated for each of the Consequences, using the evaluation classification from **Table 5**.

Table 18: Summary of Top Event – Improper Storage and Handling of Explosive (Operation Phase)

Activity or Threat	Top Event	Consequences	Description	Risk Ranking Health and Safety Risks	Risk Ranking Environmental Risks
Project Component – Explosive Storage					
Location of AN & Emulsion Silos Location of Magazines Handling and Transportation of Explosives to Storage Site Disposal of Off-Spec Explosives Offsite Storage and Handling of Wash Water from ANFO Trucks	Improper Storage and Handling	Spills	A spill due to improper storage and handling could result in negligible environmental impact.	-	5B
		Premature Detonation of Explosives	The premature detonation of explosive during the handling and storage could result in multiple fatalities and negligible environmental impact.	1E	5E

Notes:

- No inherent risks identified.

4.3.5 Top Event – Non-Compliance with Regulatory Standards

Project Component – "Sewage Treatment and Waste Management" was identified as the Hazard that could result in the Top Event – "Non-Compliance with Regulatory Standards", which is meant to define what could go wrong during the Operation Phase as distinct Consequences. Detailed breakdown of the BowTie, including the Preventative and Response Barriers, and Escalating Factors are provided in **Appendix B**, with a summary of the Threats and Consequences provided in **Table 19**. Included in **Table 19** are the High, Medium, and Low Risks that were evaluated for each of the Consequences, using the evaluation classification from **Table 5**.

Table 19: Summary of Top Event – Non-Compliance with Regulatory Standards (Operation Phase)

Activity or Threat	Top Event	Consequences	Description	Risk Ranking Health and Safety Risks	Risk Ranking Environmental Risks
Project Component – Sewage Treatment and Waste Management					
Septic Field Non-Hazardous Waste Collection Hazardous Waste Generation	Non-Compliance with Regulatory Standards	Septic Field Blockage	A septic field blockage could result in minor injury.	4E	-
		Attracting Wildlife	Attracting wildlife (i.e., through poor solid waste management and/or accumulation of salt) could result in major injury and reversible environmental impacts.	3D	3C
		Hazardous Waste Spill	A hazardous waste spill could result in minor injury and reversible environmental impact.	4D	3D

Notes:

- No inherent risks identified.

4.4 Project Phase – Reclamation and Closure

4.4.1 Top Event – Unsuccessful Reclamation Program

Project Component – "Reclamation Activities" was identified as the Hazard that could result in the Top Event – "Unsuccessful Reclamation Program", which is meant to define what could go wrong during the Reclamation and Closure Phases as distinct Consequences. Detailed breakdown of the BowTie, including the Preventative and Response Barriers, and Escalating Factors are provided in **Appendix B**, with a summary of the Threats and Consequences provided in **Table 20**. Included in **Table 20** are the High, Medium, and Low Risks that were evaluated for each of the Consequences, using the evaluation classification from **Table 5**.

Table 20: Summary of Top Event – Unsuccessful Reclamation Program (Reclamation and Closure Phase)

Activity or Threat	Top Event	Consequences	Description	Risk Ranking Health and Safety Risks	Risk Ranking Environmental Risks
Project Component – Reclamation Activities					
Reclaim Access Road Reclaim Mine Rock Piles Reclaim Site Facilities Reclaim Surface Extraction Area Reclaim Utility Services Restore Coal Haul Route Reclaim Rail Loadout Area Reclaim Grave Creek Reservoir	Unsuccessful Reclamation Program	Slope Failure – Waste Rock, Access Road and Grave Creek Reservoir	A slope failure could result in major injury and serious environmental impacts. Waste rock, sediment and mine water could potentially be released into the surrounding environment should a slope failure occur.	3E	2E
		Geotechnical Unstable Areas – Pit Wall	A geotechnical unstable area could result in the failure of the pit wall. This could result in major injury and reversible impacts to the surrounding environment.	3E	5E
		Heavy/Light Vehicle Interaction	The interaction of light and heavy vehicles on-site could result in single fatality and reversible environmental impact.	2E	4E
		Unable to Utilize Road during Evacuation	In the event that access roads are unusable during an emergency there is increased potential for minor injury.	4C	-

Notes:

- No inherent risks identified.

4.5 Project Phase – Post-Closure

4.5.1 Top Event – Uncontrolled Sediment Release during Decommissioning

Project Component – "Main Sediment Pond Decommissioning" was identified as the Hazard that could result in the Top Event – "Uncontrolled Sediment Release during Decommissioning", which is meant to define what could go wrong during the Post-Closure Phase as distinct Consequences. Detailed breakdown of the BowTie, including the Preventative and Response Barriers, and Escalating Factors are provided in **Appendix B**, with a summary of the Threats and Consequences provided in **Table 21**. Included in **Table 21** are the High, Medium, and Low Risks that were evaluated for each of the Consequences, using the evaluation classification from **Table 5**.

Table 21: Summary of Top Event – Uncontrolled Sediment Release during Decommissioning (Post-Closure Phase)

Activity or Threat	Top Event	Consequences	Description	Risk Ranking Health and Safety Risks	Risk Ranking Environmental Risks
Project Component – Main Sediment Pond Decommissioning					
Heavy Precipitation Event during Decommissioning Avalanche during Decommissioning	Uncontrolled Sediment Release during Decommissioning	Partial Failure of Embankment During Decommissioning	A partial embankment failure could result in minor injury and reversible environmental impact. A partial failure would could result in sediments and debris falling downslope into Alexander Creek.	4D	3D
		Deleterious Substance Release	A deleterious substance release into a watercourse could result in a serious environmental impact. There are known protected species in the watercourses surrounding the mine site. A deleterious release would violate the Fisheries Act.	-	2D

Notes:
- No inherent risks identified.

4.5.2 Top Event – Unforeseen Site Events

Project Component – "Post-Closure Measures" was identified as the Hazard that could result in the Top Event – "Unforeseen Site Events", which is meant to define what could go wrong during the Post-Closure Phase as distinct Consequences. Detailed breakdown of the BowTie, including the Preventative and Response Barriers, and Escalating Factors are provided in **Appendix B**, with a summary of the Threats and Consequences provided in **Table 22**. Included in **Table 22** are the High, Medium, and Low Risks that were evaluated for each of the Consequences, using the evaluation classification from **Table 5**.

Table 22: Summary of Top Event – Unforeseen Site Events (Post-Closure Phase)

Activity or Threat	Top Event	Consequences	Description	Risk Ranking Health and Safety Risks	Risk Ranking Environmental Risks
Project Component – Post-Closure Measures					
Heavy Precipitation Event Avalanche Wildfire	Unforeseen Site Events	High Sediment Loading	High sediment loading of water could result in serious environmental impacts should it occur in any of the adjacent watercourses due to mine activities.	-	2D
		Vegetation Objectives	If the vegetation objectives are not met during the Post-Closure Phase, serious environmental impact may occur. Vegetation growth is essential for successful site closure.	-	2D
		Land Use Objectives	If the land use objectives are not met during the Post-Closure Phase, serious environmental impact may occur.	-	2D
		Aquatic Objectives	If the aquatic objectives are not met during the Post-Closure Phase, serious environmental impact may occur. There are multiple watercourses surrounding the site that contain species at risk.	-	2D

Notes:
- No inherent risks identified.

4.6 General Project Risks

4.6.1 Top Event – Water Quality Impacts

"Water Quality Impacts" was identified as a cascading consequence within the following Project Components as summarized in **Table 23**. Within the respective BowTies, "Water Quality Impacts" was presented as an "Equivalent Top Event".

Table 23: List of Top Events and Consequences Leading to Water Quality Impacts

Project Component	Top Event	Consequence Leading to "Water Quality Impacts"
Project Phase - Construction		
Water Management Infrastructure	Unforeseen Site Conditions	• Partial Failure of Embankment During Construction • Overtopping of Embankment during Construction
Project Phase – Operation		
Construction of Main Sediment Pond - Water Management Infrastructure	Unforeseen Site Conditions	• Partial Failure of Embankment During Construction • Overtopping of Embankment during Construction
Operation of Main Sediment Pond - Water Management Infrastructure	Unforeseen Site Conditions	• Partial Failure of Embankment • Overtopping of Embankment • Rapid Drawdown of Pond Results in Significant Flow in Alexander Creek
Coal Preparation Plant	Unforeseen Events	• Uncontrolled Release of Process Water
Project Phase – Reclamation and Closure		
Reclamation Activities	Unsuccessful Reclamation Program	• Slope Failure - Waste Rock, Access Road and Grave Creek Reservoir
Project Phase – Post-Closure		
Main Sediment Pond Decommissioning	Uncontrolled Sediment Release During Decommissioning	• Partial Failure of Embankment During Decommissioning • Deleterious Substance Release
Post Closure Measures	Unforeseen Site Events	• High Sediment Loading • Aquatic Objectives

Therefore, "Water Quality Impacts" was brought forward as distinct Top Event for further analysis. Detailed breakdown of the BowTie, including the Preventative and Response Barriers, and Escalating Factors are provided in **Appendix B**, with a summary of the Threats and Consequences provided in **Table 24**. Included in **Table 24** are the High, Medium, and Low Risks that were evaluated for each of the Consequences, using the evaluation classification from **Table 5**.

Table 24: Summary of Top Event – Water Quality Impacts

Activity or Threat	Top Event	Consequences	Description	Risk Ranking Health and Safety Risks	Risk Ranking Environmental Risks
Selenium Nitrates Sulphates Nickel Cadmium Calcite	Water Quality Impacts	Impact to Aquatic Populations & Habitat	Many of the watercourses surrounding the mine site house various species of fish and aquatic animals. Some of these species are known to be endangered. Any impact to the aquatic populations and/or their habitat could result in reversible environmental impacts.	4E	2C
		Impacts to terrestrial Animals (Drinking Water Sources)	Terrestrial animals frequent the watercourses surrounding the site. Should any of these watercourses become impacted it could result in minor injury (i.e., human consumption of contaminated animal meat) and a reversible environmental impact.	4E	4C
		Impact to Potable Water	It is not known if the watercourses surrounding the mine site are being used for potable water sources, for the purposes of this assessment they have been assumed as potable water sources. Should these watercourses be impacted and consumed as potable water, major injury could occur.	3E	-

Notes:

- No inherent risks identified.

5.0 Mitigation Plan

5.1 Overview

A total of 16 BowTies were assessed, which included the identification of both Preventative Barriers to mitigate the Threats/Project Activities that could cause the 16 Top Events, and the corresponding Response Barriers to mitigate the consequences should the Top Events occur. Overall, 62% of the Mitigation Plan is focused on prevention (244 Preventative Barriers) while 38% of the Mitigation Plan is focused on response (147 Response Barriers) as shown in **Figure 9**.

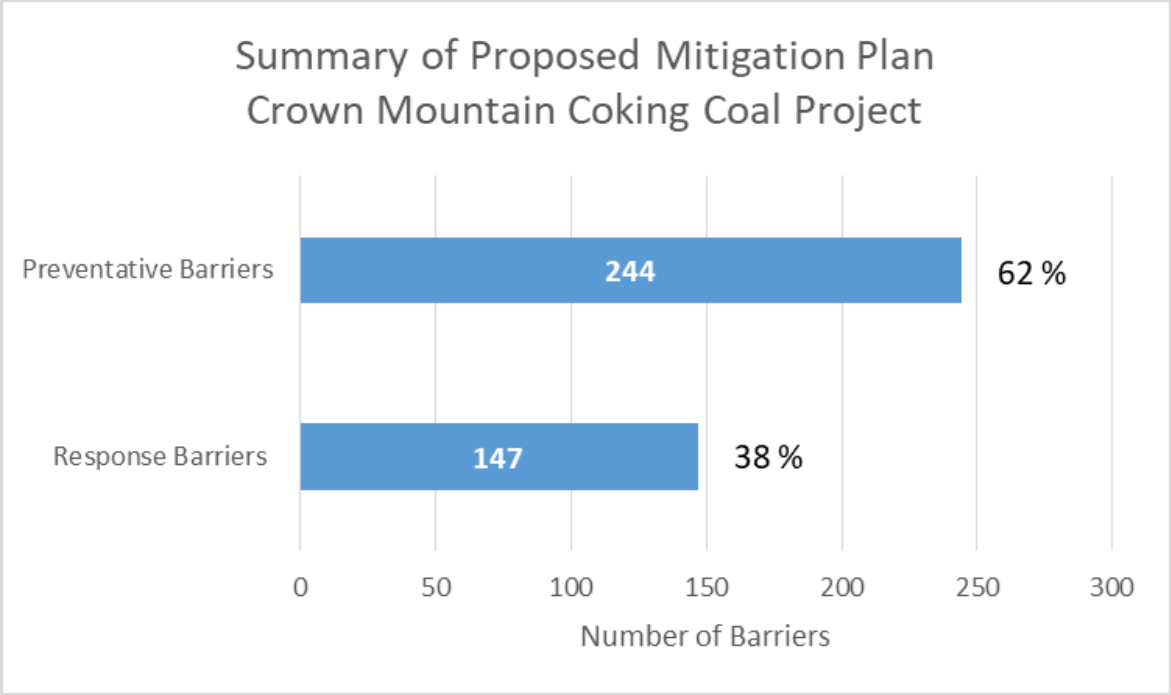


Figure 9: Summary of Proposed Mitigation Plan

A further breakdown of the apportionment of Preventative and Response Barriers per Project Phase is shown in **Figure 10**. The greatest emphasis for the Mitigation Plan, from most to least number of barriers, is as follows:

1. Operation Phase – 200 Barriers
2. Construction Phase – 89 Barriers
3. Reclamation and Closure Phase – 32 Barriers
4. Post-Closure Phase – 30 Barriers
5. Pre-Production Phase – 27 Barriers
6. General Project Risk (Water Quality) – 13 Barriers

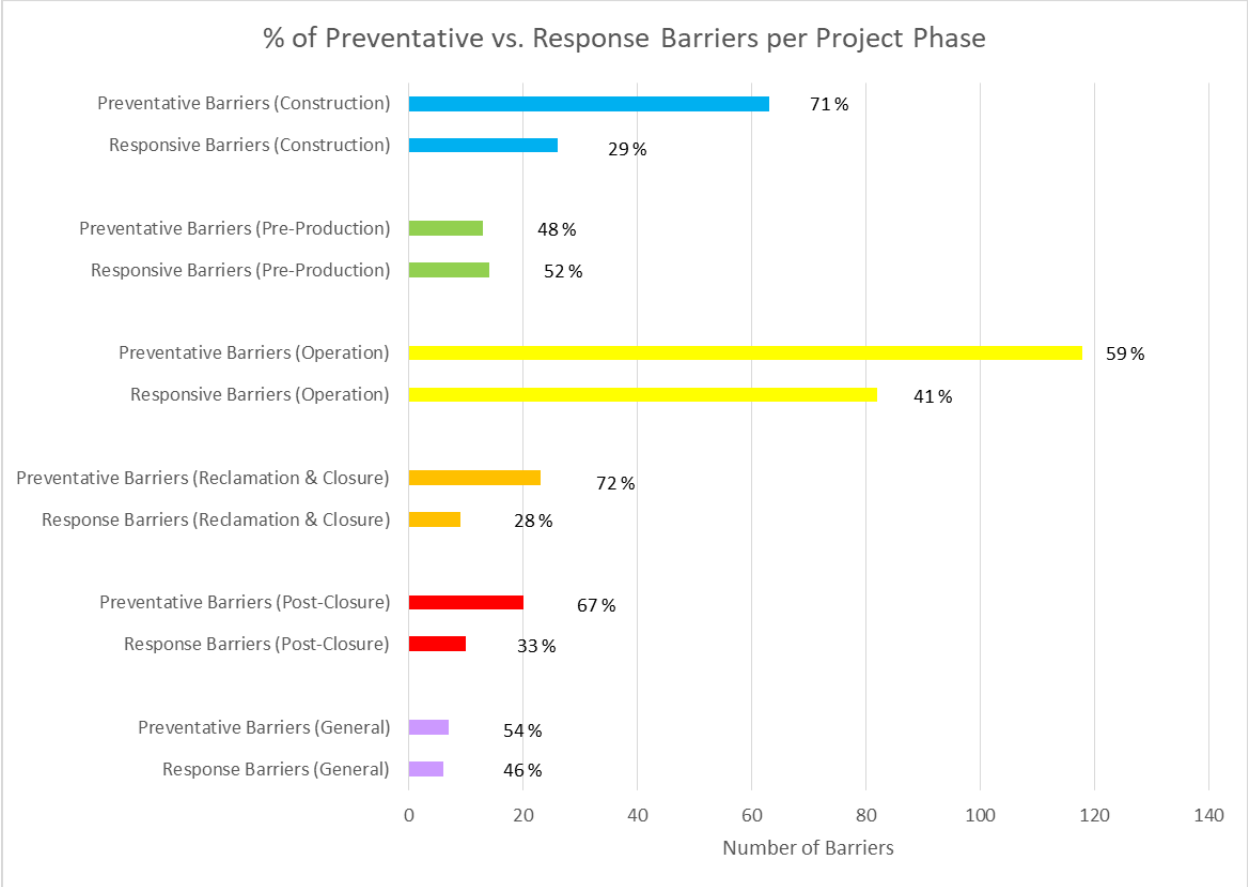
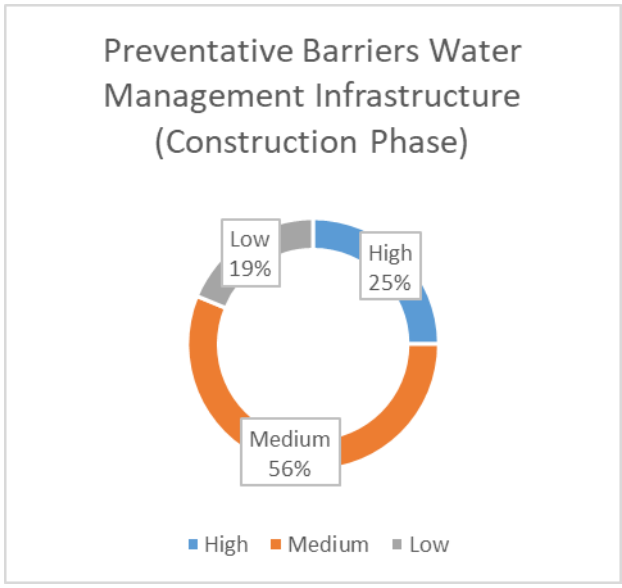


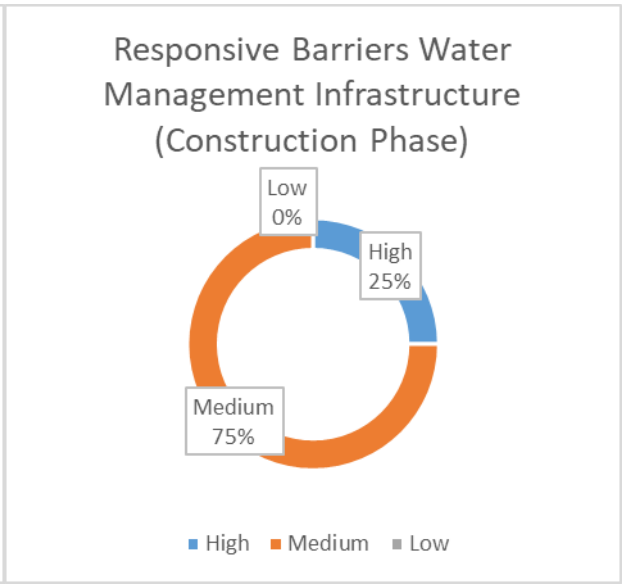
Figure 10: Apportionment of Preventative and Response Barriers per Project Phase

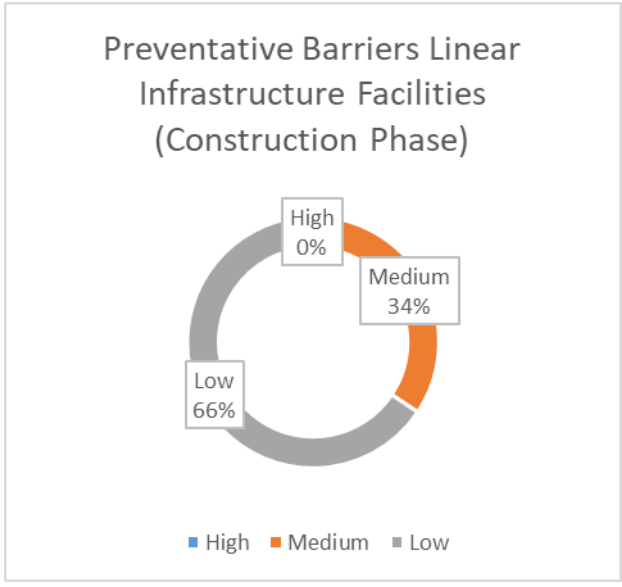
The criticality of the Barriers scored High, Medium, or Low allowed for a weighting to be applied to the importance that the Preventative and Response Barriers play to mitigate the Threats and Consequences. By Project Phase, the criticality and list of specific barriers are provided in **Sections 5.2** to **5.7**.

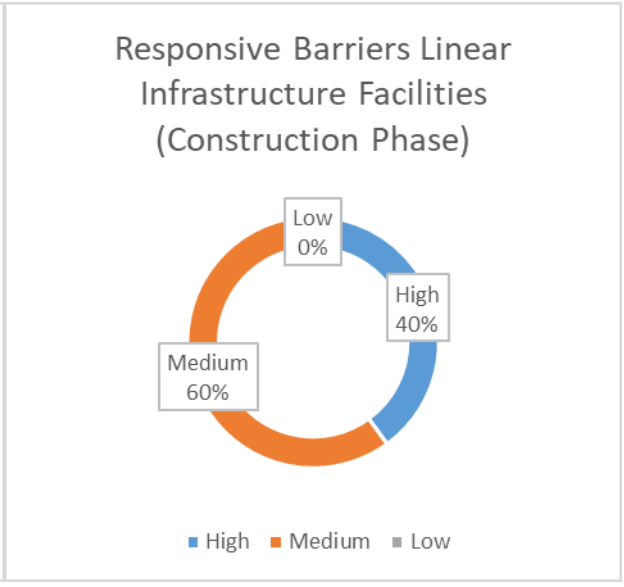
5.2 Project Phase – Construction

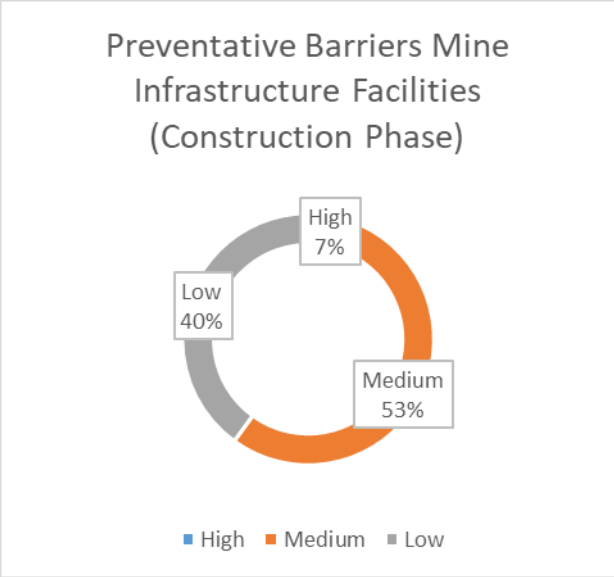
There are a total of 89 mitigation measures, split between 63 Preventative Barriers and 26 Response Barriers to mitigate the Threats and Consequences of the Construction Phase. The Criticality Scores for the Preventative and Response Barriers for the three Project Components under the Construction Phase are shown in the following donut graphs. In general, the majority of the barriers are viewed as having a "Medium" criticality to mitigate the Threats and Consequences, although for Linear Infrastructure, the majority of the Preventative Measures are considered to be "Low" criticality.

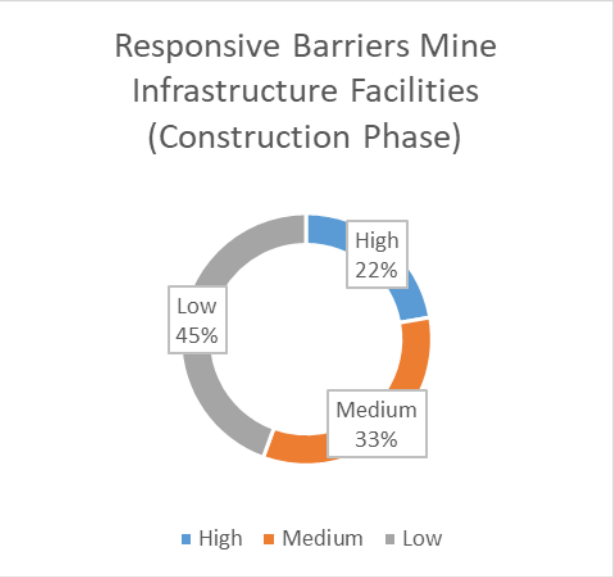

Preventative Barriers Water Management Infrastructure (Construction Phase)
Low 19%
High 25%
Medium 56%
High
Medium
Low


Responsive Barriers Water Management Infrastructure (Construction Phase)
Low 0%
High 25%
Medium 75%
High
Medium
Low


Preventative Barriers Linear Infrastructure Facilities (Construction Phase)
High 0%
Medium 34%
Low 66%
High
Medium
Low


Responsive Barriers Linear Infrastructure Facilities (Construction Phase)
Low 0%
High 40%
Medium 60%
High
Medium
Low





The specific Preventative Measures are summarized in **Table 25** and the Response Measures are summarized in **Table 26**, along with the specific Criticality scoring. Further, Escalating Factors were identified that have the potential to undermine the effectiveness of specific Preventative and Response Measures, and where applicable, additional measures have been identified to mitigate the escalating factors.

Table 25: List of Preventative Measures – Construction Phase

Preventative Measures	Activity or Threat being Mitigated	Escalating Factors	Criticality
Water Management Infrastructure – Unforeseen Site Conditions			
Geotechnical Testing Program	• Foundation Preparation • Embankment Construction	None	High
Construction Water Management Plan	• Foundation Preparation • Embankment Construction	• Heavy Precipitation Event • Risk of Avalanche	High
Timing of Activities around Adverse Weather Conditions	• Foundation Preparation • Embankment Construction	None	Medium
Contractor Vetting	• Foundation Preparation • Embankment Construction • Blasting – Construction of Ditches	None	Medium
Trigger Action Response Plan	• Foundation Preparation • Embankment Construction	None	Medium
Health and Safety Program	• Foundation Preparation • Embankment Construction	None	Medium

Preventative Measures	Activity or Threat being Mitigated	Escalating Factors	Criticality
Blasting Plan	• Blasting – Construction of Ditches	None	Low
Pre-project Planning	• Foundation Preparation • Embankment Construction	• Heavy Precipitation Event • Risk of Avalanche	Low
Linear Infrastructure Facilities – Unforeseen Site Conditions			
Construction Water Management Plan	• Construction of Rail Line and Loading Facility • Construction of Gas Line • Construction of Power Line • Construction of Coal Haul Route • Construction of Clean Coal Conveyor System	• Heavy Precipitation Event • Risk of Avalanche	Medium
Contractor Vetting	• Construction of Rail Line and Loading Facility • Construction of Gas Line • Construction of Power Line • Construction of Coal Haul Route • Construction of Clean Coal Conveyor System • Blasting	None	Medium
Pre-project Planning	• Construction of Rail Line and Loading Facility • Construction of Gas Line • Construction of Power Line • Construction of Coal Haul Route • Construction of Clean Coal Conveyor System	• Heavy Precipitation Event • Risk of Avalanche	Low
Timing of Activities around Adverse Weather Conditions	• Construction of Rail Line and Loading Facility • Construction of Gas Line • Construction of Power Line • Construction of Coal Haul Route • Construction of Clean Coal Conveyor System	None	Low
Geotechnical Testing Program	• Construction of Rail Line and Loading Facility • Construction of Gas Line • Construction of Power Line • Construction of Coal Haul Route • Construction of Clean Coal Conveyor System	None	Low
Health and Safety Program	• Construction of Rail Line and Loading Facility	None	Low

Preventative Measures	Activity or Threat being Mitigated	Escalating Factors	Criticality
	• Construction of Gas Line • Construction of Power Line • Construction of Coal Haul Route • Construction of Clean Coal Conveyor System		
Blasting Plan	• Blasting Plan	None	Low
Mine Infrastructure Facilities – Disruption to Construction Resulting in Safety Risk and/or Environmental Damage			
Geotechnical Testing Program	• Foundation Preparation	None	High
Road and Vehicle Maintenance Program	• Accessing Site	None	Medium
Contractor Vetting	• Accessing Site • Foundation Preparation • Blasting	None	Medium
Health and Safety Program	• Accessing Site • Foundation Preparation	None	Low to Medium
Construction Water Management Plan	• Foundation Preparation	• Heavy Precipitation Event • Risk of Avalanche	Medium
Timing of Activities around Adverse Weather Conditions	• Foundation Preparation	None	Medium
Trigger Action Response Plan	• Foundation Preparation	None	Medium
Pre-Project Planning	• Foundation Preparation	• Heavy Precipitation Event • Risk of Avalanche	Low
Logistics Plan – Construction Materials	• Accessing Site	None	Low
Worker Vehicle Vetting Program	• Accessing Site	None	Low
Physical Barriers – Gatehouses	• Accessing Site	None	Low
Blasting Plan	• Blasting	None	Low

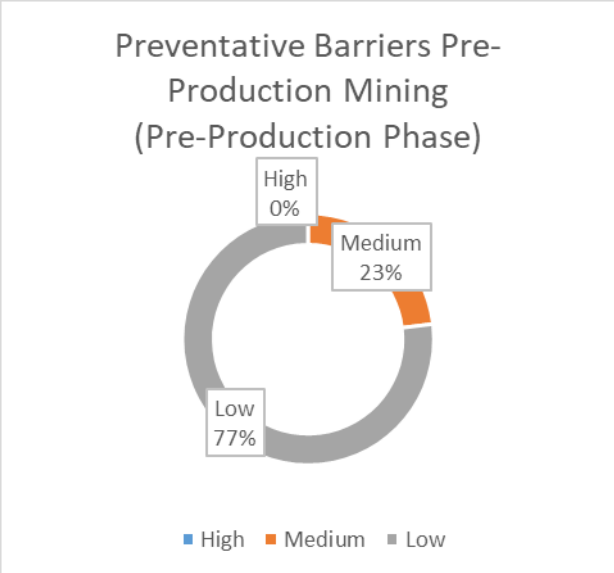
Table 26: List of Response Measures – Construction Phase

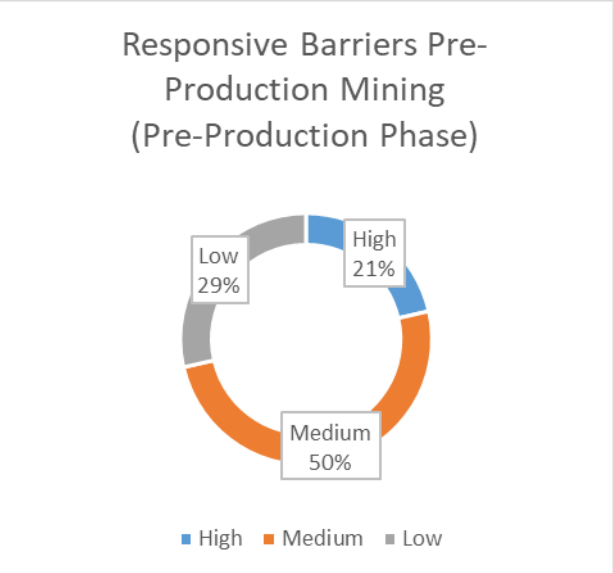
Response Measures	Consequences being Mitigated	Escalating Factors	Criticality
Water Management Infrastructure – Unforeseen Site Conditions			
Geotech Testing Program	• Embankment/Foundation Failure During Construction • Partial Failure of Embankment During Construction	None	High
Construction Diversion / Contingency Water Plan	• Overtopping of Embankment During Construction	None	High
Contractor Vetting	• Embankment/Foundation Failure During Construction	None	Medium
Health and Safety Program	• Embankment/Foundation Failure During Construction • Partial Failure of Embankment During Construction • Overtopping of Embankment During Construction	None	Medium
On-Site Engineering Inspection Program	• Embankment/Foundation Failure During Construction • Partial Failure of Embankment During Construction	None	Medium
Trigger Action Response Plan	• Embankment/Foundation Failure During Construction • Partial Failure of Embankment During Construction • Overtopping of Embankment During Construction	None	Medium
Linear Infrastructure Facilities – Unforeseen Site Conditions			
Indigenous Engagement Plan	• Archaeology Site	None	High
Construction Clearance Plan	• Archaeology Site	None	High
Redesign to Avoid Sensitive Sites	• Archaeology Site	None	Medium
Geotech Design Revisions	• Geotech Unstable Areas	None	Medium
Trigger Action Response Plan	• Geotech Unstable Areas	None	Medium
Mine Infrastructure Facilities – Disruption to Construction Resulting in Safety Risk and/or Environmental Damage			
Indigenous Engagement Plan	• Archaeology Site	None	High
Construction Clearance Plan	• Archaeology Site	None	High
Redesign to Avoid	• Archaeology Site	None	Medium

Response Measures	Consequences being Mitigated	Escalating Factors	Criticality
Sensitive Sites Trigger Action Response Plan	• Geotech Unstable Areas	None	Medium
Health and Safety Program	• Vehicular Accident on Access Road	None	Medium
Geotech Design Revisions	• Geotech Unstable Areas	None	Low
Traffic Management Plan	• Vehicular Accident on Access Road	None	Low
Secondary Access Plan	• Unable to Utilize Road During Evacuation	• Wildfire or other hazard takes out secondary access. *Mitigation – Helicopter Evacuation*	Low/Low

5.3 Project Phase – Pre-Production

There are a total of 27 mitigation measures, split between 13 Preventative Barriers and 14 Response Barriers to mitigate the Threats and Consequences of the Pre-Production Phase. The Criticality Scores for the Preventative and Response Barriers for the one Project Component under the Pre-Production Phase are shown in the following donut graphs. In general, the majority of the Preventative Barriers are viewed as having a "Low" criticality to mitigate the Threats while the majority of the Response Barriers are viewed as having a "Medium" criticality to mitigate the Consequences. All the "High" criticality barriers focus on "Response" measures.





The specific Preventative Measures are summarized in **Table 27** and the Response Measures are summarized in **Table 28**. Further, Escalating Factors were identified that have the potential to undermine the effectiveness of specific Preventative and Response Measures, and where applicable, additional measures have been identified to mitigate the escalating factors.

Table 27: List of Preventative Measures – Pre-Production Phase

Preventative Measures	Activity or Threat being Mitigated	Escalating Factors	Criticality
Pre-Production Mining – Unforeseen Site Conditions			
Site Specific Blasting Plan	• Construct Main ROM Stockpile and Facility Pad Areas	None	Medium
MLARD Plan	• Waste Rock Management Areas	None	Medium
Operating Maintenance and Surveillance Plan	• Waste Rock Management Areas • Surface Extraction Area	None	Medium
Blasting Plan	• Surface Extraction Area	None	Low
Health and Safety Program	• Construct Main ROM Stockpile and Facility Pad Areas	None	Low
Widening Pioneer Access Road	• Access Road Construction and Update	• Heavy Precipitation Event • Risk of Avalanche	Low
Construct Initial Pioneer Access Haul Road	• Access Road Construction and Update	None	Low
Upgrade Existing Forestry Road	• Access Road Construction and Update	None	Low
Pre-Stripping from Upper Benches of North Pit Plan	• Initial Site Prep	None	Low
Logging Plan	• Initial Site Prep	None	Low
Clearing and Grubbing Plan	• Initial Site Prep	None	Low
Soil Stripping and Stockpiling Plan	• Initial Site Prep	None	Low

Table 28: List of Response Measures – Pre-Production Phase

Response Measures	Consequences being Mitigated	Escalating Factors	Criticality
Pre-Production Mining – Unforeseen Site Conditions			
Indigenous Engagement Plan	• Archaeology Site	None	High
Mine Clearance Plan	• Archaeology Site	None	High
Health and Safety Program	• Heavy Vehicle / Light Vehicle Interaction	None	High
Redesign to avoid Sensitive Areas	• Archaeology Site	None	Medium
Trigger Action Response Plan	• Geotech Unstable Area – Mine Rock Storage Facility • Geotech Unstable Area – Pit Wall • Geotech Unstable Area – Access Road	None	Medium
Spill Management Plan	• Heavy Vehicle / Light Vehicle Interaction	None	Medium
Geotech Design Revisions	• Geotech Unstable Area – Mine Rock Storage Facility • Geotech Unstable Area – Pit Wall • Geotech Unstable Area – Access Road	None	Low to Medium
Traffic Management Plan	• Heavy Vehicle / Light Vehicle Interaction	None	Low
Secondary Access Plan	• Unable to Utilize Road During Evacuation	• Wildfire or other hazard takes out secondary access. *Mitigation – Helicopter Evacuation*	Low/Low

5.4 Project Phase – Operation

There are a total of 200 mitigation measures, split between 118 Preventative Barriers and 82 Response Barriers to mitigate the Threats and Consequences of the Operation Phase. The Criticality Scores for the Preventative and Response Barriers for the eight Project Components under the Operation Phase are shown in the following donut graphs.

The majority of the Preventative and Response Barriers are rated as “Low” criticality for Mine Surface Operations, and the only “High” criticality rated measures are for Response Barriers.

The majority of the Preventative and Response Barriers are rated as “Medium” criticality for the Construction of the Main Sediment Pond, and there are no “Low” criticality rated measures are for Response Barriers.

The majority of the Preventative and Response Barriers are rated as “High” and “Medium” criticality, respectively, for the Operation of the Main Sediment Pond.

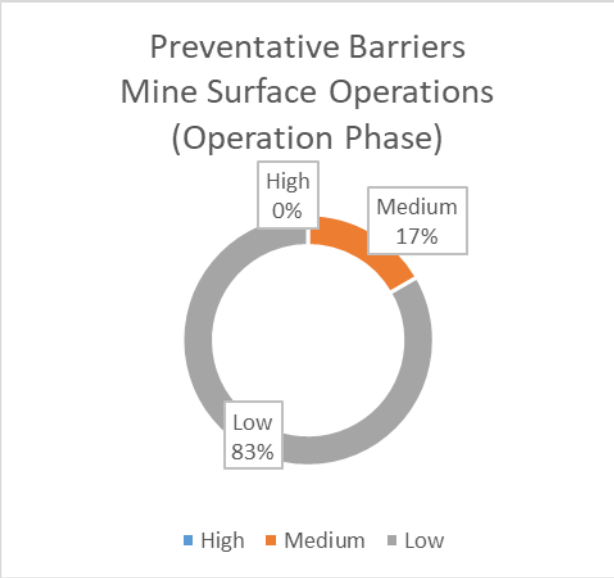
The majority of the Preventative and Response Barriers are rated as “Low” criticality for the Coal Preparation Plant, and the only “High” criticality rated measures are for Response Barriers.

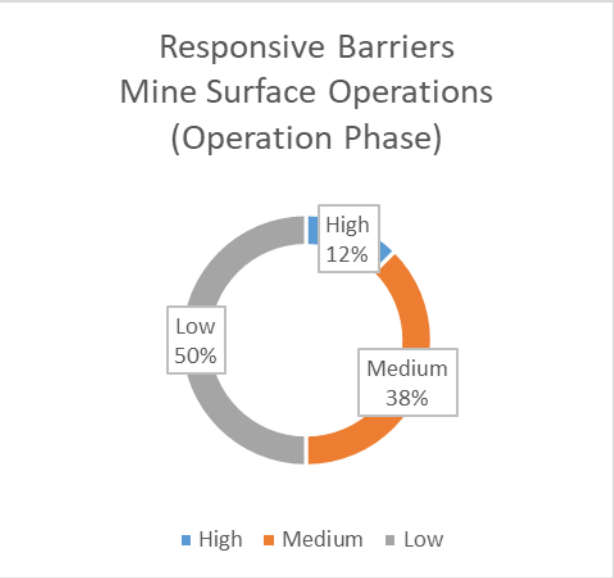
The majority of the Preventative and Response Barriers are rated as “Low” criticality for the Rail Loadout and Rail Siding operation, and the only “High” criticality rated measures are for the Preventative Barriers.

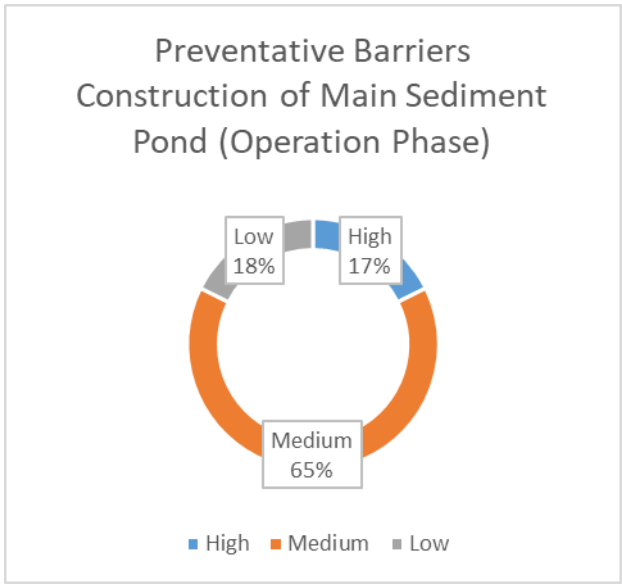
The majority of the Preventative and Response Barriers are rated as “Medium” and “Low” criticality, respectively, for the Clean Coal Haul Route operations, and the only “High” criticality rated measures are for the Preventative Barriers.

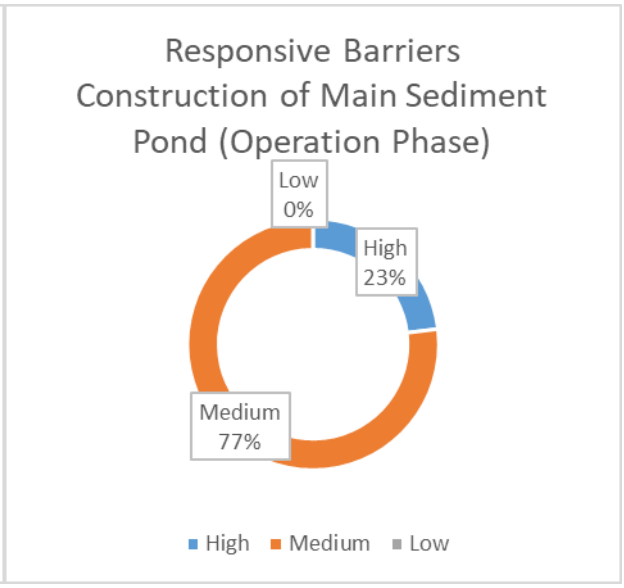
The majority of the Preventative and Response Barriers are rated as “High” criticality – 100% and 80% respectively, for Explosive Storage, with the remaining 20% of the Response Barriers rated as “Low” criticality.

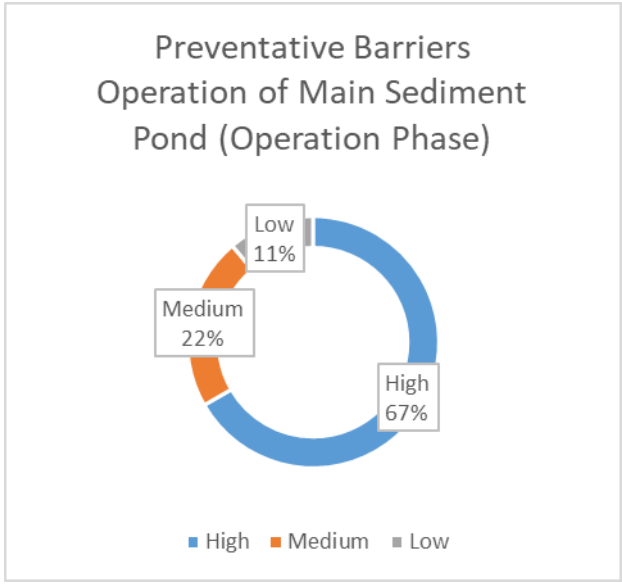
The majority of the Preventative and Response Barriers are rated as “Low” criticality – 67% and 100% respectively, for Sewage Treatment and Waste Management, with the remaining 33% of the Preventative Barriers rated as “Medium” criticality.

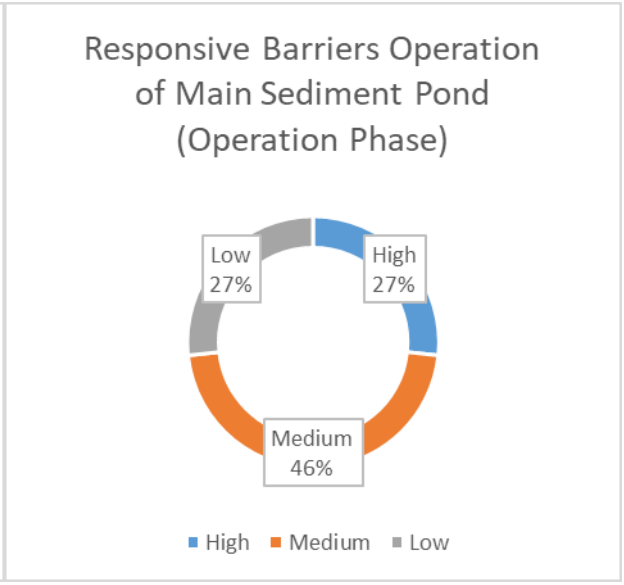


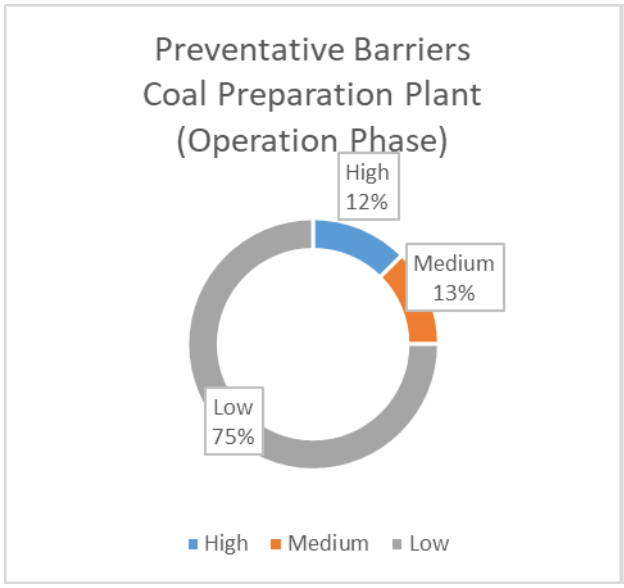


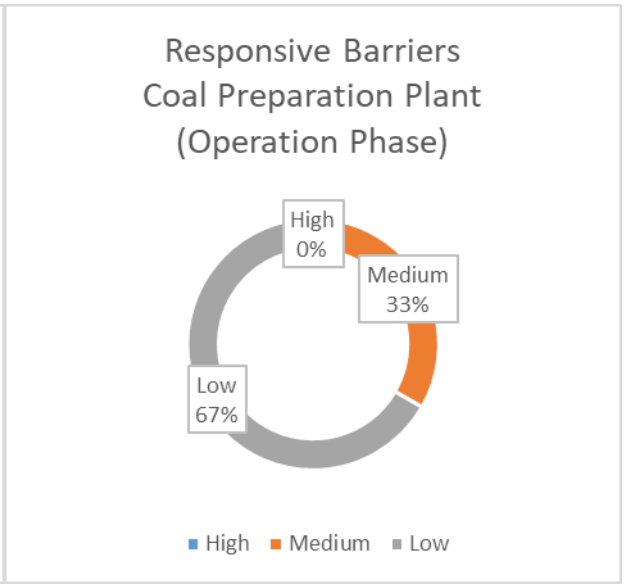

Preventative Barriers Construction of Main Sediment Pond (Operation Phase)
Low 18%
High 17%
Medium 65%
High
Medium
Low

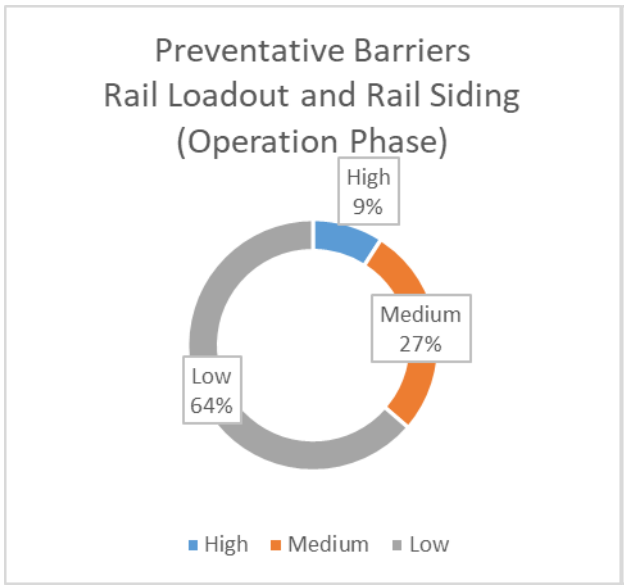

Responsive Barriers Construction of Main Sediment Pond (Operation Phase)
Low 0%
High 23%
Medium 77%
High
Medium
Low

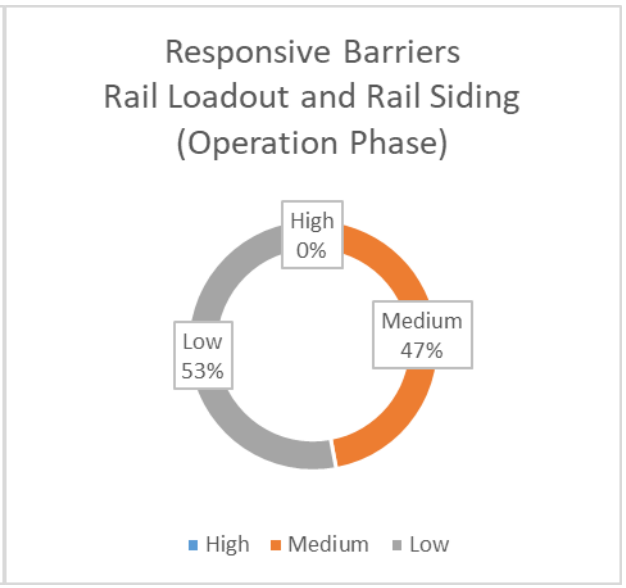

Preventative Barriers Operation of Main Sediment Pond (Operation Phase)
Low 11%
Medium 22%
High 67%
High
Medium
Low

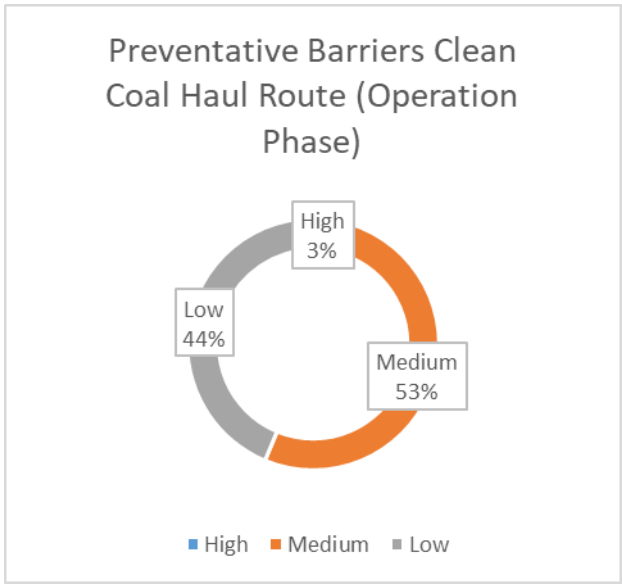

Responsive Barriers Operation of Main Sediment Pond (Operation Phase)
Low 27%
High 27%
Medium 46%
High
Medium
Low

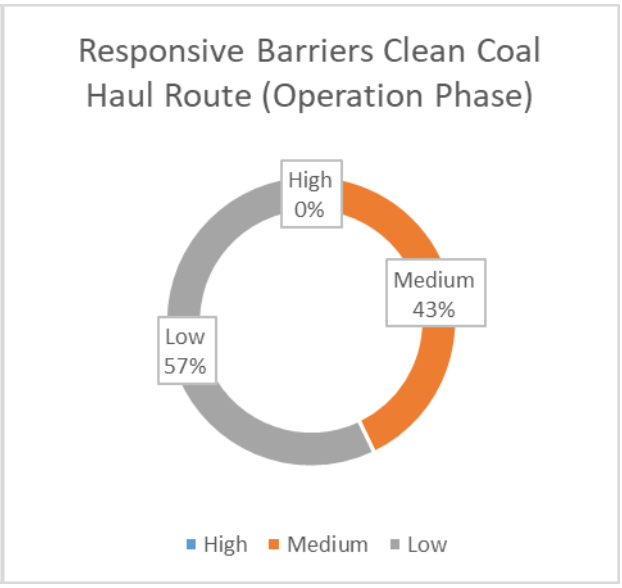

Preventative Barriers
Coal Preparation Plant
(Operation Phase)
High 12%
Medium 13%
Low 75%
High
Medium
Low

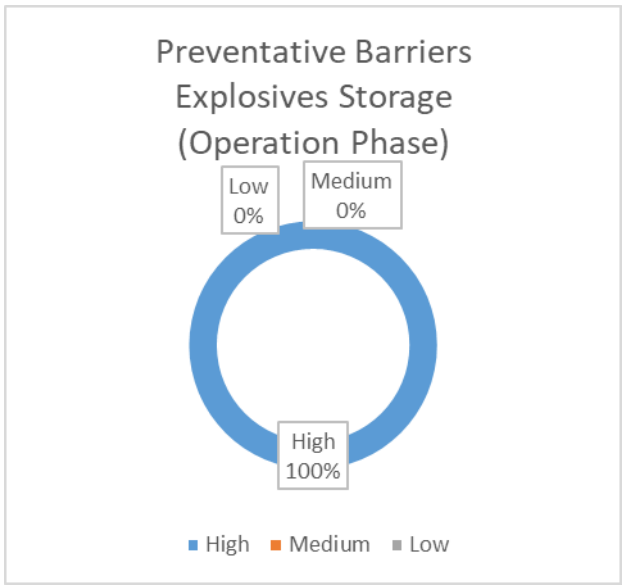

Responsive Barriers
Coal Preparation Plant
(Operation Phase)
High 0%
Medium 33%
Low 67%
High
Medium
Low

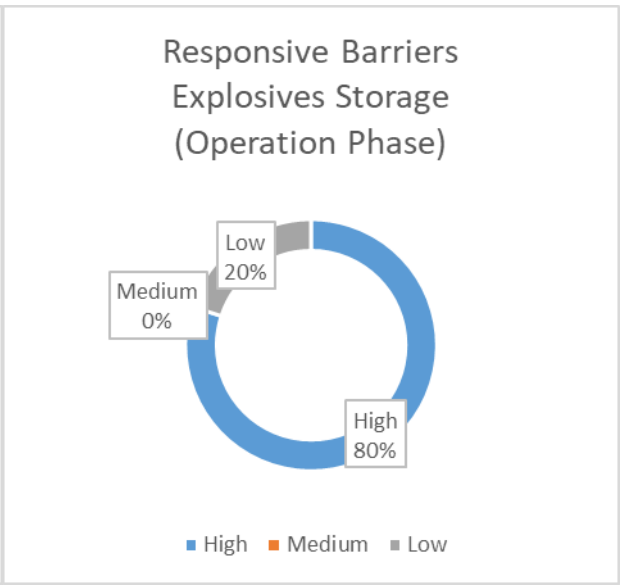

Preventative Barriers
Rail Loadout and Rail Siding
(Operation Phase)
High 9%
Medium 27%
Low 64%
High
Medium
Low

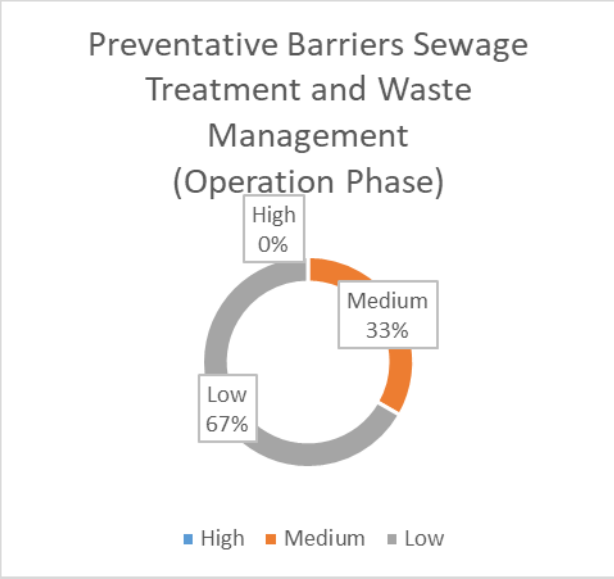

Responsive Barriers
Rail Loadout and Rail Siding
(Operation Phase)
High 0%
Medium 47%
Low 53%
High
Medium
Low

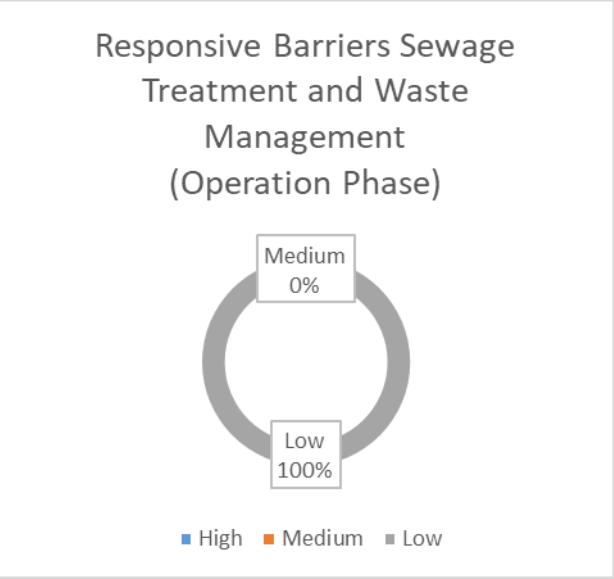

Preventative Barriers Clean Coal Haul Route (Operation Phase)
High 3%
Medium 53%
Low 44%
High
Medium
Low


Responsive Barriers Clean Coal Haul Route (Operation Phase)
High 0%
Medium 43%
Low 57%
High
Medium
Low


Preventative Barriers Explosives Storage (Operation Phase)
Low 0%
Medium 0%
High 100%
High
Medium
Low


Responsive Barriers Explosives Storage (Operation Phase)
Low 20%
Medium 0%
High 80%
High
Medium
Low





The specific Preventative Measures are summarized in **Table 29** and the specific Response Measures are summarized in **Table 30**. Further, Escalating Factors were identified that have the potential to undermine the effectiveness of specific Preventative and Response Measures, and where applicable, additional measures have been identified to mitigate the escalating factors.

Table 29: List of Preventative Measures – Operation Phase

Preventative Measures	Activity or Threat being Mitigated	Escalating Factors	Criticality
Mine Surface Operations – Unforeseen Site Conditions			
MLARD Plan	• Waste Rock Management Areas	None	Medium
Surface Water Management Plan	• Surface Water Management	None	Medium
Operating Maintenance and Surveillance Plan	• Waste Rock Management Areas • Surface Extraction Area	None	Low
Permit Design	• Waste Rock Management Areas • Surface Extraction Area	None	Low
Blasting Plan	• Surface Extraction Area	None	Low
Environmental Management System	• Site Operations • Surface Water Management	None	Low
Health and Safety Program	• Site Operations	None	Low
Standard Operating Procedures	• Site Operations	None	Low
Mine Plan	• Surface Water Management	None	Low
Construction of Main Sediment Pond – Unforeseen Site Conditions			
Health and Safety Program	• Foundation Preparation • Embankment Construction	None	High

Preventative Measures	Activity or Threat being Mitigated	Escalating Factors	Criticality
Construction Water Management Plan	• Foundation Preparation • Embankment Construction	• Heavy Precipitation Event • Risk of Avalanche	Medium
Timing of Activities around Adverse Weather Conditions	• Foundation Preparation • Embankment Construction	None	Medium
Contractor Vetting	• Foundation Preparation • Embankment Construction • Blasting	None	Medium
Trigger Action Response Plan	• Foundation Preparation • Embankment Construction	None	Medium
Geotechnical Testing Program	• Foundation Preparation • Embankment Construction	• Materials can't be used due to geotechnical reasons	Medium
Pre-project Planning	• Foundation Preparation • Embankment Construction	• Heavy Precipitation Event • Risk of Avalanche	Low to Medium
Blasting Plan	• Blasting	None	Low
Operation of Main Sediment Pond – Unforeseen Site Conditions			
Construction QA/QC	• Internal Erosion or Piping	None	High
Ongoing Inspection	• Internal Erosion or Piping • Slope Instability	None	High
Design to Specific Seismic Event	• Seismic Event	None	High
Design Requirements	• Slope Instability	None	High
Slope Stability Assessment and Mitigation	• Landslide Going into Pond	None	High
Upslope Terrain Monitoring	• Landslide Going into Pond	None	Medium
Environmental Management System	• Drought Conditions	None	Medium
Emergency Spillway Design	• Heavy Precipitation Event	None	Low
Coal Preparation Plant – Unforeseen Events			
Jersey Barriers	• Kerosene Tank	None	High
Double-Walled Tank	• Kerosene Tank	None	Medium
Dust Management Plan	• Coal Stockpile	None	Low

Preventative Measures	Activity or Threat being Mitigated	Escalating Factors	Criticality
Operations and Maintenance Program	• Steam Emissions from Coal Dryer	None	Low
Pressure Vessel Certification	• Steam Emissions from Coal Dryer	None	Low
Safe Handling Procedures	• Kerosene Tank Loading Area	None	Low
Containment Pad	• Kerosene Tank Loading Area	None	Low
Contractor Vetting	• Kerosene Tank Loading Area	None	Low
Rail Loadout and Rail Siding – Unforeseen Events			
Design to Federal Grade Crossing Standards	• Public Grade Level Crossing • Private Grade Level Crossing	None	High
Maintenance Program	• Public Grade Level Crossing • Private Grade Level Crossing	None	Medium
Operations and Maintenance Program	• Loading of Hopper Rail Cars	None	Medium
Radio Controls	• Coal Truck Delivery	None	Medium
Wildlife Barriers/Pathways	• Coal Truck Delivery	None	Medium
Speed Limits	• Coal Truck Delivery	None	Medium
Jersey Barriers	• Fuel Storage	None	Medium
Vegetation Control	• Public Grade Level Crossing • Private Grade Level Crossing • Loading of Hopper Rail Cars	None	Low
Training Program	• Train Crew Exchange	None	Low
Designated Crew Exchange Area	• Train Crew Exchange	None	Low
Loadout Override	• Loading of Hopper Rail Cars	None	Low
Remote Control of Locomotives	• Loading of Hopper Rail Cars	None	Low
Chute Maintenance	• Loading of Hopper Rail Cars	None	Low
Surge Bin	• Loading of Hopper Rail Cars	None	Low
Vehicle Maintenance	• Coal Truck Delivery	None	Low
Truck Driver Training	• Coal Truck Delivery	None	Low
Covered Stockpile	• Coal Stockpile	None	Low
Registered Tank	• Fuel Storage	None	Low
Clean Coal Haul Route – Interaction of Coal Haul Traffic and Public Traffic/Wildlife			
Early Avalanche Control Program	• Terrain Hazards	None	High
Road Maintenance Program	• Coal Haul Truck Traffic • Public Vehicle Traffic on Public Road • Light Vehicle Mine Related Traffic	None	Medium

Preventative Measures	Activity or Threat being Mitigated	Escalating Factors	Criticality
Wildlife Barriers/Pathways	• Coal Haul Truck Traffic • Wildlife on Road	None	Medium
Speed Limits	• Coal Haul Truck Traffic • Wildlife on Road	None	Medium
Design Considerations – Speed Reduction	• Public Vehicle Traffic on Public Road • Light Vehicle Mine Related Traffic	None	Medium
Jersey Barriers	• Terrain Hazards	None	Medium
Boulder Roll-out Management Plan	• Terrain Hazards	None	Medium
Community Engagement Program	• Public Vehicle Trespassing on Private Road • Hikers/Hunters Trespassing	None	Medium
Physical Barriers	• Public Vehicle Trespassing on Private Road • Hikers/Hunters Trespassing	None	Medium
Radio Controls	• Coal Haul Truck Traffic • Light Vehicle Mine Related Traffic • Wildlife on Road	None	Low to Medium
Vehicle Maintenance	• Coal Haul Truck Traffic • Light Vehicle Mine Related Traffic	None	Low
Truck Driver Training	• Coal Haul Truck Traffic • Light Vehicle Mine Related Traffic • Wildlife on Road	None	Low
Design – Pull Off Areas	• Public Vehicle Traffic on Public Road • Light Vehicle Mine Related Traffic	None	Low
Traffic Management Plan	• Public Vehicle Traffic on Public Road • Light Vehicle Mine Related Traffic	None	Low
Security Gate/Control Access	• Public Vehicle Trespassing on Private Road • Hikers/Hunters Trespassing	None	Low
Signage	• Public Vehicle Trespassing on Private Road • Hikers/Hunters Trespassing	None	Low
Explosives Storage – Improper Storage and Handling			
Design to Federal Regulations	• Location of AN & Emulsion Silos • Location of Magazines • Storage and Handling of Wash Water from ANFO Trucks	None	High
Certified 3rd Party Explosive Contractor	• Handling and Transportation of Explosives to Storage Site • Disposal of Off-Spec Explosives Off-Site • Storage and Handling of Wash	None	High

Preventative Measures	Activity or Threat being Mitigated	Escalating Factors	Criticality
	Water from ANFO Trucks		
Sewage Treatment and Waste Management – Non-Compliance with Regulatory Standards			
Waste Management Plan	• Septic Field • Non-Hazardous Waste Collection • Hazardous Waste Generation	None	Medium
Contractor Vetting	• Non-Hazardous Waste Collection	None	Medium
Design Considerations	• Septic Field	None	Low
Health and Safety Program	• Non-Hazardous Waste Collection • Hazardous Waste Generation	None	Low
Environmental Management System	• Non-Hazardous Waste Collection • Hazardous Waste Generation	None	Low
Wildlife Management Program	• Non-Hazardous Waste Collection • Hazardous Waste Generation	None	Low
Design Storage Facility	• Hazardous Waste Generation	None	Low

Table 30: List of Response Measures – Operation Phase

Response Measures	Consequences being Mitigated	Escalating Factors	Criticality
Mine Surface Operations – Unforeseen Site Conditions			
Indigenous Engagement Plan	• Archaeology Site	None	High
Mining Clearance Plan	• Archaeology Site	None	High
Trigger Action Response Plan	• Geotech Unstable Area - Mine Rock Storage Facility • Geotech Unstable Area - Pit Wall • Geotech Unstable Area - Access Road	None	Medium
Health and Safety Program	• Heavy Vehicle/Light Vehicle Interaction	None	Medium
Spill Management Plan	• Heavy Vehicle/Light Vehicle Interaction	None	Medium
Geotech Design Revisions	• Geotech Unstable Area - Mine Rock Storage Facility • Geotech Unstable Area - Pit Wall • Geotech Unstable Area - Access Road	None	Low to Medium
Operating Maintenance and Surveillance Plan	• Geotech Unstable Area - Mine Rock Storage Facility • Geotech Unstable Area - Pit Wall • Geotech Unstable Area - Access Road	None	Low
Traffic Management Plan	• Heavy Vehicle/Light Vehicle Interaction	None	Low

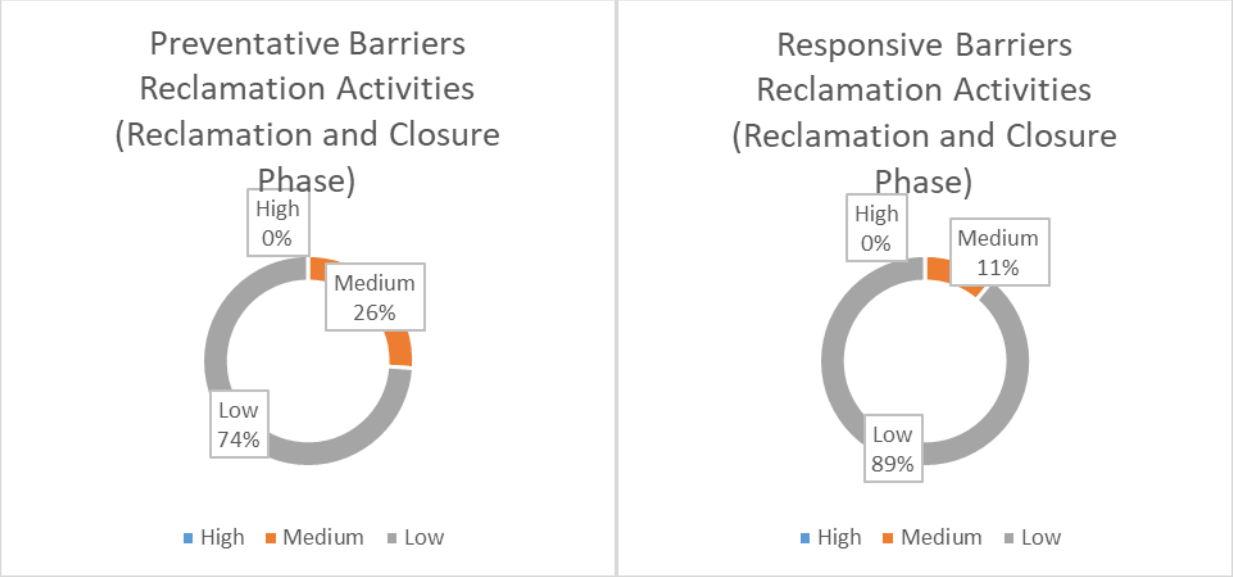
Response Measures	Consequences being Mitigated	Escalating Factors	Criticality
Secondary Access Plan	• Unable to Utilize Road during Evacuation	• Wildfire or other hazard takes out secondary access. *Mitigation – Helicopter Evacuation*	Low/Low
Construction of Main Sediment Pond – Unforeseen Site Conditions			
Health and Safety Program	• Embankment/Foundation Failure During Construction • Partial Failure of Embankment During Construction • Overtopping of Embankment During Construction	None	High
Contractor Vetting	• Embankment/Foundation Failure During Construction • Partial Failure of Embankment During Construction	None	Medium
On-Site Engineering Inspection Program	• Embankment/Foundation Failure During Construction • Partial Failure of Embankment During Construction	None	Medium
Geotech Testing Program	• Embankment/Foundation Failure During Construction • Partial Failure of Embankment During Construction	None	Medium
Trigger Action Response Plan	• Embankment/Foundation Failure During Construction • Partial Failure of Embankment During Construction • Overtopping of Embankment During Construction	None	Medium
Construction Diversion / Contingency Water Plan	• Overtopping of Embankment During Construction	None	Medium
Operation of Main Sediment Pond – Unforeseen Site Conditions			
OMS Manual	• Embankment/Foundation Failure • Partial Failure of Embankment • Overtopping of Embankment	• Change in Downstream Land Use – Increased Sensitivity. *Mitigation – Revisit Design Parameters based on Anticipated*	Medium/High

Response Measures	Consequences being Mitigated	Escalating Factors	Criticality
		Land Use changes.	
Trigger Action Response Plan	• Embankment/Foundation Failure • Partial Failure of Embankment • Overtopping of Embankment • Rapid Drawdown of Pond Results in Significant Flow in Alexander Creek	• Change in Downstream Land Use – Increased Sensitivity. *Mitigation – Revise Emergency Plan based on changing land-use.*	Medium/Low
Environmental Management System	• Rapid Drawdown of Pond Results in Significant Flow in Alexander Creek	None	Low
Coal Preparation Plant – Unforeseen Events			
Spill Response Plan	• Kerosene Spill • Uncontrolled Release of Process Water	None	Medium
Dust Management Plan	• Fugitive Dust from Coal Stockpile	• Dry Cold Water. *Mitigation – $CaCl_2$ Application.* • Drought. *Mitigation – Use of Reservoir Water.*	Low/Low/Low
Containment Sumps	• Uncontrolled Release of Process Water	None	Low
Rail Loadout and Rail Siding – Unforeseen Events			
Spill Response Plan	• Crossing Accident at Public Crossing • Crossing Accident at Private Crossing • Coal Spill at Loadout Area • Fuel Spill	None	Medium
Methane Detectors	• Coal Dust Explosion	None	Medium
Speed Limit	• Wildlife Strike by Train	None	Medium
Health and Safety Plan	• Crossing Accident at Public Crossing • Crossing Accident at Private Crossing • Derailment on the Fording Spur • Derailment on the Loadout Siding	None	Low to Medium
Secondary Access Road	• Crossing Accident at Public Crossing • Crossing Accident at Private Crossing • Derailment on the Fording Spur	None	Low

Response Measures	Consequences being Mitigated	Escalating Factors	Criticality
	• Derailment on the Loadout Siding		
Track Maintenance Program	• Derailment on the Loadout Siding	None	Low
Dust Management Plan	• Fugitive Dust Emissions	None	Low
Engineering Controls	• Coal Dust Explosion	None	Low
Clean Coal Haul Route – Interaction of Coal Haul Traffic and Public Traffic/Wildlife			
Speed Limits	• Vehicle Striking Wildlife • Coal Haul / Public Vehicle Accident • Pedestrian Struck by Vehicle	None	Medium
Truck Driver Training	• Vehicle Striking Wildlife • Coal Haul / Public Vehicle Accident • Pedestrian Struck by Vehicle	None	Low
Track Wildlife Strike Areas	• Vehicle Striking Wildlife	None	Low
Explosives Storage – Improper Storage and Handling			
Explosive Handling Employee Training	• Spills • Premature Detonation of Explosives	None	High
Certified 3rd Party Explosive Contractor	• Premature Detonation of Explosives	None	High
Design to Federal Regulations	• Premature Detonation of Explosives	None	High
Explosive Spill Response Plan	• Spills	None	Low
Sewage Treatment and Waste Management – Non-Compliance with Regulatory Standards			
Routine Maintenance	• Septic Field Blockage	None	Low
Environmental Management System	• Attracting Wildlife	None	Low
Spill Response Plan	• Hazardous Waste Spill	None	Low

5.5 Project Phase – Reclamation and Closure

There are a total of 32 mitigation measures, split between 23 Preventative Barriers and 9 Response Barriers to mitigate the Threats and Consequences of the Reclamation and Closure Phase. The Criticality Scores for the Preventative and Response Barriers for the one Project Component is shown in the following donut graphs.



The majority of the Preventative and Response Barriers are rated as "Low" criticality for Reclamation Activities, and there are no "High" criticality rated measures.

The specific "Preventative Measures" are summarized in **Table 31** and the specific "Response Measures" are summarized in **Table 32**. Further, Escalating Factors were identified that have the potential to undermine the effectiveness of specific Preventative and Response Measures, and where applicable, additional measures have been identified to mitigate the escalating factors.

Table 31: List of Preventative Measures – Reclamation and Closure Phase

Preventative Measures	Activity or Threat being Mitigated	Escalating Factors	Criticality
Reclamation Activities – Unsuccessful Reclamation Program			
Detailed Engineering Design	• Reclaim Access Road • Reclaim Mine Rock Piles • Reclaim Site Facilities • Reclaim Utility Services • Reclaim Rail Loadout Area • Reclaim Grave Creek Reservoir	None	Medium
Water Management Plan	• Reclaim Access Road	None	Low

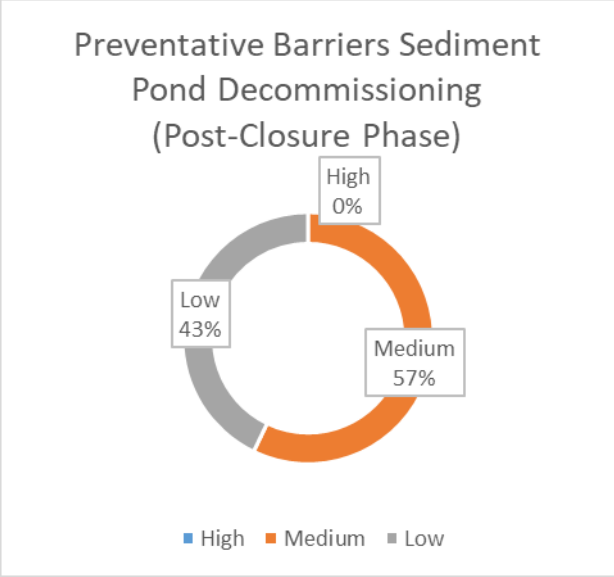
Preventative Measures	Activity or Threat being Mitigated	Escalating Factors	Criticality
SOP & Experienced Operators	• Reclaim Mine Rock Piles • Reclaim Site Facilities • Reclaim Utility Services • Reclaim Rail Loadout Area • Reclaim Grave Creek Reservoir • Reclaim Access Road • Reclaim Mine Rock Piles • Reclaim Site Facilities • Reclaim Utility Services • Reclaim Rail Loadout Area • Reclaim Grave Creek Reservoir	None	Low
Operating Maintenance and Surveillance Plan	• Reclaim Mine Rock Piles • Reclaim Surface Extraction Area	None	Low
Reclaim Scrap Steel	• Reclaim Site Facilities • Reclaim Utility Services • Reclaim Rail Loadout Area	None	Low

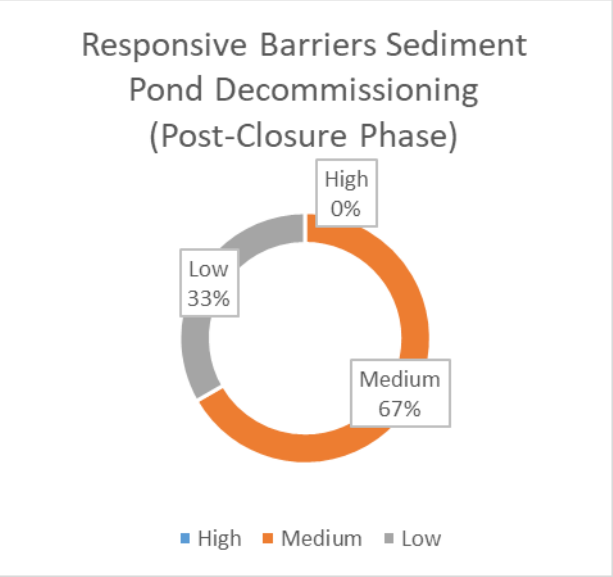
Table 32: List of Response Measures – Reclamation and Closure Phase

Response Measures	Consequences being Mitigated	Escalating Factors	Criticality
Reclamation Activities – Unsuccessful Reclamation Program			
Spill Management Plan	• Heavy Vehicle/Light Vehicle Interaction	None	Medium
Geotech Design Revisions	• Slope Failure - Waste Rock, Access Road and Grave Creek Reservoir • Geotech Unstable Area - Pit Wall	None	Low
Operating Maintenance and Surveillance Plan	• Slope Failure - Waste Rock, Access Road and Grave Creek Reservoir • Geotech Unstable Area - Pit Wall	None	Low
Health and Safety Program	• Heavy Vehicle/Light Vehicle Interaction	None	Low
Traffic Management Plan	• Heavy Vehicle/Light Vehicle Interaction	None	Low
Secondary Access Plan	• Unable to Utilize Road during Evacuation	• Wildfire or other hazard takes out secondary access. *Mitigation – Helicopter Evacuation*	Low/Low

5.6 Project Phase – Post-Closure

There are a total of 30 mitigation measures, split between 20 Preventative Barriers and 10 Response Barriers to mitigate the Threats and Consequences of the Post-Closure Phase. The Criticality Scores for the Preventative and Response Barriers for the one Project Component is shown in the following donut graphs.





The majority of the Preventative and Response Barriers are rated as "Medium" criticality for Reclamation Activities, and there are no "High" criticality rated measures.

The specific Preventative Measures are summarized in **Table 33** and the Response Measures are summarized in **Table 34**. Further, Escalating Factors were identified that have the potential to undermine the effectiveness of specific Preventative and Response Measures, and where applicable, additional measures have been identified to mitigate the escalating factors.

Table 33: List of Preventative Measures – Post-Closure Phase

Preventative Measures	Activity or Threat being Mitigated	Escalating Factors	Criticality
Main Sediment Pond Decommissioning – Uncontrolled Sediment Release During Decommissioning			
Construction Water Management Plan	• Heavy Precipitation Event during Decommissioning • Avalanche during Decommissioning	None	Medium
Contractor Vetting	• Heavy Precipitation Event during Decommissioning • Avalanche during Decommissioning	None	Medium
Trigger Action Response	• Heavy Precipitation Event during	None	Medium

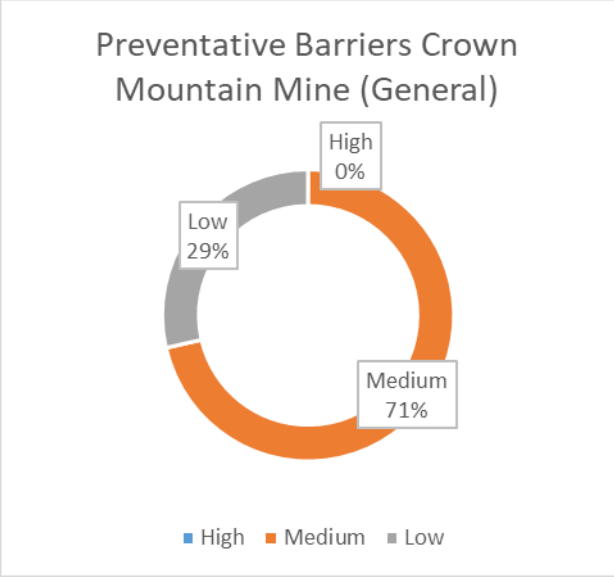
Preventative Measures	Activity or Threat being Mitigated	Escalating Factors	Criticality
Plan	Decommissioning • Avalanche during Decommissioning		
Timing of Activities around Adverse Weather Conditions	• Heavy Precipitation Event during Decommissioning • Avalanche during Decommissioning	None	Low to Medium
Health and Safety Program	• Heavy Precipitation Event during Decommissioning • Avalanche during Decommissioning	None	Low to Medium
Pre-Project Planning	• Heavy Precipitation Event during Decommissioning • Avalanche during Decommissioning	None	Low
Post-Closure Measures – Unforeseen Site Events			
Limited Public Access	• Heavy Precipitation Event • Avalanche • Wildfire	None	Medium
Operating Maintenance and Surveillance Plan	• Heavy Precipitation Event • Avalanche • Wildfire	None	Low to Medium

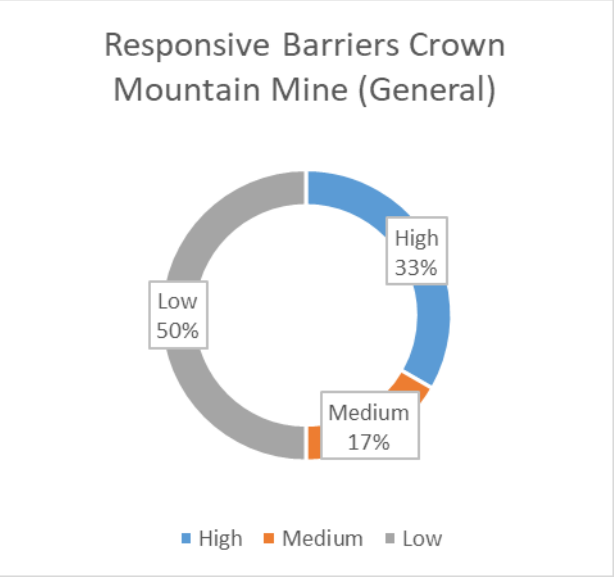
Table 34: List of Response Measures – Post-Closure Phase

Response Measures	Consequences being Mitigated	Escalating Factors	Criticality
Main Sediment Pond Decommissioning – Uncontrolled Sediment Release During Decommissioning			
On-site Engineering Inspection Program	• Partial Failure of Embankment during Decommissioning • Deleterious Substance Release	None	Medium
Health and Safety Program	• Partial Failure of Embankment during Decommissioning	None	Medium
Environmental Management Plan	• Deleterious Substance Release	None	Medium
Geotech Testing Program	• Partial Failure of Embankment during Decommissioning	None	Low
Sediment Testing Program	• Deleterious Substance Release	None	Low
Post-Closure Measures – Unforeseen Site Events			
Post-Closure Monitoring Program	• High Sediment Loading • Vegetation Objectives • Land Use Objectives • Aquatic Objectives	None	Low

5.7 General Project Risk – Water Quality Impacts

There are a total of 13 mitigation measures, split between seven Preventative Barriers and six Response Barriers to mitigate the Threats and Consequences of Water Quality Impacts. The Criticality Scores for the Preventative and Response Barriers for the one Project Component are shown in the following donut graphs.





The majority of the Preventative and Response Barriers are rated as “Medium” and “Low” criticality respectively, and the only “High” criticality rated measures are for Response Barriers.

The specific Preventative Measures are summarized in **Table 35** and the Response Measures are summarized in **Table 36**. Further, Escalating Factors were identified that have the potential to undermine the effectiveness of specific Preventative and Response Measures, and where applicable, additional measures have been identified to mitigate the escalating factors.

Table 35: List of Preventative Measures – Water Quality Impacts

Preventative Measures	Threat being Mitigated	Escalating Factors	Criticality
MLARD Plan	• Selenium • Nitrates • Sulphates • Nickel • Cadmium	None	Medium
Calcite Management Plan	• Calcite	None	Medium
Nitrate Management Plan	• Nitrates	None	Low

Preventative Measures	Threat being Mitigated	Escalating Factors	Criticality
Mitigation Measures of Consequences linked to Water Quality Impacts in Other Top Events			
Containment Sumps Spill Response Plan	• Uncontrolled Release of Process Water	None	Low Medium
Geotech Design Revisions Operating Maintenance and Surveillance Plan	• Slope Failure - Waste Rock, Access Road and Grave Creek Reservoir	None	Low Low
Environmental Management Plan Sediment Testing Program On-Site Engineering Inspection Program	• Deleterious Substance Release	None	Medium Low Medium
Post-Closure Monitoring Program	• High Sediment Loading • Aquatic Objectives	None	Low
Construction Diversion / Contingency Water Plan Trigger Action Response Plan	• Overtopping of Embankment During Construction	None	Medium Medium Medium
Environmental Management System Trigger Action Response Plan	• Rapid Drawdown of Pond Results in Significant Flow in Alexander Creek	None	Low Medium
OMS Manual Trigger Action Response Plan	• Overtopping of Embankment	• Change in Downstream Landuse - Increased Density/Sensitivity. *Mitigation - Revise Emergency Response Plan based on changing land-use*.	Medium Medium
OMS Manual Trigger Action Response Plan	• Partial Failure of Embankment	• Change in Downstream Landuse - Increased Density/Sensitivity. *Mitigation - Revise Emergency Response Plan based on changing land-use*.	Medium Medium
Contractor Vetting On-Site Engineering Inspection Program Geotech testing Program	• Partial Failure of Embankment During Construction	None	Medium Medium Medium Medium

Preventative Measures	Threat being Mitigated	Escalating Factors	Criticality
Trigger Action Response Plan On-Site Engineering Inspection Program Geotech testing Program	• Partial Failure of Embankment During Decommissioning	None	Medium Low

Table 36: List of Response Measures – Water Quality Impacts

Response Measures	Consequences being Mitigated	Escalating Factors	Criticality
Monitoring Plan	• Impact to Aquatic Population and Habitat • Impact to Terrestrial Animals (Drinking Water Sources) • Impact to Potable Water	None	Low to High
Additional Water Treatment Options	• Impact to Aquatic Population and Habitat • Impact to Terrestrial Animals (Drinking Water Sources) • Impact to Potable Water	None	Low to Medium

5.8 Mitigation Measures for Valued Components

Mitigation measures to avoid, minimize, restore, and compensate and offset Project-related effects to VCs will be presented and discussed in the effects assessment chapter of the EA. The identification and selection of technically and economically feasible mitigation measures will be developed using the approach to the mitigation hierarchy outlined by the Environmental Mitigation Policy for B.C. (Ministry of Environment, 2014a) and the related Procedures for Mitigation Impacts on Environmental Values (Environmental Mitigation Procedures; Ministry of Environment, 2014b). Key components of the mitigation hierarchy that will be applied to mitigating potential effects to VCs include:

- Avoidance – Preventing or reducing adverse effects by alternating or adjusting the location, timing, or method of a Project component or activity;
- Minimization – Preventing or reducing adverse effects by changing the design of the Project (e.g., altering location of waste rock to limit impact on avalanche chutes) or altering the timing of the Project (e.g., scheduling activities to avoid interactions with sensitive VC windows such as calving);
- Restoration – Where an adverse effect is unavoidable, establish appropriate restoration to re-establish the composition, structure, pattern, and ecological processes of the affected VC to support current and future sustainable, resilient, and healthy natural and social systems; and
- Offsetting and Compensation – If measures to avoid, minimize, and restore are not practical, offsetting impacts to VCs through compensation that results in a neutral or beneficial effect to the VC.

6.0 Conclusions

6.1 Accident and Malfunctions Assessment

The A&M Assessment identified, analyzed, and evaluated the threats and consequences of 14 Project Components that cover the Construction, Pre-Production, Operations, Reclamation and Closure, and Post-Closure Phases of the project. A total of 16 BowTies were generated with the results shown in **Figure 11**. Overall, the average Risk Classification for the Project is considered to be "Medium", representing 75% of the total risks, followed by "Low" representing 19% of the total risks, and "High" representing 6% of the total risks. A summary of the Risk Classification for all 16 BowTies are presented in **Table 37**.

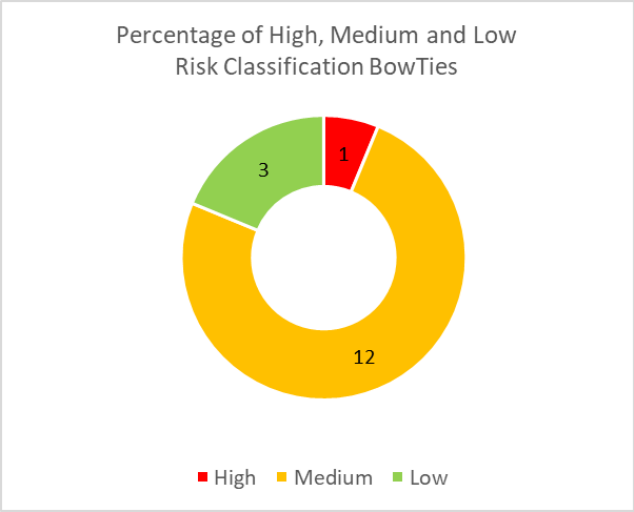
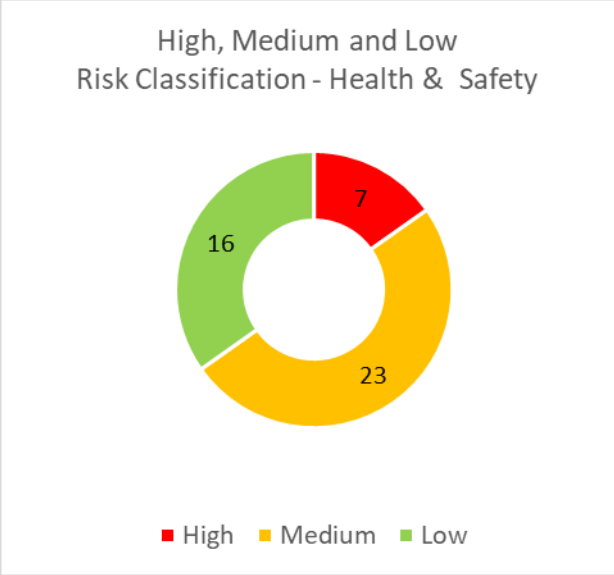


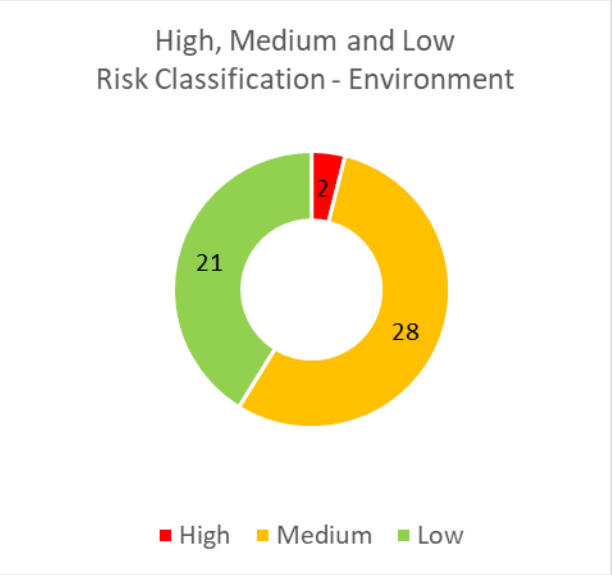
Figure 11: Summary of Risk Classification Results – A&M Assessment

Table 37: Summary of Risk Classification Results – A&M Assessment

Project Phase	Hazard (Name of BowTie)	Overall Risk Classification
Construction	Water Management Infrastructure	Medium
	Linear Infrastructure Facilities	High
	Mine Infrastructure Facilities	Medium
Pre-Production	Pre-Production Mining	Medium
	Mine Surface Operations	Medium
Operations	Construction of Main Sediment Pond - Water Management Infrastructure	Low
	Operation of Main Sediment Pond - Water Management Infrastructure	Low
	Coal Preparation Plant	Low
	Rail Loadout and Rail Siding	Medium
	Clean Coal Haul Route	Medium
	Explosives Storage	Medium
	Sewage treatment and Waste Management	Medium
Reclamation and Closure	Reclamation Activities	Medium
Post Closure	Main Sediment Pond Decommissioning	Medium
	Post Closure Measures	Medium
General	Water Quality Impacts	Medium

The Risk Classification for each BowTie is based on the assessment of Health and Safety, and Environmental impacts. In total, 46 individual Consequences have a Health and Safety risk, and 51 Consequences have an Environmental risk, both with an overall average Risk Classification of "Medium" A breakdown of the "High", "Medium", and "Low" Risk Classification scores as shown in the following donut graphs.





6.2 Mitigation Plan

A total of 391 individual mitigation measures were identified to manage the risks, with 62% focused on Prevention and 38% focused on Response. The Criticality or importance that the measures play to mitigate the risks, of each of the 391 mitigation measures was determined – ranging between "High", "Medium", and "Low". Overall, the Criticality of the Mitigation Plan is rated as "Medium", with a breakdown shown in **Figure 12**.

A breakdown of the mitigation measures per Project Phase are shown in **Table 38**.

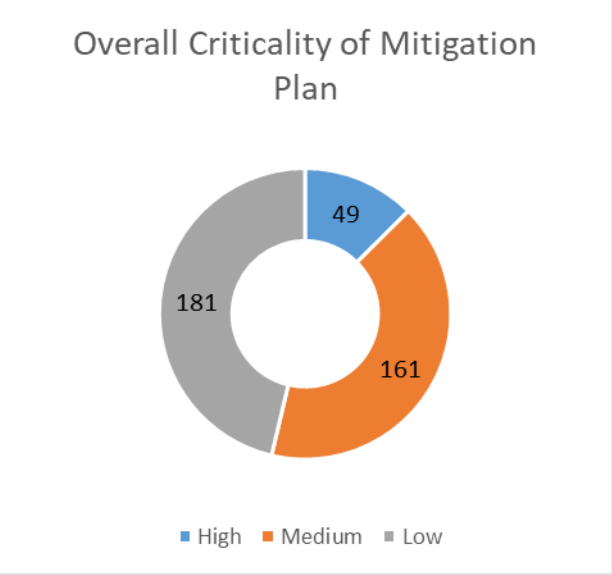


Figure 12: Overall Criticality of Mitigation Plan

Table 38: Criticality Summary of Mitigation Plan

Project Phase	Number of Mitigation Measures
Critical Score = High	
Operation	32
Construction	12
Pre-Production	3
General	2
Criticality Score = Medium	
Operation	79
Construction	43
Post-Closure	16
Pre-Production	10
Reclamation and Closure	7
General	6
Criticality Score – Low	
Operation	89
Construction	34
Reclamation and Closure	25
Post-Closure	14
Pre-Production	14
General	5

6.3 Concordance with AIR Section 4.7 Requirements

Table 39 cross-references the A&M Findings with the AIR Requirements outlined in Section 4.7 on Page 129.

Table 39: Concordance Table of AIR Requirements with A&M Assessment Findings

AIR Requirements Section 4.7		A&M Assessment Findings
Construction and Pre-Production		
✓	Vehicular accidents	A vehicle accident on the Access Road was identified as a specific Consequence for the following Project Components/Top Events: • Mine Infrastructure/ Disruption to Construction Resulting in Safety Risk and/or Environmental Damage. Refer to **Section 4.1.2**.
✓	Wildlife encounters	Work areas will be monitored during the Construction and Pre-Production phases. Wildlife encounters will be documented and modelled. Refer to **Chapter 15** of the **EA** for detailed information on wildlife interaction mitigation measures.
✓	Forest fires	Forest fires (Wildfires) were identified as an "Escalating Factor" that would undermine the ability to utilize the main access road during an evacuation. Proposed mitigation measure is to include helicopter evacuation.

AIR Requirements Section 4.7		A&M Assessment Findings
		See BowTie Mine Infrastructure Facilities/Top Event – Disruption to Construction Resulting in Safety Risk and/or Environmental Damage. Refer to **Sections 4.1.2** and **5.2**. See BowTie Pre-Production Mining/Top Event– Unforeseen Site Conditions. Refer to **Sections 4.2.1** and **5.3**.
✓	Snow/ice events	Snow/ice events are considered to be mitigating factors that can contribute to the following consequence that were assessed within the A&M Assessment: • Vehicular Accidents. Refer to **Sections 4.1.2** and **4.2.1**.
✓	Lightning strikes	Lightning strikes are recognized as a probable cause of forest fires. As such, the risks are incorporated within the following BowTies: • Mine Infrastructure Facilities/Top Event – Disruption to Construction Resulting in Safety Risk and/or Environmental Damage. Refer to **Sections 4.1.2** and **5.2**. • Pre-Production Mining/Top Event– Unforeseen Site Conditions. Refer to **Sections 4.2.1** and **5.3**. Lightning strikes, as a health and safety risk during pre-construction and construction, will be addressed in the Preventative Barrier – "Health and Safety Program".
✓	Personal health emergencies	The following Consequences were explicitly identified and assessed from a health/safety perspective in the A&M Assessment: <u>Water Management Infrastructure</u> – see **Section 4.1.1**: • Embankment/Foundation Failure During Construction • Partial Failure of Embankment During Construction • Overtopping of Embankment During Construction <u>Linear Infrastructure Facilities</u> – see **Section 4.1.1**: • Geotech Unstable Areas <u>Mine Infrastructure Facilities</u> – see **Section 4.1.2**: • Unable to Utilize Road during Evacuation • Geotechnical Unstable Areas • Vehicular Accident on Access Road <u>Pre-Production Mining</u> – see **Section 4.2.1**: • Geotechnical Unstable Areas – Access Road • Heavy/Light Vehicle Interaction • Geotechnical Unstable Areas – Mine Rock Storage Facility • Geotechnical Unstable Areas – Pit Wall • Unable to Utilize Road during Evacuation
✓	Avalanche	During the Construction Phase, avalanche was identified as an "escalating factor" that will be considered in the "Pre-Project Planning" and "Construction Water Management Plan" for the following activities (refer **to Sections 4.1.1, 4.1.2** and **4.2.1**):

AIR Requirements Section 4.7		A&M Assessment Findings
		Water Management Infrastructure, Linear Infrastructure Facilities and Mine Infrastructure Facilities: • Foundation Preparation • Embankment Construction During the Pre-Production Phase, avalanche was identified as an "escalating factor" that will be considered for "Widening the Pioneer Access Road". Refer to **Table 27**.
✓	Rockslide	"Geotech Unstable Areas" were identified as specific Consequences for the following Project Components/Top Events: • Linear Infrastructure Facilities/Top Event – Unforeseen Site Conditions. Refer to **Section 4.1.1**. • Mine Infrastructure Facilities/Top Event – Disruption to Construction Resulting in Safety Risk and/or Environmental Damage. Refer to **Section 4.1.2**. • Pre-Production Mining/Top Event – Unforeseen Site Conditions. Refer to **Section 4.2.1**.
✓	Flooding on lower elevation access roads	During the Construction and Pre-Production phases, flooding was aggregated under *Heavy Precipitation Events* and identified as an "escalating factor" for the following elements: • Water Management Infrastructure – Foundation Preparations and Embankment Construction. Refer to **Section 5.2**. • Linear Infrastructure Facilities – Construction of Rail Line and Loading Facility, Construction of Gas Line, Construction of Power Line, construction of Coal Haul Route, and Construction of Clean Coal Conveyor System. Refer to **Section 5.2**. • Mine Infrastructure Facilities – Foundation Preparations. Refer to **Section 5.2**. • Pre-Production Mining – Access Road Construction and Upgrade. Refer to **Section 5.3**.
Operation and Reclamation		
✓	Slips/trips/falls	Slips/trips/falls, as a health and safety risk during operation and reclamation activities, will be addressed in the Preventative Barrier – "Health and Safety Program" and integrated within the appropriate Safe Work Procedures and Standard Operating Procedures.
✓	Equipment incidents	The Consequence "Uncontrolled Release of Process Water" was assessed for the Project Component – Coal Preparation Plant. Refer to **Sections 4.3.2** and **5.4**.
✓	Substance abuse-related incidents	Substance abuse-related incidents, as a health and safety risk during operation and reclamation activities, will be addressed in the Preventative Barrier – "Health and Safety Program" and integrated within the appropriate Safe Work Procedures and Standard Operating Procedures.
✓	Vehicular accidents	Vehicular accidents were identified for the following Project Components/Top Events: • Mine Surface Operations/Top Event – Unforeseen Site Conditions. Refer to **Section 4.3.1**.

AIR Requirements Section 4.7		A&M Assessment Findings
		• Rail Loadout and Rail Siding/Top Event – Unforeseen Events, specifically accidents at the private and public grade level crossings. Refer to **Section 4.3.2**. • Clean Coal Haul Route/Top Event – Interaction of Coal Haul Traffic and Public Traffic/Wildlife. Refer to **Section 4.3.3**. • Reclamation Activities/Top Event – Unsuccessful Reclamation Program. Refer to **Section 4.4.1**.
✓	Wildlife encounters	Wildlife encounters were identified for the following Project Components/Top Events: • Rail Loadout and Rail Siding/Top Event – Unforeseen Events, specifically a train strikes wildlife that are on the tracks. Refer to **Section 4.3.2**. • Clean Coal Haul Route/Top Event – Interaction of Coal Haul Traffic and Public Traffic/Wildlife. Refer to **Section 4.3.3**. • Sewage Treatment and Waste Management/Top Event – Non-Compliance with Regulatory Standard. Refer to **Section 4.3.5**.
✓	Forest fires	Forest fires (wildfires) were identified as a Threat that could undermine the Post-Closure Phase of the Project. Refer to **Section 4.5.2**. Forest fires (Wildfires) were identified as an "Escalating Factor" that would undermine the ability to utilize the main access road during an evacuation. Proposed mitigation measure is to include helicopter evacuation. This applies to the following Project Components/Top Events: • Mine Surface Operations/Top Event – Unforeseen Site Conditions. Refer to **Sections 4.3.1** and **5.4**. • Reclamation Activities/Top Event – Unsuccessful Reclamation Program. Refer to **Sections 4.4.1** and **5.5**.
✓	Snow/ice events	Snow/ice events are considered to be mitigating factors that can contribute to the following consequence that were assessed within the A&M Assessment: • Vehicular Accidents. Refer to **Sections 4.3.1, 4.3.2, 4.3.3, 4.4.1** and **4.2.1**. • Public vehicles (i.e. recreational vehicles) that trespass and utilize the Private Road, causing an accident. Refer to **Section 4.3.3**.
✓	Lightning strikes	Lightning strikes are recognized as a probable cause of forest fires. As such, the risks are incorporated within the following BowTies: • Mine Surface Operations/Top Event – Unforeseen Site Conditions. Refer to **Sections 4.3.1** and **5.4**. • Reclamation Activities/Top Event– Unsuccessful Reclamation Program. Refer to **Sections 4.4.1** and **5.5**. • Post-Closure Measures/Top Event – Unforeseen Site Events. Refer to **Sections 4.5.2** and **5.6**. Lightning strikes, as a health and safety risk, will be addressed in the Preventative Barrier – "Health and Safety Program".
✓	Personal health emergencies	Personal health emergencies were identified and assessed within the following Project Components/Top Events: • Mine Surface Operations/Top Event – Unforeseen Site Conditions. Refer

AIR Requirements Section 4.7		A&M Assessment Findings
		to **Section 4.3.1**. • Construction of Main Sediment Pond/Top Event – Unforeseen Site Conditions. Refer to **Section 4.3.1** . • Operation of Main Sediment Pond/Top Event – Unforeseen Site Conditions. Refer to **Section 4.3.1**. • Coal Preparation Plant/Top Event – Unforeseen Events. Refer to **Section 4.3.2**. • Rail Loadout and Rail Siding/Top Event – Unforeseen Events. Refer to **Section 4.3.2**. • Clean Coal Haul Route/Top Event – Interaction of Coal Haul Traffic and Public Traffic/Wildlife. Refer to **Section 4.3.3**. • Explosives Storage/Top Event – Improper Storage and Handling. Refer to **Section 4.3.4**. • Sewage Treatment and Waste Management/Top Event – Non-Compliance with Regulatory Standards. Refer to **Section 4.3.5**. • Reclamation Activities/Top Event – Unsuccessful Reclamation Program. Refer to **Section 4.4.1**. • Main Sediment Pond Decommissioning/Top Event – Uncontrolled Sediment Release during Decommissioning. Refer to **Section 4.5.1**.
✓	Avalanche	Avalanche was identified as a "Threat" for the Project Component – Main Sediment Pond Decommission that could result in the Top Event – Uncontrolled Sediment Release during Decommissioning. Refer to **Section 4.5.1**.
✓	Rockslide/Landslides	"Geotech Unstable Areas" were identified as specific Consequences for the following Project Components/Top Events: • Mine Surface Operations/Top Event – Unforeseen Site Conditions. Refer to **Section 4.3.1**. • Reclamation Activities/Top Event – Unsuccessful Reclamation Program. Refer to **Section 4.4.1**.
✓	Flooding on lower elevation access roads;	During the Construction and Pre-Production phases, flooding was aggregated under *Heavy Precipitation Events* and identified as an "escalating factor" for the following elements: • Construction of Main Sediment Pond – Foundations Preparations and Embankment Construction. Refer to **Section 5.4**.
✓	Accidents involving project personnel and the public	The following Project Components/Top Events were identified and assessed: • Operation of Main Sediment Pond/Top Event – Unforeseen Site Conditions, specifically the "Rapid Drawdown of Pond Resulting in Significant Flow in Alexander Creek". Refer to **Section 4.3.1**. • Rail Loadout and Rail Siding/Top Event – Unforeseen Events, specifically either a "Crossing Accident at the Public Crossing" or a "Crossing Accident at the "Private Crossing". Refer to **Section 4.3.2**. • Clean Coal Haul Route/Top Event – Interaction of Coal Haul Traffic and Public Traffic/Wildlife, specifically a coal truck hitting a public vehicle, or a recreational vehicle/pedestrian trespassing and being struck by a vehicle. Refer to **Section 4.3.3**. • Reclamation Activities/Top Event – Unsuccessful Reclamation Program, specifically a public vehicle accident during the reclamation of the

AIR Requirements Section 4.7		A&M Assessment Findings
		Access Road. Refer to **Section 4.4.1**. Water Quality Impacts was identified as a potential Top Event that could result in potential impact to the public, as an "Escalating Factor" if downstream land-uses change and are not recognized/incorporated within the Emergency Response Plan. Refer to **Section 5.7**.
✓	Accidental release of contaminants (sewage, fuel, sediment, chemicals, etc.)	The following Project Components/Top Events were identified and assessed: • Coal Preparation Plant/Top Event – Unforeseen Events. Refer to **Section 4.3.2**. • Rail Loadout and Rail Siding/Top Event – Unforeseen Events. Refer to **Section 4.3.2**. • Explosives Storage/Top Event – Improper Storage and Handling. Refer to **Section 4.3.4**. • Sewage Treatment and Waste Management/Top Event – Non-Compliance with Regulatory Standards. Refer to **Section 4.3.5**. • Main Sediment Pond Decommissioning/Top Event – Uncontrolled Sediment Release during Decommissioning. Refer to **Section 4.5.1**. • Post-Closure Measures/Top Event – Unforeseen Site Events. Refer to **Section 4.5.2**. • General Project Risks/Top Event – Water Quality Impacts. Refer to **Section 4.6.1**.
✓	Spills of product during coal haulage/transfer	The consequences of a product spill was identified and assessed for the Project Component – Rail Loadout and Rail Sidings. Refer to **Section 4.3.2**.
✓	Explosives incidents	For the Project Component – Explosives Storage, two incidents were identified and assessed (refer to **Section 4.3.4**): • Spill; and • Premature detonation of explosives.
✓	Material handling incidents	Material handling incidents were aggregated under Spills of product during coal haulage/transfer and assessed for the Project Component – Rail Loadout and Rail Sidings. Refer to **Section 4.3.2**.
✓	Structural failure of infrastructure	The structural integrity of the Access Road was identified as potential consequence for the following Project Components: • Pre-Production Mining. Refer to **Section 4.2.1**. • Mine Surface Operations. Refer to **Section 4.3.1**.
✓	Silo fire or ignition	Silo fire or ignition incidents were aggregated under Methane accumulation and identified as a potential threat to cause an explosion at the Rail Loadout and Rail Siding. Refer to **Section 4.3.2**.
✓	Plant thermal drier fire or ignition	No convention dryer included in the design. Risks are therefore mitigated with the pressure vessel.
✓	Wind related incidents	Coal dust, as a fugitive emission caused by wind, was identified as a Consequence for the following: • Coal Preparation Plant – Fugitive Dust from Coal Stockpiles. Refer to **Section 4.3.2**. • Rail Loadout and Rail Siding – Fugitive Dust from the loadout area. Refer to **Section 4.3.2**.

AIR Requirements Section 4.7		A&M Assessment Findings
✓	Diversion ditch failure due to wash-outs or geotechnical reasons	The following Project Phases/Project Components were assessed related to the diversion ditch: • Project Construction/Water Management Infrastructure. Refer to **Section 4.1.1**. Risks are mitigated through the water management plan.
✓	Spoil pile failure/slip	Risks are mitigated through the Operating Maintenance and Surveillance Plan identified in: • Mine Surface Operations – Waste Rock Management Areas. Refer to **Section 5.4**.
✓	Methane accumulation (plant/silo)	Methane accumulation was identified as a potential threat to cause an explosion at the Rail Loadout and Rail Siding. Refer to **Section 4.3.2**.
✓	Natural gas line leak	Natural gas leaks are addressed in the general mine Health and Safety Program.

✓	Chance find of archaeological items during mining	The following Project Phases/Project Components were assessed related to potential for archaeological items being discovered:
		• Construction Phase. Refer to **Section 4.1**.
		  ○ Linear Infrastructure Facilities
		  ○ Mine Infrastructure Facilities
		• Pre-Production Phase. Refer to **Section 4.2**.
		  ○ Pre-Production Mining
		• Operation Phase. Refer to **Section 4.3**.
		  ○ Mine Surface Operations

✓	Rail-road related incident on loop/siding	A total of nine potential consequences were identified related to the Rail Loadout and Rail Siding. Refer to **Section 4.3.2**.
✓	Unexpected geologic hazard	In the Construction, Pre-Production, Operation, and the Reclamation and Closure Phases, unexpected geological hazards/consequences were captured with the Top Events – "Unforeseen Events" and "Unforeseen Site Conditions". This results in the identification and assessment of multiple consequences that are related to geologic conditions.
✓	Emergency evacuation of site due to above or other reasons	Inability to utilize the Access Road for an evacuation was identified as an "Escalating Factor" for the following Project Components, resulting in a Helicopter evacuation contingency: • Construction Phase – Mine Infrastructure Facilities. Refer to **Section 4.1**. • Pre-Production Phase – Pre-Production Mining. Refer to **Section 4.2**. • Operation – Mine Surface Operations. Refer to **Section 4.3**. • Reclamation and Closure Phase – Reclamation Activities. Refer to **Section 4.4**.
✓	Mining into a pre-existing opening	Pre-existing openings will be located on mine plans as per the Ministry of Energy and Mines *Health, Safety and Reclamation Code for Mines in British Columbia*.
✓	Mining into a pre-existing oil/gas/water well	Pre-existing oil/gas/water wells will be located on mine plans as per the Ministry of Energy and Mines *Health, Safety and Reclamation Code for Mines in British Columbia*.
✓	Failure of a containment or treatment system	The Consequence "Septic Field Blockage" was identified and assessed for the Project Component – Sewage Treatment and Waste Management. Refer to

AIR Requirements Section 4.7	A&M Assessment Findings
	Section 4.3.5. "Additional Water Treatment Options" was identified as potential Response measure to address potential Water Quality Impacts. Refer to **Table 36**.

6.4 Summary

In conclusion, the A&M Assessment of the proposed Crown Mountain Coking Coal Project has met the EIS Guideline Requirements as shown below in **Table 40**. The overall risk profile of the Project is considered to be "Medium" from a health and safety; and environmental perspective, and with a proposed Mitigation Plan that consists of 391 individual measures to be put in place.

Table 40: A&M Assessment Summary

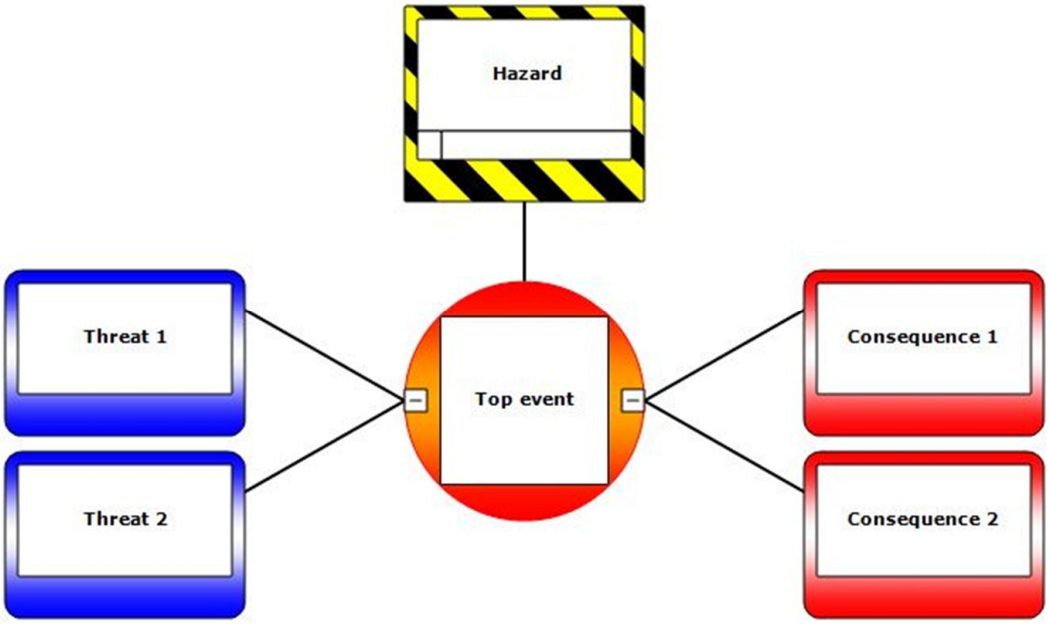
Summary of EIS Guideline Requirements EIS Section 6.6.1, Page 35	A&M Assessment
The failure of certain works caused by human error or exceptional natural events (e.g., flooding, earthquake) could cause major effects. Conduct an analysis of the risks of accidents and malfunctions, determine their effects and present a preliminary emergency measures.	The A&M Assessment has concluded that the overall risk profile of the Project is considered to be "Medium".
Taking into account the lifespan of different project components, identify the probability of potential accidents and malfunctions related to the project, including an explanation of how those events were identified, potential consequences (including the environmental effects as defined in section 5 of CEAA 2012), the plausible worst case scenarios and the effects of these scenarios.	A total of 16 accidents and malfunctions, defined as "Top Events" were identified and analyzed, translating into the identification and assessment of: • 242 Threats that can cause the 16 Top Events; and • 147 Consequences caused by the 16 Top Events. The Top Events and the Consequences cover the full range of accidents and malfunctions and associated outcomes. A total of six outcomes are considered to be plausible "worst-case" based on the "High" Risk Classification related to potential Health & Safety and Environmental impacts.

Summary of EIS Guideline Requirements EIS Section 6.6.1, Page 35	A&M Assessment
Include an identification of the magnitude of an accident and/or malfunction, including the quantity, mechanism, rate, form and characteristics of the contaminants and other materials likely to be released into the environment during the accident and/or malfunction events and would potentially result in an adverse environmental effect as defined in section 5 of CEAA 2012.	The BowTie methodology enabled for the cause-and-effect relationships to be identified, analyzed and evaluated based on the following step-wise process: 1. Define the Hazard that is the source of the Top Event. 2. Determine the Threats that could cause the Top Event to occur. 3. Identify Preventative Barriers for each Threat. 4. If the Top Event occurs, identify the Consequences. 5. Identify Response Barriers for each Consequence. 6. Test resiliency of the Barriers by identifying Escalating Factors that undermine effectiveness of Barriers. A total of 51 Environmental Consequences were identified that can result in an Environmental Risk – 2 are “High”, 28 are “Medium”, and “21” are Low. Environmental Consequences are defined as ranging from a) having a negligible reversible environmental impact requiring very minor or no remediation to b) causing disastrous environmental impact with long term effects requiring major remediation.
Describe the safeguards that have been established to protect against such occurrences and the contingency and emergency response procedures in place if such events do occur.	The Mitigation Plan consists of 391 individual measures, of which: • 244 (62%) focus on Prevention; and • 147 (38%) focus on Response. Further, Escalating Factors were identified that could undermine the effectiveness of the mitigation measures, with contingencies identified.

Appendix A

Overview of BowTie Methodology

The BowTie is a risk assessment method which is used to analyse and communicate how high risk situations arise. The BowTie is built around risk scenarios based on a hazard, and ways in which the organization can stop those scenarios from happening. The name BowTie comes from the shape of the diagram that you create which looks like a BowTie.



The goals of the BowTie method are to:

- Provide a structure to systematically analyze a hazard;
- Help determine whether the current level of control is sufficient;
- Help identify where and how investing resources would have the greatest impact; and
- Increase risk communication and awareness (CGE Risk, 2013).

The BowTie is created by first identifying the Hazard. The hazard is something that comprises part of an organization's activities which has the potential to do harm. The hazard is not necessarily going to cause harm, but given the right set of circumstances, it could. An example of a hazard could be a train transporting dangerous goods through a city core.

After we have identified the hazard, we identify what is known as the Top Event. The top event is something which causes control over the hazard to be lost. The loss of control does not necessarily translate to a total loss as control can often be regained through the use of Barriers which will be discussed further down.

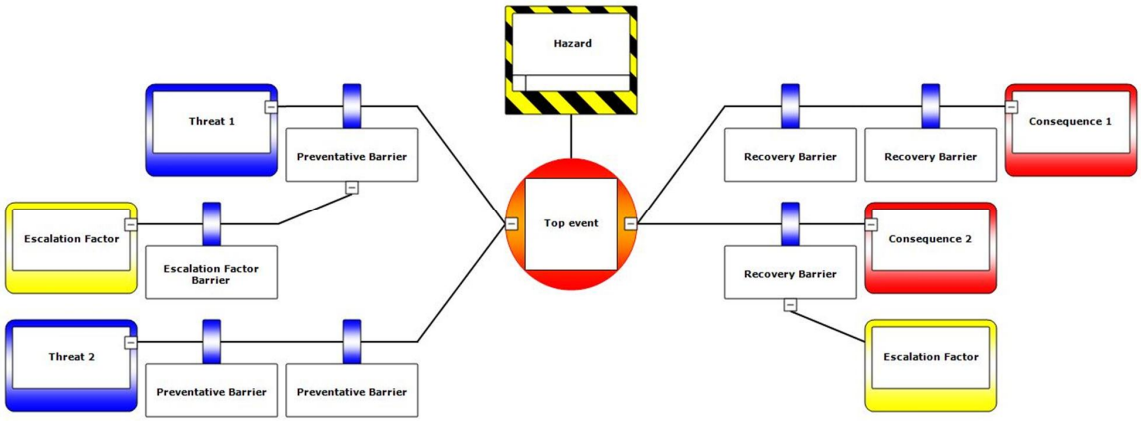
Once we have our Hazard and Top Event we can start to identify the Threats. Threats are the factors which can lead directly to the top event taking place. Each threat can independently cause the top event to occur. The threats are placed to the left of the BowTie.

Once we have identified the threats, we will start to develop the right hand side of the BowTie with the Consequences. The consequences are unwanted outcomes which can occur once the top event has taken place. Consequences are mainly unwanted because they tend to lead to loss or damage.

Once the Threats and Consequences have been identified, the next step would be to identify the Preventative Barriers and the Recovery Barriers. The Preventative Barriers are placed on the left hand side of the BowTie beside the threats. They apply to the selected threat and act as a measure to reduce or eliminate the threat. This can also be discussed as risk mitigation. The Recovery Barriers are placed on the right hand side of the BowTie beside the consequences. They apply to the selected consequences and act as a measure to reduce or eliminate the consequence to mitigate the risks. There are often multiple barriers on either side of the BowTie.

Barriers often have Escalation Factors associated with them. These are similar to threats but target a specific barrier and make it more likely that a barrier will fail. An example would be adverse weather conditions which could make recovery of the UFTB Type B package difficult or impossible. Often, Escalation Factors will also have barriers to help reduce or negate their effect. An example of this would be an escalation factor of losing power - a generator could act as a barrier to this escalation factor.

A completed BowTie could look something like the figure below. However every BowTie is unique and varies in size.



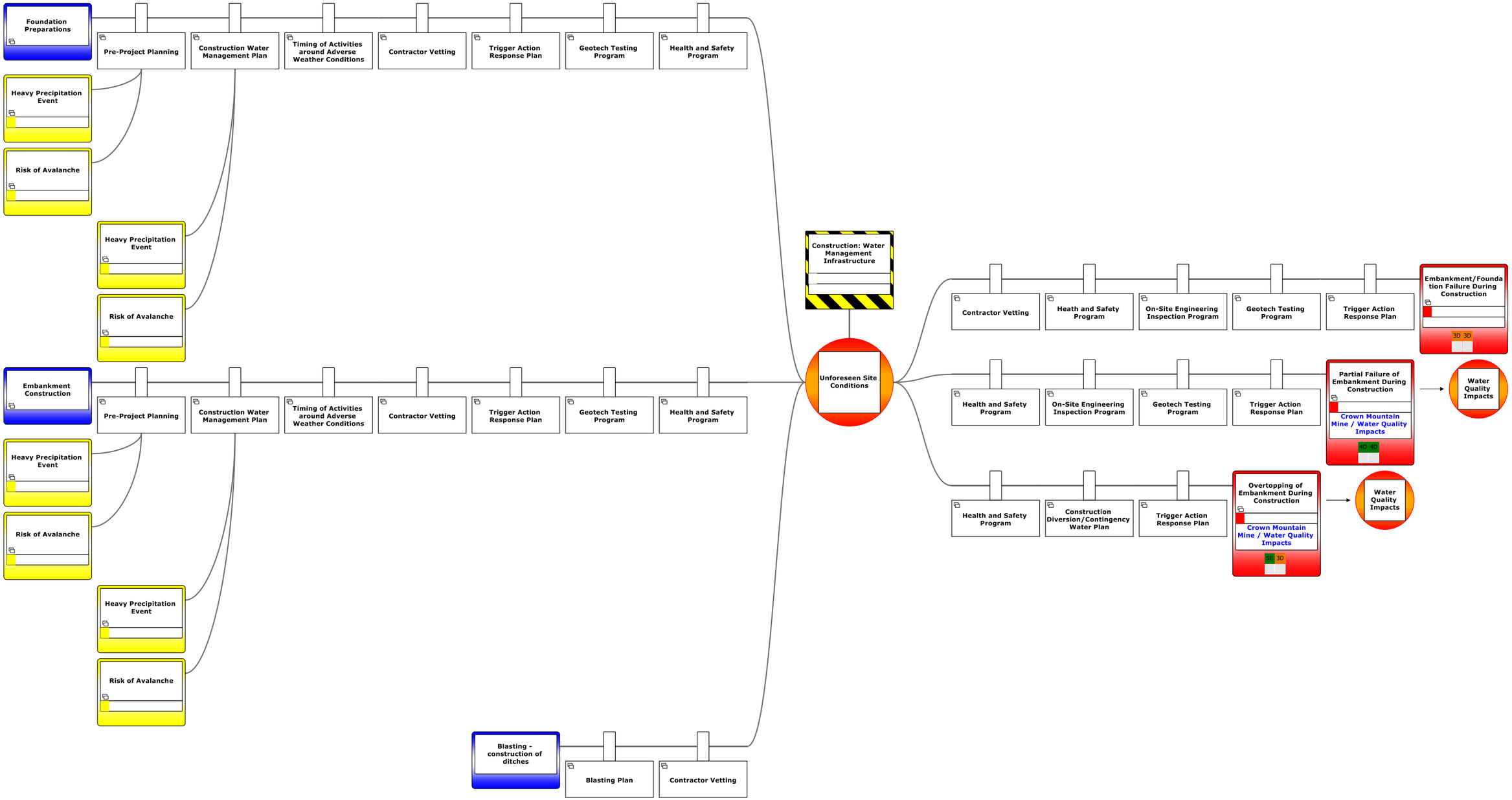
Once the BowTie diagram is finished, further steps can be taken to deepen the analysis including linking the barriers to the management system activities and ranking the effectiveness of the barriers.

Appendix B

BowTie Diagrams

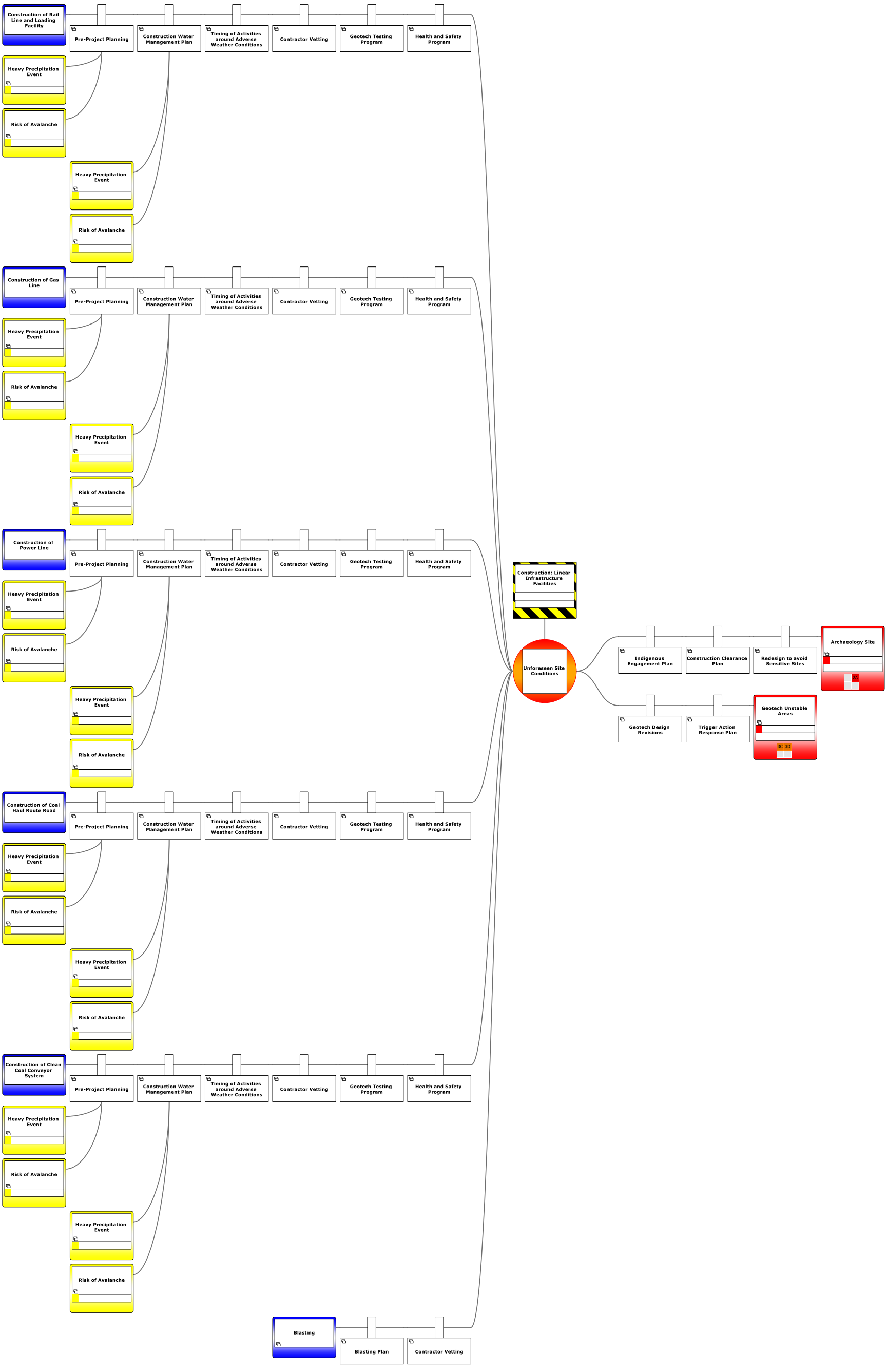
Construction

Water Management Infrastructure



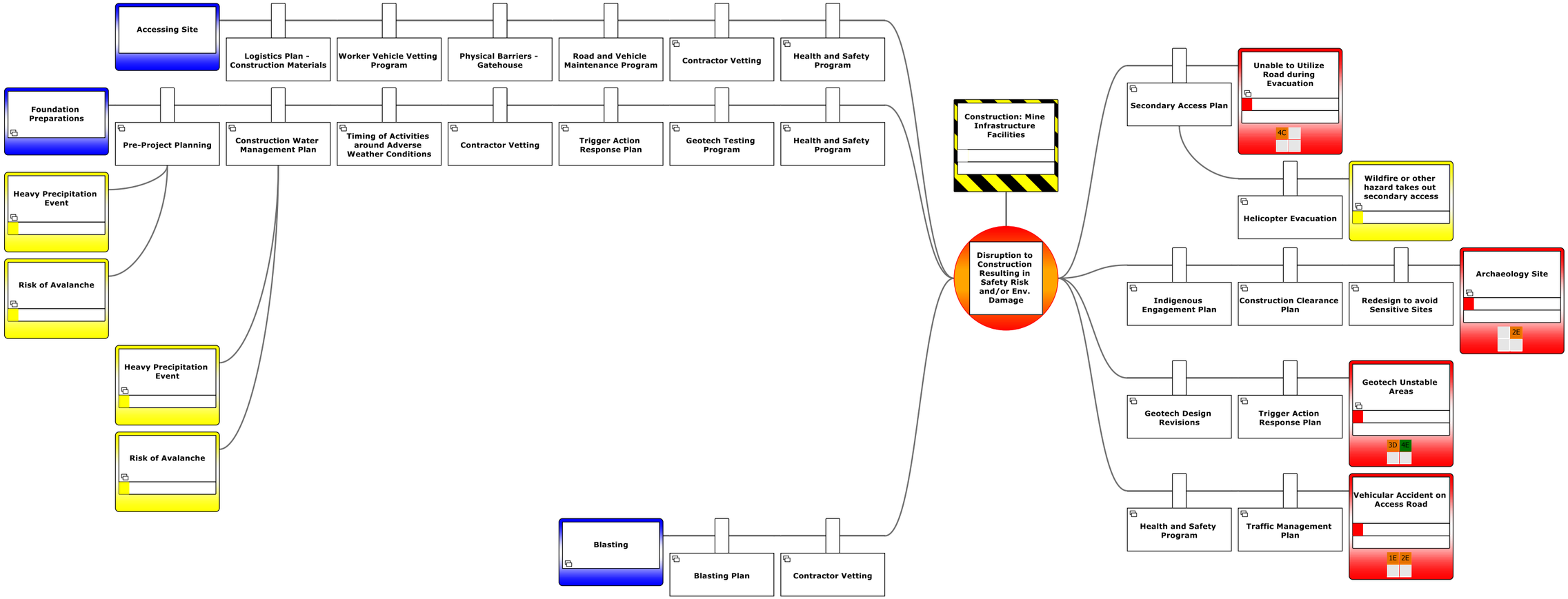
Construction

Linear Infrastructure Facilities



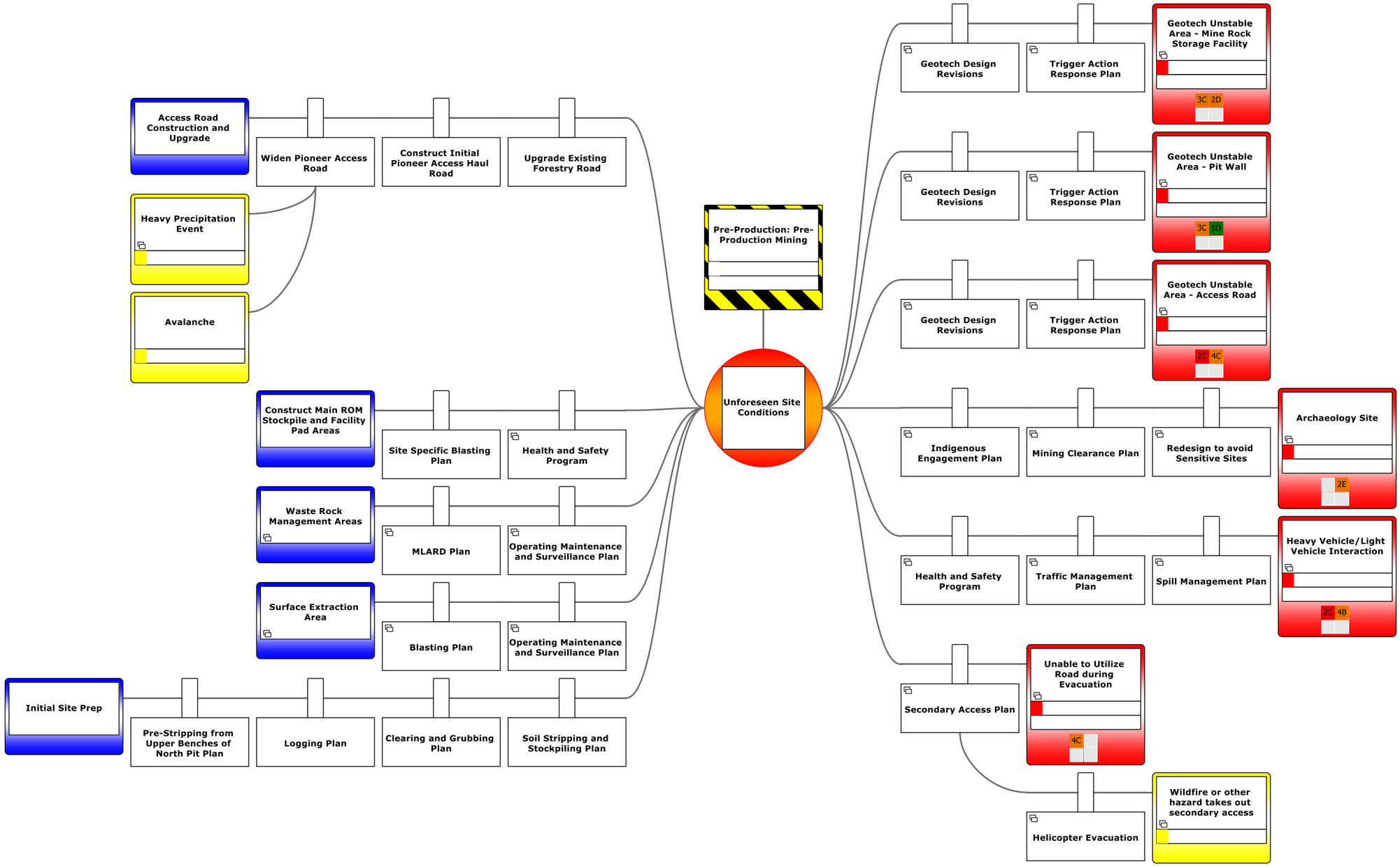
Construction

Mine Infrastructure Facilities



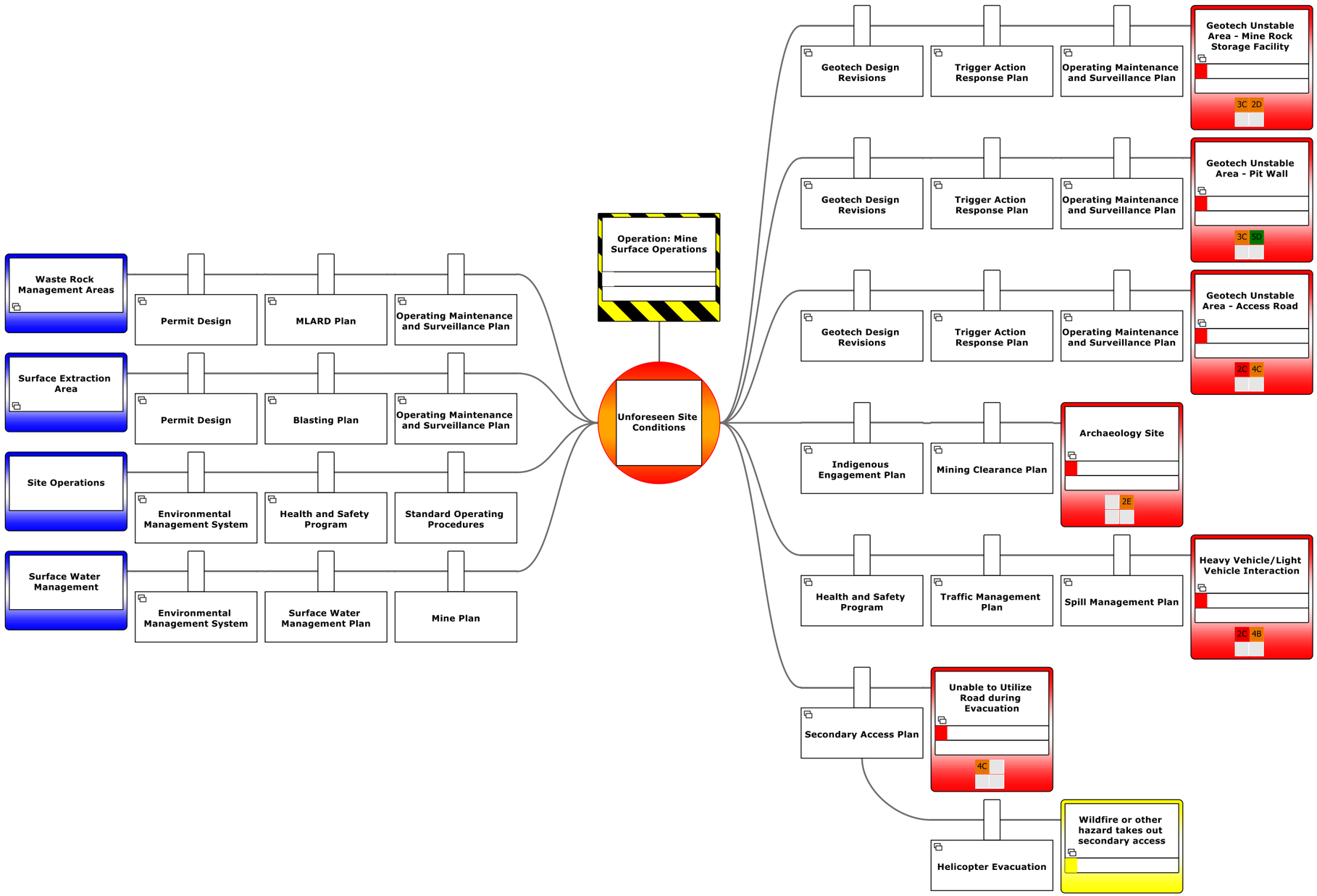
Pre-Production

Pre-Production Mining



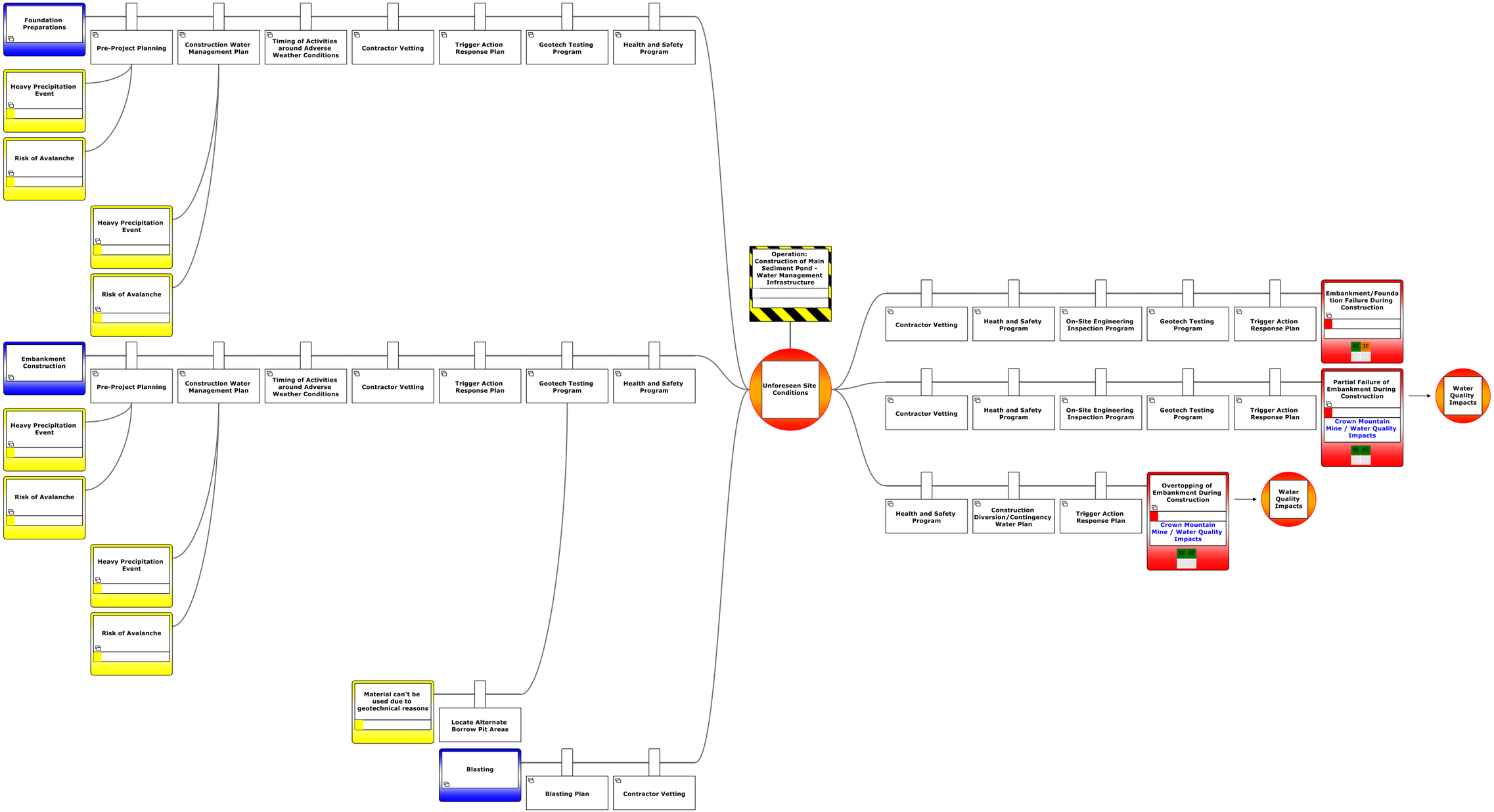
Operation

Mine Surface Operations



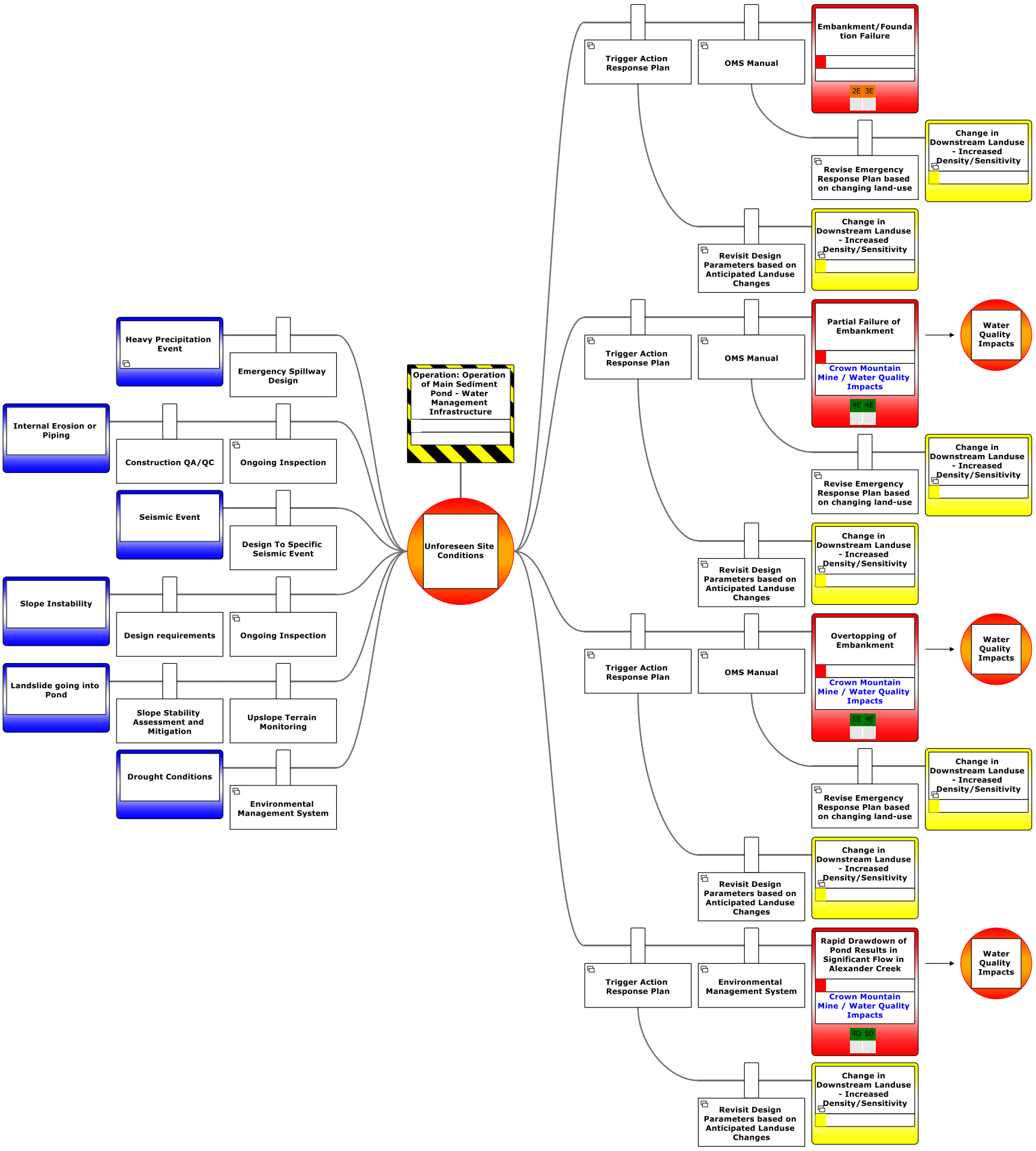
Operation

Construction of Main Sediment Pond - Water Management Infrastructure



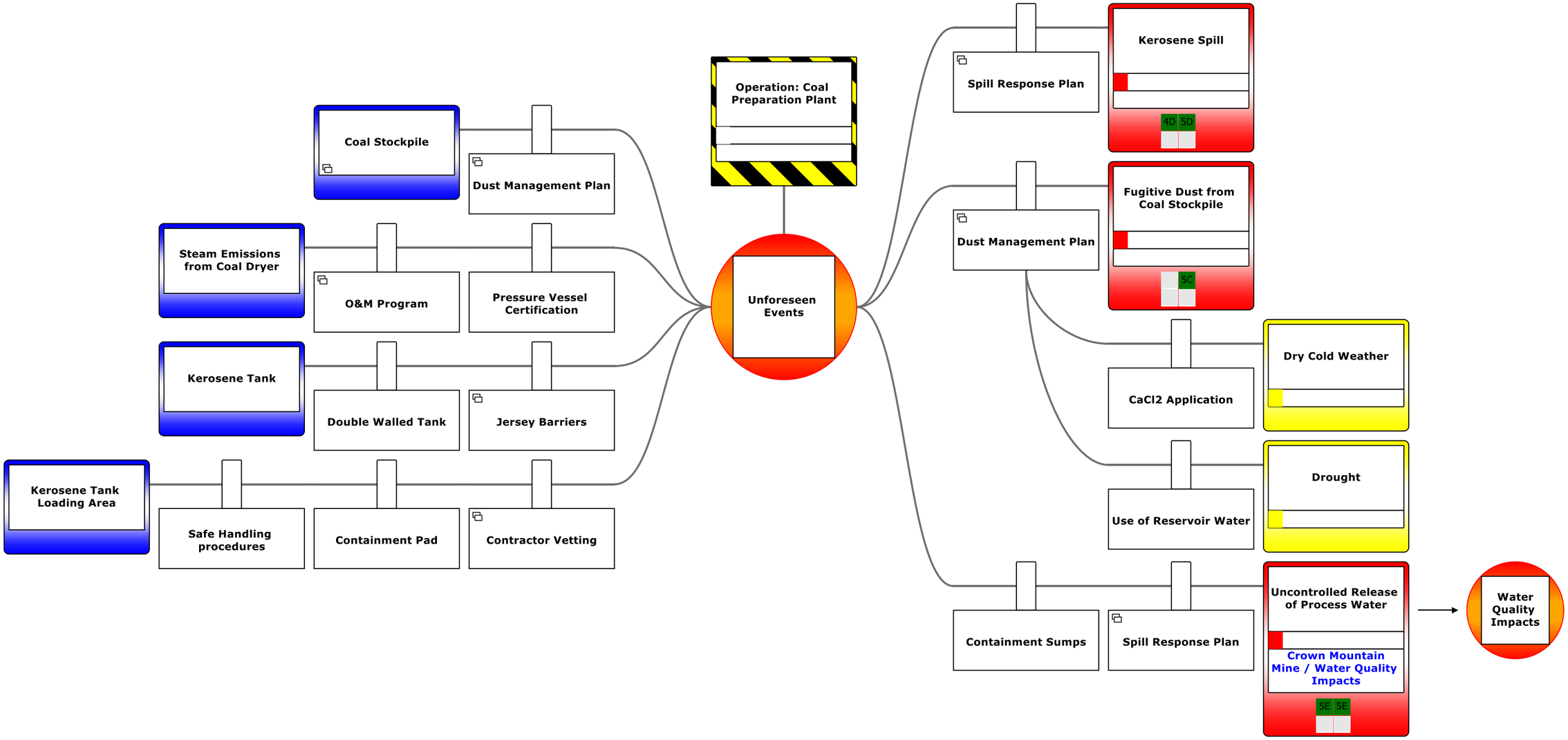
Operation

Operation of Main Sediment Pond - Water Management Infrastructure



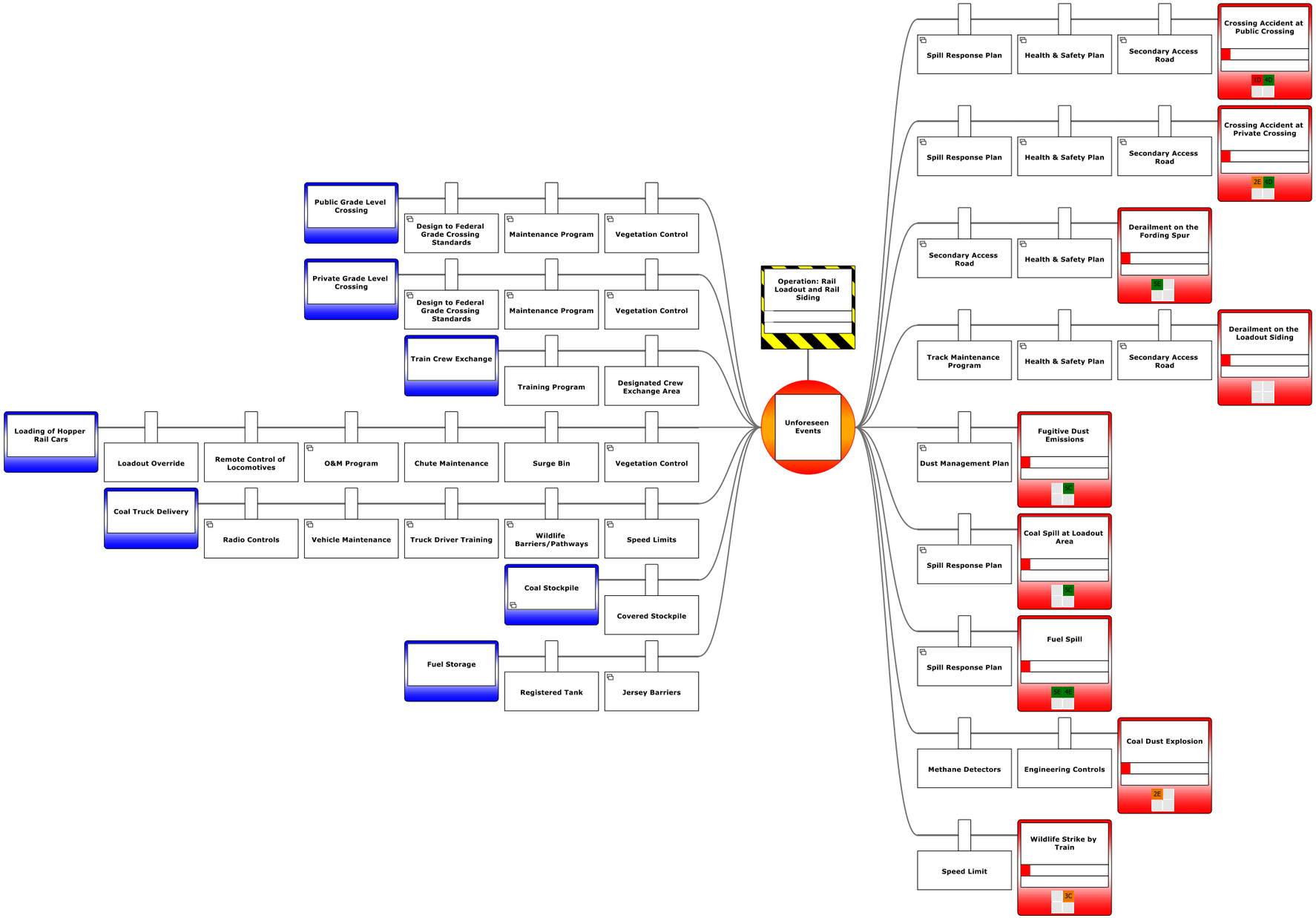
Operation

Coal Preparation Plant



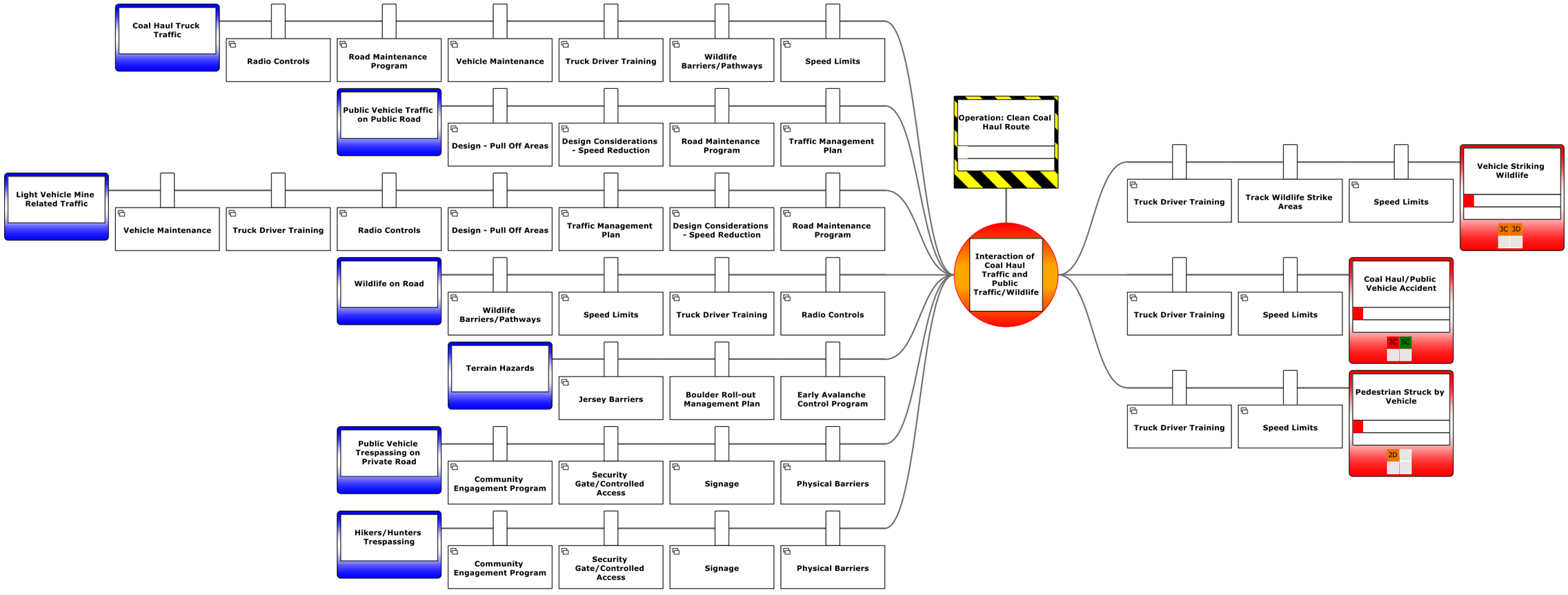
Operation

Rail Loadout and Rail Siding



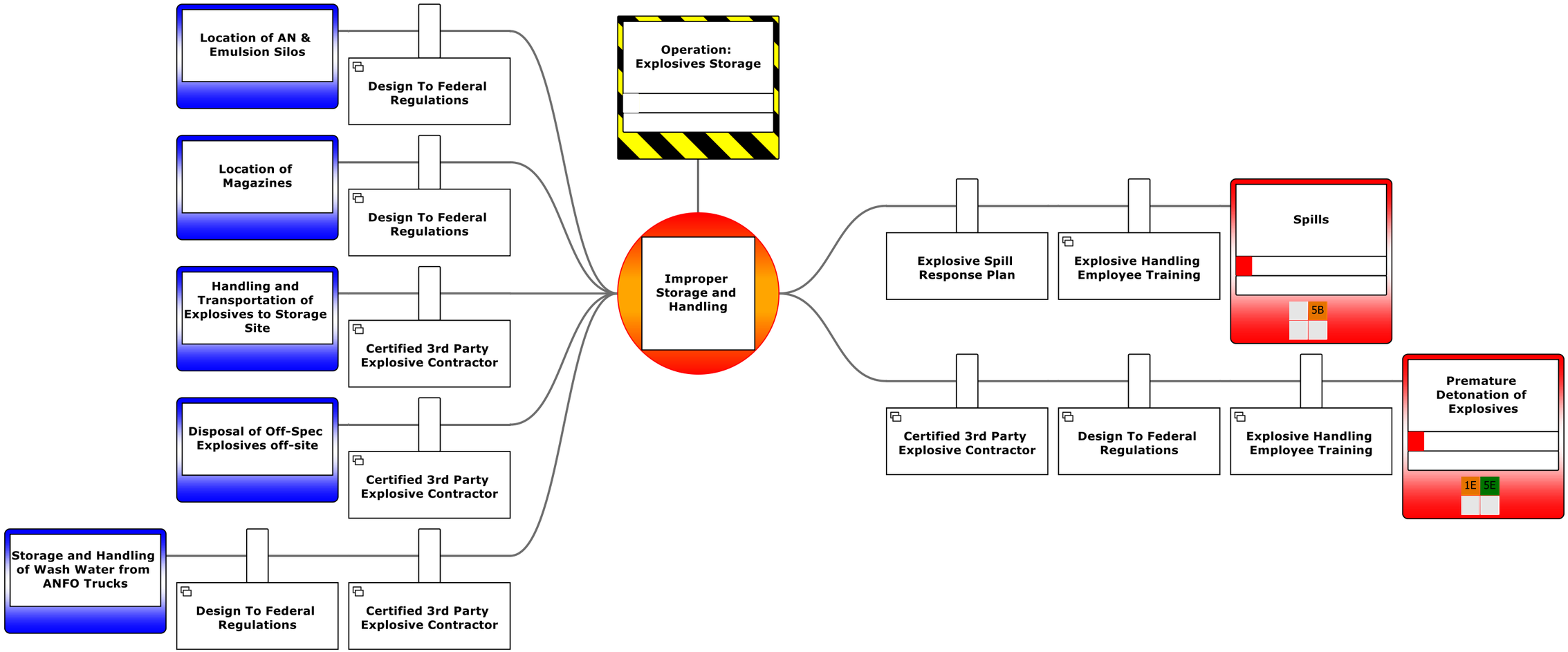
Operation

Clean Coal Haul Route



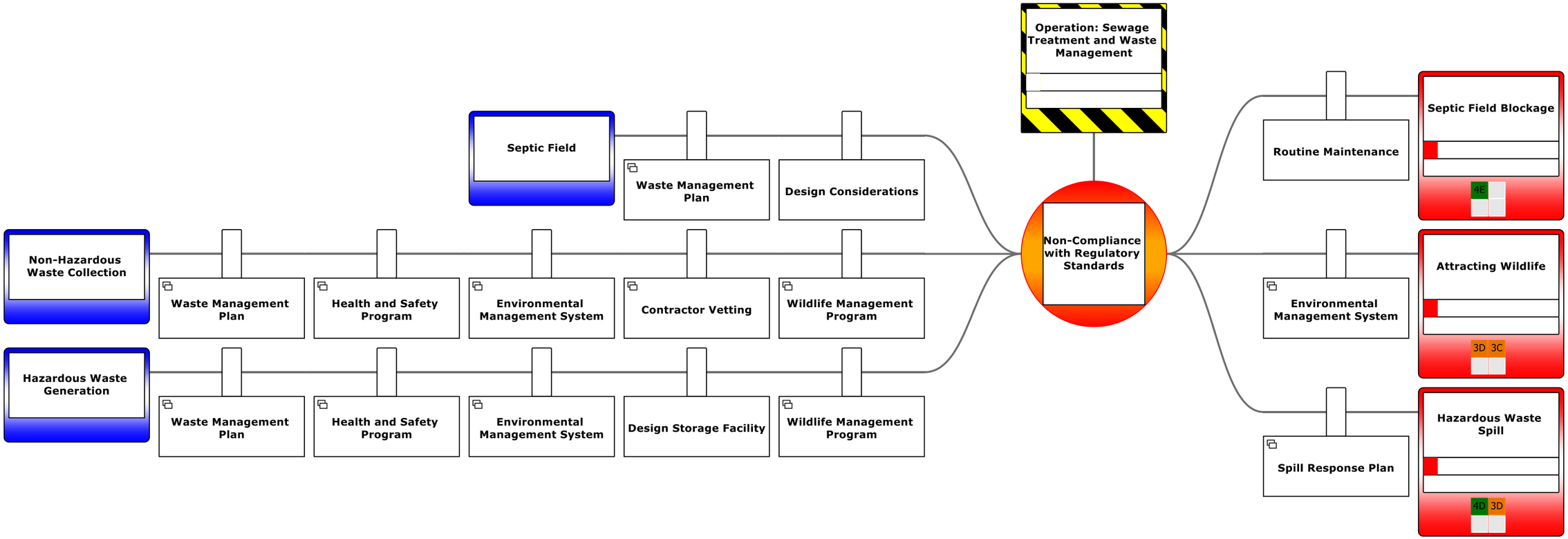
Operation

Explosives Storage



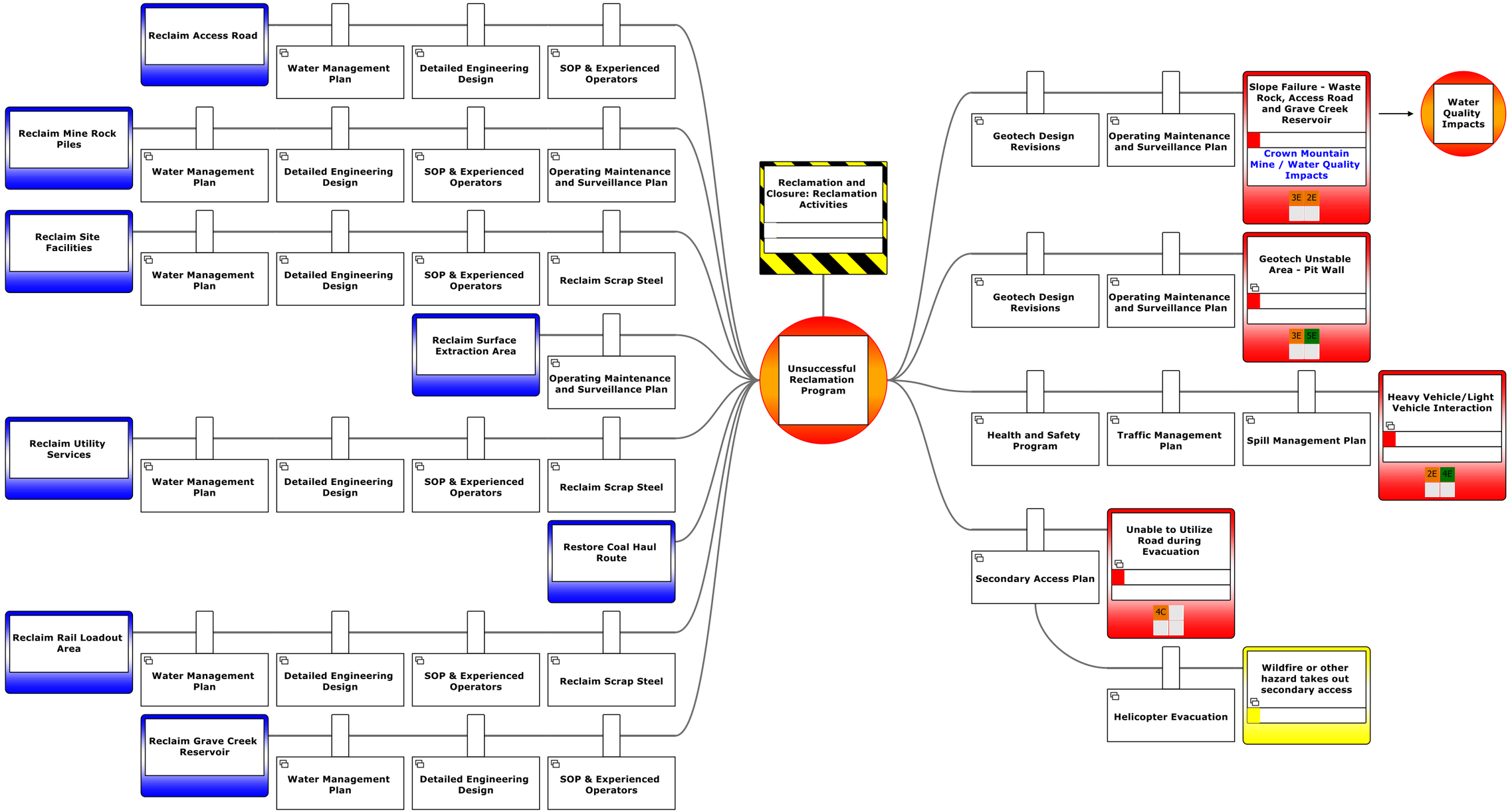
Operation

Sewage Treatment and Waste Management



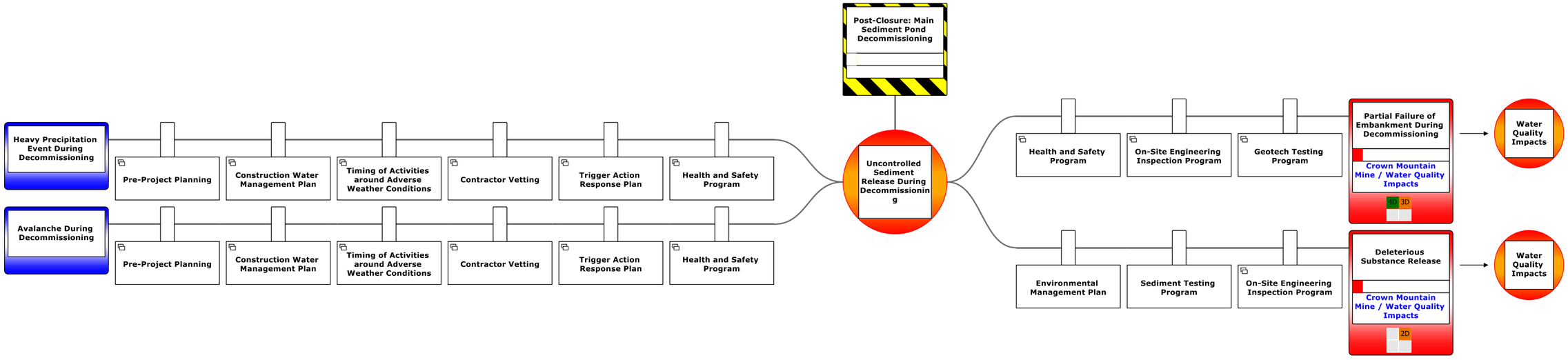
Reclamation and Closure

Reclamation Activities



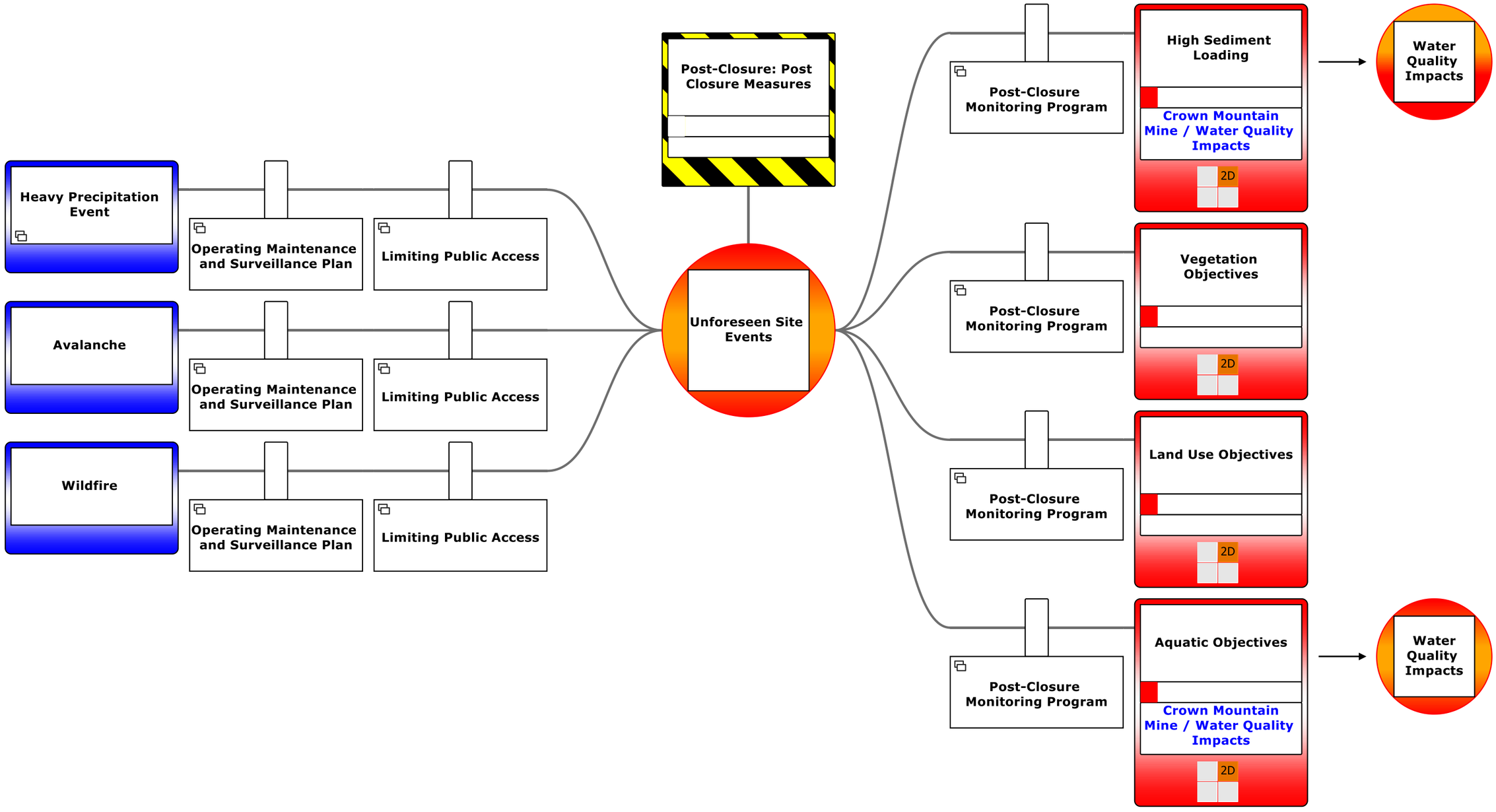
Post-Closure

Main Sediment Pond Decommissioning

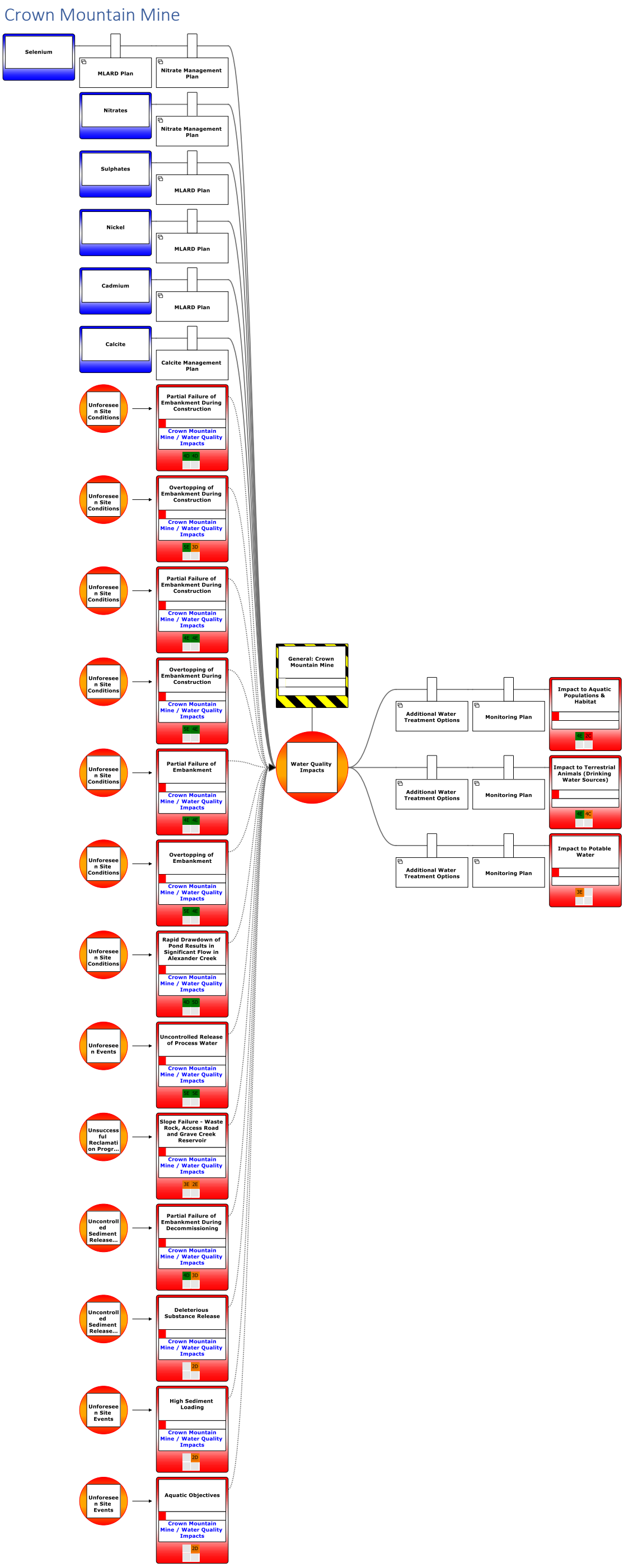


Post-Closure

Post Closure Measures



General


Crown Mountain Mine
Selenium
MLARD Plan
Nitrate Management Plan
Nitrates
Nitrate Management Plan
Sulphates
MLARD Plan
Nickel
MLARD Plan
Cadmium
MLARD Plan
Calcite
Calcite Management Plan
Unforeseen Site Conditions
Partial Failure of Embankment During Construction
Crown Mountain Mine / Water Quality Impacts
4D 4D
Unforeseen Site Conditions
Overtopping of Embankment During Construction
Crown Mountain Mine / Water Quality Impacts
3E 3D
Unforeseen Site Conditions
Partial Failure of Embankment During Construction
Crown Mountain Mine / Water Quality Impacts
4E 4E
Unforeseen Site Conditions
Overtopping of Embankment During Construction
Crown Mountain Mine / Water Quality Impacts
5E 4E
Unforeseen Site Conditions
Partial Failure of Embankment
Crown Mountain Mine / Water Quality Impacts
4E 4E
Unforeseen Site Conditions
Overtopping of Embankment
Crown Mountain Mine / Water Quality Impacts
5E 4E
Unforeseen Site Conditions
Rapid Drawdown of Pond Results in Significant Flow in Alexander Creek
Crown Mountain Mine / Water Quality Impacts
4D 5D
Unforeseen Events
Uncontrolled Release of Process Water
Crown Mountain Mine / Water Quality Impacts
5E 5E
Unsuccessful Reclamation Progr...
Slope Failure - Waste Rock, Access Road and Grave Creek Reservoir
Crown Mountain Mine / Water Quality Impacts
3E 2E
Uncontrolled Sediment Release...
Partial Failure of Embankment During Decommissioning
Crown Mountain Mine / Water Quality Impacts
4D 3D
Uncontrolled Sediment Release...
Deleterious Substance Release
Crown Mountain Mine / Water Quality Impacts
2D
Unforeseen Site Events
High Sediment Loading
Crown Mountain Mine / Water Quality Impacts
2D
Unforeseen Site Events
Aquatic Objectives
Crown Mountain Mine / Water Quality Impacts
2D
General: Crown Mountain Mine
Water Quality Impacts
Additional Water Treatment Options
Monitoring Plan
Impact to Aquatic Populations & Habitat
4E 2C
Additional Water Treatment Options
Monitoring Plan
Impact to Terrestrial Animals (Drinking Water Sources)
4E 4C
Additional Water Treatment Options
Monitoring Plan
Impact to Potable Water
3E