Appendix 20-A

Climate Change Impact Assessment

CROWN MOUNTAIN COKING COAL PROJECT

Climate Change Impact Assessment

December 2020 - 12-6231-9020

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1.0 Introduction

1.1 Project Background

NWP Coal Canada Limited (NWP) is proposing to construct and operate an open-pit metallurgical coal mine in the East Kootenay Region, approximately 12 kilometres from the District of Sparwood in Southeastern British Columbia. As proposed, the production capacity of the project would be 3.7 million tonnes per year, over a mine-life of approximately 15 years. A general map of the project site is provided in Appendix A.

Mined and washed coal will be conveyed from the production plant approximately 3 km via an overland conveyor (OLC) down the mountain, and then trucked approximately 9 km to a stockpile/loadout area where the product will be loaded, via a 16,000 tonne capacity silo, onto railcars on a new rail loop to be located adjacent to Canadian Pacific's existing common-user railway.

The Crown Mountain Coking Coal Project is nearing submittal of the Environmental Assessment Certificate Application due to occur in 2021. The Environmental Assessment (EA) requirements for the Crown Mountain Coking Coal project (the Project) are documented within the Application Information Requirements (BC MOE, April 2018), herein referred to as the AIR. Since the issuance of the AIR, the process of conducting a climate impact analysis on a project has evolved significantly. As a result of this, a more structured and robust climate change impact assessment is provided herein.

1.2 Project Description

The goal of this project is to complete a climate change impact assessment that aligns with updated practices to determine potential climate change related impacts on project infrastructure and develop potential adaptation options where required. The following sections outline the methodology used for the assessment, the identified risks, the climate change hazards that exacerbate these risks, and the recommended adaptation measures where applicable.

2.0 Methodology

The methodology employed follows principles of ISO31000 Risk Management Standards. The methodology and associated details are provided in the following sub-sections.

2.1 Scope and Timescale of Assessment

The assessment focused on the built infrastructure components related to the construction and operations of the Crown Mountain Coking Coal Project. The project was assessed for the intended construction and operation lifespan of approximately 17 years. Climate change projections were gathered for the averages of 10 years between 2030 and 2040, and 2045 and 2055 to help provide a more accurate landscape of short- and mid-term climate change trends for the project location.

2.2 Data Gathering

2.2.1 Infrastructure Components

Infrastructure data was gathered based on preliminary design and site plans. Assets and specific components were divided into categories based on their infrastructure type, which helped to guide the impact assessment. A list of infrastructure components is provided in Table 1, below.

Table 1: Infrastructure and Asset Component by Category

General Category	Specific Category	Asset Component
Buildings	Sprung Structure Shipping container sidings with cloth/fabric roof system	• Bulk Magnetite Storage • ROM Dump Hopper
	Shipping Container Structure Weatherized shipping containers	• Coal Processing Plant (CPP) Laboratory • Haul Truck Maintenance Facilities • CPP Workshop • Magazines & Silos • Flocculent Shed
	Steel Structure Pre-engineered with cladding and HVAC	• CPP Building – Processing Plant • Electrical Rooms • Steam Generation Building
	Concrete Structure Poured in place concrete station	• Breaker Station
	Pre-fab/Modular Standard pre-fabricated building	• CHPP Office and Control Room • New Valve Station (along Highway 43) • Pump Stations • Rotary Breaker Station
	Tanks/Bins Steel or fibre-reinforced plastic bins	• Fibreglass Reinforced Plastic (FRP) Tank • Reagent Tanks • Potable Water Storage Tank • Non-Potable Water Storage Tank • Truck Loadout Bins
Sites/Areas	Natural Ground/Platforms Laydown areas on natural ground	• Equipment Laydown Area
	Waste Rock Management Areas Areas for storing waste rock	• Waste Rock Management Areas
	Stockpiles Storage location for bulk materials	• Stockpiles (clean coal, breaker rejects, etc.)
	Concrete Pads/Platforms Poured in place concrete laydown areas	• Transfer Area • Fuel Island #1 • Fuel Island #2

General Category	Specific Category	Asset Component
Heavy Equipment	Heavy Machinery/Equipment Mobile or stationary equipment	• Excavators • Loaders • Water Truck • Blast Hole Drillers • Dozers • Graders • Dump Trucks • Haul Trucks • Backhoe • Crane • Diesel Generators (250 kW)
	Overland Conveyors Motorized conveyor belt with metal cladding cover	• Conveyor Cover • Reclaim Feeders • Product and Rejects Handling System
Utilities	A/G Power Lines Above ground utility and power lines	• A/G Power Lines • A/G Communication Lines
	U/G Piping Above ground utility and power lines	• Natural Gas Supply • Water Intake (from Alexander/Grave Creek)
	Drinking Water Wells Wells for potable water use	• Drilled Wells
	U/G Wastewater Treatment Tanks Typical treatment field installed underground	• Leach Field • Mobile Sewage Treatment System • Septic Field/Tanks
	Concrete Tanks Tanks for process wastewater recycling	• Thickeners
Natural Elements	Water Supply/Storage Water for process water use and dilution	• Alexander Creek • Grave Creek • Reservoir • Sedimentation Pond
Transportation	Gravel Roads Unpaved road from compacted gravel	• Haul Roads • Clean Coal Transport Route • Gravel Roads (Connecting mining sites)
	Retaining Walls Mechanically stabilized earth or concrete block retaining walls	• Retaining Walls
	Train Tracks Including rail sidings, rail bed, spurs, etc.	• New Rail Loop

2.2.2 Climate Change Data and Projections

Through the use of the open data source, the Climate Atlas of Canada, climate data was collected for the Fording River meteorological station, which was confirmed to be the most representative station for the Crown Mountain Project Site. Observed historical climate data was compiled for the period 1981 to 2010. Climate change projections were compiled for the time periods between 2030 and 2040 (short-term), and between 2045 - 2055 (mid-term) using an ensemble of Global Climate Models (GCM) with an emission scenario of RCP 8.5, demonstrating “business as usual”.

Climate data projections for the more complex climate parameters (i.e. snow events, drought conditions, wind events, avalanche threats, forest fire risks, and lightning) were discussed internally and informed by literature sources, internal analysis, and qualitative discussions. Table 2 lists the climate parameters considered and the corresponding climate data source.

Table 2: Climate Data Sources

Climate Parameter	Open Source Data	Internal Analysis
High Temperatures		
Low Temperatures		
Heavy Precipitation		
Freeze-Thaw Cycles		
Snow Events – Extreme and Regular		
Drought Conditions		
Wind Events – Extreme and Regular		
Avalanche Threats		
Forest Fire Risk		
Lightning		

The following sub sections summarize the specific climate change parameters used for the impact assessment.

2.2.2.1 High Temperatures

Very Hot Days is defined as the average number of days in a year when the temperature is above +30 °C or +32 °C, while Extremely Hot Days is defined as the average number of days in a year when the temperature is above +35 °C; these parameters are recorded as occurrences per year. As shown in Table 3, the climate parameters related to hot temperatures are expected to increase over the projected time period.

Table 3: High Temperatures

Climate Parameter	Very Hot Days (+30 °C)	Very Hot Days (+32 °C)
Unit/Frequency	Annual - # Days	Annual - # Days
Historic[1]	0.17	0.01
Predicted 2030s	1.18	0.00
Predicted 2050s	3.27	0.55

Notes:

Data obtained from the Climate Atlas of Canada.

[1] Historic average from 1981-2010 from the Climate Atlas of Canada.

2.2.2.2 Cold Temperatures

Very Cold Days are defined as the average number of days in a year when the temperature is below -15°C, while Extremely Cold Days are defined as the average number of days in a year when the temperature is below -25°C and -30°C; these parameters are recorded in average number of days per year (for any year within the specified time period). As shown in Table 4, by the 2050s, it is expected that the climate parameters related to cold temperatures are expected to decrease over the project time period.

Table 4: Cold Temperatures

Climate Parameter	Very Cold Days (-15 °C)	Extremely Cold Days (-25 °C)	Extremely Cold Days (-30 °C)
Unit/Frequency	Annual - # Days	Annual - # Days	Annual - # Days
Historic	45.64[1]	7.98[2]	4.22[1]
Predicted 2030s	38	3.64	3.09
Predicted 2050s	32.27	2.32	1.55

Notes:

Data obtained from Climate Atlas of Canada and Climate Data Canada

[1] Historic average from 1981-2010 from the Climate Atlas of Canada Climate.

[2] Modeled historical data from Climate Data predictions.

2.2.2.3 Heavy Precipitation

Heavy Precipitation occurrences are predicted to increase throughout the lifespan of this project. An increase in heavy rainfall events may lead to more frequent washouts of the access road and localized flooding in pits, causing delays in work, lost productivity and increased maintenance and reparations.

Precipitation includes rain, drizzle, snow, and sleet. The Annual Precipitation parameters were recorded in millimetres (mm), while Heavy Precipitation days were recorded in occurrences per year. As shown in Table 5, the Annual Precipitation is increasing, and Heavy Precipitation days (both measured as number of days with at least 10mm and 20mm of rain) are expected to increase by the 2050s.

Table 5: Heavy Precipitation

Climate Parameter	Annual Precipitation	Wet Days	Heavy Precipitation Days (10mm)
Unit/Frequency	Annual (mm)	Annual - # Days	Annual - # Days
Historic[1]	675.15	142	13.50
Predicted 2030s	745.55	141	17.73
Predicted 2050s	749.30	143	18.27

Notes:

Data obtained from the Climate Atlas of Canada.

[1] Historic average from 1981-2010 from the Climate Atlas of Canada.

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2.2.2.4 Freeze-thaw Cycles

Freeze-thaw Cycles occur when the air temperature fluctuates between freezing and non-freezing temperatures. During these cycles, infrastructure may be substantially impacted and significant damage to concrete and other structures due to water freezing, melting, and re-freezing. As shown in Table 6, freeze-thaw cycles are expected to slightly decrease by the 2050s after increasing in the 2030s.

Table 6: Freeze Thaw Cycles

Climate Parameter	Freeze-thaw Cycles
Unit/Frequency	Annual - # Days
Historic[1]	105.91
Predicted 2030s	110.23
Predicted 2050s	100.91

Notes:

Data obtained from the Climate Atlas of Canada.

[1] Historic average from 1981-2010 from the Climate Atlas of Canada.

2.2.2.5 Snow Events – Extreme and Regular

Snow events were qualitatively explored for this project due to its complex interactions with other climate hazards in question, and inherent difficulties in qualifying projections. Regular events are characterized by snowfall events between 10 cm and 30 cm, which is a common occurrence and threshold that operators have been managing currently. Extreme snow events are characterized by snowfall events of at least 60 cm, in which the probability was deemed almost certain to occur at least once over a 20 year period.

2.2.2.6 **Drought Conditions**

Drought conditions were considered throughout this project, and discussed qualitatively based on its interactions with other climate hazards in question, such as forest fire risk. As such it is a climate parameter that is difficult to quantify. The one parameter chosen to help inform the possibility of drought conditions is longest spell of +30°C days. As shown in Table 7, the longest spell of +30°C days is expected to increase.

Table 7: Longest Spell of+30°C Days

Climate Parameter	Longest Spell of +30°C Days
Unit/Frequency	Annual - # Days
Historic[1]	0.05
Predicted 2030s	0.00
Predicted 2050s	1.09

Notes:

Data obtained from the Climate Atlas of Canada.

[1] Historic average from 1981-2010 from the Climate Atlas of Canada.

Hot and dry conditions exist in the Elk Valley region today during the summer months. With a changing climate, warmer and drier conditions during the summer months in conjunction with other climate hazards can present increasing compounding impacts. An interaction of concern for the project includes drought conditions and thunderstorms; drought conditions may lead to an increase in likelihood and occurrence of lightning-caused forest fires.

2.2.2.7 Wind Events – Extreme and Regular

For the purpose of this project, a threshold of 125 km/h wind gusts was determined based on a combination of wind speed ranges described in the Enhanced-Fujita Scale for estimating wind speeds based on damage. Another supporting resource that informed this choice was the preliminary analysis conducted by the National Research Council (NRC; Schriever, 1977) on the wind sensitivity of single- and double-wide mobile homes and associated anchor requirements to prevent overturning.

A second threshold of 95 km/h 10-min wind was extracted from *CAN/CSA-C22.3 No.60826-10 Design Criteria of Overhead Transmission Lines* (CSA, 2010). This threshold is representative of an estimated 50-year return period for the area, and is used as the design threshold load for electrical transmission lines of standard reliability. Table 8 below presents data for the wind events described above.

Table 8: Wind Events

Climate Parameter	Wind Gusts (≥ 125 km/h)	Wind Design Value (95 km/h; 10 min wind)
Unit/Threshold	Annual Frequency	Annual Frequency
Historic	0.02	0.02
Predicted 2050s	0.03[1]	0.025[2]

Notes:

Data obtained from internal analysis.

[1] ~40% probability of occurrence over a 20 year period.

[2] >35% probability of occurrence over a 20 year period.

2.2.2.8 Avalanche Threat

For this project, risk analysis of the avalanche threat was supported by a preliminary study on the project's access roads completed by Dynamic Avalanche. The risk scoring for this parameter capitalizes on the findings related to the size and return periods of avalanche risks on the Grave Creek road. The study found that the area was susceptible to a maximum of a size 3 avalanche, and calculated a return period of 10 years. The classification of a size 3 avalanche is described in Table 9 below. A return period of 10 years is classified as moderate frequency and active in some heavy snow winters. The criterion is based on the established Avalanche Frequency table and the Canadian Avalanche Size Classification table (McClung and Schaerer, 2006).

Table 9: Canadian Avalanche Size 3 Classification (McClung and Schaerer, 2006)

Size	Description (Destructive Potential)	Typical Mass (t)	Typical Path Length (m)	Typical Impact Pressure (kPa)
3	Could bury a car, destroy a small building, or break a few trees.	10^3	1000	100

2.2.2.9 Forest Fire Risk

Forest fire risk was evaluated on both a qualitative and quantitative basis for this project due to its complex nature. A brief forensic study into past wildfire events between the years 2017 and 2020 in the region was conducted.

Climate change will bring longer fire seasons, increased lightning strikes, and deteriorating forest health conditions, each of which can increase the risk of longer active wildfire seasons. One notable interaction is fires caused by lightning strikes which account for roughly 50% of forest fires. Lightning-caused fires are reasonably expected to increase for the region due to the increase in hot and dry conditions, as well as increased occurrence and severity of thunderstorm events.

Additionally, wildfires can also exacerbate the severity of avalanches by reducing forest cover which provide slope stability and soil cohesion in mountainous areas. After a wildfire, the soil characteristics change, potentially impacting vegetation growth, leading to erosion and slope failure.

For the purpose of this project, the annual frequency for this forest fire event was calculated based on the annual likelihood of forest fires for the region and updated climate change forest fire projections provided by Yan Boulanger (pers. Comm.), forest ecology researcher at Natural Resources Canada. This can be viewed in Table 10.

Table 10: Forest Fire Risk

Climate Parameter	Wildfire[1]
Unit/Threshold	Annual Frequency[2]
Historic	3.83×10^{-4} per year
Predicted 2050s	1.42×10^{-3} per year[3]

Notes:

[1] ~2% - 3% probability of occurrence over a 20 year period.

[2] Fire return period for "Southern Cordillera" Forest Zone, as defined by Canadian Forestry Service (Boulanger et al, 2019).

[3] Although these values are extremely low, we note that forest fire projections suggest an increase of ~3.7 times by mid-century under the RCP 8.5 warming scenario (ref.).

2.2.2.10 Lightning

The historical trends observed in the Elk Valley region reflect that thunderstorms occur during the summer months, between June and September. With climate change, thunderstorms are expected to become more severe.

It is well documented that lightning strikes affect mining equipment and especially blasts and blasting equipment. Lightning strikes are known to detonate explosives prematurely and have taken the lives of mining personnel. For the purpose of this project, lightning data used was based on local lightning climatology using the Canadian Lightning Detection Network, based on a summary of 10 years of data, and is shown in Table 11.

Table 11: Lightning

Climate Parameter	Lightning
Unit/Frequency	Annual Frequency
Historic	0.05 per year (mine site); 0.008 per year (rail loading area)
Predicted 2050s	0.06 per year (mine site)[1]; 0.01 per year (rail loading area)[2]

Notes:

[1] ~70% probability of occurrence over a 20 year period for mine site buildings

[2] ~15% probability of occurrence over a 20 year period for rail loading area

Statistics have been provided for three values:

1) Average cloud-to-ground lightning occurrence for the location in strikes per square kilometer:
2) Adjusted probability taking into account mine site buildings; and
3) Adjusted probability taking into account rail spur building footprint.

Calculations are based on total footprint of buildings at the mine site and at rail spur/loading areas, including 20 meter buffer around each building. The 20 meter buffer is based on estimate lethal range for cloud-to-ground strikes (i.e., fatalities have occurred at this distance from the location of the lightning strike; *U.S. Army Training and Doctrine Command, 2002*)

2.2.3 Targeted Interviews

A total of five targeted interviews were conducted with project stakeholders with the intent to gather input towards the identification of climate change vulnerabilities to mining infrastructure and operations, and to inform viable adaptation measures. Interviews were tailored to the participant's respective areas of expertise to maximize the value of input gathered. The interviews included questions directed towards the identification of climate change impacts specific to the project, the identification of critical and vulnerable mining infrastructure, and discussion of possible adaptation measures. The interviews generated meaningful feedback from key stakeholders that helped to move the project forward. Table 12 below briefly summarizes the targeted interviews held as part of the project.

Table 12: Interview Summaries

Date	Name	Project Role/ Company	Discussion Topic
October 28, 2020	Mike Allen	General Manager NWP Coal Canada Limited	General Project Site Risks
November 4, 2020	Sean Ennis	Geotechnical/ Mining Consultant Stantec Consulting	Geotechnical and Hydrological Components

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Date	Name	Project Role/ Company	Discussion Topic
November 5, 2020	Mark Wilkin	Mine Design & Operations Consultant Sedgman	Mining Infrastructure and Facilities
November 5, 2020	David Hoekstra	Water Resource Consultant SRK Consulting	Hydrological and Water Components
November 6, 2020	Alan Jones	Avalanche Risk Consultant Dynamic Avalanche	Avalanche Risks and Response Measures

2.3 Risk Assessment Criteria

The following sections outline the methodology used in identifying climate change risks and impacts on project infrastructure. A technical workshop was held with an internal multidisciplinary team having expertise in climatology, environmental engineering, and climate change resilience and adaptation. Further details on risk identification methods are presented in Section 3: Climate Risk Assessment. The criteria used to determine likelihood and severity scores are provided in the following subsections.

2.3.1 Likelihood Scoring Criteria

The likelihood scores were developed based on how likely the risk event is to occur over the life of the project. Table 13 displays the scale used to rank the likelihood of the risk event occurring.

Table 13: Likelihood of Risk Occurring

Score	Descriptor	Likelihood of Single Event	Likelihood of Ongoing Event	Likelihood of Climate Parameter Occurring
1	Remote	Not likely to occur in Time Period	Not likely to become critical in Time Period	1 in 100 to 1 in 1000; ≤ 1% to 5%
2	Unlikely	Likely to occur once in 10 to 20 years	May become critical in 10 to 20 years	1 in 10; 5% to 15%
3	Possible	Likely to occur once between 5 and 10 years	May become critical in 5 to 10 years	1 in 5; 15% to 35%
4	Likely	Likely to occur once in 5 years (1/5)	May become critical within 5 years	1 in 2; 35% to 90%
5	Almost Certain to Occur	Likely to occur once or more Annually	Will become critical within 1 year	1 in 1.01; 90% to >99%

2.3.2 Severity Scoring Criteria

The consequence of the impacts were discussed and assigned a severity score to the risk event. The workshop participants assigned severity scores to each risk and discussed the potential consequences of the event which in turn helped provide rationale for the scores selected. The severity was assessed using three guiding categories: public safety or social risk, financial consequence or economic risk, and environmental consequence. Table 14 displays the scale used to rank the severity of interactions.

Table 14: Consequence of Risk Occurring

Score	Descriptor	Public Safety	Financial	Environmental
1	Low or Negligible	No injuries - Near miss	Infrastructure Damage or Delays leading to ≤ $ 50K	Short term no impact offsite
2	Moderate	Minor injuries to small number of public	Infrastructure Damage or Delays leading to > $ 50K - ≤ $ 100K	May impact offsite and ecosystem – Small scale < 1 month
3	Significant	Medical treatment/Reportable Injury	Infrastructure Damage or Delays leading to > $100K - ≤ $ 300K	Offsite and ecosystem impacted – Duration up to 1 year – Repairable
4	Serious	Partial disability, hospital treatment (i.e. surgery)	Infrastructure Damage or Delays leading to > $ 300K - ≤ $ 750K	Extended range – Long-term impact – May regenerate in ten years
5	Severe	Death or permanent total disability	Infrastructure Damage or Delays leading to > $ 750K	Long-term severe irreparable environmental impact - Over extended range beyond site

Professional assessment and judgement were primary elements used in assigning severity scores, and developing expected consequences. The workshop was made up of a multidisciplinary team of individuals who were knowledgeable of the infrastructure components, mining conditions and climate change impact assessments.

3.0 Climate Change Impact Assessment

The climate change impact assessment methodology encompasses the following steps:

1. Risk Identification: This step involved cross-referencing the climate hazards/parameters to the individual infrastructure component by means of an interaction matrix to determine the impact on assets/ operations;
2. Risk Analysis: This step involved assigning likelihood and severity scores for the identified interactions to determine the consequence of the impacts; and
3. Risk Evaluation: This step involved calculating risk scores and identifying unacceptable risks where adaptation options may be required.

As discussed in Section 2.3, a technical workshop with was held to complete the Climate Risk Assessment. This section presents the results from the workshop and a final list of prioritized impacts identified.

3.1 Risk Identification

An interaction matrix was compiled to identify the potential interactions between specific climate change parameters and project infrastructure components. A multidisciplinary team at Dillon populated the interaction matrix by first determining if an interaction between the climate parameter and the infrastructure component was deemed feasible and that it could cause a potentially negative impacts. The feasible interactions that may result in negative impacts are depicted by the shaded cells, in Figure 1, below.

	Climate Hazards									
Infrastructure Components	High Temperatures	Low Temperatures	Heavy Precipitation	Freeze Thaw Cycles	Snow Events - Extreme and Regular	Drought Conditions	Wind Events - Extreme and Regular	Avalanche Threat	Forest Fire Risk	Lightning
General Project Risks (Construction)		■	■		■		■	■		
Buildings					■		■		■	■
Sites/Areas			■				■		■	■
Heavy Equipment	■	■	■				■		■	■
Utilities			■	■	■	■	■	■	■	■
Natural Elements						■				
Transportation	■		■	■			■	■	■	

Figure 1: Risk Identification Interaction Matrix

3.2 Risk Analysis

Upon identification of the initial interactions and risk statements, an internal workshop was held to identify likelihood and severity scores (as defined in Sections 2.3.1 and 2.3.2, respectively) for each risk statement.

The final risk score was calculated based on standard risk assessment principles whereby *Risk = Likelihood x Severity*. Likelihood is defined as the probability of an event or an incident occurring, whether defined, measured or determined objectively or subjectively. Severity is defined as the consequence of the event or incident in question occurring, in consideration of public safety, economic impacts, and environmental impacts. Figure 2, below, shows the risk tolerance threshold used in evaluating the risk score for this project.

Severity						
	Severe	5	10	15	20	25
	Serious	4	8	12	16	20
	Significant	3	6	9	12	15
	Moderate	2	4	6	8	10
	Low	1	2	3	4	5
Risk Matrix		Remote	Unlikely	Possible	Likely	Almost Certain
		Likelihood				

Figure 2: Risk Evaluation Matrix

A negligible score (i.e., green square) signifies a negligible risk event that does not require further consideration. A low score (i.e., yellow square) signifies a low risk where controls are likely not required to reduce the risk, but continuous monitoring should be a consideration. A moderate score (i.e., orange square) signifies a moderate risk where some controls may be required to control or lower risks. These are typically the areas of “known” risks, where the risk is simply identified for consideration during the design of the project. A high score (i.e., red square) signifies a high or unacceptable risk where high priority or immediate controls are required.

A risk score of five (i.e., brown square) signifies that the risk is a special case and additional consideration may be required on a case-by-case basis. As per the matrix, a risk score of five can only be achieved when a severity or a likelihood score is at the extreme (i.e., score of five). Acute conditions with high severity scores signify that the event is not likely to occur, but if it does, the consequences are severe or catastrophic. Likewise, acute conditions with high likelihood scores signify that the event may occur several times over the lifespan of the infrastructure, but the consequence is minimal, leading to an ongoing or cumulative effect. Both situations warrant additional consideration to help lessen impacts on the infrastructure.

In total, the assessed risks amounted to three high risks, ten moderate risks, eight special case risks, twenty low risks and five negligible risk interactions. Adaptation measures were developed for moderate and high risks only; special case risks were discussed on a case by case basis. The full list of risks can be found in Appendix B and includes the risk statements, the likelihood and severity scores, as well as the calculated risk score and corresponding rating. From the climate hazards used for the assessment, wind events, avalanches, and lightning were found to produce the most infrastructure interactions.

3.3 Recommended Adaptation Measures

The purpose of the climate change impact assessment was to identify climate change related impacts and risks related to the construction and operations of the Crown Mountain Coking Coal Project. A final adaptation workshop was held with the Dillon internal team and the main project contact at NWP to review moderate and high risks and discuss current risk mitigation measures, and potential additional risk mitigation/ adaptation measures to be considered. The workshop included consideration of special case risks as well, and included of the development of policy based and physical based adaptation measures for recommendation.

Policy based measures typically included updates and recommendations related to Standard Operating Procedures (SOP) as well as operations, maintenance and management plans. Physical based measures typically included alterations or design changes to the physical components of assets or sites. These measures are presented in detail in Appendix C, but are summarized below by climate parameters.

3.3.1 Heavy Precipitation

Heavy precipitation events can impact access roads by way of localized flooding and or washouts. It is assumed that access and haul roads are to be constructed with proper drainage and storm water management systems in consideration of precipitation trends for the region. Proper notification protocols are also expected to be in place to trigger prompt road work following a washout event.

3.3.2 Snow Events – Extreme and Regular

The main interactions and risks associated with snow events were related to buildings on-site, particularly the sprung and modular structures. Snow accumulated on roof systems can impact the structural integrity of buildings. Extreme snow events are characterized by at least 60 cm of snow in a day, while regular snow events are characterized by 10 cm to 30 cm of snow in a day. The recommended adaptation measures would be to obtain area-specific roof loading requirements from Environment and Climate Change Canada (ECCC) and build structure to those recommendations. Additionally, buildings shall include snow-shedding capabilities to help periodically remove snow to avoid excessive build-up of ice and snow.

3.3.3 Drought Conditions

During drought conditions when it is hot and dry, the overland conveyors are suspected to be impacted by higher risks of fire which can result in large infrastructure and environmental damage. It is expected that fire prevention, detection, and suppression systems would be in place to manage this risk but a review of current recommended best practices would help inform future decision-making in this regard.

Furthermore, a risk interaction related to the sedimentation pond requires further assessment to determine if projected drought conditions may impact pond water levels which my result in insufficient dilution of mine affected water. Environmental compliance monitoring is expected to take place continuously throughout the project and mitigation measures will be implemented as necessary.

3.3.4 Wind Events – Extreme and Regular

A total of seven risk interactions were identified for wind events – both for extreme and regular events.

Extreme wind events with speeds of greater than 125 km/h are anticipated to impact modular buildings, power lines, and heavy machinery and equipment. The adaptation measures recommended as part of this project include additional anchoring of equipment where required, and appropriate reviews of O&M plans and SOPs to include frequent conditions assessments of infrastructure components.

Regular wind events are expected to transport dust to surrounding areas and nearby streams. This can lead to environmental compliance concerns which can impact operations if these impacts are not mitigated. However, it is assumed that the Dust Control Management Plan produced as part of this project will sufficiently mitigate these specific risks.

3.3.5 Avalanche Threat

Avalanches can impact access roads and above ground power lines. It is assumed that a comprehensive plan to manage avalanche risks for the project is in development. It is expected that reliable warning systems, procedures and policies would be in place throughout the project, including recommendations on specific measures such as Remote Avalanche Control System (RACS) and snow defence structures.

3.3.6 Forest Fire Risk

The forest fire risk interactions identified were considered acute conditions (special cases) with high severity scores and low probability of occurrence. These events are not likely to occur, but if they do, the consequences can be severe or catastrophic. The assets of concern for the project include the explosives facility, the stockpile at the train loadout, the main overland conveyor, the above ground power lines, and the rail loop. It is assumed that all assets will have sufficient buffer zones to the tree line to help mitigate this risk, however, it is recommended to consider the use of fire retardant equipment and materials for construction, and that there is a nearby water supply and firefighting equipment in case of a fire.

3.3.7 Lightning

Lightning is anticipated to have possible impacts on the explosives facility, the stockpiles at the train loadout, heavy machinery and equipment, and the overland conveyors. The adaptation measures recommended encompassed grounding sites and facilities, and establishing systems that would reliably predict and warn project personnel about incoming thunderstorm events. Revisions of the SOP for operations during thunderstorm events are also recommended to have the appropriate and effective protocols in order to manage the risks of catastrophic impacts.

4.0 Conclusion

The risks and recommendations listed above and in Appendix C are being considered within the project design. The Crown Mountain Coking Coal project team is cognizant of the risks identified in this report as well as the recommended adaptation measures to mitigate these risks.

5.0 References

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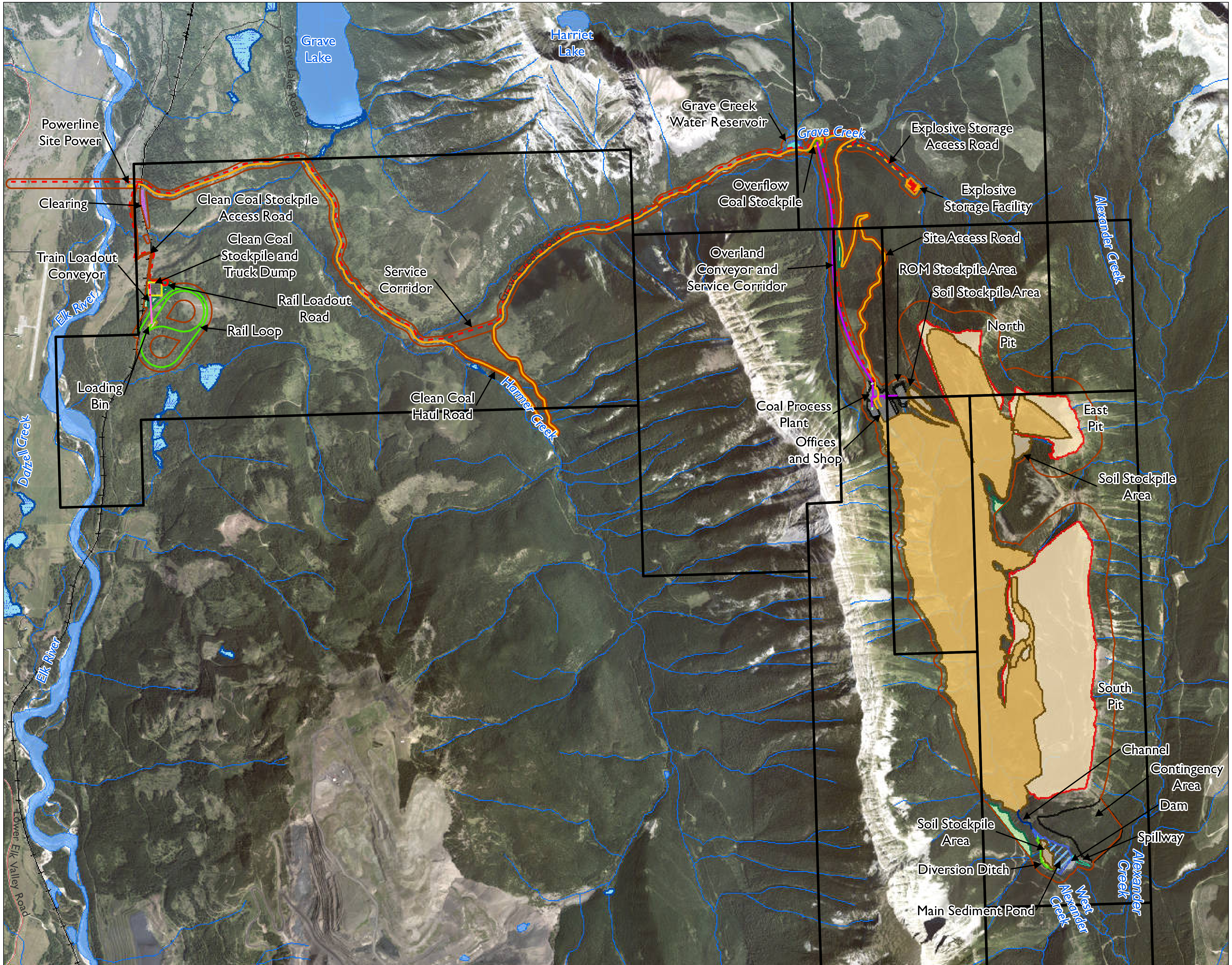
Appendix A

Project Site Map



Crown Mountain Coking Coal Project

FIGURE 1

PROJECT FOOTPRINT - 2020\10\26

LEGEND

Project Footprint

Project Footprint Infrastructure

- 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

Base Data

- Arterial Roads
- Local/Resource Roads
- Railway (Canadian Pacific)
- Watercourse
- Waterbody
- Wetland
- BC/Alberta Border
- Coal Tenure Licenses

0 1 2 Kilometers

N W E S

SCALE 1:40,000

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

DILLON CONSULTING

PROJECT: 12-6231

STATUS: DRAFT

DATE: 2020-10-30

Appendix B

List of Identified Risks

Risk Code	Risk Statement	Risk Score	Risk Rating
General Project Risks - C			
C1	Extreme low temperatures causing engines/ motors to fail, leading to increased maintenance or replacement (financial risk)	1	Negligible Risk
C2	Extreme rainfall events leading to onsite impacts, loss of materials/ equipment leading to delays in work.	6	Low Risk
C3	Extreme snow events can lead to delays in work and potentially more damaging avalanches. This results in financial losses associated with controlled avalanches and clean up, and delays in construction	4	Low Risk
C4	High Winds can transport dust to surrounding areas and nearby streams leading to increased turbidity and environmental compliance concerns	10	Moderate Risk
C5	Depending on the intensity, the impacts of avalanches range from impeding access and movement in sites to potential loss of life.	6	Low Risk
Buildings - B			
B1	Snow events can result in excess loading on cloth/ fabric roof leading to small leaks, damage	5	Special Case
B2	Extreme snow events can result in excess loading on cloth/ fabric roof leading to complete failure	9	Moderate Risk
B3	Extreme snow events can result in excess loading on cloth/ fabric roof leading to small leaks, damage	5	Special Case
B4	Extreme snow events can result in excess loading on cloth/ fabric roof leading to complete failure	9	Moderate Risk
B5	High Winds toppling structures leading to equipment damage and health and safety concerns (potential loss of life)	16	High Risk
B6	Forest fires can reach the explosives facility leading to financial losses and loss of life	5	Special Case
B7	Lightning can prematurely detonate charged explosives and damage electronic equipment leading to financial losses and possible loss of life	20	High Risk
Sites/Areas - S			
S1	Waste rock may contain harmful by-products. These areas are not covered and are exposed to the elements, therefore runoff as caused by heavy rainfall events can lead to downstream contamination and increased turbidity in nearby streams. Environmental compliance concerns - When contact water gets loose/ exceeds storage capacity	2	Low Risk
S2	Waste rock areas are not covered and exposed to the elements, High Winds can transport dust to surrounding areas and nearby streams leading to increased turbidity and environmental compliance concerns	10	Negligible Risk
S3	Forest fires can reach the train loadout facility, which is also used to store coking coal product. Explosion risk and complete loss of asset and product	5	Negligible Risk
S4	Lightning at the Train Loadout Facility and nearby stockpile can be dangerous due to explosive nature of coking coal. Lightning caused fire could lead to significant damage and financial losses	15	Low Risk

S5	Heavy precipitation with high water flows can overwhelm diversion channels and can lead to localized flooding	2	Negligible Risk
Heavy Equipment - H			
H1	Extreme temperatures causing heat stroke for High Temps, and frostbite/ hypothermia for Low Temps.	3	Low Risk
H2	Extreme low temperatures causing engines/ motors to fail, leading to increased maintenance or replacement (financial risk)	1	Negligible Risk
H3	High winds leading to dangerous working conditions resulting in missed work days - Financial and employee impacts	5	Special Risk
H4	Lightning Strikes can cause significant, instantaneous damage to heavy vehicles and equipment and stall work operations, leading to financial loss	12	Moderate Risk
H5	Heavy Rain causing sediment and materail washouts at footing/ connections of the Overland Conveyor, resulting in significant damage to the conveyor	4	Low Risk
H6	The mechanical components of the OLC can get hot and produce sparks. During high temperatures or drought conditions this can lead to higher chances of belts catching fire, which can result in large infrastructure and environmental damage.	15	High Risk
H7	High winds physically impacting OLC metal cladding cover leading to infrastructure damage (financial risk)	8	Moderate Risk
H8	Forest fires can impact the OLC which is a direct path to the production plant. An uncontrolled fire can lead to significant infrastructure losses and loss of life	5	Special Case
H9	Lightning Strikes can cause significant, instantaneous damage to the OLC which can stall work operations, leading to financial loss	8	Moderate Risk
Utilities – U			
U1	Extreme Snow and/or Freezing Rain events can cause strain on power lines leading to damage or loss of lines and power to the facility	6	Low Risk
U1	Wet snow events can cause strain on power lines leading to damage or loss of lines and power to the facility	6	Low Risk
U1	High Winds can cause strain on power lines leading to damage or loss of lines and power to the facility	8	Moderate Risk
U2	Power lines in road section GS3 - Size 3 avalanche can destroy A/G power lines, causing delays of work and financial losses related to remediation	12	Moderate Risk
U3	Forest fires can cause significant damage to power lines leading to complete loss of asset and significant delays in work	5	Special Case
U4	Lightning strikes can cause line outages which can lead to delays in work and financial losses	6	Low Risk
U5	Freeze Thaw Cycles can lead to frost heaves, resulting in strain on underground piping which could lead to cracks or breaks	4	Low Risk

U6	Heavy Precipitation causing run offs from potentially contaminated areas can reach the well heads or infiltrate soils nearby, impacting the potable water source.	3	Low Risk
U7	Drought Conditions can lead to depleted water levels and slow down groundwater recharge.	6	Low Risk
U8	Freeze Thaw Cycles can lead to frost heaves, resulting in strain on underground infrastructure which could lead to cracks leading to sewage discharge and other environmental concerns	4	Low Risk
Natural Elements - N			
N1	Drought Conditions can lead to depleted water levels and constrain water usage.	3	Low Risk
N2	Drought Conditions can lead to depleted water levels and constrain water usage. - For environmental compliances (ensuring dilution in sedimentation pond)	N/A	Not Rated
Transportation - T			
T1	Freeze-Thaw Cycles can lead to frost heaves resulting in large pot holes which can lead to damage to haul trucks and machinery - delays in work/ financial losses	4	Low Risk
T2	High Winds can transport dust to surrounding areas and nearby streams leading to increased turbidity and environmental compliance concerns	5	Special Case
T3	Road section GS3 - Avalanche size 3 can damage infrastructure surrounding road section and impede access and movement causing delays of work leading to financial losses.	9	Moderate Risk
T4	All other road sections - Avalanche size 3 can damage infrastructure surrounding road section and impede access and movement causing delays of work leading to financial losses.	3	Low Risk
T5	Heavy Precipitation causing localized flooding can impede access to site, leading to delays of work and financial losses	12	Moderate Risk
T6	Heavy precipitation events leading to runoff causing loose soils within retaining walls to become dislodged, impacting structural integrity of the wall	4	Low Risk
T7	High Temperatures can lead to thermal expansion of train tracks which can result in loading issues, increased maintenance or delays in work	3	Low Risk
T8	High Winds can blow trees and/or debris onto the tracks which can result in maintenance nuisances and delays in work	4	Low Risk
T9	Fires can cause significant damage to the rail lines leading to delay of work and financial losses	5	Special Case

Appendix C

List of Recommended Adaptation Measures

Item	Rationale	Policy Based Adaptation Measures	Physical Based Adaptation Measures
General Project Risks - G			
C4	Difficult to quantify because the site is situated in the valley but it is suspected that it would not take an extreme wind speed to kick up and transport dust.	1. Dust Control Management Plan that includes establishing a weather monitoring station and dust control measures such as watering	
Buildings - B			
B1	This area receives a significant amount of snow. a 10cm-30cm event is inevitable over the operation life, but this type of impact can be managable.	1. Revise O&M and SOP to include regular inspections of roofing systems	1. Snow to be removed periodically to avoid ice build up 2. Design buildings to include snow shedding
B2	Extreme snowfall (over 3 days) is almost certain to occur over the 20 year period, but the chances of this causing a complete failure is at the level of possible. This impact is signficant as it can happen suddenly and potentially injure employees.	1. Acquire specific roof loading for the area from ECCC and design buildings to those standards.	1. Snow to be removed periodically to avoid ice build up 2. Design buildings to include snow shedding
B3	This area receives a significant amount of snow. a 10cm-30cm event is inevitable over the operation life, but this type of impact can be managable.	1. Revise O&M and SOP to include regular inspections of roofing systems	
B4	Extreme snowfall (over 3 days) is almost certain to occur over the 20 year period, but the chances of this causing a complete failure is at the level of possible. This impact is signficant as it can happen suddenly and potentially injure employees.	1. Acquire specific roof loading for the area from ECCC and design buildings to those standards.	1. Snow to be removed periodically to avoid ice build up 2. Design buildings to include snow shedding
B5	Metal building systems are known to be impacted by wind gusts >125kph. These winds could impact metal cladding resulting in financial impacts. Likely a 1 in 10 year event.	1. Revise O&M and SOP to review anchoring systems when high wind events are predicted	1. Anchor modular structure appropriately, review EF damage indicators and windspeeds for design thresholds.
B6	Explosives used for this project are volatile and can cause significant damage if in contact with fire	1. Include SOP to ensure no flammables are stored in close proximity to the facility	1. Ensure facility has a fire buffer. 2. Ensure fire retardant equipment is used for construction
B7	Likelihood of 4 was assigned based on explosives facility elevation. Ranked as high Severity as lightning can prematurely detonate any charged explosives	1. Look into deploying a reliable prediction system and warning system 2. Early lightning warning system - Alert people in charge of safety about different thunderstorm stages so preventative measures can be taken 3. Revise SOP for work during electrical storms (e.g. directions on where to park in a storm, procedure when a truck is struck by lightning, when to halt operations such as blasting and surveying), and including an evacuation plan as well as designating staff member to be responsible for decision making in the event of an incoming storm	1. Ensure sites/facilities are grounded - Lightning rods system
Sites/Areas- S			
S2	Through recent studies, dust transport from accross valley (from other mine) is making its way onto creek/ surface water at the coking coal site. Waste Rock piles could contain harmful contaminants that could be transported.	1. Dust Control Management Plan (refer to the CDC's Best Practices for Dust Control in Coal Mining)	
S3	Infrastructure damage. Train loadout also holds coking product which presents an explosion risk that could be catastrophic.	1. Review SOP for evacuation perimeter in the event of a wildfire	1. Ensure train loadout has a fire buffer

Item	Rationale	Policy Based Adaptation Measures	Physical Based Adaptation Measures
S4	Infrastructure damage. Train loadout also holds coking product which presents an explosion risk that could be catastrophic.	1. See resilience measures for B7 Less of a concer - all facilities are grounded here	1. See resilience measures for B7
Heavy Equipment - H			
H3	Very low likelihood that a wind gust would cause damage to heavy equipment - It would require a tornado, which is not impossible. If a tornado occurs, impact is severe. However, there could be delays and stoppages in mining activities due to adverse wind conditions.	1. Revise O&M and SOP to identify which mining activities (if any) can be impacted by high wind speeds and to manage the impacted work.	
H4	Severity is rated significant due to potential infrastructure and equipment damage and it also presents more strain to operations.	1. See resilience measures for B7	1. See resilience measures for B7
H6	Very hard to quantify but possible due to increased high temperature days and dry conditions. A conveyor belt fire can lead to catastrophic impacts if not detected and rapidly contained.	1. Revise O&M and SOP to include regular conditions assessments on the OLC belt especially friction points that may cause sparks and belt fires. - OLCs are checked routinely (there's a set procedure to maintain/grease/inspect).	1. Implement fire detection/ suppression system - This may include alarms, suppression system or isolation protocols based on fire protection guidelines for conveyors transporting coal. Link to guidelines
H7	Metal building systems are known to be impacted by wind gusts >125kph. These winds could impact metal cladding on OLC, resulting in financial impacts. Likely a 1 in 10 year event.	1. Follow Building Code and CSA guildines for fastening/ anchoring system during installation	
H8	OLC leads to plants and stock pile of facility - fire can spread to other facilities and become catastrophic.	1. Revise O&M and SOP to include regular conditions assessments on the OLC belt especially friction points that may cause sparks and belt fires.	1. Ensure facility has a fire buffer. 2. Ensure fire retardant equipment is used for construction
H9	Lightning Strikes can cause significant, instantaneous damage to the OLC which can stall work operations, leading to financial loss	1. See resilience measures for B7. All grounded	1. Ensure OLC has a fire buffer. 2. Ensure fire retardant equipment is used for construction
Utilities - U			
U1	Downed power lines and potentially a few utility poles would result in some delays and a financial impact to replace	1. Ensure proper response protocols are in place with appropriate utlity agencies (BC Hydro) for quick remediation	
U2	Likelihood is 88% chance over 20 year for GS 3 section for size 3 avalanche. Remediation efforts may be difficult in the winter due to accessibility concerns. Other operations are also impacted including productivity and output losses. Flagged with a severity of 4 due to its potentially high impact.	1. Implement an avalanche forecasting and worker safety program; 2. Monitor daily weather observations: Daily snowpack, and avalanche observations	1. Install Remote Avalance Control Systems (RACS) and deploy as needed and recommended based on Dynamic Avalanche Report
U3	linear infrastructure, wood frame poles would be completely destroyed. Major financial implications and delays of work		1. Ensure there is an appropriate fire buffer along the road and A/G power lines. (1.5x height of trees currently)
Natural Elements - N			
N2	Concerns related to making sure there is enough water to dilution when necessary	1. Further study may be required. Environmental compliance monitoring is expected to take place continuously and mitigation measures will be implmented as necessary	
Transportation - T			

Item	Rationale	Policy Based Adaptation Measures	Physical Based Adaptation Measures
T2	Rated high likelihood; low severity - more of a nuisance but impacts would mostly be neutral. Some degree of dust transport is unavoidable.	1. Dust Control Management Plan	
T3	88-90% of happening once over the 20 year time frame (1 in 10 year event over a 20 year period). Severity was determined to be 3 based on amount of remediation work required, delays and opportunity costs.	1. Implement an avalanche forecasting and worker safety program; 2. Monitor daily weather observations: Daily snowpack, and avalanche observations 3. Ensure proper warning systems, procedures and policies are in place.	1. Install Remote Avalance Control Systems (RACS) and deploy as needed and recommended based on Dynamic Avalanche Report 2. Construct Avalanche Defence Structures - e.g. snow sheds and snow support structures, as laid out in Dynamic Avalanche report
T5	Shut down of processes due to workers unable to access sites, no movement of people and equipment around facilities leading to delays and inoperability	1. Design road and storm water management systems to conservatively forecasted heavy rainfall events to ensure proper management and drainage. 2. Ensure proper notification protocols are in place to trigger road work after a washout event.	
T9	Railway sleepers are made of wood which can lead to damage or complete loss in a forest fire, also causing significant work delays		1. Ensure facility has a fire buffer. 2. Ensure fire retardant equipment is used for construction 3. Ensure availability of water supply (e.g. establish a pond) and fire fighting equipment nearby