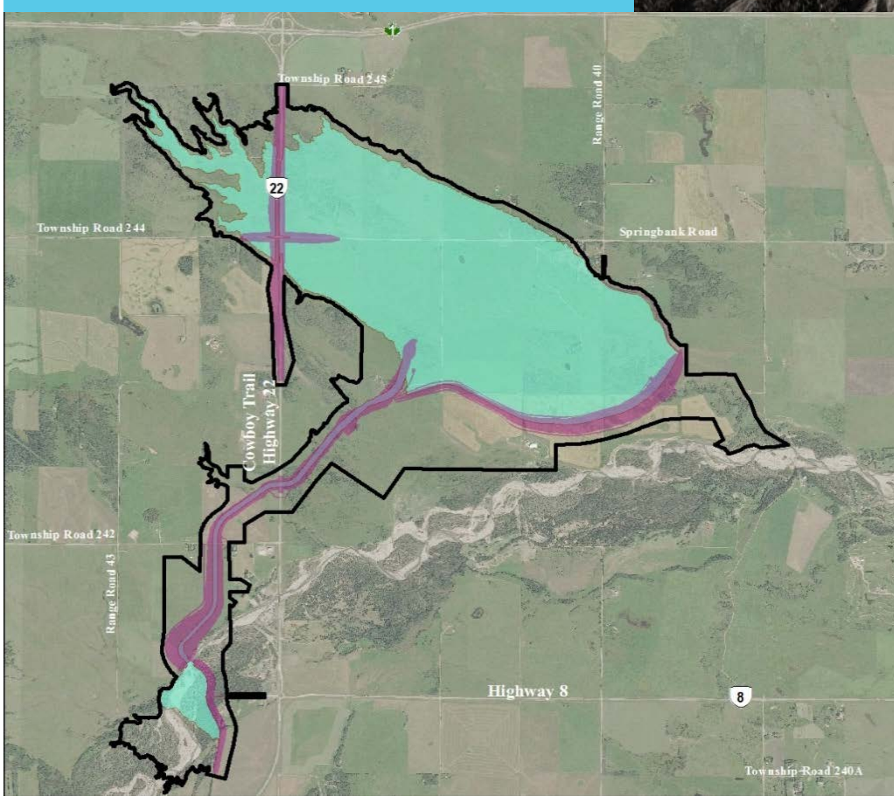
Springbank Off-stream Reservoir Project

Environmental Impact Assessment



Volume 3D
Effects Assessment
(Accidents and Malfunctions, Effects of the Environment on the Project, and Summary of Environmental Effects)

March 2018

Alberta Transportation

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Abbreviations

AEP	Alberta Environment and Parks
AER	Alberta Energy Regulator
AEMA	Alberta Emergency Management Agency
CDA	Canadian Dam Association
CEA Agency	Canadian Environmental Assessment Agency
CEMA	Calgary Emergency Management Agency
CO	Carbon monoxide
ECO Plan	Environmental Construction Operations Plan
EMS	Environmental Management System
EPEA	*Alberta Environmental Protection and Enhancement Act*
HVP	high vapour pressure
IDF	Inflow design flood
LAA	local assessment area
LVP	low vapour pressure
MEP	Municipal Emergency Plan
NEB	National Energy Board
PDA	project development area
PIL	Project Inclusion List
PMF	probable maximum flood

POC	Provincial Operations Centre
RAA	regional assessment area
STARS	Shock Trauma Air Rescue Service
TLRU	traditional land and resource use
VC	valued component
VOCs	volatile organic compound
WHMIS	Workplace Hazardous Materials Information System

1.0 ACCIDENTS AND MALFUNCTIONS

1.1 INTRODUCTION

The Alberta Environment and Parks (AEP) Terms of Reference for the Project (Section 3.2 [D]) requires that the environmental impact assessment identifies potential accidents and malfunctions that could occur. The Canadian Environmental Assessment Agency (CEA Agency) Guidelines for the Project (Section 6.6.1) requires an analysis of the risks of accidents and malfunctions, their effects, and preliminary emergency measures.

Accidents and malfunctions are events or conditions that are unplanned and unlikely (rare). They are distinct from effects caused by the Project arising from planned physical works and activities that are certain (and are assessed in Volumes 3A, 3B and 3C). Accidents and malfunctions can occur as a result of equipment failure, human error, or other possible causes.

Many accidents and malfunctions are preventable and may be avoided or effects mitigated by appropriate planning, design, equipment selection, hazard analysis and corrective action, emergency response planning, and security management. Response to accidents and malfunctions are also typically unique (compared to other effects) being reliant on emergency response (i.e., following specific protocols and rapidly implemented, customized to the specific type of event) to address such effects.

A key objective of response is ensuring human safety and containment (i.e., minimizing spatial extent). These considerations are included in the assessment of effects and evaluation of significance.

This section identifies potential accidents and malfunctions, identifies the interaction between valued components (VCs), assesses the risk of accidents and malfunctions associated with the Project in relation to the identified VCs, outlines the commitments, contingency and emergency response procedures, and determines the residual environmental effects from the accidents and malfunctions scenarios.

1.2 ASSESSMENT APPROACH

1.2.1 Methods for Assessment of Accidents and Malfunctions

The assessment for each accident or malfunction scenario follows these steps:

- Identify potential accidents or malfunctions, describe the general conditions that would lead to each accident and malfunction during each Project phase.
- Identify the interaction and description of potential effects between VCs (if applicable) for each accident and malfunction scenario.
- Identify the Project safety, design measures, or contingency and emergency response procedures for managing or mitigating risk for each accident and malfunction scenario that is presented.
- Describe the residual environmental effects and associated significance on VCs that may result from accidents and malfunctions in consideration of emergency response plans.

1.2.2 Identification of Potential Accident and Malfunction Scenarios

Based on professional judgment, experience with similar projects, and, in consideration of comments provided by agencies, Indigenous groups and the public, the following accidents and malfunction scenarios have the potential to occur as a result of the Project or during project activities:

- **off-stream dam failure or breach** — uncontrolled release of retained water from the off-stream dam as a result of piping, slumping or overtopping failure of the dam and subsequent inundation of downstream areas
- **diversion structure failure or breach** — failure or breach of the service spillway, auxiliary spillway, or floodplain berm during flood operations as a result of electrical or design failure of the diversion structure
- **fire** — an explosion or fire, including wildfires
- **hazardous materials spill** — spills of fuel or other chemicals used on site, or during transportation to site during construction; or, from third parties using the roads during dry operations or flood operations
- **vehicle accident** — vehicle collision because of traffic to and from site and the operation of equipment on-site
- **pipeline rupture** — rupture of pipelines located in the project development area (PDA)

Section 1.4 describes each scenario, which are selected for assessment because the mechanisms that could lead to the event may cause an adverse effect to human or environmental receptors.

1.2.3 Effects Assessment

Section 1.5 provides a qualitative analysis of the potential effect of each selected accident and malfunction event on selected VCs. Due to their unique nature, each event has the potential to affect different VCs. The analysis focuses on VCs that are most likely to be affected and effects that have the potential to exceed effects of routine operation of the Project. All events have a low probability of occurrence (are rare), which reduces the likelihood of the resulting environmental effects to occur. Some degree of uncertainty is inherent throughout the accidents and malfunction assessment process. These uncertainties are addressed by incorporating conservative assumptions in the analysis. As a result, the assessment tends to overstate the actual risk and provide conservative conclusions. The assumptions associated with the analyses are addressed throughout the assessment.

Traditional knowledge and traditional land and resource use (TLRU) information is considered at a landscape level to determine where accidents or malfunctions would have the potential to affect traditional uses. Information gathered as part of Indigenous engagement (see Volume 1, Section 7; Volume 4, Appendix B) is used to identify where potential effects may cause disruptions to Indigenous activity in that area). Consideration of the potential effects on archaeological and heritage resources is also assessed.

1.3 PROJECT DESIGN MEASURES AND EMERGENCY RESPONSE APPROACH TO REDUCE RISK

The Project is regulated by AEP *Dam and Canal Safety Guidelines* (1999) and the Canadian Dam Association (CDA) *Dam Safety Guidelines* (2007) and has been designed to comply with the provincial *Water Act*. The Project meets design standards established by these safety guidelines. Refer to Volume 1, Section 5 for additional discussion of dam safety.

1.3.1 Construction

1.3.1.1 Alberta Transportation ECO Plan Framework Requirements

Alberta Transportation has an Environmental Management System (EMS) that will be applied to the Project during construction. The EMS includes standard environmental practices and procedures and spill release reporting procedures. In addition to the EMS, Alberta Transportation requires an Environmental Construction Operations Plan (ECO Plan) to be developed by the selected construction contractor using Alberta Transportation's ECO Plan framework which is a joint document prepared by Alberta Transportation, the City of Calgary, and the City of

Edmonton. The ECO Plan will be a project-specific plan that identifies and mitigates the potential environmental effects of construction. The ECO Plan is required to specifically identify hazardous materials handling measures and emergency response procedures. The contractor will be responsible for developing and implementing the ECO Plan. The ECO plan framework is provided in Volume 4, Supporting Documentation, Document 4.

Hazardous Materials Handling

The ECO Plan will identify every hazardous material to be stored on site by the Contractor and all sub-contractors, along with material-specific handling, containment, storage and disposal procedures. The storage location(s) of hazardous material will be identified on a site diagram included within the plan. Hazardous materials will be transported, handled and stored in compliance with the Workplace Hazardous Materials Information System (WHMIS). A list of hazardous materials used and stored on site together with material safety data sheets (MSDS) will be maintained and prominently displayed on site. Workers will be educated and trained so they understand the hazards, and know how to work safely with hazardous products.

Examples of hazardous materials and associated handling procedures include:

- Diesel fuel — designated refueling areas will be established at least 100 m from a water body. Fuel will be stored in a double walled tank located on an impervious tray with the capacity to hold 110% of the stored liquid volume. On-site fueling will follow best management practices which as detailed in the ECO Plan. Fire extinguishers will be located at all refueling stations and no smoking signs will be erected. Spill kits will be available at all refueling stations and on all fuel and service vehicles and workers will be trained in their use.
- Lubricating oil — lubricating oil will be stored in a fire proof containment locker and clearly labelled. When lubricating oil is used, the contractor will provide secondary containment with capacity to hold 110% of the stored liquid volume.

Environmental Emergency Prevention and Response

The ECO Plan will identify potential project-related incidents that may impact the environment. These incidents could be the result of natural events, accidents, human error or improper work practices. Examples of potential incidents include:

- contaminant spills and releases to land, water and air from fuels, oils, lubricants and chemicals
- discovery of historical contamination
- erosion events of land (e.g., water, wind), watercourses (e.g., bank erosion, flooding), berms and coffer dams.

The ECO Plan will provide emergency procedures to prevent and respond to potential incidents that may impact the environment. The emergency response procedures will include:

- training provisions to make the contractor staff and sub-contractors aware of their responsibilities during emergency situations
- a list of equipment and materials available on site, including their specific location
- initial response to an emergency, describing the steps to be taken and equipment to be used
- immediate reporting of environmental incidents to appropriate authorities
- post-emergency review, follow up and improvement of procedures as needed

The contractor is responsible to ensure that each emergency response procedure reflects the current specific regulatory requirements. The ECO Plan will include contamination discovery and release reporting emergency response procedures. The immediate reporting of environmental releases and spills is a requirement of provincial and federal environmental legislation.

The ECO Plan will include a current emergency contact list and describe where it will be posted. The list must include names and contact details for key personnel and applicable regulatory agencies.

1.3.1.2 Alberta Transportation Environmental Management System Requirements – Spill Release Reporting Procedures

The procedures detailed within the EMS are intended to address the release of hazardous materials and sediment under the federal *Fisheries Act*, the *Transportation of Dangerous Goods Act* and the *Alberta Environmental Protection and Enhancement Act* (EPEA).

In general, EPEA requires that all releases that have caused, are causing, or have the potential to cause adverse effects on the environment must be reported (s. 110). Failure to report a release is itself an offence under EPEA (s. 227).

In the event of a spill on site the selected construction Contractor will be responsible for reporting the spill and a two-stage reporting procedure will be implemented, as follows:

Stage 1 - Oral Reporting

Contact the Environmental Response Centre (AEP) at – (780) 422-4505 or 1-800-222-6514 (24 hrs). A reference number will be provided at the time of the oral report. Once the oral report has been made, the Environmental Response Centre will ensure that relevant federal and provincial authorities are contacted on Alberta Transportation’s behalf.

Stage 2 – Written Reporting

Written reports will be submitted to the Environmental Response Centre within 7 days of the oral report. The *Release Reporting Regulation* sets out the content and manner required for a written report. The written report must include the following information:

a. The date and time of the release;
b. The location of the point of the release;
c. The duration of the release and the release rate;
d. The composition of the release including concentration, total weight, quantity or amount released;
e. A detailed description of the circumstances leading up to the release;
f. The steps or procedures which were taken to minimize or stop the release;
g. The steps or procedures which will be taken to prevent future releases; and
h. Any other information required.

The report will be mailed or faxed to:

AEP
Environmental Response Centre
111 Twin Atria Building
4999-98 Ave.
Edmonton, Alberta T6B 2X3
Fax: (780) 427-3178

Email : ERC.Environment@gov.ab.ca

1.3.2 Dry Operations, Flood Operations and Post-flood Operations

Both the Province of Alberta and the City and Calgary have emergency response procedures in place that are applicable during dry operations and flood operations phase. Details are discussed below.

1.3.2.1 AEP – Emergency Preparedness Plan and Emergency Response Plan

Section 6 of the provincial *Water Act* requires the operator of the Project prepare an Emergency Preparedness Plan (EPP) and Emergency Response Plan (ERP) that is specific to the dam and its operation (Alberta Environment 2003). These documents will be prepared prior to operation of the project and administered through the Project's lifecycle. As the operator of the Project, AEP will develop the EPP and the ERP prior to the operation of the Project.

Emergency planning for a flood emergency in Alberta relies on dam owners providing warnings of any Imminent Flood Emergencies (IFE) and downstream local authorities initiating their own Municipal Emergency Plans (MEP) in response to those warnings. The ERP will detail the actions to be taken, including warnings issued to emergency responders. The EPP will in general terms describe the actions expected of other emergency responders. The EPP will contain inundation maps and flood arrival details that will allow responders to plan appropriately for these situations, when they occur.

The EPP lists the 'fan-out' notification procedures and has key contact numbers for other responding agencies. Local authorities, municipalities and other stakeholders will use the developed EPP to update their existing MEPs and it is the responsibility of those agencies to ensure their MEPs for a major flood or dam breach are current and functional.

The ERP is the response document that couples with the EPP and is enacted in the event of an emergency at the Project. The ERP will establish the Site Command Post (SCP) and if required, activate the province's Regional Emergency Operations Centre (REOC). The ERP will then direct staff to begin notification as per the 'fan-out' procedures described in the EPP. The SCP will then notify the Government Emergency Operations Centre (GEOC) and advise them to begin the 'fan-out' procedures in the case of an Imminent Flood Emergency (Alberta Environment 2003). The SCP staff will also begin to notify residents below the dam as per the downstream notifications table that will be provided within the ERP. Local authorities and First Nations will be responsible for activating their Municipal Emergency Response Plans (MEP) following notifications and if necessary, will send a representative to the REOC. The RCMP may also be requested to send a representative to the REOC. If an Imminent Flood Emergency has been declared, AEP's Flow Forecasting Program will activate Alberta Environment's Emergency Resource Centre (ERC). The Flow Forecasting Program can also initiate the province's Emergency Public Warning System, which supplements the telephone based notices initiated earlier in the process by the SCP.

1.3.2.2 City of Calgary Emergency Management Agency

The Calgary Emergency Management Agency (CEMA) of the City of Calgary plans and coordinates emergency services and resources during major emergencies and disasters (City of Calgary 2017). CEMA works with other City departments, corporations, communities and non-profit agencies to increase Calgary's capacity to be prepared for and recover more quickly from a disaster.

CEMA was established under the Province of Alberta's Emergency Management Act. CEMA is responsible to maintaining and coordinating the MEP. The MEP is a guide for preparation and response to major emergencies and disasters affecting Calgary. The plan documents the roles and responsibilities of internal, external, and supporting agency representatives during all phases of an event. The MEP can be activated by the Chief of CEMA, who is the lead authority responsible for public safety and municipal response before, during and after local disasters.

The MEP is intended to provide for prompt coordination of the City's resources when consequences of an identified emergency, disaster, or catastrophe and subsequent recovery are outside the scope of normal operations. The only accident scenario in which CEMA would be involved would be in the unlikely event of a failure of breach of the off-stream reservoir dam resulting in the release of large volumes of flood water.

1.3.2.3 Rocky View County – Municipal Emergency Management Plan

Rocky View County's Municipal Emergency Advisory Committee and Municipal Emergency Management Agency plans and coordinates emergency services and resources during major emergencies and disasters within the county, and reviews the Municipal Emergency Management Plan. Like the City of Calgary's MEP, Rocky View County's MEP was established under Bylaw C-7396-2014 and is a guide for preparation and response to major emergencies and disasters affecting the county. The plan documents the roles and responsibilities of internal, external, and support agency representatives during all phases of an emergency event.

1.3.2.4 Alberta Emergency Management Agency

The Government of Alberta has numerous emergency plans that address specific hazards. The Alberta Emergency Management Agency (AEMA) leads the coordination, collaboration and co-operation of all organizations involved in the prevention, preparedness and response to disasters and emergencies if enacted through the Project's ERP and established SCP or REOC (see Section 1.3.2.1) and AEP's Flow Forecasting Program within the EPP.

The AEMA acts as the coordinating agency facilitating emergency operations planning meetings and for coordinating activities within the Provincial Operations Centre (POC), in coordination with the SCP or REOC. The POC serves as a communication and response coordination centre that is staffed 24 hours a day, 7 days a week. The POC is a central point for the collection, evaluation and dissemination of information concerning a single incident or multiple incidents in the province of Alberta. The POC is responsible for coordinating the initial response and maintaining support for a response to a natural or human-induced disaster.

The only accident scenario in which AEMA would be involved would be in the unlikely event of a failure or breach of the off-stream dam, which would result in the release of large volumes of flood water downstream.

1.3.2.5 Response Capacity

The Project is close to numerous emergency response centers. First response would likely be from fire stations providing trained personal and equipment. Because the Project is located within Rocky View County, the closest Rocky View County fire stations are Springbank Fire Station 102 (approximately 14 km) and Bearspaw Fire Station 103 (approximately 45 km). Inter-municipal agreements provide for services from other closely located fire departments (e.g., City of Calgary, Redwood Meadows and Cochrane). Response times from emergency services to an incident on the Project site is estimated to be less than 30 minutes, based on relative distance to the nearest detachments and urban centres.

Medical emergencies in Rocky View County are serviced by ground ambulance operated by Alberta Health Services. Air ambulance support for the transportation of critically ill of injured patients is provided by the Shock Trauma Air Rescue Service (STARS). Major medical centers are in Calgary (e.g., Foothills Medical Centre, Rocky View General Hospital and the Peter Lougheed Centre).

1.4 DESCRIPTION OF POTENTIAL ACCIDENT AND MALFUNCTION SCENARIOS AND POTENTIAL PATHWAYS OF EFFECTS

The following sections provide a description of each of the potential scenarios including:

- project phases and seasons of the year
- the characteristics of any contaminants or other material likely to be released into the environment
- the potential pathways of effects to the relevant VCs (site specific sensitivities)

Expected quantities, forms, and rates of any potential contaminant are estimated based on professional judgment if exact values are not publicly available.

1.4.1 Off-Stream Dam Failure or Breach

A dam failure or breach could occur and is evaluated for flood operations during spring and summer. Because the off-stream dam is being constructed under dry conditions, breach during construction is not considered. Dam failure or breach during dry operations is not considered because there is no retained water in the reservoir. Dam failure or breach during the fall and winter is not considered because the dam would only hold water for a period of time following a flood, which is anticipated to be limited to the spring and summer seasons. Further discussion of dam safety and breach analysis for the Project are provided in Volume 1, Section 5.0.

Failure of the off-stream dam could occur during flood operations due to:

- piping (internal erosion of soil particles within the dam caused by retained water that seeps through the dam structure (FEMA n.d.).
- overtopping of the dam resulting in erosion and head cutting that can progress from the crest of the dam to its base causing a rapid release of the retained water. This type of failure scenario could occur during a flood-induced failure of the diversion structure. Overtopping could occur if the floodwater volume exceeds the probable maximum flood (PMF)[1] design criteria, and the emergency spillway fails to operate as anticipated (due to design error or debris blockage), or if the diversion inlet gates fail to shut once the reservoir reaches maximum capacity.
- sloughing or slope failure of the dam or valley walls from saturation of soil material. This type of failure can cause waves in the reservoir that can overtop the dam and cause failures as described above, or can result in mass wasting of the dam structure causing it to weaken and failure by rapid increase in piping or collapse from instability.

The effects of a failure of the dam were modeled and are described in Volume 1, Section 5.0. The Project has been designed to prevent overtopping of the dam as the crest of the dam is set 2.75 m above the predicted headpond level when storing design flood level (2013 flood), and 1.5 m above the maximum elevation of the reservoir when the Project is planned to be passing the PMF.

A key design safety feature of the off-stream reservoir is that the inflow of floodwaters to the reservoir can be restricted by closing the vertical lift gates on the diversion inlet. This feature can dramatically reduce the risk of failure from too much inflow to the reservoir, through the ability to stop the inflow should problems within the dam arise.

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[1] The PMF is defined as the flood that may be expected to result from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the drainage basin. The project components are designed to withstand PMF of 2,770 m^3/s without catastrophic failure.

1.4.1.1 Released Substances

Should the dam fail, the characteristics of the substances released would be determined by the material carried into the off-stream reservoir during the flood (e.g., suspended solids, vegetation). The dam structure is a clay-cored earth embankment set upon fine grained glaciolacustrine deposits. Failure would contribute additional clay and fine-grained earth material to the flood waters washed into the downstream area. Depending on the volume of water released, additional vegetation and debris from the downstream reaches of the Elbow River that are inundated by the floodwave could also be washed downstream.

1.4.1.2 Valued Component Selection and Potential Pathway of Effects

In the unlikely event of a failure of the off-stream dam, the following VCs could be adversely affected:

- hydrology, surface water quality, and aquatic ecology
- vegetation and wetlands, soils and terrain, and wildlife and biodiversity
- land and resource use (including federal lands), infrastructure and services, and employment and economy
- public health (including downstream community safety, drinking water quality and country foods) for Indigenous and non-Indigenous receptors

There is also the potential for adverse effects on traditional land and resource use (including heritage resources) downstream of the off-stream reservoir, where they exist. Section 1.5.1 provides an assessment of the potential effects on these VCs.

1.4.2 Diversion Structure Failure or Breach

The diversion structure is comprised of three main components: the floodplain berm, auxiliary spillway and service spillway. Acting in tandem, they drive water into the diversion channel through the diversion inlet located on river-left of the structure. Together they impound sufficient water to be classified as a dam and are rated as “high” hazard structures under the CDA guidelines. Combined, the service spillway and auxiliary spillway have the capacity to pass up to 1/3 the flow rate between the 1:1000 year flood and the PMF, in accordance with the guidelines. The auxiliary spillway is designed to activate when inflow exceeds the capacity of the service spillway and the diversion inlet.

In addition to excessive inflow, the delivery of sediment and woody debris could affect the capacity of the system and raise the backwater in the diversion structure to undesirable levels. To mitigate the risk of overtopping in these situations, the service spillway and diversion inlet gate bays are designed to pass debris and maintain operation should debris accumulate on key components. The pneumatic system that raises the service spillway gates are designed to operate effectively if one or more key components are damaged; should a failure occur, the gates would be in the downward position for safe passage of flow. The auxiliary spillway is a full depth concrete structure designed to maintain its resiliency from frequent overtopping. Though not desirable, such overtopping could occur if debris accumulations, sediment accumulations, or turbulence cause sudden rises in its backwater during flood operation. The auxiliary spillway system has been designed to not raise the risk of flooding upstream of the diversion structure. Backwater influence during a failure to operate is limited to the most upstream extent of the floodplain berm.

A failure or breach of the diversion structure (service spillway, auxiliary spillway and floodplain berm) has been evaluated during only spring and summer because these are the months there is potential for its operation. Malfunctions due to events such as ice jams occurring on the Elbow River in the winter are low due to minimal winter water flow, an ice cover that thermally degrades before the mountain freshet, and the passive nature of the diversion structure when not in flood operations mode.

1.4.2.1 Released Substances

Should a failure occur, the characteristics of the substances released would be determined by the material gathered during flood upstream. In such an event, flood water containing natural debris (e.g., suspended sediment, vegetation) would pass through the service spillway, over the auxiliary spillway or through a breach in the floodplain berm.

1.4.2.2 Valued Component Selection and Potential Pathway of Effects

In the event of failure or breach of the floodplain berm, the following VCs could be adversely affected:

- hydrology, surface water quality, and aquatic ecology
- vegetation and wetlands, soils and terrain, and wildlife and biodiversity
- land and resource use, infrastructure and services, and employment and economy
- public health (including downstream community safety, drinking water quality and country foods) for Indigenous and non-Indigenous receptors

There is also the potential for adverse effects on traditional land and resource use (including heritage resources) downstream, where they exist. Section 1.5.2 provides an assessment of the potential effects on these VCs.

1.4.3 Fire

Fire may be caused by natural events such as lightning strikes and wildfire, electrically-powered Project component malfunction (e.g., service spillway gates, diversion inlet gates, controls and instrumentation in control building), equipment malfunction, or anthropogenic activities. Lightning strikes and wildfire may occur on a seasonal basis (higher probability in the summer and fall) during any phase of the Project. Project component malfunction is most likely to occur during flood operations or during maintenance while components are in use. Equipment malfunction and other anthropogenic activities causing fire are most likely to occur during construction and maintenance during dry operations, as well as during post-flood operations while anthropogenic activities are occurring on-site.

1.4.3.1 Released Substances

During a fire, potential substances would depend upon the material under combustion. Combustion of hydrocarbon-based operational chemicals, such as hydraulic oil or motor fuel, would primarily generate CO_2, CO, combustion gases, and water vapour. Smoke and other particulate matter would impair air quality for the duration of the fire.

1.4.3.2 Valued Component Selection and Potential Pathway of Effects

In the unlikely event of a fire, the following VCs could be adversely affected:

- air quality
- vegetation and wetlands, and wildlife
- land and resource use, infrastructure and services, and employment and economy
- public health (including country foods) for Indigenous and non-Indigenous receptors

There is also the potential for adverse effects on traditional land and resource use (including heritage resources) within the Project area, where they exist. Section 1.5.3 provides an assessment of the potential effects on these VCs.

1.4.4 Hazardous Materials Spill

Hazardous material spills may occur as the result of improper handling, use, or storage of these materials on-site. Hazardous materials will also be transported to and from the Project site (see Section 1.5.5). The likelihood of a hazardous material spill is higher during construction when fuel and materials will be stored on-site. The likelihood of a hazardous spill during maintenance activities, dry operations, flood, and post-flood operations is low because minimum materials will remain on-site. Because construction is expected to extend year-round, the likelihood of a hazardous spill is the same for all times of year. Due to Project activities and location, there is also the potential for hazardous materials to be spilled in a terrestrial or aquatic environment.

1.4.4.1 Released Substances

Hazardous materials may include fuels (e.g., gasoline, diesel and propane), lubricants (e.g., engine oil, transmission or drive train oil, hydraulic oil, gear oil and lubricating grease), coolants (e.g., ethylene glycol and propylene glycol), paints, and solvents or other materials transported along the highway. In the event of an accidental spill, the material spilled could evaporate to produce small amounts of fugitive air emissions of various fractions of volatile organic compounds (VOCs).

1.4.4.2 Valued Component Selection and Potential Pathway of Effects

In the unlikely event of a hazardous materials spill, the following VCs could be adversely affected:

- air quality
- surface water quality, and aquatic ecology (if a spill reaches an aquatic environment)
- vegetation and wetlands, soils, and wildlife and biodiversity
- public health (including drinking water quality, if a spill reaches an aquatic environment; and country foods) for Indigenous and non-Indigenous receptors
- land and resource use

There is also the potential for adverse effects on traditional land and resource use, where they exist, if areas are temporarily off limits because of clean-up and remediation activities. Section 1.5.4 provides an assessment of the potential effects on these VCs.

1.4.5 Vehicle Accident

Vehicle traffic will occur during all phases of the Project and all times of year due to movement of equipment, supplies, materials, and personnel to and from the Project site and along the public highway and road network that crosses the PDA. A vehicle collision could occur on roads leading to or from the Project or within the Project site. Vehicle accidents can result in injury or death to humans and wildlife, the release of hazardous materials into a terrestrial or aquatic environment, as well as damage to property or infrastructure.

1.4.5.1 Released Substances

Substances that may be released because of a vehicle collision are primarily fuel (e.g., gasoline or diesel); however, the introduction of additional contaminants are subject to what the vehicle is carrying at the time of collision (e.g., dust suppressants, domestic waste, lubricants). The amount of contaminant released would be a function of the size of the vehicle (e.g., fuel tank size of a semi-truck can be up to 300 gallons).

1.4.5.2 Valued Component Selection and Potential Pathway of Effects

In the unlikely event of a vehicle accident, the following VCs could be adversely affected:

- surface water quality, and aquatic ecology (if a spill from an accident reaches an aquatic environment)
- vegetation and wetlands, soils and terrain, and wildlife and biodiversity
- public health (including drinking water quality, if a spill from an accident reaches an aquatic environment, and country foods) for Indigenous and non-Indigenous receptors
- land and resource use, infrastructure and services, and employment and economy

There is also the potential for adverse effects on traditional land and resource use, where they exist, if areas are temporarily off limits because of emergency response or clean-up activities. Section 1.5.5 provides an assessment of the potential effects on these VCs.

1.4.6 Pipeline Rupture

The PDA has active buried pipelines operated by third-parties (see Volume 1, Section 3.2.8.1 for details associated with operators and current locations). Mitigation measures to reduce the likelihood of pipeline rupture include re-location (i.e., realignment of a portion of the pipeline along a new right-of-way) or retrofitting, as agreed with the third-party operators' specifications and agreements with Alberta Transportation. Activities associated with the re-location or retrofit will be executed entirely by the third-party pipeline operators. Alberta Transportation is not responsible for the execution of any of these activities. It is also the sole responsibility of those pipeline operators to develop appropriate emergency preparedness plans and emergency response plans to account for potential pipeline rupture during these activities, which will occur during the construction phase of the Project.

These pipelines are not a physical works component or a physical activity of the Project. The physical activity however of their re-location or retrofitting is associated with the Project, as those activities are necessary for the Project to be constructed. As such, pipeline ruptures are assessed here.

Two mechanisms have been considered that could result in a pipeline rupture: during construction as retrofitting or re-location activities would occur at the same time as the Project construction phase; and, during flood operations when there is water in the off-stream reservoir. An assessment of potential effects during dry operations (after the pipelines have been retrofitted and re-located) and post-flood operations are not considered because environmental conditions are largely similar, the likelihood for a rupture occurring after re-location or retrofitting activities is considered lower, and the potential for effects is considered higher during flooding, since there would be a greater chance for product to reach the aquatic environment.

1.4.6.1 Released Substances

Publicly available information indicates that the pipelines transport high vapour pressure (HVP) and low vapour pressure (LVP) product. LVP products (e.g., oil, synthetic oil) remain in a liquid state within the pipeline and at atmospheric pressure. HVP products (e.g., propane, other natural gas liquids) can be gaseous or liquid while travelling through the pipeline, with any liquid phase transforming upon release into gaseous at atmospheric pressure. Specific operational details (e.g., pressures) are not publicly available.

1.4.6.2 Valued Component Selection and Potential Pathway of Effects

In the unlikely event of a pipeline rupture, the following VCs could be adversely affected:

- air quality
- hydrogeology, surface water quality, and aquatic ecology
- vegetation and wetlands, soils and terrain, and wildlife and biodiversity
- public health (including exposures via inhalation of vapours, ingestion of drinking water and ingestion of country foods) for Indigenous and non-Indigenous receptors
- land and resource use, infrastructure and services, and employment and economy

There is also the potential for adverse effects on traditional land and resource use, where they exist, if areas are temporarily off limits because of emergency response or clean-up activities. Section 1.5.6 provides an assessment of the potential effects on these VCs.

1.4.7 Valued Component Interaction Summary

Table 1-1 summaries the identified interactions between the selected accidents and malfunctions and VCs. Only interactions for which an environmental effect is identified are assessed further (as indicated with a check mark).

Table 1-1 Potential Interactions of Project Accidents and Malfunctions with Valued Components

VC	Accident/Malfunction					
	Off-stream Dam Failure or Breach	Diversion Structure Failure or Breach	Fire	Hazardous Materials Spill	Vehicle Accident	Pipeline Rupture
Air quality and climate	–	–	✓	✓	–	✓
Acoustic Environment	–	–	–	–	–	–
Hydrogeology	–	–	–	–	–	✓
Hydrology	✓	✓	–	–	–	–
Surface water quality	✓	✓	–	✓	✓	✓
Aquatic ecology	✓	✓	-	✓	✓	✓
Terrain and soils	✓	✓	✓	✓	✓	✓
Vegetation and wetlands	✓	✓	✓	✓	✓	✓
Wildlife and biodiversity (including migratory birds and species at risk)	✓	✓	✓	✓	✓	✓
Land use and management	✓	✓	✓	✓	✓	✓
Historical resources	✓	✓	✓	-	–	--
Traditional land and resource use	✓	✓	✓	✓	✓	✓
Public health	✓	✓	✓	✓	✓	✓
Infrastructure and services	✓	✓	✓	-	✓	✓
Employment and economy	✓	✓	✓	-	✓	✓

NOTES:
✓ = Potential interaction
– = No interaction

1.5 EFFECTS ASSESSMENT

1.5.1 Off-Stream Dam Failure or Breach

Design of the dam embankment was developed in accordance with Canadian Dam Association (CDA) Dam Safety Guidelines (2007) and AEP Dam and Canal Safety Guidelines (1999). Accordingly, the off-stream dam has been designed to standards consistent with a hazard classification of "very high" per the AEP guidelines and "extreme" per the CDA guidelines (see Volume 1, Section 5.0 for details on dam safety design).

The off-stream dam has been designed to prevent 'piping' during flood operations. Results of geotechnical investigation have been incorporated into Project design: the off-stream dam would be constructed with an impermeable core to prevent water from 'piping' laterally through the dam and a filter structure on the outer side of the core to allow water to drain without affecting the integrity of the dam. Instrumentation would be incorporated into the design to monitor seepage and settlement. If piping occurs, the diversion inlet gates may be closed to prevent more water from entering the reservoir, which would prevent further structural pressure on the dam and restrict the amount of water that could be released by failure or breach. If monitoring for seepage and settlement reveals the potential for having lost material due to piping the dam would be inspected and repaired before further use.

An emergency spillway will be located on the east side of the diversion channel approximately 1,300 m upstream of the off-stream reservoir. The emergency spillway has a crest elevation of 1210.75 m, which is 2.75 m lower than the crest elevation of the dam. The crest elevation of the emergency spillway is the same as the full-service elevation of the reservoir, which is the elevation of water to be retained during a design flood. The emergency spillway has been designed to operate if floodwater volumes stored in the off-stream reservoir exceed its design flood volume. This scenario could only occur if the diversion inlet gates fail to close once the off-stream reservoir is full, or if local extreme rainfall amounts within the reservoir causes it to exceed its retention volume for water. The emergency spillway will be constructed of concrete, founded on bedrock and will be monitored for debris accumulations on its crest and head-cutting on its downstream channel, during flood and post-flood operations.

Another design feature that serves-dual purpose in dam safety is the inclusion of breast walls above the diversion inlet gate bays. If the diversion inlet gates fail to close during flood operations, the breast walls would limit the flow of flood water into the off-stream reservoir to 600 m^3/s, which can be managed by the emergency spillway.

In the unlikely event of a failure or breach, the potential effects to VCs would be dependent on the volume of water held within the off-stream reservoir. Failure or breach of the off-stream dam during a design flood would release up to 77,771,000 m^3 of water. A failure during a 1:10 year flood (500,000 m^3), 1:100 year flood (30,100, 000m^3), or when the reservoir is only partially filled would have lesser effects to VCs because not as much water would be released during these conditions. The likelihood of a design flood occurring is approximately 0.5% in any given year; the probability of a 1:100 year flood occurring in any given year is approximately 1%; and the probability of a 1:10 year flood occurring in any given year is approximately 10%. (see Volume 3B, Section 6.1). Therefore, the likelihood of a failure during these conditions would be even less. Although there is a potential for residual adverse effects on VCs from a failure or breach, the likelihood of the event is very low. Spatial extent of effects would also depend on the volume of water released.

Depending on the size of the flood and volume of water in the reservoir, the magnitude of effects from a dam failure or breach would vary from low to high. If a dam failure or breach of high magnitude did occur, public health and safety would be affected, including the potential for human injury or loss of life. In addition, the biophysical environment, lands used for traditional and non-traditional use, infrastructure and services (including property), and employment and economy would be affected. Effects to infrastructure and services could result due to a direct loss of infrastructure or a reduction in local services from emergency response efforts.

A dam failure or breach of lower magnitude would result in similar effects to VCs but of higher magnitude relative to an unmitigated flood (in the absence of the Project). Changes in the hydrological regime (beyond the range evident in the historical record within the Elbow River), sediment transport dynamics, and surface water quality (e.g., turbidity, suspended sediment concentrations, herbicides) would occur. These changes could also alter or destroy fish habitat, which may result in the direct or indirect death of fish.

Depending on the level of failure or breach, the velocity of the flood water could create erosion and sedimentation at and downstream of the failure or breach location. A release of debris from within the reservoir would likely be more localized at the location of the failure or breach; however, depending on the velocity of water released, additional soil and vegetation could be swept up and carried downstream. Direct loss or alteration of vegetation and wetlands could occur from the release of water and sediment deposition during a failure or breech. Flooding or infilling of wildlife habitat could occur, particularly at the location of the failure or breach and directly downstream. Mortality of wildlife (including migratory birds and species at risk) may also occur from the release of water, suspended solids, and sediment. An obstruction of use and access of land and water resources for recreation and traditional uses could occur from flooding of lands downstream on Elbow River. If a failure or breach were to occur when water levels in the off-stream reservoir were high (e.g., design flood), effects to federal lands could occur by way of localized flooding, erosion, and sedimentation deposition within the Elbow River valley. The duration of the effects would remain until damage from flooding is repaired (where, and if possible).

In the event of failure or breach of the dam, AEMA and CEMA would enact emergency response procedures and disaster recovery programs, as per the ERP and EPP for the Project (see Section 1.3.2).

1.5.2 Diversion Structure Failure or Breach

The diversion structure is comprised of the floodplain berm, auxiliary spillway and service spillway and together raise the floodwater level on Elbow River to drive it into the diversion channel via the diversion inlet located on river-left of the structure. The diversion structure is classified as a “high” hazard structure. As such, the system elements are designed to safely pass the required inflow design flood with a peak magnitude that is 1/3 between the 1000-year flood and the PMF.

If a failure of the floodplain berm were to occur, effects to VCs would be similar during a flood event in the absence of the Project. Results of breach analysis were incorporated into project design, as discussed in Volume 1, Section 5.1.

The release of water during such an event, may not change the hydrological regime (beyond the range evident in the historical record), but would likely create short-term changes to sediment transport dynamics, and surface water quality (e.g., turbidity, suspended sediment concentrations, herbicides). Drinking water quality is likely not to be affected because of the short-term duration of effects. There is a low likelihood that changes to fish habitat or direct death of fish would occur as a result of floodplain berm failure or breach.

Direct loss or alteration of vegetation could occur from the release of water and sediment deposition. Flooding or infilling of wildlife habitat could occur, particularly at the location of the failure or breach and directly downstream. Mortality of wildlife (including migratory birds and species at risk) may also occur from the release of water and sediment, but the likelihood is low due to the low volume and rate of release.

Effects on public health in relation to drinking water quality is not likely. However, potential effects to wildlife and vegetation could affect country foods, although the likelihood is low. Effects to infrastructure and services could occur due to direct damage of infrastructure (e.g., Kamp Kiwanis). A temporary restriction of use and access of land and water resources for recreation and traditional uses could occur from flooding of lands downstream, or from emergency response measures after a failure or breach. Due to the location of the flood-plain berm, the likelihood of effects to federal lands is low. The duration of the effects would remain until damage from flooding is repaired (where possible).

Should a failure or breach of the floodplain berm occur, emergency response procedures as per the EPP and ERP would be implemented to address public health and safety concerns, and reduce potential damage to infrastructure and services during flooding.

1.5.3 Fire

Effects from a fire would be dependent on the spatial extent and location of the fire. Larger fires could pose a risk to life as well as damage to infrastructure and surrounding lands (resources used for recreation, traditional uses, and wildlife habitat). Fires of a larger size could also result in temporary exceedances of applicable ambient air quality standards (e.g., dust and smoke). However, the likelihood of a fire that size occurring is low.

Should a fire occur, effects on vegetation would be limited to the location of the fire. The effect on wildlife (including migratory birds, species at risk, and country foods) would likely be restricted to those species with limited mobility to avoid a fire (i.e., some small mammals, amphibians and juvenile birds in nests), which could result in injury or mortality. Species that are highly mobile, such as large mammals and adult birds, would likely disperse from the area. Indirect effects on wildlife may result from the loss of habitat due to burning of vegetation, or avoidance of the area because of the fire or subsequent emergency response activities.

Contractors would develop fire protection procedures as part of the Project's ECO Plan, to address fire prevention and emergency response procedures on-site during construction, dry operations maintenance activities, and post-flood operations cleanup activities. On-site personnel will be trained in fire prevention, including proper disposal of hot or burning material and designated smoking areas, and response. Equipment and project components will be maintained to applicable standards to reduce likelihood of malfunction resulting in fire and explosion. Flammable materials will be stored following regulatory requirements. Access roads constructed to the PDA and in the PDA (e.g., along the top of the dam) will be permanent for the life of the Project and allow for access to the PDA by firefighters during all phases of the Project. Response times from emergency services to an incident on the Project site would be expected to be less than 30 minutes.

Given the location of the Project components in relation to other properties, if a fire were to occur it would likely remain within the PDA. The likelihood of damage to residential or commercial infrastructure, or to federal lands from Project-related fires is low. Short-term disruption of use and access of land for recreation and traditional uses could occur from emergency response measures.

1.5.4 Hazardous Materials Spill

Effects from a hazardous material spill are dependent on the volume, location, and type of material spilled. Spills could result in human injury and effects on terrestrial and aquatic environments. Spills are more likely to occur during construction as more materials will be transported to and remain on-site during this phase. Hazardous materials may also be spilled outside of the Project site while being transported. Spills are more likely to occur on land then in waterways, due to the nature of Project components. In the event of a spill, response measures would focus on containment of the spill to limit the effects, cleanup of the spill, and remediation of the affected areas as quickly as possible. These activities may include disposal of hazardous waste at approved facilities or engaging a third-party to support the spill response measures.

In the event of a spill, soil quality could be affected in the area. Subsequent removal of the contaminated soil would result in soil loss. Effects would also depend on the location and extent of the spill. Because an event is more likely to occur during construction, the soil effects would be confined to a localized, contiguous and defined area. This would facilitate faster cleanup and remediation. Effects on vegetation could occur through direct contact with a spilled substance, or vegetation loss through removal of affected soils and vegetation during cleanup. There is also the potential for materials to remain in the soil for prolonged periods of time, which could affect soil capability and the ability for vegetation to grow.

Depending on the characteristics of the material, terrestrial wildlife species (including migratory birds, species at risk, and country foods) could be affected by a spill of hazardous material. Ungulates and other terrestrial wildlife could be affected if they contact, inhale or ingest the material. However, wildlife would likely be avoiding the area due to noise from project activities associated with cleanup efforts. Mitigation measures will also be implemented to reduce the interaction of wildlife with Project components during construction (e.g., nest searches), making the likelihood of a wildlife interaction with a hazardous material spill low.

Spills would have limited potential to affect groundwater, as they would be confined to the soils within the timeframe of a cleanup response and be appropriately contained and excavated before migrating to the groundwater table.

The likelihood of hazardous materials spill causing adverse effects to terrestrial VCs is low due to mitigation measures set out as part of Alberta Transportation's EMS ECO Plans (Section 1.3), which would outline how hazardous materials would be handled and stored on-site, as well as spill prevention and response procedures. Activities associated with the handling of hazardous materials will be within designated areas of the project site. Worker health, safety, and environment training will include spill prevention and response procedures. All workers would be required to have Workplace Hazardous Materials Information System (WHMIS) training. Equipment would be operated and maintained to applicable standards to reduce the likelihood of a spill. To reduce the potential for a spill during transportation, transport of hazardous materials to and from the project site, storage, use and disposal will be in accordance with regulatory requirements, and hazardous materials associated with the Project would be in compliance with the *Transportation of Dangerous Goods Act*.

The release of materials into an aquatic environment could occur during the construction phase (specifically the construction of the diversion structure). However, due to project activities, the likelihood of a spill into an aquatic environment is lower than one to a terrestrial environment. The potential effects with a release into an aquatic environment could be greater because of the difficulty in containing and subsequently cleaning up contaminants, compared with a release on land, which can be more quickly contained and cleaned. The effects associated with a spill into an aquatic environment are largely related to surface water quality and aquatic ecology. Release of material into an aquatic environment could alter water chemistry and create short-term effects on water quality parameters and possible exceedance of applicable guidelines (including drinking water). Changes to fish habitat and direct death to fish could occur through the toxicological effects of the material spilled. The effects on surface water quality and aquatic ecology would be dependent on the characteristics and volume of material spilled, and further influenced by seasonal timing of the release, which can affect:

- sensitivity of aquatic biota in the receiving water (dependent on season and life cycle activities of a specific species during that time)
- dispersion of the product (high flow versus low flow, portion of spill that enters the aquatic environment)

Potential environmental effects on species groups that use aquatic environments, including amphibians, birds (including migratory birds and species at risk) and semi-aquatic mammals could also result from a release of hazardous material. Potential effects into an aquatic environment include increased mortality risk, reduced habitat availability, and reduced food availability.

The likelihood of hazardous materials spill causing adverse effects on aquatic VCs is low due to mitigation measures set out as part of Alberta Transportation’s EMS ECO Plans (Section 1.3). Mitigation for project activities in and near water will be part of the EMS and ECO Plans. Activities near water will be planned and completed in the dry and isolated from watercourses to prevent hazardous materials from entering a watercourse. Hazardous materials will be stored, used and disposed of in accordance with regulatory requirements. A minimum 100 m setback between stored hazardous materials and rivers, streams and surface water bodies will also be implemented. With such mitigation, cleanup response times are anticipated to be adequate to contain and remediate downstream effects.

1.5.5 Vehicle Accident

Vehicle traffic will occur during all phases of the Project and all times of year as a result of the movement of equipment, supplies, materials, and personnel to and from the project site and normal public use of roads. Vehicle accidents may occur outside of the project site while vehicles are driving to or from the project site (e.g., Highway 22), or within the project site (e.g., roads on major components of the Project). The likelihood of a vehicle accident is higher during the construction phase as an increase in vehicle traffic is expected in order to deliver materials and equipment to the project site, and the use of heavy machinery will be required on-site during this phase (see Volume 1, Section 3.3.2 for a description of equipment requirements for the Project).

Vehicle accidents can result in injury or death to humans and wildlife, the release of hazardous materials into aquatic or terrestrial environments, as well as damage to property or habitat. Response measures would vary depending on the location and type of vehicle accident. Response measures may include contacting on-site emergency response personnel or regional emergency services. A vehicle collision would likely result in a call to 911 and use of emergency response services. As a vehicle collision is unlikely to result in any large-scale event, response should be within the capacity of local emergency response services. A vehicle collision involving injury or fatality would be an isolated event.

If a vehicle accident were to occur, the potential effects to VCs would be dependent on if the accident resulted in the release of fuel or hazardous materials. There is also the potential for a vehicle collision to result in ignition of fuels. Should an accident result in the release of material from the vehicles, effects would depend on the volume, location, and type of material spilled. See Section 1.5.4 for a discussion of potential effects on VCs associated with a hazardous materials spill into a terrestrial environment. Wildlife mortality related to vehicle collisions is discussed in the wildlife and biodiversity assessment (see Volume 3A, Section 11).

During construction, if a vehicle accident were to occur that resulted in the release of fuel or hazardous materials into an aquatic environment, it could have localized effects on surface water quality and aquatic ecology. If a vehicle collision were to occur outside the Project site, response times for containment of fuel or hazardous materials cold be reduced, which could allow for entry into an aquatic environment. See Section 1.5.4 for a discussion of potential effects on VCs associated with a hazardous materials spill into an aquatic environment.

Mitigation to reduce the risk of vehicle accidents includes development of traffic accommodation strategies. Alberta Transportation will also consult regularly with Rocky View County to provide project updates, and to identify and address project-related traffic problems and other potential implications for services and infrastructure. All workers would be required to work in a safe manner and complete health, safety, and environment training. Project-related vehicles would be required to follow traffic rules such as speed limits and weight restrictions and federal and provincial highway regulations.

1.5.6 Pipeline Rupture

For safety and design purposes, existing pipelines in the PDA will be retrofitted or re-located to accommodate the Project footprint and all project phases. It is the responsibility of the pipeline operators for the planning and execution of these activities. The pipelines within the PDA are regulated by provincial (Alberta Energy Regulator, AER) or federal (National Energy Board, NEB) authorities. Under AER, pipeline incidences are rated as follows (AER 2018):

- low consequence: Incidents that involve little to no substance released and have little to no impact on the public, wildlife, and the environment (no impact on a waterbody).
- medium consequence: Incidents that could have a moderate impact on the public, wildlife, or the environment, and no impact on a flowing waterbody.
- high consequence: Incidents that could have significant impact on the public, wildlife, or the environment, or that involve the release of a substance that affects a large area or waterbody.

In 2017, approximately 93% of the pipeline incident recordings to AER were of low to medium consequence (total of 460 provincial wide). Of those incidents, 61% had less than 1 m^3 of material released (AER 2018). In 2016, 101 pipeline incidents were reported to the Transportation Safety Board (TSB), about half of which occurred on transmission lines (TSB 2017). Of those 101 incidents, 57 involved no release of product. Most releases were related to natural gas, and were relatively small (over 75% of releases were less than 25 m^3). There was only one crude oil release greater than 1.5 m^3 (TSB 2017). There have been no fatal accidents on a federally regulated pipeline system directly resulting from the operation of a pipeline since the inception of the TSB (TSB 2017).

As outlined in Section 1.4.6, two mechanisms have been considered that could result in a pipeline rupture: a rupture of a third-party pipeline during retrofitting or re-location activities undertaken by the pipeline operator, and a rupture of a third-party pipeline during flood operations when there is water in the reservoir. If a pipeline rupture were to occur, the potential effects on the environment and human receptors would depend on the nature of the rupture (e.g., mechanism of release, volume of product released, type of product within the pipeline, the characteristics of the receiving environment and the effectiveness of applicable spill response). The timing (i.e., phase of the Project) of the rupture would also influence the VCs affected. Effects from released materials into an aquatic environment (i.e., during flood operations) could be greater than a release into a terrestrial environment (i.e., during construction re-location and retrofitting). However, because the Project is located near a major urban area, emergency response to a pipeline rupture would be rapid compared to pipelines within more remote areas.

In the event of a pipeline rupture, it will be the responsibility of the third-party operator of that pipeline to contain the rupture and cleanup any contaminated soils or water in accordance with applicable guidelines. Alberta Transportation's role in this type of accident or malfunction would be to hold any contaminated water (should the rupture occur during flood operations) within the PDA so that contaminated water is not released back to the Elbow River until applicable guidelines were met. As both regulatory agencies have seen a reduction in pipeline ruptures due to improved design and safety during all pipeline phases (e.g., construction, maintenance, and operation), the likelihood of a rupture during these activities is very low. Furthermore, of the incidents that have resulted in a release of product, the release volumes have been low, limiting the potential for adverse effects on VCs.

1.5.6.1 Pipeline Rupture during Re-location or Retrofitting Activities

Prior to any retrofitting or re-location activities as agreed upon with the third-party operators' specifications and agreements with Alberta Transportation, pipeline operators would execute damage prevention as well as EPPs to reduce the potential for incidents. If a pipeline incident were to occur, it is likely the amount of product released would be negligible or comparable to the statistical history described previously. The former amount reflects shut-down of the pipeline during the activity (between shut-off valves) and the latter reflects "hot-tapping" while product remains in the pipeline. The approach selected would be identified during detailed planning. Effects would be short-term as both the identification of a release and execution of a pipeline emergency response would be rapid.

In the highly unlikely event of a rupture leading to a product release during retrofitting or re-location, the air quality, vegetation, soils, wildlife, groundwater, public health, and land used could be affected. Effects to VCs will also vary depending on the type of material released during a rupture (LVP vs. HVP products). For example, LVP products may be more persistent in the environment due to their higher content of high molecular weight constituents.

A change in air quality could result from the volatile emissions from released products to atmosphere. Changes in air quality may also affect public health, as people in the immediate area of the rupture may inhale the vapours. Evaporative losses occur in minutes to hours after release. Because HVP products transform into gas at atmospheric pressure, most of the HVP products will be lost to evaporation, while the amount of LVP product that would evaporate will vary by product type, ranging from up to 75% by mass for condensates and light oils to less than 10% for heavy oils (Lee et al. 2015). However, because the amount of product within the pipeline during retrofitting or relocation is expected to be low, effects to air quality are expected to be very localized, and of short duration.

Pipeline products could spill onto soil and disperse vertically and horizontally through interstitial (pore) spaces, which would affect soil quality. Cleanup activities could also result in a change in soil quantity, as contaminated soils may need to be removed during cleanup activities. Effects to soil quality would depend on such factors as type of product released, characteristics of the soil, season, size and rate of release, as well as the speed and success of emergency containment and clean-up activities. Effects associated with a HVP product release would be less than the effects of a LVP product release because of the tendency of the former product to immediately evaporate to air. Because of the amount of product within the pipeline during retrofitting or relocation is expected to be low, the likely extent of effects would be limited to a localized area and remediated in short duration. The likelihood of effects to vegetation are low as vegetation clearing will be part of retrofitting or re-location activities.

Terrestrial wildlife (including species at risk and migratory birds) could be affected if they contact, inhale, or ingest the released product following a pipeline rupture. Because HVP products transform into gas at atmospheric pressure, there would be limited potential for an interaction in the event of a release of HVP product. In the event of a release of LVP products, the likelihood of an interaction with wildlife during a pipeline rupture is low because human presence during re-locations or retrofitting and the subsequent emergency response activities would be disruptive and force them to move to other, unaffected areas.

The likelihood of released product reaching groundwater during re-location and retrofitting is low. A product release could affect groundwater if the product (or water-soluble components) infiltrated into the soil and reached the water table. The ability of product or water-soluble constituents to reach the groundwater is influenced by the depth to groundwater, the permeability of the geological media, climatic conditions, release volume and rate, as well as time. HVP products would volatize to air and therefore would not be expected to affect groundwater quality. In the event of a LVP product release, the volume of the release is expected to be small, the product would be physically recovered, and remediation of soil would protect groundwater quality from potential degradation.

The potential for explosion could occur if the released product is ignited. Both HVP and LVP have the potential for ignition. Should an explosion occur, there is the potential for human injury or loss of life. However, the likelihood of such an event is very low because of the demonstrated effectiveness of properly executed emergency preparedness plans.

A pipeline rupture from retrofitting or re-location activities also has the potential to temporarily limit the use of areas for recreational and traditional land uses (specifically access roads). Temporary restrictions on recreational and traditional activities could result from clean-up activities. The likelihood of a rupture during retrofitting or re-location activities affecting recreational and traditional land uses is low because the expected low release volume would limit effects to the Project site.

1.5.6.2 Pipeline Rupture during Flood Operations

During a flood, pipelines would be operational and transporting product, with a potential for greater release volumes. If a rupture were to occur, released products could be introduced into an aquatic environment. As such the potential effects are different than those discussed during retrofitting or re-location. However, the likelihood of a pipeline rupture leading to a large release of product is a highly unlikely event.

If a rupture during flood operations occurred, the effects would likely be limited to the PDA (and largely within the off-stream reservoir). As part of emergency response plans, pipeline operators would implement measures to complete shutdown and isolation of the pipeline. Should a rupture result in contamination of the water within the off-stream reservoir, contaminated water would be held within the reservoir and not released back to the Elbow River until applicable guidelines were met. For some VCs, cleanup and remediation activities could occur during the flood operations (e.g., surface water quality); however, some VCs (e.g., soil) would need to be addressed during post-flood operations once the water is released from the off-stream reservoir.

Potential effects to the environment and human receptors would depend on the nature of the rupture (e.g., mechanism of release, volume of product released, type of product within the pipeline, nature of the receiving environment, and the effectiveness of applicable spill response). Depending on the timing and location of the pipeline rupture, effects on air, soils, groundwater, surface water quality, aquatic ecology, vegetation and wetlands, wildlife, public health, and traditional land use may occur. Effects on VCs will vary depending on the type of material released during a rupture (LVP vs. HVP products). For example, LVP products would likely form a slick when released into water whereas HVP products would largely volatilize to the atmosphere.

A change in air quality could result from the release of volatile emissions from products to the atmosphere in the minutes to hours after the release. Because HVP products transform into gas at atmospheric pressure, most of the HVP products will be lost to evaporation, while the amount of LVP product that would evaporate will vary by product type (Lee et al. 2015). The extent of changes to air quality (and hence the potential for people to inhale volatiles from released product) will depend on the volume and areal extent of release, the volatility of the product, and atmospheric conditions at the time of the release. For large releases, changes to air quality may also occur during soil remediation activities, and product is re-exposed to air. The typical health effects associated with short-term (acute) inhalation of volatiles from petroleum products are headaches, dizziness, and nausea. However, effects to air quality (and human health from inhalation exposures) are expected to be of short duration and reversible.

Both a change in soil quality (contamination by released product) and soil quantity (removal of contaminated soil during clean-up activities) could occur. Released product could spread laterally in soil prior to migrating vertically downwards. HVP product would tend to volatilize and migrate upwards, with limited potential for downwards migration. LVP may initially migrate upwards (due to the pressure while pumps remain operating, or the presence of saturated soil conditions), or downward (due to gravity drain down). The potential amount of soil quantity lost during clean-up activities would depend on the release rate and volume of product as well as the soil conditions; however, effects would likely be limited to the PDA.

Depending upon the soil (e.g., porosity, soil moisture), rate of release, and product released properties, groundwater effects could occur. HVP product would tend to volatilize upon release, with limited potential for downward migration. In general, the potential for groundwater contamination following a subsurface release would be more probable:

- where a relatively shallow water table is present (as opposed to locations where a deeper, confined aquifer system is present)
- where soils with high permeability are present throughout the unsaturated zone
- where specific groundwater resources have been identified as being particularly vulnerable to contamination

In the unlikely event of a rupture, the release would be detected by third-party operators if it occurred and remediation of soil would protect the groundwater quality from degradation.

A pipeline rupture that releases materials into the off-stream reservoir could result in effects to water quality. A release that is large enough to migrate up through soil and enter the waterbody could alter water chemistry through dissolution of water-soluble components. There is the potential for fish species to occupy the off-stream reservoir during flood operations, allowing for a potential effect to fish species Some product components (such as benzene) may be acutely toxic to fish when dissolved in water. Other components (such as polycyclic aromatic hydrocarbons) may cause chronic toxicity if there is a persistent source (Lee et al. 2015).

A release of LVP product could form a slick at the surface, or interact with suspended sediment. Slicks at the water surface pose a risk to birds and mammals through physical oiling of feathers and fur, which could limit a bird's ability to fly or a mammal's ability to insulate properly. Interactions with suspended sediment may promote deposition of contaminated sediment in areas where water velocity and turbulence are low. Exposure to contaminated sediment and related environmental effects on abundance of benthic macroinvertebrate prey can lead to chronic and sublethal environmental effects on fish, including effects on reproduction, growth and survival (Lee et al. 2015). Effects on surface water and sediment would likely be localized to the PDA because contaminated water and sediment will be held within the off-stream reservoir.

The duration of the effect would be based on the speed and success of emergency containment and clean-up activities by third parties.

Should the release extend to the shoreline, effects to vegetation could occur (more probable in LVP product release). Effects on vegetation could occur through direct contact with the pipeline material, or vegetation loss through removal of affected soils and vegetation during cleanup. Environmental effects would vary due to growth form, species morphology and physiology. The effects of vegetation would likely be limited to the PDA. Changes in vegetation could potentially last more than one growing season, as timing of such an event would occur in spring or summer when plants are actively growing and most susceptible. Vegetation would likely recover, over time, through existing seedbanks in undisturbed soils, and unaffected vegetation that spreads from undisturbed areas into disturbed areas.

Effects on wildlife could occur if species are close to the off-stream reservoir during the time of rupture (e.g., water birds – including migratory birds and species at risk) through direct contact or ingestion of contaminated sediment or prey. The environmental effects of a release on semi-aquatic birds and mammals would depend upon the nature of the release and the number and types of species that are exposed. During cleanup and remediation activities, emergency response would reduce the potential exposure of birds and mammals, reducing the likelihood of further wildlife effects.

A pipeline rupture during flood operations has the potential to temporarily limit the use of areas for recreational and traditional land uses (specifically access roads). However, the likelihood of a rupture affecting recreational and traditional land uses is low. As a rupture is occurring simultaneously to a flood large enough to cause diversion into the off-stream reservoir, temporary restrictions on recreational and traditional activities may already be in place. Due to the nature of the event, the potential to effect to federal lands is also low.

1.6 RESIDUAL ENVIRONMENTAL EFFECTS AND SIGNIFICANCE DETERMINATION

1.6.1 Off-Stream Reservoir Dam Failure or Breach

The off-stream dam is designed to a hazard classification “extreme” per the CDA guidelines. The dam has an emergency spillway that has the capacity to pass the flood water that can be delivered to the dam during the Probable Maximum Flood (PMF) and prevent overtopping. The dam is equipped with sensors that are monitored for seepage and deformation during operations. If stability issues arise or for other reasons the flow to the reservoir needs to be stopped, the gates at the diversion inlet can close and the inflow stopped to mitigate risk of failure of the dam.

However, if a dam failure or breach did occur, public health and safety, the biophysical environment, lands used for traditional and non-traditional use, infrastructure and services, and employment and economy would be affected. Depending on the size of the flood and volume of water in the reservoir, the magnitude of residual effects would vary from low to high. Dam failure or breach would result in inundation of surrounding areas, federal lands, as well as residential and commercial property, and the potential for human injury or loss of life. Emergency response plans would be implemented to address public safety concerns and mitigate damage to infrastructure and services. Residual effects of the worst-case dam failure are predicted to be significant but unlikely.

1.6.2 Diversion Structure Failure or Breach

The floodplain berm, auxiliary spillway and service spillway are designed to a hazard classification “high” per the CDA guidelines. The service spillway and auxiliary spillway have the capacity to pass up to 1/3 the flow rate between the 1:1000 year flood and the PMF, in accordance with the guidelines. The auxiliary spillway is designed to activate when inflow exceeds the capacity of the service spillway and diversion inlet.

In addition to excessive inflow, the delivery of sediment and woody debris could affect the capacity of the system and raise the backwater in the diversion structure. To mitigate the risk of overtopping, the service spillway gate bays and the gate bays of the diversion inlet have been designed to pass debris; but, also maintain operation should debris accumulate on key components. The pneumatic system that raises the service spillway gates are designed to operate effectively if one or more air bags are damaged and fail in the downward position for safe passage of flow. The auxiliary spillway is a full depth concrete structure designed to maintain is resiliency from frequent overtopping. Though not desirable, such overtopping could occur if debris accumulations, sediment accumulations or turbulence cause sudden rise in backwater during operation.

The system has been designed to prevent flooding upstream of the diversion structure; backwater influence during a failure to operate is limited to the most upstream extent of the floodplain berm.

In the event of failure or breach of the floodplain berm, public health and safety, the biophysical environment, lands used for traditional and non-traditional use, infrastructure and services, and employment and economy would be affected. Failure or breach would result in similar effects to VCs relative to an unmitigated flood (in the absence of the Project), including inundation of surrounding areas, as well as commercial property; however, effects are predicted to be short-term (approximately 30 minutes). With the implementation of design and emergency response plans to address public safety concerns and mitigate damage to infrastructure and services, residual effects on identified VCs are predicted to be not significant and unlikely.

1.6.3 Fire

The likelihood of fire because of Project component and equipment malfunction is low. Fire is more likely to occur because of lightning strikes and wildfire during dry weather and anthropogenic activities. A large fire could result in temporary exceedances of applicable ambient air quality standards and effects on public health through changes in air quality and immediate threats to safety and infrastructure. It could also affect crops, grazing land, native vegetation, wildlife habitat, land and resource use, and traditional land and resource use. However, the potential for fires because of Project activities is low and fire prevention measures on-site will meet applicable standards. Fires may occur because of natural events in which case emergency response procedures are designed to extinguish fires quickly and limit damage. Fire would be most likely restricted to the PDA if it is caused by Project component and equipment malfunction or anthropogenic activities at the PDA; a fire caused by natural causes (e.g., a wildfire caused by lightning strikes) may extend into the RAA.

With the implementation of preventative measures and emergency response procedures, residual effects of fire on identified VCs as a result of Project components are predicted to be not significant and unlikely.

1.6.4 Hazardous Materials Spill

A hazardous materials spill could result in contamination of the biophysical environment and lands used for traditional and non-traditional resource use and immediate threats to public health. However, training and appropriate handling, use, and storage of hazardous materials on-site are designed to prevent hazardous materials spills. If they occur, hazardous materials spills are therefore anticipated to be small in scale and to be cleaned-up and remediated using standard equipment. With the implementation of preventative measures and emergency response procedures, residual effects of hazardous materials spills on identified VCs are predicted to be not significant and unlikely.

1.6.5 Vehicle Accidents

Vehicle accidents could result in wildlife mortality and immediate threats to public health. A vehicle collision resulting in the release of fuel or hazardous material could also have localized effects on surface water quality. An accident occurrence that results in human injury would be significant; however, employee training (Section 1.3) and traffic accommodation plans (Volume 3A, Section 16.4.2) are designed to reduce the risk of vehicle accidents.

1.6.6 Pipeline Rupture

The potential for pipeline rupture is low as retrofitting and re-location of pipelines will be undertaken by the pipeline operators and follow standard safety and company requirements. The potential effects to VCs are dependent on the nature of the rupture (e.g., LVP or HVP products release, release volume, characteristics of the receiving environment). In the event of a rupture, the pipeline operating companies would be responsible for the cleanup of any contaminated terrestrial or aquatic environments and would be required to meet applicable guidelines for each. Companies responsible for the re-location or retrofitting of the pipelines will have an emergency preparedness plan to reduce the probability of a rupture as well as an emergency response plan, in the unlikely event of a rupture.

In the event that a rupture occurred during flood operations and enter the reservoir, the water within the off-stream reservoir would not be released back to the Elbow River until applicable guidelines were met.

Depending on the nature of the rupture event, even with the implementation of preventative measures, there is a potential for significant effects on identified VCs. However, the probability of such an event is highly unlikely.

1.7 CUMULATIVE EFFECTS OF ACCIDENTS AND MALFUNCTIONS

As discussed above, accidents and malfunctions are rare events and typically are relatively localized in spatial extent, with effects typically subject to emergency response already planned following prescribed protocols. The exact details of such events, beyond that described above, cannot however be further determined given various possibilities of precise location, timing and characteristics of such effects (e.g., magnitude, duration). As such, given also the uncertainties in such details for most other projects and physical activities identified with effects that may interact with the Project (as identified in Volume 3C, Section 1.1.4), conducting a cumulative effects assessment of accidents and malfunctions is a highly uncertain exercise with limited opportunity to provide other than a general and qualitative characterization of cumulative effect. Such a discussion follows based on consideration of a few dominantly influencing factors: relative spatial containment of effect, occurrence (or at least higher probability) during specific project phases, and nature of effects management response. Generally, most events (four of the six) are relatively spatially limited with an expectation of rapid containment of any released substances. The more spatially and temporally limited the event, the less the likelihood of a cumulative effect.

The following discussion of possible cumulative effects is based on two categories of events:

- localized: relatively brief and spatially limited to within or no further than adjacent to the PDA, or
- non-localized: of longer duration and spatially extending further out to the relevant RAAs.

1.7.1 Localized Events

The following four events result in relatively localized effects to the source of the event: fire, hazardous materials spill, vehicle accident and pipeline rupture. All effects would occur within or likely at most adjacent to the PDA. The first three would more likely occur, were they to occur at all, only during construction. The fourth event (pipeline rupture) may also (as assessed above) occur during flood operations.

Based on the Project Inclusion List, effects from the following projects and physical activities may have potential to interact cumulatively with the Project events described previously during construction: upgrades to Highways 1, 8 and 22, and NGTL West Path Rocky View section pipeline. Other projects and physical activities are likely too distant to result in a cumulative effect. For flood operations, the pipeline rupture event may interact cumulatively with upgrades to Highways 1, 8 and 22.

Both the NGTL West Path Rocky View section pipeline and upgrades to Highways 1, 8 and 22 would involve use of heavy machinery and equipment adjacent and through the PDA during construction. While the most likely, if not only potential pathway, for cumulative effects with the Project is for airborne emissions, the intermittency and spatial separation of these effects, however, makes cumulative effects unlikely. In further consideration of implementation of the emergency response measures as described in previous sections, the cumulative effects are not significant.

1.7.2 Non-localized Events

The following two events result in effects that extend beyond the PDA: off-stream dam failure or breach, and diversion structure failure or breach. These would only occur, were they to occur at all, during flood operations.

Based on the Project Inclusion List (see Volume 3C, Section 1, Table 1-1), effects from the following projects and physical activities may have potential to interact cumulatively with the off-stream dam failure or breach event during flood operations alongside the Elbow River channel: agriculture lands, infrastructure, Tsuut'ina Nation, and City of Calgary. Other projects and physical activities are likely to distant to result in a cumulative effect.

Based on the Project Inclusion List, effects from the following projects and physical activities may have potential to interact cumulatively with the diversion structure failure or breach event during flood operations: AEP Watercourse Protective Notation, AEP Fisheries Habitat Protection Area Disposition, Kamp Kiwanis, Camp Gardner, and City of Calgary. Other projects and physical activities are likely to distant to result in a cumulative effect.

The other projects and physical activities listed in the Project Inclusion List are existing and would continue into the future. They mostly reflect various land uses adjacent to Elbow River that may reside in the path of water released during a failure or breach, which would send a pulse of water downstream towards the City of Calgary. Notwithstanding the extensive emergency response measures described in previous sections, these events have the potential for significant effects on public safety and property, but are unlikely.

1.8 REFERENCES

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