Elbow River at McLean Creek Dam (MC1)
Environmental Impact Screening Report

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EXECUTIVE SUMMARY

INTRODUCTION

In 2013, flooding within the Bow River and tributaries inundated downtown Calgary and several other communities in southern Alberta, causing loss of life and major damage to infrastructure. In response to the June 2013 flood event (2013 flood), the Alberta Government committed to providing flood mitigation to prevent future damage from similar flood events.

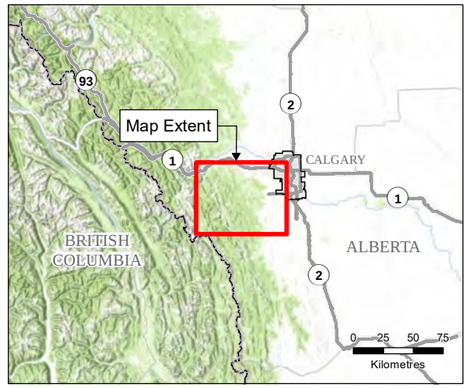
The Alberta Government, through Alberta Transportation (AT), is currently in the planning and design stage of the Springbank Off-stream Reservoir Project (SR1 Project), which is located within Rocky View County approximately 15 kilometres (km) west of Calgary in southern Alberta. The SR1 Project is subject to review under the *Environmental Protection and Enhancement Act*, RSA 2000, c. e-12 (EPEA) and the *Canadian Environmental Assessment Act, 2012*, SC 2012, c.19, s.52 (CEAA 2012). The EPEA Terms of Reference (Section 7.1[A]) require AT to describe the SR1 Project alternatives considered for flood mitigation. Section 19(1)(g) of CEAA 2012 also requires the environmental assessment of a designated project (i.e., the SR1 Project) to consider alternative means of carrying out the designated project that are technically and economically feasible and the potential environmental effects of any such alternative means.

Alberta Transportation investigated the Elbow River at McLean Creek Dam (MC1) Option (MC1 Option, or Option) as the alternative means to the SR1 Project. The MC1 Option would be located in Kananaskis Country, approximately 10 km upstream from the hamlet of Bragg Creek and 40 km west of Calgary (**Figure 1**) and has been developed to a conceptual level of design. This Environmental Impact Screening Report is intended to describe the environmental effects of the MC1 Option, and propose mitigation strategies to eliminate or reduce potential environmental effects. The potential environmental effects described in this report include those listed in Section 5 of CEAA 2012, as well as those related to accidents and malfunctions and cumulative effects in accordance with section 19(1)(a) of CEAA 2012. The findings of this Environmental Impact Screening Report have been used to support the alternatives assessment presented in the SR1 Environmental Impact Assessment.

The Alberta *Water Act*, RSA 2000, c. W-3, regulates activities that alter flows or water levels in a water body, and the Water (Ministerial) Regulation of the *Water Act* regulates dam safety. Constructing MC1 would alter water levels upstream of the dam and flows in the Elbow River downstream of the dam. Accordingly, the MC1 Option would require approval under the *Water Act* prior to construction as well as a licence under the *Water Act* to operate the dam.

Elbow River at McLean Creek Dam (MC1)

Option Location



Legend

- SR1 Project Location

MC1 Option Footprint

- 2013 Flood Event (1424.1 m)
- Dam Footprint
- Probable Maximum Flood (PMF) Level
- Highway 66 Re-alignment
- Permanent Pond
- Hamlet or Townsite
- Highway
- Reserve
- Provincial Park
- The Kananaskis Country
- Urban Area
- Watercourse
- Waterbody

Notes

1. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Basedata: Government of Alberta
- Dam and flood details: Opus International Consultants Limited, 2017
- Borrow Areas: Hatch Ltd., 2017
- Background Image: ESRI World Topographic Map
- Inset Maps: ESRI World Topographic Map

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Option Setting, Option Benefit, and Alternatives

Option Setting

The MC1 Option would be located on land traditionally used by the Treaty 7 First Nations and is located within the Métis Nation of Alberta (Region 3). There are no First Nations reserves within or adjacent to the Option area; however, the Elbow River and lower reaches of its tributaries are areas where Indigenous groups hunt or participate in other traditional activities.

MC1 would manage flows in the Elbow River, which is a tributary of the Bow River, within the South Saskatchewan River basin in southern Alberta. The headwaters of the Elbow River begin outside of Peter Lougheed Provincial Park, located approximately 70 km southwest of Calgary. The Elbow River meanders northeast for approximately 90 km before entering the Glenmore Reservoir, which then flows into the Bow River. The Red Deer River basin to the north, the South Saskatchewan River basin to the east, and the Old Man River basin to the south comprise the boundaries of the Bow River basin. Tributaries of the Elbow River within, upstream, and downstream of the MC1 Option area include McLean Creek, Canyon Creek, Prairie Creek, Powderface Creek, Silvester Creek, Ranger Creek, and Connop Creek. The Elbow River is unregulated upstream of the Glenmore Reservoir, although embankments or dams are present on some of the tributaries.

Option Benefits

The 2013 flood demonstrated the need for further flood mitigation along the Elbow River to reduce the effect of larger flood events and protect the communities of Bragg Creek, Redwood Meadows, and Calgary. The MC1 Option would provide flood mitigation for Calgary, as well as the communities of Bragg Creek, Redwood Meadows, and the Tsuut'ina Nation IR No. 145.

In addition to property impacts associated with flooding, the adverse health effects associated with flooding events are recognized globally, varying from physical harm in the short-term to delayed mental health problems in the long-term. The health benefits of flood reduction are numerous; implementing flood reduction and flood damage mitigation strategies would reduce adverse health effects associated directly with pre-flooding, flooding, and post-flooding events.

Alternatives to the Option

Workshops were conducted to identify and review alternative designs and methods of construction of MC1. An option to construct MC1 as a central concrete gravity dam flanked by embankments (anchored dam) was eliminated due to prohibitive costs. Similarly, elimination of the permanent pond was considered but was not carried forward as an option for operational reasons.

MC1 OPTION DESCRIPTION

The Alberta Government would own and operate MC1, and AT would be responsible for its development, design, and construction. If constructed, Alberta Environment and Parks (AEP) would assume control and responsibility for the management and operation of the MC1 Option as part of its water management operations. Currently, AEP is responsible for managing, operating, and maintaining provincially owned water management infrastructure throughout Alberta.

MC1 would include an earth fill dam across the Elbow River valley, which would provide flow regulation within the river upstream of its confluence with McLean Creek. Normal river flows would be controlled through two gated, 6-m-diameter, low-level diversion tunnels located along the south side of the Elbow River channel. Other elements of the MC1 Option include an ungated service spillway and an auxiliary spillway to protect the dam during more extreme flood events. The permanent pond created by the dam would be approximately 3.5 million cubic metres (m^3) of water (**Table 1**).

MC1 would be designed to withstand the probable maximum flood (PMF). The peak reservoir inflow rate for the PMF would be 2,770 m^3/s (cubic metres per second) and the maximum reservoir volume would be 93 million m^3. In the event of the PMF, the auxiliary spillway located along the south abutment of the dam would be activated. **Table 1** outlines the design criteria for the MC1 Option.

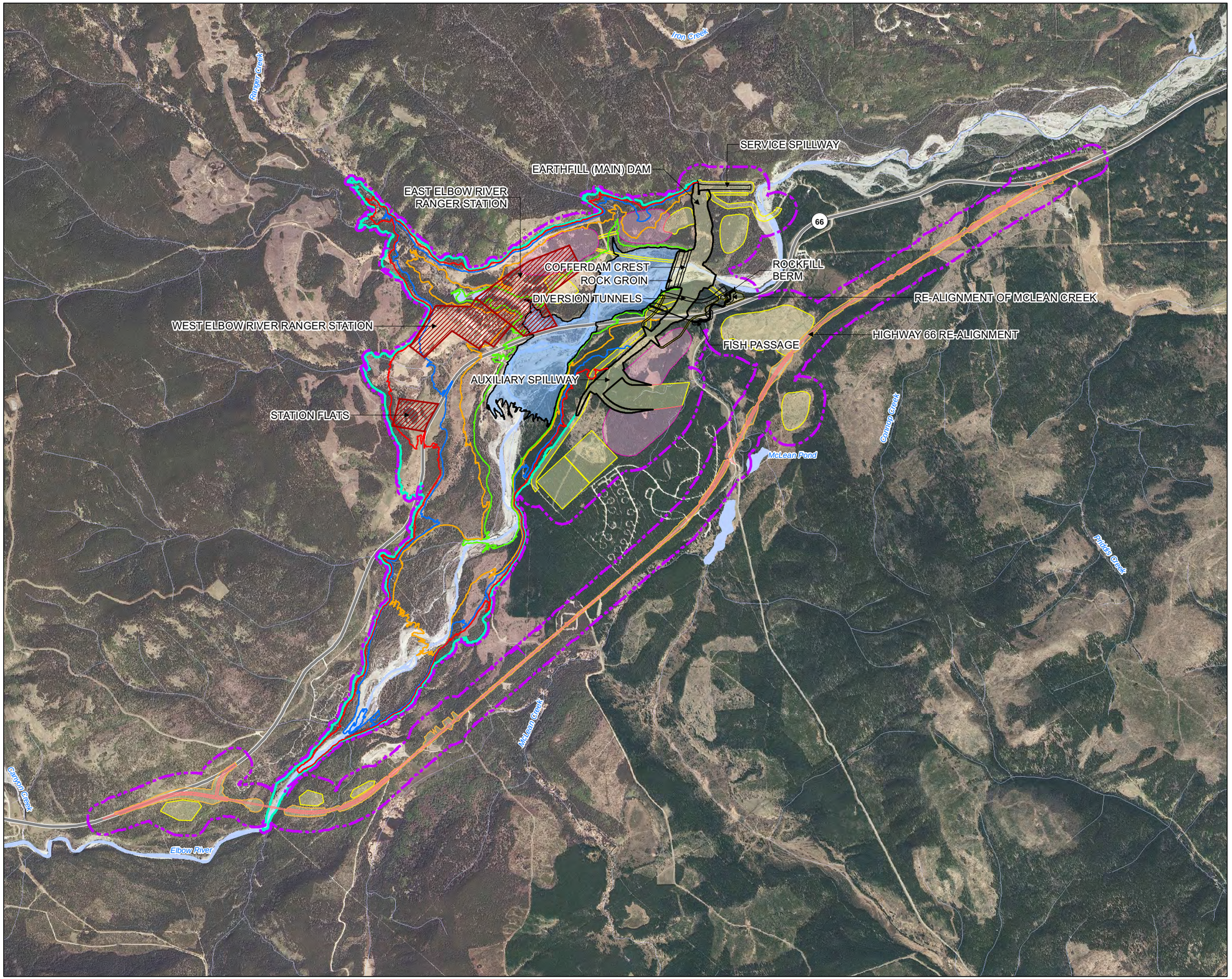
Table 1 Design Criteria for the Elbow River Dam at McLean Creek Option

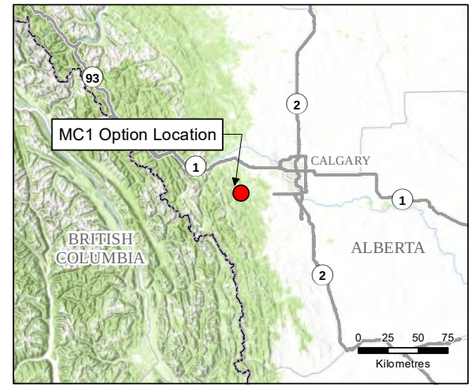
	Permanent Pond	20-year Flood Event	100-year Flood Event	June 2013 Flood	500-year Flood Event	Probable Maximum Flood
Peak reservoir inflow rate (m^3/s)	13.4	440	930	1,240	1,984	2,770
Diversion tunnels peak discharge rate (m^3/s)	13.4	220	220	220	810	1,000
Service spillway peak discharge rate (m^3/s)	0	0	0	0	0	600
Auxiliary spillway peak discharge rate (m^3/s)	0	0	0	0	0	1,000
Maximum reservoir water surface elevation (metres)	1,395	1,403.8	1,419.5	1,424.1	1,424.4	1,428.1
Maximum total contained water volume (million m^3)	3.5	12.3	51.0	71.5	73.0	93.0

Sources of materials and aggregate for the construction of the MC1 Option (e.g., dam embankment) have been identified along with stockpile and spoil locations. Material required for construction would be sourced from borrow areas located in the general vicinity of the MC1 Option components. The layout of the MC1 Option is shown in (Figure 2).

Elbow River at McLean Creek Dam (MC1)

Option Area





Legend

- MC1 Option Area
- MC1 Option Dam
- Highway 66 Re-alignment
- Probable Maximum Flood (PMF) Level
- 2013 Flood Event (1424.1 m)
- 1:100 Flood Event
- 1:20 Flood Event
- 1:50 Flood Event
- Borrow Area
- Laydown Area/Disturbed Area
- Permanent Pond
- Existing Park Infrastructure to be Removed
- Highway
- Watercourse
- Waterbody

Notes

1. All locations and features should be considered approximate and are to be used for discussion purposes only.
2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Basedata: Government of Alberta, 2017
- Preferred Road Option and Disturbed Areas: Opus International Consultants Limited, 2017
- Dam Details: Hatch Ltd., 2017
- Aerial Imagery: SPOT 1.5 m, 2016
- Inset Basemap: ESRI Topographic Basemap

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The MC1 Option construction schedule outlines a four-year construction phase. Many of the main Option components and relocation of infrastructure and facilities would be constructed and completed within the first two years.

The dam would pass flows during normal operations. During a flood event, the dam would retain flood waters and regulate downstream flows.

CONTAMINATED SITES ASSESSMENT

In support of MC1 Option planning, a Phase II Environmental Site Assessment was conducted, focused at the Elbow Valley Ranger Station (EVRS) and other potentially contaminated areas. Soil analytical results indicated elevated metals and dissolved metals concentrations as well as toluene, polycyclic aromatic hydrocarbons, several nutrients above background levels, and nitrite concentrations greater than guideline values. A cost was assigned to each potential environmental liability item that was identified during the Phase II Environmental Site Assessment. These values were aggregated to produce a total cost for remediating and managing environmental liabilities identified for each site.

ASSESSMENT METHODOLOGY

The Environmental Impact Assessment screening methodology follows recommended guidelines and legislated requirements, pursuant to the EPEA and CEAA 2012. The MC1 Option assessment considers three development scenarios: Baseline Case, Application Case, and Planned Development Case.

The purpose of this Environmental Impact Screening Report was to identify the key potential environmental effects of the MC1 Option and the associated mitigation measures necessary to reduce, eliminate, or compensate for those predicted effects. Baseline data collected were focused on acquiring sufficient data to identify these key effects and mitigation measures. For many Valued Components (VCs), baseline descriptions rely on previous studies and available literature, including:

- Environmental Overview of the Conceptual Elbow River Dam at McLean Creek (AMEC 2015)
- Site C Clean Energy Project Environmental Impact Statement (BC Hydro 2013)
- Cougar Creek Debris Flood Retention Structure Environmental Impact Assessment (Town of Canmore 2016)
- Environmental Impact Assessment – Glacier Power Ltd. Dunvegan Hydroelectric Project (Jacques Witford 2006)
- South Saskatchewan Regional Plan 2014-2024 (Government of Alberta 2017a)
- Water quality monitoring data from Glenmore Reservoir (Government of Alberta 2017b)
- Elbow River Basin Water Management Plan (Elbow River Watershed Partnership 2009))
- Natural Regions and Subregions of Alberta (NRC 2006)

A full description of the appropriateness of publicly available data for the assessment of each VC is included within each relevant section.

The following field studies were conducted (and continue to be conducted) to supplement public and existing data:

- Vegetation and Wetlands surveys – October 2, 2016, June and August 2017
- Wildlife surveys – March, April, May, June, July, and August 2017 (planned September, October, November 2017)
- Fish habitat use and fish habitat – May, June, July, August 2017 and October, November 2016

The following VCs were selected for assessing effects related to the MC1 Option:

- Physical Environment
  - Air Quality
  - Climate and Climate Change
  - Noise
  - Terrain and Soils
  - Groundwater Quantity
  - Groundwater Quality
  - Fluvial Geomorphology
  - Surface Water Quality
  - Drinking Water Quality
- Biophysical Environment
  - Vegetation
  - Wetlands
  - Grizzly Bear
  - Ungulates
  - Bats
  - Breeding Birds
  - Raptors and Owls
  - Harlequin Duck
  - Piscivorous Birds
  - Amphibians and Reptiles
  - Fish and Fish Habitat

- Human Environment
  - Land Use and Management
  - Socioeconomic Resources
  - Public Health and Safety.

ATMOSPHERIC ENVIRONMENT

MC1 is located within a humid continental climate zone, typified by large seasonal temperature differences with warm, humid summers and cold (sometimes severely cold) winters. There is an average of 440 millimetres of rainfall annually. The highest rainfall amounts occur between May and September. An average of 240 centimetres of snow is received annually, with greatest monthly snowfall amounts occurring from October to November and from March to April.

Overall, existing air quality is considered good. The existing atmospheric environment is primarily affected by industrial and agricultural activity in the area, vehicle traffic along Highway 66, and residential areas of Bragg Creek and Redwood Meadows.

The assessment of Atmospheric Environment largely relies on information regarding equipment and key construction activities that was used to support the air and noise assessments conducted for the Site C Clean Energy Project, as the project components and sources of air and noise emissions for the Site C project are similar to those expected for the MC1 Option.

Key findings of the assessment include the following:

- Activities for the MC1 Option would result in increased emissions and ambient concentrations of criteria air contaminants (CACs). Exceedances of relevant ambient air quality criteria may occur during the Construction phase.
- Activities for the MC1 Option would result in increased emissions of greenhouse gases (GHGs), primarily during the Construction phase. Total GHG emissions would be greater than federal and provincial reporting thresholds, but would likely be small relative to existing provincial and national emissions.
- Activities for the MC1 Option would result in increased noise levels primarily during the Construction phase.

Mitigation measures that would be implemented to address potential effects on air quality and noise include regular inspection of vehicles and equipment, selection of an asphalt plant, management of open burning, clearing of loose sediment on reservoir banks, reduction of exposure to elevated ambient concentrations of CACs, and development and implementation of fugitive dust management and noise management measures.

Exceedances of ambient air quality criteria may occur during the Construction phase at the McLean Creek Campground, Easter Seals Camp Horizon, and Paddy's Flat Campground. To reduce exposure to potential air quality effects, the McLean Creek Campground, Easter Seals Camp Horizon, and Paddy's Flat Campground would likely need to be closed during Construction. Gooseberry Campground may also be closed at night during the peak construction period to prevent sleep disturbance to campers.

After the implementation of mitigation measures, adverse residual effects would be likely for increased emissions and ambient concentrations of CACs, increased emissions of GHGs, and increased noise levels during both the Construction and the Operation and Maintenance phases. Due to the predicted effectiveness of mitigation measures, however, these residual effects would likely be non-substantive.

TERRAIN AND SOILS

MC1 is located within the Montane Natural Subregion of the Rocky Mountain Natural Region, which is characterized by mountains and foothills separated by deep glacial valleys. The surficial geology is typical of the location, with glacial and fluvial deposits being common. The glacial till deposits have been dissected by the Elbow River and tributaries. Generally, the recent fluvial deposits along the Elbow River are bounded by glaciofluvial terraces, in turn bounded by morainal and glaciolacustrine deposits over bedrock and glaciofluvial deposits. Colluvial deposits overlying bedrock are present, and bedrock outcrops tend to occur on the steepest slopes where river incision has exposed rock faces. There are also areas of organic and lacustrine terrain units. The dominant soil orders are Luvisols, Brunisols, and Regosols.

Key findings of the assessment include the following:

- Approximately 165 ha of soil would be temporarily disturbed and 161 ha would be covered by permanent infrastructure during Construction.
- Changes in soil quality could occur where in situ soils likely would be disturbed by MC1 activities; in soils that are salvaged and stockpiled for reclamation; or indirectly through proximity to construction or excavation areas.
- A change in topography during would occur in areas of substantial earth-moving activities (i.e., four borrow areas and the dam).
- Potentially unstable slopes located within or at the edge of the reservoir may be destabilized by changes in groundwater gradients caused by impoundment of water in the reservoir. Approximately 8% of the reservoir was mapped as having a moderate or high likelihood of landslide initiation following reservoir filling or rapid drawdown.
- Inundation in the reservoir may cause additional effects including sedimentation and changes in soil quality.

Mitigation measures proposed to address potential effects to terrain and soils include soil salvage, reclamation and revegetation of disturbed soils, and monitoring and maintenance for post-flood events. Additionally, an Erosion and Sediment Control Plan would be implemented.

After the implementation of mitigation measures, adverse residual effects to terrain and soils would be likely, including a change in soil quantity, a change in topography, a decrease in slope stability in areas of the reservoir, and effects due to inundation and sediment deposition in a flood event. These residual effects would largely be limited in spatial extent to the MC1 Option footprint, and in some cases, would reverse over time; therefore, all residual effects to Terrain and Soils would likely be non-substantive.

HYDROGEOLOGY

The Elbow River aquifer was formed by river deposition comprising high-permeability fluvial deposits, and is hydraulically connected to the Elbow River such that groundwater flows to the river during periods of low flow, and river water recharges the aquifer during times of high river or flood flow. Groundwater quality is generally excellent with concentrations of total dissolved solids typically in the 200 milligrams per litre (mg/L) to 300 mg/L range. There are approximately 10 supply wells in the reservoir boundary. Most wells are owned by AEP, and a small number of private recreational facilities. Most of the wells are classified for domestic use.

Key findings of the assessment are summarized below.

- Groundwater Quantity:
  - Diversion of groundwater may be required to allow safe excavation of granular material during construction.
  - Removal of the sand and gravel aquifer materials in the bed of the Elbow Creek and replacement with impervious fill material (and grout curtain) would cut off groundwater flow through the aquifers.
  - All supply wells within the flood footprint would be vulnerable to damage from floodwaters.
  - Land saturation in proximity to the permanent pond would result in a permanent increase in groundwater quantity, and may result in a temporary increase in groundwater quantity beneath the full flood footprint.
- Groundwater Quality:
  - Clearing of vegetation and topsoil during construction may affect groundwater quality without appropriate handling practices.
  - Groundwater supply wells within the flood footprint are vulnerable to damage from floodwaters. There is risk of contamination entering aquifers under high-flow conditions through supply wells that have not been identified and wells that have not been properly decommissioned.

Mitigation measures proposed to reduce or eliminate potential effects to Groundwater Quantity and Groundwater Quality include decommissioning groundwater supply wells within the reservoir, maintaining surface flows downstream of the dam, and developing and implementing measures for soil salvage and

reclamation and revegetation. These measures would fully mitigate potential effects to Groundwater Quality.

After the implementation of mitigation measures, residual effects to Groundwater Quantity would likely include the following: an adverse residual effect is predicted for reduced groundwater quantity downgradient of the dam embankment; and a positive residual effect is predicted for increased groundwater quantity in proximity of the permanent pond and the flood footprint. The adverse effect to downgradient flow would be highly localized in extent because the point-source flow from the diversion tunnel would likely spread out within the alluvial aquifer, and other surface and groundwater inputs would likely re-establish normal flow patterns and surface water / groundwater interaction within several kilometres. Thus, this adverse residual effect would likely be non-substantive.

FLUVIAL GEOMORPHOLOGY

The Elbow River is a low-order braided system in the vicinity of MC1. This channel pattern is characterized by frequent unvegetated mid-channel bars that divide the channel into multiple flow paths (channels). Braiding generally occurs in relatively steep environments with high sediment supply, and is commonly observed in unconfined sections of mountain streams, particularly downstream of glaciated terrain. The Elbow River exhibits a braided pattern in unconfined reaches, and a single-thread (single channel) pattern where the river is confined by less erodible channel banks (e.g., bedrock).

Key findings of the assessment including the following:

- Sediment retention in the permanent pond following impoundment of the Elbow River would occur at the upstream end of the permanent pond due to the associated decrease in water velocity. Sediment would likely accumulate at the upstream end of the reservoir at an average rate of 19,400 tonnes to 77,000 tonnes annually.
- The MC1 Option would result in both a decrease in downstream peak flows and a decrease in the sediment supply, which may result in channel degradation, channel narrowing, coarsening of bed material, pattern simplification, and aggradation at tributary junctions downstream of MC1 to the intake of the Glenmore Reservoir.

Mitigation measures include maintaining flow competence (i.e., allowing flows that exceed the threshold for flow entrainment) and sediment augmentation downstream of MC1.

After the implementation of mitigation measures, adverse residual effects to Fluvial Geomorphology would remain for sediment retention in the reservoir, and changes to channel morphology. The residual effect to sediment retention in the reservoir would likely be non-substantive primarily due to the localized nature of the effect. The residual effect to changes to channel morphology would likely be a substantive effect because the effect would extend to the Glenmore Reservoir, would be irreversible, and would result in a moderate degree of change in channel morphology in the affected area.

WATER QUALITY

The Elbow River near Bragg Creek shows chemical attributes of a highly productive system that would be expected to support a diverse food web for fish and other aquatic organisms. The river is turbid, particularly during the spring and summer snowmelt periods, which infers rapid weathering of parent materials upstream of sampling sites. The occurrence of pathogens indicates upstream contamination from uncontained seepage of untreated wastewater. Total and methylated mercury levels are also high. Nitrogen-to-phosphorus ratios indicate potential phosphorus deficiency of algal growth, which means that any addition of phosphorus could greatly increase algal growth rates and biomass. Multiple water licences for surface water diversion, including drinking water, also exist between MC1 and the Glenmore Reservoir.

Key findings of the assessment include the following:

- Surface Water Quality for Aquatic Organisms and Drinking Water Quality:
  - Activities such as ground disturbance, blasting, use of heavy equipment, and operation of the reservoir could lead to turbidity in exceedance of relevant guidelines.
  - Removal of fuel storage tanks and fuelling stations and chemical and soil waste removal at the EVRS and other provincial park infrastructure could cause chemical leaching in the soil and into the Elbow River and tributary flow into the Elbow River. Handling of these materials during the reclamation process, including runoff from temporary stockpiles or soil inundation during reclamation, could result in potential exceedances of relevant guidelines.
  - Nutrient loading could arise from the decomposition of vegetation and organic material following flooding of soil for the permanent pond, which could ultimately result in increased algal growth and biomass. This in turn could decrease dissolved oxygen and create conditions favourable for methylmercury formation. Nutrient inputs can also favour cyanobacteria, which can produce microcystins that are harmful if ingested.
- Drinking Water Quality:
  - Activities associated with the MC1 Option could lead to an increase in dissolved organic matter, which may interact with chlorine or ozone disinfectants in any downstream water intakes to form disinfectant byproducts. Chloramines, trihalomethanes, chlorate, and dichlorophenol exemplify disinfection byproducts that can impart unpleasant taste and odour to water, and some may be carcinogenic at high concentrations.
  - Pathogens may be introduced into the Elbow River during the decommissioning of the EVRS and other park infrastructure as contaminated soils from septic fields and waste treatment facilities are removed.

Mitigation measures proposed to reduce or eliminate potential effects to Surface Water Quality for Aquatic Organisms and Drinking Water Quality include fully decommissioning and reclaiming the EVRS and Stations Flats day use area, and removing all vegetation and topsoil within the permanent pond area. Additionally, measures would be developed and implemented to manage for chemical contaminants, cementitious materials, wastewater containment, and blast management. An Erosion and Sediment Control Plan would also be implemented.

After the implementation of mitigation measures, an adverse residual effect would likely remain for both VCs due to increased algal biomass. The removal of vegetation and topsoil around the permanent pond prior to inundation would significantly reduce the release of nutrients into the permanent pond, but it is unlikely that all organic material and soil could be removed during this process. This residual effect would likely be more pronounced in winter when the water residence time in the reservoir is greatest; however, although this residual effect would likely be more pronounced immediately after construction, it would also diminish over time as nutrient availability decreases. Dilution during snow melt would also facilitate nutrient flushing and reduce long-term downstream effects. The residual effect would likely be non-substantive.

VEGETATION AND WETLANDS

The location of the MC1 Option within the Montane Subregion of the Rocky Mountain Natural Region of Alberta comprises typical vegetation including a mix of grasslands and deciduous-coniferous forests on southern and western aspects, and predominantly coniferous forests on northern aspects and at higher elevations. Vegetation communities in the general MC1 Option area are characterized as mixed wood over-storey dominated by lodgepole pine (*Pinus contorta*), aspen (*Populus tremuloides*), Douglas fir (*Pseudotsuga menziesii*), and white spruce (*Picea glauca*). The understories are dominated by Canada buffaloberry (*Shepherdia canadensis*), bearberry (*Arcostaphylos uva-ursi*), hairy wild rye (*Leymus innovatus*), and pine reed grass (*Calamagrostis rubescens*), along with a number of forbs. Wetlands are sparse within the Montane Subregion; typically, they are rich, often calcareous fens and marshes.

More than 400 tracked plant species have been recorded within the Montane Subregion, two of which are listed in Schedule 1 of the *Species at Risk Act*, SC 2002 c. 29 (SARA): the western blue flag (*Iris missouriensis*), and the Haller's apple moss (*Bartramia halleriana*).

Key findings of the assessment include the following:

- Approximately 265 ha of vegetation communities (including wetlands) would be temporarily or permanently disturbed by the MC1 Option; the remaining 61 ha is categorized as anthropogenic. Permanent direct and induced MC1-effects to vegetation communities would likely be approximately 203 ha. Vegetation communities would be affected by clearing activities, changes to the hydrological regime, or indirect effects from dust and silt, traffic, and road maintenance activities (e.g., road salt) or the introduction of invasive species.
- Approximately 30.4 ha of wetland would be directly affected by the MC1 Option, and an additional 60.5 ha would be temporarily affected. These wetlands would be affected due to clearing activities, changes to the hydrological regime, temporary flooding, or deposition of fill.
- Three tracked species – Palmate germanderwort (*Riccardia palmata*), glaucus-headed earthwort (*Scapania glaucocephala*), and ragged-leaf liverwort (*Lophozia incisa*) – were identified during baseline studies, with palmate germanderwort and glaucus-headed earthwort located within the Option footprint. These species, and others not yet identified, may be affected due to direct removal, hydrological regime changes, and introduction of invasive species.

Mitigation measures proposed to reduce or eliminate potential effects to Vegetation and Wetlands include measures for reclamation and revegetation, riparian vegetation management, sensitive plant surveys, dust controls, and an invasive plant program. Additionally, an Erosion and Sediment Control Plan would be implemented, and AT would be required to follow the standard avoidance, minimization, and compensation measures described in the new Alberta Wetland Policy. Under this policy, a compensation payment would be made to Ducks Unlimited Canada to implement projects that benefit wetlands within the Saskatchewan River Watershed.

After the implementation of mitigation measures, two adverse residual effects are predicted for Vegetation: a change in vegetated area, and a loss of biodiversity diversity. Additionally, adverse residual effects for Wetlands are predicted to include a change in wetland area and function, and a change in species diversity. While all residual effects would be localized to the MC1 Option area, the changes would be irreversible. Although compensation would be made for wetland loss, these measures would not offset interim and long-term loss to wetland area and function within the MC1 LAA. This residual effect is considered substantive. As well, the loss of biodiversity due to the loss of tracked plant species is considered substantive.

WILDLIFE AND WILDLIFE HABITAT

The region around MC1 is productive for wildlife associated with lodgepole pine, mixed wood forests, and streams including: mammals such as grizzly bear (*Ursus arctos*), moose (*Alces alces*), mule deer (*Odocoileus hemionus*), white-tailed deer (*O. virginianus*), and several species of bats; birds such as common raven (*Corvus corax*), black-billed magpie (*Pica hudsonia*), Bohemian waxwing (*Bombycilla garrulus*), mountain chickadee (*Poecile gambeli*), boreal chickadee (*P. hudsonicus*), and American dipper (*Cinclus mexicanus*); and amphibians such as wood frog (*Lithobates sylvaticus*), western toad (*Anaxyrus boreas*), and common garter snake (*Thamnophis sirtalis*).

Multiple wildlife species of conservation concern are known to occur or are thought to occur in the Option area, including the little brown bat (*Myotis lucifugus*) and Northern myotis (*M. septentionalis*), which are both listed on schedule 1 of SARA as endangered. Common nighthawk (*Chordeiles minor*) and olive-sided flycatcher (*Contopus cooperi*) are listed on schedule 1 of SARA as threatened. Horned grebe (*Podiceps auritus*) and Western toad are both listed on schedule 1 of SARA as special concern. Grizzly bear is listed as endangered under the provincial *Wildlife Act*. Many other wildlife species are listed provincially as sensitive, including harlequin duck (*Histrionicus histrionicus*), sharp-tailed grouse (*Tympanuchus phasianellus*), Columbia spotted frog (*Rana luteiventris*), and long-toed salamander (*Ambystoma macrodactylum*).

Key findings of the assessment include the following:

- Grizzly Bear:
  - The location of the MC1 Option is in Bear Management Area 5; the Option footprint overlaps both the Recovery and Support Zones in Area 5. Vehicle collision mortality is the one of the leading causes of mortality for grizzly bears in Area 5. Use of the realigned Highway 66 would likely continue to be a source of mortality for grizzly bear, as well as effect movement patterns for grizzly bear.
  - The MC1 Option would result in habitat loss for grizzly bear. Core security, foraging, and potentially denning habitat availability would be adversely affected. Change in habitat may also occur as a result of sensory disturbance (i.e., noise associated with construction activity), which can result in reduced habitat suitability.
- Ungulates:
  - The MC1 Option is located in a Key Wildlife Biodiversity Zone, established to protect habitats that support wintering ungulates and biodiversity. The MC1 Option would result in habitat loss for ungulates. Winter foraging habitat availability would be reduced due to vegetation clearing and construction of permanent infrastructure required for the Option.
  - Changes to linear disturbance densities could alter predator-prey dynamics by increasing the likelihood of encounters with predators such as wolves.
- Bats:
  - The removal of forest habitat, particularly mature to old forest, could adversely affect the availability of roost sites for bats (used during late spring, summer, and fall). Vegetation clearing may directly or indirectly cause mortality to bats, as tree removal may destroy occupied roosts or remove suitable habitat for bats.
  - Forage availability for bats would likely be improved with the creation of a permanent pond that provides habitat for insects.
- Birds – Breeding Birds, Raptors and Owls, Harlequin Duck, Piscivorous Birds:
  - Change in habitat associated with vegetation clearing and sensory disturbances would include loss of breeding, foraging, and brood habitat for birds. Clearing in the footprint of the permanent pond would create nesting habitat for ground-nesting species that (e.g., Canada goose (*Branta canadensis*), killdeer (*Charadrius vociferous*), and common nighthawk). Creation of the permanent pond would create foraging habitat for piscivorous birds.
  - Option activities would create a risk of direct mortality for birds.
- Amphibians and Reptiles:
  - Grubbing and clearing activities would alter or remove terrestrial habitats used by amphibians and reptiles for foraging, and potentially alter or remove habitat features used for overwintering requisites.
  - Option activities may also cause direct mortality for amphibians and reptiles. In addition, vehicle use of the re-aligned portions of Highway 66 could result in vehicle collision mortality for amphibians and reptiles, due to the highway's proximity to wetland habitats.

- MC1 could create breeding habitat for western toad and other amphibian species through the creation of the permanent pond, if shallow margins are present, as well as in the borrow areas, which may create low wetland habitats that could be used by amphibians for breeding.

Mitigation measures proposed to reduce or eliminate potential effects to Wildlife and Wildlife Habitat include footprint reductions and access considerations during detailed design, timing considerations, pre-construction surveys for raptor nests and sensitive features, wildlife passage structures for the realigned section of Highway 66, and measures to reduce wildlife-human interactions. Additionally, an Erosion and Sediment Control Plan would be implemented.

After the implementation of mitigation measures, adverse residual effects to Wildlife and Wildlife Habitat would remain due to a change in habitat for all VCs. Positive effects to a change in habitat would also be likely; for example, the creation of the permanent pond could provide habitat for bats, piscivorous birds, and amphibians. Adverse residual effects to a change in movement would remain for Grizzly Bear, Ungulates, and Amphibians and Reptiles. A residual effect on change in mortality risk would remain for Grizzly Bear, Ungulates, Bats, Breeding Birds, Raptors and Owls, and Amphibians and Reptiles. All residual effects to Wildlife and Wildlife Habitat VCs are likely to be non-substantive.

FISH AND FISH HABITAT

The Elbow River watershed supports several fish species of management concern, including bull trout (*Salvelinus confluentus*); brook trout (*S. fontinalis*); rainbow trout (*Oncorhynchus mykiss*); cutthroat trout (*O. clarkii*; introduced); brown trout (*Salmo trutta*; introduced); mountain whitefish (*Prosopium williamsoni*); northern pike (*Esox lucius*); and burbot (*Lota lota)*. Other species known to occur in the Elbow River watershed include brook stickleback (*Culaea inconstans*); lake chub (*Couesius plumbeus)*; trout-perch (*Percopsis omiscomaycus*); pearl dace (*Margariscus margarita*); longnose dace (*Rhinichthus cataractae*); fathead minnow (*Pimephales promelas*); longnose sucker (*Catostomus catostomus*); and white sucker (*C. commersoni*).

Of the fish species that are known to occur in the Elbow River and tributaries around MC1, bull trout is the only species of conservation concern that could reasonably occur. The Option area lies entirely within the range of the Upper Elbow River population, which is listed as being of High Risk of extirpation given that it comprises between 50 and 250 adults. The species' Saskatchewan-Nelson Rivers populations (which encompasses the Upper Elbow River population) are listed as Threatened by the Committee on the Status of Endangered Wildlife in Canada. Although the species is currently not listed under SARA Schedule 1, the Government of Canada has recently consulted with the public as part of their determination as to whether to list the species under SARA. Provincially, bull trout are listed as Sensitive to human activities or natural events.

Key findings of the assessment include the following:

- The construction of the Option components including the earth fill dam, rock groin, and cofferdam would result in a direct and permanent loss of fish habitat.
- Alteration of habitat would likely result during episodic changes in water levels in the reservoir which would reduce the consistency and suitability of habitat, as well as temporarily influence habitat composition.
- The creation of the permanent pond would considerably alter the physical, chemical, and ecological characteristics of the area immediately upstream from the dam. Some new wintering habitat may result from the creation of the permanent pond, and coarse substrate deposition at the upstream end of the permanent pond may enhance foraging or spawning habitat, representing potential positive effects.
- Some mortality of fish passing through the diversion tunnels during construction would likely occur.
- The fish community assemblage could be altered in the permanent pond. Conditions would favour species more adept at adapting to altered environments and ecosystems more representative of lacustrine conditions.

Mitigation measures proposed to reduce or eliminate potential effects to Fish and Fish Habitat include inclusion of a fish passage structure in the dam; consideration of habitat avoidance measures during detailed design; fish habitat restoration, enhancement, and compensatory offset programs; and measures for management of fish health, blasting, invasive species and fish diseases, and riparian vegetation. Flow through the diversion tunnels and fish passage structure would be managed to maintain instream flow needs. Tunnels would be designed to reduce fish entrainment. An Erosion and Sediment Control Plan would also be implemented.

With the implementation of mitigation measures, adverse residual effects to Fish and Fish Habitat are predicted to remain for permanent alteration and destruction of fish habitat, effects on fish mortality and productivity, effect on migration and movement, and effect on fish assemblage due to habitat change. With the exception of effects to fish mortality and productivity, these residual effects are not expected to result in population-level effects, and would therefore be non-substantive. However, the potential residual effect on fish mortality and productivity is considered substantive for bull trout, as mortality from fish passing through the diversion tunnels during construction would likely be unavoidable. Any mortality to bull trout would have population level effects due to the small size of the Upper Elbow River population.

LAND USE AND MANAGEMENT

MC1 would be situated on Crown land within the provincial Green Zone. Land use management direction in Kananaskis Country is provided at a strategic level in the South Saskatchewan Regional Plan, pursuant to the *Alberta Land Stewardship Act,* SA 2009*,* c. A-26.8. The South Saskatchewan Regional Plan provides direction to activities on Crown lands, through existing legislation (e.g., the *Public Lands Act*, RSA 2000, c.

P-40; the *Forests Act,* RSA 2000, c.F-22; provincial park legislation, sub-regional plans). The park system in the region includes provincial parks, provincial recreation areas (PRAs), wildland provincial parks, and an ecological reserve. The Option area is situated in a predominantly recreational area that is considered one of the most heavily used single access points to Kananaskis Country. The Elbow River valley experiences the highest levels of recreational use within Kananaskis County, supported by proximity to Calgary, and its accessible roads, facilities, and trail systems. An extensive network of trails throughout the valley on the north side of the Elbow River are used year-round for mountain biking, skiing, snowshoeing, hiking, and horse riding.

Current land and resource uses include forestry, agriculture (i.e., cattle grazing), recreation, hunting and fishing, trapping, oil and gas development activities, and sand and gravel quarrying. Existing infrastructure within the MC1 Option area includes the EVRS complex and firefighting base camp. The EVRS is located on the north side of Highway 66 along both sides of Ranger Creek, and serves staff from Alberta Forestry Protection Services, Alberta Parks and Recreation, and Alberta Fish and Wildlife. Other physical infrastructure in the Option area includes four PRAs, Highway 66, electrical transmission lines owned by Fortis Alberta, one pipeline owned by Atco Gas and Pipelines Ltd, an access road owned by Husky Oil Corporation, two abandoned wellsites owned by Shell Canada, and a non-motorized trail network on the north side of the Elbow River.

Key findings of the assessment include the following:

- Construction of MC1 would result in a permanent loss of portions of McLean Creek PRA and Elbow River PRA, including campsites and day use areas. A portion of the McLean Creek campground would be permanently closed and relocated. River Cove Group Campground and Station Flats day use area in the Elbow River PRA are within the reservoir, and would be permanently closed and relocated for public safety reasons.
- Paddy's Flat campground and McLean Creek campground would be closed for the duration of Construction, due to noise and air quality concerns related to the MC1 Option, and would be fully accessible once construction is complete.
- Changes to resource and commercial use resulting from construction activities would affect lands used for resource activities. Reservoir operation would displace grazing allotments and grazing leases within the reservoir.

Mitigation measures proposed to reduce or eliminate potential effects to Land Use and Management include identifying alternative areas to offset loss of protected areas; retaining or reconstructing access to affected recreation areas; redirecting recreational users to other recreational use areas; creation of a recreation site associated with the permanent pond; communication of construction schedule and road closures; development of a traffic accommodation strategies; compensation for grazing allotment holders and registered fur management area holders; developing and implementing a plan for infrastructure relocation.

With the implementation of mitigation measures, adverse residual effects to Land Use and Management are predicted to remain for changes to protected areas, changes to resource and commercial users, changes to recreational use, change in the quality of the recreational experience, and disruption of infrastructure. With the exception of the change to recreational use, all residual effects are likely to be non-substantive as mitigation measures are likely to be highly effective at reducing or eliminating the predicted residual effects. However, the change to recreational use would include extensive closures of popular trails, changes to fishing opportunities, and loss of popular campgrounds and day use areas. Due to the permanent changes that would occur in the Elbow River Valley on PRAs and other unprotected recreational use areas, in the context of the high level of intensity of recreational use that the LAA currently receives, the effect on recreational use is likely to be substantive.

SOCIO-ECONOMIC RESOURCES

Alberta's provincial economy has led Canada in economic growth during the past 20 years, despite the acknowledgement of recession in 2015. Currently, Alberta's oil and gas sector accounts for 19% of its gross domestic product (GDP), with other non-energy sectors, such as construction, finance and real estate, and business and commercial services growing significantly over the last three decades. For 2016 – 2017, Alberta's provincial revenue is projected to be $41.4 billion, 3.7% lower than forecasted in 2015 – 2016.

Key findings of the assessment include the following:

- Positive effects would occur for provincial and regional economies. The effect on the regional economy, and to a lesser extent, the provincial economy would be an increase in GDP, labour income, and employment. Option CAPEX would generate direct and indirect effects of $238,226,000 in GDP, $162,040,00 in labour income, and 2,700 jobs (FTE) over the four-year Construction phase.
- Positive effects would occur to the labour force, primarily during construction. MC1 would require a construction workforce for an approximate four-year Construction period, ranging from 100 to 150 workers and increasing to 200 at peak construction periods. Much of the force would be sourced from Calgary and adjacent areas.
- A positive effect would also occur due to contracting and procurement opportunities.
- An adverse effect to economic activities of resource-dependent businesses and industry would occur, primarily on lands and uses displaced by MC1, although campground operators and other resource users may experience economic loss.
- A positive effect to regional economic conditions would result in changes to regional businesses from the construction workforce spending earnings on goods and services, thereby redistributing employment income in the region and contributing to induced employment and GDP.
- Worker demand may create a shortage of local accommodation.

Mitigation measures proposed to reduce or eliminate potential effects to Socio-economic Resources include mitigation for loss of economic opportunity such as identifying alternative areas to offset loss of protected areas, and retaining or reconstructing access to affected recreation areas; and establishment of a work camp during construction.

Positive residual effects to Socio-economic Resources are predicted to remain for changes to provincial and regional economies, change in labour force, change in contracting and procurement opportunities, and change to regional economic conditions. The change to provincial and regional economies is likely to be a substantive positive residual effect due to the high magnitude of the change. All other positive residual effects are likely to be non-substantive, as they are likely to be more moderate (i.e. limited) in magnitude.

With the implementation of mitigation measures, adverse residual effects to Socio-economic Resources are predicted to remain for change in economic activities of resource-dependent businesses and industry, and change in availability of accommodation. These adverse residual effects are likely to be non-substantive due to the effectiveness of mitigation measures to reduce the magnitude of the residual effect, and that the most employees are assumed to be based in Calgary or other regional communities and would not require local accommodation.

PUBLIC HEALTH AND SAFETY

Health services in Bragg Creek (and by association Redwood Meadows) are provided by a clinic that operates under Mountain Woods Health Services in association with the Calgary Rural Primary Care Network. Health services on the Tsuut'ina Nation are provided by the Tsuut'ina Clinic, which is supported by the Calgary West Rural Primary Care Network.

There is currently no significant infrastructure in place to protect communities downstream of the MC1 Option from flooding, although flood reduction measures are currently being planned in high risk communities. Flooding is classified as an extreme weather event that is exacerbated by climate change. As such, these events are likely to increase in the future both in frequency and magnitude.

Key findings of the assessment include the following:

- Construction activities associated with the MC1 Option would result in an increase in CAC concentrations and short-term air concentrations of fine particulate matter ($PM_{2.5}$) and nitrogen dioxide would exceed health-based exposure limits. Health effects would likely be reversible.
- In a flood event, once flood waters have receded from the banks of the reservoir after a flood event, dust emissions from wind erosion of reservoir banks could result in increased $PM_{2.5}$ concentrations. Health effects likely would be reversible assuming acute exposure duration.
- The MC1 Option would have a positive effect on regional health services as a result of flood reduction, removing health care demands and improving overall public safety associated with emergency preparedness and emergency response during flood conditions. Flood reduction would result in numerous benefits to health and regional health services before, during, and after a flood event. This would be positive in terms of public health and safety.

Mitigation measures would include public access restrictions, a traffic accommodation strategy, an alternative base for regional emergency response services, and emergency preparedness and emergency response measures.

A positive residual effects to Public Health and Safety is predicted to remain for emergency preparedness/ response during a flood event. The flood protection provided by MC1 Option would improve overall public health and safety and emergency preparedness / emergency response during flood conditions, and is likely to be a substantive effect.

PLANNED DEVELOPMENT CASE

All predicted substantive adverse residual effects were carried forward for consideration in the Planned Development Case (i.e., the environmental conditions that may occur as a result of the interaction of MC1 with other existing and planned projects and activities that can be reasonably expected to occur). The Planned Development Case was evaluated through the completion of a cumulative effects assessment (AEP 2013), which examines how the substantive adverse effects of the MC1 Option may interact spatially and temporally with the residual effects of other past, present, or future projects.

The predicted substantive adverse residual effects considered in the Planned Development Case were:

- Fluvial Geomorphology: changes to channel morphology
- Vegetation and Wetlands: reduction in biodiversity due to loss of tracked plant species
- Wetlands: reduction in wetland area and function
- Fish and Fish Habitat: increased risk of fish mortality and reduced productivity for bull trout
- Land and Resource Use: reduction to recreational use

These predicted substantive adverse residual effects were screened for potential interactions against past, current, and reasonably foreseeable future major projects (i.e., valued at $5 million or greater), as well as smaller projects and activities such as pipelines and super pipes, transmission lines, roads, wells, and grazing. Interactions were evaluated to determine the potential for a potentially substantive cumulative effect. Although interactions between MC1-specific adverse residual effects were identified, these interactions are unlikely to result in substantive adverse cumulative effects, assuming all projects and activities are constructed and operated according to applicable guidelines and best management practices. Thus, no potential for substantive cumulative effects was identified.

EFFECTS ASSESSMENT SUMMARY

The results of the effects assessment, indicates that five VCs are likely to experience residual adverse effects that are considered to be substantive, as a result of construction and operation of the Option:

- Fluvial Geomorphology: changes to channel morphology
- Vegetation and Wetlands: reduction in biodiversity due to loss of tracked plant species
- Wetlands: reduction in wetland area and function
- Fish and Fish Habitat: increased risk of fish mortality and reduced productivity for bull trout
- Land and Resource Use: reduction to recreational use

Additionally, the Option would be likely to have the following positive substantive residual effects:

- Socio-economic Resources: an increase in provincial and regional economies
- Health and Safety: improved emergency preparedness / response and reduced health and safety risk during a flood event

All substantive adverse residual effects were brought forward into the Planned Development Case, and screened against past, present, and reasonably foreseeable projects and activities to determine if a substantive adverse cumulative effect could occur. No potential for substantive cumulative effects was identified.

Effects of the Environment on the Option

Beaver Flats Landslide Complex

The Beaver Flats Landslide Complex, located approximately 8 km upstream of the eastern most extent of the reservoir and 12 km upstream of the MC1 dam site, is thought to be two distinct rock slides. Because the deposit of two rock avalanches is visible on both sides of the Elbow River, it is assumed that historic slide events dammed the Elbow River and led to outbreak floods.

The Beaver Flats Landslide Complex is regarded as most likely to interrupt flows in the Elbow River given. A preliminary analysis of this Landslide Complex suggests a failure frequency of up to approximately 1 in 3,000. Based on historic failures, a potential failure of this complex may create a dam approximately 57 m high, with a peak flow from dam breach estimated to range from 4,300 m^3/s to 42,000 m^3/s. This outburst would substantially exceed the peak flow estimate for hydrological floods (i.e., 2,770 m^3/s for the PMF). This preliminary analysis implies a substantially higher frequency and magnitude of a landslide outburst flood than the PMF.

MC1 may provide a level of protection to the downstream environment from a landslide dam outbreak flood, as the modelled landslide dam outbreak flood could be contained by MC1, assuming a total reservoir storage volume of 93 million m^3, of which approximately 88 million m^3 would be available for flood storage between the permanent pond and the maximum reservoir level. These preliminary conclusions would require examination through field work and landslide runout modelling.

Accidents and Malfunctions

Earthworks Failure of the Main Dam

Several scenarios, including an earthquake or seismic event piping (seepage causing internal erosion of the dam) through the earth fill dam or its foundation and overtopping during the PMF, could result in a failure of the main dam. Such a failure, if it were to occur during or immediately following a major flood event, would result in the release of a substantial volume of water (up to 93 million m^3) downstream, and a consequent increase in peak flow for a short period of time as this pulse of water moves downstream.

A failure of the main dam would have major effects to the downstream environment. Bank erosion and substantial scouring of the streambed would occur in the immediate vicinity of failure. Failure of the earth fill dam would release earth and debris into the Elbow River, and would result in the rapid drawdown of the reservoir water, which could result in landslides. The high energy of flows through a breach in the dam would result in scouring of the stream channel, and consequently would increase the concentration of suspended solids in downstream waters. The pulse of water and subsequent high sediment loads would affect fish and fish habitat in downstream watercourses. Wildlife within the flooded area could be injured or killed by the force of the flood wave or impingement against obstacles, or could be drowned. Vegetation and ecological communities may be affected by direct damage or loss of vegetation on the flood's flow path due to scouring, or may be smothered by sediment.

A failure of the main dam would adversely affect land and resource use due to its effects on fish, wildlife, and vegetation, as described above, as well as effects on agriculture, livestock, and forestry. Other effects would likely include damages to community infrastructure such as roads, highways, trails, and transmission lines; the Bragg Creek and Redwood Meadows communities; outdoor recreation and tourism; and visual and aesthetic resources of the river valley downstream. Residences and recreational areas could be inundated by waters released through a breach in the dam.

The consequence classification rating for the MC1 dam would be extreme due to the downstream population at risk; therefore, the MC1 Option would be designed to the PMF. Safety design considerations include construction of a well-founded and continuous slurry wall to prevent piping failures, and activation of the service spillway. The main dam would be monitored, and in the event of a trigger indicating dam instability or failure, emergency response measures would be triggered. A failure of the dam is considered a rare event. Due to the risk of human fatalities, the consequence of a dam failure is severe. On this basis, the risk associated with failure of the dam is high.

In the event of a failure of the main dam, an evacuation would be undertaken immediately to protect the safety of employees, site personnel, and the public. Monitoring and assessment programs would be initiated to identify any residual effects in the receiving biophysical and human environment.

Earthworks Failure of the Cofferdam

As with the main dam, scenarios such as an earthquake, seismic event, or piping through the dam or its foundation could result in failure of the structure during the Construction phase. Such a failure would result in the release of a large volume of water and material into the downstream environment.

The potential effect of a failure of the cofferdam would be similar to those associated with failure of the main dam, but of a lower scale and magnitude given the substantially lower volume of water that would be retained by the cofferdam when compared to the main dam.

Best practices recommend cofferdams are designed to handle 1:20-year flood event plus 1 m of freeboard. The MC1 cofferdam would be designed to handle a 1:50-year flood event plus 3 m to 5 m of freeboard. Emergency response measures would be the similar to those for the main dam.

The likelihood of failure of the cofferdam is considered rare. Since the maximum storage capacity of the cofferdam is less than half of that of the main dam, the potential effects associated with the failure of the upstream cofferdam would be similar to those described for the main dam, but would be lower in severity and geographic extent. Due to the risk of human fatalities, the consequence of a dam failure is still considered to be severe. On this basis, the risk associated with a failure of the cofferdam is high.

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LIST OF ACRONYMS, ABBREVIATIONS, SYMBOLS, AND UNITS OF MEASURE

Acronym / Abbreviation	Definition
2013 flood	June 2013 flood event
AAC	Annual Allowable Cut
AADT	average annual daily traffic
AAQO	ambient air quality objective
ABMI	Alberta Biodiversity Monitoring Institute
ACIMS	Alberta Conservation Information Management System
AEP	Alberta Environment and Parks
AER	Alberta Energy Regulators
AESRD	Alberta Environment and Sustainable Resource Development
AHS	Alberta Health Services
AO	aesthetic objective
AOI	Area of Influence
APEC	area of potential environmental concern
AQ	air quality
ASDT	average daily summer traffic
ASL	ambient sound level
AST	above-ground storage tank
AT	Alberta Transportation
ATK	Aboriginal Traditional Knowledge
BC MWLAP	British Columbia Ministry of Water, Lands and Parks
BGC	BGC Engineering Inc.
Bgs	below ground surface
BMA	Bear Management Area
BMP	best management practice
BRG	Bragg Creek soils
BRK	Bedrock
CAAQS	Canadian Ambient Air Quality Standards
CAC	criteria air contaminant
CAPEX	capital expenditure
CATR	Calgary and Area Tourism Region
CCME	Canadian Council of Ministers of the Environment
CDA	Canadian Dam Association
CEA	Cumulative Effect Assessment
CEA Agency	Canadian Environmental Assessment Agency
CEAA 2012	*Canadian Environmental Assessment Act, 2012*

Acronym / Abbreviation	Definition
CEPA 1999	*Canadian Environmental Protection Act, 1999*
CI	confidence interval
CMA	Census Metropolitan Area
CMHC	Canada Mortgage and Housing Corporation
CNT	Consultative Notation
COPC	contaminant of potential concern
COPD	chronic obstructive pulmonary disease
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CPUE	catch per unit effort
DBP	disinfection byproduct
DIS	Disturbed
DFO	Fisheries and Oceans Canada
DNL	Darnel soils
DO	dissolved oxygen
DOM	dissolved organic matter
DRS	Disposition Reservation
ECO Plan	Environmental Construction Operations Plan
EIA	Environmental Impact Assessment
EIS	Environmental Impact Screening
ELB	Elbow soils
ELC	Ecological Land Classification
ELR	Elbow Robinson soils
EMP	environmental management plan
EPEA	*Environmental Protection and Enhancement Act*
EPP	Environmental Preparedness Plan
EPT	Ephemeroptera, Plecoptera, Trichoptera
ERP	Emergency Response Plan
ESA	Environmental Site Assessment
ESRD	Environment and Sustainable Resource Development
EVRS	Elbow Valley Ranger Station
FMA	Forest Management Agreement
FMU	Forest Management Unit
FRK	Frank soils
FSI	Fish Sustainability Index
FSL	Full Supply Level
FTE	full-time equivalent
FWMIS	Fisheries and Wildlife Management Information System

Acronym / Abbreviation	Definition
GDP	gross domestic product
GHG	greenhouse gas
H:V	horizontal to vertical
HDX	Hillsdale soils
Hemmera	Hemmera Envirochem Inc.
HFC	Hydrofluorocarbon
HNR	highway noise receptor
HRIA	Historical Resources Impact Assessment
HROA	Historical Resources Overview Assessment
HRS	Holding Reservation
HRV	historical resources value
HUC	Hydrological Unit Code
IHD	ischemic heart disease
IPCC	Intergovernmental Panel on Climate Change
IR	Indian Reserve
IRP	Integrated Resource Plan
KID	Kananaskis Improvement District
KWBZ	Key Wildlife Biodiversity Zone
LAA	Local Assessment Area
LFN	low-frequency noise
LSD	Legal Subdivision
LUF	(provincial) Land-use Framework
LWD	large woody debris
MAC	maximum acceptable concentration
MBCA	*Migratory Birds Convention Act*
MC1	Elbow River at McLean Creek Dam
MD	Municipal District
MLE	McLean Creek soils
MLS	middle landslide
MNA	Métis Nation of Alberta
MNL	mitigation noise level
MPN	mean probable number
MTBE	methyl tertiary-butyl ether
MTF	Mitford soils
NHS	National Household Survey
NLS	north landslide
NM	not measured

Acronym / Abbreviation	Definition
NR	noise receptor
NTU	nephelometric turbidity unit
OHV	off-highway vehicle
OPEX	operational expenditures
Option	MC1 Option
PCN	Primary Care Network
PLUZ	Public Land Use Zone
PFC	perfluorinated compound
PLUZ	Public Land Use Zone
$PM_{2.5}$	fine particulate matter
PMF	probable maximum flood
PNT	Protective Notation
POT	Pothole Creek soils
PPX	Pipestone soils
PRA	Provincial Recreation Area
QAES	Qualified Aquatic Environment Specialist
RAA	Regional Assessment Area
RAP	restricted activity period
RFMA	Registered Fur Management Area
RNS	Robinson soils
RRD	registered roadway
RS	Ranger Station
RSA	Revised Statutes of Alberta
SA	Statutes of Alberta
SARA	*Species at Risk Act*
SC	Statutes of Canada
SCA	soil conservation area
SD	standard deviation
SDL	Sarcee Developments
SIL	Survey Intensity Level
SN	Snye
SLS	south landslide
SPR	Spruce Ridge soils
SR1	Springbank Off-stream Reservoir
SRP	soluble reactive phosphorus
SSR	South Saskatchewan Region
SSRB	South Saskatchewan River Basin

Acronym / Abbreviation	Definition
SSRP	South Saskatchewan Regional Plan
SWCRR	Southwest Calgary Ring Road
SWQ	surface water quality
TDP	total dissolved phosphorus
TK	Traditional Knowledge
TLU	traditional land use
TN	total nitrogen
TP	total phosphorus
TP&R	disposition type located in provincial parks
TSP	total suspended particulates
TSS	total suspended solids
TOR	terms of reference
US EPA	United States Environmental Protection Agency
UTM	Universal Transverse Mercator
VC	Valued Component
WHO	World Health Organization
WLB	Willoughby soils
WMU	Wildlife Management Unit
ZOI	Zone of Influence

Symbol, Unit of Measure	Definition
%	percent
%HA	percent highly annoyed
µg/m^3	micrograms per cubic metre
µg/L	micrograms per litre
CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
dam^3	cubic decametre
dB	Decibel
dBA	A-weighted decibels
ha	hectare
km	kilometre
km/hr	kilometres per hour
km^2	square kilometres

1.0 INTRODUCTION

Flooding within the Bow River and tributaries in June 2013 inundated downtown Calgary and several other communities in southern Alberta including Bragg Creek and Redwood Meadows, causing loss of life and major damage to infrastructure. In response to the June 2013 flood event (2013 flood), the Alberta Government committed to providing flood mitigation to reduce future damage from similar flood events.

The Alberta Government, through Alberta Transportation, is currently in the planning and design stage of the Springbank Off-stream Reservoir (SR1) Project, which is located within Rocky View County approximately 15 kilometres (km) west of Calgary in southern Alberta. The SR1 Project is subject to review under the *Environmental Protection and Enhancement Act* (RSA 2000. c.e-12) (EPEA) and the *Canadian Environmental Assessment Act, 2012* (SC 2012, c.19, s.52) (CEAA 2012).

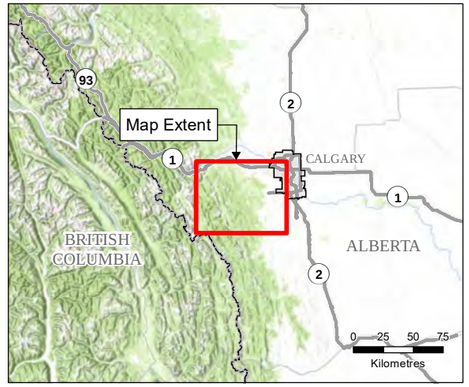
The Elbow River at McLean Creek Dam (MC1) Option Environmental Impact Screening (EIS) Report has been developed to facilitate a comparison of this alternative option with the SR1 Project. The MC1 EIS Report has been developed to comply with the requirements of *Addressing "Purpose of" and "Alternative Means" under the Canadian Environmental Assessment Act, 2012* (CEA Agency 2015), and provides an assessment of potential environmental effects and proposed mitigation in a manner that aligns as much as practical with the the SR1 Project Environmental Impact Assessment (EIA). A full discussion of alternative options can be found within the SR1 EIA.

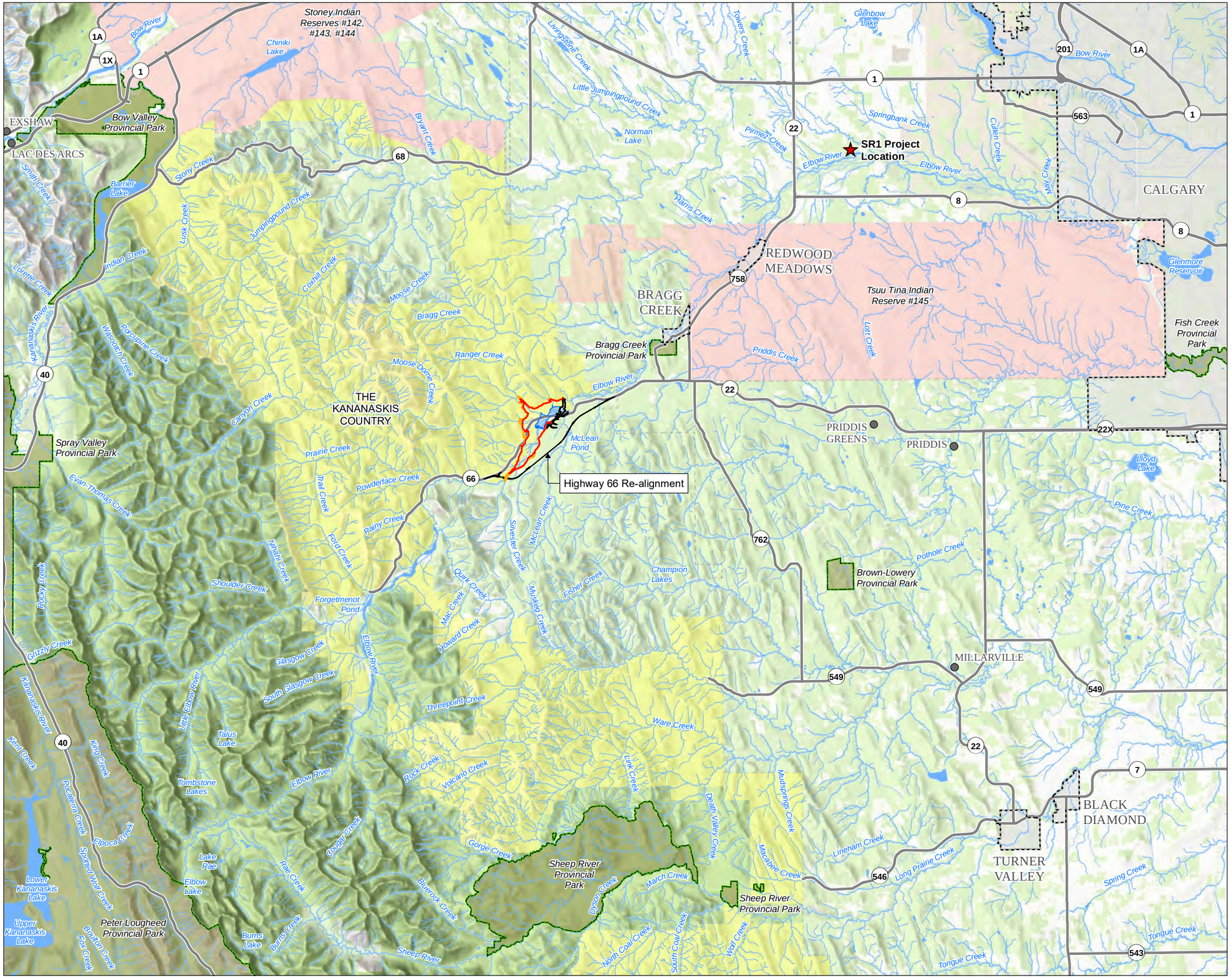
The MC1 Option has been developed at a conceptual level, and involves the construction of an earth fill dam across the mainstem of the Elbow River and an associated permanent pond, along with a reservoir that would retain water during a flood event. The MC1 Option would be located in Kananaskis Country, approximately 10 km upstream (west) from the hamlet of Bragg Creek and 40 km west of Calgary in southern Alberta **(Figure 1-1-1**). The largest flood on record on the Elbow River at Bragg Creek occurred on June 20, 2013 with a peak instantaneous flow of 1,170 cubic metres per second (m^3/s), which corresponds to a return period exceeding 200 years. Large floods also occurred in 1995 and 2005 with peak instantaneous discharges of 377 m^3/s and 308 m^3/s, respectively, at Bragg Creek (Opus 2017a).

The MC1 Option would also be subject to review under the EPEA, although it does not meet the threshold of the Regulation Designating Physical Activities and would not be subject to review under CEAA 2012; i.e., 1,500 hectares (ha) more than the natural water body. However, where possible, effects requiring consideration under CEAA 2012 have been scoped into the MC1 EIS Report to provide comparison to the environmental effects of the SR1 Project.

Elbow River at McLean Creek Dam (MC1)

Option Location





Legend

- Dam Footprint
- Probable Maximum Flood (PMF) Level
- 2013 Flood Event (1424.1 m)
- Highway 66 Re-alignment
- SR1 Project Location
- Permanent Pond
- Hamlet or Townsite
- Highway
- Reserve
- Provincial Park
- The Kananaskis Country
- Urban Area
- Watercourse
- Waterbody

Notes

1. This map is not intended to be a “stand-alone” document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Basedata: Government of Alberta
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- Borrow Areas: Hatch Ltd., 2017
- Background Image: ESRI World Topographic Map
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2.0 MC1 OPTION SETTING, BENEFIT AND ALTERNATIVES

2.1 MC1 OPTION SETTING

2.1.1 HISTORICAL SETTING

The Option would be located on land traditionally used by Treaty 7 First Nations and is located within the Métis Nation of Alberta (Region 3). There are no First Nations reserves within or adjacent to the MC1 Option area; however, the Elbow River and lower reaches of its tributaries are areas where Indigenous peoples hunt or participate in other traditional activities.

The Tsuut'ina peoples migrated south onto the Great Plains, prior to any written records of the area, then travelled south into Blackfoot territory, becoming allies of the Blackfoot people (Macdonald 2009). In 1883, the Tsuut'ina people agreed to the current location of the Tsuut'ina First Nation reserve, noting its proximity to the sacred Moose Mountain (an integral part of their cultural rites of passage), and availability of traditional plants and medicines.

Stoney First Nation peoples are descendants from western groups of Assiniboine, particularly from individual bands of Dakota, Lakota and Nakota. Following their migration, the Nakoda (later Stoney) were divided geographically and culturally into two tribal groups: the Chan Tonga Nakoda (Wood Stoney - 'Big Woods People', Swampy Ground Assiniboine) and the *Îyãñé* Nakoda (Ye Xa Yabine, Mountain Stoney or Hebina - Rock Mountain People). In 1877, the Chan Tonga Nakoda (Wood Stoney) signed Treaty 6. *Îyãñé* Nakoda claim historical use of the eastern slopes of the Rocky Mountains (Treaty 7 Management Corp. 2017). In exchange for use of traditional native lands, the Crown agreed to honor the *Îyãñé* Nakoda's right to self-government and an ancestral way of life. As part of Treaty 7, they were also promised 279 km² of reserve lands along the Bow River between the Kananaskis River and the Ghost River, which became Big Horn Indian Reserve (IR) 144A, Stoney IRs 142, 143, 144 and Eden Valley IR 216, all of which are shared between the Bearspaw, Chiniki and Wesley bands, respectively. Following the signing of Treaty 7, the ***Îyãñé Nakoda*** were recognized by the federal government as one entity, the Stony Band of Indians (later referred to as the Stoney Band or Stoney Tribe).

European settlement in the region occurred in the late nineteenth and early twentieth centuries. Early settlement took place on the plains within the region, but with suitable land and climate located in the foothills, settlers moved west, where forest lands were converted into grain fields and used as grazing areas (Kariel 1997). Historical land use throughout the region prior to the early twentieth century primarily included homesteading and agriculture, with limited logging and coal mining. Logging within the region in the late nineteenth century mainly took place within the foothill slopes of the Elbow and Sheep rivers. Coal was mined in the region, but never on a large scale (Hempstead 2013). Beginning in the early twentieth century, major land uses within the region changed to include ranching and agriculture, logging, oil and gas extraction, coal mining, and recreation and tourism (Kariel 1997).

2.1.2 BIOPHYSICAL SETTING

The MC1 Option area is located in the Rocky Mountain Natural Region, which runs along the continental divide and spans an elevation range from approximately 825 metres (m) to over 3,600 m (Natural Regions Committee 2006). This Natural Region is characterized by grasslands, shrubs, and forest, as well as alpine areas above the treeline (Government of Alberta 2017). The MC1 Option area spans an elevation range from approximately 1,380 m to 1,428 m, and is located within the Montane Natural Subregion of the Rocky Mountain Natural Region. This Subregion is characterized by mountains and foothills separated by deep glacial valleys. Vegetation communities are a mix of grasslands and deciduous-coniferous forests in southerly and westerly aspects, and predominantly coniferous forests on northerly aspects and at higher elevations (Natural Regions Committee 2006).

2.1.2.1 Geology

Surficial materials in the Montane Natural Subregion are mainly medium textured, weakly calcareous tills; however, these deposits are quite thin in steeper areas, and textures tend to be variable (Natural Regions Committee 2006). The Montane Natural Subregion is underlain by Cretaceous and Tertiary sedimentary rocks, and, while bedrock exposures do occur, glacial till deposits, fluvial deposits along river valleys, and occasionally highly calcareous, wind-deposited materials are prevalent (Natural Regions Committee 2006). In major river valleys, where rivers have dissected the glacial till, fluvial and glaciofluvial sands and gravels form level to gently undulating terraces on valley bottoms; till and colluvial deposits of variable textures occur on lower slopes (Natural Regions Committee 2006). Valley slopes contain thin deposits of glacial till, and higher elevations are covered by a thin veneer of bedrock and till-derived soil and rock-creep colluvium above bedrock (AMEC 2015).

2.1.2.2 Climate

The MC1 Option area is located within a humid continental climate zone, typified by large seasonal temperature differences with warm, humid summers and cold (sometimes severely cold) winters. There is an average of 440 millimetres of rainfall annually (Government of Canada 2016). The highest rainfall amounts occur between May and September. An average of 240 centimetres of snow is received annually, with greatest monthly snowfall amounts occurring from October to November and from March to April (Government of Canada 2016).

The MC1 Option area is located in the rain shadow of the Canadian Rocky Mountains. Environment Canada climate normals for the period from 1981 to 2010 at the Elbow RS climate station, which is located approximately 2 km west of the proposed MC1 dam site (**Figure 2.1-1**), are shown in **Table 2.1-1.**

Elbow River at McLean Creek Dam (MC1)

Climate and Hydrometric Stations

Legend

- Surface Water Local Assessment Area
- Surface Water Regional Assessment Area
- MC1 Dam
- Highway 66 Re-alignment
- Probable Maximum Flood (PMF) Level
- 2013 Flood Event (1424.1 m)
- Permanent Pond
- Hamlet
- Highway
- Reserve
- Provincial Park
- Urban Area
- Watercourse
- Waterbody
- Climate Station
- Hydrometric Station

Notes

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Table 2.1-1 Climate Normals Elbow RS Climate Station (1981 – 2010)

Month	Daily Average Temperature (ºC)	Daily Maximum Temperature (ºC)	Daily Minimum Temperature (ºC)	Precipitation (mm)
January	–7.9	0.3	–16.1	23.3
February	–6.1	2.0	–14.1	21.9
March	–3.3	4.3	–10.9	41.6
April	2.3	9.8	–5.2	49.2
May	6.7	14.2	–0.9	101.1
June	10.6	18.3	2.8	124.6
July	13.2	21.6	4.7	66.9
August	12.9	21.7	4.1	76.9
September	8.3	16.8	–0.2	66.3
October	3.2	11.4	–4.9	41.4
November	–4.4	3.3	–12.0	32.4
December	–7.9	0.0	–15.8	19.9
Annual	**2.3**	**10.3**	**–5.7**	**665.4**

Data Source: Government of Canada Canadian Climate Normals

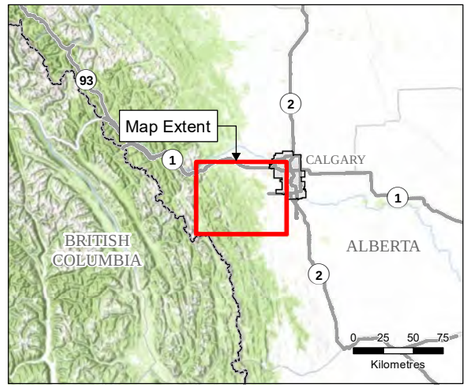
2.1.2.3 Hydrology

The MC1 Option would manage flows in the Elbow River, which is a tributary of the Bow River, within the South Saskatchewan River basin in southern Alberta. The Bow River basin is bounded by the Red Deer River basin to the north, the South Saskatchewan River basin to the east, and the Old Man River basin to the south. The headwaters of the Elbow River begin outside of Peter Lougheed Provincial Park, located approximately 70 km southwest of Calgary. The Elbow River meanders northeast for approximately 90 km before entering the Glenmore Reservoir, which then flows into the Bow River (**Figure 2.1-2**). The Elbow River is unregulated upstream of the Glenmore Reservoir, and receives flow from four main tributaries: Little Elbow River, McLean Creek, Bragg Creek, and Lott Creek. Some embankments or dams are present on some of the tributaries. The Little Elbow River is the largest tributary and drains the northwestern portion of the watershed. The total watershed area upstream of Glenmore Reservoir (and the city of Calgary) is 1,217 square kilometres (km^2).

The watershed hydrology is snowmelt-dominated, with peak flows occurring during the late spring and early summer. Peak flows commonly occur from mid-May through to mid-July, which coincides with the timing of the highest precipitation (**Table 2.1-2**), as well as the spring snowmelt.

Elbow River at McLean Creek Dam (MC1)

Elbow River Watershed Upstream and Downstream of the Option Area



Earthfill (Main) Dam

Highway 66 Re-alignment

Legend

- MC1 Dam
- Highway 66 Re-alignment
- 2013 Flood Event (1,424.5 m)
- Probable Maximum Flood (PMF) Level
- Permanent Pond
- Hamlet
- Highway
- Reserve
- Provincial Park
- Urban Area
- Watercourse
- Waterbody

Notes

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The Water Survey of Canada (WSC) hydrometric station Elbow River at Bragg Creek (Station ID 05BJ004) is located approximately 11 km downstream of the MC1 Option area. This station has a watershed area of 791 km^2, which is unregulated, and the period of record is 1923 to 2017 (95 years).

The Elbow River has an average flow ranging from 4 m^3/s in winter months to 31 m^3/s during spring freshet (ERB 2009). Peak flows at the MC1 Option area commonly occur from mid-May through to mid-July, which coincides with the timing of the highest precipitation, as well as the spring snowmelt (Opus 2017b). The average summer flow is 13 m^3/s (Opus 2017a).

There is substantial groundwater and surface water interaction between the Elbow River and the Elbow River alluvial aquifer, a shallow, unconfined gravel and sand unit deposit that is located throughout the length of the river. The alluvial aquifer supplies baseflow to the Elbow River during low flow periods and river water flows into the aquifer during high flow events (ERB 2009).

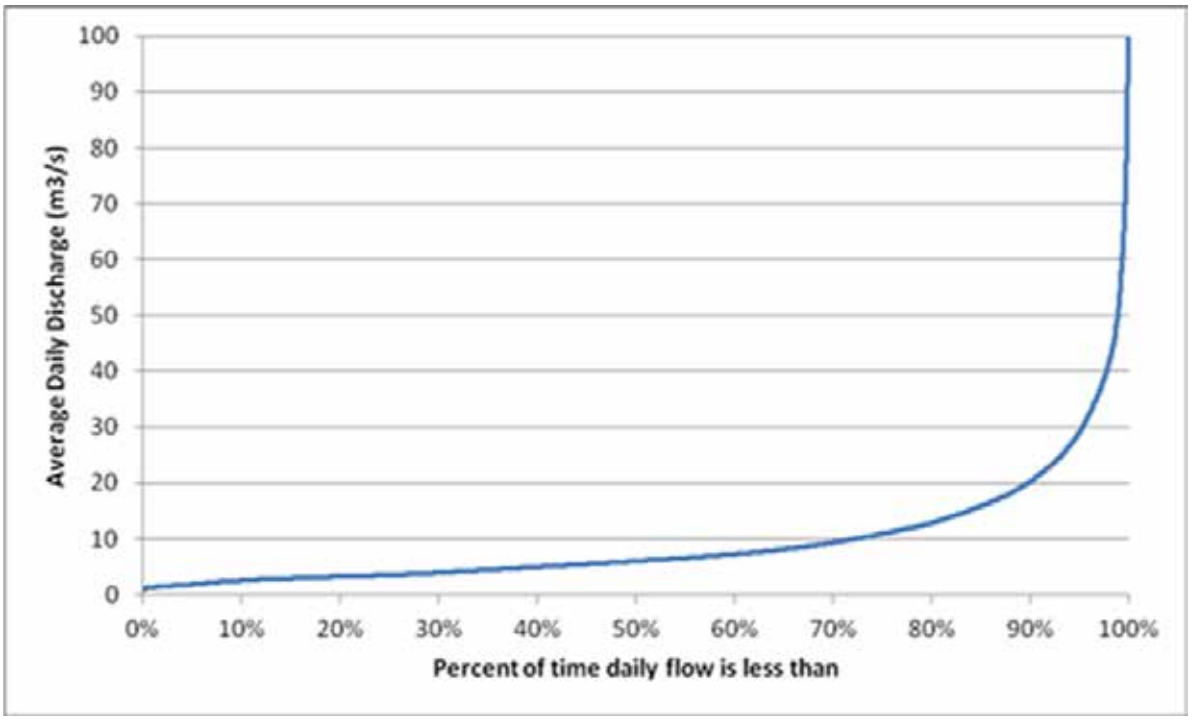
Flows at the MC1 dam site were calculated by pro-rating the Elbow River at Bragg Creek based on the relative watershed areas (Opus 2017b). The mean annual flow at the MC1 dam site is expected to be 8.6 m^3/s. A summary of monthly average, maximum, and minimum flows is provided in **Table 2.1-2**.

Table 2.1-2 Summary of Monthly Flows at Elbow River at Bragg Creek Water Survey of Canada Station

Flow Parameter	Monthly Discharge (m^3/s)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean	3.03	2.94	3.25	4.68	14.6	26.2	15.6	9.42	8.13	6.54	4.79	3.74
Max	4.89	4.45	6.32	9.34	39.8	77.4	41.3	22.5	29.5	14.2	7.8	6.23
Min	1.89	2.01	1.63	3.04	4.52	5.81	2.32	3.48	4.39	3.78	3.14	2.36

Source: Opus (2017b)

The annual flow curve is shown in **Figure 2.1-3**, which shows how frequently specific flows are exceeded. For example, based on the data presented in **Figure 2.1-3** , the average daily flow at the MC1 dam site is less than 10 m^3/s approximately 75 percent (%) of the time (flow exceeds 10 m^3/s approximately 25% of the time). These curves provide information regarding how frequently high flows occur within the Elbow River.



Source: Opus (2017a)

Figure 2.1-3 Annual Flow Curve for the Elbow River at McLean Creek Dam Option

Since peak flows are an important consideration for both MC1 construction and flood control effectiveness, a flood frequency analysis was undertaken at the Elbow River at Bragg Creek WSC station using available maximum peak instantaneous streamflow data; the data was then prorated to the drainage area at the MC1 dam site using methods outlined in the Opus Conceptual Design Report (Opus 2017*a*,*b*). Results of the flood frequency analysis are presented in **Table 2.1-3.**

Table 2.1-3 Peak Flow Estimates for the Elbow River at McLean Creek Dam Option

Return Period (years)	20	100	500	Probable Maximum Flood
Instantaneous Maximum Flow (m^3/s)	440	930	1,625	2,770

The largest flood on record occurred on June 20, 2013, with a peak instantaneous flow of 1,170 m^3/s at WSC gauge 05BJ004, which corresponds to a return period exceeding 200 years. Large floods also occurred in 1995 and 2005, with peak instantaneous discharges of 377 m^3/s and 308 m^3/s at Bragg Creek, respectively (Opus 2017b).

The probable maximum flood (PMF) for the Elbow River was developed for the SR1 Project and was applied directly to the MC1 dam site to support the conceptual design (Opus 2017a). The PMF can be thought of as the conceivable catastrophic flood (Alberta Transportation 2004). Based on the Opus Conceptual Design Report (2017*a*), the Elbow River PMF at the MC1 dam site is estimated to be 2,770 m^3/s.

2.1.3 BIOLOGICAL SETTING

2.1.3.1 Vegetation and Ecosystems

The vegetation in the Montane Natural Subregion is generally a mix of grasslands and deciduous-coniferous forests on southern and western aspects, and predominantly coniferous forests on northern aspects and at higher elevations (Natural Regions Committee 2006). Plant communities do vary both locally and across the Subregion in response to slope, aspect, elevation, and latitude (Natural Regions Committee 2006). The nearby Elbow River and McLean Creek Provincial Recreation Areas are characterized as mixed wood over-storey dominated by lodgepole pine (*Pinus contorta*), aspen (*Populus tremuloides*), Douglas fir (*Pseudotsuga menziesii*), and white spruce (*Picea glauca*) (Government of Alberta 2012). The understories are dominated by Canada buffaloberry (*Shepherdia canadensis*), bearberry (*Arcostaphylos uva-ursi*), hairy wild rye (*Leymus innovatus*), and pine reed grass (*Calamagrostis rubescens*), along with a number of forbs.

Wetlands are sparse within this Subregion; typically, they are rich, often calcareous fens and marshes (Natural Regions Committee 2006).

More than 400 tracked plant species have been recorded within this Natural Subregion, two of which are listed in Schedule 1 of the *Species at Risk Act*, S.C. 2002, c. 29 (SARA): the western blue flag (*Iris missouriensis*) and the Haller's apple moss (*Bartramia halleriana*).

2.1.3.2 Wildlife and Wildlife Habitat

The Montane Subregion has a number of unique habitats and wildlife species assemblages (Natural Regions Committee 2006). The region around the MC1 Option area is productive for many species associated with lodgepole pine, mix wood forests and streams including: grizzly bear (*Ursus arctos*), moose (*Alces alces)*, mule deer (*Odocoileus hemionus),* gray wolf (*Canis lupus)*, red squirrel (*Tamiasciurus hudsonicus*), beaver (*Castor Canadensis*), muskrat (*Ondatra zibethicus*) and several species of bats.

Bird species within the subregion include: bald eagle (*Haliaeetus leucocephalus*), harlequin duck (*Histrionicus histrionicus*), American dipper (*Cinclus mesicanus*), yellow-rumped warbler (*Setophaga coronata*), pine siskin (*Spinus pinus*), alder flycatcher (*Empidonax alnorum*), Swainson's thrush (*Catharus ustulatus*), warbling vireo (*Vireo gilvus*), calliope hummingbird (*Selasphorus calliope*), common nighthawk (*Chordeiles minor*), great blue heron (*Ardea herodias*) and sharp-tailed grouse (*Tympanuchus phasianellus*).

Western toad (*Anaxyrus boreas*), Columbia spotted frog (*Rana luteiventris*) and long-toed salamander (*Ambystoma macrodactylum*) are commonly associated with wetlands and mix wood communities in the subregion (Natural Regions Committee 2006).

Multiple wildlife species of conservation concern are known to occur or are thought to occur in the MC1 Option area, including the little brown bat (*Myotis lucifugus*) and Northern myotis (*M. septentionalis*) which are both listed on schedule 1 of SARA as Endangered. Common nighthawk and Olive-sided flycatcher (*Contopus cooperi*) are listed on schedule 1 of SARA as Threatened. Horned grebe (*Podiceps auritus*) and Western toad are both listed on schedule 1 of SARA as Special Concern. Grizzly bear are listed as endangered under the provincial *Wildlife Act* RSA 2000, c. W-10. Many other wildlife species are listed provincially as sensitive, including harlequin duck, sharp-tailed grouse, Columbia spotted frog, and long-toed salamander (AEP 2017).

2.1.3.3 Aquatic Resources

In the broader MC1 Option area, the Elbow River watershed supports several fish species of management concern, including the following sportfish species: bull trout (*Salvelinus confluentus*); brook trout (*S. fontinalis*); rainbow trout (*Oncorhynchus mykiss*); cutthroat trout (*O. clarkii*; introduced); brown trout (*Salmo trutta*; introduced) mountain whitefish (*Prosopium williamsoni*); northern pike (*Esox lucius*); and burbot (*Lota lota)* (FWMIS 2017). Hybridization between bull trout and brook trout as well as between cutthroat trout and rainbow trout is also documented in the watershed. Species, other than sportfish, also known to occur in the Elbow River watershed include brook stickleback (*Culaea inconstans*); lake chub (*Couesius plumbeus)*; trout-perch (*Percopsis omiscomaycus*); pearl dace (*Margariscus margarita*); longnose dace (*Rhinichthus cataractae*); fathead minnow (*Pimephales promelas*) longnose sucker (*Catostomus catostomus*); and white sucker (*Catostomus commersoni*).

Of the fish species that are known to occur in the Elbow River and tributaries around MC1, bull trout is the only species of conservation concern that could reasonably be expected to occur. The species' Saskatchewan-Nelson Rivers populations (which encompasses the Elbow River population) are listed as Threatened by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2017). Although the species is currently not listed under SARA Schedule 1 (Environment Canada 2017), the Government of Canada has recently completed the consultation of the public as part of their determination as to whether to list the species under SARA. Provincially, bull trout are listed as Sensitive to human activities or natural events (ASRD 2010).

2.1.4 HUMAN ENVIRONMENT SETTING

2.1.4.1 Current Land Use

The MC1 Option area is situated within the South Saskatchewan Region of Alberta, which includes the cities of Calgary, Lethbridge, and Medicine Hat, and defines the most southerly portion of the province. The South Saskatchewan Region covers approximately 12.6% of Alberta's total land area and approximately 44% of its residents (Government of Alberta 2017). The diversified economy includes agriculture, tourism, and forestry activities, as well as manufacturing and services to support oil and natural gas development and the technology sector (Government of Alberta 2017). Agriculture is the primary renewable resource in the South Saskatchewan Region.

The MC1 Option area is located in Kananaskis Country where current land and resources include forestry, agriculture (i.e., cattle grazing), recreation, hunting, trapping and fishing, trapping, oil and gas development activities, and sand and gravel quarrying. The Elbow River valley experiences the highest levels of recreational use within Kananaskis County (Government of Alberta 2012). The area is used for a variety of motorized and non-motorized recreational activities including hiking, camping, horseback riding, mountain biking, paddling, rafting, skiing, snowshoeing, target shooting, wildlife viewing and photography. The MC1 Option area is situated in a predominantly recreational area that is considered one of the most heavily used single access points to Kananaskis Country. Four Provincial Recreation Areas surround the MC1 Option area: Elbow River, McLean Creek, Gooseberry and Elbow River Boat Launch.

Twenty disposition reservations and notations overlap with MC1 Option area and surrounding lands. Disposition reservations/notations are areas with a registered interest by one or more agencies, and where land use restrictions or a requirement for consultation are imposed with respect to surface disposition. Thirty-two dispositions (i.e., permits, licenses or leases) also overlap with the MC1 Option area and surrounding lands. These dispositions include recreation leases, mineral surface leases, miscellaneous leases, easements for powerlines, pipeline agreements and pipeline installation leases and two park easements.

2.1.4.2 Current Water Use

Water demand within the Elbow River sub-basin and the Bow River basin is high. In 2006, approximately 20,000 licences were issued by Alberta Environment and Parks (AEP) for the South Saskatchewan River Basin (SSRB), and as of 2007, 60% to 70% of the natural flow of the Bow River sub-basin, including the Elbow River, was allocated through river licences issued by AEP (Wintergreen Water Co-op 2007). According to the SSRB Watershed Management Plan, the limits for water allocation were reached and exceeded within the Bow River basin, resulting in altered flow regimes and a moratorium on new water licence applications for the SSRB region, a situation that is still in place as of 2017. An exception to the moratorium is granted for First Nations, to meet water conservation objectives and to supply water storage projects (as per an Approved Water Management Plan) (Alberta Water Portal 2017).

According to the Bow River Basin Council, in 2010 the total annual surface and groundwater allocations in the Bow River Basin totalled 2,801 million m^3 (Bow River Basin Council 2017). The large majority of total allocation comprised agricultural uses, with irrigation accounting for approximately 71%, while municipalities accounted for 18% of total allocations. The remaining water allocations were for water, fish, wildlife, and habitat management (7%), industrial and commercial uses (2%), and other uses (2%).

The Elbow River basin provides water to an average of 40% to 45% of Calgary's population through the Glenmore Dam Reservoir (City of Calgary 2014). According to the Calgary Watershed Report 2010 – 2012, water quality within the Elbow River upstream of the Glenmore Dam is generally considered good when

compared against the Canadian Council of Ministers of the Environment Water Quality Index (City of Calgary 2014). Ongoing water quality issues within the Bow River basin include point and non-point source contaminants, such as phosphorus.

A total of 92 surface diversion records exist in the Elbow River for sub-basin agriculture commercial and de-water purposes and there are several water intake licenses for the Elbow River downstream of the MC1 site up to the Glenmore Reservoir.

In addition, five water supply wells are located within the footprint of the proposed MC1 reservoir: of which two are within the footprint of the permanent pond. An additional five water supply wells are located outside of the reservoir footprint: two overlap with other MC1 components (i.e., Highway 66 realignment and laydown area).

2.1.4.3 Planning Framework

Land use management direction in Kananaskis Country is provided at a strategic level in the South Saskatchewan Regional Plan, pursuant to the *Alberta Land Stewardship Act,* SA 2009, c.A-26.8. This plan sets out an approach to manage land use in the region for the long term and is an iterative plan designed to be reviewed every 10 years. The South Saskatchewan Regional Plan provides direction to activities on Crown lands, through existing legislation and sub-regional plans. Regional planning direction in the SSRB is in the context of the provincial Land Use Framework, which aims to manage to the cumulative effects of development on the environment.

The South Saskatchewan Regional Plan identifies Kananaskis Country as an important recreational and tourism area with the potential to become a major tourist draw for Alberta (Government of Alberta 2017). The permanent pond would create a recreational opportunity. Allen Bill Pond was a popular fishing pond that was destroyed by the 2013 flood. The creation of a new permanent pond behind the dam is identified as a potential positive effect on recreational use of the Elbow River Valley.

The Elbow River Watershed Partnership worked with the stakeholders, including the Bow River Management Plan Technical Committee, to develop the Elbow River Basin Water Management Plan released in 2008 and further revised in 2009 (ERWB 2009). The Elbow River Basin Water Management Plan identifies four outcomes which are aligned with the Alberta Government's Alberta Water for Life Strategy and general stewardship objectives:

- Safe, secure drinking water supply
- Healthy aquatic ecosystems
- Reliable, quality water supplies for a sustainable economy
- Inclusive, integrated and committed stewardship of the river and watershed

The MC1 Option would, by design, affect streamflows in the Elbow River. Retention of flood flows would decrease flows during the flood event and increase flows following the event. Water dam structures influence aquatic ecosystems. Several mitigation measures have been proposed to minimize the influence of the MC1 dam on the aquatic environment. Should the MC1 Option move forward, monitoring for downstream effects on water quality and aquatic ecosystems would be implemented to verify the continued health of these systems.

2.1.5 INDIGENOUS RIGHTS AND INTERESTS

The MC1 Option area occurs within the traditional territory of Treaty 7 First Nations as well as within the geographical and legal boundaries of Métis Nation of Alberta (Region 3). As identified **Figure 2.1-4**,Treaty 7 covers roughly 130,000 km^2 of land within Alberta from the Rocky Mountains to the west, the Cypress Hills to the east, the Red Deer River to the north, and the US border to the south (INAC 2017a).

Tsuut'ina Nation is in closest proximity to the MC1 Option, with reserve lands located approximately 10 km from the MC1 Option area. Stoney First Nations has lands located within 40 km of MC1. Siksika First Nation, Piikani First Nation and Blood Tribe are located more than 100 km from the MC1 Option area (**Table 2.1-4**).

There are no First Nations reserves within or adjacent to the MC1 Option area. However Treaty 7 First Nations may use the Elbow River and its tributaries as areas where they may hunt or participate in other traditional activities, including fishing, as part of their traditional rights. The presence of the MC1 Option could affect the traditional activities of Indigenous peoples, including Métis groups, in the area. Five signatory First Nations of Treaty 7, as well as Métis Nation of Alberta (Region 3) have the potential to be affected and/or have interest in MC1.

Table 2.1-4 Indigenous Peoples Potentially Impacted and/or Interested in the Option

Indigenous Peoples	Distance from MC1 Option area (approximate km)
Tsuut'ina Nation (IR 145)	downstream (east) 10 km
Stoney First Nations (IR 142-143-144) (Bearspaw, Chiniki and Wesley Bands)	North 30 km Northwest 37 km
Siksika First Nation (IR 146)	East 115 km
Piikani First Nation (IR 147)	South 175 km
Blood Tribe (IR 148)	South 200 km
Métis Nation of Alberta (Region 3)	N/A

The following sections provides a brief background on Treaty 7, including more specific information pertaining to Tsuut'ina Nation and Stoney First Nations, as well as Métis Nation of Alberta (Region 3).

To-date no Option-specific consultation has occurred with Indigenous peoples. Should the MC1 Option proceed through formal regulatory approvals processes, and should the Government of Alberta determine that consultation is required, additional Indigenous peoples may be identified and included.

Tsuut'ina Nation

Tsuut'ina Nation IR 145 is located approximately 10 km downstream of the MC1 Option area (**Figure 2.1-4**) covering 294.17 km^2 in area (INAC 2017). IR 145 is situated between Bragg Creek to the west, and stretches east, bordering the City of Calgary. As of March 2017, Tsuut'ina Nation has a registered population of 2,313 members, with 336 living off reserve (INAC 2017c).

IR 145 also includes the community of Redwood Meadows, located approximately 15 km downstream of MC1. Redwood Meadows is a residential community situated around an 18-hole golf course leased to Sarcee Developments, a wholly owned Tsuut'ina company. Redwood Meadows is jointly administered by an elected Mayor and Council and the Tsuut'ina Nation (Calgary Regional Partnership 2012). Tsuut'ina Nation is governed under a custom electoral system which elects 12 councilors, including Chief councilor, to three year terms.

Tsuut'ina Nation has acknowledged interests in the general area of McLean Creek through their feedback in review of the proposed SR1 Project. Both the MC1 Option and SR1 Project are located within Tsuut'ina Nation's asserted traditional territory, an area for which they hold Indigenous, treaty and inherent rights. To-date no Option-related consultation has been undertaken with Tsuut'ina Nation.

Potential interest Tsuut'ina Nation may have with respect to the MC1 Option includes:

- Potential impacts to land, fish & fish habitat and migratory birds.
- Potential impacts on Indigenous and/or treaty rights and interests including hunting, fishing and harvesting of medicinal plants.
- Permanent change to the Elbow River.
- Increase risk of flooding on the IR 145, the Municipality of Redwood Meadows, and the Band-owned Redwood Meadows Golf Course.
- Scoping of the environmental assessment, including appropriate integration of traditional land use and oral evidence.
- Potential impacts to human health and well-being as a result of increased noise, dust and air population during construction disrupting their quiet enjoyment of the land.
- Concerns about the land affected by the diversion of Highway 66 and any other additional access created by MC1.

- Potential to impact Tsuut'ina ability to develop reserve land in proximity to the Option, due to increase risk of flooding.

Tsuut'ina Nation has noted the proximity of the SR1 Project to Tsuut'ina reserve lands will likely result in greater risk to their rights and interests by potentially altering the course of the Elbow river, flooding Tsuut'ina traditional territory and/or reserve lands and altering surrounding ecosystems (CEA Agency 2016). Tsuut'ina Nation has also stated that the MC1 Option, being located in a higher watershed area, is a better option for Tsuut'ina and other flood-affected communities (Calgary Herald 2017).

Stoney (Nakoda) First Nations

As of March 2017, Stoney First Nations had a collective population of 5,592 registered members, with 678 living off reserve. The individual populations of each respective Nation are provided in **Table 2.1-5**.

Table 2.1-5 Registered Populations of Stoney First Nations

First Nation	Registered Population	Registered Population off Reserve
Bearspaw First Nation	1,974	210
Chiniki First Nation	1,764	210
Wesley First Nation	1,854	258
Total	5,592	678

Source: INAC 2017b

Each of the Stoney First Nations are governed under a custom electoral system with each electing five councilors, including Chief councilor, to three year terms.

Stoney First Nations have asserted interests in the general area of MC1 and the proposed SR1 Project, including Indigenous, Treaty and inherent rights. Both the Option and the Project are within their asserted Territory, where they would have historically traveled. To-date no MC1-related consultation has been undertaken with Stoney First Nations.

Interests or concerns Stoney First Nations have raised with respect to the SR1 Project, and which are notable to the MC1 Option, include:

- Proximately of lands to the SR1 Project
- Indigenous title and rights within their traditional territory (as per Wesley First Nation V Alberta Court of Queens)
- Asserted water rights were not extinguished by the signing of Treaty 7, concerned that the SR1 Project will affect these rights.
- Potential adverse effects to their current traditional use of the land for wildlife, fish, birds and vegetation

- Potential MC1-related effects to the access to, and enjoyment of, exercising their treaty rights and cultural practices
- Potential effects to wildlife.

Métis Nation of Alberta (Region 3)

Since its inception in 1928, the Métis Nation of Alberta (MNA) is the Métis Government in the province of Alberta. The purpose of the MNA is to support the inclusion of Métis Albertans interests in governments' policy and decision-making processes.

The MNA is governed by a Provincial Council, comprised of a Provincial President and Vice-President, and six regional Presidents and Vice-Presidents, all democratically elected. Region 3 represents the Springbank and McLean Creek areas (MNA 2017).

Region 3 Métis have a membership in excess of 25,000 people. To-date, there has been no engagement with MNA Region 3 and no concerns have been raised.

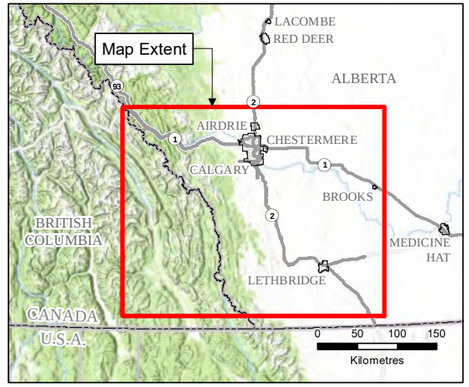
Treaty 8 (1899)

- Metis Nation of Alberta (Region 3) covers the entire map extent.
- Treaty 7 covers entire map extent except for a small portion in the northwest corner.

MC1 Option Location

Elbow River at McLean Creek Dam (MC1)

Indigenous Peoples Setting



Legend

- MC1 Option Location
- Hamlet
- Highway
- Treaty Boundary
- Reserve
- National Park
- Provincial Park
- Urban Area
- Watercourse
- Waterbody

Notes

1. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.
2. Metis Nation of Alberta (Region 3) covers the entire map extent.
3. Treaty 7 covers entire map extent except for a small portion in the northwest corner.

Sources

- Basedata: Government of Alberta
- First Nations Reserves: Governemnt of Alberta
- Background Image: ESRI World Topographic Map
- Inset Maps: ESRI World Topographic Map

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Alberta Transportation

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2.1.6 HISTORICAL RESOURCES

The MC1 Option would be a major undertaking that would have substantive surface and subsurface impacts on a large area, and activities associated with MC1 construction and operation have the potential to affect historical resources, including archaeological sites, traditional sites and areas, and palaeontological resources.

In April 2017, a Historical Resources Overview was completed to determine the nature and extent of the MC1 Option area's historical resources potential and evaluate the need for a Historical Resources Impact Assessment (HRIA) in accordance with the Alberta *Historical Resources Act.* A detailed report on this overview assessment is included as **Appendix 2-A Historical Resources Overview Elbow River at McLean Creek Dam (MC1)**, and a brief overview of the findings and recommendations is provided below. Should the MC1 Option proceed, the contents of the Historical Resources Overview would be submitted to Alberta Culture and Tourism for their assessment and they would issue a requirement for an HRIA or provide a *Historical Resources Act* approval that would allow the MC1 Option to proceed without an HRIA. An HRIA or *Historical Resources Act* approval would reduce project impacts on historical resources and, where possible, add to the archaeological, palaeontological and historical knowledge base for the area.

The Historical Resources Overview assessment involved a review of the general biogeophysical situation of the Option location, including surficial and bedrock geology, topography, geomorphology, vegetation, as well as the area's historical resource record, including past research in the area, recorded historical resource sites, palaeontological locales and related information. Key conclusions and recommendations are based on the following:

- The absence of any known historic structures, along with the general terrain of the MC1 Option area suggest there is little potential for any actual or possible historic structures to be impacted.
- The MC1 Option has the potential to impact historical resources, including archaeological sites and areas, palaeontological finds and locales, and traditional land use and resource sites.
- Completion of both archaeological and palaeontological HRIAs are recommended for areas where MC1-related surface or subsurface impacts to minimally disturbed or undisturbed natural terrain are likely.

2.2 MC1 OPTION BENEFIT

2.2.1 MC1 OPTION RATIONALE

The adverse health effects associated with flooding events are recognized globally. The World Health Organization recognizes direct and indirect health effects associated with flooding, varying from physical harm in the short-term to delayed mental health problems in the long-term (Hancock et al. 2015). Evidence observed in Canada suggests an increase in adverse health effects related to extreme weather events, with flooding being one of the most frequent types of extreme weather events (Austin et al. 2015; Warren

and Lemmen 2014). Flood mitigation is anticipated to have a positive effect on emergency preparedness and response in terms of flood reduction. The health benefits of flood reduction to health and regional health services are numerous; implementing flood reduction and flood damage mitigation strategies will reduce adverse health effects associated directly with pre-flooding, during, and post-flooding events.

The 2013 flood demonstrated the need for further flood mitigation along the Elbow River to reduce the effect of larger flood events and protect the downstream communities of Bragg Creek, Redwood Meadows, and Calgary and led to a number of flood mitigation options being considered including the MC1 Option. Subsequent sections of this EIS Report provide additional information on the broader range of flood mitigation options that were considered during flood mitigation planning that led to the selection of the SR1 Project.

2.2.2 MC1 Option History

Flood mitigation options for Calgary have been identified for decades. Alberta Environment and the City of Calgary commissioned the *1986 Elbow River Floodplain Management Study* (WER 1986). This study identified several flood mitigation options with the potential for additional flood water storage upstream of Calgary, including: the MC1 site, the Sarcee Reservoir site, and two diversions through Fish Creek Park: the Priddis and the Pirmez diversions.

In 2015, AEP conducted a review and cost benefit analysis of the SR1 Project and the MC1 Option, both of which entail the storage of flood water leading to a reduction in the peak river discharge through Calgary during flood events. For this review, both projects were presented at an early conceptual design level, with limited or no consultation activities being undertaken or baseline data being collected. The review concluded that the MC1 Option, when compared with the SR1 Project, would be costlier, have a higher risk for both cost increases and catastrophic failure, require a longer construction timeline, likely trap more bedload and thus have a greater impact on sediment transport within the Elbow River, and have a greater environmental impact (Deltares 2015). As a result of these findings, the SR1 Project was identified as having a higher benefit/cost ratio and in October 2015, AEP released a decision statement that indicated a decision to move forward with the SR1 Project (AEP 2015).

2.3 MC1 Option Alternatives

Alternatives to the SR1 Project are outlined the SR1 EIA report. The following section discusses the design refinements made to the MC1 Option during technical engineering workshops. Workshops were conducted to identify and review alternative designs and methods of construction for the MC1 Option. An option to construct MC1 as a central concrete gravity dam flanked by embankments (anchored dam) was eliminated due to prohibitive costs. Similarly, elimination of the permanent pond was considered but was not carried forward as an option for operational reasons.

The technical engineering workshops and subsequent evaluation of alternatives resulted in several refinements to the conceptual design, including creation of diversion tunnels rather than conduits, and reduction of the permanent pond and dam height while still providing adequate flood storage capacity, and to increase the cofferdam rating from 1:20 year flood to 1:50 year flood.

3.0 MC1 OPTION DESCRIPTION

3.1 THE PROPONENT

The Alberta Government would own and operate the MC1 Option. The Alberta Government owns and operates approximately 10% of the 1,550 regulated dams throughout the province (Government of Alberta 2017). Alberta Transportation would be responsible for the development, design, and construction of the MC1 Option.

If the MC1 Option is constructed, AEP would assume control and responsibility for the management and operation of the MC1 dam as part of its water management operations, which are responsible for managing, operating, and maintaining provincially owned water management infrastructure throughout Alberta. Existing dam infrastructure in southwestern Alberta regulated by AEP include the Glenmore Dam, Bearspaw Dam, Ghost Intake Dam, and Canyon Dam (Government of Alberta 2017). These dams all have a consequence classification of extreme.

3.2 TECHNICAL AND CONSULTANT TEAM

A team of qualified professionals have provided engineering and technical support for this EIS Report. The qualifications are described in **Table 3.2-1**. The environmental assessment process was managed by Hemmera Envirochem Inc. The Senior Technical Reviewer is Malcolm Smith, M.Sc., R.P.Bio; the Project Manager is Tim Wildling, PMP, LLB, and the EIS Lead is Lisa DeSandoli, M.Sc.

Engineering design was managed by Opus with support from Hatch, BGC Engineering, and other technical specialists. The engineering design team was responsible for the engineering cost estimate and construction schedule.

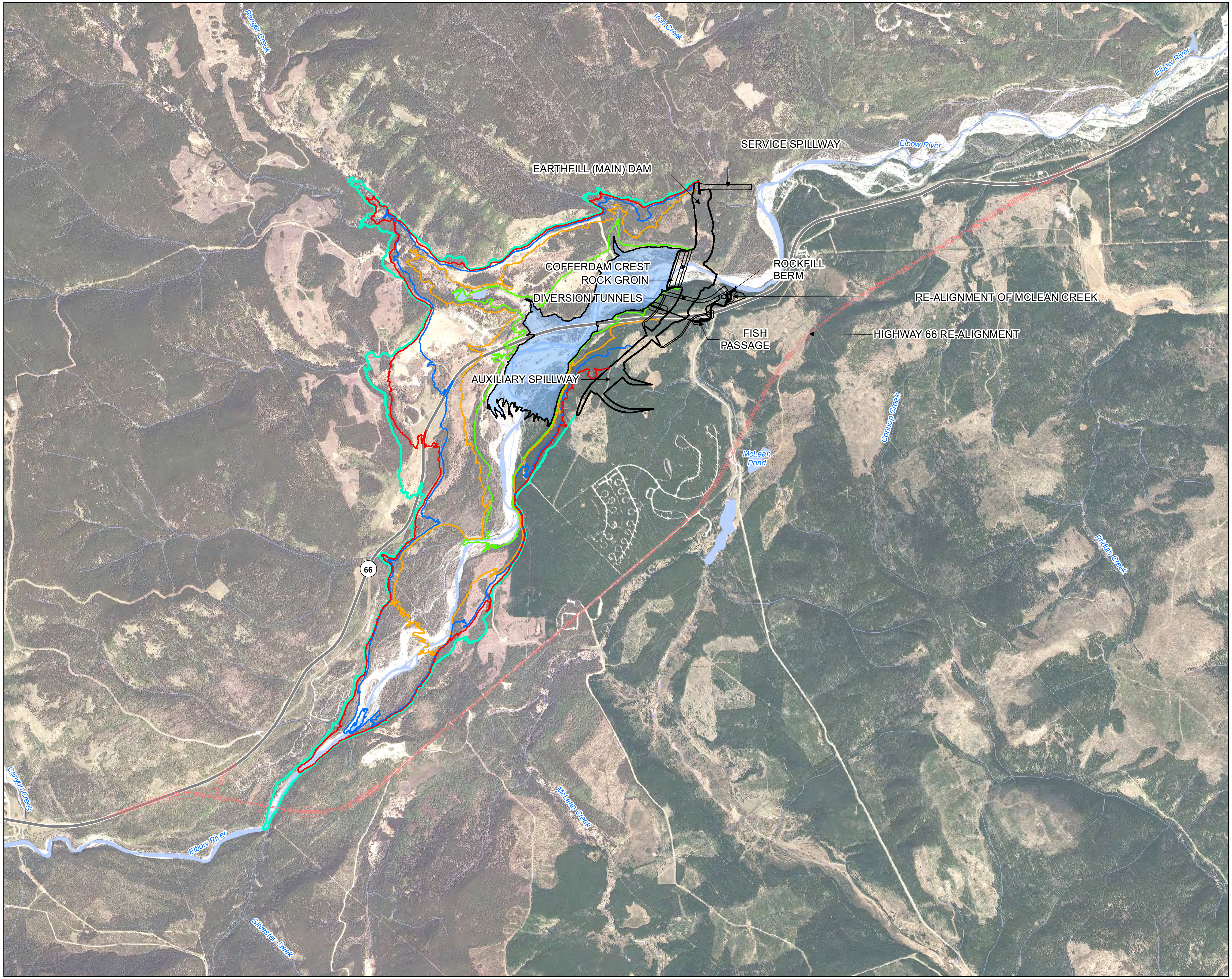
Table 3.2-1 Environmental Impact Screening Team

Company	EA Section	Responsibility
Hemmera Envirochem Inc.	Section 1.0 Introduction Section 2.0 MC1 Option Setting, Context and Rationale Section 3.0 MC1 Option Description (in conjunction with Opus Engineering) Section 4.0 Environmental Impact Screening Methodology Section 5.0 Summary of Environmental, Social and Economic Assessment Section 9.0 Planned Development Case Section 10.0 Effects of the Environment on the MC1 Option Section 11.0 Accidents and Malfunctions Section 12.0 Conclusion	Lisa DeSandoli, M.Sc., B.A.Sc.

Company	EA Section	Responsibility
	Section 6.1 Atmospheric Environment	Mark Milner, M.Eng., B.Ed., M.Sc., P.Eng.
	Section 6.2 Terrain and Soils	Ruth Hardy, P.Ag.,
	Section 6.3 Hydrogeology	Gerry Papini, P.Geo.
	Section 6.4 Fluvial Geomorphology	Lara Taylor, MRM, P.Eng.
	Section 7.2 Wildlife	Charlie Palmer, M.Sc., P.Biol., R.P.Bio Sheila Mckeage, B.Sc., P.Biol., R.P.Bio.
	Section 7.3 Aquatic Environment	Greg Eisler, B.Sc. (Honours), P.Biol., R.P.Bio
	Section 8.1 Land Use and Management and Infrastructure	Nina Barton, B.Sc., MRM
	Section 8.2 Socio-economic Assessment	Nina Barton, B.Sc., MRM
	Section 8.3 Public Health and Safety	Colleen Purtill, B.Sc., P.Biol., DAPT
Opus Stewart Weir	Section 3.0 MC1 Option Description (in conjunction with Hemmera)	Rob Lonson, P.Eng
Limnotek	Section 6.5 Water Quality	Chris Perrin, M.Sc., R.P.Bio
Maddison Consultants	Section 7.1 Vegetation	Micaele Florendo, B.Sc., P.Biol., R.P.Bio
Kendall Associates	Section 2.1.5 Indigenous Rights and Interests	Robert Kendall
Arrow Archaeology	Section 2.1.6 Historical Resources	Neil Mirau, BA, PhD (candidate)

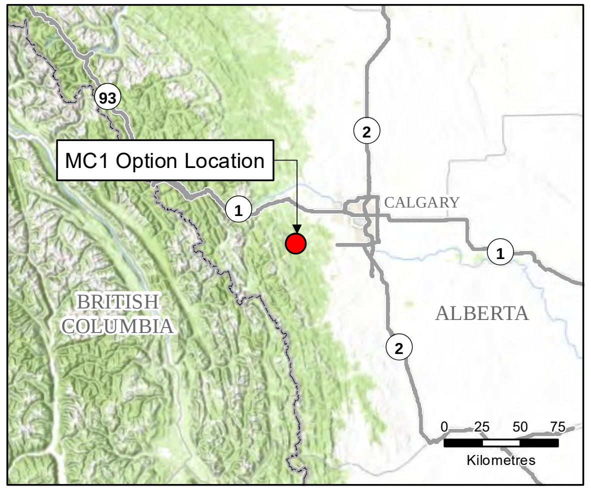
3.3 MC1 OPTION COMPONENTS

The MC1 Option would include an earth fill dam across the Elbow River valley, which would provide flow regulation within the river, upstream of its confluence with McLean Creek. Normal river flows would be controlled through two gated 6-m-diameter, low-level diversion tunnels located along the south side of the Elbow River channel. Other elements of the MC1 Option include an ungated service spillway and an auxiliary spillway to protect the MC1 dam during more extreme flood events. The permanent pond created by the dam would be approximately 3.5 million cubic metres (m^3) ($3.5*10^6$ m^3) of water. Material required for construction would be sourced from borrow areas located in the general vicinity of the MC1 components. The layout of the MC1 Option is shown in **Figure 3.3-1**.



Elbow River at McLean Creek Dam (MC1)

Option Layout



Legend

- MC1 Dam
- Highway 66 Re-alignment
- Probable Maximum Flood (PMF) Level
- 2013 Flood Event (1424.1 m)
- 1:100 Flood Event
- 1:20 Flood Event
- 1:50 Flood Event
- Permanent Pond
- Highway
- Watercourse
- Waterbody

Notes

1. All locations and features should be considered approximate and are to be used for discussion purposes only.
2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Basedata: Government of Alberta, 2017
- Preferred Road Option: Opus International Consultants Limited, 2017
- Dam Details: Hatch Ltd., 2016
- Aerial Imagery: SPOT 1.5 m, 2016
- Inset Basemap: ESRI Topographic Basemap

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The Elbow River has a watershed area of 702 km^2 upstream of the dam site (Opus 2017a). The MC1 Option would be designed to be capable of managing and mitigating the downstream effects of a flood of magnitude similar to the 2013 flood event. The primary objective, from a flood handling standpoint, would be to temporarily store water by regulating outflows during a large flood event to a release rate that is manageable by the Glenmore Reservoir (Opus 2017a). Outflows from MC1 would be larger than the 170 m^3/s Glenmore dam outflow, and the differential in flow between the MC1 outflow and the Glenmore Dam outflow would be stored within the Glenmore Reservoir. Over the approximately 65 hour period in which the 2013 inflows would exceed the critical flow of 170 m^3/s, this would require that MC1 releases be limited to an average flow of approximately 212 m^3/s.

The MC1 Option would be designed to withstand the probable maximum flood (PMF) with a maximum reservoir level of 1,428.1 m. The auxiliary spillway would be activated at a level of 1426.1 m. The PMF is defined as the most severe flood that may be reasonably expected to occur at a location. The probability of such a flood occurring is very low (e.g., once in some tens of thousands of years). The peak reservoir inflow rate for the PMF would be 2,770 m^3/s and the maximum reservoir volume would be 93 million m^{3,} (Opus 2017a). In the event of the PMF, the auxiliary spillway located along the south abutment of the dam would be activated. **Table 3.3-1** outlines the design criteria for the MC1 Option.

Table 3.3-1 Design Criteria for the Elbow River at McLean Creek Dam Option

	Permanent Pond	20-year Flood Event	100-year Flood Event	June 2013 Flood	500-year Flood Event	Probable Maximum Flood
Peak reservoir inflow rate (m^3/s)	13.4	440	930	1,240	1,984	2,770
Diversion tunnels peak discharge rate (m^3/s)	13.4	212	212	220	810	1,000
Service spillway peak discharge rate (m^3/s)	0	0	0	0	0	600
Auxiliary spillway peak discharge rate (m^3/s)	0	0	0	0	0	1,000
Maximum reservoir water surface elevation (m)	1395	1404.7	1419.8	1424.4	1,424.4	1428.1
Maximum total contained water volume (million m^3)	3.5	13.4	52.1	73.5	73.0	93.0

Option components are described in the following sections.

3.3.1 EARTH FILL (MAIN) DAM

The main dam would be an earth fill embankment with a clay core and a crest elevation of 1,429.0 m above datum. Impervious fill clay till used in the construction of the core of the dam would be sourced from borrow areas close to the dam (Opus 2017*a*). The maximum height of the main dam would be 50 m,

with 3H:1V (horizontal to vertical) slopes. The total length of the main dam would be approximately 2,400 m, ranging from approximately 250 m (upstream) to 100 m (downstream) through the valley. The left abutment wall would be as deep as 42 m and would be 370 m in length. The right abutment would be 7 m deep on average and a length of 930 m.The main dam would be designed to store water to an elevation of 1424.5 m, which would be the elevation of the service spillway. With diversion tunnel flow restricted to 220 m^3/s, this would protect the downstream environment from an event similar to the 2013 flood.

During dam construction, the dam foundation preparation in the Elbow River bed would consist of the removal of existing riverbed alluvium to expose the top of bedrock under the MC1 footprint. Under the central core of the dam, weathered rock would be excavated to a depth of 3 m, to expose sound bedrock. The bedrock would then be treated by slush grouting joints in the rock (Opus 2017a). Valley sections of the dam would be excavated back into the slopes with benches at an average slope of 1H:6V in rock and 2.5H:1V soil. A 3-m-wide bench would be created for every 6 m vertical excavation of rock for the central core area for construction staging an equipment access (Opus 2017*a*). In addition, the bedrock would be drilled and grouted creating a single grout line curtain in the rock consisting of 20 m deep primary and secondary grout holes (Opus 2017*a*).

3.3.2 COFFERDAM (CONSTRUCTION)

A cofferdam would initially divert water into the diversion tunnels to facilitate construction of the main dam. The cofferdam, with diversion tunnels fully open, would provide protection from a 1:50 year flood event. The cofferdam would be an earth embankment with a clay core, which crests at an elevation of 1,399.1 m. The height of the cofferdam would be approximately 19 m with 3H:1V slopes.

Two diversion tunnels (**Section 3.3.3**) would be constructed prior to the construction of the cofferdam during which time the river will flow in its natural channel (Opus 2017a). The upstream cofferdam will then be constructed in two phases. In the first phase, a low fill will be placed to a height of approximately five meters to divert flows to the diversion tunnels and to provide protection for foundation grouting and placement of impervious fill. In the second phase, the main cofferdam would be placed to a full height of approximately 19 m (Opus 2017*a*). The main cofferdam will be incorporated into the body of the main dam (Opus 2017*a*).

3.3.3 DIVERSION TUNNELS

Two gated diversion tunnels would be installed at an invert elevation of 1,384 m for the upstream. The vertical lift gates would be 4.7 m by 4.7 m and would be adjusted as required to maintain the permanent pond level, provide low flows downstream of the dam, and control flows and provide protection during flood events. Each diversion tunnel would be 6 m in diameter and 440 m in length. The inlet of diversion tunnels

would consist of a headwall, tunnel inlets and side wing walls. A portal face extending 6 m above the tunnel crown would be required to initiate tunneling and would be excavated by drilling and blasting in benches up slope (Opus 2017*a*).

During construction of the main dam, the diversion tunnels would divert flow around the dam structure. During operation, the diversion tunnels would pass normal flows. Mean summer flows are 13.4 m^3/s and mean winter flows are 3 m/s. During flooding, the diversion tunnels would convey flows up to 1000 m^3/s.

The diversion tunnels would discharge water into a rock stilling basin downstream of the dam. The stilling basin would be located at the current outlet of McLean Creek into Elbow River. The stilling basin would be 80 m long by 40 m wide and 5 m deep, and would dissipate energy from high velocity tunnel flows during normal operations and flood events. Riprap at the outlet of the stilling basin would provide erosion protection (Opus 2017*a*). A small fill extension upstream of the dam would provide access to the hoist house and stop logs would be installed at the portals of diversion tunnels to isolate the main gates where maintenance or repair would be required during operations (Opus 2017*a*).

3.3.4 SERVICE SPILLWAY

The service spillway would be an ungated concrete chute with a crest elevation of 1,424.5 m and width of approximately 40 m. The service spillway would be located on the northern end of the left abutment and would feature a fixed crested ogee weir. a long chute (approximately 410 m in length) down the existing slope to the Elbow River and a flip-buck near the river (Opus 2017*a*). The service spillway would be designed to discharge flows greater than the 2013 flood event as well as the PMF flow. During the PMF, the service spillways would be capable of discharging flows up to 600 m^3/s (Opus 2017*b*).

The service spillway chute would be founded on 2.5 m of granular fill to provide frost protection to the foundation soils and to provide under-slab drainage for seepage as well as precipitation entering the backfill (Opus 2017*a*). The flip-bucket would be situated at the base of the chute and would be constructed from concrete. The flip-bucket would be 25 m wide and between 4 and 8 m in thickness. The flip-bucket would throw spill releases a sufficient distance from the structure into the plunge pool, where the energy from these flows would dissipate as it re-joins the Elbow River (Opus 2017*a*). A concrete apron constructed at the outlet of the service spillway would provide erosion protection (Opus 2017*a*).

3.3.5 AUXILIARY SPILLWAY

The auxiliary spillway would be an earth-cut channel designed to pass flows and protect the main dam during a PMF event. The auxiliary spillway would have a crest height of 1,426.1 m and would be 200 m wide. During a PMF event, the auxiliary spillway would discharge flows up to 1,000 m^3/s (Opus 2017*a*).

3.3.6 PERMANENT POND

The permanent pond would be at elevation of 1,395 m, would have a surface area of approximately 72 ha, and would submerge approximately 2.6 km of river upstream. The permanent pond would hold approximately 3.5 million m^3 of water as dead storage. The purpose of the permanent pond would be to manage bedload or larger sediments that may damage the MC1 dam. Vegetation and organic soil would be cleared from the footprint of the permanent pond prior to inundation.

The planned water residence time in the permanent pond would be low to prevent effects to water quality. The planned spring and summer time water residence time of 3.5 days would meet this objective (**Table 3.3-2**). Summer water residence time would be sufficiently low to prevent stable temperature stratification and limit changes in temperature from that of the inflow Elbow River.

Table 3.3-2 Average Values of Hydrological Metrics for the Permanent Pond, by Season

Metric	Summer	Winter
Permanent pond volume (Million m^3)	4.0	5.0
Mean rate of outflow (m^3/s)	13.4	3.0
Mean water residence time (days)	3.5	19.3

Note: volume and flow data are from Opus (2017b).

3.3.7 RESERVOIR

The reservoir is the area immediately upstream of the MC1 dam that would be capable of containing a flood event similar in magnitude to the 2013 flood. During the PMF the water level in the reservoir would be at elevation 1,428.1 m. During routine operation, vegetation would be retained and the reservoir would be dry above the elevation of the permanent pond.

Duration of the inundation period would depend on flood volumes, but is anticipated to range from three days for a 1:20 year flood, to nine days for a flood event equivalent to the 2013 flood; and longer for a larger flood.

3.3.8 ROCK GROIN

A permanent rock groin would be installed within the Elbow River to facilitate the construction and protection of the cofferdam by channelizing river flows into the diversion tunnels. The inlets of the diversion tunnels would be 4 m to 5 m above the existing Elbow River streambed; thus, water must pool 4 m to 5 m before the tunnels become activated. During construction, the diversion tunnels would be fully opened to allow for water to freely pass through.

3.3.9 BORROW AREAS

Both granular and till material would be sourced from borrow areas located within the MC1 Option area. Possible borrow areas have been identified at key locations within the MC1 Option area.

3.3.10 FISH PASSAGE

A fish passage structure has been designed to mitigate the movement and passage of fish upstream and downstream of the dam site. The fish passage structure consists of an inlet structure/ fishway exit, bypass tunnel, nature-like fishway and outlet structure/fishway entrance. The fishway channel would be a 350 m long earthworks structure, constructed on an engineered fill foundation with a geomembrane/geotextile sandwich and base layer to prevent any deformation, seepage or leakage (Opus 2017b). The fishway would have an average slope of 5% and would be compatible with the hydraulic and geotechnical design of the dam and expected dam operational scenarios (Opus 2017a).

During operation, the water level within the fish passage tunnel would be maintained at an elevation of approximately 1394 m, and flows into the fish passage facility would be regulated at the intake to maintain this flow throughout the expected range in the permanent pond (Opus 2017*a*).

3.3.11 HIGHWAY 66 RELOCATION

Construction and operation of the MC1 dam would require the relocation of approximately 10 km of Highway 66, including a bridge across the Elbow River. A portion of the existing Highway 66 would be inundated by the permanent pond, and would be relocated to the south.

3.3.12 REALIGNMENT OF MCLEAN CREEK

Construction and operation of the MC1 dam would require the realignment of McLean Creek at its confluence with the Elbow River. A rock fill berm would be placed between McLean Creek and the rock stilling basin, into which the diversion tunnels would discharge, and McLean Creek would discharge into the Elbow River through an armoured channel consisting of riprap over bedding material to protect against erosion (Opus 2017*a*).

Existing Infrastructure including Provincial Parks and Elbow Ranger Station Facility Decommissioning and Removal

Existing infrastructure in the MC1 Option area is shown on **Figure 3.3-2.** Existing infrastructure in the vicinity of MC1 includes park infrastructure (Allen Bill and River Cove, McLean Creek Campground, Paddy's Flat Campground, Station Flats), the Elbow Valley Ranger Station, Highway 66, wellsites (including abandoned wells) and groundwater supply wells.

Provincial facilities would be affected by the placement of the MC1 Option. Provincial facilities that would be decommissioned and removed as part of the MC1 Option include the following:

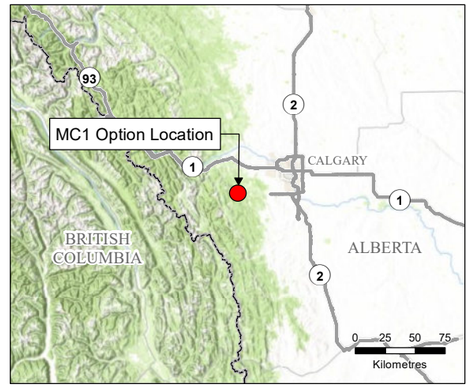
- Elbow Ranger Station and the associated water and wastewater treatment facilities
- Station Flats
- Allen Bill day use area and River Cove
- A portion of the McLean Creek Campground.

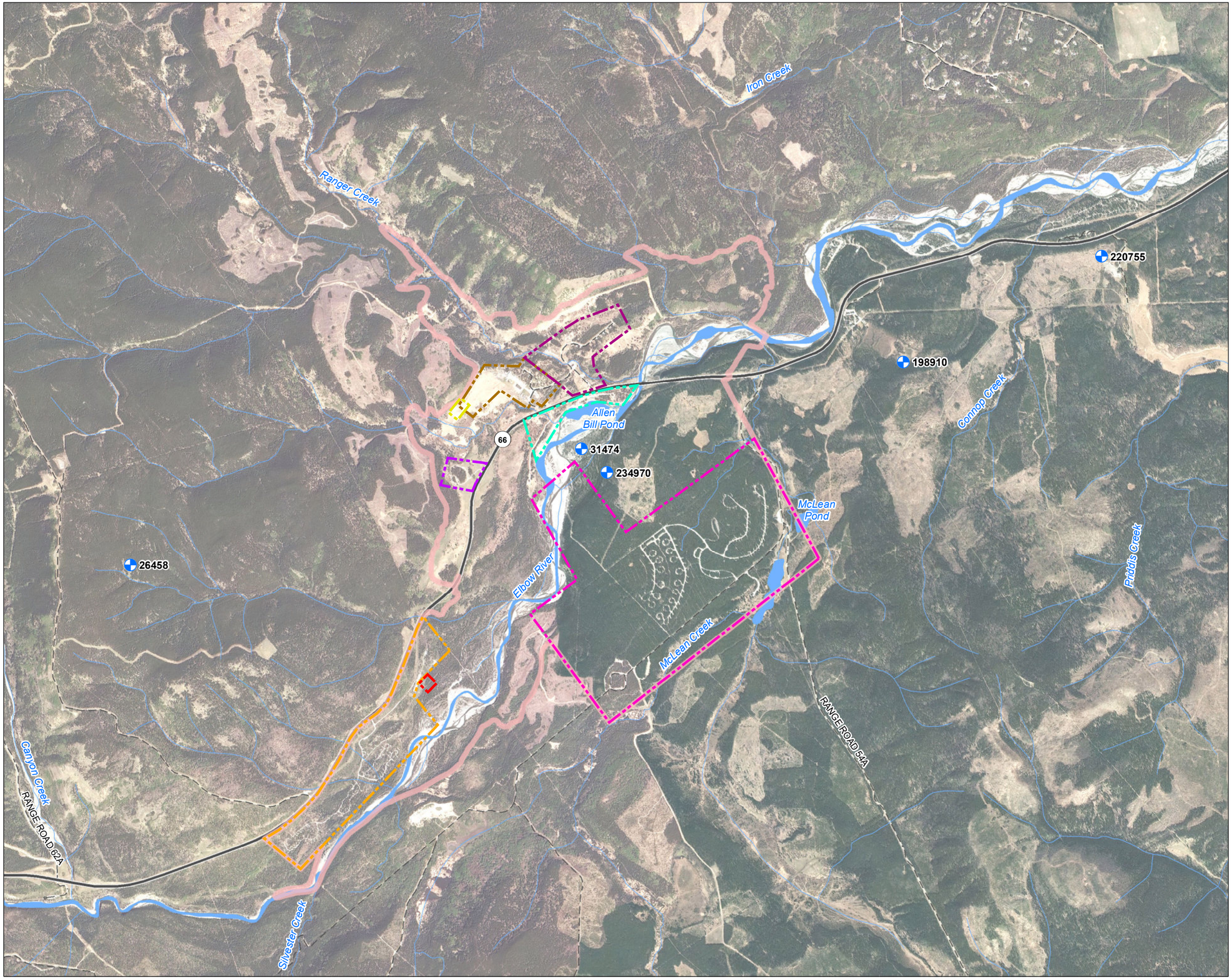
The remainder of the McLean Creek Campground and Paddy's Flat Campground are outside of the footprint of the current MC1 Option design and would not have to be decommissioned.

The location to where facilities would be relocated (e.g., Gooseberry Ranger Station) is not assessed as part of this EIS Report. If required, additional information on the relocation of facilities would be provided during more detailed designs.

Elbow River at McLean Creek Dam (MC1)

Existing Infrastructure in the Option Area





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- Groundwater Diversion License Location

Existing Infrastructure

- Abandoned 100/03-24-022-06-W5M Herron Petroleum Wellsite
- Allen Bill & River Cove Campground
- East Elbow Valley Ranger Station
- McLean Creek Campground
- Paddy's Flat Campground
- Abandoned 100/06-25-022-06-W5M Shell Wellsite
- Station Flats
- West Elbow Valley Ranger Station
- Phase I ESA Investigation Extents
- Highway
- Road
- Watercourse
- Waterbody

Notes

1. All mapped features are approximate and should be used for discussion purposes only.
2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Aerial Imagery: SPOT 1.5 m, 2016
- Inset Basemap: ESRI Topographic Basemap

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3.4 MC1 OPTION DEVELOPMENT PLAN

The development plan for the MC1 Option is outlined in the sections below.

3.4.1 CONSTRUCTION MATERIALS

Sources of materials and aggregate for the construction of MC1 (e.g., dam embankment) have been identified along with stockpile and spoil locations. **Figure 3.4-1, Figure 3.4-2**, **Figure 3.4-3** and **Figure 3.4-4** show the development of these areas.

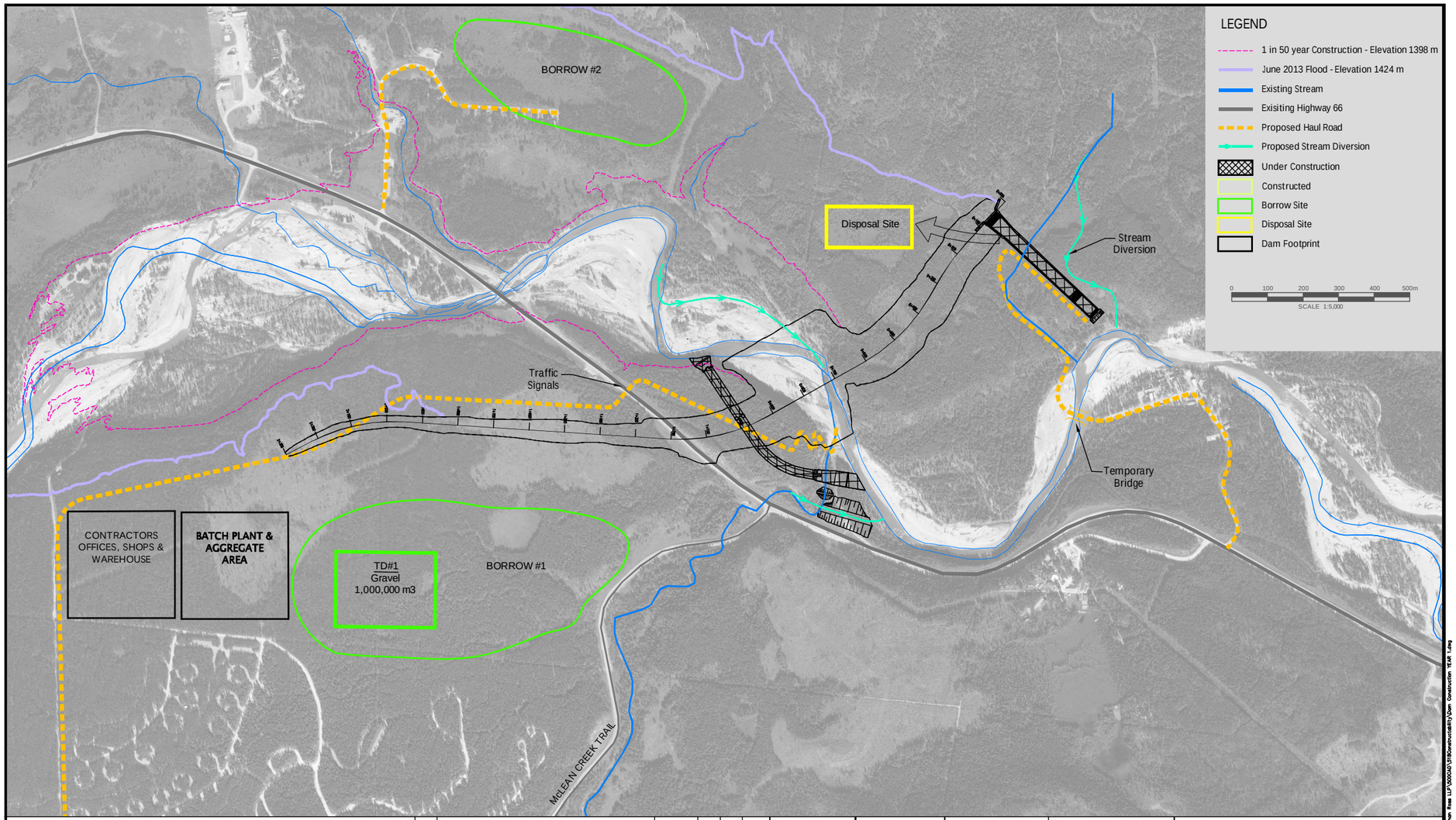
3.4.2 CONSTRUCTION SCHEDULE

Two detailed construction schedules for the MC1 Option were developed during conceptual design: a spring start schedule and fall start schedule (Opus 2017a). The fall construction schedule was selected late in the conceptual design stage, due to its shorter duration. The fall construction schedule outlines an approximate 3.5-year Construction phase with the facility operational for flood protection after three spring seasons. Many of the main MC1 components and relocation of infrastructure and facilities would be constructed and completed within the first two years. A general overview of activities to proceed is included in **Table 3.4-1** the sequencing of activities at the MC1 dam site are shown on **Figure 3.4-1** to **Figure 3.4-4**.

Table 3.4-1 Elbow River at McLean Creek Dam Option Construction Schedule – Fall Start

Construction Year	Tasks
Year 1	Initial site preparation, camp, garage and laydown installation; installation of access roads to spillway and borrow areas
	Diversion tunnel construction including excavation, drilling and blasting; tunneling at the upstream and downstream portals, erection and calibration of the shotcrete and concrete plants, and the fabrication and assembly of tunnel forms; concrete lining of portal structures, tunnels and stilling basin.
	Begin construction of service spillway
	Highway relocation including land clearing and earthworks; initial site preparation of access, staging area for bridge construction and construction of the substructure for the bridge across the Elbow River
	The relocation of McLean Creek store; initiation of demolition of the Elbow Valley Ranger Station; and construction of the Gooseberry Ranger station; McLean Creek campground lot replacement
Year 2	Continuation of the construction of the bridge across the Elbow River including construction of the superstructure and completion of the finishings
	Continuation of spillway construction
	Construction of main dam components including construction of the cofferdam, foundation preparation and grouting of central portion of the dam; construction of the right and left abutments; fish passage structure, and river channel rock trimming
	Continuation of highway relocation including paving, finishing and reclamation
	Completion of demolition of the Elbow Valley Ranger Station and infrastructure relocation

Construction Year	Tasks
Year 3	Completion of service spillway construction
	Completion of dam earthworks including balancing fill to specified elevation; testing and commissioning gates
	Demolition of the existing highway bridge
Year 4	Site restoration and reclamation, topsoil and seeding



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ISSUED FOR CONSTRUCTION		

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PERMIT NUMBER P 292
The Association of Professional Engineers and Geoscientists of Alberta

N.T.S.

MCLENNAN ROSS LLP

MCLEAN CREEK

YEAR 1

LEGAL DESCRIPTION

DWG. No.: C01

DATE: MAR. 30, 2017

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Elbow River at McLean Creek Dam (MC1)

Elbow River at McLean Creek Dam Site Construction – Year 1

Legend

Refer to OPUS figure C01

Notes

1. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Cross-section completed by AMEC Environment and Infrastrucure. Environmental Overview of the Conceptual Elbow River Dam at McLean Creek, 2015.

Scale: Refer to OPUS figure C01

Page Size: 11" x 17"

2025-001.01	Production Date: Sep 15, 2017	Figure 3.4-1

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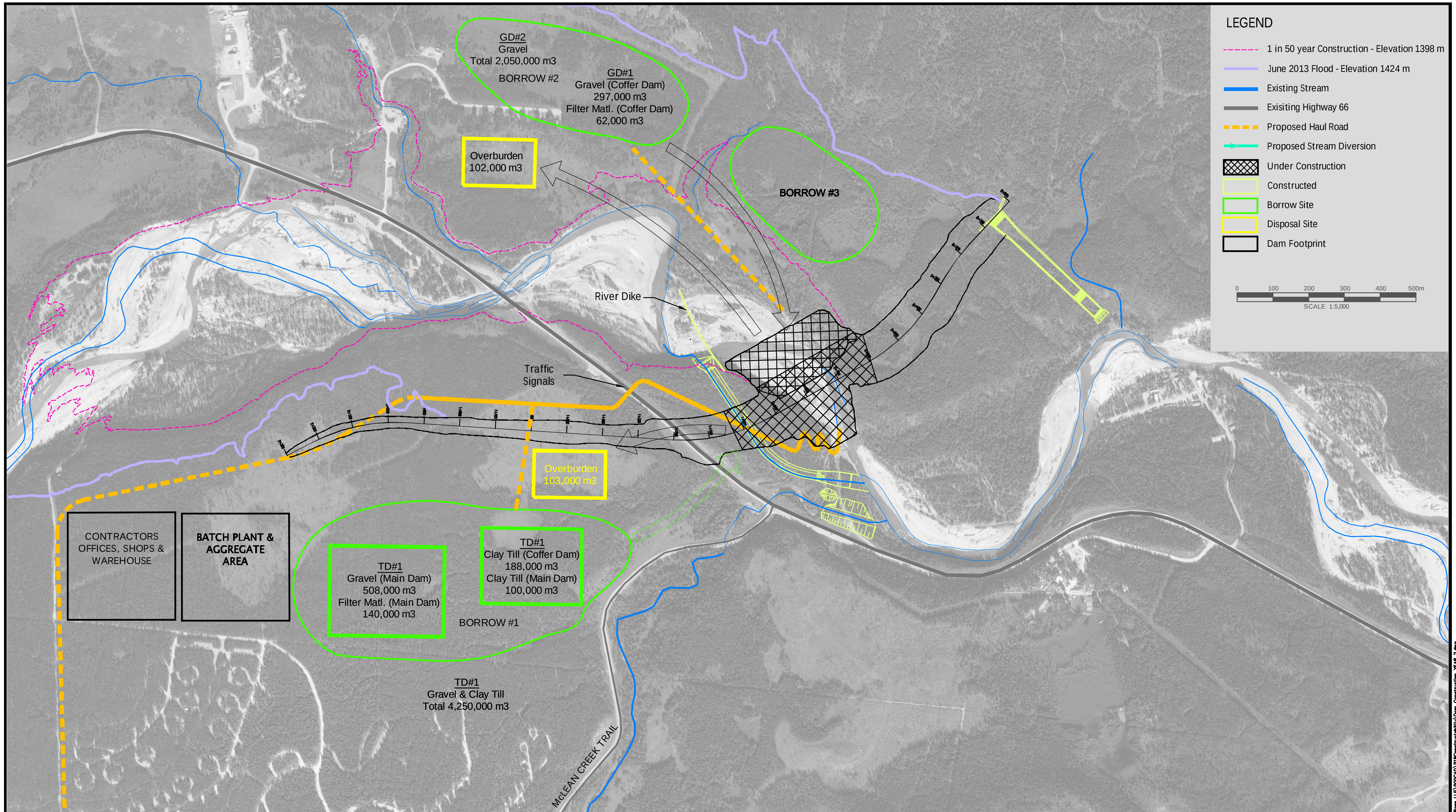
Alberta Transportation

Elbow River at McLean Creek Dam (MC1)

Elbow River at McLean Creek Dam Site Construction – Year 2



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ENGINEERING RECORD

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The Association of Professional Engineers and Geoscientists of Alberta

N.T.S.

MCLENNAN ROSS LLP

MCLEAN CREEK

YEAR 2

LEGAL DESCRIPTION

DWG. No.: C02

DATE: MAR. 30, 2017

Legend

Refer to OPUS figure C02

Notes

1. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Cross-section completed by AMEC Environment and Infrastrucure. Environmental Overview of the Conceptual Elbow River Dam at McLean Creek, 2015.

Scale: Refer to OPUS figure C02

Page Size: 11" x 17"

2025-001.01	Production Date: Sep 15, 2017	Figure 3.4-2

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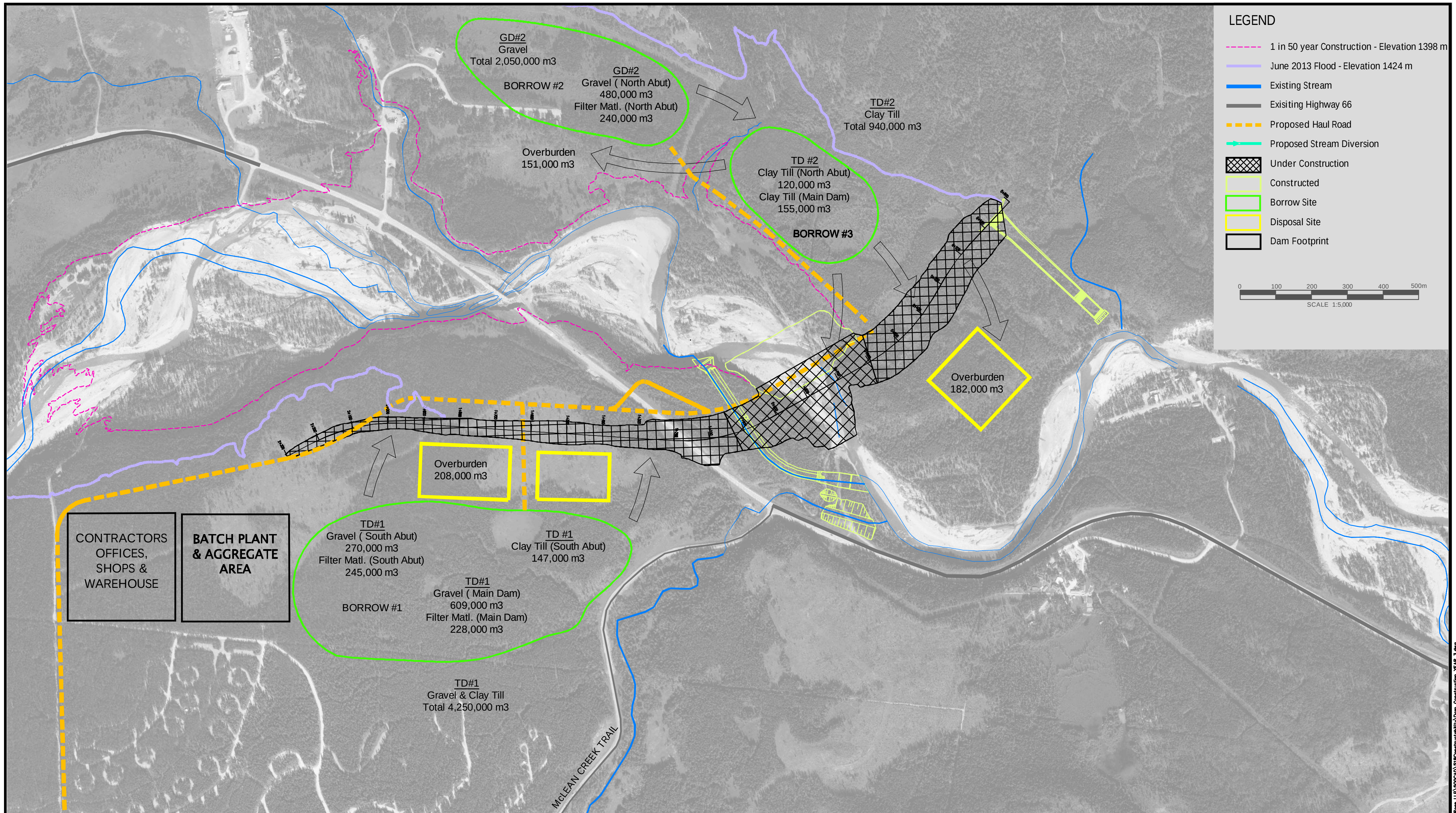
Alberta Transportation

Elbow River at McLean Creek Dam (MC1)

Elbow River at McLean Creek Dam Site Construction – Year 3



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MCLENNAN ROSS LLP

MCLEAN CREEK

YEAR 3

LEGAL DESCRIPTION

DWG. No.: C03

DATE: MAR. 30, 2017

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Refer to OPUS figure C03

Notes

1. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Cross-section completed by AMEC Environment and Infrastrucure. Environmental Overview of the Conceptual Elbow River Dam at McLean Creek, 2015.

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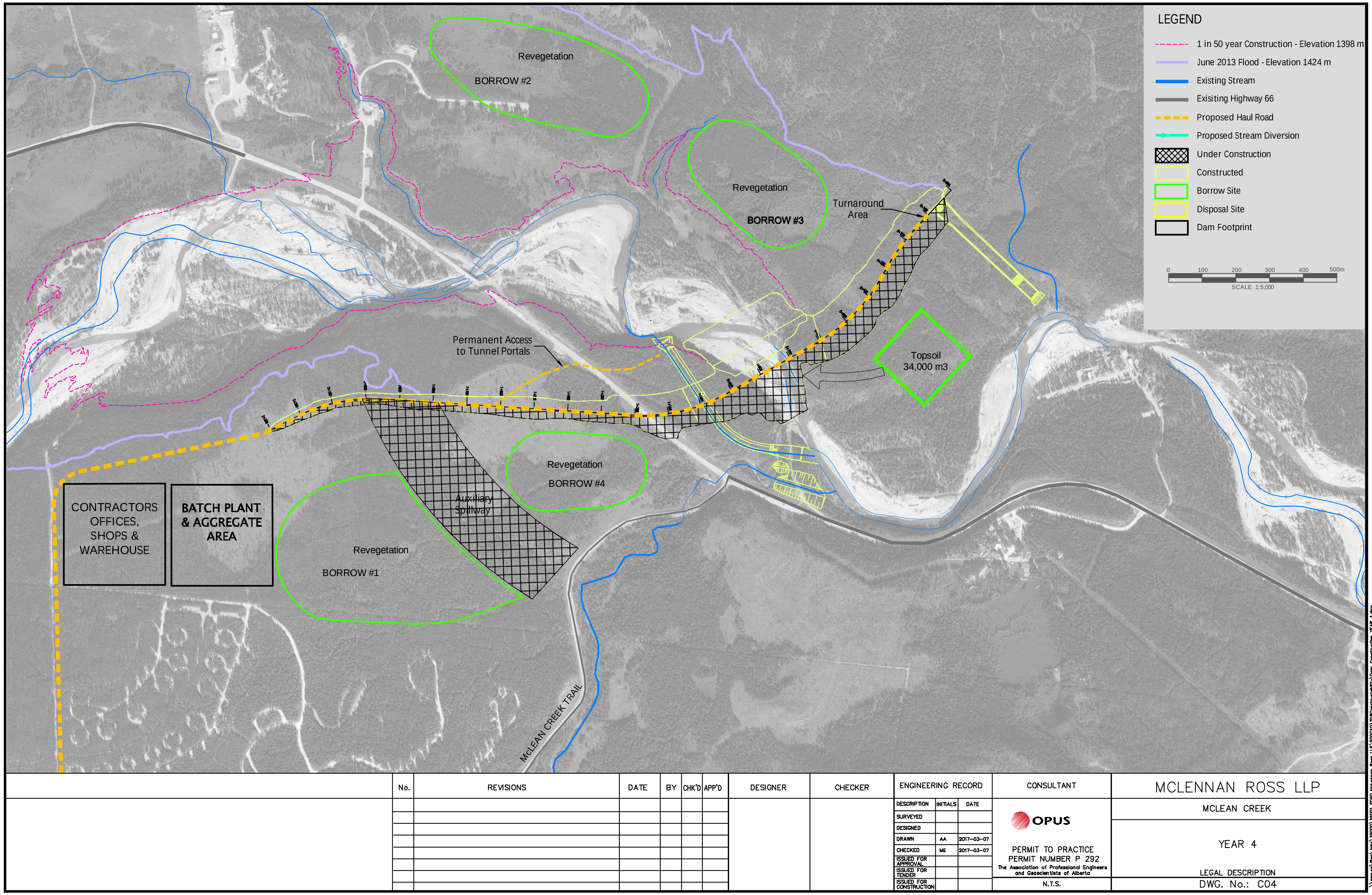
Alberta Transportation

Elbow River at McLean Creek Dam (MC1)

Elbow River at McLean Creek Dam Site Construction – Year 4



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Refer to OPUS figure C04

Notes

1. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Cross-section completed by AMEC Environment and Infrastrucure. Environmental Overview of the Conceptual Elbow River Dam at McLean Creek, 2015.

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Page Size: 11" x 17"

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3.5 CONTAMINATED SITES

In support of the MC1 Option planning, a Phase I Environmental Site Assessment (ESA) was conducted within MC1 Option area (**Appendix 3–A Phase I Environmental Site Assessment Elbow River at McLean Creek Dam (MC1) Option**). The objective of the Phase I ESA was to identify areas of potential environmental concern (APECs) and contaminants of potential concern associated with present and/or historical on-site and off-site activities that may have impacted soil and/or groundwater. Based on the findings of the Phase I ESA, further environmental investigation (i.e., **2017 Phase II Environmental Site Assessment Elbow River at McLean Creek Dam (MC1) Option, Appendix 3–B**) was recommended at the West and East Elbow Valley Ranger Station, as well as the 100/06-25-022-06 W5 Shell Canada Ltd. and 100/03-24-022-06 W5 Herron Petroleum Ltd. abandoned wellsites (see **Figure 3.4-1**).

Soil analytical results from the Phase II ESA indicated elevated metals concentrations in the septic field, toluene at the helicopter fuel cache, and polycyclic aromatic hydrocarbons at the aboveground storage tank (AST)/former underground storage tank (UST) area. Soil samples collected near the septic fields indicated several nutrients above background levels.

Dissolved metals concentrations in groundwater samples exceeded applicable guidelines at the sump load-out for the administration building (for the workshop and wash bay) and near the AST/former UST area. These impacts appear to be associated with changes in water oxidation - reduction chemistry associated with the breakdown of organic matter (e.g., hydrocarbons). Groundwater samples collected in the AST/former UST area also indicated concentrations of nitrate greater than guideline values. The groundwater sample collected from the wash bay area also indicated a nitrite concentration greater than guideline values. The source of nitrate and nitrite in groundwater remains unclear although exceedances may be associated with use of nitrogen containing soaps in the wash bay, or migration from the up-gradient septic fields.

A cost was assigned to each potential environmental liability item that was identified during the ESA. These values were aggregated to produce a total environmental liability estimate for each site. The liability estimates associated with each location are presented in **Appendix 3-C Environmental Liability Assessment Elbow River at McLean Creek Dam (MC1) Option**.

Additional recommendations of the Phase I ESA were to install secondary containment at the helicopter fuel cache (45 gallon drums), paint trailer, and fuel storage shed. Prior to decommissioning infrastructure within the focus sites, a qualified assessor should be retained to obtain and analyze samples from onsite infrastructure for hazardous building materials.

3.6 PROPOSED OPERATIONS

There are three potential scenarios for the operation of the MC1 dam. The MC1 dam is expected to be operated based on the inflows to the reservoir:

- **Non-flood conditions** – Under non-flood conditions, inflows would be passed through the diversion tunnels.
- **Flood conditions** – The MC1 Option would be designed to be capable of absorbing and mitigating the downstream effects of a flood of magnitude similar to the 2013 flood event. If inflows to the MC1 Option area began to exceed approximately 2120 m^3/s, water would be retained in the reservoir and the water surface elevation would therefore rise.
- **Large flood conditions** – If the level in the reservoir reached a level above 1424.4 m, the tunnel gates would be opened further and flows downstream of the MC1 dam would be increased, which would limit the water surface elevation increase in the reservoir and reduce the risk that the spillways will be required.

Both the service and auxiliary spillways are only expected to be required during large flood events (e.g., the 2013 flood). When the reservoir elevation exceeds 1,424.5 m, flows would begin to pass down the service spillway. If reservoir levels continued to rise to 1,426.1 m, water would begin to be conveyed down the auxiliary spillway.

3.7 WATER MANAGEMENT

The Alberta *Water Act*, RSA 2000, c. W-3, regulates activities that alter flows or water levels in a water body, and the Water (Ministerial) Regulation of the *Water Act* regulates dam safety. Constructing MC1 would alter water levels upstream of the dam and flows in the Elbow River downstream of the dam. Accordingly, the MC1 Option would require approval under the *Water Act* prior to construction as well as a licence under the *Water Act* to operate the dam.

The MC1 dam would pass flows during normal operations and no effects to water consumption uses upstream or downstream of MC1 are anticipated. During a flood event, the MC1 dam would retain flood waters and regulate downstream flows which would likely benefit users.

3.7.1 REFERENCES

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4.0 ENVIRONMENTAL IMPACT SCREENING METHODOLOGY

This section presents the methodology for the Environmental Impact Screening (EIS) Report for the Elbow River Dam at McLean Creek (MC1) Option.

4.1 ANALYSIS OF ALTERNATIVE MEANS TO THE SR1 PROJECT

The MC1 Option EIS Report has been developed to facilitate a comparison of this alternative option with the Springbank Off-stream Reservoir (SR1) Project. In addition, the MC1 EIS Report has been developed to comply with the requirements of *Addressing "Purpose of" and "Alternative Means" under the Canadian Environmental Assessment Act, 2012* SC 2012, c. 19, s. 52 (CEAA 2012) (CEA Agency 2015), and provides an assessment of potential environmental effects and proposed mitigation in a manner that aligns as much as practical with the SR1 Project Environmental Impact Assessment (EIA).

As identified by the CEA Agency (2015), the four steps of an alternative means analysis include the following:

- Step 1: Identify technically and economically feasible alternative means.
- Step 2: List their potential effects on Valued Components (VCs).
- Step 3: Select the approach for the analysis of alternative means
  - Case A – Identifying a preferred means
  - Case B – Bringing forward multiple alternative means.
- Step 4: Assess the environmental effects of the alternative means.

The SR1 Project is the selected project. The MC1 Option has been identified to support Step 3, Case A – identifying a preferred means. The *McLean Creek (MC1) Dam Updated Conceptual Design Report – Final* (Opus 2017) was developed as part of the options assessment to support the SR1 EIA submission. This EIS Report identifies and evaluates the potential effects on VCs, and compares them, as much as practical, with the SR1 Project, based on the conceptual design of the MC1 Option. The SR1 EIA will include a concise summary documenting Steps 1 to 3 of the alternative means analysis. This MC1 EIS Report assesses the environmental effects of the alternative means.

4.2 SCREENING METHODOLOGY

The EIS Report methodology outlined in this section provides a structured framework that is consistently applied to the assessment of values that are considered in the EIS Report. This methodology follows recommended guidelines and legislated requirements, pursuant to the Alberta *Environmental Protection and Enhancement Act*, RSA 2000. c.e-12 (EPEA). The EPEA outlines the environmental assessment process and regulates water infrastructure projects (i.e., dams greater than 15 metres (m)), the release of hazardous and non-hazardous substances and conservation and reclamation activities.

Additional provincial general legislation that would apply to the MC1 Option includes the *Public Lands Act,* RSA 2000, c.p-40 and the *Water Act*, RSA 2000, c.w-3. As per Sections 2 and 54 of the *Public Lands Act*, any modifications or structures that may affect the bed and shore below the high water mark are subject to review. The MC1 Option would also be subject to review under the *Water Act* related to Dam Safety and Authorization to Construct and Operate. It is expected the MC1 dam structure would be classified by the Canadian Dam Association (CDA) as a 'very high consequence dam" and would be designed, reviewed and regulated accordingly. To this end, it would need to comply with the *Water Act* and Part 6 of the Water (Ministerial) Regulation (A.R. 205/1998), which establishes dam and canal safety requirements. It is expected the MC1 Option would be reviewed for compliance with both the *Alberta Dam and Canal Safety Guidelines* (Alberta Government 1999) and the CDA *Dam Safety Guidelines* (CDA 2013. In addition, an authorization under Part 4 of Alberta *Water Act* would be required for the construction and operation of the MC1 Option.

The MC1 Option would not meet the threshold of the Regulation Designating Physical Activities (SOR/2012-147), and would not be subject to review under CEAA 2012; i.e., 1,500 hectares more than the natural water body. Where possible, effects requiring consideration under CEAA 2012 have been scoped into the MC1 EIS Report to provide comparison to the environmental effects of the SR1 Project. Section 5(1)(a) of CEAA 2012 requires the assessment of assessment of fish and fish habitat as defined in subsection 2(1) of the *Fisheries Act*, RSC 1985, c. F-14, aquatic species defined in subsection 2(1) of the *Species at Risk Act*, SC 2002, c. 29, and migratory birds as defined in subsection 2(1) of the *Migratory Birds Convention Act 1994*, SC 1994, c. 22. In addition, section 5(1)(c) of CEAA 2012 requires an assessment of the effect of the changes to the environment on Aboriginal peoples.

Additional general federal legislation that would apply to the MC1 Option includes the *Canadian Environmental Protection Act*, *1999*, SC 1999, c. 33, which provides the framework for protection of the environment and human health.

The methodology for this EIS Report has been developed with consideration of the following documents:

- Guide to *Preparing Environmental Impact Assessment Reports in Alberta* (AEP 2013)
- *Cumulative Effects Assessment in Environmental Impact Assessment Reports Required under the Alberta Environmental Protection and Enhancement Act* (AEP et al. n.d.)
- *Final Guidelines for the Preparation of an Environmental Impact Assessment for the Springbank Off-stream Reservoir Project* (EIS Guidelines; CEA Agency 2016)
- *Addressing "Purpose of" and "Alternative Means" under the Canadian Environmental Assessment Act, 2012* (CEA Agency 2015)

The MC1 EIS Report considers three development scenarios: Baseline Case, Application Case, and Planned Development Case. The assessment methodology follows five main steps, namely:

- Issues scoping
- Describing baseline conditions (Baseline Case)
- Assessing potential MC1-related effects and measurable parameters (Application Case)

- Specifying follow-up monitoring.
- Assessing cumulative effects (Planned Development Case)

4.3 ISSUES SCOPING

Candidate VCs were reviewed and selected for their applicability to the MC1 Option. Valued Components were selected that may interact directly with MC1-related activities or potentially affect other physical, biophysical or human components when disturbed. The following sections present the selected VCs, as well as the assessment boundaries and measurable parameters.

4.3.1 SELECTED VALUED COMPONENTS

The selected VCs for the MC1 EIS Report, along with the potential interaction between the MC1 and the VC, are presented in **Table 4.3-1**. Valued Components that were considered for inclusion in the MC1 EIS Report, but ultimately not selected, are presented in **Table 4.3-2**, along with the rationale for their exclusion.

Table 4.3-1 Selected Valued Components for the Elbow River McLean Creek Dam Option

EIS Report Section	Selected VC	Interaction
Section 6.1 Atmospheric Environment	Air Quality	MC1-related activities may result in emissions of air contaminants and contribute to changes in air quality in the project area.
	Climate and Climate Change	MC1-related activities may result in emissions of greenhouse gases and contribute to climate change.
	Noise	MC1-related activities may result in changes of noise levels and low frequency noise in the project area.
Section 6.2 Terrain and Soils	Terrain and Soils	MC1-related activities may change soil quantity and quality, slope stability and topography, as well as increase erosion and cause effects due to inundation and sediment deposition.
Section 6.3 Hydrogeology	Groundwater Quantity	Changes to the groundwater recharge and interaction with surface water would result from the flooding upstream of the dam and interception of groundwater flow through the Elbow River Valley by the MC1 dam.
	Groundwater Quality	Presence of the permanent pond, and interception of flow downstream of the dam could influence groundwater quality adjacent to the pond and, to a lesser extent, the flood footprint.
Section 6.4 Fluvial Geomorphology	Fluvial Geomorphology	Construction of the dam, and impoundment of water, would result in sediment build up in the reservoir and increased erosion downstream of the dam, which would change channel morphology in the Elbow River.
Section 6.5 Water Quality	Surface Water Quality for Aquatic Organisms	The construction and operation of the MC1 dam would change water quality in the Elbow River and the area of the permanent pond. Such changes in water quality could change habitat conditions for aquatic organisms.
	Drinking Water Quality	MC1-related construction activities (e.g., land clearing and decommissioning of facilities) may adversely affect water quality by mediating chemical contaminants, pathogens and sediment transport to watercourses. Immediately following permanent pond filling, water quality may change from that presently found in the river, and may not meet standards for drinking water supply.

EIS Report Section	Selected VC	Interaction
Section 7.1 Vegetation and Wetlands	Vegetation	MC1 could displace and alter vegetation species composition and extent through both permanent and periodic inundation, direct removal during construction, and potential spread of invasive species during construction and flooding.
	Wetlands	MC1 may affect wetlands through both permanent and periodic inundation of the reservoir, as well as by direct removal during construction, change in wetland functionality and/or classification resulting from the change in the water table, and the potential spread of invasive species during construction and flooding.
Section 7.2 Wildlife and Wildlife Habitat	Grizzly Bear	Grizzly bear are known to occur in the vicinity of the Option area and interactions with MC1 components or activities are likely. Grizzly bear are listed as At Risk provincially and Endangered under the Alberta *Wildlife Act*, RSA 2000, c. W-10, and as Special Concern by the Committee on the Status of Endangered Wildlife in Canada. The MC1 Option area is within a Grizzly Bear Zone and in a Recovery and Support Zone, which is defined in the Grizzly Bear Recovery Plan.
	Ungulates	Ungulates (moose, deer, elk) are known to occur in the vicinity of the MC1 Option area, and interactions with MC1 components or activities are likely. The MC1 Option area is in a Key Wildlife Biodiversity Zone. These zones are established to protect habitats that support wintering ungulates and biodiversity. Ungulates are harvested species with economic and social importance to First Nations, the public, and the Government of Alberta
	Bats	Bats are likely present in the vicinity of the MC1 Option area based on range maps and available habitats, and interactions with MC1 Option components or activities are likely. Little brown bat and northern long-eared bat are schedule 1 species under SARA
	Birds Breeding birds Raptors and owls Harlequin duck Piscivorous birds	Birds are known to occur in the vicinity of the MC1 Option area, and interactions with MC1 components or activities are likely. Most bird species and their nests are protected by the *Migratory Birds Convention Act* and the *Wildlife Act.* Harlequin duck is identified in the Kananaskis Country Provincial Recreation Area and Bragg Creek Provincial Park Management Plan as a species of management concern.
	Amphibians and reptiles	Amphibians and reptiles include species of management concern to science, the public, and regulators due to their sensitivity to environmental change and population declines
Section 7.3 Aquatic Environment	Fish and Fish Habitat	The creation of the MC1 dam would result in changes to existing fish habitat, may indirectly affect fish habitat in adjacent areas in the Elbow River and tributaries, and may create new different habitat in the permanent pond and flood inundation areas. These changes may indirectly affect species distribution and abundance upstream and downstream of the dam.
Section 8.1 Land Use and Management	Land Use and Management	Construction and operation of MC1 would result in changes in current uses of some lands and resources including: recreational use of lands and waterways, access to recreational and resource use areas, and land use policies and resource management initiatives. The MC1 Option would also result in changes, including removal or relocation, to existing infrastructure including roads, buildings, facilities, water supply wells and abandoned oil wellsites.

EIS Report Section	Selected VC	Interaction
Section 8.2 Socioeconomic Resources	Socioeconomic Resources	The MC1 Option would result in changes, including some benefits, to local and regional economies and the regional labour market as a result of employment and capital expenditures related to constructing and operating MC1.
Section 8.3 Public Health and Safety	Public Health and Safety	Public health may be affected by MC1-related changes to air quality, drinking water quality, soil quality, and noise levels. Changes in traffic flow and MC1-related construction and operation activities may interact directly with public safety. The MC1 Option would mitigate flood risks downstream of the site, which would also directly affect public health and safety.

Table 4.3-2 Valued Components not selected for the Elbow River at McLean Creek Dam Environmental Impact Screening Report

Selected VC	Rationale
Contaminated Sites	Although some potential contaminants of concern were identified in some areas that would be decommissioned as part of the MC1 Option, assessment of contaminated sites is addressed through the Alberta Environmental Site Assessment Guidelines and the Canadian Standards Association (CSA) Standard Z678-01 - Phase I Environmental Site Assessment (ESA) and CSA Standard Z769-00 – Phase II ESA requirements for Phase I and II studies. The Phase I ESA and Phase II ESA are included as **Appendix 3-A** and **Appendix 3-B,** respectively.
Hydrology	Although the creation of the MC1 dam would alter the surface hydrology of the Elbow River, the purpose of the MC1 Option is to reduce peak flows in the Elbow River during a flood event. Hydrology is discussed in **Section 2.1 Option Setting**.
Historical Resources	A Historical Resources Overview was conducted for the MC1 Option; findings are summarized in **Section 2.1 Option Setting**, and the report is attached as **Appendix 2-A**. If the MC1 Option were to proceed, the contents of the Historical Resources Overview would be Alberta Culture and Tourism, which would either issue a requirement for an Historical Resources Impact Assessment or provide a *Historical Resources Act* (RSA 2000, c. H-9) approval that would allow the MC1 Option to proceed without an Historical Resources Impact Assessment.
Traditional Knowledge	A summary of Indigenous rights and interests in the MC1 Option area is presented in **Section 2.1 Option Setting**. No MC1-specific consultation has been conducted for this assessment. Traditional Knowledge is held by the community, and only with direct consultation and negotiation could an agreement be reached for them to gather and share that information with the Proponent; therefore, Traditional Knowledge is not included as a VC.

4.3.2 ASSESSMENT BOUNDARIES

Assessment boundaries define the maximum limit within which the effects assessments are conducted. Spatial and temporal boundaries encompass the areas and times within which the MC1 Option likely interact with the VCs. Each discipline section of the EIS Report describes spatial and temporal boundaries and the rationale for their selection, as well as any administrative (i.e., political, economic, fiscal or social constraints that may not align with the assessment boundaries) and technical boundaries (i.e., constraints imposed on the EIS Report by limitations in the ability to predict the effects of the MC1 Option), if applicable.

4.3.2.1 Spatial Boundaries

Local and regional assessment boundaries are identified for each discipline based on the spatial characteristics of the MC1 Option and the VCs identified for the discipline, as well as for additional areas within which MC1-VC interactions and effects are expected to occur. Each discipline section in the MC1 EIS Report describes how scientific and other information influenced the establishment of spatial boundaries, and indicates how consideration of technical or administrative boundaries, as applicable, were factored into the selection of the spatial boundaries.

Definitions for the spatial boundaries established for the assessment of potential MC1-related effects are defined in **Table 4.3-3**, and the spatial boundaries for the VCs are presented in **Table 4.3-4**.

Table 4.3-3 Spatial Boundary Definitions

Spatial Boundary	Description of Assessment Area
MC1 footprint	Area in which MC1-related physical disturbance is anticipated to occur.
MC1 Option area	Area in which MC1-related physical disturbance is anticipated to occur, plus a 100-m buffer around the: · embankment and excavation areas · spillways and outlet works · road relocation.
Local Assessment Area(LAA)	Encompasses the area within which the MC1 Option would be likely to interact with and potentially result in effects to the VCs. Based on the design flood of the 2013 flood event, and includes the downstream area of influence, where applicable.
Regional Assessment Area (RAA)	Provides the regional context for the assessment of potential MC1-related effects within the LAA; unless otherwise indicated, the RAA also encompasses the area within which MC1-related residual effects on the VCs are likely to combine with the residual effects of other projects and activities to result in a cumulative effect on the VCs.

The Local Assessment Area (LAA) for each discipline encompasses the maximum geographical area within which the MC1 Option would belikely to interact with and potentially have a direct or indirect effect on the VCs identified for that discipline. In determining LAA boundaries, consideration is given to the nature and characteristics of each VC, and its potential exposure or susceptibility to various influences (e.g., changes caused by the MC1 Option or along the pathways of effects). The downstream area of influence (AOI) is included as part of the LAA for the relevant VCs. The downstream AOI includes natural and manmade features within the riparian zone that would be affected by the attenuation of flooding by the MC1 Option, up to the point where the effects on river flows would be considered insubstantial.

The Regional Assessment Area (RAA), which encompasses the LAA, is established to provide a regional context for the assessment of MC1-related effects. The RAA also encompasses the area within which the residual effects of the MC1 Option are likely to interact with the residual effects of other past, present, or future projects or activities to result in a cumulative effect or effects. As a result, the RAA also defines the spatial boundaries for the cumulative effects assessment.

MC1 Option area

The MC1 Option area for the MC1 EIS Report includes the area directly affected by the proposed works and related relocations and new constructions, and a buffer area.

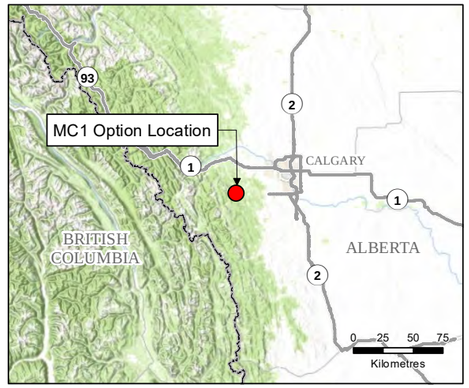
The MC1 Option area is defined as comprising the following:

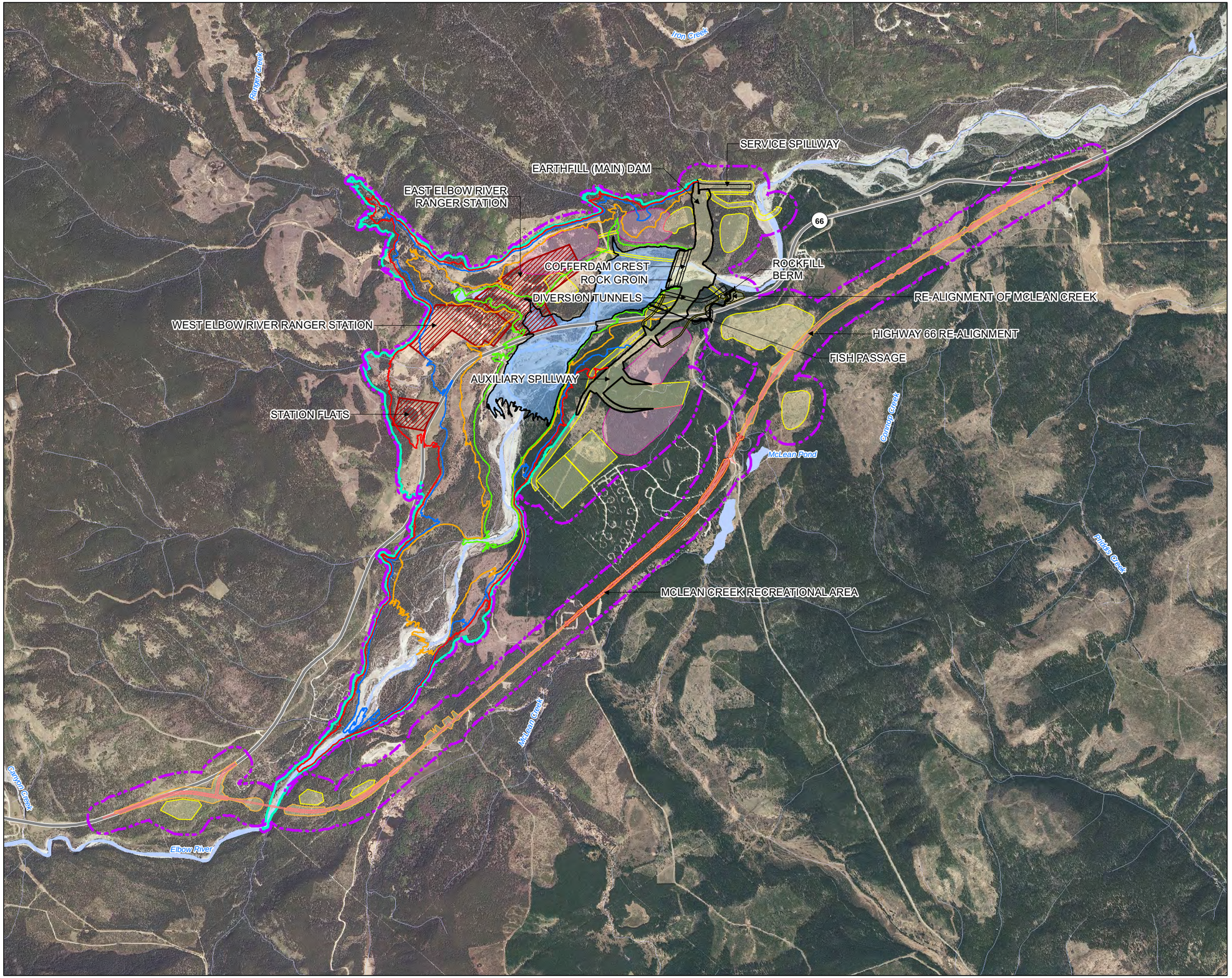
- The reservoir at PMF level
- Embankment and excavation areas plus a 100-m buffer
- Spillways and outlet works plus a 100-m buffer
- Any areas of road relocation plus a 100-m buffer
- Areas affected by the decommissioning and relocation of recreational or other facilities
- Borrow and spoil areas
- Areas of temporary construction disturbance (e.g., laydowns, stockpile locations).

The MC1 footprint, situated within the MC1 Option area, is the area directly disturbed by construction and operation activities (excluding buffers). The MC1 Option area and footprint are shown in **Figure 4.3-1**.

Elbow River at McLean Creek Dam (MC1)

Option Area





Legend

- MC1 Option Area
- MC1 Dam
- Highway 66 Re-alignment
- Probable Maximum Flood (PMF) Level
- 2013 Flood Event (1424.1 m)
- 1:100 Flood Event
- 1:20 Flood Event
- 1:50 Flood Event
- Borrow Area
- Laydown Area/Disturbed Area
- Permanent Pond
- Existing Park Infrastructure to be Removed
- Highway
- Watercourse
- Waterbody

Notes

1. All locations and features should be considered approximate and are to be used for discussion purposes only.
2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Basedata: Government of Alberta, 2017
- Preferred Road Option and Disturbed Areas: Opus International Consultants Limited, 2017
- Dam Details: Hatch Ltd., 2017
- Aerial Imagery: SPOT 1.5 m, 2016
- Inset Basemap: ESRI Topographic Basemap

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In determining these spatial boundaries, the MC1 study team considered available scientific information; other information including pertinent ecological, social, and cultural values as identified through baseline studies; relevant information included in the SR1 EIA; and input received from government agencies.

Table 4.3-4 Local and Regional Assessment Areas for the Elbow River at McLean Creek Dam Option

Valued Component	Local Assessment Area	Regional Assessment Area
Atmospheric Environment	N/A. Greenhouse gases are assessed on a regional basis.	Greenhouse gases: Alberta and Canada.
	Air Quality: Rectangular area extending 5 kilometers from MC1 footprint	Air Quality: Rectangular area extending 20 km from the MC1 footprint.
	Noise: MC1 footprint plus 2-km buffer	Noise: MC1 footprint plus 5-km buffer.
Terrain and Soils	Based on the AMEC 2015 study area and extended to include additional MC1 components (the highway realignment and one area with a 100 m buffer).	LAA plus 5-km buffer.
Groundwater Quality and Quantity	The MC1 Option area plus the downstream AOI incorporating Elbow Creek and associated alluvial aquifer from the dam to outlet of the permanent gated outlet conduit structure.	Encompasses the area within 1 km off the LAA and the pond level during an event similar to the 2013 flood.
Fluvial Geomorphology	The Elbow River from the MC1 reservoir downstream to where the Elbow River enters the Glenmore Reservoir.	The Elbow River watershed to the upstream extent of the Glenmore Reservoir.
Surface Water Quality for Aquatic Organisms and Drinking Water Quality	The Elbow River from the upstream extent of the reservoir formed by the MC1 dam down to the upstream extent of the Glenmore Reservoir.	The Elbow River Watershed from headwaters to the upstream extent of the Glenmore Reservoir.
Vegetation and Wetlands	MC1 footprint plus a 100 m buffer.	The Elbow River Watershed from headwaters to the upstream extent of the Glenmore Reservoir.
Wildlife and Wildlife Habitat (all VCs)	Comprises an approximate 1-km buffer around the MC1 infrastructure, and includes the realigned Highway 66 and permanent pond.	Grizzly Bear Management Area 5.
Fish and Fish Habitat	The Elbow River and tributaries (upstream of the MC1 dam to the 2013 flood elevation and the Elbow River, approximately 1 km downstream of the MC1 dam. Includes instream habitat and riparian habitat (at an average depth of 10 m on each bank/approach).	The Elbow River Watershed from headwaters to the upstream extent of the Glenmore Reservoir.
Land Use and Management and Infrastructure	Encompasses an approximately 1-km buffer around the MC1 Option area, the 2013 flood event, and the realignment for Highway 66. The LAA is the area with the highest potential for direct interactions with land and resource use and access to resource and recreational areas.	Extends upstream approximately 9 km within the Elbow valley and adjacent slopes to the mouth of Quirk Creek, and downstream approximately 9 km to the Bragg Creek Area Structure Plan eastern boundary to include downstream land use.

Valued Component	Local Assessment Area	Regional Assessment Area
Socio-economic Resources	N/A. The socio-economic resources assessment area is defined as the RAA.	Includes municipalities and communities, including Indigenous communities, where most of the construction workforce for the MC1 Option could reasonably be expected to be accommodated. These communities include the City of Calgary, and the communities of Bragg Creek, Redwood Meadows, and parts of Kananaskis Improvement District. The communities of Bragg Creek and Redwood Meadows are expected to experience potential MC1-related effects due to population change and increased traffic volumes.
Public Health and Safety	Encompasses the area within which the MC1 Option would be likely to interact with and potentially result in effects on the local atmospheric environment, water quality and flood risk, as follows: Atmospheric environment: extending 5 km from the MC1 Option area. Water quality: Elbow River from the upstream extent of the MC1 reservoir to the upstream extent of the Glenmore Reservoir Flood risk: includes Bragg Creek and Redwood Meadows	Encompasses the area within which the MC1 Option would be likely to interact with and potentially result in effects on the regional atmospheric environment, water quality and flood risk, as follows: Atmospheric environment: extending 20 km from the MC1 Option area. Water quality: Elbow River Watershed from the headwaters to the upstream extent of the Glenmore Reservoir. Flood risk: includes Bragg Creek, Redwood Meadows and the City of Calgary.

4.3.2.2 Temporal Boundaries

The temporal boundaries identified for the VC assessments encompass periods during which the MC1 Option may affect VCs. These boundaries were determined based on the timing and duration of MC1 Option phases and related activities. Potential effects are considered for each phase of the MC1 Option as described in **Table 4.3-5**. Temporal characteristics of the VCs, relevant to the effects assessment, are documented in each discipline section.

Table 4.3-5 Temporal Boundaries for the Effects Assessment

MC1 Option Phase	Length of Phase
Construction	4 years
Operation and Maintenance	Assumed to operate in perpetuity

There is no decommissioning phase, as the MC1 infrastructure would be likely to operate in perpetuity.

4.3.2.3 Administrative and Technical Boundaries

Administrative boundaries arise when political, economic, or social issues, as well as fiscal or other resourcing issues constrain the assessment of potential MC1-related effects.

Technical boundaries arise when there are limitations to the ability to predict effects from a project; this may occur when sampling is constrained by legal restrictions, when large geographical settings limit the ability to sample properly, or when modelling constraints impose limitations on the analysis.

4.4 BASELINE CASE

According to Alberta Environment and Parks, "The Baseline Case establishes the conditions that exist or would exist prior to development of the project or the conditions that would exist if the project were not developed." (AEP 2013). Baseline conditions are described in each discipline section based information derived from the following sources:

- Provincial, federal, Indigenous groups, and local government jurisdictions, mandates, agreements, and interests of specific relevance to the VC(s)
- Desktop and field studies conducted for the MC1 Option
- Scientific and other information, such as published literature, databases, remote sensing imagery and data, monitoring programs, and previous environmental assessments or associated technical reports.

The majority of the baseline descriptions rely on previous studies and available literature. The MC1 study team has assumed that the existing conditions are consistent with those reported in the data sources and literature reviewed, unless otherwise noted. Available data sources that were reviewed by all disciplines include the following:

- Environmental Overview of the Conceptual Elbow River Dam at McLean Creek (AMEC 2015)
- South Saskatchewan Regional Plan 2014-2024 (Government of Alberta 2014)
- Elbow River Basin Water Management Plan (Elbow River Watershed Partnership 2009)
- Natural Regions and Subregions of Alberta (Natural Regions Committee 2006)

The specific data sources that were reviewed for discipline sections (e.g., Alberta water well database) are listed in each discipline sections (see **Section 6.1 Atmospheric Environment** to **Section 8.3 Public Health and Safety**).

Limited field studies were conducted in support of the MC1 Option. The field programs that were undertaken as part of this EIS Report include the following:

- June and August, 2017 and October 2, 2016 – Vegetation surveys (see **Section 7.1 Vegetation and Wetlands**)
- March, April, May, June, August 2017 – Wildlife surveys (see **Section 7.2 Wildlife and Wildlife Habitat**)
- October and November 2016 – Fish habitat use and fish habitat potential (see **Section 7.3 Aquatic Environment**)

Baseline conditions descriptions of the RAA and the LAA (which includes the MC1 Option area), include the historic, regional, and local context for the VCs. The quality and reliability of the baseline data and their applicability for the purpose used, including any uncertainty or gaps, are discussed in each discipline section.

4.5 APPLICATION CASE

The Application Case describes the effects of the MC1 Option added to Baseline Case (i.e., assesses the potential MC1-related effects).

Potential interactions between MC1 VCs and activities and disciplines during the construction and operation of MC1 VCs are identified in **Table 4.5-1**. A preliminary evaluation of the potential effects associated with these interactions on the VC was carried out to focus the assessment on only those interactions likely to result in an adverse effect. When no interaction has been identified, or when a negligible interaction has been identified that is undetectable or unmeasurable, the effect has not been carried forward for this assessment. When standard and high-efficacy mitigation would likely address identified potential effects fully, the study team has nonetheless assessed the effect to ensure the mitigation is identified and specified in the EIS Report.

Table 4.5-1 Preliminary MC1 Option Interactions List by Discipline

		Discipline											
Phase	**Activity**	**Atmospheric Environment**	**Terrain and Soils**	**Hydrogeology**	**Surface Water**	**Water Quality**	**Vegetation and Wetlands**	**Wildlife and Wildlife Habitat**	**Aquatic Environment**	**Land Use and Management**	**Historical Resources**	**Socio-economic**	**Public Health and Safety**
Construction	Clearing	X	X	X	X	X	X	X	X	X	X	X	X
	Road construction	X	X	-	X	X	X	X	X	X	X	X	X
	Decommissioning and removal of existing provincial parks infrastructure and ranger station	X	X	-	-	X	X	X	X	X	X	X	X
	Dam (cofferdam and earth fill) construction	X	X	X	X	X	X	X	X	X	X	X	X
	Spillway construction	X	X	-	-	X	X	X	X	X	X	X	X
	Rock groin and diversion tunnels construction	X	X	-	-	X	X	X	X	X	X	X	X

	Discipline												
Phase	**Activity**	**Atmospheric Environment**	**Terrain and Soils**	**Hydrogeology**	**Surface Water**	**Water Quality**	**Vegetation and Wetlands**	**Wildlife and Wildlife Habitat**	**Aquatic Environment**	**Land Use and Management**	**Historical Resources**	**Socio-economic**	**Public Health and Safety**
	Laydown areas construction and use	X	X	-	-	X	X	X	-	X	X	X	X
	Stockpile development and use	X	X	-	-	X	X	X	-	X	X	X	X
	Borrow and spoil areas development and use	X	X	X	-	X	X	X	X	X	X	X	X
	Realignment of McLean Creek and other small waterbodies	x	X	-	X	X	X	X	X	X	X	-	X
	Realignment of Highway 66	X	X	-	X	X	X	X	X	X	X	X	X
	Storage of water in permanent pond	X	X	X	X	X	X	X	X	X	X	X	X
	Reclamation	X	X	-	X	X	X	X	X	-	X	X	X
Operation and Maintenance	Routine and Flood Operations and Maintenance	X	X	X	X	X	X	X	X	X	X	X	X

Note: X – interaction; '-' is no interaction

Each discipline section assesses potential MC1-related effects by:

1. Identifying potential MC1 Option interactions with the VC(s)
2. Describing potential MC1-related effects to the VC(s)
3. Describing proposed mitigation measures
4. Characterizing the residual effects to the VC(s).

These four steps are described in the following subsections.

4.5.1 Potential Effects and Measurable Parameters

Each identified MC1-related effect on a VC is described in comparison to the baseline conditions, along with the cause, type, and nature of the potential effect and its direction (positive or adverse).

The MC1 study team selected measurable parameters that generate useful data to inform an understanding of the potential effects of the MC1 Option on each VC. As part of the EIS Report methodology, the study team then selected measurable parameters that are used to develop a baseline against which:

- Potential MC1-related effects could be measured
- Mitigation measures could be developed
- Effectiveness of mitigation and regulatory compliance could be evaluated.

The measurable parameters for the VC assessments are included in each discipline section.

4.5.2 MITIGATION MEASURES

Mitigation measures are proposed to avoid or minimize potential effects, restore on-site conditions, or offset potential adverse environmental effects. Identified as any practical means taken to manage potential adverse effects, mitigation measures can be used alone or in combination. These measures are described and summarized in table format in each discipline section. The expected performance standard of the mitigation measures (i.e., how the mitigation would reduce the effect) is also described.

In accordance with Alberta Transportation standard practice, best management practices and standard mitigation measures would be included in the Environmental Construction Operations (ECO) Plan that would be developed by the contractor and reviewed by Alberta Transportation prior to the start of construction. Examples of best management practices and standard mitigation measures that would be included in the ECO Plan for the associated activities include the following:

- Vehicle maintenance
- Open burning
- Clearing and grubbing
- Soil handling measures
- Revegetation and reclamation measures
- Traffic controls

4.5.3 RESIDUAL EFFECTS

Potential residual effects of the MC1 Option, and the VC-specific context for these effects, are described in terms of effects criteria definitions and descriptions of context. Definitions for each residual effect characteristic and rating are derived according to the following hierarchy:

- A published regulatory or industry standard or criterion that establishes a threshold
- A range of values or standards that, while not regulated, are widely recognized and accepted
- Professional judgment (with a rationale given).

Clear definitions for each residual effect characteristic, accompanied by supporting rationales, are provided in each VC assessment section. Residual effects for each VC are characterized in terms of the following criteria: direction, extent, magnitude, duration, reversibility, frequency of occurrence, and confidence (**Table 4.5-2)**.

Table 4.5-2 Residual Effects Characteristics for MC1 Option

Residual Effect Characteristic	Rating	Definition
Direction	· Positive	Net benefit.
	· Adverse	Net loss.
Extent	· Local	Confined to the area directly disturbed by MC1 facilities.
	· Sub-regional	Limited to one natural region and within the LAA.
	· Regional	Within the RAA.
Magnitude	· Negligible	No detectable change in the receptor quality, quantity, or other attribute from background conditions (defined for each VC).
	· Minor	Within acceptable protective standards and/or causes no detectable change to the resource (defined for each VC).
	· Moderate	Within acceptable protective standards and/or causes a detectable change to the resource (defined for each VC).
	· Major	Exceeds protective standards and/or causes a detectable change to the resource beyond the range of tolerance (defined for each VC).
Duration	· Short-term	Defined for each VC.
	· Long-term	Defined for each VC.
Reversibility	· Reversible	Effect would be reversed once the activity causing the residual effect ceases.
	· Not reversible	Effect would be permanent.
Frequency	· Isolated	Defined for each VC.
	· Rare	Defined for each VC.
	· Frequent	Defined for each VC.
	· Continuous	Effect would occur continuously over the life of the MC1 Option.
Confidence	· High	Rating predictions are based on a good understanding of cause-effect relationships and/or using data specific to the MC1 Option area.
	· Moderate	Rating predictions are based on a good understanding of cause-effect relationships relying on data from elsewhere, or incomplete understanding of cause-effect relationships from data specific to the MC1 Option.
	· Low	Rating predictions are based on an incomplete understanding of cause-effect relationships and incomplete data.

Because baseline data and modelling studies are necessarily less detailed for this EIS Report than what is required in an EIA for regulatory submission, the significance of the residual effects has not been determined as described in the EIA Guide (AEP 2013). This alternatives assessment is thus supported by delineation of potential MC1-related residual effects, which are described as follows:

- Non-substantive residual effect – mitigation measures have not fully eliminated the effects, but have reduced the magnitude, extent, and/or duration to such a degree as to avoid any substantive effect on the VC. This characterization is based on the definitions and rating of effects characteristics defined in each discipline section.
- Substantive residual effect – adverse effects are likely to be high in magnitude, regional in extent, and long term in duration after implementation of mitigation.

4.5.4 FOLLOW-UP MONITORING

Each discipline section describes whether monitoring would be required during implementation of the MC1 Option to verify effect predictions, ensure compliance with regulatory requirements and approval conditions, and evaluate the effectiveness of mitigation measures. Any gaps in knowledge or understanding related to assessment findings would also be addressed through monitoring.

When uncertainty exists regarding, for example, the effectiveness of a particular mitigation measure, the discipline section may describe a follow-up strategy. Any additional recommended field studies are identified and discussed in this section. Key components of such a strategy include identification of technically and economically feasible alternate mitigation measures, design of an appropriate monitoring and evaluation approach, and development of procedures for implementation of the alternate measures and continued effectiveness monitoring, evaluation, and adjustment.

4.6 PLANNED DEVELOPMENT CASE

The Planned Development Case describes the environmental conditions that may occur as a result of the interaction of the MC1 Option with other existing projects and other planned projects that can be reasonably expected to occur (i.e., cumulative effects assessment) (AEP 2013). The Planned Development Case is presented in **Section 9.0**. examines how the substantive adverse effects of the MC1 Option may interact spatially and temporally with the residual effects of other past, present, or future projects. Cumulative effects are defined as: “the changes to the environment caused by an activity in combination with other past, present, and reasonably foreseeable human activities.” (AEP et al. n.d.)

The Planned Development Case has been conducted on adverse substantive residual effects (as identified in each discipline section). Environmental assessment best practice suggests that all residual effects remaining after the implementation of mitigation measures are considered in a Planned Development Case; however, due to underlying data limitations for this alternatives assessment, it has been determined that a Planned Development Case for all residual effects (i.e., non-substantive and substantive) would not result

in meaningful conclusions for some disciplines. Similarly, only interactions that could result in a potentially substantive cumulative adverse effect are identified. The methodology for the Planned Development Case is described in **Section 9.0**.

4.7 REFERENCES

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5.0 SUMMARY OF ENVIRONMENTAL, SOCIAL AND ECONOMIC ASSESSMENT

This section provides an overview of the key effects, mitigation measures and residual adverse environmental and social effects of the MC1 Option in comparison to its social, environmental and economic benefits. See Section **6.0 Physical Environment**, **Section 7.0 Biophysical Environment**, and **Section 8.0 Human Environment** for the complete assessment of potential effects, mitigation measures and residual effects, which are described in each discipline section.

Section 5.1 outlines the key effects and mitigation measures that have been identified for the MC1 Option. **Section 5.2** identifies the residual effect, after the implementation of mitigation measures, that are likely to remain and provides a characterization of the effect for the MC1 Option. Residual effects have been classified as either substantive or non-substantive, as described in **Section 4.0 Environmental Impact Screening Methodology**. Substantive residual effects are carried forward to the **Planned Development Case** (**Section 9.0**).

The recommended follow-up monitoring programs are summarized in **Section 5.35.3**.

5.1 SUMMARY OF KEY EFFECTS AND MITIGATION MEASURES FOR THE MC1 OPTION

Valued Component	Key Effects	Key Mitigation Measures
Air Quality, Climate Change, and Noise	· Increased emissions and ambient concentrations of criteria air contaminants (CACs). Exceedances of ambient air quality criteria may occur during the Construction phase at the McLean Creek Campground, Easter Seals Camp Horizon, and Paddy's Flat Campground · Greenhouse gas emissions · Increased noise levels. Nighttime noise levels at Gooseberry, McLean Creek, and Paddy's Flat Campgrounds would exceed sleep disturbance thresholds during portions of the Construction phase.	· To reduce exposure to potential air quality effects, the McLean Creek Campground, Easter Seals Camp Horizon, and Paddy's Flat Campground would likely need to be closed during Construction. · Gooseberry Campground may also be closed at night during the peak construction period to prevent sleep disturbance to campers.
Terrain and Soils	· Soil disturbance – Approximately 165 ha of soil would be temporarily disturbed and 161 ha would be covered by permanent infrastructure during Construction. · Soil destabilization – Destabilization may occur potentially unstable slopes located within or at the edge of the reservoir by changes in groundwater gradients resulting from the permanent pond. Approximately 8% of the reservoir was mapped as having a moderate or high likelihood of landslide initiation following reservoir filling or rapid drawdown.	· Ensure areas of slope instability would be identified and addressed in the engineering design. · Maintain vegetation in the area between the permanent pond level and the maximum flood level (i.e., reservoir) to stabilize soil and prevent erosion.
Groundwater Quality and Groundwater Quantity	· Groundwater flow – Removal of the sand and gravel aquifer materials in the bed of the Elbow Creek and replacement with impervious fill material and grout curtain would cut off groundwater flow through the aquifers. · Aquifer integrity – Supply wells within the flood footprint would be vulnerable to damage from floodwaters. There is risk of contamination entering aquifers under high-flow conditions through supply wells that have not been identified and wells that have not been properly decommissioned	· Maintain surface flows downstream of MC1. · Decommission existing groundwater wells within the reservoir.

Valued Component	Key Effects	Key Mitigation Measures
Fluvial Geomorphology	· Sediment accumulation – Sediment retention in the permanent pond following impoundment of the Elbow River would occur at the upstream end of the permanent pond due to the associated decrease in water velocity. · Decrease in downstream peak flows and sediment supply – Potential effects may include channel degradation, channel narrowing, coarsening of bed material, pattern simplification, and aggradation at tributary junctions downstream of MC1 to the intake of the Glenmore Reservoir.	· Maintain flow competence (i.e., allow flows that exceed the threshold for flow entrainment). · Conduct sediment augmentation downstream of MC1.
Surface Water Quality	· Nutrient loading – Decomposition of vegetation and organic material following flooding of soil for the permanent pond, which could ultimately result in increased algal growth and biomass, decreases in dissolved oxygen, and methylmercury formation.	· Remove all vegetation and topsoil within the permanent pond area.
Drinking Water Quality	· Reduction in quality – Increase in dissolved organic matter may interact with chlorine or ozone disinfectants in any downstream water intakes to form disinfectant byproducts. Chloramines, trihalomethanes, chlorate, dichlorophenol, exemplify disinfection byproducts that can impart unpleasant taste and odour to water, and some may be carcinogenic at high concentrations. · Introduction of pathogens – During the decommissioning of the EVRS and other park infrastructure, pathogens may be introduced into the Elbow River as contaminated soils from septic fields and waste treatment facilities are removed.	· Remove all vegetation and topsoil within the permanent pond area. · Fully decommission and reclaim the Elbow Valley Ranger Station and Stations Flats day use area.
Vegetation	· Vegetation disturbance – Approximately 265 hectares (ha) of vegetation communities (including wetlands) would be directly disturbed by the MC1 Option. · Effects to tracked species – Two tracked species– would be directly affected by the MC1 Option.	· Reclaim and revegetate disturbed sites. · Develop and implement invasive plant program. · Conduct sensitive plant surveys.
Wetlands	· Permanent effects to wetlands – Approximately23 ha of wetland would be permanently affected.	· Develop a wetland restoration and compensation plan in accordance with the Alberta Wetland Policy. · Develop and implement invasive plant program.

Valued Component	Key Effects	Key Mitigation Measures
Grizzly Bear	· Interaction with established Bear Management Area – MC1 is located in Bear Management Area 5; the Option footprint overlaps both the Recovery and Support Zones in Area 5 · Habitat loss from the Option footprint, and habitat alteration from sensory disturbance · Mortality from human-bear conflict · Change in movement	· Minimize habitat loss during detailed design. · Reduce human-wildlife interactions during construction. · Install wildlife passage structures on Highway 66.
Ungulates	· Interaction with Key Biodiversity Zone – MC1 is located in a Key Wildlife Biodiversity Zone, established to protect habitats that support wintering ungulates and biodiversity · Change in movement · Changes to linear disturbance densities could alter predator-prey dynamics	· Minimize habitat loss during detailed design. · Install wildlife passage structures on Highway 66.
Bats	· Habitat loss · Improvement in forage availability due to permanent pond	· Include timing considerations during construction activities. · Conduct pre-construction raptor nest surveys and buffers.
Birds – Breeding Birds, Raptors and Owls, Harlequin Duck, Piscivorous Birds	· Habitat loss from the Option footprint, and habitat change as a result of sensory disturbance · Creation of nesting habitat for ground-nesting birds · Creation of foraging habitat in permanent pond for piscivorous birds	· Minimize habitat loss during detailed design. · Conduct pre-construction raptor nest surveys and buffer. · Include timing considerations during construction activities.
Amphibians and Reptiles	· Habitat loss · Direct mortality from vehicle strikes · Creation of breeding habitat for amphibians in permanent pond	· Pre-construction sensitive feature study. · Include timing considerations during construction activities. · Install wildlife passage structures on Highway 66.
Fish and Fish Habitat	· Habitat loss and alteration from the Option footprint and changes in the flow regimes · Alteration of habitat during flood events · Some mortality of fish passing through the diversion tunnels during Construction · Alteration of fish community assemblage in the permanent pond – Conditions would favour species more adept at adapting to altered environments and ecosystems more representative of lacustrine conditions	· Include a fish passage structure in the design of the dam. · Manage flow through the diversion tunnels and fish passage structure to maintain instream flow needs. · Design diversion tunnels to prevent entrainment. · Conduct required habitat enhancement, compensation and offsetting measures.

Valued Component	Key Effects	Key Mitigation Measures
Land Use and Infrastructure	· Permanent loss of portions of McLean Creek and Elbow River Public Recreation Areas · Closure and relocation of a portion of the McLean Creek campground · Permanent closure and relocation of River Cove Group Campground and Station Flats day use area · Changes in recreational use from river to lake-type activities, through creation of the permanent pond · Changes in resource uses in the area – including forestry activities, grazing, oil and gas operations, sand and gravel quarries	· Identify alternative areas to offset loss of protected areas. · Provide compensation for grazing allotment holders and registered fur management area holders. · Replacement of recreational facilities and features disturbed or displaced by the MC1 Option (e.g., picnic areas, lookout points, campsites, interpretative signage, trails and trailheads).
Socio-economic Resources	· Regional and provincial economic benefits associated with construction-related employment, training opportunities, and reducing flood mitigation costs. · Positive benefits to the labour force due to Option employment · Positive effect on contracting and procurement opportunities · Economic losses to resource-dependent businesses, industry, and campground operators · Shortage of worker demand – which may create a shortage of local accommodation	· Establish a construction work camp. · Compensate affected parties.
Human Health	· Localized and temporary increases in ambient concentrations of air contaminants (e.g., total suspended particulates, dust) from Construction-related activities · Dust emissions from wind erosion of reservoir banks – increased $PM_{2.5}$ concentrations may result after a flood event. · Positive effect on regional health services – Flood reduction, removing health care demands and improving overall public safety associated with emergency preparedness and emergency response during flood conditions.	· Implement public access restrictions. · Temporarily close campgrounds and Easter Seals Camp Horizon (see Atmospheric Environment).

5.2 SUMMARY OF KEY EFFECTS AND MITIGATION MEASURES FOR THE MC1 OPTION

Valued Component	Description of Residual Effect	MC1 Phase	Adverse or Positive	Residual Effects Characteristics	Substantive / Non-substantive
Physical Environment					
Air Quality	Increased emissions and ambient concentrations of air contaminants	Construction	Adverse	· Major magnitude · Local extent · Frequent occurrence · Short-term duration	Non-substantive
Climate and Climate Change	Increased emissions of greenhouse gases	Construction	Adverse	· Moderate magnitude · Regional extent · Frequent occurrence · Long-term duration	Non-substantive
Noise	Increased noise	Construction	Adverse	· Minor magnitude · Local extent · Frequent occurrence · Short-term duration	Non-substantive
Terrain and Soils	Change in soil quantity	Construction	Adverse	· Moderate magnitude · Local extent · Continuous occurrence · Long-term duration	Non-substantive
	Change in topography	Construction	Adverse	· Negligible magnitude · Project footprint · Continuous occurrence · Long-term duration	Non-substantive
	Effects due to inundation and sediment deposition	Operation and Maintenance	Adverse	· Moderate magnitude · Local extent · Rare occurrence · Long-term duration	Non-substantive
	Decrease in slope stability during flood events or close thereafter.	Operation and Maintenance	Adverse	· Moderate magnitude · Local extent	Non-substantive

Valued Component	Description of Residual Effect	MC1 Phase	Adverse or Positive	Residual Effects Characteristics	Substantive / Non-substantive
				· Rare occurrence · Long-term duration	
Groundwater Quantity	Reduced groundwater level in the Elbow Creek aquifers downgradient of the dam.	Construction Operation and Maintenance	Adverse	· Moderate magnitude · Local extent · Continuous occurrence · Long-term duration	Non-substantive
	Increased groundwater quantity from permanent pond	Operation and Maintenance	Positive	· Minor magnitude · Local extent · Continuous occurrence · Long-term duration	Non-substantive
Fluvial Geomorphology	Increased sediment upstream of the dam.	Operation and Maintenance	Adverse	· Moderate magnitude · Local extent · Continuous occurrence · Long-term duration	Non-substantive
	Changes to channel morphology due to sediment deficit downstream.	Operation and Maintenance	Adverse	· Moderate magnitude · Sub-regional extent · Continuous occurrence · Long-term duration	Non-substantive
Water Quality – Water Quality for Aquatic Organisms, Drinking Water Quality	Release of nutrients leading to excessive algal growth	Operation and Maintenance	Adverse	· Minor magnitude · Sub-regional extent · Continuous occurrence · Long term duration	Non-substantive
Biophysical Environment					
Vegetation	Change in vegetated area	Construction	Adverse	· Local extent · Moderate magnitude · Isolated-rare frequency · Long-term duration	Non-substantive

Valued Component	Description of Residual Effect	MC1 Phase	Adverse or Positive	Residual Effects Characteristics	Substantive / Non-substantive
	Reduction in biodiversity due to loss of tracked plant species (applies to Vegetation and Wetlands)	Construction Operation and Maintenance	Adverse	· Local extent · Minor magnitude · Isolated frequency · Long-term duration	Substantive
Wetlands	Reduction in wetland area and function	Construction Operation and Maintenance	Adverse	· Regional extent · Major magnitude · Isolated frequency · Long-term duration	Substantive
Grizzly bear, Ungulates	Removal or alteration of habitat	Construction Operation and maintenance	Adverse	· Local extent · Moderate magnitude · Continuous frequency · Long-term duration	Non-substantive
	Change in movement	Operation and Maintenance	Adverse	· Local extent · Minor magnitude · Continuous frequency · Long-term duration	Non-substantive
	Change in mortality risk	Operation and Maintenance	Adverse	· Local extent · Minor magnitude · Continuous frequency · Long-term duration	Non-substantive
Bats	Removal or alteration of forest habitat	Construction	Adverse	· Local extent · Moderate magnitude · Continuous frequency · Long-term duration	Non-substantive
	Improved forage habitat by presence of permanent pond	Operation and Maintenance	Positive	· Local extent · Moderate magnitude · Continuous frequency · Long-term duration	Non-substantive

Valued Component	Description of Residual Effect	MC1 Phase	Adverse or Positive	Residual Effects Characteristics	Substantive / Non-substantive
	Change in mortality risk	Construction Operation and Maintenance	Adverse	· Local extent · Moderate magnitude · Continuous frequency · Long-term duration	Non-substantive
Birds	Removal of breeding and foraging habitat for breeding birds, raptors and owls	Construction	Adverse	· Local extent · Moderate magnitude · Continuous frequency · Long-term duration	Non-substantive
	Change in mortality risk due to clearing activities for breeding birds, raptors and owls	Construction	Adverse	· Local extent · Minor magnitude · Frequent · Long-term duration	Non-substantive
	Change in habitat for harlequin duck due to alteration in the riverine system	Construction Operation and Maintenance	Adverse	· Local extent · Minor magnitude · Continuous frequency · Long-term duration	Non-substantive
	Change in habitat for piscivorous birds due to the creation of permanent pond	Construction Operation and Maintenance	Positive	· Local extent · Minor magnitude · Continuous frequency · Long-term duration	Non-substantive
	Change in mortality risk for breeding birds	Operation and Maintenance	Adverse	· Local extent · Minor magnitude · Infrequent · Long-term duration	Non-substantive

Valued Component	Description of Residual Effect	MC1 Phase	Adverse or Positive	Residual Effects Characteristics	Substantive / Non-substantive
Amphibians and Reptiles	Loss of habitats	Construction Operation and maintenance	Adverse	• Local extent • Moderate magnitude • Continuous frequency • Long-term duration	Non-substantive
	Changes to movement for amphibians and reptiles	Construction Operation and maintenance	Adverse	• Local extent • Moderate magnitude • Continuous frequency • Long-term duration	Non-substantive
	Change in mortality risk	Construction Operation and maintenance	Adverse	• Local extent • Moderate magnitude • Frequent • Long-term duration	Non-substantive
Fish and Fish Habitat	Permanent alteration or destruction of fish habitat	Construction Operation and Maintenance	Adverse	• Regional extent • Moderate magnitude • Continuous occurrence • Long-term	Non-substantive
	Increased risk of fish mortality and reduced productivity for bull trout	Construction Operation and Maintenance	Adverse	• Regional extent • Moderate to major magnitude • Continuous occurrence (productivity); rare occurrence (mortality) • Short-term and Long-term duration	Substantive
	Effect on migration and movement	Operation and Maintenance	Adverse	• Regional extent • Minor magnitude • Rare occurrence • Long-term duration	Non-substantive
	Effect on fish assemblage due to habitat change	Operation and Maintenance	Adverse	• Local extent • Moderate magnitude • Continuous occurrence • Long-term duration	Non-substantive

Valued Component	Description of Residual Effect	MC1 Phase	Adverse or Positive	Residual Effects Characteristics	Substantive / Non-substantive
Human Environment					
Land Use and Management	Changes to Protected Areas	Construction	Adverse	· Local extent · Moderate magnitude · Isolated occurrence · Short-term duration	Non-substantive
	Changes to resource and commercial uses	Construction	Adverse	· Local extent · Moderate magnitude · Isolated occurrence · Short-term duration	Non-substantive
	Reduction to recreational use	Construction Operation and Maintenance	Adverse	· Regional extent · Major magnitude · Continuous occurrence · Long-term duration	Substantive
	Change in the quality of the recreational experience	Construction Operation and Maintenance	Adverse (loss of recreational areas or quality of experience)	· Local extent · Moderate magnitude · Continuous occurrence · Long-term duration	Non-substantive
		Construction Operation and Maintenance	Positive (new site at the permanent pond)	· Regional extent · Moderate magnitude · Continuous occurrence · Long-term duration	Non-substantive
	Disruption of infrastructure	Construction	Adverse	· Local extent · Moderate magnitude · Isolated occurrence · Short-term duration	Non-substantive

Valued Component	Description of Residual Effect	MC1 Phase	Adverse or Positive	Residual Effects Characteristics	Substantive / Non-substantive
Socio-economic Resources	Increase to provincial and regional economics	Construction	Positive	· Regional extent · Moderate magnitude · Continuous occurrence · Long-term duration	Substantive
	Change to regional economic conditions	Construction	Positive	· Regional extent · Moderate magnitude · Continuous occurrence · Short-term duration	Non-substantive
	Change in labour force	Construction	Positive	· Regional extent · Moderate magnitude · Continuous occurrence · Short-term duration	Non-substantive
	Opportunities for contracting and procurement	Construction Operation and Maintenance	Positive	· Regional extent · Moderate magnitude · Continuous occurrence · Short-term duration	Non-substantive
	Change in economic activities of resource-dependent business and industry	Construction	Adverse	· Regional extent · Minor magnitude · Isolated occurrence · Short-term duration	Non-substantive
	Change to availability of accommodation	Construction	Adverse	· Local extent · Minor magnitude · Continuous frequency · Short-term duration	Non-substantive
Public Health and Safety	Improved emergency preparedness / response and reduced health and safety risk during a flood event	Operation and Maintenance	Positive	· Positive · Regional extent · Major magnitude · Rare frequency · Long-term duration	Substantive

5.3 FOLLOW-UP MONITORING PROGRAMS

Follow-up monitoring programs would be conducted on VCs to verify the accuracy of the residual effects predictions, assess the efficacy of proposed mitigation measures, and to in order to inform the need for adaptive management. Additional follow-up monitoring programs that are recommended based on the effects assessment are outlined below.

Environmental Value	Description of Follow-up Monitoring Program
Atmospheric Environment	An air quality monitoring program would be developed to manage air quality during the Construction phase. One continuous monitor would be installed to collect ambient concentrations of total suspended particulates and $PM_{2.5}$ for the duration of the Construction phase.
Terrain and Soils	Post-flood event monitoring and maintenance, including adaptive management measures, are recommended for the Operation and Maintenance phase. The objectives of this monitoring work would be to identify the short-term and long-term effects of inundation in the reservoir, including on terrain stability and vegetation (and indirectly on soil quality), with the goal of identifying the potential effects early and developing appropriate mitigation measures to minimize the potential effects resulting from a flood event
Fluvial Geomorphology	A monitoring program is recommended to monitor morphologic adjustments associated with MC1. This monitoring program would inform monitoring of other VCs (e.g., fish) and help understand MC1-related effects to those VCs and whether additional mitigation measures are required.
Water Quality	A monitoring program for water quality parameters would be implemented so that, where monitoring data show exceedances of guidelines or standards, the mitigation measures would be adjusted accordingly. If no exceedances occur, the monitoring data would provide technical support that the receiving environment is adequately protected according to accepted standards. Data collected during the monitoring program would also yield important information for decision support regarding current and future reservoir development. Follow-up monitoring for Water Quality would include continuous and event-driven inspections.
Vegetation and Wetlands	The recommended follow-up monitoring programs would include monitoring fens specifically after flooding to identify any remediation that may be required, as well as monitoring the remainder of the fens outside the footprint area to determine the health of the remainder of the fen and any remediation measures that may be necessary to restore the functionality of the fen.
Wildlife and Wildlife Habitat	Monitoring and follow-up programs are recommended to verify MC1-related effects on Wildlife and Wildlife Habitat VCs, and provide the basis for adaptive management: A Piscivorous Bird Toxicology Monitoring program would be implemented within the permanent pond, due to the potential for bioaccumulation of methylmercury. The monitoring plan would validate predicted MC1-related effects and inform offsetting or supplemental mitigation needs. Wildlife (large and small mammals, amphibians and reptiles) and human use of the wildlife passage structures would be monitored to confirm the efficacy of the structures and inform an adaptive management strategy.

Environmental Value	Description of Follow-up Monitoring Program
Aquatic Environment	Monitoring programs are recommended to evaluate pre- and post-construction conditions as they relate to Aquatic Environment, and inform the need for and scope of adaptive management: A Fish Habitat Monitoring program would evaluate pre- and post-construction changes. Results of the plan would inform appropriate remedial or supplemental mitigation needs, and may also assist in altering offsetting requirements, if required. A Fish Toxicology Monitoring program would be implemented within the permanent pond and downstream habitat. The monitoring plan would validate the potential effects and inform offsetting or supplemental mitigation needs. An Aquatic Community Assemblage Monitoring program would evaluate pre- and post-construction changes to fish species, benthic invertebrates, and periphyton communities, upstream and downstream from the earth fill dam. Fish passage would be monitored during both Construction and Operation and Maintenance phases. During Construction, monitoring the effectiveness of the diversion tunnels to provide safe downstream passage of fish would be necessary.