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

Section 7.0 – Biological Environment

Prepared for:
Alberta Transportation

Prepared by:
Hemmera Envirochem Inc.
Suite 302, 322 11th Avenue SW
Calgary AB TR 0C5

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7.0 BIOLOGICAL ENVIRONMENT

7.1 VEGETATION AND WETLANDS

This section describes potential effects to Vegetation and Wetlands from the proposed Elbow River Dam at McLean Creek (MC1) Dam Option (MC1, Option, or MC1 Option). Vegetation is defined as vegetated areas within the MC1 Option area. Wetlands are defined as areas that are saturated with water for long enough to promote formation of water-altered soils, growth of water-tolerant vegetation, and various kinds of biological activity that are adapted to wet environments (ESRD 2015). The term sensitive species refers to those vascular plants, bryophytes, and lichens occurring within the Option area and designated as at risk, may be at risk, sensitive, or tracked by Alberta Environment and Parks (AEP). Sensitive species can also be listed as endangered, threatened, or a species of concern in Schedule 1 of the *Species at Risk Act*, SC 2002, c. 29 (SARA), or a species listed as extinct, extirpated, endangered, threatened, or special concern by the Committee on the Status of Endangered Wildlife in Canada. Invasive plants are defined as those species listed as noxious or prohibited noxious weeds under the *Weed Control Act*, SOA 2008, c. W-5.1.

The assessments presented in this section are supported by or linked to the assessments presented in the following sections:

- Section 6.3 Hydrogeology
- Section 6.4 Fluvial Geomorphology
- Section 6.5 Water Quality
- Section 7.2 Wildlife and Wildlife Habitat
- Section 7.3 Aquatic Environment

7.1.1 SCOPE OF ASSESSMENT

This section reviews the scope of the assessment for Vegetation and Wetlands, and includes the regulatory framework, data sources, Valued Components (VCs), measurable parameters, and assessment boundaries relevant for Wildlife and Wildlife Habitat.

7.1.1.1 Regulatory Framework

This section provides an overview of the relevant regulatory framework and requirements for the assessment of potential MC1-related effects on Vegetation and Wetlands, as summarized in **Table 7.1-1**.

Table 7.1-1 Summary of Applicable Regulatory and Policy Framework for Vegetation and Wetlands

Name	Jurisdiction	Description
Species at Risk Act	Federal	Sections 32 and 33 of SARA make it an offence to: · Kill, harm, harass, capture, or take an individual of a listed species that is extirpated, endangered, or threatened · Possess, collect, buy, sell, or trade an individual of a listed species that is extirpated, endangered, or threatened, or its part or derivative · Damage or destroy the residence of one or more individuals of a listed endangered or threatened species or of a listed extirpated species if a recovery strategy has recommended its reintroduction. Projects that require an environmental assessment under an Act of Parliament would have to take into account the MC1 Option's effects on listed wildlife species and their critical habitats. W*ildlife species* is defined in SARA as a species, subspecies, variety, or geographically or genetically distinct population of animal, plant, or other organism (other than a bacterium or virus) that is wild by nature and (a) is native to Canada (b) has extended its range into Canada without human intervention, and has been present in Canada for at least 50 years.
Water Act	Provincial	Alberta's *Water Act* requires approval and/or a licence to be obtained prior to construction within a waterbody, or to divert and use water from a waterbody. Activities related to waterbodies requiring approval under the *Water Act* include: partial or complete infilling of a waterbody for road construction, residential development, recreational, agricultural, and industrial uses, or any other purpose; any activity affecting or potentially affecting the aquatic environment (cumulative effects) and involving the disturbance, alteration, or modification of a waterbody including field ditching; erosion protection (e.g., rip-rap, rock armouring, gabion baskets, etc.); removal or destruction of vegetation, aquatic plants, and trees within the confines of the bed and shores of a waterbody; draining of a waterbody; or re-alignment of a waterbody.
Environmental Protection and Enhancement Act	Provincial	Alberta Environment and Parks regulates a wide range of activities under the *Environmental Protection and Enhancement Act* through conditions set out in regulations, approvals, and codes of practice. The Wastewater and Storm Regulation gives AEP the responsibility of regulating storm drainage and wastewater systems including constructed wetlands. Should the MC1 Option require stormwater management facilities, this portion of the regulation would apply. In addition, the Environmental Protection and Enhancement Act regulates the application, transportation and disposal of pesticides, which may be necessary with the applicability of the *Weed Control Act*.
Public Lands Act	Provincial	Section 3 provides for provincial ownership of beds and shores of permanent and naturally occurring waterbodies.
Wildlife (Amendment) *Act*	Provincial	Alberta's *Wildlife Act* designates wildlife on private and public lands as being a provincial jurisdiction (outside national parks and other federal lands), and Section 6 designates certain species as endangered. Under the *Wildlife Act*, endangered species include: (iii) A kind of plant, alga, or fungus prescribed as endangered. Where work is to be carried out in areas with endangered species known to be present, operators must comply with certain procedures, as outlined by AEP.

Name	Jurisdiction	Description
Weed Control Act	Provincial	This legislation aims to regulate noxious weeds, prohibited noxious weeds, and weed seeds through various control measures, such as inspection and enforcement, together with provisions for recovery of expenses in cases of non-compliance. Additionally, it mandates the licensing of seed-cleaning plants and mechanisms. Under Part 1, responsibility for control of noxious weeds is explained: "A person shall control a noxious weed that is on land the person owns or occupies". Furthermore, Part 1 stipulates, "Subject to the regulations, a person shall not use or move anything that, if used or moved, might spread a noxious weed or prohibited noxious weed…".
Alberta Wetland Policy	Provincial	The goal of the new Alberta Wetland Policy (AEP 2013) is to conserve, protect, and manage Alberta's wetlands to sustain the benefits they provide to the environment, society, and the economy. To achieve this, the policy focuses on the following outcomes: 1. Wetlands of highest value are protected for the long-term benefit to all Albertans. 2. Wetlands and their benefits are conserved and restored in areas where losses have been high. 3. Wetlands are managed by avoiding, minimizing, and replacing lost wetland value. 4. Wetland management is considered in a regional context. Wetland value is assessed based on relative abundance on the landscape, supported biodiversity, ability to improve water quality, importance to flood reduction, and human uses. The Alberta Wetland Mitigation Directive in the New Alberta Wetland Policy specifies the documentation needed to demonstrate applicants' efforts to avoid wetlands and minimize effects. Where avoidance is not possible, minimization plans, replacement plans, and permittee replacement requirements are described.
Sensitive Species Survey Guidelines	Provincial	AEP and the Alberta Native Plants Council provide guidelines for sensitive species sampling.

7.1.1.2 Data Sources

Data sources for the assessment of Vegetation and Wetlands include MC1-specific data and government databases. The following data sources have been reviewed:

- Environmental Overview of the McLean Creek Dam (AMEC 2015).
- Terrain Analysis for Borrow Sites for the proposed MC1 Option (BGC 2016).
- South Saskatchewan Regional Plan (Government of Alberta 2017a).
- Elbow River Basin Water Management Plan (Elbow River Watershed Partnership 2009).
- *Alberta Conservation Information Management System (ACIMS) (Alberta Parks 2015a).*
- *Alberta Conservation Information Management System Tracked Elements by Natural Subregions (Alberta Parks 2015b).*
- Species at Risk Public Registry (Government of Canada 2016).

An on-site biological reconnaissance was conducted on October 2, 2016 to review existing conditions within the Option area. The reconnaissance was conducted both from a vehicle and on foot over targeted areas identified using maps from AMEC 2015.

Vegetation sampling to detect early blooming sensitive botanical species was conducted on-site between June 12 and June 16, 2017 and between June 19 and June 21, 2017. Vegetation sampling to detect late blooming sensitive botanical species was conducted on-site between August 7 and 11, 2017. During these field assessments, Ecological Land Classification (ELC) sampling was conducted throughout the site to verify the ELC information for the study area. In addition, the Alberta Wetland Classification System was used to identify and classify wetlands within the MC1 Option area.

7.1.1.3 Valued Components

Vegetation and Wetlands may interact directly with MC1-related activities (e.g., clearing and grubbing, earthworks, flooding, change in the water table, and hydrology), in addition, the degradation or removal of vegetation and wetlands may adversely affect other biophysical components (e.g., Wildlife and Wildlife Habitat and Water Quality) when disturbed (**Table 7.1-2)**.

Table 7.1-2 Valued Components for Vegetation and Wetlands

Valued Component	Interaction
Vegetation	Vegetation is central to ecosystem function (for wildlife habitat, wildlife movement, seed dispersal, spread of invasive species, and habitat for sensitive species) and revegetation planning (for species that would revegetate flooded areas). Vegetation would be affected by the MC1 Option through both permanent and periodic inundation, direct removal during construction, change in vegetation type resulting from the change in the water table and other temporary disturbances, and potential spread of invasive species due to construction and flooding. Three sensitive non-vascular plants were detected during vegetation sampling in June 2017. An assessment of vegetation and wetlands supports the assessment of Aquatic Resources, Wildlife and Wildlife Habitat, Water Quality, and Terrain and Soils.
Wetlands	Wetlands filter water, store nutrients and carbon, and provide wildlife habitat. Wetlands may be affected by the MC1 Option 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 with the disturbance associated with construction and flooding. An assessment of wetlands contributes to the assessment of Aquatic Environment, Wildlife and Wildlife Habitat, Water Quality, as well as Vegetation and Terrain and Soils.

7.1.1.4 Measurable Parameters

Measurable parameters are quantitative or qualitative measures used to describe existing conditions and trends, and evaluate potential Option-related effects on each VC. The measurable parameters selected for the Vegetation and Wetland VCs are shown in **Table 7.1-3**. Potential adverse effects on these VCs arising from potential interactions with the MC1 Option are discussed in more detail in **Section 7.1.3**.

Table 7.1-3 Measurable Parameters for Vegetation and Wetlands

Selected VC	Potential Option-related Effects	Measurable Parameter
Vegetation	Change in species diversity	· Occurrence and population attributes of species occurring within the Option area · Introduction or spread of invasive species · Change in ACIMS tracked non vascular plant species and associated habitat.
	Change in vegetated areas	· Areal extent (hectares (ha)) of vegetated areas and non-vegetated areas
Wetlands	Change in wetland area and function	· Areal extent (ha) of wetlands loss or disturbance to wetlands ecosystems

7.1.1.5 Assessment Boundaries

Spatial Boundaries

Spatial boundaries for the assessment of Vegetation and Wetlands are described in **Table 7.1-4** and shown on **Figure 7.1-1**. The MC1 Option area encompasses the MC1 footprint and a 100-metre (m) buffer. The Local Assessment Area (LAA) encompasses the maximum geographical area where MC1 is expected to interact with and potentially have a direct or indirect effect on Vegetation and Wetlands. For the purposes of this assessment, the LAA coincides with the Option area, since the direct and indirect effects of the MC1 Option are not anticipated to extend beyond the 100-m buffer around the MC1 footprint.

The Regional Assessment Area (RAA) is established to provide a regional context for the assessment of Option-related effects. The RAA encompasses the area where the residual effects of the MC1 Option would likely interact with the residual effects of other past, present, or future projects or activities to result in a cumulative effect or effects. The RAA for Vegetation and Wetlands includes the Elbow River Watershed, since dispersal of invasive plant species would most likely result from the spread of seeds and vegetative propagules caused by altered hydrology following the introduction of the dam within the watershed.

Table 7.1-4 Spatial Boundary Definitions for Vegetation and Wetlands

Spatial Boundary	Description of Assessment Area
Option area	Encompasses the MC1 footprint and a 100-m buffer around the embankment and excavation areas, spillways and outlet works, road, and borrow areas.
Local Assessment Area	Equivalent to the Option area
Regional Assessment Area	Encompasses the Elbow River Watershed.

Temporal Boundaries

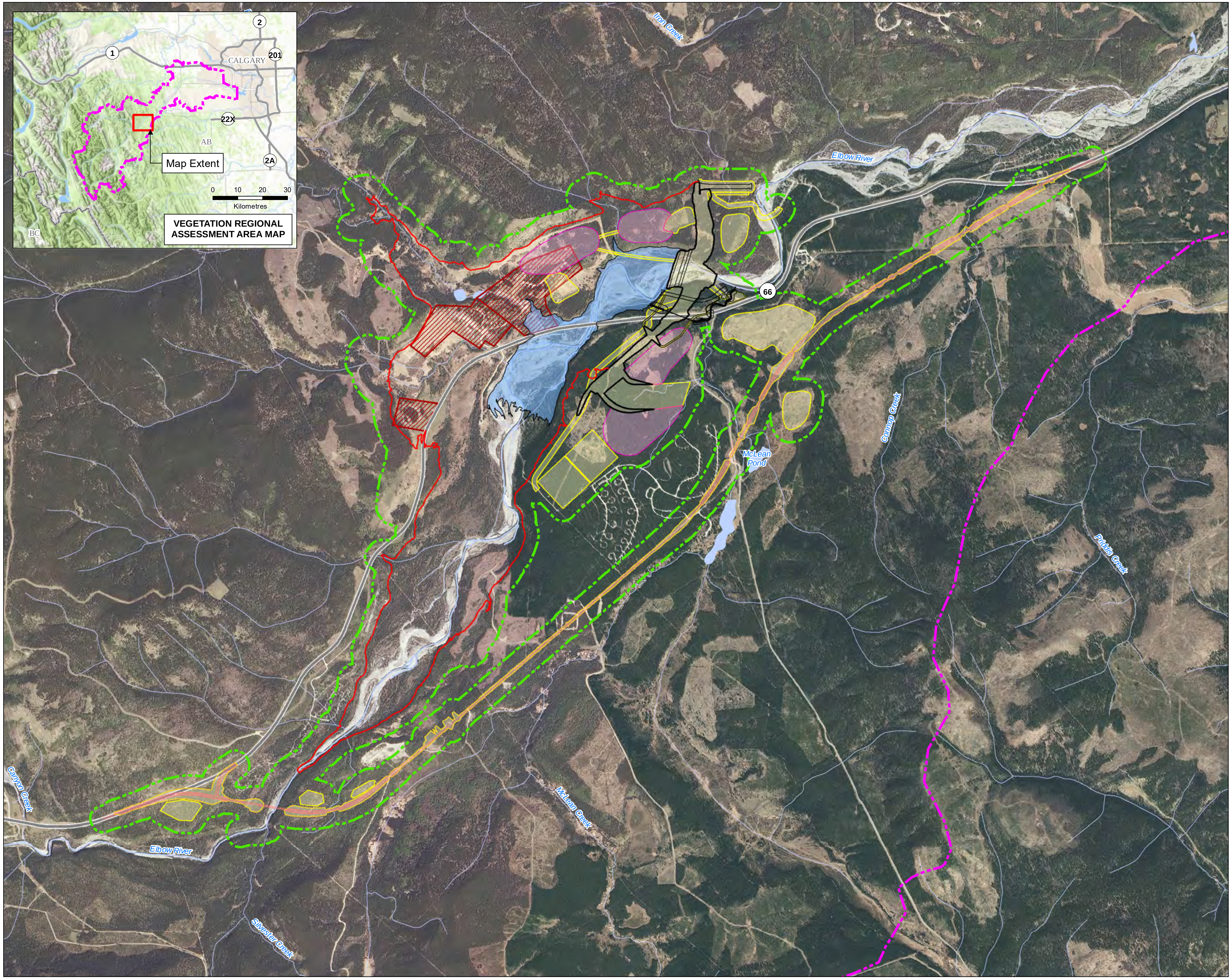
The temporal boundaries of MC1 consist of the Construction and Operation and Maintenance phases, which are described in **Section 3.0 MC1 Option Description**. Components and activities related to the MC1 Option would likely interact with and potentially affect Vegetation and Wetlands during these phases.

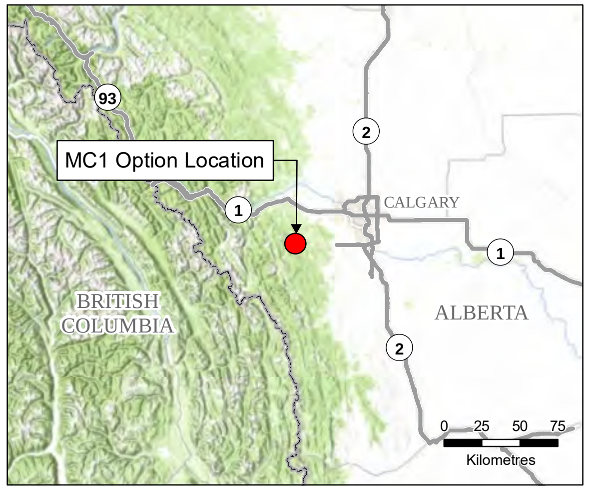
Administrative and Technical Boundaries

No administrative and technical boundaries (e.g., political, economic, or social issues, as well as fiscal or other resourcing issues constraining the assessment of potential effects of the Option) were identified for the assessment of potential MC1-related effects on Vegetation and Wetlands.

Elbow River at McLean Creek Dam (MC1)

Vegetation and Wetlands Local Assessment Area and Regional Assessment Area





Legend

- Vegetation Local Assessment Area
- Vegetation Regional Assessment Area
- MC1 Dam
- Highway 66 Re-alignment
- 2013 Flood Event (1424.1 m)
- Borrow Area
- Laydown Area/Disturbed Area
- Permanent Pond
- Existing Park Infrastructure to be Removed
- Highway

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

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7.1.2 BASELINE CASE

The baseline case for Vegetation and Wetlands is presented for the RAA and LAA using data compiled from the sources listed in **Section 7.1.1.2**.

The location of the MC1 Option is within the Montane Subregion of the Rocky Mountain Natural Region of Alberta, which is characterized by mountains and foothills separated by deep glacial valleys. The vegetation in this Natural Subregion is generally a mix of grasslands and deciduous-coniferous forests on southern and western aspects, and predominantly coniferous forests on northern aspects (Government of Alberta 2006).

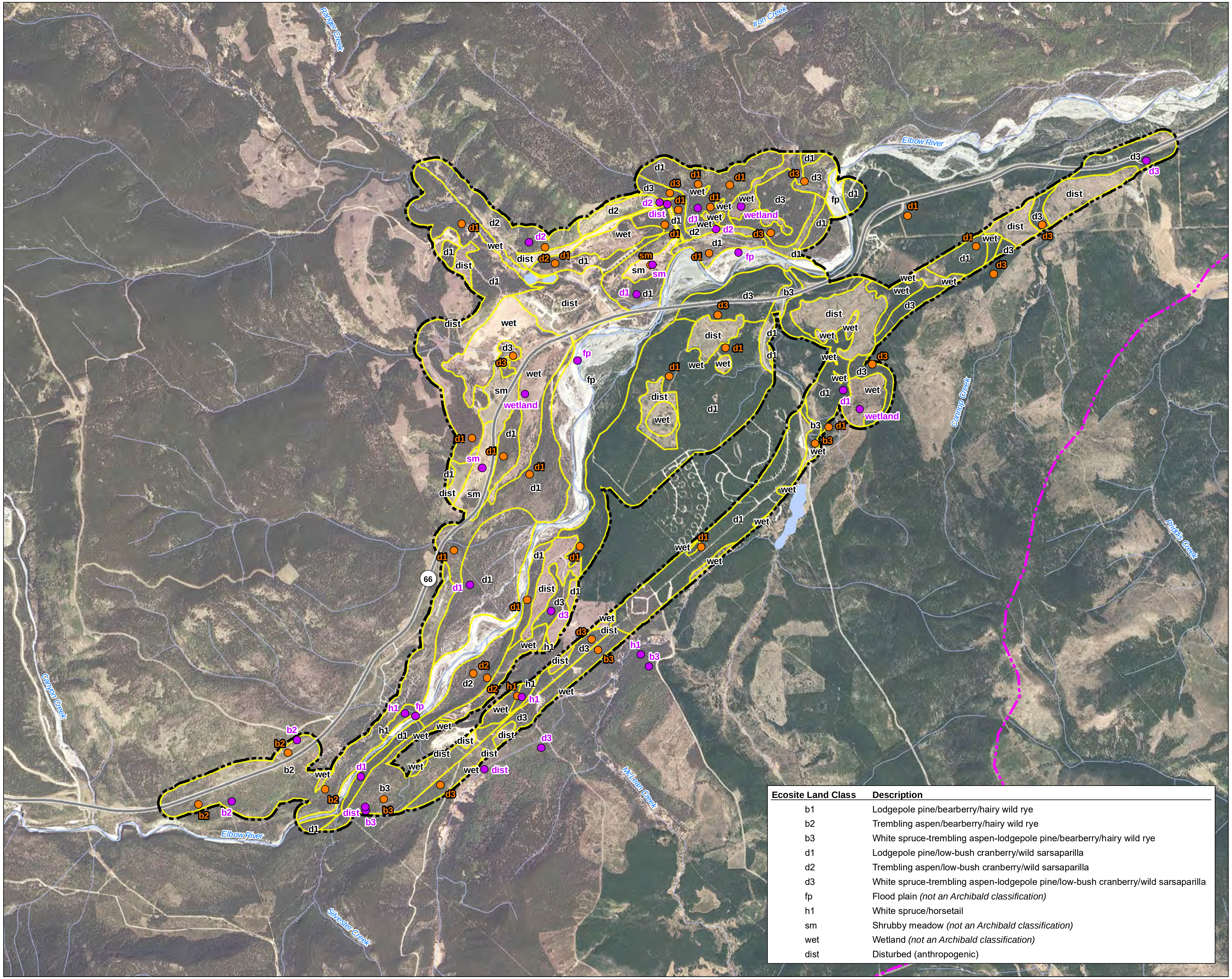
Plant communities vary both locally and across the Natural Subregion in response to slope, aspect, elevation, and latitude (Government of Alberta 2006). The Kananaskis Country Provincial Recreation Areas (PRAs) and Bragg Creek Management Plan (Government of Alberta 2012) characterize the Elbow River and McLean Creek PRA 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*). Alder (*Alnus* sp.) and red osier dogwood (*Cornus sericea*) can also be found in abundance. Willow (*Salix* sp.) communities are common in riparian areas; grasslands are also common, often on south- and west-facing slopes. Grass species include rough fescue (*Festuca scabrella*), bluebunch fescue (*Festuca idahoensis*), and parry oatgrass (*Danthonia parryi*) (Government of Alberta 2012).

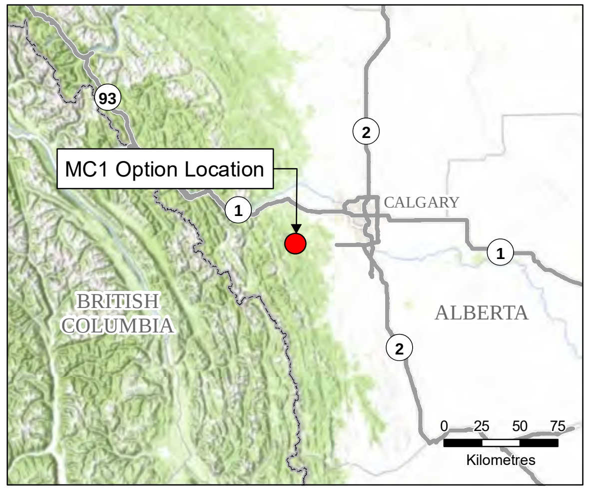
Nine ELCs were mapped within the LAA during the vegetation sampling (**Figure 7.1-2**). Most of the ELCs were determined based on the *Field Guide to Ecosites of Southwestern Alberta* (Archibald et.al. 1996). Ecosites detected within the LAA include:

- Trembling aspen/bearberry/hairy wild rye (b2)
- White spruce-trembling aspen-lodgepole pine/bearberry/hairy wild rye (b3)
- Lodgepole pine/low-bush cranberry/wild sarsaparilla (d1)
- White spruce/low-bush cranberry/wild sarsaparilla (d2)
- White spruce-trembling aspen-lodgepole pine/low-bush cranberry/wild sarsaparilla (d3)
- White spruce/horsetail (h1).

Elbow River at McLean Creek Dam (MC1)

Ecological Land Classes





Legend

- Vegetation Local Assessment Area
- Vegetation Regional Assessment Area
- Highway
- Watercourse
- Waterbody
- Ecological Land Class Plot
- Ecological Land Class Verification
- Ecological Land Class

Ecosite Land Class	Description
b1	Lodgepole pine/bearberry/hairy wild rye
b2	Trembling aspen/bearberry/hairy wild rye
b3	White spruce-trembling aspen-lodgepole pine/bearberry/hairy wild rye
d1	Lodgepole pine/low-bush cranberry/wild sarsaparilla
d2	Trembling aspen/low-bush cranberry/wild sarsaparilla
d3	White spruce-trembling aspen-lodgepole pine/low-bush cranberry/wild sarsaparilla
fp	Flood plain *(not an Archibald classification)*
h1	White spruce/horsetail
sm	Shrubby meadow *(not an Archibald classification)*
wet	Wetland *(not an Archibald classification)*
dist	Disturbed (anthropogenic)

Notes

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Sources

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Three ELCs were created to describe the vegetation more effectively in some areas: these included disturbed (dist) (anthropogenic), floodplain (fp), and shrubby meadow (sm). Disturbed (anthropogenic) are areas where the canopy has been removed due to timber harvesting, infrastructure, or other manmade disturbances. Floodplain refers to the active flood plain of the Elbow River. Shrubby meadows are areas that are dominated by grasses and forbs with a shrub canopy layer but few, if any, trees. The dominant grass species include hairy wild rye (*Leymus innovatus*), with common woodrush (*Luzula multiflora*) and tussock sedge (*Carex diandra).* Forbs include scattered occurrences of wild strawberry (*Fragaria virginana*), shooting star (*Primula pauciflora*), golden alexanders (*Zizia aurea)*, meadow-rue (*Thalictrum* sp.), and northern bedstraw (*Gallium boreale*). Shrubs include bog birch (*Betula pumila*), shrubby cinquefoil (*Potentilla fruiticosa*), and willow (*Salix sp*). The *Field Guide to Ecosites of Southwestern Alberta* does not consider wetlands in the ecosite classification; therefore, wetland areas were identified and classified using the Alberta Wetland Classification System (AWCS).

Wetlands are sparse within this Natural Subregion; typically, they are rich, often calcareous fens and marshes (Government of Alberta 2006). Wetlands function to mitigate effects of floods and droughts by storing and slowly releasing water; improving water quality by attenuating nutrients and contaminants; recharging groundwater tables; storing and sequestering carbon; and supporting a rich array of biodiversity (Government of Alberta 2017b, ESRD 2015).

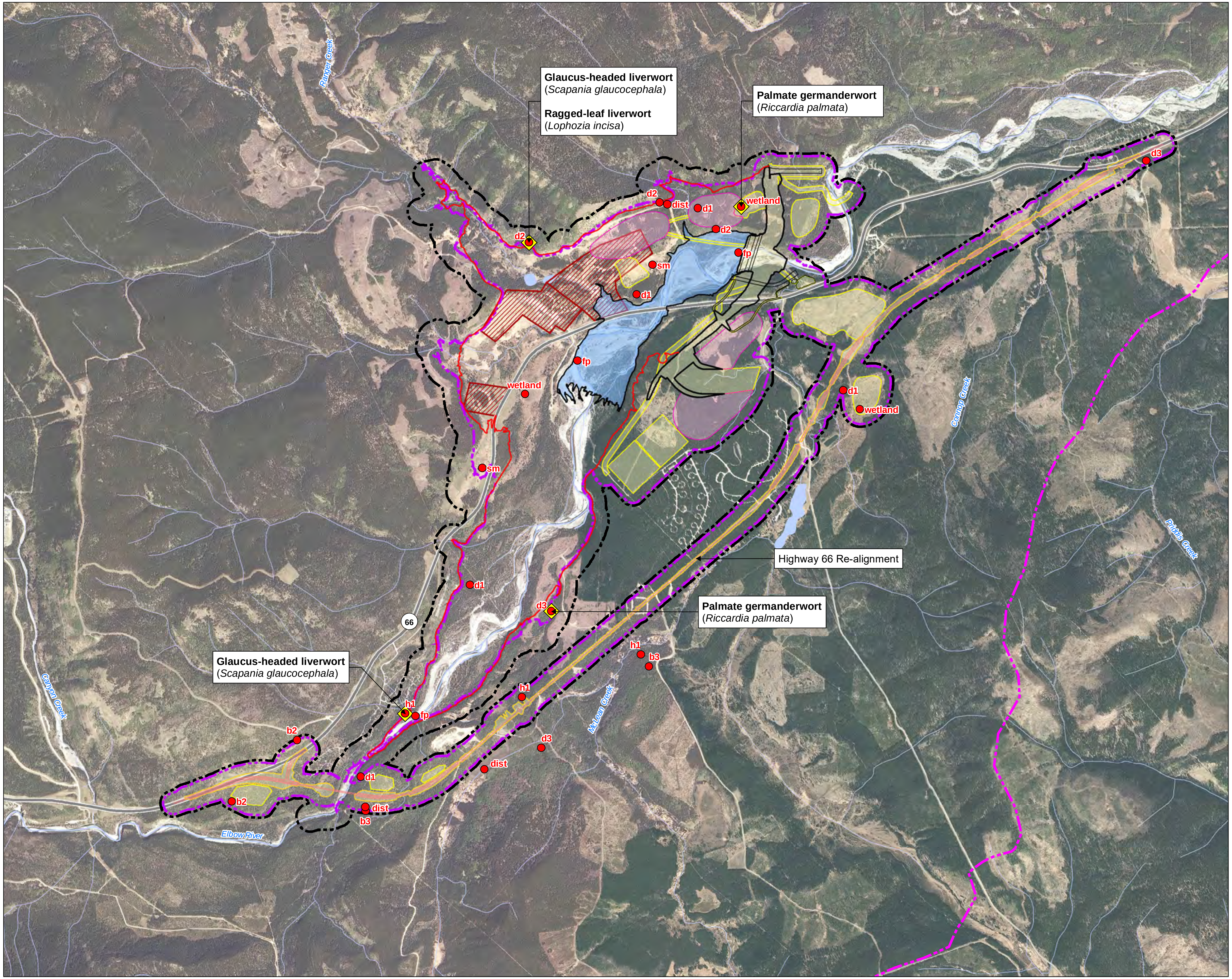
Thirty-one wetlands were identified and classified within the MC1 LAA during the wetland classification assessment (**Appendix 7-A Wetland Identification and Classification Assessment, Elbow River at McLean Creek Dam (MC1) Option**). Wetlands classified in the LAA include 14 shrubby fens (98.85 hectares (ha), 3 graminoid fens (8.21 ha), 2 semi-permanent freshwater shallow open water (0.57 ha), 2 seasonal freshwater marshes (7.46 ha), 1 wooded fen (9.02 ha), 6 shrubby swamps (59.07 ha), 1 temporary freshwater marsh (4.96 ha), 1 marsh (0.75 ha), and 1 permanent freshwater shallow open pond (10.66 ha).

More than 400 tracked plant species have been recorded within this Natural Subregion by ACIMS, two of which are listed in Schedule 1 of SARA: the western blue flag (*Iris missouriensis*) and the Haller's apple moss (*Bartramia halleriana*). Tracked species are placed on a tracking or watch list by ACIMS when current data suggest they may be rare within the province. This list serves as a focus for actively gathering location and occurrence information (Alberta Parks 2015b). Available documented occurrence data are over 50 years old and, given the recent changes in the landscape from the 2013 flood, cannot be used reliably to determine the presence of rare plants within the vicinity of the MC1 Option. Vegetation sampling conducted in June and August of 2017 detected the presence of three tracked non-vascular plant species within the study area, including palmate germanderwort (*Riccardia palmata*), glaucous-headed earthwort (*Scapania glaucocephala)*, and ragged-leaf liverwort (*Lophozia incisa*) (**Figure 7.1-3**) (**Appendix 7-B**

Results of Vegetation Mapping and Sampling at the Site of the Proposed Elbow River at McLean Creek Dam (MC1) Option).

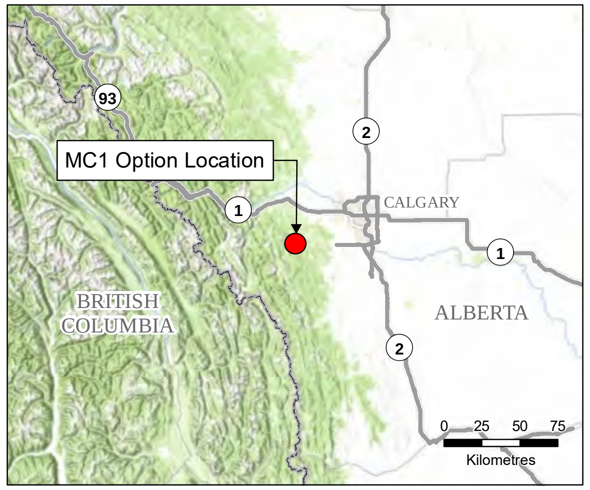
This Natural Subregion is valued for its recreational activities and domestic grazing. In addition, timber harvesting is locally important, but regeneration is challenging due to potentially dry conditions and calcareous soils (Government of Alberta 2006).

Ruderal species such as white clover (*Trifolium pratens*), creeping thistle (*Cirsium arvense*), and common dandelion (*Taraxacum officinale*) occur throughout the LAA, mainly along pedestrian and vehicular corridors and trails. Viper's bugloss (*Echium vulgare*), which was detected within the study area, is listed as a noxious weed by in the *Weed Control Act*.



Elbow River at McLean Creek Dam (MC1)

Sensitive Botanical Species



Legend

- Sensitive Botanical Species Location
- Ecological Land Class Plot
- MC1 Option Area
- Vegetation Local Assessment Area
- Vegetation Regional Assessment Area
- MC1 Dam
- Highway 66 Re-alignment
- 2013 Flood Event (1424.1 m)
- Borrow Area
- Laydown Area/Disturbed Area
- Permanent Pond
- Existing Park Infrastructure to be Removed
- Highway
- Watercourse
- Waterbody

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7.1.3 Application Case

The Application Case presents a description of the effects of the MC1 Option added to the Baseline Case (i.e., the Application Case includes the assessment of Option-related effects). The following sections present potential interactions with the MC1 Option, related effects, and associated mitigation measures, along with an assessment of residual effects.

7.1.3.1 Potential Option Interactions

For the purpose of this assessment, MC1 Option-related interactions with Vegetation and Wetlands and effects from each interaction have been identified, quantified, and qualified from baseline data collected within the Option area. Interactions between the MC1 Option and Vegetation and Wetlands are presented in **Table 7.1-5**.

Table 7.1-5 Identification of Option Interactions with Vegetation and Wetlands

Phase	Activity	Vegetation		Wetlands	
		Interaction	Effect	Interaction	Effect
Construction	Clearing	X	· Change in vegetated area · Change in species diversity	X	· Change in wetland area and function · Change in species diversity
	Road construction	X	· Change in vegetated area · Change in species diversity	X	· Change in wetland area and function · Change in species diversity
	Decommissioning and removal of existing provincial parks infrastructure and ranger station	X	· Change in vegetated area · Change in species diversity	X	· Change in wetland area and function · Change in species diversity
	Dam (cofferdam and earth fill) construction	X	· Change in vegetated area · Change in species diversity	X	· Change in wetland area and function · Change in species diversity
	Spillway construction	X	· Change in vegetated area · Change in species diversity	X	· Change in wetland area and function · Change in species diversity
	Rock groin and diversion tunnels construction	X	· Change in vegetated area · Change in species diversity	X	· Change in wetland area and function · Change in species diversity

Phase	Activity	Vegetation		Wetlands	
		Interaction	Effect	Interaction	Effect
	Laydown areas construction and use	X	· Change in vegetated area · Change in species diversity	X	· Change in wetland area and function · Change in species diversity
	Stockpile development and use	X	· Change in vegetated area · Change in species diversity	X	· Change in wetland area and function · Change in species diversity
	Borrow and spoil areas development and use	X	· Change in vegetated area · Change in species diversity · Removal of palmate germanderwort	X	· Change in wetland area and function · Change in species diversity
	Realignment of McLean Creek and other small waterbodies	X	· Change in vegetated area · Change in species diversity	X	· Change in wetland area and function · Change in species diversity
	Realignment of Highway 66	X	· Change in vegetated area · Change in species diversity	X	· Change in wetland area and function · Change in species diversity
	Storage of water in permanent pond	X	· Change in species diversity · Flooding of ragged-leaf liverwort and glaucus-headed earthwort	X	· Change in wetland area and function · Change in species diversity
	Reclamation	X	· Change in vegetated area · Change in species diversity	X	· Change in wetland area and function · Change in species diversity
Operation and Maintenance	Routine and flood operation and maintenance	X	· Change in vegetated area · Change in species diversity	X	· Change in wetland area and function · Change in species diversity

Note: X – potential interaction

The Construction phase, would result in the direct removal of vegetation and wetlands. This removal may be permanent in the road alignment, MC1 dam footprint, borrow areas within fens, and permanent pond boundary; the removal may be temporary in borrow areas outside fens, construction staging areas, backslopes, and areas of remedial grading. One population of palmate germanderwort would be permanently removed within a proposed borrow area. The other population of palmate germanderwort, along with one of the detected populations of the glaucus- headed earthwort and the population of ragged-leaf liverwort population are outside the 2013 flood level but within the PMF boundary (i.e., the reservoir). In addition, the population of the glaucus-headed earthwort is within the reservoir, and within the 2013 flood level. Although any flood events would be temporary, the alteration in hydrology would likely cause these species to die off, resulting in permanent effects to these species once flooding to this elevation has occurred.

Construction activities associated with the MC1 Option may introduce or spread invasive weed species in areas that may receive temporary effect, such as borrow areas, laydown areas, backslopes, and remedial grading areas. The introduction of invasive weed species may result in the degradation of adjacent habitat as well as disturbance or mortality of species adjacent to the MC1 Option, thereby increasing the number of habitats disturbed. In addition, waterways and roadways may create corridors for the establishment and spread of invasive exotic plant species. In addition, exposed silt deposited from slowed floodwaters as a result of flood events may provide ideal growing conditions for the establishment or spread of invasive exotics introduced by surface flows within the watershed if they occur upstream within the RAA.

Both the realigned roadway and permanent pond may result in the fragmentation of habitats within the RAA and LAA, which would lessen the value of remaining habitat pieces by reducing the movement and genetic flow of plant species and creating a corridor for the establishment of invasive exotic species.

Indirect effects include dust, and activities of equipment or personnel outside the designated construction areas during the Construction phase. Potential indirect effects during the Operation and Maintenance phase include temporary flooding, silt deposits, and the introduction of invasive species. These indirect effects would increase the extent of disturbed habitat.

7.1.3.2 MC1 Option-related Effects

This section considers adverse MC1 Option-related effects on VCs arising from interactions, as identified in **Table 7.1-5** and in relation to the measurable parameters listed in **Table 7.1-4**. Mitigation measures for each Option-related effect are described in **Section 7.1.3.3**.

Vegetation – Change in Vegetated Area

Construction

Clearing may be required in the MC1 Option area for the laydown areas to accommodate construction, development of stockpiles as well as borrow and spoil areas, reclamation, and flooding in the reservoir above the permanent pond elevation. These clearing activities may result in the temporary removal of vegetation and wetlands within the Option area.

Clearing of the Option area for construction of the earth fill dam, diversion tunnels, service and auxiliary spillways, permanent pond, and borrow and spoil areas within the fens, as well as realignment of Highway 66, and addition of new parks infrastructure would result in the permanent removal of vegetation within the Option area. In addition, the proposed borrow area located at the palmate germanderwort location would result in the direct, permanent removal of this species and its associated microhabitat.

The MC1 footprint (temporary and permanent disturbance areas) would cover a total of 326 ha. Direct temporary and permanent disturbance associated with the vegetation removal for the MC1 Option are quantified in **Table 7.1-6**.

Table 7.1-6 Direct Temporary and Permanent Disturbance by Ecological Land Classification

Code	Ecological Land Classification	Temporary Disturbance (ha)	Permanent Disturbance (ha)
b2	Trembling aspen/bearberry/hairy wild rye	3.9	9.1
b3	White spruce-trembling aspen-lodgepole pine bearberry/hairy wild rye	3.0	5.5
dist	Disturbed (Anthropogenic)	47.8	13.6
d1	Lodgepole pine/low-bush cranberry/wild sarsaparilla	64.7	41.5
d2	Trembling aspen/ low-bush cranberry/wild sarsaparilla	1.9	1.4
d3	White spruce-trembling aspen-lodgepole pine/ low-bush cranberry/wild sarsaparilla	9.6	23.5
h1	White spruce/horsetail	-	0.3
wet	Wetland	31.3	6.8
sm	Shrubby meadow	2.1	0.2
fp	Floodplain	0.7	59.1
	Total	**165.0**	**161.0**

Indirect effects during the Construction phase may include dust and silt generated from activities of equipment or personnel outside designated construction areas. These indirect effects would lower the value of adjacent habitats for plants, thereby increasing the number of disturbed habitats. This effect would be most pronounced in delicate habitats such as the fens (including AWCS classifications shrubby fen, graminoid fen, and wooded fen) where effects to portions of the fen may cause the vegetation to die off gradually within the remainder of the fen. Potential effects to fens are considered in more detail below.

Changes in the amount, timing, and duration of surface water supply to shoreline vegetation during MC1's Construction phase may affect the characteristics of soils and plant communities in the vicinity of the Option. The resulting change in hydrology from retaining water during a flood may alter the vegetation to more water-tolerant (hydrophytic) species. In addition, water diversions and alterations in the water regime associated with dam construction may affect habitats along river margins and shorelines, including fragmentation of habitat into smaller pieces, which may be less favourable or inhospitable.

Operation and Maintenance

Indirect effects during MC1's Operation and Maintenance phase include the effect on adjacent habitat caused by traffic, contamination from road salt, herbicide application, runoff, silt, scouring, introduction of invasive weed species, changes to hydrological regimes resulting from vegetation clearing and road-building during construction. A flood similar in magnitude to the 2013 flood would affect 457 ha in the reservoir. Maximum flooding within the reservoir will create additional affects outside the 2013 flood level. The indirect effects mentioned previously would lower the value of adjacent habitats for plants, thereby increasing the number of disturbed habitats. This effect would be most pronounced in delicate, but relatively high ecological functioning habitats such as fens (including AWCS fens classified as shrubby fens, graminoid fens, and wooded fens) where effects to portions of a fen would cause the vegetation to die off gradually within the remainder of the fen. Potential effects to fens are considered in more detail below under the subheading Change in Wetland Area and Function.

Changes in the amount, timing, and duration of surface water supply to shoreline vegetation may affect the characteristics of soils and plant communities in the Option area. In addition, water diversions and alterations in the water regime associated with the dam operation may affect habitats along river margins and shorelines, including the fragmentation of habitat into smaller pieces, which may be less favourable or inhospitable.

In addition, road runoff carrying road salt and hydrocarbons may contaminate soils adjacent to the realigned roadway. Direct temporary and permanent effects associated with the vegetation removal for the MC1 Option are quantified in **Table 7.1-7** and shown in **Figure 7.1-3**.

Table 7.1-7 Direct and Induced Temporary and Permanent Effects by Ecological Land Classification

Code	Ecological Land Classification	Temporary Effects (ha)	Permanent Effects (ha)
b2	Trembling aspen/bearberry/hairy wild rye	2.54	13.03
b3	White spruce-trembling aspen-lodgepole pine bearberry/hairy wild rye	0	8.49
dist	Disturbed (Anthropogenic)	56.32	33.54
d1	Lodgepole pine/low-bush cranberry/wild sarsaparilla	205.85	58.17
d2	Trembling aspen/ low-bush cranberry/wild sarsaparilla	22.60	3.01
d3	White spruce-trembling aspen-lodgepole pine/ low-bush cranberry/wild sarsaparilla	24.61	27.98

Code	Ecological Land Classification	Temporary Effects (ha)	Permanent Effects (ha)
h1	White spruce/horsetail	0.96	0.35
wetland	Wetland	60.53	30.52
Sm	Shrubby meadow	16.83	2.20
fp	Floodplain	66.41	59.06
	Total	456.65	236.35

Wetlands – Change in Wetland Area and Function

Construction

Direct and permanent removal of wetlands would occur within the Option area due to clearing of the Option area for construction of the dam and embankment, spillway, and outlet structure; permanent storage of water in the resulting permanent pond roadway, and borrow areas; development of spoil areas within the fens; and the addition of new parks.

The MC1 Option would result in the permanent removal of 30.42 ha of wetland and temporary disturbance to an additional 60.53 ha (**Table 7.1-6**). Direct effects such as depositing fill into portions of the fens and using the fens as borrow or stockpile areas may result in indirect, long-term effects to the remainder of the wetland as the non-vascular plants within the fen die off. An estimated 30.42 ha of wetlands would be permanently effected by the MC1 Option (**Table 7.1-8)**. The result of the gradual change in biodiversity within the fen would be a degradation of wetland function; specifically, the storing and slow release of water, the ability of the fen to recharge groundwater tables, the storage and sequestering of carbon, as well as the attenuation of nutrients and environmental contaminants. In addition, effects to wetland 1 (see **Table 7.1-8**) would result in the removal of palmate germanderwort, a sensitive botanical species.

Operation and Maintenance

Temporary flooding of wetlands within the reservoir may alter the hydrology of the wetlands. In addition, flood waters would deposit sediments or may scour the fens, which may result in long-term die-off of the non-vascular plants within the fen. The result of the gradual change in biodiversity within the fen may be a degradation of wetland function; specifically, the storing and slow release of water, the ability of the fen to recharge groundwater tables, the storage and sequestering of carbon, as well as the attenuation of nutrients and environmental contaminants.

Direct and indirect temporary and permanent effects associated with vegetation removal for the Option are quantified in **Table 7.1-8** and shown in **Figure 7.1-1** for wetlands detected within the LAA. Permanent effects include the area of permanent disturbance, as identified in **Table 7.1-6,** as well as permanent effects to adjacent vegetation caused by the removal of wetlands.

Table 7.1-8 Temporary and Permanent Effects Associated with Wetland Vegetation Removal within the Local Assessment Area

Wetland ID	Wetland Classification	Total Area (ha)	Approximate Area of Temporary Effects (ha)	Approximate Area of Permanent Effects (ha)
1	Shrubby fen	9.07	1.55	6.64
2	Shrubby fen	0.55	-	0.55
3	Shrubby fen	0.25	-	0.25
4	Shrubby swamp	0.26	-	0.26
5	Shrubby fen	1.10	-	0.21
6	Shrubby fen	23.57	23.57	-
7	Shrubby swamp	31.95	27.84	-
8	Graminoid fen	2.42	-	-
9	Graminoid fen	0.49	-	-
10	Shrubby fen	22.33	0	0.41
11	Shrubby swamp	15.43	-	-
12	Shrubby swamp	0.57	-	-
13	Graminoid fen	5.30	0	2.42
14	Seasonal freshwater marsh	0.06	-	0.06
15	Shrubby fen	1.40	-	1.39
16	Semi-permanent freshwater shallow open water	0.50	-	-
17	Semi-permanent freshwater shallow open water	0.07	-	-
18	Shrubby fen	22.74	-	5.63
19	Seasonal freshwater marsh	7.40	-	0.84
20	Shrubby fen	4.37	-	-
21	Wooded fen	9.02	-	1.80
22	Shrubby swamp	1.07	-	0.94
23	Shrubby fen	1.11	-	0.19
24	Shrubby fen	0.62	-	-
25	Shrubby fen	0.35	-	0.08
26	Shrubby fen	10.98	2.23	8.75
27	Temporary freshwater marsh	4.96	4.96	-
28	Shrubby fen	0.41	0.38	-
31	Permanent freshwater shallow open pond	10.66	-	-

Wetland ID	Wetland Classification	Total Area (ha)	Approximate Area of Temporary Effects (ha)	Approximate Area of Permanent Effects (ha)
32	Shrubby swamp	9.79	-	-
33	Marsh	0.75	-	-
Total area (ha)		**199.55**	**60.53**	**30.42**

Vegetation and Wetlands – Change in Species Diversity

Construction

In addition to the removal of habitats, permanent and temporary clearing of vegetation and wetlands within the LAA would result in the removal of the three tracked botanical species detected during botanical sampling. A population of palmate germanderwort would be directly removed during construction.

Furthermore, water diversions and alterations in the water regime associated with the dam construction may affect sensitive species occurrences along river margins and shorelines downstream as the dam releases floodwaters.

Indirect effects include changes in the amount, timing, and duration of surface water supply to vegetation within the LAA during the Construction phase, which would affect the characteristics of soils and plant communities in the vicinity of the LAA, thereby potentially altering species diversity. This effect could result in changes to the hydrological regime, which would alter habitat conditions that may lead to the loss of listed species as described previously in **Section 7.1.3.2** (Wetlands – Change in Wetland Area and Function) This effect would also occur within the floodplain of the Elbow River and in the riparian areas of creeks within the LAA, since the temporary redirection of water during construction would result in a change in hydrology, which may result in a change in vegetation.

Various Construction-phase activities can produce dust, which may adversely affect the health of adjacent vegetation communities. Dust may have a detrimental effect on the health, growth, and development of adjacent vegetation. The primary effects of dust are generally confined to areas immediately adjacent to construction and roadways.

Vehicles, equipment, and clothing can carry invasive plant species to the LAA from areas already infested, and deposit them in a new location. Furthermore, invasive plants can be introduced to an area via contaminated gravels and soils. Activities that disturb soil and vegetation such as clearing, grubbing, and road-building can contribute to the introduction or spread of invasive species since disturbed soils are susceptible to their establishment. The introduction of invasive species would decrease the extent and diversity of native vegetation communities. Given the existing occurrence of invasive plant species within the LAA, the occurrence of invasive plant species within the watershed, and the surface water flow mechanism for the distribution of seeds, coupled with the deposition of nutrient-rich silts within the temporary flood area and the proliferation of noxious weeds into adjacent habitats, a change in species diversity is considered a potential Option-related effect during the Construction phase.

Operation and Maintenance

Changes in the amount, timing, and duration of surface water supply within the LAA during operation of the dam would affect the characteristics of soils and plant communities in the RAA, thereby potentially altering species diversity. This effect would be most pronounced in delicate, but relatively high ecological functioning habitats such as the fen (including AWCS classifications shrubby fen, graminoid fen, and wooded fen) within the LAA where effects to portions of the fen would cause the vegetation to die off gradually within the remainder of the fen. The result of the gradual change in biodiversity within the fen would be a degradation of wetland function; specifically, the storing and slow release of water, the ability of the fen to recharge groundwater tables, the storage and sequestering of carbon, as well as the attenuation of nutrients and environmental contaminants. This effect would also occur within the floodplain of the Elbow River and in the riparian areas of creeks within the LAA, since the water within the permanent pond and temporary flooding would result in a change in hydrology within the LAA, which in turn would result in a gradual change in vegetation. The result of the gradual shift in vegetation would depend on the frequency and duration of flood events.

A population of glaucus-headed earthwort occurs within both the 2013 flood level boundary. A population of palmate germanderwort, glaucus-headed earthwort and ragged-leaf liverwort occur outside the 2013 flood level but within the reservoir. With maximum flooding in the reservoir, the change in water regime associated with the dam operation would most likely result in die-off of these sensitive botanical species, resulting in a permanent, direct effect. Given the small probability of experiencing a PMF event, it is expected that the likelihood of experiencing this event is very small.

Ongoing operation of the roadway can produce dust, which may adversely affect the health, growth, and development of adjacent vegetation communities. The primary effects of dust are generally confined to areas immediately adjacent to construction sites and roadways.

Vehicles, equipment, and clothing can carry invasive plant species to the LAA from areas already infested, and may deposit them in a new location. Invasive species could also be introduced during the Operation and Maintenance phase with receding floodwaters potentially transporting them from upstream in the watershed to freshly deposited silt; in addition, the realigned roadway could operate as a colonization and dispersal route for invasive species. The introduction of invasive species would subsequently decrease the extent and diversity of the native vegetation communities. Given the existing occurrence of invasive plant species within the LAA, the occurrence of invasive plant species within the watershed, and the surface water flow mechanism for the distribution of seeds, coupled with the deposition of nutrient-rich silts within the temporary flood area and the proliferation of noxious weeds into adjacent habitats, a change in species diversity is considered a potential Option-related effect during the Operation and Maintenance phase.

Temporary flooding of wetlands within the reservoir would alter the hydrology of affected wetlands. In addition, flood waters would introduce silt and sediments into the fens, or may scour the fens, which may result in long-term die-off of the non-vascular plants within the fen. The result of the gradual change in biodiversity within the fen would be a degradation of wetland function; specifically, the storing and slow release of water, the ability of the fen to recharge groundwater tables, the storage and sequestering of carbon, as well as the attenuation of nutrients and contaminants.

7.1.3.3 Mitigation Measures

Measures to mitigate effects on the Vegetation and Wetlands VCs comprise any practical means for managing potential adverse effects. In accordance with Alberta Transportation standard practice, best management practices (BMPs) and standard mitigation measures, including those outlined below to address potential effects to Vegetation and Wetlands, would be included in the Environmental Construction Operations Plan that would be developed by the contractor and reviewed by Alberta Transportation prior to the start of Construction. Mitigation measures to address potential adverse effects, discussed in **Section 7.1.3.2**, are described below and summarized in **Table 7.1-9**. The final column in the table identifies whether or not there is the potential for a residual effect.

Identification of the proposed mitigation measures has been informed by a review of policies and management plans (listed below), consideration of mitigation measures and follow-up programs for similar projects, and a high-level evaluation of technical and economic feasibility of proposed measures. Policies and management plans that have informed the selection of mitigation measures for Vegetation and Wetlands include:

- Alberta Wetland Policy (AEP 2013)
- Alberta Wetland Mitigation Directive (Government of Alberta 2017b)
- Kananaskis Country Provincial Recreation Areas and Bragg Creek Provincial Park Management Plan (Government of Alberta 2012)
- The *Weed Control Act*.

Mitigation approaches provided in the policies identified above that are relevant to the MC1 Option are recommended for adoption during the final design, Construction, and Operation and Maintenance phases of the MC1 Option. In addition to the application of relevant features from the above policies, the following Option-specific mitigation measures are also considered appropriate.

Revegetation and Reclamation Measures

Areas of temporary effects, such as backslopes and laydown and borrow areas outside the fen areas, would be revegetated using a native plant seed mix. This measure would assist in the re-establishment of native vegetation within the LAA after construction, thereby reducing the effect of the proposed Option on Vegetation. In addition, after decommissioning and relocation of parks facilities, site remediation areas would also be revegetated with a site-specific seed mix described by a qualified botanist during detailed design. A qualified botanist would help re-establish native vegetation while reducing the overall permanent effect of the MC1 Option on the Vegetation VC. Botanists are considered qualified if they have at least five years' experience conducting floristic surveys in southwestern Alberta and are knowledgeable about habitat restoration and enhancement. Since the Option could result in some areas that would be permanently affected due the addition of hardscape and a permanent pond, a residual loss of vegetation, as identified in **Section 7.1.3.4**, is anticipated following development and implementation of a Revegetation and Reclamation Plan and revegetation mitigation measures.

Riparian Vegetation Management Measures

Vegetation management and mitigation measures to reduce or eliminate potential effects to riparian vegetation would be developed for implementation during the Construction and Operation and Maintenance phases. The Kananaskis Country Provincial Recreation Areas and Bragg Creek Provincial Park Management Plan (Government of Alberta 2012) indicates that development within PRAs should minimize effects to riparian habitats and riparian habitat function. Examples of mitigation measures that would be included in this plan include limiting the removal of riparian areas to areas that are critical for construction or operational needs; establishing and maintaining riparian buffers at road crossings and borrow pits; and selecting strategies for the removal of terrestrial biota and soil from the anticipated footprint of the permanent pond as outlined in the **Section 7.3 Aquatic Environment**.

Wetland Mitigation Measures

A hierarchical approach is typically used to identify strategies to avoid or minimize potential effects on wetlands from the MC1 Option. The three types of mitigation associated with the potential effects on Wetlands are identified as follows:

- **Avoidance:** Avoiding potential effects on Wetlands is the primary and preferred response by the Province of Alberta. Avoidance measures include Option redesign, as well as Construction and Operation and Maintenance-phase procedures and practices to avoid affecting wetlands.
- **Minimization:** Where avoidance is not possible, standard mitigation measures, BMPs, and construction and operation and maintenance management plans would be developed and implemented to reduce potential effects.

- **Replacement:** As a last resort and where avoidance and minimization efforts would not be feasible, wetland replacement, as outlined in the Alberta Wetland Mitigation Directive (Government of Alberta 2017b), would be required.

The MC1 Option is currently in its conceptual design phase, and it is expected that through consultation activities and internal review processes, avoidance and minimization strategies would be incorporated into the Option's final design.

Under the Alberta Wetland Policy (AEP 2013), replacement is based on the functionality of the affected wetlands; the higher the ecological functionality of the wetland to be affected, the higher the replacement ratio to offset effects to the wetland. Once a wetland assessment and effects report has been completed for the Option area, it must be submitted, along with a mitigation plan, prior to ground disturbance with an Application for a Licence under the *Water Act*, RSA 2000, c. W-3, and would form the basis of a Wetland Restoration and Compensation Plan. Since the Alberta Wetland Rapid Evaluation Tool form and shapefile has not yet been completed for the Option (Government of Alberta 2015), wetland areas are approximate and the relative wetland ecological function value has been estimated. Potential effects estimated by wetland class are outlined in **Section 7.1.3.2**. Based on these estimated areas and an estimated relative wetland function value of "B" for all of the wetlands, the anticipated replacement ratio for the Option would be 3:1. Therefore, to offset the estimated 30.42 ha of direct, permanent effects, approximately 91.26 ha would be included in the in-lieu fee program for wetland replacement to the designated Wetland Replacement Agent for Zone 13 of the province. This program would fulfill the wetland replacement obligation by paying in-lieu fees directly to the designated wetland replacement agent, which would expend these fees on replacement actions to restore, enhance, or construct a wetland. In 2015, the land value in Zone 13 was listed as $17,700 per ha for a total in-lieu fee of approximately $1,651,302 (Government of Alberta 2017b). Note that this wetland compensation estimate differs from that proposed in Opus 2017a because the Opus number is an early estimate based on preliminary classification, and this estimate was generated later and is based on detailed field work. The overall Option engineering and construction budget contains sufficient contingency to account for refinements, and this revised number should not appreciably change the overall Option cost estimate.

In Alberta, there are currently no means to compensate for indirect or long-term effects associated with construction, operation, and maintenance of projects; however, the entire areas classified as fen within the Option area would likely be indirectly affected by the MC1 Option with a gradual change in relative wetland function over time. Monitoring the fens would therefore be included as a portion of the minimization proposal to accompany the *Water Act* Application for the Option (See **Section 7.1.4**).

Proposed effects to the bed and shore of both Elbow River and McLean Creek would require a disposition under the *Public Lands Act*, RSA 2000, c. P-40. Furthermore, any effects to seasonal freshwater marshes and fen wetland classifications would require an assessment for wetland basin permanence to determine if the wetlands meet the criteria (permanent and naturally occurring waterbody) to be claimed by the Crown. This assessment would be conducted concurrently with the *Alberta Wetland Rapid Evaluation Tool* information and submitted to the Public Lands Branch of AEP for a claim determination by the Crown. If any of the wetlands are claimed by the Crown, then a disposition must be obtained under the *Public Lands Act* for any access to or activity on public lands and in compliance with the Public Lands Administration Regulation (187/2011).

Following implementation of avoidance, minimization, and replacement measures, which would be identified in the *Water Act* approval, residual effects would be likely with the gradual degradation of wetland function in the remaining areas of fens and within the reservoir.

Dust Controls

During the Construction phase, the speed limit at the site would be kept to 30 kilometres per hour wherever possible to reduce the dust produced by vehicles. All MC1 Option personnel would obey speed limit rules, both along public roads and on designated Option access roads. Driving off designated Option routes would not be permitted. When required (e.g., during periods of dry, hot weather), a water truck would be used to water non-paved roads in the Option area to reduce dust deposition on adjacent vegetation.

Following the implementation of these measures, the residual effects associated with dust on adjacent vegetation during the Construction phase would likely be negligible.

Invasive Plant Program

Non-native plant material would not be brought onto the construction site. In addition, to reduce the spread of invasive species identified as noxious or prohibited noxious weeds under the *Weed Control Act*, construction activities would include the use of a wash station in a designated area to wash equipment prior to being used in the Option area.

Following the Construction phase, surveys for noxious or prohibited noxious weeds under the *Weed Control Act* would be conducted annually during the fall along the realigned highway; within the flood zone above the permanent pond; within the borrow, laydown, and staging areas; and in the vicinity of the relocated facilities. Additionally, any noxious or prohibited noxious weed species detected would be removed. This proposed mitigation is consistent with the Kananaskis Country Provincial Recreation Areas and Bragg Creek Provincial Park Management Plan (Government of Alberta 2012), which indicates that annual inventories of invasive plant species within the PRAs should be conducted to control or remove exotic plants as required and eliminate the occurrence of invasive plant species listed under the *Weed Control Act*. With the implementation of this measure, there would be no residual effects of the MC1 Option on Vegetation, Wetlands, and Sensitive Botanical Species related to the spread or introduction of invasive species.

Erosion and Sediment Control Plan

Prevention of erosion and containment of sediment during the Construction and Operation and Maintenance phases of the MC1 Option would be important in reducing the potential adverse effects on Vegetation and Wetlands. An Erosion and Sediment Control Plan would be developed and implemented for near and instream works occurring during the Construction and Operation and Maintenance phases. This mitigation measure is described in more detail in **Section 6.2 Terrain and Soils** and **Section 7.3 Aquatic Environment**.

Implementation of this plan would likely sufficiently reduce or eliminate the potential adverse effects to Vegetation and Wetlands resulting from sediment mobilization caused during the Construction phase.

Table 7.1-9 Summary of Potential Effects and Mitigation Measures for Vegetation and Wetlands

Summary of Potential Effect and Classification	Components	Contributing Activities	Proposed Mitigation Measure	Detectable / Measurable Residual Effect
Construction Phase				
Vegetation: Change in vegetated area	Construction of the main dam, entrance and egress of diversion tunnels, cofferdam, service spillway, auxiliary spillway, permanent pond, reservoir, Highway 66 relocation, and facility relocation	· Permanent removal of vegetation during site clearing, earthworks, permanent pond construction, road construction and Highway 66 relocation, and facilities decommissioning and relocation · Temporary removal of vegetation during construction of staging areas, borrow pits, and sediment deposits and scouring within the PMF boundary · Indirect effects of Construction-phase activities including, dust, silt, activities of equipment and personnel outside designated construction areas, introduction or spread of invasive species	· Revegetation and reclamation measures · Wetland mitigation measures · Riparian vegetation and management measures · Dust controls · Invasive plant program · Erosion and Sediment and Erosion Control Plan	Yes
Wetlands: Change in wetland area and function	Construction of the main dam, entrance and egress of diversion tunnels, borrow areas, temporary haul roads, batch plant and aggregate area, service spillway, auxiliary spillway, permanent pond, Highway 66 relocation, and facility relocation	· Site clearing, earthworks, permanent pond, road construction and Highway 66 relocation, facilities decommissioning and relocation, indirect effects during Construction	· Wetland mitigation measures · Erosion and Sediment Control Plan	Yes
Vegetation, Wetlands: Change in species diversity	Construction of the main dam, entrance and egress of diversion tunnels, cofferdam, borrow areas, temporary haul roads, batch plant and aggregate area, service spillway, auxiliary spillway, permanent pond, Highway 66 relocation, and facility relocation	· Site clearing, earthworks, permanent pond, road construction and Highway 66 relocation, facilities decommissioning and relocation. Indirect effects such as water diversion, dust, sediment and erosion, invasive plant introduction and spread	· Wetland mitigation measures · Dust controls · Invasive plant program · Erosion and Sediment Control Plan	Yes

Summary of Potential Effect and Classification	Components	Contributing Activities	Proposed Mitigation Measure	Detectable / Measurable Residual Effect
Operation and Maintenance Phase				
Vegetation: Change in vegetated area	Road operation and maintenance, facility operation and maintenance, long-term effects of borrow areas, laydown and storage within fens, scouring and sediment deposits in fens as a result of flood waters within reservoir	· Habitat fragmentation from pond, invasive plant introduction and spread, dust	· Invasive plant program	Yes
Vegetation, Wetlands: Change in species diversity	Road operation and maintenance, facility operation and maintenance, long-term effects of borrow areas, laydown and storage within fens, scouring and sediment deposits in fens as a result of flood waters within reservoir	· Habitat fragmentation from pond, invasive plant introduction and spread, dust	· Invasive plant program · Monitoring program for fens (see **Section 7.1.4**)	Yes

7.1.3.4 Residual Effects

Residual effects are effects related to the MC1 Option that are anticipated to occur to VCs after the application of mitigation measures. The determination of a substantive or non-substantive residual effect includes such characterization as magnitude, regional extent, and duration. For the purpose of this discussion, anticipated residual effects are delineated as:

- Non-substantive residual effect – mitigation measures have not fully eliminated the effects, but have reduced the magnitude, extent, or duration to avoid a substantive effect on the VC. This characterization is based on the definitions and rating of effects characteristics outlined in **Table 7.1-10.**
- Substantive residual effect – adverse effects would likely be high in magnitude, regional in extent, or long term in duration even after implementation of mitigation.

Residual Effects Characteristics

Residual effects are characterized based on the criteria defined in **Table 7.1-10**. The effect characteristics are assessed in the context of the Vegetation VC and Wetlands VC.

Table 7.1-10 Residual Effects Characteristics for Vegetation and Wetlands

Residual Effect Characteristic	Rating	Definition
Direction	Positive	Net benefit to Vegetation and Wetlands.
	Adverse	Net loss to Vegetation and Wetlands.
Extent	Local	Confined to the area directly disturbed by Option facilities.
	Subregional	Limited to one natural region and within the LAA.
	Regional	Within the RAA.
Magnitude	Negligible	No detectable change in the Vegetation or Wetlands quality, quantity, or other attributes from background conditions.
	Minor	Minimal change in the Vegetation or Wetlands quality, quantity or other attributes from background conditions.
	Moderate	Moderate change in the Vegetation or Wetlands quality, quantity, or other attributes from background conditions.
	Major	Major change in the Vegetation or Wetlands quality, quantity, or other attributes from background conditions.
Duration	Short-term	Temporary effects to Vegetation or Wetlands that are detectable for 5 to 10 years after the event.
	Long-term	Permanent effects to Vegetation or Wetlands.
Reversibility	Reversible	Effect can be reversed once the activity causing the residual effect ceases.
	Not reversible	Effect is permanent.
Frequency	Isolated	A single event.
	Rare	A few events over the course of a year.
	Frequent	A constantly occurring event.

Residual Effect Characteristic	Rating	Definition
Confidence	High	Rating predictions are based on a good understanding of cause-effect relationships and/or using data specific to the 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 Option.
	Low	Rating predictions are based on an incomplete understanding of cause-effect relationships and incomplete data.

Change in Vegetated Area

Construction, operation, and maintenance of the MC1 Option would result in an adverse residual effect to the Vegetation VC due to a change in vegetated area. The construction of MC1 and relocation of the roadway and facilities would result in the permanent and direct removal of vegetated areas for both the hardscape surfaces and the permanent pond. Although mitigation measures include the revegetation of areas temporarily affected during the Construction phase and implementation of riparian management measures, some areas would not be revegetated. Activities during the Operation and Maintenance phase would further add to change of vegetated area, particularly the operation of the reservoir during flood events. However, given the amount of vegetated area available in the RAA that would not be affected by the MC1 Option, this residual effect is likely to be non-substantive. While changes in wetland are included in the change of vegetated area residual effect, due to the special nature and consideration of wetlands, residual effects to wetlands are evaluated separately.

Table 7.1-11 summarizes the effects characteristics of the anticipated changes in the Vegetation VC, and provides a rationale for the rating.

Table 7.1-11 Summary of Effect Characteristics Ratings for Change in Vegetated Area

Residual Effects Characteristic	Rating	Rationale for Rating
Direction	Adverse	The replacement of vegetation with hardscapes, roadways, and permanent pond adversely affects quantity of vegetated habitat.
Extent	Local	Direct vegetation removal would occur within the footprint of the MC1 Option.
Magnitude	Moderate	The loss of vegetated habitat along with the loss of relatively higher ecologically functioning habitats is an adverse effect on both the quality and quantity of vegetated habitat in the vicinity of the MC1 Option.
Duration	Long-term	Effect would be long term due to the nature of the Option activities (i.e., permanent footprint).
Reversibility	Not reversible	Effect would be irreversible due to the nature of the Option (i.e., permanent footprint).
Frequency	Isolated-rare	The vegetation would be directly and permanently removed during Construction and replaced with either hardscape or permanent pond.
Confidence	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.

Change in Wetland Area and Function

Construction of the Option would result in an adverse residual effect to the Wetlands VC due to a change in wetland area and function.

Although standard avoidance, minimization, and compensation measures are described in the Alberta Wetland Policy (AEP 2013), these measures do not offset interim and long-term loss to wetland area and function within the watershed. Compensation is proposed to be paid to organization identified as the designated Wetland Replacement Agent. Since wetlands would not be directly replaced within the Elbow River watershed, removal of wetlands would result in wetland area loss and reduction of wetland ecological function within the Elbow River watershed; this loss and reduction would conflict with the mandate of Ducks Unlimited Canada to implement projects that benefit wetlands within the Saskatchewan River Watershed.

In addition, there is currently no means to offset gradual degradation of wetland function as a result of development. The areas of fens remaining outside the borrow, laydown, and staging areas, as well as the scouring and sediment deposits associated with flooding within the reservoir would likely result in a gradual change in biodiversity of the fen as well as a loss of ecological function of the fen as the vegetation dies off. Fens are peat-based wetlands that develop over thousands of years and function to transport large volumes of water and nutrients across the landscape; they also help regulate water flow, help prevent downstream flooding by absorbing precipitation, and store large amounts of carbon to help moderate climate change. The current scientific consensus is that once they are damaged, fens are impossible to restore to their original ecological functionality (DUC 2017); therefore, the resulting loss of ecological function of fens would be a substantive residual effect to the changes in wetland area and function. **Table 7.1-12** summarizes the effects characteristics of the anticipated changes in the Wetlands VC, and provides a rationale for the rating.

Table 7.1-12 Summary of Effect Characteristics Ratings for Change in Wetland Area and Function

Residual Effects Characteristic	Rating	Rationale for Rating
Direction	Adverse	Removal of wetlands would adversely affect ecological function of wetland habitat within the Elbow River Watershed.
Extent	Regional	Direct wetland removal would occur within the Option footprint with little to no replacement within the RAA. In addition, there would be a gradual degradation of the ecological function of the remainder of the fens within the LAA.
Magnitude	Major	The replacement of ecologically functioning habitats such as wetlands with hardscape, roadways, and a permanent pond would adversely affect both the quality and quantity of wetland habitat in the vicinity of the MC1 Option. As noted previously, the current in-lieu fee would result in wetland area loss and reduction of wetland ecological function within the Elbow River Watershed. In addition, the long-term degradation of fens is an adverse effect on both the quantity and quality of wetlands within the RAA for which there is currently no compensation required under the *Water Act*.
Duration	Long-term	Direct loss of wetlands along with the gradual loss of the ecological function of the remainder of the wetland would result in a long-term residual effect.

Residual Effects Characteristic	Rating	Rationale for Rating
Reversibility	Not reversible	Loss of wetlands and degradation of their ecological function cannot be reversed.
Frequency	Isolated	The Option would result in the direct removal of wetlands within the Option area and the gradual degradation of the ecological functionality of the remainder of the wetland; therefore, the frequency of the residual effect characteristics is considered to be isolated.
Confidence	High	Rating predictions are based on a good understanding of cause-effect relationships.

Change in Species Diversity

Activities anticipated during the Construction, and Operation and Maintenance phases of the MC1 Option would result in an adverse residual effect to Vegetation and Wetlands due to changes in species diversity.

The direct, temporary, and permanent loss of vegetation associated with the construction of the MC1 Option would involve the permanent and direct removal of sensitive botanical species including an occurrence of palmate germanderwort and its associated microhabitat from the MC1 LAA. In addition, the occurrence of glaucus-headed earthwort within both the 2013 flood level and the PMF boundary, as well as the occurrence of palmate germanderwort, glaucus-headed earthwort, and ragged-leaf liverwort and their associated microhabitats would be temporarily affected by flooding within the PMF boundary of the MC1 LAA. With the change in water regime within the PMF boundary, the occurrences of palmate germanderwort, glaucus-headed earthwort, and ragged-leaf liverwort would die off within the MC1 LAA when flood waters reach those levels. In addition, there are no mitigation measures available to offset these effects. The MC1 Option would therefore result in substantive residual effects to the change in species diversity.

Table 7.1-12 summarizes the effects characteristics of the anticipated changes in the species diversity, and provides a rationale for the rating.

Table 7.1-13 Summary of Effect Characteristics Ratings for Change in Species Diversity

Residual Effects Characteristic	Rating	Rationale for Rating
Direction	Adverse	The removal of vegetated habitats would result in the removal of sensitive species. The introduction and spread of invasive species may reduce the species diversity of the RAA. Indirect effects in the fens resulting from species die-off would result in a change in biodiversity.
Extent	Local	Habitat removal would occur within the Option footprint.
Magnitude	Minor	The Option would result in the direct and permanent removal of sensitive non-vascular plant species, including palmate germanderwort, glaucous-headed earthwort, and ragged-leaf liverwort. These species are tracked by ACIMS, but are not formally listed.
Duration	Long-term	Loss of sensitive botanical species would result in a permanent and long-term effect.

Residual Effects Characteristic	Rating	Rationale for Rating
Reversibility	Not reversible	Loss of sensitive species cannot be reversed.
Frequency	Isolated	Sensitive species would be directly removed during Construction and replaced with either hardscape or permanent pond.
Confidence	High	Rating predictions are based on a good understanding of cause-effect relationships.

7.1.3.5 Summary of Vegetation and Wetlands Assessment

There would likely be two adverse substantive MC1-related residual effects on Vegetation and Wetlands, and one adverse non-substantive residual effect for Vegetation. The non-substantive residual effect for vegetation is the change in vegetation area. One substantive residual effect is likely to occur for Wetlands: change in wetland area and function, and one substantive residual effect for both Vegetation and Wetlands would be a change in species diversity. These substantive residual effects are carried forward for consideration in the cumulative effects assessment. (**Section 9.0 Planned Development Case**).

7.1.4 FOLLOW-UP MONITORING FOR VEGETATION AND WETLANDS

Follow-up monitoring for vegetation and wetlands would be conducted to verify residual effects predictions, and to monitor the effectiveness of mitigation measures.

The follow-up monitoring plan 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 construction area to determine the health of the remainder of the fen and any remediation measures that may be necessary to restore lost functionality. Remediation activities may include, but would not be limited to weed removal and sediment and silt removal to delay the loss of functionality in the fens.

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7.2 WILDLIFE AND WILDLIFE HABITAT

This section addresses potential MC1-related environmental effects to Wildlife and Wildlife Habitat, which is defined here as native fauna including breeding birds, mammals, amphibians, reptiles, and their associated habitats (i.e., nests and dens).

The assessments presented in this section are supported by or linked to the assessments presented in the following sections:

- Section 6.4 Fluvial Geomorphology
- Section 7.1 Vegetation
- Section 7.3 Aquatic Environment
- Section 8.1 Land Use Management and Infrastructure

7.2.1 SCOPE OF ASSESSMENT

This section reviews the scope of the assessment for Wildlife and Wildlife Habitat Valued Component (VC), and includes the regulatory framework, data sources, VCs, measurable parameters, and assessment boundaries relevant for Wildlife and Wildlife Habitat.

7.2.1.1 Regulatory Framework

This section provides an overview of the relevant regulatory framework and requirements for the assessment of potential MC1-related effects to Wildlife and Wildlife Habitat, as summarized in **Table 7.2-1**.

Table 7.2-1 Summary of Applicable Regulatory and Policy Framework for Wildlife and Wildlife Habitat

Name	Jurisdiction	Description
Migratory Birds Convention Act, 1994, SC 1994, c. 22 (MBCA)	Federal	The MBCA protects various species of migratory game birds, migratory insectivorous birds, and migratory non-game birds. Section 5 of the MBCA prohibits the disturbance, destruction, or removal of a nest or related shelter or egg of a migratory bird, or possession of a live migratory bird, or a carcass, nest, or egg of a migratory bird. The MBCA also prohibits the deposit by a person or vessel of a substance, or combination of substances, that is harmful to migratory birds in waters or an area frequented by migratory birds.

Name	Jurisdiction	Description
Species at Risk Act, SC 2002, c. 29 (SARA)	Federal	SARA provides management for Canadian indigenous species, subspecies, and distinct populations to prevent species from becoming extirpated or extinct; provides for the recovery of endangered or threatened species; and encourages the management of other species to prevent them from becoming at risk. SARA prohibits killing, harming, harassing, capturing, or taking wildlife listed as extirpated, endangered, or threatened. SARA prohibits damage to defined residences and designated critical habitat of listed species and applies only on federal land, with the exception of aquatic species and migratory birds listed in the federal MBCA. In some circumstances, the federal prohibitions can be applied to other species on private or provincial Crown land if it is deemed that provincial or voluntary measures do not adequately protect a species and its residence. Specific sections of SARA outlining relevant prohibitions are as follows: Section 32 – Prohibition against killing, harming, harassing, capturing, or taking an individual of a species listed as extirpated, endangered, or threatened. Section 33 – Prohibition against damaging or destroying the residence of individuals of a species listed as extirpated, endangered, or threatened.
Committee on the Status of Endangered Wildlife in Canada (COSEWIC)	Federal	COSEWIC is an arms-length advisory panel to the Minister of Environment and Climate Change concerning the status of wildlife species at risk of extinction in Canada. COSEWIC assesses the risk status of wildlife species, and makes recommendations for species to be listed under SARA. It carries no regulatory weight, but is an indication of federal species at risk.
Wildlife Act, RSA 2000, c. W-10	Provincial	Section 3 of the Wildlife Act provides Wildlife Prohibitions and Protections that prohibit willful molestation, disturbance, or destruction of a house, nest, den (of the species and in the times of year set out in W Reg 96), or beaver dam, except where done under specific license or authorization. Section 9 of the Wildlife Act refers to the Wildlife Regulation within which schedule 6 prescribes Endangered and Threatened species.
Wildlife Regulation, Alberta Regulation 143/1997, (Wildlife Act)	Provincial	Schedule 6 (Part 1) of the Wildlife Regulation lists Endangered and Threatened species in Alberta.
General Status of Alberta Wild Species (AEP 2017a)	Provincial	The General Status of Alberta Wild Species is an evaluation of the general status of all wild vertebrate species in Alberta. General status determination is the first step in a continuing process of evaluating and reporting on the biological status of Alberta's wild species. Similar to COSEWIC assessments, it carries no regulatory weight, but is an indication of provincial species at risk.
Environmentally Significant Areas Provincial Update 2009 (Fiera Biological Consulting 2009)	Provincial	Environmentally Significant Areas are places in Alberta that are vital to the long-term maintenance of biological diversity, soil, water, or other natural processes at multiple spatial scales. They are identified as areas containing rare or unique elements in the province, or areas that include elements that may require special management consideration due to their conservation needs. The identification of ESAs is a natural resource management tool.

In addition to the regulatory and policy frameworks relevant to the assessment of Wildlife and Wildlife Habitat, various best practices (e.g., guidance/standards) relevant to the assessment and management of Wildlife and Wildlife Habitat are described in **Table 7.2-2**.

Table 7.2-2 Summary of Applicable Best Practices for Wildlife and Wildlife Habitat

Name	Description
Sensitive Species Survey Guidelines (ESRD 2013)	The Sensitive Species Survey Guidelines provide standard survey methods for species of management concern.
Enhanced Approval Process.Integrated Standards and Guidelines (Alberta Energy Regulator 2013)	This document details setbacks from wildlife habitat features and standards for industrial development in provincially defined Wildlife Sensitivity Zones.
Wildlife Sensitivity Zones	Wildlife Sensitivity Zones are mapped by the Government of Alberta to provide industrial operators, government departments and the general public with the best information currently available on the extent of wildlife sensitivities as part of the Enhanced Approval Process. Specific operating conditions apply to industrial activities within these sensitive feature layers to help mitigate the effects of development on populations and habitat.
Recommended Land Use Guidelines: Key Wildlife and Biodiversity Zones (ESRD 2015)	Describes intent of the Key Wildlife and Biodiversity Zone designations/identifications, guidelines and strategies for the use of these zones without compromising their critical use by wildlife in the late fall and winter.
South Saskatchewan Regional Plan 2014-2024 (Government of Alberta 2017)	This document provides direction regarding activities on provincial Crown lands and describes regional planning objectives for maintaining biodiversity. The SSRP is implemented through existing legislation and is utilized in the context of in the context of the provincial Land Use Framework (LUF), which aims to manage to the cumulative effects of development on the environment.
Kananaskis Country Provincial Recreation Areas and Bragg Creek Provincial Park Management Plan (Government of Alberta 2012)	This document details management objectives for harlequin duck including maintaining undisturbed access to river habitat.
Elbow River Basin Water Management Plan (Elbow River Watershed Partnership 2009)	This document establishes reach-specific guidelines for water quality in the Elbow River watershed and provides decision-making advice to federal, provincial and municipal authorities. It additionally makes recommendations regarding land-use practices and monitoring activities.
Draft Alberta Grizzly Bear Recovery Plan (Alberta Environment and Parks 2016a)	The recovery plan lays out recovery goals and objectives for managing grizzly bears in the bear management zones of Alberta.

7.2.1.2 Data Sources

Data sources for the assessment of Wildlife and Wildlife Habitat include data collected for the conceptual design of MC1, government databases, scientific literature such as journal publications and white papers, as well as in-person interviews with Alberta Environment and Parks (AEP) staff and field studies carried out by the assessment team. The results of a query of the Fish and Wildlife Management Information System

(FWMIS) were provided by Brett Boukall (B. Boukall Pers. Comm). The following data sources were reviewed:

- Environmental Overview of the McLean Creek Dam (AMEC 2015)
- Species at Risk Public Registry (Government of Canada 2017)
- Alberta Wild Species General Status Listing -2015 (AEP 2017)
- Fish and Wildlife Management Information System (FWMIS) (Government of Alberta 2015; B. Boukall Pers. Comm)
- Fish and Wildlife Management Information Tool (FWMIT) (Government of Alberta 2015)
- Alberta Conservation Information Management System (ACIMS) (Alberta Tourism Parks and Recreation 2017)
- Google Earth© imagery (2016)
- Natural Regions and Subregions of Alberta (Natural Regions Committee 2006)
- Wildlife Sensitivity Zones (Government of Alberta 2015)
- Alberta Biodiversity Monitoring Institute Data Analytics Portal (ABMI) (ABMI 2009)
- Alberta Environment and Parks Wild Species Status Database (AEP 2017a)

Baseline wildlife data collection in support of the MC1 Environmental Impact Assessment is limited to a Winter Wildlife Survey that was conducted in the winter of 2016. A full suite of wildlife surveys are planned for spring, summer, and fall 2017 to address gaps in the information provided by the data sources listed above (**Table 7.2-3**). Ongoing field studies that extend into Fall 2017, such as the trail camera monitoring, will be submitted as an addendum to this Report.

The assessment team reviewed *Environmental Overview of the McLean Creek Dam* (AMEC 2015) in preparation of this assessment. Field data collection for the AMEC 2015 report was conducted in 2014, and included auditory surveys for amphibians, nocturnal owl surveys, and an aerial raptor nest survey. The assessment assumes wildlife and habitat conditions in the vicinity of MC1 have not substantially changed since AMEC completed its report. The assessment team also relied upon data from the Government of Alberta's FWMIS, which is the central repository of fish and wildlife inventory data for government, industry, and the public. The AMEC 2015 overview document and the FWMIS data comprised the best available sources of site-specific wildlife information at the time of writing.

Table 7.2-3 Wildlife Surveys and Timing Required to Complete Baseline Studies

Wildlife Survey	Survey Timing
Mammals	June 15, 2017 – November 14, 2017 (trail camera)
	March 13 and14, 2017
Sharp-tailed Grouse	Mid-March to mid-April, 2017
Nocturnal Owl Survey	Mid-March to late May 2017
	September 2017
Spring Bird Migration	Late March – mid May 2017
Raptor Nest	March – late June, 2017
Amphibians	Spring (May-June) breeding season (nocturnal acoustic surveys followed by eggmass survey)
Breeding Birds	Late May – late June, 2017
Riverine Birds	May and August 2017
Bats	May 1 – September 31, 2017
Fall Bird Migration	Early August – late October 2017
Habitat Modelling	September 2017

7.2.1.3 Valued Components

Wildlife and wildlife habitat may be affected by MC1-related changes to habitat and habitat quality, including in Wildlife Sensitivity Zones (Government of Alberta 2015). Multiple species of management concern, including species of importance to science, the public, or regulators may be affected (**Table 7.2-4**).

Table 7.2-4 Valued Components for Wildlife and Wildlife Habitat

Valued Components	Interaction
Grizzly Bear	· Known to occur in the vicinity of MC1 and interactions with MC1 components or activities are likely. · Listed as At Risk provincially, Endangered under the Alberta *Wildlife Act*, and as Special Concern by COSEWIC. · MC1 footprint is in a Key Wildlife Biodiversity Zone. These zones are established to protect habitats that support wintering ungulates and biodiversity. Ungulate carcasses and young calves are food sources for grizzly bear. · MC1 footprint is within Grizzly Bear Zone (Alberta Energy Regulator 2013, Government of Alberta 2015). · MC1 footprint is in Recovery and Support Zones defined in the Grizzly Bear Recovery Plan (AEP 2016a).
Ungulates	· Known to occur in the vicinity of the MC1 Option (moose, deer), and interactions with MC1 components or activities are likely. · MC1 area is in a Key Wildlife Biodiversity Zone, established to protect habitats that support wintering ungulates and biodiversity.

Valued Components		Interaction
		· Harvested species with economic and social importance to Indigenous Peoples, the public, and the Government of Alberta.
Bats		· Likely present in the vicinity of MC1 based on range maps and available habitats. Interactions with MC1 components or activities are likely. · Little brown bat and northern long-eared bat are Schedule 1 endangered species under SARA, and are likely to occur near MC1 based on species range.
Birds	Breeding birds	· Known occurrence in the vicinity of the MC1, and interactions with MC1 components or activities are likely. · Most bird species and their nests are protected by the MBCA and the Wildlife Act. · Species of management concern are likely to occur in the vicinity of the MC1. · Harlequin duck is identified in Kananaskis Country Provincial Recreation Areas and Bragg Creek Provincial Park Management Plan (2012) as a species of management concern. · Piscivorous birds may be marginally present in the vicinity of the MC1 at baseline, but are considered more likely present in the application case with potential interactions with MC1 components and activities during the Operation and Maintenance phase. They are also protected under the MBCA, so are included as VC in support of a conservative assessment approach.
	Raptors and Owls	
	Harlequin duck	
	Piscivorous birds	
Amphibians and Reptiles		· Include species of management concern to science, the public, and regulators due to their sensitivity to environmental change and population declines. · Western toad is likely present in the vicinity of the MC1, and interactions with MC1 components and activities are likely. It is a Schedule 1 listed species under SARA. · Common garter snake and terrestrial garter snake are likely to occur in the vicinity of the MC1. Garter snake hibernacula (includes all three species of garter snake that occur in the province) are protected under the *Wildlife Act*.

7.2.1.4 Measurable Parameters

Measurable parameters are quantitative or qualitative measures used to describe existing conditions and evaluate potential MC1-related effects to VCs. The measurable parameters selected for Wildlife and Wildlife Habitat are shown in **Table 7.2-5**. Potential adverse MC1-related effects to Wildlife and Wildlife Habitat arising from potential interactions are discussed in more detail in **Section 7.2.3.**

Table 7.2-5 Measurable Parameters for Wildlife and Wildlife Habitat

Selected VC	Potential MC1-related Effect	Measurable Parameter
Wildlife and Wildlife Habitat (all VCs)	Change in habitat	· Area (ha) of wildlife habitat directly altered · Area (ha) of designated habitat areas (e.g., Key Wildlife Biodiversity Zone; Grizzly Bear Zones) directly affected
	Change in movement	· Qualitative assessment of physical or perceived barriers to wildlife movement
	Change in mortality risk	· Wildlife mortality during construction · Wildlife mortality during operation · Change in linear disturbance density (grizzly bear, ungulates)

7.2.1.5 Assessment Boundaries

Spatial Boundaries

Spatial boundaries for the assessment of Wildlife and Wildlife Habitat are detailed in **Table 7.2-6** and **Figure 7.2-1.**The MC1 Option area is the anticipated spatial extent of direct effects to VCs. It includes a 100-metre (m) buffer around MC1 infrastructure as detailed in **Table 7.2-6.**

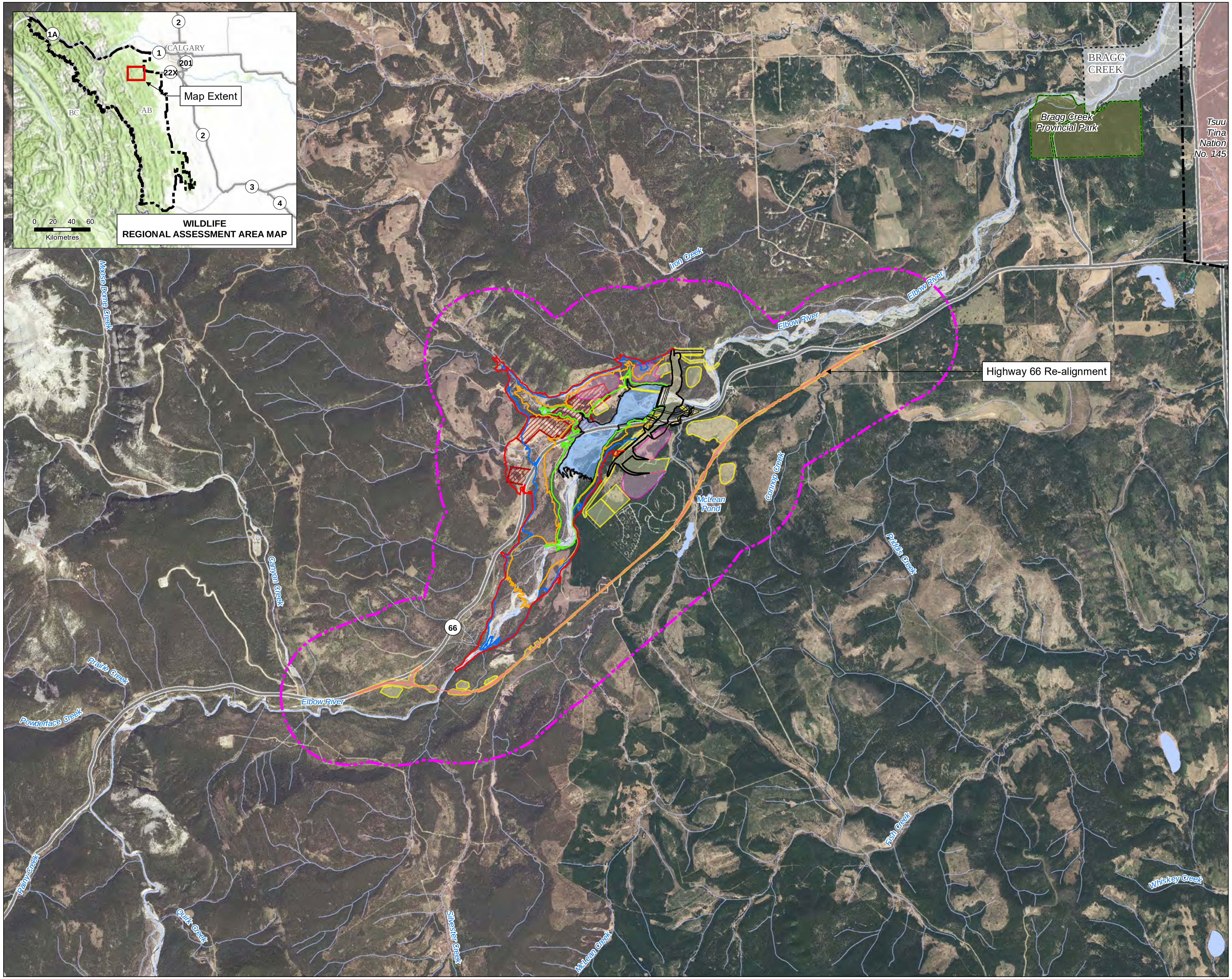
The Local Assessment Area (LAA) includes the geographical area where components and activities are anticipated to interact with Wildlife and Wildlife Habitat VCs. The Regional Assessment Area (RAA) provides a regional context for the assessment of MC1-related effects. The RAA includes the area where residual effects of the Option are likely to interact with the residual effects of other past, present, or future projects resulting in cumulative effects.

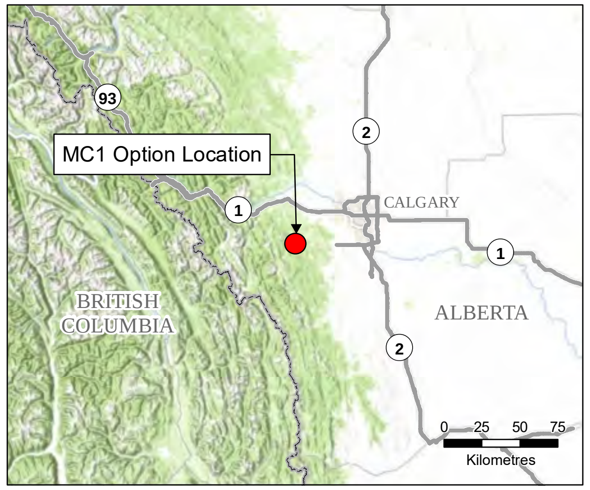
Table 7.2-6 Spatial Boundary Definitions for the Assessment of Wildlife and Wildlife Habitat

Spatial Boundary	Description of Assessment Area
MC1 Option Area	Area in which MC1-related physical disturbance is anticipated, and an additional 100-m buffer around the: · embankment and excavation areas · spillways and outlet works · road relocation.
Local Assessment Area (LAA)	The LAA includes an approximate 1-km buffer around the Option infrastructure, realigned Highway 66, and Full Supply Level permanent pond (equivalent to the AMEC 2015 Study Area).
Regional Assessment Area (RAA)	The RAA is defined by the boundaries of the Livingstone Grizzly Bear Management Area (BMA 5). This area is pertinent to wildlife VCs because it is sufficiently large to encompass an area where local populations of large terrestrial mammals could be affected by MC1-related effects as well as undergo cumulative effects.

Elbow River at McLean Creek Dam (MC1)

Wildlife and Wildlife Habitat Local Assessment Area and Regional Assessment Area





Legend

- MC1 Option Area
- Wildlife Local Assessment Area
- Wildlife Regional Assessment Area
- MC1 Dam
- Highway 66 Re-alignment
- 2013 Flood Event (1424.1 m)
- 1:100 Flood Event
- 1:20 Flood Event
- 1:50 Flood Event
- Borrow Area
- Laydown Area/Disturbed Area
- Pond Level
- Existing Park Infrastructure to be Removed
- Highway
- Reserve
- Hamlet of Bragg Creek
- Provincial Park
- 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 1.5m, 2016
- Inset Basemap: ESRI Topographic Basemap

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Alberta Transportation

Temporal Boundaries

The temporal boundaries of the Option include the Construction and Operation and Maintenance phases of the Option, which are described in **Section 3.0 MC1 Option Description**.

Administrative Boundaries

The following administrative boundaries were identified for the assessment of potential MC1-related effects on Wildlife and Wildlife Habitat.

The South Saskatchewan Regional Plan (SSRP) sets out an approach to manage land use in the region for the long term. Regional planning direction is guided by the provincial Land Use Framework, which aims to manage the cumulative effects of development on the environment. The SSRP 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, and sub-regional plans). Of relevance to the Wildlife and Wildlife Habitat VCs are objectives to maintain biodiversity. Ongoing and future development of the Regional Land Use Plans, such as the SSRP and access management sub-plans under the Land Use Framework, will be the primary way access management will be implemented for grizzly bear (*Ursus arctos*) under the recovery plan process (AEP 2016*a*).

The Kananaskis Country Provincial Recreation Areas (PRAs) and Bragg Creek Provincial Park Management Plan (2012) includes management objectives for harlequin duck including maintaining undisturbed access to river habitat.

Environmentally Significant Area (ESA) 8 overlaps with the LAA (Fiera Biological Consulting 2009). Established to support and contribute to the long-term maintenance of biological diversity, soil, water, and other natural processes, ESAs may contain rare or unique elements that require special management consideration (Fiera Biological Consulting 2009). In ESA 8, 45 elements of conservation concern have been identified, including birds, mammals, insects, and vegetation of hydrological importance; however, ESA 8 is not recognized as containing important wildlife habitat (Fiera Biological Consulting 2009). Other important characteristics include large natural areas, rare or unique landforms, and sites of recognized significance, including three provincial parks (Fiera Biological Consulting 2009).

The (draft) Alberta Grizzly Bear Recovery Plan defines Bear Management Areas (BMAs) in the Province of Alberta. Within the BMAs, recovery, support, and habitat linkage management zones are delineated (AEP 2016*a*). The RAA is defined by the boundaries of BMA 5 or the Livingstone BMA (**Figure 7.2-2**). The RAA includes the recovery and support management zones of BMA 5, and the LAA and Option area intersect with the Recovery Zone. Management goals are associated with the recovery and support zones. The Alberta Grizzly Bear Recovery Plan's stated recovery goal and objectives for the zones are as follows:

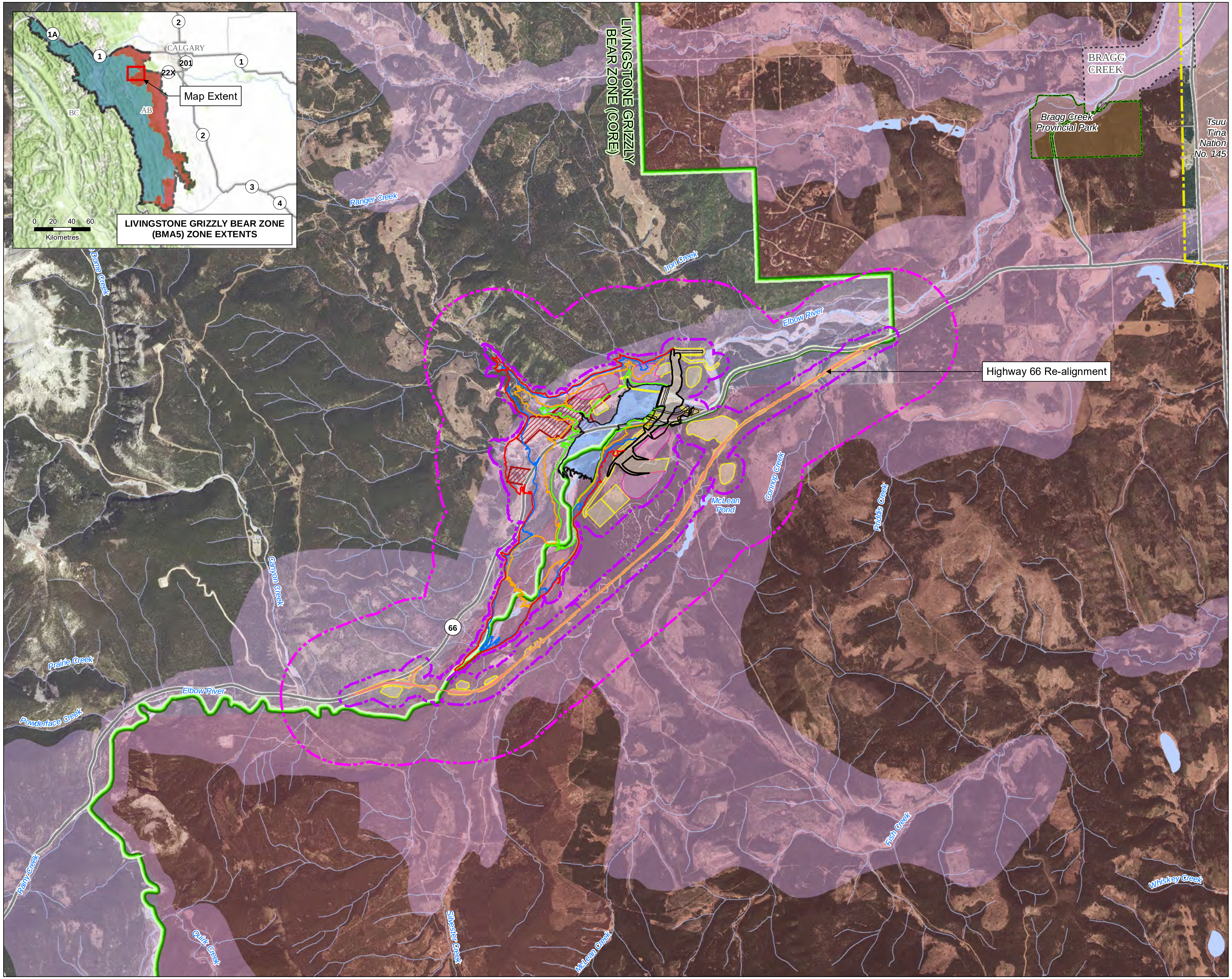
Recovery Zone:

- Goals: Alberta grizzly bear population in the Recovery Zone is not limited by human-caused mortality, has access to secure habitat, is able to safely disperse across major road corridors, and that Albertans are supportive of grizzly bear conservation and management activities.
- Objectives (includes only those relevant to this assessment):

  1. Density of grizzly bears in the Recovery Zone is not limited by human-caused mortality, and is either stable or increasing over time.
  2. In Recovery and Support zones of BMA 5, known human-caused mortality rates are less than or equal to 6 percent (%), of which the female mortality rate does not exceed 1.8% (other zones are less than or equal to 4% human-caused mortality, and female mortality not to exceed 1.2%)
  3. Habitat security for grizzly bear in the Recovery Zone is maintained or improved.

Support Zone:

- Management Intentions: Support zones are intended to support the population of grizzly bears in the Recovery Zone by creating a priority area for the management of bear attractants and other sources of human-wildlife conflict adjacent to the Recovery Zone, thereby improving the survival rate of grizzly bears, females, and females with cubs that are moving through the Recovery and Support Zones.



Elbow River at McLean Creek Dam (MC1)

Wildlife Sensitivity Zones and Grizzly Bear Recovery and Support Zones in Relation to the Regional Assessment Area and Local Assessment Area

Legend

- MC1 Option Area
- Wildlife Local Assessment Area
- Wildlife Regional Assessment Area
- MC1 Dam
- Highway 66 Re-alignment
- 2013 Flood Event (1424.1 m)
- 1:100 Flood Event
- 1:20 Flood Event
- 1:50 Flood Event
- Borrow Area
- Laydown Area/Disturbed Area
- Pond Level
- Existing Park Infrastructure to be Removed
- Highway
- Reserve
- Hamlet of Bragg Creek
- Provincial Park
- Watercourse
- Waterbody
- Core Grizzly Bear Zone
- Key Wildlife and Biodiversity Zone (ungulates)
- Livingstone Grizzly Bear Zone (BMA5)
- BMA5 Support (Secondary) Zone
- BMA5 Recovery (Core) Zone

Notes

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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 1.5m, 2016
- Inset Basemap: ESRI Topographic Basemap

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Two provincially designated Wildlife Sensitivity Zones (Government of Alberta 2015) overlap with LAA and RAA (**Figure 7.2-2**). These zones and their development standards are outlined in **Table 7.2-7**.

Table 7.2-7 Wildlife Sensitivity Zones that Overlap with Local Assessment Area and Regional Assessment Area

Provincially Designated Wildlife Sensitivity Zone	Target Species	Desired Outcomes	Standards	Restricted Activity Period
Grizzly Bear Zone	Grizzly Bear	· Reduce all sources of human-caused mortality · Reduce human-bear conflicts · Avoid development within key habitats and key seasons at the local regionally level · Maintain high value and low mortality risk habitat areas · Avoid development of grizzly bear attractants (all sources)	· Access management · Section 100.9.3 Approval for the Enhanced Approval Process (Government of Alberta 2012)	No restricted activity period
Key Wildlife and Biodiversity Zone	Ungulate species	· Maintain the long-term integrity and productivity of key ungulate winter ranges and riparian corridors where ungulates concentrate · Protect movement corridors of regionally sensitive species · Protect areas with rich diverse habitats and regionally sensitive habitat types · Protect key hiding and thermal cover for wildlife	· Protect vegetation from being cleared by minimizing all industrial activity · Minimize activity during winter months · Reduce access and/or do not create new access · Follow general timing restrictions · Section 100.9.6. Approval for the Enhanced Approval Process (Government of Alberta 2012)	No construction between December 15 and April 30

Sources: Alberta Energy Regulator 2013; ESRD 2015

Technical Boundaries

The document Environmental Overview of the McLean Creek Dam (AMEC 2015) report was used to inform the assessment of MC1-related effects to wildlife and habitat. In this report, wildlife and habitats in the vicinity of the Option are described based on a desktop assessment and surveys conducted for amphibians, nocturnal owls, beavers, and raptor nests (AMEC 2015). The spatial boundaries provided in AMEC 2015 are considered a technical boundary in this assessment because the AMEC 2015 document scope does not fully address Wildlife and Wildlife Habitat VCs identified in this Environmental Impact Screening Report. To address this technical boundary more fulsome field data were collected in spring and summer 2017.

The wildlife field data collection program was partially complete, and ongoing at the time of writing. The assessment team has also relied on professional judgement and an understanding of regional wildlife habitat relationships to conduct this assessment. Wildlife studies will be completed by fall 2017 and will be used to verify current assumptions regarding site-specific wildlife presence and habitat, and facilitate a more detailed effects assessment (**Table 7.2-3**).

An additional limitation to the technical boundary for this assessment is a lack of quantification regarding baseline human use of the LAA. The use of the McLean Creek OHV Use Zone, for example, may reduce habitat values for large mammals in the LAA, and therefore may limit use of this area by VCs.

These limitations can be offset by adopting a conservative approach to identifying and characterizing MC1-related effects on Wildlife and Wildlife Habitat. For example, establishing a 100-m buffer around proposed infrastructure in footprint calculations should avoid the under-estimation of MC1-related effects due to direct habitat loss and sensory disturbance.

7.2.2 Baseline Case

The baseline conditions for Wildlife and Wildlife Habitat VCs are characterized below using the best available data as of May 2017 (**Section 7.2.1.2).** This section presents a general description of the Option setting, and describes the Baseline Case for selected VCs.

7.2.2.1 MC1 Option Setting

The MC1 Option is located within the Montane Subregion of the Rocky Mountain Natural Region of Alberta (Natural Regions Committee 2006). This Subregion is characterized by mountains and foothills separated by deep glacial valleys (Natural Regions Committee 2006). Montane elevations range from 825 m to 1,850 m (Natural Regions Committee 2006). 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).

The assessment team classified vegetation communities in the LAA using the ecological land class system developed by Archibald et al. (1996). Vegetation communities in the LAA are composed of nine ecosite phases and one disturbed land class (**Table 7.2-8**). The LAA is characterized by forested upland habitats with low, wet habitats associated with terraces and floodplains of the Elbow River and other tributaries.

Table 7.2-8 Vegetation Communities of the Local Assessment Area

Ecological Land Class Code	Ecological Land Class Description	Area (ha)	Percent (%)
b2	Aspen / bearberry / hairy wild rye	260.89	6.81
b3/b2	Transition between b3 and b2	8.3	0.2
b3	Aspen / white spruce / lodgepole pine bearberry/hairy wild rye	169.8	4.4
d1	Lodgepole pine /low-bush cranberry/ wild sarsaparilla	1,136.3	29.7
d2	Trembling aspen/ low-bush cranberry/ wild sarsaparilla	125.2	3.3
d3	Aspen / white spruce / lodgepole pine/low-bush cranberry / wild sarsaparilla	325.7	8.5
d4	White spruce / low-bush cranberry / wild sarsaparilla	37.5	1.0
fp	floodplain	164.7	4.3
sm	Shrubby meadow	30.7	0.8
h1	White spruce/horsetail	8.7	0.2
dist	Disturbed anthropogenic	211.4	5.5
unclassified	unclassified	1,166.1	30.4
	Total	**3,831.7**	**100**

Wildlife diversity in the RAA is indicative of known wildlife-habitat associations within the Montane Subregion, which supports a number of large and small mammal species including: grizzly bear, black bear, moose, mule deer, white-tailed deer, coyote, gray wolf, red squirrel, beaver and muskrat.

Within Douglas-fir, lodgepole pine, and mixed wood communities, common bird species include: yellow-rumped warbler, dark-eyed junco, chipping sparrow, red crossbill, pine siskin, alder flycatcher, Swainson's thrush, warbling vireo, Calliope hummingbird, rufous hummingbird, Tennessee warbler, orange-crowned warbler, northern waterthrush, MacGillivray's warbler, American redstart, and western tanager.

Wetlands, mixed forest, and streams support Barrow's goldeneye, Wilson's snipe, and common yellowthroat. Harlequin duck and American dipper are commonly found along swift flowing streams associated with mixed wood communities (Natural Regions Committee 2006).

Amphibians associated with wetlands and mixed wood communities in the Montane Subregion include western toad, Columbia spotted frog and long-toed salamander (Natural Regions Committee 2006).

A review of FWMIS records (Government of Alberta 2015) and AMEC (2015) indicates the potential presence of 68 wildlife species within the LAA and RAA. Forty-nine (49) species are species of management concern. Species of management concern are listed in **Table 7.2-9.** The following discussion of baseline conditions focuses on the species outlined in the VC selection table, as listed in **Table 7.2-4**.

7.2.2.2 Mammals

Desktop review indicates that a variety of mammal species are known or are likely to occur in the LAA. Coyote, gray wolf, bobcat, Canada lynx, cougar, black bear and grizzly bear use habitats within the LAA based on FWMIS records (Government of Alberta 2015) (**Table 7.2-3**). Ungulates are common in the LAA including moose, and both mule deer and white-tailed deer. Elk are also known to use habitats in or near the LAA. Other ungulates that use the RAA include mountain goats and bighorn sheep. There is a Mountain Goat and Bighorn Sheep Zone located approximately 5 kilometres (km) to west of the LAA (Government of Alberta 2015). Small and common mammals including snowshoe hare, red squirrel, striped skunk, American marten, ermine, and least weasel are also known to use the LAA (**Figure 7.2-4**).

Several mammal species occurring or potentially occurring in the LAA are species of management concern (**Table 7.2-9**). These include grizzly bear, which is provincially listed as At Risk, and as Endangered under the Wildlife Regulation of Alberta's *Wildlife Act*. Two bat species – little brown bat and northern long-eared bat– are listed under Schedule 1 of SARA as Endangered, and are likely to occur in the RAA.

The 2016 winter wildlife survey confirmed the presence of several species listed above. A total of seven mammal species were detected: moose, white-tailed deer, red squirrel, snowshoe hare, coyote, mice, and weasel species.

Table 7.2-9 Mammal Species of Management Concern with the Potential to Occur in the Regional Assessment Area

Common Name[1]	Scientific Name	Provincial Status[2]	Wildlife Act[3]	COSEWIC[4]	SARA Schedule and Status[5]	Detected in the LAA in Spring and Summer 2017[6]
American badger	*Taxidea taxus*	Sensitive	Data Deficient	Special Concern	No Schedule No Status	-
Bobcat	*Lynx rufus*	Sensitive	-	-	- -	-
Canada lynx	*Lynx canadensis*	Sensitive	-	Not at Risk	- -	yes
Fisher	*Martes pennanti*	Sensitive	-	-	- -	-
Grizzly bear	*Ursus arctos*	At Risk	Threatened	Special Concern	- -	yes
Long-tailed weasel	*Mustela frenata*	May Be at Risk	-	Not at Risk	- -	-
Olive-backed pocket mouse	*Perognathus fasciatus*	Sensitive	-	-	- -	-

Common Name[1]	Scientific Name	Provincial Status[2]	Wildlife Act[3]	COSEWIC[4]	SARA Schedule and Status[5]	Detected in the LAA in Spring and Summer 2017[6]
Silver-haired bat	*Lasionycteris noctivagans*	Sensitive	-	-	- -	-
Water vole	*Microtus richardsoni*	Sensitive	-	-	- -	-
Wolverine	*Gulo gulo*	May Be at Risk	-	Special Concern	No Schedule No Status	-
Western small-footed bat	*Myotis ciliolabrum*	Sensitive	Special Concern	-	- -	-
Eastern red bat	*Lasiurus borealis*	Sensitive	-	-	- -	-
Hoary bat	*Lasiurus cinereus*	Sensitive	-	-	- -	-
Little brown bat	*Myotis lucifugus*	May Be at Risk	-	Endangered	Schedule 1 Endangered	yes
Northern long-eared bat	*Myotis septentrionalis*	May Be at Risk	-	Endangered	Schedule 1 Endangered	yes

Sources:

1 List compiled from FWMIS (Government of Alberta 2015) and AMEC 2015

2 AEP 2017a

3 AEP Species listed under the Wildlife Regulation of Alberta's *Wildlife Act*

4 Committee on the Status of Endangered Wildlife in Canada 2017

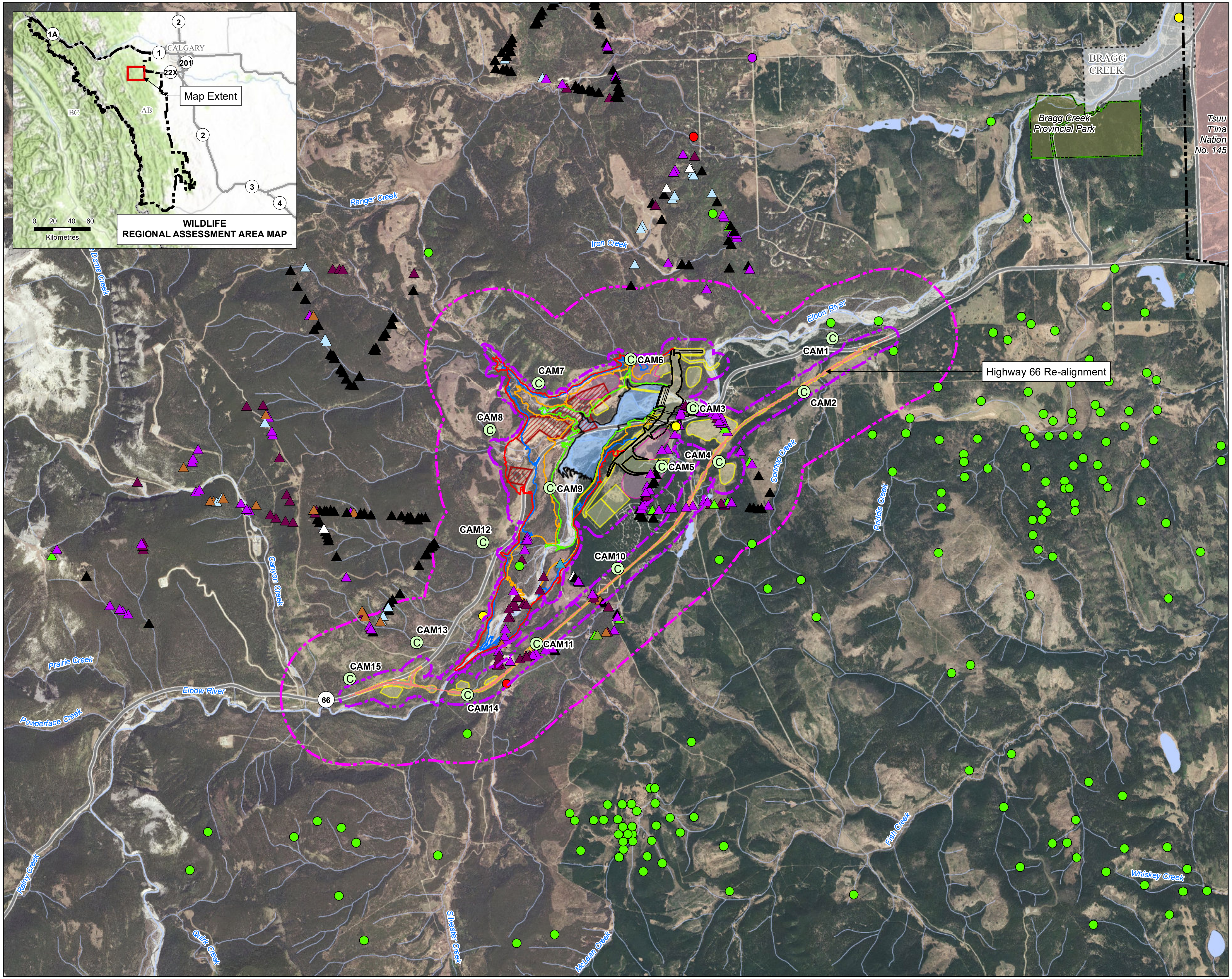
5 *Species At Risk Act*

6 Observed during surveys or incidentally in Spring and Summer 2017

Notes: "-"= not listed or not detected

AEP definitions: *At Risk* – Any species known to be at risk after formal detailed status assessment and legal designation as *Endangered* or *Threatened* in Alberta; *May Be At Risk* – Any species that may be at risk of extinction or extirpation, and is therefore a candidate for detailed risk assessment; *Sensitive* – Any species that is not at risk of extinction or extirpation but may require special attention or protection to prevent it from becoming at risk; *Undetermined* – Any species for which insufficient information, knowledge or data is available.

SARA definitions: *endangered* – A species facing imminent extirpation or extinction; *threatened* – A species likely to become endangered if limiting factors are not reversed; s*pecial concern* – A species of special concern because of characteristics that make it particularly sensitive to human activities or natural events; *not at risk* – A species that has been evaluated and found to be not at risk; *indeterminate* – A species for which there is insufficient scientific information to support status designation.



Elbow River at McLean Creek Dam (MC1)

Trail Camera Locations and Large Carnivore and Furbearer Records

Legend

- MC1 Option Area
- Wildlife Local Assessment Area
- Wildlife Regional Assessment Area
- MC1 Dam
- Highway 66 Re-alignment
- 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
- Reserve
- Hamlet of Bragg Creek
- Provincial Park
- Watercourse
- Waterbody
- Trail Camera Location

Mammal Sighting FWMIS Observation Locations

- Black Bear
- Coyote
- Grizzly Bear
- Gray Wolf

Mammal Tracks FWMIS Observation Locations

- Bobcat
- Canada Lynx
- Cougar
- Coyote
- Ermine
- Gray Wolf
- Least Weasel
- Marten
- Striped Skunk

Notes

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Sources

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

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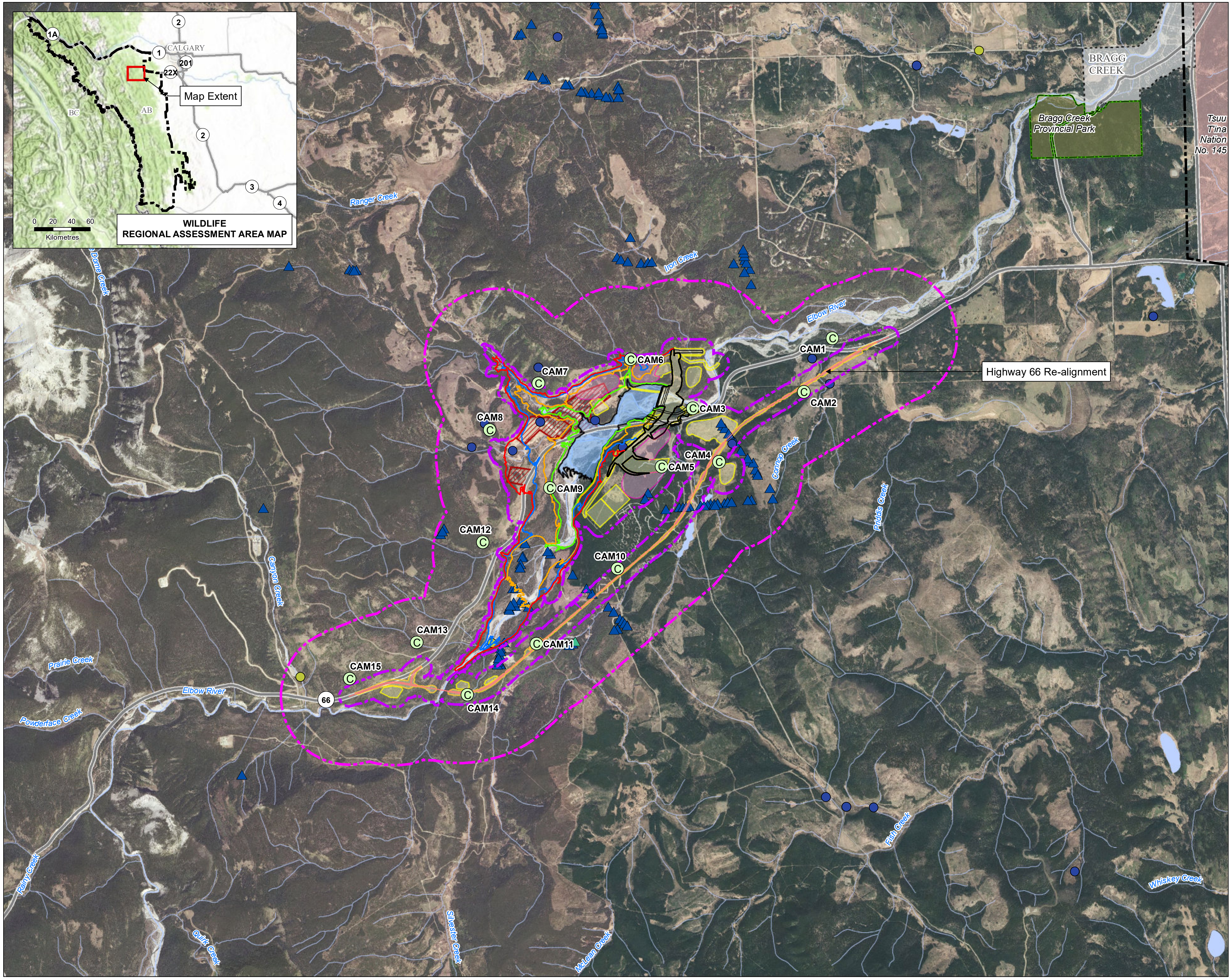

Elbow River at McLean Creek Dam (MC1)

Trail Camera Locations and Ungulate Records

Legend

- MC1 Option Area
- Wildlife Local Assessment Area
- Wildlife Regional Assessment Area
- MC1 Dam
- Highway 66 Re-alignment
- 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
- Reserve
- Hamlet of Bragg Creek
- Provincial Park
- Watercourse
- Waterbody
- Trail Camera Location

Mammal Sighting FWMIS Observation Locations

- Moose
- White-Tailed Deer

Mammal Tracks FWMIS Observation Locations

- Horse
- Moose

Notes

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- Dam Details: Hatch Ltd., 2017
- FWMIS: Government of Alberta, 2017
- Aerial Imagery: SPOT 1.5 m, 2016

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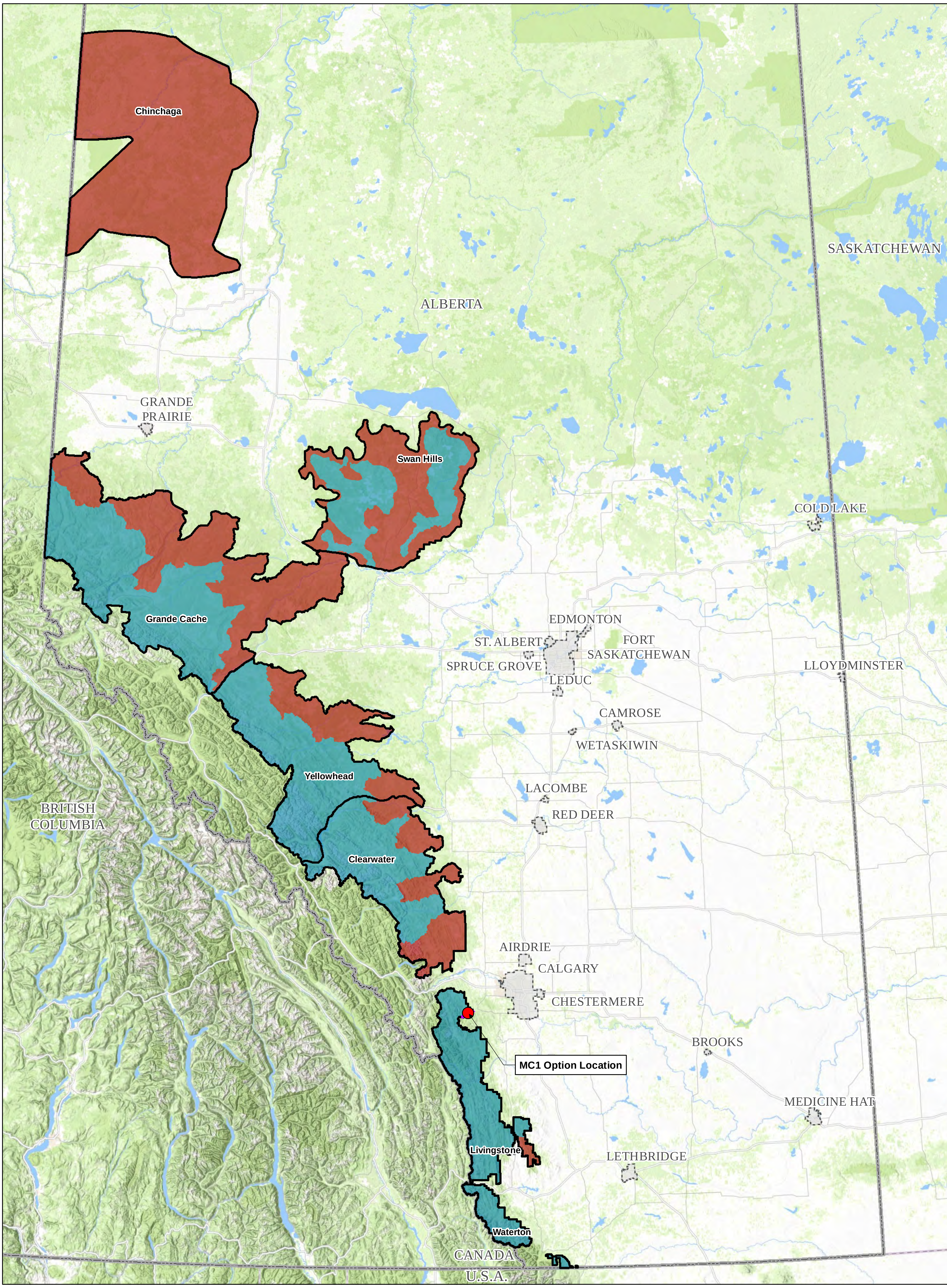
Grizzly Bear

Grizzly bear are listed as Endangered under the Wildlife Regulation of Alberta's *Wildlife Act*, and as At Risk under the Alberta Wild Species General Status Listing (AEP 2017a).

Grizzly bear are habitat generalists that require large areas to meet their life requisites for food and security. Their habitat associations are mainly based on forage availability, and habitat use changes over the seasons. In the spring, grizzly bear use dry, steep subalpine grasslands in mountainous regions and moist stream banks and channels in lower elevations (AEP 2016b). In the summer, they generally inhabit wet stream sides in mature spruce forests, gully bottoms, wet meadows and fens and disturbed areas (AEP 2016b). During the winter, grizzly bear den on slopes where the ground is stabilized by root systems of trees and shrubs and where accumulation of snow adds insulation (AEP 2016b).

A key component of high-value grizzly bear habitat is core security. Core security habitat occurs where the potential for encounters with humans is limited and foraging requirements can be met. Core security habitats reduce the rate of encounters between adult female grizzly bears and humans, which subsequently reduces the risk of habituated bears, bears killed out of self defence, and bears removed by management agencies. Core security habitat in the RAA is represented by the Recovery Zone area of the Livingstone BMA 5.

The RAA is defined by the extent of the Recovery and Support Zones of the Livingstone BMA 5 (**Figure 7.2-1**). As of 2006, the BMA 5 population estimate was 90 grizzly bears (Confidence Interval (CI): 75-116), with a density of 12 bears per 1,000 km (includes Banff National Park south of Highway 1) (Alberta Grizzly Bear Inventory Team 2007). An analysis of the observed mortality rate between 1994 and 2002 indicated a slowly increasing sub-population in the northern portion of BMA 5 (Garshelis et al. 2005). The eastward expansion of occurrence in BMA 5 possibly indicates an expanding population (Northrup et al. 2012, Urmson and Morehouse 2012), and there is high connectivity with BMA 6 to the south and British Columbia to the west (Proctor et al. 2012) (**Figure 7.2-5**).



Legend

- MC1 Option Area
- Urban Area
- Grizzly Bear Management Zone
- Grizzly Bear Management Zone (Core)
- Grizzly Bear Management Zone (Secondary)

Sources

- Basedata: Government of Alberta, 2017
- Grizzly Bear Management Zones: Government of Alberta, 2017
- Basemap: ESRI World Topo Base

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Notes

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Elbow River at McLean Creek Dam (MC1)

Grizzly Bear Management Zones in Alberta

2025-001.01	Production Date: Sep 15, 2017	Figure 7.2-5

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The human-caused mortality rate (excluding relocations) in BMA 5 is over the 4% threshold identified in the Draft Recovery Plan (which is intended to allow population growth), and female mortality is over the 1.2% threshold (AEP 2016a). If relocations are considered mortalities, these rates are higher. From 2009 to 2013, vehicle collision mortality accounted for 42% (9 of 21) of total human-caused mortality, and illegal harvests accounted for an additional 29% (6 of 21) (AEP 2016*a*) (**Table 7.2-10**). A total of 36 grizzly bears were relocated in response to human-bear interactions during the same period (AEP 2016*a*). At the BMA scale, open road density within BMA 5 is well managed, with 11.8% of the BMA classified as primary or secondary sink habitats (AEP 2016a). Human-bear conflict in BMA 5 is related largely to livestock interactions in the Support Zone (AEP 2016a) (**Table 7.2-5**).

Table 7.2-10 Causes of Mortality for Grizzly Bear in Alberta by Grizzly Bear Management Area

Mortality Cause	Grizzly Bear Management Area						
	1	2	3	4	5	6	7
Problem	0	2	0	0	0	3	0
Illegal	2	13	8	2	6	4	5
Indigenous Groups' Harvest	0	3	0	0	2	2	1
Mistaken Identification	1	2	0	0	0	0	0
Accidental	0	2	1	1	0	2	0
Road Kill	0	6	0	0	9	0	0
Train	0	0	0	2	0	0	0
Self Defense	1	4	0	0	4	1	1
Natural	0	1	0	0	3	0	1
Unknown	0	2	3	0	2	2	0
Total Mortality	4	36	12	5	26	14	8
Human Caused	4	32	9	5	21	12	7

Note: Adapted from AEP 2016a

Causes of human-caused grizzly bear mortality in each Bear Management Area from 2009 to 2013 as reported in the compulsory reporting and registration of dead grizzly bear incidents. The morality cause categories were assigned by the Provincial Carnivore Specialist.

The main vegetation communities within the LAA are dominated by white spruce, aspen, and lodgepole pine with shrubby groundcover and pockets of disturbed open areas suitable for spring, summer, and winter grizzly bear habitat. The Elbow River likely provides an important regional movement corridor for grizzly bear. Riparian areas are high-use areas for grizzly bears for foraging and travelling. The presence of McLean Creek (PRA) within the LAA may provide additional food attractants to grizzly bear in the area. Additional field studies are required to describe habitat use by grizzly bear within the LAA.

The results of the trail camera monitoring program and the habitat modelling exercise planned for summer and fall 2017 will verify assumptions about grizzly bear use in the LAA. These results will be available in fall or winter 2017.

Ungulates

The RAA overlays a Key Wildlife and Biodiversity Zone (Government of Alberta 2015) (**Figure 7.2-2**). The purpose of the Key Wildlife and Biodiversity Zone is to protect and maintain the long-term integrity and productivity of ungulate winter ranges for security and thermal cover, movement corridors, and biodiversity in areas with rich diversity and regionally sensitive habitat types (ESRD 2015). There are restricted activity periods for industrial activity within Key Wildlife Biodiversity Zones. South of Highway 1, the restricted activity period is from December 15 to April 30, during which no industrial activity is permitted, except with prior approval from AEP (ESRD 2015).

Several ungulate species are known to use the RAA. Moose and deer are present in winter (**Figure 7.2-4**); feral horse sign was also noted during snow track surveys reported on in the FWMIS results. Habitats in the LAA support ungulates throughout the year, as evidenced by the presence of the Key Wildlife Biodiversity Zone, and FWMIS track data. Trail camera monitoring and habitat modelling of the LAA planned for fall 2017 will provide details on the relative value of habitats for ungulate VCs in relation to MC1. These results will be available in fall or winter 2017.

Moose

Moose populations are considered provincially and federally secure. Moose are species of management concern because they are a harvested species with social and economic value (Timmerman and Rodgers 2005).

Moose prefer habitats with a mixture of open, early successional shrubby areas that they use for foraging, and dense deciduous or coniferous forest that provide protective cover for predator avoidance and protect against excessive snow accumulation (Westworth Associates 1990). Depth and duration of snow cover generally determine seasonal movements of moose, though moose commonly winter in areas with 50 cm or more of snow cover (Blood 2000). During winter, moose primarily forage on willow species, as well as red-osier dogwood, cottonwood, paper birch, trembling aspen, high-bush cranberry, false box, and subalpine fir (Blood 2000, Aresenault 2000).

The LAA and RAA provide suitable winter foraging habitat for moose, as shown by numerous FWMIS records from a winter track study (Government of Alberta 2015). Records from the FWMIS of the LAA show widespread use of the area by moose (**Figure 7.2-4**). Moose records are likely attributable to the location of surveys conducted, rather than a measure of habitat suitability (**Figure 7.2-4**). Moose and moose sign were observed during the winter wildlife study.

Deer

Both white-tailed deer and mule deer are anticipated to use the LAA and RAA based on species range. White-tailed deer and mule deer are provincially and federally secure species. Deer are species of management concern because, like moose, they are a harvested species with social and economic value (Timmerman and Rodgers 2005).

White-tailed deer are tolerant to human disturbances, and prefer aspen groves, wooded river flats, and deep ravine habitat (AEP 2017e). White-tail deer subsist on diets of shrubby vegetation and forbs including: snowberry, rose, Saskatoon berry, choke cherry, creeping junipers, willow, aspen, asters, and horsetails (Alberta Environmental Protection 1995). In Alberta, winter causes white-tailed deer to move to micro-habitats with access to areas that green up quickly in the spring (i.e., lower elevations and major drainage features such as the Bow River). Snow accumulation will cause deer to begin feeding on woody browse over forbs; and snow depths exceeding 51 cm will limit mobility(Alberta Environmental Protection 1995).

Mule deer are commonly found in deep ravine habitat, edges of coniferous forests, hilly areas, and mixed-wood forests (AEP 2017a). Mule deer are typically more common in mountainous areas than white-tailed deer (AEP 2017a). Winter track study data from FWMIS show abundant deer sign where the survey was conducted, as depicted in the triangular patterns in **Figure 7.2-3**) (Government of Alberta 2015). Deer tracks were observed within the LAA and RAA during the winter wildlife study.

Bats

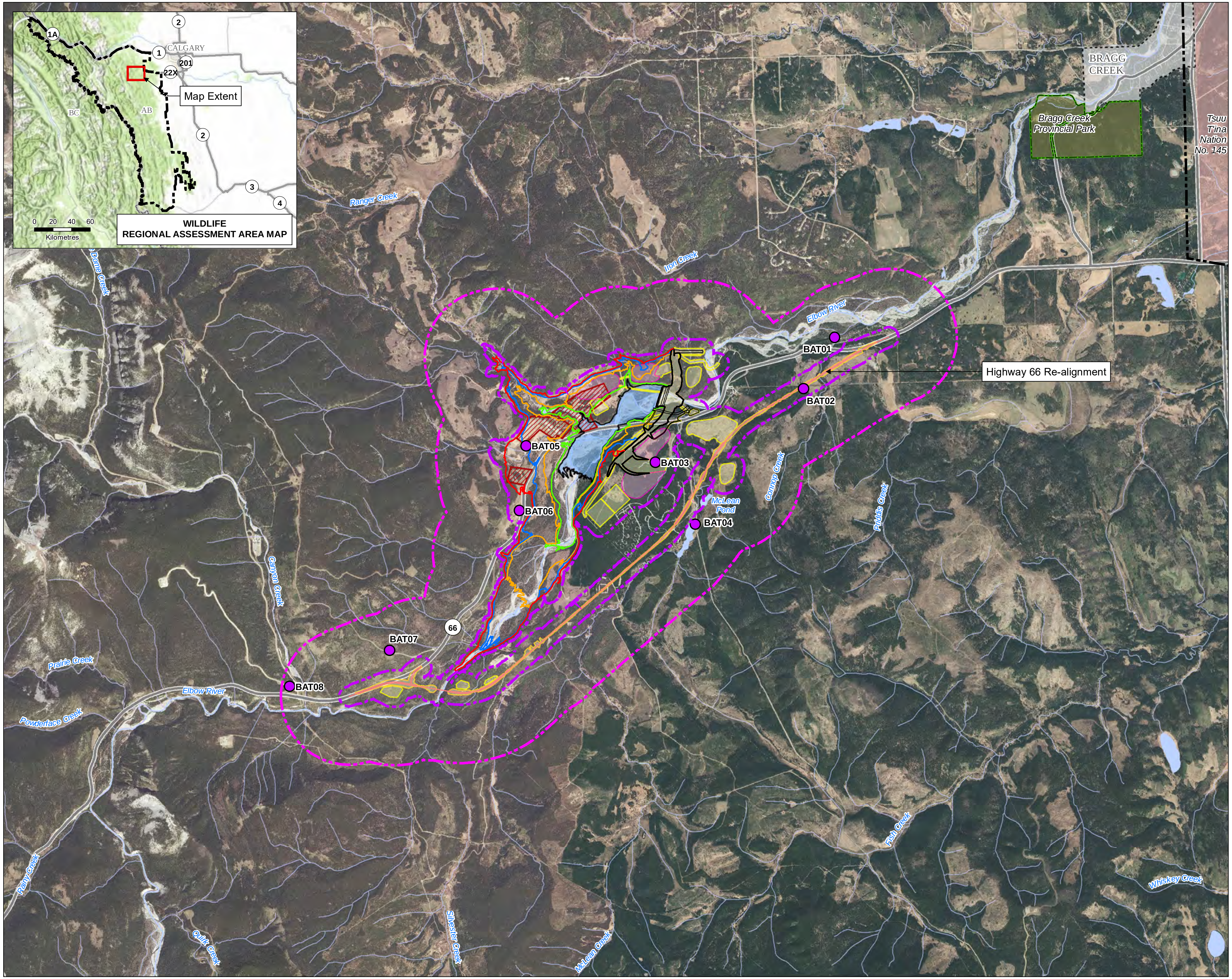
Bats, in general, are of management concern because of population declines in other jurisdictions (US Fish and Wildlife Service 2017). Nine bat species may occur in the LAA based on species range; these include eastern red bat (*Lasiurus borealis*), hoary bat (*Lasiurus cinereus*), silver-haired bat (*Lasionycteris noctivagans*), little brown bat, big brown bat, long-legged bat, northern long-eared bat, long-eared bat (*Plecotus auritus*), western small-footed myotis (*Myotis ciliolabrum*). Of these bat species, three are migratory (eastern red bat, hoary bat, silver-haired bat), and the remaining six species are resident or non-migratory bats.

Hoary bat, eastern red bat, silver-haired bat, and western small-footed bat are listed as Sensitive; northern long-eared bat is listed as May Be at Risk; long-legged myotis is listed as Undetermined; and the remaining species are Secure (see **Table 7.2-9**) (AEP 2017a). Two species are listed as Endangered on Schedule 1 of SARA: little brown bat and northern long-eared bat, and both have been detected in the LAA during acoustic monitoring conducted in Summer 2017 (**Figure 7.2-6**).

This federal listing is due to the fungal disease known as white nose syndrome; however, the disease, while moving west, and already detected in the western United States (Lorch et al. 2016), has not been detected on bats in Alberta.

Bats within the LAA will use a variety of habitats for both roosting and foraging. Bat habitat use can be broadly classified into two groups: non-clutter adapted species and clutter-adapted species. Eastern red bat, little brown bat, big brown bat, silver-haired bat, and hoary bat tend to choose larger canopy gaps and open habitat (non-clutter adapted species). Northern long-eared bat and long-eared myotis are considered a clutter adapted species, and are associated with thicker vegetation and increased canopy cover (Hogberg et al. 2002, Ford et al. 2005, Schirmacher et al. 2007).

The presence of coniferous and mixed forest can provide suitable roosting habitat for most of the species with potential to occur in the LAA. Roost sites may also exist in buildings currently present in the Option footprint. Bedrock exposures within the foothills and in the valleys may be used by resident bats as hibernacula or throughout the year by long-eared myotis and western small-footed myotis (Solick and Barclay 2006). Additionally, even though habitat use is variable for most of the bats within the LAA, forest edges, riparian areas, and wetlands have proven to be an important feature for bats, providing habitat with low structural complexity and high insect abundance (Hogberg et al. 2002, Menzel et al. 2002)



Elbow River at McLean Creek Dam (MC1)

Bat Survey Locations

Legend

- MC1 Option Area
- Wildlife Local Assessment Area
- Wildlife Regional Assessment Area
- MC1 Dam
- Highway 66 Re-alignment
- 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
- Reserve
- Hamlet of Bragg Creek
- Provincial Park
- Watercourse
- Waterbody
- Bat Detector Location

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
- FWMIS: Government of Alberta, 2017
- Aerial Imagery: SPOT 1.5 m, 2016

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Kilometres

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7.2.2.3 Birds

A variety of bird species are anticipated to use the LAA and RAA throughout the year. Records from FWMIS show 62 species in and adjacent to the LAA; the winter wildlife study also detected several winter resident species.

Bird species detected during the winter wildlife study included common raven, black-billed magpie, Bohemian waxwing, mountain chickadee, boreal chickadee, and American dipper.

Bird Species of Management Concern

Twenty-eight species of management concern have the potential to occur in the LAA and RAA, including songbirds, raptors, owls, waterfowl, and shorebirds (**Table 7.2-11**). These species and their federal and provincial regulatory status ranks are listed in **Table 7.2-11**.

Table 7.2-11 Bird Species of Concern with the Potential to Occur within the Local and Regional Assessment Areas

Common Name	Scientific Name	Provincial Status[2]	Wildlife Act[3]	COSEWIC[4]	SARA Schedule and Status[5]	Detected in the LAA (Spring and Summer 2017)[6]
Alder flycatcher	*Empidonax alnorum*	Sensitive	-	-	-	yes
American kestrel	*Falco sparverius*	Sensitive	-	-	-	-
Bald eagle	*Haliaeetus leucocephalus*	Sensitive	-	Not at Risk	-	-
Baltimore oriole	*Icterus galbula*	Sensitive	-	-	-	-
Barn swallow	*Hirundo rustica*	Sensitive	-	Threatened	No Schedule No Status	yes
Barred owl	*Strix varia*	Sensitive	Special Concern	-	-	yes
Black-backed woodpecker	*Picoides arcticus*	Sensitive	-	-	-	-
Brewer's sparrow	*Spizella breweri*	Sensitive	-	-	-	-
Broad-winged hawk	*Buteo platypterus*	Sensitive	-	-	-	-
Brown creeper	*Certhia americana*	Sensitive	-	-	-	yes
Clark's nutcracker	*Nucifraga columbiana*	Sensitive	-	-	-	-
Common nighthawk	*Chordeiles minor*	Sensitive	-	Threatened	Schedule 1 Threatened	yes
Eastern phoebe	*Sayornis phoebe*	Sensitive	-	-	-	-
Common yellowthroat	*Geothlypis trichas*	Sensitive	-	-	-	-

Common Name	Scientific Name	Provincial Status[2]	Wildlife Act[3]	COSEWIC[4]	SARA Schedule and Status[5]	Detected in the LAA (Spring and Summer 2017)[6]
Great blue heron	*Ardea herodias*	Sensitive	-	-	-	-
Great gray owl	*Strix nebulosa*	Sensitive	-	Not at Risk	-	
Harlequin duck	*Histrionicus histrionicus*	Sensitive	Special Concern	-	-	yes
Horned grebe	*Podiceps auritus*	Sensitive	-	Special Concern	Schedule 1 Special Concern	-
Least flycatcher	*Empidonax minimus*	Sensitive	-	-	-	yes
Northern pygmy-owl	*Glaucidium gnoma*	Sensitive	-	-	-	-
Olive-sided flycatcher	*Contopus cooperi*	May Be at Risk	-	Threatened	Schedule 1 Threatened	yes
Osprey	*Pandion haliaetus*	Sensitive	-	-	-	-
Pied-billed grebe	*Podilymbus podiceps*	Sensitive	-	-	-	-
Pileated woodpecker	*Dryocupus pileatus*	Sensitive	-	-	-	-
Sharp-tailed grouse	*Tympanuchus phasianellus*	Sensitive	-	-	-	-
Sora	*Porzana carolina*	Sensitive	-	-	-	-
Western tanager	*Piranga ludoviciana*	Sensitive	-	-	-	yes
Western wood-pewee	*Contopus sordidulus*	May Be at Risk	-	-	-	yes

Sources:

1 List compiled from FWMIS (Government of Alberta 2015) and AMEC 2015

2 AEP 2017a

3 AEP Species listed under the Wildlife Regulation of Alberta's *Wildlife Act*

4 Committee on the Status of Endangered Wildlife in Canada 2017

5 *Species At Risk Act*

6 Observed during surveys or incidentally in Spring and Summer 2017

Notes: "-"= not listed or not detected

AEP definitions: *At Risk* – Any species known to be at risk after formal detailed status assessment and legal designation as *Endangered* or *Threatened* in Alberta; *May Be At Risk* – Any species that may be at risk of extinction or extirpation, and is therefore a candidate for detailed risk assessment; *Sensitive* – Any species that is not at risk of extinction or extirpation but may require special attention or protection to prevent it from becoming at risk; *Undetermined* – Any species for which insufficient information, knowledge or data is available.

SARA definitions: *endangered* – A species facing imminent extirpation or extinction; *threatened* – A species likely to become endangered if limiting factors are not reversed; *special concern* – A species of special concern because of characteristics that make it particularly sensitive to human activities or natural events; *not at risk* – A species that has been evaluated and found to be not at risk; *indeterminate* – A species for which there is insufficient scientific information to support status designation.

Breeding Birds

The term breeding birds primarily refers to migratory birds that seasonally migrate, breed, and raise their young in locations other than their wintering habitat. In Canada, most species of breeding birds are protected under the regulations of the MBCA. The extent of use of the LAA and RAA for breeding songbirds is expected to be high given the presence of mixed-wood, coniferous, and wetland vegetation communities, as well as open disturbed areas.

The desktop review of data sources listed in **Section 7.2.1.2** indicates that a wide variety of songbirds may use the LAA during the breeding season. Data derived from FWMIS includes breeding bird survey data from a point near the Elbow River within the LAA (**Figure 7.2-7**). The species detected at this location were common forest birds: American robin, black-capped chickadee, common raven, dark-eyed junco, European starling, hairy woodpecker, ovenbird, red-breasted nuthatch, ruby-crowned kinglet, red-tailed hawk, ruffed grouse, red-winged blackbird, Wilson’s snipe, white-throated sparrow, and yellow-bellied sapsucker.

A total of 44 breeding bird plots were surveyed in the LAA in Spring and Summer 2017. The first round of surveys occurred on May 31 and June 1 2017, and the second round of surveys occurred on June 27 and 28, 2017. Most plots were surveyed in both rounds, except for lots BBS01 and BBS02 which were only surveyed once.

A total of 537 individual birds across 51 species were detected during the surveys within breeding bird plots (**Appendix 7-D Technical Data Report 2017 Breeding Bird Survey, Elbow River at McLean Creek Dam (MC1) Option**). Six provincially or federally listed species were detected during the breeding bird surveys (**Table 7.2-12**). These species were: alder flycatcher, brown creeper, common yellowthroat, least flycatcher, western tanager, and western wood-pewee. Both olive-sided flycatcher and common nighthawk were observed incidentally in the LAA and are Schedule 1 Threatened species under SARA. The five most abundant species encountered were yellow-rumped warbler, Tennessee warbler, ruby-crowned kinglet, chipping sparrow and dark-eyed junco.

Breeding bird data were also collected at an Alberta Biodiversity Monitoring Inventory site (ABMI #1491), located approximately 12 km east of the LAA. During a survey in 2009, 47 bird species were detected (ABMI 2009). Of these 47 species, the 10 most abundant species documented were mostly common forest birds: pine siskin, Tennessee warbler, evening grosbeak, American robin, brown-headed cowbird, Canada goose, clay-coloured sparrow, chipping sparrow, ruby-crowned kinglet, and Wilson's snipe. Two species of management concern were detected during this survey: Baltimore oriole and Cape May warbler. Both species are considered Sensitive by AEP (2017). No federally listed Schedule 1 listed species under the SARA were identified during the ABMI survey.

Table 7.2-12 Species of Breeding Birds Observed by Habitat Type During Spring 2017

Species	Dominant Habitat Types within 100 metres of Breeding Bird Survey Locations								
	b3 (n=1)	d1 (n=27)	d3 (n=5)	disturbed (n=3)	d2 (n=1)	b2 (n=4)	flood plain (n=2)	wetland (n=1)	Total
alder flycatcher	-	-	-	-	-	-	-	1	1
American robin	-	16	4	3	1	1	2	2	29
boreal chickadee	-	-	-	-	-	-	1	-	1
brown creeper	-	9	-	-	-	-	-	-	9
brown-headed cowbird	-	12	2	3	-	1	-	-	18
Cassin's vireo	-	1	-	-	-	-	-	-	1
chipping sparrow	2	11	5	7	-	9	2	2	38
clay-colored sparrow	-	1	-	-	-	-	-	2	3
common raven	-	1	-	-	-	-	-	-	1
common yellowthroat	-	1	-	-	-	-	-	-	1
dark-eyed junco	-	29	-	3	-	6	-	-	38
downy woodpecker	-	-	-	1	-	-	-	-	1
evening grosbeak	-	2	-	-	-	-	-	-	2
golden-crowned kinglet	-	4	3	1	-	-	-	-	8
gray jay	1	9	-	4	-	-	-	-	14
hairy woodpecker	-	-	1	-	-	-	-	-	1
Hammond's flycatcher	-	1	-	-	-	2	1	-	4
house wren	-	3	-	-	-	2	-	-	5
Le Conte's sparrow	-	6	1	5	-	1	-	-	13
least flycatcher	-	5	4	-	-	1	-	3	13
Lincoln's sparrow	-	1	-	1	-	1	-	-	3
magnolia warbler	-	3	-	-	-	-	1	-	4
mountain bluebird	-	-	-	1	-	-	-	-	1
mountain chickadee	2	17	2	2	-	3	-	-	26
northern flicker	-	-	-	-	-	1	-	-	1
northern waterthrush	-	1	-	-	1	-	-	-	2
ovenbird	-	1	-	-	-	-	-	-	1
pine siskin	-	5	-	3	-	3	-	-	11
red crossbill	-	-	-	-	-	22	-	-	22
red-breasted nuthatch	-	10	5	-	-	3	2	-	20
red-eyed vireo	1	1	-	-	-	-	-	-	2

Species	Dominant Habitat Types within 100 metres of Breeding Bird Survey Locations								
	b3 (n=1)	d1 (n=27)	d3 (n=5)	disturbed (n=3)	d2 (n=1)	b2 (n=4)	flood plain (n=2)	wetland (n=1)	Total
ruby-crowned kinglet	1	24	5	2	1	4	1	1	39
ruffed grouse	1	5	1	-	-	-	-	-	7
spotted sandpiper	-	1	-	-	-	-	-	-	1
Swainson's thrush	1	13	3	3	3	2	1	-	26
Tennessee warbler	1	24	7	3	-	4	-	1	40
Townsend's warbler	-	1	1	-	-	-	1	1	4
tree swallow	-	-	-	-	-	2	-	-	2
varied thrush	-	4	-	-	1	-	-	-	5
warbling vireo	2	14	3	2	-	4	-	2	27
western tanager	-	1	-	-	-	-	-	-	1
western wood-pewee	-	5	3	1	1	-	-	2	12
white-crowned sparrow	-	2	-	3	-	2	-	3	10
white-throated sparrow	-	3	3	-	-	1	-	-	7
willow flycatcher	-	1	2	-	-	-	-	-	3
Wilson's snipe	-	3	-	3	-	-	-	-	6
Wilson's warbler	-	-	1	-	-	-	-	-	1
winter wren	-	1	-	-	-	-	-	-	1
yellow warbler	-	2	-	-	-	-	-	-	2
yellow-bellied sapsucker	-	3	-	-	-	-	-	-	3
yellow-rumped warbler	-	36	3	2	-	1	4	-	46
All Species Combined	12	293	59	53	8	76	16	20	537

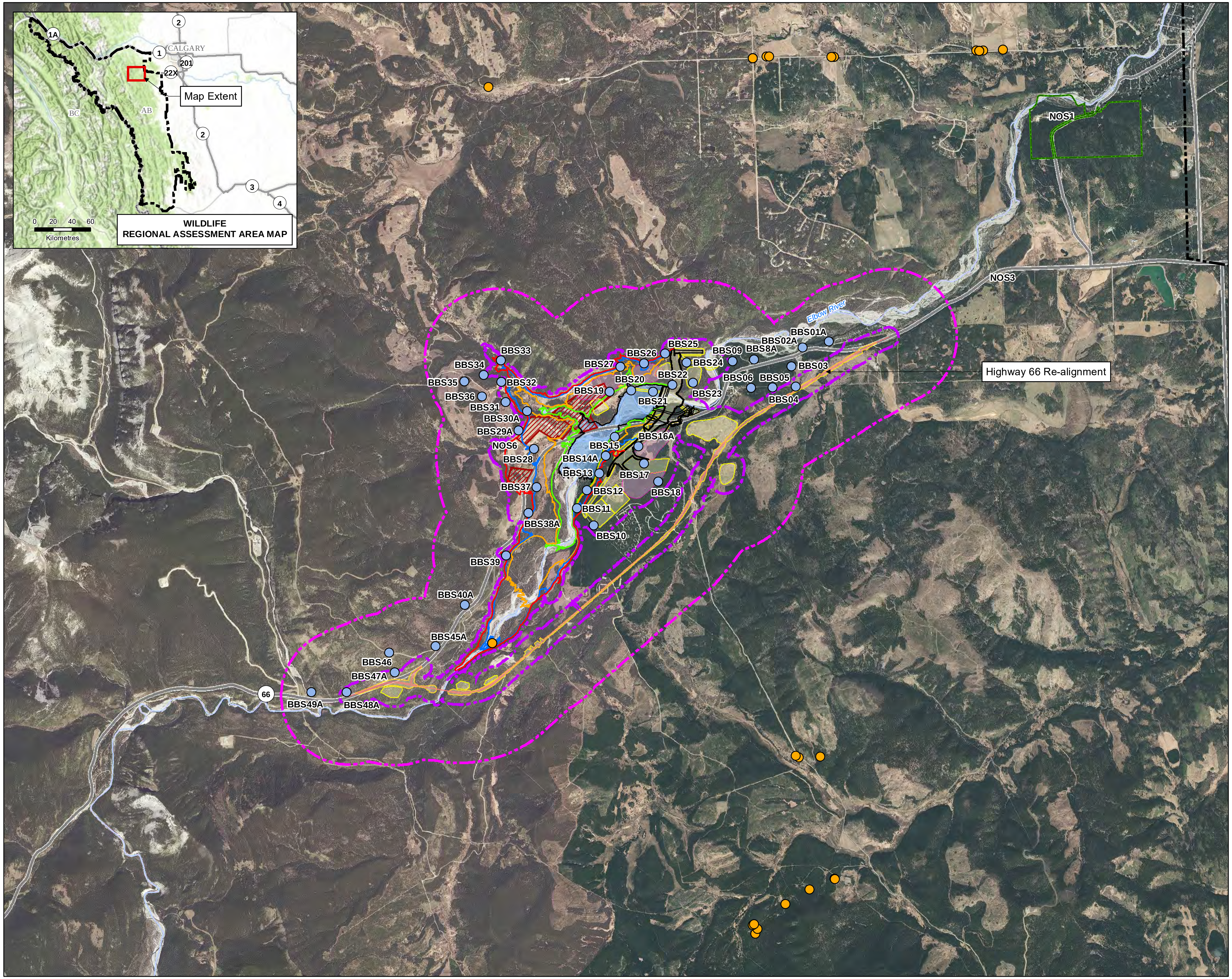
Notes:

(a) Species that are **bolded** and *italicized* are provincially listed by AEP or federally listed by SARA or the Alberta *Wildlife Act*
n = number of survey plots; - = None observed

Olive-sided flycatcher presence in the LAA was confirmed through an incidental observation during breeding bird surveys conducted in Spring 2017. Olive-sided flycatcher is not listed in **Table 7.2-12** because it was observed outside of the survey plot, and is therefore considered an incidental observation. There are no FWMIS records of olive-sided flycatcher in or near the LAA. Olive-sided flycatcher is federally listed as a Schedule 1, threatened species under SARA, and as May be at Risk in Alberta (AEP 2017a). This species is federally listed because like many aerial insectivores, the long-term trend in population numbers shows a downward trajectory. Olive-sided flycatcher is mainly associated with open areas such as forest clearings, forest edges located near natural openings (such as rivers or swamps), or human-made openings (such as logged areas). These areas usually contain tall live trees or snags for perching and from which the species can forage from (COSEWIC 2007a). It is likely that the LAA and RAA contain breeding habitat for the olive-sided flycatcher given the presence of open disturbed areas and early successional forest communities within which tall snags and residual live trees may be present. As mentioned above, Olive-sided flycatcher has been recently detected in the LAA, and habitat modelling is underway to quantify and evaluate habitats in the LAA that could be used for breeding by this species. These results will be available in fall or winter 2017, and will be appended to this Report at that time.

Common nighthawk may occur within the LAA and RAA, based on habitat and species range. Common nighthawk presence was confirmed through a single incidental detection during amphibian studies in support of this effects assessment. However, no common nighthawks were detected during call-playback surveys, which were conducted at bat survey locations in Spring and Summer 2017 (**Figure 7.2-6**), and there are no FWMIS records of common nighthawk in or near the LAA. The common nighthawk is listed as threatened under Schedule 1 of SARA, and is considered Sensitive in Alberta (**Table 7.2-11**). The reasons for the decline in common nighthawk populations are thought to be the result of a decline in insect populations due to high rates of pesticide use, as well as habitat loss and alteration, fire suppression, and intensive agricultural practices (COSEWIC 2007b). Breeding habitat for this species may occur the in the LAA, and habitat modelling is underway to quantify and evaluate habitat suitability for breeding common nighthawk.

Common nighthawk are found in mixed-wood, coniferous, and pine forests, and they use a variety of habitats including open, vegetation-free habitats, such as dunes, beaches, recently harvested forests, burnt-over areas, logged areas, rocky outcrops, rocky barrens, grasslands, pastures, peat bogs, marshes, lakeshores, and river banks (COSEWIC 2007b). A wide range of substrates are used for nesting including bare or scraped ground. Nesting microsite characteristics are open ground cover with low or limited vegetation and adequate camouflage from predators (Environment Canada 2015).



Elbow River at McLean Creek Dam (MC1)

Bird Survey Locations and Breeding Bird Records

Legend

- MC1 Option Area
- Wildlife Local Assessment Area
- Wildlife Regional Assessment Area
- MC1 Dam
- Highway 66 Re-alignment
- 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
- Reserve
- Hamlet of Bragg Creek
- Provincial Park
- Watercourse
- Waterbody
- Breeding Bird Survey Location
- Passerine FWMIS Observation Location

Notes

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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
- FWMIS: Government of Alberta, 2017
- Aerial Imagery: SPOT 1.5 m, 2016

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Kilometres

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Raptors and Owls

Raptor and owl species use forested habitats in the LAA and RAA to meet their life requisites. Habitats in the LAA may support foraging for a diversity of raptor species, but high-quality nesting habitats for large raptors are limited (AMEC 2015). Nesting raptors and owls are protected under the *Wildlife Act*. In the LAA, AMEC (2015) noted a lack of large, old deciduous trees interspersed in coniferous stands, which are often used by nesting raptors. The AMEC (2015) aerial survey for raptor nests resulted in no detections of large stick nests used by raptors.

Based on species ranges, the LAA may provide foraging habitat for raptor species of management concern. These species and their conservation status are detailed in **Table 7.2-11.** American kestrel, bald eagle, broad-winged hawk, and osprey are provincially listed as Sensitive. Data derived from FWMIS include a detection of red-tailed hawk within the LAA. Red-tailed hawks are a common species in Alberta that use a variety of habitats.

A review of FWMIS data shows detections of barred owl, boreal owl, great gray owl, great horned owl, and northern hawk owl, northern pygmy owl within or adjacent to the LAA (**Table 7.2-11**). Great gray owl and northern pygmy owl are provincially listed as Sensitive, and barred owl is provincially listed as Sensitive and also listed as Special Concern under the Wildlife Regulation of Alberta's *Wildlife Act*.

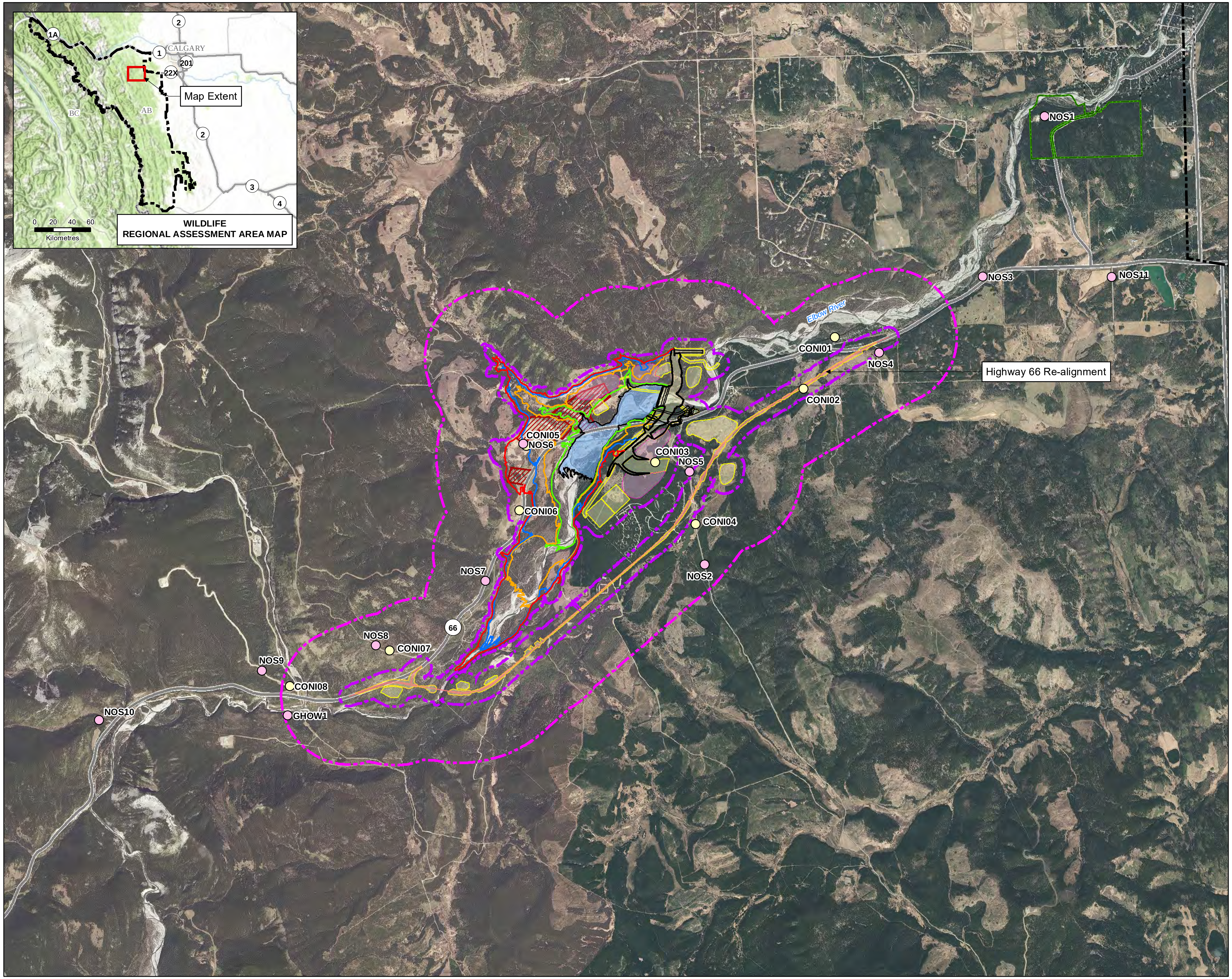
AMEC (2015) detected barred owl, great gray owl, and northern saw-whet owl during the 2014 surveys. The barred owl was detected in the southern part of the LAA, and the great gray owl was identified near McLean Creek. Incidentally, the northern saw-whet owl was detected north of Highway 66 near Ranger Creek during AMEC owl surveys (AMEC 2015).

The assessment team detected northern saw-whet owl, great-horned owl, and barred owl during the 2017 surveys. The barred owl was detected during the nocturnal owl survey, near point NOS-01 (**Figure 7.2-8**).

The assessment team assumes that raptors and owls are using forested habitats in the LAA as nesting habitat. Surveys with the objective of detecting nocturnal owl nests were undertaken in spring 2017, and no nests were detected. However, a lack of detections does not confirm raptor nest absence in the LAA.

Elbow River at McLean Creek Dam (MC1)

Nocturnal Owl and Common Nighthawk Survey Locations



Legend

- Wildlife Local Assessment Area
- Wildlife Regional Assessment Area
- MC1 Dam
- Highway 66 Re-alignment
- 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
- Reserve
- Hamlet of Bragg Creek
- Provincial Park
- Watercourse
- Waterbody
- Common Nighthawk Survey Location
- Nocturnal Owl Survey Location

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- Aerial Imagery: SPOT 1.5 m, 2016

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2025-001.01	Production Date: Sep 15, 2017	Figure 7.2-8

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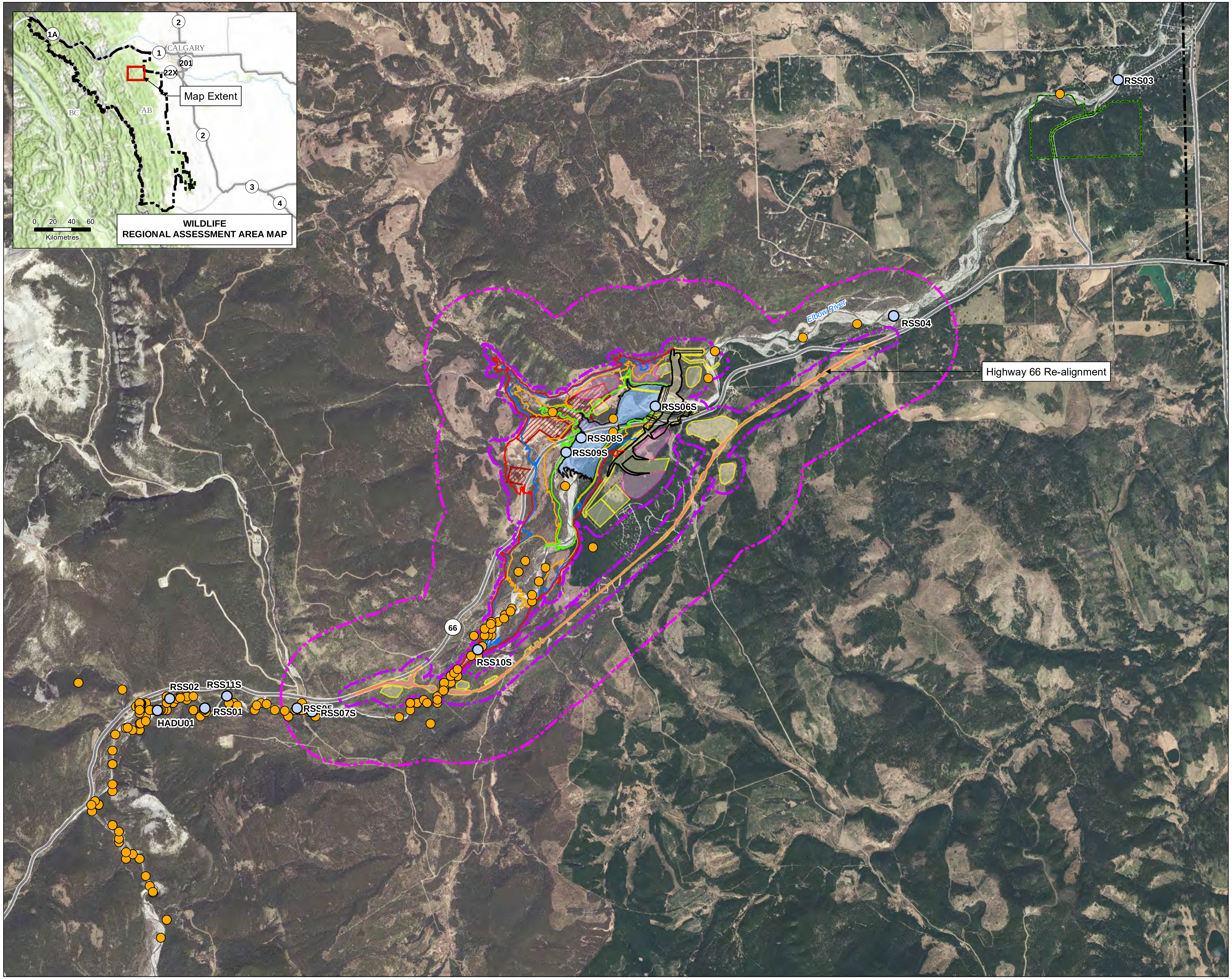
Harlequin Duck

Harlequin duck are known to occur within the LAA on the Elbow River. Records from FWMIS show a concentration of sightings of this species upstream of the Option footprint (**Figure 7.2-9**). Harlequin duck are listed as Sensitive in Alberta (AEP 2017).

The Kananaskis Country PRAs and Bragg Creek Provincial Park Management Plan (2012) identifies the continued undisturbed access to habitat along the Elbow River by the harlequin duck as a main objective within its wildlife management objectives and actions. The species is thought to be sensitive to human activities due to late maturity and intermittent breeding behaviour, as well as specific breeding habitat requirements that render the species vulnerable to logging, mining, grazing, and outdoor recreation AEP 2017b). In Alberta, harlequin duck breeding habitats are largely restricted to the mountain and foothill regions of the province (AEP 2017b). They require vegetative cover on islands and shorelines, clear water for preying on invertebrates, islands in mid-stream, braided channels, lower gradients, and cobble and boulder substrate (MacCallum 2001). Factors that increase the likelihood of habitat use by harlequin duck are the presence of hiding cover along streams such as overhanging vegetation, large woody debris, instream loafing sites (boulders or gravel bars adjacent to swiftly flowing water), and absence of human disturbance (MacCallum 2001).

The assessment team conducted riverine bird surveys to target harlequin duck during spring and summer 2017, and confirmed harlequin duck use of the Elbow River in the Option area.



Elbow River at McLean Creek Dam (MC1), AB

Harlequin Duck Records and Survey Locations

Legend

- MC1 Option Area
- Wildlife Local Assessment Area
- Wildlife Regional Assessment Area
- MC1 Dam
- Highway 66 Re-alignment
- 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
- River Shoreline Survey Location

FWMIS Observation Locations

- Harlequin Duck

Notes

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Piscivorous Birds

The term piscivorous birds here refers to fish-eating birds that primarily use lake habitats for foraging and nesting life requisites. In the Baseline Case, lake habitat does not occur in the LAA. This sub-group of birds is included in the assessment to account for anticipated changes to the Elbow River as a result of MC1.

Belted kingfisher, common loon, and common merganser are species that would potentially use the permanent pond after construction is complete. Common loon and common merganser are known to use the LAA and adjacent areas based on FWMIS records (Government of Alberta 2015).

The most important requirements for belted kingfisher breeding habitat appear to be waterbodies that support aquatic animal populations and nearly vertical earth exposures for digging nesting burrows (Cornell Lab of Ornithology 2017). Belted kingfisher use a variety of waterbodies such as streams, rivers, ponds, and lakes, in which prey are clearly visible. Common loon use a variety of freshwater aquatic habitats with clear water and abundant fish, including reservoirs (Cornell Lab of Ornithology 2017). Water quality is important for successful breeding. Loons are visual predators, and clear water is crucial for efficient foraging. Breeding habitats for common merganser include lakes and rivers bordered by forests mature enough to provide suitable tree cavities (Cornell Lab of Ornithology 2017).

The piscivorous bird species noted above are likely present in the LAA in the Baseline Case, and it is anticipated that their use of the LAA would increase with MC1 implementation. Riverine bird studies conducted in spring and summer 2017 will address the assumption that piscivorous birds are marginally present in the LAA in the Baseline Case.

7.2.2.4 Amphibians and Reptiles

Amphibian and reptile species are known to occur in the LAA and RAA, based on species range, available habitat data, and individual occurrence observations drawn from FWMIS, AMEC (2015), and field studies conducted in 2017. Five species of amphibians (boreal chorus frog, wood frog, long-toed salamander, Columbia spotted frog and western toad) and three species of reptile (common garter snake, terrestrial garter snake, and plains garter snake) are known to occur or have the potential to occur within the LAA. Of these, three species of amphibians and three species of reptiles are of management concern on a provincial or national level, and are listed in **Table 7.2-13**.

Table 7.2-13 Amphibian and Reptile Species of Concern with the Potential to Occur within the Local and Regional Assessment Areas

Common Name[1]	Scientific Name	Provincial Status[2]	Wildlife Act[3]	COSEWIC[4]	SARA Schedule and Status[5]	Detected in the LAA in Spring and Summer 2017[6]
Long-toed salamander	*Ambystoma macrodactylum*	Sensitive	Special Concern	Not at Risk	- -	-
Columbia spotted frog	*Rana luteiventris*	Sensitive	-	Not at Risk	- -	-
Western toad	*Anaxyrus boreas*	Sensitive	-	Special Concern	Schedule 1 Special Concern	yes
Plains garter snake	*Thamnophis radix*	Sensitive	-	-	- -	-
Common garter snake	*Thamnophis sirtalis*	Sensitive	-	-	- -	-
Terrestrial garter snake	*Thamnophis elegans*	Sensitive	-	-	- -	-

Sources:

1 List compiled from FWMIS (Government of Alberta 2015) and AMEC 2015

2 AEP 2017a

3 AEP Species listed under the Wildlife Regulation of Alberta's *Wildlife Act*

4 Committee on the Status of Endangered Wildlife in Canada 2017

5 *Species At Risk Act*

6 Observed during surveys or incidentally in Spring and Summer 2017

Notes: "-"= not listed, or not detected

AEP definitions: *At Risk* – Any species known to be at risk after formal detailed status assessment and legal designation as *Endangered* or *Threatened* in Alberta; *May Be At Risk* – Any species that may be at risk of extinction or extirpation, and is therefore a candidate for detailed risk assessment; *Sensitive* – Any species that is not at risk of extinction or extirpation but may require special attention or protection to prevent it from becoming at risk; *Undetermined* – Any species for which insufficient information, knowledge or data is available.

SARA definitions: *endangered* – A species facing imminent extirpation or extinction; *threatened* – A species likely to become endangered if limiting factors are not reversed; s*pecial concern* – A species of special concern because of characteristics that make it particularly sensitive to human activities or natural events; *not at risk* – A species that has been evaluated and found to be not at risk; *indeterminate* – A species for which there is insufficient scientific information to support status designation.

Egg mass and auditory surveys were conducted in the LAA in Spring and Summer 2017 (**Appendix 7-C Technical Data Report 2017 Amphibian Survey Elbow River at McLean Creek Dam (MC1) Option**). Western toad tadpoles were observed at AMPH08, and adult wood frogs were observed at eight of the ten plots. Wood frogs and boreal chorus frogs were observed incidentally during nocturnal owl surveys near NOS06 and NOS11 (**Figure 7.2-8**). These observations corroborate AMEC's (2015) findings of breeding wood frogs and boreal chorus frogs in Spring 2014. A garter snake was also incidentally observed during egg mass surveys. The observer was not able positively identify the garter snake to species due to the brief nature of the encounter.

Amphibian and reptile species are known to utilize a variety of aquatic habitats including riparian areas, wetlands, ponds, and bogs known to be present within the LAA and RAA. Habitats used for hibernation and foraging can also include rocky outcrops, upland areas such as meadows or spruce forests, and small mammal holes near water.

Western toad breed in a wide range of natural and artificial aquatic habitats with depths ranging from 5 centimetres (cm) to 2 m, with potential breeding sites that include stream edges, ponds, bogs, shallow margins of lakes, wet meadows, and anthropogenic features such as ditches and road ruts (Reimchen 1992, Gyug 1996). They aggregate at breeding sites in the spring (April to June). Ideal breeding site characteristics include still water, shallow margins (≤15 cm), and permanent or semi-permanent water levels that persist for a minimum of three months for tadpoles to undergo metamorphosis (Hammerson 1999, Holland 2002). Western toad are present and use wetland habitats in the LAA for breeding, based on observations collected in 2017 (AMPH08) (**Figure 7.2-10**).

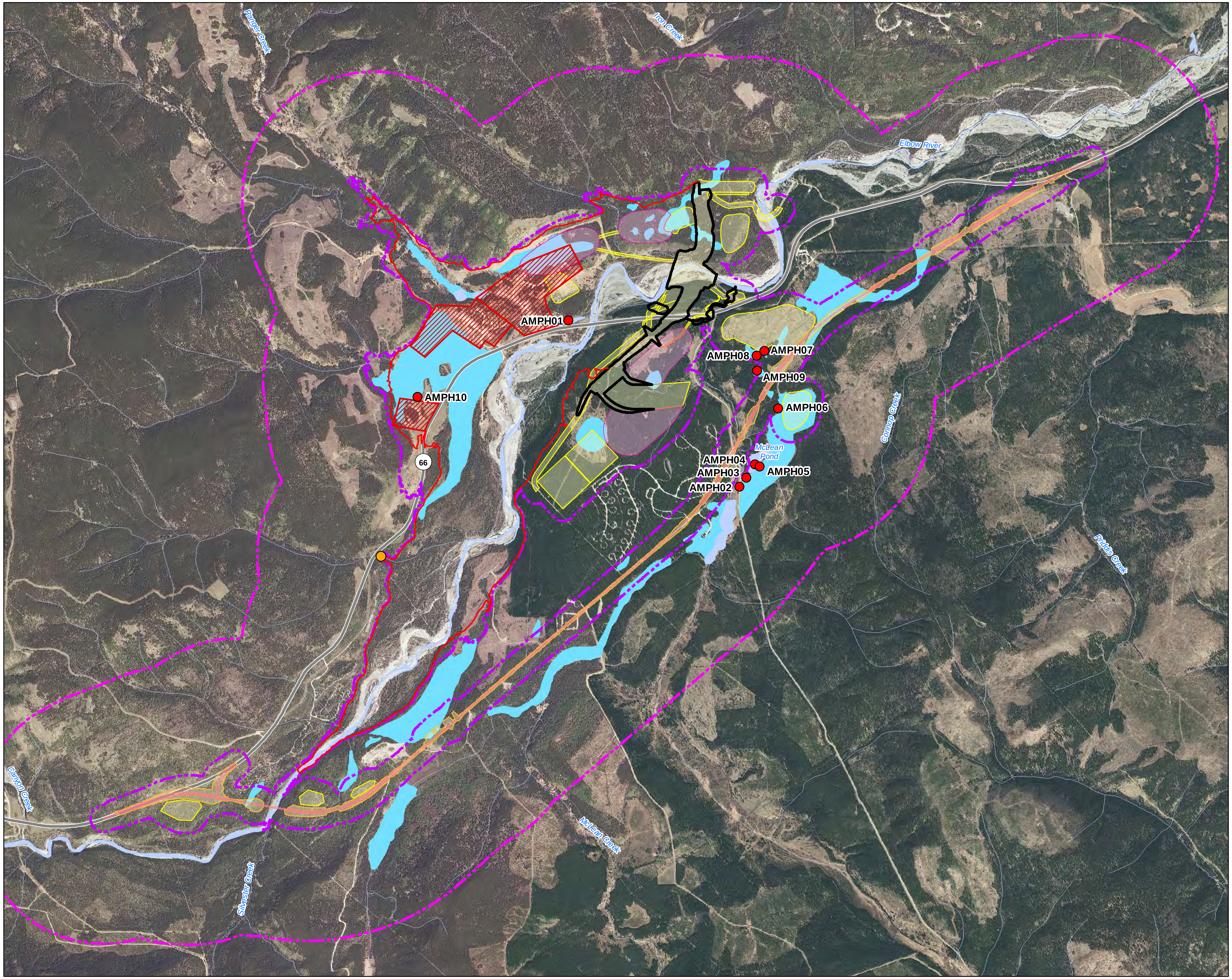
Following breeding, adult western toad spends up to 90% of their lives in terrestrial habitats, which include forested areas, wet shrub lands, avalanche slopes, and meadows, particularly those areas with dense cover for protection against predation. They may also remain and forage in adjacent marshes and riparian edges of breeding sites, or they may travel up to several km to other wetlands, riparian areas, or upland areas (COSEWIC 2012). Western toad hibernates underground in small mammal holes near water. While they hibernate in a variety of habitats, they have a strong association with spruce forests (COSEWIC 2012).

Long-toed salamander are known to occur in the Bow River Corridor (AEP 2016c). Terrestrial habitat use is variable, but is broadly characterized as moist forest providing substantial cover in the form of forest litter in close proximity to breeding ponds. Habitat requirements for breeding ponds are permanent, shallow water bodies lacking fish (AEP 2016c). It is assumed that long-toed salamanders are present in the LAA.

Garter snakes can be found in a wide variety of habitats, and are often encountered along the margins of wetlands, rivers, and other bodies of water (Alberta Conservation Association 2010). Common garter snake and terrestrial garter snake are the most likely to occur in the LAA based on species range, and are present in the LAA based on available habitats and an incidental observation in 2017.

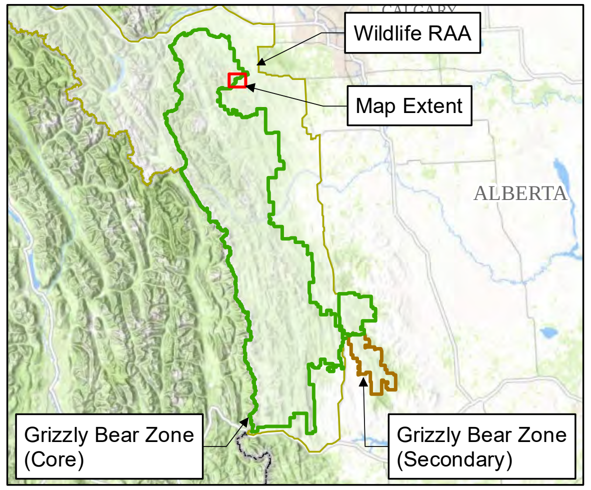
Snake hibernacula (wintering dens) are protected from disturbance under the regulations of Alberta's *Wildlife Act* throughout Alberta and throughout the year (Alta Reg 143/1997). Hibernacula are used for several years and are located in the crevices of rocky outcrops, slumps along river valleys, animal burrows, and other subterranean spaces that extend far underground and below the frost line (Alberta Conservation Association 2010). Hibernacula are relatively rare on the landscape, and if hibernacula of substantial size were present in the RAA it would likely be known to regional or park biologists, or the public due to high levels of human use in the LAA. Discussions with the AEP Regional Biologist did not identify known hibernacula in the Option area, nor was a hibernacula survey suggested. Surveys for garter snake hibernacula are not planned, but species will be recorded if observed incidentally.

Characterization of wetlands within the LAA was carried out as part of spring and summer field studies in 2017 (See **Section 7.1 Vegetation and Wetlands**).



Elbow River at McLean Creek Dam (MC1)

Amphibian Survey Locations and Amphibian and Reptile Records



Legend

- Highway
- MC1 Dam
- 2013 Flood Event (1424.1m)
- Highway 66 Re-alignment
- Borrow Area
- Laydown Area/Disturbed Area
- Watercourse
- Waterbody
- Wetland
- MC1 Option Area
- Wildlife Local Assessment Area
- Wildlife Regional Assessment Area
- Existing Park Infrastructure to be Removed
- Amphibian Survey Plot Location

FWIMIS Observation Locations

- Wood Frog

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

N

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Metres

NAD 1983 UTM Zone 11N

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2025-001.01	Production Date: Sep 15, 2017	Figure 7.2-10

HEMMERA

Alberta Transportation

7.2.3 APPLICATION CASE

The Application Case describes the effects of the MC1 Option added to Baseline Case (i.e., assesses MC1-related effects). The following sections present the potential MC1-related interactions, effects and mitigation measures, along with an assessment of residual effects.

7.2.3.1 Potential MC1 Option Interactions

The potential for effects due to interactions between MC1 activities and Wildlife and Wildlife Habitat subcomponents are provided below and in **Table 7.2-14**.

Table 7.2-14 Identification of Potential MC1 Interactions with Wildlife and Wildlife Habitat

Phase	Activity	Potential Effects	Grizzly Bear	Ungulates	Bats	Breeding Birds	Raptors and Owls	Harlequin Duck	Piscivorous Birds*	Amphibians and Reptiles	Rationale for Interaction
Construction	Clearing	Change in habitat	X	X	X	X	X	X	-	X	Vegetation clearing results in change in habitat for terrestrial and aquatic species.
		Change in movement	-	-	-	-	-	-	-	X	Amphibians and reptiles are less mobile than other VCs and cleared areas may be movement barriers.
		Change in mortality risk	X	X	X	X	X	X	-	X	Collision mortality risk is associated with vehicle and equipment use all VCs. Potential for loss of nests or roost sites.
	Road construction	Change in habitat	-	-	-	-	-	-	-	X	Habitat change already occurred with clearing. Potential interaction of habitat change for amphibians and reptiles due to altered drainage patterns.
		Change in movement	-	-	-	-	-	-	-	-	Change in movement temporary and not likely to cause adverse effects.
		Change in mortality risk	X	X	X	X	X	X	-	X	Collision mortality risk is associated with vehicle and equipment use for all VCs. Construction activities in grizzly bear habitat increase the risk of bear-human interactions. Instream works associated with bridge construction could interact with harlequin duck mortality risk.
	Decommissioning and removal of existing parks infrastructure	Change in habitat	X	X	X	X	X	-	-	X	New permanent infrastructure is a permanent habitat change
		Change in movement	X	X	-	-	-	-	-	-	New permanent infrastructure could alter the terrestrial movements of large terrestrial mammals either through avoidance or attraction.
		Change in mortality risk	X	X	X	X	X	X	-	X	Collision mortality risk is associated with vehicle and equipment use for all VCs. Construction activities in grizzly bear habitat increase the risk of bear-human interactions.

Phase	Activity	Potential Effects	Grizzly Bear	Ungulates	Bats	Breeding Birds	Raptors and Owls	Harlequin Duck	Piscivorous Birds*	Amphibians and Reptiles	Rationale for Interaction
	Dam (cofferdam and earth fill) construction	Change in habitat	X	X	X	X	X	X	X	X	New permanent infrastructure is a permanent habitat change. Instream works may interact with harlequin duck and piscivorous bird habitat. Instream concrete work could adversely affect aquatic life due to changes in pH.
		Change in movement	X	X	-	-	-	-	-	-	New permanent infrastructure could alter the terrestrial movements of large terrestrial mammals either through avoidance or attraction.
		Change in mortality risk	X	X	X	X	X	X	X	X	Collision mortality risk is associated with vehicle and equipment use for all VCs. Construction activities in grizzly bear habitat increase the risk of bear-human interactions. Instream works could interact with harlequin duck and piscivorous bird mortality risk.
	Spillway construction	Change in habitat	X	X	X	X	X	X	-	X	New permanent infrastructure is a permanent habitat change. Instream works may interact with harlequin duck and piscivorous bird habitat. Instream concrete work could negatively affect aquatic life due to changes in pH.
		Change in movement	X	X	-	-	-	-	-	-	New permanent infrastructure could alter the terrestrial movements of large terrestrial mammals either through avoidance or attraction.
		Change in mortality risk	X	X	X	X	X	X	X	X	Collision mortality risk is associated with vehicle and equipment use for all VCs. Construction activities in grizzly bear habitat increase the risk of bear-human interactions. Instream works could interact with harlequin duck and piscivorous bird mortality risk.
	Rock groin and diversion tunnels	Change in habitat	X	X	X	X	X	X	-	X	New permanent infrastructure is a permanent habitat change. Instream works may interact with harlequin duck and piscivorous bird habitat. Instream concrete work could adversely affect aquatic life due to changes in pH.

Phase	Activity	Potential Effects	Grizzly Bear	Ungulates	Bats	Breeding Birds	Raptors and Owls	Harlequin Duck	Piscivorous Birds*	Amphibians and Reptiles	Rationale for Interaction
		Change in movement	X	X	-	-	-	-	-	-	New permanent infrastructure could alter the terrestrial movements of large terrestrial mammals either through avoidance or attraction.
		Change in mortality risk	X	X	X	X	X	X	x	X	Collision mortality risk is associated with vehicle and equipment use for all VCs. Construction activities in grizzly bear habitat increase the risk of bear-human interactions.
	Laydown areas construction and use	Change in habitat	X	X	-	-	-	-	-	X	Habitat change associated with laydown areas may temporarily reduce foraging opportunities for grizzly bears, ungulates, and change terrestrial habitat use by amphibians and reptiles.
		Change in movement	-	-	-	-	-	-	-	-	Temporary change not anticipated to be a movement barrier.
		Change in mortality risk	X	X	X	X	X	-	-	X	Collision mortality risk is associated with vehicle and equipment use for all terrestrial VCs. Construction activities in grizzly bear habitat increase the risk of bear-human interactions. Presence of construction camp introduces bear attractants and increases human presence. Bear-human conflicts.
	Stockpile development and use	Change in habitat	X	X	-	-	-	-	-	X	Habitat change associated with stockpiles may temporarily reduce foraging opportunities for grizzly bears, ungulates, and change terrestrial habitat use by amphibians and reptiles.
		Change in movement	-	-	-	-	-	-	-	-	Temporary change not anticipated to be a movement barrier.
		Change in mortality risk	X	X	X	X	X	-	-	X	Collision mortality risk is associated with vehicle and equipment use for all terrestrial VCs. Construction activities in grizzly bear habitat increase the risk of bear-human interactions.

Phase	Activity	Potential Effects	Grizzly Bear	Ungulates	Bats	Breeding Birds	Raptors and Owls	Harlequin Duck	Piscivorous Birds*	Amphibians and Reptiles	Rationale for Interaction
	Borrow and spoil areas development and use	Change in habitat	X	X	-	-	-	-	-	X	Primarily a temporary habitat change. Borrow pit development creates a depression that may retain water and alter habitat for amphibians and reptiles.
		Change in movement	-	-	-	-	-	-	-	-	Temporary change and is not anticipated to be a movement barrier.
		Change in mortality risk	X	X	X	X	X	-	-	X	Collision mortality risk is associated with vehicle and equipment use for all terrestrial VCs. Construction activities in grizzly bear habitat increase the risk of bear-human interactions
	Realignment of McLean Creek and other small waterbodies	Change in habitat	-	-	-	-	-	X	-	X	Interaction with aquatic habitats could occur for harlequin duck and amphibians and reptiles.
		Change in movement	-	-	-	-	-	-	-	X	MC1 activities related to realigning the watercourses could interact with amphibian movements.
		Change in mortality risk	X	X	X	X	X	-	-	X	Collision mortality risk is associated with vehicle and equipment use for all terrestrial VCs. Construction activities in grizzly bear habitat increase the risk of bear-human interactions.
	Realignment of Highway 66	Change in habitat	-	-	-	-	-	-	-	X	For most VCs habitat change has already taken place (i.e. clearing, ground disturbance). For amphibians and reptiles, highway construction and highway surface can alter habitat by altering water flows.
		Change in movement	X	X	-	-	-	-	-	X	The re-alignment of Highway 66 would interact temporarily with terrestrial movements of large mammals during construction, but the presence of the re-aligned Highway 66 and associated traffic could be a movement barrier for terrestrial mammals, amphibians.

Phase	Activity	Potential Effects	Grizzly Bear	Ungulates	Bats	Breeding Birds	Raptors and Owls	Harlequin Duck	Piscivorous Birds*	Amphibians and Reptiles	Rationale for Interaction
		Change in mortality risk	X	X	X	X	X	-	-	X	Collision mortality risk is associated with vehicle and equipment use for all terrestrial VCs. Construction activities in grizzly bear habitat increase the risk of bear-human interactions. Operation and Maintenance phase vehicle traffic on the Highway 66 would increase mortality risk for terrestrial VCs due to potential vehicle collision mortality.
	Storage of water in permanent pond	Change in habitat	X	X	X	X	X	X	X	X	Change in habitat from river system to permanent pond. Habitat creation for piscivorous birds and potential foraging habitat for birds. Loss or alteration of terrestrial habitat for large mammals.
		Change in movement	X	X	-	-	-	-	-	X	Presence of permanent pond would interact with terrestrial mammal and amphibian and reptile movements.
		Change in mortality risk	-	-	-	X	-	-	X	-	Fluctuations in the water levels of the reservoir above the permanent pond could interact with ground nests by flooding nests.
	Reclamation	Change in habitat	X	X	-	-	-	-	-	-	Change in habitat in association with reclamation depends on revegetation plan. Could increase forage values for some species.
		Change in movement	-	-	-	-	-	-	-	-	Reclamation work is not anticipated to interact with VC movements.
		Change in mortality risk	X	X	X	X	X	-	-	X	Collision mortality risk is associated with vehicle and equipment use for all terrestrial VCs. Construction activities in grizzly bear habitat increase the risk of bear-human interactions. Potential for palatable species seeded near roads during revegetation to attract bears and ungulates foraging, and increases risk for mortality through vehicle collision or hunting.

Phase	Activity	Potential Effects	Grizzly Bear	Ungulates	Bats	Breeding Birds	Raptors and Owls	Harlequin Duck	Piscivorous Birds*	Amphibians and Reptiles	Rationale for Interaction
Operation and Maintenance	Routine and Flood Operation and Maintenance	Change in habitat	-	-	X	-	-	X	X	-	Temporary water fluctuations in the reservoir above the permanent pond may create nesting opportunities for ground nesting birds.
		Change in movement	-	-	-	-	-	-	-	-	No interactions are anticipated with respect to change in movement for VCs.
		Change in mortality risk	X	X	X	X	X	-	-	X	Collision mortality risk is associated with vehicle and equipment use for terrestrial VCs. Operation and Maintenance activities in grizzly bear habitat increase the risk of bear-human interactions. Fluctuating water levels above the permanent pond could affect ground nesting bird mortality risk.

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

Change in Habitat

Construction of MC1 infrastructure would result in the direct removal of wildlife habitat. This removal would be permanent in the road alignment, dam and spillway footprint, and permanent pond boundary; the removal could be temporary in borrow areas, construction staging areas, backslopes, and remedial grading, as well as in floods above the permanent pond boundary. Change in terrestrial habitat would interact with all terrestrial wildlife VCs (grizzly bear, ungulates, bats, breeding birds, raptors, owls, amphibians, and reptiles). In addition, changes in aquatic habitats would interact with those VCs that use aquatic habitats (harlequin duck, piscivorous birds, amphibians, and reptiles). The change to wildlife habitat would result in the direct removal or alteration of provincially identified Wildlife Sensitivity Zones (Government of Alberta 2015) such as the Grizzly Bear Zone, Key Wildlife Biodiversity Zone, and Recovery and Support Zones identified in the Grizzly Bear Recovery Plan (AEP 2016a).

Change in Movement

MC1-related changes to the ability of amphibians and reptiles to move are possible in relation to temporary and permanent changes in habitat required to construct the MC1 Option. Change in movement is also a potential effect related to the re-aligned section of Highway 66 in the Operation and Maintenance Phase.

Change in Mortality Risk

Construction activities related to the Option could result in wildlife mortality through increased likelihood of human-bear interactions, collisions with construction vehicles and equipment, instream works, and vegetation removal, which could affect active nests, roosts, or breeding ponds. The magnitude of the effect of wildlife mortality will be dependent on the time of year when construction activity occurs, and the wildlife VCs that are present in areas affected. Change in mortality risk is also a potential MC1-related effect associated with terrestrial VCs during the Operation and Maintenance phase due to vehicle collision mortality on the re-aligned section of Highway 66.

7.2.3.2 Potential MC1-related Effects

This section considers potential adverse MC1-related effects on VCs arising from potential interactions, as identified in **Table 7.2-14**, and in relation to the measurable parameters listed in **Table 7.2-5**. Mitigation measures for each potential effect are described in **Section 7.2.3.3.**

Change in Habitat

Grizzly Bear

Construction would result in permanent and temporary habitat loss for grizzly bear in the Option footprint. Core security, foraging, and potentially denning habitat availability would be adversely affected.

For the purpose of this assessment, core security habitat is defined by Alberta's Grizzly Bear Recovery Plan BMA 5's Recovery Zone polygon. Other habitats, including foraging habitats used by grizzly bear for other life requisites, are defined by Support Zone polygons (**Figure 7.2-2**).

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 in some areas of the Option footprint, including a zone of influence (i.e., area of reduced use or avoidance). MC1 Option footprint calculations of habitat change include a 100-m buffer on all MC1 infrastructure to account for the zone of influence of sensory disturbance.

An analysis of the spatial extent of potential MC1-related effects indicates a decrease of 0.02% to core security grizzly bear habitat available in the RAA from Baseline Case to Application Case and a decrease of 0.05 % in the habitats used for other life requisites (**Table 7.2-15**) (**Figure 7.2-2**). At the scale of the LAA, habitat change in core security habitat is a –7.09% change, and a –7.99% change in the habitats used for other life requisites.

Potential changes to habitat used by grizzly bears for denning is assumed to be low because bear dens are rare on the landscape. Habitat models based on vegetation mapping will be used to verify assumptions regarding the low likelihood of MC1-related adverse effects to grizzly denning habitats. A report will be prepared and appended to this Report in the fall of 2017.

Table 7.2-15 Grizzly Bear Habitat Change in the MC1 Assessment Areas

Assessment Areas	Grizzly Bear Recovery Plan Polygons	Baseline Case	Application Case	Change	Change
		(ha)	(ha)	(ha)	(%)
RAA	Recovery Zone	473,401.1	473,262.0	-139.2	-0.03%
	Support Zone	549,495.5	549,346.3	-149.2	-0.03%
LAA	Recovery Zone	1,964.0	1,824.9	-139.2	-7.09%
	Support Zone	1,867.7	1,718.5	-149.2	-7.99%

This potential MC1-related effect would occur during the Construction phase, but would persist through the Operation and Maintenance phases of MC1. Habitat change for grizzly bear would also be affected by the selection of vegetation species used during the reclamation process. As stated in the Approval Standard 200.9.3.1 of the EAP Integrated Standards and Guidelines (Alberta Energy Regulator 2013), no legumes are to be seeded for any revegetation.

Ungulates

Construction would result in permanent and temporary habitat loss for ungulates in the Option footprint. Winter foraging habitat availability would be reduced due to vegetation clearing and the construction of permanent infrastructure required for MC1. For this assessment, winter foraging habitat is defined by the

Key Wildlife and Biodiversity Zone polygon. In the Option footprint calculations of habitat change include a 100-m buffer on all MC1 infrastructure to account for the zone of influence associated with sensory disturbance.

MC1-related habitat loss would result in the loss of 288 ha of winter foraging habitat for ungulates; this represents a decrease of 0.12% in the RAA and a decrease of 9.26% in the LAA (**Table 7.2-16**, **Figure 7.2-2**)

Table 7.2-16 Habitat Change within the Key Wildlife Biodiversity Zone (Ungulate Foraging Habitat)

Assessment Areas	Baseline Case (ha)	Application Case (ha)	Change (ha)	Change (%)
RAA	233,791.6	233,503.2	-288.4	-0.12%
LAA	3,114.0	2,825.6	-288.4	-9.26%

This potential MC1-related effect would persist throughout the Construction and Operation and Maintenance phases of MC1. Moose and deer are mobile species that are expected to be able to utilize other proximate habitats to fulfill life requisites.

Bats

The removal of forest habitat during the Construction phase, particularly mature to old forest, could have an adverse effect on the availability of roost sites for bats (used in late spring, summer, and fall). Roost sites may also exist in buildings currently present in the Option footprint that would be removed prior to or during construction. Forage availability for bats would likely be improved by the Option with the creation of a permanent pond that provides habitat for insect prey, which are primary prey items for bats.

Breeding Birds, Raptors and Owls

Potential effects to breeding birds, raptors, and owls during the Construction phase include habitat loss and alteration from site clearing and sensory disturbances. Clearing and grubbing in the Option footprint may result in the loss of active nesting sites for breeding birds and raptors. Vegetation clearing could also result in the loss of potential nesting sites if a nest that is used year after year is destroyed. Sensory disturbance due to noise, human presence, and the use of heavy equipment during construction may indirectly affect nesting success. Vegetation clearing required for permanent MC1 infrastructure, including the permanent pond, is anticipated to affect 161 hectares (ha) of potential nesting habitat.

Changes in habitat associated with the Operation and Maintenance phase include the potential for flood events in the reservoir (above the permanent pond), and clearing in the footprint of the permanent pond to create nesting habitat for ground-nesting species that may not be currently using the area, such as Canada goose, killdeer and other shorebirds, and potentially common nighthawk.

Harlequin Duck

The change from a fluvial to a lacustrine system during the Construction and Operation and Maintenance phases would alter the habitat used by harlequin duck in the Option footprint. Optimal habitat for harlequin duck is a 1% to 7% gradient fast-flowing stream with clear water and overhanging vegetation (MacCallum 2001); these conditions are present in the LAA as are harlequin ducks. Construction of the dam and embankment structure and the subsequent filling of the permanent pond will replace fast-flowing stream habitat with less optimal lacustrine habitat. While harlequin duck are known to use lakes, such use is less common than for fast-flowing rivers (Campbell et al. 1990) where benthic larval insect prey and highly oxygenated waters occur (Goudie and Gilliland 2008). Harlequin duck migrate seasonally to Alberta to breed in and around vegetated shorelines and islands in clear streams with braided channels and cobble–boulder substrates (MacCallum 2001). Water clarity is very important for harlequin duck as they are a visual feeder. Replacing the stream habitat with lacustrine habitat may affect their ability to feed due to reduced water velocity and alterations to water clarity.

Based on FWMIS records, harlequin duck use is concentrated in the upper reaches of the LAA, south and west (upstream) of the proposed bridge crossing (**Figure 7.2-7**). In this area there would be minimal MC1-related changes to habitat because the permanent pond, where lacustrine replacement will occur, would be situated downstream. An analysis of 250-m stream reaches in the LAA (Elbow River and tributaries) shows that currently:

- 25 of the 63 Elbow River reaches in the LAA had harlequin duck observations (it is assumed that harlequin duck observations coincide with suitable habitat).
- 7 of the 253 tributary reaches in the LAA had harlequin duck observations

In the Application Case, primarily as a result of the creation of the permanent pond, just two of the Elbow River reaches that currently host harlequin duck would change to a gradient that is likely less suitable for their use.

The Elbow River flows and substrate would not be expected to change in the upstream area where most harlequin duck occur. Similarly, MC1-related changes to water clarity are not expected. In the area that would be replaced with the permanent pond, where small numbers of harlequin duck have been observed, the changes to water flow, gradient, and clarity would be expected to markedly change the habitat suitability for harlequin duck. Future use by harlequin duck in this area is not expected. Current harlequin duck use of the affected stretch of the Elbow River is small in comparison to the upstream stretches where gradients are higher and thus habitat is more suitable.

Piscivorous Birds

The establishment of the permanent pond during the Operation and Maintenance phase could create habitat for piscivorous bird species that currently may not be found in the LAA and RAA due to the lack of lacustrine habitat. It is likely that the reservoir would be colonized with fish during post-construction, and that fish communities would change over time (**Section 7.3.8.2**), with an anticipated short-term decline in the abundance of bull trout and mountain whitefish as brook trout and white suckers colonize the permanent pond. It is also possible that some trout species (rainbow trout and brown trout, for example) could use the reservoir and permanent pond for wintering habitat and spawn upstream of MC1.

Flood events during the Operation and Maintenance phase in the area proposed for the reservoir above the permanent pond may cause changes to the existing vegetation community in that area, creating nesting habitat for ground-nesting piscivorous birds and other ground-nesting species where it did not previously exist.

Amphibians and Reptiles

Construction activities could adversely affect amphibians and reptiles through changes to habitat. Grubbing and clearing would alter or remove terrestrial habitats used by amphibians and reptiles for foraging, and potentially alter or remove habitat features used for overwintering. Terrestrial habitat losses during the Construction phase would be related to temporary infrastructure including the haul roads, the borrow pits, laydown areas, offices and support buildings, and in the footprint of permanent structures (auxiliary spillway, earthworks, coffer dam, rock groin and permanent pond). Aquatic habitat losses would include effects of the stream diversion during construction and the loss of riparian habitat resulting from the filling of the permanent pond, in addition to the effect of any temporary or permanent infrastructure on wetlands or ponds within the Option footprint.

Potential amphibian breeding habitat in the LAA occurs in the vicinity of the Highway 66 re-alignment area and elsewhere in the Option footprint (**Figure 7.1-1, Table 7.2-17**). Wetlands that are likely to act as breeding ponds for amphibians are marsh and shallow open water features.

The Option footprint effects to wetlands are described in **Section 7.1.3,** and are quantified in **Table 7.2-17** and **Table 7.2-18.** Wetland amphibian breeding habitat present in the Option footprint could be lost or altered by MC1 activities involving heavy equipment use, ground disturbance, or changes to local hydrology (See **Section 7.1.3** for additional details).

Table 7.2-17 Potential Amphibian Breeding Ponds in the MC1 Footprint and Anticipated Effects

Wetland ID	Wetland Classification	Total Area (ha)	Approximate Area of Temporary Effects (ha)	Approximate Area of Permanent Effects (ha)
14	Seasonal freshwater marsh	0.06	0	0.06
16	Semi-permanent freshwater shallow open water	0.5	0	0
17	Semi-permanent freshwater shallow open water	0.07	0	0
19	Seasonal freshwater marsh	7.4	0	0.84
27	Temporary freshwater marsh	4.96	4.96	0
31	Permanent freshwater shallow open pond	10.66	0	0
33	marsh	0.75	0	0
Total		**24.1**	**4.96**	**0.91**

Loss of terrestrial and riparian habitat would reduce the overall foraging and breeding habitat available to amphibians and reptiles in the LAA. Potential amphibian and reptile foraging habitat in the LAA in the Option footprint is likely to be associated with shrubby fen and shrubby swamp habitats (**Figure 7.1-1**, **Table 7.2-18**). MC1 Option-related effects to wetlands is discussed in more detail in **Section 7.1.3.2**. Potential effects to overwintering habitats for amphibians and reptiles are not quantifiable as these habitat associations are not well understood. At present, no snake hibernacula are known to be located within the LAA, and western toad hibernation habitat is considered to likely be present in the Option footprint, due to the known presence of western toad in the LAA.

Table 7.2-18 Potential Amphibian and Reptile Foraging Habitats in the MC1 Footprint and Anticipated Effects

Wetland ID	Wetland Classification	Total Area (ha)	Approximate Area of Temporary Effects (ha)	Approximate Area of Permanent Effects (ha)
1	Shrubby fen	9.07	1.55	6.64
2	Shrubby fen	0.55	0	0.55
3	Shrubby fen	0.25	0	0.25
4	Shrubby swamp	0.26	0	0.26
5	Shrubby fen	1.1	0	0.21
6	Shrubby fen	23.57	23.57	0
7	Shrubby swamp	31.95	27.84	0
10	Shrubby fen	22.33	0	0.41
11	Shrubby swamp	15.43	0	0
12	Shrubby swamp	0.57	0	0

Wetland ID	Wetland Classification	Total Area (ha)	Approximate Area of Temporary Effects (ha)	Approximate Area of Permanent Effects (ha)
15	Shrubby fen	1.4	0	1.39
18	Shrubby fen	22.74	0	5.63
20	Shrubby fen	4.37	0	0
21	Wooded fen	9.02	0	1.8
22	Shrubby swamp	1.07	0	0.94
23	Shrubby fen	1.11	0	0.19
24	Shrubby fen	0.62	0	0
25	Shrubby fen	0.35	0	0.08
26	Shrubby fen	10.98	2.23	8.75
28	Shrubby fen	0.41	0.38	0
32	Shrubby swamp	9.79	0	0
Total		**166.94**	**55.57**	**27.1**

The creation and presence of the permanent pond during both the Construction and Operation and Maintenance phases may potentially create breeding habitat for western toad and other amphibian species if shallow margins are present. The creation of borrow areas may also create low wet habitats that could be used by amphibians for breeding in some years.

Change in Movement

Grizzly Bear and Ungulates

Grizzly bear, moose, and deer, are mobile species and are anticipated to be able to avoid areas where MC1 activities are occurring during the Construction phase. Daily or seasonal movement patterns for these species are not expected to be adversely affected above baseline conditions during the Construction phase. Indirect effects associated with sensory disturbance (e.g., noise from construction activities) may change normal movement patterns through avoidance or displacement away from otherwise suitable habitat. Species may be attracted to human activity and alter normal movement patterns. Conventional hydroelectric project footprints are identified as adversely affecting grizzly bear by altering bear movements in relation to MC1 infrastructure (McLellan 1990). It is assumed that the permanent pond and reservoir may also alter grizzly bear movements. These alterations to movement patterns are possible in relation to MC1 components, but are unlikely to represent barriers to movement or to manifest in measurable adverse affects on grizzly bear or ungulates.

The presence and use of the existing alignment of Highway 66 affects bear and ungulate movements in the Baseline Case; the re-aligned portion of Highway 66 required for MC1 implementation is anticipated to have similar, but incremental effects, in the Operation and Maintenance phase. Northrup et al. (2012) found that grizzly bear avoid roads with traffic volumes of 20 to 100 vehicles per day, and strongly avoid roads with greater than 100 vehicles per day in southwest Alberta. Alexander et al. (2005) suggest highway mitigations to improve wildlife permeability should be considered at approximately 5,000 vehicles per day (as cited in AEP 2016*a*). Alberta Transportation collects Average Annual Daily Traffic and Average Summer Daily Traffic estimates throughout the province, and the data collection point closest to MC1 is west of Highway 758 on Highway 66. Most recent data are from 2016 with an Average Annual Daily Traffic estimate of 1,890 vehicles per day, and an Average Summer Daily Traffic estimate of 2,830 vehicles per day. Traffic volumes have been increasing annually over most years since 2007 at this location, and average summer traffic is considerably higher (**Table 7.2-19**).

Table 7.2-19 Traffic Volume Estimates for Highway 66 near the Local Assessment Area

Location on Highway 66	2007 AADT	2008 AADT	2009 AADT	2010 AADT	2011 AADT	2012 AADT	2013 AADT	2014 AADT	2015 AADT	2016 AADT	2016 ASDT
	AADT = Annual Average Daily Traffic; ASDT=Average Summer Daily Traffic (vehicles/day)										
2.9 km West of 22 & 66 Bragg Creek	1440	1370	1440	1470	1490	1570	1360	1580	1780	1880	2830
West of Highway 758 SW of Bragg Creek	1440	1370	1430	1450	1470	1580	1360	1570	1780	1890	2830
E of 758 SW of Bragg Creek	1230	1170	1220	1240	1260	1340	1160	1360	1540	1720	2580
W of 22 SE of Bragg Creek	1230	1170	1220	1240	1260	1340	1160	1360	1540	1720	2580

Source: (CornerStone Solutions Inc. 2017)

With Average Summer Daily Traffic estimates at more than 2,800 vehicles per day (summer time is the relevant season for bear activity) in the Baseline Case, and traffic volumes likely to increase in the future, it is possible that the re-aligned section Highway 66 may constitute an important MC1-related barrier to movement during the Operation and Maintenance phase.

Amphibians and Reptiles

MC1-related changes to the ability of amphibians and reptiles to move are possible in relation to temporary and permanent changes in habitat from infrastructure and roads acting as barriers to movement during MC1's Construction and Operation and Maintenance phases. For amphibians, barriers between breeding, overwintering, and foraging habitats would result in the most pronounced MC1-related effects. For reptiles, barriers that intersect foraging habitat would be most relevant.

The effects of these MC1-related changes would be most pronounced for amphibian adults moving from hibernation habitats to breeding habitats, and for amphibian juveniles emerging from breeding habitats and dispersing to foraging or overwintering locations. For western toad, the critical window for adult movement would be one to two weeks in late spring, from mid-April to June, while for long-toed salamander adults the window is early spring, from mid-April to May, often before breeding ponds are entirely clear of ice (AEP 2016c). Western toad juveniles metamorphose within three months of egg laying, and form large, dense aggregations and migrate into terrestrial foraging areas, sometimes several kilometres away from water bodies, in late July to August (Environment and Climate Change Canada 2016). Long-toed salamander juveniles may overwinter before metamorphosis in breeding ponds in areas where the water or temperature is particularly cold. Most long-toed salamander juveniles emerge in late summer or early fall in order to access hibernation burrowing sites. Adult long-toed salamanders can be found up to 1 km away from breeding sites (BC MOE 2017, AEP 2016c).

The movement of garter snakes would be most vulnerable to MC1-related effects during emergence from hibernacula in the spring. Since no hibernacula are known to occur in the LAA, however, MC1-related effects to reptile movement would be a more general impediment to movement between and through various foraging habitats.

Change in Mortality Risk

Grizzly Bear

Construction activities that increase human presence in the LAA may adversely affect grizzly bear because construction activities increase the likelihood of human-bear interactions, which can result in bear mortality. Human-caused mortality is the most important limiting factor for grizzly bear, and is the proximate cause of grizzly bear declines in North America (T. Hamilton, Pers. Comm. in Stotyn et al. 2008). The human-caused mortality rate (excluding relocations) in BMA 5 is over the 4% threshold identified in the Draft Recovery Plan (which is thought to allow population growth), and female mortality is over the 1.2% threshold (AEP 2016a). If relocations are considered mortalities, these rates are higher. From 2009 to 2013, vehicle collision mortality accounted for 42% (9 of 21) of total human-caused mortality, and illegal harvests accounted for an additional 29% (6 of 21) (AEP 2016a).

Increases in road lengths in the LAA may increase mortality risk for grizzly bears using the area by increasing the likelihood of human-bear interactions. The mechanisms of potential increases to mortality risk are increased likelihood of human-bear interactions related to increased human presence required for construction and the presence of a construction camp, vehicle collision mortality, and increased opportunity for illegal hunting. Vehicle collision mortality and illegal hunting are the leading causes of grizzly bear mortality in the RAA (**Table 7.2-10**). MC1 construction and operation would result in increased road lengths within the LAA (18.19 %) and RAA (0.23%) (**Table 7.2-20**). MC1 construction activities include re-locating a stretch of Highway 66 within and directly proximate to Grizzly Bear Recovery and Support Zones identified in the Grizzly Bear Recovery Plan (AEP 2016*a*). The presence and use of the existing alignment of Highway 66 affects bear mortality risk in the Baseline Case; the re-aligned portion of Highway 66 required for MC1 implementation is anticipated to have similar, but incremental effects, in the Operation and Maintenance phase because portions of the existing Highway 66 will remain in use. In the Operation and Maintenance phase, vehicle use of the re-aligned section of Highway 66 may constitute a potential source of mortality for bears, whether or not traffic thresholds are realized. It is reasonably foreseeable that traffic volumes on Highway 66 would increase in the future given the upward trends occurring in previous years (**Table 7.2-19**), particularly during the summer months when grizzly bears are active.

Changes in linear disturbance density in the RAA is the relevant metric of change in mortality risk for grizzly bear. Areas with higher road densities are associated with increased risk of human-caused bear mortality (AEP 2016a). Alberta Environment and Parks (2016a) recommends that open road density remains at less than 0.6 km/km^2 in the Recovery Zone and less than 0.75 km/km^2 in the Support Zone. This metric is measured at the scale of the RAA, and as previously mentioned in **Section 7.2.2.2,** is considered well managed and therefore below threshold values in the RAA (AEP 2016a).

At the scale of the LAA, linear disturbance density calculations include powerline rights of way and are well above thresholds described in AEP (2016a) in both the Baseline Case and Application Case (**Table 7.2-21**). However, it is not considered appropriate to draw conclusions regarding linear disturbance density effects on grizzly bears at the scale of the LAA due to its small size.

Table 7.2-20 Change in Road Lengths in the Assessment Area

Assessment Area	Baseline Case Roads (m)	Application Case Roads (m)	Change (m)	Change (%)
Local Assessment Area	48,073.8	56,818.3	8,744.6	18.19%
Regional Assessment Area	3,817,976.4	3,826,721.0	8,744.6	0.23%

Table 7.2-21 Change in Linear Disturbance Density in the Assessment Areas

Assessment Area	Baseline Case Linear Density (km/sq.km)	Application Case Linear Density (km/sq.km)	Change (km/km^2)	Change (%)
Local Assessment Area	0.45	0.45	Negligible	0.3%
Regional Assessment Area	0.13	0.13	Negligible	0.0%

The vehicle traffic associated with the re-aligned section of Highway 66 may constitute a potential source of mortality for bears whether or not traffic thresholds are realized. MC1-related traffic increases would be limited to the construction phase. It is reasonably foreseeable that overall traffic volumes on Highway 66 would increase in the future given upward trends in previous years (**Table 7.2-19**).

Ungulates

Similar to grizzly bears, changes in linear disturbance density in the RAA is a relevant metric of change in mortality risk for ungulates; however, the mechanism of change in mortality risk differs. Changes to linear disturbance densities associated with construction and the presence of MC1 roads in the Operation and Maintenance phase could alter predator dynamics by increasing the likelihood of encounters with predators such as wolves. Illegal hunting is also a likely factor of mortality risk for ungulates in both the Baseline and Application cases, as linear disturbance density and increases in road lengths occur through increased access. The threshold of linear disturbance density that applies to grizzly bear also applies to ungulates, where habitat effectiveness decreases with disturbance densities above 0.6 km/ km^2 (Forman et al. 1997). Linear disturbance densities in the LAA exceed this threshold in the Baseline Case and Application Case (**Table 7.2-21**), but are below this threshold at the scale of the RAA.

Vehicle collision mortality for ungulates is reasonably foreseeable with the vehicle use of the re-aligned portions of Highway 66 during the Operation and Maintenance phase. As mentioned previously, traffic volumes in the area have trended upwards in the last 10 years (**Table 7.2-19**), and are likely to continue to increase over time. The presence and use of the existing alignment of Highway 66 affects ungulate mortality risk in the Baseline Case; the re-aligned portion of Highway 66 required for MC1 implementation is anticipated to have similar, but incremental effects, in the Operation and Maintenance phase because portions of the existing Highway 66 alignment will remain in use.

Bats

Vegetation clearing and demolition of existing structures in the LAA during MC1's Construction phase may directly or indirectly cause mortality to bats via destruction of existing roosts. Destruction of roosts may have a much higher effect on bat mortality during the reproductive period (June to August) due to the vulnerability of pups that remain in the roost throughout the day (Alberta Community Bat Program 2017, AEP 2017). Conducting clearing and demolition work in the spring prior to the reproductive period could result in lower, but indirect mortality as displaced bats expend limited energy reserves finding new roosts.

While removing suitable roosting habitat for bats may indirectly increase bat mortality by requiring their limited energy reserves for finding new roosts, or spending more energy thermoregulating in sub-optimal roosts, the creation of a permanent pond with enhanced foraging opportunities may balance this effect.

During the Construction phase, the potential for high mortality effects to bats also exists around disturbance to hibernacula that may exist in the Option footprint. Bats in Alberta have been found hibernating in caves, in sheltered locations in rock cliffs along rivers, and occasionally in buildings, and it is illegal to disturb bat hibernacula between September 1 and April 30 (AEP 2017h).

In the Construction and Operation and Maintenance phases, the presence of new roads (temporary haul roads) and the new permanent location of the highway introduces the potential for vehicle-related collisions with bats (Fensome and Matthews 2015). The re-alignment of the highway may result in different mortality rates due to the new location, which is not currently experiencing this effect. Vehicle use of roads is known to affect bats; similarly, noise, lighting, and collision fatalities reduce the numbers of bats close to roads (Berthinussen and Altringham 2012, Kitzes and Merenlender 2014). Though the levels of effect are not widely understood, several studies in North America and worldwide suggest the rate of collision mortality is likely somewhere in the range of 0.3 to 33 bats per km of road per year. The studies reviewed as part of this MC1's effects assessment indicate the following bat fatality rates:

- 0.3 bats per km per year for a suburban area in Poland (Lesiński 2007)
- 1.5 bats per km per year near windbreaks in Poland (Lesiński et al. 2011)
- 2.7 bats per km per year for forests in Poland (Lesiński 2007)
- 3 bats per km per year for forests in Northern California (Medinas et al. 2013)
- 4.0 bats per km per year for open areas in Poland (Lesiński et al. 2011)
- 4.9 bats per km per year for protected forest in Poland (Lesiński et al. 2011)
- 5.7 bats per km per year for a built-up area in Poland (Lesiński et al. 2011)
- 6.8 bats per km per year for tree patches in Poland (Lesiński 2007)
- 33 bats per km per year in Pennsylvania (Russell et al. 2009).

Other than perhaps the Russell et al. (2009) study, these estimates do not account for searcher efficiency or scavenger removal, which could introduce an estimated 12- to 16-fold increase in the mortality rate (Lesiński et al. 2011, Berthinussen and Altringham 2015). Uncertainties are potentially high in applying these estimates to Alberta because these data have been collected in other regions and habitats with different bat species, and the studies that do exist for other regions are sparse and use inconsistent methods. Nonetheless, the evidence for effects is established, and an approximate level of effect can be estimated from the literature.

A fatality rate for highways of six bats per km per year was adopted for this assessment. This estimate excludes correction factors for scavenger removal and searcher efficiency, which if applied could make them over 10 times higher (Berthinussen and Altringham 2015); however, the relatively low volumes of traffic on roads (currently less than 5,000 vehicles per day) compared with larger urban centers, especially during the short summer nights when bats are most active, argues for lower estimates to be used. This level of effect equates to 63 bats per year, based on the 10.5 km re-aligned section of Highway 66. The presence and use of the existing alignment of Highway 66 affects bat mortality risk in the Baseline Case; the re-aligned portion of Highway 66 required for MC1 implementation is anticipated to have similar, but incremental effects, in the Operation and Maintenance phase because portions of the existing Highway 66 will remain in use.

Breeding Birds, Raptors, and Owls

Clearing and grubbing in the Option footprint during MC1 Construction may result in the loss of active and potential nesting sites for breeding birds, raptors, and owls. Sensory disturbance due to noise, human presence, and the use of heavy equipment during construction may indirectly adversely affect nesting success. Mortality of nestlings and eggs may occur directly due to clearing and grubbing activities destroying active nests or indirectly as a result of sensory disturbance causing adults to abandon active nests. Change in mortality risk for breeding birds, raptors, and owls would also occur as a result of vehicle use of the re-alignment of Highway 66 in the Operation and Maintenance phase, because portions of the existing Highway 66 will remain in use.

Harlequin Duck

Changes to harlequin duck mortality risk are not anticipated as a result of MC1 construction or operation and maintenance activities. Harlequin ducks are anticipated to utilize habitats outside of the Option footprint during construction and maintain use of habitats in the LAA that are unaffected throughout the life of MC1. If harlequin ducks cease to use the Elbow River in the reaches affected by MC1, then interactions related to changes in mortality risk are not anticipated.

Piscivorous Birds and Breeding Birds (ground-nesting)

Near the completion of the Construction phase, the change from a riverine to a lacustrine system with the construction of the permanent pond could encourage the establishment of populations of bird species that utilize lake habitats, and are not currently known to be, or are rarely present in the Option area. During the Operation and Maintenance phase, as vegetation and fish communities become established, water and shorebirds such as ducks, geese, killdeer, plover, gulls, and potentially some raptors may have more suitable conditions for habitation than present at the Baseline Case. This would be both a positive and an adverse effect on mortality risk for these bird species.

The presence and operation of the permanent pond during the Operation and Maintenance phase could pose a mortality risk for newly established species, through bioaccumulation of methylmercury from newly flooded soil and vegetation, as discussed in the Aquatic Environment effects assessment section (**Section 7.3.3**), affecting piscivorous birds such as loons, belted kingfisher, bald eagle, osprey, grebes, and terns. Mercury contamination of fishes was estimated to be low in likelihood due to the planned low water residence time in the spring and summer. The potential effect on piscivorous birds from eating prey fish with methylmercury accumulations is considered low. The avian species that would be affected in this way are not currently present, or are not present in high numbers. The removal of vegetation and soils, and other mitigation to minimize methylmercury bioaccumulation in the permanent pond (**Section 6.5 Water Quality**) would reduce the potential for effects on piscivorous birds.

Peak flows on the Elbow River commonly occur from mid-May through to mid-July, due to high seasonal precipitation combined with spring snow melt (BGC 2017), result in the highest flood risk during this time, and coincide with nesting windows for many bird species. During flood events, when the area proposed for the reservoir above the permanent pond is inundated, breeding and roosting by birds that utilize open areas may experience adverse affects from nest flooding, potentially acting as a population sink for species not previously affected. Currently, ground-nesting species that might be affected are not known to use the proposed reservoir area, but after several cycles of inundation the conditions for nesting by several species, including common nighthawk, Canada goose, and killdeer and other shorebirds, might be present. The effects would, however, be infrequent, and the changes caused by inundation would be reversible; as flood waters recede habitat would be available again.

Amphibians and Reptiles

Change to mortality risk for amphibians and reptiles may occur from heavy equipment use and vehicle movement along temporary haul roads during the Construction phase in both terrestrial and aquatic habitats. Amphibians and reptiles may be crushed or incur other direct adverse effects associated with equipment use. Construction activities that involve vegetation clearing, ground disturbance, aquatic works, and MC1 vehicle traffic may result in direct mortality for amphibians and reptiles.

Construction activities that result in shallow indentations (such as tire ruts in temporary haul roads or excavation activities at borrow sites) that fill with water may form attractive breeding sites for western toad. Eggs and tadpoles occurring in these temporarily wet features, are highly likely to be disturbed or destroyed by desiccation, high temperatures, or interference by construction equipment. These features may act as population sinks during the Construction phase, and increase the risk of MC1-related western toad mortality.

Activities that require excavation within riparian areas of the Elbow River and tributaries in the LAA could result in the destruction or alteration of garter snake hibernacula. As mentioned above in **Section 7.2.2.4**, garter snake hibernacula are protected year-round under the *Wildlife Act,* however none are known to exist in the LAA.

The vehicle use of the re-aligned portions of Highway 66 could result in vehicle collision mortality for amphibians and reptiles due to proximity to wetland habitats in the LAA in the Operation and Maintenance phase. This is anticipated to be an effect that is incremental to the Baseline mortality associated with the existing Highway 66 alignment.

7.2.3.3 Mitigation Measures

Mitigation measures comprise any practical means taken to manage potential adverse effects, and may include applicable standards, guidelines, and best management practices (BMPs) supported by specific guidance documents. Mitigation measures to address potential adverse effects, discussed in **Section 7.2.3.2,** are described below and summarized in **Table 7.2-23.** In accordance with Alberta Transportation standard practice, BMPs and standard mitigation measures would be included in the Environmental Construction Operations Plan (ECO Plan) that would be developed by the contractor and accepted by Alberta Transportation prior to the start of construction.

Reduce MC1 Footprint during Design

A key mitigation for minimizing effects to wildlife, particularly in relation to habitat-related effects, is to reduce the overall footprint required for MC1. During detailed design, typically there are opportunities to optimize the design and location of MC1 components – giving consideration for information from impact assessment and more detailed geotechnical information, and the presence of existing development. Such considerations can reduce the area required for construction and operation to the minimum required for the Option, and or locate them in less sensitive areas. This mitigation addresses effects to change in habitat for all wildlife VCs. It is a pragmatic, cost-effective technique that uses available information to sensibly design MC1 in a way that includes sensitivity to the location and the potential effects.

Access Considerations during Design

The creation of new road access in the Grizzly Bear Zone or the Key Wildlife Biodiversity Zone requires design considerations per the Approval Standards detailed *EAP Integrated Standards and Guidelines* document (Alberta Energy Regulator 2013). This mitigation addresses effects to change in mortality risk for grizzly bear and ungulates because it relates to access management at the design level. Measures that reduce access effects to grizzly bear and ungulates on their winter range would reduce the potential for human interactions and thereby reduce mortality risk. Access standards as prescribed by Alberta Energy Regulator (2013) also include measures to conduct integrated land management planning whereby changes to habitat would also be reduced in the Wildlife Sensitivity Zones for grizzly bear and ungulates. Access considerations, when incorporated into the Option design phase, are considered effective mitigations.

Timing Considerations

Scheduling MC1 construction activities to avoid restricted activity periods is an effective mitigation for reducing effects to Wildlife VC in relation to change in mortality risk.

To minimize impacts to breeding wildlife, especially birds protected by the *Wildlife Act* and *Migratory Birds Convention Act*, vegetation grubbing and clearing would occur outside the critical breeding season. Timing considerations and setback guidance for industrial development in Alberta is usually according to Alberta Energy Regulator (2013) standards. Although the MC1 Option would be regulated by the Ministry of Environment and Parks, it is assumed that similar timing considerations and setback guidance would be applied to the MC1 Option. Clearing would occur within least risk timing windows (Alberta Energy Regulator 2013), which include:

- Approximately August 15 to March 31 for breeding birds
- Approximately August 15 to February 15 for raptors and owls (see Alberta Energy Regulator 2013 for details on specific species)

Approximately September 1 to May 31 for removal of potential bat roost trees, if required (Holroyd and Craig 2016). This timing should also be applied to demolition of existing structures that might be used as roosting habitat by bats (Alberta Community Bat Program 2017).

If tree-clearing activities are conducted during the breeding period, nest and den clearing surveys using a standardized protocol would be conducted by a qualified professional immediately prior to clearing activities with the objective of locating any active nests or dens. For breeding birds, a series of three surveys would be completed within five days, allowing a clearing window of three days for vegetation removal to occur. Generally, active songbird nests, when encountered during a pre-clearing survey in industrial developments, are given a buffer of 30 m; raptor and waterfowl nest buffers are usually determined in consultation with regulators.

Adhering to these timing windows would also minimize the potential for vegetation clearing to affect potential bat tree roosts. Ideally, removal of potential bat roost trees, if required, should occur between September 1 and May 31 (Holroyd and Craig 2016). Conducting vegetation clearing and demolition of existing buildings in the winter, when most bats are hibernating, may minimize direct and indirect mortality effects on bats (Alberta Community Bat Program 2017). Alberta-specific guidance exists for just one bat species, northern long-eared bat, and for this species roost trees are considered sensitive to removal year-round. If presence of this species is confirmed during 2017 field work, additional mitigation may be necessary.

Hibernating bats are particularly sensitive to disturbance; disturbance of hibernacula between September 1 and May 31st is illegal in Alberta. Avoiding blasting or excavation work that may impact hibernation habitat in the winter and evaluating buildings for demolition for presence of hibernating bats prior to demolition would minimize direct mortality risk.

The nests and dens of some other species are sensitive to effects year-round., which cannot be mitigated through timing restrictions (e.g., western toad, long-toed salamander, wandering and red-sided garter snakes, and northern long-eared bat (Alberta Energy Regulator 2013). If these wildlife habitat features are identified in the Option footprint, setbacks around the features would be indicated. If setbacks are not possible, Alberta Transportation (Proponent) will work with the regulator to determine an appropriate course of action.

Planning construction activities could help mitigate MC1-related effects to western toad and long-toed salamander movement during critical migration periods in the spring and late summer, especially timing the use of roads or any access into riparian areas surrounding breeding ponds, wetlands, or other aquatic habitats. Where the Option construction footprint overlaps the Key Wildlife Biodiversity Zone, construction activities would be avoided between December 15 and April 30 due to disturbances to ungulate winter range and the potential to disturb life requisites related to winter survival and calving. If construction activities are required during the restricted activity period in the Key Wildlife Biodiversity Zone, the Proponent will work with regulators to develop a mitigation plan that reduces the effects of construction activity on overwintering ungulates.

The implementation of timing consideration mitigations would reduce adverse effects related to change in mortality risk for all wildlife VCs during MC1's Construction phase. This mitigation is considered effective because it reduces interactions between VCs during periods when the respective wildlife species are more susceptible to MC1 activity.

Pre-construction Raptor Nest Surveys and Setbacks

A pre-construction raptor nest survey would be conducted by qualified professionals to verify that active raptor nests are not present. The survey method to be used is as follows:

- Ground or aerial surveys would occur within 500 m of the Option footprint prior to tree-falling activities to locate any active raptor nests. Raptor nest surveys would focus on suitable habitat.
- Should clearing be required during the breeding season for raptors (February 15 to August 15 for most raptors), pre-construction surveys for nesting raptors may be completed in conjunction with surveys for wildlife or breeding bird nests.
- If nests are located, setbacks to protect raptor nests be determined by a Qualified Environmental Professional (QEP), or in consultation with regulators.
- If the survey is completed outside the breeding season, the results of the survey would be valid until the onset of the next breeding season.

Pre-construction Sensitive Feature Surveys and Setbacks

A pre-construction sensitive feature survey would be conducted by qualified professionals to verify that the following features in **Table 7.2-22** are not present or if present have the appropriate setbacks (from Alberta Energy Regulator 2013). Potential effects and mitigation measures for Wildlife and Wildlife Habitat are summarized in **Table 7.2-23**.

Table 7.2-22 Pre-construction Surveys and Setbacks

Species	Recommended Setback
Western toad	100 m setback on breeding pond
Long-toed salamander	50 m – 200 m setback on breeding pond depending on disturbance level
Wandering and red-sided garter snakes	200 m – 500 m setback from hibernacula depending on disturbance level
Northern long-eared bat	50 m – 300 m setback from roost trees depending on disturbance level
Grizzly bear dens	200 m – 500 m setback depending on disturbance level
Pileated woodpecker nests	0 m – 100 m setback depending on season and disturbance level
Barred owl nests	0 m – 500 m setback depending on season and disturbance level
Golden eagle nests	50 m – 1,000 m setback depending on season and disturbance level
Bald eagle nests	50 m– 1,000 m setback depending on season and disturbance level
Osprey nests	0 m – 750 m setback depending on season and disturbance level
Northern goshawk nests	0 m – 500 m setback depending on season and disturbance level
Peregrine falcon nests	50 m – 1,000 m setback depending on season and disturbance level

Wildlife feature setbacks are mitigations that reduce the effects of change in habitat, change in movement, and change in mortality risk. Setbacks are effective because they reduce the probability of adverse interactions between wildlife and MC1 components and activities.

Wildlife Management Measures

Wildlife Management Measures would be defined prior to the start of the Construction phase, and would include the following features to reduce effects during construction:

- Proponent commitments about relevant wildlife and vegetation mitigation and BMPs for wildlife incorporating provincial, federal, and professional guidance
- Waste management provisions, including the appropriate disposal of food and garbage waste to avoid interactions with bears
- A mechanism to report and disseminate wildlife sighting and mortality information to the AEP and the construction team (for awareness and safety)
- Mitigation to identify and protect wildlife habitat features such as breeding ponds, hibernacula, roost trees, nests, dens, wallows, or mineral licks through setbacks
- Reclamation measures would return areas temporarily disturbed by MC1 to suitable wildlife habitat (e.g., no legume species can be used for revegetation in the Grizzly Bear Zone-see Standard Operating Condition 200.9.3.1 (Alberta Energy Regulator 2013)
- Access management would reduce the likelihood of human-wildlife interactions in the both the Construction and the Operation and Maintenance phases (see Approval Standards (Alberta Energy Regulator 2013) for access requirements in a Grizzly Bear Zone and the Key Wildlife Biodiversity Zone)
- Traffic management protocols to reduce MC1-related traffic in the construction footprint.

The implementation of these measures would effectively reduce MC1-related effects to change in habitat, and change in mortality risk for all wildlife VCs. Implementation of reclamation and revegetation measures would reduce MC1-related effects on movements for amphibian and reptiles. In addition, implementation of these measures would effectively reduce reasonably foreseeable interactions with wildlife in the Option area.

Erosion and Sediment Control Plan

An Erosion and Sediment Control Plan would be implemented to reduce MC1-related effects to water quality in Option area water courses and waterbodies during the Construction phase (See **Section 6.5 Water Quality** and **Section 7.3 Aquatic Environment**). Implementation of the Erosion and Sediment Control Plan is a standard mitigation intended to reduce adverse alteration of aquatic habitats due to MC1 activities, and should effectively reduce change in habitat effects for amphibians, harlequin duck, and piscivorous birds.

Reduce Wildlife-Human Interactions

Employees and contractors would be trained in techniques for avoiding interactions with wildlife, and for proper conduct during an unavoidable interaction. All personnel working at the Option site would undergo bear awareness and safety training prior to commencing work on-site. Wildlife awareness training and support material such as Alberta's BearSmart Program Manual would be provided as a component of the Construction Wildlife Management Measures mitigation. This mitigation is primarily aimed at reducing mortality impacts to grizzly bear related to increased human presence in Option area during the Construction phase.

Wildlife Passage Structures for Realigned Section of Highway 66

Wildlife underpass structures and fencing for the re-aligned section of Highway 66 would be included to reduce potential effects related change in movement and change in mortality risk for grizzly bear and ungulates. Structures designed for this size of terrestrial animal would also provide passage for other wildlife species. Underpass structures have been shown to be effective in reducing movement barriers and mortality risk for grizzly bears within or directly adjacent to the RAA boundary (Banff National Park).

Revegetation and Reclamation Measures

Areas of temporary effects, such as backslopes and laydown and borrow areas outside the fen areas, would be revegetated using a native plant seed mix. This measure would assist in the re-establishment of native vegetation within the LAA after construction, thereby reducing the effect of the proposed Option on Vegetation. In addition, after decommissioning and relocation of parks facilities, site remediation areas would also be revegetated. Reseeding, at the direction of a qualified botanist, would help re-establish native vegetation while reducing the overall permanent effect of the MC1 Option on the Vegetation VC. Botanists are considered qualified if they have at least five years' experience conducting floristic surveys in southwestern Alberta and are knowledgeable about habitat restoration and enhancement.

Table 7.2-23 Summary of Potential Effects and Mitigation Measures for Wildlife and Wildlife Habitat

Summary of Potential Effect and Classification	VC Affected	MC1 Components	Contributing MC1 Activities	Proposed Mitigation Measure	Detectable / Measurable Residual Effect
Construction Phase					
Change in habitat	Grizzly bear Ungulates Bats Breeding birds Raptors and owls Harlequin duck Piscivorous birds Amphibians and reptiles	All components resulting in permanent habitat change and sensory disturbance	Operation of heavy equipment Flood event Operation of waste storage and disposal Construction and use of access roads Construction of staging areas Site restoration and landscaping Possible operation of cement batch plant Site clearing Blasting Cut and fill of drainage ditches and culverts Placement and operation of field offices and other buildings Filling of permanent pond	Minimize MC1 footprint during design Timing considerations Pre-construction raptor nest surveys and buffers Pre-construction sensitive feature surveys and install buffers Wildlife Management Measures Reduce wildlife-human interactions Erosion and Sediment Control Plan Revegetation and Reclamation measures	Yes
Change in movement	Grizzly bear Ungulates Amphibians and reptiles	All permanent components	General construction operations (top row of this table) plus the following items: Presence of permanent MC1 infrastructure	Minimize MC1 footprint during design Access considerations during design Timing considerations Pre-construction sensitive feature surveys and install buffers Wildlife Management Measures Reduce wildlife-human interactions	No

Summary of Potential Effect and Classification	VC Affected	MC1 Components	Contributing MC1 Activities	Proposed Mitigation Measure	Detectable / Measurable Residual Effect
Change in mortality risk	Grizzly bear Ungulates Bats Breeding birds Raptors and owls Harlequin duck Piscivorous birds Amphibians and reptiles	All components that increase MC1-related human presence in the RAA including vehicle traffic.	All activities that increase MC1-related human presence in the RAA including vehicle traffic Instream works could affect harlequin duck breeding and foraging	Minimize MC1 footprint during design Timing considerations Pre-construction raptor nest surveys and install buffers Pre-construction sensitive feature surveys and install buffers Wildlife Management Measures Reduce wildlife-human interactions	Yes
Operation and Maintenance Phase					
Change in Habitat	Bats Harlequin duck Piscivorous birds	Reservoir and permanent pond	Presence of reservoir and permanent pond	Minimize MC1 footprint during design	Yes
Change in Movement	Grizzly bear Ungulates Amphibians and reptiles	Re-routed section of Highway 66	Vehicle use of re-routed section of Highway 66	Wildlife passage structure on Highway 66 Wildlife Management Measures	Yes
Change in Mortality Risk	Grizzly bear Ungulates Bats Breeding birds Raptors and owls Common nighthawk Olive-sided flycatcher Piscivorous birds Amphibians and reptiles	Reservoir Vehicle use of Highway 66	Water fluctuations in reservoir above permanent pond Increased linear disturbance density in the RAA Increasing vehicle traffic on Highway 66	Minimize MC1 footprint during design Wildlife passage structure on re-alignment of Highway 66 Wildlife Management Measures Reduce human-wildlife Interactions	Yes

During the Construction phase, activities that would result in permanent habitat change such as the construction of permanent infrastructure would be likely to result in residual effects for all Wildlife and Wildlife Habitat VCs. Sensory disturbance during construction would exacerbate habitat change during this period, but it would be temporary, and would only occur while construction activities are underway.

Mitigation measures are likely to reduce the effect of habitat change, but residual change is anticipated for all VCs as a result of MC1 construction.

Change in movement is brought forward into the residual effects characterization for grizzly bear and ungulates in relation to the presence of vehicle traffic associated with Highway 66 during the MC1's Operation and Maintenance phase.

The change in movement for grizzly bear during the Construction phase is not carried forward as a residual effect as grizzly bear are mobile and are anticipated to move away from MC1 activities. Mitigation measures are likely to reduce adverse affects to bear movements, and include implementation of a Traffic and Access Management Plan.

The change in movement and change in mortality risk during the Construction phase are not carried forward as residual effects for ungulates since these species are mobile, and are anticipated to move away from MC1 activities. Traffic management (as a component of the ECO Plan) would likely successfully mitigate the change in mortality risk (due to MC1-related vehicle traffic).

The change in mortality risk is brought forward to the residual effects characterization for grizzly bear, ungulates, bats, breeding birds, raptors, owls, ground-nesting birds, amphibians, and reptiles.

7.2.3.4 Residual Effects

Residual effects are MC1-related effects that are anticipated to occur to VCs after the application of mitigation measures. This section describes how the residual effects of MC1 are characterized and summarized for Wildlife and Wildlife Habitat. The determination of a substantive or non-substantive residual effect includes a characterization including magnitude, regional extent, and duration.

Residual Effects Characteristics

Residual effects are characterized based on the criteria defined in **Table 7.2-24**. The effect characteristics are assessed in the context of the Wildlife and Wildlife Habitat. Non-substantive residual effects occur if mitigation measures have not fully eliminated the effects, but have reduced the magnitude, extent, or duration to such a degree as to avoid substantive effect on the VC. Substantive residual effects occur if adverse effects are predicted to be high in magnitude, regional in extent, and/or long-term in duration even after implementation of mitigation.

Table 7.2-24 Residual Effects Characteristics for Wildlife and Wildlife Habitat

Residual Effect Characteristic	Rating	Definition
Direction	Positive	Net benefit to Wildlife and Wildlife Habitat.
	Adverse	Net loss to Wildlife and Wildlife Habitat.
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 from baseline.
	Minor	Detectable changes from baseline conditions; changes within range of natural variability of resource and/or causes no detectable change to the resource.
	Moderate	Detectable changes from baseline conditions; changes beyond range of natural variability of resource but not posing risk to local populations.
	Major	Detectable changes from baseline conditions; changes beyond range of natural variability of resource. Poses risk to local populations.
Duration	Short-term	Restricted to the Construction phase.
	Long-term	Extends through the Operation and Maintenance phase and beyond.
Reversibility	Reversible	Effect can be reversed once the activity causing the residual effect ceases.
	Not reversible	Effect is permanent.
Frequency	Isolated	Residual effect occurs once.
	Rare	Residual effect occurs multiple times.
	Frequent	Residual effect occurs regularly or continuously.
	Continuous	
Confidence	High	Rating predictions are based on a good understanding of cause-effect relationships and/or using data specific to the 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 MC1.
	Low	Rating predictions are based on an incomplete understanding of cause-effect relationships and incomplete data.

Change in Habitat

Grizzly Bear and Ungulates

Change in habitat for grizzly bear and ungulates would be an adverse residual effect of MC1 Construction. Change in habitat would occur directly through vegetation clearing during the Construction phase, which would remove or alter habitat and replace it with MC1 infrastructure. Habitat change in the RAA would affect the Recovery (–139 ha) and Support Zones (–149 ha) identified in the Grizzly Bear Recovery Plan, which represent core security and foraging habitats. Habitat change would also occur in a Key Wildlife Biodiversity Zone (–288 ha) used by ungulates as winter range habitat. Sensory disturbance from construction activities and human presence may cause grizzly bear and ungulates to avoid otherwise suitable habitat, but in the

Construction phase this effect is limited to the duration of construction activities. During the Operations and Maintenance phase, sensory disturbance associated with permanent infrastructure is possible, and is likely to dissipate with time as animals habituate to the presence and operation of the infrastructure. The alteration or destruction of grizzly bear den habitat would be reduced by identifying areas with elevated potential for bear denning activity through habitat mapping, conducting pre-construction surveys dens in identified areas, and avoiding direct disturbance of active dens through timing considerations and adherence to setbacks. Revegetation as part of reclamation measures would avoid the use of legume species in an effort to avoid attracting bears into areas where human-bear interactions are more likely such as along roadsides or proximate to MC1 infrastructure.

Change in habitat for grizzly bear and ungulates is an adverse residual effect (**Table 7.2-25**) that would be local in extent, limited to the Option footprint, and likely of moderate magnitude. Habitat change would be unavoidable with MC1 implementation, although MC1-related habitat changes occurring over the long-term would not likely inhibit the ability of grizzly bear and ungulates from meeting their life requisites. Areas required for MC1 infrastructure would result in non-reversible and continuous habitat change, whereas temporary habitat alterations associated with construction activities such as vegetation clearing, borrow areas, and staging areas would be temporary and reversible. The residual effect of change in habitat is well understood, and the confidence in the assessment is high. Change in habitat is considered to be a non-substantive residual effect for grizzly bear and ungulates as this MC1-related change would not affect these VCs at the local population scale.

Table 7.2-25 Summary of Effect Characteristics Ratings for Change in Habitat for Grizzly Bear and Ungulates

Residual Effect Characteristic	Rating	Rationale for Rating
Direction	Adverse	Permanent habitat loss in MC1 footprint for grizzly bears and ungulates.
Extent	Local	Habitat change would be limited to the Option footprint.
Magnitude	Moderate	Habitat change would evident, but would not likely affect local populations from acquiring life requisites.
Duration	Long-term	Habitat change would persist throughout Operation and Maintenance and beyond.
Reversibility	Reversible and Non-Reversible	Temporary changes would be reversible. Permanent changes would likely be mostly non-reversible: habitat is replaced by MC1 infrastructure.
Frequency	Continuous	Permanent habitat changes would be continuous.
Confidence	High	Predictable. Habitat change is well understood in the context of industrial developments.

Bats

The removal of forest habitat during MC1's Construction phase, particularly in more mature forest, may have an adverse residual effect on the availability of roost sites for bats (used in late spring, summer and fall). Foraging habitat for bats would likely be improved by the construction and presence of a permanent pond that enhances insects, which are prey for bats; therefore, change in habitat is anticipated to have both positive and adverse residual effects.

Adverse residual effects to bats from habitat change would be expected due to vegetation removal in the permanent pond, highway and dam areas. Change in habitat associated with MC1 would likely have adverse, local residual effects that are limited to the Option footprint (**Table 7.2-26**). Roosting habitat may be lost or altered where clearing affects mature forest. This would be a moderate magnitude residual effect because habitat change cannot be avoided, but these changes are unlikely to be of sufficient magnitude as to prohibit bats from meeting their life requisites within the RAA. Habitat change in the Option footprint would occur in the long-term, and would mostly be a non-reversible residual effect, with some natural regeneration anticipated.

Positive direction effects to change in habitat are also anticipated. The creation of the permanent pond could provide foraging habitat for bats in the LAA, which currently does not exist at Baseline Case.

The presence of Schedule 1 Endangered bat species (little brown bat and northern long-eared bat) was confirmed during 2017 field studies; and, confidence in this assessment is moderate because there is a good understanding of cause-and-effect relationships regarding bats and habitat change. Bat surveys were conducted during summer 2017 and confirmed species presence in the LAA, which increases confidence in the assessment of effects for this VC to moderate. Change in habitat is considered to be a non-substantive residual effect for bats in the RAA.

Table 7.2-26 Summary of Effect Characteristics Ratings for Change in Habitat for Bats

Residual Effect Characteristic	Rating	Rationale for Rating
Direction	Adverse and Positive	Vegetation removal poses a risk of loss of potential roost sites, creation of the permanent pond may provide improved foraging habitat
Extent	Local	Effects confined to the Option Footprint
Magnitude	Moderate	Change in habitat effects are unknown because studies to understand the presence of bat species in the affected area have yet to be undertaken. Assume moderate effects at this time because of the presence of one of the two more-sensitive bat species, including little brown bat, appears likely.
Duration	Long-term	Effects will persist throughout Operation and Maintenance
Reversibility	Non-reversible	Non-reversible, habitat is replaced by permanent infrastructure
Frequency	Continuous	Habitat loss effects, while the result of a one-time activity are continuous for the population.
Confidence	Moderate	The presence of Schedule 1 Endangered bat species (little brown bat and northern long-eared bat) was confirmed in 2017.

Breeding Birds, Raptors, and Owls

Change in habitat associated with construction activities such as vegetation clearing for MC1 would likely result in adverse, local residual effects that would be limited to the Option footprint (**Table 7.2-27**). Reducing the size of the Option footprint during the design phase would mitigate some effects to change in habitat for breeding birds, raptors, and owls.

MC1 construction would reduce breeding and foraging habitat for these VCs in the LAA. This residual effect is rated as moderate in magnitude because habitat change cannot be avoided, but these changes are unlikely to be of sufficient magnitude as to prohibit breeding birds, and raptors and owls from meeting their life requisites within the LAA. Habitat change in the Option footprint would occur in the long term, and would be mostly a non-reversible residual effect, with some natural regeneration anticipated. Habitat loss for breeding birds is a predictable, well-understood residual effect, and confidence in this assessment is high. This is considered to be a non-substantive residual effect as MC1-related habitat change would not likely affect breeding birds, raptors, or owls at the local population scale.

Table 7.2-27 Summary of Effect Characteristics Ratings for Change in Habitat for Breeding Birds, Raptors, and Owls

Residual Effect Characteristic	Rating	Rationale for Rating
Direction	Adverse	Permanent habitat loss in MC1 footprint for breeding birds and raptors.
Extent	Local	Habitat change is limited to the Option footprint with occasional flood events that alter habitat quality and availability.
Magnitude	Moderate	Habitat change is evident, but not likely to affect local populations from acquiring life requisites.
Duration	Long-term	Habitat change will persist throughout the Operation and Maintenance phase and beyond.
Reversibility	Reversible and Not-Reversible	Habitat changes would be mostly non-reversible. Habitat would be replaced by MC1 infrastructure. Some temporary change also anticipated.
Frequency	Continuous	Habitat changes would be continuous.
Confidence	High	Habitat change is well understood in the context of industrial developments.

Harlequin Duck

Adverse residual effects to harlequin duck would be expected due to the change in habitat for the species as a result of the alteration to the riverine system and the change to a lacustrine system. This change would occur during MC1's Construction phase in association with instream works required for dam construction. While mitigation for current and gradient is not possible, retention of riverside vegetation upstream of the permanent pond may reduce some effects. Further, mitigation efforts to retain water quality (reduce turbidity) (see **Section 6.5 Water Quality**) would reduce the potential for altered habitat to result in non-use by harlequin duck.

Change in habitat associated with the Option would likely have adverse and local residual effects that would be limited to the permanent pond (**Table 7.2-28**). Minor amounts of breeding, foraging, and brood habitat would be lost or altered due to MC1 construction; this residual effect would be of minor magnitude because habitat change cannot be avoided, and the change in habitat would affect a small proportion of the total habitat used by harlequin duck in the LAA (2 of 25 reaches used by harlequin duck on the Elbow River). Habitat change in the Option footprint would occur in the long-term, and would be mostly a non-reversible residual effect. Habitat loss is a predictable, well understood residual effect, and confidence in the assessment is high. This is considered as a non-substantive residual effect that is not anticipated to affect the sustainability of the local population of harlequin ducks.

Table 7.2-28 Summary of Effect Characteristics Ratings for Change in Habitat for Harlequin Duck

Residual Effect Characteristic	Rating	Rationale for Rating
Direction	Adverse	Reduction in flowing water at gradients > 1% and reduction in overhanging vegetation reduces habitat for harlequin duck foraging, breeding, and brood rearing.
Extent	Local	Permanent pond area
Magnitude	Minor	The change in habitat would affect a small / low proportion of the total habitat used by harlequin duck in the LAA.
Duration	Long-term / Permanent	Habitat change would be permanent.
Reversibility	Non-reversible	The habitat change is considered non-reversible.
Frequency	Continuous	Habitat change would be continuous.
Confidence	High	The habitat needs for harlequin duck are well understood.

Piscivorous Birds

Positive residual effects to piscivorous birds are anticipated during the MC1's Operation and Maintenance phase due to alteration from a riverine system to a lacustrine system as a result of the creation of the permanent pond, and the potential change in habitat in the reservoir area as a result of flooding. Fish species are likely to colonize the pond and provide foraging opportunities for some species of piscivorous birds that were not available prior to MC1 Option implementation. Vegetation community changes in the reservoir area above the permanent pond could create nesting habitat for ground-nesting piscivorous birds. Change in habitat associated with MC1 would have positive local residual effects that would be limited to the permanent pond and the reservoir area (**Table 7.2-29**). The creation of the permanent pond would create foraging and nesting habitat for piscivorous birds that does not currently exist in the LAA in the Baseline Case. This would be of minor magnitude because the change in habitat would affect a low proportion of the total habitat that would be used by piscivorous birds. Habitat change in the

Option area would be long-term and non-reversible. This is a predictable, moderately well understood residual effect, which requires assumptions about future bird and fish colonization of habitats that are not present at Baseline. Change in habitat is considered to be a non-substantive residual effect for piscivorous birds in the RAA.

Table 7.2-29 Summary of Effect Characteristics Ratings for Change in Habitat for Piscivorous Birds

Residual Effect Characteristic	Rating	Rationale for Rating
Direction	Positive	Creation of lacustrine habitat could create foraging and nesting opportunities for piscivorous birds.
Extent	Local	Permanent pond area and reservoir
Magnitude	Minor	The change in habitat would affect a small / low proportion of the total habitat used by piscivorous birds in the LAA.
Duration	Long-term / Permanent	Habitat change would be permanent.
Reversibility	Non-reversible	The habitat change is considered non-reversible.
Frequency	Continuous	Habitat change would be continuous.
Confidence	Moderate	The change in habitat from riverine to lacustrine is understood, but predicting fish and bird community changes is somewhat speculative.

Amphibians and Reptiles

Loss or alteration of habitat for amphibians and reptiles would be an adverse residual effect from MC1 activities during the Construction, Operation and Maintenance phases (**Table 7.2-30**). Amphibian and reptile presence in the LAA has been recently confirmed. Western toad, boreal chorus frog, wood frog, and a garter snake were detected during Spring and Summer 2017.

Wetland habitats used for foraging, overwintering, and breeding habitats for amphibians and foraging habitats for reptiles would be adversely affected by MC1. Mitigations to reduce effects to change in habitat for amphibians and reptiles include: setbacks from breeding ponds and wetlands for sensitive amphibians such as western toad and long-toed salamander, revegetation of temporary Construction areas, pre-construction surveys for sensitive features, and measures to reduce the Option footprint. Mitigation measures specific to construction will be contained and implemented as part of the ECO Plan. These mitigations are anticipated to substantially reduce MC1-related effects on both sensitive habitats and overall habitat used by amphibians and reptiles. Nonetheless, residual effects related to habitat change and loss are anticipated for this VC.

Change in habitat would be a local effect, limited to the Option footprint, and would be of moderate magnitude. While habitat change would be unavoidable and MC1-related habitat changes are unlikely to limit amphibian and reptile life requisites in the LAA, the permanent habitat change would be non-reversible and continuous. The residual effect of change in habitat for western toad and other amphibians and reptiles in the LAA is well understood. Change in habitat is considered to be a non-substantive residual effect for amphibians and reptiles in the LAA.

Table 7.2-30 Summary of Effect Characteristics Ratings for Change in Habitat for Amphibians and Reptiles

Residual Effect Characteristic	Rating	Rationale for Rating
Direction	Adverse	Permanent habitat loss in MC1 footprint for amphibians and reptiles in the Construction phase and extending into the Operation and Maintenance phase.
Extent	Local	Habitat change is limited to the Option footprint with occasional flood events that alter habitat quality and availability.
Magnitude	Moderate	Change in habitat effects are unknown because studies to understand the presence of amphibian and reptiles in the affected area have yet to be undertaken. Assume moderate effects at this time because presence seems likely.
Duration	Long-term	Habitat change will persist throughout Operation and Maintenance phase and beyond.
Reversibility	Non-reversible	Habitat changes are mostly non-reversible; habitat is replaced by MC1 infrastructure.
Frequency	Continuous	Habitat changes are continuous throughout Operation and Maintenance phase.
Confidence	High	Habitat change related to wetland habitats used by amphibians and reptiles is well-understood.

Change in Movement

Grizzly Bear and Ungulates

Changes to movement for grizzly bears and ungulates would likely occur from vehicle use of the re-aligned portions of Highway 66 in the MC1's Operation and Maintenance phase. MC1 mitigation measures that include wildlife passage structures (and associated fencing) would effectively mitigate barriers to movement for grizzly bear within and directly proximate to Recovery and Support Zone habitats identified in the Grizzly Bear Recovery Plan. These structures would effectively mitigate barriers to movement and reduce mortality risk for grizzly bears, ungulates, and other VC subcomponents occurring in the RAA.

Residual effects associated with change in movement would be local in extent, restricted to the re-aligned portions of Highway 66, and would be effectively reduced to minor magnitude with the inclusion of wildlife passage structures and fencing (**Table 7.2-31**). This residual effect would persist throughout the long term, and would be non-reversible as the re-aligned portions of Highway 66 are considered permanent. Wildlife passage structures are known to be effective in Banff National Park and elsewhere. For example, passage structures in Banff National Park have been installed since 1996 in association with highway twinning activities (6 overpasses, and 38 underpasses), and sufficient numbers of male and female grizzly bears are using these structures such that the local grizzly bear population is no longer considered demographically separate and gene flow is sufficient to prevent genetic isolation (AEP 2016a). Confidence in this assessment is high. With implementation of wildlife passage mitigation, this is considered as a non-substantive residual effect.

Table 7.2-31 Summary of Effect Characteristics Ratings for Change in Movement for Grizzly Bear and Ungulates

Residual Effect Characteristic	Rating	Rationale for Rating
Direction	Negative	Vehicle traffic on Highway 66 would pose a barrier to movement.
Extent	Local	Barrier to movement would be limited to the Option footprint (re-aligned portion of Highway 66), and would be mitigated by wildlife passage structures and fencing.
Magnitude	Minor	Change in movement would not likely affect local populations from acquiring life requisites.
Duration	Long-term	Movement barrier would persist throughout Operation and Maintenance phase and beyond.
Reversibility	Non-Reversible	Movement barriers associated with Highway 66 are permanent
Frequency	Continuous	Change to movement would be continuous while barrier persists.
Confidence	High	Effects related to movement barriers are well understood.

Amphibians and Reptiles

Adverse MC1-related changes to movement for amphibians and reptiles would be associated with temporary and permanent MC1 structures such as haul roads, borrow pits, or the re-aligned Highway 66, forming barriers between amphibian aquatic and terrestrial breeding, foraging, and overwintering habitats (ponds, wetlands, and upland areas), or through general reptile foraging habitats (terrestrial and riparian areas). Mitigations such as reducing the Option footprint, implementing applicable BMPs such as setbacks from wetlands, revegetating temporary construction areas, and designing wildlife passage structures in appropriate locations and configurations would likely effectively address adverse MC1-related effects on amphibian and reptile movements. Pre-construction surveys for sensitive habitats would likely help inform the location and design of these structures.

Residual effects associated with change in movement would be local in extent, restricted to the Option footprint, and would be effectively reduced to moderate magnitude with the inclusion of mitigation measures (**Table 7.2-32**). This residual effect would likely persist throughout the long term and would be non-reversible, although it would be non-substantive following implementation of appropriate mitigation measures. Confidence in this assessment is moderate because amphibian and reptile movements are reasonably well understood, but movement patterns within the LAA are based on professional judgement.

Table 7.2-32 Summary of Effect Characteristics Ratings for Change in Movement for Amphibians and Reptiles

Residual Effect Characteristic	Rating	Rationale for Rating
Direction	Adverse	Permanent barriers to movement in the form of infrastructure within the Option footprint for amphibians and reptiles, beginning during the Construction phase and extending into the Operation and Maintenance phase.
Extent	Local	Barriers to movement would be limited to the Option footprint
Magnitude	Moderate	Change in habitat effects are unknown because studies to understand the presence of amphibians and reptiles in the affected area have yet to be undertaken. Assume moderate effects at this time because presence seems likely.
Duration	Long-term	Change to movement will persist throughout Operation and Maintenance phase and beyond.
Reversibility	Non-Reversible	Changes to movement are mostly non-reversible. MC1 infrastructure forms a barrier to movement within the Option footprint, but partial reversibility would be realized with reclamation of temporary construction areas and implementation of wildlife passage structures.
Frequency	Continuous	Habitat changes would be continuous throughout Operation and Maintenance phase.
Confidence	Moderate	Amphibian and reptiles presence and the presence of sensitive habitats are known, but movements within the LAA are speculative.

Change in Mortality Risk

Grizzly Bear and Ungulates

MC1's Construction and Operation and Maintenance phases would confer increased mortality risk for grizzly bears and ungulates using the LAA. As discussed above in **Section 7.2.3.2**, this risk would be related to the following mechanisms:

- Increased risk of human-wildlife interactions for grizzly bear Construction due to attractants associated with the construction camp, increased likelihood of vehicle collisions due to construction traffic, illegal hunting on MC1 roads, and increased linear disturbance density associated with the Option
- Increased risk of collision mortality on the re-aligned section of Highway 66 in the Operation and Maintenance phase for grizzly bear and ungulates
- Potential change to ungulate predator-prey dynamics due to increased linear disturbance density in the Option area, and increased risk of illegal hunting due to increased access.

Mitigation to reduce wildlife-human interactions such as measures for waste management as well as BearSmart training for construction workers would effectively reduce mortality risk for grizzly bear in the LAA (contained in the ECO Plan). Mortality risk would be limited to the Option footprint (re-aligned portion of Highway 66), and mitigated by wildlife passage structures (and fencing), implementation of the access management plan, as well as incorporation of access standards for the Grizzly Bear Zone and the Key Wildlife Biodiversity Zone in MC1's design (Alberta Energy Regulator 2013) (**Table 7.2-33**).

Change in mortality risk would be a minor magnitude effect for grizzly bear and ungulates because of the mitigations described. Change in mortality risk will persist in the long-term, and it is considered a non-reversible effect. Wildlife passage structures and access management are well understood to reduce adverse changes in mortality risk for grizzly bear and ungulates. This is considered as a non-substantive residual effect.

Table 7.2-33 Summary of Effect Characteristics Ratings for Change in Mortality Risk for Grizzly Bear and Ungulates

Residual Effect Characteristic	Rating	Rationale for Rating
Direction	Adverse	Construction activities could disturb or destroy bear dens, vehicle traffic on Highway 66, posing a mortality risk. Increased linear disturbance density would increase potential for illegal hunting.
Extent	Local	Mortality risk would be limited to the Option footprint (re-aligned portion of Highway 66). Mortality risk would be mitigated by wildlife passage structures and access management.
Magnitude	Minor	Change in mortality risk would not likely affect subsistence capabilities of local populations, given mitigations.
Duration	Long-term	Change to mortality risk would persist throughout Operation and Maintenance phase and beyond.
Reversibility	Non-Reversible	Change to mortality risk is non-reversible
Frequency	Continuous	Change to mortality risk would be continuous.
Confidence	Moderate	Effects related to mortality risk are well understood.

Bats

Residual effects from vehicular collisions would be expected in the area of the new alignment of Highway 66. The extent of effects from collisions is unknown relative to the population size, but the science behind determination of the effect is well established. Moderate effects are assumed at this time due to the re-aligned highway route. This would be an adverse effect, considered local in extent (**Table 7.2-34**). Collisions would persist throughout the Operation and Maintenance phase, increased collision risk is considered a non-reversible effect. Increased mortality risk to bats due vehicle collisions associated with the use of Highway 66 would be frequent and unpredictable because the relative abundance and use of the area by bats, particularly sensitive species, is not well-understood. The presence of Schedule 1 Endangered bats, the little brown bat and northern long-eared bat, was confirmed following acoustic monitoring. Conducting vegetation clearing and demolition work in the winter, when most bats are hibernating, would minimize direct and indirect mortality effects on bats (Alberta Community Bat Program 2017). The mortality risk for bats in the Option area would be effectively reduced by implementing timing considerations aimed at avoiding blasting or excavation work that affects hibernation habitat in the winter, and conducting pre-construction surveys to evaluate buildings prior to demolition for presence of hibernating bats. The residual effect of MC1-related change in bat mortality risk is considered non-substantive.

Table 7.2-34 Summary of Effect Characteristics Ratings for Change in Mortality Risk for Bats

Residual Effect Characteristic	Rating	Rationale for Rating
Direction	Adverse	Vegetation clearing and vehicle traffic on MC1 roads and Highway 66 poses a mortality risk.
Extent	Local	Effects would be confined to the new highway segment.
Magnitude	Moderate	The extent of effects of collision unknown relative to the population size, but the science behind the effect is well established. Assume moderate effects at this time because this is a new and high-speed highway route.
Duration	Long-term	Collisions would persist throughout the Operation and Maintenance phase and beyond.
Reversibility	Non-reversible	Change to mortality risk is non-reversible.
Frequency	Frequent	Collision effects would be continuous during highway operation.
Confidence	Moderate	Studies to understand the presence of bat species in the affected area are ongoing. The presence of particularly sensitive bat species (little brown bat and northern long-eared bat) has not been confirmed but is assumed as part of the conservative approach.

Breeding Birds, Raptors, and Owls

Given timing consideration mitigations to conduct clearing activities outside of breeding windows, and pre-construction surveys for raptor nests and sensitive wildlife habitat features, residual effects to breeding birds, raptors, and owls related to increased mortality risk would be limited to vehicular interactions and nestling mortality from sensory disturbance causing nest abandonment. The residual effect would be adverse (**Table 7.2-35**), limited to the Option footprint including the extent to which sensory disturbance could affect nesting raptors, local in extent, and minor in magnitude. Change in mortality risk would occur while construction activities are being carried out, and while vehicles are moving along MC1 roads including Highway 66; therefore, this residual effect would be considered frequent, and is considered a non-reversible effect. Change in mortality risk is considered a non-substantive adverse residual effect to breeding birds, raptors, and owls.

Table 7.2-35 Summary of Effect Characteristics Ratings for Change in Mortality Risk for Breeding Birds, Raptors, and Owls

Residual Effect Characteristic	Rating	Rationale for Rating
Direction	Adverse	Increased risk to mortality for breeding birds and raptors due to construction activities, and interactions with vehicles.
Extent	Local	Mortality risk would be limited to the Option footprint and zone of influence.
Magnitude	Minor	Change in mortality risk would not likely affect local populations
Duration	Long-term	Residual effects to mortality of nestlings would be limited to the Construction phase. Vehicle collision mortality will persist throughout the Operation and Maintenance phase.
Reversibility	Non-reversible	Change to mortality risk is non-reversible
Frequency	Frequent	Change to mortality risk would be frequent during the Construction phase.
Confidence	Predictable	Interactions are well understood.

Breeding Birds (Ground-nesting)

Change in mortality risk for ground-nesting breeding birds during the Operation and Maintenance Phase would be an adverse residual effect that would be minor in magnitude. During flood events, when the reservoir above the permanent pond would be inundated, breeding birds that utilize open areas could experience adverse affects of nest flooding and increased mortality risk for nestlings or eggs. After several cycles of inundation the conditions for nesting by several species, including common nighthawk, Canada goose, killdeer, and other shorebirds, could be affected by reservoir fluctuations. Residual effects for the mortality risk to ground-nesting birds would be infrequent. Changes caused by inundation would be reversible as flood waters recede, making habitat available again. Confidence in the characterization of change in mortality risk to ground-nesting breeding birds is low because the assessment relies on speculation about future weather conditions and species that might be present if predicted conditions materialize. Overall, this is considered a non-substantive residual effect (see **Table 7.2-36**).

Table 7.2-36 Summary of Effect Characteristics Ratings for Change in Mortality Risk for Breeding Birds (Ground-nesting)

Residual Effect Characteristic	Rating	Rationale for Rating
Direction	Adverse	Increased risk to mortality for breeding birds due to intermittent flooding of reservoir.
Extent	Local	Mortality risk would be limited to the Option footprint.
Magnitude	Minor	Change in mortality risk would not likely to affect local populations.
Duration	Long-term	Residual effects to mortality of nestlings would persist throughout Operation and Maintenance phase.
Reversibility	Reversible	Change to mortality risk would be reversible; mortality risk would return to previous baseline after flooding dissipates.

Residual Effect Characteristic	Rating	Rationale for Rating
Frequency	Infrequent	Change to mortality risk would be infrequent and limited to flood events.
Confidence	Low	Species abundance and distribution in the LAA in the post-construction period are based on professional judgement, and depend on predicted conditions materializing.

Amphibians and Reptiles

Change to mortality risk for amphibians and reptiles may occur from activities that involve vegetation clearing, ground disturbance, aquatic works, and MC1 vehicle traffic during the Construction phase, or from interactions with vehicles in the re-aligned portion of Highway 66 during the Operation and Maintenance phase. Amphibians and reptiles could be crushed or incur other direct adverse effects associated with equipment or vehicle use. This would constitute an adverse effect, and would be limited to the Option footprint and associated temporary use areas during the Construction phase (**Table 7.2-37**). Implementation of mitigations including pre-construction sensitive features surveys and wildlife passage structures, would likely effectively reduce MC1-related effects to amphibian and reptile mortality to result in a non-substantive residual effect. Construction specific mitigation measures will be contained in the ECO Plan.

Confidence in this assessment is moderate, because amphibian and reptile presence has been confirmed, but relative abundance and distribution in the LAA is not well understood.

Table 7.2-37 Summary of Effect Characteristics Ratings for Change in Mortality Risk for Amphibians and Reptiles

Residual Effect Characteristic	Rating	Rationale for Rating
Direction	Adverse	Increased risk to mortality for amphibians and reptiles due to construction activities and interactions with vehicles.
Extent	Local	Mortality risk would be limited to the Option footprint and zone of influence during construction.
Magnitude	Moderate	Change in mortality risk could affect local populations, depending on availability of sensitive habitat.
Duration	Long-term	Residual effects to mortality would occur primarily during the Construction phase. Vehicle collision mortality would persist throughout the Operation and Maintenance phase.
Reversibility	Reversible	Change to mortality risk would be semi-reversible with completion of Construction phase and implementation of appropriate wildlife passage structures. Mortality risk would likely return to close to previous baseline conditions.
Frequency	Frequent	Change to mortality risk would be frequent during construction, ongoing during use of re-aligned portion of Highway 66.
Confidence	Moderate	Interactions are well understood; relative abundance and distribution in the LAA is not well understood.

7.2.3.5 Summary of Wildlife and Wildlife Habitat Assessment

Based on the effects characterization described above, non-substantive adverse residual effects are likely to occur for Wildlife and Wildlife Habitat for change in habitat for grizzly bear, ungulates, bats, breeding birds, raptors, and owls, harlequin duck, and amphibians and reptiles; change in movement for grizzly bear, ungulates, and amphibians and reptiles; and change in mortality risk for grizzly bear, ungulates, bats, breeding birds (including ground nesting breeding birds, raptors, owls, and amphibians and reptiles. Non-substantive positive residual effects are likely to occur for change in habitat for bats and piscivorous birds. No substantive residual effect(s) on Wildlife and Wildlife Habitat are likely to occur as a result of the MC1 Option.

7.2.4 FOLLOW-UP MONITORING FOR WILDLIFE AND WILDLIFE HABITAT

Monitoring and follow-up programs are proposed to confirm the predictions of this MC1-related effects assessment of Wildlife and Wildlife Habitat, and provide the basis for adaptive management. Such monitoring would include the programs outlined below.

Piscivorous Bird Toxicology Monitoring

Building on the Fish Toxicology Monitoring Program discussed in **Section 7.3.4**, toxicology monitoring for piscivorous birds that are predicted to use the permanent pond is also warranted, due to the potential bioaccumulation of methylmercury. Removing terrestrial vegetation and soil for the permanent pond could reduce the potential for bacterial methylation, although the complete effectiveness of this mitigation measures in eliminating bioaccumulation in piscivorous birds is unknown. As a result, a Fish Toxicology Monitoring paired with a Piscivorous Bird Toxicology Monitoring Program would be implemented to monitor the permanent pond and downstream habitat. The monitoring plan would validate predicted Option-related effects and inform offsetting or supplemental mitigation needs.

Wildlife Passage Monitoring and Adaptive Management Strategy

The wildlife passage structures and fencing associated with the re-aligned portions of Highway 66 are anticipated to reduce road mortality effects for terrestrial wildlife. Large and small mammals, amphibians, and reptiles are anticipated to use these structures. Monitoring wildlife and human use of these structures would validate the potential effects assessment, quantify mitigation efficacy, and inform an adaptive management strategy to reduce Option-related wildlife mortality.

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7.3 Aquatic Environment

This section describes potential effects to the Aquatic Environment from the proposed Elbow River at McLean Creek Dam (MC1) Option (MC1, Option, or MC1 Option), which is defined for this assessment as the Fish and Fish Habitat Valued Component (VC).

The assessments presented in this section are supported by or linked to the assessments presented in the following sections:

- Section 6.2 Terrain and Soils
- Section 6.3 Hydrogeology
- Section 6.4 Fluvial Geomorphology
- Section 6.5 Water Quality
- Section 7.1 Vegetation and Wetlands
- Section 8.1 Land Use and Management

7.3.1 Scope of Assessment

This section reviews the scope of the assessment for the Aquatic Environment and includes the regulatory framework, data sources, measurable parameters, and assessment boundaries relevant for Fish and Fish Habitat VC.

7.3.1.1 Regulatory Framework

Relevant regulatory framework and requirements that are applicable to the Aquatic Environment are summarized in **Table 7.3-1**.

Table 7.3-1 Summary of Applicable Regulatory and Policy Framework for Aquatic Environment

Name	Jurisdiction	Description
Species at Risk Act (*SARA*) S.C. 2002, c. 29	Federal	SARA prohibits the killing, harming or harassing of listed species, trading in the parts of listed species, and damaging or destroying the residence of an individual of a listed species. SARA's Schedule 1 lists species as extirpated, endangered, threatened, or special concern. Species included in Schedule 1 are established by the federal Cabinet and are based on recommendations by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and consultation with government, Indigenous Peoples, and the public. Although there are no fish species currently listed under Schedule 1 within the MC1 area, bull trout populations in the Elbow River are currently under consideration for inclusion under Schedule 1.
Fisheries Act (Canada) R.S.C. 1985, c. F-14 (as amended on February 26, 2015)	Federal	The Fisheries Act contains clauses for fisheries protection and pollution prevention to prevent serious harm to fish (Sections 34 and 35) and its scope includes "all internal waters of Canada"

Name	Jurisdiction	Description
		(Section 2(1)). This scope means the Fisheries Act is in effect in the MC 1 area and must be considered in the effects assessment. Fisheries and Oceans Canada (DFO) has published a series of guidance documents that relate to the implementation of the recent amendments to the Fisheries Act, including Fisheries Protection Policy Statement (DFO 2013a) and Measures to Avoid Causing Harm to Fish and Fish Habitat (DFO 2013b). The Fisheries Act defines "serious harm to fish" (Serious Harm) as "the death of fish or any permanent alteration to, or destruction of, fish habitat". "Fish", in turn, is defined as (a) parts of fish, (b) shellfish, crustaceans, marine animals and any parts of shellfish, crustaceans or marine animals, and (c) the eggs, sperm, spawn, larvae, spat and juvenile stages of fish, shellfish, crustaceans and marine animals.
Fisheries Act (Alberta)	Provincial	The clause "Measures Protective of Health, Ecology and Economy: Health ecological and economic protection", Section 32 provides ecological protection against invasive organisms that may pose an ecological threat or genetic danger to native fish species. The Alberta Fisheries Act requires measures be taken to ensure aquatic invasive species do not occupy or establish in the project infrastructure and therefore must be considered in the effects assessment.
Wildlife Act (Alberta)	Provincial	Fish species that are sensitive to human activities or natural events are those that "…are not at risk of extinction or extirpation but may require special attention or protection to prevent if form becoming at risk" (ASRD 2010). In addition, Alberta's Endangered Species Conservation Committee has identified bull trout as Threatened (AESRD 2014) which means they are currently listed under Alberta's Wildlife Act.
Provincial Parks Act (Alberta)	Provincial	The MC1 area encompasses aquatic habitat contained within the Elbow River Provincial Recreation Area. Provincial Recreation Areas are established and governed under the Provincial Parks Act. Provincial Recreation Areas can support a range of outdoor activities and are managed with outdoor recreation as a primary goal though can be developed, and they serve an important role in management of adjacent Crown lands and waters by localizing the impact of development and serving as staging areas. The Bragg Creek Provincial Park occurs approximately 10 km downstream from the MC1 area.

In addition to the regulatory and policy frameworks relevant to the Aquatic Environment, various best practices (e.g., guidance/standards) are applicable to the MC1 Option. Best practices to be considered from the perspective of Aquatic Environment are described in **Table 7.3-2**.

Table 7.3-2 Summary of Applicable Best Practices for Aquatic Environment

Name	Description
Water Act - Codes of Practice	During the Construction phase, all instream activities must follow the codes of practice for Class C watercourses in Alberta and measures to limit the potential of reducing the productive capacity of the aquatic environment. Mitigation measures include those specific to project planning (i.e. containment and spill management), erosion and sediment control, fish protection, shoreline re-vegetation and stabilization, and operation of machinery). Construction activities must consider the Restricted Activity Period (RAP) for the Elbow River and tributaries contained within the MC1 area (i.e. September 1 to August 15).
Instream Flow Needs	Fish passage must be maintained during construction and operation of the dam, and must not impede spawning and migration activities of fish species residing in the area. Water levels must be sufficiently maintained during the spawning period for fish species that spawn within fringe habitats (e.g., brown trout normally spawn near cover structures that are located along the banks of a watercourse), as these habitats may be more heavily affected by fluctuations in water level (i.e., dewatering of brown trout redds).
Whirling Disease Decontamination Protocols	Considering the recent discovery of whirling disease in Alberta, the Alberta government has implemented comprehensive decontamination protocols to help limit the spread of the spores and parasite that causes whirling disease. Alberta Environment and Parks decontamination protocols should be followed for all personal and machinery that will conduct instream activities. It is anticipated these protocols will encompass needs for all other aquatic invasive species.
Measures to Avoid Causing Harm to Fish and Fish Habitat	Provided by Fisheries and Oceans Canada (DFO), Measures to Avoid Causing Harm to Fish and Fish Habitat (DFO 2013b) serve as advice to help proponents comply with the Fisheries Act when planning and constructing works in or near water. The mitigation and avoidance strategies are relevant to various industry types and potential disturbances that, if unmitigated, may result in a residual effect on fish habitat and ultimately could cause a serious harm event. These measures, along with any additional, alternative or supplemental project or activity specific mitigation can be used to ensure all potential project pathways of effects are broken, in turn eliminating the potential for residual effects and/or serious harm.
Stepping Back from the Water – A Beneficial Management Practices Guide for New Development near Water Bodies in Alberta's Settled Region	Given the value of riparian habitats to aquatic ecosystems and species, the Alberta government has published this guiding document for proponents looking to construct new developments near waterbodies (AESRD 2012). This guideline introduces riparian areas, recommendations for setback widths and buffers, an overview of riparian areas and how they function, measures for protecting and conserving riparian areas, a listing for legislation and policy affecting riparian areas in Alberta, examples of riparian guidelines from other jurisdictions, best practices for development projects, managing runoff from new development and a resource list for further reference.
Administrative Guide for Approvals to Protect Surface Water Bodies Under the Water Act (2001)	This guide identifies methods to protect all permanent and intermittent natural surface water bodies throughout the province, in rural and urban areas, on private and public land (AENV 2001). The guide defines the various activities requiring approval under the Water Act and provides for consistent application of the Water Act.
Watershed Management Plans	Intended for the conservation, management, and protection of riparian health, watershed management plans provide guidance for responsible development of near watercourse areas. Examples of management plans relevant to MC1 include the Elbow River Basin Water Management Plan (Elbow River Watershed Partnership 2008).
Land Use Framework	Balancing the demands of all user groups on the province's park land, air, water, and habitat, regarding Alberta's social and environmental goals, the Land Use Framework is intended to support the management and development of public land in a responsible manner.

Name	Description
Water for Life Strategy	A provincial approach applicable to all waterbodies in the province to ensure safe, secure drinking water, healthy aquatic ecosystems, and reliable quality water supplies for a sustainable economy (Alberta Environment and Parks 2017).
Kananaskis Country Provincial Recreation Areas and Bragg Creek Provincial Park Management Plan	Both the Elbow River Provincial Recreation Area and the Bragg Creek Provincial Park are priority sites in the Alberta parks system. As such, they have been selected as priorities for management plan development (Government of Alberta, 2012a). This singular management plan outlines the overall management direction for these two priority areas as: to provide high quality, safe, and enjoyable recreation experiences for visitors in well designed and maintained facilities while providing staging areas to recreation areas to adjacent Crown lands; support the development of tourism activities that mesh with park features and facilities and nearby community initiatives; protect important natural, cultural, and scenic values of the areas; and provide interpretation and education opportunities as appropriate.
Alberta Transportation Environmental Management Systems Manual (2016)	Alberta Transportation's Environmental Management System is an organizational approach to environmental management with the goal of making environmental considerations, including those occurring over or near watercourses, part of daily activities.

7.3.1.2 Data Sources

Data sources used in the assessment of the Aquatic Environment VC included MC1-specific data, data collected for the SR1 Project, government databases, as well as scientific literature from peer reviewed journals. The following data sources (among others) were reviewed:

- Fish and Wildlife Habitat Mapping Tool (FWMIS 2017)
- Environmental Overview of the Conceptual Elbow River Dam at McLean Creek (AMEC 2015)
- Bull Trout Conservation Management Plan (ASRD 2012)
- Biological Effects of Sediment on Bull Trout and Their Habitat – Guidance for Evaluating Effects (Muck 2010)
- Fall Spawning Surveys on the Elbow River 2007 (Eisler and Popowich 2008)
- Seasonal Movement Patterns and Habitat Selection of Bull Trout (*Salvelinus confluentus*) in fluvial environments (Popowich and Paul 2006)
- Determining Bull Trout (*Salvenlinus confluentus*) Habitat and Prey Selection Using Snorkel Surveys and Stable Isotope Analysis (Popowich 2005)
- Elbow River Basin Water Management Plan (Elbow River Watershed Partnership 2008)
- Elbow River Watershed 2012 Riparian Health Inventory Project Kananaskis Country Alberta (Alberta Riparian Habitat Management Society 2013)
- Riparian Disturbance and Bank Armouring Inventory – Bow, Elbow, Highwood and Sheep Rivers, 2016 (Eisler and Popowich 2017)
- Aquatic Insects as Water Quality Indicators in the Elbow River Watershed, Alberta. (Benoit et al. 2016)
- Elbow River Instream Flow Needs Study (Golder Associates Ltd. 2005)

- Status of Bull Trout (*Salvelinus confluentus*) in Alberta: Update 2009 (Government of Alberta and ACA 2009)
- Bull Trout Fish Sustainability Index (FSI) – Adult Population Density (Government of Alberta 2015a)
- Bull Trout Fish Sustainability Index (FSI) – Habitat Protection Need (Government of Alberta 2015b)
- Various technical documents related to the life history and habitat requirements of fish species within the RAA.

In addition to the review of information contained in the references above, baseline fish habitat use and habitat potential information was collected in the fall of 2016 and summer 2017 specifically for MC1. Relevant existing information coupled with current, MC1-specific data, serves as the basis for analysis of potential effects on the Aquatic Environment. Much of the existing data available for MC1 pre-dates the influence of the 2013 flood conditions experienced in the Elbow River watershed (2013 flood), and as a result the literature may not fully represent post-flood conditions in the assessment area. Similarly, MC1-specific sampling was conducted over two seasons (i.e., fall 2016 and summer 2017).

A comprehensive understanding of fish abundance (e.g., biomass/catch per unit effort [CPUE]) and movement to and through the MC1 Option area, post-2013 flood is currently not available (Sanderman, Pers. Comm.). In addition, post-2013 flood fish migration data has not been collected for this section of the Elbow River. A fish-tagging program to quantify fish movement through the Elbow River is essential to confirm the potential effects that construction of the MC1 dam will have for fish in the area. It will also inform the need for, and evolving design of, a fish passage facility.

Comprehensive baseline benthic invertebrate and periphyton data is lacking for the Elbow River in general and the MC1 area specifically (Sanderman, Pers. Comm. March, 2017). Hemmera was unable to collect baseline benthic invertebrate and periphyton data prior to the completion of this assessment. Benthic invertebrates and periphyton are more sensitive to a variety of habitat disturbances than fish because of their mostly sessile life-histories (Gaufin, 1973; Berkman et al., 1986). When available, these data would also provide an additional line of evidence of effects resulting from construction and operation of MC1. In the absence of benthic and periphyton data collected specifically for MC1, the assessment refers to benthic invertebrate data collected approximately 25 km downstream (i.e., at Highway 22) and approximately 8 km upstream (i.e., Cobble Flats area) (Benoit et al. 2016). These data are not from a peer reviewed report so is not likely a suitable proxy for community assemblage information. However, benthic invertebrate data were also collected on behalf of the SR1 Project and have been considered as part of this assessment. Should the MC1 Option be considered beyond this suitability assessment, more detailed assessments of fish habitat use and benthic and periphyton communities will be required.

Metal toxicology data in fish is also lacking within the Elbow River (Sanderman, Pers. Comm. March, 2017). This information would be essential for monitoring fish health during the Construction and Operation phases. There are also limited data on Indigenous Peoples' fisheries use within the MC1 area (Kendal Pers.

Comm. March, 2017). Should the MC1 Option be further considered consultation with Indigenous stakeholders in the area will be required to collect sufficient data on fisheries use.

This assessment is based on review of MC1 Option information related to structure design and operation as provided in **Section 3.0 MC1 Option Description**, as well as draft conceptual designs for a fish passage facility (Northwest Hydraulic Consultants (NHC), 2017). The identification of potential MC1-related effects and the recommendations for further study made above is, therefore, based exclusively on this information and should be considered subject to change, pending design or operational changes.

7.3.1.3 Valued Components

Aquatic Resources may be affected by MC1-related activities (e.g., clearing and grubbing, earthworks) and changes to other biophysical components (e.g., vegetation, wildlife, water quality) (**Table 7.3-3**).

Table 7.3-3 Valued Components for Aquatic Environment

Valued Component	Interaction
Fish and Fish Habitat	Direct loss and alteration to fish habitat is anticipated as a result of construction and operation of the MC1 Option. The Option will alter previously lotic habitat (i.e., rivers) into lentic habitat (i.e., reservoir) potentially affecting benthic invertebrate and periphyton communities residing in the Elbow River and tributaries. The Option may also indirectly affect fish habitat in adjacent areas (e.g., changes in water quality) in the Elbow River and tributaries. These changes may indirectly affect the species, distribution and abundance of resident fish upstream and potentially downstream if changes in water quality and habitat occur due to changes in flow, nutrient cycling, sediment transport and benthic invertebrate and periphyton assemblage (abundance and diversity). Fish passage may be impeded resulting in isolation of populations or inability to access important spawning or overwintering habitat and fish entrainment in diversion tunnels is possible.

The assessment of Fish and Fish Habitat was designed to focus on specific species considered most appropriate in the context of existing conditions in the MC1 Option area. In this context, the assessment of Fish and Fish Habitat measurable parameters focuses on four indicator species as presented in **Table 7.3-4**, where appropriate. Bull trout (*Salvelinus confluentus*), mountain whitefish (*Prosopium williamsoni*), brown trout (*Salmo trutta*) and rainbow trout (*Oncorhynchus mykiss*) were selected as indicator species, given their importance as recreational fishery species, differing levels of sensitivity to perturbation of habitat and unique life history characteristics and habitat needs. Although cutthroat trout (introduced) (*Oncorhynchus clarki*) are also likely present in the MC1 Option area, the population is expected to have experienced hybridization with rainbow trout (Sanderman, Pers Comm. March 2017) at and downstream from the MC1 Option area. As a result, effects on rainbow trout (a confirmed indicator species) are generally considered to be equivalent to those for cutthroat trout for the purposes of this assessment, although we recognize that the two species do have some acute differences in habitat preferences and life stage strategies.

Table 7.3-4 Indicator Species Selected for Fish and Fish Habitat

Indicator	Rationale for Selection
Bull trout	Bull trout are an important element of the recreational fishery. They are presumably valuable to Indigenous Peoples as well. A provincial management plan is in place for the species and the South and North Saskatchewan populations are being considered for listing under SARA. Bull trout is a fall spawning species that requires clean, unembedded substrate for the construction of redds. Of the indicator species, bull trout have the longest migratory tendencies, generally spawning upstream from the MC1 Option area and wintering near and downstream from the MC1 Option area.
Mountain whitefish	Mountain whitefish are anticipated to be the most prevalent sportfish species within the MC1 Option area and are considered to represent a substantial portion of all harvested fish. They are known to be sensitive to habitat alterations, although they are not listed provincially or federally. They are a fall spawning species which do not construct redds but require deep habitat units for spawning.
Brown trout	Brown trout are known to occur in the Elbow River and Ranger Creek. The species is not listed as being of conservation concern either provincially or federally. Brown trout spawn in the winter, and typically rely on shallow water habitats for spawning and rearing life stages.
Rainbow trout	Like brown trout, rainbow trout are documented in both the Elbow River and Ranger Creek. Rainbow trout spawn in the spring, typically before freshet and create redds in gravel and cobble substrate. The species is not listed as being of conservation concern either provincially or federally.

MC1-related construction activities are likely to occur during sensitive life periods of all fish species in the MC1 Option area, including those of the selected indicator species. For juvenile fish, these life periods include rearing and wintering, while for adults, sensitive periods include adult spawning (including migration), feeding and wintering

7.3.1.4 Measurable Parameters

Measurable parameters are quantitative or qualitative measures used to describe existing conditions and trends, and to evaluate potential MC1-related effects to the VC. The measurable parameters selected for Fish and Fish Habitat are shown in **Table 7.3-5**. Potential adverse MC1-related effects to this VC, arising from potential interactions, are discussed in more detail in **Section 7.3.3.1**.

Table 7.3-5 Measurable Parameters for Aquatic Environment

Valued Component	Potential MC1-related Effects	Measurable Parameter
Fish and Fish Habitat	Permanent alteration and/or destruction of fish habitat (Serious Harm to Fish)[1]	Temporal and spatial (m^2) extent of altered and/or destroyed instream fish habitat Temporal and spatial (m^2) extent of altered and/or destroyed riparian habitat Quality of altered or destroyed fish habitat for life stages of various species Change in channel morphology Change in availability of large woody debris (LWD) downstream from the dam Change in water flow (m^3/s) Change in water quality Changes in benthic invertebrate and periphyton communities
	Fish Mortality and Productivity	Direct fish mortality Reduction in fish productivity (results from individual fish completing their life cycle, and having vital rates that are sufficient to generate a sustainable yield at the population level) due to changes in water quality, channel morphology, and/or sediment recruitment Mortality of eggs due to seasonal fluctuations in water level during Operation and Maintenance Change in fish distribution and abundance (e.g., CPUE, biomass)
	Impediment to migration and movement	Blockage of watercourses either temporarily during construction or permanently from dam construction
	Changes to fish assemblages due to habitat change	Change from riverine to lacustrine habitat Alteration to fish community composition (i.e., change inspecies present or abundances of existing community species)

Notes: Given the interim nature of this assessment, consultation with Alberta Environment and Parks or Fisheries and Oceans Canada (DFO) regarding the potential need for offsetting has not been initiated.

7.3.1.5 Assessment Boundaries

The Aquatic Environment's Local Assessment Area (LAA) encompasses the maximum geographical area within which the MC1 Option is expected to interact, and potentially have a direct or indirect effect on the Aquatic Environment (**Figure 7.3-1, Table 7.3-6)**. The LAA the 2013 Flood Event (2013 flood) water level elevation. The LAA extends approximately 10 km downstream from the MC1 footprint (i.e., defined as the Area of Influence or AOI) to facilitate a representative understanding on potential effects both upstream and downstream from the MC1 footprint. The LAA includes instream habitat within the MC1 Option area of the Elbow River, between points immediately upstream from the proposed re-alignment to the Highway 66 crossing (i.e., which extends beyond the 2013 flood elevation) and approximately 10 km downstream from the MC1 footprint. The LAA also includes instream habitat in Ranger Creek, Connop Creek, McLean Creek (at two separate locations) and several unnamed tributaries to the Elbow River, Ranger Creek and/or McLean Creek. Unnamed tributaries of the Elbow River include those defined for the purposes of this assessment as unnamed tributaries A (FWMIS ID 22258) (unnamed tributary A), B (FWMIS ID 22262) (unnamed tributary B), C (FWMIS ID 26085) (unnamed tributary C), D (FWMIS ID 67379) (unnamed tributary D), E (FWMIS ID 68068) (unnamed tributary E), F (FWMIS ID 22257) (unnamed tributary F), G (FWMIS ID 67841) (unnamed tributary G), and H (FWMIS ID 67813) (unnamed tributary H). Similarly, unnamed tributaries of McLean Creek have been defined as unnamed tributary I (FWMIS ID 67619) and unnamed tributary J (FWMIS ID 67725) and the unnamed tributary to Ranger Creek has been defined as unnamed tributary K (FWMIS ID 67396).

In general, where tributaries are anticipated to be influenced by the operation of the dam during 2013 flood level event, they were assessed from their confluence with the Elbow River (or Ranger Creek), upstream to/or through the 2013 flood elevation level, where channel definition permitted. Where tributaries that are not to be influenced by the operation of the MC1 dam but may be crossed or otherwise influenced by other MC1 infrastructure or activities (e.g., road construction or spillway construction), these tributaries were generally assessed between 100 m upstream of the infrastructure or activity location to 300 m downstream.

In addition to the instream habitat values, the LAA also includes a representative area for riparian habitat which, for the purposes of this assessment, is defined as being to a depth of 10 m over the length of both banks of the watercourses within the LAA upstream of the MC1 dam to the 2013 flood elevation. At tributaries which are to be crossed or otherwise influenced by other MC1 infrastructure or activities, riparian habitats were also included in the LAA and again defined as being to a depth of 10 m over the length of both banks in the immediate area of the MC1 infrastructure (e.g., road crossing) or activity. In quantifying riparian habitat, the length of riparian habitat is considered contiguous and functional to fish in all reaches except where field observations have concluded otherwise (e.g., Eisler and Popowich 2017).

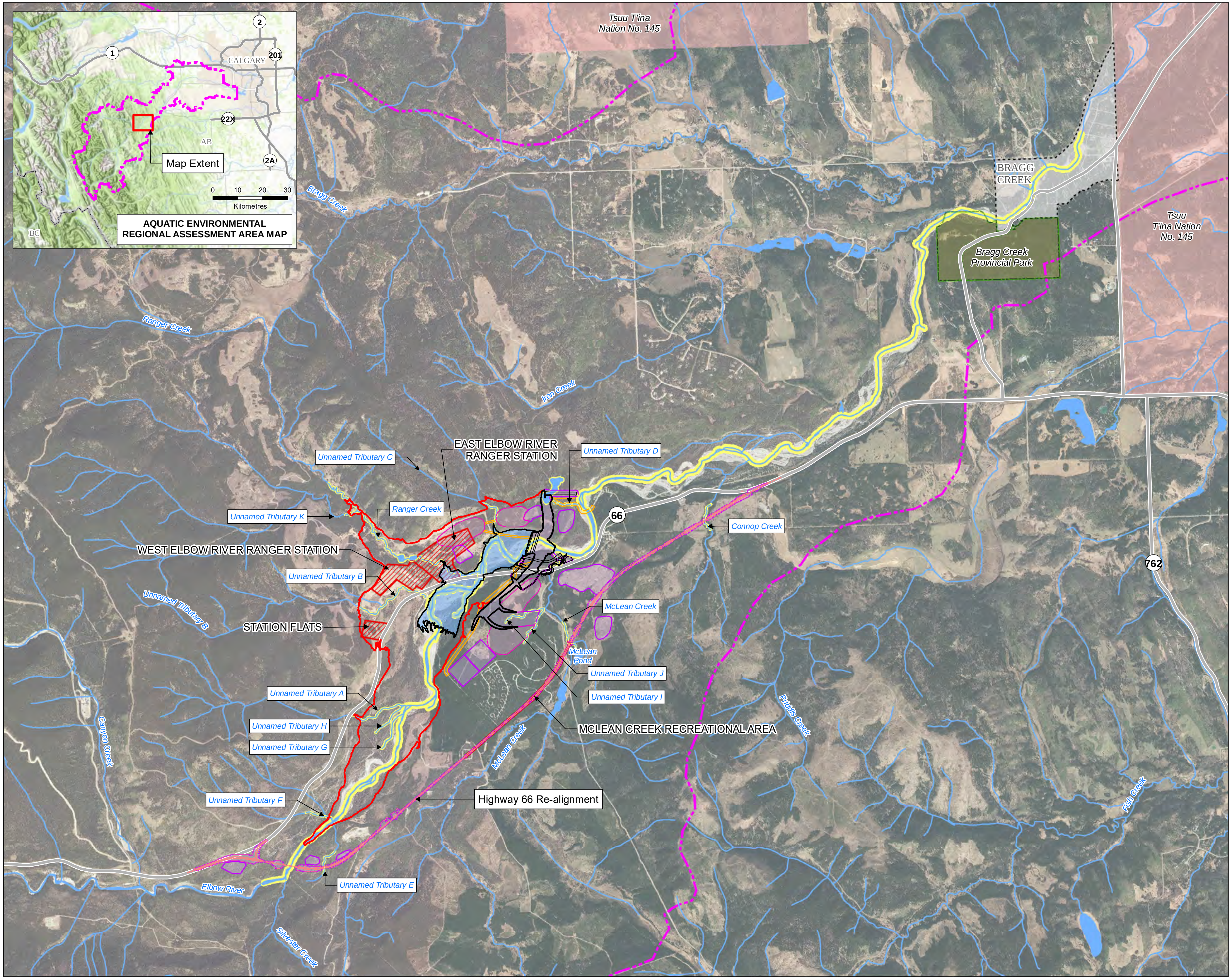
The Aquatic Environment Regional Assessment Area (RAA), which encompasses the LAA (**Figure 7.3-1**), is established to provide a regional context for the assessment of MC1-related effects. The RAA, also encompasses the area within which the residual effects of the MC1 Option are likely to interact with the residual effects of other past, present or future projects or activities to result in a cumulative effect or effects. As shown in **Figure 7.3-1 t**he RAA includes the entire Elbow River watershed, downstream to the inlet at the Glenmore Reservoir.

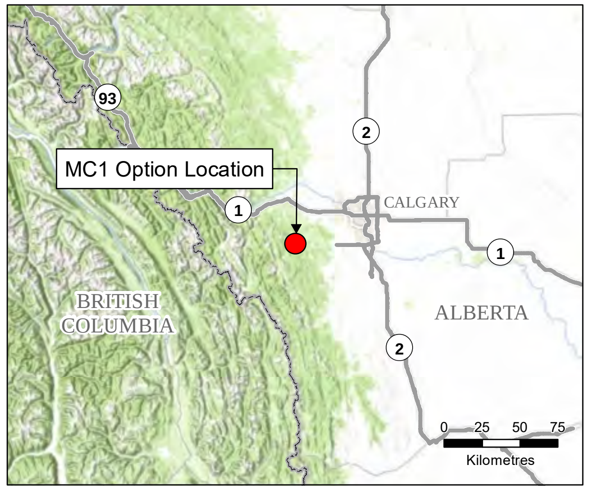
Table 7.3-6 Spatial Boundary Definitions for Aquatic Environment

Spatial Boundary	Description of Assessment Area
MC1 Option area	Encompasses the MC1 footprint and a 100 m buffer around the embankment and excavation areas, spillways and outlet works, road and borrow areas.
Local Assessment Area	The Elbow River and tributaries upstream of the proposed MC1 dam to the 2013 flood elevation and the Elbow River approximately 10 km downstream of the proposed MC1 dam. Includes instream habitat and riparian habitat (at an average depth of 10 m on each bank/approach). For tributaries not within the footprint of the MC1 dam but associated with other infrastructure or activities (e.g., Hwy 66 realignment) over a distance of 100 m upstream to 300 m downstream (or to where connection with Elbow River or McLean Creek occurs) of the activity or infrastructure location. Riparian habitat in these tributaries was included to a depth of 10 m on each bank/approach over the linear extent of the anticipated infrastructure or activity.
Regional Assessment Area	The Elbow River watershed downstream to (but not including) the Glenmore Reservoir. Includes instream habitat (to an average width of 60 m in the Elbow River and average 10 m width on all other watercourses) and riparian habitat (to a depth of 10 m on each bank/approach).

Elbow River at McLean Creek Dam (MC1)

Aquatic Environment Local Assessment Area and Regional Assessment Area





Legend

- Aquatic Environment Local Assessment Area
- Aquatic Environment Regional Assessment Area
- 2013 Flood Event Line
- MC1 Option Dam
- Highway 66 Re-alignment
- Borrow Area
- Laydown/Disturbed Area
- Temporary Haul Road
- Permanent Pond
- Existing Park Infrastructure to be Removed
- Highway
- Hamlet of Bragg Creek
- Reserve
- Provincial Park
- 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
- Aerial Image: SPOT 1.5 m, 2016
- Inset Maps: ESRI World Topographic Map

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Temporal Boundaries

The temporal boundaries of the MC1 Option consist of the Construction, and Operation and Maintenance phases, which are described in **Section 3.0 MC1 Option Description**.

The temporal characteristics of Fish and Fish Habitat are described in the existing conditions and related to seasonal variations in activity, including spawning, rearing and wintering life stages. Temporal characteristics are also considered in the identification of the potential MC1-related effects, and in the proposed mitigation measures.

Administrative Boundaries

The LAA and RAA for Aquatic Environment are both encompassed by Alberta Environment and Parks' (AEP's) Fisheries Management Zone 1, and AEP's Watershed Unit Eastern Slopes 1. This Watershed Unit is inclusive of the Oldman River watershed upstream from Secondary Road 509 near Coalhurst and the Bow River watershed upstream of Highway 24 near Carseland. Since this management zone extends beyond the boundaries of the Aquatic Environment's LAA and RAA, the assessment is limited exclusively to the Elbow River watershed.

Fish species of conservation concern (e.g., those listed or being considered for listing under Schedule 1 of SARA) are often categorized using designated units developed in context of genetic analysis, range disjunction and distribution. As a result, species that are listed under *SARA* typically have a far reaching 'designated unit' that often extends beyond realistic study boundaries of more localized effects assessments. One such designated unit of note for the MC1 Option, specific to Aquatic Environment, is the COSEWIC and *SARA*-defined Saskatchewan – Nelson River designated unit of populations of bull trout. This designated unit, which is comprised of all drainages within the Saskatchewan and Nelson River Basins, is not relevant to assessing potential effects of the MC1 Option since they are removed from the Elbow River populations by barriers to upstream migration (e.g., Glenmore Reservoir). As such, with respect to bull trout, the population's conservation status within the 'Core Area' of the Upper Elbow River, as defined by Alberta Sustainable Resource Development and Alberta Conservation Association (2009), provides the relevant administrative boundary.

The LAA and RAA for Aquatic Environment are both contained within AEP's Hydrological Unit Code (HUC 8) 04021001. In Alberta, a HUC is an assigned identification number representative of drainage basin feature classes. This HUC extends through the entire watershed, including downstream through and beyond the Glenmore Reservoir and to the confluence with the Bow River.

Technical Boundaries

Data compiled to support the assessment of the Aquatic Environment consisted of a combination of baseline data collection and the review of other existing information. These various data sources come with inherent technical limitations which form the basis of the technical boundaries for this assessment (e.g.,completing field surveys in areas that are safely accessible and completing a single season of sampling).

These limitations are common to effects assessments that rely on these types of data and do not preclude the ability to assess potential MC1-related effects. Such limitations can be offset through the use of a conservative approach to the identification and evaluation of potential effects. In the context of MC1, a conservative approach to identifying potential MC1-related effects involves the establishment of a 100 m buffer around proposed infrastructure, which provides an over-estimation of potential effects.

Data gaps exist in both existing literature and baseline fish and fish habitat data collected to date MC1. For example, existing information related to benthic invertebrate and periphyton communities is limited, although where available and practical to do so, information was used with the understanding it was not MC1-specific. The potential to sample fish communities in the unnamed watercourses within the LAA in fall 2016 was precluded due to concerns of potential coincidence/interference with fall spawning activity. As well, the timing of fall field programs did not allow for all watercourses within the LAA to be visited during flowing conditions to assess fish habitat composition, potential and use. Where possible, habitat was visited during a in summer 2016 for these purposes.

There currently exist no anthropogenic barriers to fish migration within the Elbow River in the RAA (i.e., upstream from the Glenmore Reservoir). However, Elbow Falls, a naturally occurring feature located approximately 13 km upstream from MC1 footprint may represent a barrier to upstream fish migration. Prior to the 2013 flood, Elbow Falls was considered a biological barrier to upstream fish migration; however, this has not been confirmed following changes to the feature resulting from the flood. For the purposes of the assessment, Elbow Falls is assumed to remain as a barrier to upstream movement of all fish species and that no genetic variations exist among fish of the same species within the RAA downstream of Elbow Falls.

7.3.2 Baseline Case

This section describes the existing conditions of the Aquatic Environment within the RAA and LAA, and is based on the results of a literature review and interpretation of existing background information on fish and fish habitat using data compiled from the sources listed in **Section 7.3.1.2**. Onsite assessments of fish habitat and seasonal species use are also considered for this purpose. Baseline data collections methods for Aquatic Resources are included in **Appendix 7-E.** The general characteristics of watercourses are also described in **Section 6.4 Fluvial Geomorphology**.

7.3.2.1 General Characteristics of the Local and Regional Assessment Areas

The MC1 Option occurs in the Montane Natural Subregion of the Rocky Mountain Natural Region of Alberta (Natural Regions Committee 2006). This subregion is characterized by rolling and hilly foothills, generally with open coniferous forests and/or grasslands. It is the driest and warmest of the three Rocky Mountain Natural Regions and has cooler summers but warmer winters due to Chinooks (Natural Regions Committee 2006). The Elbow River watershed spans areas characterized as Subalpine, Boreal Foothill and Aspen Parkland.

The MC1 Option area is contained within the boundaries of the Elbow Area of Kananaskis Country. Further downstream, the Elbow River passes through the Gooseberry Provincial Recreation Area before leaving the boundaries of Kananaskis Country. Once within Alberta's Municipal District of Rocky View #44, the river borders the Bragg Creek Provincial Park before passing through the Hamlet of Bragg Creek. Downstream from Bragg Creek, the river traverses through the northwestern portion of the Tsuut'ina Nation Reservation prior to its intersection with Highway 22. Downstream from Highway 22, the river flows adjacent to primarily private lands, until passing through Clearwater Park and intersecting with Highway 8. Downstream from Highway 8, flow returns to within the boundaries of the Tsuut'ina Indian Reserve (IR) No. 145before entering the Weaselhead Natural Area and emptying into Glenmore Reservoir within the city limits of Calgary.

With respect to water management planning, the Elbow River watershed is divided into three reaches (Elbow River Watershed Partnership 2008). The RAA spans the upper and central rural reaches, including land uses such as tourism and recreation as well as portions within the Management District of Rocky View, including the Hamlet of Bragg Creek and Tsuut'ina IR No. 145 lands.

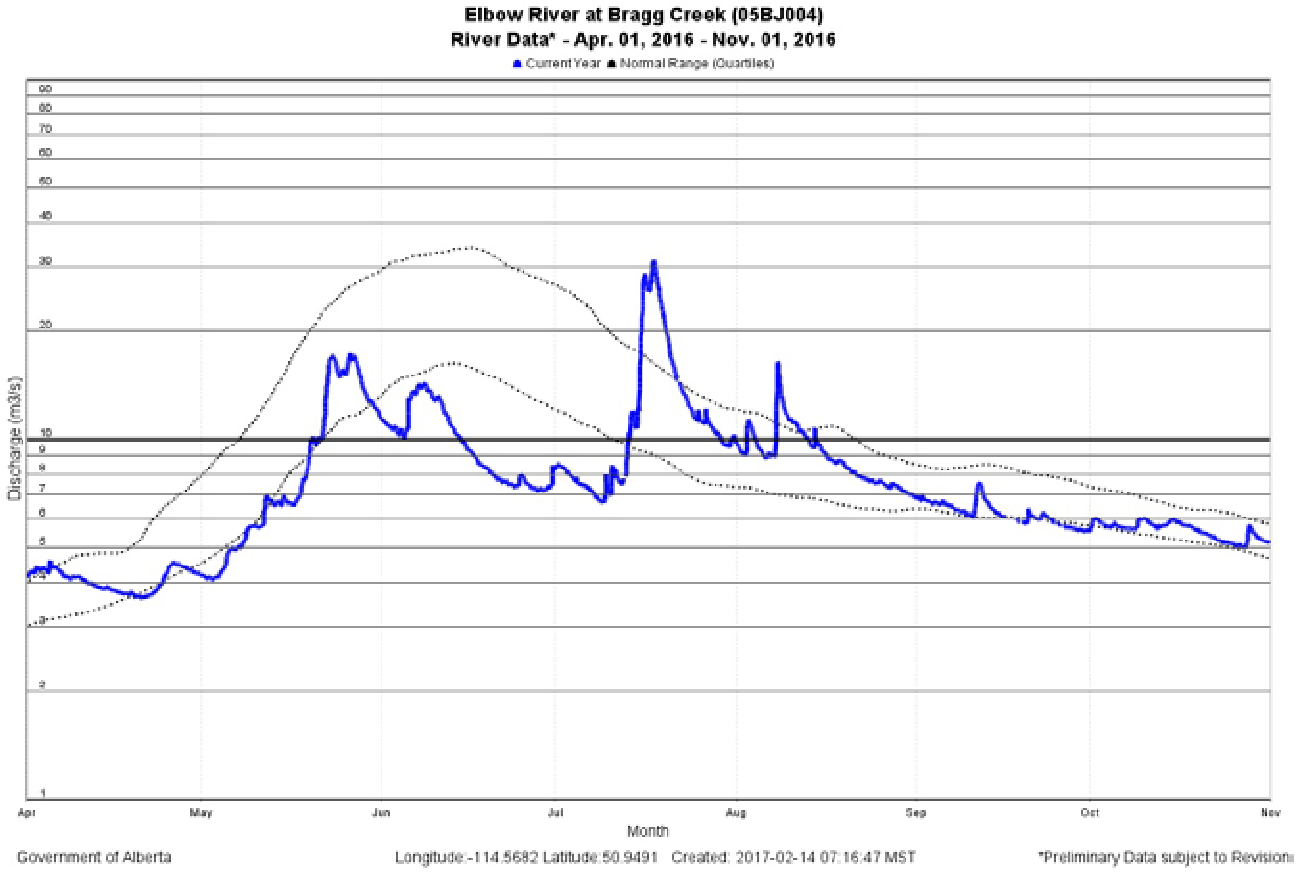
The Elbow River watershed (i.e., upstream from the Glenmore Reservoir), drains an area of 1,190 km^2. At MC1, the Elbow River is a sixth order (Strahler) watercourse. Major tributaries within the watershed upstream from MC1 include the Little Elbow River as well as Ranger, Quirk, Silvester, Prairie, and Cougar creeks. Downstream from MC1 notable tributaries include McLean, Pirmez, Cullen and Lott creeks. Ranger Creek, at its confluence with the Elbow River is a fourth order watercourse. McLean Creek is also a fourth order watercourse at its confluence with the Elbow River, while Connop Creek is a second order watercourse at it confluence with the Elbow River. The unnamed tributaries within the LAA are either first, second or third order tributaries.

Elbow Lake, the headwaters of the Elbow River, occurs within Peter Lougheed Provincial Park at 2,120 m above sea level (asl). In contrast, the elevation at the outlet of the Elbow River into Glenmore Reservoir, approximately 105 km downstream, is 1,080 m asl. The resulting average gradient over this distance is approximately 1%, and while there are sections of relatively 'flat' habitat as the river approaches the Glenmore Reservoir, much of the habitat within the Elbow River watershed upstream from MC1 is characterized by comparatively steep gradient and swift moving water.

Within the LAA, the Elbow River, McLean Creek and Ranger Creek are mapped as Class C watercourses, based on AEP's Code of Practice for Watercourse Crossings – Calgary Area Map (Government of Alberta 2012b, 2013). Although not mapped, Connop Creek and unnamed tributaries, A, C, D, E, F, G, H, I, J and K inherit a Class C designation given their connection and proximity to either the Elbow River or McLean or Ranger creeks (Government of Alberta 2012b, 2013). In Alberta, Class C water bodies are generalized as moderately sensitive habitats that can be damaged by unconfined or unrestricted activity, but which are broadly distributed and capable of supporting local fish species populations (Government of Alberta 2001). Each of the Class C watercourses within the LAA has an assigned instream restricted activity period (RAP) of September 1 through August 15 (inclusive). Unnamed tributary B is a mapped Class D watercourse (Government of Alberta 2012b, 2013). However, since the potential MC1-related effects all occur within the downstream most 2 km of this watercourse, unnamed tributary B also inherits the Elbow River's Class C designation and RAP. Watercourses with a Class D designated are typically considered to be of low sensitivity and are generally defined as being non-fish-bearing (Government of Alberta 2001).

Detailed information about surface water flow at the MC1 Option area (i.e., exclusive of flow entering the Elbow River from tributaries occurring between the MC1 Option area and the monitoring station) is provided in **Section 2.0 MC1 Option Setting, Benefit and Alternatives**. However, flow data, specific to the Elbow River and as recorded approximately 11 km downstream from the MC1 Option area, is available from a hydrological station on the Elbow River at Bragg Creek (Station No. 05BJ004) (**Figure 7.3-2**). This information is not exclusively representative of flows at the MC1 site, given the inflow of tributaries between the MC1 Option area and monitoring station. However, data from this station is useful for providing a generalized understanding of the flow regime within the Elbow River and more broadly its watershed. Flow patterns within the Elbow River, upstream from the Glenmore Reservoir are not regulated and are maintained by natural precipitation, runoff events and a network of wetlands and alluvial aquifers (Government of Alberta 2017a), as lowland melt and freshet events occur. Following freshet, flows generally recede during the summer, fall and winter months. The average monthly flow rate during the freshet period (i.e., June) is 26.2 m^3/s (Environment Canada 2017a), although this value has ranged between 77.4 m^3/s and 5.8 m^3/s since recordings began at this station. In contrast, the lowest mean monthly discharge typically occurs in January and has averaged 3.0 m^3/s.

No monitoring stations exist on any of the Elbow River's tributaries. It is realistic, however, to expect that flow regimes similar to the Elbow River are represented in many of the tributaries. Discharge rates in smaller watercourses and drainages are more likely to be influenced more by localized precipitation events than the larger watercourses in the watershed. Where groundwater inflow is not present, flow in these smaller watercourses may be seasonal and consequently some could be dry or frozen to bottom during the fall and winter seasons.



Source: Government of Alberta (2017)

Figure 7.3-2 Hydrometric Flow Data for the Elbow River at Bragg Creek (05BJ004)

7.3.2.2 Fish Species Composition and Abundance

Within the RAA, the Elbow River watershed supports several fish species of management concern (**Table 7.3-7**), including the following sportfish species: bull trout; brook trout (*Salvelinus. fontinalis*); rainbow trout; cutthroat trout (introduced); brown trout; mountain whitefish; 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*). Within the LAA, eight fish species are known to occur (FWMIS 2017). These include brook trout, brown trout, bull trout, cutthroat trout, mountain whitefish, rainbow trout, white sucker and longnose dace.

Combined, the sportfish species listed in **Table 7.3-7** comprises the community which has been presumed to represent the recreational fishery within the RAA and LAA. The presence of an Indigenous fishery(ies) in the RAA is currently unknown; consultation would be required to determine the presence or absence of such a fishery(ies) should MC1 proceed through regulatory approvals. To date, evidence of Indigenous Peoples using the Elbow River as an Indigenous Fishery has not been identified (Kendel Pers. Comm. March, 2017). Although some individual Band members may use the area for fishing occasionally, no evidence of specific current or traditional use in the MC1 Option area has been found (Kendel Pers. Comm. March, 2017). There are no commercial fisheries in the RAA, nor are any expected in the foreseeable future.

Of the species that are known to occur in the LAA, bull trout is the only species of conservation concern that could reasonably be expected to occur in the LAA. The species Saskatchewan-Nelson Rivers populations (which encompasses the Elbow River population) are listed as Threatened by COSEWIC (2017). Although the species is currently not listed under SARA Schedule 1 (Environment Canada 2017b), 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). Sensitive species are those that "...*are not at risk of extinction or extirpation but may require special attention or protection to prevent it from becoming at risk*" (ASRD, 2010). In addition, Alberta's Endangered Species Conservation Committee has identified bull trout as Threatened (AESRD 2014), which means they are currently listed under Alberta's *Wildlife Act*. The Upper Elbow River population (identified as a Core Area population (ASRD and ACA 2009), which occurs in the RAA, is listed as being of High Risk of extirpation given that it comprises between 50 and 250 adults (ASRD and ACA 2009). Alberta has implemented a provincial conservation management plan for bull trout (ASRD 2012), which contains recovery objectives and strategies recommended for the maintenance or enhancement of bull trout habitat and populations.

Although native to the Elbow River watershed, pure strain westslope cutthroat trout (*Oncorhynchus clarkii lewisi*) have been extirpated from habitat within the LAA, as well as all watercourses within the Elbow River watershed downstream from MC1 (Earle. Pers. Comm. July 2015). Within the RAA, westslope cutthroat trout are known only to exist with Prairie, Silvester and Trail Creeks, tributaries that all occur upstream from Elbow Falls. The species is listed as Threatened in Alberta under the *Wildlife Act* (ASRD 2010) and are an At Risk species, meaning that the species "is known to be at risk after formal detailed status assessment and legal designation as Endangered or Threatened in Alberta" (ASRD 2010). The species is listed as threatened under SARA (Environment Canada 2017b).

Table 7.3-7 Fish Species Known to Occur in the Regional Assessment Area

Common Name[1]	Scientific Name	Spawning Season[2]	Provincial Status[3]	COSEWIC-Listed Species[4]
SPORTFISH				
bull trout (BLTR) (South Saskatchewan River population)	Salvelinus confluentus	fall	sensitive[5, A]	threatened
brook trout (BKTR)	Salvelinus fontinalis	fall	exotic/alien	not listed
brown trout (BNTR)	Salmo trutta	fall	exotic/alien	not listed
rainbow trout	Oncorhynchus mykiss	spring	secure	not listed
cutthroat trout (Introduced populations)	Oncorhynchus clarki	spring	exotic/alien	not listed
westslope cutthroat trout (native Alberta populations)	Oncorhynchus clarkii lewisi	spring	at risk[5, A]	threatenedB
mountain whitefish	Prosopium williamsoni	fall	secure	not listed
burbot	Lota lota	winter	secure	not listed
northern pike	Esox lucius	spring	secure	not listed
NON-SPORTFISH				
longnose sucker	*Catostomus catostomus*	spring	secure	not listed
white sucker	*Catostomus commersoni*	spring	secure	not listed
lake chub	*Couesius plumbeus*	spring	secure	not listed
longnose dace	*Rhinichthys cataractae*	spring-summer	secure	not listed
pearl dace	*Margariscus margarita*	spring-summer	undetermined	not listed
trout-perch	*Percopsis omiscomaycus*	spring-summer	secure	not listed
brook stickleback	*Culaea inconstans*	spring-summer	secure	not listed
fathead minnow	*Pimephales promelas*	summer	secure	not listed

Sources:

1 List compiled from Nelson and Paetz 1992, Alberta Sustainable Resource Development 2010, Fisheries and Wildlife Management Information System 2017
2 Joynt and Sullivan 2003, Nelson and Paetz 1992
3 Alberta Sustainalbe Resource Development 2010
4 Committee on the Status of Endangered Wildlife in Canada 2017 Alberta population
5 Alberta Environment and Sustainable Resource Development 2014

Notes:

A Also listed as Threatened under the Alberta *Wildlife Act*
B Also listed as Threatened under the federal *Species at Risk Act*.

It is realistic to expect that brook trout, brown trout, rainbow trout, cutthroat trout (introduced populations), bull trout, mountain whitefish and longnose dace occur in the LAA year-round. Sucker species (i.e., longnose and white sucker) may also occur seasonally, although they have not been documented in the Elbow River, upstream from MC1 (FWMIS 2017). Each of the previously documented species can be expected in the Elbow River and McLean Creek, and while the same species (except white sucker) have been documented previously in Ranger Creek (FWMIS 2017), it is reasonable to expect that only brook trout and possibly cutthroat trout (introduced) and/or rainbow trout to occupy habitat Ranger Creek upstream from the confluence with the Elbow River. Brook trout are the only species previously documented in Connop Creek (FWMIS 2017), and although there is no documented evidence of fish presence in any of the unnamed tributaries included in the LAA (FWMIS 2017), the absence of fish in these watercourses should not be presumed. In the absence of historical presence/absence information it is reasonable to anticipate that brook trout may occur in the lower reaches of some unnamed tributaries within the LAA.

To better understand fish presence and distribution through the largest watercourse in the LAA during the fall season, a snorkel survey was conducted within Elbow River in October 2016. This survey included habitat within the LAA upstream from the MC1 Option area and habitat within 1 km downstream. Given the coincidence of the survey with anticipated spawning period for mountain whitefish, the survey was focussed within habitats most likely to be used for that species' spawning. The survey was also intended to document the presence of other species as they were encountered. Although the potential for the methods and timing of this survey was prioritized for a specific species, sampling results are expected to remain an indication that the sportfish community composition may be dominated by mountain whitefish (**Table 7.3-8**). The observation of forage and coarse species was beyond the scope of the MC1 team's snorkel survey so the prevalence of longnose dace and potentially sucker species was not considered during the survey. Resulting relative proportions of mountain whitefish and other species observed during the 2016 snorkel survey are generally similar to those reported for the same approximate area in 2007 (Eisler and Popowich 2008), although a comparatively larger proportion of rainbow trout were observed in 2016.

Table 7.3-8 Fish Observed during Snorkel Survey of the Local Assessment Area, Elbow River 2016

Species Observed	Number Observed by Size Class (Total Length)		
	<30 cm	30- 40 cm	40-50 cm
Mountain whitefish	61	81	9
Rainbow trout	17	22	4
Bull trout	0	0	1
Unidentified trout spp.	1	1	1

Neither comprehensive biomass nor population estimate data are available for any of the watercourses in the LAA (Sanderman, Pers. Comm. May 2017); however, fish capture information from the Elbow River corroborates the MC1 study team's assertion related to fish community composition in this watercourse. Since 2000, several sampling events have occurred in the Elbow River within the MC1 Aquatic Environment LAA (AEP 2017). Generalized interpretations on catch composition from this data support the potential that mountain whitefish are the most prevalent species in the LAA, followed in order by brook trout, brown trout, rainbow trout, and bull trout. Caution should also be applied when considering this interpretation as sampling methodology (i.e., boat-based electrofishing versus backpack electrofishing) and timing are likely to have introduced some biases. Notwithstanding, CPUE values (all species combined) ranged between 0 fish per 100 seconds of effort to 3.89 fish per 100 seconds of effort.

Sampling the fish community composition and abundance in the LAA in fall 2016 was precluded. In addition, fall spawning surveys were not conducted in other watercourses within the LAA due to early freeze-up and low water conditions coinciding with the timing of the assessments. It is realistic, however, to expect that brook trout spawning could occur in Ranger, McLean and Connop creeks in particular. Habitat conditions in Ranger Creek and McLean Creek are most conducive to spawning by brook trout and to a presumed lesser extent for other fall spawning species (e.g., brown trout, bull trout, and mountain whitefish).

Collection of fish community data was completed in 2017. Sampling of the fisheries communities during this program included several tributaries (where flow and conditions permitted) within the LAA (i.e., including McLean Creek and Connop Creek). During this sampling, fish were captured or encountered at McLean Creek (both sites), unnamed tributary A, Connop Creek and unnamed tributary K. Sampling was not conducted in Ranger Creek, given existing fisheries information documented for the watercourse. Although useful from a presence/absence perspective, historical data from Ranger Creek is somewhat limited in scope and sporadic in location. As a result, it is recommended that it not be considered for any purpose other than presence/absence consideration. The absence of flow in unnamed tributaries D, E, G, H, I, and J precluded sampling of fish communities in summer 2017. No existing fish sampling data is available for these watercourses/drainages (FWMIS, 2017).

A spawning survey for rainbow trout was attempted in the mainstem of the Elbow River and Ranger Creek (i.e., through the LAA) in early summer 2017. However, high flows and turbid conditions precluded reliable observations confirming or refuting the potential for spawning by this species. In the absence of these data, habitat potential information collected in 2016 and 2017 is used to determine the potential for spawning in these watercourses.

7.3.2.3 Indicator Species

Bull Trout

A cold-water species, bull trout are frequently referenced as having the most sensitive and complex habitat requirements among trout and char species in western North America (Brewin et al. 1997, Mackay et al. 1997). The species is a late summer to early fall spawning species, with spawning in the Elbow River watershed typically occurring in late August to late October. Spawning and egg incubation requires clean (i.e., unembedded) gravels and cobble substrates (2 millimetres (mm) to 256 mm) and groundwater inflow (Stewart et al 2007, Roberge et al 2002, Evans et al. 2002, ASRD and ACA 2009). Redds (i.e., excavations made by spawning fish) are created by a spawning pair, in which fertilized eggs are deposited. Bull trout eggs incubate in interstitial spaces of redd spoil piles, and hatch in March to April.

While in the gravel, bull trout eggs are susceptible to several environmental and biological factors, including sediment deposition, streambed scour, reduced water flow, and wading mammals. After emergence in the spring (i.e., March and April), there is typically a downstream migration of young of the year to low velocity (less than 0.4 metres per second (m/s)) backwater areas, lakes, or side channels (Stewart et al 2007, Roberge et al 2002, Evanset al. 2002, ASRD and ACA 2009). Preferred rearing habitat for the species includes pool-run habitats with cobble and boulder substrates. As juveniles mature, they seek deeper pools associated with large, woody debris in lower tributary reaches (ASRD and ACA 2009). Bull trout typically spawn annually, and in some populations spawning may occur bi-annually (ASRD 2012). Wintering typically requires deep (i.e., greater than 1.0 m) pool habitat, associated with low to moderate velocity (0.2 m/s) (Popowich 2005, Stewart et al 2007, Roberge et al 2002, Evans et al. 2002, ASRD and ACA 2009).

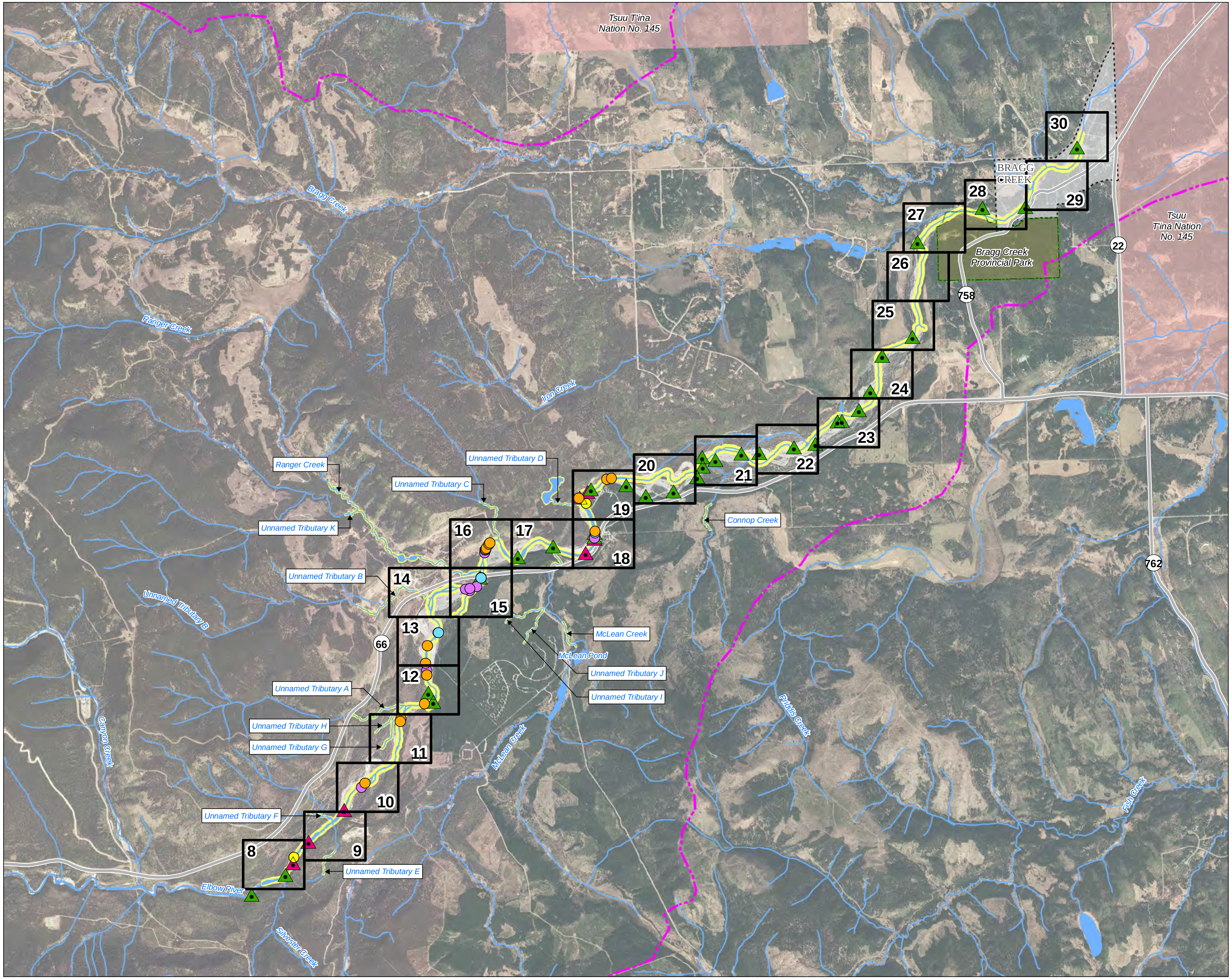
In general, bull trout are susceptible to angler overharvest, are slow to mature, and have sensitive habitat requirements. They also face competition from introduced non-native species and invasive species, and experience habitat fragmentation. These factors, many of which occur within the RAA, are cited as influences contributing to the species decline through most of their range in North America (e.g., Berry 1994, Brewin and Brewin 1997, Pollard and Down 2001, Post and Johnston 2002). Locally, these same factors are represented in Fish Sustainability Index (FSI) modelling results relative to the bull trout populations in the Elbow River watershed. According to the FSI results from a population integrity perspective, the current density of adult bull trout within the RAA is rated as Very Low (1) (Government of Alberta 2015a). Bull trout FSI results specific to habitat protection needs within the RAA are High (2) (Government of Alberta 2015b). Combined, these results suggest that sustainability of the bull trout population within the RAA is at considerable risk. No FSI modelling results are available for any of the other species known to occur in the MC1 Option area (Sanderman, Pers. Comm. May 2017).

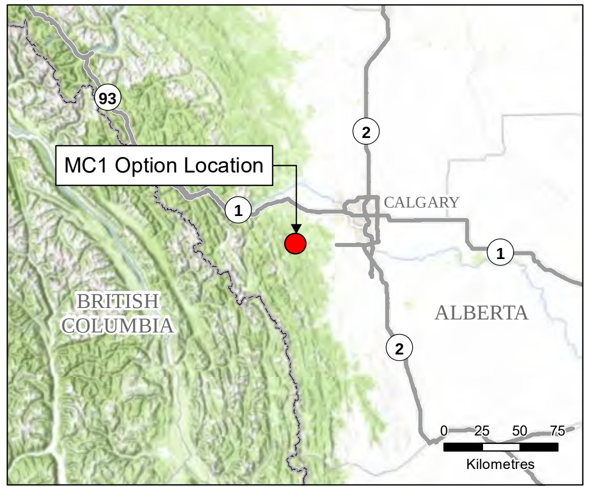
As many as three different life history strategies may be represented by bull trout populations in the LAA and RAA: stream-resident; fluvial; and adfluvial. Fluvial and adfluvial strategies are migratory forms and can result in widely ranging distance of migration, while resident spawning strategies result from fish spawning in the same watercourse in which all other life stages are completed. Prior to the 2013 flood in the Elbow River, spawning by resident and fluvial bull trout populations typically occurred upstream from the Aquatic Environment LAA, nearer Elbow Falls (Eisler and Popowich 2008). However, a migration tracking study completed upstream from the Glenmore Reservoir Dam in 2004 and 2005 (Popowich and Paul 2006) indicated that many of that study’s tagged bull trout (i.e., tagged during spawning migrations near Elbow Falls) were subsequently observed within habitat downstream form the confluence of Bragg Creek to Highway 22 bridge crossing outside the typical spawning period (i.e., during the winter periods). Popowich and Paul (2006) indicated the “most notable” location for bull trout congregations, post-spawn, was near Bragg Creek, within and downstream from the Aquatic Environment LAA. Nearly all winter observations of tagged fish by Popowich and Paul (2006) occurred downstream from the MC1 Option area, confirming considerable and repeated migration for bull trout through the LAA for spawning and wintering life history needs. Observations related to spawning and wintering tendencies from this study suggest that the population is comprised (at least primarily) of a fluvial population of bull trout.

Comprehensive spawning and migration surveys from Elbow Falls to the Glenmore Reservoir have not been replicated following the 2013 flood, so it is unclear whether a significant change in spawning and wintering patterns have resulted throughout the Elbow River. However, specific to the LAA, spawning survey results from 2014 (AMEC 2015) and 2016 indicate that bull trout spawning has been occurring in the vicinity of the MC1 Option area, both upstream and downstream from MC1 (**Figure 7.3-3**). The MC1 study team conducted an initial bull trout redd survey within a select reach of the Elbow River within LAA in late October 2016, and then repeated the survey on November 7 and 8, 2016. In some instances, bull trout redds were encountered in similar locations as documented in 2014 (AMEC 2015), although new or alternate spawning locations were also identified in 2016. In general, redds were located in preferred habitat types (i.e., transitional areas between pool and riffle units), with water depths between 0.3 m and 0.8 m, and in areas where large gravel and unembedded cobble dominated substrate composition. Redd diameters ranged between 0.5 m and 1.0 m. No bull trout were observed during the 2016 redd survey, nor were any fish observations reported during AMEC’s survey in 2014 (AMEC 2015).

Elbow River at McLean Creek Dam (MC1)

Presumed Spawning Locations of Bull Trout, Brown Trout, and Mountain Whitefish within the Local Assessment Area





Legend

- Congregation of adult mountain whitefish (2007) (Eisler and Popowich 2008)
- Congregation of adult mountain whitefish (2016)
- brown trout redd (2016)
- bull trout redd (2016)
- bull trout redd (2014) (AMEC 2015)
- bull trout redd (2007) (Applied Aquatic 2008)
- Aquatic Environment Local Assessment Area
- Aquatic Environment Regional Assessment Area
- Habitat Mapping Figure Extent and Figure Number
- Highway
- Hamlet of Bragg Creek
- Reserve
- Provincial Park
- 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
- Aerial Image: SPOT 1.5 m, 2016
- Inset Maps: ESRI World Topographic Map

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Alberta Transportation

Mountain Whitefish

Mountain whitefish are native to much of western North America. In Alberta, they occur throughout much of the South and North Saskatchewan, Athabasca, and Peace River Basins. Within watercourses along Alberta's Eastern Slopes, they have historically comprised a substantial portion of the annual angler harvest (IEC Beak Consultants Ltd. 1985, Nelson and Paetz 1992).

Although managed as a sportfish, mountain whitefish have been historically considered a 'trash fish' by many anglers for much of the twentieth century (Brown 2010). Regardless, the species is known to be sensitive to habitat alterations (Meyer et al. 2009), as evidenced by population declines attributed in some instances to anthropogenic development (Meyer et al. 2009). The presence of this species in watercourses has in some instances been shown to be strongly correlated to channel widths that exceed 10 m (Meyer et al. 2009).

Spawning may occur in the same locations as summer foraging; however, most mountain whitefish populations migrate to common spawning locations (McPhail and Troffe 1998). It is reported that the species' spawning is triggered when water temperatures drop below 10° C and peak when they fall to 6° C (McPhail and Troffe 2001), although the timing of spawning can vary depending on many geographic or environmental influences. During a mountain whitefish spawning survey conducted in the Elbow River (i.e., within the RAA) in 2007 (Eisler and Popowich 2008), spawning began in the second week of October. In contrast, populations representing adfluvial life history strategies may be delayed in the onset of spawning. Popowich and Eisler (2011) reported that adfluvial spawning of mountain whitefish in 2010 in the Kananaskis River, upstream from Barrier Lake, did not begin until the first week of November.

Typically, adult mountain whitefish congregate in large numbers prior to spawning, making the identification of potential spawning habitat relatively convenient when done via underwater observations. Run and pool habitats are preferred spawning habitat in lotic systems (R.L. & L. Environmental Services Ltd. 1982, Eisler and Popowich 2008), generally in those deeper than 0.5 m and with velocities between 0.7 m/s and 1.1 m/s (Ford et al 1995, R.L&L Environmental Services Ltd 1996, Roberge et al. 2002, Thompson and Davies 1976). There is no site preparation, regardless of the presence or absence of flow, and eggs are broadcast over unembedded substrate. In lotic habitats, specifically, eggs are broadcast and fertilized in the water column as they are dispersed by the current and before they settle onto and between unembedded substrate. Lake spawning, in the absence of current, has also been reported (McPhail and Troffe 2001, Nelson 1965).

Eggs incubate through winter, and fry emergence in Alberta typically occurs between March and late April (Nelson and Paetz 1992). Work completed in the Athabasca River more recently, however, suggested larvae emergence occurred between early April and early May in that specific watershed (R.L. & L. Environmental Services Ltd. 1994, 1995). Newly emerged fry may use protected side pools, while in summer and early fall they generally inhabit side channel areas (Meyer et al. 2009), generally of depths between 0.15 m and 0.75 m and velocities of 0.3 m/s and 0.8 m/s (Ford et al 1995, R.L&L Environmental Services Ltd 1996, Roberge et al. 2002, Thompson and Davies 1976). Wintering typically requires deep (greater than 1.0 m) pool habitat.

The primary purpose of the MC1 study team's fall snorkel survey was to document potential post-2013 flood spawning locations of mountain whitefish within the LAA. Results from the 2016 spawning survey provide an updated snapshot of potential spawning habitat use by mountain whitefish as compared to the last spawning survey completed in the area in 2007 (Eisler and Popowich 2008). A total of seven congregations (i.e., averaging 19 individuals) of adult (i.e., over 20 cm total length) mountain whitefish were observed during the 2016 spawning survey (**Figure 7.3-3**). Given that the timing of the survey (October 12) coincided with the approximate timing of peak spawning in 2007 (Eisler and Popowich 2008), it is reasonable to interpret that these congregations were in or near selected spawning habitat. The location of each congregation of adult mountain whitefish was associated with a preferred spawning habitat type (i.e., deep water run units). It should be noted that additional congregations (and potential spawning) of adult mountain whitefish may have also occurred in habitat further downstream within the LAA, although were not documented as the survey was limited to a distance of 1 km downstream from the MC1 Option area.

The locations of most spawning congregations observed in 2016 were shifted comparatively to those documented in 2007 (Eisler and Popowich 2008) (**Figure 7.3-3)**. This is not unexpected given the substantial shift in habitat morphology and substrate composition throughout much of the Elbow River resulting from the 2013 floods. The number of spawning congregations observed and the size of congregations were also comparatively less in 2016. Ten congregations, averaging 28 individuals each were observed in 2007 (Eisler and Popowich 2008). Although differences in methodology between the surveys may have influenced these comparisons, the results of the 2016 spawning survey indicate the LAA continues to provide valuable spawning habitat for mountain whitefish.

Brown Trout

Brown trout are not native to Alberta, and the species is listed as "exotic" in this province (ASRD 2010). The species introduction has been successful throughout much of western Alberta, particularly in the North Saskatchewan, Red Deer, Bow, and Oldman river basins, and since their first introduction into the province in the early 1900s, they have been managed as a sportfish species. The introduction of brown trout is believed to be responsible for the decline of some native trout and char species where the species now co-exist (Nelson and Paetz 1992). Populations of brown trout in the Bow River Basin are descendants of fish imported from Europe (e.g., Scotland and Germany).

Although lacustrine morphs will represent an adfluvial life history strategy, the species have also been reported to spawn on windswept lake shorelines in Europe. In Alberta, however, brown trout primarily spawn in lotic environments, generally in late autumn to early winter. Redds are excavated in oxygen-rich habitat when water temperatures are between 7° C and 10° C (Joynt and Sullivan 2003, Scott and Crossman 1973). Side channels and other shallow (less than 1.0 m) water habitats (e.g., glides and shallow run habitats) are typically preferred spawning areas (McPhail 2007, Raleigh et al. 1986, Sikina and Bryski 2005, Nelson and Paetz 1992).

Adults prefer to inhabit slower-moving waters in the lower reaches of streams, and generally select areas where they can lie in deep pools or under the protective covering of banks or snags (Nelson and Paetz 1992). Optimal brown trout habitat is characterized by clear, cool to cold water with unembedded coarse substrate in riffle-run areas (Raleigh et al. 1986). Canopy cover or near stream overhanging vegetation is important to the species (Cunjak and Power 1986), and spawning generally occurs where instream or overhead cover is present or in the immediate vicinity (Peterson and Meagher 2014). Cunjak and Power (1986) highlighted the importance of overhead cover to the species, particularly during the winter season, as aggregations of brown trout selected areas with slow-moving water. In general, wintering habitat for the species consists of moderately deep (0.8 m to 1.0 m) pool habitat with velocities ranging between 0.02 m/s and 0.08 m/s (McPhail 2007, Raleigh et al. 1986, Sikina and Bryski 2005, Nelson and Paetz 1992). Preferred rearing habitat includes side channels, margins of riffles, and runs of depths that are less than 0.6 m and velocities ranging between 0.15 m/s to 0.50 m/s (McPhail 2007, Raleigh et al. 1986, Sikina and Bryski 2005, Nelson and Paetz 1992).

Existing information related to preferred brown trout spawning and wintering locations within the LAA and RAA is limited (AEP 2017). As a result, it should be presumed that habitat within the LAA is used year-round by the species, particularly given the presence of some side channel and deep-water habitats with appropriate water conditions and instream and near-stream cover elements. The MC1 study team conducted a redd survey, focusing specifically on brown trout spawning activity while supplementing the preceding bull trout redd survey, on November 7 and 8, 2016. A total of 14 suspected brown trout redds were identified during this survey (i.e., occurring over the same reach of the Elbow River as the mountain whitefish and bull trout spawning surveys). In some instances, a single redd was encountered, while in other locations multiple redds were encountered in a cluster, or a communal redd was observed. Water depths at redd locations ranged between 0.38 m and 0.83 m, and redd diameters ranged between 0.35 m and 0.95 m. Adult brown trout were observed on or in the immediate vicinity of some of the redds, and on occasion were observed digging. These observations validated the suitability of the survey's timing, and confirmed the origin of the redds. It is important to note that to avoid double counting redds, brown trout redd locations were identified with reference to bull trout redd location data from late October 2016. Size of redd, associated substrate size, and other influences were considered when determining the species of origin for redds encountered during the November spawning survey.

Rainbow Trout

Rainbow trout spawn during spring/early summer, from late April to June, generally when water temperatures range between 5° C to 15° C. Variance in timing may result depending on native versus non-native strains and the altitude of the population (Ford et al. 1995, Joynt and Sullivan 2003, Nelson and Paetz 1992). The species is a redd builder and generally spawns in glide habitat with small gravel (2 mm to 26 mm) and velocities of between 0.3 m/s and 0.7 m/s (McPhail 2007 and Raleigh et al 1984).

Overhead cover (i.e., large woody debris (LWD) and riparian vegetation) are important elements of suitable habitat for rainbow trout in small watercourse, with riffles, run glides, and pools each being preferred habitat for various life stages of the species (McPhail 2007). Juvenile rainbow trout inhabit shallow riffles and run and snye (i.e., backwater) habitats that are generally between 0.5 m and 0.8 m deep and have velocities ranging between 0.1 m/s and 0.3 m/s (McPhail 2007, Raleigh et al 1984).

Wintering habitat typically consists of deep (greater than1.0 m) pool or snye habitats, with gravel, sand, or cobble substrates and low velocities (McPhail 2007, Raleigh et al 1984). Instream and near stream cover elements are useful to rainbow trout wintering success.

Existing information related to preferred rainbow trout spawning and wintering locations within the LAA and RAA is limited (AEP 2017). As a result, and as with brown trout, it should be presumed that habitat within the LAA and in particular the Elbow River is used year-round by the species.

7.3.2.4 Fish Movement and Migration

There is limited existing information related to the seasonal migration of fish species within the LAA and RAA. The only known recent study focused on the post-spawning migration tendencies of bull trout between Elbow Falls and the Glenmore Reservoir (Popowich and Paul 2006). There are also no known studies documenting the migration of juvenile fish (any species) within the RAA or any of the other indicator species for MC1. As a result, the information presented in this section is based on Popowich and Paul (2006), information from other studies in other locations, where warranted, and the author's knowledge of the Elbow River fish species that have been selected as indicator species for this assessment. **Table 7.3-9** summarizes the presumed movement patterns of indicator fish species within the LAA. For the purposes of this discussion, juvenile life stage includes fry and juvenile fish.

Interpretations of radio-telemetry data provided by Popowich and Paul (2006), indicate that adult bull trout generally migrate between wintering and spawning habitat located considerable (i.e., more than 20 km) distances apart within the Elbow River. It is unclear whether additional migrations occur to support feeding, although none is expected. It is presumed that adult bull trout, when compared to the other indicator species, has the longest migratory pattern within the RAA. Further, their current migration patterns would likely result in semi-annual movements of many individuals through the MC1 Option area each year. In general, movement of juvenile bull trout through the LAA occurs annually, after emergence and as rearing fish disperse from natal habitats in or upstream from the MC1.

The movement of adult mountain whitefish, rainbow trout, and brown trout can be expected seasonally; however, the extent of each species' migration distances is unclear. In the absence of confirmed migration tendencies, it is reasonable to presume that rainbow trout and brown trout spawning and wintering migrations may occur in and through the area of MC1, and the same could be presumed, although to a lesser extent, for mountain whitefish. The potential for rainbow trout and brown trout employing fluvial or adfluvial strategies in the RAA seems more likely than that for mountain whitefish. As with bull trout, it is presumed that movement of rearing rainbow trout, brown trout, and mountain whitefish within and through the LAA would generally be annual and in a downstream direction.

Movement of some fish within the LAA and between the Elbow River and the tributaries is likely. While migration from the Elbow River into the tributaries by the indicator species for spawning or wintering purposes is unlikely, it is possible for adult feeding opportunities or when velocity refuge is sought during high flow events in the Elbow River. Movement into and out of the tributaries by other species (e.g., brook trout) is expected, but is likely dependant on flow conditions. Movement within the tributaries by species other than the indicator species is likely during flow seasons.

7.3.2.5 Health and Survival

No known literature is available pertaining to fish health in the Elbow River, specifically within the RAA. It is presumed that contaminant loads in fish conform to federal guidelines as there are no current fish consumption advisories in effect for the Elbow River watershed (Government of Alberta 2016).

Table 7.3-9 Presumed Movement Patterns of Indicator Fish Species within the Local Assessment Area

Species	January		February		March		April		May		June		July		August		September		October		November		December	
	U[1]	D[1]	U	D	U	D	U	D	U	D	U	D	U	D	U	D	U	D	U	D	U	D	U	D
Bull trout						J[2]		J		J		J	A	J	A		A		A	A		A		A
Mountain whitefish						J		J		J		J		J		J	A		A	A	A	A		A
Brown trout								J		J		J		J		J	A		A		A	A	A	A
Rainbow trout					A		A		A		A	J A		J A		J A		J A		J A				

Notes:

1 U- upstream; D - downstream

2 Life stage abbreviations: J - Juvenile (including fry), A - Adult

7.3.2.6 Fish Habitat

The base case of benthic invertebrate and periphyton communities, an integral component of fish habitat, is described below for the relevant areas of the Elbow River watershed collectively, while other characteristics that contribute to fish habitat are described separately.

Benthic Invertebrate and Periphyton Communities

Benthic invertebrates are organisms which live in or on the bottom of watercourses and waterbodies. Periphyton is a mixture of algae, cyanobacteria, and detritus covering underwater surfaces in most aquatic ecosystems. Benthic invertebrates and periphyton are a key part of the aquatic food web as they are a food source for fish. Being ecologically important to fish habitat they are therefore included in the assessment of potential effects as an element of the Aquatic Environment.

Benthic invertebrates are commonly used biological indicators for freshwater habitats for several reasons: they are sedentary and can be representative of site specific impacts as they would remain in the same area for the length of their lifespan; they are generally ubiquitous and abundant; and they are diverse and can be long lived (1-3 years) (Government of Canada 2012). Periphyton can also be an indicator of water quality as they respond to changing environmental conditions.

The general morphology in the LAA, particularly in the Elbow River, consists of riffles and shallow runs (<0.75 m) with bolder, cobble, and gravel, and several snyes interspersed, which comprised clay and silt substrate (refer to **Section 7.3.2.6**). Based on these characteristics, it is expected a benthic community would be composed largely of benthic invertebrates associated with larger particle size and swift water, such as orders Ephemeroptera (Mayflies), Plecoptera (Stoneflies), and Trichoptera (Caddisflies) (EPT).

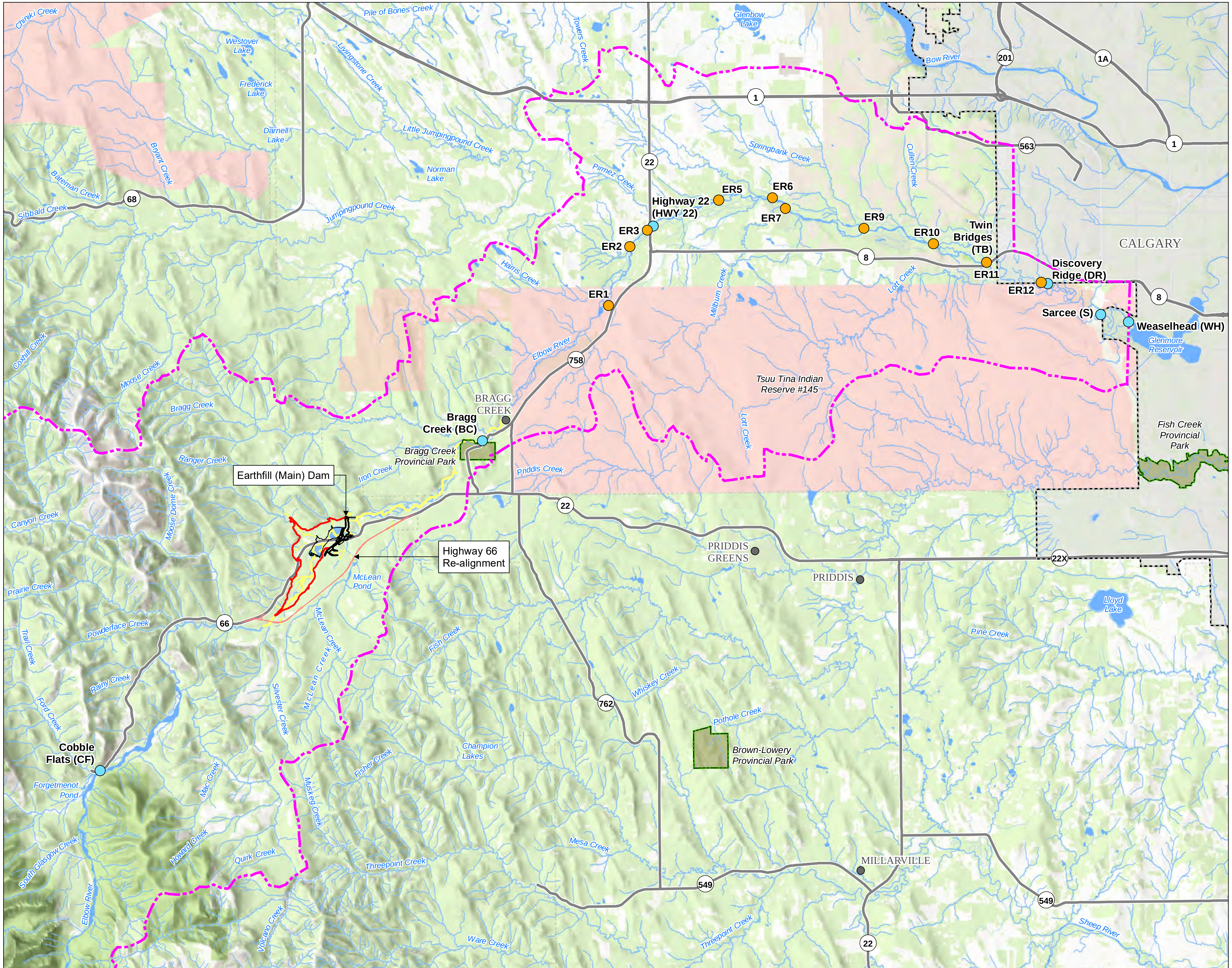
A study completed by the University of Calgary on benthic communities within the Elbow River watershed included sampling sites from Cobble Flats (i.e., upstream from the MC1 Option area) to the Weaselhead Natural Area immediately west of the City of Calgary (i.e., downstream from the MC1 Option area) (Benoit et al. 2016) (**Figure 7.3-4**)**.** The Cobble Flats site, upstream of the LAA, and the Bragg Creek site, within the LAA, includes similar benthic communities most likely to be present in the area of MC1. Comparing the abundance of EPT to the overall invertebrate community (percent EPT index) is a common method of determining freshwater stream health. In general, EPT have lower tolerance for environmental changes and pollution, compared to others (e.g., Chironomidae family), which can survive in areas with a higher fine sediment load and pollutant concentration (Benoit et al., 2016), therefore a higher percentage of EPT in a stream is indicative of a healthier aquatic ecosystem. The percent EPT at Cobble Flats and Bragg Creek was 94.2% and 96.3%, respectively. EPT abundance showed a decreasing trend moving from the LAA downstream toward the City of Calgary (Highway 22 90.8%, Twin Bridges 83.8%, Discovery Ridge 48.6%, Sarcee 52.0%, Weaselhead Natural Area 0%). Other indices to describe the health of the benthic community near the LAA such as richness (presence of various species calculated by area), evenness (distribution of the communities of species), and a diversity index (combines species richness and evenness) were rated as healthy until declining in the Weaselhead Natural Area.

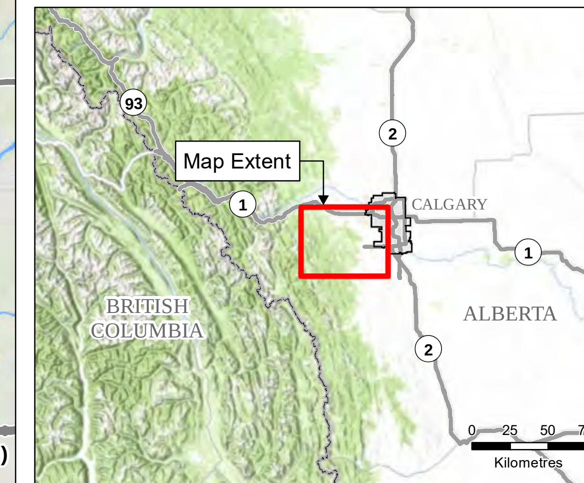
Data collected on behalf of the SR1 Project and provided by Stantec (Stantec 2016) (**Figure 7.3-4**), suggests a similar trend, with sites sampled on the Elbow River upstream of Highway 22 having a higher percent EPT (Site ER1=39%, Site ER2=42%, Site ER3=11%), compared to sites sampled downstream of Highway 22 (Site ER5=35%, Site ER6=6%, Site ER7=10%, Site ER9=16%, Site ER10=7%, Site ER11=13%, Site ER12=8%.

In general, there is limited literature on benthic and periphyton community analysis in the Elbow River watershed. Should MC1 be considered further beyond this suitability assessment, periphyton community analysis should be conducted to include species analysis and chlorophyll a analysis, which would characterize changes in algal biomass and potential effects to the food web.

Elbow River at McLean Creek Dam (MC1)

Historical Locations of Benthic Sampling Studies





Legend

- Aquatic Environment Local Assessment Area
- Aquatic Environment Regional Assessment Area
- MC1 Option Dam
- Highway 66 Re-alignment
- 2013 Flood Event Line
- Permanent Pond
- Hamlet
- Highway
- Reserve
- Provincial Park
- Urban Area
- Watercourse
- Waterbody

Historical Benthic Sample Locations

- Benoit et al., 2016
- Stantec, 2016

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
- Historical Benthic Sample Locations: University of Calgary, Benoit et al., 2016; Stantec, 2016
- Background Image: ESRI World Topographic Map
- Inset Maps: ESRI World Topographic Map

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Kilometres

NAD 1983 10TM AEP Resource

Page Size: 11" x 17"

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Alberta Transportation

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Other Fish Habitat Characteristics

The characteristics of fish habitat within some of the watercourses within the LAA were first documented in terms of their quantity and overall quality (habitat assessment) in fall 2016. In spring/summer 2017, habitat characteristics were collected for the first time at the following watercourses: McLean Creek (two sites), Connop Creek, unnamed tributaries D, E, F, G, H, I, J, and K. Additional information (i.e., supplementing data collected in 2016) was also collected in 2017 from unnamed tributaries A, B and C, and the zone of influence for the Elbow River was expanded from 1 km to 10 km downstream from the MC1 dam. This information, along with that from other relevant sources, extended the understanding of fish habitat potential as first provided on behalf of MC1by AMEC (2015). A summary of where suitable fish habitat exists, specific to the indicator species and relative to the MC1 footprint, is provided in **Section 7.3.2.3**. Information collected during habitat assessments and supplementary review of existing information would serve as the basis for an evaluation of potential habitat losses and gains.

Details related to the methodology of the habitat assessments were based on industry standards within the province of Alberta, although were customized to meet the needs of this suitability assessment. The following summarizes the results of the habitat assessments within the Elbow River, Ranger Creek, and unnamed tributaries A, B, C, D, E, F, G, H, I, J, K, Connop Creek, and McLean Creek at its confluence with the Elbow River (McLean Creek confluence), and at its crossing with realigned Highway 66 (McLean Creek crossing). Site atlases for each watercourse are provided in **Appendix 7-F.** A summary of where suitable (i.e., marginal or higher) habitat potential ratings were assigned for indicator species within watercourses in the LAA is provided in **Table 7.3-10**. In this summary table, the presence of habitat deemed to be of marginal or higher importance to indicator species is represented by a check mark. Where dashed lines occur, no suitable habitat exists (nil potential) for indicator species.

Elbow River

In addition to the review of existing habitat potential and use data, field based habitat assessments were conducted by the MC1 study team in fall 2016 and summer 2017. Habitat assessed extended from a point upstream of the potential Highway 66 realignment crossing (i.e., approximately 8 km upstream from the MC1 dam location) to a point approximately 10 km downstream from the MC1 dam location (**Figure 7.3-1)**.

Within the assessed reach, the Elbow River's historical irregular meander pattern has been exaggerated by the consequences of the 2013 flood. As AMEC (2015) described, the river within the assessed reach is frequently braided with associated transitory depositional features (e.g., mid-channel, point, and side bars) and unvegetated islands. Bank scour was evident through the LAA, with exposed coarse substrate visible on many vertical and sloping banks. Bedrock influence remains evident in locations (e.g., at the proposed MC1 footprint), particularly where the channel is forced through steep canyon walls. Flood sign remained obvious, three years post-flood, with LWD deposits occurring in a clump pattern, typically in depositional areas.

Water quality parameters (i.e., dissolved oxygen concentration, conductivity, and pH) were all expected to be within the guidelines for the protection of aquatic life (as defined in CCME 2007) at all times of year, as discussed in **Section 6.5 Water Quality**. Water temperatures were also expected to be within the suitable ranges for all life stages of the indicator species, although as with many other watercourses in southern Alberta, temperatures may have exceeded upper thresholds for cold water species on occasion. Detailed temperature data collected within the Elbow River during the spring 2017 field assessment is presented below.

The average channel width through the assessed reach was 57.1 m, compared to average wetted width of 20.0 m. Banks were predominantly vertical and sloping in nature, with unstable banks noted in sections of concentrated flow. Given the prevalence of gravel and cobble bank compositions, limited undercut banks are present. Water depth averaged 1.0 m at the time of the original assessment (i.e., October 5 and 6 2016), and ranged between 0.2 m and over 2.5 m in depth. Discharge within the Elbow River during the original habitat assessment (fall 2016) was approximately 5.8 m^3/s (Government of Alberta 2017a), and was considered average for the time of year. In comparison, discharge during the habitat assessment (May 3, 2017) of the Elbow River was approximately 6.0 m^3/s.

Habitat morphology within the assessed reach was dominated by riffle habitat units (65%), followed by shallow run (R3) (15%), moderate run (R2) (4%), deep run (R1) (4%), snye or backwater (SN) (3%), and alternating shallow run and riffle (2%) habitat types. Other habitat types were also present (e.g., deep pool (P3), rapid, cascade, shallow pool (P3), moderately deep pool (P2), and flat, but to a lesser extent. Instream cover opportunities for fish are provided primarily by LWD, although depth, aquatic vegetation, and substrate also provide some cover. Cover sources outside the wetted width included debris jams (LWD), overhanging vegetation, and undercut banks. As with instream cover opportunities, LWD provided the bulk of cover from above.

Within the assessed reach, riparian habitat primarily consisted of lodgepole pine (*Pinus contorta*) and white spruce (*Picea glauca*), with the understorey consisting of buffaloberry (*Shepherdia canadensi*s), alder (*Alnus* spp.), juniper (*Juniperus* spp.), and bearberry (*Arctostaphylos alpian*) (AMEC 2015). Riparian habitat is functional for fish in many locations (where flow remains adjacent to the bank); however, given the extensive scour and channel migration within the flood plain resulting from the 2013 flood, riparian habitat is not always of substantive value to fish within the Aquatic Environment LAA and RAA. Riparian habitat is not contiguous throughout the assessed reach, as several existing anthropogenic disturbances were noted during a riparian disturbance mapping in 2016 (Eisler and Popowich 2017). This study indicates that seven flood armouring or private infrastructure elements have disturbed a total of 2,149 m of riparian habitat within the assessed reach. Within the broader scope of Eisler and Popowich (2017), a total of 7,887 m (or 6.3%) of all riparian habitat was noted as disturbed between River Cove Group Campground and the Glenmore Reservoir (i.e., an area encompassed by the RAA). These values do not include areas where the functionality of riparian habitat has been diminished by the 2013 flood. Specific to the area near Allen Bill Day Use Area, a riparian health assessment of an 890-m-long site (ELB23) along the north bank of the Elbow River by Alberta Riparian Habitat Management Society (2012) indicated that riparian habitat at this location was “Unhealthy”; i.e., severe impairment to riparian functions due to management or natural causes (Alberta Riparian Habitat Management Society 2012). This assessment was completed prior the 2013 floods, however, and some change to the area has likely occurred.

Temperatures recorded in the Elbow River within the approximate area of where the permanent pond would occur ranged between 3.8 ºC and 14.9 ºC**.** Temperatures 5 km downstream of the proposed dam location ranged from 4.0 ºC to 13.4 ºC, while temperatures 10 km downstream ranged from 4.5 ºC to 15.3 ºC. Daily averages from each of the logger locations (see **Figure 7.3-5** to **Figure 7.3-7**) were within the tolerable ranges for bull trout and mountain whitefish, the two indicator species most sensitive to elevated water temperatures. Given their relative tolerance for slightly higher water temperatures, these average daily temperatures were also within the acceptable ranges for brown trout and rainbow trout.

In general, the Elbow River provides suitable habitat for all life stages of each of the indicator species, as well as that for the other three species known to occur in the MC1 Option area (e.g., brook trout). As evidenced by results from spawning surveys occurring since 2014, the assessed reach provides important spawning habitat potential for bull trout, mountain whitefish, and brown trout. Confirmation of habitat potential to support rainbow trout spawning was scheduled for summer 2017; however, the survey was not feasible due to high and extended turbidity conditions. Habitats where spawning of indicator species was observed or presumed in the Elbow River (see **Figure 7.3-8** to **Figure 7.3-30**) should be considered sensitive areas. Diversity of cover and habitat complexity indicate the assessed reach provides important habitat potential for each of the four indicator species. The availability of woody debris instream, combined with the prevalence of coarse substrate and suitable water quality, suggest that benthic invertebrate communities is likely thriving in the assessed reach, further supporting the presumption that an important feeding potential exists for each of the indicator species. Wintering habitat exists within the Elbow River, although it is most abundantly for small-bodied fish (e.g., juveniles). Although there were 14 deep pool habitats (greater than 1 m) identified within the Elbow River during the habitat assessment, they occurred typically as secondary units, and were less than 20 m in length. Notably, the majority of wintering habitat for adult fish in the assessed reach was encountered downstream from MC1.

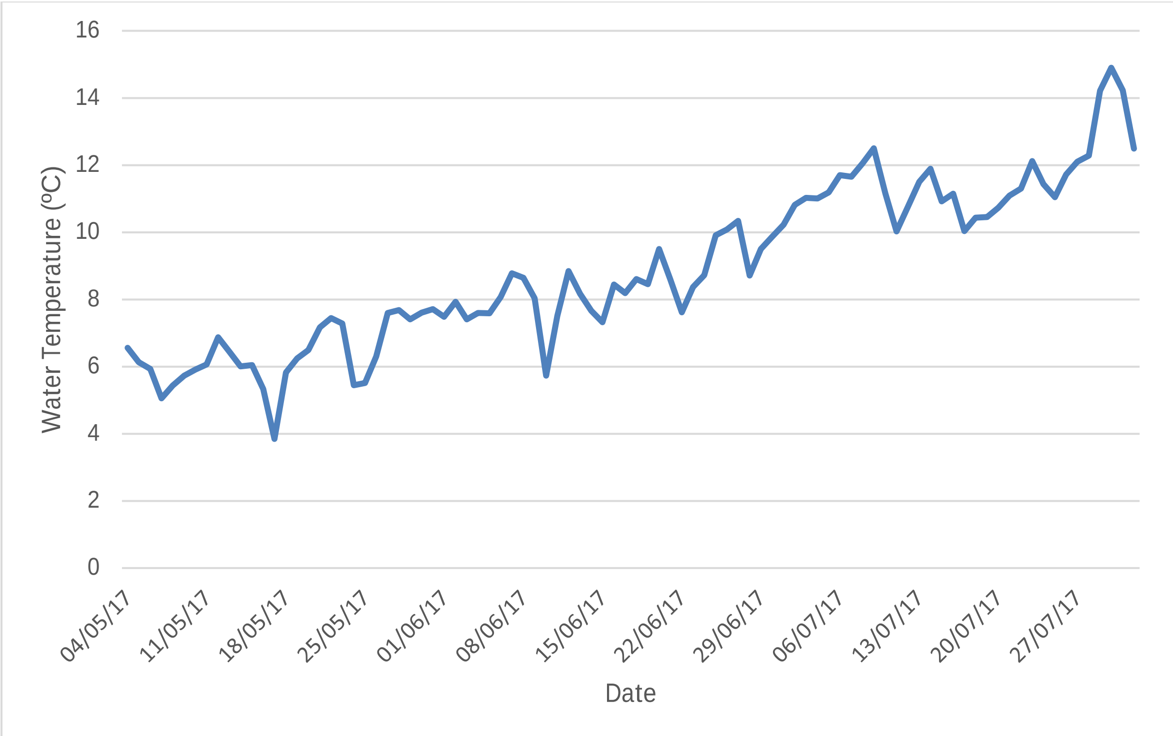


Figure 7.3-5 Average Daily Water Temperature in the Elbow River at Permanent Pond Location, Summer 2017

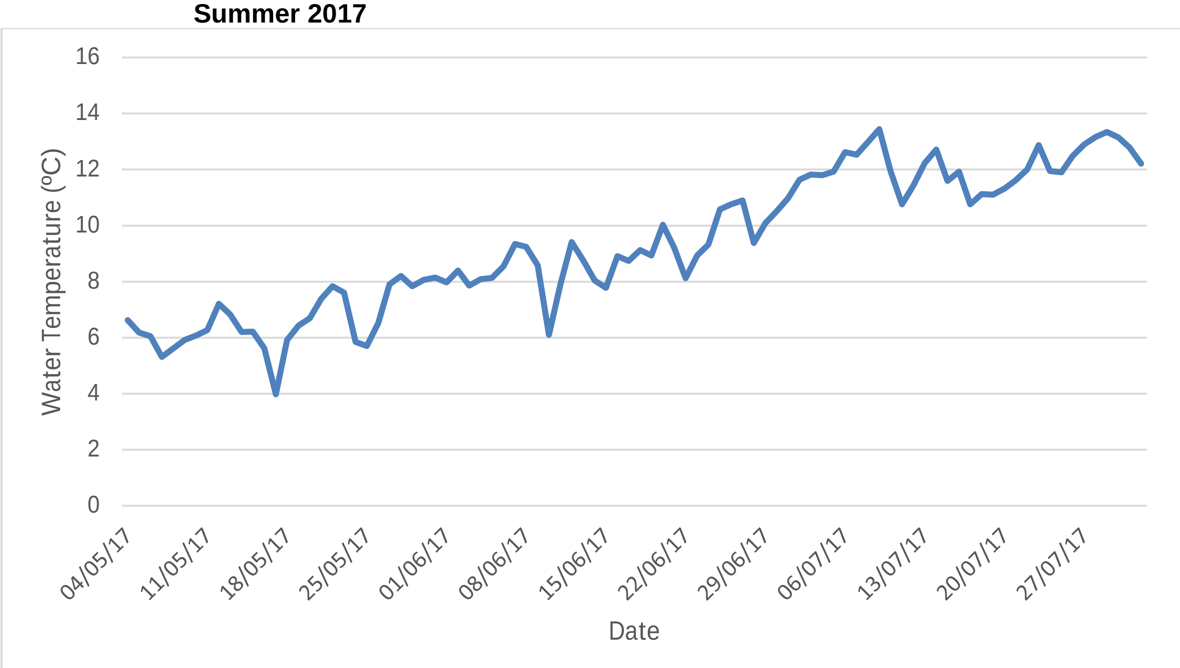


Figure 7.3-6 Average Daily Water Temperatures in the Elbow River 5 km Downstream from the MC1 Dam Location, Summer 2017

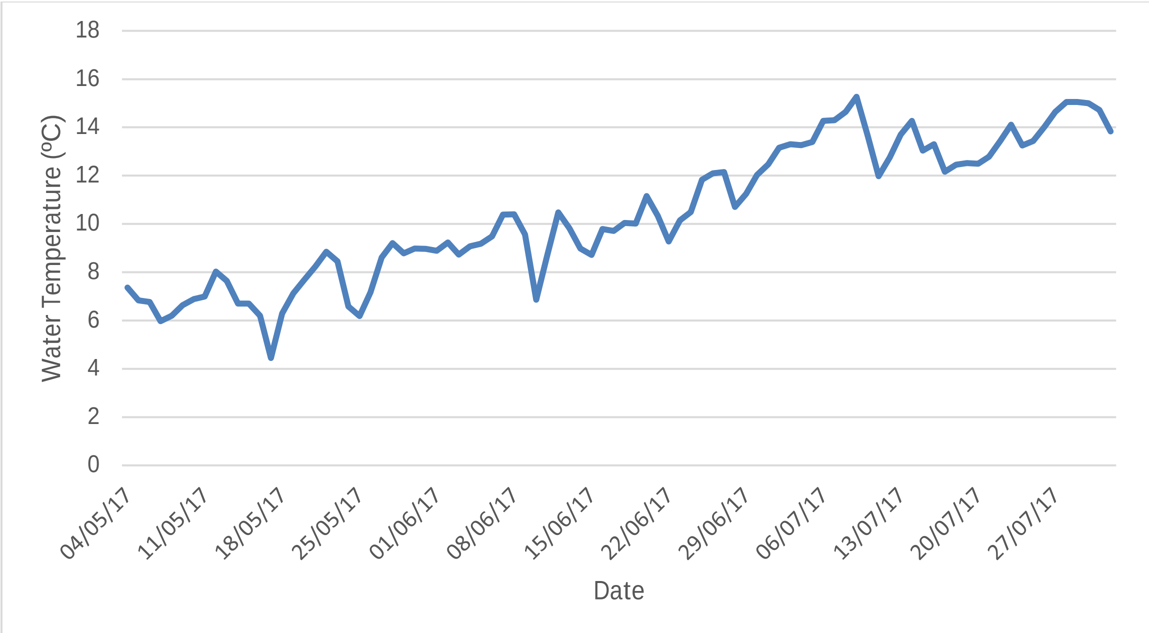


Figure 7.3-7 Average Daily Water Temperature in the Elbow River 10 km Downstream from the MC1 Dam Location, Summer 2017

Table 7.3-10 Fish Habitat Suitability for Indicator Species in the Local Assessment Area

Species	Upstream From MC1 Footprint				MC1 Footprint				Downstream From MC1 Footprint			
	Spawning	Rearing	Feeding	Wintering	Spawning	Rearing	Feeding	Wintering	Spawning	Rearing	Feeding	Wintering
Elbow River												
Bull trout	ü	ü	ü	ü	ü	ü	ü	ü	ü	ü	ü	ü
Mountain whitefish	ü	ü	ü	ü	ü	ü	ü	ü	ü	ü	ü	ü
Brown trout	ü	ü	ü	ü	ü	ü	ü	ü	ü	ü	ü	ü
Rainbow trout	ü	ü	ü	ü	ü	ü	ü	ü	ü	ü	ü	ü
Ranger Creek												
Bull trout	--	ü	--	ü	--	--	--	--				
Mountain whitefish	--	ü	--	ü	--	--	--	--				
Brown trout	ü	ü	ü	ü	--	--	--	--				
Rainbow trout	ü	ü	ü	ü	--	--	--	--				

Species	Upstream From MC1 Footprint				MC1 Footprint				Downstream From MC1 Footprint			
	Spawning	Rearing	Feeding	Wintering	Spawning	Rearing	Feeding	Wintering	Spawning	Rearing	Feeding	Wintering
unnamed tributary A												
Bull trout	--	ü	--	--								
Mountain whitefish	--	--	--	--								
Brown trout	--	ü	--	--								
Rainbow trout	ü	ü	ü	--								
unnamed tributary B												
Bull trout	--	--	--	--								
Mountain whitefish	--	--	--	--								
Brown trout	--	--	--	--								
Rainbow trout	--	--	--	--								
unnamed tributary C												
Bull trout	--	--	--	--	--	--	--	--				
Mountain whitefish	--	--	--	--	--	--	--	--				
Brown trout	--	--	--	--	--	--	--	--				
Rainbow trout	--	--	--	--	--	--	--	--				
unnamed tributary D												
Bull trout					--	--	--	--	--	--	--	--
Mountain whitefish					--	--	--	--	--	--	--	--
Brown trout					--	--	--	--	--	--	--	--
Rainbow trout					--	--	--		--	--	--	--
unnamed tributary E												
Bull trout	--	--	--	--								
Mountain whitefish	--	--	--	--								
Brown trout	--	--	--	--								
Rainbow trout	--	--	--	--								

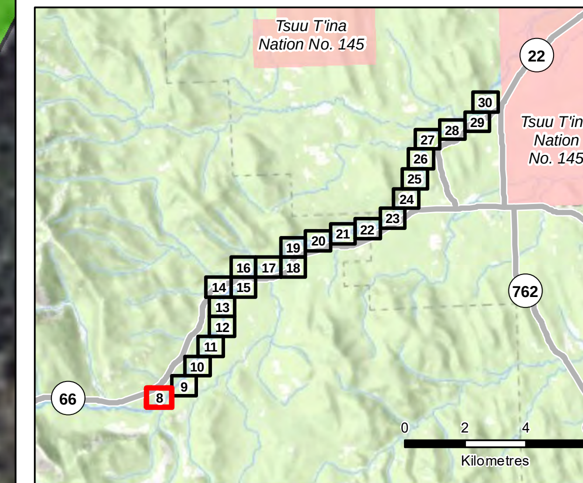
Species	Upstream From MC1 Footprint				MC1 Footprint				Downstream From MC1 Footprint			
	Spawning	Rearing	Feeding	Wintering	Spawning	Rearing	Feeding	Wintering	Spawning	Rearing	Feeding	Wintering
unnamed tributary F												
Bull trout	--	--	--	--								
Mountain whitefish	--	--	--	--								
Brown trout	--	--	--	--								
Rainbow trout	--	--	--	--								
unnamed tributary G												
Bull trout	--	--	--	--								
Mountain whitefish	--	--	--	--								
Brown trout	--	--	--	--								
Rainbow trout	--	--	--	--								
unnamed tributary H												
Bull trout	--	--	--	--								
Mountain whitefish	--	--	--	--								
Brown trout	--	--	--	--								
Rainbow trout	--	--	--	--								
unnamed tributary I												
Bull trout									--	--	--	--
Mountain whitefish									--	--	--	--
Brown trout									--	--	--	--
Rainbow trout									--	--	--	--
unnamed tributary J												
Bull trout									--	--	--	--
Mountain whitefish									--	--	--	--
Brown trout									--	--	--	--
Rainbow trout									--	--	--	--

Species	Upstream From MC1 Footprint				MC1 Footprint				Downstream From MC1 Footprint			
	Spawning	Rearing	Feeding	Wintering	Spawning	Rearing	Feeding	Wintering	Spawning	Rearing	Feeding	Wintering
unnamed tributary K												
Bull trout	--	ü	--	--								
Mountain whitefish	--	--	--	--								
Brown trout	--	ü	--	--								
Rainbow trout	ü	ü	ü	--								
Connop Creek												
Bull trout									--	ü	--	--
Mountain whitefish									--	--	--	--
Brown trout									--	ü	ü	--
Rainbow trout									ü	ü	ü	--
McLean Creek (confluence)												
Bull trout					--	ü	ü	ü	--	ü	ü	ü
Mountain whitefish					--	--	--	--	--	--	--	--
Brown trout					--	ü	ü	ü	--	ü	ü	ü
Rainbow trout					ü	ü	ü	ü	ü	ü	ü	ü
McLean Creek (crossing)												
Bull trout					--	ü	ü	ü				
Mountain whitefish					--	--	--	--				
Brown trout					ü	ü	ü	ü				
Rainbow trout					ü	ü	ü	ü				

Note – shaded cells indicate where habitat within individual watercourses does not exist relative to the location of the MC1 footprint.

Elbow River at McLean Creek Dam (MC1)

Elbow River Habitat Units within the Local Assessment Area



Legend

Channel Unit/Habitat

- Beaver impoundment
- Cascade
- Interstitial Flow
- Pool
- Rapid
- Riffle
- Run
- Snye
- Flow Direction
- Highway Direction Arrow
- Highway or Road

- Congregation of adult mountain whitefish (2007) (Eisler and Popowich 2008)
- Congregation of adult mountain whitefish (2016)
- bull trout redd (2016)
- Mountain Whitefish Snorkel Survey

Channel Unit/Habitat

R1	Class 1 Run; Deep Run >1.0 m
R2	Class 2 Run; Moderate Run 0.75-1.0 m
R3	Class 3 Run; Shallow Run < 0.75 m
P1	Class 1; Deep Pool >1.0 m
P2	Class 2; Moderate Pool 0.75-1.0 m
P3	Class 3; Shallow Pool < 0.75 m

CA	Cascade	RF	Riffle
CH	Chute	SL	Slough
FL	Flat	SN	Snye
RA	Rapid	SF	Subsurface Flow

Substrates

Be	Bedrock
Bo	Boulder
Co	Cobble
Gr	Gravel
Sa	Sand
C/S	Clay Silt
Or	Organics

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
- Aerial Image: SPOT 1.5 m, 2016
- 2014 Bull Trout Locations: AMEC, 2015
- 2007 Mountain Whitefish Locations: Eisler and Popowich, 2008

N

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Metres

NAD 1983 UTM Zone 11N

Page Size: 11" x 17"

2025-001.01	Production Date: Sep 15, 2017	Figure 7.3-8

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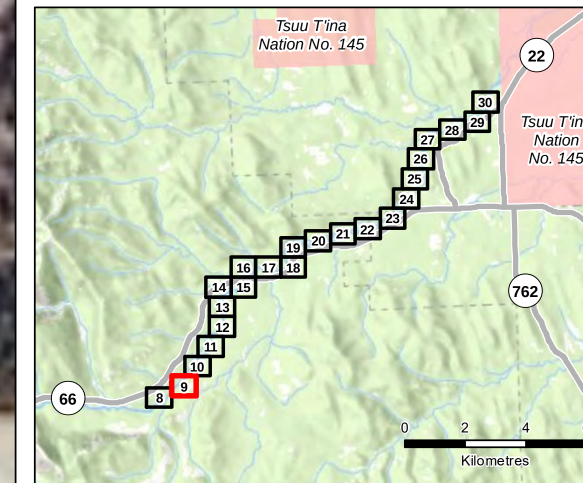
Elbow River at McLean Creek Dam (MC1)

Elbow River Habitat Units within the Local Assessment Area



Legend

Channel Unit/Habitat

- Beaver impoundment
- Cascade
- Interstitial Flow
- Pool
- Rapid
- Riffle
- Run
- Snye
- Flow Direction
- Highway or Road

- Congregation of adult mountain whitefish (2016)
- bull trout redd (2016)
- Mountain Whitefish Snorkel Survey
- Stolen Water Temperature Logger

Channel Unit/Habitat		Substrates	
R1	Class 1 Run; Deep Run >1.0 m	Be	Bedrock
R2	Class 2 Run; Moderate Run 0.75-1.0 m	Bo	Boulder
R3	Class 3 Run; Shallow Run < 0.75 m	Co	Cobble
P1	Class 1; Deep Pool >1.0 m	Gr	Gravel
P2	Class 2; Moderate Pool 0.75-1.0 m	Sa	Sand
P3	Class 3; Shallow Pool < 0.75 m	C/S	Clay Silt
		Or	Organics

CA	Cascade	RF	Riffle
CH	Chute	SL	Slough
FL	Flat	SN	Snye
RA	Rapid	SF	Subsurface Flow

Notes

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- 2007 Mountain Whitefish Locations: Eisler and Popowich, 2008

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Metres

NAD 1983 UTM Zone 11N

Page Size: 11" x 17"

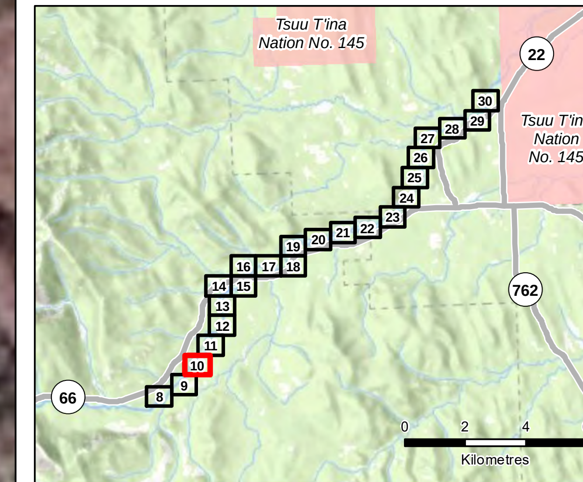
2025-001.01	Production Date: Sep 15, 2017	Figure 7.3-9

HEMMERA

Alberta Transportation

Elbow River at McLean Creek Dam (MC1)

Elbow River Habitat Units within the Local Assessment Area



Legend

Channel Unit/Habitat
- Beaver impoundment
- Cascade
- Interstitial Flow
- Pool
- Rapid
- Riffle
- Run
- Snye
- Flow Direction
- Highway or Road

- Congregation of adult mountain whitefish (2016)
- brown trout redd (2016)
- bull trout redd (2014) (AMEC 2015)
- Mountain Whitefish Snorkel Survey

Channel Unit/Habitat		Substrates	
R1	Class 1 Run; Deep Run >1.0 m	Be	Bedrock
R2	Class 2 Run; Moderate Run 0.75-1.0 m	Bo	Boulder
R3	Class 3 Run; Shallow Run < 0.75 m	Co	Cobble
P1	Class 1; Deep Pool >1.0 m	Gr	Gravel
P2	Class 2; Moderate Pool 0.75-1.0 m	Sa	Sand
P3	Class 3; Shallow Pool < 0.75 m	C/S	Clay Silt
CA	Cascade	Or	Organics
CH	Chute		
FL	Flat		
RA	Rapid		
RF	Riffle		
SL	Slough		
SN	Snye		
SF	Subsurface Flow		

Notes

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Sources

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- 2014 Bull Trout Locations: AMEC, 2015
- 2007 Mountain Whitefish Locations: Eisler and Popowich, 2008

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Metres

NAD 1983 UTM Zone 11N

Page Size: 11" x 17"

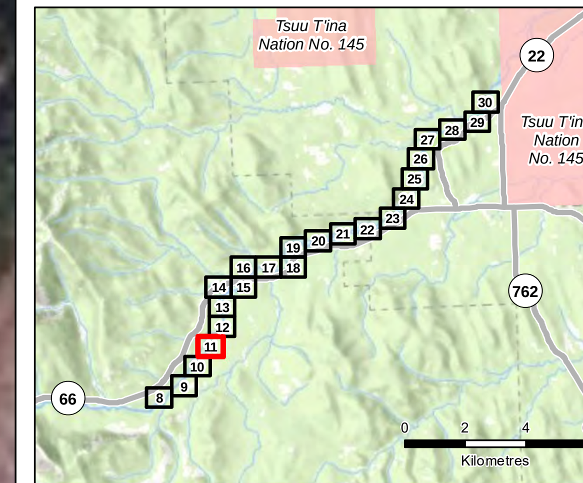
2025-001.01	Production Date: Sep 15, 2017	Figure 7.3-10

HEMMERA

Alberta Transportation

Elbow River at McLean Creek Dam (MC1)

Elbow River Habitat Units within the Local Assessment Area



Legend

Channel Unit/Habitat

- Beaver impoundment
- Cascade
- Interstitial Flow
- Pool
- Rapid
- Riffle
- Run
- Snye
- Flow Direction
- Highway or Road

brown trout redd (2016)

Channel Unit/Habitat	
R1	Class 1 Run; Deep Run >1.0 m
R2	Class 2 Run; Moderate Run 0.75-1.0 m
R3	Class 3 Run; Shallow Run < 0.75 m
P1	Class 1; Deep Pool >1.0 m
P2	Class 2; Moderate Pool 0.75-1.0 m
P3	Class 3; Shallow Pool < 0.75 m
CA	Cascade
CH	Chute
FL	Flat
RA	Rapid
RF	Riffle
SL	Slough
SN	Snye
SF	Subsurface Flow

Substrates	
Be	Bedrock
Bo	Boulder
Co	Cobble
Gr	Gravel
Sa	Sand
C/S	Clay Silt
Or	Organics

Notes

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Metres

NAD 1983 UTM Zone 11N

Page Size: 11" x 17"

2025-001.01	Production Date: Sep 15, 2017	Figure 7.3-11

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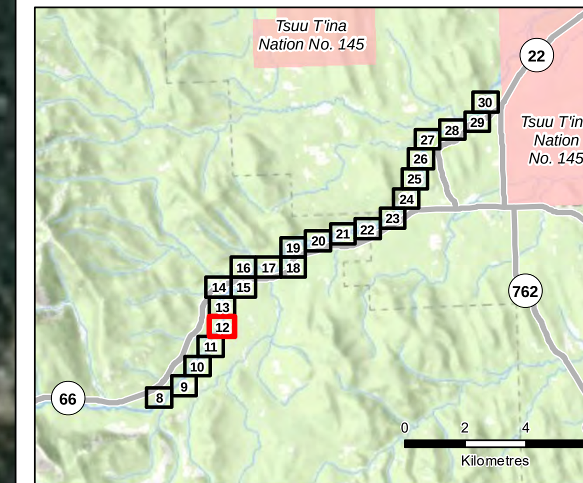
Alberta Transportation

Elbow River at McLean Creek Dam (MC1)

Elbow River Habitat Units within the Local Assessment Area



Legend

Channel Unit/Habitat

- Beaver impoundment
- Cascade
- Interstitial Flow
- Pool
- Rapid
- Riffle
- Run
- Snye
- Flow Direction
- Highway or Road
- Congregation of adult mountain whitefish (2007) (Eisler and Popowich 2008)
- brown trout redd (2016)
- bull trout redd (2014) (AMEC 2015)

Channel Unit/Habitat

R1	Class 1 Run; Deep Run >1.0 m
R2	Class 2 Run; Moderate Run 0.75-1.0 m
R3	Class 3 Run; Shallow Run < 0.75 m
P1	Class 1; Deep Pool >1.0 m
P2	Class 2; Moderate Pool 0.75-1.0 m
P3	Class 3; Shallow Pool < 0.75 m
CA	Cascade
CH	Chute
FL	Flat
RA	Rapid
RF	Riffle
SL	Slough
SN	Snye
SF	Subsurface Flow

Substrates

Be	Bedrock
Bo	Boulder
Co	Cobble
Gr	Gravel
Sa	Sand
C/S	Clay Silt
Or	Organics

Notes

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Sources

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- Aerial Image: SPOT 1.5 m, 2016
- 2014 Bull Trout Locations: AMEC, 2015
- 2007 Mountain Whitefish Locations: Eisler and Popowich, 2008

N

1:2,500

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Metres

NAD 1983 UTM Zone 11N

Page Size: 11" x 17"

2025-001.01	Production Date: Sep 15, 2017	Figure 7.3-12

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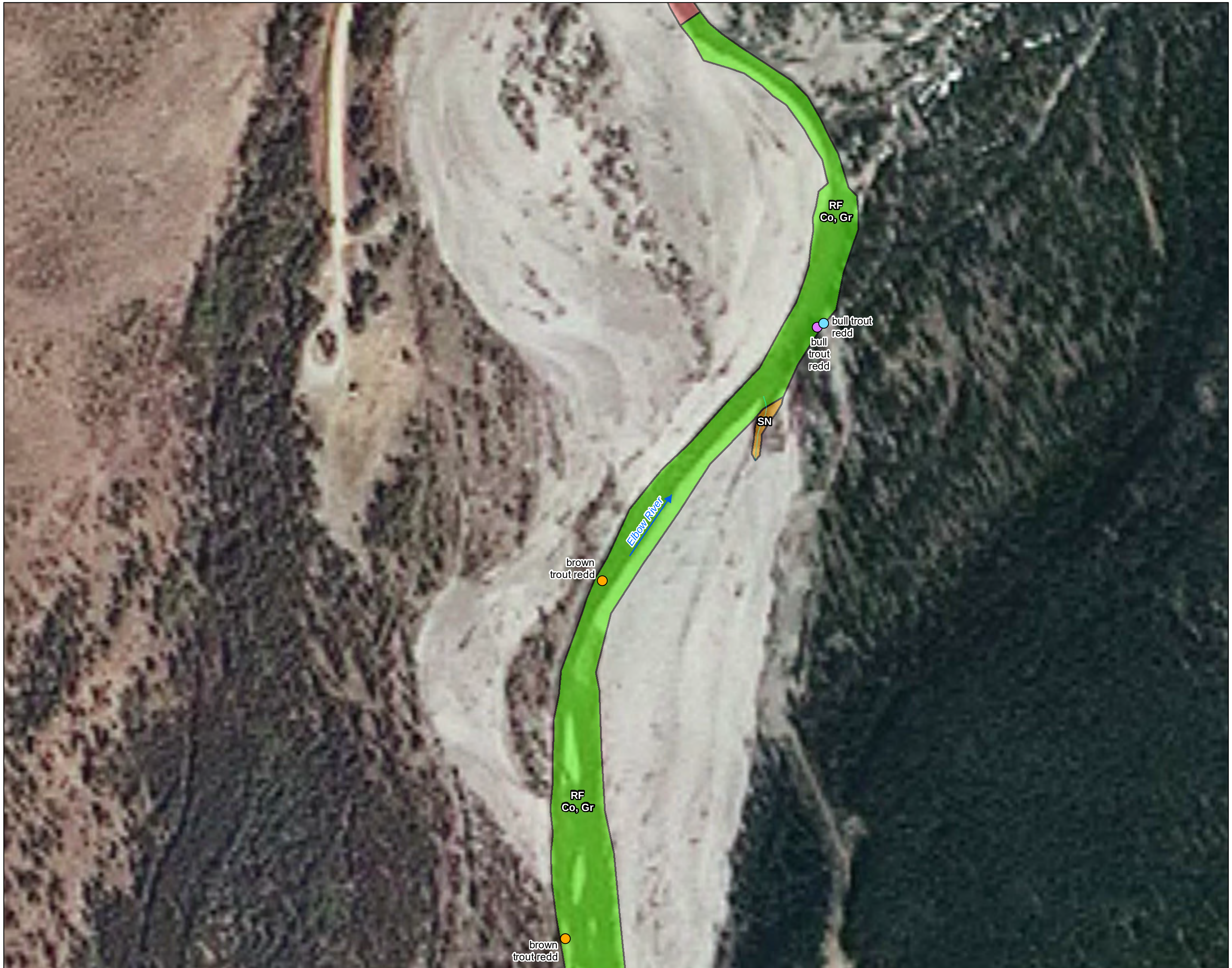
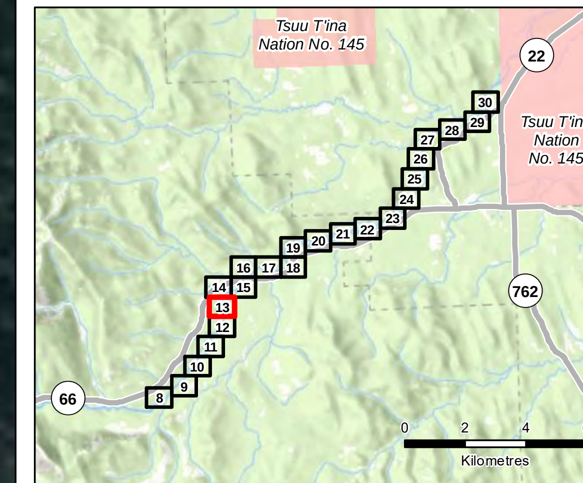
Alberta Transportation

Elbow River at McLean Creek Dam (MC1)

Elbow River Habitat Units within the Local Assessment Area





Legend

Channel Unit/Habitat

- Beaver impoundment
- Cascade
- Interstitial Flow
- Pool
- Rapid
- Riffle
- Run
- Snye
- Flow Direction
- Highway or Road

- brown trout redd (2016)
- bull trout redd (2016)
- bull trout redd (2014) (AMEC 2015)

Channel Unit/Habitat	
R1	Class 1 Run; Deep Run >1.0 m
R2	Class 2 Run; Moderate Run 0.75-1.0 m
R3	Class 3 Run; Shallow Run < 0.75 m
P1	Class 1; Deep Pool >1.0 m
P2	Class 2; Moderate Pool 0.75-1.0 m
P3	Class 3; Shallow Pool < 0.75 m
CA	Cascade
CH	Chute
FL	Flat
RA	Rapid
RF	Riffle
SL	Slough
SN	Snye
SF	Subsurface Flow

Substrates	
Be	Bedrock
Bo	Boulder
Co	Cobble
Gr	Gravel
Sa	Sand
C/S	Clay Silt
Or	Organics

Notes

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Sources

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- 2007 Mountain Whitefish Locations: Eisler and Popowich, 2008

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Metres

NAD 1983 UTM Zone 11N

Page Size: 11" x 17"

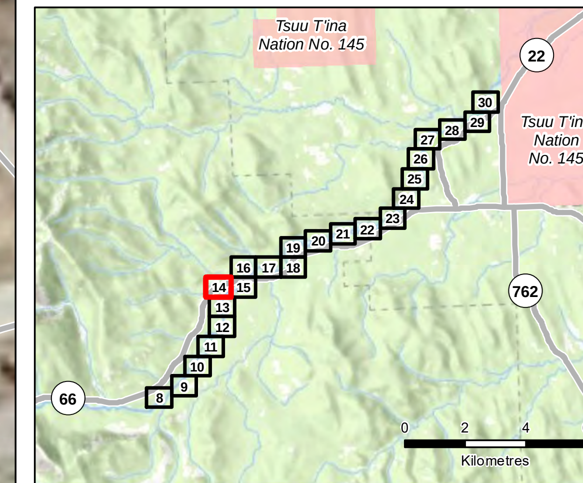
2025-001.01	Production Date: Sep 15, 2017	Figure 7.3-13

HEMMERA

Alberta Transportation

Elbow River at McLean Creek Dam (MC1)

Elbow River Habitat Units within the Local Assessment Area



Legend

Channel Unit/Habitat

- Beaver impoundment
- Cascade
- Interstitial Flow
- Pool
- Rapid
- Riffle
- Run
- Snye

- Flow Direction
- Highway Direction Arrow
- Highway or Road
- Water Temperature Logger

Channel Unit/Habitat		Substrates	
R1	Class 1 Run; Deep Run >1.0 m	Be	Bedrock
R2	Class 2 Run; Moderate Run 0.75-1.0 m	Bo	Boulder
R3	Class 3 Run; Shallow Run < 0.75 m	Co	Cobble
P1	Class 1; Deep Pool >1.0 m	Gr	Gravel
P2	Class 2; Moderate Pool 0.75-1.0 m	Sa	Sand
P3	Class 3; Shallow Pool < 0.75 m	C/S	Clay Silt
		Or	Organics

CA	Cascade	RF	Riffle
CH	Chute	SL	Slough
FL	Flat	SN	Snye
RA	Rapid	SF	Subsurface Flow

Notes

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Metres

NAD 1983 UTM Zone 11N

Page Size: 11" x 17"

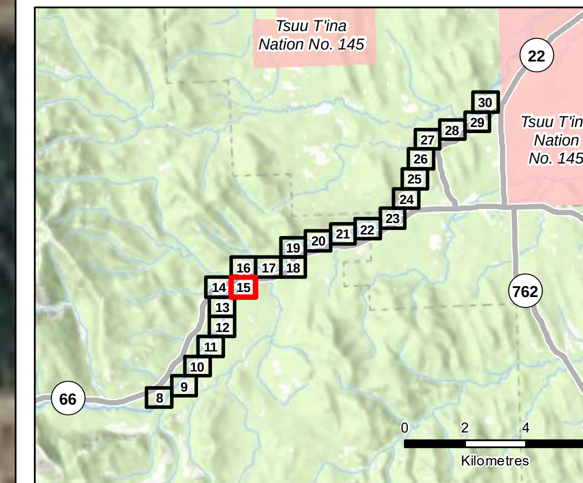
2025-001.01	Production Date: Sep 15, 2017	Figure 7.3-14

HEMMERA

Alberta Transportation

Elbow River at McLean Creek Dam (MC1)

Elbow River Habitat Units within the Local Assessment Area



Legend

Channel Unit/Habitat

- Beaver impoundment
- Cascade
- Interstitial Flow
- Pool
- Rapid
- Riffle
- Run
- Snye
- Flow Direction
- Highway Direction Arrow
- Highway or Road

- Congregation of adult mountain whitefish (2007) (Eisler and Popowich 2008)
- bull trout redd (2016)
- bull trout redd (2014) (AMEC 2015)
- Water Temperature Logger

Channel Unit/Habitat

R1	Class 1 Run; Deep Run >1.0 m
R2	Class 2 Run; Moderate Run 0.75-1.0 m
R3	Class 3 Run; Shallow Run < 0.75 m
P1	Class 1; Deep Pool >1.0 m
P2	Class 2; Moderate Pool 0.75-1.0 m
P3	Class 3; Shallow Pool < 0.75 m
CA	Cascade
CH	Chute
FL	Flat
RA	Rapid
RF	Riffle
SL	Slough
SN	Snye
SF	Subsurface Flow

Substrates

Be	Bedrock
Bo	Boulder
Co	Cobble
Gr	Gravel
Sa	Sand
C/S	Clay Silt
Or	Organics

Notes

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- 2007 Mountain Whitefish Locations: Eisler and Popowich, 2008

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Metres

NAD 1983 UTM Zone 11N

Page Size: 11" x 17"

2025-001.01	Production Date: Sep 15, 2017	Figure 7.3-15

HEMMERA

Alberta Transportation

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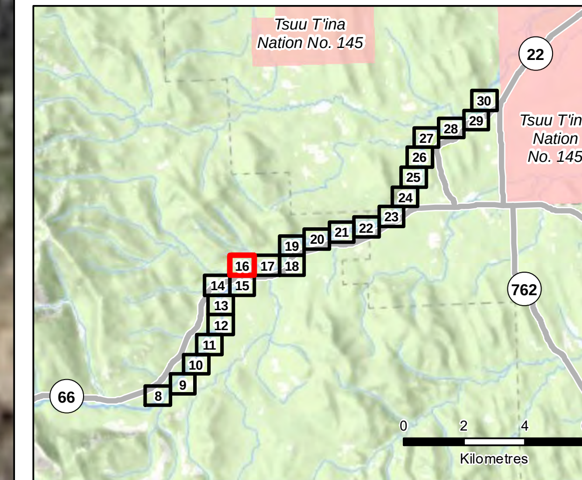
Elbow River at McLean Creek Dam (MC1)

Elbow River Habitat Units within the Local Assessment Area



Legend

Channel Unit/Habitat

- Beaver impoundment
- Cascade
- Interstitial Flow
- Pool
- Rapid
- Riffle
- Run
- Snye
- Flow Direction
- Highway or Road

- brown trout redd (2016)
- bull trout redd (2016)
- bull trout redd (2014) (AMEC 2015)
- Water Temperature Logger

Channel Unit/Habitat

R1	Class 1 Run; Deep Run >1.0 m
R2	Class 2 Run; Moderate Run 0.75-1.0 m
R3	Class 3 Run; Shallow Run < 0.75 m
P1	Class 1; Deep Pool >1.0 m
P2	Class 2; Moderate Pool 0.75-1.0 m
P3	Class 3; Shallow Pool < 0.75 m
CA	Cascade
CH	Chute
FL	Flat
RA	Rapid
RF	Riffle
SL	Slough
SN	Snye
SF	Subsurface Flow

Substrates

Be	Bedrock
Bo	Boulder
Co	Cobble
Gr	Gravel
Sa	Sand
C/S	Clay Silt
Or	Organics

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- 2007 Mountain Whitefish Locations: Eisler and Popowich, 2008

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Metres

NAD 1983 UTM Zone 11N

Page Size: 11" x 17"

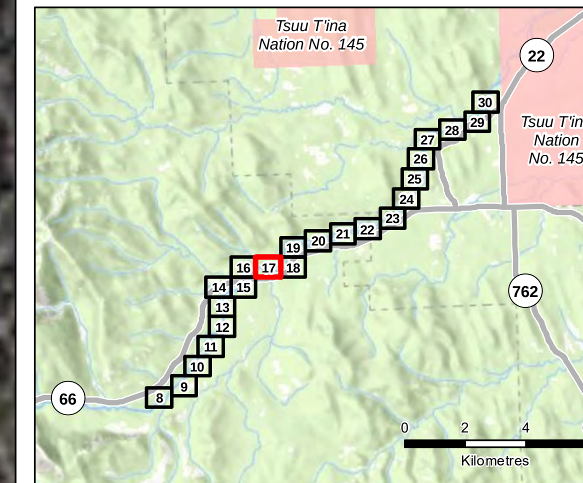
2025-001.01	Production Date: Sep 15, 2017	Figure 7.3-16

HEMMERA

Alberta Transportation

Elbow River at McLean Creek Dam (MC1)

Elbow River Habitat Units within the Local Assessment Area



Legend

Channel Unit/Habitat

- Beaver impoundment
- Cascade
- Interstitial Flow
- Pool
- Rapid
- Riffle
- Run
- Snye
- Flow Direction
- Highway Direction Arrow
- Highway or Road

Congregation of adult mountain whitefish (2007) (Eisler and Popowich 2008)

Channel Unit/Habitat

R1	Class 1 Run; Deep Run >1.0 m
R2	Class 2 Run; Moderate Run 0.75-1.0 m
R3	Class 3 Run; Shallow Run < 0.75 m
P1	Class 1; Deep Pool >1.0 m
P2	Class 2; Moderate Pool 0.75-1.0 m
P3	Class 3; Shallow Pool < 0.75 m

CA	Cascade	RF	Riffle
CH	Chute	SL	Slough
FL	Flat	SN	Snye
RA	Rapid	SF	Subsurface Flow

Substrates

Be	Bedrock
Bo	Boulder
Co	Cobble
Gr	Gravel
Sa	Sand
C/S	Clay Silt
Or	Organics

Notes

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- 2007 Mountain Whitefish Locations: Eisler and Popowich, 2008

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Metres

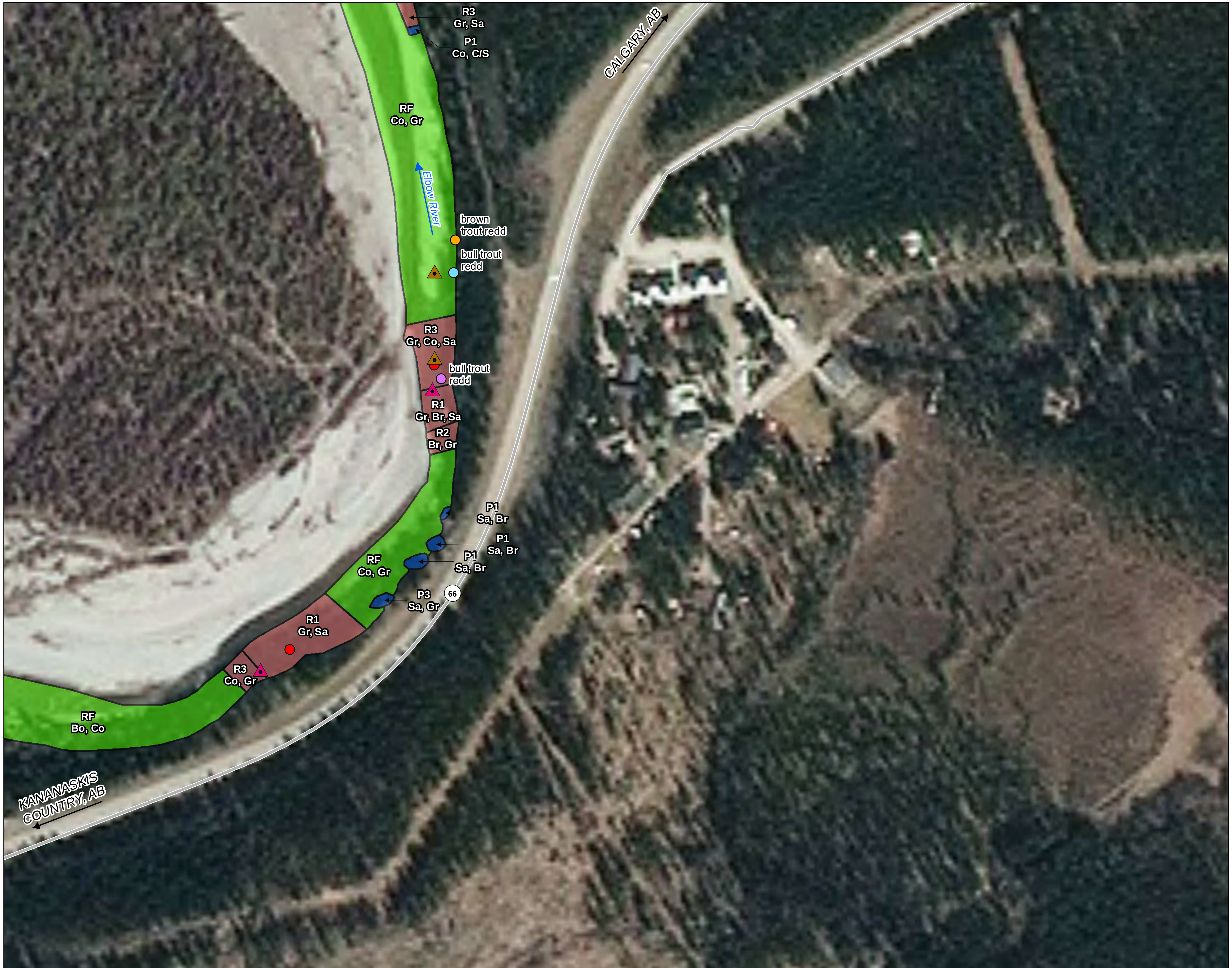
NAD 1983 UTM Zone 11N

Page Size: 11" x 17"

2025-001.01	Production Date: Sep 15, 2017	Figure 7.3-17

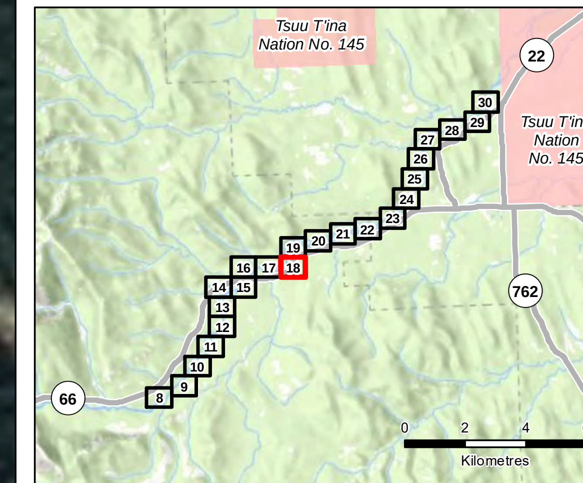
HEMMERA

Alberta Transportation



Elbow River at McLean Creek Dam (MC1)

Elbow River Habitat Units within the Local Assessment Area



Legend

Channel Unit/Habitat

- Beaver impoundment
- Cascade
- Interstitial Flow
- Pool
- Rapid
- Riffle
- Run
- Snye
- Flow Direction
- Highway Direction Arrow
- Highway or Road
- Congregation of adult mountain whitefish (2007) (Eisler and Popowich 2008)
- Congregation of adult mountain whitefish (2016)
- brown trout redd (2016)
- bull trout redd (2016)
- bull trout redd (2014) (AMEC 2015)
- Mountain Whitefish Snorkel Survey

Channel Unit/Habitat

R1 Class 1 Run; Deep Run >1.0 m
R2 Class 2 Run; Moderate Run 0.75-1.0 m
R3 Class 3 Run; Shallow Run < 0.75 m

P1 Class 1; Deep Pool >1.0 m
P2 Class 2; Moderate Pool 0.75-1.0 m
P3 Class 3; Shallow Pool < 0.75 m

CA	Cascade	RF	Riffle
CH	Chute	SL	Slough
FL	Flat	SN	Snye
RA	Rapid	SF	Subsurface Flow

Substrates

Be	Bedrock
Bo	Boulder
Co	Cobble
Gr	Gravel
Sa	Sand
C/S	Clay Silt
Or	Organics

Notes

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- 2007 Mountain Whitefish Locations: Eisler and Popowich, 2008

N

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Metres

NAD 1983 UTM Zone 11N

Page Size: 11" x 17"

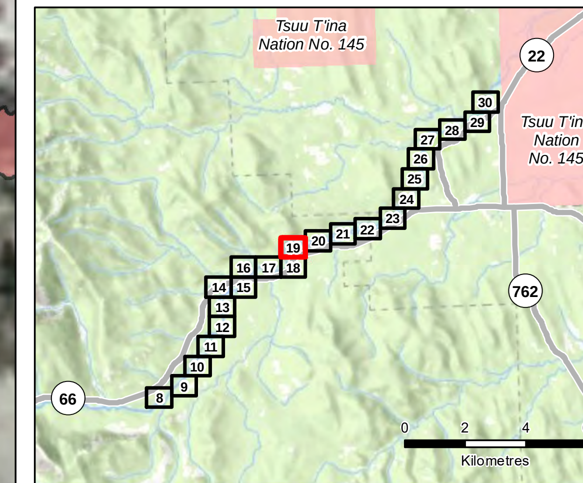
2025-001.01	Production Date: Sep 15, 2017	Figure 7.3-18

HEMMERA

Alberta Transportation

Elbow River at McLean Creek Dam (MC1)

Elbow River Habitat Units within the Local Assessment Area



Legend

Channel Unit/Habitat

- Beaver impoundment
- Cascade
- Interstitial Flow
- Pool
- Rapid
- Riffle
- Run
- Snye
- Flow Direction
- Highway Direction Arrow
- Highway or Road

- Congregation of adult mountain whitefish (2007) (Eisler and Popowich 2008)
- Congregation of adult mountain whitefish (2016)
- brown trout redd (2016)
- Mountain Whitefish Snorkel Survey

Channel Unit/Habitat

R1	Class 1 Run; Deep Run >1.0 m
R2	Class 2 Run; Moderate Run 0.75-1.0 m
R3	Class 3 Run; Shallow Run < 0.75 m
P1	Class 1; Deep Pool >1.0 m
P2	Class 2; Moderate Pool 0.75-1.0 m
P3	Class 3; Shallow Pool < 0.75 m

CA	Cascade	RF	Riffle
CH	Chute	SL	Slough
FL	Flat	SN	Snye
RA	Rapid	SF	Subsurface Flow

Substrates

Be	Bedrock
Bo	Boulder
Co	Cobble
Gr	Gravel
Sa	Sand
C/S	Clay Silt
Or	Organics

Notes

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- 2007 Mountain Whitefish Locations: Eisler and Popowich, 2008

N

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Metres

NAD 1983 UTM Zone 11N

Page Size: 11" x 17"

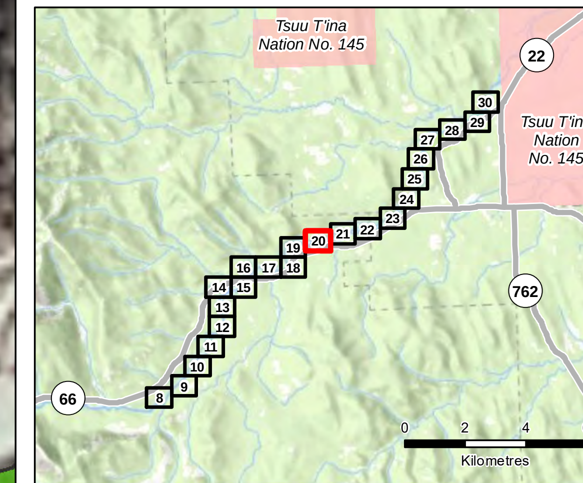
2025-001.01	Production Date: Sep 15, 2017	Figure 7.3-19

HEMMERA

Alberta Transportation

Elbow River at McLean Creek Dam (MC1)

Elbow River Habitat Units within the Local Assessment Area



Legend

Channel Unit/Habitat

- Beaver impoundment
- Cascade
- Interstitial Flow
- Pool
- Rapid
- Riffle
- Run
- Snye
- Flow Direction
- Highway Direction Arrow
- Highway or Road

Congregation of adult mountain whitefish (2007) (Eisler and Popowich 2008)

Channel Unit/Habitat

R1	Class 1 Run; Deep Run >1.0 m
R2	Class 2 Run; Moderate Run 0.75-1.0 m
R3	Class 3 Run; Shallow Run < 0.75 m
P1	Class 1; Deep Pool >1.0 m
P2	Class 2; Moderate Pool 0.75-1.0 m
P3	Class 3; Shallow Pool < 0.75 m
CA	Cascade
CH	Chute
FL	Flat
RA	Rapid
RF	Riffle
SL	Slough
SN	Snye
SF	Subsurface Flow

Substrates

Be	Bedrock
Bo	Boulder
Co	Cobble
Gr	Gravel
Sa	Sand
C/S	Clay Silt
Or	Organics

Notes

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- 2007 Mountain Whitefish Locations: Eisler and Popowich, 2008

N

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Metres

NAD 1983 UTM Zone 11N

Page Size: 11" x 17"

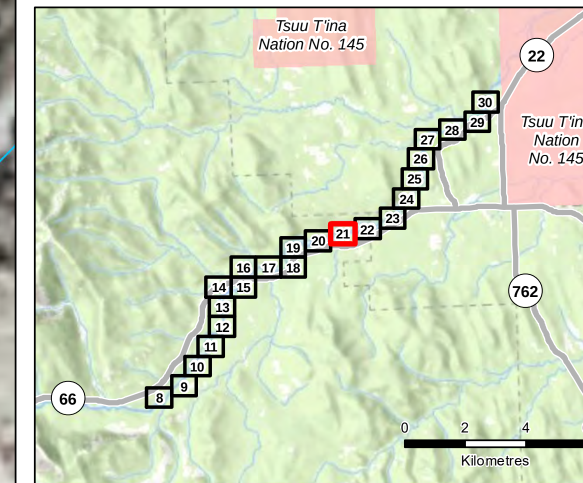
2025-001.01	Production Date: Sep 15, 2017	Figure 7.3-20

HEMMERA

Alberta Transportation

Elbow River at McLean Creek Dam (MC1)

Elbow River Habitat Units within the Local Assessment Area



Legend

Channel Unit/Habitat

- Beaver impoundment
- Cascade
- Interstitial Flow
- Pool
- Rapid
- Riffle
- Run
- Snye
- Flow Direction
- Highway or Road

Congregation of adult mountain whitefish (2007) (Eisler and Popowich 2008)

Channel Unit/Habitat		Substrates	
R1	Class 1 Run; Deep Run >1.0 m	Be	Bedrock
R2	Class 2 Run; Moderate Run 0.75-1.0 m	Bo	Boulder
R3	Class 3 Run; Shallow Run < 0.75 m	Co	Cobble
P1	Class 1; Deep Pool >1.0 m	Gr	Gravel
P2	Class 2; Moderate Pool 0.75-1.0 m	Sa	Sand
P3	Class 3; Shallow Pool < 0.75 m	C/S	Clay Silt
		Or	Organics

CA	Cascade	RF	Riffle
CH	Chute	SL	Slough
FL	Flat	SN	Snye
RA	Rapid	SF	Subsurface Flow

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N

1:2,500

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Metres

NAD 1983 UTM Zone 11N

Page Size: 11" x 17"

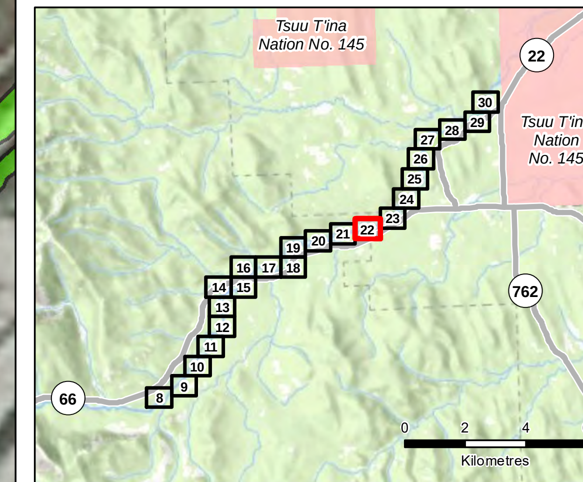
2025-001.01	Production Date: Sep 15, 2017	Figure 7.3-21

HEMMERA

Alberta Transportation

Elbow River at McLean Creek Dam (MC1)

Elbow River Habitat Units within the Local Assessment Area



Legend

Channel Unit/Habitat

- Beaver impoundment
- Cascade
- Interstitial Flow
- Pool
- Rapid
- Riffle
- Run
- Snye
- Flow Direction
- Highway Direction Arrow
- Highway or Road
- Congregation of adult mountain whitefish (2007) (Eisler and Popowich 2008)
- Water Temperature Logger

Channel Unit/Habitat

R1	Class 1 Run; Deep Run >1.0 m
R2	Class 2 Run; Moderate Run 0.75-1.0 m
R3	Class 3 Run; Shallow Run < 0.75 m
P1	Class 1; Deep Pool >1.0 m
P2	Class 2; Moderate Pool 0.75-1.0 m
P3	Class 3; Shallow Pool < 0.75 m
CA	Cascade
CH	Chute
FL	Flat
RA	Rapid
RF	Riffle
SL	Slough
SN	Snye
SF	Subsurface Flow

Substrates

Be	Bedrock
Bo	Boulder
Co	Cobble
Gr	Gravel
Sa	Sand
C/S	Clay Silt
Or	Organics

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N

1:2,500

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Metres

NAD 1983 UTM Zone 11N

Page Size: 11" x 17"

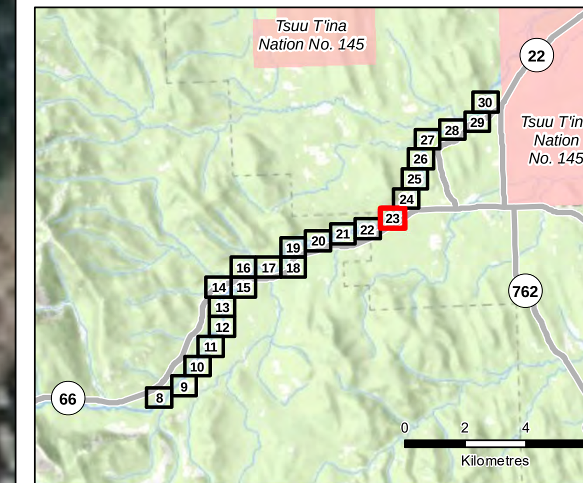
2025-001.01	Production Date: Sep 15, 2017	Figure 7.3-22

HEMMERA

Alberta Transportation

Elbow River at McLean Creek Dam (MC1)

Elbow River Habitat Units within the Local Assessment Area



Legend

Channel Unit/Habitat

- Beaver impoundment
- Cascade
- Interstitial Flow
- Pool
- Rapid
- Riffle
- Run
- Snye
- Flow Direction
- Highway Direction Arrow
- Highway or Road

Congregation of adult mountain whitefish (2007) (Eisler and Popowich 2008)

Channel Unit/Habitat

R1	Class 1 Run; Deep Run >1.0 m
R2	Class 2 Run; Moderate Run 0.75-1.0 m
R3	Class 3 Run; Shallow Run < 0.75 m
P1	Class 1; Deep Pool >1.0 m
P2	Class 2; Moderate Pool 0.75-1.0 m
P3	Class 3; Shallow Pool < 0.75 m
CA	Cascade
CH	Chute
FL	Flat
RA	Rapid
RF	Riffle
SL	Slough
SN	Snye
SF	Subsurface Flow

Substrates

Be	Bedrock
Bo	Boulder
Co	Cobble
Gr	Gravel
Sa	Sand
C/S	Clay Silt
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N

1:2,500

0 50 100 150

Metres

NAD 1983 UTM Zone 11N

Page Size: 11" x 17"

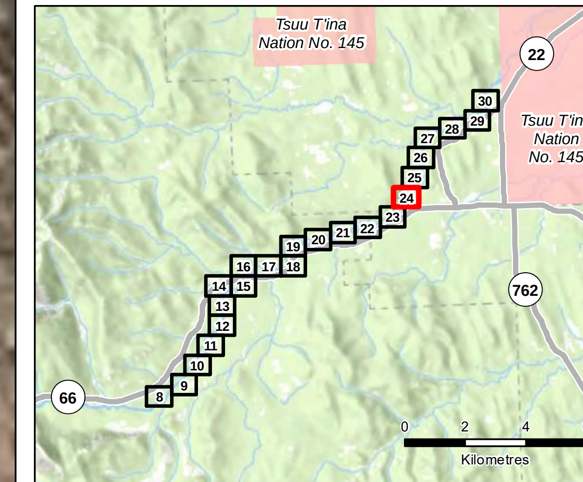
2025-001.01	Production Date: Sep 15, 2017	Figure 7.3-23

HEMMERA

Alberta Transportation

Elbow River at McLean Creek Dam (MC1)

Elbow River Habitat Units within the Local Assessment Area



Legend

Channel Unit/Habitat

- Beaver impoundment
- Cascade
- Interstitial Flow
- Pool
- Rapid
- Riffle
- Run
- Snye
- Flow Direction
- Highway or Road

Congregation of adult mountain whitefish (2007) (Eisler and Popowich 2008)

Channel Unit/Habitat

R1	Class 1 Run; Deep Run >1.0 m
R2	Class 2 Run; Moderate Run 0.75-1.0 m
R3	Class 3 Run; Shallow Run < 0.75 m
P1	Class 1; Deep Pool >1.0 m
P2	Class 2; Moderate Pool 0.75-1.0 m
P3	Class 3; Shallow Pool < 0.75 m
CA	Cascade
CH	Chute
FL	Flat
RA	Rapid
RF	Riffle
SL	Slough
SN	Snye
SF	Subsurface Flow

Substrates

Be	Bedrock
Bo	Boulder
Co	Cobble
Gr	Gravel
Sa	Sand
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N

1:2,500

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Metres

NAD 1983 UTM Zone 11N

Page Size: 11" x 17"

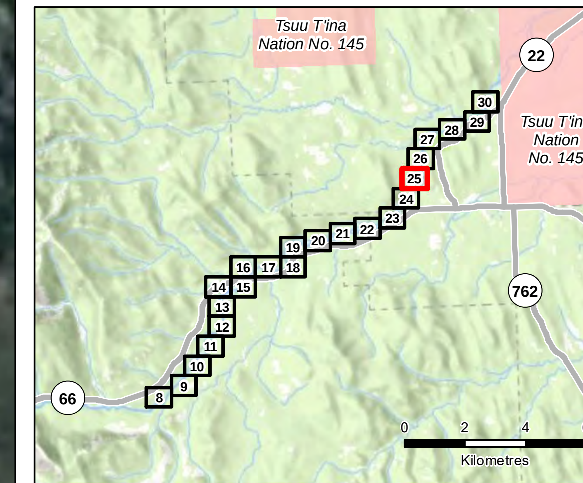
2025-001.01	Production Date: Sep 15, 2017	Figure 7.3-24

HEMMERA

Alberta Transportation

Elbow River at McLean Creek Dam (MC1)

Elbow River Habitat Units within the Local Assessment Area



Legend

Channel Unit/Habitat

- Beaver impoundment
- Cascade
- Interstitial Flow
- Pool
- Rapid
- Riffle
- Run
- Snye
- Flow Direction
- Highway or Road

Congregation of adult mountain whitefish (2007) (Eisler and Popowich 2008)

Channel Unit/Habitat			
R1	Class 1 Run; Deep Run >1.0 m		
R2	Class 2 Run; Moderate Run 0.75-1.0 m		
R3	Class 3 Run; Shallow Run < 0.75 m		
P1	Class 1; Deep Pool >1.0 m		
P2	Class 2; Moderate Pool 0.75-1.0 m		
P3	Class 3; Shallow Pool < 0.75 m		
CA	Cascade	RF	Riffle
CH	Chute	SL	Slough
FL	Flat	SN	Snye
RA	Rapid	SF	Subsurface Flow

Substrates	
Be	Bedrock
Bo	Boulder
Co	Cobble
Gr	Gravel
Sa	Sand
C/S	Clay Silt
Or	Organics

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- 2007 Mountain Whitefish Locations: Eisler and Popowich, 2008

N

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0 50 100 150

Metres

NAD 1983 UTM Zone 11N

Page Size: 11" x 17"

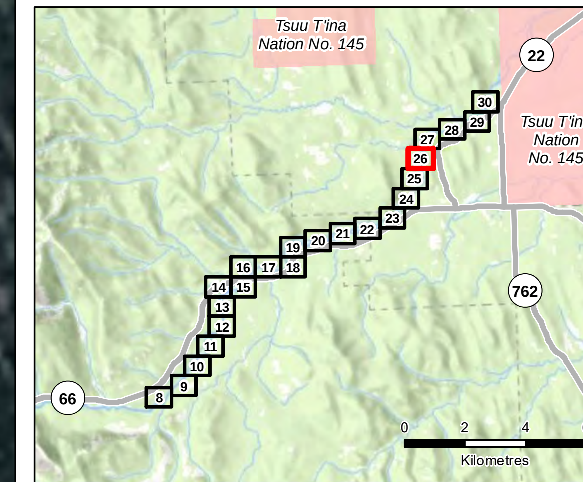
2025-001.01	Production Date: Sep 15, 2017	Figure 7.3-25

HEMMERA

Alberta Transportation

Elbow River at McLean Creek Dam (MC1)

Elbow River Habitat Units within the Local Assessment Area



Legend

Channel Unit/Habitat

- Beaver impoundment
- Cascade
- Interstitial Flow
- Pool
- Rapid
- Riffle
- Run
- Snye
- Flow Direction
- Highway or Road

Channel Unit/Habitat

R1	Class 1 Run; Deep Run >1.0 m
R2	Class 2 Run; Moderate Run 0.75-1.0 m
R3	Class 3 Run; Shallow Run < 0.75 m
P1	Class 1; Deep Pool >1.0 m
P2	Class 2; Moderate Pool 0.75-1.0 m
P3	Class 3; Shallow Pool < 0.75 m
CA	Cascade
CH	Chute
FL	Flat
RA	Rapid
RF	Riffle
SL	Slough
SN	Snye
SF	Subsurface Flow

Substrates

Be	Bedrock
Bo	Boulder
Co	Cobble
Gr	Gravel
Sa	Sand
C/S	Clay Silt
Or	Organics

Notes

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Sources

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Metres

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Page Size: 11" x 17"

2025-001.01	Production Date: Sep 15, 2017	Figure 7.3-26

HEMMERA

Alberta Transportation

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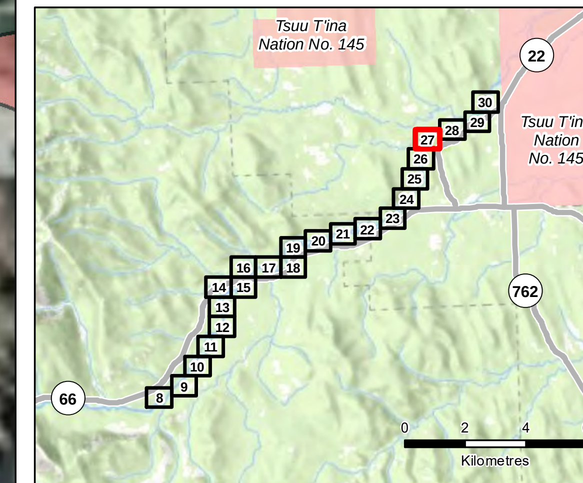
Elbow River at McLean Creek Dam (MC1)

Elbow River Habitat Units within the Local Assessment Area



Legend

Channel Unit/Habitat

- Beaver impoundment
- Cascade
- Interstitial Flow
- Pool
- Rapid
- Riffle
- Run
- Snye
- Flow Direction
- Highway Direction Arrow
- Highway or Road

Congregation of adult mountain whitefish (2007) (Eisler and Popowich 2008)

Channel Unit/Habitat

R1	Class 1 Run; Deep Run >1.0 m
R2	Class 2 Run; Moderate Run 0.75-1.0 m
R3	Class 3 Run; Shallow Run < 0.75 m
P1	Class 1; Deep Pool >1.0 m
P2	Class 2; Moderate Pool 0.75-1.0 m
P3	Class 3; Shallow Pool < 0.75 m
CA	Cascade
CH	Chute
FL	Flat
RA	Rapid
RF	Riffle
SL	Slough
SN	Snye
SF	Subsurface Flow

Substrates

Be	Bedrock
Bo	Boulder
Co	Cobble
Gr	Gravel
Sa	Sand
C/S	Clay Silt
Or	Organics

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N

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Metres

NAD 1983 UTM Zone 11N

Page Size: 11" x 17"

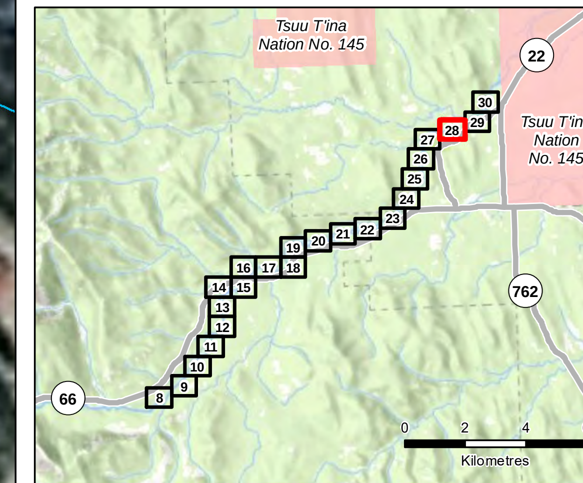
2025-001.01	Production Date: Sep 15, 2017	Figure 7.3-27

HEMMERA

Alberta Transportation

Elbow River at McLean Creek Dam (MC1)

Elbow River Habitat Units within the Local Assessment Area



Legend

Channel Unit/Habitat

- Beaver impoundment
- Cascade
- Interstitial Flow
- Pool
- Rapid
- Riffle
- Run
- Snye
- Flow Direction
- Highway Direction Arrow
- Highway or Road

Congregation of adult mountain whitefish (2007) (Eisler and Popowich 2008)

Channel Unit/Habitat		Substrates	
R1	Class 1 Run; Deep Run >1.0 m	Be	Bedrock
R2	Class 2 Run; Moderate Run 0.75-1.0 m	Bo	Boulder
R3	Class 3 Run; Shallow Run < 0.75 m	Co	Cobble
P1	Class 1; Deep Pool >1.0 m	Gr	Gravel
P2	Class 2; Moderate Pool 0.75-1.0 m	Sa	Sand
P3	Class 3; Shallow Pool < 0.75 m	C/S	Clay Silt
CA	Cascade	Or	Organics
CH	Chute		
FL	Flat		
RA	Rapid		
RF	Riffle		
SL	Slough		
SN	Snye		
SF	Subsurface Flow		

Notes

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Metres

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Page Size: 11" x 17"

2025-001.01	Production Date: Sep 15, 2017	Figure 7.3-28

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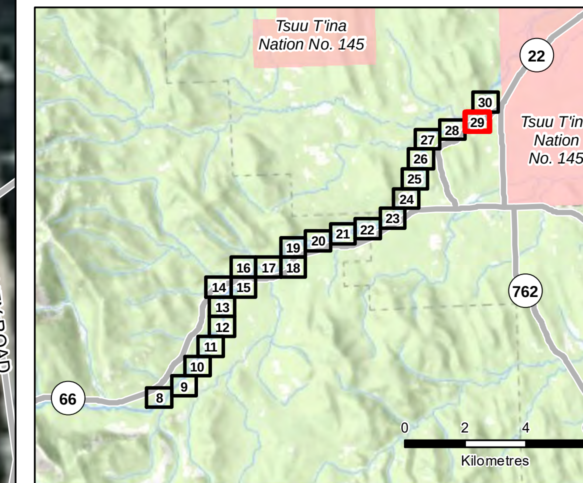
Elbow River at McLean Creek Dam (MC1)

Elbow River Habitat Units within the Local Assessment Area



Legend

Channel Unit/Habitat

- Beaver impoundment
- Cascade
- Interstitial Flow
- Pool
- Rapid
- Riffle
- Run
- Snye
- Flow Direction
- Highway Direction Arrow
- Highway or Road

Channel Unit/Habitat		Substrates	
R1	Class 1 Run; Deep Run >1.0 m	Be	Bedrock
R2	Class 2 Run; Moderate Run 0.75-1.0 m	Bo	Boulder
R3	Class 3 Run; Shallow Run < 0.75 m	Co	Cobble
P1	Class 1; Deep Pool >1.0 m	Gr	Gravel
P2	Class 2; Moderate Pool 0.75-1.0 m	Sa	Sand
P3	Class 3; Shallow Pool < 0.75 m	C/S	Clay Silt
		Or	Organics

CA	Cascade	RF	Riffle
CH	Chute	SL	Slough
FL	Flat	SN	Snye
RA	Rapid	SF	Subsurface Flow

Notes

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- 2007 Mountain Whitefish Locations: Eisler and Popowich, 2008

N

1:2,500

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Metres

NAD 1983 UTM Zone 11N

Page Size: 11" x 17"

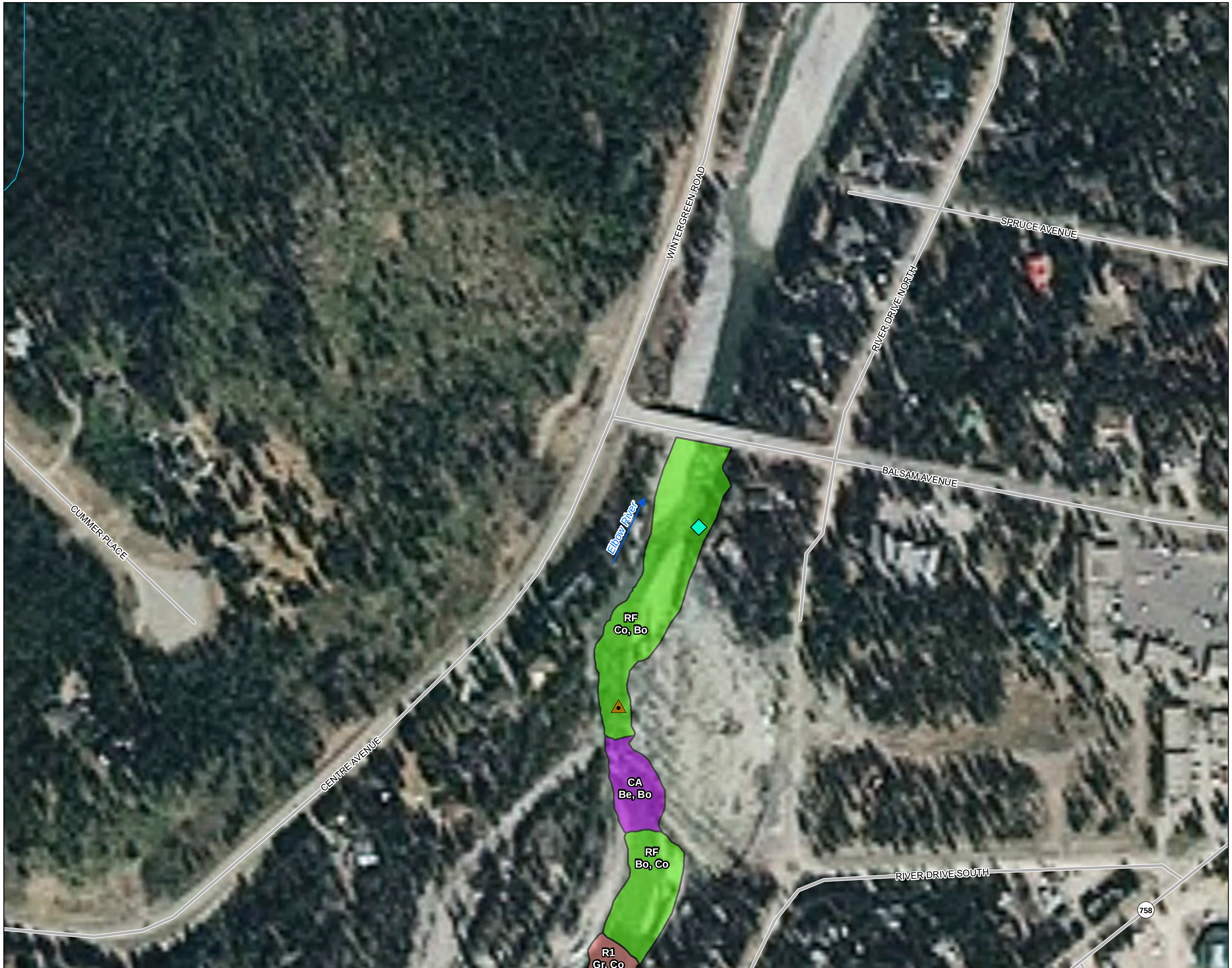
2025-001.01	Production Date: Sep 15, 2017	Figure 7.3-29

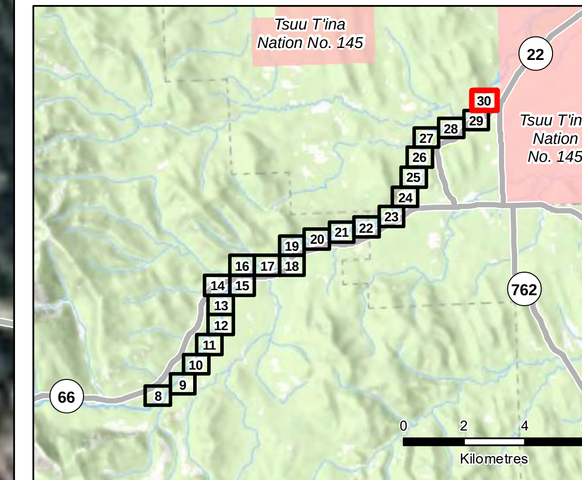
HEMMERA

Alberta Transportation

Elbow River at McLean Creek Dam (MC1)

Elbow River Habitat Units within the Local Assessment Area





Legend

Channel Unit/Habitat

- Beaver impoundment
- Cascade
- Interstitial Flow
- Pool
- Rapid
- Riffle
- Run
- Snye
- Flow Direction
- Highway or Road
- Congregation of adult mountain whitefish (2007) (Eisler and Popowich 2008)
- Water Temperature Logger

Channel Unit/Habitat

R1	Class 1 Run; Deep Run >1.0 m
R2	Class 2 Run; Moderate Run 0.75-1.0 m
R3	Class 3 Run; Shallow Run < 0.75 m
P1	Class 1; Deep Pool >1.0 m
P2	Class 2; Moderate Pool 0.75-1.0 m
P3	Class 3; Shallow Pool < 0.75 m
CA	Cascade
CH	Chute
FL	Flat
RA	Rapid
RF	Riffle
SL	Slough
SN	Snye
SF	Subsurface Flow

Substrates

Be	Bedrock
Bo	Boulder
Co	Cobble
Gr	Gravel
Sa	Sand
C/S	Clay Silt
Or	Organics

Notes

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- 2007 Mountain Whitefish Locations: Eisler and Popowich, 2008

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Metres

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Page Size: 11" x 17"

2025-001.01	Production Date: Sep 15, 2017	Figure 7.3-30

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Alberta Transportation

Ranger Creek

The assessment of fish habitat potential in Ranger Creek occurred in part in 2016 and was supplemented by sampling in summer 2017. The reach assessed encompasses habitat with the potential to be influenced by the creation of the permanent pond and inundation during substantial flood events following the construction of MC1.

Ranger Creek represents an irregular meander pattern as it flows in a southeasterly direction toward its confluence with the Elbow River, which occurs downstream from the Highway 66 crossing of the Elbow River (**Figure 7.3-31** to **Figure 7.3-34)**. During the MC1 study team's habitat assessment on October 4, 2016, three beaver impoundments were encountered. Each was the result of recent or ongoing beaver activity, and while the upstream-most two impoundments were not considered barriers to upstream fish migration, the downstream-most impoundment was of sufficient height and width that it was expected to limit upstream fish migration seasonally, although not on a permanent basis. Fish of various life stages were observed during the habitat assessment and throughout the assessed reach, including black spotted salmonids and suspected brook trout.

Signs of flood evidence were observed over the approximate 3.8-km assessment reach, as bank scour was noted on outside meander bends, debris was observed above bank tops, and side channels were occasionally encountered. The average channel width through the assessed reach was 8.4 m, while the average wetted width was 4.5 m. Banks, consisting primarily of gravels and cobble, were generally vertical and sloping in nature, although sections of undercut banks were also observed. Water depth averaged 0.4 m at the time of the assessment and ranged between 0.1 m and 1.5 m in depth.

Habitat composition within the LAA was dominated by shallow run (R3) and riffle habitat units (87%). Differentiation between shallow run and riffle units was blurred in many locations, and as a result these habitat units are combined in many instances for discussion and mapping purposes. Aside from the three impoundments (5%), five deep water (over 1.0 m) pool units (P1) were observed. Combined with the impoundments, these habitat units were considered to provide much of the potential wintering habitat for fish in Ranger Creek. Of particular value to wintering fish in Ranger Creek was a deep pool unit adjacent to the Elbow River Ranger Station, which provided approximately 49 m^2 of suitable wintering habitat at the time of the site visit.

Cover opportunities were abundant in the LAA, both from instream and overhead sources. Substrate, woody debris (large and small), turbulence, and depth all provided considerable instream cover opportunities to rearing fish, while overhanging vegetation, debris jams, and undercut banks also contributed overhead refuge. Cobbles dominated substrate composition (37%), although fines and organics were also abundant (26%), followed by gravel (25%). Minimal elements of boulder (9%) and bedrock (2%) were observed.

A spawning survey was conducted over the length of the watercourse in fall 2016, concurrent to the habitat assessment. No redds were identified, and it was noted that the substrates were highly embedded. Extended periods of turbid conditions in spring 2017 precluded the completion of a spring spawning survey in Ranger Creek (e.g., rainbow trout). In the absence of confirmed or refuted spawning activity, the potential for spawning at this watercourse is presumed based on habitat characteristics only.

A riparian disturbance inventory was conducted during field work conducted in spring / summer 2017, during which 11 anthropogenic disturbances (i.e. pedestrian clearspan bridges, parking lot, ranger station, transmission line, barbed wire fence, cattle crossings, and a power line) resulted in a total of 6,240 m^2 of observed riparian habitat disturbances within the assessed reach. This disturbed area is equivalent to 16.4% of an approximate total of 38,000 m^2 of riparian habitat within Ranger Creek component of the LAA.

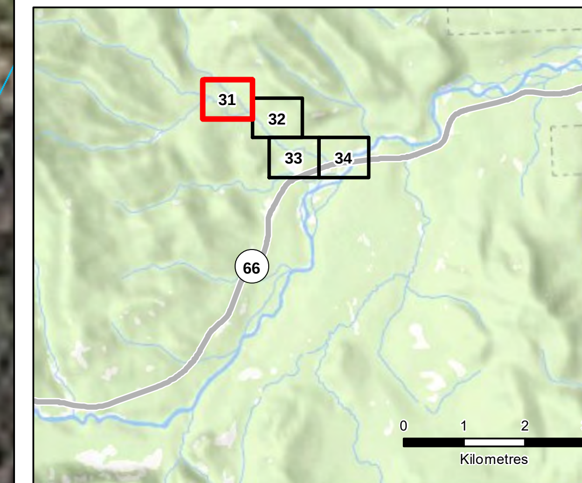
Fish sampling was not conducted in Ranger Creek given the known presence of fish (FWMIS 2017).

Water temperatures recorded in Ranger Creek ranged from 0.6 ºC to 9.3ºC within the area coinciding with the permanent pond, and from 0.6 ºC to 14.8 ºC in habitat upstream of the permanent pond. Differences in the maximum temperature measured between the Ranger Creek permeant pond and upstream temperature loggers, although unconfirmed, are the suspected result of differences in water depth and habitat type in which the loggers were deployed. The temperature logger installed in the vicinity of the permanent pond was placed in a shallow run habitat (<0.75 m) while the upstream temperature logger was placed in a deep pool habitat (>1.0 m). Regardless, average daily water temperatures recorded within Ranger Creek (see **Figure 7.3-35** to **Figure 7.3-36**) were within the tolerable ranges for bull trout and mountain whitefish, the more sensitive indicator species.to water temperature, and are also within acceptable ranges for more tolerant indicator species, brown trout and rainbow trout.

Within the LAA, Ranger Creek provides habitat for multiple life stages of fish. Although shallow run and riffle units were plentiful at the time of the assessment, coarse substrate within them were generally embedded with fines and organics. Brook trout spawning likely occurs widely throughout the LAA, while there exists marginal potential for spawning by rainbow trout and brown trout. Mountain whitefish spawning in Ranger Creek is not expected (i.e., habitat is of nil potential for this species). Although feeding and cover opportunities are limited for large bodied fish, habitat within Ranger Creek is valuable to multiple rearing juvenile fishes. Among the indicator species, habitat likely provides important rearing potential for rainbow trout and brown trout and marginal rearing potential for bull trout and mountain whitefish. Wintering habitat within Ranger Creek is present, particularly within the impoundments near the Elbow River confluence, although it is expected to be most suitable for small-bodied fish and rearing sportfish. As a result, the habitat potential for wintering of rainbow trout and brown trout was rated as important; wintering of non-indicator species (e.g., brook trout) is also expected. In comparison, wintering habitat potential for mountain whitefish and bull trout is marginal.

Elbow River at McLean Creek Dam (MC1)

Ranger Creek Habitat Units within the Local Assessment Area



Legend

Channel Unit/Habitat

- Cascade
- Flat
- Pool
- Rapid
- Riffle
- Run
- Alternating Riffle Run Habitat
- Beaver Impoundment
- Wetland/Beaver Impoundment

- Flow Direction
- Watercourse

Channel Unit/Habitat

R1	Class 1 Run; Deep Run >1.0 m
R2	Class 2 Run; Moderate Run 0.75-1.0 m
R3	Class 3 Run; Shallow Run < 0.75 m
P1	Class 1; Deep Pool >1.0 m
P2	Class 2; Moderate Pool 0.75-1.0 m
P3	Class 3; Shallow Pool < 0.75 m
CA	Cascade
CH	Chute
FL	Flat
RA	Rapid
RF	Riffle
SL	Slough
SN	Snye
SF	Subsurface Flow

Substrates

Be	Bedrock
Bo	Boulder
Co	Cobble
Gr	Gravel
Sa	Sand
C/S	Clay Silt
Or	Organics

Notes

1. The width of Ranger Creek is arbitrary and does not represent the true dimensions of the creek. It shoud be used for discussion purposes only.
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Sources

- Basedata: Government of Alberta
- Aerial Image: SPOT 1.5m, 2016

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Metres

NAD 1983 UTM Zone 11N

Page Size: 11" x 17"

2025-001.01	Production Date: Sep 18, 2017	Figure 7.3-31

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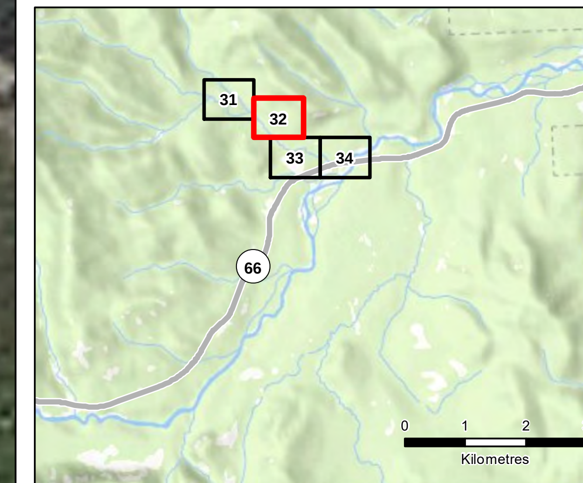
Alberta Transportation

Elbow River at McLean Creek Dam (MC1)

Ranger Creek Habitat Units within the Local Assessment Area



Legend

Channel Unit/Habitat

- Cascade
- Flat
- Pool
- Rapid
- Riffle
- Run
- Alternating Riffle Run Habitat
- Beaver Impoundment
- Wetland/Beaver Impoundment

- Flow Direction
- Watercourse

Channel Unit/Habitat

R1	Class 1 Run; Deep Run >1.0 m
R2	Class 2 Run; Moderate Run 0.75-1.0 m
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Substrates

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Metres

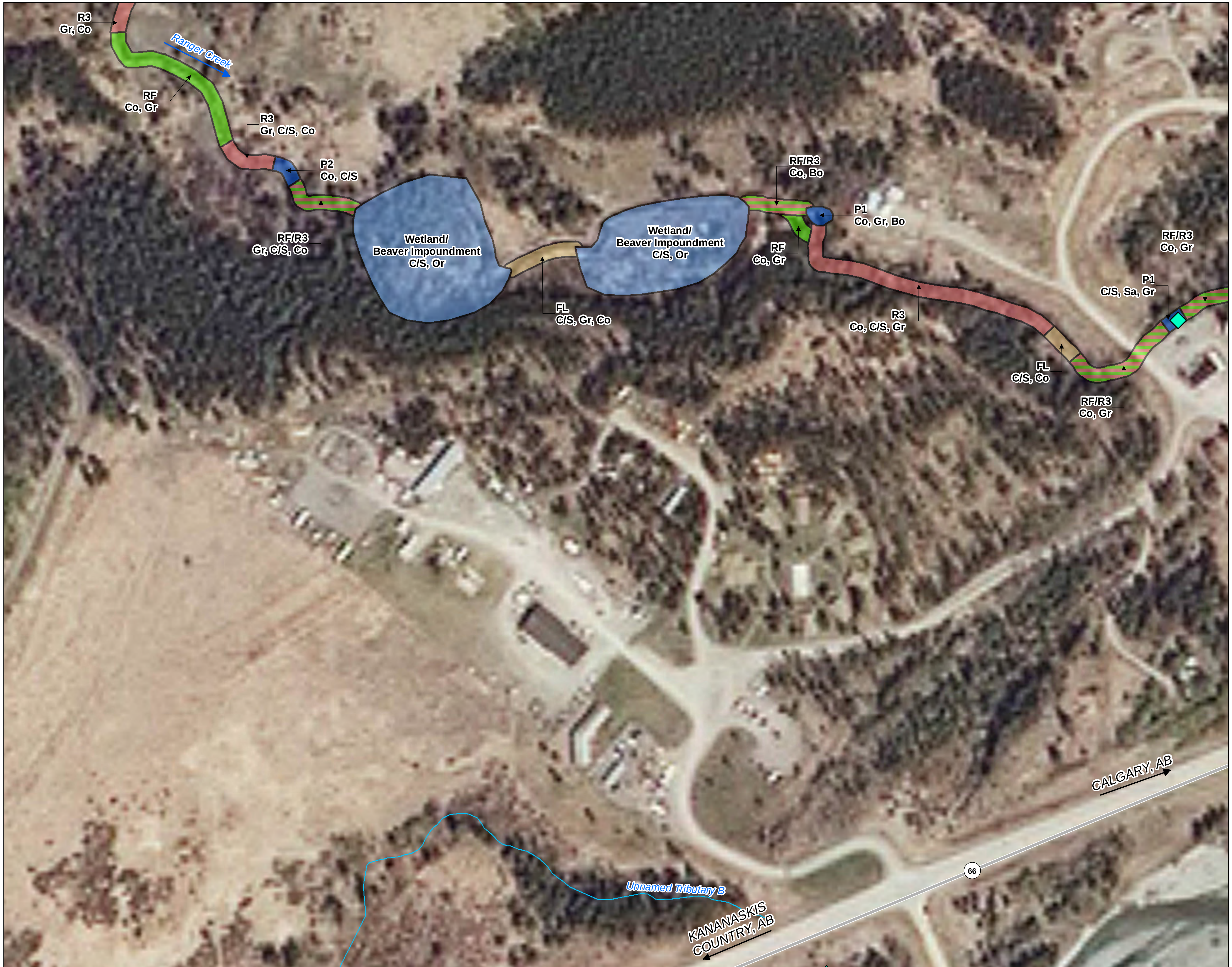
NAD 1983 UTM Zone 11N

Page Size: 11" x 17"

2025-001.01	Production Date: Sep 18, 2017	Figure 7.3-32

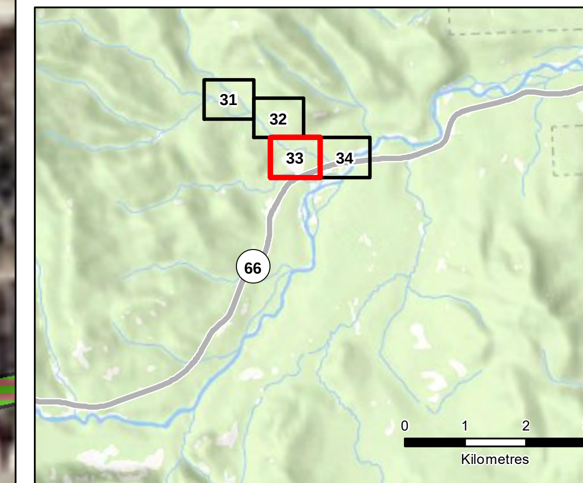
HEMMERA

Alberta Transportation



Elbow River at McLean Creek Dam (MC1)

Ranger Creek Habitat Units within the Local Assessment Area



Legend

Channel Unit/Habitat

- Cascade
- Flat
- Pool
- Rapid
- Riffle
- Run
- Alternating Riffle Run Habitat
- Beaver Impoundment
- Wetland/Beaver Impoundment

- Flow Direction
- Highway Direction Arrow
- Highway
- Watercourse
- Water Temperature Logger

Channel Unit/Habitat

R1	Class 1 Run; Deep Run >1.0 m
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Metres

NAD 1983 UTM Zone 11N

Page Size: 11" x 17"

2025-001.01	Production Date: Sep 18, 2017	Figure 7.3-33

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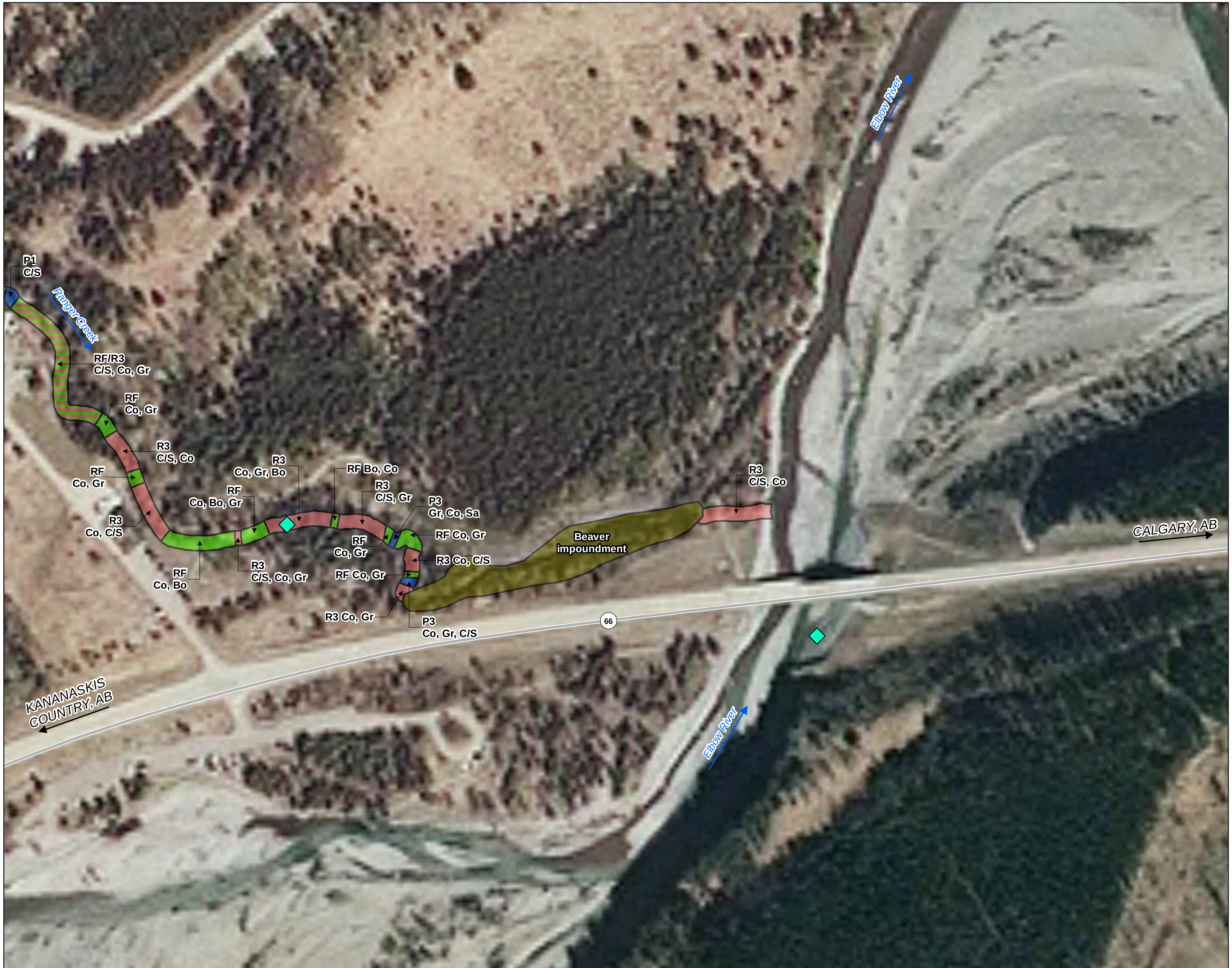
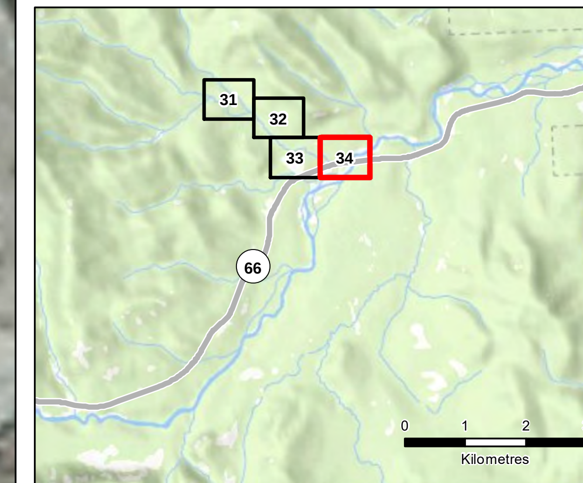
Elbow River at McLean Creek Dam (MC1)

Ranger Creek Habitat Units within the Local Assessment Area





Legend

Channel Unit/Habitat

- Cascade
- Flat
- Pool
- Rapid
- Riffle
- Run
- Alternating Riffle Run Habitat
- Beaver Impoundment
- Wetland/Beaver Impoundment

- Flow Direction
- Highway Direction Arrow
- Highway
- Watercourse
- Water Temperature Logger

Channel Unit/Habitat

R1	Class 1 Run; Deep Run >1.0 m
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C/S	Clay Silt
Or	Organics

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N

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Metres

NAD 1983 UTM Zone 11N

Page Size: 11" x 17"

2025-001.01	Production Date: Sep 18, 2017	Figure 7.3-34

HEMMERA

Alberta Transportation

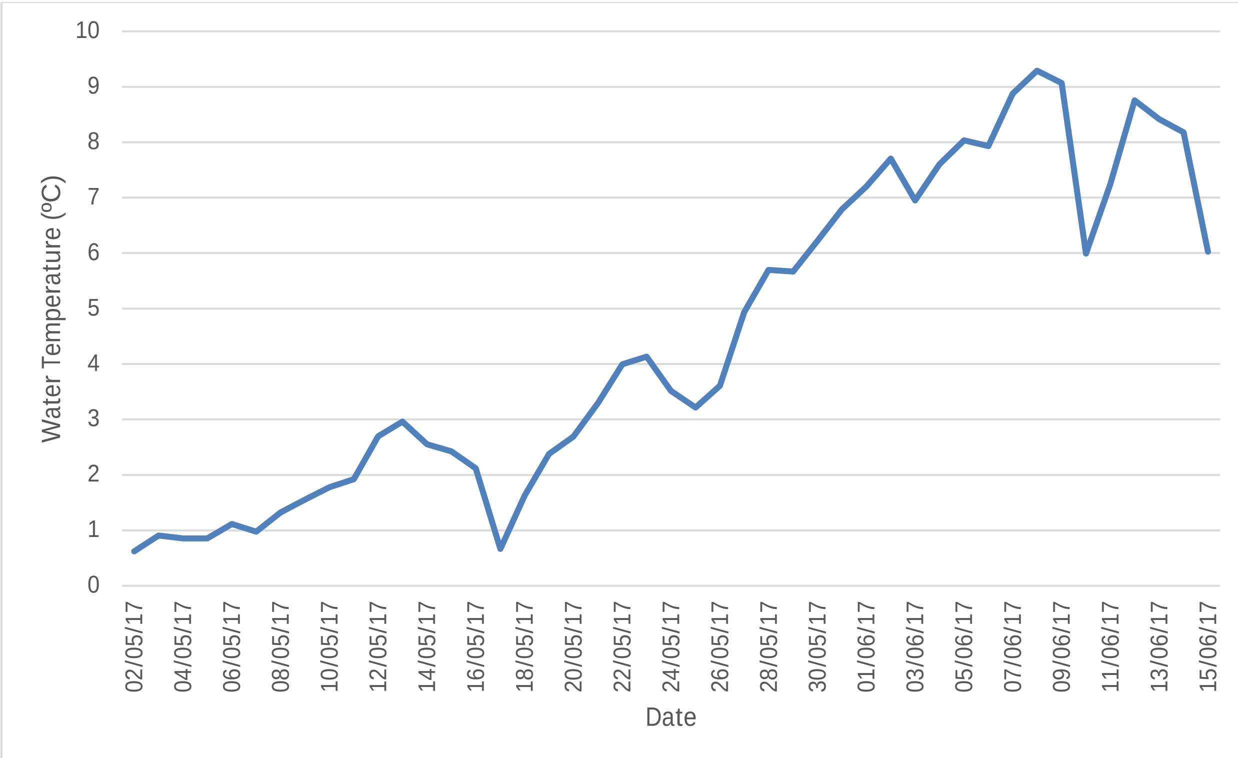


Figure 7.3-35 Average Daily Water Temperature in Ranger Creek at Permanent Pond Location, Summer 2017

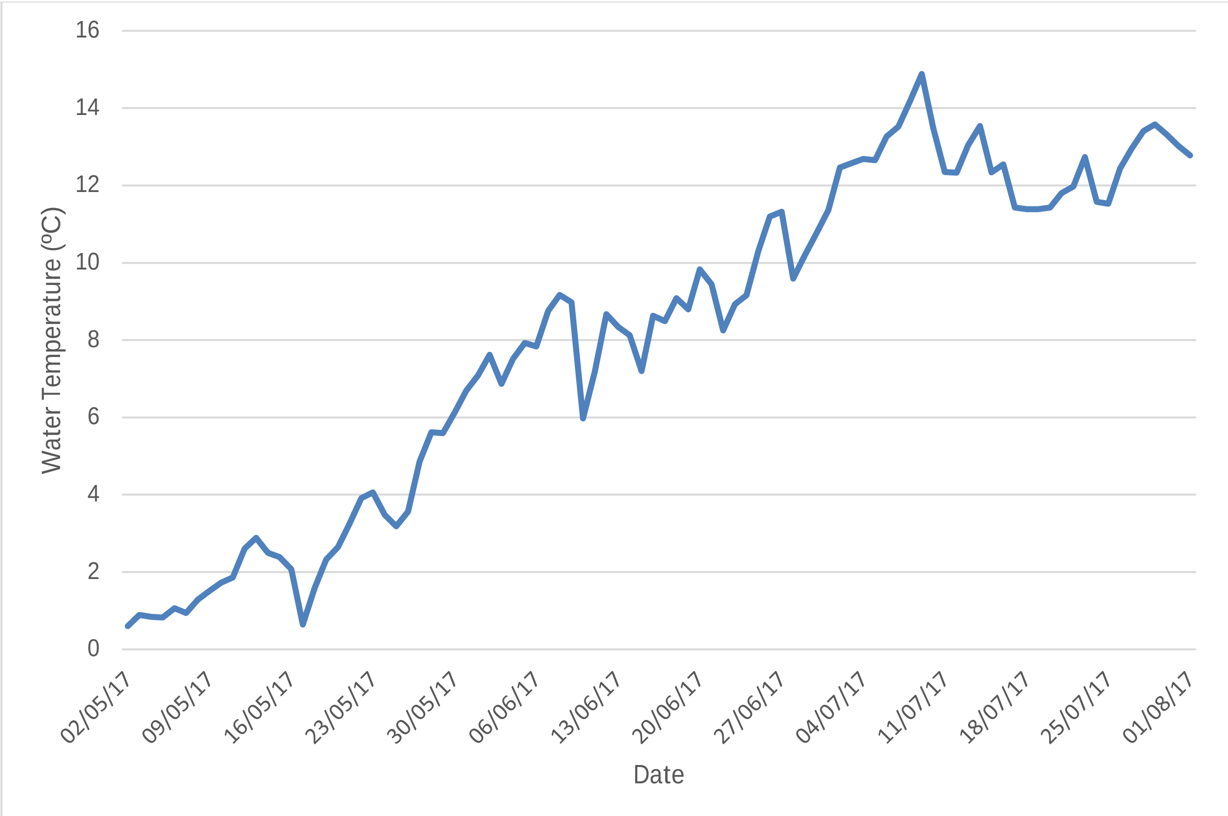


Figure 7.3-36 Average Daily Water Temperature in Ranger Creek Upstream of the Permanent Pond Location, Summer 2017

Unnamed Tributary A

Habitat within unnamed tributary A was originally assessed on October 10, 2016, over a distance of 620 m which included the area anticipated to be influenced by the permanent pond and habitat that may become inundated during substantial flood events following the construction of MC1. As described by AMEC (2015), this unnamed tributary flow occurs easterly under Highway 66, before passing through a forested flood plain and emptying into the Elbow River (**Figure 7.3-37**). At the Highway 66 crossing, flow is conveyed by a culvert, which at the time of the assessment was perched 0.3 m above the channel downstream. Depth immediately below the culvert was 0.8 m, suggesting the culvert crossing may represent a permanent barrier to fish migration. Fish passage was also limited by a section of sub-surface flow within the Aquatic Environment LAA (AMEC 2015). Habitat occurring on both sides of the culvert crossing and section of sub-surface flow was also limiting to fish as sections of undefined channel, overland flow, and limited water depth were all observed during the habitat assessment.

Where discernable, channel definition averaged 7.0 m in width, and wetted width averaged 4.5 m. Water depth ranged between 0.2 m and 0.8 m, and averaged 0.4 m. Substrate was highly embedded, primarily consisting of organics and fines (36%) and cobble (33%), although gravel (25%) and boulder (6%) elements were also present. Substrate compositions upstream from the Highway 66 crossing were markedly different than in areas downstream from the crossing, a presumed artefact of lessened gradients and increased depositional areas downstream from the highway.

Potential cover for fish was scarce but where present primarily resulted from woody debris (both large and small) instream and near stream. Undercut banks, canopy cover, and substrate also offered a limited amount of potential refuge to fish. Given the overall shallow conditions, distinct habitat unit boundaries were often blurred, particularly those between shallow pools (P3), riffles, and shallow run (R3) units. As a result, these units were combined for mapping and analysis purposes. Cumulatively, shallow pools, riffles, and shallow run habitat contributed over 95% of the habitat composition in the tributary. No fish were observed during the habitat assessment and active sampling was precluded.

A riparian disturbance inventory was conducted within the assessed reach in summer 2017, during which two anthropogenic elements (i.e. culvert crossing and riprap) totalling 550 m^2 of disturbed riparian habitat were observed. This value corresponds to approximately 4.4% of the approximated total potential riparian habitat (12,400 m^2) within the assessed reach.

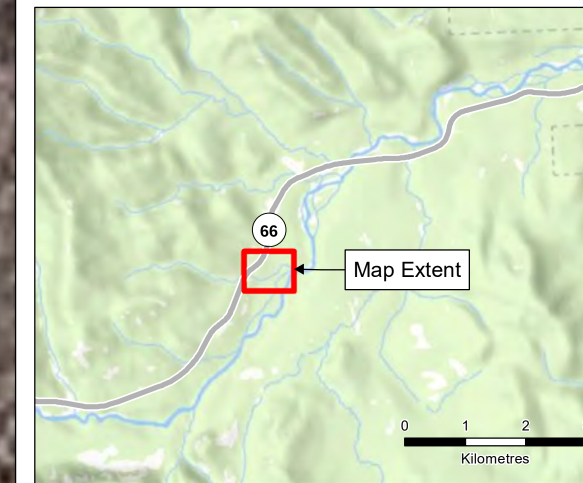
Fish sampling, utilizing a backpack electrofishing unit (i.e., Smith Root™ LR24), was also conducted in summer 2017. Sampling was conducted along a 620 m stretch of the tributary within the LAA. One bull trout (juvenile) was captured at the upstream extent of the assessed reach, within a moderately deep pool habitat (P2) immediately downstream of the Highway 66 culvert crossing. Given a lack of continuous flow in sections of the tributary downstream from the capture location, it is expected that this fish may have been stranded after seeking refuge in the tributary during a high-water event (e.g., spring freshet).

Average daily water temperatures recorded in unnamed tributary A ranged from 5.7ºC to 10.2ºC (**Figure 7.3-38**). The range in values are suitable for bull trout and mountain whitefish, the two indicator species most sensitive to elevated water temperatures. Given their relative tolerance for slightly higher water temperatures, the temperatures recorded in summer 2017 were also within the acceptable ranges for brown trout and rainbow trout.

Unnamed tributary A provides marginal to nil habitat potential for all life stages of the indicator species. Shallow conditions, a lack of habitat complexity, limited cover opportunities, and embedded substrate, combined with potential fish barriers, suggest that presence of indicator species in the Aquatic Environment LAA during low flow conditions is not probable. However, the presence of an adult bull trout at the upstream extent of the assessed reach during the summer 2017 survey indicates that fish are able to move through the watercourse, seasonally during periods of high flow (e.g., spring freshet).

Elbow River at McLean Creek Dam (MC1)

Unnamed Tributary A Habitat Units within the Local Assessment Area



Legend

Channel Unit/Habitat
- Cascade
- Pool
- Riffle
- Alternating Riffle Run Habitat

- Flow Direction
- Highway Direction Arrow
- Watercourse
- Highway
- Water Temperature Logger

Channel Unit/Habitat

R1 Class 1 Run; Deep Run >1.0 m
R2 Class 2 Run; Moderate Run 0.75-1.0 m
R3 Class 3 Run; Shallow Run < 0.75 m

P1 Class 1; Deep Pool >1.0 m
P2 Class 2; Moderate Pool 0.75-1.0 m
P3 Class 3; Shallow Pool < 0.75 m

CA	Cascade	RF	Riffle
CH	Chute	SL	Slough
FL	Flat	SN	Snye
RA	Rapid	SF	Subsurface Flow

Substrates

Be	Bedrock
Bo	Boulder
Co	Cobble
Gr	Gravel
Sa	Sand
C/S	Clay Silt
Or	Organics

Notes

1. The width of Unnamed Tributary A is arbitrary and does not represent the true dimensions of the creek. It shoud 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
- Aerial Image: SPOT 1.5 m, 2016

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Metres

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Page Size: 11" x 17"

2025-001.01	Production Date: Sep 15, 2017	Figure 7.3-37

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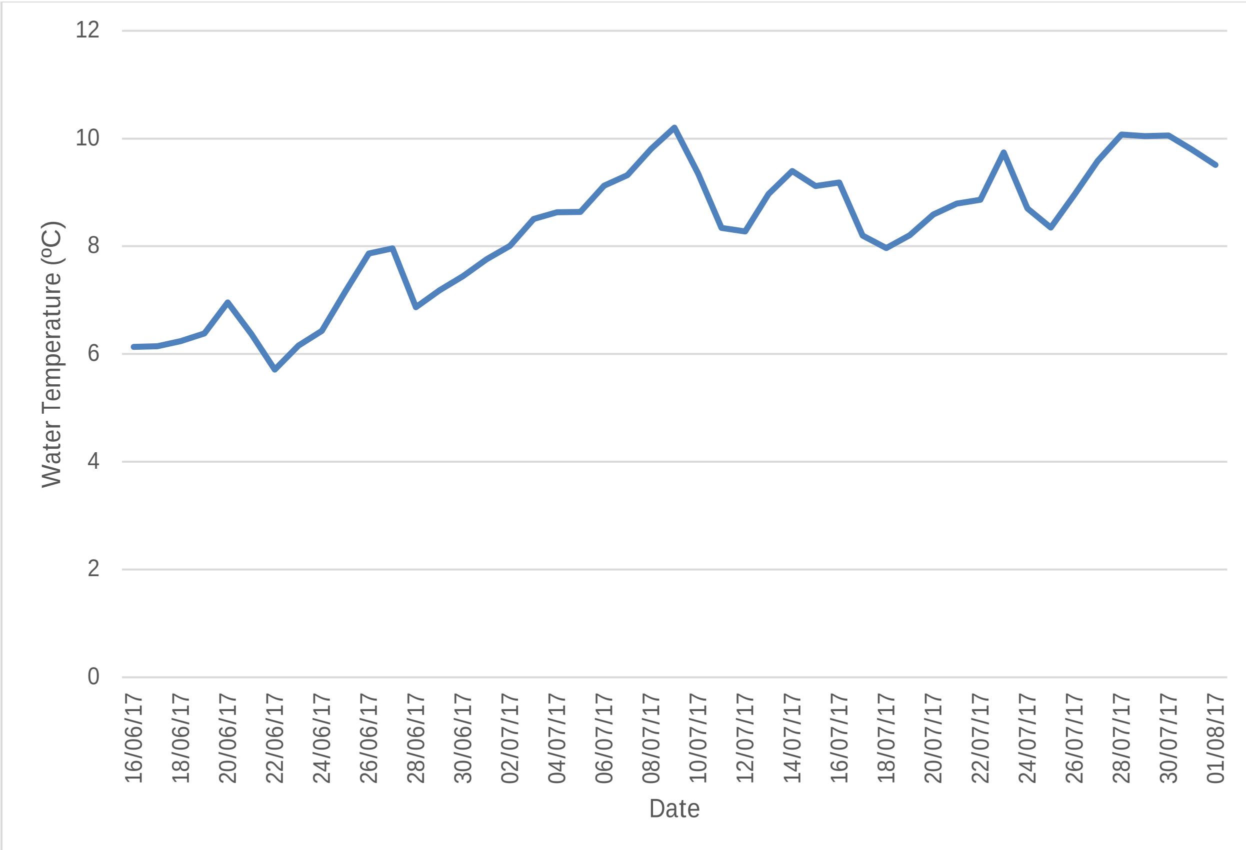


Figure 7.3-38 Average Daily Water Temperature in Unnamed Tributary A, Summer 2017

Unnamed Tributary B

Prior to the 2013 flood, this watercourse was a tributary with direct connectivity to Allen Bill Pond, a stocked fishery located within the Elbow River flood plain, immediately downstream from a culvert crossing under Highway 66. The pond feature was destroyed by flooding in 2013 and has not been reconstructed; however, during remediation efforts at the tributary's Highway 66 crossing, the culvert outlet and the area immediately downslope were armoured with boulders. As a result, flow from the culvert outlet now passes through a steepened cascade feature, prior to emptying onto the Elbow River floodplain. During a previous site visit (AMEC 2015), flow downstream of the armoured channel also proceeded subsurface prior to joining the Elbow River, resulting in another seasonal barrier to fish. Given the presence of barriers at the confluence, fish passage from the Elbow River into the unnamed tributary is expected to be precluded year-round.

In fall 2016, the MC1 study team visited this tributary to characterize habitat characteristics upslope and beyond the anticipated level of inundation that may occur during substantial flood events following the construction of MC1. Upstream from the existing Highway 66 crossing, habitat was primarily characterized as alternating riffle and shallow runs (RF/R3), interspersed with shallow pools (P3) until approximately 310 m upstream from the tributary's confluence with the Elbow River (see **Figure 7.3-39** to **Figure 7.3-40**). Upslope from this point, channel definition was described by AMEC (2015) as indiscernible, and no flow existed, an observation re-affirmed in 2016 as areas upslope from this point lacked channel definition. Where channel definition was present (i.e., between this location and the culvert crossing), mean channel and wetted widths were 4.8 m and 3.2 m, respectively, and the average depth of water was 0.4 m. As at unnamed tributary A, fines and organic material dominated substrate composition, and where coarse substrate was observed, it was highly embedded. Woody debris, both small and large, and overhanging vegetation offered limited potential fish cover opportunities. No fish were observed during the habitat assessment.

An inventory of riparian habitat was completed at this watercourse on August 2, 2017. Two anthropogenic elements were observed during the inventory. These included the two culvert crossings (i.e., Highway 66 culvert and downstream culvert outlet), which combined resulted in approximately 1,640 m^2 of disturbed riparian habitat. Approximately 4,560 m^2 of riparian habitat remains undisturbed within the assessed reach. The amount of existing disturbed habitat accounts for approximately 26% of the total riparian habitat within the LAA.

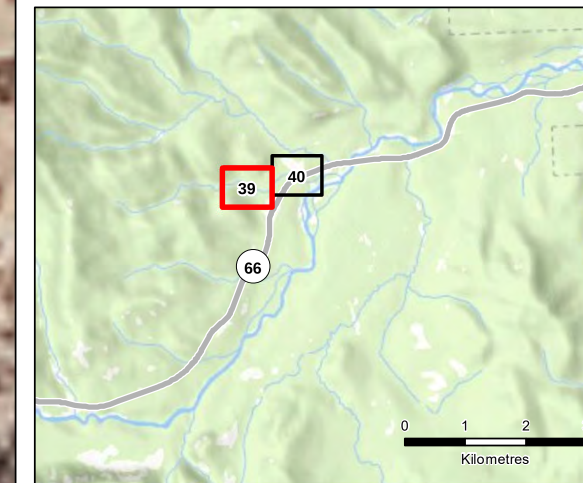
Fish sampling (i.e., backpack electrofishing) was conducted concurrently with the riparian habitat inventory survey on August 2, 2017. The sampling was conducted within a 210 m section from the confluence of unnamed tributary B and the Elbow River, in an upstream direction, until continuous dry channel was encountered. Over this reach, only isolated sections of water were present and conducive to sampling. No fish were captured or observed during 227 seconds of fishing effort.

Water temperatures recorded in unnamed tributary B ranged from 7.8 ºC to 13.2 ºC (**Figure 7.3-41**). The range of the values were within the tolerable ranges for each of the indicator species.

The permanent barrier to fish migration resulting from the steep, armoured culvert outlet is anticipated to precluded upstream fish migration into this unnamed tributary in all seasons. A general lack of depth, cover, and suitable spawning substrate further reduce the habitat potential upstream from the barrier. As a result, there exists nil habitat potential for indicator species within the LAA.

Elbow River at McLean Creek Dam (MC1)

Unnamed Tributary B Habitat Units within the Local Assessment Area



Legend

Channel Unit/Habitat

- Dry
- Boulder Garden
- Pool
- Alternating Riffle Run Habitat
- Non-defined Channel

Flow Direction

Channel Unit/Habitat

R1 Class 1 Run; Deep Run >1.0 m
R2 Class 2 Run; Moderate Run 0.75-1.0 m
R3 Class 3 Run; Shallow Run < 0.75 m

P1 Class 1; Deep Pool >1.0 m
P2 Class 2; Moderate Pool 0.75-1.0 m
P3 Class 3; Shallow Pool < 0.75 m

CA	Cascade	RF	Riffle
CH	Chute	SL	Slough
FL	Flat	SN	Snye
RA	Rapid	SF	Subsurface Flow

Substrates

Be	Bedrock
Bo	Boulder
Co	Cobble
Gr	Gravel
Sa	Sand
C/S	Clay Silt
Or	Organics

Notes

1. The width of Unnamed Tributary B is arbitrary and does not represent the true dimensions of the creek. It shoud 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
- Aerial Image: SPOT 1.5m, 2016

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Metres

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Page Size: 11" x 17"

2025-001.01	Production Date: Sep 15, 2017	Figure 7.3-39

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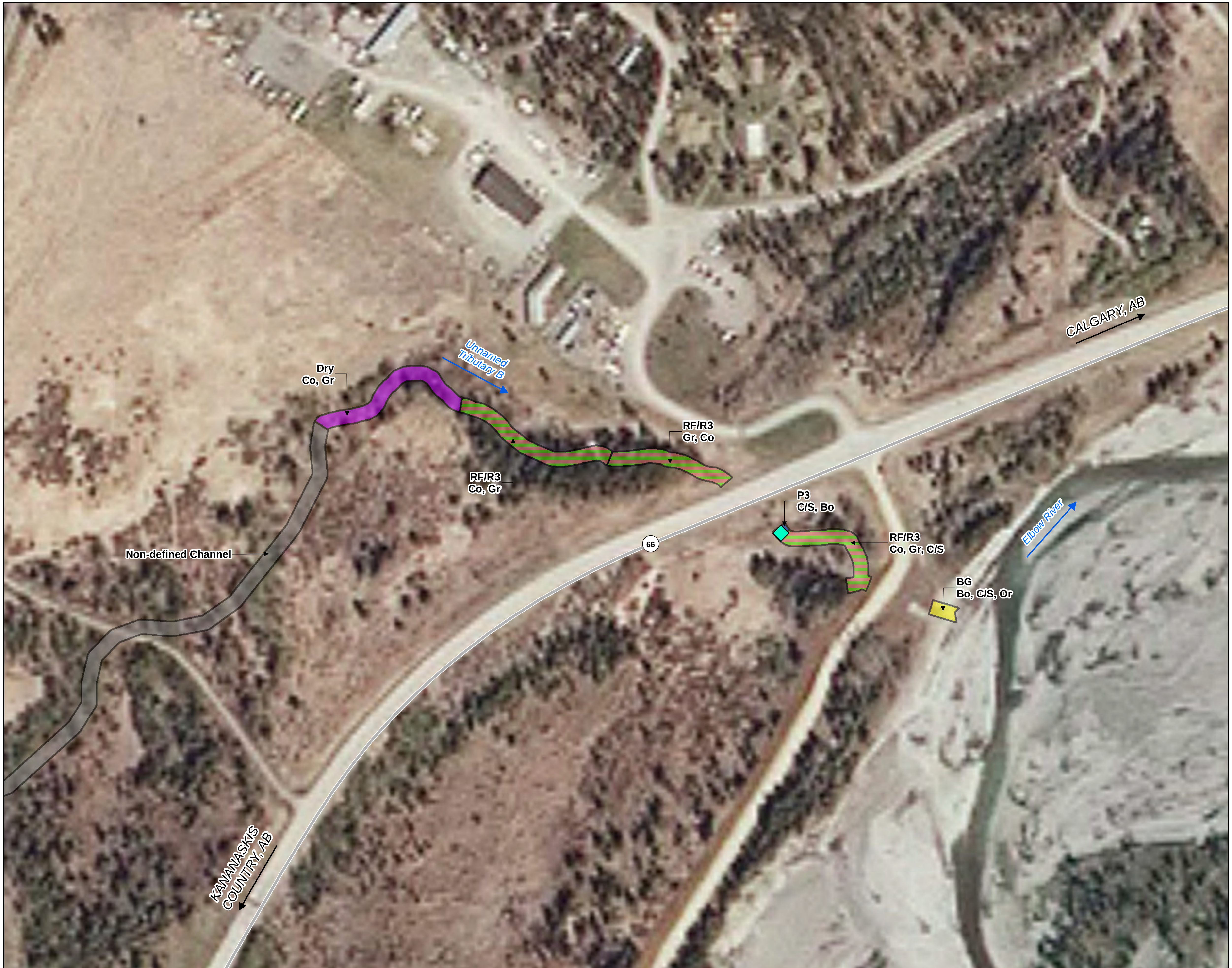
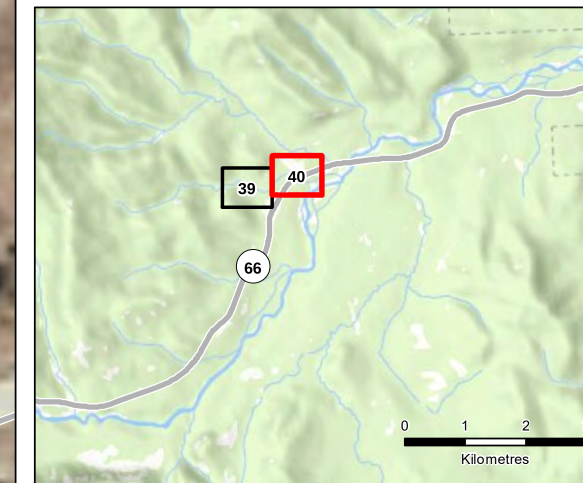
Elbow River at McLean Creek Dam (MC1)

Unnamed Tributary B Habitat Units within the Local Assessment Area





Legend

Channel Unit/Habitat

- Dry
- Boulder Garden
- Pool
- Alternating Riffle Run Habitat
- Non-defined Channel
- Flow Direction
- Highway Direction Arrow
- Highway
- Water Temperature Logger

Channel Unit/Habitat

R1	Class 1 Run; Deep Run >1.0 m
R2	Class 2 Run; Moderate Run 0.75-1.0 m
R3	Class 3 Run; Shallow Run < 0.75 m
P1	Class 1; Deep Pool >1.0 m
P2	Class 2; Moderate Pool 0.75-1.0 m
P3	Class 3; Shallow Pool < 0.75 m
CA	Cascade
CH	Chute
FL	Flat
RA	Rapid
RF	Riffle
SL	Slough
SN	Snye
SF	Subsurface Flow

Substrates

Be	Bedrock
Bo	Boulder
Co	Cobble
Gr	Gravel
Sa	Sand
C/S	Clay Silt
Or	Organics

Notes

1. The width of Unnamed Tributary B is arbitrary and does not represent the true dimensions of the creek. It shoud 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
- Aerial Image: SPOT 1.5m, 2016

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Page Size: 11" x 17"

2025-001.01	Production Date: Sep 15, 2017	Figure 7.3-40

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Alberta Transportation

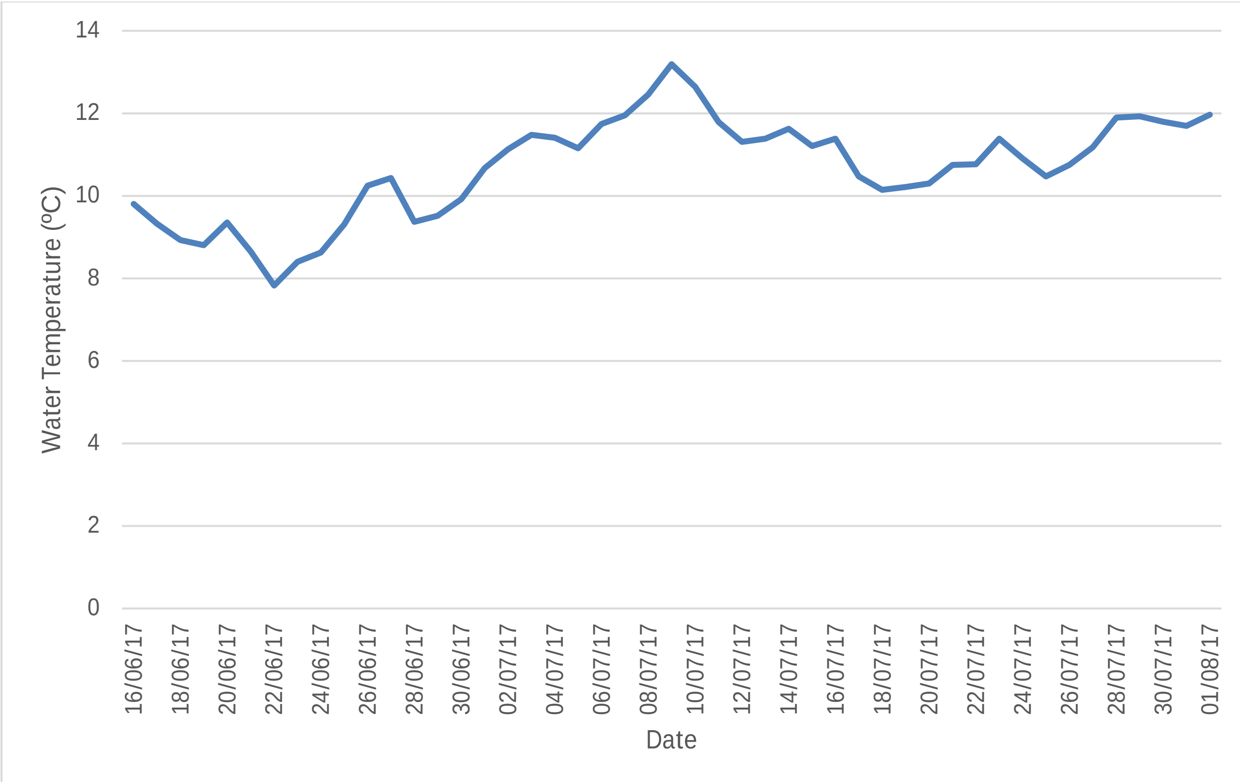


Figure 7.3-41 Average Daily Water Temperature in Unnamed Tributary B, Summer 2017

Unnamed Tributary C

Originating along a northeast facing slope, this unnamed tributary is a second order stream at its confluence with the Elbow River. The confluence occurs approximately 800 m upstream from the location of the MC1 dam (**Figure 7.3-42**). Habitat in this unnamed tributary was originally characterized in fall 2016 by the MC1 study team and was revisited during field work in summer 2017 to extend habitat mapping upslope to and beyond the potential elevation of inundation that may result during substantial flood events following the construction of MC1. During these assessments, the tributary flowed through a steepened forested valley through much of the LAA before passing into the Elbow River's flood plain at its confluence. A consequence of the terrain's gradient, the channel in the upstream-most reaches of the Aquatic Environment LAA was incised and well defined, and showed sign of erosional events (i.e., scoured banks and widened channel). Within these reaches, considerable amounts of woody debris and vegetation occur within, over, and near the channel and provided ample potential instream and overhead cover opportunities to fish. Overhanging vegetation and substrate also provided potential cover elements. In downstream sections, within the Elbow River flood plain, channel definition becomes marginalized and sections of overland flow occurred. Multiple bridged pedestrian and mountain bike crossings intersected the tributary within the Aquatic Environment LAA.

Habitat morphology, particularly in the upstream-most reaches of the Aquatic Environment LAA, consisted of sequencing cascade units, separated by marginally defined riffles and shallow (less than 0.75 m deep) run and pool habitats. Residual pool depth within the LAA is reported to range between 0.3 m and 0.4 m (AMEC 2015). Downstream, closer to the confluence, habitat composition became more dominated by shallow, nearly indiscernible run habitats. The average channel width over the entire Aquatic Environment LAA is 2.8 m, while the average width at the time of the habitat assessment was 1.3 m. Although sections of instability occur in the steepened, upstream reaches, bank are largely stable through the LAA, and their heights, as reported by AMEC (2015), range between 0.4 m and 1.3 m. Substrate in the upstream-most reaches of the LAA primarily consists of cobble, while fines and organics comprise most of the substrate composition in the lower reaches of the tributary.

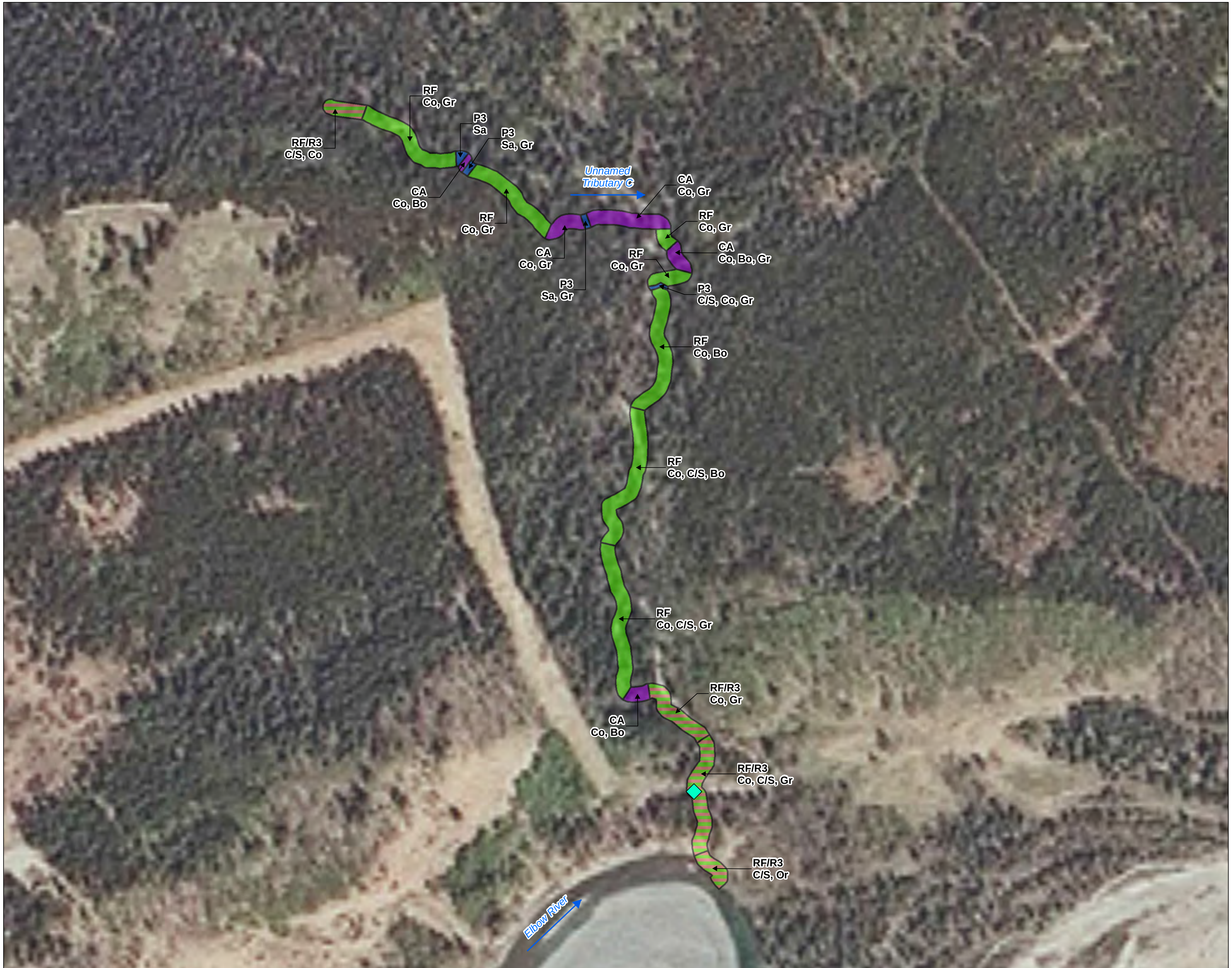
Sections of steep (i.e., cascading) and shallow habitats in the upstream-most sections of this tributary may represent seasonal barriers to fish and, in general, reduce the overall habitat suitability of this tributary. Similarly, sections of marginally defined channel in the downstream sections are also expected to limit the tributary's value to fish year-round. Although it is not known whether connectivity existed prior to the 2013 floods, fish passage from the Elbow River into the tributary currently is not possible. AMEC (2015) reported a 1.5-m vertical drop from the unnamed tributary to the Elbow River at the confluence, while during the MC1 study team's habitat assessment this barrier to upstream migration was increased to 4 m.

A riparian disturbance inventory conducted in summer 2017 identified seven anthropogenic elements (i.e. decommissioned pedestrian trail, barbed wire fence, cattle crossings, and pedestrian clearspan bridges) affecting a length of 510 m^2 of riparian habitat within the assessed reach. This corresponds to 3.2% of 16,000 m^2 of riparian habitat within the LAA.

Daily average water temperatures recorded in unnamed tributary C ranged from 7.8 ºC to 13.2 ºC (**Figure 7.3-43**). These values were within the tolerable ranges for bull trout and mountain whitefish, the two indicator species most sensitive to elevated water temperatures. Given their relative tolerance for slightly higher water temperatures, the temperatures recorded in summer 2017 were also within the acceptable ranges for brown trout and rainbow trout.

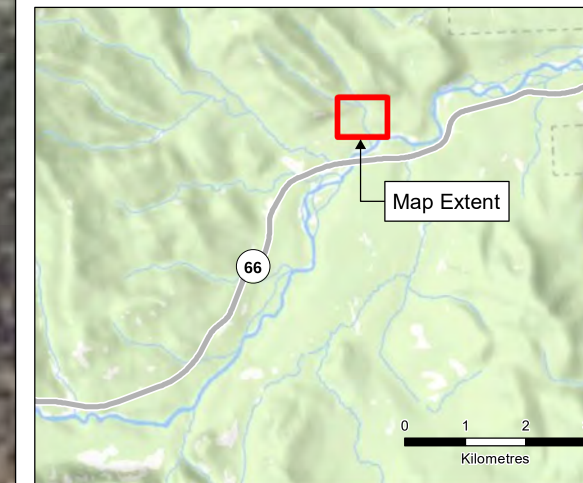
Fish sampling was conducted within habitat upstream from the migration barrier in summer 2017. No fish were captured or observed during 400 seconds of electrofishing effort.

Overall, the habitat within the unnamed tributary was of nil potential for the indicator species during the two assessments. While rearing opportunities may exist for other fish species (e.g., brook trout), this tributary is not expected to provide habitat for any of the indicator species at any time of year.



Elbow River at McLean Creek Dam (MC1)

Unnamed Tributary C Habitat Units within the Local Assessment Area



Legend

Channel Unit/Habitat

- Cascade
- Pool
- Riffle
- Alternating Riffle Run Habitat
- Unmapped Habitat

- Flow Direction
- Water Temperature Logger

Channel Unit/Habitat

R1	Class 1 Run; Deep Run >1.0 m
R2	Class 2 Run; Moderate Run 0.75-1.0 m
R3	Class 3 Run; Shallow Run < 0.75 m
P1	Class 1; Deep Pool >1.0 m
P2	Class 2; Moderate Pool 0.75-1.0 m
P3	Class 3; Shallow Pool < 0.75 m
CA	Cascade
CH	Chute
FL	Flat
RA	Rapid
RF	Riffle
SL	Slough
SN	Snye
SF	Subsurface Flow

Substrates

Be	Bedrock
Bo	Boulder
Co	Cobble
Gr	Gravel
Sa	Sand
C/S	Clay Silt
Or	Organics

Notes

1. The width of Unnamed Tributary C is arbitrary and does not represent the true dimensions of the creek. It shoud 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
- Aerial Image: SPOT 1.5 m, 2016

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Metres

NAD 1983 UTM Zone 11N

Page Size: 11" x 17"

2025-001.01	Production Date: Sep 15, 2017	Figure 7.3-42

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Alberta Transportation

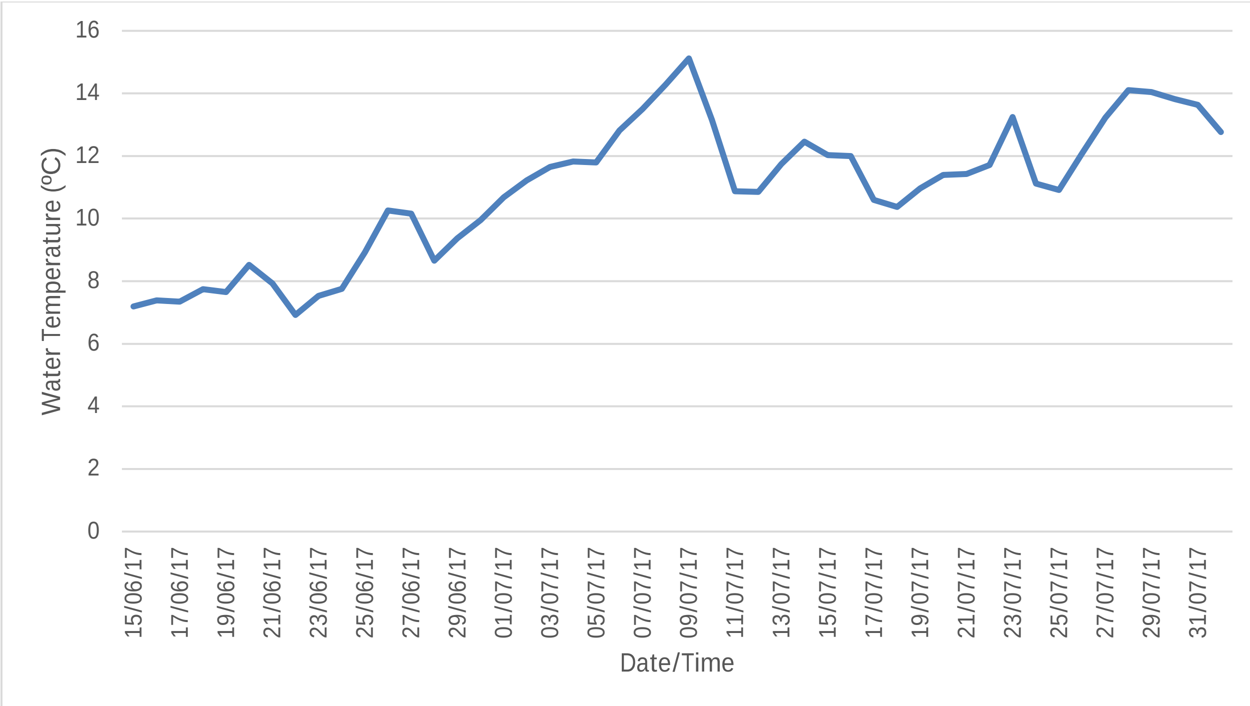


Figure 7.3-43 Average Daily Water Temperature in Unnamed Tributary C, Summer 2017

Unnamed Tributary D

During the MC1 team's assessment in summer 2017, unnamed tributary D was characterised as having a sinuous pattern, being confined within its valley walls, and flowing in a southeast direction toward its confluence with the Elbow River (**Figure 7.3-44**). The pattern of drainage occurs downstream of the MC1 dam, but intersects the service spillway and temporary haul road locations. At the time of assessment (July 20, 2017), flow was considered to be low for the time of year, with sections of dry channel observed throughout the assessed reach. Beaver activity (i.e., felled trees) was noted within a section of the tributary which lacked channel definition, immediately upstream from the tributary's confluence with the Elbow River This beaver activity does not represent a barrier to upstream fish movement.

Substrate throughout the length of the watercourse consisted primarily of fines, although pockets of cobbles occurred near the confluence. Organic material was present throughout the upstream section of the tributary, immediately downstream of a shrubby fen wetland complex (refer to **Section 7.1 Vegetation and Wetlands**). The average channel and wetted widths were 1.3 m and 0.8 m, respectively. Banks are generally sloping with low stability and ranged in height between 0.3 m to 2 m.

At the upper extent of the assessed reach, this tributary is defined as a shrubby fen wetland complex (refer to **Section 7.1 Wetlands and Vegetation**). Immediately downslope from this feature, water drains through a slough before becoming subsurface. Although sections of defined channel were encountered downslope of the slough, no surface flow was observed. Nearest the drainage's junction with the Elbow River, channel definition is diminished, as there is no obvious confluence within the Elbow River's flood plain.

At the drainage's junction with the Elbow River, extensive bed load deposition (resulting from the Elbow River) was observed from the base of the valley wall through the Elbow River flood plain. Although flow was audible, it was subsurface, beneath this deposited material. Where channel definition was obvious, extensive bank slumping and woody debris within the channel was observed. It is suspected that the woody debris may result in sequencing drop structures, creating cascade habitat units during periods when surface flow occurs.

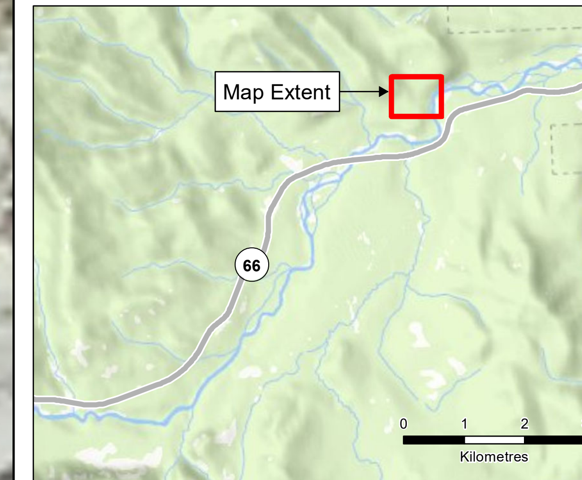
A riparian disturbance inventory was conducted on August 2, 2017. During this survey three anthropogenic elements (i.e. cattle crossings, and two pedestrian bridges), resulting in a total of approximately 100 m^2 of disturbed riparian habitat was observed. This value represents approximately 0.6% of the total riparian habitat (16,240 m^2) within the assessed reach

Fish sampling was not conducted during the assessment as fish habitat consisted of isolated sloughs alternating with extensive sections of dry and/or sub surface flow.

Overall, the habitat within the unnamed tributary was rated to be of nil potential for the indicator species, and this tributary is not expected to provide habitat for any of the indicator species at any time of year.

Elbow River at McLean Creek Dam (MC1)

Unnamed Tributary D Habitat Units within the Local Assessment Area



Legend

Channel Unit/Habitat

- Non-defined Channel
- Dry
- Subsurface Flow
- Slough
- Wetland

Flow Direction

Channel Unit/Habitat

R1	Class 1 Run; Deep Run >1.0 m
R2	Class 2 Run; Moderate Run 0.75-1.0 m
R3	Class 3 Run; Shallow Run < 0.75 m
P1	Class 1; Deep Pool >1.0 m
P2	Class 2; Moderate Pool 0.75-1.0 m
P3	Class 3; Shallow Pool < 0.75 m
CA	Cascade
CH	Chute
FL	Flat
RA	Rapid
RF	Riffle
SL	Slough
SN	Snye
SF	Subsurface Flow

Substrates

Be	Bedrock
Bo	Boulder
Co	Cobble
Gr	Gravel
Sa	Sand
C/S	Clay Silt
Or	Organics

Notes

1. The width of Unnamed Tributary D is arbitrary and does not represent the true dimensions of the creek. It shoud 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
- Aerial Image: SPOT 1.5 m, 2016

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Metres

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2025-001.01	Production Date: Sep 15, 2017	Figure 7.3-44

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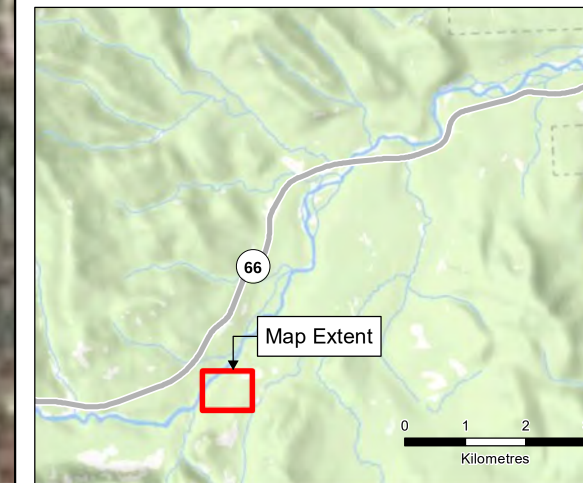
Unnamed Tributary E

An assessment of habitat potential in this unnamed tributary occurred on August 2, 2017, over a reach of terrain upslope and downslope from the potential crossing of the realigned Highway 66. During this assessment, no flow or channel definition was observed throughout the LAA (**Figure 7.3-45**). The absence of a defined channel indicates that this drainage is not a defined watercourse (Government of Alberta 2001), while the absence of flow further confirms it is unlikely to provide reliable, consistent fish habitat to any of the indicator species. Over land flow may occur seasonally (i.e., during snow melt or high precipitation events), but its overall lack of connectivity limits its potential for fish. Sampling of fish was precluded by the absence of water. No disturbances of riparian habitat were observed.

Elbow River at McLean Creek Dam (MC1)

Unnamed Tributary E Habitat Units within the Local Assessment Area



Legend

Flow Direction

Channel Unit/Habitat

Non-defined Channel

Channel Unit/Habitat

R1 Class 1 Run; Deep Run >1.0 m
R2 Class 2 Run; Moderate Run 0.75-1.0 m
R3 Class 3 Run; Shallow Run < 0.75 m

P1 Class 1; Deep Pool >1.0 m
P2 Class 2; Moderate Pool 0.75-1.0 m
P3 Class 3; Shallow Pool < 0.75 m

CA Cascade
CH Chute
FL Flat
RA Rapid
RF Riffle
SL Slough
SN Snye
SF Subsurface Flow

Substrates

Be Bedrock
Bo Boulder
Co Cobble
Gr Gravel
Sa Sand
C/S Clay Silt
Or Organics

Notes

1. The width of Unnamed Tributary E is arbitrary and does not represent the true dimensions of the creek. It shoud 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
- Aerial Image: SPOT 1.5 m, 2016

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Metres

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Page Size: 11" x 17"

2025-001.01	Production Date: Sep 15, 2017	Figure 7.3-45

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Alberta Transportation

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Unnamed Tributary F

A habitat assessment of this watercourse was completed by the MC1 study team on July 13, 2017. The assessed reach was limited to habitat extending upstream from the Elbow River and predominantly within the anticipated potential area of inundation (during substantial flood events) following the construction of MC1. During this assessment, unnamed tributary F was characterised as having an irregular meander pattern and as being frequently confined as it flows in a north-easterly direction towards its confluence with the Elbow River (**Figure 7.3-46**). The average channel and wetted widths were 2.0 m and 1.1 m, respectively. Although banks were generally sloping in shape, some undercutting features were observed. In general, bank stability was rated as low and bank height ranged from 0.3 m to 3.5 m.

Substrate consisted primarily of organics and fines, with gravel and cobbles more prominent at the downstream section of the assessed reach. Cover for fish was provided primarily by woody debris, overhanging vegetation, and boulders.

Habitat morphology consisted primarily of shallow riffles, separated by shallow run and pool (<0.75 m) habitats, particularly in the upper sections of the assessed reach. Sections of subsurface flow and boulder garden habitats were also present, but to a lesser extent. A small and marginally defined wetland feature was observed at the confluence of this tributary and the Elbow River, although flow exiting the wetland was indiscernible. An estimated 30% of the tributary's channel was dry at the time of assessment, suggesting that the watercourse's flow regime is likely seasonal. Multiple log jams were observed throughout the assessed reach, as well as a gravel side bar at the Elbow River confluence. These debris jams, combined with limited flows are suspected to represent potential barriers to upstream fish movement, at least seasonally.

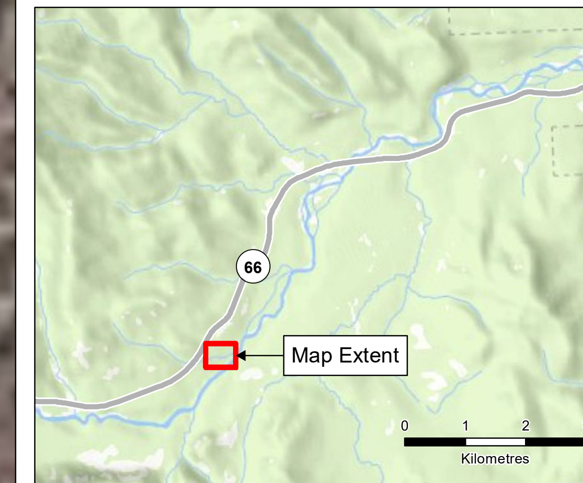
A riparian disturbance inventory was also conducted during the July 13, 2017 site visit. Three anthropogenic elements (i.e. road culvert crossing, pedestrian culvert crossing, pedestrian bridge) were observed as having an influence on riparian habitat. Combined, these disturbances totalled 320 m^2, a value which represents approximately 0.04% of the total riparian habitat (8,640 m^2) within the assessed reach. Riparian vegetation is composed of grasses, shrubs, and mixed forest.

No fish were captured during the assessment, despite a total of 521 seconds of backpack electrofishing effort within the channelized portions of the watercourse.

Based on observations made during the assessment in summer 2017, it is presumed this watercourse is of limited value to fish. The presence of extensive barriers to fish movement at the confluence with Elbow River (i.e., wetland, log jams, and sub surface flow) and seasonally dry sections of channel support the overall evaluation of nil habitat potential for the indicator species. It is recognized, however, that habitat value in this unnamed tributary may increase during years in which more precipitation occurs.

Elbow River at McLean Creek Dam (MC1)

Unnamed Tributary F Habitat Units within the Local Assessment Area



Legend

Channel Unit/Habitat

- Run
- Subsurface Flow
- Flat
- Run/Boulder Garden
- Pool
- Riffle

Flow Direction

Stolen Water Temperature Logger

Channel Unit/Habitat

R1	Class 1 Run; Deep Run >1.0 m
R2	Class 2 Run; Moderate Run 0.75-1.0 m
R3	Class 3 Run; Shallow Run < 0.75 m
P1	Class 1; Deep Pool >1.0 m
P2	Class 2; Moderate Pool 0.75-1.0 m
P3	Class 3; Shallow Pool < 0.75 m
BG	Boulder Garden
CA	Cascade
CH	Chute
FL	Flat
RA	Rapid
RF	Riffle
SL	Slough
SN	Snye
SF	Subsurface Flow

Substrates

Be	Bedrock
Bo	Boulder
Co	Cobble
Gr	Gravel
Sa	Sand
C/S	Clay Silt
Or	Organics

Notes

1. The width of Unnamed Tributary F is arbitrary and does not represent the true dimensions of the creek. It shoud 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
- Aerial Image: SPOT 1.5 m, 2016

N

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0 25 50 75

Metres

NAD 1983 UTM Zone 11N

Page Size: 11" x 17"

2025-001.01	Production Date: Sep 15, 2017	Figure 7.3-46

HEMMERA

Alberta Transportation

Unnamed Tributary G

An assessment of fish habitat potential and use was conducted in this unnamed tributary on July 19, 2017, given that its location coincides with the area of potential inundation during substantial flood events following the construction of MC1. Unnamed tributary G has a sinuous pattern and within the assessed reach flows in a north-easterly direction toward its confluence with the Elbow River. The confluence of this tributary with the Elbow River occur upstream from the MC1 dam and upper extent of the permanent pond (**Figure 7.3-47**). During the assessment, this watercourse was characterized as being unconfined by valley walls and as containing substrates primarily comprised of highly embedded substrates, followed by fines and cobbles, interspersed with moderate amounts of gravel. At the time of assessment, water levels were considered to be low for the time of year, as sections of dry channel were encountered, suggesting flow within this tributary may only occur seasonally. The average channel and wetted widths were 12.7 m and 4.3 m, respectively. Banks were generally sloping, with some undercut sections, and were in general of low stability. Bank height ranges from 1.3 m to 3.1 m.

Habitat morphology consisted primarily of slough habitats, alternating with sections of dry channel. Extensive algal growth was present within slough habitats. At the approximate mid-point within the assessed reach, the channel of this unnamed tributary was split into two, with both the right (south) and left (north) channels draining separately over the remainder of the reach and joining the Elbow River at unique locations. The divided channel is the presumed result of recent flood events.

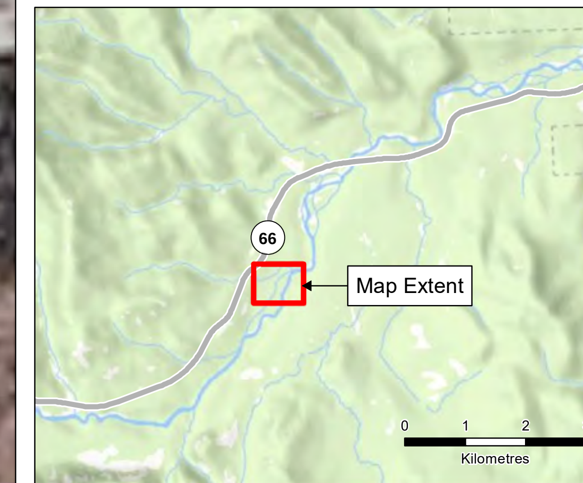
No anthropogenic disturbances to the riparian habitat were observed during the assessment, suggesting that there exists approximately 11,060 m^2 of undisturbed riparian habitat within the assessed reach.

Fish sampling was not conducted in summer 2017 due to dry conditions at the time of the assessment. No fish were observed within slough habitats.

Lack of connectivity, and the presumed seasonal flow regime of unnamed tributary G suggests that its habitat may only be available to fish seasonally at best. Although its value may be increased in years with higher precipitation or prolonged runoff periods, the habitat within the unnamed tributary was rated to be of nil potential for the indicator species.

Elbow River at McLean Creek Dam (MC1)

Unnamed Tributary G Habitat Units within the Local Assessment Area



Legend

Channel Unit/Habitat

- Dry
- Slough

- Flow Direction
- Watercourse
- Highway

Channel Unit/Habitat	
R1	Class 1 Run; Deep Run >1.0 m
R2	Class 2 Run; Moderate Run 0.75-1.0 m
R3	Class 3 Run; Shallow Run < 0.75 m
P1	Class 1; Deep Pool >1.0 m
P2	Class 2; Moderate Pool 0.75-1.0 m
P3	Class 3; Shallow Pool < 0.75 m
CA	Cascade
CH	Chute
FL	Flat
RA	Rapid
RF	Riffle
SL	Slough
SN	Snye
SF	Subsurface Flow

Substrates	
Be	Bedrock
Bo	Boulder
Co	Cobble
Gr	Gravel
Sa	Sand
C/S	Clay Silt
Or	Organics

Notes

1. The width of Unnamed Tributary G is arbitrary and does not represent the true dimensions of the creek. It shoud 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
- Aerial Image: SPOT 1.5 m, 2016

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Metres

NAD 1983 UTM Zone 11N

Page Size: 11" x 17"

2025-001.01	Production Date: Sep 15, 2017	Figure 7.3-47

HEMMERA

Alberta Transportation

Unnamed Tributary H

Similar to unnamed tributary G, unnamed tributary H (in its entirety) is located upstream from the potential location of the MC1 dam and upper extent of the permanent pond location, but within the anticipated area to be inundated during considerable flood events. It also drains north-easterly although empties into unnamed tributary A instead of joining the Elbow River directly (**Figure 7.3-48**). During the MC1 team's assessment of this tributary on July 19, 2017, the channel was characterized as being occasionally confined and following a sinuous pattern. Substrates throughout the assessed reach consisted of gravel and cobbles, with fines dominating the downstream extent of the watercourse. The average channel and wetted widths were 7.4 m and 3.0 m, respectively. The banks were characterised as sloping and rated as having low stability. Bank height ranged from 0.4 m to 2.1 m.

Dry conditions were encountered throughout much of the assessed reach. Water was present in slough habitat, located at the downstream end of the assessed reach near the tributary's confluence with unnamed tributary A. Where water occurred, cover opportunities for fish was provided predominately by overhanging vegetation and undercut banks within the slough habitat.

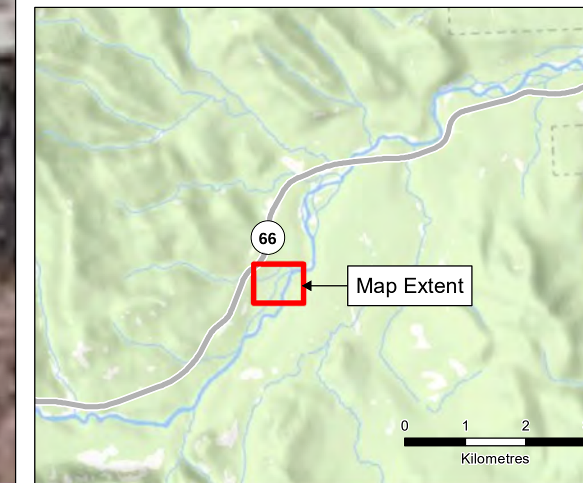
An inventory of riparian habitat through the assessed reach resulted in the identification of three anthropogenic elements (i.e. road culvert crossing, pedestrian culvert crossing, pedestrian bridge) that had disturbed existing riparian vegetation. Combined, these disturbances totalled 320 m^2, a value which represents approximately 0.04% of the total riparian habitat (8,640 m^2) within the assessed reach. Riparian vegetation is composed of grasses, shrubs, and mixed forest.

Fish sampling was not conducted in summer 2017 due to dry conditions at the time of the assessment. No fish were observed within the slough habitat.

As with unnamed tributary G, a lack of connectivity, and the presumed seasonal flow regime of this watercourse suggests that its habitat may only be available to fish seasonally at best. Although its value may be increased in years with higher precipitation or prolonged runoff periods, the habitat within the unnamed tributary was rated to be of nil potential for the indicator species.

Elbow River at McLean Creek Dam (MC1)

Unnamed Tributary H Habitat Units within the Local Assessment Area



Legend

Channel Unit/Habitat

- Dry
- Slough

- Flow Direction
- Watercourse
- Highway

Channel Unit/Habitat

R1	Class 1 Run; Deep Run >1.0 m
R2	Class 2 Run; Moderate Run 0.75-1.0 m
R3	Class 3 Run; Shallow Run < 0.75 m
P1	Class 1; Deep Pool >1.0 m
P2	Class 2; Moderate Pool 0.75-1.0 m
P3	Class 3; Shallow Pool < 0.75 m
CA	Cascade
CH	Chute
FL	Flat
RA	Rapid
RF	Riffle
SL	Slough
SN	Snye
SF	Subsurface Flow

Substrates

Be	Bedrock
Bo	Boulder
Co	Cobble
Gr	Gravel
Sa	Sand
C/S	Clay Silt
Or	Organics

Notes

1. The width of Unnamed Tributary H is arbitrary and does not represent the true dimensions of the creek. It shoud 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
- Aerial Image: SPOT 1.5 m, 2016

N

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0 50 100 150

Metres

NAD 1983 UTM Zone 11N

Page Size: 11" x 17"

2025-001.01	Production Date: Sep 15, 2017	Figure 7.3-48

HEMMERA

Alberta Transportation

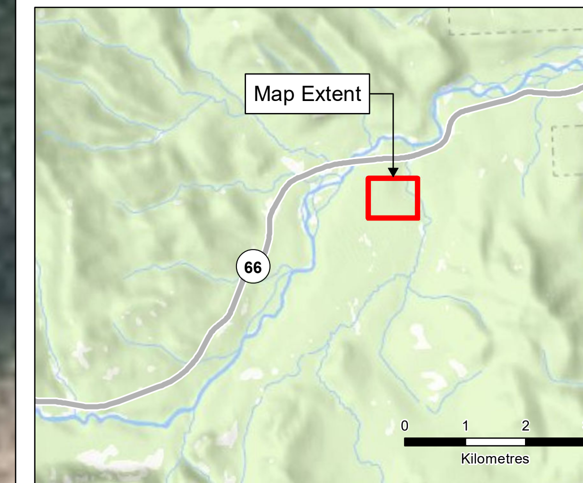
Path: O:\!2000\2025\001\01\mxd\ea\Fig7_3-48__2025_001_01_Aquatics_UnnamedHHabitat_170914.mxd

An assessment of habitat potential in this unnamed tributary occurred on August 1, 2017. Based on a review of topographic mapping, the location of this tributary occurs downstream from the auxiliary spillway, where earthworks are anticipated to facilitate drainage in the event of flood events that exceed 2013 levels (**Figure 7.3-49**). Also based on a review of topographical information, the direction of drainage for this unnamed tributary was presumed to be easterly, towards its confluence with McLean Creek). However, during this assessment, marginally defined and discontinuous (i.e., < 50 m in length) were observed throughout the assessed reach and no flow or standing water was encountered.

The lack of continuous channel definition and absence of surface flow indicates that this drainage is unlikely to provide reliable, consistent fish habitat to any of the indicator species. While over land flow may occur seasonally (i.e., during snow melt or high precipitation events), the drainage's overall lack of connectivity limits its potential for fish. Sampling of fish was precluded by the absence of water. No disturbances of riparian habitat were observed.

Elbow River at McLean Creek Dam (MC1)

Unnamed Tributary I Habitat Units within the Local Assessment Area



Legend

Channel Unit/Habitat

Non-defined Channel

Flow Direction

Watercourse

Road

Channel Unit/Habitat		**Substrates**	
R1	Class 1 Run; Deep Run >1.0 m	Be	Bedrock
R2	Class 2 Run; Moderate Run 0.75-1.0 m	Bo	Boulder
R3	Class 3 Run; Shallow Run < 0.75 m	Co	Cobble
P1	Class 1; Deep Pool >1.0 m	Gr	Gravel
P2	Class 2; Moderate Pool 0.75-1.0 m	Sa	Sand
P3	Class 3; Shallow Pool < 0.75 m	C/S	Clay Silt
CA	Cascade	Or	Organics
CH	Chute		
FL	Flat		
RA	Rapid		
RF	Riffle		
SL	Slough		
SN	Snye		
SF	Subsurface Flow		

Notes

1. The width of Unnamed Tributary I is arbitrary and does not represent the true dimensions of the creek. It shoud 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
- Aerial Image: SPOT 1.5 m, 2016

N

1:2,500

0 50 100 150

Metres

NAD 1983 UTM Zone 11N

Page Size: 11" x 17"

2025-001.01	Production Date: Sep 15, 2017	Figure 7.3-49

HEMMERA

Alberta Transportation

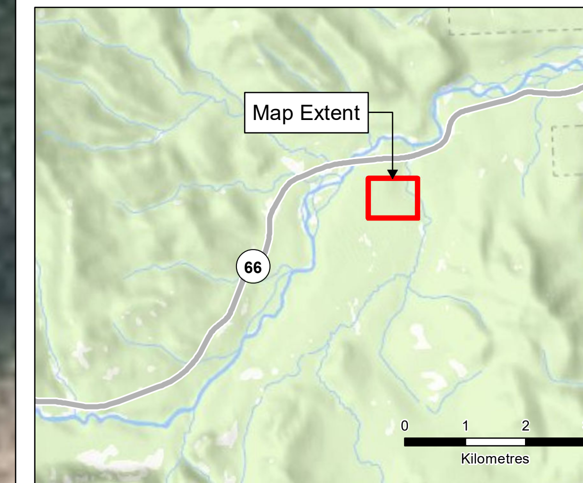
Unnamed Tributary J

As with unnamed tributary I, topographical information suggests this drainage should proceed easterly, from the approximate area of a MC1 borrow pit towards its confluence with McLean Creek (**Figure 7.3-50**). However, during an assessment of habitat potential in this unnamed tributary on August 1, 2017, only limited discontinuous sections (i.e., extending over lengths of 5 m to 10 m) of scour was observed and no flow or standing water was encountered.

The lack of continuous channel definition and absence of surface flow indicates that this drainage is unlikely to provide reliable, consistent fish habitat to any of the indicator species. While over land flow may occur seasonally (i.e., during snow melt or high precipitation events), the drainage's overall lack of connectivity limits its potential for fish. Sampling of fish was precluded by the absence of water. No disturbances of riparian habitat were observed.

Elbow River at McLean Creek Dam (MC1)

Unnamed Tributary J Habitat Units within the Local Assessment Area



Legend

Channel Unit/Habitat

Non-defined Channel

Flow Direction

Watercourse

Road

Channel Unit/Habitat

R1 Class 1 Run; Deep Run >1.0 m
R2 Class 2 Run; Moderate Run 0.75-1.0 m
R3 Class 3 Run; Shallow Run < 0.75 m

P1 Class 1; Deep Pool >1.0 m
P2 Class 2; Moderate Pool 0.75-1.0 m
P3 Class 3; Shallow Pool < 0.75 m

CA Cascade
CH Chute
FL Flat
RA Rapid
RF Riffle
SL Slough
SN Snye
SF Subsurface Flow

Substrates

Be Bedrock
Bo Boulder
Co Cobble
Gr Gravel
Sa Sand
C/S Clay Silt
Or Organics

Notes

1. The width of Unnamed Tributary J is arbitrary and does not represent the true dimensions of the creek. It shoud 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

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Metres

NAD 1983 UTM Zone 11N

Page Size: 11" x 17"

2025-001.01	Production Date: Sep 15, 2017	Figure 7.3-50

HEMMERA

Alberta Transportation

Unnamed Tributary K

An assessment fish habitat potential and use in this unnamed tributary was conducted by the MC1 study team on July 14, 2017, over a reach that extended upstream through the anticipated 2013 flood level. During this assessment, unnamed tributary K was characterised as flowing in an irregular meander pattern, that is occasionally confined, southeasterly towards its confluence with Ranger Creek (**Figure 7.3-51**). The average channel and wetted widths throughout the assessed reach were 4.9 m and 2.4 m, respectively. Banks were generally sloped in nature and of low to moderate stability. Bank height ranged from 0.2 m to 2.2 m throughout the assessed reach. Flow was present through the assessed reach and was considered to be at a moderate stage at the time of the habitat assessment.

Substrates consisted primarily of cobbles, followed by gravels, fines, and boulders with moderate embeddedness. Despite this tributary's connectivity to Ranger Creek, and the proximity of the assessed reaches of both watercourses, a marked difference in substrate embeddedness was noted between the two. Specifically, substrates within this unnamed tributary were obviously less embedded, indicating that it may provide more suitable spawning conditions for redd building species. A comparative decrease in substrate embeddedness in unnamed tributary K was presumably the result of relatively limited anthropogenic influences (e.g., cattle crossings) within its assessed reach.

Habitat morphology consisted primarily of riffle units, followed by deep pool and alternating riffle and run habitats, with shallow run habitat (<0.75 m) to a lesser extent. Suitable small gravel spawning areas were observed in riffle habitats close to the tributary's confluence with Ranger Creek. Cover for fish consisted primarily of woody debris, with moderate amounts of overhanging vegetation and undercut banks.

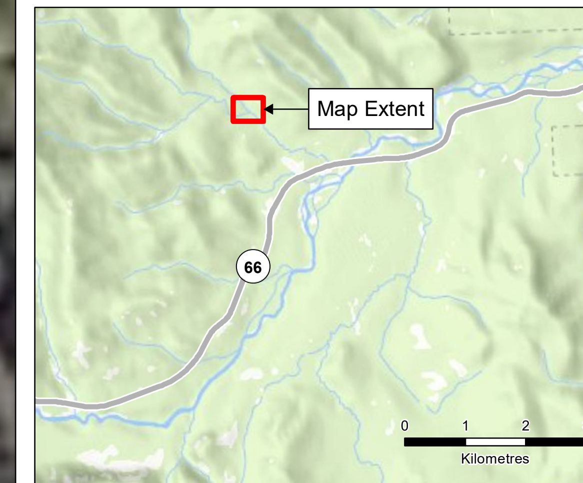
During an inventory of riparian habitats, two anthropogenic elements (i.e. off-highway vehicle crossing and pedestrian bridge) were identified. Combined, these disturbances totalled 80 m^2, a value which represents approximately 2% of the approximated total riparian habitat (4,000 m^2) within the assessed reach.

Fish sampling was not conducted in unnamed tributary K as fish presence was easily detected through visual observations. Given the absence of barriers to migration and the proximity of Ranger Creek, it was presumed that fish observed during the assessment of unnamed tributary K were of similar composition as previously documented in Ranger Creek.

Overall, the habitat potential within unnamed tributary K is considered to be suitable for fish, including some of the indicator species. Specifically, habitat within the tributary is considered as being of marginal importance for spawning, rearing, and feeding for rainbow trout and of marginal potential for rearing habitat for brown trout and bull trout. Given the prevalence of brook trout within Ranger Creek, it is also expected that unnamed tributary K provides suitable habitat for all life stages of brook trout as well.

Elbow River at McLean Creek Dam (MC1)

Unnamed Tributary K Habitat Units within the Local Assessment Area



Legend

Channel Unit/Habitat

- Pool
- Riffle
- Run
- Alternating Riffle Run Habitat
- Flow Direction
- Watercourse

Channel Unit/Habitat

R1	Class 1 Run; Deep Run >1.0 m
R2	Class 2 Run; Moderate Run 0.75-1.0 m
R3	Class 3 Run; Shallow Run < 0.75 m
P1	Class 1; Deep Pool >1.0 m
P2	Class 2; Moderate Pool 0.75-1.0 m
P3	Class 3; Shallow Pool < 0.75 m
CA	Cascade
CH	Chute
FL	Flat
RA	Rapid
RF	Riffle
SL	Slough
SN	Snye
SF	Subsurface Flow

Substrates

Be	Bedrock
Bo	Boulder
Co	Cobble
Gr	Gravel
Sa	Sand
C/S	Clay Silt
Or	Organics

Notes

1. The width of Unnamed Tributary K is arbitrary and does not represent the true dimensions of the creek. It shoud 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
- Aerial Image: SPOT 1.5 m, 2016

N

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Metres

NAD 1983 UTM Zone 11N

Page Size: 11" x 17"

2025-001.01	Production Date: Sep 15, 2017	Figure 7.3-51

HEMMERA

Alberta Transportation

Connop Creek

Given the potential for the realignment of Highway 66 to require a permanent vehicle crossing (i.e., culvert) of Connop Creek, the MC1 study team conducted an assessment of fish habitat potential over an approximate 400 m reach, extending 100 m upstream from the potential crossing to 300 m downstream. This assessment was completed on July 13, 2017.

During the assessment, Connop Creek was characterised as perennial watercourse with an irregular meander pattern. It was observed to be occasionally confined and flowing generally in a northeasterly direction toward its confluence with the Elbow River (**Figure 7.3-52**). Average channel and wetted widths are 3.1 m and 2.2 m respectively during the assessment and banks were characterised as sloping in shape and of low stability. Bank heights ranged in from 0.2 m to 0.7 m.

Substrates within Connop Creek consisted primarily of fines and cobbles. Substrate embeddedness was rated as high with fines inundated throughout the assessed reach.

Habitat morphology was composed primarily of alternating riffle and run habitats. Shallow run (<0.75 m) and deep pool habitats (>1.0 m) are also present, but to a lesser extent.

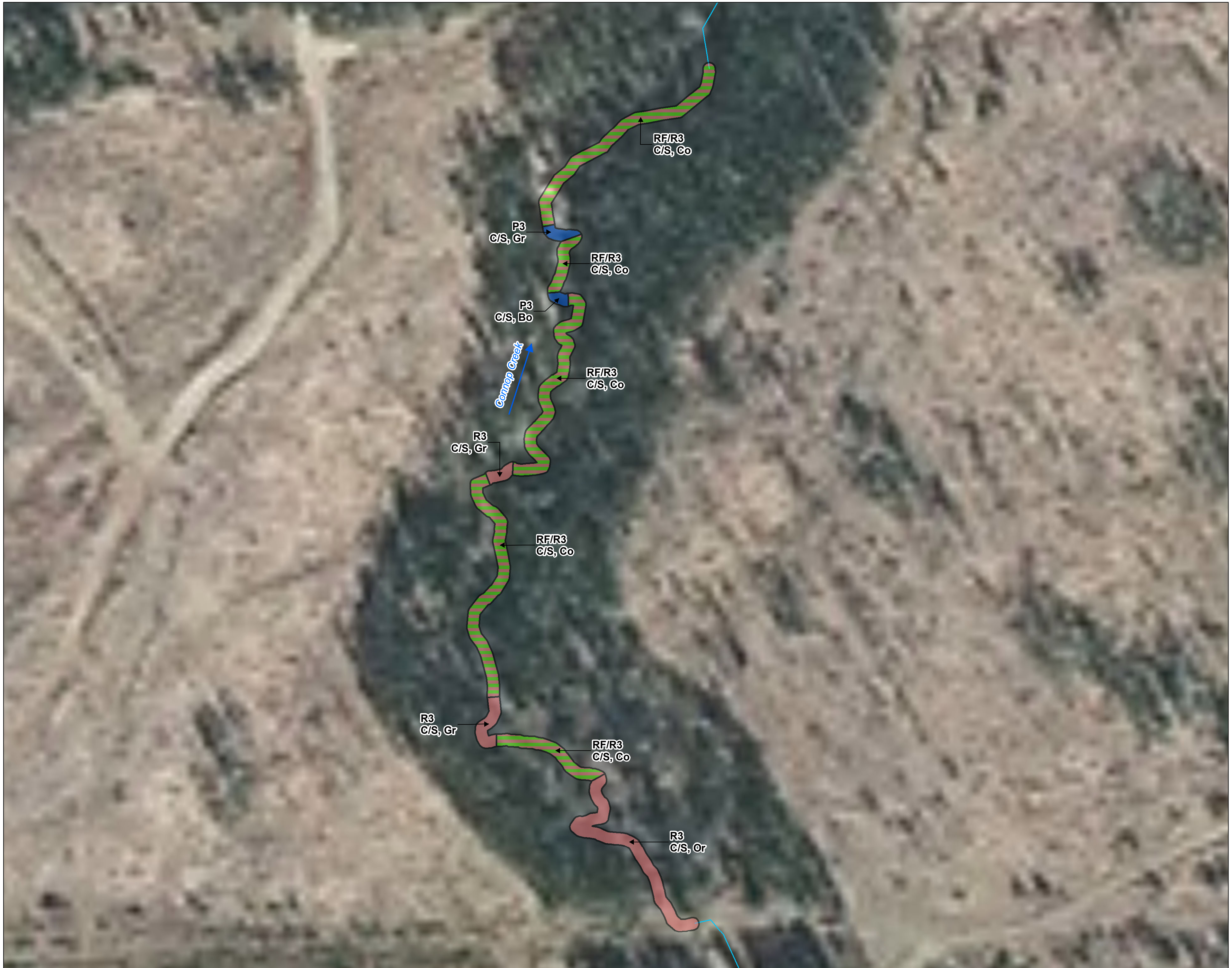
During the assessments' riparian inventory, one anthropogenic element that influence riparian areas was encountered. The disturbance occurred over an area of 10 m^2, an area which is equivalent to 0.13% of an approximated 8,000 m^2 of riparian habitat within assessed reach.

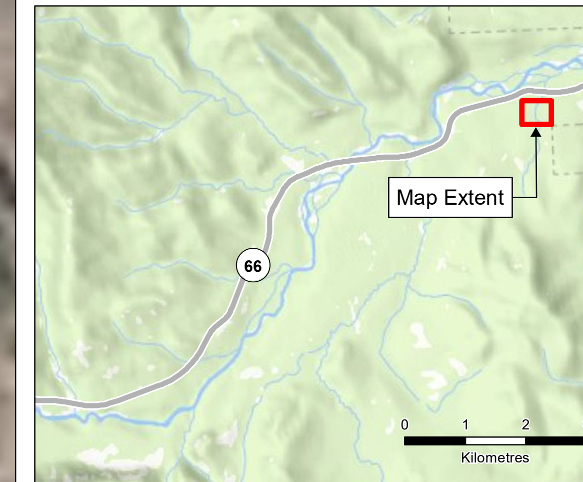
Fish sampling, using a backpack electrofishing unit (Smith Root™ LR24) was completed over the assessed reach. One brook trout was captured, despite a total of 875 seconds of fishing effort. Additional fish were observed but not captured, generally within alternating riffle – run and shallow run habitats.

Overall, habitat in Connop Creek was characterised as providing nil to marginal potential for spawning habitat for rainbow trout, brown trout, and bull trout. This was predominantly due to the extensive inundation of fines overtop coarse substrate. Feeding habitat potential was rated as marginal for rainbow trout and brown trout due to the lack of suitable deep habitat units (i.e., >1.0 m) and habitat complexity. Wintering habitat potential was considered nil for all indicator species given the absence of suitably deep pool units. Despite the assessed limited overall potential for indicator species, Connop Creek is expected to support various life stages of brook trout.

Elbow River at McLean Creek Dam (MC1)

Connop Creek at Proposed Highway 66 Crossing Habitat Units within the Local Assessment Area





Legend

Channel Unit/Habitat

- Pool
- Run
- Alternating Riffle Run Habitat

- Flow Direction
- Watercourse

Channel Unit/Habitat		Substrates	
R1	Class 1 Run; Deep Run >1.0 m	Be	Bedrock
R2	Class 2 Run; Moderate Run 0.75-1.0 m	Bo	Boulder
R3	Class 3 Run; Shallow Run < 0.75 m	Co	Cobble
P1	Class 1; Deep Pool >1.0 m	Gr	Gravel
P2	Class 2; Moderate Pool 0.75-1.0 m	Sa	Sand
P3	Class 3; Shallow Pool < 0.75 m	C/S	Clay Silt
CA	Cascade	Or	Organics
CH	Chute		
FL	Flat		
RA	Rapid		
RF	Riffle		
SL	Slough		
SN	Snye		
SF	Subsurface Flow		

Notes

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Sources

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Metres

NAD 1983 UTM Zone 11N

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2025-001.01	Production Date: Sep 15, 2017	Figure 7.3-52

HEMMERA

Alberta Transportation

McLean Creek (confluence)

Given the potential for McLean Creek to be realigned for the purposes of the MC1 diversion tunnel and outlet and fish passage facility structures, the MC1 study team assessed fish habitat use and potential over an approximate 300 m reach extending from the existing Highway 66 crossing downstream to the Elbow River confluence. This reach encompasses the length of habitat to be potentially influenced by MC1. This assessment was completed on August 1, 2017.

The McLean Creek confluence reach was characterised as being largely confined by steepened valley walls and of an irregular meander pattern which drains northeast towards the Elbow River (**Figure 7.3-53**). The average channel width was 8.7 m, with an average wetted width of 5.0 m. Banks were characterised as sloping with sections of overhanging bank. Bank height ranged from 0.4 to 9.0 m with low to moderate stability.

Substrates consisted primarily of gravel and cobbles, followed in abundance by boulders and fines, with trace amounts of bedrock and organic material. Substrates had moderate embeddedness throughout the assessed reach. Water levels within Mclean Creek were considered to be low at the time of the assessment.

Habitat morphology within the assessed reach were comprised primarily of alternating riffle and run habitats. Shallow run and flat (<0.75 m) habitat, and moderate (0.75 m to 1.0 m) and deep pool (>1.0 m) habitats were also present, but to a lesser extent. Cover types for fish were mainly boulders and woody debris, with trace amounts of overhanging vegetation and undercut banks.

During the inventory of riparian habitat two anthropogenic elements (i.e. a culvert crossing and highway right of way) which influenced existing riparian components were identified. Combined, these disturbances totalled 360 m^2 of riparian habitat, resulting in disturbance to 4.3% of the approximate total riparian habitat of 8,400 m^2.

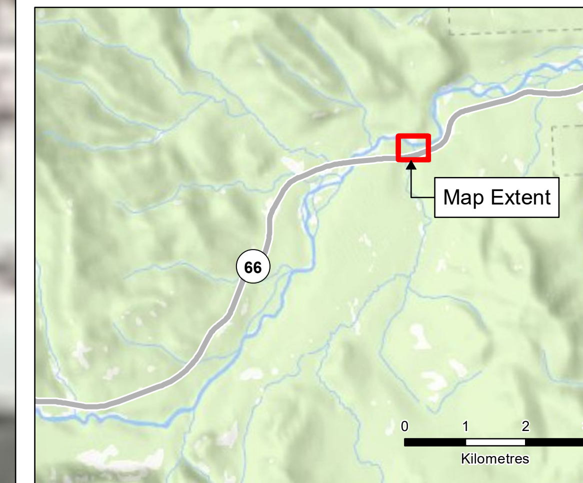
Fish sampling (1,977 seconds of backpack electrofishing effort), conducted over the approximate 300 m reach, resulted in the capture of 51 fish. Longnose dace were the most prevalent species captured (35), followed by brown trout (15), and rainbow trout (1).

Average daily water temperatures recorded in McLean Creek ranged from 12.0 ºC to 19.5 ºC **Figure 7.3-54**)**.** The trend in temperature values immediately prior to the removal of the logger was considered to be nearing the upper acute temperature thresholds (22 ºC) for the indicator species bull trout and mountain whitefish. However, the maximum temperature recorded may not reflect actual temperatures within the watercourse as the logger was found to be out of the water upon retrieval, which may have been due to changed water levels since its deployment or due to tampering.

Habitat potential for indicator species in McLean Creek (confluence) was characterised as being generally suitable for spawning of rainbow trout and but unsuitable for the remaining indicator species due partially to high substrate embeddedness and limited flow in late summer/fall periods. The potential for habitat to provide support to rearing rainbow trout, brown trout, and bull trout was all considered suitable, while marginal for adult feeding opportunities. Wintering habitat was rated as marginal for all indicator species expect for mountain whitefish, as wintering is in the reach is anticipated but likely largely provided by a single deep pool habitat located immediately downstream of the Highway 66 culvert crossing.

Elbow River at McLean Creek Dam (MC1)

McLean Creek at Elbow River Confluence Habitat Units within the Local Assessment Area



Legend

Channel Unit/Habitat

- Chute
- Flat
- Pool
- Riffle
- Run
- Alternating Riffle Run Habitat

- Flow Direction
- Highway Direction Arrow
- Watercourse
- Highway or Road

Channel Unit/Habitat

R1	Class 1 Run; Deep Run >1.0 m
R2	Class 2 Run; Moderate Run 0.75-1.0 m
R3	Class 3 Run; Shallow Run < 0.75 m
P1	Class 1; Deep Pool >1.0 m
P2	Class 2; Moderate Pool 0.75-1.0 m
P3	Class 3; Shallow Pool < 0.75 m
CA	Cascade
CH	Chute
FL	Flat
RA	Rapid
RF	Riffle
SL	Slough
SN	Snye
SF	Subsurface Flow

Substrates

Be	Bedrock
Bo	Boulder
Co	Cobble
Gr	Gravel
Sa	Sand
C/S	Clay Silt
Or	Organics

Notes

1. The width of McLean Creek is arbitrary and does not represent the true dimensions of the creek. It 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

- Basedata: Government of Alberta
- Aerial Image: SPOT 1.5 m, 2016

N

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Metres

NAD 1983 UTM Zone 11N

Page Size: 11" x 17"

2025-001.01	Production Date: Sep 15, 2017	Figure 7.3-53

HEMMERA

Alberta Transportation

McLean Creek (crossing)

Given the potential for the realignment of Highway 66 to require a new permanent vehicle crossing (i.e., culvert) of McLean Creek, the MC1 study team conducted an assessment of fish habitat potential over an approximate 400 m reach, extending 100 m upstream from the potential crossing to 300 m downstream (**Figure 7.3-55**). This assessment was completed on August 1, 2017.

Within the assessed reach, McLean Creek was frequently confined by steepened approaches and represents a sinuous pattern. Given the unseasonably dry conditions prior to the assessment, the watercourse was at a low stage at the time of assessment. Average channel and wetted widths were 5.6 m and 3.2 m, respectively. Banks were generally sloping with moderate to high stability. Bank height ranged in height from 0.7 m– 9.3 m.

Substrates within the assessed reach consisted primarily of fines, although cobble, gravel, boulder and bedrock elements were also observed. Given the high abundance of fines, the substrate with the reach was considered to be highly embedded.

Habitat morphology consisted primarily of alternating riffle and run habitat, followed by shallow flat (<0.75 m) and riffle habitats. A limited section of cascade habitat was located near the downstream extent of the assessed reach. Cover for fish were provided primarily by boulders, woody debris, and trace amounts of overhanging and instream vegetation.

An inventory of riparian habitat resulted in the identification of one anthropogenic disturbance (i.e., a decommissioned off highway vehicle crossing at the site of the proposed Highway 66 culvert crossing). This disturbance measured 80 m^2, which corresponds to approximately 1% of an approximated total of 8,000 m^2 of riparian habitat within the LAA.

Fish sampling (1,554 seconds of electrofishing effort) over the 400 m reach resulted in the capture of 135 fish. The composition of captured fish included longnose dace (131), rainbow trout (3), and brown trout (1).

Overall, suitable habitat exists for indicator species within this assessed reach. However, despite the large numbers of fish encountered during the assessment, only a marginal potential for habitat to support spawning of rainbow and brown trout exists at the potential crossing location due to high embeddedness high composition of fines. The potential for habitat elsewhere in the reach is greater, where substrate embeddedness and greater diversity in substrate types were observed. The potential for habitat to support rearing rainbow trout, brown trout, and bull trout was considered suitable, while it was expected to provide marginal potential for adult feeding opportunities. Limited wintering opportunities were observed for all indicator species during the assessment, resulting in a marginal potential rating for this life stage for all indicator species except mountain whitefish.

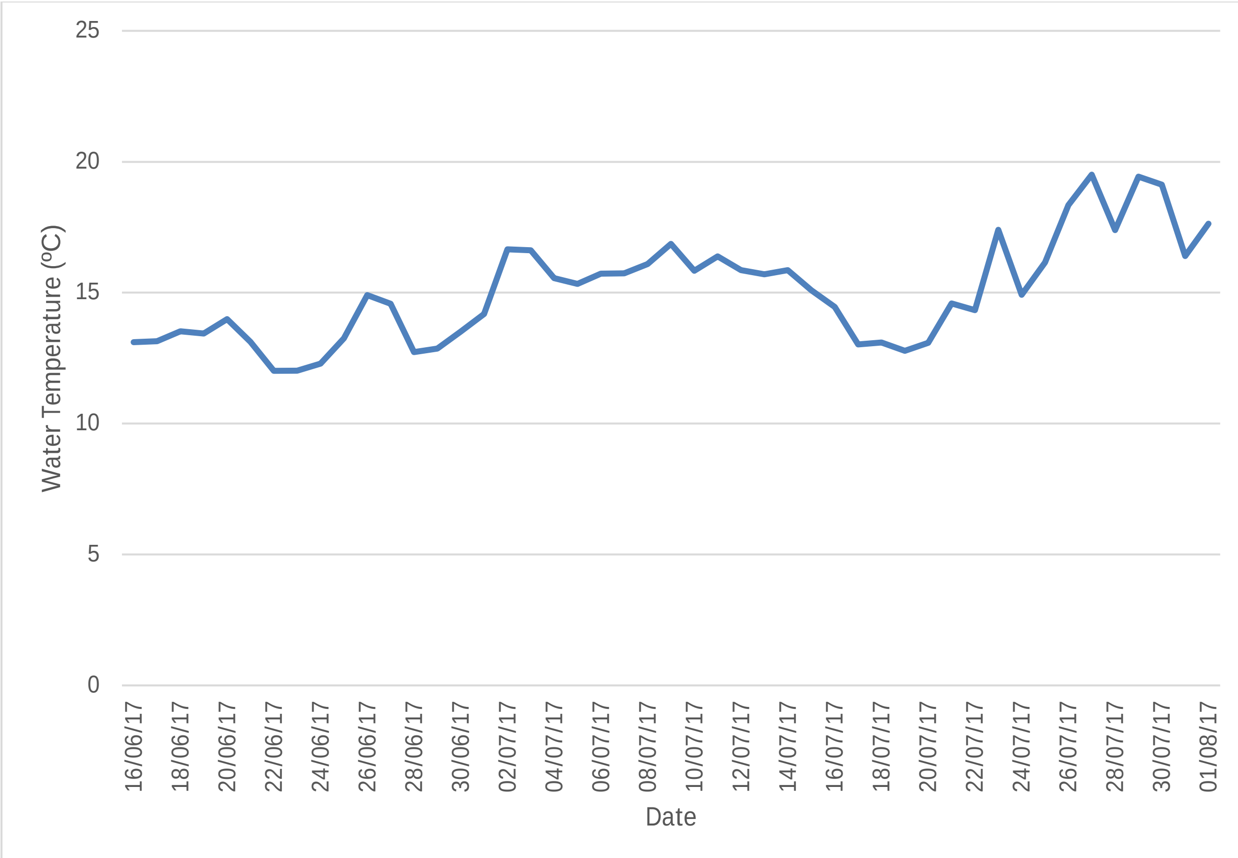
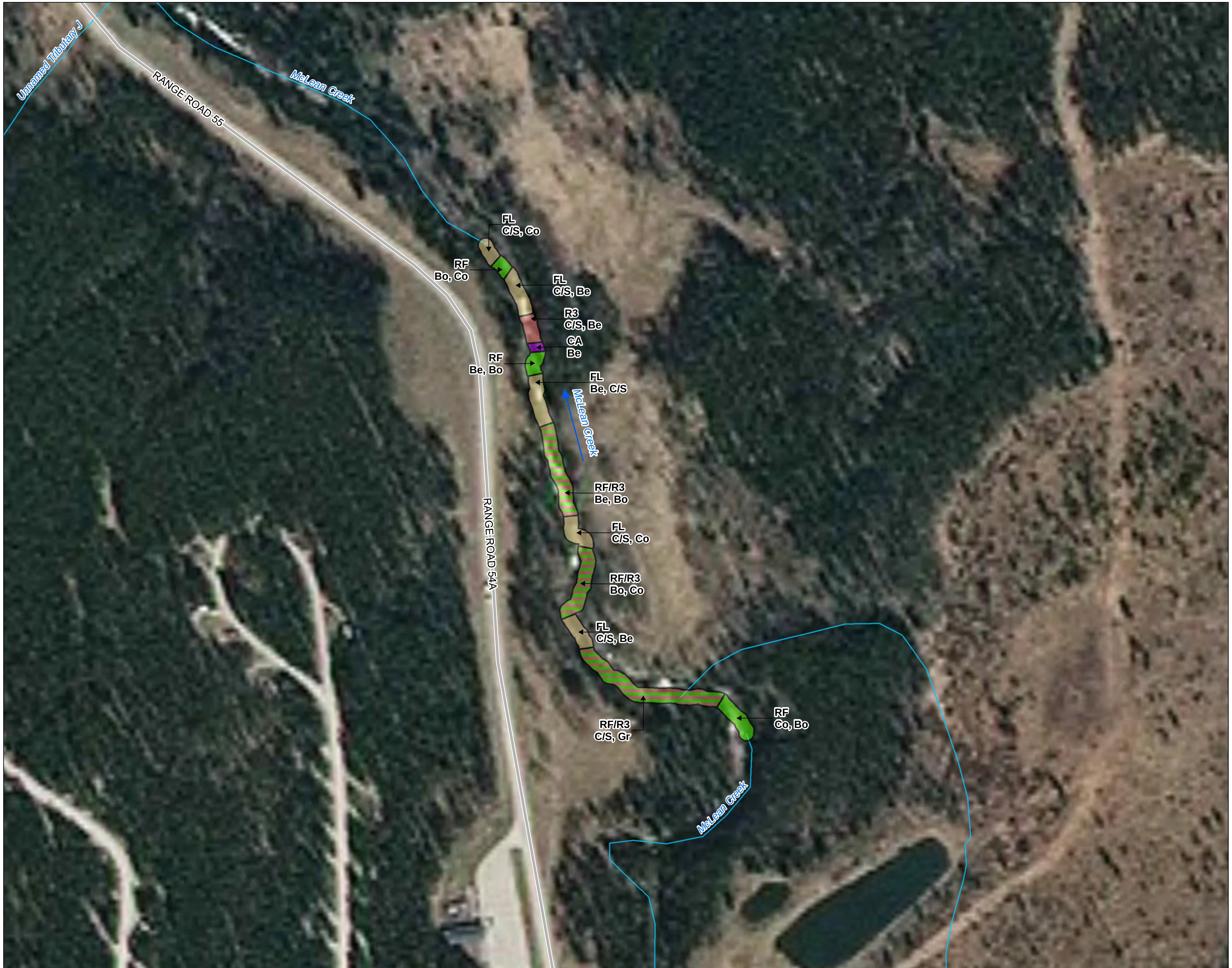
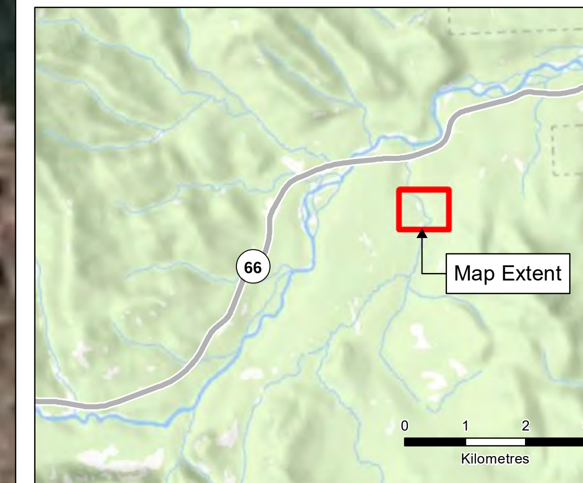


Figure 7.3-54 Average Daily Water Temperature in McLean Creek at its confluence with the Elbow River, Summer 2017

Elbow River at McLean Creek Dam (MC1)

McLean Creek at Proposed Highway 66 Crossing Habitat Units within the Local Assessment Area





Legend

Channel Unit/Habitat

- Cascade
- Flat
- Pool
- Riffle
- Run
- Alternating Riffle Run Habitat

- Flow Direction
- Watercourse
- Highway

Channel Unit/Habitat

R1	Class 1 Run; Deep Run >1.0 m		
R2	Class 2 Run; Moderate Run 0.75-1.0 m		
R3	Class 3 Run; Shallow Run < 0.75 m		
P1	Class 1; Deep Pool >1.0 m		
P2	Class 2; Moderate Pool 0.75-1.0 m		
P3	Class 3; Shallow Pool < 0.75 m		
CA	Cascade	RF	Riffle
CH	Chute	SL	Slough
FL	Flat	SN	Snye
RA	Rapid	SF	Subsurface Flow

Substrates

Be	Bedrock
Bo	Boulder
Co	Cobble
Gr	Gravel
Sa	Sand
C/S	Clay Silt
Or	Organics

Notes

1. The width of McLean Creek is arbitrary and does not represent the true dimensions of the creek. It shoud 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
- Aerial Image: SPOT 1.5 m, 2016

N

1:2,500

0 50 100 150

Metres

NAD 1983 UTM Zone 11N

Page Size: 11" x 17"

2025-001.01	Production Date: Sep 15, 2017	Figure 7.3-55

HEMMERA

Alberta Transportation

7.3.2.7 Aquatic Invasive Species and Fish Diseases

The Alberta Invasive Species Council (2017) currently lists nine invasive aquatic species as occurring within the province. Among these, Eurasian watermilfoil (*Myriophyllum spicatum*), Quagga mussel (*Dreissena bugensis*), and Zebra mussel (*D. polymorpha*) are of highest concern to Alberta's aquatic resource managers. None of the nine listed invasive species are known to occur in the Elbow River watershed, upstream from Glenmore Reservoir (Wilson, Pers. Comm. March 2017). Didymo algae (*Didymosphenia geminate*) is considered an invasive species where it exists, and is non-native to its environment. Didymo does occur in the Bow River Basin and may exist within the Elbow River watershed; however, since it is not yet known if Didymo is native to the Elbow River, it is not currently listed as an invasive species (Wilson, Pers. Comm. March 2017).

In August 2016, the presence of whirling disease (*Myxobolus cerebralis*) was confirmed for the first time in Alberta. Whirling disease is caused by a myxozoan parasite that has a two-host life cycle involving salmonid fishes (e.g., rainbow trout, cutthroat trout, bull trout, brown trout, mountain whitefish) and a tubificid oligochaete (*Tubifex tubifex*). Infection with *Myxobolus cerebralis* can cause debilitating deformities to the skull and spine of young salmonids, which in turn result in involuntary and erratic whirling behaviour, eventually leading to death of the infected fish. There are many possible vectors of whirling disease as transfer of the parasite can occur through infected fish and sediment containing infected tubifex worms. Following the initial detection of whirling disease, AEP (and National Parks Aquatic Team staff) conducted a sampling program targeting hundreds of sampling sites within salmonid habitat across Alberta. The bulk of results of this testing is still pending; however, on February 10, 2017 and based on preliminary results from several sampling stations, the Canadian Food Inspection Agency declared Bow River Basin as an infected area for this disease (Government of Canada 2017). Sampling results from within the RAA and potentially the LAA may be forthcoming, but are currently unknown. Subsequent announcements from the Canadian Food Inspection Agency indicate that whirling disease has also been confirmed as occurring in the Oldman River and Red Deer River watersheds, although these occur outside the RAA.

7.3.3 APPLICATION CASE

7.3.3.1 Potential Option Interactions

This section summarizes anticipated interactions of MC1 components and activities with Aquatic Environment and the associated measurable parameters listed in **Table 7.3-5**, as provided in **Table 7.3-11.** Each potential effect is then discussed in more detail in **Section 7.3.2.2,** while interactions with no anticipated effect are not considered further in the assessment. Mitigation relevant to the potential effects from the perspective of the Aquatic Environment is subsequently provided in **Section 7.3.3.3**.

Table 7.3-11 Identification of Potential Option Interactions with Aquatic Environment

Phase	Activity	Fish and Fish Habitat	
		Interaction	Potential Effect
Construction	Clearing	X	· Permanent alteration and/or destruction of fish habitat · Fish mortality and productivity
	Road construction	X	· Permanent alteration and/or destruction of fish habitat · Fish mortality and productivity · Impediment to migration and movement
	Decommissioning and removal of existing provincial parks infrastructure and ranger station	X	· Contamination of fish habitat
	Dam (cofferdam, rock groyne, and earth fill) construction	X	· Permanent alteration and/or destruction of fish habitat · Fish mortality and productivity · Impediment to migration and movement
	Spillway construction	X	· Permanent alteration and/or destruction of fish habitat · Fish mortality and productivity · Impediment to migration and movement
	Outlet structure construction	X	· Permanent alteration and/or destruction of fish habitat · Fish mortality and productivity · Impediment to migration and movement
	Laydown areas construction and use	-	-
	Stockpile development and use	-	-
	Borrow and spoil areas development and use	X	· Clearing of riparian habitat or destruction or alteration of instream habitat
	Realignment of watercourse(s)	X	· Permanent alteration and/or destruction of fish habitat · Fish mortality and productivity · Impediment to migration and movement · Clearing of riparian habitat
	Realignment of Highway 66	X	· Permanent alteration and/or destruction of fish habitat · Fish mortality and productivity · Impediment to migration and movement · Clearing of riparian habitat

Phase	Activity	Fish and Fish Habitat	
		Interaction	Potential Effect
	Storage of water in permanent pond	X	· Permanent alteration and/or destruction of fish habitat · Fish mortality and productivity · Changes to fish assemblages due to habitat change
	Reclamation	X	· Fish mortality and productivity
Operation and Maintenance	Routine and Flood Operations and Maintenance	X	· Periodic alteration and/or destruction of fish habitat · Fish mortality and productivity · Impediment to migration and movement · Changes to fish assemblages due to habitat change

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

7.3.3.2 Potential MC1-related Effects

This section considers potential adverse MC1-related effects on the Aquatic Environment arising from potential interactions, as identified in **Table 7.3-11** and in relation to the measurable parameters listed in **Table 7.3-5.** Mitigation measures for each potential effect are described in **Section 7.3.3.3.**

Permanent Alteration and Destruction of Fish Habitat

The MC1 Option may adversely affect fish habitat during its Construction and Operation and Maintenance phases. During the Construction phase, MC1 may directly eliminate or alter fish habitat by placing permanent physical structures over viable fish habitat or functional riparian areas; clearing riparian vegetation; altering channel morphology by creating the permanent pond; realigning watercourses for MC1 infrastructure; constructing temporary and/or permanent watercourse crossings; excavating borrow pits; or installing armouring features within the channel of any watercourse. Construction activities may also influence water quality through the introduction of sediment or deleterious substances and temporarily affect benthic invertebrate and periphyton community assemblage (abundance and diversity) as well as fish distribution and abundance. Decommissioning of existing infrastructure (e.g., removal of contaminated soils and sewage lagoon) also may introduce deleterious substances. During reclamation activities, sediment may mobilize into fish habitat. A summary of the estimated anticipated area of permanently altered or destroyed fish habitat resulting from the Construction phase is provided in **Table 7.3-12.**

During the Operation and Maintenance phase, MC1 activities may compound some of these same potential effects, and may alter fish habitat by changing the physical or chemical characteristics of habitat as well as benthic invertebrate and periphyton community assemblage (abundance and diversity) within the MC1 footprint and adjacent areas (i.e., both upstream and downstream). A summary of the estimated area of altered or destroyed fish and fish habitat resulting from the Operation and Maintenance phase is provided in **Table 7.3-13**.

Construction

Within the LAA, the expected footprint of the earth fill dam alone (henceforth considered inclusive of the cofferdam and rock groin) to be constructed within the Elbow River's channel is approximately 3 hectares (ha). Both the cofferdam and rock groin would remain as permanent features of the earth fill dam, following their use during construction. Additional permanent features including the service and auxiliary spillways, diversion tunnels and outlet, and fish passage facility and permanent road crossings at Connop Creek, McLean Creek and unnamed tributary E combined represent more than 10 ha of additional estimated permanent footprint area. This footprint area does not include any potential instream elements associated with temporary vehicle and equipment crossings needed during construction (0.3 ha), or the permanent watercourse crossing installation at the Elbow River by the Highway 66 crossing (realignment), as the Option's crossing of the Elbow River would consist of a single span bridge and would not require any instream disturbance for construction. Combined, it is anticipated that the total permanent footprint of MC1 within watercourses (regardless of whether they provide fish habitat or not) is approximately 3.5 ha.

Based on habitat use investigations within the LAA, the earth fill dam's footprint coincides with an estimated total of 16,500 m^2 of riverine habitat in the Elbow River. Habitat within the dam footprint currently consists of primarily extended riffle units, with secondary glide and shallow run units intermixed, comprising unembedded gravel and cobble substrate. Although this unit does offer rearing and feeding opportunities for multiple species, spawning of indicator species has not been documented in this habitat to date, and it is unsuitable for wintering of large-bodied fish. The absence of spawning year-round by all species should not be presumed, as the habitat has sufficient potential to support the spawning of indicator species (i.e., bull trout, brown trout, rainbow trout) as well as brook trout.

Although it would be filled near the completion of construction, the creation of a permanent pond immediately upstream of the earth fill dam would also permanently alter the amount and quality of habitat available to all fishes in the MC1 area (**Table 7.3-12**). The pond level would fluctuate during the Operation and Maintenance phase; however, the elevation of the inlet (invert) to the diversion tunnel system (1,384 m) would be 4 m to 5 m above that of the current channel at this location (i.e., beyond the current ordinary high-water mark). The minimum volume of dead storage within the permanent pond would likely be approximately 3,500 cubic decametres (dam^3). The permanent impoundment of this volume would result in the pond extending approximately 2.6 km upstream within the Elbow River from the earth fill dam. Over this distance, approximately 57,064 m^2 of existing instream area of the Elbow River would be permanently inundated (**Table 7.3-12**), essentially resulting in the area's transition from lotic to lacustrine habitat. To date, spawning by indicator species has been confirmed in 3,326 m^2 (4%) of this area in 2014 (AMEC 2015) and 2016. A total of 300 m^2 of existing habitat is also presumed to currently provide important wintering habitat opportunities to indicator species within the boundaries of the potential permanent pond.

The permanent pond would also extend upstream within Ranger Creek (approximately 675 m) and unnamed tributary C (approximately 300 m). An estimated total of 6,636 m^2 of alterations would be made to tributary habitats, including 212 m^2 of presumed spawning and 4,541 m^2 of presumed wintering habitat, within Ranger Creek (**Table 7.3-12**). Since there exists insufficient potential for habitat to support indicator species in unnamed tributary C, the area of inundation within this tributary is not considered lost or altered fish habitat). Inundation of the unnamed tributaries A, B, F, G, and H is also not expected to result from the creation of the permanent pond. Although spawning potential for indicator species within these tributaries is comparatively limited and wintering of adult indicator species is unlikely, habitat within Ranger Creek specifically is expected to support all life stages of other fish species (e.g., brook trout). In general, the alteration of habitat quality and quantity within these tributaries is expected to be an adverse effect.

A total of 80,200 m^2 of lotic habitat would be replaced by 377,297 m^2 of littoral area (i.e., defined as water depth less than 6 m) and 343,297 m^2 of limnetic area, as estimated at the permanent pond's lowest elevation. In general, habitats that are characterized by shallow depths, moderate velocities, and unembedded substrate would decrease in extent and distribution following the creation of the permanent pond. In comparison, habitats with a generalized increase in water depth and lower water velocities would become more prevalent. Overall, the areal extent available to fish would increase within the permanent pond as compared to the area of existing riverine habitat, although the amount and suitability of this habitat would fluctuate with pond levels, thereby limiting the ability of fish to consistently utilize the newly formed habitats. As an example and based on modelling completed on behalf of the Dunvegan Hydroelectric Project (Jacques Whitford 2006), it is realistic to expect that rearing (i.e., littoral zones) and wintering opportunities (i.e., increased ice cover during winter) may increase within the permanent pond; however, the reduction of water velocities throughout much of the ponded area and a corresponding deposition of sediment would diminish the quality and quantity of spawning habitat for all fish species known to occur in the MC1 Option area.

Excavation of borrow pit areas, in locations beyond the limits of the permanent pond or other MC1 infrastructure, could alter additional existing habitat through the removal of coarse substrate, although avoidance is likely possible (see **Section 7.3.3.3**). Similarly, disturbance to riparian areas or instream habitat (i.e., during clearing activities) of unnamed tributaries to McLean Creek (unnamed tributaries I and J) during earthworks downslope of the auxiliary spillway may alter the characteristics of these drainages, but given the existing lack of suitability of these drainages for all fish, no effects on fish habitat are expected

Realignment of McLean Creek to facilitate the diversion tunnel outlet and fish passage facility would result in the loss or alteration of approximately 2,100 m^2 of fish habitat, 505 m^2 of which is considered spawning or wintering habitat for indicator species. Although realignment of unnamed tributary D is expected for the purposes of construction of the service spillway, unnamed tributary D is not considered to be fish habitat. As a result, no loss or alteration of fish habitat is predicted in this instance.

The realignment of Highway 66 would include culvert crossing installations at Connop Creek, McLean Creek and unnamed tributary E. Given the lack of fish habitat potential at unnamed tributary E, no loss is expected at this location. However, at the crossing locations of Connop Creek and McLean Creek, approximately 222 m^2 and 141 m^2, respectively, of fish habitat would be permanently lost or altered. Although none of this habitat loss is expected to represent spawning or wintering habitat for indicator species, it is possible that some of this footprint would coincide with spawning habitat for brook trout.

Table 7.3-12 Estimated Potential Fish Habitat Loss and Alterations Resulting from Construction of MC1

Habitat Type	Estimated Area of Loss or Altered Fish Habitat[1] (m^2)	Confirmed or Presumed Spawning Habitat[2] (m^2) Potentially Altered	Presumed Wintering Habitat Potentially Altered[3] (m^2)	Substrate	
				Dominant	Sub-Dominant
Elbow River					
Pool 1	300	-	300	Cobble	Gravel
Pool 2	-	-	--	Gravel	Fines
Pool 3	-	-	-	-	-
Run 1	-	-	-	-	-
Run 2	-	-	-	Cobble	Gravel
Run 3	18,206	3,326	-	Cobble	Gravel
Riffle	49,430		-	Cobble	Gravel
Cascade	-	-	-	-	-
Rapid	-	-	-	Boulder	Cobble
Snye	5,628	-	-	Fines	Cobble
Total	**73,564[4]**	**3,326**	**300**	**Cobble**	**Gravel**
Ranger Creek[5]					
Impoundment (beaver pond)	4,478	-	4,478	Fines	-
Pool 1	63	-	63	Fines	Gravel
Pool 2	-	-	-	Fines	Gravel
Pool 3	-	-	-	Fines	Gravel
Run 1	-	-	-	-	-
Run 2	-	-	-	-	-
Run 3	565	92	-	Gravel	Fines
Riffle/Run	601	120	-	Cobble	Gravel

Habitat Type	Estimated Area of Loss or Altered Fish Habitat[1] (m²)	Confirmed or Presumed Spawning Habitat[2] (m²) Potentially Altered	Presumed Wintering Habitat Potentially Altered[3] (m²)	Substrate	
				Dominant	Sub-Dominant
Riffle	435	-	-	Cobble	Gravel
Cascade	-	-	-	-	-
Total	**6,151**	**212**	**4,541**	**Cobble**	**Fines**
McLean Creek (confluence)					
Pool 1	125	-	125	Fines	Gravel
Pool 2	90	-	90	Gravel	-
Pool 3	0	-	-	-	-
Flat 1	0	-	-	-	-
Flat 2	0	-	-	-	-
Flat 3	225	-	-	Gravel	Fines
Run 1	0	-	-	-	-
Run 2	0	-	-	-	-
Run 3	330	150	-	Gravel	Cobble
Riffle/Run	925	100	-	Boulder	Cobble
Riffle	395	40	-	Boulder	Cobble
Chute	10	-	-	Bedrock	-
Total	**2,100**	**290**	**215**	**Boulder**	**Cobble**
McLean Creek (crossing)[6]					
Pool 1	0	-	-	-	-
Pool 2	0	-	-	-	-
Pool 3	0	-	-	-	-
Flat 1	0	-	-	-	-
Flat 2	0	-	-	-	-
Flat 3	16	-	-	Fines	Bedrock
Run 1	0	-	-	-	-
Run 2	0	-	-	-	-
Run 3	0	-	-	-	-
Riffle/Run	206	-	-	Fines	Gravel
Riffle	0	-	-	-	-
Total	**222**	**0**	**0**	**Fines**	**Gravel**

Habitat Type	Estimated Area of Loss or Altered Fish Habitat[1] (m^2)	Confirmed or Presumed Spawning Habitat[2] (m^2) Potentially Altered	Presumed Wintering Habitat Potentially Altered[3] (m^2)	Substrate	
				Dominant	Sub-Dominant
Connop Creek[6]					
Pool 1	0	-	-	-	-
Pool 2	0	-	-	-	-
Pool 3	0	-	-	-	-
Run 1	0	-	-	-	-
Run 2	0	-	-	-	-
Run 3	0	-	-	-	-
Riffle/Run	141	-	-	Fines	Cobble
Riffle	0	-	-	-	-
Cascade	0	-	-	-	-
Total	**141**	**0**	**0**	**Fines**	**Gravel**

Notes:

1 Based on habitat morphology mapped in fall 2016 and summer 2017 with reference to the MC1 Option Description and specific to indicator species only.

2 Based on confirmation of spawning activity of fall spawning indicator species in the Elbow River in fall 2016 and presumption of spawning potential in tributaries in fall of 2016 and summer 2017 – where spawning habitat was presumed to be influenced, the entire associated habitat unit area was considered.

3 Use of habitat for wintering by indicator species has not been confirmed in any watercourse, but is based on habitat potential and characteristics observed during habitat inventory in fall 2016 and summer 2017.

4 Of this total, approximately 16,500 m^2 of potential loss of habitat would result within the footprint of the earth fill dam, coffer dam, and rock groin, and the remaining area would be altered by creation of the permanent pond.

5 All totals are presumed to be alterations of habitat resulting from creation of permanent pond.

6 All totals are presumed to be alterations or loss of habitat resulting from the construction of the Highway 66 watercourse crossings.

The following non-fish-bearing watercourses would also be impacted by the construction of MC1 but are not considered as part of the lost or altered fish habitat totals: 485 m^2 for unnamed tributary C, 437 m^2 for unnamed tributary D, 2,145 m^2 for unnamed tributary E, 2,910 m^2 for unnamed tributary I, and 790 m^2 for unnamed tributary J.

Pool 1 = deep pool habitat (>1.0 m); Pool 2 = moderate pool habitat (0.75 – 1.0 m); Pool 3 = shallow pool habitat (<0.75 m).
Run 1 = deep run habitat (>1.0 m); Run 2 = moderate run habitat (0.75 – 1.0 m); Run 3 = shallow run habitat (<0.75 m).
Flat 1 = deep flat habitat (>1.0 m); Flat 2 = moderate flat habitat (0.75 – 1.0 m); Flat 3 = shallow flat habitat (<0.75 m).
Riffle/Run = alternating riffle and shallow run (Run 3) habitat.
m = metre; m^2 = square metre.

Clearing activities in preparation of the MC1 Option area for the earth fill dam footprint, the creation of the permanent pond, and the Highway 66 crossing (realignment) of the Elbow River, McLean Creek, Connop Creek and unnamed tributary E would likely result in the removal of 10.3 ha of riparian vegetation adjacent to lotic habitats (i.e., to a depth of 10 m). While this area represents an estimated 21% of known undisturbed riparian habitat within the LAA (28.2 ha), it is less than 0.3% of presumed undisturbed habitat within the RAA (3,998.2 ha). Additional clearing of riparian vegetation would likely be needed at the tributaries of the Elbow River for the realignment of Highway 66 and construction of the auxiliary spillway, along with realignments of McLean Creek and unnamed tributary to the Elbow River (i.e., currently not included in the LAA) (**Section 7.1 Vegetation and Wetlands**).

Unmitigated surface runoff from disturbed approaches, offstream laydown areas, road construction zones, store piles, instream isolation measures, or other disturbances of channel banks and beds may result in increased sediment inputs within the LAA (**Section 6.5 Water Quality**). More specifically, if increased sediment mobilization occurs during periods of low suspended sediment concentrations (i.e., late fall and winter) or during important life stages of fish species (i.e., spawning and wintering); reductions of habitat quality and mortality of sensitive life stages of fish (e.g., eggs and larvae) may result downstream. The duration and magnitude of these potential mobilizations during the Construction phase is unknown; however, given the multi-year construction schedule, scope of excavation, and site preparation (i.e., specifically at the earth fill dam location), they may be substantial. Elevated and prolonged suspended concentrations are harmful to fish and fish habitat (Newcombe 1994, Anderson et al. 1995, Muck 2010). Potential effects range from decreased health and reduced viability of eggs and larvae to physiological influence on juvenile and adult fish; smothering of food production units; and degradation of wintering, spawning, and rearing habitats through the deposition of fine materials in interstitial spaces among coarse substrates.

Sediment introductions would also result from the creation of a new water-bank interface zone as a result of the increased elevation in the permanent pond. Over time, and with repeated fluctuations in water level, bank/approach erosional events would result in the mobilization of sediment, most of which is expected to initially settle within the ponded area (**Section 6.5 Water Quality**).

During the Construction phase, MC1 may directly eliminate and/or alter benthic and periphyton habitat by placing permanent physical structures over viable stream habitat, altering channel morphology through the creation of the permanent pond, realigning watercourses for infrastructure, constructing watercourse crossings and/or excavating borrow pits or installing armouring features within the channel of any watercourse. Changes in benthic invertebrate and periphyton numbers and productivity may be correlated with construction activities. Construction activities associated with the earth fill dam and road crossing(s) will also require heavy machinery that may affect watercourse structure and input sediment load. It has been suggested that effects to benthic invertebrates from stream-crossing infrastructure (such as pipelines) are short term and non-residual (Tsui and McCart, 1981), this may be similar for linear crossings such as roads.

Although construction activities within all watercourses would likely be completed with the use of isolation measures, some mobilization of sediment is still anticipated. The quantities and durations of mobilizations are unknown and would vary depending on the activities and substrate that is disturbed. Increased turbidity in the water column from TSS may adversely affect the photosynthetic activity of periphyton. Sediment and fine material may accumulate on stream bottoms, altering substrate composition and affecting benthic macroinvertebrate's ability to cling to surfaces. As well, increased TSS may lead to scouring, filling, or clogging the interstitial spaces of sediment, limiting benthic living space and productivity (Sosiak and Dixon 2004).

Construction of the earth fill dam or channel realignments in the Elbow River may affect benthic and periphyton survival by introducing contaminants or fine materials, or when the isolated areas are dewatered or excavation occurs. Although mitigation measures suggest a step-wise isolation of the Elbow River to ensure construction would occur in the dry, benthic and periphyton species cannot be salvaged.

Operation and Maintenance

During Operation and Maintenance, MC1 may affect fish habitat through:

- The transition from lotic to lacustrine-based habitat within the permanent pond
- Episodic fluctuations of water levels beyond the maximum elevation of the permanent pond which would result in the inconsistent availability and value to fish of shallow water areas (i.e., littoral zones)
- Temporary inundation of the Elbow River, Ranger Creek, and unnamed tributaries A and K during flood events which would adversely influence spawning and overwintering habitat for indicator (or other fishes) species in the absence of MC1
- Potential changes to riparian habitat upstream of the dam resulting from changes in water elevation
- The use of the MC1 diversion tunnel outlet structure and fish passage facility
- The use of the service and auxiliary spillways during a 2013 flood level event
- Modified flow regime downstream of the diversion tunnel outlet structure and fish passage facility
- Altered morphology and habitat value resulting from flow changes
- Scouring of substrate near the diversion tunnel outlet structure
- Influence of MC1 on water temperature in the Elbow River and inundated tributaries both upstream and downstream from the dam
- Potential increase in spawning and feeding opportunities in the upstream reaches of the permanent pond resulting from the deposition of larger coarse substrate
- The cessation of coarse substrate transport to downstream of the earth fill dam which would result in altered spawning potential
- A gradual decrease in the movement of finer substrate through the diversion tunnels which may result in a decreased potential for increased embeddedness of coarse substrate

- A reduction in the quantity of groundwater downstream of the earth fill dam
- Fluctuating water levels which may alter channel morphology downstream and substrate and woody debris movement, which may lead to changes in benthic and periphyton abundance and diversity
- Increased suspended sediment concentrations downstream of the earth fill dam which may lead to alteration of the benthic and periphyton community
- Nutrient releases from flooded soils that are retained in the permanent pond which may lead to enhanced periphyton growth which could result in a community shift in primary producers in the permanent pond and upstream area

Following construction, aquatic habitat within the permanent pond is anticipated to undergo an ecosystem transition (from lotic to lacustrine-based). However, due to an anticipated short water residence time during the flowing seasons within the permanent pond (3.5 days), no appreciable upsurge in nutrient concentration or phytoplankton biomass is expected, and the permanent pond would likely retain oligotrophic conditions (**Section 6.5 Water Quality**). More prolonged water residence time during winter (19 days) may result in greater retention of nutrients within the permanent pond and potentially more phytoplankton biomass than in the spring and summer (**Section 6.5 Water Quality**), although it is unknown whether this potential change would positively influence fish and fish habitat.

During normal operation, water levels upstream from the earth fill dam may fluctuate episodically beyond the maximum elevation of the permanent pond. The change in elevation of water level may vary seasonally, and possibly more frequently (e.g., weekly or daily) depending on freshet peak flows and associated flood mitigation considerations. For example, during 1:20 flood events, the water level in the resulting reservoir is expected to increase to approximately 1,403.8 m and result in a reservoir containing 12,300 dam^3. In comparison, elevation of water level at the 2013 flood elevation is expected to be 1,424.1 m and corresponding reservoir volume of 67,600 dam^3. Regardless of peak flow levels, operational requirements and resulting water levels within the reservoir, including shallow water areas (i.e., littoral zones and habitat further upstream within the reservoir) would be of inconsistent availability and value to fish.

At 2013 flood flow levels, an additional 161,762 m^2 (i.e., beyond the level of habitat permanently inundated by the construction of the permanent pond) of lotic instream area in the Elbow River, Ranger Creek, and unnamed tributaries A, B, C, E, F, G, H and K would likely become temporarily inundated. However, given the lack of suitability for indicator species in each of these unnamed tributaries except unnamed tributaries A and K, the anticipated area of altered fish habitat (for indicator species) resulting from a 2013 flood level event is anticipated to be 153,674 m^2 (**Table 7.3-13**). Of this area, 41,594 m^2 of confirmed (i.e., Elbow River) or presumed (Ranger Creek and unnamed tributaries A and K) spawning and overwintering habitat for indicator species, it is reasonable to expect these habitats would likely be adversely influenced by flooding events in the absence of MC1.

Although the periodic inundation of these habitats would temporarily alter their characteristics (e.g., water depths, velocity), the results of the inundation may have positive, adverse, or no influence on fish habitat.

For example, where the habitat value for indicator species is currently limited (e.g., unnamed tributary B), flooding of watercourses may result in an increase in habitat potential for fishes seeking refuge from elevated suspended sediment concentrations. Where suitable lotic habitat currently exists for indicator species or other fishes (e.g., within the Elbow River upstream of the permanent pond or within Ranger Creek), fish present during the flood event would likely either move upstream to other potentially suitable habitat, such as the reservoir, where they can seek refuge from increased velocities and suspended sediment concentrations. Over time, the compounded occurrences of flooding and receding levels would result in sediment deposition, bank erosion, and degradation of riparian habitat. Although increased water levels and depths may increase wintering potential, the presumed operational drawdown of water levels during winter suggests wintering habitat may not be increased by the operation of the reservoir (i.e., beyond the permanent pond levels).

Effects on riparian habitat upstream from the earth fill dam during the Operation and Maintenance phase would be reflective of changes in water elevation (**Section 7.1 Vegetation and Wetlands**). More regular inundation of riparian areas would occur at elevations between the permanent pond and water level elevations in the reservoir, and it is in this area where more substantive alterations to the ecology of near-shore vegetation would be anticipated. Determination of the areal extent of the alteration is not possible due to the anticipated regulatory of fluctuation; however, at 1:20 flood events for example, an additional 5.5 ha of riparian habitat would be temporarily inundated by the reservoir.

Downstream from the earth fill dam, potential effects on fish habitat may result from use of the MC1 diversion tunnel outlet structure and fish passage facility. Potential effects would vary in scope and timing in existing riffle habitat (5,146 m^2) between the earth fill dam and diversion tunnel outlet structure during the Operation and Maintenance phase. Depending on gradient in the area and flow rates through the diversion tunnels, existing riffle habitat may be altered to a backwater or ponded area of a reduced area. The estimated value of this alteration is presented in **Table 7.3-13**. No spawning or wintering habitat was observed in this reach during the 2016 fall habitat and spawning inventories, although the area is expected to regularly support rearing and feeding fishes.

Although effects would also be likely during the use of the service and auxiliary spillways, such effects would only be anticipated during a 2013 flood level event. As a result, the potential effects from the operation of these features (i.e., extensive scouring and mobilization of high concentrations of sediment) have not been included in this suitability assessment, as similar levels of naturally occurring scouring and sediment mobilizations would likely result in the area in the absence of MC1's infrastructure.

In general, it can be expected that the flow regime downstream from MC1 would largely emulate the naturally occurring upstream conditions in the LAA; however, naturally occurring substantial peak and low flow attenuations can be expected in habitat downstream from the diversion tunnel outlet structure and fish passage facility (**Section 6.4 Fluvial Geomorphology**). During a 1:20 level flood event for example, the reservoir would likely be above its permanent pond level (1,395 m) (i.e., filling) for approximately 70 hours, and would require approximately 30 hours to draw back down. As a further example, at a 1:100 flood level, the reservoir would fill for 160 hours, while drawdown would take approximately 110 hours. This range in operational needs of MC1, which are likely to occur seasonally, would create a modified flow regime downstream. Any attenuation of high and low flow events would influence fish habitat availability and quality downstream of MC1, particularly in shallow water habitats, although the immediate alteration of channel habitat morphology may not be discernible. The attenuation of flow would reduce the frequency and magnitude of extreme high-flow events downstream of the earth fill dam, which in turn would decrease the potential for lateral channel migration. Over time, this flow decrease would reduce substrate and woody debris recruitment from eroding banks and approaches. In addition, the elimination of extreme flood events would likely stabilize the existing channel downstream from MC1, in turn allowing for the re-establishment of bank stability and increasing the functionality of riparian vegetation.

Some scouring of substrate near the diversion tunnel outlet structure may result, and the morphology and habitat value of the Elbow River between the earth fill dam and outlet structure may be altered as flows change. Aside from this assumed effect, the full spatial extent of the potential changes to habitat availability within the Elbow River resulting from normal operation of the diversion tunnels is unknown. Modelling by BC Hydro (2013) regarding similar potential effects in the Peace River from the Site C Dam indicated that influences on habitat by fluctuating water levels, resulting from that project’s proposed hydroelectric operation approach, were expected a considerable distance downstream (approximately 16 km), since there are no large tributary inputs that would attenuate peaks or compensate during low flows. Given the similar lack of major tributaries downstream from MC1, flow regime effects may also extend to habitats in Elbow River beyond 1 km downstream.

Water temperature in the Elbow River and inundated tributaries may be influenced by MC1, both upstream and downstream from the earth fill dam, although the potential influence may change between seasons and may be modest due to the limited anticipated water residence time in the permanent pond. As described in **Section 6.5 Water Quality**, the estimated residence time of water in the permanent pond is 3.5 days, while in winter this period may extend to 19.3 days, suggesting a potential larger influence during the winter season.

Insufficient data currently precludes the potential for modelling of the potential influence of MC1 on water temperatures, although information from other similar projects suggest that effects to water temperature may occur year-round and may have both positive and adverse effects on fish habitat potential and use.

Modelling completed on behalf of the Site C Clean Energy Project indicated that water temperatures in the Peace River immediately downstream of the dam were expected to increase during the summer and early winter (i.e., July through January) by between 0.3º C and 1.5º C compared to baseline conditions, and would be cooler during the spring (i.e., March to June) by between 0.4º C and 0.9 º C (BC Hydro 2013). In that same assessment, it was predicted that changes to water temperature could result as far as 62 km downstream, and the increase in winter water temperatures would extend fish wintering habitat further downstream compared to baseline conditions. Obvious differences in project scope exist between MC1 and Site C, so these comparisons are provided for context only. Similarly, modelling of potential water temperatures in the Oldman River downstream from the Oldman River Dam suggested warmer winter water temperatures and cooler summer temperatures following dam construction (Government of Canada 1992). With warmer winter temperatures, however, an increase in the potential for frazil (i.e., accumulation of ice crystals in water that is too turbulent to freeze solid) and anchor ice (i.e., ice formed below the surface of a body of water and attached to the bottom or to submerged objects) downstream would result, causing harmful effects on spawning and juvenile fish seeking refuge in coarse substrates during winter. Since there would be an anticipated low potential for buffering of this influence by groundwater intrusions (**Section 6.3 Hydrogeology**), increased potential of frazil and anchor ice downstream from the earth fill dam could be consequential to the habitat potential of the Elbow River, as bull trout, brown trout, and mountain whitefish spawning is known to occur immediately downstream from the earth fill dam, and their eggs incubate over the winter season. Similar increased potential influences of frazil and anchor ice were referenced during the assessment of potential effects of the Dunvegan Dam; however, it was expected that frazil and anchor ice would only result in the project's tailrace zone and positive effects of open water conditions would extend between 10 km and 90 km downstream from the headworks during winter (Jacques Whitford 2006).

Within the permanent pond, water temperatures would likely increase through the summer months, particularly in littoral zones, as freshet flows diminish; however, modelling completed on behalf of the Dunvegan Project in the Peace River indicated that only minimal changes to water temperatures (0.1° C to 0.3° C) were expected in that project's headpond (Jacques Whitford 2006), suggesting that minimal increase may be expected following MC1's construction as well. That assessment further indicated that given the relatively small size of the headpond and the shortened period (i.e., 6 hours) for water to pass through the head pond, natural diurnal fluctuations in water temperature would be of larger consequence.

Monitoring of water temperatures in the Little Bow River, both upstream and downstream from the Twin Valley Reservoir following construction of the Twin Valley Dam, also support the presumed pattern of increased summer temperatures in upstream reaches and decreased temperatures downstream of impoundments (Sosiak 2011). However, changes in water temperatures observed upstream (i.e., to as high as 1.6° C) and downstream (i.e., 3° C to 4° C lower) of the dam at the Twin Valley Reservoir were more substantial than those modelled for the Oldman Dam and Peace River. Changes in water temperatures in the Aquatic Environment LAA similar, to those observed downstream of the Twin Valley Reservoir, would reduce the suitability of fish habitat for the species in the MC1 Option area, particularly within the permanent pond and for cold water indicator species such as bull trout and mountain whitefish. Temperature criteria for bull trout (Environmental Management Associates 1992) indicate that adult and fry acute daily maximum temperature is 22° C and chronic (7-day mean) temperatures greater than 15° C are stressful for bull trout. Maximum temperature tolerance of adult mountain whitefish, prior to chronic effects, is 18° C for fry and adult mountain whitefish, and the acute daily maximum for the species is 22° C for adults and 24° C for fry.

During the Operation and Maintenance phase of MC1, some deposition of larger coarse substrate is possible in the upstream reaches of the permanent pond (**Section 6.4 Fluvial Geomorphology**), which, if realized, may provide increased spawning and feeding opportunities in the immediate vicinity. However, within much of the permanent pond relatively higher concentrations of fine materials resulting from river and tributary inputs and bank and shoreline erosion during water level fluctuations would dominate the sediment transport compositions, and generally increase substrate embeddedness, particularly during the spring and summer seasons (see **Section 6.5 Water Quality**).

Given the elevated nature of the inlet to the diversion tunnels and fish passage facility, the transportation of coarse substrate downstream of the earth fill dam would not occur during the Operation and Maintenance phase (**Section 6.4 Fluvial Geomorphology**). The gradual natural migration of gravels and cobble from the vicinity of the diversion tunnel outlet and habitats downstream, combined with the lack of recruitment from upstream sources, has the potential to adversely and incrementally influence the spawning potential for each of the indicator species within the Elbow River. The spatial effect of this influence is unknown; however, this effect is known to occur elsewhere in the Elbow River, downstream from the Glenmore Reservoir, where spawning habitat for brown trout, rainbow trout, and mountain whitefish has been compromised over multiple kilometres through the ongoing operation of the Glenmore Dam and armouring of banks adjacent to private and public infrastructure. Given the presumed differences in operational procedures, it is unclear whether the same magnitude or spatial extent of this influence would result from MC1.

In addition to the cessation of coarse substrate transport, movement of finer substrates through the diversion tunnels may also decrease over time. Modelling for the Site C dam suggested that the mean annual sediment transport load from that project would be reduced by 54% due to the settling in the reservoir, and that further reductions would result with the contributions of flow from major tributaries downstream (BC Hydro 2013). Although the influence of major tributary flows is not likely to be substantial in the Elbow River, a generalized reduction in the transport of fine sediments would likely decrease the potential for increased embeddedness of coarse substrates over a considerable distance downstream, thereby potentially positively influencing spawning, rearing, and feeding habitats for some indicator species.

The quantity of groundwater would likely be reduced downstream of the earth fill dam following construction of MC1 (**Section 6.3 Hydrogeology**). The spatial extent of this potential influence is unknown, although it may extend beyond 1 km downstream. The reduction of groundwater may affect suitability of spawning habitat for redd-building indicator species, most specifically bull trout, downstream from the MC1 footprint.

Dam operations would result in fluctuating water levels, possibly altering channel morphology downstream and substrate and woody debris movement, which may lead to changes in benthic and periphyton abundance and diversity.

Baseline suspended sediment concentrations downstream of the LAA were reviewed and are provided in **Section 6.5 Water Quality**. As MC1-specific downstream distribution of elevated suspended sediment concentrations have not been developed modelling completed on behalf of the Site C Dam assessment, was used to provide a general understanding of the anticipated zone of influence (ZOI). Information from the Site C Dam assessment indicated that elevated suspended sediment concentrations caused by activities in the dam and generating station construction ZOI would extend downstream approximately 15.9 km, although it is acknowledged that the scope of the Site C Dam is considerably greater than for MC1.

Changes to channel morphology and substrate expected from dam operations may lead to alteration of the benthic and periphyton community. Increased turbidity from TSS due to dam operations may adversely affect the photosynthetic activity of algae. As well, increased TSS may clog the interstitial spaces of sediment, limiting benthic production (Sosiak and Dixon 2004).

Nutrient releases from flooded soils that are retained in the pond may lead to enhanced periphyton growth. This is more likely in winter months when the estimated holding time in the pond is 19 days (**Section 6.5 Water Quality**).

In a study done by BC Hydro (2013), a community shift (in the pond/stream/area) was observed in primary producers after reservoir construction, from periphyton to plankton. This is due to periphyton growth favouring littoral zones (shoreline) rather than deep water (BC Hydro 2013). Benthic invertebrates and periphyton residing in the littoral zone may be adversely affected during water level fluctuations during operation of a dam, as well as being affected by variable discharge rates.

Overall, the operation of the MC1 components could result in comparatively more adverse potential influences than positive influences upstream and within the permanent pond. Similarly, predominantly adverse effects on fish habitat are anticipated downstream from the earth fill dam, although insufficient data precludes site-specific modelling related to temperature, ice regime, groundwater, flow, sediment load, and woody debris and substrate recruitment changes. The magnitude and spatial extent of each of potential influences on fish habitat is unknown, and as a result is not included in **Table 7.3-13**.

Table 7.3-13 Estimated Potential Fish Habitat Alterations Resulting from the Operation and Maintenance Phase of MC1

Habitat Type	Estimated Area Altered Fish Habitat[1] (m^2)	Confirmed or Presumed Spawning Habitat Potentially Altered[2] (m^2)	Presumed Wintering Habitat Potentially Altered[3] (m^2)	Substrate	
				Dominant	Sub-Dominant
Elbow River Upstream of Earth Fill Dam					
Pool 1	584	-	584	Cobble	Gravel
Pool 2	81	-	81	Gravel	Fines
Pool 3	625	-	-	-	-
Run 1	1,350	1,350	-	-	-
Run 2	1,520	-	-	Cobble	Gravel
Run 3	13,830	12,530	-	Cobble	Gravel
Riffle	105,930	23,645	-	Cobble	Gravel
Cascade	2,625	-	-	-	-
Rapid	1,525	-	-	Boulder	Cobble
Snye	2,340	-	-	Fines	Cobble
Total	130,410	37,525	665	Cobble	Gravel
Elbow River Downstream of Dam					
Pool 1	-	-	-	-	-
Pool 2	-	-	-	-	-
Pool 3	-	-	-	-	-
Run 1	500		-	Cobble	Gravel
Run 2	-	-	-	-	-
Run 3	-	-	-	Cobble	Gravel
Riffle	5,546		-	Cobble	Gravel
Cascade	-	-	-	-	-
Rapid	-	-	-	-	-
Snye	-	-	-	-	-
Total	**6,046**	**0**	**0**	**Cobble**	**Gravel**
Ranger Creek					
Impoundment	502	-	502	Fines	-
Pool 1	129	-	129	Fines	Gravel
Pool 2	161	-	161	Fines	Gravel
Pool 3	43	-	-	Fines	Gravel
Flat 1	-	-	-	-	-
Flat 2	401	-	-	Fines	Gravel
Flat 3	114	-	-	Fines	Cobble
Run 1	-	-	-	-	-
Run 2	-	-	-	-	-
Run 3	-	-	-	Gravel	Fines
Riffle/Run	12,099	1,575		Cobble	Gravel

Habitat Type	Estimated Area Altered Fish Habitat[1] (m^2)	Confirmed or Presumed Spawning Habitat Potentially Altered[2] (m^2)	Presumed Wintering Habitat Potentially Altered[3] (m^2)	Substrate	
				Dominant	Sub-Dominant
Riffle	216	-	-	Cobble	Gravel
Cascade	13	-	-	Bedrock	-
Total	**13,678**	**1,575**	**792**	**Cobble**	**Fines**
unnamed tributary A					
Pool 1	-	-	-	-	-
Pool 2	20	-	20	-	-
Pool 3	-	-	-	-	-
Run 1	-	-	-	-	-
Run 2	-	-	-	-	-
Run 3	-	-	-	-	-
Riffle/Run	2,053	-	-	Cobble	Fines
Riffle	810	-	-	Gravel	Boulder
Cascade	105	-	-	Cobble	Boulder
Total	**2,994**	**0**	**20**	**Fines**	**Cobble**
unnamed tributary K					
Pool 1	0	-	-	--	--
Pool 2	0	-	-	--	--
Pool 3	216	-	-	Gravel	Fines
Run 1	0	-	-	--	--
Run 2	0	-	-	--	--
Run 3	15	-	-	Fines	Cobble
Riffle/Run	172	-	-	Cobble	Gravel
Riffle	562	-	-	Cobble	Boulder
Cascade	0	-	-	--	--
Total	**965**	**0**	**0**	**Cobble**	**Gravel**

Notes:

1 Based on habitat morphology inventory in fall 2016 and summer 2017 with reference to anticipated 2013 flood level elevation provided in the MC1 Option Description and specific to indicator species only.

2 Based on confirmation of spawning activity of fall spawning indicator species in the Elbow River in fall 2016 and summer 2017 and presumption of spawning potential in tributaries; where spawning habitat was presumed to be influenced, the entire associated habitat unit area was considered.

3 Use of habitat for wintering by indicator species has not been confirmed in any watercourse, but is based on habitat potential and characteristics observed during habitat inventory in fall 2016 and summer 2017.

The following non-fish-bearing watercourses would also be impacted by the operation and maintenance phase of MC1, although are not considered as part of fish habitat loss or alternation totals in the table: 811 m^2 for unnamed tributary B, 1053 m^2 for unnamed tributary C, 61 m^2 for unnamed tributary F, 2378 m^2 for unnamed tributary G, and 2505 m^2 for unnamed tributary H.

Pool 1 = deep pool habitat (>1.0 m); Pool 2 = moderate pool habitat (0.75 – 1.0 m); Pool 3 = shallow pool habitat (<0.75 m)

Run 1 = deep run habitat (>1.0 m); Run 2 = moderate run habitat (0.75 – 1.0 m); Run 3 = shallow run habitat (<0.75 m)

Flat 1 = deep flat habitat (>1.0 m); Flat 2 = moderate flat habitat (0.75 – 1.0 m); Flat 3 = shallow flat habitat (<0.75 m)

Riffle/Run = alternating riffle and shallow run (Run 3) habitat

m = metre; m^2 = square metre

Fish Mortality and Productivity

Fish mortality and productivity may be influenced during the Construction and Operation and Maintenance phases. Potential effects include fish stranding, fish entrainment and mortality, impingement during dewatering, introduction of deleterious substances, introduction of invasive species or fish diseases, as well as physiological effects and behavioural responses by fish resulting from changes to sediment inputs during construction. Similarly, changes in productivity resulting from altered water quality parameters, channel morphology and substrate and woody debris recruitment are anticipated throughout the Operation and Maintenance phase. Fish entrainment, mortality, and stranding may also occur during the Operation and Maintenance phase, most likely during flood conditions.

Construction Phase

During Construction, MC1 may affect fish mortality and productivity through:

- Fish stranding within isolated sections of the Elbow River during construction of the dam, McLean Creek during its realignment, or within McLean and/or Connop Creek during road crossing installation may affect fish survival when the isolated areas are dewatered or excavation occurs
- Impingement on intake screens or entrainment of fish into pump intakes
- Fish injury and/or mortality may result during the passage of water through the diversion tunnels during an approximate 28-month period between the activation of the diversion tunnel and the activation of the MC1 fish passage facility
- The spread of invasive species (e.g., didymo) and whirling disease by machinery, personnel and isolation measures.
- The introduction of deleterious substances into fish habitat may occur during the decommissioning of existing infrastructure within MC1 footprint (i.e., remediation of contaminated soils and sewage lagoon at the Elbow Valley Ranger Station)
- Mobilization of sediment may occur during one-time fordings of machinery as well as the installation and removal of isolation measures, clearing activities, road construction, and reclamation activities which include moving or manipulating soil immediately near watercourses. These activities could potentially elevate suspended sediments and potentially affected life stages (e.g., adults and juvenile or eggs and larve) during construction
- Increase in recreational fishingMC1 could result in a marked influence on population abundance (e.g., bull trout).
- Blasting would be required during construction. The use of explosives in or near water can produce shock waves, increase sediment concentrations and leave residue behind which could increase the concentration of nitrogen in the watercourse.

Fish stranding within isolated sections of the Elbow River during construction of the earth fill dam may affect fish survival when the isolated areas are dewatered or excavation occurs. A step-wise isolation of the Elbow River would be necessary to ensure the effective construction of the dam, and excavations would occur in the dry or otherwise isolated from flow. This means that multiple and/or prolonged isolations may result.

During the construction of the realigned Highway 66, more isolations may be necessary, although a clear span bridge would be used at the Elbow River crossing, presumably precluding the need for instream work at this particular location. Additional isolations may be required during construction of other elements of theMC1 Option (e.g., spillways, installation of culvert road crossings of remaining watercourses along the Highway 66 realignment, as well as the channel realignment of McLean Creek.

During the isolation of instream construction areas, dewatering is anticipated. Dewatering systems would likely consist of single or multiple fuel or electric pumps to draw down and maintain dry conditions so that excavation and dam construction can occur in the dry. Impingement on intake screens or entrainment of fish into the pump intakes would result in fish mortality.

Fish injury and/or mortality may result during the passage of water through the diversion tunnels during an approximate 28-month period between the activation of the diversion tunnel and the activation of the MC1 fish passage facility (i.e., when flow regulation begins with the use of gated shafts on the diversion tunnels). Estimated velocities exceeding 5.0 m/s have been modelled for within portions of the diversion tunnels associated with monthly mean flow rates during the open water season. During 1:20 flood events, modelled velocities at the outlet may approach 14.5 m/s (Hatch unpublished data). A review of shear effects of water velocities on fish health, at hydraulic features lacking turbines, indicate that survival of juvenile fish can become compromised as rates approach 16.0 m/s (Ruggles and Murray 1983), velocities which exceed those expected to occur as a result of MC1. However, given the potential for fish impact on tunnel walls and/or spilling basin velocity diffusers, the potential remains for fish injury and/or mortality, particularly of large-bodied fish.

Construction activities associated with the dam and road crossing would require a considerable number of heavy machinery components. Machinery, personnel, and isolation measures are all possible vectors for the spread of invasive species (e.g., didymo) and whirling disease, which, once introduced into a watershed, can result in loss of fish productivity and mortality.

Introduction of deleterious substances into fish habitat may also occur during the decommissioning of existing infrastructure within MC1 footprint. In particular, the remediation of contaminated soils and sewage lagoon at the Elbow Valley Ranger Station would require material handling. Improper handling and containment or disposal techniques may lead to contaminants entering fish-bearing habitat, potentially resulting in reduced productivity or fish mortality.

Although construction activities within all watercourses would likely be completed with the use of isolation measures, mobilization of sediment is inevitable. One-time fordings of machinery as well as the installation and removal of isolation measures would result in the mobilization of sediment. The number and duration of mobilizations are unknown and may vary depending on the activities required and substrate that is disturbed. Clearing activities and road construction, although land-based, may also result in sediment mobilizations. Once mobilized via surface runoff, sediment input into fish habitat is possible and may result in deposition over spawning habitat, interruption of feeding opportunities and, if at high enough concentrations, fish mortality.

Reclamation activities would also include moving or manipulating soil immediately near watercourses. Although instream works are not anticipated as part of reclamation, the introduction of sediment into fish habitat during this phase has the same potential to influence fish health and productivity as during other Construction-phase activities.

Mean baseline TSS concentrations collected from two locations downstream of the Optionarea are provided in **Section 6.5 Water Quality.** However, real-time background values collected would be required to confirm the potential effect of elevated suspended sediments on the potentially affected life stages (e.g., adults and juvenile or eggs and larvae) during construction. Depending on background TSS values, the acceptable range (i.e., in both magnitude and duration) in increased concentrations would change. The spatial extent of influence of elevated suspended sediment concentrations on downstream habitat and fish (ZOI) is generally determined in the field, and is based on the professional experience and judgement of a Qualified Aquatic Environment Specialist (QAES), who considers a variety of factors (e.g., stream gradient, channel width, channel depth, channel morphology, flow velocity and discharge, and instream cover). The ZOI typically includes the area of the watercourse where 90% of the sediment load caused by construction activities is expected to fall out of suspension and be deposited (Government of Alberta 2001, 2013). For reference only (i.e., given the substantial differences in conditions and location), modelling completed on behalf of the Site C Clean Energy Project assessment indicated that elevated suspended sediment concentrations caused by activities in the dam and generating station construction zone would extend downstream approximately 15.9 km.

Over the anticipated multi-year construction period, changes may result in the potential for fish mortality from recreation fishing. While a reduction of angling may result from the public during the construction phase, angling effort overall may increase, specifically by MC1 construction staff. While the number of fish that may be caught could be limited, any increased capture opportunity for some species could still result in a marked influence on population abundance (e.g., bull trout). Blasting would be required during construction to clear rock for the construction of the diversion tunnels. The use of explosives in or near water produces shock waves that can be lethal to fish, eggs, and larvae, and can increase suspected sediment concentrations due to the agitation of rock and soils. Residue to blasting may also increase the concentration of nitrogen within the watercourse (**Section 6.5 Water Quality**).

Operation and Maintenance

During Operation and Maintenance, MC1 may affect fish mortality and productivity through:

- The alterations of habitat types upstream from the dam
- The potential of an initial surge of nutrient inflow and algal production upstream of the dam
- A potential decrease in the transport of fine sediment through the diversion tunnels over time which may result in an overall coarsening of bed material downstream of the dam
- Fish or egg stranding during flow attenuations (i.e., water level decreases). In general, the faster the decrease in water level, the more susceptible fish are to stranding
- The timing and pace of water retention and release may result in substantial and rapid changes in water levels during spawning and egg incubation periods (e.g., spring, fall, and winter) and may have adverse effects on the survival of spawn and overall productivity of fish
- Fish entrainment may occur within the diversion due to high tunnel velocities near the upstream gates
- Mercury contamination in the permanent pond may occur as terrestrial vegetation would be flooded and subject to decomposition over time
- Demands on dissolved oxygen are expected within the permanent pond, particularly during the short term as biological material decomposes under ice which may reduce the suitability for all life stages of fish within the area
- The spillway has the potential to result in the increase of total gas pressure (referred to as gas supersaturation) by forcing air to plunge to depth.

Reflective of the anticipated alterations in habitat types upstream from the dam (see Permanent Alteration and Destruction of Fish Habitat), fish productivity (e.g., biomass) would likely be decreased within the permanent pond and areas immediately upstream, where episodic reservoir filling continuously changes water levels between the elevation of the permanent pond and seasonal water levels.

As discussed in **Section 6.5 Water Quality** a limited potential exists for an initial surge of nutrient inflow and algal production upstream from the dam, particularly during winter months when water residence time is comparatively longer than in summer and spring. There is insufficient data on primary and secondary producers and existing fish productivity levels within the LAA so site-specific productivity modelling is not possible. For comparison purposes only, the MC1 study team reviewed productivity modelling completed by BC Hydro (2013) in the Peace River prior to the start of construction of the Site C dam. Modelling results suggested a potential 1.8-fold increase in total biomass of harvestable fish would result in the upstream reservoir relative to baseline conditions. Caution is recommended when interpreting this comparison, however, as the modelled increase was considered to primarily result from the diverse fish community assemblage of the Peace River and the anticipated increase of populations of planktivorous species that favor lacustrine environments. Productivity levels, for category of fishes that were more representative of those within the MC1 LAA (i.e., inclusive of mountain whitefish and bull trout), were generally expected to decline within the resulting reservoir. This same pattern would be expected in the permanent pond during the Operation and Maintenance phase.

Productivity is also likely to be altered downstream from the dam during the Operation and Maintenance phase. Except for major flood events that would result in the activation of the service spillway, fine sediment transport through the diversion tunnels may decrease with time, and an overall coursening of bed material is likely (**Section 6.4 Fluvial Geomorphology**). This alteration to substrate compositions may influence the potential of spawning, rearing, and feeding opportunities for each indicator species, although likely within relative proximity (e.g., within 1 km to 5 km) of the diversion tunnel outlet structure. Modelling completed by Jacques Whitford (2006) for habitat downstream of the withdrawn Dunvegan Hydroelectric Project suggested that productivity of mountain whitefish was anticipated to double due to the benefits of increased water clarity and decreased sediment inputs. However, productivity of bull trout, as well as a category of fishes including rainbow trout, were expected to decline. It is also important to note that this model did not correlate the potential for limited coarse substrate recruitment downstream from the dam during its operation phase.

Fish or eggs may also be stranded during flow attenuations that are anticipated as part of the Operation and Maintenance phase, most specifically during or immediately following substantial flood events. The risk of fish stranding coincides primarily with water level decreases, and in general the faster the decrease in water level, the more susceptible fish are to stranding. Other influences that affect the potential for stranding include fish species, life stage (e.g., adult vs. egg), and size, as well as time of year. Although stranding may occur within the permanent pond or reservoir, higher risks are anticipated downstream from the dam. Aside from McLean Creek, no tributaries within the LAA would be expected to effectively attenuate a quick reduction in flow within the Elbow River. Risks of stranding downstream of the dam are also likely to be increased with proximity to the dam footprint. In addition to shallow water habitats downstream from the diversion tunnel outlet, habitat between the dam and diversion tunnel outlet may be a location prone to fish stranding.

The timing and pace of water retention and release would be of critical importance to fish, particularly downstream from the dam. Substantial and rapid changes in water levels during spawning and egg incubation periods (e.g., spring, fall, and winter) may have adverse effects on the survival of spawn and overall productivity of fish. This is of particular relevance to species that utilize shallow water habitats for spawning such as bull trout, rainbow trout, and brown trout.

Entrainment occurs when a fish is accidentally drawn, or intentionally enters, into a water intake structure and cannot escape due to excessive water velocity (DFO 1995). Fish entrainment during the Operation and Maintenance phase may occur within the diversion tunnel. Although velocities within the upstream end of the diversion tunnel (i.e., upstream from the diversion tunnel gates) would be limited (e.g., less than 1.0 m/s), velocities near the gates may be considerable (e.g., approximately 15 m/s) and would exceed the swimming abilities of all fish in the MC1 Option area. Injury or mortality to fish would likely result if fish pass into the diversion tunnels and approach the gates. Entrainment or mortality of fish travelling downstream over the service spillway or auxiliary spillway is presumed, although at a relatively infrequent occurrence.

The fish community within the LAA and RAA consists of both migratory (e.g., bull trout, mountain whitefish) and non-migratory fish populations (e.g., brook trout). Based on predicted downstream migration patterns of juvenile and adult indicator species (**Table 7.3-9**), entrainment in the diversion tunnels would likely occur (unless mitigated) during spring, summer, and fall. Depending on the species, entrainment during these times may include juveniles migrating (or fry passively drifting) downstream to rearing habitats or adults migrating post-spawn to wintering habitats downstream from the dam. In general, larger-bodied, subcarangiform (i.e., undulating mode of swimming with side to side amplitude) fish are less susceptible to entrainment due their stronger swim abilities (Katopodis and Gervais 2016). During annual fish rescue operations, Trout Unlimited Canada (Lindsay and Peterson 2017) frequently reported that the bulk of fish entrained in irrigation canals in southern Alberta were small-sized species (e.g., cyprinids) and juveniles of large-bodied species.

Bacterial methylation of naturally occurring mercury from newly flooded soil and vegetation is a common occurrence in new reservoirs (DFO 1991). Methylmercury accumulates through the food chain, reaching elevated concentrations in organisms with high trophic states such as predacious fish (Jones et al. 1986). Increases in mercury concentration in fishes on the order of three to six times the background level were considered possible during the assessment of the Oldman River Dam (Government of Canada 1992). Baseline fish toxicology information is not available for the LAA (Sanderman, Pers. Comm. March 2017), and there is uncertainty over the naturally occurring levels of mercury in the Elbow River (**Section 6.5 Water Quality**). Through the Operation and Maintenance phase, however, mercury contamination of fishes in the permanent pond may occur as terrestrial vegetation would be flooded and subject to decomposition over time. This potential would likely be limited due to the low water residence time anticipated during the spring and summer in particular (**Section 6.5 Water Quality**).

Demands on dissolved oxygen are also expected within the permanent pond during the Operation and Maintenance phase, particularly during the short term as biological material decomposes under ice (**Section 6.5 Water Quality**). In winter, this influence may reduce the suitability for all life stages of fish within the area; however, the upper limit of water residence time anticipated during all seasons is not expected to result in harmful reductions in oxygen concentrations.

Spillways on water control structures can result in the increase of total gas pressure (referred to as gas supersaturation) by forcing air to plunge to depth, where it is forced into solution under pressure (Smith 1974; Fidler and Miller 2004). Supersaturated gases, when they exceed atmospheric pressure, form gas bubbles in water and in fish, causing disorientation, injury, and mortality. Water depth is a consideration in the evaluation of this potential adverse effects on fish, meaning that deeper plunge pool areas would offer greater opportunity for fish to avoid excessive increases in total gas pressure. Insufficient data about the service spillway, auxiliary spillway and diversion tunnel outlet structure limit the potential to evaluate the MC1’s potential influence of gas supersaturation on fish in the LAA, although spilling basins are proposed, and would be anticipated to reduce the potential for supersaturation. The anticipated use of the spillways at flood events exceeding 2013 flood level events suggest the potential effect from these features would be seldom realized. Information related to this potential influence was also provided during the assessment of the Oldman River Dam (Government of Canada 1992). Conflicting inputs were received on whether gas supersaturation would occur downstream from the Oldman Dam, although it was suggested that once a plunge pool formed downstream from MC1’s spillway, gas supersaturation may persist for up to 1 km downstream from the dam (i.e., depending on the turbulence of the river), and could result in the mortality or impairment of fish.

Impediment to Migration and Movement

Successful passage of fish (e.g., bull trout) through water management structures is possible as reported by O’Brien (1999), and it is recommended that any dam constructed in Alberta incorporate innovative fish passage designs to ensure safe and effective migration for fishes (ASRD 2012). Fish passage considerations would, therefore, be necessary during the Construction and Operation and Maintenance phases.

Although it is presumed that instream activities would not be required for the construction of the realigned Highway 66 crossing of the Elbow River, fish passage may be affected by instream works associated with the construction of watercourse crossings at other watercourses (e.g., McLean Creek) and operational practices of the dam. Instream works may also be required for the construction of the spillways, the realignment of the McLean Creek and unnamed tributary to the Elbow River (unnamed tributaries D and I).

Impediment of fish passage, both in upstream and downstream directions, is also possible during the Operation and Maintenance phase, although mitigation measures (i.e., fish passage facility) developed as part of the design may substantially or completely mitigate this potential effect.

Construction

Construction of the earth fill dam would require multiple years to complete. Fish migration may be influenced throughout the entire construction period, with excavation, site isolation and dam construction each expected to occur behind coffer dam style isolation measures or through use of the diversion tunnels as bypass measures. Given the canyon characteristics at the proposed footprint location, restriction of the active channel during isolation(s) would be inevitable during initial stages of construction, most specifically during the installation of the coffer dam(s). During this stage, channel restriction would result in increased water velocities through and immediately downstream from the construction zone. The lack of detailed construction plans currently precludes the potential for velocity modelling.

It is expected that the commissioning of MC1's outlet diversion tunnels would occur in the initial stages of construction of the dam, as it is proposed to also be used to facilitate isolation of the worksite during later stages of construction. Following the completion of the coffer dam and rock groyne, all river flow would be directed through the diversion tunnels (without application of flow controlling gates) for an approximate 28-month period over which the remaining elements of the dam would be built and before the regulation of flow through the diversion tunnels is initiated. During this time, it is anticipated that passage of fish in an upstream direction through the diversion tunnels, particularly over the lower-most 300 m, would be precluded (at least seasonally) by water velocities that exceed the burst, prolonged and/or sustained swimming capabilities of fish that occur in the MC1 Option area. Passage of fish in a downstream direction during this period is expected to be possible, although some injury and/or mortality of fish may result (see **Fish Mortality and Productivity**, above).

During the realignment of McLean Creek fish passage would be affected (if not mitigated) by isolation measures needed to ensure instream work occurring in the dry. Similarly, construction activities associated with culvert crossings at McLean Creek and Connop Creek would represent potential temporary obstructions to migrating fish. Although instream work at unnamed tributary D and I may also be needed, fish presence is unlikely in these locations as so there exists limited potential for affecting fish passage.

Based on predicted fish movement patterns (**Table 7.3-9**), upstream migration by adult Indicator species could be anticipated between March and December during each year of MC1 construction.

Operation and Maintenance

During the operations and maintenance phase of MC1, the passage of fish in both directions is considered of utmost importance to the preservation of habitat accessibility for all fish species that occur in the MC1 Option area. This is of particular importance to bull trout, which are expected to require passage through the MC1 footprint while migrating between spawning habitat (i.e., mostly occurring upstream) and wintering habitat (i.e., predominantly occurring downstream).

In the absence of fish passage considerations integrated into the MC1 design, the safe and successful passage of fish through the MC1 diversion tunnels during the Operation and Maintenance phase is not considered feasible, given among other variables, elevated velocities at the outlet and near the gate shafts. Without such design considerations, the MC1 dam would represent a barrier to upstream migration of all sizes of all fish species and would likely be an impassable barrier for downstream migration, particularly of large bodied fishes.

Given the potential for the MC1 to impede migration of fish populations (without appropriate mitigation), Alberta Transportation has developed a conceptual design for a fish passage facility, with a maximum design flow rate of 2 m^3/s, which is intended to pass fish upstream and downstream through the dam. The intent of the fish passage facility is to provide suitable opportunity for upstream and downstream passage of migratory adult fishes, with a priority for ensuring passage of bull trout (Kupferschmidt, Pers. Comm. June 2017). Additional features to be considered in the conceptual design include the incorporation of a fish guidance system within the permanent pond upstream from the dam. Should this system be feasible, it is expected to increase the effectiveness of the fish passage facility to successfully provide passage to fish migration downstream, specifically by directing fish away from the inlet of the diversion tunnels, thereby potentially reducing the potential for entrainment and/or mortality.

Changes to Fish Assemblages Due to Habitat Changes

Consequences of altered habitat types immediately upstream from the dam, suggest that the fish community composition upstream from the dam (i.e., within the permanent pond) may be altered during Operation and Maintenance phase. Changes to the composition of fish communities downstream may also result.

Operation and Maintenance

The transition of habitat within the permanent pond from a fluvial-based system to a more lacustrine-dominated environment would likely decrease overall habitat suitability for the indicator species; however, these effects may be limited to the area of the permanent pond or perhaps slightly beyond (i.e., between the permanent pond and 2013 flood event level where episodic fluctuations in water levels would result).

Insufficient data prevents modelling of the anticipated changes over short (1 to 10 years), medium (10 to 30 years), and long (over 30 years) terms; however, a rapid decline in the abundance and distribution of bull trout and mountain whitefish (and potentially other species) would likely occur in the permanent pond and reservoir in the short term. Modelling conducted by BC Hydro (2013) during the assessment of potential effects of the Site C Dam suggested a similar trend in the Peace River, although the modelling results indicated that bull trout would remain, most frequently in lower section of the resulting reservoir and in tributaries where riverine habitats were unaffected. Key differences when considering this comparison include the sizable differences in scale of the reservoir to be created by MC1 and that of the Site C Dam and that bull trout are not known to occur in existing tributary habitat within the LAA. In contrast, a report by Lima et al (2017) indicated that while construction and operation of the Oldman River Dam did not have a direct effect on the overall taxonomic diversity (mean species richness) of fish in the system, there has been a resulting, significant change in the relative abundances of species with contrasting functional strategies. Specific to reservoir and reaches of the Oldman River immediately upstream, westslope cutthroat trout and bull trout were reported as “nearly disappearing” from the reservoir within the period > 5 years after dam completion (Lima et al 2017). This same report indicated of opposing increases in abundance of white sucker and longnose dace in these habitats, citing changes from lotic to lentic ecosystem, associated changes to habitat characteristics (e.g., flow, substrate, spawning opportunities) and that these species are non-migratory and able to adapt to wide ranging flow conditions. There were no data located comparing pre- and post-construction fish community composition data in Alberta hydroelectric facilities/reservoirs owned by TransAlta Corporation (Corbett pers. comm.).

It is unknown whether any the indicator species would adopt an adfluvial strategy following the creation of the permanent pond and reservoir, relying on the reservoir and permanent pond for wintering habitat while seasonally migrating to more suitable spawning habitat upstream. Comprehensive wintering and spawning migration information about mountain whitefish, rainbow trout and brown trout populations in the Elbow River watershed does not exist, although indications from a bull trout habitat utilization study conducted by Popowich and Paul (2006) suggest that bull trout are not currently using the Glenmore Reservoir for wintering habitat, and instead rely on riverine habitat upstream primarily between Bragg Creek and Highway 22. The relatively limited wintering of bull trout upstream from the MC1 Option area observed by Popowich and Paul (2006) suggests that suitable wintering habitat for this species may not exist to the same magnitude or value upstream. This assertion is supported by the classification of few wintering habitats upstream from the dam location (i.e., within the LAA) during the MC1 study team's habitat assessment in fall 2016.

Of the eight species known to currently occur in the MC1 Option area, brook trout, longnose dace and white sucker are likely the most tolerant of habitat perturbations to the aquatic environment, and are adept at exploiting new habitats. Populations of rainbow trout and brown trout may also be adept to the change in habitat conditions, although their success may be limited. As a comparative reference only, the Environmental Assessment Panel that reviewed environmental impact considerations (Government of Canada 1992) related to the construction of the Oldman Dam concluded: "… the reservoir will not support a fishery of any consequence. The major species in the reservoir will probably not be game fish" (Government of Canada 1992). The Elbow River downstream of the MC1 footprint would be characterized by a regulated flow regime during the Operation and Maintenance phase, most notably during substantial flood events. Resulting changes to the sediment regime, water temperatures, and ice formation patterns, along with attenuated peak and low flows, reduced woody debris, and spawning substrate recruitment are all influences that could affect the abundance and distribution of fish species within the LAA or further downstream. As an example, Paragamian (2002) reported a shift in community composition in the Kootenai River, downstream of and following the operation of the Libby Dam in Idaho. This study reported a reduction in the relative abundance of mountain whitefish between sampling events in 1980 and 1994. Alternatively, a marked increase in the relative abundance of largescale sucker coincided with the same time-period. Growth of mountain whitefish in downstream habitats was also reported as having slowed after dam construction. It was interpreted that a nutrient sink effect, river flow regulation, a lack of flushing flows, power peaking and changes in river temperature may have led to the reported shift in the Kootenai River fish community structure.

7.3.3.3 Mitigation Measures

A hierarchical approach is typically used in identifying strategies to avoid or minimize potential effects on aquatic habitats. The four types of mitigation associated with MC1's potential effects related to the Aquatic Environment are presented as follows:

- **Avoidance:** Measures to avoid potential effects on the Aquatic Environment incorporated into design include considerations such as site and scale selection, project scheduling, project design, and Construction and Operation-phase procedures and practices.
- **Minimization:** Where potential effects on the Aquatic Environment are unavoidable, standard mitigation measures, best management practices (BMPs), and construction and operation management plans would be implemented and/or developed and implemented to reduce potential effects.
- **Restoration or Habitat Enhancement:** Where potential effects are unavoidable and would not be sufficiently reduced by standard mitigation measures, BMPs or EMPs, affected elements may be restored or enhanced (as feasible).
- **Offsetting:** Where on-site restoration or habitat enhancement is not feasible or would not be possible to the level that would eliminate potential effects, appropriate offsetting plans would be developed and implemented to counter-balance residential adverse effects of the MC1 Option on the Aquatic Environment.

MC1 is currently at a preliminary level of design, and were it to be advanced further (i.e., detailed design and construction), several avoidance strategies would be incorporated into the final design. Given the current level of design, several potential MC1-specific avoidance strategies have not been developed and are not discussed further in this assessment.

Mitigation measures, restoration and enhancement plans, and offsetting developed for MC1, specific to the Aquatic Environment assessment, would comprise any practical means taken to manage potential adverse effects. In accordance with Alberta Transportation standard practice, BMPs and standard and/or specific mitigation measures would be included in the Environmental Construction Operations (ECO) Plan that would be developed by the contractor and accepted by Alberta Transportation prior to the start of construction. Mitigation measures to address potential adverse effects, discussed in **Section 7.3.3.2,** are described below and summarized in **Table 7.3-14.** The final column in the table identifies whether there is the potential for a residual effect. Residual effects likely to remain after the implementation of mitigation measures are carried forward in the assessment. Similar or supplemental mitigation measures, directly relevant to and provided by other disciplines (e.g., Fluvial Geomorphology, Water Quality) in this assessment may also be appropriate for consideration for their potential to ensure maintenance of the Aquatic Environment; however, they are not included for discussion in this section. Examples of other mitigation measures that may be suitable for purposes of the Aquatic Environment contaminated soil containment measures and wastewater containment measures (**Section 6.5 Water Quality**), as well as Maintain Flow Competence and Sediment Augmentation (**Section 6.4 Fluvial Geomorphology**).

The selection of mitigation measures, specific to the Aquatic Environment, has been informed by a review of standard industry and BMPs (included those listed below), consideration of mitigation measures and follow-up programs proposed and undertaken for similar projects, and a high-level evaluation of technical and economic feasibility of proposed measures. Design and operation details, along with input from regulators, the public, and Indigenous Peoples would further inform the following list of appropriate mitigation measures should a more comprehensive environmental assessment be required.

- Fisheries Protection Policy Statement (DFO 2013a)
- Measures to Avoid Causing Harm to Fish and Fish Habitat (DFO 2013b)
- Fisheries Productivity Investment Policy: A Proponent's Guide to Offsetting (DFO 2013c)
- Code of Practice for Watercourse Crossings (Government of Alberta 2012b)
- Alberta Transportation's Environmental Management System Manual (Alberta Transportation 2016)
- Pipeline Associated Watercourse Crossings (Canadian Association of Petroleum Producers, Canadian Energy Pipeline Association, and Canadian Gas Association 2012)
- Stepping back from the Water: A Beneficial Management Practices Guide for New Development near Water Bodies in Alberta's Settled Region (AESRD 2012).

Mitigation relevant to MC1 provided in the above industry standard guidelines and BMPs are recommended for adoption for final design and the Construction phase. In addition to the application of relevant features from the above BMPs, the following specific mitigation strategies, plans and/or policies are also appropriate.

Aquatic Habitat Management Measures

Due to the potential changes to fish habitat caused by MC1 components, there are no technically feasible mitigation options for the anticipated loss or alteration of riverine habitat, particularly upstream from the dam. Habitat enhancement and compensatory offsets are assumed to be required for MC1 and the mitigation programme would need to include detailed fish habitat restoration, enhancement, and compensatory offset programs necessary to reduce or effectively compensate for the potential effects from permanent alteration or destruction of fish habitat and fish mortality and productivity during the Construction and Operation and Maintenance phases.

Enhancement opportunities include the creation of artificial habitat features within the permanent pond and augmentation of existing in-channel or near-channel (e.g., substrate) habitats upstream from the permanent pond and downstream from the diversion tunnel outlet. Detailed offset planning, if MC1 were to be advanced beyond this suitability assessment, would include consultation with local stakeholders and provincial and federal regulatory agencies in accordance with the potential *Fisheries Act* Authorization. Restoration, enhancement, and offsetting programs would likely focus on the improvement or creation of equal or greater quality and quantity of habitat previously used by potentially affected indicator species, or other species.

Based on Fisheries and Oceans Canada's (DFO's) hierarchical priority for offsetting programs, habitat enhancement or creation would be focused within or as close to the MC1 Option area as possible.

Developing aquatic habitat management strategies would also include mitigation measures which would be developed during future design phases and incorporated during the excavation of borrow pits, realignment of watercourses, and when responding to the potential influence of earthworks downslope from the auxiliary spillway. Specifically, the avoidance of excavation within the channels of all watercourses, as well as within established riparian buffer areas (e.g., 30 m) on either side, would avoid additional alteration of habitat potential in the Elbow River and in any of the tributaries currently within the boundaries of the identified permanent or temporary disturbance areas. Assuming this avoidance strategy is adopted, the potential related effects from this construction activity would be limited.

From an ecological perspective, avoidance strategies and habitat enhancement and offsets would not fully mitigate habitat loss and alterations effects or associated changes to fish productivity resulting from the MC1 Option.

Fish Health Management Measures

To further mitigate against the potential permanent alteration or destruction of fish habitat and reduce adverse effects related to fish mortality and productivity resulting from MC1 construction and operation, Fish Health Management strategies would be included in the ECO Plan and the following Dam Operations Plan implemented. These strategies should encompass the Construction and Operation and Maintenance phases of MC1, and include:

- Guidance on timing (e.g., onset and duration) considerations for instream construction activities (i.e., times that are representative of critical periods for fish) and screening of water intake structures expected for construction (e.g., DFO 1995).
- Details related to the salvage and replacement of fish potentially stranded during isolation installation or within areas where works may be necessary to occur without isolation from flows or water.
- Prescribed approaches for the planned sampling of abundance and condition of fish that pass through the diversion tunnel during the Construction phase.
- Approach to periodic surveillance of fish habitat areas where potential exposure or standing of side channel and mainstem margins may occur during reductions in flows through the diversion tunnels, particularly during the initial filling of the permanent pond and subsequent operations, specifically immediately before and during substantial flood events; or alternatively identifying areas were stranding is possible and provide positive drainage or isolation of these areas to avoid stranding post-construction.
- Provisions for avoiding the generation and introduction of sediment to the aquatic environment including defining construction scheduling with consideration for periods of high background sediment levels and outside RAPs (where feasible), selecting clean rock or wash rock materials for

construction to minimize the amount of sediments that are introduced in the aquatic environment, and sourcing substrate for use in the coffer dam or earth fill dam from locations outside the wetted perimeter of any watercourse.

- A monitoring component, specifically for the evaluation of fish health for individuals passing through the diversion tunnels during downstream migrations, both during Construction and Maintenance and Operation phases.

The successful application of these strategies would likely reduce the potential for mortality of fish during the Construction and Operation and Maintenance, except for potential for entrainment within the diversion tunnels.

Blast Management Measures

As described in **Section 6.5 Water Quality**, Alberta Transportation's contractor as part of the ECO Plan would address blast management to reduce the potential MC1-related effect of fish mortality during construction. This plan would provide BMPs for the use of explosives in or near fish habitat (Wright and Hopky 1998, Chilibeck et al. 1993). Examples of specific measures, as outlined by DFO (2013b) include:

- Time in-water work requiring the use of explosives to prevent disruption of vulnerable fish life stages, including eggs and larvae, by adhering to appropriate fisheries timing windows.
- Isolate the work site to exclude fish from within the blast area by using bubble/air curtains (i.e., a column of bubbled water extending from the substrate to the water surface as generated by forcing large volumes of air through a perforated pipe/hose), cofferdams, or aquadams.
- Remove any fish trapped within the isolated area and release unharmed beyond the blast area prior to initiating blasting.
- Minimize blast charge weights used, and subdivide each charge into a series of smaller charges in blast holes (i.e., decking) with a minimum 25-millisecond (1/1000 seconds) delay between charge detonations.
- Back-fill blast holes (stemmed) with sand or gravel to grade or to streambed/water interface to confine the blast.
- Place blasting mats overtop of holes to minimize scattering of blast debris around the area.
- Do not use ammonium nitrate-based explosives in or near water due to the production of toxic byproducts.
- Remove all blasting debris and other associated equipment or products from the blast area.

With the successful application of appropriate mitigation measures, the prevention of fish mortality during blasting activities may be possible.

Riparian Vegetation Management Measures

Appropriate management of riparian areas would help to mitigate potential permanent alteration or destruction of fish habitat and adverse effects related to fish mortality and productivity. Examples of mitigation strategies that would be included in this plan are limiting the removal of riparian areas only to areas critical for clearing, construction or operational needs; establishing and maintaining riparian buffers at road crossings, downslope from the auxiliary spillway, and in intended borrow pits; and devising selective strategies for removing terrestrial biota and soil from the anticipated footprint of the permanent pond to reduce the potential for bacterial methylation. Additional examples of suitable mitigation, as defined by DFO (2013b) include:

- Keep clearing of riparian vegetation to a minimum: use existing trails, roads, or cut lines wherever possible to avoid disturbance to the riparian vegetation and prevent soil compaction. When practical, prune or top the vegetation instead of grubbing/uprooting.
- Minimize the removal of natural woody debris, rocks, sand, or other materials from the banks, the shoreline, or the bed of the waterbody below the ordinary high-water mark. If material is removed from the waterbody, set it aside and return it to the original location once construction activities are completed.
- Immediately stabilize shoreline or banks disturbed by any activity associated with theMC1 Option to prevent erosion or sedimentation, preferably through re-vegetation with native species suitable for the site.
- Restore bed and banks of the waterbody to their original contour and gradient; if the original gradient cannot be restored due to instability, restore a stable gradient that does not obstruct fish passage.
- If replacement rock reinforcement/armouring is required to stabilize eroding or exposed areas, ensure that appropriately sized, clean rock is used, and that rock is installed at a similar slope to maintain a uniform bank/shoreline and natural stream/shoreline alignment.
- Remove all construction materials from site upon MC1 completion.
- Where species at risk occur do not remove riparian vegetation if the riparian area is identified as part of critical habitat of an aquatic listed species at risk.

Implementation of this plan is expected to sufficiently limit disturbance to riparian areas, other than only those necessarily cleared for footprint purposes.

Erosion and Sediment Control Plan

Prevention and containment of construction and operation-induced erosion and sediment mobilizations would be important in reducing the potential for permanent alteration or destruction of fish habitat and adverse effects related to fish mortality and productivity. An Erosion and Sediment Control Plan would be developed and implemented to guide near and instream works occurring during the Construction and Operation and Maintenance phases. As defined by DFO (2013b) Measures to Avoid Causing Harm to Fish and Fish Habitat, erosion and sediment control measures would be maintained until all disturbed ground has been permanently stabilized, suspended sediment has resettled to the bed of the waterbody or settling basin, and runoff water is clear. The plan would, where applicable, include:

- Recommendations for installation of effective erosion and sediment control measures before starting work to prevent sediment from entering the water body.
- Measures for managing water flowing onto the site, as well as water being pumped or diverted from the site such that sediment is filtered out prior to the water entering a waterbody. For example, pumping or diverting water to a vegetated area, constructing a settling basin or other filtration system.
- Descriptions of site isolation measures (e.g., silt boom or silt curtain) for containing suspended sediment where in-water work is required (e.g., dredging, underwater cable installation).
- Measures for containing and stabilizing waste material (e.g., dredging spoils, construction waste and materials, commercial logging waste, uprooted or cut aquatic plants, accumulated debris) above the high-water mark of nearby waterbodies to prevent re-entry.
- Prescribed inspections and maintenance of erosion and sediment control measures and structures during the Construction phase.
- Required repairs to erosion and sediment control measures and structures if damage occurs.
- Plans for the removal of non-biodegradable erosion and sediment control materials once the site is stabilized.
- Strategies to control and eliminate surface runoff beyond MC1 Option sites and into watercourses.

This plan would also include a water quality (TSS) monitoring program for all activities expected to influence sediment mobilization or bank instability. This monitoring element would be used to direct construction activities and inform decisions about time and sequencing of in-stream construction activities. If monitoring reveals construction activities are causing harmful sediment events, additional mitigation may be required. Monitoring for TSS (or turbidity as a proxy) would also provide technically sound data related to the extent and magnitude of unavoidable mobilization events. Appropriate thresholds for increases in TSS would be established with reference to provincial or federal water quality guidelines (e.g., CCME 2007) for the protection of aquatic life and critical life stage timing for fish. Water quality monitoring planning would be developed and implemented by a QAES.

Implementation of this plan would likely sufficiently reduce or eliminate the potential for habitat loss, a reduction in productivity, or fish mortality resulting from sediment mobilizations during the Construction phase.

Care of Water

The rate of flow retention and release from the permanent pond or reservoir would have important implications on habitat quality and quantity both upstream and downstream of the earth fill dam and during the initial commissioning of the permanent pond and subsequent flood mitigation needs. The magnitude and frequency of elevation changes within the permanent pond and the timing and pace of water release would be regulated as part of AEP's operations plan to reduce potential effects on shoreline (littoral) fish habitat.

Instream flow needs would be developed from information specific to the habitat requirements of critical life stages of the indicator species. The application of appropriate instream flow needs considerations would avoid the potential for spawn or fish to become stranded or exposed during flow reductions and damage to important habitats during flow release periods. Example considerations for instream flow needs include implementing a 15% rule (i.e., flow releases would be within 15% of naturally occurring flow rates at the inlet to the permanent pond) or ensuring that flow rates through the diversion tunnels are maintained within the daily quartiles of historical flow. Care of water would also include mitigative measures or strategic planning to minimize the frequency and duration of instream works, isolation events, and water diversion steps.

The implementation of effective water flow management would reduce the potential for fish mortality and reduced fish productivity during the MC1's Operation and Maintenance phase. Complete mitigation of altered productivity in upstream and downstream areas is unlikely, although insufficient data exists to quantify the effects.

Angling Prohibition Policy

To reduce the potential effect of fish mortality and productivity, Alberta Transportation would consult with Fisheries Resource Management staff of AEP to develop and implement a no angling policy (for MC1 staff and public) during the Construction phase. Further reduction may result by instituting a no trespass zone on property controlled by Alberta Transportation. Further implementation of a wide-ranging no-angling policy during the Operation and Maintenance phase will at the discretion of AEP fisheries manager. However, current provincial regulations (Government of Alberta 2017b), currently prohibit angling within 23 m of the dam, spillways, and diversion tunnel outlet (as well as any associated fish passage feature that may be developed as part of the final design of the MC1 Option).

These measures are expected to prevent fish mortality from recreational angling.

Invasive Species and Fish Disease Management Measures

It would be important to prevent the spread of invasive species (e.g., didymo) and fish diseases (e.g., whirling disease) to or from the Elbow River watershed. Although no provincially endorsed decontamination protocol or operating procedures for construction contractors currently exist in Alberta, MC1-specific invasive species and fish disease management strategies would be developed and implemented in both the ECO Plan and the Operations documentation.

Short-term and long-term decontamination methods would be implemented by construction contractors and Operation and Maintenance staff when on site. Example mitigation measures to be developed include the prescribed application of relevant and effective disinfectants (e.g., Quat Plus) or alternates (e.g., steam treatments) to machinery and equipment to be used at the MC1 site but which were last used at other sites.

Other strategies may include the dedicated use of only decontaminated equipment (i.e., once decontaminated machinery or equipment would remain on-site until no longer needed) during the Construction or Operation and Maintenance phases.

Implementation of these measures is expected to eliminate the potential for introduction or export of invasive species and fish diseases to and from the MC1 Option area.

Design for Fish Exclusion

It is possible that fish entrainment would occur within the diversion tunnels, specifically when fish travelling downstream pass into the diversion tunnels either when the fish passage facility is not active or instead of actively selecting the alternative fish passage facility when it is operational. Entrainment of fish within the diversion tunnels could be expected to lead to injury or mortality and reduced overall productivity of the fishery. During future design phases, fish exclusion measures to the diversion tunnel inlet gates and/or that smooth and gradual transitions between rectangular inlets/exits and diversion tunnels should be incorporated. Future designs should also establish orientation and sizing of all openings and exits to reduce hydraulic turbulence and explore the potential to reduce velocities at all embedded features (e.g., gates). Viable downstream passage through the spilling basin and associated riprap apron should also be considered during subsequent design phases (e.g., reduced obstructions from the turbulent zone of the outlet structure).

As an alternative to applying measures directly at the diversion tunnels (which may not be feasible), it is recommended that a fish guiding system (e.g., guide nets) be developed for installation within the permanent pond. The intent of the guiding system would be to direct downstream migrating fish, particularly those that are not likely to travel at considerable depth (e.g., juvenile fish), to the fish passage facility inlet and away from the diversion tunnels. The application of this mitigation could be expected to substantially reduce the potential for entrainment and mortality of fish during the Maintenance and Operation phase.

It is likely not realistic to expect a similar level of effectiveness to result from the implementation of a similar guiding and catchment system during the Construction phase (i.e., during unregulated flow periods before the permanent pond is created). Potential risks to loss or damage to temporarily facilities from unregulated flows would limit the feasibility of the system and increased risks of fish impingement, injury and mortality could be expected from among others impingement, contact with debris and fish handling. Mortality rates resulting the passage of fish through the diversion tunnels during construction, with the application of future design consideration noted above, are expected to be comparatively lower, although this assertion would require monitoring for confirmation.

With the successful implementation of exclusion device(s) associated with the diversion tunnels, limited entrainment of fish within the diversion tunnel is assumed during the Operation and Maintenance phase, although some residual effects of fish mortality during the Construction phase are possible. Entrainment and/or mortality of fish passing over either of the Option's spillways is considered to be an infrequent potential effect, but one that would not be completely mitigated.

Design to Reduce Total Gas Pressure (Gas Supersaturation)

The likelihood of gas supersaturation to influence the potential effect of fish mortality and productivity during the Operation and Maintenance phase is largely unknown but presumed to be limited. While total dissolved gas would not likely result through regular operation of the diversion tunnel (i.e., at the outlet structure), this effect would likely be realized when/if the service spillway and/or auxiliary spillway are activated. To mitigate this potential, revised spillway design or development of operational procedures would reduce the magnitude and duration of events. Refinement of mitigation details specific to design and operational procedures would be possible as designs and operations for the service spillway develop. Design modifications and operational considerations are expected to reduce the potential influence of gas supersaturation on fish to levels where harm to fish is not anticipated.

Fish Passage Management Measures

Planning for fish passage has been initiated with the drafting of a conceptual design for the Option's fish passage facility (NHC 2017). The continued development and implementation of fish management mitigation measures is needed to maintain fish passage beyond the MC1's footprint during both the Construction and Operation and Maintenance phases.

Relevant mitigation strategies include developing appropriate timing any instream works (i.e., those occurring before the application of diversion tunnels as an unregulated bypass channel) that could prevent migration, as well as contingency plans to facilitate passage if construction occurs within a restricted period or extends beyond durations established in Alberta's Code of Practice for Watercourse Crossings (i.e., 14 days if outside the RAP) (Government of Alberta 2012b).

During future MC1 design and planning phases, the ECO Plan would indicate the sequencing of construction activities, particularly with respect to constructing the diversion tunnels and fish passage facility. If flow diversion is reliant on a clean flow bypass scenario during the latter stages of earth fill dam construction (i.e., through the diversion tunnels) for an extended period (e.g., 28 months as planned), artificial means would be needed to ensure upstream fish passage beyond the construction area. As such, a temporary trap and haul system would be incorporated into future design planning. Further information about the magnitude and timing of migration patterns for rainbow trout, brown trout, and mountain whitefish would be needed to define the period(s) in which the temporary trap and haul system would be most important; however, it is expected that artificial fish passage would be required at least during the late summer and early fall period, when bull trout (and potentially brown trout and mountain whitefish) are known to migrate upstream past the MC1 Option area. The scale of the temporary system would also be dependant on the length and frequency of migratory needs by the species in the area, but could range from a temporary portable fish fence installed seasonally (e.g., during the fall period corresponding to lower flow) to a more robust facility requiring detailed engineering design.

The MC1 study team identified and considered several options for providing sustainable fish passage in both directions following construction. These options included trap and haul strategies, altering the structural and operational characteristics of the current diversion tunnel, modifying permanent pond elevations, and developing a separate fish passage facility to allow the movement of upstream and downstream migrating fish. Following a constraints evaluation of several alternative options, the MC1 Option has proceeded through the conceptual design phase for the development of a separate fish passage facility. The developing designs for the Option’s unique fish passage facility (NHC 2017) incorporates several structural elements, each of which have been designed using a conservative approach for fish size and swimming capabilities. Given their preliminary nature, these designs would need to be revisited during future design considerations.

Based on the preliminary design specifications of the Option’s fish passage facility, upstream passage of adult sportfish (i.e., bull trout, rainbow trout, brown trout and mountain whitefish) would likely be possible through the facility’s outlet structure, naturally designed fishway, bypass tunnel, and inlet control structures (NHC 2017). Further design analysis is needed, however, before it can be determined whether passage of juvenile salmonids and smaller-bodied fishes (e.g., longnose dace) would be possible (Kupfershcmidt, Pers. Comm. June 2017).

Effectiveness of fish passage structures can vary, depending on site conditions, structure characteristics, and fish species present. For example, a review of effectiveness of three U.S. hydropower projects (Federal Energy Regulatory Commission 2004) indicated that upstream passage was proven effective at rates between 45% to 67% (by species). Naturally designed fishways have previously shown to provide incidental benefits of passage for other species besides those considered for design purposes (e.g., forage species) (Food and Agriculture Organization of the United Nations/Deutscher Verbankd fur Wasserwirtschaft and Kulturbau e.V. [UN FAO] 2002). In addition, fish have been previously observed residing in habitat (and possibly selecting habitat) within lengthy enclosed concrete tunnels (Trout Unlimited Canada 2001).

Additional mitigation requirements may be considered during future fish passage facility planning/designs stages, including incorporation of a fish counter monitoring system (or alternate effective monitoring program) at the fish passage facility’s entrance and outlet; evaluation of the potential need for year-round access for migration (i.e., including winter season; lighting elements within the bypass tunnel; and inclusion of a fish guiding system (see **Design for Fish Exclusion** above) within the permanent pond to direct downstream-migrating fish to the fish passage facility’s inlet structure. Depending on the final design’s potential to pass small-bodied fish, a periodic capture and relocation program for small fish species (e.g., longnose dace), may also be implemented as part of the ECO Plan. The results of studies into the genetic exchange requirements of upstream and downstream populations and the degree of success of the fish passage facility to enable passage of all species and life stages of fish known to occur in the MC1 Option area would also influence development and implementation of the measures. Similar supplemental or contingent capture and relocation program planning may also be necessary for large-bodied fish if monitoring of the fish passage facility indicates it is not providing passage for adult salmonids as designed.

The implementation of these mitigation measures would considerably increase the potential for safe and effective fish passage in both directions during Construction and Operation and Maintenance phases, particularly for adult fish. Residual effects during the Construction phase are not expected, pending the application of appropriate trap and haul measures. The passage of all fish (i.e., species and sizes) during the Operation and Maintenance phase is considered uncertain, however, as the successes of fishways ranges widely, and would depend on final designs. It is therefore assumed that some residual effects associated with fish passage would result during the Operation and Maintenance phase.

Table 7.3-14 Summary of Potential Effects and Mitigation Measures for Fish and Fish Habitat

Summary of Potential Effect and Classification	Components	Contributing Activities	Proposed Mitigation Measure	Detectable / Measurable Residual Effect
Construction Phase				
Permanent Alteration and Destruction of Fish Habitat (Serious Harm to Fish)	Earth fill dam and permanent pond, spillways, borrow pits and Hwy 66 watercourse crossing	Operation of heavy equipment Operation of waste storage and disposal Construction and use of access roads Construction of staging areas Site restoration and landscaping Possible operation of cement batch plant Site clearing Blasting Cut and fill of drainage ditches and culverts Placement and operation of field offices and other buildings Operation of stockpiles of construction materials (aggregate, borrow material) Foundation excavation and grouting Sediment disturbance during instream works Realignment of watercourses for spillway construction or outlet structure Removal of vegetation and organic soil layer within the permanent pond footprint. Flooding to form the permanent pond Construction of instream footprint	Application of relevant Measures to Avoid Causing Harm to Fish and Fish Habitat (DFO 2013) (e.g., minimize footprint in Option design) Adherence to the Code of Practice for Watercourse Crossings (Government of Alberta 2013) Use of best management practices identified in Alberta Transportation's Environmental Management System Manual (Alberta Transportation 2013) Aquatic Habitat Management Measures Fish Health Management Measures Riparian Vegetation Management Measures Erosion and Sediment Control Plan Blast Management Measures	Yes

Summary of Potential Effect and Classification	Components	Contributing Activities	Proposed Mitigation Measure	Detectable / Measurable Residual Effect
Fish Mortality and Productivity	Earth fill dam and permanent pond, spillways, borrow pits and Hwy 66 watercourse crossing	Operation of heavy equipment Isolation of workspaces within watercourse Flood event Operation of waste storage and disposal Construction and use of access roads Construction of staging areas Site restoration and landscaping Possible operation of cement batch plant Site clearing Blasting Foundation excavation and grouting Sediment disturbance during instream works Realignment of watercourses for spillway construction or outlet structure Flooding to form the permanent pond Construction of instream footprint	Application of relevant Measures to Avoid Causing Harm to Fish and Fish Habitat (DFO 2013) (e.g., adherence to timing windows) Adherence to the Code of Practice for Watercourse Crossings (Government of Alberta 2013) Fish Health Management Measures Aquatic Habitat Management Measures Angling Prohibition Policy Invasive Species/Fish Disease Management Measures Blast Management Measures Care of Water Erosion and Sediment Control Plan Design for Fish Exclusion Design to Reduce Total Gas Pressure (Gas Supersaturation) Fish Passage Management Measures Riparian Vegetation Management Measures	Yes
Impediment to Migration and Movement	Earth fill dam and permanent pond, spillways and Hwy 66 watercourse crossings	Isolation of workspaces instream Realignment of watercourses for spillway construction or outlet structure Construction of fish passage facility	Fish Passage Management Measures	No

Summary of Potential Effect and Classification	Components	Contributing Activities	Proposed Mitigation Measure	Detectable / Measurable Residual Effect
Operation and Maintenance Phase				
Permanent Alteration and Destruction of Fish Habitat (Serious Harm to Fish)	Earth fill dam and permanent pond, spillways and Hwy 66 watercourse crossings	Operation of permanent pond, diversion tunnels and spillways and road crossings	Aquatic Habitat Management Measures Care of Water Fish Health Management Measures Riparian Vegetation Management Measures Erosion and Sediment Control Plan	Yes
Fish Mortality and Productivity	Earth fill dam and permanent pond, spillways and Hwy 66 watercourse crossings	Operation of permanent pond, diversion tunnels and spillways and road crossings	Application of relevant Measures to Avoid Causing Harm to Fish and Fish Habitat (DFO 2013) (e.g., adherence to timing windows) Adherence to the Code of Practice for Watercourse Crossings (Government of Alberta 2013) Care of Water Design for Fish Exclusion Fish Passage Management Measures Fish Health Management Measures Design to Reduce Total Gas Pressure (Gas Supersaturation) Aquatic Habitat Management Measures Riparian Vegetation Management Measures Invasive Species/Fish Disease Management Measures Erosion and Sediment Control Plan	Yes
Impediment to Migration and Movement	Earth fill dam and permanent pond, spillways and Hwy 66 watercourse crossings	Operation of diversion tunnels Operation of fish passage facility	Adherence to the Code of Practice for Watercourse Crossings (Government of Alberta 2013) Fish Passage Management Measures Care of Water Design for Fish Exclusion	Yes
Changes to Fish Assemblages Due to Habitat Changes	Earth fill dam and permanent pond, spillways and Hwy 66 watercourse crossings	Operation of earthfill dam, permanent pond and diversion tunnels	Fish Passage Management Measures Aquatic Habitat Management Measures	Yes

7.3.3.4 Residual Effects

Residual effects are MC1-related effects that are anticipated to occur after the application of mitigation measures. This section describes how the residual effects of theMC1 Option are characterized and summarized for Aquatic Environment. The determination of a substantive or non-substantive residual effect includes a characterization including magnitude, regional extent, and duration.

Potential MC1-related residual effects are delineated as follows:

- **Non-substantive residual effect** – where mitigation measures have not fully eliminated the effects but have reduced the magnitude, extent, or duration to such a degree as to avoid a population level effect on the VC. This characterization is based on the definitions and rating of effects characteristics outlined in **Table 7.3-15**.
- **Substantive residual effect** – where adverse effects are predicted to be relevant the population level (e.g., high in magnitude, regional in extent, or long term in duration) even after implementation of mitigation.

Residual Effects Characteristics

Residual effects for Fish and Fish Habitat VC are characterized based on the criteria defined in **Table 7.3-15**.

Table 7.3-15 Residual Effects Characteristics for Fish and Fish Habitat

Residual Effect Characteristic	Rating	Definition
Direction	Positive	Net benefit to Fish and Fish Habitat.
	Adverse	Net loss to Fish and Fish Habitat.
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 adverse effect to the accessibility, productivity, or functionality of instream and riparian habitat, or reduction in the health or mortality of bull trout, mountain whitefish, brown trout, rainbow trout.
	Minor	No detectable change to habitat and accessibility; with no risk to health or mortality of bull trout, mountain whitefish, brown trout, rainbow trout.
	Moderate	Measurable adverse effect on fish habitat; moderate risk to health, loss of productivity or mortality of bull trout, mountain whitefish, brown trout, rainbow trout.
	Major	Measurable adverse effect to habitat; high risk of health, loss of productivity or mortality effects on bull trout, mountain whitefish, brown trout, rainbow trout.
Duration	Short-term	Effect would last less than typical lifespan of fish species affected (5-10 years).
	Long-term	Effect would last longer than typical age of fish species affected (> 10 years)
Reversibility	Reversible	Effect could be reversed once the activity causing the residual effect ceases.
	Not reversible	Effect would be permanent.
Frequency	Isolated	Effect would be confined to a single event of the assessment period
	Rare	Effect would occur intermittently but repeatedly over the assessment period.
	Frequent	Event would occur regularly or continuously over the assessment period.
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 MC1.
	Low	Rating predictions are based on an incomplete understanding of cause-effect relationships and incomplete data.

Permanent Alteration or Destruction of Fish Habitat

Some adverse effects on fish habitat potential are unavoidable and would not likely be completely mitigated through the Construction and Operation and Maintenance phases.

During the Construction phase, construction of the earth fill dam would result in a direct and permanent loss of fish habitat, although none of this area is currently confirmed as being used for spawning or wintering of the indicator species. The salvage of benthic invertebrates and periphyton during construction is not feasible and would result in the temporary loss of feeding opportunities. The creation of the permanent pond, also considered part of the Construction phase, would considerably alter the physical, chemical, and ecological characteristics of the area immediately upstream from the dam, both within the Elbow River and multiple tributaries. Useful spawning habitat for mountain whitefish would be included in this altered area. Although spikes in suspended sediments are likely to occur during some construction steps, the application of diligent sediment control measures may sufficiently reduce their effects to avoid alteration of downstream habitat, reduced productivity, and fish mortality.

Additional direct loss and alteration of fish habitat is expected to result from the realignment of McLean Creek to facilitate the construction of the diversion tunnel outlet structure and/or the fish passage facility. Loss or alteration of fish habitat is also expected to result from the construction of culvert crossings (for the realignment of Hwy 66) of Connop Creek and McLean Creek. It is realistic to expect some potential for the delayed, or even unrealized effectiveness, of offset measures for MC1, particularly given the scale of anticipated offsetting needs. Residual effects occurring during the Construction phase would likely be of moderate magnitude.

Alteration of habitat is also expected to result during the Operation and Maintenance phase, both upstream and downstream of the dam. Episodic changes in water levels in the reservoir would reduce the consistency and suitability of habitat, and would temporarily influence habitat composition. 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. Although habitat enhancement and compensation measures used to mitigate effects to fish populations would also help maintain or restore benthic and periphyton populations, the resulting benthic and periphyton populations upstream from the MC1 dam may not reflect the original community at the MC1 footprint. Currently, there is a lack of baseline data for primary producers in this area which results in some degree of uncertainty regarding this potential effect.

Downstream from the dam, habitat between the dam and the diversion tunnel outlet structure would change frequently, depending on flow rates through the diversion tunnel and the amount of resulting backwater. Effects of the Operations and Maintenance phase on habitat downstream of the earth fill dam are also expected to influence water temperature, sediment load and substrate compositions, peak and low flow rates, and potentially ice regimes. Some augmentative mitigation options are possible to counter alterations to fish habitat; however, since the magnitude and spatial extent of these influences is unknown, it is reasonable to expect that adverse effects on spawning, wintering, and rearing habitats would result downstream from the dam.

Overall, the anticipated adverse residual effects of the MC1 Option on fish habitat are expected to be moderate in scale, and since they are not expected to result in population-level effects of fish, are likely to be non-substantive for both Option phases. The confidence level of this assertion, specifically for habitat downstream of the dam, is moderate (**Table 7.3-16)**, and considerations related to this residual effect may change as further modelling related to potential influences on temperature, sediment transport, substrate composition, ice regime, and operational flow patterns is completed.

Table 7.3-16 Summary of Effect Characteristics Ratings for Permanent Destruction and/or Alteration of Fish Habitat

Residual Effects Characteristic	Rating	Rationale for Rating
Direction	Adverse	Direct and permanent loss of fish habitat within the MC1 footprint in the Elbow River and tributaries. Potential adverse effects on physical, chemical and ecological characteristic of the area immediately upstream and downstream of the dam due to the creation of the permanent pond, fluctuations in water levels due to flood storage, and fluctuation in water levels downstream of the dam.
Extent	Regional	Effects may be pronounced within the MC1 footprint Extent of effects downstream from the outlet structure is unknown but may extend beyond 1 km downstream.
Magnitude	Moderate	Adverse effects to Fish and Fish Habitat would be expected within the local and regional level; however, they are not expected to result in population level effects.
Duration	Short-term and long-term	Adverse effects anticipated during some Construction-phase activities when spikes in suspended sediments are likely to occur Altered habitat within the permanent pond following construction may alter habitat composition. Long-term effects would result of permanent and direct loss of fish habitat resulting from the MC1 footprint.
Reversibility	Not reversible	The direct loss or alteration of fish habitat resulting from the MC1 footprint would be permanent.
Frequency	Frequent	The effects of habitat loss would be continuous given the permanent nature of the MC1 footprint and operation schedule.
Confidence	Low to High	Footprint and habitat potential of affected area is understood, although effects downstream during the Operation and Maintenance phase is unconfirmed due to lack of information. Predictions of population level changes to benthic and periphyton communities are based on limited understanding of cause-effect relationships and/or limited baseline data.

Effect on Fish Mortality and Productivity

Construction

Mortality of fish passing through the diversion tunnels during the Construction phase would likely be unavoidable. The rate of mortality is expected to be low and the duration of the potential effect is limited to two or three migratory periods; however, the effect of the loss of even small numbers (e.g., 10) of adult bull trout from the Upper Elbow River population is considered of major magnitude and could have long-lasting implications on the productivity of the species. The potential for fish mortality during the Construction phase therefore likely represents a substantive effect, although the confidence in this assertion is low (**Table 7.3-17**).

Table 7.3-17 Summary of Effect Characteristics Ratings for Fish Mortality and Productivity - Construction

Residual Effects Characteristic	Rating	Rationale for Rating
Direction	Adverse	Mortality of some fish which pass through the diversion tunnels during their use as a bypass channel (i.e., during the remainder of construction) is expected. Adverse effects on fish productivity are anticipated as the result of changes to water temperature, sediment load and ice regimes, as well as attenuated flow rates downstream of the dam.
Extent	Regional	The mortality of migratory fish may extend regionally.
Magnitude	Major	Mortality of adult bull trout would be of a major magnitude.
Duration	Short-term and Long-term	Potential mortality of fish would be limited to the period in which the diversion tunnels were in use as a bypass channel (i.e., over the remainder of construction), and potentially during the activation of spillways.
Reversibility	Not reversible	Effects of mortality would be permanent.
Frequency	Rare	Fish mortality is considered a rare event.
Confidence	Low	Effects on mortality during Construction phase is unconfirmed due to lack of information.

Operation and Maintenance

During the Operation and Maintenance phase, changes to water temperature, sediment load, and ice regimes, as well as attenuated flow rates are expected downstream of the dam, resulting in an expected modest adverse influence on the productivity of fish habitat within relative proximity (e.g., 1 km) of the MC1 footprint. Upstream, between the permanent pond and seasonal reservoir elevations, periodic inundations and incremental sediment deposition events are expected to moderately to substantially reduce fish productivity, although are not likely to result in mortality. Residual effects related to changes in water temperature, sediment loads, ice regimes, and attenuated flow rates during the Construction and Operation and Maintenance phases are expected to be non-substantive.

Overall this Option's potential residual effect on fish mortality and productivity is likely to be substantive although, with the lack of detailed site-specific information to support modelling, confidence in this determination is low (**Table 7.3-18**).

Table 7.3-18 Summary of Effect Characteristics Ratings for Fish Mortality and Productivity – Operation and Maintenance

Residual Effects Characteristic	Rating	Rationale for Rating
Direction	Adverse	Adverse effects on fish productivity are anticipated as the result of changes to water temperature, sediment load and ice regimes, as well as attenuated flow rates downstream of the dam. Upstream of the dam, the periodic inundations and incremental sediment deposition events are expected to reduce fish productivity.
Extent	Regional	Productivity within the LAA is expected to decrease due changes in environmental conditions.
Magnitude	Moderate- Major	Adverse effects environmental conditions are considered to be moderate resulting in a reduction in productivity although unlikely to result in mortality. The mortality of adult bull trout would be of a major magnitude.
Duration	Short-term and Long-term	Productivity within the permanent pond would change with time over the short term until a new equilibrium is reached, at which time it would remain relatively constant. Influence on productivity downstream would be long-lasting, reflective of operational schedule of the Option.
Reversibility	Not reversible	Effects on productivity would be ongoing and continuous, while mortality is considered a rare event.
Frequency	Rare - Frequent	Effects on productivity would be ongoing and continuous
Confidence	Low	Comprehensive modelling information about magnitude and extent of effects on mortality not available and characterization is based on interpretations from other projects.

Effect on Migration and Movement

An adverse residual effect on migration and movement is predicted to occur during the Operation and Maintenance phase. While the fish passage facility would potentially mitigate effect on migration and movement across the dam, additional design refinement and passage analysis would be required to ensure the effectiveness of MC1's fish passage facility. Conceptual designs suggest that passage of adult salmonids (in both directions) during the Operation and Maintenance phase can be achieved, although it is likely not realistic to expect the MC1 fish passage facility to pass all fish at all times. Thus, the residual effect on migration and movement due to limited passage is likely to be non-substantive. Given the conceptual nature of designs for the fish passage facility and the expected design modification and associated passage analysis needed, confidence in this determination is currently low (**Table 7.3-19**).

Table 7.3-19 Summary of Effect Characteristics Ratings for Fish Migration and Movement

Residual Effects Characteristic	Rating	Rationale for Rating
Direction	Adverse	Preliminary design of the MC1 fish passage facility suggests passage of adult salmonids would be possible in both directions. It is currently unknown whether passage of juvenile fish or smaller bodied species would be possible.
Extent	RAA	Bull trout are known to winter in habitat predominantly downstream from MC1 and spawn in habitat near and upstream of MC1. Migratory tendencies of other species and juvenile salmonids is largely unknown.
Magnitude	Minor	Success rates of fishways in general range widely, and it is realistic to expect that passage of some adult salmonids may not be possible. Passage of most adults is expected annually.
Duration	Long-term	Impediment of fish passage during the Operation and Maintenance phase (albeit at unknown extent) would extend beyond the lifespan of all Indicator Species.
Reversibility	Non-reversible	Residual effect is expected to occur as long as the dam is in place.
Frequency	Rare	Reduction in fish passage may occur periodically through the Operation and Maintenance phase.
Confidence	Low	Inference of fish passage potential has been based on conceptual designs.

Effect on Fish Assemblage due to Habitat Change

Considering the potential for an overall decreased habitat suitability (e.g., potentially altered benthic and periphyton community assemblage) within the permanent pond, the fish community assemblage may be altered in habitat immediately upstream from the dam. Conditions would favour species more adept at adapting to altered environments and ecosystems more representative of lacustrine conditions. Should sucker species occur upstream of the dam prior to construction, their prevalence would increase. The assemblage of the fish community is not expected to change downstream from the dam, although relative abundances of individual species in the immediate vicinity of MC1 may be altered.

Overall, this potential residual effect is likely to be non-substantive, as its potential extent is local and of moderate magnitude. Given the absence of detailed modelling, however, this determination is primarily based on inferences from other projects of similar design, and is reflective of a low confidence level (**Table 7.3-20**).

Table 7.3-20 Summary of Effect Characteristics Ratings for Fish Assemblage

Residual Effects Characteristic	Rating	Rationale for Rating
Direction	Adverse	Fish community composition within the permanent pond would change as conditions would favor species more representative of lacustrine conditions.
Extent	Local	Effect is expected to be limited to the permanent pond.
Magnitude	Moderate	While mortality is not anticipated, overall avoidance of habitat by Indicator Species may occur.
Duration	Long-term	Potential effect would result for more than 10 years.
Reversibility	Non-reversible	Permanent pond would be a permanent feature during the lifespan of MC1.
Frequency	Frequent	Residual effect would occur continuously.
Confidence	Low	Prediction is based on comparison of potential influences on habitat parameters from other project inferences

7.3.3.5 Summary of Aquatic Environment Assessment

There is a potential for a substantive residual effect on fish and fish habitat during the Construction and/or Operation and Maintenance phases.

Non-substantive residual effects to fish and fish habitat are likely from the loss or alteration of limiting (i.e., spawning and presumed wintering habitat) lotic habitat resulting from the construction of the earth fill dam, creation of permanent pond, and alteration of lotic habitat upstream and downstream from the dam. The operation of MC1 components may also cause a reduction in fish productivity upstream and downstream from earth fill dam, although the effects may be localized and, therefore, would be non-substantive. Alteration to habitat feasibility, particularly upstream of the dam but limited to the permanent pond, may also influence fish community assemblage. This potential residual effect is considered non-substantive, although the confidence level of this assertion is limited due to the lack of predictive modelling.

Despite the inclusion of a fish passage facility, MC1 may still impede the passage of some fish (e.g., non-sportfish or juvenile salmonids) during Operation and Maintenance; however, further design refinement and analysis may further inform this assertion or eliminate the concerns regarding fish passage. This potential residual effect is also currently considered non-substantive, although certainty in this determination is low.

The potential for the residual effect of fish mortality to occur during the Construction phase is likely to be a substantive effect, primarily given the major consequences should even relatively few adult bull trout be lost from the Upper Elbow River population. The confidence level of this assessment is low, and this residual effect is carried forward for consideration in the cumulative effects assessment (**Section 9.0 Planned Development Case**).

7.3.4 FOLLOW-UP MONITORING FOR AQUATIC ENVIRONMENT

Additional baseline programs are being considered for fall and winter 2017 and winter and spring 2018 to further characterize existing fish and fish habitat conditions and further inform a more comprehensive effects assessment should questions arise or MC1 be considered further. In addition to additional baseline field studies, the implementation of the monitoring plans throughout the Construction and Operation and Maintenance phases is necessary to evaluate pre- and post-construction conditions as they relate to Aquatic Environment.

Fish Habitat Monitoring

During the Operation and Maintenance phase, effects, that cannot be mitigated, are likely on parameters that contribute to the overall viability of fish habitat, specifically to physical habitat characteristics including water temperature, dissolved oxygen, ice formations and substrate compositions. Although some habitat enhancement opportunities may exist in habitat upstream and downstream from the earth fill dam (see Aquatic Habitat Management Measures in **Section 7.3.3.3**), there are no expected feasible mitigation measures for water temperature, dissolved oxygen, ice formations, or sediment load compositions. A Fish Habitat Monitoring program would be developed to evaluate pre- and post-construction changes in these characteristics. The plan would also include designs for effectiveness monitoring of other mitigation measures that were applied during the Construction phase and the Operation and Maintenance phase and to validate predictions about physical changes to habitat in the permanent pond and riverine habitat downstream from the earth fill dam. Results of the plan would inform appropriate remedial or supplemental mitigation needs, and may also assist in altering offsetting requirements (if required).

Fish Toxicology Monitoring

Removal of terrestrial vegetation and soil from the expected footprint of the permanent pond may reduce the potential for bacterial methylation. The complete elimination of this potential adverse effect on fish mortality and productivity is unlikely, however. As a result, 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.

Aquatic Community Assemblage Monitoring

Assuming the unavoidable effects on habitat morphology and suitability within the permanent pond, a resulting shift in community assemblage of aquatic species may occur. An Aquatic Community Assemblage Monitoring program would be developed to evaluate pre- and post-construction changes to fish species, benthic invertebrates, and periphyton communities, upstream and downstream from the earth fill dam.

Fish Passage Monitoring

Fish passage would need to be monitored during both Construction and Operation and Monitoring phases. During Construction, monitoring the effectiveness of the diversion tunnels to provide safe downstream passage of fish would be necessary (see **Fish Health Management**). Evaluation of the number and condition of fish passing downstream through the structure would be needed on a scheduled frequency, and would focus on target species and size of fish.

7.3.5 REFERENCES

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Personal Communication*:*

Corbett, Aleta. Senior Environmental Specialist. TransAlta Corporation. Calgary, Alberta.

Earle, Jennifer. Fisheries Biologist, Resource Management Program, Alberta Environment and Parks. Cochrane, Alberta. July 2015

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Sanderman, Mike. Fisheries Biologist. Resource Management Program, Alberta Environment and Parks. Cochrane, Alberta. March and May 2017.

Wilson, Kate. Aquatic Invasive Species Specialist, Fish and Wildlife Policy, Alberta Environment and Parks. Edmonton, Alberta. March 2017