Table of Contents

LIST OF TABLES

LIST OF FIGURES

Natural Resources Conservation Board
May 2019

LIST OF APPENDICES

Abbreviations

AAAQG	Alberta Ambient Air Quality Guideline
AAD	average annual damage
AADT	average annual daily traffic
AB WQG	Environmental Quality Guidelines for Alberta Surface Waters
AEP	Alberta Environment and Parks
AER	Alberta Energy Regulator
ANFO	ammonium nitrate/fuel oil
BOD	biochemical oxygen demand
BSP	biologically sensitive period
CCME	Canadian Council of Ministers of the Environment
CDA	Canadian Dam Association
CEA Agency	Canadian Environmental Assessment Agency
COPC	contaminants of potential concern
CRA	Commercial, Recreational and Aboriginal
CWQG	Canadian Water Quality Guidelines
D_{50}	median particle size
dBL	decibel level
DEP	diesel exhaust particulate
DFO	Fisheries and Oceans Canada
DO	dissolved oxygen
ECCC	Environment and Climate Change Canada
EIA	environmental impact assessment
EIS	environmental impact statement
EPEA	*Environmental Protection and Enhancement Act*
GPS	global positioning system
HHRA	human health risk assessment
IDF	inflow design flood

LAA	local assessment area
L_{dn}	day-night average sound level
LiDAR	light detection and ranging
LLOW	low-level outlet works
LOAEL	lowest observed adverse effect level
LOR	limit of reporting
LOS	level of service
LUA	land use area
MBCA	Migratory Birds Convention Act
MC1	McLean Creek Option
MNL	mitigated noise limit
MPOI	maximum point of impingement
MU	measurement uncertainty
NOAEL	no observed adverse effect level
NRCB	Natural Resources Conservation Board
OHV	off-highway vehicle
PDA	Project development area
PLUZ	public land use zone
PM_{10}	particulate matter less than 10 micrometers in diameter
$PM_{2.5}$	particulate matter less than 2.5 micrometers in diameter
PMF	probable maximum flood
PRA	provincial recreation area
Project	Springbank Off-stream Reservoir
PV	present value
QAES	qualified aquatic environmental specialist
RAA	regional assessment area
RTK	real time kinematic
SOD	sediment oxygen demand
SOMC	species of management concern
SR	special receptor

SR1	Springbank Off-stream Reservoir
SSC	suspended sediment concentration
SVM	seasonal variability metric
TDR	technical data report
TDS	total dissolved sediments
TGP	total gas pressure
TOR	terms of reference
TRV	toxicological reference value
TSP	total suspended particles
TSS	total suspended solids
TUS	Traditional Use Studies
VC	valued component
VHV	volatile headspace vapours
VOC	volatile organic compound
WHO	World Health Organization
WMMP	Wildlife Mitigation and Monitoring Plan
WSC	Water Survey of Canada

2 NATURAL RESOURCES CONSERVATION BOARD

2.1 GENERAL

Question 1

EIS Summary, Section 3.6.2.4, Page 3.24
Volume 1, Section 2.2.5, Pages 2.25 and 2.26

Alberta Transportation lists two options when discussing alternatives for the low-level outlet channel: *upsizing the existing stream to convey to peak design flow to the Elbow River and delay reshaping the channel until it is necessary*. Alberta Transportation also states that the *choice was made to delay maintenance on the channel until such a time as it may be required*.

a. **Provide rational for considering channel work in the existing stream maintenance instead of deferred construction.**

b. **Provide the cost of upsizing the existing channel in the existing stream to peak design flood at the time of Project construction.**

Response 1

a. Volume 1, Section 2.2., page 2.26 provides the rationale for the recommended approach:

> "Upsizing the existing stream during construction would result in reshaping the channel, likely to the size of a design flood. This would include the addition of armouring of the channel and would affect the aquatic ecosystem of the stream, including any fish habitat. The riparian conditions along the stream would be altered with the removal of vegetation paralleling the stream. The upsizing would involve instream work and offer the potential for erosion of sediment into the stream and downstream to the Elbow River.
>
> If stream maintenance were to be postponed until a large flood had occurred and the extent of stream damage following reservoir draining had been evaluated, effects to the stream and adjacent environment may be less extensive that those for a design flood."

In order to convey and control the release of water from the off-stream reservoir at the maximum rate of releaser rate (27 m^3/s, although actual release rates will likely be less), the design of an engineered channel (replacing the unnamed creek) would need to be approximately 15 m wide and 1.5 m deep. This 1,800 m channel would require approximately 40,000 m^3 of excavation and 9,000 m^3 of riprap channel protection. To provide construction access, an estimated 6 ha of area would need to be cleared and grubbed.

By contrast, stream maintenance in the unnamed creek following the release of water from the off-stream reservoir after a flood would be more limited. As indicated in Volume 3B, Section 6, the unnamed creek is undersized for the expected design flood discharge; therefore, there could be erosion of the bed and banks. However, the unnamed creek is nested within a larger floodplain valley that is vegetated with forest and shrub. Overbank flows within the floodplain have lower shear stress and erosive power. Root mass from the vegetation may provide erosion protection within the floodplain area. Maintenance may be provided by smaller equipment that can access the creek banks without wide-scale vegetation removal. This will reduce impacts to the creek.

b. Table IR1-1 lists anticipated construction costs of converting the unnamed creek at the time of Project construction. As this proposed design is conceptual, a contingency of 20% is used for this cost opinion.

Table IR1-1 Conceptual Cost Opinion for Replacing the Unnamed Creek with an Engineered Channel

Items	Units	Quantity	Unit Rates	Cost ($2017)
Mobilization	lump sum	5% of Const. Cost	$ 169,480	$ 169,480
Common excavation	m^3	43,200	$ 5.50	$ 237,600
Overhaul excavation	$km*m^3$	43,200	$ 2.00	$ 86,400
Riprap Zone 6B	m^3	16,200	$ 165.00	$ 2,673,000
Non-woven geotextile	m^2	27,000	$ 3.50	$ 94,500
Clearing and grubbing	ha	6.3	$ 11,000.00	$ 69,300
Seeding and planting	ha	3.6	$ 8,000.00	$ 28,800
Engineered channel outlet structure	lump sum		$ 200,000.00	$ 200,000
			Sub-Total	**$ 3,559,080**
		Contingency (20%)		$ 711,816
			Total	**$ 4,270,896**

Question 2

Volume 1, Section 1.3.2.1, Page 1.12
Volume 3A, Section 12.4.2, Page 12.24
Volume 4, Appendix D, Section 5.1.3, Page 5.1

Alberta Transportation states *Area C: has options for grazing through public leases. The land would be publicly owned and privately stewarded*.

Alberta Transportation states in Volume 3A that *AEP would own and manage these areas. (including Area C).*

Alberta Transportation then goes on to state in Volume 4 that *Area C is generally north of the Springbank Road and west of Highway 22 and would be inundated at the design flood. These lands would remain under private ownership and management. Current land uses, which are mainly agricultural, can continue*.

a. Clarify the future ownership of Area C.

Response 2

a. Alberta Transportation acknowledges the conflicting statements regarding Area C.

Since filing of the EIA, Alberta Transportation has created a draft post-construction land use document for the Project (Appendix IR2-1). This document provides the draft principles of future land use for the PDA, which was developed through the engagement process and includes feedback received by First Nations and stakeholders. The principles apply to the land use area (LUA) outlined in yellow in Figure 1 of Appendix IR2-1. The primary use of all lands within the PDA, including the LUA, is for flood mitigation. In light of the primary use, the safety of anyone with access or land users will be an overriding factor.

Question 3

Volume 1, Section 2.2.1.3, Table 2-2, Pages 2.10 and 2.11
EIS Summary, Section 3.6.1, Table 3-2, Pages 3.16 to 3.17

Table 2-2 describes recreational use of the MC1 area including loss of campsites and impact on hiking, cross country skiing, snowshoeing, guiding, outfitting, etc.

a. **Clarify the extent to which recreational activities described in the tables are expected to be available in the operational phase of MC1.**

Response 3

a. The MC1 Option area overlaps with the Kananaskis Country Public Land Use Zone (PLUZ) to the north of the Elbow River, and the McLean Creek PLUZ to the south. These public lands are areas where the Public Lands Administration Regulation (187/2011) applies conditions to protect sensitive resources and manage user activities. Provincial Recreation Areas (PRAs) in the PLUZs overlap with the MC1 Option area. During the operational phase of the MC1 Option, the Elbow River PRA and a portion of the McLean Creek PRA would be permanently displaced and no longer available for recreational use (Table IR3-1). The main earthfill dam, cofferdam and service spillways would be located at the northern boundary of the McLean Creek PRA.

Table IR3-1 Public Land Use Zones and Provincial Recreation Areas in the MC1 Option Area

Public Land Use Zone / Provincial Recreation Area	Total Area (ha)	Area (ha) within MC1 Option Area	% of intersect in MC1 Option Area	Reduction in total area available for recreational activities during operation (%)
Kananaskis Country PLUZ	112,923.0	509.3	<1.0	Negligible
McLean Creek PLUZ	20,020.0	484.6	2.4	Negligible
Elbow River PRA	236.2	171.1	72.4	100%
McLean Creek PRA	245.1	101.7	41.5	Approximately 30% to 40%, due to highway realignment
Gooseberry PRA	41.4	5.3	12.8	Negligible
SOURCE: Hemmera 2017				

Campgrounds and Day Use Areas

Station Flats, Allen Bill and River Cove day use areas in the Elbow River PRA and the River Cove group campground would be closed and decommissioned for the MC1 Option (Table IR3-2). In addition, a portion of the McLean Creek Campground in the McLean Creek PRA overlapping the realignment for Highway 66 would require closure and decommissioning. Paddy's Flat Campground is outside the footprint of the MC1 Option design and future use would not be affected. The proposed realignment of Highway 66 runs southwest from Gooseberry PRA through McLean Creek Off-Highway Vehicle PLUZ and McLean Creek PRA, adjacent to McLean Pond and through a portion of McLean Creek Campground. Alternative areas would be identified to offset the loss of these areas and provide equivalent recreational services.

Hemmera (2017) recommended the identification of alternative areas to offset the permanent loss of recreation areas and infrastructure. Recreation infrastructure includes campsites, day use parking, picnic areas, facilities and interpretive trails. The identified offset areas would be made available to the public after construction. It is assumed that specific facilities and functionality would be fully offset with replacement infrastructure. Because there are no detailed plans for specific replacement infrastructure, there may be changes in the recreational experience in the future as a result of facilities being located in different areas.

Table IR3-2 Campgrounds and Day Use Areas in the MC1 Option Area

Campground / Day Use Area	Approximate Extent of Overlap with MC1 Option Area (%)	Notes
Station Flats Day Use Area	100	Day use areas would be closed and functionally offset with alternative areas.
Allen Bill Day Use Area	100	
River Cove Day Use Area	100	
River Cove Group Campground	100	Group campground would be closed and functionally offset with alternative areas
McLean Creek Campground	30-40	Estimated 50-60 campsites that overlap or are adjacent to the highway realignment would have required closure and relocation
McLean Creek Camper's Centre (store)	100	Overlaps with highway realignment – would require closure and relocation
McLean Pond	Minor overlap during construction	Open
McLean Creek Interpretive Trail	Minor overlap during construction	Open
SOURCE: Hemmera 2017		

In consideration of the high level of recreational use that the Elbow River area currently supports, it is likely that some recreational users would be displaced by the MC1 Option to other recreational areas during the operational phase. Displaced users may in turn cause pressure on the capacity of other campgrounds and day use areas in Kananaskis Country and the surrounding region; however, it is assumed that the implementation of offset areas would accommodate the displaced demand without adverse effects on other recreational areas.

MULTI-USE TRAILS (NON-MOTORIZED)

Station Flats and Allen Bill parking areas are used as access points where recreational users access the extensive trail network in the Elbow River valley. The trails are used for mountain biking, horse riding, hiking, cross-country skiing and snowshoeing. Specific multi-use trails that overlap with the MC1 Option area, and they would require rerouting, include portions of Elbow Trail, Snagmore Trail, Sugar Mama and Sugar Daddy trails, Tom Snow, Ridgeback 2, Bobcat, and the Elbow Valley connector trail. These trails would partially overlap with the permanent pond and portions of the dam and other permanent MC1 Option infrastructure (Table IR3-3). The relocation of a portion of Highway 66 would permanently remove access to portions of PRAs and trail networks. Where possible, access points to recreation areas would be retained or would be reconstructed as soon as possible after construction. Additional work would be needed to confirm the effects to specific trails and other areas and to confirm the effectiveness of proposed mitigation measures. Additional offset areas may be required if popular trail areas could not be reconstructed or rerouted.

Table IR3-3 Identified Non-motorized Recreational Trails in the MC1 Option Area

Trail Name	Approximate Access Location	Identified Trail Uses	Approximate Length (km)	Approximate extent of overlap with the MC1 Option Area
Snagmore	Sugar Daddy and Elbow Trails	Mountain biking Snowshoeing	4.8	~50% overlap; directly overlaps with dam infrastructure
Elbow Trail	Highway 66 at Elbow Valley Ranger Station	Hiking Cross country skiing	6.9	>50% overlap
Sugar Mama	East of Elbow Valley Ranger Station on trail network	Mountain biking Snowshoeing	3.4	Trailhead in MC1 Option area
Sugar Daddy	East of Elbow Valley Ranger Station on trail network	Mountain biking Snowshoeing	3.8	Trailhead in MC1 Option area
Tom Snow	Station Flats Trailhead off Hwy 66	Mountain biking	28.1	~30% of trail and trailhead in MC1 Option area

Table IR3-3 Identified Non-motorized Recreational Trails in the MC1 Option Area

Trail Name	Approximate Access Location	Identified Trail Uses	Approximate Length (km)	Approximate extent of overlap with the MC1 Option Area
Ridgeback 2	Sugar Mama, other trails in trail network	Mountain biking	2.3	~25% of trail and trailhead in MC1 Option area
Bobcat	Ridgeback, other trails in trail network	Mountain biking Hiking	4.0	Trailhead in MC1 Option area
Diamond T Loop	Elbow Valley and Tom Snow Trails	Horse riding Hiking	3.9	~50% overlap
Elbow Valley (Connector Trail)	Station Flats Trailhead off Hwy 66, Ing's Mine Road, Moose Mountain Road	Mountain biking Hiking Horse riding	9.0	~50% of trail and trailhead in MC1 Option area
Sulphur Springs	Stations Flats trailhead at Elbow Valley Trail	Mountain biking Hiking Horse riding	5.8	Both trailheads in MC1 Option area
Pneuma	Moose Mountain Road off Hwy 66 and other trails	Mountain biking	10.3	Trailhead in MC1 Option area
Special K	Pneuma Trail or Moose Mountain Road	Mountain biking	4.8	Trailhead accessed by Tom Snow Trail
SOURCE: Hemmera 2017				

Off-Highway Vehicle (OHV) Trails

Approximately 2.4% of the McLean Creek OHV PLUZ overlaps with the MC1 Option area (see Table IR3-1). The auxiliary spillway and the majority of the realignment of Highway 66 are located in the McLean Creek OHV PLUZ on the south side of the Elbow River. OHV trails and shared use roads overlapping with these MC1 Option components would require closure and relocation during construction. Portions of affected OHV trails would be permanently displaced by the assumed highway realignment. The degree of overlap with OHV trails would be needed. As with the multi-use trails on the north side of the Elbow River, access points would be retained or relocated where possible, and work would be completed during detailed MC1 Option design to confirm the effects to specific trails and other areas and to confirm the effectiveness of proposed mitigation measures.

River Uses

Paddling activities—including kayaking, canoeing and whitewater rafting—are popular activities in Elbow River. Experienced whitewater paddlers access the river between Elbow Falls and Elbow River Boat Launch PRA. The MC1 Option would result in inundation of reaches upstream of the dam but would not extend to the Elbow River Boat Launch PRA. No changes to upstream whitewater paddling or rafting between Elbow Falls and Elbow River Boat Launch would be expected due to the MC1 Option.

Commercial and recreational paddlers and rafters currently access the river at the Allen Bill parking area, just upstream of the proposed location for the MC1 Option. Paddling and rafting trips typically occur in May and June, depending on water levels. The permanent pond would obstruct navigation down the river; therefore, as a result of the MC1 Option, commercial and recreational paddlers and rafters would need to relocate to an access point downstream of the dam. During normal operations, inflows would be passed through the MC1 Option diversion tunnels. During a flood event, excess water, over the set flow threshold (i.e., 212 m^3/s), would be retained in the reservoir.

Recreational fishing for native and introduced trout and mountain whitefish is identified as a popular activity in Elbow River and its tributaries. Construction of the MC1 Option would eliminate or alter fish habitat in reaches upstream and downstream of the MC1 Option dam, as well as within multiple tributaries in the area due to placement of dam components, changes to channel morphology due to the permanent pond and realignment of watercourses. The alteration and destruction of fish habitat due to the construction of the MC1 Option would result in a substantive decline in productivity levels for bull trout, which is a species of conservation concern (Hemmera 2017). Other adverse residual effects on fish and fish habitat, including effects on migration and changes to the fish assemblage were considered to be negligible. However, changes to fish and fish habitat would permanently and adversely affect the quality of the recreational fishing experience in affected habitats upstream and downstream in the Elbow River and affected tributaries over the long term.

References

Hemmera Envirochem Inc. (Hemmera). 2017. Elbow River at McLean Creek Dam (MC1) Environmental Impact Screening Report. Report prepared for Alberta Transportation by Hemmera Envirochem Inc, September 2017.

Question 4

<u>Volume 1, Section 2.2.1.3, Table 2-2, Page 2.12</u>
<u>EIS Summary, Section 3.6.1, Table 3-2, Page 3.18</u>

In the category of *Construction Timelines*, Alberta Transportation states that '*Special measures would be required for winter construction, including heating and hoarding for concrete, and the continuous 24-hour per day earthfill operations" should rapid year-round construction proceed. Such measures would also affect the cost of construction.*

a. Costing for MC1 appears in numerous sections of the EIA including the cost-benefit analysis. Confirm whether year-round construction was contemplated for MC1 and whether the additional costs were included in the MC1 construction cost estimates used throughout the document.

Response 4

a. Yes, year-round construction of the MC1 Option was contemplated and associated costs were included in all applicable estimates throughout the design process. Some items (e.g., concrete structures) that could have been constructed during winter months but at high cost (due to heating, hoarding) where found to not be necessary for achieving reasonable MC1 Option completion dates. This was similar for either spring or fall construction. Therefore, in either case the primary construction tasks were scheduled during optimal seasonal conditions, and not for year-round construction.

   MC1 Option items that included winter construction costs include (Hemmera 2017):

   - Elbow Valley Ranger Station relocation
   - McLean Creek Campground lot replacement
   - Elbow River diversion tunneling
   - spillway topsoil stripping
   - Highway 66 bridge substructure

REFERENCES

Hemmera Envirochem Inc. 2017. Elbow River at McLean Creek Dam (MC1) Environmental Impact Screening Report. Report prepared for Alberta Transportation by Hemmera Envirochem Inc, September 2017.

Question 5

Volume 1, Section 2.2.1.3, Table 2-3, Page 2.13
EIS Summary, Section 3.0, Page 3.2 and Volume 1, Section 1.2, Page 1.3
Volume 1, Section 2.2.1.2, Page 2.5

Alberta Transportation states the *Catchment Area* for the Springbank Project is *868 km^2* and for the MacLean Creek (MC1) Option is *695 km^2*.

Alberta Transportation also states in the EIS Summary that the Project *can hold 77,771,000 m^3 of water as active flood storage*.

Alberta Transportation then states on page 2.5 that the MC1 Option is *designed to withstand the probable maximum flood (PMF) of 2770 m^3/s. The maximum reservoir volume, when passing that flood, would be 93 million m^3…*

a. Explain the methodology and rationale for concluding that flood protection is greater with a SR1 larger catchment area even though SR1 has a smaller maximum reservoir when compared to MC1.

Response 5

a. The preamble is comparing two unrelated characteristics of the SR1and MC1 Option reservoirs. "Active flood storage" is the volume in the reservoir that is used to manage floods though the facilities operation. SR1 active flood storage volume is 77,771,000 m^3. The MC1 Option active flood storage volume would be 73,000,000 m^3. SR! has as its design basis active flood flow reduction to reduce the flow rates that were experienced in the 2013 flood event (or equivalent) to no more than 160 m^3/s downstream of Glenmore Reservoir (the design basis for the MC1 Option is similar, 170 m^3/s). The flow rate was selected by the Government of Alberta because it is the flow rate at which property damage from overland flooding begins to occur within Calgary. Though the two projects have different storage volumes and inflow and outflow rates, they provide the same level of active flood flow reduction and the same level of flood mitigation. The design bases of both SR1 and MC1 Option allocate 10 million m^3 of active storage capacity in the Glenmore Reservoir; and both projects rely on this allocation to achieve their goal.

"Maximum reservoir volume" is the volume that a reservoir will hold when passing the inflow design flood (dam safety flood). SR1 and the MC1 Option passively allow the amount of the flood that is larger than they can handle to pass safely downstream and without catastrophic failure of either SR1 or the MC1 Option infrastructure. The excess flow passes over the spillways, auxiliary spillways, and emergency spillways of the facilities without regulation. Federal and provincial dam safety guidelines classify both SR1 and MC1 Option as “Extreme” consequence dams and, under these provincial regulations, the inflow design flood for both reservoirs is the watershed’s probable maximum flood (PMF).

When passing this excess flood flow (greater than the design flood and up to the PMF), the reservoirs stored water volumes rise with the rising water passing over the auxiliary and emergency spillways. At full spillway discharge, the water level in both SR1and the MC1 Option reservoirs are higher than the level it would be at their full active flood storage volume.

When the spillways are discharging at maximum capacity (inflow design flood) the water behind the dam is termed the “maximum reservoir volume”. When passing the PMF, the volume of water behind the MC1 Option dam is 93,000,000 m^3, whereas the volume behind SR1 dam is 77,771,000 m^3. The difference between the two can be attributed to the general arrangement and hydraulic design of the facilities. SR1 has an auxiliary spillway that allows much of the excess flood flow to pass without being diverted to the reservoir. As a result, the SR1 reservoir does not rise as much as the MC1 Option reservoir when passing the PMF.

Given that both offer similar storage capabilities for the 2013 flood, and similar design bases for flood mitigation, the primary reasons that the flood mitigation is better with SR1 are the following:

- SR1 it is located further downstream than the MC1 Option. It is, therefore, in a better position to intercept and manage runoff from the additional 173 km^2 of catchment area that is between SR1 and the MC1 Option. This additional catchment area is a 25% increase over the MC1 Option catchment area, and this additional area allows SR1 to manage flood generating runoff from the major tributaries of MacLean Creek, Harris Creek, Iron Creek, Bragg Creek, and a considerable amount from unnamed creeks, tributaries, and drainages. The MC1 Option would not be able to manage flood runoff generated from this additional catchment area.
- SR1 has been designed to limit releases from the Glenmore Reservoir dam to 160 m^3/s, which is slightly lower than the value of 170 m^3/s adopted in the design of the MC1 Option. The use of 160 m^3/s as the target for SR1 was to coincide with the maximum discharge capacity of Glenmore Reservoir’s outlet, which has a capacity of 160 m^3/s.

Question 6

Volume 1, Section 2.2.1.3, Table 2-2, Pages 2.9 to 2.12
Volume 1, Section 2.2.1.3, Table 2-3, Page 2.13
EIS Summary, Section 3.6.1, Table 3-2, Pages 3.15 to 3.18

a. Provide a concordance table showing references for each bulleted item in the tables.

b. Identify which of the comparisons between the Project and MC1 in these tables are currently applicable.

Response 6

a-b. Volume 1, Section 2.2.1.3, Table 2-2 and EIS Summary, Section 3.6.1, Table 3-2 are from the AEP (2015).

Table IR6-1 is reproduced here from Volume 1, Table 2-3. The table provides references (in red text) for the original bulleted items and provides updates (indicated in red text).

Table IR6-1 Alternative Option Comparison (revision to Volume 1, Table 2-3)

Parameter	The Project (SR1)	MC1 Option	Updates to the EIA
Catchment Area	• 868 km² Stantec 2015. Flood Frequency Analysis Report, p 34.	• 695 km² Opus. 2017. McLean Creek (MC1) Dam, Updated Conceptual Design Report – Final, Appendix 1: Hydrology Report. p 2.	• Catchment areas remain applicable.
Geohazard	• Dam embankment: low risk of earthquake damage These were preliminary statements based on information available at the time, so no reference is available.	• Larger dam embankment and so possibly greater susceptibility to earthquake damage	• The seismic design factors have been addressed as part of Project design. Volume 1, Section 2.2.1.2 and Section 3.1

Table IR6-1 Alternative Option Comparison (revision to Volume 1, Table 2-3)

Parameter	The Project (SR1)	MC1 Option	Updates to the EIA
Project Timeline	• Operational 2020 Volume 1, Section 1.2.1	• Operational 5.5 years from decision to move forward Volume 4, Supporting Documentation, Document 2. Hemmera Report, p vi	• The Operational 2020 date originally presented in the table for the Project refers to the completion of construction at the end of 2020 and ready for a flood in the spring of 2021 (i.e., partially operational). • The current projected timeline is for the Project to be functionally operational after the second year of construction (1:100 year flood) and to be fully operational to handle the design flood after the third year of construction. • The updated timeline for MC1 Option, assuming a 5-year regulatory process, to be operational would be 9 years from the decision to move forward (i.e., ready the following flood season).
Environmental Issues	• Key Wildlife and Biodiversity Zone Volume 3A, Figure 11-2	• Key Wildlife and Biodiversity Zone, Grizzly Bear Zone (key habitat) Volume 3A, Figure 11-2	• Key Wildlife and Biodiversity Zones remain applicable
	• Fish passage at the diversion structure may be affected by low flows in the Elbow River. Volume 3A, Section 8.4.2.1, p 8.49	• The dam creates a permanent barrier to fish movement on the Elbow River including Bull Trout, a federal species at risk Volume 4, Supporting Documentation, Document 2. Hemmera Report, p xvii	• Fish passage mitigations at the Project's diversion structure are now not expected to impede fish passage. See IR91 for details. • The MC1 Option conceptual design includes a fish passage facility to mitigate effects to fish movement.

Table IR6-1 Alternative Option Comparison (revision to Volume 1, Table 2-3)

Parameter	The Project (SR1)	MC1 Option	Updates to the EIA
	• Off-stream reservoir does not affect fish habitat on the Elbow River The reservoir is off-stream and therefore habitat in the Elbow River will remain riverine. Volume 3A, Section 8.4.4.1, p 8.56	• The dam creates a permanent upstream pond changing the habitat from a riverine one to a lake one Volume 4, Supporting Documentation, Document 2. Hemmera Report, p xvii	• Statements on potential changes to riverine fish habitat for each facility remain applicable.
	• Flow through river structure will have minimal impact on river morphology Volume 3A, Section 6.5.2, p 6.41	• Blockage of river sediment transport by the dam will result in erosion and reshaping of river downstream Volume 4, Supporting Documentation, Document 2. Hemmera Report, p xi	• Statements on effects to river morphology remain applicable
Flooding Risk During Construction	• Minimal risk to downstream communities during construction Volume 1, Section 5.1.1, p 5.2	• Potentially significant risk downstream if flood were to exceed the 1:50 year flood, particularly during the first two years of dam construction Opus. 2017. McLean Creek (MC1) Dam, Updated Conceptual Design Report – Final, Volume 1, p 54	• Statements on flood risk during construction remain applicable

Table IR6-1 Alternative Option Comparison (revision to Volume 1, Table 2-3)

<table>
<tr><th>Parameter</th><th>The Project (SR1)</th><th>MC1 Option</th><th>Updates to the EIA</th></tr>
<tr><td>Cost</td><td>• $372 million (including the estimated $60 million the government will recover from the sale of any surplus land purchased through the acquisition options provided to landowners)
Volume 4, Supporting Documentation, Document 1. IBI Report Analysis of Flood Mitigation Projects for The City of Calgary and Environs on the Elbow River with Emphasis on MC1 and SR1, Exhibit 6.1.</td><td>• $406 million
Volume 4, Supporting Documentation, Document 1. IBI Report Analysis of Flood Mitigation Projects for The City of Calgary and Environs on the Elbow River with Emphasis on MC1 and SR1, Exhibit 6.1.</td><td>• The costs of both SR1 and the MC1 Option have been updated since the EIA was filed in March 2018. The updated construction cost for SR1 is $312.2 million, plus $140 million for land costs.
• The updated cost for MC1 Option is $406.7 million.
See the updated cost estimates presented in the response to IR35 and its appendices for details. The costs are reflective of Alberta Transportations current understanding of the costs associated with both SR1 and MC1 Option</td></tr>
<tr><td rowspan="2">Geotechnical Factors</td><td>• No major foreseeable geotechnical issues.
• Dam construction will be off-stream away from the geotechnical effects of the Elbow River valley</td><td>• The geotechnical issues associated with the McLean Creek option are significantly more complex than the Springbank Project</td><td rowspan="2">• Geotechnical evaluation is ongoing. Both projects are complex from a geotechnical perspective.</td></tr>
<tr><td colspan="2">These were preliminary statements based on information available at the time, so no reference is available.</td></tr>
</table>

Table IR6-1 Alternative Option Comparison (revision to Volume 1, Table 2-3)

Parameter	The Project (SR1)	MC1 Option	Updates to the EIA
Benefit/Cost Ratio	• 1.68 Volume 4, Supporting Documentation, Document 1. IBI Report Analysis of Flood Mitigation Projects for The City of Calgary and Environs on the Elbow River with Emphasis on MC1 and SR1, Exhibit 6.2.	• 1.44 Supporting Documentation, Document 1. IBI Report Analysis of Flood Mitigation Projects for The City of Calgary and Environs on the Elbow River with Emphasis on MC1 and SR1, Exhibit 6.2.	• A number of variables used in the August 2017 benefit cost analysis have changed since its submission in Volume 4 Supporting Documentation, Document 1, including the timing of costs and benefits. As a result, an updated 2019 Benefit/Cost Analysis has been prepared (see Appendix IR6-1). The 2019 Benefit/Cost Analysis shows the benefit/cost ratio would be 1.37 for SR1 and 1.41 for the MC1 Option.

Construction of the Project requires the acquisition of private land. Land values and purchase costs were estimated for the benefit/cost analyses completed in 2015 and 2017. The market land value was assessed based on comparable sales for equivalent highest and best land uses. Typical compensation values for non-market transactions were added. A detailed assessment of individual property owner's specific damages was not possible at that time.

Since the original land acquisition estimates, Alberta Transportation has begun negotiations with landowners with the objective of achieving "voluntary, willing sellers acquisitions." During this process, it has become apparent that willing sales of the land will require higher compensatory amounts than originally anticipated. Accordingly, the current estimate for acquiring land from affected owners is updated to $140 million.

In addition, the 2017 benefit/cost study assumed that any residual land acquired outside the PDA could be resold and the land within the PDA leased for compatible uses. These costs are not considered in the 2019 Benefit/Cost Analysis because the assumption has since changed on the value of lands. Available lands on the periphery of the PDA could be sold following construction of the Project (see Appendix IR6-1). Interim updates on cost may occur as the Project advances through regulatory approval.

Construction of the MC1 Option would require the cancellation of 31 dispositions within the affected area. The dispositions are governed by section 81 and 82 of the *Public Lands Act*. The potential cost of cancelling these dispositions for construction of the MC1 Option is unknown. Alberta Transportation has a contingent liability for cancelling these, dispositions, which cannot be quantified until the parties negotiate the amount payable or, failing a negotiated amount, as determined by the Land Compensation Board as set out in subsection 82 (6) and (7) of the *Public Lands Act*.

REFERENCES

AEP (Alberta Environment and Parks). 2015. Recommendations on the Elbow River major infrastructure decisions. 5pp.

Opus. 2017. McLean Creek (MC1) Dam, Updated Conceptual Design Report – Final. Report prepared for Government of Alberta.

Stantec. 2015. Springbank Off-Stream Reservoir Project Hydrology Flood Frequency Analysis - Report on Methods and Results (Revision 1). Report prepared for Alberta Transportation.

Question 7

Volume 1, Section 2.2.1.3, Table 2-3, Page 2.13

Alberta Transportation states that the Project is *Operational in 2020* while the MC1 Option is O*perational 5.5 years from decision to move forward* under the project timeline.

a. Clarify baseline project timelines for SR1 and MC1 under the assumption that each project is initiated at the same time.

Response 7

a. Work to progress the Project has been ongoing for 4.5 years while the MC1 Option remains at the conceptual design stage. However, if both projects were assumed to be initiated at the same time, the project timelines are estimated to be as follows:

- Project design (2 years), environmental studies (2 years) and regulatory process (1.5 years) would be the same for both SR1 and the MC1 Option. Project design and environmental studies would proceed in parallel.
- Construction for the Project is estimated as 36 months, with it being functionally operational after the second year of construction (1:100 year flood) and to be fully operational to handle the design flood after the third year of operation.
- Construction for the MC1 Option is estimated as 3 years, with a start in fall, Year 1; dam able to accommodate 1:50 year flood by winter Year 2; and dam able to accommodate design flood by the winter Year 3.

Question 8

Volume 1, Section 2.2.1.3, Table 2-3, Page 2.13

For the parameter, *Flooding Risk During Construction*, Alberta Transportation states *Minimal risk to downstream communities during construction*.

a. What is the minimal risk compared to?

b. What is the maximum flood event downstream communities would be protected from during each year of the Project construction?

Response 8

a. Volume 1, Section 2, Table 2-3 is the comparison between SR1 and the MC1 Option. With respect to a flood during construction, SR1 represents a lower risk to downstream communities, compared to the MC1 Option.

   The essential flood mitigation components of both SR1 and the MC1 Option are the dams. These components are also the key aspects in comparing safety during construction. When waters are impounded during construction and prior to commissioning and testing, the risk of a breach is introduced. This risk is elevated if flood waters are so great that they overtop the incomplete dam and cause failure by downcutting through its engineered fill.

   The differences in how the dams are situated with respect to the river makes SR1 less risky than the MC1 Option during construction because SR1 is an off-stream reservoir and the dam is not located in the Elbow River. The instream activities during construction of SR1 consist of a 460 m long temporary channel from the Elbow River, sized to have a diversion capacity of up to a 1:20 year flood. The temporary channel allows for the construction of the permanent diversion structure and floodplain berm. This instream work is expected to occur over a 13-month period from July through to the following July. Until the diversion inlet gates are commissioned at the final stages of construction, there is no mechanism that could impound flood waters prematurely during construction, and, therefore, no risk of breach.

   In contrast, activities during construction of the MC1 Option would involve work in the Elbow River that includes the construction of four coffer dams, diversion tunnels, the main dam and spillways. This work would occur during a 24-month period during which the incomplete works will span the Elbow River valley. During this period, the Elbow River would be partially damned. If flooding were severe enough to induce a breach, the debris released, and the breach wave could damage downstream communities.

b. SR1 would provide no flood protection until after the second year of construction (1:100 year flood) and it will be fully operational to handle a design flood after the third year of construction.

Question 9

<u>Volume 1, Section 2.2.1.3, Table 2-2, Page 2.12</u>
<u>EIS Summary, Section 3.6.1, Table 3-2, Page 3.18</u>

Under the category of Conclusions, Alberta Transportation states that *Overall, the assessment and scoring for SR1 are considerably more favourable than for the proposed MC1. When social and recreational values enter into the equation the evidence is overwhelmingly in favour of the social good created by the Project from a cost, environmental and risk basis.*

a. Provide references for the scoring and evidence that supports this statement including references to the social good created by the Project.

Response 9

a. As stated in Volume 1, Section 2, Table 2-2 and in the EIS Summary, Table 3-2, the bulleted items are from AEP (2015). The introduction to Table 3-2 states that AEP compiled a category-by-category comparison between the Project and the MC1 Option based on the results of the AMEC (2014) and Deltares (2015) reports. Both the Alberta Environment and Parks report and the Deltares report are included in Volume 4, Supporting Documentation, Document 3 of the EIA.

   The conclusion statement regarding "social good" is in both the Deltares and AEP reports and neither report provides a reference for the scoring. "Social good" can be defined as an action that provides a benefit to the general public (Business Dictionary nd). The evidence to support the statement is provided in Table 2-2 (Volume 1) and Table 3-2 (EIS Summary).

REFERENCES

Alberta Environment and Parks. 2015. Recommendations on the Elbow River major infrastructure decisions. 5pp.

AMEC (AMEC Environment and Infrastructure). 2014. Southern Alberta Flood Recovery Task Force Flood Mitigation Measures for the Bow River, Elbow River and Oldman River Basins Volume 1 – Summary Recommendations Report. Submitted to Southern Alberta Flood Recovery Task Force, Calgary, Alberta. June 2014.

Business Dictonary. nd. http://www.businessdictionary.com/definition/social-good.html

Deltares. 2015. Recommendations on the Elbow River major infrastructure decisions. Submitted to Alberta Environment and Parks Resilience and Mitigation. October 2015.

Question 10

Volume 1, Section 2.2.1.3, Table 2-3, Page 2.13
Volume 3A, Section 17.4.1.5, Table 17-14, Page 17.25
Volume 3A, Section 17.4.1.5, Table 17-15, Page 17.26
Volume 4, Supporting Documentation, 1. IBI Report, Executive Summary, Page 2
Volume 4, Supporting Documentation, 1. IBI Report, Section 6.2.2, Exhibit 6.1, Page 35
Reference Document: Springbank Off-stream Storage Project, Preliminary Design Report (DRAFT), Stantec Consulting Services Ltd., March 31, 2017, Section 13.4, Page 200
Reference Document: Springbank Off-stream Storage Project, Preliminary Design Report (DRAFT), Stantec Consulting Services Ltd., March 31, 2017Appendix G Construction, Page 3112 of 3119.

Alberta Transportation states that *$372 million (including the estimated $60 million the government will recover from the sale of any surplus land purchased*…. (Volume 1), that *Project construction is estimated at $249 million* (Volume 3A), $291.7 million plus another $80 million for land costs (Volume 4), and a total cost opinion of *$279 million* (Reference Document).

a. Provide detailed final costs for the Project and clarify these discrepancies.

Response 10

a. The cost estimate provided in Volume 4, Supporting Documentation, Document 1 is consistent with the total cost provided by Stantec in Volume 1, Section 2, Table 2-3 ($372 million), which is the sum of $291.7 million capital cost plus $80 million for land. The capital cost opinion of $279 million (exclusive of land but including contingency) is an older figure presented in the Volume 3A, Section 17. The capital cost estimate has been updated to $312.2 million (additional details are presented in the response to IR17, Appendix IR17-1). The economic impacts analysis provided in the response to IR17, Appendix IR17-1, excludes contingency costs so it is based on a $280 million capital expenditure.

   The economic impacts analysis used in the preparation of Volume 3A, Section 17.4 used an earlier capital cost estimate of $249 million (plus land cost). This section has been updated using the updated cost of $312.2 million (plus land cost and is presented in the response to IR17, as Appendix IR17-1). The conclusions of the updated assessment of effects on employment and economy are that effects are positive.

Question 11

Volume 1, Section 2.2.2.2, Page 2.20
Volume 1, Section 3.2.1.2, Page 3.7

Alberta Transportation states on page 2.20 that Obermeyer Crest Gate's *inability to pass bedload during floods is partially mitigated with the addition of the adjacent sluiceway, which passes flow and sediment*. While on page 3.7 the sluiceway is not listed or described with the service spillway and its components.

a. Describe the sluiceway location and function.

Response 11

a. The sluiceway was considered in early iterations of the diversion structure's design but is no longer a component of the Project.

Question 12

Volume 1, Section 3.2.6, Pages 3.18
EIS Summary, Section 3.6.2.4, Page 3.24
Volume 1, Section 2.2.5, Pages 2.25

Alberta Transportation states *The conduit will discharge into an 18 m long energy dissipation basin to reduce the speed of the water entering the channel*.

Alberta Transportation also states that *The existing stream is undersized to handle the design peak discharge and, therefore, it would likely erode and scour during high discharges from the low-level outlet works.*

a. Assess potential accidents and/or malfunctions at the off-stream dam due to erosion and scouring of the existing stream channel.

Response 12

a. No accidents or malfunctions are anticipated at the off-stream dam due to erosion and scouring of the unnamed creek (existing stream channel).

   As noted in Volume 1, Section 2.2.5, Alberta Transportation anticipates there will be erosion and scouring of the existing unnamed creek as a result of planned discharge of flood water held in the off-stream reservoir. A conduit will be graded below the low-level outlet works to convey the release of water away from the toe of the dam into the existing unnamed creek, such that any erosion would not affect the infrastructure or operation of the dam. The outlet structure will direct flow into an 18 m long energy dissipation basin to reduce the speed of the water entering the unnamed creek.

Question 13

Volume 1, Section 3.3.8, Table 3-7, Page 3.32
Reference Document: Springbank Off-stream Storage Project, Preliminary Design Report (DRAFT), Stantec Consulting Services Ltd., March 31, 2017, Appendix G Construction, Pages 3109 to 3112

Alberta Transportation states *Temp Bridge Construction is scheduled to occur in May, June and July of 2019*.

Temporary bridge construction costs (installation and removal) are not included as a line item in the cost table.

a. Provide the construction costs of the temporary bridge installation and removal.

Response 13

a. The cost associated with the construction of the temporary bridge is not included in the overall Project construction costs. The final decision for the means, methods and costs of the temporary bridge are the responsibility of the successful construction contractor.

Question 14

Volume 1, Section 8.0, Page 8.1 to 8.3
Volume 4, Supporting Documentation, Section 8, Pages 8-1 to 8-7

Alberta Transportation references reports for the Project (Stantec) and for the MC1 alternative (from Opus) which are not included in the Supporting Documentation.

a. Provide the final report(s), as listed in Section 8.0, in the Supporting Documentation.

Response 14

a. See Table IR14-1

Table IR14-1 Additional Reports Related to the MC1 Option

Reference	Response
Opus (Opus Stewart Weir). 2017. McLean Creek (MC1) Dam: Updated conceptual design report - final; 2 volumes.	Appended to this response, as Appendix IR14-1.
Stantec Consulting Ltd. 2015. Springbank Off-Stream Reservoir (SR1) – conceptual design update. March 31, 2015. Internal memo	This reference was not directly cited in Volume 1 and was included in the Section 8 Reference list in error. This report is attached as Appendix IR14-2.
Stantec Consulting Ltd. 2016a. Springbank Off-Stream Reservoir Project. Canada Environmental Assessment Act project description. Prepared for Alberta Transportation	This reference is available at the Canadian Environmental Assessment Agency website, Document No.4. This report is attached as Appendix IR14-3.
Stantec Consulting Ltd. 2016b. Hazard classification – off-stream storage dam Springbank Off-Stream Reservoir Project (SR1). Internal memo.	This reference was not directly cited in Volume 1 and was included in the Section 8 Reference list in error. This report is attached as Appendix IR14-4.
Stantec Consulting Ltd. 2016c. Dam alignment and toe location relative to the Elbow River. Internal memo.	This reference was not directly cited in Volume 1 and was included in the Section 8 Reference list in error. This report is attached as Appendix IR14-5.
Stantec Consulting Ltd. 2017a. Breach analysis and inundation mapping. Springbank Off-Stream Reservoir (SR1). Internal memo	The breach analysis and inundation mapping memo will be included in Alberta Transportation's submission to AEP under the provincial Dam and Canal Safety Regulatory Framework on a confidential basis. The provincial dam safety regulator will have an opportunity to review that information, at that time.
Stantec Consulting Ltd. 2017b. Springbank Off-stream Storage Project Interim Design Report.	The Interim Design Report is still in draft as engineering investigation and designs are in the process of being advanced; therefore, it is not being provided. The finalized design report will be made available once complete. This report will be reviewed by the dam safety regulator at AEP prior to the NRCB hearing.
Stantec Consulting Ltd. 2018. Springbank Off-Stream Reservoir Project Environmental Impact Assessment. Canada Environmental Assessment Act. Canada Environmental Assessment Act effects assessment. Prepared for Alberta Transportation	This reference was included in the EIA Section 8 reference list in error. The reference refers to the EIA itself.

Question 15

Volume 1, Section 8.0, Page 8.3

Alberta Transportation references *Stantec Consulting Ltd. 2017b. Springbank Off-stream Storage Project Interim Design Report*, dated March 31, 2017 which is watermarked DRAFT and has no signature or stamp.

a. Provide a final (signed and stamped) version of this report.

b. Provide an updated concordance table with any report and EIA section changes if required.

Response 15

a-b. The Interim Design Report is still in draft as engineering investigation and designs are in the process of being advanced; therefore, it is not being provided. The finalized design report will be made available once complete. This report will be reviewed by the dam safety regulator at AEP prior to the NRCB hearing.

Question 16

Volume 3A, Section 4.3, Page 4.21
Volume 1, Section A.2.1.3, Page A.6

Alberta Transportation suggests that blasting may be required for the diversion channel, and that details on the blasting would be submitted by the contractor to Alberta Transportation.

Alberta Transportation states *If rock is encountered, it will be mechanically removed using rippers or pneumatic or hydraulic breakers. Blasting will not be permitted*.

a. Explain if bedrock is expected to be encountered during diversion channel excavation.

b. Provide details of permitting and requirements for blasting.

c. Clarify the depth of bedrock that can be removed using rippers or breakers.

d. If blasting is planned then explain:

  i. The additional noise effects of blasting on receptors.

  ii. The additional air quality effects of blasting (during wet and dry conditions) on receptors.

e. If blasting is not planned then explain:

i. **The noise effects of the bedrock excavation construction techniques (rippers and/or breakers).**

ii. **The air quality effects of the bedrock excavation construction techniques (rippers and/or breakers).**

Response 16

BACKGROUND INFORMATION

Alberta Transportation has not yet completed the detailed geotechnical analysis and final construction planning required to make a definitive determination as to whether blasting is required. Based on preliminary information from geotechnical investigations at the site completed to date, Alberta Transportation anticipates that all the bedrock encountered may be able to be removed using rippers and breakers. However, blasting is being retained as a possible option during construction if bedrock cannot be removed mechanically. As a conservative estimate for the purpose of responding to this information request, it is assumed that up to 60% of bedrock needing to be removed may require blasting.

a. Bedrock is expected to be encountered during diversion channel excavation. Approximately 1 million m^3 of bedrock will be excavated during construction.

b. If it is determined that blasting is necessary (i.e. mechanical ways of removing bedrock are not viable), up to 600,000 m^3 of the bedrock may require blasting during excavation (i.e., the 60% assumption above). The average daily excavation rate of bedrock is 15,000 m^3 per day. Bedrock excavation is expected to occur over a nominal 70-day period. If required, blasting is anticipated primarily to be used in areas of deeper-lying bedrock. If blasting is required, the Contractor will be required to hold a valid blasting permit issued by the Alberta Government, Occupational Health and Safety.

c. Based on information from geotechnical investigations at site, Alberta Transportation anticipates that all the bedrock encountered can be removed using rippers and breakers because conventional excavation equipment is viable to the full depth of channel excavation. However, blasting has been retained as an option during construction if bedrock cannot be removed mechanically.

d. i. Although it was stated that "blasting may occur during the Project construction" (Volume 3A, Section 4.4, page 4-21), Alberta Transportation is not expecting to use blasting as a means of removing bedrock. If there are no other viable means of removing bedrock, then blasting may be considered. Blasting air overpressure and vibration are short duration events that tend to have a negligible effect on the day-night average sound level (L_{dn}) used to evaluate the noise effect. Air overpressure effects commonly occur in the low frequency part of the audible frequency spectrum and may or may not be audible. Ground vibration may be perceptible but not audible. The most applicable guidelines are from Environment Canada (2009) and Health Canada (2017). Environment Canada defines a threshold of 12.5 mm/s for ground vibration and an air overpressure threshold of 128 linear decibel level (dBL); Health Canada recommends an air overpressure threshold of 125 dBL for a single blast per day. If blasting is required, the construction contractors' blast design will be developed using air overpressure and vibration prediction models to meet these thresholds.

ii. In areas of blasting, a pattern of holes will be drilled into the rock each day. The holes are filled with an ammonium nitrate/fuel oil (ANFO) explosive and detonated. Assuming average bedrock breakage difficulty, it is estimated that 0.26 kg of ANFO will be required per m^3 of bedrock (U.S. Department of the Interior Bureau of Reclamation 2001). Based on the assumption of blasting 60% of bedrock that needs removal, it is estimated that 156 tonnes of ANFO will be required for bedrock blasting over the 70-day period, or approximately 2.2 tonnes of ANFO per day.

Blasting results in emissions of gases, including nitrogen oxide (NO_X), carbon monoxide (CO), and sulfur dioxide (SO_2), as well as particulate matter (Australian Government 2012). Modern blasting techniques typically use bulk emulsion explosives due to improved water resistance, increased reliability, and better energy distributions (Australian Government 2012). In terms of emissions, ANFO emulsion formulations allow for close to optimum combustion, which reduces NO_X and CO formation when compared to conventional ANFO (Budin 2009; Rowland et al. 2001; Sapko et al. 1999).

Emission rates associated with blasting are estimated from Australian Government (2012). Alberta Transportation has selected the emission factor that corresponds to drill hole diameters greater than 6 inches because the drill hole diameter is not yet known and the respective NO_X and CO emission factors are the largest. Emission factors are presented in Table IR16-1. Low sulphur diesel fuel in the bulk ANFO emulsion explosive will also be used, and the SO_2 emission factor has been adjusted to reflect this. The SO_2 emission factor is based on a maximum estimate of 8% diesel fuel in the bulk ANFO emulsion explosive (Australian Government 2012) and the maximum sulphur content in low-sulphur diesel fuel (15 parts per million (ppm)). Emission rates of CO, NO_X and SO_2 associated with blasting are calculated based on the average daily explosive usage rate of 2.2 tonnes/day during the 70-day excavation period.

Updated construction emissions, including blasting emissions, are listed in Table IR16-2. The inclusion of blasting emissions increases construction daily average emissions by 0.56%, 0.14%, 3.2%, 2.3%, 0.84% and 0% for NO_X, SO_2, CO, particulate matter less than 2.5 micrometers in diameter ($PM_{2.5}$), total organic content (TSP) and volatile organic compound (VOC), respectively. The inclusion of blasting emissions increases construction annual average emissions by 0.14%, 0.037%, 0.84%, 0.49%, 0.17% and 0% for NO_X, SO_2, CO, $PM_{2.5}$, TSP and VOC, respectively.

The addition of blasting emissions results in a small increase in estimated daily and annual emissions during construction, ranging from 0% to 3.2%. This small increase in emissions is not anticipated to result in a material change to the air quality model predictions and does not change the conclusion that the overall residual effect for air quality is not significant.

Table IR16-1 Construction Blasting Emissions

Pollutant	Emission Factor (kg/tonne of ANFO) [c]	Blasting Emission Rate (kg/d)	
		Daily Average [a]	Annual Average [b]
NO_X	3.8	8.5	1.6
CO	21	47	9.0
SO_2	0.0024	0.0053	0.0010
$PM_{2.5}$	5.1	11	2.2
TSP	51	114	21.8

NOTES:
[a] Daily emission rates are based on maximum daily blasting emission during the 70-day nominal excavation period.
[b] Annual emission rates are based on scaled (reduced) emission rates over one-year.
[c] Emission factors from Australian Government (2012; Table 7, Appendix C).

Table IR16-2 Updated Construction Emission Rates

Emission Source	Daily Emission Rates [a] (kg/d)						Annual Emission Rates [b] (kg/d)					
	NO_X	SO_2	CO	$PM_{2.5}$	TSP	VOC	NO_X	SO_2	CO	$PM_{2.5}$	TSP	VOC
Diesel exhaust emissions from off-road equipment	1,524	3.9	1,450	83.8	86.4	124	1,134	2.8	1,074	62.6	64.5	93.0
Fugitive dust emissions from bulldozing and grading	—	—	—	36.9	351	—	—	—	—	20.3	193	—
Fugitive dust emissions from off-road equipment in transition	—	—	—	4.4	154	—	—	—	—	1.9	67.6	—
Fugitive dust emissions from material loading and unloading	—	—	—	5.8	80.9	—	—	—	—	5.2	71.9	—
Fugitive dust emissions from truck traffic on haul roads	—	—	—	368 [c]	12,875[c]	—	—	—	—	356 [c]	12,476[c]	—
Fugitive dust emissions from wind erosion [d]	—	—	—	0.728[e]	6.1 [e]	—	—	—	—	0.728 [e]	6.1[e]	—
TOTAL emissions (EIA)	1,524	3.9	1,450	499	13,554	124	1,134	2.8	1,074	447	12,879	93
Blasting Emissions	8.5	0.0053	47	11	114	-	1.6	0.0010	9.0	2.2	21.8	-
Percent Increase (%)	0.56%	0.14%	3.2%	2.3%	0.84%	0.0%	0.14%	0.037%	0.84%	0.49%	0.17%	0.0%
TOTAL emissions (Updated)	1,532	3.9	1,497	510	13,668	124	1,136	2.8	1,083	449	12,901	93

NOTES:

[a] Daily emission rates are based on maximum hourly emission rates and the work hours per day for each activity

[b] Annual emission rates are based on scaled (reduced) hourly emission rates and the work hours per day for each activity

[c] Daily emission rates for haul roads represent emissions during summer with applied dust control efficiency (75%) corresponding to water application twice daily

[d] Wind erosion emissions represent emissions at hourly average wind speed greater than 10.8 m/s. At wind speeds less than 10.8 m/s, no wind erosion emissions are generated.

[e] Annual emission rate estimated based on 0.37% probability of hourly average wind speed greater than 10 m/s, taken from CALMET for the location of the temporary topsoil and overburden stockpile.

e. i. Based on the conservative assumption that 60% of bedrock will be blasted, the 400.000 m^3 of rock excavation not requiring blasting will employ a hydraulic excavator. The excavation will operate for 11 hours per day, considering downtime, shift changes, and maintenance. There will be 6.9 hours of operation during daytime and 4.1 hours during nighttime. Two bedrock zone areas are expected to be excavated. The entire excavation activities will take approximately 70 days.

Based on the bedrock zone locations, the closest noise receptor is SR20, approximately 360 m from the excavation activity. SR20 is a rural residence adjacent to Township Road 242. The noise emission level of the hydraulic excavator is estimated to be 117 dBA sound power level. The noise model predicts the day-night equivalent sound level (L_{dn}) will be 53.3 dBA at SR20, which is below the Health Canada prescribed MNL of 57 dBA for activities less than two months duration. Other receptors, both Indigenous and non-Indigenous people, located at a farther distance from the excavation, will have less noise effect from the activities and will result in compliance with the MNL.

ii. Emissions associated with bedrock excavation activities using hydraulic excavators have already been included in the emission inventory in the form of diesel exhaust emissions from excavation; hauling equipment; and fugitive dust associated with movement of heavy equipment, bulldozing and grading, material loading and unloading, and haul trucks (Volume 4, Appendix E, Attachment 3A, Section 3A.3.2.). There are no changes to the predicted air quality effects on receptors and no changes to the conclusion that the overall residual effect for air quality is not significant.

REFERENCES

Australian Government. 2012. National Pollutant Inventory, Emission Estimation Technique Manual for Explosives detonation and firing ranges, Version 3.0, January 2012

Budin, Matt. 2009. The Benefits of Bulk Emulsion Explosives in Underground Applications through String Loading, Presented at the Society of Mining Engineers 2009 Conference. Denver, Colorado.

Environment Canada. 2009. Environmental Code of Practice for Metal Mines. 1/MM/17 Mining Section Mining and Processing Division Public and Resources Sectors Directorate Environmental Stewardship Branch Environment Canada. Ottawa, Ontario.

Health Canada. 2017. Guidance for Evaluating Human Health Impacts in Environmental Assessment: Noise, Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Ontario.

U.S. Department of Interior Bureau of Reclamation. 2001. Engineering Geology Field Manual. Second Edition. Volume II. Chapter 19: Blast Design. https://www.usbr.gov/tsc/techreferences/mands/geologyfieldmanual-vol2/Chapter19.pdf

Rowland JH, Mainiero RJ, and DA Hurd. 2001. Factors affecting fumes production of an emulsion and ANFO/emulsion blends. In: Proceedings of the 27th Annual Conference on Explosives and Blasting Technique. Orlando, FL: International Society of Explosives Engineers.

Sapko M, Rowland J, Mainiero R, Zlochower I. 1999. Chemical and Physical Factors That Influence NOx Production During Blasting-Exploratory Study. In Proceedings of The Annual Conference on Explosives and Blasting Technique, 2002 Feb 10 (Vol. 2, pp. 317-330). ISEE; 1999.

Question 17

Volume 3A, Section 17.4.1.2, Page 17.24
Reference Document: Springbank Off-stream Storage Project, Preliminary Design Report (DRAFT), Stantec Consulting Services Ltd., March 31, 2017, Section 13.3.3, Page 200

Alberta Transportation states that *cost estimates considered the conceptual designs presented in Stantec (2017)* and that *cost estimates are considered Class D (accurate to within +/-50%) (Volume 3A)*.

Alberta Transportation states in the reference document that a *contingency factor of 15% is utilized at this point in the process to reflect the level of study and knowledge that is possessed currently*.

a. Explain why a cost contingency factor of 15% is appropriate for the Project if the cost estimates are +/-50%.

b. Update the cost contingency factor percentage and/or the cost estimate percentage for the Project.

Response 17

a. The 15% contingency factor is appropriate because that is consistent with the accuracy level of the Alberta Transportation Class B cost estimate (level of accuracy is +/- 15%) (GoA 2011), which is the cost accuracy level available for the EIA. Volume 3A, Section 17.4.1.2 has been updated to indicate that the cost estimates provided are accurate to an Alberta Transportation Class B level of accuracy (+/- 15%) rather than Class D level of accuracy (+/- 50%). The updated Volume 3A, Section 17.4 is provided as Appendix IR17-1.

b. The cost contingency factor, which is currently based on 15% of the estimated construction cost does not need to be updated, because this is based on the current Class B cost estimate undertaken for the Project.

REFERENCES

GoA (Government of Alberta). 2011. Engineering Consulting Guidelines for Highway, Bridge, and Water Projects. Volume 2 – Design and Tender. Available at: https://www.alberta.ca/engineering-consultant-guidelines-highway-bridge-water-vol-1-design-and-tender.aspx

Question 18

Volume 3B, Section 17.3, Tables 17-4 to 17-6, Pages 17.8 to 17.10
Volume 3B, Section 17.7, Page 17.12
Volume 4, Supporting Documentation, 1. IBI Report, Section 5.2, Page 34
Volume 4, Supporting Documentation, 1. IBI Report, Section 5.1.1, Page 27
Volume 4, Supporting Documentation, 1. IBI Report, Section 5.1.2, Page 31

Alberta Transportation states *Upstream protection to the 1:200-year level on the Elbow River results in a reduction of $27.7 million in AAD from the existing mitigation amount*.

The data in Tables 17-4 to 17-6 are not included in the referenced reports.

a. Provide the report source for the data in Tables 17-4 to 17-6.

b. Provide information detailing the calculation of the $27.7 million AAD in Section 5.2, similar to the information detailed in the 2017 IBI Report section 5.1.1 and 5.1.2.

Response 18

a. The report source for the data in Table 17-4 to 17-6 is the City of Calgary damages database, Scenarios 1 and 2 (Volume 4, Supporting Documentation, Document 1).

b. The following table summarizes the calculation of the $27.7 million reduction in average annual damage (AAD) on Elbow River due to benefits of the Project.

Table IR18-1 Reduction of Annual Damage due to the Project (SR1)

Damage Category	Scenario			Reduction (B - C)
	Unmitigated (A)	Existing (B)	SR1 (C)	
Direct Structural	$23,272,489	$20,989,147	$7,659,297	$13,329,850
Non-Res Disruption	$7,169,299	$6,364,328	$1,782,575	$4,581,753
Res Displacement	$1,123,697	$1,002,985	$402,961	$600,024
Intangibles	$5,794,648	$3,830,222	$1,796,937	$2,033,285
Infrastructure	$7,625,821	$7,038,429	$1,419,579	$5,618,850
Traffic	$504,191	$489,750	$110,389	$379,361
Habitat Restoration	$209,596	$172,963	$93,730	$79,233
Emergency Operations	$1,412,324	$1,206,093	$318,779	$887,314
Waste Disp.	$395,632	$356,815	$130,208	$226,607
Total	$47,407,695	$41,450,721	$13,714,456	$27,736,266

Question 19

Volume 3D, Section 1.2.2, Page 1.2

Alberta Transportation states *failure or breach of the service spillway, auxiliary spillway, or flood plain berm during flood operations as a result of electrical or design failure of the diversion structure*.

While the potential of electrical failure at the service spillway is listed as an item to be discussed, potential electrical failure at the diversion inlet is not included in this list. Other sections of the EIA contain details on the potential malfunctions of electrical failure on the diversion structure.

a. Describe the failure or breach of the service spillway, diversion inlet, auxiliary spillway, or flood plain berm during flood operations as a result of an electrical failure at the service spillway and the diversion inlet.

i. Include failure of service spillway to be raised (left, right or both sides) and failure of the diversion inlet gates to be raised (left, right or both gates).

ii. Discuss time implications (and associated flood water volumes passing downstream of the service spillway) arising from an electrical failure at the time the service spillway and diversion inlet would be activated to divert flood waters for the 1:100 and 2013 floods.

Response 19

a. Electrical failure of the diversion inlet or the service spillway would not result in a failure or breach of the service spillway, diversion inlet, auxiliary spillway, or floodplain berm.

   Backup power supply is provided to the control building and gate systems with an on-site generator. A generator receptacle mounted to the exterior of the control building will be available to plug in a portable generator in the event that utility power is unavailable and the backup generator fails to run. A manual transfer switch will be designed into the system for operators to control the source of generator power. Further details on the backup power supply for the gates can be found in the response to IR458.

   i. If all power supplies and backups fail, loss of power will have varying impact on the operation of each of the following structures.

      DIVERSION INLET

      If the diversion inlet gates are closed, flows will remain in the Elbow River and continue downstream and impacts to downstream areas will be the same as impacts without the Project. The design of the service spillway and auxiliary spillway capacity for the inflow design flood (IDF) assume that the gates are closed and, thus, have sufficient capacity to pass without overtopping or breach of the floodplain berm.

      If the diversion inlet gates are open, the gates may be lowered under their own weight through release of the hoist break. During this period with gates open and a corresponding flood that exceeds the capacity of the off-stream reservoir, an emergency spillway is provided along the channel to pass excess flows and prevent breach. No impacts are anticipated downstream because flow within Elbow River downstream would be the same with or without a failure.

      SERVICE SPILLWAY

      If the service spillway gates are open (lowered), the gates may be raised through use of an external gas-powered air compressor that connects with an external connector to the Obermeyer pneumatic bladder system.

      During the period with gates open, diversion flows may not match the target operation levels. Excess flows downstream will be stored by Glenmore Reservoir up until the excess capacity within Glenmore is exhausted. Should the external gas-powered air compressor fail and the backup power systems remain down, flows downstream will be equal to conditions without the Project. This would not result in a potential breach scenario.

If the service spillway gates are closed (raised) when an electrical failure occurs, the air bladders may be lowered by releasing air from the Obermeyer pneumatic bladder system manually through air release valves. This would lower the gates under the weight of the water and enable the passage of flows downstream.

ii. The Project relies on both the off-stream reservoir and Glenmore Reservoir to provide flood protection for the design flood. Glenmore Reservoir has a reserve capacity of 10,000 dam^3 for flood storage at the start of a flood event.

If the occurrence of a power failure of both primary and back-up systems results in the prevention of flood diversion into the off-stream reservoir, Glenmore Reservoir will provide storage of flood flows until power is restored.

For the 1:100 year flood, it is estimated that Glenmore Reservoir could provide storage for up to 11 hours before its capacity is exhausted. At that time, diversion into the off-stream reservoir would need to be operational to maintain flood flows downstream of Glenmore Reservoir to 160 m^3/s.

For the design flood, it is estimated that the available reserve storage in Glenmore Reservoir would be exhausted within approximately five hours of the beginning of a flood. At that time, diversion into the off-stream reservoir would need to be operational to maintain flood flows of 160 m^3/s downstream of Glenmore Reservoir.

Question 20

<u>Volume 3D, Section 1.6.2, Page 1.31</u>

Alberta Transportation states *Floodplain berm/diversion structure (f)ailure or breach would result in similar effects to VCs relative to an unmitigated flood (in the absence of the Project), including inundation of surrounding areas, as well as commercial property; however the effects are predicted to be short term (approximately 30 minutes).*

a. Clarify how an unmitigated flood (in absence of the Project) has predicted short term effects of approximately 30 minutes. Include the flood effects of:

i. the volume (and flow rate) of water held behind the floodplain berm/diversion structure at one moment in time; and

ii. the volume (and flow rate) of water that would flow through a failed floodplain berm/diversion structure from the time of failure until the end of the flood.

Response 20

a. The time period of 30 minutes does not refer to the duration of flooding for an unmitigated flood. Rather, the 30 minutes is predicted duration when downstream flows during a breach scenario of the floodplain berm would exceed the downstream flows for a flood without a breach.

The 30-minute period was determined based on hydraulic modelling of floods with and without a breach of the floodplain berm. The area affected is downstream of the floodplain berm. The statement "…would result in similar effects…" refers to similarity of effects on valued components due to any flood. The magnitude of effects from a breach of the floodplain berm, however, is anticipated to be substantially less than flood conditions without the Project, given the relatively lower flow (as further indicated in response to part ii below).

i. The volume behind the floodplain berm measured from its crest height of 1,221.5 m is 2,920 dam^3. This volume may be temporarily stored behind the berm during flood operations, and it would be released on the receding portion of the flood as the diversion gates are closed and the service spillway is lowered to the fully open position. When passing the inflow design flood (IDF), the excess flow passes through the service spillway and over the auxiliary spillway to limit the increase in backwater from the floodplain berm. The anticipated spatial extent of backwater created by the floodplain berm is roughly the same area as anticipated during an IDF without the Project. Backwater created by the floodplain berm when passing the IDF remains in the PDA. Therefore, effects on valued components are similar, but of a lesser magnitude, than from an IDF without the Project.

ii. Should the floodplain berm breach when passing the IDF, the breached water would increase flow immediately downstream of the floodplain berm by approximately 12% of the IDF (from 2,770 m^3/s to 3,103 m^3/s). This is estimated to increase water height by approximately 20 cm for the anticipated 30 minutes duration. The anticipated spatial extent of breached water remains close to the area of flooding from an IDF without the Project. Therefore, effects on valued components are similar, but of a lesser magnitude, than from an IDF without the Project.

Question 21

Volume 4, Supporting Documents, 1. IBI Group Report, August 2017, Page 1
Volume 4, Supporting Documents, 1. IBI Group Report, August 2017, Exhibit 4.1, Page 11
Volume 4, Appendix E, Attachment 3A, Section 3A.3.1, Page 3A.11
Reference Document: McLean Creek (MC1) Dam, Updated Conceptual Design Report – Final – Vol 1 of 2, Opus Stewart Weir, August 23, 2017
Section 10.3.1, Page 51
Appendix A, Page 97 of 134

Alberta Transportation provides the costs of the *Off-Stream Storage Dam* as *$38,643,000*.

Alberta Transportation states *Earth material for the construction of the off-stream dam will be borrowed primarily from the diversion channel excavation (4.75 million m³). Additional earth material (1.09 million m³) will be borrowed from a designated are within the PDA (Borrow Area 1)*.

Alberta Transportation states *the estimated 4.5 million m³ of dam earthworks.*

Alberta Transportation states in Appendix A that the *SUB-TOTAL, MAIN DAM $98,699,300.*

The Project dam and the MC1 dam require a similar volume of earthworks for construction of an earth fill dam.

a. Explain the cost difference between the Project dam ($38 million) and the cost of the MC1 dam ($98 million).

Response 21

a. The two key differentiators for the cost between the dams are 1) the sources of borrow material for construction of the embankments varies and is accounted for differently in the construction estimates (so the $38 million and $89 million referenced in the information request are not an appropriate comparison) and 2) the MC1 Option dam requires a significant foundation treatment program to control seepage, and SR1 does not.

   There are the following additional considerations:

   - An updated cost opinion for SR1 is provided in response to IR35 as Appendix IR35-2. The costs associated with earthworks ($38 million) has not changed since filing the EIA.

- An updated cost opinion for the MC1 Option is provided in response to IR35 as Appendix IR31-1. Through the update and review, further construction staging and unit price refinement resulted in an updated MC1 Option cost. The earthworks portion of the MC1 Option is now estimated at $89 million rather than the $98 million indicated in Appendix A of Volume 4, Supporting Documentation, Document 1.
- The costs for SR1 are based upon preliminary designs, whereas the costs for the MC1 Option are based upon less accurate conceptual design.

Additional discussion on the borrow costs for dam construction and the foundation treatment program follow.

BORROW COSTS FOR DAM CONSTRUCTION

The cost estimates for the construction of SR1 and the MC1 Option presented the excavation, hauling and placement of fill for dam construction in different line items. For SR1, dam fill will be largely sourced from the diversion channel excavation. Borrow costs for SR1 fill materials are included in the line item for excavation and haul costs for the diversion channel and not in the line item for the SR1 dam costs. The borrow costs and placement costs for the MC1 Option are included in MC1 Option dam costs.

Details of the costs for excavation of SR1 diversion channel are provided in the response to IR35, as Appendix IR35-2, rows 159 and 160, which includes the excavation and hauling of 4.1 million cubic metres of material from the diversion channel to the dam, for a total cost of approximately $40 million. Adding these excavation and hauling costs to the SR1 dam cost brings the total cost to construct the SR1 dam to approximately $79 million ($40 million for diversion excavation material + $39 million (rounded up from $38.6 million).

FOUNDATION TREATMENT PROGRAM

Foundation treatment for the MC1 Option for under seepage control requires the construction of a plastic concrete cut-off wall 42 m deep on the left abutment, soil/slurry cut-off walls in the right abutment, and grouting within the bedrock under the dam footprint. The costs for these activities are approximately $28 million.

SUMMARY

SR1 does not require foundation treatments to control seepage. Therefore, after accounting for the difference in how borrow costs are treated between the two projects, the balance of the difference in costs between SR1 and the MC1 Option is due to the additional $28 million required for the cut-offs and grouting for the MC1 Option.

Table IR21-1 shows how the two projects compare.

Table IR21-1 SR1 and MC1 Option Earthworks Components

Dam Earthworks Component	MC1 Option Dam	SR1 Dam
Foundation Treatment Program	$28 M	$0 M (not required)
Dam Fill Costs	$61 M (includes costs for borrow and placement)	$79 M (includes $39 M for fill placement plus $40 M for diversion channel excavation and hauling)
Total	$89M	$79 M

As can be seen in Table IR21-1, once differences in how borrow costs are accounted for between SR1 and the MC1 Option cost estimates, the relative costs are comparable given that SR1 has been developed to a preliminary level of design, and the MC1 Option is still at the concept level of design.

Question 22

Volume 4, Supporting Documentation, 1. IBI Report, Page 2

The Treasury Board of Canada recommends the application of a discount rate of 8% for regulatory interventions and 3% for the evaluation of social goods (enviro/human health, etc.)

a. **Describe how the discount rate of 4% was selected and indicate if the 4% real rate is intended to reflect the time value of money, risk, or both.**

b. **Provide a sensitivity analysis of the real discount rate ranging between 3% and 8%.**

Response 22

a. The discount rate reflects the risk and time value of money from the perspective of the Government of Alberta. The default discount rate in 2014 for all of Alberta Transportation projects was 4%. In 2014, inflation was low (Alberta Consumer Price Index of 2.6% (2014) and 1.1% (2015)), reducing the time value of money costs. As a result, a low discount rate of 4% was used. Also, it has long been the practice of Alberta Transportation to use a 4% discount rate for projects.

The use of a 4% discount rate for this public project is further supported by Weitzman (2001), wherein 2,800 Ph.D.-level economists were surveyed, asking what rate should be used to discount the expected benefits and costs of projects being proposed to mitigate possible effects of climate change. Out of 2,160 responses, the mean rate was 4%.

The Treasury Board of Canada's *Canadian Cost-Benefit Analysis Guide: Regulatory Proposals* recommends a discount rate of 8% for regulatory interventions, based on the weighted average of the rate of return on postponed investment, the rate of interest on domestic savings, and the marginal cost of foreign capital. The rate is from The Economic Opportunity Cost of Capital for Canada – An Empirical update (Jenkins 2007). However, since that publication, rates have declined significantly for these measures. For example, Jenkins states that they assume the average yield of long-term Government of Canada Bonds will remain around 5.25% with an inflation rate at 2%. However, in 2018 the average yield of such a bond is around 2.26%. (Bank of Canada, government of Canada Benchmark Bond Yields – 10 year)[1]. The current recommended opportunity cost value has been challenged as being too high (Boardman 2010).

The recommended 3% rate for evaluation of social goods is the social time preference rate, which is based on the rate at which individuals discount future consumption and the projected growth rate in consumption. Social discount rates are controversial. The current Treasury Board Policy on Cost-Benefit Analysis states that the lower 3% social discount rate is more appropriate when the impacts occur over 50 years or more[2].

There are enough opinions in the literature to justify any range of rates, particularly because a 100-year benefit/cost analysis for flood damage reduction involves many considerations, including opportunity costs and intergenerational benefits.

b. A number of variables used in the August 2017 benefit cost analysis have changed since its submission in Volume 4, Supporting Documentation, Document 1, including the timing of costs and benefits. As a result, an updated 2019 benefit cost analysis is provided in the response to IR 6, Appendix IR6-1.

The following tables provide the requested sensitivity analysis. The results are shown for both the 2017 analysis (Volume 4, Supporting Documentation, Document 1) and the 2019 analysis (Appendix IR6-1). The 2019 analysis includes costs from 2019 onward, as described in Appendix IR6-1.

[1] https://www.bankofcanada.ca/wp-content/uploads/2010/09/selected_historical_v122543.pdf
[2] https://www.canada.ca/en/treasury-board-secretariat/services/federal-regulatory-management/guidelines-tools/policy-cost-benefit-analysis.html

Table IR22-1 Present Values Assuming a 4% Discount Rate

Indicator	2017 analysis		2019 analysis	
	SR1	MC1 Option	SR1	MC1 Option
PV Benefits	$653,008,000	$578,997,000	$591,610,000	$481,467,000
PV Costs	$388,943,000	$402,999,000	$432,258,000	$340,832,000
Net Present Value	$264,065,000	$175,998,000	$159,352,000	$140,635,000
Benefit/Cost Ratio	1.68	1.44	1.37	1.41

Table IR22-2 Present Values Assuming a 3% Discount Rate

Indicator	2017 analysis		2019 analysis	
	SR1	MC1 Option	SR1	MC1 Option
PV Benefits	$849,507,000	$773,337,000	$786,445,000	$670,132,000
PV Costs	$397,178,000	$426,160,000	$454,834,000	$375,402,000
Net Present Value	$452,329,000	$347,177,000	$331,611,000	$294,730,000
Benefit/Cost Ratio	2.14	1.81	1.73	1.79

Table IR22-3 Present Values Assuming an 8% Discount Rate

Indicator	2017 analysis		2019 analysis	
	SR1	MC1 Option	SR1	MC1 Option
PV Benefits	$320,864,000	$254,680,000	$265,527,000	$177,997,000
PV Costs	$372,131,000	$344,903,000	$379,875,000	$249,895,000
Net Present Value	-$51,267,000	-$90,223,000	-$114,348,000	-$71,898,000
Benefit/Cost Ratio	0.86	0.74	0.70	0.71

Question 23

<u>Volume 4, Supporting Documentation, 1. IBI Report, Section 3.3.1.1, Page 10, and Exhibits 3.5, 3.6 and 3.7</u>

The IBI report includes a "Triple Bottom Line" analysis.

a. Explain the rationale for analyzing SR1 but excluding MC1 from the Triple Bottom Line analysis.

b. Explain how the triple bottom line analysis of the 12 mitigation scenarios were used to compare SR1 and MC1.

Response 23

a. The triple bottom line analysis was completed for the City of Calgary Flood Mitigation Options Assessment report dated February 2017 (see Appendix IR23-1). This analysis included many scenarios, each with a variety of mitigation measures. A major component of the assessment was an estimate of the damage reduction value for each of the mitigation scenarios. One of these scenarios included an upstream storage facility on Elbow River, upstream from Calgary. This facility was the only mitigation on Elbow River in this scenario, and it is assumed to be SR1. However, the level of protection and assessment results would have been the same if it was assumed to be MC1 Option because the scope of the assessment was limited to the City of Calgary.

   The City of Calgary Flood Mitigation Options Assessment report is the source of the benefits (flood damages averted) to Calgary for both SR1 and the MC1Option in the benefit/cost analysis provided in Volume 4, Supporting Documentation, Document 1. The omission of MC1 from the City of Calgary Flood Mitigation Options Assessment analysis has no impact on the comparison of the two projects in the benefit/cost analysis.

   Note that the additional benefits that the MC1 Option may provide upstream of the City of Calgary have been estimated and included in an updated benefit/cost analysis (see the response to IR35, Appendix IR35-1)

b. The triple bottom line analysis was not used to compare SR1 and the MC1 Option. SR1 was included as an upstream storage option for Elbow River and, as such, the MC1 Option would have yielded the same benefits had it been included. As stated in the response to a., the source for the estimate to the benefits to Calgary for both SR1 and the MC1 Option is in Volume 4, Supporting Documentation, Document 1.

Question 24

Volume 4, Supporting Documentation, 1. IBI Report, Exhibit 5.9

The table shows total estimated average annual damages under the existing mitigation scenario at $116,579,000 million.

The $116.6M is broken down to the Bow River $57,128,000 and the Elbow River at $41,451,000, totaling $98,579,000.

a. Explain the discrepancy in the totals.

Response 24

a. The value for Bow River is not correct. The correct value is $75,128, 000. This change has no impact on the analysis or any results.

Question 25

Volume 4, Supporting Documentation, 1. IBI Report, Section 4.1.2.2, Page 12-13.

Alberta Transportation states *for the purpose of the benefit/cost analysis, it is assumed that the land (residual) and improvements acquired outside the Project Perimeter would be re-soild at comparable values (acquisition prices)*. The possibility of injurious affection suggests a potential differential between the purchase and resale of land.

a. Provide justification for the assumption that the market value for land will be unchanged between the purchase and resale of land after affected portions are removed.

b. If a price differential is anticipated, adjust the benefit/cost analysis accordingly.

Response 25

a. A number of variables used in the 2017 Benefit/Cost Analysis have changed since its submission (see Volume 4. Supporting Documentation, Document 1). The 2017 benefit/cost study assumed that any residual land acquired outside the PDA could be resold and the land within the PDA leased for compatible uses. These cost have not been considered in the 2019 Benefit/Cost Analysis because the assumption has since changed on the value of lands. Available lands on the periphery of the PDA may be sold following the construction of the Project Interim updates on cost may be provided as the Project advances through regulatory approval. However, to address the question, the following response is provided in relation to the 2017 Benefit/Cost Analysis provided in the EIA (Volume 4, Supporting Documentation, Document 1).

The following points are pertinent to the potential value of the lands, which could be acquired over and above the minimal required acreage for the Project, and therefore should be considered in the overall land cost analysis for this Project.

- The basic land and improvement valuation for the Project includes the assumption that most of the lands will likely be expropriated or acquired under the imminent possibility of expropriation by the Alberta Transportation.
- The valuation of all full quarter sections is predicated on the inclusion of the “first parcel out” subdivision opportunity afforded to private landowners under the prevailing planning legislation.
- The agricultural and country residential land markets tend to show a high correlation of land price expressed on a per acre basis to overall land size. Generally, the larger the parcel, the lower the overall price per acre it will command. Conversely, the smaller the parcel, the higher the price per acre it will usually realize.
- The vast majority of the residual parcels, considered in the larger scale of overall property acquisition involving some 6,500 acres, will result in titled acreages of less than 160 acres, and in many cases, much less than 160 acres. On the basis of size alone, this would suggest that the remnant parcels will carry a higher value per acre than the parent parcel they were created from.
- It is assumed that the residual parcels will retain the same designated land use as the initial parent parcels from which they were subdivided. Therefore, they will have the same general highest and best use.
- Under an agricultural regime, these residual parcels would allow for the construction of a single-family residence and related outbuildings for agricultural purposes.
- On the assumption that the residual parcels have the ability to be legally accessed and serviced (as more appropriately detailed within the cost benefit analysis), they have the potential to carry a higher price per acre than that which was ascribed to the parent parcel they were created from.
- Furthermore, from a locational standpoint, most of the residual parcels will have direct interface with open space that constitutes the off-stream reservoir proposed for the Project.
- Given there can be no permanent development within the off-stream reservoir, the residential qualities of the residual parcels would be of an above average nature.
- The possibility of delineating the off-stream reservoir from the residual parcels, by way of providing an access road to the various residual properties, could also be considered.

On the basis of the preceding, it is reasonable to assume that the costs to acquire the residual parcels at the time of overall acquisition have the potential to be materially recovered through the re-sale of the residual parcels as envisioned, under the same land use designation and highest and best use, which currently exists. This process may involve additional expenditure in terms of constructing rural roads that delineate the off-stream reservoir, which could also prove to be a benefit for maintenance and safety issues.

b. Given the response to a., this issue is not applicable.

Question 26

Volume 4, Supporting Documentation, 1. IBI Report, Section 4.1.2.9.1, Page 19

Alberta Transportation states *Due to a lack of full access to parcels and information, IBI Group was unable to take into account potential losses in income from cell phone towers, oil and gas wells, or other parcel specific sources of income*.

a. Confirm that there are no current oil or gas wells that will be impacted by the Project.

b. Provide the results of discussions with mineral rights holders about the Project.

Response 26

a. A review of current oil and gas wells registered with the Alberta Energy Regulator (AER) does not show any oil or gas wells located within the PDA; therefore, no current oil and gas wells will be impacted by the Project.

b. The only land title that has mineral rights associated with it (originally identified as within the PDA) is 97N204 which has all mines and mineral rights for the northwest quarter of Section 17, Township 24, Range 3 West of the 5 Meridian, issued in October 1954. Due to refinement of the Project requirements this section is now outside the PDA. Alberta Transportation has not had discussions with the landowner specific to mineral rights on this land.

REFERENCES

Alberta Energy Regulator (AER): ST37: List of Wells in Alberta Monthly Updates. Last accessed on October 1, 2018. Accessed via website: https://www.aer.ca/providing-information/data-and-reports/statistical-reports/st37

Question 27

<u>Volume 4, Supporting Documentation, 1. IBI Report, Exhibit 4.12, Page 22</u>

The text preceding Exhibit 4.12 states that the *...total potential leaseback income for the Project Perimeter is $1,392,000 per year*. However, the total potential income presented in the table is $714,620.

a. Explain the income discrepancy.

Response 27

BACKGROUND INFORMATION

A number of variables used in the 2017 Benefit/Cost Analysis have changed since its submission (see Volume 4, Supporting Documentation, Document 1). The updated 2019 Benefit/Cost Analysis has been provided in the response to IR6, Appendix IR6-1. The lease of land has been removed from the assessment of SR1 costs in the 2019 Benefit/Cost Analysis. To address the question, the following response is provided in relation to the 2017 Benefit/Cost Analysis in the EIA.

a. The capitalization rate for the reservoir, dam, and outlet area was reduced from 4% to a more conservative rate of 1%. This change was not updated in the text. The $1,392,000 in the text was incorrect and the $714,620 in the table is correct. The assessment was based on the value in the table and is thus unchanged by the in-text error.

Question 28

<u>Volume 4, Supporting Documentation, 1. IBI Report, Section 5.1.1.2.3, Page 28</u>

Regarding indirect damage estimates for habitat restoration:

a. Provide justification for the monetization method used for avoided habitat damages. Clarify why a benefits-transfer method was not used to evaluate values for habitat.

b. Clarify whether any environmental damages are anticipated to result from the construction and/or operation of either SR1 or MC1. If so, included these damages as project costs in the benefits/cost analysis.

Response 28

a. Flooding on Bow River and Elbow River is a natural occurrence and erosion is a process of natural sediment transport. A cost to the City of Calgary is incurred when post-flood erosion control projects are necessary to protect human infrastructure and alter the river banks unnaturally.

   The habitat offsetting costs are tangible monetary damages because they are costs to the City and required for erosion control work after a flood, above and beyond the direct remediation costs. The habitat-offsetting cost method provides the basis for directly estimating the damage (and remediation) of habitat values. Because this approach is based on past events within the City, it is considered more accurate than the benefit-transfer approach, which relies on quantification of environmental benefits, based on values identified from research undertaken in other locations.

b. Some environmental damages were monetized for the construction and operation of SR1 and the MC1 Option.

Question 29

Volume 4, Supporting Documentation, 1. IBI Report, Section 5.1.1.2.4, Pages 28 and 2

Alberta Transportation states *The methodology for assigning a monetary value to intangible damages such as public health is detailed in the Calgary Flood Mitigation Option Assessment study. These amounts represent the present value of annual payments for 100 years derived from secondary research on household willingness-to-pay to avoid the intangible effects of flooding.* The willingness to pay (WTP) estimates used in the calculation of avoided intangible damages seem high compared to published WTP estimates for reduction in morbidity or mortality (for example see Adamowicz et al., 2011 and Alberini et al., 2006, respectively).

a. Provide the rationale for the willingness to pay estimates used to calculate avoided intangible damages.

b. Clarify if/how intangible damages were adjusted to account for the probability of a flood occurring.

c. Provide references for willingness to pay estimates or adjust the calculations as required.

d. Provide the Calgary Flood Mitigation Option Assessment study.

Response 29

a. The reference to willingness to pay (WTP) amounts were directly related to household impacts of flooding. Other public health WTP estimates (Adamowicz et al. 2011; Alberini et al. 2006) refer to discrete health impacts on a population, not the impact of a flooded home.

   The flood avoidance WTP studies used by IBI were conducted after major floods and covered a broad range of impacts, not only mortality and morbidity, which are relatively low risks in this context. Because these studies elicit responses on a wide range of stress factors affecting households, this value can be considered as a single quality-of-life intangible value. The combination of physical and mental well-being would cover impacts, including but not limited to, for example, illness, worry, loss of services, community relations, loss of enjoyment of the environment, or damage to historical assets.

   Although the studies used by IBI are in the context of the United Kingdom, this value/method is directly from flood affected households in a comparable urban setting to the City of Calgary. There is no better data available related to flooding events in Canada.

b. The intangible damage amount was incurred per flooded household for each modelled event and added to the total damage amount. The probability of a flood occurring is accounted for in the calculation of average annual damages.

c. The two reference WTP studies are the following:

   - Flood, E. A. “The appraisal of human related intangible impacts of flooding.” (2004).
   - Joseph, Rotimi, David Proverbs, and Jessica Lamond. “Assessing the value of intangible benefits of property level flood risk adaptation (PLFRA) measures.” *Natural Hazards* 79.2: 1275-1297 (2015).

   The main objective of the 2004 study by the UK Department for Environment, Food and Rural Affairs on intangible impacts was to determine a value to be used nationally for mitigation assessments. The study included a detailed health impact survey of flooded households and a WTP in order to avoid the intangible impacts. The overall mean WTP values for flooded respondents was about £200 per household per year, or approximately $615 CAD in current dollars. The 2015 study found a mean WTP value of £653 per household per year, or approximately $1,300 CAD. In the more recent study (Joseph et al. 2015), results are much higher because the research was conducted after more severe flooding during 2007, and it focused on a wider range of intangible impacts.

d. The Calgary Flood Mitigation Options Assessment Study is provided in the response to IR23, as Appendix IR23-1.

Question 30

Volume 4, Supporting Documentation, 1. IBI Report, Section 5.1.4.2, Page 34
Volume 4, Supporting Documentation, 1. IBI Report, Section 5.1.4, Page 33

Alberta Transportation states *Detailed design of the dyke system has been estimated at $32.8 million (previously estimated at $6 million)* under the heading *Flood Defences at Bragg Creek*.

The Province is initiating this solution independent of considerations relating to benefits accruing to MC1 vs SR1. Accordingly, these are considered "sunk costs" and no additional benefits to MC1 or costs to SR1 associated with this standalone alternative have been factored into the benefit/cost analysis.

Page 33 of the IBI Report states that *Given the total value of flood recovery projects associated with the 2013 flood ($5.6 million) it is suggested that the additional benefits would be nominal in any event and would not impact the benefit/cost ratio significantly*.

Alberta Transportation discusses that Bragg Creek and Redwood Meadows *could be afforded partial, if not full protection, by the proposed McLean Creek project. These potential damages averted constitute costs over and above those accruing to the City of Calgary and would logically be taken into consideration as part of the benefit/cost analysis*.

a. Explain what additional flood mitigation is necessary at Bragg Creek with the MC1 option.

b. Provide updated results for the net present value and benefit/cost ratio for the Project and MC1 when the costs and benefits of the flood protection dykes at Bragg Creek are included.

Response 30

a. Assuming that the MC1 Option had been selected and built, no additional flood mitigation measures would have been necessary at Bragg Creek because the MC1 Option would have provided full flood protection.

   When SR1 was selected as the flood protection project for the City of Calgary and downstream communities in 2014, separate flood protection projects were pursued for Bragg Creek and Redwood Meadows.

b. A number of variables used in the 2017 Benefit/Cost Analysis have changed since its submission (Volume 4, Supporting Documentation, Document 1). An updated 2019 Benefit/Cost Analysis has been provided in the response to IR6, Appendix IR6-1. To fairly account for and compare the difference in protection of property between the MC1 Option and SR1 sites, the additional benefits of MC1 Option would be added to the benefit/cost analysis. The 2017 Benefit/Cost Analysis provided in the EIA did not include the additional

MC1 Option benefits because a detailed study had not been completed at that time. IBI Group has since completed a flood damage estimation for properties downstream of the MC1 Option and upstream of SR1 and the additional benefits have been included in the 2019 Benefit/Cost Analysis (Appendix IR6-1). The additional benefits provided by the MC1 Option, primarily in the area of Bragg Creek and Redwood Meadows, amount to approximately $180,000 in average annual damages (AAD).

The utility of using a benefit/cost analysis to compare SR1 to the preliminary cost estimates for the MC1Option is questionable. Not only do they continue to diverge in terms of the detail and confidence in cost estimates, but challenges arise in attempting to align the two projects for a fair benefit/cost comparison.

As described in Appendix IR6-1, it is unrealistic to align SR1 and the MC1 Option with a common start year because there are five years of costs to date for SR1, and the costs include environmental assessment costs and the regulatory review process. However, if one were to do so, the benefit/cost ratio would be 1.24 for SR1 and 1.41 for the MC1 Option. More realistically, if only projected costs from 2019 onward were considered, the benefit/cost ratio would be 1.37 for SR1 and 1.41 for the MC1 Option. SR1 achieves a higher net present value because the benefits are realized five years earlier than the MC1 Option.

The flood mitigation at Bragg Creek is a separate project, already underway. However, if the estimated $32.8 million for Bragg Creek flood protection is added to the projected costs of SR1 in 2019, and the $180,000 in AAD added to the benefits for that protection, the benefit cost ratio would decrease from 1.37 to 1.28.

Question 31

Volume 4, Supporting Documentation, 1. IBI Report, Section 6.2.3, Page 36

Alberta Transportation states *To fairly include this difference in the benefit/cost analysis, the annual benefits (average annual damages averted) begin in 2020 for the SR1 project and in 2023 for the MC1 project. Over the same 100 year period (2018-2118), with the 4% discount rate, the four-year advantage gives SR1 $74 million in additional present value of benefits compared to MC1.*

Under *Assumptions regarding timing*, Alberta Transportation lists that the annual benefit amounts begin in year 3 for SR1 and year 6 for MC1.

a. Explain the contradiction between the 4 year differential for annual benefits in the explanatory text compared to the 3 year differential stated in the assumptions. Which year differential was used to calculate the present value of benefits?

b. Provide the difference in present value of costs between SR1 and MC1 given that the costs for SR1 are expended in two years when compared to MC1 costs that occur later and spread over a longer period.

Response 31

a. The four-year differential in the explanatory text in the 2017 Benefit/Cost Analysis (BCA) is not correct and is not used in the assessment. A three-year differential is used, and it is based on the information provided by Alberta Transportation to IBI Group at that time. It is used to calculate the present value of benefits in the assessment. As stated in the 2017 BCA, the benefits for SR1 and the MC1 Option are assumed to begin in 2020 and 2023, respectively. This gives SR1 an additional three years of benefits compared to the MC1 Option.

   A number of variables used in the 2017 benefit cost analysis have changed since its submission (Volume 4, Supporting Documentation, Document 1), including the timing of costs and benefits. The 2019 BCA is provided in the response to IR6, Appendix IR6-1.

b. Assumptions in the 2017 BCA regarding timing are described in Volume 4, Supporting Documentation, Document 1, Section 6.2.3, page 36.

   The costs for both projects are discounted at the same rate as benefits (4%). The present value (PV) and total discount for project costs (prior to operation) is provided in Table IR31-1.

Table IR31-1 Discounted Costs for SR1 and MC1 Option in 2017 Benefit/Cost Analysis

	SR1	MC1 Option
Total Development Costs	$371,712,000	$406,353,000
PV at 4% Discount Rate	$366,102,154	$363,753,988
Discount	$5,609,846	$42,599,012
Discount as % of Total	1.5%	10.5%

   Timing and costs for both projects have been updated for the purposes of the 2019 BCA, and it is provided in Appendix IR6-1. As with the 2017 BCA, benefits and costs are discounted at 4%. The 2019 BCA includes two scenarios: 1) all costs spent and projected from 2014 and 2) projected costs from 2019 onward. The 2019 BCA assumes that construction of the MC1 Option would begin in 2025. The discounted costs (prior to operation) for both projects and both benefit/cost scenarios are presented in Table IR31-2.

Table IR31-2 Discounted Costs for SR1 and MC1 Option – April 2019 Benefit/Cost Analysis

	From 2014		From 2019	
	SR1	**MC1 Option**	**SR1**	**MC1 Option**
Total Development Costs	$463,401,085	$406,658,880	$423,615,098	$406,658,880
PV at 4% Discount Rate	$357,780,154	$254,645,105	$391,171,562	$309,814,708
Discount	$105,620,931	$152,013,775	$32,443,536	$96,844,172
Discount as % of Total	22.8%	37.4%	7.7%	23.8%

Question 32

Volume 4, Supporting Documentation, 1. IBI Report

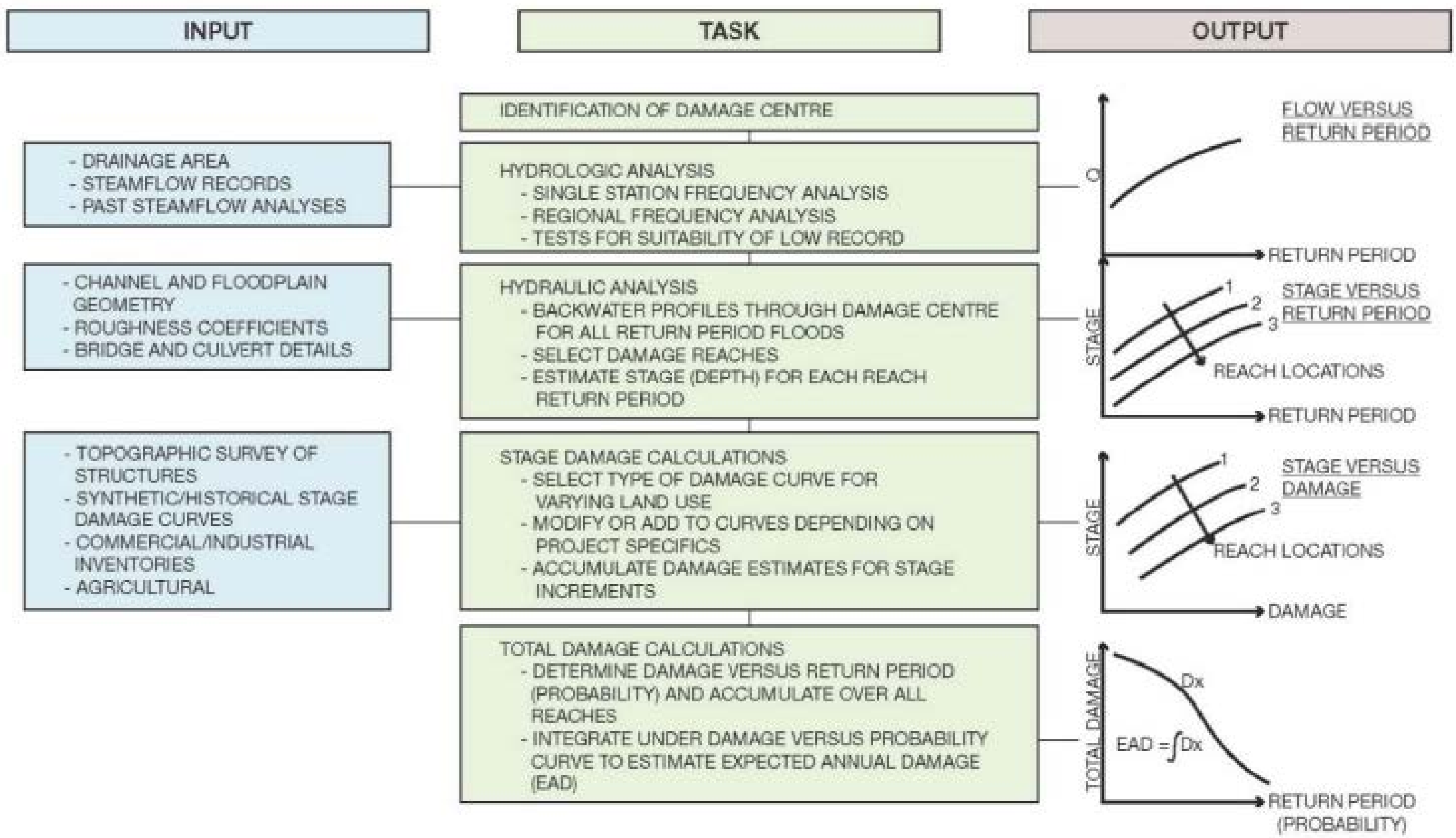
Apart from the probability of flooding, the BCA report does not specifically address the risk and uncertainty associated with key parameters in the benefit cost analysis.

a. Provide a robust sensitivity analysis that identifies uncertain variables in the study and demonstrates the magnitude of changes in these parameters on the study outcome. A Monte Carlo simulations in place of traditional sensitivity analysis is acceptable.

Response 32

a. Flood damage estimation and benefit/cost analysis methods associated with flood damage reduction studies are well-established in the literature and have been recently formalized in NRC (2017). Figure IR32-1 shows the multiple data inputs for estimating flood damage from that report.

Each of the inputs, in turn, relies on many assumptions, such as factors related to hydrologic and hydraulic analysis used to estimate depth of flooding by return period. In addition, there are other assumptions related to the creation and application of stage-damage functions, behavior during an actual event, extent of sewer backup and groundwater propagation beyond the area of inundation, indirect and intangible damages and other technical details related to flooding. For the majority of these factors, there is no known probability and, hence, no ability to undertake a meaningful sensitivity analysis to determine confidence intervals or perform a Monte Carlo simulation. Given acceptance of the costs and benefits (flood damages averted), the only uncertain variables that can be considered are discount rate and timing.



Source: Paragon Engineering "Flood Damages: A Review of Estimation Techniques" - Ministry of Natural Resources (March 1984)

Figure IR32-1 General Flood Damage Calculations Methodology

REFERENCES

NRC (Natural Resources Canada). 2017. Canadian Guidelines and Database of Flood Vulnerability Functions, Public Safety Canada, March 2017. Authored by IBI Group.

Question 33

Reference Document: McLean Creek (MC1) Dam, Updated – Conceptual Design Report – Final – Vol 1 of 2, Opus Stewart Weir, August 23, 2017.
Section 1.2, Page 3
Section 6.1.4.1, Pages 28 and 29

Alberta Transportation states that the McLean Creek option is proposed to work in conjunction with the Glenmore Reservoir to attenuate flood events.

a. Clarify how the storage at the Glenmore Reservoir is to be considered in conjunction with the McLean Creek option to mitigate the design (2013) flood.

b. Describe how the two reservoirs would work together.

c. Identify structural and/or operational modifications to the Glenmore Dam and Reservoir that will be required in order to operate McLean Creek as designed.

Response 33

a-b. The MC1 Option is an instream flood management facility; therefore, all inflows associated with any flood would pass through the reservoir before being passed on to Glenmore Reservoir. A portion of these inflows would be stored within the MC1 Option reservoir, and the remainder would be released in a controlled manner through the MC1 Option tunnels. Flows through Glenmore Dam would also be controlled to limit the Glenmore Dam discharges from exceeding 170 m^3/s for floods up to and including the 2013 flood.

The MC1 Option reservoir and Glenmore Reservoir would be operated in series. During floods similar to the 2013 flood, the majority of drainage basin runoff would originate on the steep mountain slopes in the upper reaches of the Elbow River drainage basin that are upstream of MC1 Option dam and reservoir. Outflow released through the MC1 Option dam diversion tunnels would be controlled to limit the peak flow released downstream to Glenmore Reservoir. This peak flow would be retained in the MC1 Option reservoir and would be released in a controlled manner when the risk of flooding subsides.

For example, during passage of a 2013 magnitude of flood, the outflows from the MC1 Option would be restricted to approximately 212 m^3/s, which is larger than the 170 m^3/s Glenmore Dam outflow. The difference in flow rate between the MC1 Option outflow (which would become the Glenmore Dam inflow) and the Glenmore Dam outflow would be stored within Glenmore Reservoir. This is shown schematically in Figure IR33-1. Shown on the figure are 1) the MC1 Option inflow hydrograph, 2) the MC1 Option outflow hydrograph, and 3) the reservoir level for MC1 Option during the passage of a flood. Also shown are the portions of the flow hydrograph that would be stored in the MC1 Option reservoir, and those that would have been immediately passed downriver for storage in the Glenmore Reservoir.

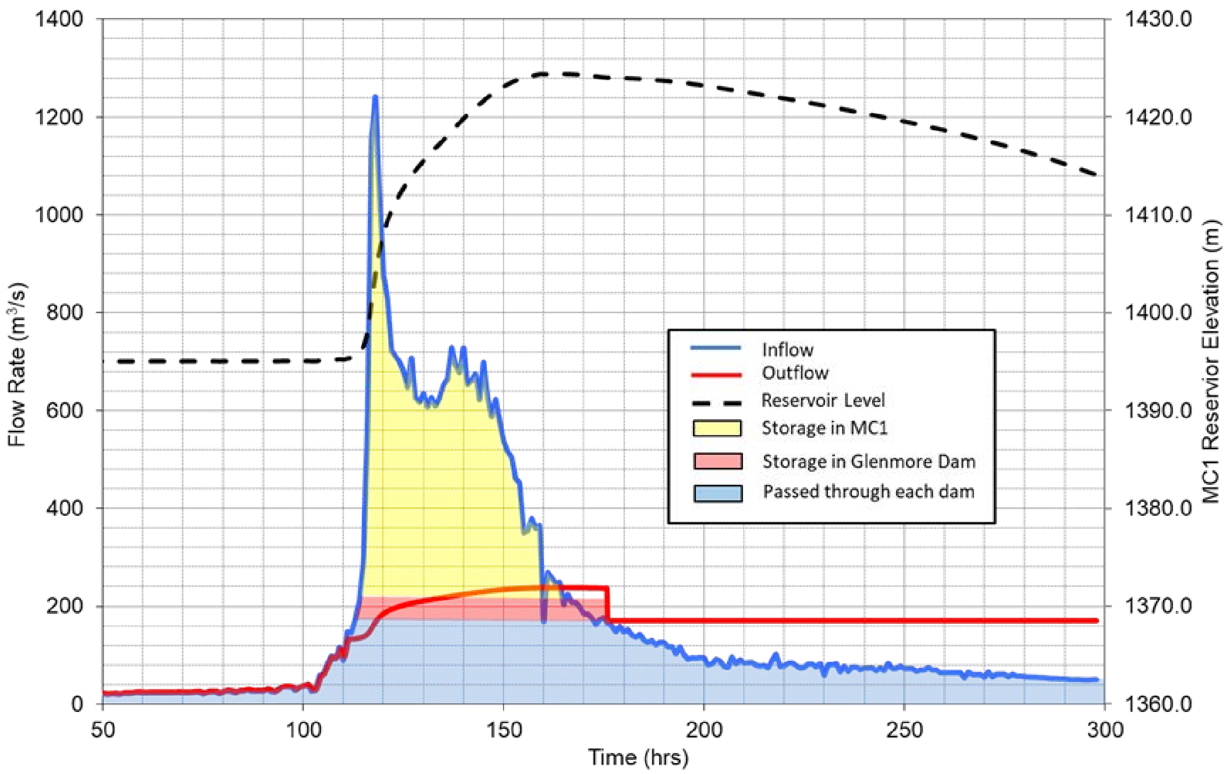


Figure IR33-1 MC1 Option Passage of the 2013 Flood

Over the approximately 65-hour period in which the 2013 flood inflows exceed the critical flow of 170 m³/s, the MC1 Option diversion tunnel gates would be operated to release an average flow of approximately 212 m³/s (i.e., the 42 m³/s differential between 212 m³/s and 170 m³/s over a 65-hour period equates to approximately 10 million m³). Storage of this flow differential in Glenmore Reservoir would cause the Glenmore Reservoir to rise 3.7 m from its initial drawdown level, mobilizing roughly 10 million m³ of storage within Glenmore Reservoir. This operation could be adjusted depending on the exact nature of the inflow hydrograph, the location of the precipitation event (upstream or downstream of MC1 Option dam), and actual flood forecasts, but the principal would be the same when managing each flood.

c. No modifications (either operational or structural) would need to be implemented at Glenmore Dam to assist the MC1 Option system management of water flow. It is expected that the City would continue to lower the reservoir level (El. 1,071.85 m) in anticipation of a large flood on Elbow River. This would provide more than 10 million m^3 of flood storage.

Question 34

Reference Document: McLean Creek (MC1) Dam, Updated Conceptual Design Report – Final – Vol 1 of 2, Opus Stewart Weir, August 23, 2017, Section 6.1.4.4, Page 32
Reference Document: McLean Creek (MC1) Dam, Updated Conceptual Design Report – Final – Vol 1 of 2, Opus Stewart Weir, August 23, 2017, Section 6.1.4.5, Page 33
Reference Document: McLean Creek (MC1) Dam, Updated Conceptual Design Report – Final – Vol 1 of 2, Opus Stewart Weir, August 23, 2017, Appendix A, Page 100/134
Reference Document: McLean Creek (MC1) Dam, Updated Conceptual Design Report – Final – Vol 2 of 2, Opus Stewart Weir, August, 2017, Appendix 5, McLean Creek Damsite MC1-Workshop #2 Value Engineering & Risk Analysis, December 14, 2016, Page 15
Reference Document: McLean Creek (MC1) Dam, Updated Conceptual Design Report – Final – Vol 2 of 2, Opus Stewart Weir, August, 2017, Appendix 5, McLean Creek Damsite MC1 Value Engineering - Evaluation Phase, February 20, 2017, Page 6.

Alberta Transportation states *The simulation implies that the 1000-year flood could be managed without mobilizing the service spillway. Peak water levels would be just at the crest elevation of the ogee weir.*

Alberta Transportation then states on in section 6.1.4.5 on page 33 that *The basin response to the PMF rainfall would require the tunnel gates to be fully opened, and the reservoir level would continue to climb, mobilizing first the service spillway, and after that, the auxiliary spillway.*

Peak outflows through the tunnel would reach 1000 m^3/s, peak outflows from the service spillway would reach 600 m^3/s, and peak outflows through the auxiliary spillway would reach 1000 m^3/s.

Alberta Transportation references:
SUB-TOTAL SERVICE SPILLWAY $45,893,000
SUB-TOTAL, AUXILIARY SPILLWAY $1,488,000

Alberta Transportation indicates that the idea/option of *12-Eliminate service spillway and use expanded auxiliary spillway*.

Alberta Transportation states on page 6 *40. Eliminate service spillway and use expanded auxiliary spillway. (eliminate, not feasible)*

MC1 spillways are activated for floods greater than the 1000-year flood. The service spillway has a maximum peak outflow of 600 m³/s and a cost estimate of $45,893,000. The auxiliary spillway has a maximum peak outflow of 1000 m³/s and a cost estimate of $1,488,000.

a. **Explain why it is not feasible to eliminate the service spillway and use an expanded auxiliary spillway at MC1.**

b. **Provide the cost of spillways at MC1 if the service spillway was eliminated and the auxiliary spillway was designed for floods greater than the 1000-year flood and designed for 1600 m³/s peak flow of the PMF flood.**

c. **Provide the updated total cost for MC1, if the spillway cost difference is greater than $1 million from the reference document spillway costs.**

Response 34

a. Using one spillway was considered as an early option in the study to reduce overall costs associated with the MC1 Option design. However, concern was raised given the probable maximum flood (PMF) flow rates and the resulting erosion and sedimentation downstream that may result should the auxiliary spillway mobilize too early in the hydrological regime. A combination of a concrete spillway and earthen auxiliary spillway was considered to be the most cost-effective solution. To determine the overall size of the concrete spillway, the Code of Practice by AEP, Canadian Dam Association (CDA) guidelines along with impact to the reach from the erosion and sediment of the earthen channel, were considered.

   The Code of Practice Maps published by AEP (see Figure IR34-1) indicates that this reach of Elbow River is primarily made up of Class C spawning habitat. In Figure IR34-1, the location of the MC1 Option dam and (green colored) Class C Elbow River is presented. The temporary loss and impact to this Class C habitat would represent a sufficiently severe environmental impact to warrant a hazard classification of “High” consequence under the CDA guidelines. Adoption of this environmentally based classification would require that the MC1 Option be capable of passing a flood that is equivalent to one third between the 1:1,000 year flood and the PMF (subsequently referred to as the 1/3 PMF) before releasing any water through the earthen auxiliary spillway.

   Given the above, the MC1 Option was designed with a concrete overflow service spillway that would mobilize in advance of the earthen auxiliary spillway. Operation of the service spillway would have a much smaller environmental impact and would help to delay mobilization of the auxiliary spillway. Spill release priority was given to the diversion tunnels, then to the service spillway, and then finally to the auxiliary spillway. The auxiliary spillway would be the last to mobilize and operate for the smallest amount of time, given the expected channel erosion. Without the service spillway, the auxiliary spillway would mobilize too early in the hydrological regime, and the project would not meet CDA guidelines.

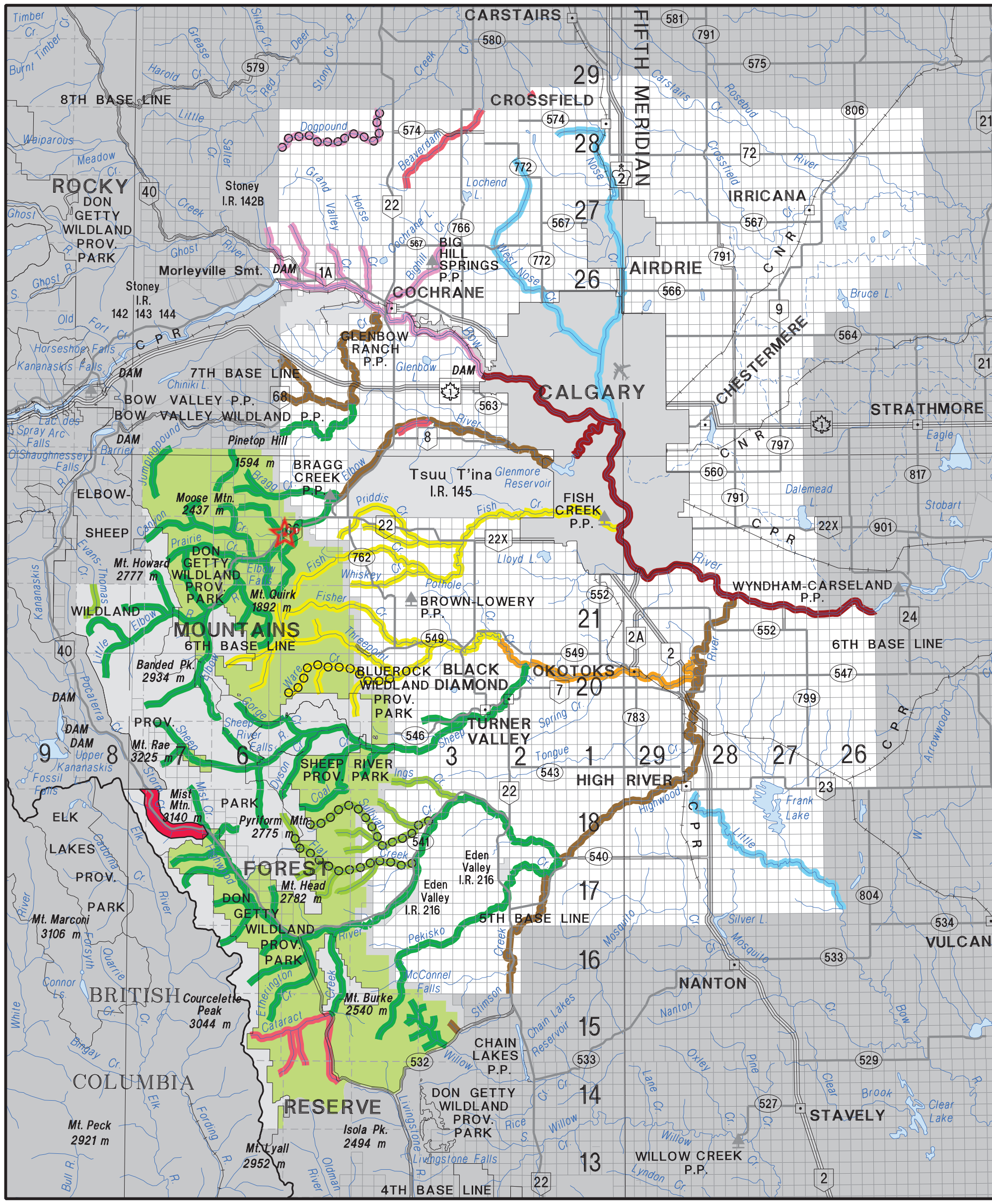
The structure sizes and invert elevations were accordingly set so that the auxiliary spillway would only mobilize for floods larger than the 1/3 PMF, and would not operate under driving heads of more than 2 m. This was confirmed by routing simulations, which showed the MC1 Option reservoir would rise to El. 1,426 m (just below the structure invert elevation) during the 1/3 PMF; the auxiliary spillway invert was set accordingly. In addition, the service spillway was located on the left abutment, the opposite bank to that of the auxiliary spillway. This would separate the discharge channels of the two primary spill facilities, the diversion tunnels and the service spillway, for as long as possible.

The dimensions selected for each spill component for the MC1 Option were based on a conceptual level of study, and the need for a service spillway could not be ruled out and was, therefore, retained in the MC1 Option.

b-c. The entire elimination of a concrete spillway cannot be rationalized as a feasible option (see the response to a) because:

- there are concerns for erosion of the right abutment when the auxiliary spillway mobilizes
- erosion, and subsequent deposition of eroded material in the downstream river channel, will have a substantial impact
- because of this erosion, the CDA guidelines require that the mobilization of this auxiliary spillway be delayed until the passage of only very large floods.

The service spillway will help to delay the point at which the additional capacity of the auxiliary spillway would be required and, therefore, cannot be eliminated. The service and auxiliary spillways could be combined into one larger concrete spillway, but the incremental cost of the larger concrete structure would be much higher than the $1.5 million estimate cost of the auxiliary spillway.



Water Body Class	Water Body Class Symbol	Restricted Activity Period
Class A	or	- See applicable Code of Practice for specific requirements
Class B		- May 16 to August 15 and September 1 to April 30
		- September 16 to April 15
		- April 16 to July 15
Class C		- May 16 to August 15 and September 1 to April 30
		- September 1 to August 15
		- September 1 to July 15
		- May 1 to July 15 and September 16 to April 15
		- May 1 to July 15 and September 16 to April 5
		- September 16 to April 15
		- October 1 to April 15
		- May 1 to August 15 and September 16 to April 15
		- April 1 to May 31
Class D	None	- No Restricted Activity Period

Locations of Class A and B Water Bodies

Any person who carries out an activity governed by a Code of Practice (Code) under the *Water Act*, must use all of the following information to determine the Class of water body applicable to the activity location: the Code provisions and the applicable Management Area Map (the map), including the associated map legend and its tables. The table below describes the locations of Class A and B water bodies. Where water body Classes appear to overlap on the map or where the water body Class indicated by the map differs from the map legend and its tables, the water body Class indicated in the map legend and tables will apply.

Water Body	Water Body Class	Location	Comments
Dogpound Creek	B	From **Twp 28 – Rge 4 – W5** Sec 33 To **Twp 28 – Rge 5 – W5** Sec 18	Brown trout spawning habitat.
Flat Creek	B	From **Twp 17 – Rge 4 – W5** Sec 36 To **Twp 18 – Rge 5 – W5** Sec 8	Rainbow trout spawning habitat.
Storm Creek	A	**Twp 18 – Rge 7 – W5** Sec 19, 20, 30, 31	Bull trout spawning habitat.
Sullivan Creek	B	From **Twp 18 – Rge 3 – W5** Sec 20 To **Twp 18 – Rge 5 – W5** Sec 16	Rainbow trout spawning habitat.
Ware Creek	B	From **Twp 20 – Rge 4 – W5** Sec 22 To **Twp 20 – Rge 5 – W5** Sec 18	Rainbow trout spawning habitat.

Green Area, M.O. 22/99, May 1999

White Area

McLean Creek (MC1)

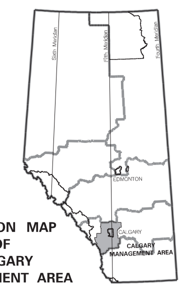
Code of Practice for Pipelines and Telecommunication Lines Crossing a Water Body

Code of Practice for Watercourse Crossings

Code of Practice for Outfall Structures on Water Bodies

Calgary Management Area Map

November 2012



LOCATION MAP OF CALGARY MANAGEMENT AREA

This map forms part of the Code of Practice for Pipelines and Telecommunication Lines Crossing a Water Body, the Code of Practice for Watercourse Crossings and the Code of Practice for Outfall Structures on Water Bodies. This map is subject to change.

Note: The Water Body Classifications and Restricted Activity Periods on this map are only for water bodies as defined in the *Water Act* Codes of Practice (Codes). The Codes also outline provisions for: determining exceptions to coded water bodies, and determining the classification and Restricted Activity Periods for unmapped and uncoded water bodies. For detailed information please refer to the appropriate Code.

Wetlands, sloughs, and both fish bearing and non–fish bearing lakes are outside the scope of the Codes. Activities on these types of water bodies may require authorizations under the *Water Act* and, therefore, an application under the *Water Act* should be submitted to your nearest regional Alberta Environment office.

For additional information on the Codes and other authorizations check the Alberta Environment and Sustainable Resource Development website at http://environment.alberta.ca/01330.html or contact your nearest regional Alberta Environment office.

Alberta Environment and Sustainable Resource Development

Prepared by Resource Information Management Branch, Corporate Services Division
Base Map Provided by Spatial Data Warehouse Ltd.

Figure IR34-1 Code of Practice for Water Bodies

Question 35

Reference Document: Springbank Off-stream Storage Project, Preliminary Design Report (DRAFT), Stantec Consulting Services Ltd., March 31, 2017, Appendix G Construction, Page 3111 of 3119
Reference Document: McLean Creek (MC1) Dam, Updated Conceptual Design Report – Final – Vol 1 of 2, Opus Stewart Weir, August 23, 2017. Appendix A, Page 97 and 100 of 134

Alberta Transportation states in Appendix G:

Item	*Unit Price $/m³*
Emergency Spillway	
Structural concrete	*1340.82*
Off-Stream Storage Dam	
Zone 1A – Impervious Fill	*3.00*
Zone 2A – Random Fill	*1.50*
Fine filter – Zone 3A	*55.00*

Alberta Transportation states in Appendix A:

Item	*Unit Price $/m³*
Service Spillway (Page 100)	
Concrete	*730.00*
Main Dam (Page 97)	
Zone 1A – Impervious	*10.00*
Zone 2A – Unclassified Fill	*10.00*
Zone 3A – Fine filter	*20.00*

Both the reports list similar sources and methods for developing the cost estimate for the respective projects. However, some of the unit prices in the line cost items are quite different between the projects.

a. **Review the detailed line item costs for the Project and MC1 of comparable products and services. If the unit price difference is significant, and the quantity required makes a "material difference" (greater than $1 million) to the cost of the Project or MC1, then:**

- **i.** **provide project specific justification for the material difference.**
- **ii.** **provide an appropriate unit price for use with both projects (Project and MC1) and explain why that choice was made; or**
- **iii.** **provide multiple pricing options (high and low, at minimum) for that line item.**

b. Provide updated costs for both the Project and MC1, if the total cost is materially different.

c. Update any EIA sections affected by the updated costs.

Response 35

a. The unit rates identified in the IR are not comparable on a per line item basis between the SR1 and MC1 Option.

   i. The structural concrete costs referenced in the tables (Appendix G table for SR1 and Appendix A table for MC1) have different assumptions:

   - For SR1, the unit price ($1,340/m^3) for concrete includes the reinforcement steel for the structure. Further, the concrete is assumed to come from an off-site source because granular material for on-site production is not available.
   - For the MC1 Option, the referenced unit price ($730/m^3) has been updated in Appendix IR35-1. The updated unit price is $950/m^3 without the reinforcement steel and $1,110/m^3 including the steel. The concrete for the MC1 Option is assumed to would have been produced on-site using a batch plant and available aggregate.

   The earthwork unit rates compared in the tables above also do not include the same construction elements:

   - For SR1, the unit price ($3/m^3) for Zone 1A Impervious Fill comes from the off-stream dam section of the cost opinion. This unit price is for placement and compaction of the soil. The unit price for excavation of the soil from the borrow source or the diversion channel is accounted for in a separate line item and unit price ($5.50/m^3). Finally, hauling of the material from the diversion channel to the off-stream dam is accounted for separately with an average unit price of ($4.25/m^3). Therefore, the costs for Zone 1A material ranges from $8.50/m^3 for material excavated from the borrow source in the reservoir to $12.75/m^3 for material excavated in the diversion channel.
   - For the MC1 Option, the updated unit price is $9/m^3 for Zone 1A and 2A and includes excavation at the planned borrow locations, haul for the MC1 Option terrain and temporary haul roads as well as placement of the material (see Appendix IR35-1).

   The fine filter unit rates are also not comparable:

   - The SR1 unit price for fine filter is $55.00m^3 (see row 118 in Appendix IR35-2) and must be sourced off-site. Most of the cost for this line item is the transportation of the material from an off-site quarry that is located a substantial distance from SR1.
   - The updated MC1 Option Cost Opinion (Appendix IR35-1) unit price for Zone 3A- fine filter is $20/m^3 and would have been sourced and processed from on-site material.

ii. and iii. As demonstrated in item i., direct comparison of certain unit rates between the two designs are not appropriate because of varied material sourcing.

b. The construction cost opinions for both projects were estimated by the design professionals for SR1 and the MC1 Option, respectively, and consistent with practices for the current level of design advancement. A normal process in the development of heavy civil projects are refined costs estimates as additional information and design is completed. The updated cost estimate opinions is provided for the MC1 Option (Appendix IR35-1) and SR1 (Appendix IR35-2).

c. Volume 3A, Section 17.4 is updated (see the response to IR17, as Appendix IR17-1), based on assumed construction cost of $312.2 million for SR1.

Question 36

Reference Document: Springbank Off-stream Storage Project, Preliminary Design Report (DRAFT), Stantec Consulting Services Ltd., March 31, 2017, Appendix G Construction, Page 3109 of 3119

Alberta Transportation states that:

Highway 22 Bridge Crossing	***See Separate Breakout***
Township Road 242 Bridge Crossing	***See Separate Breakout***
Grade and Resurface Highway 22 and Springbank Road	***See Separate Breakout***

The separate cost breakouts for these items were not supplied.

a. Provide the separate cost breakouts for the stated items.

Response 36

a. Separate cost breakout for the items are provided in Table IR36-1.

Table IR36-1 Costs for Road Modifications

Highway 22 Bridge Crossing	***$5.42 million***
Township Road 242 Bridge Crossing	***$4.21 million***
Grade and Resurface Highway 22 and Springbank Road	***$15.5 million***

Question 37

Volume 3A, Section 10.2.2.2, Figure 10-3, Page 10.20 and Volume 3A, Section 10.2.2.3, Page 10.29
Volume 3A, Section 10.4.4.1, Page 10.50

Alberta Transportation states on page 10.29 that *Three plant species of management concern were identified during rare plant surveys in the PDA…*.

Alberta Transportation states on page 10.50 that *Effects on plant SOMC from vegetation clearing are not anticipated, because none were observed in the PDA.*

a. Clarify the contradiction between these two statements and confirm the number of plant SOMC in the PDA.

Response 37

a. The statement on page 10.29 is not correct: only one plant species of management concern was found within the PDA. To clarify, three rare plants—blunt-leaved watercress (*Rorripa curvipes*), slender cress (*Rorripa tenerrima*) and dwarf bulrush (*Trichophorum pumilum*)—were identified during field surveys. Two species—blunt-leaved watercress and dwarf bulrush—were observed outside the PDA. One species, slender cress, is located within the PDA but not in an area of construction activities (see Volume 3A. Section 10, Figure 10-3). Because the rare plant locations are not located in construction areas, effects on plant species of management concern from vegetation clearing are not anticipated.

Question 38

Volume 3A, Section 10.4.5, Page 10.51
Volume 3A, Section 10.5, Page 10.52
Volume 3A, Section 10.5, Table 10-14, Page 10.53

Alberta Transportation states on page 10.51 that *Residual project effects are expected to be adverse, moderate in magnitude*…

Alberta Transportation states on page 10.52 that *All residual project effects are expected to occur during construction, be low in magnitude*…

Alberta Transportation indicates that the magnitude of all residual effects is L (Low) on page 10.53.

a. Clarify the contradiction in the above statements and confirm the Projects residual effects for Wetlands.

Response 38

a. The conclusion of "moderate in magnitude" effects in Volume 3A, Section 10.4.5, Page 10.51 is incorrect. Volume 3A, Section 10.5, Table 10-14 is correct in stating that residual project effects will be "low in magnitude." This is because no wetland function category is lost from the LAA and effects are anticipated to be low for wetland function.

Question 39

Volume 3A, Section 10.4.3, Page 10.50
Volume 3A, Section 10.5, Table 10-14, Page 10.53

Alberta Transportation indicates that the change in community diversity effects would be reversible for temporary disturbances, and irreversible for permanent project components (page 10.50). While on page 10.53 Alberta Transportation indicates that the change in community diversity effects would be reversible.

a. Clarify the reversibility of residual effects for the Change in Community Diversity.

Response 39

a. Table 10-14, Volume 3A, Section 10.5, Page 10.53 is incorrect. Effects on community diversity from construction and dry operations are expected to be reversible for temporary disturbances and irreversible for permanent Project components. Effects from temporary disturbances are considered reversible because affected areas will be actively reclaimed, and native vegetation re-established.

Question 40

Volume 3A, Section 5.3, Page 5.28
Volume 3A, Section 5.4.2.1, Page 5.30

Alberta Transportation states that construction of the water diversion structure is not expected to interact with groundwater resources. However, in Section 5.4.2.1, page 5.30 Alberta Transportation states that the project has the potential to change groundwater quantity in and near the PDA as a result of local dewatering that might be required for the various project components, including the diversion channel.

a. Explain the contradiction between these two sections.

Response 40

a. There is no contradiction between these two sections because they are referring to different components of the Project. The locations of the diversion structure (a point feature within the Elbow River valley) and the diversion channel (a linear feature primarily situated outside the Elbow River valley and at higher elevations above the thalweg of the Elbow River valley) (see Volume 1, Section 3.0, Figure 3-1) lead to differences in regard to their potential interaction with groundwater during construction activities.

   The water diversion structure is situated in the valley of Elbow River, within the floodway and adjacent to the main thalweg of Elbow River. Construction of the diversion structure will require the use of temporary in-stream works to control the ingress of water into areas where subsurface components (e.g., structural foundations) are being constructed. Water ingression in this area would primarily be originating from surface water, either from direct, surface flow paths into an excavation, or from subsurface flow paths through the permeable alluvial deposits in the area. Thus, potential interactions related to construction activity within the Elbow River valley are more relevant to surface water rather than groundwater.

   Other Project infrastructure, including the diversion channel, the dam and other features are situated outside the Elbow River valley and at higher elevations above the thalweg. Construction dewatering that may be required in areas outside the Elbow River valley would lead to direct interactions with groundwater, since dewatering in these areas would seek to deliberately lower the groundwater table to prevent groundwater ingression into an excavation.

Question 41

Volume 3A, Section 5.4.2.2, Page 5.32

Alberta Transportation states that *The Project has the potential to change groundwater quantity in and near the PDA as a result of local, shallow and temporary subsurface dewatering that might be required to facilitate construction of the diversion channel, dam and floodplain berm, outlet works, bridge, excavation of borrow pits, and utility requirements*.

a. Comment on the potential impact of the cones of depression associated with dewatering activities on yield from local water wells.

b. What mitigation measures will be taken to reduce any impacts on water wells caused by dewatering activities?

Response 41

a. Subsurface dewatering may be required for construction of Project infrastructure; however, the need for localized (within PAA) construction dewatering will be determined on a site-specific basis during pre-construction planning. Depending on local conditions at the time of construction and the time of year, construction dewatering may not be required in all cases. Nonetheless, construction dewatering is considered as a potentially valid interaction and, thus, is considered in the hydrogeology assessment.

   Domestic water wells within the PDA will be decommissioned prior to construction, and no domestic wells will be next to areas that require dewatering. Section 3.3, Figure 3-28 in the Hydrogeology TDR Update (see response to IR42, Appendix IR42-1) presents the locations of domestic wells within the RAA (and thus LAA/PDA). Wells for which the location is known (through field verification) are shown. Some of these wells may be situated in areas where drawdowns in water levels could occur (based on dry operations, not construction dewatering). Of these wells, some could be retained for use in the monitoring program for the Project. Wells that will be disturbed by construction activities will be decommissioned. The procedure that will be used to decommission these wells is described in further detail in the response to IR44.

b. Domestic water wells within the PDA will be decommissioned, so there will not be any domestic water wells near areas that could require dewatering.

   Regional scale effects on groundwater levels as a result of construction dewatering will be mitigated by discharging the collected water back into the local watershed, where practical (where discharging the water will not interfere with construction activities). As such, effects on groundwater that extend beyond the LAA and into the RAA are not anticipated because the regional scale water balance will not be altered.

Question 42

<u>Volume 3B, Section 5.2.1, Page 5.2</u>

Alberta Transportation used a mathematical model to depict the subsurface geologic setting and associated physical parameters that govern the flow of groundwater <u>through porous media.</u>

a. Comment on the significance of groundwater flow through fractures in local geological deposits (e.g., glacial till, shallow bedrock).

b. Comment on the impact of not considering fracture flow on modelling prediction scenarios.

Natural Resources Conservation Board
May 2019

Response 42

a. Flow through secondary porosity such as fractures in a porous media generally increases the permeability or hydraulic conductivity relative to the permeability of similar, unfractured deposits of a given porous media. Fracturing of porous media occur for two reason, in this case: 1) weathering (areal exposure) of the lacustrine and till units and 2) fracturing of the bedrock units in highly deformed and topographically elevated bedrock features.

   For fractures related to weathering of the unconsolidated deposits, it is well documented (Hendry 1988; Ameli et al. 2015) that the fractures in till decrease with depth and the permeability trends back towards the permeability of un-weathered till. The approximately upper 5 m of the porous media is exposed to weathering and can have higher permeability.

   For bedrock fractures, they can enhance permeability similarly to weathered tills. However, bedrock fractures are site-specific and are difficult to map at a regional scale, particularly in highly deformed areas with veneers of unconsolidated material, as is the case in the RAA. Bedrock fractures generally date back to the mountain building period millions of years ago and remineralization can occur in fractures precluding the effects of secondary porosity.

   The fracture patterns were implemented in the model by means of creating an additional upper bedrock layer and isolating the upper 15 m of the bedrock volume. This layer was used to approximate the upper fractured zone of the bedrock where increased permeability is expected. The model is capable of producing realistic results with a broadly applied bedrock permeability zones due to the spatial averaging effect. Thus, groundwater flow through fractures is not considered large; therefore, the numerical model is sufficient for predicting the effects of the Project on groundwater.

b. While the effects of fractures are not implemented explicitly using a numerical solution, the numerical model accounts for increased permeability due to the bedrock fractures by including a higher hydraulic conductivity layer, as noted in a. This approach adequately approximates the aggregate effect of bedrock fractures. Further details are provided in Section 4.2 of the Hydrogeology TDR Update (Appendix IR42-1).

REFERENCES

Hendry, M. (1988). Hydrogeology of Clay Till in a Prairie Region of Canada. Ground Water. 26. 607-614.

Ameli, A., McDonnell, J., and Bishop, K, 2016. The exponential decline in saturated hydraulic conductivity with depth: a novel method for exploring its effect on water flow paths and transit time distribution Hydrol. Process. (2016) Published online in Wiley Online Library (wileyonlinelibrary.com)

Question 43

<u>Volume 3B, Section 5.2.1.1, Page 5.3</u>

The mathematical model was calibrated using a combination of heads measured in monitoring wells situated within the LAA, heads measured in domestic wells situated in the RAA, and other information. Since the length of the open interval and depth of water wells can be highly variable it can be challenging to use water level information from wells to generate an accurate potentiometric surface since the hydraulic head information can be extremely variable.

a. Comment on how variability of hydraulic head in water wells was accounted for during mathematical model calibration.

Response 43

a. There are inherent limitations to completing a regional study of this size, particularly given the topographic variation from semi-mountainous to foothills to plains. The RAA topography ranges in elevation from 1,365 m asl to 1,125 m asl. Public water well records are recorded over a large time frame. However, they are not always constructed using best practices (e.g., long production intervals, multi-aquifer completion) and recorded static levels may be influenced by local pumping resulting in records with variable data quality and completeness.

   These challenges were overcome by completing a data quality review, followed by a culling process to remove low quality records. Geostatistical methods were used to reduce the noise related to the nature of the available data. The data culling procedure created a subset of hydraulic head data control points for geostatistical modeling generated by interpolation (Kriging) of over 2,000 hydraulic head data control points across the RAA. The statistical averaging over such a large dataset reduces the variability so that the potentiometric surface can be a reliable of representation (i.e., interpolated values are used between known head control elevations).

   At the RAA scale, the geostatistical model of the bedrock potentiometric surface and the water table surface are used to calibrate the observed and modelled hydraulic features across the RAA. This is an important step in tuning the model boundary conditions to emulate the active hydrogeological framework of the RAA.

   At the PDA and LAA scales, dedicated calibration points were chosen from a high-quality subset of data including Project-specific instrumentation and data, as well as field-verified water well data. Accordingly, there is high confidence in the quality of the calibration data set in the PDA and LAA. Calibration points from these areas were chosen based on their closeness to Project infrastructure and ability to predict the hydrogeological effects in those areas.

Question 44

Volume 3B, Section 5.2.3.2, Page 5.50

Alberta Transportation states that water wells in the PDA will be decommissioned as part of the construction phase. Proper decommissioning or reclamation of the wells will be important to ensure these wells do not provide a pathway for surface water to impact groundwater quality (particularly in the off- stream storage area).

a. **Provide details on the process that will be used to "decommission" water wells in the PDA.**

b. **Indicate whether the monitoring wells installed in the PDA as part of the hydrogeological/geotechnical assessment will also be "decommissioned".**

Response 44

a. Water wells previously installed for domestic and agricultural water supply (see the response to IR42, Appendix IR42-1, Figure 3-28) will be assessed through field-verification to determine the potential for them to act as a pathway for vertical migration of surface water into the groundwater system. Water wells within the PDA that will be within the wetted perimeter of the off-stream reservoir (when it is used for partial diversion of flood waters) would be decommissioned in accordance with the *Water Act (Ministerial) Regulations*. Decommissioning includes removal of the wellhead and pumping/distribution piping, removal of the submersible pump, shock chlorination within the well casing, followed by removal of the well casing and screen where possible (or cutting of the casing below ground level), and sealing of the borehole with bentonite grout or cement using a tremie tube such that the sealing progresses from the bottom of the borehole back to ground surface. Following decommissioning, an updated Water Well Driller's Report will be submitted to AEP to provide a record of proper well decommissioning.

b. Monitoring wells installed within the PDA as part of the hydrogeology and geotechnical field programs will be assessed for their potential to act as a pathway for vertical migration of surface water into the groundwater system. There is a need to balance the potential risks that are posed by a monitoring well with the need for ongoing groundwater monitoring. Some of these monitoring wells will be retained for long term monitoring if the well poses a low risk for groundwater contamination but is of high value to the groundwater monitoring network. Such wells could include those that do not fully penetrate the low permeability clays/silts that underly the PDA, are outside the wetted perimeter of the off-stream reservoir during a design flood, or are in areas where the potential depth of submersion is low, or is anticipated to be infrequent. Such areas would generally be situated near the perimeter of the off-stream reservoir.

Monitoring wells that are of little value to the groundwater monitoring network, that fully penetrate the low permeability clays/silts into underlying bedrock, or are situated in areas prone to frequent inundation (in areas inundated by a 1:10 year flood) will be decommissioned using the same procedures noted in (a).

Question 45

Appendix 1, Hydrogeology Baseline Technical Data Report, Section 2.6, Page 2.14

Alberta Transportation states that *An interpreted poteniometric surface for the unconsolidated deposits and poteniometric surface for the bedrock units were created for the RAA. A potentiometric surface represents the elevation to which water would rise in the aquifer if it was not confined, and is equivalent to the water table in the unconfined areas of the aquifer*.

a. Given that some unconsolidated deposits and bedrock units are confined, comment on the significance of considering the geologic units to be unconfined when developing the potentiometric surfaces.

Response 45

a. The surfaces are created based on interpolation (kriging) of the hydraulic head measured at the well locations. Whether or not the geological units are confined or unconfined is not relevant to the assumed surfaces because it is not necessary to presuppose which condition dominates when developing potentiometric surfaces.

Question 46

Volume 3C, Section 2.3, Page 2.3

a. Clarify if the proposed groundwater monitoring is a one-time event or will it be on- going.

b. Provide information on the sampling frequency and parameters analyzed if the monitoring is on-going.

Response 46

a-b. Groundwater monitoring will be ongoing throughout the Project life. A conceptual groundwater monitoring plan is provided as Appendix IR46-1, which provides details regarding the conceptual groundwater monitoring plan, including the frequency of sampling and parameters to be analyzed.

Question 47

Volume 3A, Section 11.4.2.2, Page 11.39

Alberta Transportation states that when an active nest or den is found, provincial or federal disturbance setback distances for SOMC will be used.

a. **Clarify what setback distance will be used for SOMC identified in the PDA that are not listed in the provincial or federal tables (e.g., olive-sided flycatcher).**

Response 47

a. As stated in Volume 3A, Section 11.4.2.2, Table 11-11, the recommended setback distances for olive-sided flycatcher range from 50 m to 300 m depending on the level of disturbance. If a species of management concern (SOMC) feature (e.g., nest, den) is identified during a pre-construction wildlife survey that is not listed in Volume 3A, Section 11, Table 11-10 or Table 11-11, AEP and/or Environment and Climate Change Canada (ECCC) would be consulted to determine the appropriate site-specific mitigation and recommended setback distance.

Question 48

Volume 3A, Section 11.4.6, Table 11-4, Page 11.66
Volume 3A, Section 11.7.2, Page 11.68

The table states that changes in movement are expected to be *reversible*. Yet, in Section 11.7.2 (Page 11.68) it is stated that *there is some uncertainty how ungulates and other wildlife would respond to these structures if they are encountered during daily or seasonal movements.*

a. **Given the uncertainty of how ungulates and other wildlife would respond to permanent project structures (e.g., diversion channel), comment on why changes in movement are expected to be reversible?**

Response 48

a. The residual effects characterization related to reversibility assumes the residual effect is likely to be reversed after activity completions and reclamation (see Volume 3A, Section 11, Table 11-5). Change in movement due to sensory disturbance during construction would be considered reversible after construction activities cease.

   However, Table 11-14 (Volume 3A, Section 11) should have read “Irreversible” (I)) for change in movement during dry operations because Project structures will be permanent and not decommissioned; see the red text and strikeout for the revised information in Table IR48-1 (the relevant cell is in gray). Although change in movement is considered irreversible during dry operations, it is expected that wildlife will continue to maintain daily or seasonal movements in the LAA using alternate or existing travel routes where mitigation will be applied (e.g., wildlife-friendly fencing, vegetated side slopes along diversion channel).

Table IR48-1 Project Residual Effects on Wildlife and Biodiversity during Construction and Dry Operations (Revision of Table 11-14 in Volume 3A, Section 11)

Residual Environmental Effect	Residual Effects Characterization								
	Project Phase	Timing	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socio-economic
Change in Habitat	C	S/R	A	L-H	LAA	ST/LT	S	R	D
	O	N/A	A	L-H	LAA	LT	IR	R	D
Change in Movement	C	S/R	A	L-M	LAA	ST	C	R	D
	O	N/A	A	L-M	LAA	LT	C	~~R~~ I	D
Change in Mortality Risk	C	S/R	A	L	RAA	ST	IR	R	D
	O	N/A	A	L	LAA	LT	IR	R	D
Change in Biodiversity	C	S/R	A	L	RAA	ST/LT	S	R	D
	O	N/A	A	L	LAA	LT	IR	R	D

KEY

See Table 11-5 for detailed definitions

Project Phase
C: Construction
O: Dry Operation

Timing Consideration
T: Time of day
S: Seasonality
R: Regulatory

Direction:
P: Positive
A: Adverse
N: Neutral

Magnitude:
N: Negligible
L: Low
M: Moderate
H: High

Geographic Extent:
PDA: Project development area
LAA: local assessment area
RAA: regional assessment area

Duration:
ST: Short-term;
LT: Long-term

N/A: Not applicable

Frequency:
S: Single event
IR: Irregular event
R: Regular event
C: Continuous

Reversibility:
R: Reversible
I: Irreversible

Ecological and Socio-Economic Context:
D: Disturbed
U: Undisturbed

Question 49

Volume 3B, Section 11.3.2.1, Page 11.9

Alberta Transportation states that *flood events of moderate magnitude can help maintain riparian habitat.*

a. Clarify what flood intensity is considered moderate.

Response 49

a. As described in Volume 3B, Section 11.3.2.1, Page 11.9, natural floods, in general, maintain riparian habitat through moderate (i.e., intermediate) disturbance regimes that increase habitat heterogeneity and biodiversity (Beechie et al. 2006). A moderate magnitude flood with recurrences of 1 in 5 to 1 in 10 years has been reported to provide suitable conditions for cottonwood tree recruitment, which contributes to the maintenance of riparian habitat (Mahoney and Rood 1998).

REFERENCES

Beechie, T.J., M. Liermann, M.M. Pollock, S. Baker, J. Davies. 2006. Channel pattern and river-floodplain dynamics in forested mountain river systems. Geomorphology 78: 124-141.

Mahoney, J.M., and S.B. Rood. 1998. Streamflow requirements for cottonwood seedling recruitment – an integrative model. Wetlands 18: 634-645.

Question 50

Volume 3B, Section 11.3.2.2, Page 11.9

Alberta Transportation states that a qualified biologist would be employed to conduct nest searches when sediment cleanup and debris removal from the off-stream storage area occurs seven days following reservoir draining and during the Restricted Activity Period.

a. Why would the nest searches occur seven days following reservoir draining (i.e., why not before seven days)?

Response 50

a. During reservoir draining, habitat is not immediately suitable for nesting due to wet ground conditions, sediment deposition, and presence of debris. If sediment and debris cleanup occur less than seven days (Gregoire 2010 pers. comm.; Gregoire 2014 pers. comm.) after draining is completed in a specific area, nest surveys are not recommended because habitat conditions will not be suitable for nesting and site disturbance is ongoing, reducing the likelihood of birds re-nesting.

However, if maintenance activities are planned within the restricted activity period for migratory birds and delayed later than seven days after draining (e.g., delays in equipment deployment or ground conditions), pre-disturbance nest surveys will be conducted to determine if birds have begun to re-establish nests in the area.

REFERENCES

Gregoire, P. 2010. Senior Environmental Assessment Officer, Canadian Wildlife Service, Prairie & Northern Region, Environment Canada. Personal communication, email.

Gregoire, P. 2014. Senior Environmental Assessment Officer, Canadian Wildlife Service, Prairie & Northern Region, Environment Canada. Personal communication, email.

Question 51

Volume 3C, Section 2.9, Page 2.4

a. Clarify if there will be wildlife monitoring during maintenance activities in the restricted activity period (esp. during post flood sediment clean-up).

Response 51

a. Debris removal will occur outside the restricted activity period for the Key Wildlife and Biodiversity Zone (see Alberta Transportation (2018)). In the reservoir, sediment and debris will be moved away from areas (but remain in the reservoir) if the presence of these materials affects the functioning of the reservoir or associated structures. Movement of sediment and debris will occur in other areas of the PDA (e.g., diversion channel, outlet structure, unnamed creek) to maintain free flow of water.

Pre-disturbance nest surveys will be conducted to reduce the risk to migratory birds and raptors during post-flood operations if maintenance activities are planned within the restricted activity period for migratory birds (April 15 to August 31) or raptors (February 15 to August 15) (see Volume 3B, Section 11.3.2.2). Wildlife monitoring during post-flood operations will be defined in the wildlife mitigation and monitoring plan (see the response to IR425, Appendix IR425-1 for a draft), which will be developed in consultation with provincial and federal regulators.

REFERENCES

Alberta Transportation. 2018. Debris Deflector—Environmental Assessment Addendum. CEA Agency Document 25. Prepared by Stantec Consulting Ltd. for Alberta Transportation (addendum to the March 2018 EIA)

Question 52

<u>Volume 1, Section 3.1, Page 3.1</u>

Alberta Transportation states that *the diversion capacity and combined storage of Glenmore Reservoir allows the Project to mitigate downstream flood damages* and that available active flood storage at Glenmore Reservoir is 10,000,000 m^3.

a. Clarify if storage at the Glenmore Reservoir is to be considered in conjunction with the Project and if the capacity at the Glenmore Reservoir is required for the Project to mitigate the design (2013) flood.

b. Describe how the two reservoirs would work together.

c. Describe structural and/or operational modifications to the Glenmore Dam and Reservoir that would be required in order to operate the Project as designed or for potential future joint operation.

Response 52

a. Yes, the Glenmore Reservoir storage capacity of 10,000,000 m^3 is to be considered in conjunction with the Project; the combined storage capacity of the Glenmore Reservoir and the Project is required to mitigate the design (2013) flood.

b. AEP Operations will be in communication with the City of Calgary in advance of and during the flood season each year, so each party will maintain an understanding of the system's status. The need for flood operations will be identified through this advanced communication and will be informed by forecasted and measured flows on Elbow River at the diversion structure and upstream. Flood water will be partially diverted into the off-stream reservoir when flows in Elbow River at the diversion structure exceed 160 m^3/s. The meaning of partial diversion of flood water is as follows:

- If 170 m^3/s is flowing in the river, 10 m^3/s would be diverted into the reservoir and 160 m^3/s would continue downstream to Glenmore Reservoir.
- A 1:10 year flood has a peak flow of 330 m^3/s, so 170 m^3/s would be diverted into the reservoir and 160 m^3/s would continue downstream.

- A 1:100 year flood has a peak flow of 755 m^3/s, so 595 m^3/s would be diverted into the reservoir and 160 m^3/s would continue downstream.
- If the maximum diversion capacity of 600 m^3/s is exceeded, then the service spillway gates would lower and start to let more than 160 m^3/s downstream. A flood with the magnitude of the 2013 flood, with a peak flow of 1,240 m^3/s, would have 600 m^3/s diverted into the reservoir and 640 m^3/s would continue downstream.

Water diversion will cease once flows in the Elbow River recede to less than 160 m^3/s or when the off-stream reservoir is at capacity. Figure IR52-1 is a flow chart that illustrates the draft operational procedures for the Project–Glenmore Reservoir System. These draft operational procedures may be updated as and when required should the Glenmore Reservoir operations change over time.

c. No structural modifications to the Glenmore Dam and Reservoir would be required for the Project to operate as designed or for potential future joint operation. Operationally, the City of Calgary must maintain a reserve capacity of 10,000,000 m^3 within Glenmore Reservoir during the flood season.

DRAFT

PRE-EVENT PROCEDURES

>48 Hours Prior to Flood

Alberta Flood Forecasting predicts a significant event within the Elbow Basin

- Personnel dispatched to site for operations preparation.
- Check system/gate operations.
- Notify City of Calgary Business Continuity and Emergency Management (BCEM) that AEP Staff are mobilizing to site
- Constant monitoring of upstream flow gauges

24 Hours Prior to Flood

Flows not expected to increase

Continue monitoring flows until risk has passed

Flood Forecast indicates pending operation in 24 hours

Flood Forecast indicates pending operation in 24 hours

Begin 24-hour operation of Diversion and Off-stream Dam

General Assumptions/Recommendations

- AEP flood forecasting shall provide continuous flood forecast modeling and is responsible for alerting personnel of impending flood risk.
- Automatic control with manual override (and remote available).
- City of Calgary and AEP are in frequent communication prior to flood season.
- All existing hydrometric stations are in operation prior to flood season.
- A hydrometric station is installed at the Highway 22 Bridge.
- Glenmore performs pre-flood draw down levels for all flood events. (See bottom left for Glenmore operations). *ASSUMPTION OF 10,000 DAM³ OF AVAILABLE STORAGE IN GLENMORE*
- Priority should always be to divert into Off-stream Reservoir over Glenmore.
- Gate operating position will be adjusted at regular intervals.
- Assume annual OMS work is on-going, including exercising of gates, inspections, reservoir maintenance, etc.

Decision to Divert

City and AEP in communication

AEP Operations Considers the Following:

- Consultation with City of Calgary
- If Forecast Model Predicts Flows to Exceed 160 m^3/s in 3-hr Measured Flows
- Bragg Creek Gauge (ID 05BJ004) Indicates Flows Greater than 160 m^3/s
- Sarcee Bridge Gauge (ID 05BJ010) Indicates Flows Greater than 160 m^3/s
- Proposed Diversion Headwater Gauge Indicates Flows Greater than 160 m^3/s
- Proposed Highway 22 Gauge Indicates Flows Greater than 160 m^3/s

Raise Project headpond in anticipation of diversion

Decision to Divert

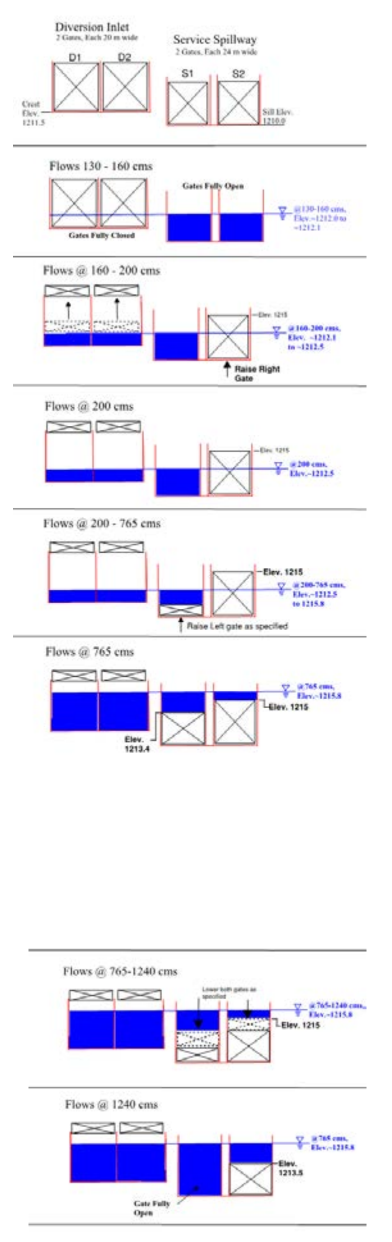
Begin Notification of Impending Operation

- Notify City of Calgary BCEM
- Notify Downstream Property Owners
- Trigger Warning Lights/Sirens.
- Close Off-Stream Reservoir Low Level Outlet Structure
- Secure Site
- Notify Appropriate Authorities and River Forecast Team

Proceed to Operations for Diversion Structure and Monitor Glenmore Levels

- Use Constant Monitoring of Gauges and Project Headpond Elevations to Predict Flows and Gate Position.
- Utilize Diversion Headwater Gauge for Water Surface Information
- Use New Gauge at Highway 22 and on Obermeyer Gates to Monitor Downstream Flow

NOTE: Time to Raise or lower Gates 1m = XX Minutes



IN PROGRESS

	Recommended Gate Positions						Flows (m3/s)	
	Flow (cms)	Approximate Water Surface Elevation (m)	Diversion Inlet Gates X- Closed, O- Open D1	Diversion Inlet Gates X- Closed, O- Open D3	Crest Gate S1 Elev. (m)	Crest Gate S2 Elev. (m)	Diversion	Downstream at Highway 22
Limit Downstream Flows to 160 m3/s	130-160	1212.0 - 1212.2	X	X	1210.0	1215.0	0.0	130-160
	160-170	1212.0 - 1212.2	O	X	1210.0	1215.0		
	170-180	1212.0 - 1212.2	O	X	1210.0	1215.0		
	180-190	1212.0 - 1212.2	O	O	1210.0	1215.0		
	190-200	1212.0 - 1212.2	O	O	1210.0	1215.0		
	200-220	1212.2 - 1212.5	O	O	1210.3	1215.0		
	220-240					1215.0		
	240-260					1215.0		
	260-280					1215.0		
	280-300					1215.0		
	300-320					1215.0		
	320-340	1213.3 - 1213.5			1210.9	1215.0		
	340-360					1215.0		
	360-380					1215.0		
	380-400					1215.0		
	400-420					1215.0		
	420-440					1215.0		
	440-460					1215.0		
	460-480					1215.0		
	480-500					1215.0		
	500-520					1215.0		
	520-540	1214.5 - 1214.7			1212.1	1215.0		
	540-560					1215.0		
	560-580					1215.0		
	580-600					1215.0		
	600-620					1215.0		
	620-640	1214.5 -1214.8	O	O	1214.0	1215.0		
	640-680							
	700-720							
	720-740							
	740-760	1215.0- 1215.4	O	O	1214.0	1214.0	600.0	140-160
	760-780	1215.7- 1215.9					600.0	
Maintain 600 m3/s Diversion	780-800	1215.7- 1215.9					600.0	
	800-820	1215.7- 1215.9					600.0	
	820-840	1215.7- 1215.9					600.0	
	840 - 860	1215.7- 1215.9					600.0	
	860 - 880	1215.7- 1215.9					600.0	
	880 - 900	1215.7- 1215.9					600.0	
	900 - 920	1215.7- 1215.9						
	920 - 940	1215.7- 1215.9						
	940 - 960	1215.7- 1215.9						
	960 - 980	1215.7- 1215.9						
	980 - 1000	1215.7- 1215.9						
	1000 - 1020	1215.7- 1215.9						
	1020 - 1040	1215.7- 1215.9						
	1040 - 1060	1215.7- 1215.9						
	1060 - 1080	1215.7- 1215.9						
	1080 - 1100	1215.7- 1215.9						
	1100 - 1120	1215.7- 1215.9						
	1120 - 1140	1215.7- 1215.9						
	1140 - 1160	1215.7- 1215.9						
	1160 - 1180	1215.7- 1215.9						
	1180 - 1200	1215.7- 1215.9						
	1200 - 1220	1215.7- 1215.9						
	1220 - 1240	1215.7- 1215.9						
Extreme Flood Events	1240 - 1260	1215.7- 1215.9						
	1300-1400	1215.6-1215.8			1210	1210		
	1400-1500	1215.8-1216.0			1210	1210		
	1500-1600	1215.4-1215.6			1210	1210		
	1600-1700	...	...	...	...	...		
	1700-1900	...	...	...	...	...		
	1900-2100	...	...	...	...	...		
	2100-2300	...	...	...	...	...		
	2300-2500	...	...	...	...	...		
	2500-2700 (PMF Event)	1217.8	1212	1212	1210	1210		

Diversion Structure Shutdown

Decision to Stop Diversion Prior to Off-stream Reservoir Full

- Measured flows at Sarcee below 160 m^3/s
- Measured flows at Bragg Creek below 160 m^3/s
- Measured inflow at Glenmore below 160 m^3/s
- Measured flow at Diversion headwater gauge below 160 m^3/s
- Glenmore levels are not increasing
- No additional rain predicted for event
- Baseflow lag is receding in inflow hydrograph
- Forecast model does not predict increase in flows

Flows Recede Below 160 m^3/s

Off-stream Reservoir Full

Stop Diversion

If capacity remains in Glenmore

Coordinate with Glenmore Operating Personnel to determine appropriate time to drain.

Drawdown Instructions

- No additional rain forecasted
- Consider negative impacts of Off-stream Reservoir drawdown (i.e. How full is Glenmore, any observable damage to Glenmore, Off-stream Reservoir, future rainfall predictions, water quality, sediment, etc.

- Close Diversion Structures
- Lower River Gates
- Open Off-stream Reservoir Low Level Outlet Works
- Continue monitoring flow information
- Continue monitoring Glenmore levels

- Inspect the Reservoir
- Maintenance as required

If no additional capacity in Glenmore

Perform additional diversion into Off-stream Reservoir until Glenmore levels reduce to safe elevation

Alternate Operations

Flows Exceed 1700 m^3/s

NOTE:

1. THIS SCENARIO WILL REQUIRE THE DIVERSION INLET GATES TO BE OPERATED TO LIMIT INFLOW TO PROJECT DIVERSION CHANNEL TO 600 m^3/s.

Off-stream Reservoir is at Capacity

NOTE:
1. THIS SCENARIO MAY OCCUR WHEN ENOUGH FLOW HAS BEEN DIVERTED INTO THE OFF-STREAM RESERVOIR AND THE MAXIMUM DESIGN CAPACITY HAS BEEN REACHED.

Off-stream Reservoir Reaches Elevation 1210.75

NOTIFY CITY OF CALGARY BCEM AND AEP RIVER FORECAST

Close Diversion Gates

Proceed to Drawdown Instructions

Glenmore Reservoir Levels Higher than Expected

NOTE:
1. THIS SCENARIO MAY OCCUR FROM THE FOLLOWING;
⇒ INITIAL OPERATIONS ERRORS OF THE PROJECT MAKING "CATCH-UP" DESIRED,
⇒ SIGNIFICANT RAINFALL CONTRIBUTIONS OCCUR BETWEEN THE PROJECT AND GLENMORE
⇒ IF BACK TO BACK MAJOR RAINFALL EVENTS ARE FORECAST.
⇒ UNDER DROUGHT SCENARIO
2. CONFIRMATION WITH CALGARY OPERATORS SHOULD BE OBTAINED PRIOR TO ALTERING TYPICAL OPERATIONS.

Glenmore Operations Elevations–Draft To Be Updated

NOTE: Glenmore Operations in conjunction with the Project will need to be re-considered once the construction of the Glenmore Gates Project has been completed and changed Glenmore Operating Procedures are in place.

Glenmore operations will inform the Project operations, not guide them.

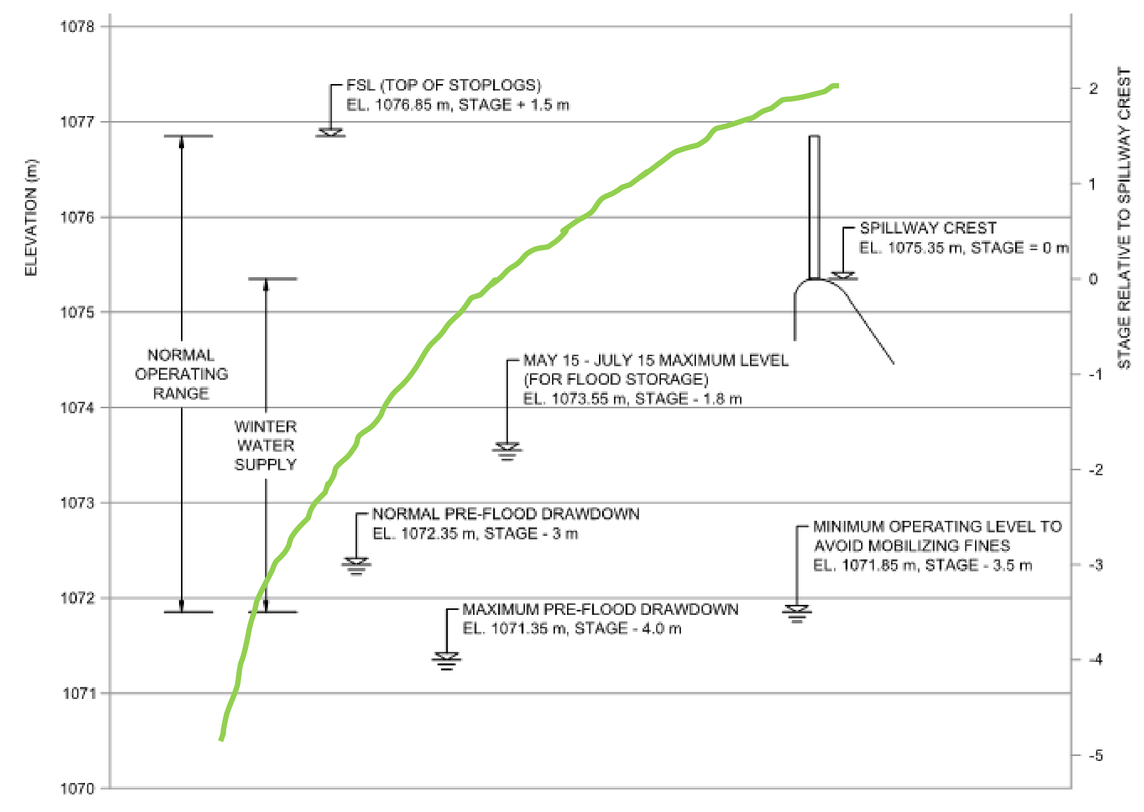


Figure IR52-1 Draft Operational Procedures for the Project--Glenmore Reservoir System

Question 53

Volume 3A, Section 6.1.4.1, Figure 6-1, Page 6.6
Volume 4, Appendix J, 2.1, Page 2.1

Alberta Transportation states that the *LAA included the PDA and the Elbow River from Redwood Meadows to the inlet of Glenmore Reservoir* (Volume 3A 6.1.4.1), that the *LAA extends from the diversion structure*…(Appendix J, 2.1). In Figure 6-1 (which is used again in various sections) it appears it may start below Redwood Meadows (i.e., inlet structure) and that the LAA may include the Glenmore Reservoir.

a. **Clarify and explain the boundaries of the LAA for the hydrology assessment scenarios.**

b. **Update any of the hydrology and surface water quality sections of the EIA affected by the boundaries of the LAA, ensuring that the assessments include all areas of the LAA where applicable.**

Response 53

a. The description of the LAA in Appendix J, 2.1 is incorrect. The boundaries of the LAA for hydrology extend from approximately 2.3 km northeast of Redwood Meadows townsite (approximately 1,100 m southwest of the diversion inlet structure) to the inlet of the Glenmore Reservoir.

   Volume 3A, Section 6, Figure 6-1 is incorrect; see Figure IR54-1 in the response to IR54 for the correct boundary of the LAA for both the hydrology and water quality LAA. The LAA includes Elbow River to the inlet of Glenmore Reservoir but does not include Glenmore Reservoir.

b. The assessment of effects to hydrology and surface water quality reflect the LAA boundary as described in a.

Question 54

Volume 3A, Section 6.1.4.1, Figure 6-1, Page 6.6
Volume 4, Appendix J, 2.1, Page 2.1

Alberta Transportation states that the *RAA is the Elbow River watershed from headwaters to Glenmore Dam* (Volume 3A, 6.1.4.1), that the *RAA is the Elbow River watershed, including Glenmore Reservoir* (Appendix J, 2.1), and Figure 6-1 appears to include the entire watershed, including the Glenmore Reservoir and upstream and downstream of the Glenmore Reservoir.

a. Clarify and explain the boundaries of the RAA for the hydrology assessment, including why the Glenmore Reservoir and downstream of the Glenmore Reservoir is, or is not, included in either of the assessment areas given that the goal of the Project is to limit discharge downstream from the Glenmore Reservoir to less than 160 m^3/s.

b. Provide a description of the hydrology of the Elbow River at the Glenmore Reservoir and below the Glenmore Dam to the confluence with the Bow River. If it is determined to be within the RAA, explain why this assessment was not completed.

c. Update the hydrology and surface water quality sections affected by the boundaries of the RAA, ensuring that the assessments include all areas of the RAA.

Response 54

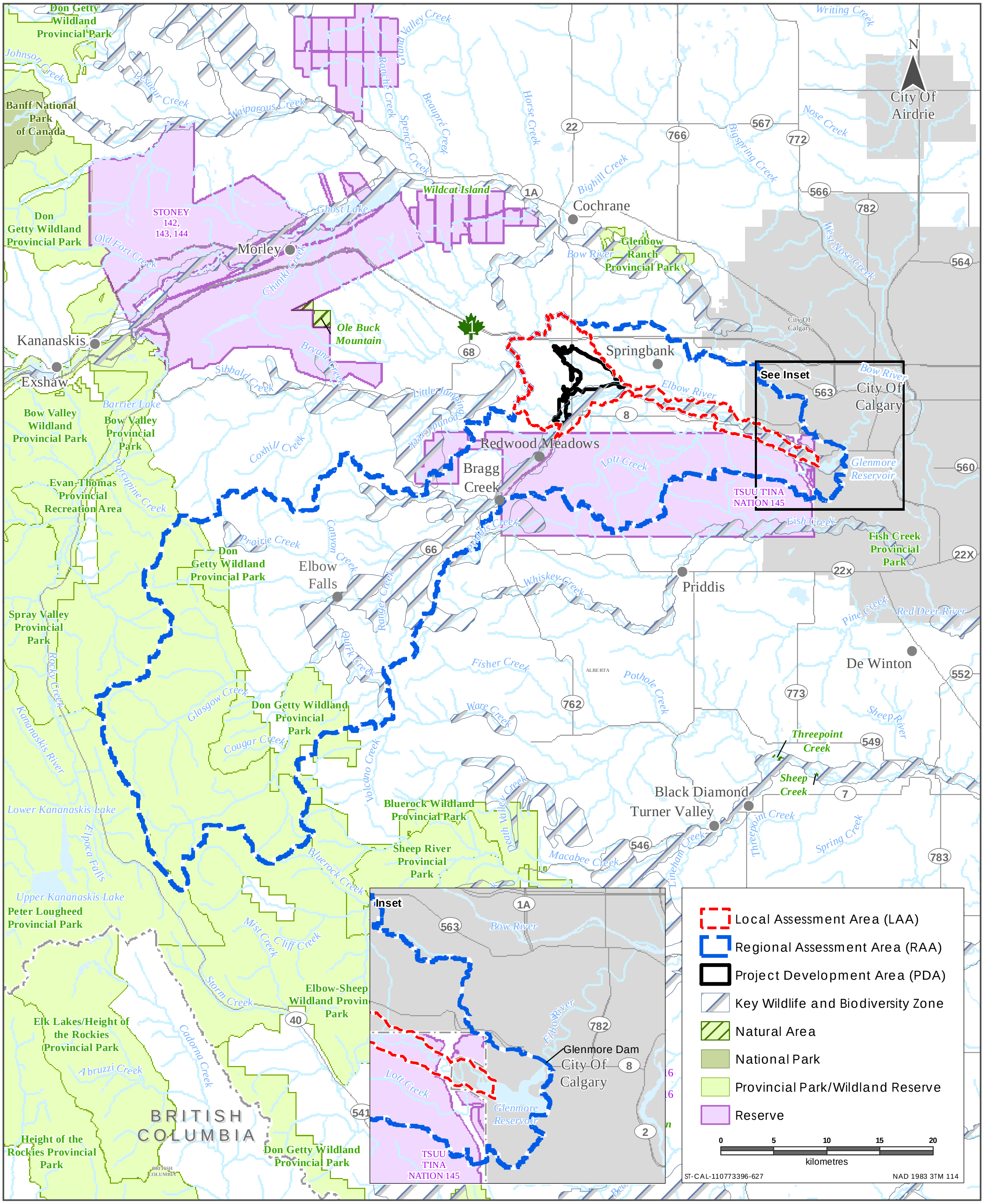
a. The boundary of the RAA for the hydrology assessment is the Elbow River watershed from the watershed headwaters to the outlet of Glenmore Dam; therefore, the RAA includes Glenmore Reservoir but does not extend downstream of Glenmore Dam.

   By diverting flow greater than 160 m^3/s, the hydrology of Elbow River between the Project site and Glenmore Dam is jointly managed by AEP and the City of Calgary. The control of hydrology downstream of Glenmore Dam is under the sole control of the City of Calgary. Therefore, the hydrology RAA for the Project does not extend downstream of Glenmore Dam. Volume 3A, Figure 6-1 is incorrect for the boundary of the hydrology RAA. Figure IR54-1 shows the correct boundary.

   Volume 3A, Figure 7-1 shows an incorrect boundary for the surface water quality RAA. Figure IR54-1 is also a correction to Figure 7-1.

b. Elbow River below the Glenmore Dam to the confluence of the Bow River is not included within the RAA. The assessment of effects on hydrology and surface water reflects the RAA boundary, as presented in Figure IR54-1.

c. No updates to the hydrology and surface water quality sections are needed because the RAA boundary has not changed.



Sources: Base Data - ESRI, Natural Earth, Government of Alberta, Government of Canada
Thematic Data - ERBC, Government of Alberta, Stantec Ltd

Hydrology and Surface Water Quality Spatial Boundaries

Stantec

Figure IR54-1

Question 55

<u>Volume 3A, Section 6.1.5, Page 6.10</u>
<u>Volume 3A, Section 6.1.5, Table 6-2, Page 6.8</u>

Alberta Transportation states that *[t]he definitions for magnitude of effects on hydrology, including sediment transport is further defined as follows…low magnitude change (<15%)…moderate magnitude change (15-30%)…high magnitude change (>30%)*…

These definitions do not appear to be used when assessing the magnitude of effects throughout the hydrology assessment and does not appear to be consistent with Table 6-2 on Page 6.8. The term negligible is often used when discussing magnitude, though is not defined here in the text.

a. Use the provided definitions, or provide definitions for the terms used, for assessing magnitude of effects throughout the hydrology sections of the EIA. Provide updates and make all necessary changes throughout the hydrology sections in both text and tables.

Response 55

a. Volume 3A, Section 6, Page 6-10 is missing a paragraph describing negligible magnitude. Following is added text (in red and indicated renumbering):

“The definitions for magnitude of effects on hydrology, including sediment transport is further defined as follows:

1. “A negligible magnitude change (<10%): Variations in hydrology and sediment transport that are <10% change from existing conditions are not measurable within reasonable accuracy or detected by environmental receptors. Changes in hydrology and sediment transport of less than 10% are considered to result in little to no variation in predicted or measured effects.”
2. A low magnitude change (<15%): Variations in hydrology and sediment transport that are <15% change from existing conditions are likely not measurable within reasonable accuracy or detected by environmental receptors. A 15% reduction in flow is generally used as a maximum threshold for maintenance of instream flow needs in Alberta watercourses (Locke and Paul 2011).
3. A moderate magnitude change (15-30%): Variations in hydrology and sediment transport that are between 15% to 30% relative change from existing conditions may be observable, measurable, and detectable by environmental receptors, depending on frequency and duration. Measurable effects on water levels and flow velocities may occur with associated changes in sediment transport and potential changes in channel morphology.

4. A high magnitude change (>30%): Variations in hydrology and sediment transport that relate to a change in streamflow greater than 30% from existing conditions are likely detectable by environmental receptors, depending on frequency and duration. Measurable effects on water levels and flow velocities most likely occur with changes in sediment transport and associated changes in channel morphology.

The discussion in Volume 3B, Section 6.4.2, Section 6.4.5, Table 6-11 on magnitude of hydrological effects during flood and post-flood operations is consistent with the above definitions.

When considering the ecological context, the magnitude of change in hydrology is considered over a long-term time frame. For a design flood, 1:100-year or 1:10 year flood, the peak and volume of the water are reduced by a large magnitude. (This is the reason for the Project, to mitigate a flood and prevent economic and environmental damage downstream.)

Additional revisions are required in Volume 3B, Section 6, Table 6-11, as indicated in Table IR55-1; changes are indicated by strikeout and red text. The overall change in hydrology is negligible when considered in the long term (duration). Evaporative loss is a long-term hydrology adverse effect because there is an increase in water lost from the system. It is also an effect across the RAA. Because the change in hydrology (short term) is planned and intended to mitigate flooding, the effect is considered high in magnitude but positive in direction.

The discussion on magnitude of effects on sediment shows the effect as a reduction of greater than 30% (50% and 65%) for design and 1:100 year floods, respectively. The magnitude for hydrology (short term) is assessed as high and positive.

The change in morphology is described in the Table 6-10 in Volume 3B, Section 6.4.4. The changes are between 3% to 24% which would be negligible to moderate effect. The Project Effects table (Table IR55-1) should be changed so that the characterization of magnitude for change in channel morphology is “N to M” rather than “H”.

Table IR55-1 Project Effects on Hydrology during Flood and Post-Flood Operations (revision to Volume 3A, Section 6, Table 6-11)

Effect	Effects Characterization								
	Project Phase	Timing	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socio-economic Context
~~Change in Hydrology~~ Change in Hydrology (long term)	F, PF	N/A	A	N	~~PDA~~ RAA	~~ST~~ LT	IR	I	D
Change in Hydrology (short term) [this is a new row]	F, PF	N/A	P	H	RAA	ST	IR	I	D
Change in Suspended Sediment Transport	F, PF	N/A	~~A~~ A,P	H	LAA	ST to LT	IR	I	D, U
Change in River Channel Morphology	F, PF	N/A	A	~~H~~ N to M	PDA	LT	IR	I	D

KEY

See Table 6-2 in Volume 3A for detailed definitions

Project Phase
F: Flood Operations
PF: Post-Flood Operations

Timing Consideration
S: Seasonality
T: Time of day
R: Regulatory

Direction:
P: Positive
A: Adverse
N: Neutral

Magnitude:
N: Negligible
L: Low
M: Moderate
H: High

Geographic Extent:
PDA: Project Development Area
LAA: Local Assessment Area
RAA: Regional Assessment Area

Duration:
ST: Short-term;
MT: Medium-term
LT: Long-term

N/A: Not applicable

Frequency:
S: Single event
IR: Irregular event
R: Regular event
C: Continuous

Reversibility:
R: Reversible
I: Irreversible

Ecological/Socio-Economic Context:
D: Disturbed
U: Undisturbed

Question 56

Volume 3A, Section 6.2.2.4, Table 6-5

a. Provide mean (1979-2016) monthly peak flows for Bragg Creek and Sarcee Bridge stations in the Table, or in a new separate table (TOR 3.4.1B).

Response 56

a. Table IR56-1 provides mean peak monthly flow for Elbow River at the Bragg Creek and Sarcee Bridge stations from 1979 to 2016.

Table IR56-1 Summary of Mean Peak Monthly Flow for Bragg Creek and Sarcee Bridge (1979-2016)

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	Peak Flow (m^3/s) (standard deviation in brackets)											
05BJ004 Elbow River at Bragg Creek	4.89 (0.7)	4.45 (0.5)	6.32 (0.7)	6.53 (0.9)	30 (6.6)	77.4 (15)	35 (6.4)	22.5 (3.4)	16.9 (3.1)	11.4 (1.8)	7.8 (1.1)	6.23 (0.9)
05BJ010 Elbow River at Sarcee Bridge	4.53 (0.6)	4.12 (0.3)	5.86 (0.8)	8.59 (1.5)	36.7 (8.8)	92.8 (19.5)	35.1 (7.3)	23.6 (3.9)	22 (3.9)	14.1 (2.2)	6.44 (0.6)	5.06 (0.5)

Question 57

Volume 3A, Section 6.2.2.4, Page 6.33

Alberta Transportation states that *there are several small, naturally occurring waterbodies in the PDA. These waterbodies are primarily fed by the low-level outlet and its tributaries.*

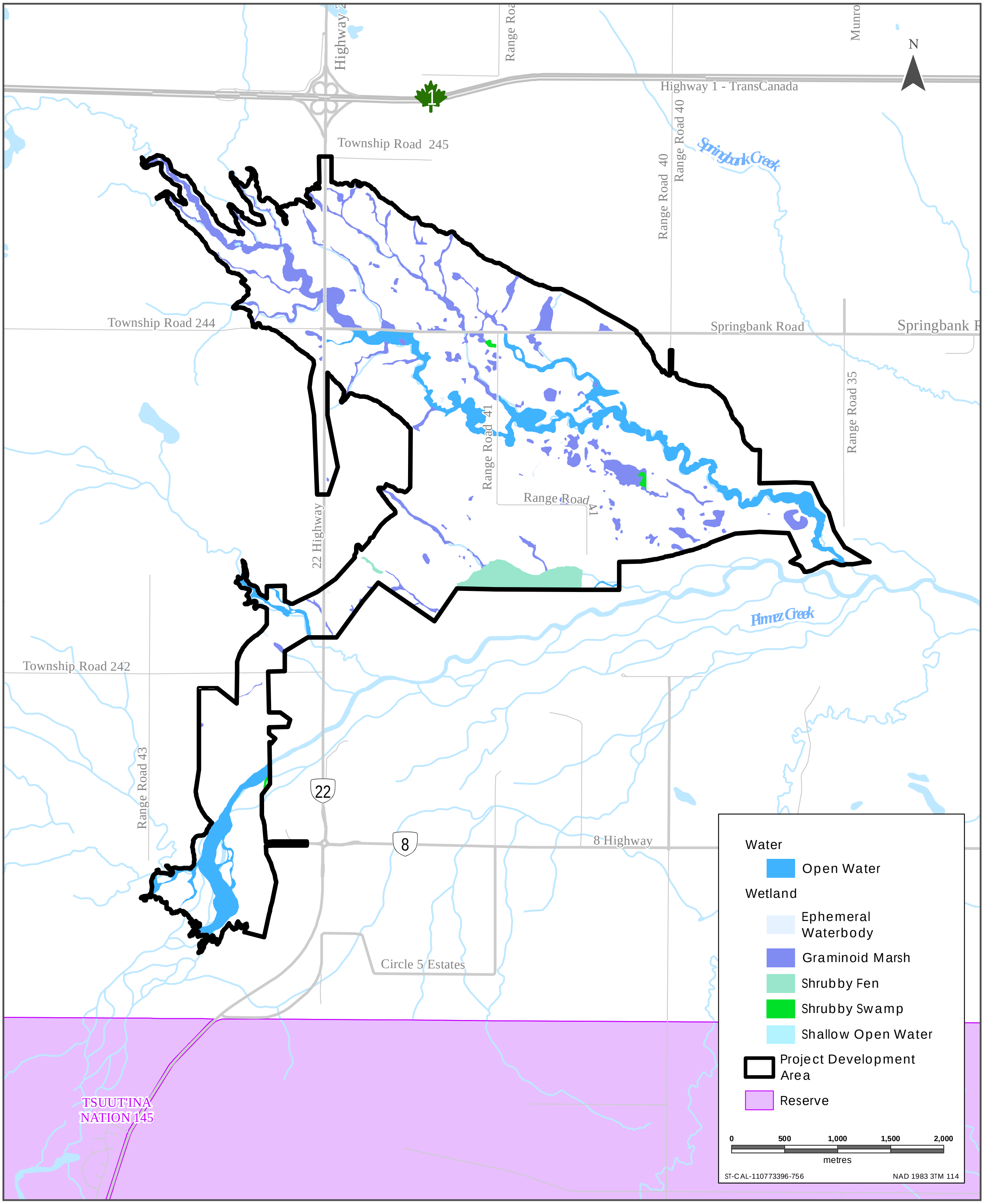
a. Confirm that these waterbodies are primarily fed by the unnamed creek and its tributaries.

b. Provide a figure identifying the approximate areas of these waterbodies.

Response 57

a. Yes, these waterbodies are primarily fed by the unnamed creek (low-level outlet channel) and its tributaries.

b. Figure IR57-1 shows the locations of the waterbodies (including wetlands). The total area of the shown waterbodies is 225 ha.



Sources: Base Data - Government of Alberta, Government of Canada, Thematic Data - Stantec Ltd.

Waterbodies in the PDA

Stantec

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT

Figure IR57-1

Question 58

<u>Volume 3A, Section 6.2.2.6, Table 6-9, Page 6.36</u>

Alberta Transportation states that water licences allocated within the LAA and associated volumes are summarized in Table 6-9.

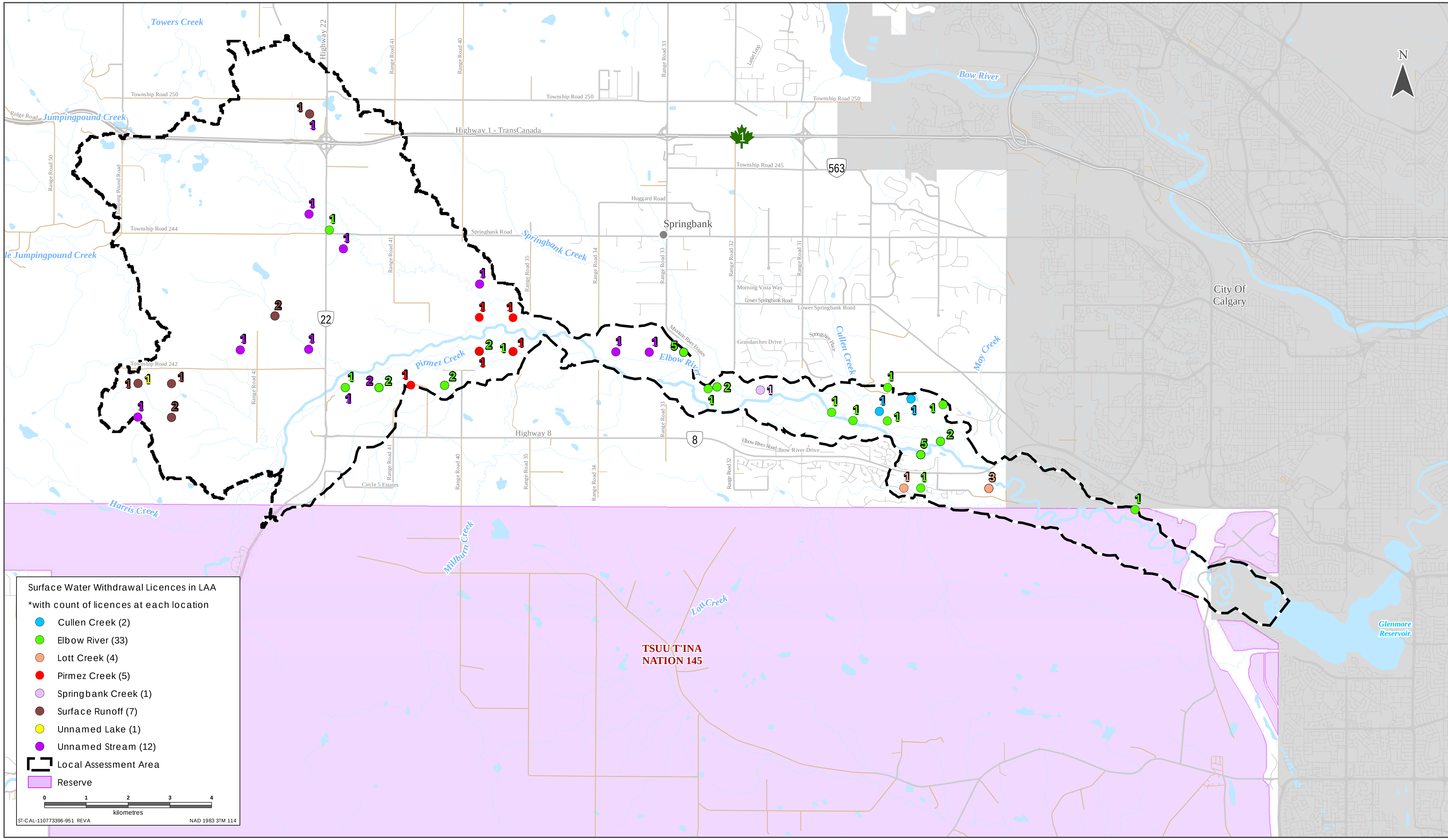
a. Provide a figure showing the locations of each water licensee identified in the table.

Response 58

a. Figure IR58-1 shows the location of each water licence identified in Volume 3A, Section 6.2.2.6, Table 6-9. In some instances, there are multiple licences at the same location and that has been indicated numerically.

The surface water withdrawal licence data illustrated in Figure IR58-1 was provided by Alberta Environment and Parks (J.Yan. Applications Analyst, pers comm. April 4, 2017) and has not been verified.

Natural Resources Conservation Board
May 2019



Sources: Base Data - Government of Alberta, Government of Canada. Thematic Data - Stantec Ltd.

Stantec

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT

Surface Water Withdrawal Licences in the Hydrology Local Assessment Area

Figure IR58-1

Question 59

<u>Volume 3A, Section 6.5.2, Page 6.40</u>

Alberta Transportation states that *flow estimates from the five intersected tributaries are extremely low, likely intermittent and are already affected by roads, cultivation, and dugouts*. Although likely low in volume (or intermittent) during normal years, these tributaries appear to be permanently intersected by the diversion channel following construction and may convey greater volumes during flood years.

a. **Provide details on how water is being diverted or managed from these tributaries.**

b. **Estimate the frequency, volume, and duration of flow that would drain from the low- level outlet as a result of inputs from the tributaries, as well as the suspended sediment concentration within this water.**

c. **Identify mitigation measures that could be implemented if required (e.g., for sedimentation).**

d. **Evaluate residual effects on potentially impacted areas (e.g., indicator fish species and life stage).**

Response 59

a. The tributaries are permanently intersected by the diversion channel; so, all flows will be directed down the diversion channel and, if sufficiently high in magnitude, into the reservoir. Since the outlet structure remains open during dry operations, tributary flows would ultimately be routed back into Elbow River through the unnamed creek (low-level outlet channel). Hydraulic analyses were completed for these local inflows to anticipate runoff rates and calculate erosion potential, and these analyses were incorporated into the diversion channel design.

b. Runoff simulations for the tributaries were modelled for contributions to the diversion channel and reservoir without diversion operations. A 1:10-year, 24-hour rain event was used to develop flow and stage hydrographs and assess peak inflow into the outlet structure. During this event, the maximum flow rate from the reservoir is 13.3 m^3/s. Water quality, including suspended sediment, in the outlet, is expected to be unchanged during dry operations.

c. Based on the responses to a. and b., mitigation is not required.

d. Potential residual effects are described in Section 6.5.2, Page 6-41. Due to the low or intermittent flows in the tributaries, potential use by fish in the tributaries is likely limited. The lower reaches of the unnamed creek will still be available as a low velocity refuge for fish during active flooding in the river and diversion into the reservoir is occurring, but not release from the reservoir). Residual effects to fish indicator species would be negligible.

Question 60

<u>Volume 3A, Section 6.5.2, Page 6.40</u>

Alberta Transportation states that *during dry operations, there is potential for increased flows in the low level outlet through the intersection of the diversion channel with shallow groundwater seepage…the spatial extent of groundwater seepage would be determined by the depth of local water tables.*

a. **Quantify the amount of groundwater expected to be discharged through the low level outlet and how this change relates to baseline conditions.**

b. **Discuss effects this may have on unnamed creek downstream from the low level outlet.**

Response 60

a. Seepage into the diversion channel (when dry) is estimated by the numerical groundwater flow model provided in the Hydrogeology TDR Update (see response to IR42, Appendix IR42-1, Section 5.5). The estimated net seepage into the diversion channel is 0.013 m^3/s. Whether this seepage water eventually flows to the unnamed creek depends on climatic conditions at the time (given the relatively low seepage rate). For example, during wet periods of the year or soon after a major rainfall event, this water would likely pass through the unnamed creek system because the shallow subsurface would be more saturated. During dry periods of the year, this seepage water may entirely be lost from the surface water system to a combination of downward infiltration into the subsurface and evapotranspiration into the atmosphere.

b. The natural flow in the unnamed creek is generally intermittent, but the mean flow is approximately 0.03 m^3/s with peak flow measured as 0.79 m^3/s after a period of prolonged rainfall (Volume 4A, Appendix J, Section 3.3.1.2, Page 3.18).

Question 61

Volume 3B, Section 6.0, Page 6.1

a. Explain what effects (cumulative or otherwise) any changes or upgrades at Bragg Creek or Redwood Meadows may have on future flow dynamics during flood events (e.g., increase water volume, speed, etc.).

Response 61

a. The proposed flood mitigation for Bragg Creek (AFW 2017) and Redwood Meadows (ARM 2018), both based on a dyked design, result in local hydrology (flow dynamic) changes along dyked portions of the river and downstream. This can be generally characterized for those reaches, hydrologically, by increase in elevation (or level) of river water and increased velocity, with the greatest change occurring within the dyked reach, then attenuating downstream as the river flow diffuses along the existing natural channel.

Based on currently available information for those two projects, the flood mitigation likely does not contribute to measurable effects that may incrementally act with the Springbank Off-Stream Reservoir Project (the Project). As explained further below, in summary, this conclusion is based on none-to-negligible downstream hydrological effect of the mitigation projects upstream of the Project and none-to-negligible hydrological effect upstream of the Project, resulting in none-to-low likelihood of interaction of effects causing cumulative or other effects between the Project and the upstream mitigation projects.

Effects on River Elevation and Velocity

The Hamlet of Bragg Creek is approximately 4.7 km upstream of Redwood Meadows (based on the community's full boundary) and 9.5 km upstream of the Project PDA. The Community of Redwood Meadows is approximately 1.8 km upstream of the Project PDA.

The proposed Bragg Creek project would have a measurable but negligible hydrological effect on Redwood Meadows; specifically (AFW 2017; p. 19) an increase in water elevation of 0.03 m and an increase in water velocity of 0.03 m/s at the upstream end of the community of Redwood Meadows. This diminishes to 0.01 m and 0.01 m/s at the downstream end of the community.

The proposed Redwood Meadows project is predicted to increase water elevation by 0.4 m (AFW 2017; p.19) at the upstream end of the community of Redwood Meadows (13 times the increase of 0.03 m attributable to the Bragg Creek project).

The proposed Redwood Meadows project is predicted to increase water levels at the downstream end of the community by approximately 0.2 to 0.4 m (ARM 2018, Figure 28) diminishing to 0.05 to 0.1 m approximately 800 m further downstream. This project would also cause a negligible change to velocity (ARM 2018; Figure 24).

These values reflect a 1:100 flood condition for both projects. While these values do not reflect both projects as operating at the same time, cumulative effects, while likely measurable, are likely negligible based on above. To provide context, the 2013 flood, in the vicinity of Bragg Creek, flowed at a velocity of 4 m/s to 5 m/s (AFW 2017; Table 6.1, p. vi) with an average elevation gain of approximately 4 m (AFW 2017; Drawing C-0004). These values are more than 100 times greater than those directly attributable to either proposed project. The 2013 flood offers a reasonable comparison given the similarity in peak volume flow rate with the 1:100 flood: 1,170 m^3/s and 990 m^3/s, respectively, a difference of 15%.

Project Backwater

The maximum spatial area of backwater effect (i.e., heightened water elevation in Elbow River upstream of the diversion structure) is within the PDA.

Both the Bragg Creek and Redwood Meadows projects are upstream of the Project and at a higher elevation (Volume 4, Appendix J, Figure 3-3). Proceeding upstream of the Highway 22 bridge, Redwood Meadows lies at an elevation gain of approximately 50 m, and Bragg Creek lies at an elevation gain of approximately 100 m. As such, no interaction is expected between a backwater effect created by the Project and effects from the two upstream projects; therefore, the Project is not expected to contribute to any cumulative effects. Figure IR61-1 provides the distances of the backwater to both Redwood Meadows and the Tsuut'ina Nation Reserve.

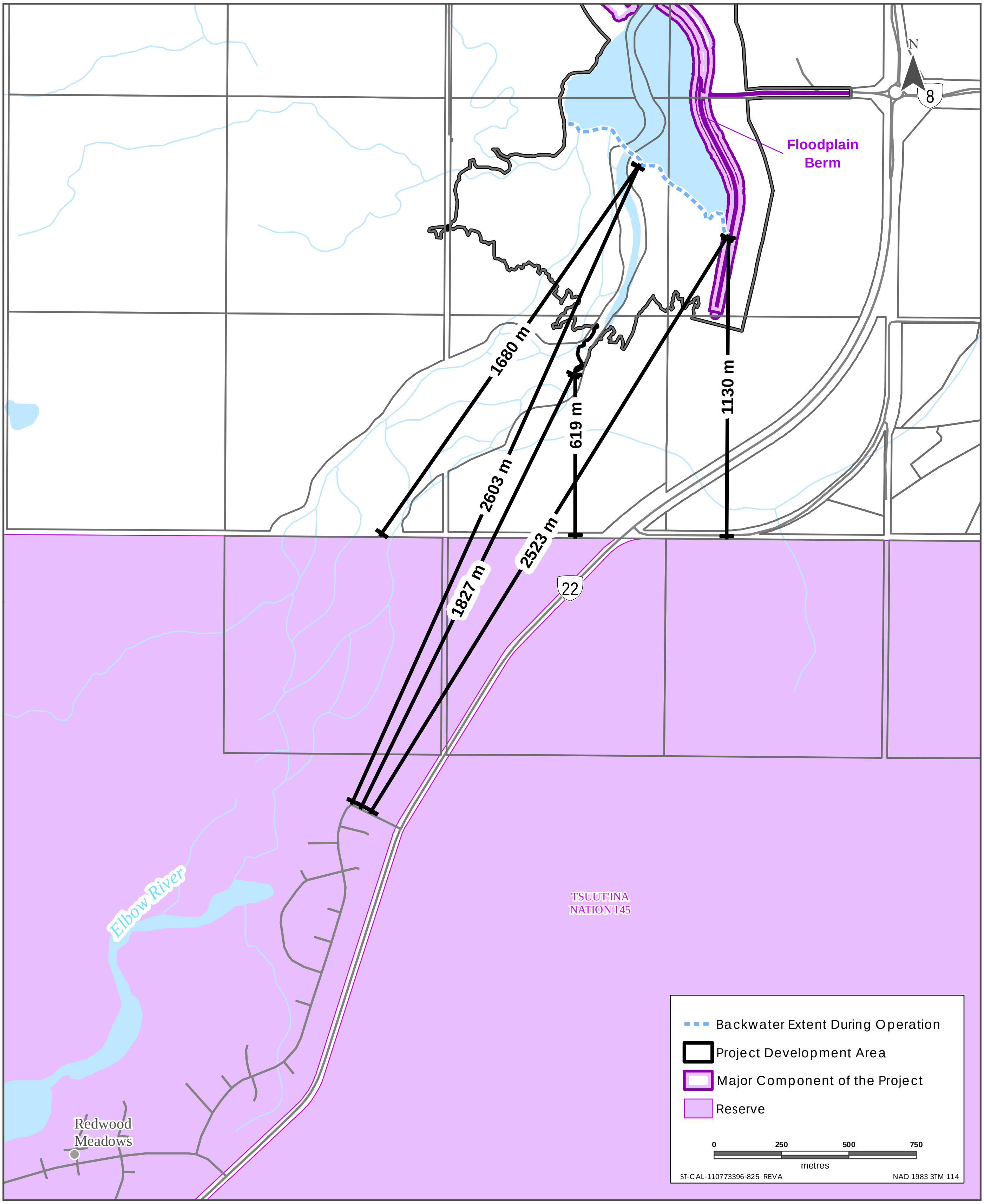
Conclusions

Given the maximum upstream Project hydrological effect, the distances between projects, and downstream hydrological effect of either the Bragg Creek or Redwood Meadows projects, cumulative effects are unlikely. If any such effect occurs, the effect would be negligible, certainly relative to natural flood conditions (without the Project).

References

AFW (Amec Foster Wheeler). 2017. Bragg Creek Flood Design Mitigation Report. Submitted to Rocky View County by AFW.

ARM (Aquatic Resource Management Ltd.). 2018. A Risk and Data Gap Analysis and Template of Mitigation Requirements and Costs Associated with Providing Protection for theTsuuT'ina Lands Adjacent to the Elbow River Upstream of the Proposed Springbank Dry Dam (SR-1). Prepared for TsuuT'ina Nation by ARM, Cochrane, Alberta.



Sources: Base Data - Government of Alberta, Government of Canada, Thematic Data - Stantec Ltd.

Distances of Tsuut'ina **Nation** and Redwood Meadows from Project Features and Backwater Limit

Stantec

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT ENVIRONMENTAL ASSESSMENT

Figure IR61-1

Question 62

Volume 3B, Section 6.1, Page 6.2
Volume 3B, Section 6.4, Page 6.12
Volume 3B, Section 6.5, Page 6.75

Alberta Transportation states that *[n]o definition for significance is provided because the purpose of the Project is to actively modify the hydrology of the Elbow River during floods by diverting flows greater than 160 m^3/s.*

a. **Provide assessments for the significance of the Project on hydrology and determine the significance for changes in hydrology, including an assessment of if these changes may be neutral, positive, or negative. Without a determination of a significance change in hydrology during Project operation may not be effective. This should include how target discharge below the Glenmore Dam is achieved and maintained.**

Response 62

a. The Project's effects on hydrology are positive; the effects are not adverse. The rationale for this is discussed below. A conclusion of significance was not provided because, by law[3], guidance[4] and precedence, significance conclusions are made only for adverse effects. If however, nonetheless, a significance conclusion were to be provided, it would be significant (positive).

RATIONALE FOR CONCLUSION OF POSITIVE EFFECT

As stated in Volume 3B, Section 6.4, page 6.12, "The primary purpose of the Project is to mitigate downstream flood hazard to the City of Calgary by modifying the hydrology of the Elbow River during a high flow by temporarily diverting water." The Project's effects on hydrology are on an intermittent, emergency-response basis. As such, these effects are not the result of regular, continuous routine operations.

The operation of the Project will achieve and maintain the target Elbow River flow rate below the Glenmore Dam (less than 160 m^3/s) for floods up to the design flood, achieved by a diverting a portion of Elbow River flood flows when the river flow is above 160 m^3/s. As a consequence of this design objective, the Project will affect hydrology by reducing flows in Elbow River for the 1:10 year flood and greater magnitude floods.

---

[3] *Canadian Environmental Assessment Act*, An Act respecting the environmental assessment of certain activities and the prevention of significant adverse environmental effects, S.C. 2012, c. 19, s. 52
[4] Operational Policy Statement Determining Whether a Designated Project is Likely to Cause Significant Adverse Environmental Effects under the *Canadian Environmental Assessment Act,* 2012 (November 2015)

These flow reductions will have a positive socio-economic effect on communities downstream of the Project by reducing potential damage to infrastructure; personal and business buildings and contents; human health. These reductions will also have a positive effect on natural features (e.g., soils, vegetation, wildlife) downstream of the Project by the substantial reduction of adverse effects relative to a flood without the Project: the Project will reduce the disturbance and/or destruction of riparian and adjoining areas along Elbow River, while still allowing flood flows of 160 m^3/s that will maintain river ecological functions.

The change in water quantity between the natural flood condition and the effects of the Project will be minimal because the water will be retained in the off-stream reservoir and released back to Elbow River when flooding and erosive potential have been reduced.

Question 63

Volume 3B, Section 6.2.1, Page 6.3

Alberta Transportation states that *the slope value decrease can be interpreted as indicating that a significant proportion of fine sediment goes into storage between Bragg Creek and Sarcee Bridge during high flows….the remobilization of stored sediment likely explains why the rating curve parameters suggest that suspended sediment concentrations at Sarcee Bridge are higher at low flows…*

a. Explain what was defined as fine sediment in this statement.

b. Clarify what processes control how fine sediment settles out during high flows and then is remobilized during low flows or if it is proportionally more significant.

Response 63

a. The definition of fine sediment refers to the portion of sediment that is suspended and was measured during the suspended sediment sampling programs. Because the proportion and size of sediment that is suspended during sampling periods is highly dependent upon the flow velocity at the time of the sampling, no specific grain size definition would be applicable.

b. Proportionally, the suspended sediment concentration is over 200% greater at the Sarcee Bridge (30.5 mg/L) location compared to the Bragg Creek Bridge (9.7 mg/L) location during a flow rate of 10 m^3/s. Suspended sediment concentration is 84% greater at the Bragg Creek Bridge (32,881.0 mg/L) compared to the Sarcee Bridge location (5,139.9 mg/L) at a flow rate of 500 m^3/s. The difference likely relates to the storage potential of suspended sediment between the bridge locations, when compared to the reach of river upstream of the Bragg Creek Bridge. At lower flow rates, the difference between TSS concentrations do not appear substantial, however at higher flow rates they are substantial.

The difference between the two sampling locations does indicate that a substantial proportion of the suspended sediment load goes into storage between Bragg Creek Bridge and Sarcee Bridge during high flows. Although a detailed analysis of this would not give insight into Project operations, the difference is likely related to the geomorphology of the channel between the two bridge locations. In particular, the channel slope decreases from 0.64% at the Bragg Creek Bridge to 0.23% at the Sarcee Bridge. This decrease would result in lower stream power at similar flow rates and be favorable for sediment deposition. An additional factor is the morphology of the channel: the reach between the two bridges exhibits braided-like morphology and is wider than upstream of the Bragg Creek Bridge. This again results in lower stream power and decreased channel depths during similar flow rates, which results in sediment deposition.

Question 64

Volume 3B, Section 6.2.1, Table 6-2, Page 6.6

a. Clarify if values are estimated (as suggested by title of the table) or based on samples (as suggested in the text).

b. Explain the error associated with suspended sediment concentration laboratory analysis and whether there is any statistically significant difference between the Bragg Creek and Sarcee Bridge locations for each month.

c. Describe any potential differences in interpretations if loads are considered as opposed to concentrations.

Response 64

a. The suspended sediment concentrations (SSC) or total suspended solids (TSS) values in Table 6-2 were generated as follows:

   i. for flows lower than 100 m^3/s, the estimates are based on data collected by the City of Calgary from 1999 to 2015 and by Stantec in 2016 (Figure 6-1)

   ii. for flows up to 1,000 m^3/s, the estimates are based on mathematical fitting of the relationships of SSC to flow rate

   iii. for the design flood of 1,170 m^3/s, the estimate is based on extrapolating the fitted curve to generate the peak SSC concentrations.

   Therefore, these values were derived based on a combination of field sample data and curve fitting estimation.

b. A typical error associated with the reported laboratory analysis is a measurement uncertainty (MU) calculated by an analytical laboratory during analysis of the samples and depends on many factors, such as the incomplete definition of the quantity being measured, non-representative sampling, inadequate knowledge of the effects of environmental conditions on the measurement, personal bias in reading analog instruments, inexact values of measurement standards and reference materials, variations in repeated observations under identical conditions (JCGM 2008).

The TSS samples collected in 2016 were analyzed by ALS Environmental laboratory (ALS) gravimetrically by filtering a sample through a glass fibre filter and drying the filter at 104 ^{0}C (APHA Method 2540). The detection limit (limit of reporting, or LOR) for this method was 3 mg/L. The MU for TSS values from 1xLOR to 10xLOR was from 30% to 15%, respectively (J. Spira, personal communication, 28 Jan 2019). The MU for TSS values greater than 10xLOR was 15%.

The method of analysis for the TSS data by the City of Calgary is also gravimetric (C. Rickard, personal communication, 19 Feb 2019) with a reported detection limit of 2 mg/L and 0.5 mg/L. The MU can not always be confirmed for the older TSS data collected by the City of Calgary because some of the important information that is required for calculations of the MU may no longer be available for older records. Therefore, there is an analytical uncertainty related with the older data. However, since a similar method of analysis (gravimetrical) was used for TSS data collected by the City of Calgary and for TSS data analyzed by ALS, a similar range of MUs is expected: 30% to 15% for 1xLOR to 10xLOR, respectively, and 15% for values greater than 10xLOR.

Monthly TSS concentrations at Bragg Creek and Sarcee Bridge shown in Table 6-2 were significantly different ($p<0.05$) for each month. Due to large sample sizes a non-parametric Kruskal-Wallis method was used, which then was followed by Pairwise Wilcoxon rank sum tests. The probability values (p-values) were adjusted using the Benjamini-Hochberg procedure to decrease the false discovery rate.

c. If loads are considered instead of concentrations, the interpretations would not change. Moreover, a reduction of suspended sediment concentrations causes even greater reduction of suspended sediment yield (or mass). For example, as indicated in the response to IR71, the 7% reduction of suspended sediment concentrations corresponds to a 65% reduction of suspended sediment mass in Elbow River for the 1:100 year flood (Volume 3B, Section 6, Table 6-6). Therefore, the decline of the percent difference downstream from Bragg Creek to Sarcee Bridge would be even greater.

REFERENCES

JCGM (Joint Committee for Guides in Metrology). 2008. JCGM 100: Evaluation of Measurement Data - Guide to the Expression of Uncertainty in Measurement. Technical Report, JCGM, 2008.

Rickard, C., Government of Alberta, SK. “Re: TSS Method” Received by Elena Khozhina, 19 February 2019.

Spira, J., ALS Environmental at Saskatoon, SK. “Re: Measurement Uncertainty” Received by Elena Khozhina, 28 January 2019.

Question 65

Volume 3B, Section 6.2.2, Figure 6-2, Page 6.7
Volume 4, Appendix J 3.3.4.1, Page 3.32 and 3.35

Alberta Transportation states that *analysis of the D50 surface/D50 subsurface for the Elbow River suggests that surface armouring increases downstream and coarse sediment transport becomes increasing supply-limited (Figure 6-2)*.

a. Provide greater justification and support for this statement. The figure (top portion; ratios) does not indicate a significant difference with greater distance from source (i.e., near or as high ratios at 80-85 km and ~92 km as >105 km; and low ratio at 105 km as <80 km). The last ratio is the highest, but the relationship is weak at best.

b. Describe the type of analysis that was conducted to reach this conclusion.

c. What is the statistical significance of this conclusion (i.e., show that there is a significant different in the ratio from upstream to downstream)?

Response 65

a-c. The data presented in Volume 3B, Section 6, Figure 6-2 suggests a trend towards increased armouring for sites ER-100 to ER-109 (corresponding to less than 80 km to approximately 94 km). For the sites downstream of ER-109, the trend is less evident and there are an insufficient number of data points from which to draw conclusions. Whether armouring increases or decreases in the downstream direction does not alter the conclusions made in the assessment because armouring was not considered as being material to the final conclusions reached regarding changes to channel morphology. Therefore, statistical analysis was not conducted.

Question 66

Volume 3B, Section 6.4.1.1, Page 6.14
Volume 3A, Section 6.2.2.4, Table 6-7, Page 6.29

Alberta Transportation explains that *a single peaked, high flood flow in 2008 had an hourly peak of approximately 204 m³/s…the hourly hydrographs from these floods are used as a best representation of the approximate 1:10…flood in the model*.

a. **Explain if any changes in model interpretations and assessments would be required if data from the 2005 flood flows were used for the 1:10 year event (slightly greater, but similar peaks, and greater overall discharge volume; Volume 3A Table 6-7).**

Response 66

a. A 1:10 year flood has a peak flow rate of 200 m^3/s. The 2008 flood is the closest on-record flood matching that peak (204 m^3/s) and was, therefore, used as the best approximation for a 1:10 year flood. The peak flow rate measured during the 2005 flood was 308 m^3/s and is closer to a 1:20 year flood, which has a peak of 330 m^3/s. As a result, the flows measured in 2005 would not be appropriate for a 1:10 year analysis.

Question 67

Volume 3B, Section 6.4.1.4, Page 6.15

a. **Describe the calibration and validation methods used for the hydrodynamic modeling.**

b. **Provide modelling confidence and errors (or ranges) associated with the made predictions.**

Response 67

a. Model calibrations were conducted for three months of simulation, from May 1 to July 31, 2013. Data used for the model calibration were:

   - hourly discharge measured at Water Survey of Canada (WSC) station 05BJ004 (Bragg Creek; upstream boundary of the modelling)
   - daily water levels measured at WSC station 05BJ008 (Glenmore dam; downstream boundary of the modelling)
   - daily water levels measured at WSC station 05BJ010 (Sarcee Bridge)

Modelling results for water levels were calibrated with the measurements at WSC station 05BJ010 (Sarcee Bridge).

Calibration was carried out by altering the following model parameters:

- model mesh size
- simulation time step
- bed resistance (varied in domain)

There is no comparable data set in which to do an independent validation. Other typical spring floods would be much smaller than the 2013 flood and not comparable.

b. Water levels were calibrated with the measurements at WSC station 05BJ010 (Sarcee Bridge), as shown in Figure IR67-1.

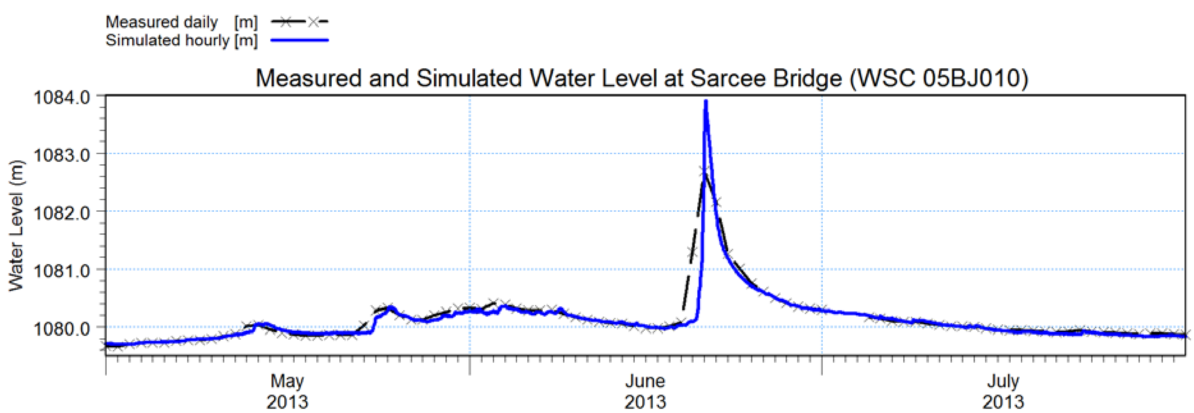


Figure IR67-1 Measured and Simulated Water Level at Sarcee Bridge (WSC 05BJ010)

The calibration shows the simulation reproduces the measured water levels in terms of the variation magnitudes and phases, except at the peak. This is because the model is showing hourly water levels and the data only provides daily levels. (The daily measured level likely misses the peak elevation.) Overall, this indicates a high level of confidence in the hydrodynamic model.

Question 68

<u>Volume 3B, Section 6.4.2.3, Page 6.23</u>

Alberta Transportation states *because this percentage is well below 10%, the effect on the hydrological regime for the design flood, in terms of annual volume, is negligible in magnitude and transient*.

a. Confirm that this statement, and associated numbers, are for the 1:100 year flood and not the design flood.

b. Use defined terms for magnitude (i.e., low, moderate, high).

Response 68

a. The statement and associated numbers are for the 1:100 year flood and not for the design flood

b. The effects characterization for magnitude as negligible is the same as is presented in Volume 3A, Section 6, Table 6-2, page 6-8. The defined terms for magnitude from Table 6-2 are provide below for ease of reference.

   Negligible – little to no variation predicted in measurable parameters, with variations that are less than 10% relative change from existing condition values.

   Low – small variation predicted in measurable parameters, with variations that are between 10% and 15% relative change from existing conditions.

   Moderate – modest variation predicted in measurable parameters, with variations that are between 15% and 30% relative change from existing conditions.

   High – large variation predicted in measurable parameters, with variations that are greater than 30% relative change from existing conditions

Question 69

Volume 3B, Section 6.4.3, Page 6.26

Alberta Transportation states that *the effects of diversion would be to change suspended sediment concentrations and local suspended sediment yields in the Elbow River*.

a. **Explain how diversion would change suspended sediment concentrations in the Elbow River, including assumed stratification and/or variation in concentrations between diverted and non-diverted water. If suspended sediment load (yield) was meant, update text and associated assessments.**

Response 69

a. The quote in the above preamble is correct; as stated in Section 6.4.3 (Volume 3B, page 6.26), changes in suspended sediment concentration will be reduced in Elbow River during diversion.

   Suspended sediment concentration is the amount of sediment held in suspension in a determined volume of water such as milligrams of sediment per liter of water or grams of sediment per m^3 of water. Sediment yield is the mass of suspended sediment produced over a set amount of time such as kilotonnes of sediment flowing into the off-stream reservoir during diversion.

   As a result of the diversion, suspended sediment concentrations would be reduced by a relatively small amount for the design flood, as shown on Figure 6-13 (Volume 3B, Section 6.4.3) and reproduced here as Figure IR69-1. The reduction is from about 140,000 g/m^3 to about 135,000 g/m^3.

   Diverting flows from the Elbow River will result in a decrease in flow volume and velocity downstream of the diversion structure. Shear stress decreases with a reduction in flow velocity; subsequently, the amount of sediment that can be transported in the river flow at that time is reduced and suspended sediment concentrations decrease.

   "The effects of diversion on shear stress and suspended sediment concentrations at Highway 22 are shown in Figure IR69-1. The Highway 22 station is located approximately 300 m downstream of the diversion infrastructure and would show the greatest effect. Peak suspended sediment concentrations are reduced by approximately 2% during diversion." (Volume 3B, Section 6.4.3.2, page 6.32.)

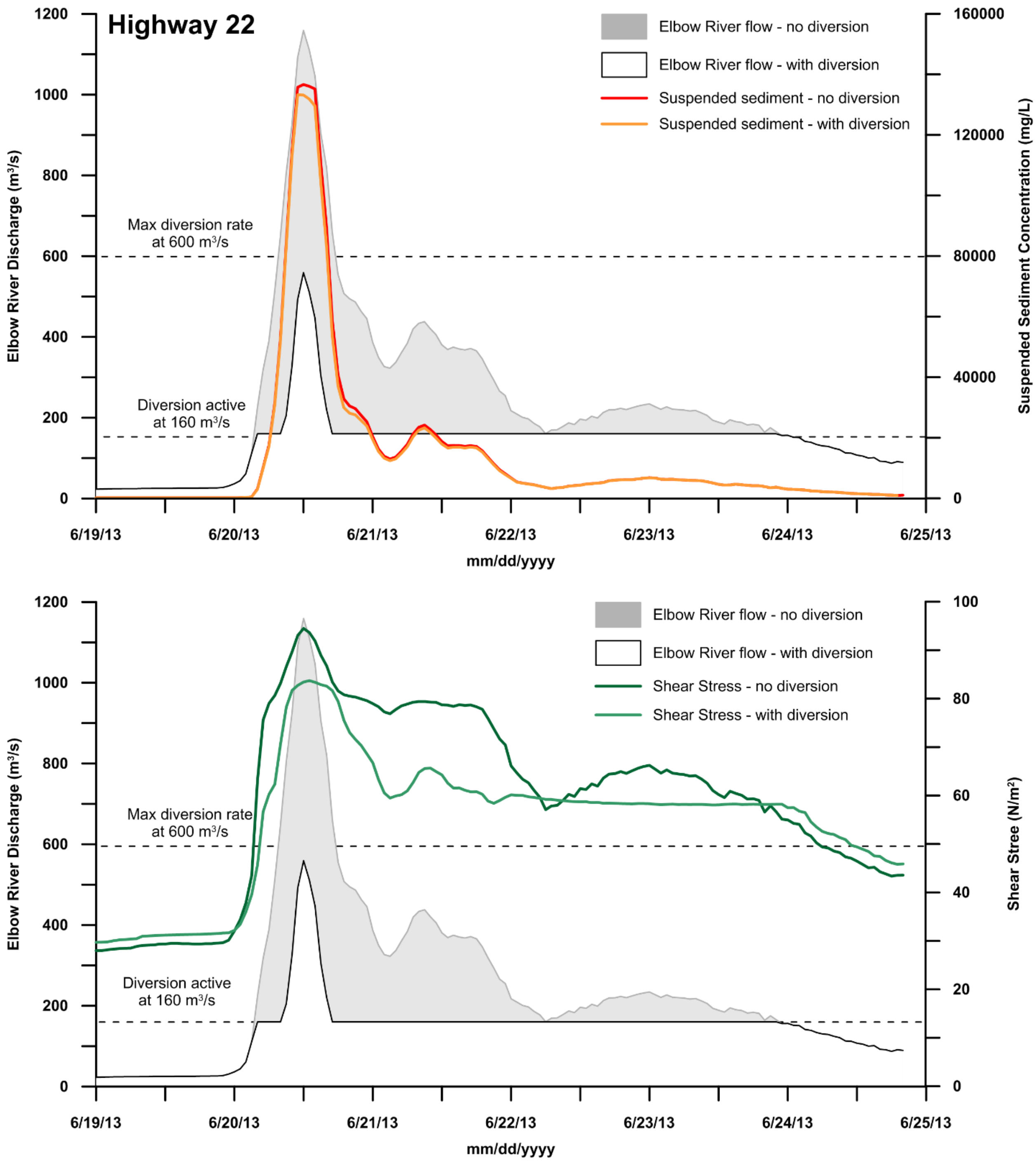


Figure IR69-1 **Suspended Sediment Concentrations and Shear Stress at Highway 22 for the Design Flood (from Volume 3B, Section 6, Figure 6-13)**

Shear stress in Elbow River is lower with the Project in place than without the Project (lower graph). The effect of the Project on suspended sediment concentrations during a 1:100 year flood is a decrease of 7% compared to not having the Project in place (Section 6.4.4.3, page 6.37). For a 1:10 year flood, the decrease is 1% (Section 6.4.3.4, page 6.47).

The change in yield is larger because a large volume of water and sediment load is diverted. During diversion of a design flood, approximately 50% of the sediment yield in Elbow River will be deposited into the off-stream reservoir.

Question 70

Volume 3B, Section 6.4.3.2, Page 6.35

Alberta Transportation states that *peak concentrations modelled at the confluence of the low-level outlet and Elbow River are in the range of 18,000 g/m³ but decline to 5,700 g/m³ approximately 1.0 km downstream (Table 6-7). Historical data suggests that monthly suspended sediment concentrations at the time of release in August, without 2013 data, average 16 g/m³, with a maximum of approximately 50 g/m³, at Highway 22 (Figure 6-1)…flow and storage effects in the Elbow River dilutes this suspended sediment input to 68.6 kt, a 25% decrease by approximately 1.0 km downstream of the confluence with the low-level outlet*.

a. **Discuss implications of changes to movement of the suspended sediment and increased deposition within the 1.0 km stretch downstream from the confluence of the low-level outlet with the Elbow River (i.e., difference in timing of sediment transport, sediment characteristics, and changes in deposition rate and location between baseline conditions and Project flood conditions).**

b. **Assess potential effects of releasing water with relatively higher TSS concentrations for longer duration from the reservoir post-flood, relative to natural flood patterns.**

Response 70

a. Releasing the full-service volume of water from the reservoir under different operational release conditions is discussed in the response IR295. In summary, the lower the release rate, the longer the time it takes to empty the reservoir; however, this also decreases the concentration of suspended sediments released from the reservoir at the end of reservoir emptying. This also changes the timing of when increased sediments are released into Elbow River compared to natural flood conditions.

Peak flows and elevated sediments in Elbow River generally occur in June (Volume 4, Appendix J, Section 3.3.1 page 3.12, Figure 3-6; Section 3.3.2, page 3.24, Figure 3-13). Timing of water release will vary but maintain elevated river water levels for longer periods than compared to years that natural flood (without the Project). Also, suspended sediment concentrations will be released from the reservoir to the river later in the season (i.e., post-retention) than would be experienced in a year with a natural flood (without the Project).

Potential effects are discussed in the response to IR295 as follows:

> "Water quality parameters associated with TSS will increase in Elbow river in a manner similar to suspended sediments. However, sediment related parameters are bound with sediment particles and will not be available for biological assimilation (Volume 3B. Section 7.4.6, page 7.20-7.23). Only 1.8% of the sediments entering the reservoir (for a design flood) will be released from the reservoir (Volume 3B, Section 7.4.6, page 7.23) and over 98% will remain in the reservoir; therefore the suspended sediment and related parameter loading on Elbow River and Glenmore Reservoir is greatly reduced compared to a situation without the Project.
>
> Managing the operational release rates to minimize effects to water quality during the period of reservoir drawdown discussed here (i.e., June 20 through December 7), must consider biological sensitive periods in Elbow River. Drawing down the reservoir with a slower operational release rate will reduce TSS in the river; however, this may mean TSS is increased during a sensitive period when effects are greater. The period during late summer (i.e., August) is when water temperatures in Elbow River are elevated; the combined effect of sediment and elevated temperatures may affect the ability for resident fish to consume oxygen (Servizi and Martens 1990, Henley et al 2000). The period of time between October through November is when Mountain Whitefish and Brown Trout are spawning and suspended sediments can cause harm to newly spawned eggs."

Effects on fish are discussed in the response to IR100.

As stated in the response to IR295a. "AEP will manage the release rate in a manner that mitigates detrimental effects to resident fish populations in Elbow River. Operational flexibility provides the reservoir operator the ability to manage how water is returned to the river while controlling factors such as sediment release. The release rate will be maintained in a manner results in the reservoir being empty prior to October to avoid biologically sensitive periods for resident populations of fish in Elbow River."

b. As presented in Volume 3B Section 6.4.3.1 (p. 6.26), the Project causes a high magnitude effect on suspended sediment concentrations and yields in Elbow River. Floods larger than the 1:10 year flood would cause yield reductions greater than 30% from existing conditions. However, if flood flow rates in Elbow River exceed 760 m^3/s, a larger portion of the flood flow and associated suspended sediment would remain in Elbow River because the capacity of the diversion channel would be reached and the inlet gates closed. As a result, the effect of the Project on concentrations and yields would diminish with floods greater that the 1:100 year flood. This effect can be seen in the reduced percentage of suspended sediment mass change in Elbow River for the design flood (50% reduction) compared to the 1:100 flood

(65% reduction). Because smaller floods have a higher probability of occurrence in any given year, suspended sediment yields in the Elbow River would be reduced.

For the 1:100 year flood, the release of water can carry up to 219.1 kt of suspended sediment mass from the reservoir to the river. However, flow and storage effects in the Elbow River dilutes this suspended sediment input to 150.5 kt by approximately 1 km downstream. This re-introduction of material partially offsets the material deposited in the reservoir during diversion. The final depositional location of the suspended sediment re-introduced into the river is highly dependent on local bed morphology and hydraulics. Given the combined flow in the river and flow out of the reservoir, suspended sediment will remain in suspension until Glenore Reservoir. Although the timing of the increase in suspended sediment concentrations will be delayed compared to conditions without the Project, this is not expected to result in increased deposition within the 1.0 km stretch downstream from the confluence of the unnamed creek with the river.

The effects on suspended sediment concentrations and yields related to the release of water from the reservoir are expected to be minimal.

REFERENCES

Henley, W.F., M.A. Patterson, R.J. Neves and A.S. Lemly. 2000. Effects of Sedimentation and Turbididty in Lotic Food Webs: A Concise Review for Natural Resource Managers. Reviews in Fisheries Science. Vol 8(2): 125-139.

Servizi, J.A. and D.W. Martens. 1990. Effects of Temperature, Season and Fish Size on Acute Lethality of Suspended Sediments to Coho Salmon (Oncorhynchus kisutch). Canadian Journal of Fisheries and Aquatic Sciences. Vol. 48: 493-497.

Question 71

<u>Volume 3B, Section 6.4.3.3, Page 6.39</u>

Alberta Transportation summarizes that *suspended sediment concentrations would reduce slightly, but with suspended sediment yields reduced by up to 65% during active diversion.*

a. **Provide an assessment on the potential impacts of this (positive or negative) and the potential magnitude of these impacts.**

Response 71

a. With the Project, the effect during diversion on suspended sediment concentrations at Highway 22 (where the largest concentrations occur) is a reduction of suspended sediment concentrations by approximately 7% (Volume 3B, Section 6.4.3.3, page 6-39). This is a positive effect from the Project, which shows that water quality in the Elbow River would be improved during flooding conditions with the Project, compared to without the Project.

   The 7% reduction of suspended sediment concentrations corresponds to a 65% reduction of suspended sediment mass in the Elbow River for the 1:100 flood (Volume 3B, Section 6.4.3.1, Table 6-6). This is a positive effect in that there is a diversion of a large amount of suspended sediments into the reservoir and a reduction of yield downstream on Elbow River. Without the Project, this sediment would have been transported downstream. The magnitude of this positive effect is high since more than 30% (see Volume 3A, Table 6-2) of the suspended sediment mass in the Elbow River would be reduced during the 1:100 flood compared to without the Project.

Question 72

Volume 3B, Section 6.4.4, Page 6.52

Alberta Transportation states that *under flood conditions, the primary particle size transported in the Elbow River would likely be gravel sized material, with a median grain size of 21 mm.*

a. Clarify how flood conditions are defined here (e.g., use of discharge ranges or exceedance may be appropriate).

b. Clarify how material smaller than gravel size are prevented from mobilizing during flood conditions, or if this is by relative volume/weight.

Response 72

a. Flood conditions in this context can be described as the flow that can cause particle detachment and transport when a river runs out of its confines and submerges surrounding areas. The “flood conditions” are not able to be quantified as a range of flood flows or exceedance flows because:

   - A river discharge is the flow rate of water moving through a given cross-section area in the river channel. With a certain value of discharge, the velocity varies with the cross-section area by locations of the river channel.
   - The mobilization of sediment is determined by the local velocity and the resulting shear stress, which can vary from location to location.

The hydrodynamic and sediment transport models determine local velocity and associated local shear stress throughout the modelled domain. As a rough estimate, Figure IR72-1 shows the relation between sediment particle size and water velocity that determines whether a flow will erode, transport or deposit a sediment particle. To mobilize gravel-sized material (a median grain size of 21 mm), the velocity would be larger than 0.4 m/s.

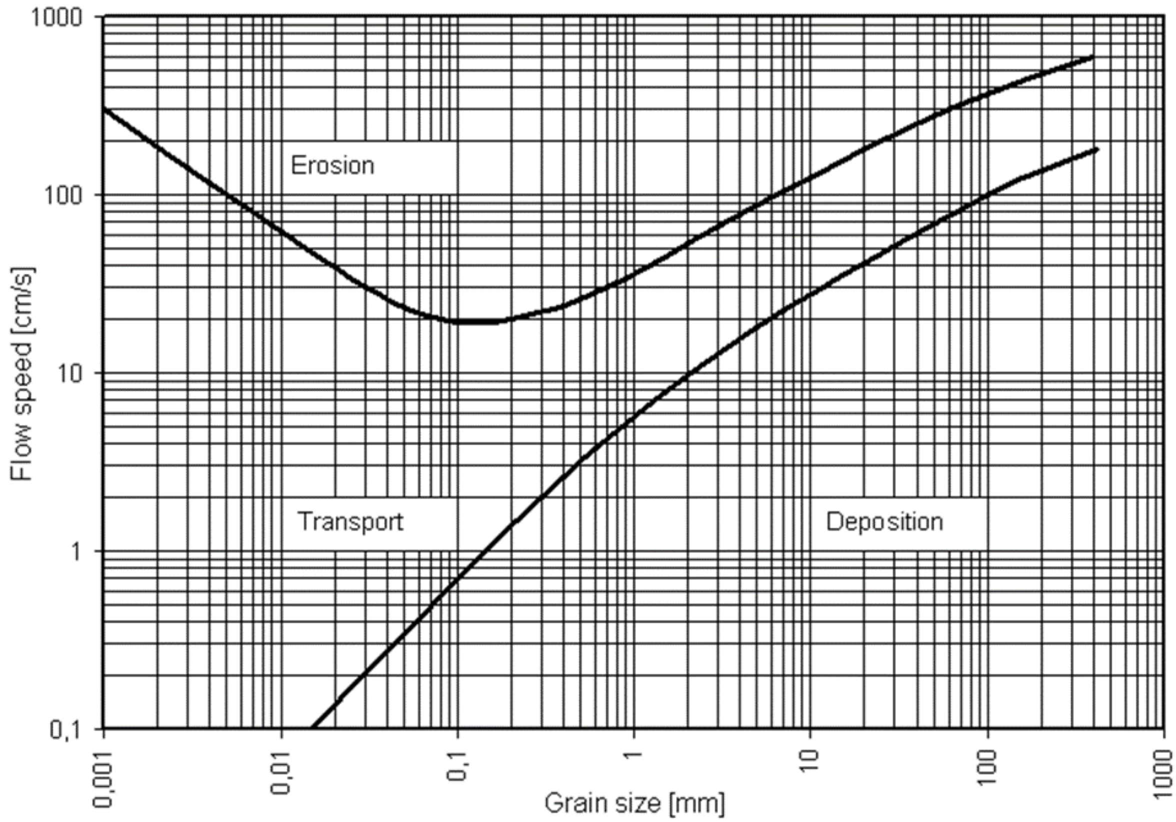


Figure IR72-1 Correlation Between Suspended Sediment Grain Size and River Flow Speed

b. The assessment does not assume the smaller particles are prevented from mobilizing during a flood condition; the text indicates that 21 mm is the median particle size. The text in Volume 3B, Section 6.4.4, page 6.52 states "Typically, the range of particle sizes that are transported as bedload are restricted to those greater than 0.063 mm in size" refers to the minimum particle size in the bedload sediment category.

Question 73

Volume 3B, Section 6.4.4.1, Page 6.53

Alberta Transportation states that *to assess the effect of active diversion on downstream geomorphology, three locations are used to illustrate potential effects. These locations represent changes in the upper, middle, and lower sections of the Elbow River downstream of the diversion inlet.*

a. Estimate the spatial extent (i.e., upstream distance and surface area) of potential backwater effect on the Elbow River for each Project phase.

b. Explain any differences that may occur on geomorphology upstream of the diversion inlet as a result of the diversion structure operations (e.g., due to changes in elevation, velocity, volumes, etc.).

c. Estimate the type, volume, and depth of sediments deposited and the locations of deposition upstream of the diversion structure.

Response 73

a. Backwater effect is caused by a hydraulic constriction that increases the upstream water surface elevation in comparison to the pre-Project conditions (existing conditions). Figure IR265-1, Figure IR265-2, and Figure IR265-3 display results of the hydraulic model defining these locations for the 1:10 year, 1:100 year and design year flood peak flows. The results are summarized in Table IR73-1.

Table IR73-1 Backwater Effects from the Project

Flood	Peak Flow (m^3/s)	Length of Backwater Along the River Channel Centerline (m)	Area of Backwater (ha)
1:10 year	200	190	10.8
1:100 year	765	500	21.2
Design flood	1240	500	23.5

b. Operation of the diversion structure is not initiated until flow in the Elbow River reaches 160 m^3/s. For the majority of time (dry operations and post-flood operations), the flows and sediment transport processes will differ marginally as compared to conditions without the Project. During flood operations, as described in a., water surface elevations will increase upstream of the diversion structure and flow velocity will decrease; as a result, the sediment transport capacity of the river will decrease. This effect will occur within the backwater area identified in a.

As sediment-laden flood water approaches the backwater area, coarser bedload sediment carried by the high velocity flow is expected to drop out as velocities decrease. Finer material will continue to move downstream until flow velocities are no longer sufficient to keep the sediment grains entrained (the size of the grains depend on velocity and volume of flow in Elbow River, as well as the supply of sediment in the river). After flood diversion ends, sediment transport through the service spillway will resume.

Volume and depths of deposition will depend on the magnitude and duration of the flood as well as the supply of sediment available during the flood. Physical model run scenarios that modelled aggradational and degradation bedforms during various model runs are presented in the response to IR454, Appendix IR454-1.

Sediment deposited within the backwater area during diversion will start to be re-entrained as velocities increase and a channel will likely be re-formed through the depositional area. Morphologically, the channel may exhibit braid like patterns as flow cuts through the deposited material. During the recessional limb of the hydrograph, the main channel of Elbow River would be expected to return to a more wandering pattern. Lag deposits from the operation of the Project may alter hydraulics locally. However, the majority of grain sizes will be mobile at floods in excess of the bankfull flow (approximately 40 m^3/s) and up to the 160 m^3/s.

The area of Elbow River upstream of the Project will be monitored after construction of the diversion structures, before and after floods that require diversion, to determine whether geomorphic changes have occurred and that could inhibit fish passage are short-lived or mitigated. This includes re-establishment of a single main channel with the approximate bankfull dimensions of the existing channel in Elbow River.

c. Predicting the type, volume, and depth of sediments deposited and the locations of deposition upstream of the diversion structure is difficult to predict accurately. Uncertainty in sediment transport in controlled settings is large in rivers such as Elbow River which have complex hydraulics, high variable sediment supply, and high large wood debris loading. The uncertainty in the sediment transport models for predicted bedload can range as high as 50% to 100% (Gomez and Church 1989). As presented in b., aggradation and degradation will occur upstream of the diversion structure. The impact of which depends on the magnitude of the flood, the volume of material deposited, and the magnitude of flows for floods greater than or equal to 160 m^3/s.

References

Gomez, B., and M. Church. 1989. An assessment of bed load sediment transport formulae for gravel bed rivers. Water Resources Research 25: 1161-1186.

Question 74

Volume 4, Appendix J, Section 2.1, Page 2.1

Alberta Transportation states that *the LAA also encompasses the water quality modelling domain*.

a. Provide details on water quality modelling. It does not appear that modelling of water quality is provided in other sections (i.e., water quality section), only summaries of data.

Response 74

a. Water quality modeling is focused on two parameters, total suspended sediments (TSS) and total dissolved sediments (TDS) (Volume 4, Appendix J, Section 2.2.5, page 2.14). Modelling was not directly done for other water quality parameters; rather the assessment considers the spatial and temporal patterns for a selection of 57 water quality parameters compared to TSS.

The main Project-related effect on water quality is related to TSS (Volume 4, Appendix K, Section 2.2.4, page 2.14 and Section 3.0, page 3.1). The similarity of spatial and temporal patterns between each water quality constituent and TSS (i.e., linkage between water quality and TSS) was used to ascertain the potential for Project-related effects on water quality.

The water quality modeling is represented by the sediment transport modelling, including modeling of TSS and TDS sediment yields (Volume 4, Appendix J, Section 2.2.6, page 2.17). The results of the sediment transport modeling are presented in Section 3.3.4.1 (Total Suspended Sediment and Total Dissolved Solids) under the Results section (Section 3.0) (Volume 4, Appendix J, Section 3.3.4.1, page 3.35).

Question 75

Volume 4, Appendix J, Section 2.3.4, Page 2.24

Alberta Transportation states that *suspended sediment yields were estimated from the converted turbidity data and discharge data*.

a. Provide details (e.g., data or graphs) on how this relationship between turbidity and sediment was determined specific to the study area.

Natural Resources Conservation Board
May 2019

Response 75

a. In Section 3.3.2.1, it is mentioned that:

"conversion of the continuously measured turbidity to total suspended solids (TSS) was based on 11 grab samples. The range of concentrations represented by the grab samples is low, ranging from 1.5 mg/L to approximately 70 mg/L" (Volume 4, Appendix J, Section 3.3.2.1, Page 3.25). The details are shown in Table IR75-1.

Table IR75-1 Turbidity and Total Suspended Solids (TSS) in Elbow River at Highway 22

mm/dd/yyyy	HH:MM	TSS (mg/L)	Turbidity (NTU)
5/20/2016	12:15	21.7	4.544
5/26/2016	13:15	37	7.381
5/26/2016	16:30	52.3	11.262
5/26/2016	19:39	63.7	14.179
5/30/2016	13:30	10.3	3.235
5/30/2016	15:30	11	2.99
6/14/2016	14:00	1.5	1.051
6/14/2016	14:45	1.5	1.081
6/14/2016	15:30	1.5	1.164
6/23/2016	14:00	1.5	1.003
7/19/2016	19:00	39	7.02
9/1/2016	9:55	1.5	1.21

Relationship between turbidity and TSS was tested in R, a software package for statistical computing and graphics, using a regression code to predict TSS values for the continuous turbidity data (Figure IR75-1).

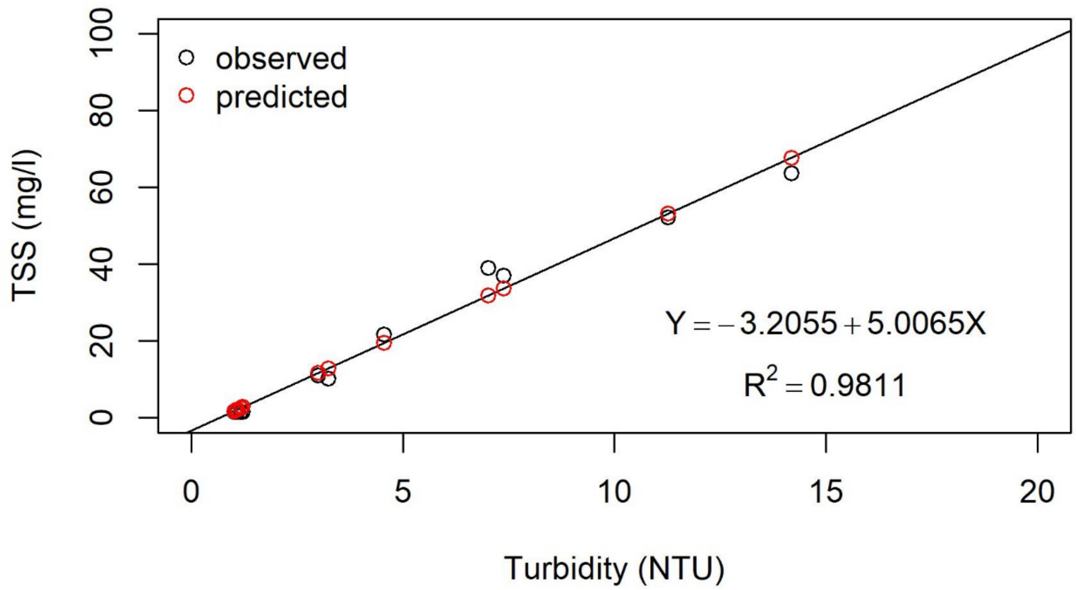


Figure IR75-1 Relationship between Turbidity and Total Suspended Solids

Question 76

Volume 4, Appendix J, Section 2.3.5, Page 2.26

Alberta Transportation states that *TDS in mg/L was estimated by applying a multiplier of 0.55 to the EC values, as per the manufacturer's recommendation.*

a. Explain how appropriate this multiplier is to this stretch of the Elbow River.

b. Show validation results of this relationship or if it was not completed, explain why validation of this multiplier was not completed (e.g., through comparison with calculated TDS values or comparison with select samples for TDS analysis).

Response 76

a. The multiplier (0.55) was chosen following manufacturer's recommendations for typical values of the relationship between total dissolved solids (TDS) and electrical conductivity (EC) in surface water (Campbell 2016). The instruction manual for the sensor that was used for EC measurements (CS547A Conductivity and Temperature Probe and A547 Interface Instruction Manual, Revision: 11/16, 2016), states, "EC measurements can be used to estimate dissolved solids. For high accuracy, calibration to the specific stream is required. However, for rough estimates, values between 550 and 750 mg·L^{-1}/mS·cm^{-1} are typical with the higher values generally being associated with waters high in sulfate concentration." (Hem 1970; p. 99).

The manufacturer's recommendation is based on Hem (1970). In that paper, the multiplier varied from 0.54 to 0.96 with higher values associated with high sulphate concentrations (up to approximately 560 mg/L, Figure 11 in Hem (1970)). Sulphate concentrations are low in the Elbow River (45.1 mg/L to 73.9 mg/L at Highway 22 (ER H22) in 2016, as stated in Volume 4, Appendix K, Attachment A). The Elbow River value corresponds to the low sulphate concentrations reported in the paper (approximately 25 mg/L, Figure 11 in Hem (1970)). The paper states that usually the multiplier varies from 0.55 to 0.75 in natural waters. Therefore, the low multiplier of 0.55 is used in the Hydrology Technical Data Report (Volume 4, Appendix J).

b. Data on conductivity and TDS in Volume 4, Appendix K, Attachment A-1, page A.1 at Highway 22 for 20 May, 23 June, and 19 July is used to validate the ratio of TDS to conductivity (TDS/conductivity) for 2016. Sampling results in Elbow River at Highway 22 varies from 0.54 to 0.62 (see Table IR76-1), with the average value of 0.58 (Table IR76-1). Similarly, historical monitoring data shows that the ratio of TDS to specific conductivity varies from 0.53 to 0.61 with the average value of 0.57 (Table IR76-2). The historical data is represented by the data provided by AEP. No other historical data contained TDS values.

Table IR76-1 TDS versus Conductivity in Elbow River at Highway 22, 2016 sample results

Sample ID	ER H22	ER H22	ER H22
Date Sampled	20-May-2016	23-Jun-2016	19-Jul-2016
Conductivity, µS/cm	390	387	331
TDS (Calculated by ALS Environmental Laboratory), mg/L	231	239	179
TDS /conductivity	0.59	0.62	0.54
NOTE: ER H22 – Elbow River at Highway 22.			

Table IR76-2 TDS versus Conductivity in Elbow River at Highway 22 and Upstream of Twin Bridges at Highway 8, Historical Data

Date Sampled	Conductance, µS/cm	TDS (Calculated), mg/L	TDS /specific conductance
Elbow River at Highway 22			
1/22/1979	425	237	0.56
2/6/1979	420	238	0.57
2/20/1979	422	237	0.56
3/6/1979	415	233	0.56
3/20/1979	400	225	0.56
4/3/1979	420	234	0.56
4/17/1979	390	217	0.56
5/1/1979	319	178	0.56
5/16/1979	323	179	0.55
5/30/1979	320	179	0.56
6/12/1979	329	184	0.56
6/26/1979	349	191	0.55
7/11/1979	355	199	0.56
7/25/1979	362	205	0.57
8/8/1979	367	219	0.60
8/22/1979	403	233	0.58
9/5/1979	406	234	0.58
9/17/1979	402	240	0.60
10/2/1979	424	243	0.57
10/16/1979	383	233	0.61
10/31/1979	417	236	0.57
11/14/1979	411	232	0.56
11/28/1979	435	245	0.56
12/12/1979	453	256	0.57
Elbow River Upstream of Twin Bridges at highway 8			
1/22/1979	403	228	0.57
2/6/1979	440	262	0.60
2/20/1979	408	230	0.56
3/6/1979	403	226	0.56
3/20/1979	390	220	0.56

Table IR76-2 TDS versus Conductivity in Elbow River at Highway 22 and Upstream of Twin Bridges at Highway 8, Historical Data

Date Sampled	Conductance, µS/cm	TDS (Calculated), mg/L	TDS /specific conductance
4/3/1979	422	234	0.55
4/17/1979	380	215	0.57
5/1/1979	305	161	0.53
5/16/1979	292	167	0.57
5/30/1979	311	170	0.55
6/12/1979	309	174	0.56
6/26/1979	334	187	0.56
7/11/1979	343	191	0.56
7/25/1979	362	203	0.56
8/8/1979	369	217	0.59
8/22/1979	385	226	0.59
9/5/1979	393	225	0.57
9/17/1979	382	230	0.60
10/2/1979	406	233	0.57
10/16/1979	407	231	0.57
10/31/1979	392	232	0.59
11/14/1979	386	219	0.57
11/28/1979	412	230	0.56
12/12/1979	424	239	0.56
7/4/1994	378	212	0.56
10/3/1994	426	241	0.57
7/10/1995	326	180	0.55

The average multiplier values (0.57 and 0.58) obtained as the result of the validation are close to the used multiplier (0.55). The percent difference between the average TDS calculated using 0.55 and the validated multipliers is 1.8% for 2016 data and 2.7% for historical data (Table IR76-3). These percent differences do not change the results of the assessment.

Table IR76-3 Percent Difference Between Used and Validated TDS Values

	2016 (mg/L)	Historical (mg/L)
Average Conductivity	394	369
TDS used = average conductivity of 0.55	217	203
TDS validated 2016 = average conductivity of 0.57	225	-
TDS validated historical = average conductivity of 0.58	-	214
% difference between used and validated TDS	1.8	2.7

REFERENCES

Campbell (Campbell Scientific, Inc.). 2016. CS547A Conductivity and Temperature Probe and A547 Interface Instruction Manual, Revision: 11/16. Available at https://s.campbellsci.com/documents/us/manuals/cs547a.pdf

Hem, John D. 1970. Geological Survey Water-Supply Paper 1473: Study and Interpretation of the Chemical Characteristics of Natural Water. United States Department of the Interior, Geological Survey, Library of Congress catalog-card No. 73-606921, PP.99-102. United States Government Printing Office, Washington. Available at https://pubs.usgs.gov/wsp/1473/report.pdf

Question 77

Volume 4, Appendix J, Section 2.4.2, Page 2.37

Text is missing from the paragraph that starts *modelling of sediment transport was based on a combination of field collected data and site specific mathematical relationships between discharge and the.*

a. Provide the rest of the missing text.

Response 77

a. The text should read “Modelling of sediment transport was based on a combination of field collected data and site specific mathematical relationships between discharge and the concentration of suspended sediment”.

Question 78

Volume 4, Appendix J, Section 3.3.2.2, Page 3.25

a. If TDS was determined by a multiplier of EC, justify why it is appropriate to discuss TDS here and not simply EC as a measured parameter?

Response 78

a. A derived value of total dissolved solids (TDS) concentrations from electrical conductivity (EC) measurements is an appropriate parameter, as opposed to EC alone, for the following reasons:

1. the derived value of TDS can be compared to historical TDS data (concentrations and yields) (Volume 4, Appendix J, Section 2.2.5)
2. missing total suspended sediment (TSS) data can be predicted by evaluating the relationship between TDS and TSS (Volume 4, Appendix J, Section 2.2.5)
3. predicted TSS data can be compared to bedrock-sourced groundwater TDS data (Volume 4, Appendix J, Section 3.3.2.2).

Question 79

Volume 4, Appendix J, Section 3.3.4.1, Page 3.35

Alberta Transportation references that *long-term data sets were sourced from Alberta Environment and Parks and the City of Calgary water quality data bases (see Appendix D4 for detail)*.

a. Where can Appendix D4 be found in the provided material? If not originally included, provide Appendix D4.

Response 79

a. Appendix D4 is not the correct reference. The correct reference is Volume 4, Appendix K, the Surface Water Quality Technical Data Report. In Appendix K, Table 2-2 lists the site locations and years of data collected. Figure 2-1 in Appendix K shows the site locations. The table is duplicated as Table IR79-1. The figure is duplicated as Figure IR79-1.

Table IR79-1 Relevant Water Quality Data for the Regional Assessment Area (from Volume 4, Appendix K, Table 2-2)

Site ID	Site Name	Source	Longitude	Latitude	First Year	Last Year
Elbow River Mainstem Sites						
N/A	Elbow River above Bragg Creek[a]	City of Calgary	-114.581043	50.943478	1998	2013
AB05BJ0115	Elbow River upstream of Bragg Creek[a]	AEP	-114.343000	50.946390	1999	2002
N/A	Elbow River at Highway 22 Bridge[b]	City of Calgary	-114.466077	51.032861	1998	2013
ER H22	Elbow River at Highway 22 Bridge	Stantec	-114.466669	51.032943	2015	2016
AB05BJ0170	Elbow River at Highway 22[b]	AEP	-114.280500	51.031940	1979	2002
AB05BJ0290	Elbow River upstream of Twin Bridges at Highway 8[c]	AEP	-114.142500	51.016670	1979	2009
N/A	Elbow River at Twin Bridges[c]	City of Calgary	-114.237602	51.013748	1982	2013
AB05BJ0295	Elbow River downstream of Twin Bridges[c]	AEP	-114.141200	51.014030	1999	2008
N/A	Elbow River at Sarcee Bridge[d]	City of Calgary	-114.165348	50.995597	1981	2015
AB05BJ0300	Elbow River at Sarcee Bridge[d]	AEP	-114.095500	50.995000	1988	1999
AB05BJ0320	Elbow River at Weaselhead Bridge[e]	AEP	-114.085000	50.991670	1999	2002
N/A	Elbow River at Weaselhead Foot Bridge[e]	City of Calgary	-114.147664	50.992120	1991	2013
Elbow River Tributary Sites						
TR1	unnamed creek	Stantec	-114.394953	51.046729	2016	2016
N/A	Lott Creek near mouth[f]	City of Calgary	-114.236598	51.008734	2002	2013
AB05BJ0020	Lott Creek at mouth[f]	AEP	-114.141100	51.008530	1986	2002
AB05BJ0200	Millburn Creek near the mouth	AEP	-114.230800	51.037170	1989	2002
AB05BJ0190	Pirmez Creek at the mouth	AEP	-114.235700	51.041530	1989	2002
AB05BJ0210	Springbank Creek near the mouth	AEP	-114.191400	51.035580	1989	2002

Table IR79-1 Relevant Water Quality Data for the Regional Assessment Area (from Volume 4, Appendix K, Table 2-2)

Site ID	Site Name	Source	Longitude	Latitude	First Year	Last Year
Glenmore Reservoir Sites						
N/A	Glenmore Reservoir - Raw Water Intake[g]	City of Calgary	-114.097400	51.000600	2000	2015

NOTES:

[a] Data for AEP site AB05BJ0115 Elbow River upstream of Bragg Creek and the City site Elbow River above Bragg Creek were combined because the locations are close and water quality is assumed to be the same or very similar between the two sites.

[b] Data for AEP site AB05BJ0170 Elbow River at Highway 22, the City site Elbow River at Highway 22 Bridge, and Stantec data for the Elbow River at Highway 22 (ER H22) were combined because the locations are close and water quality is assumed to be the same or very similar between the three sites.

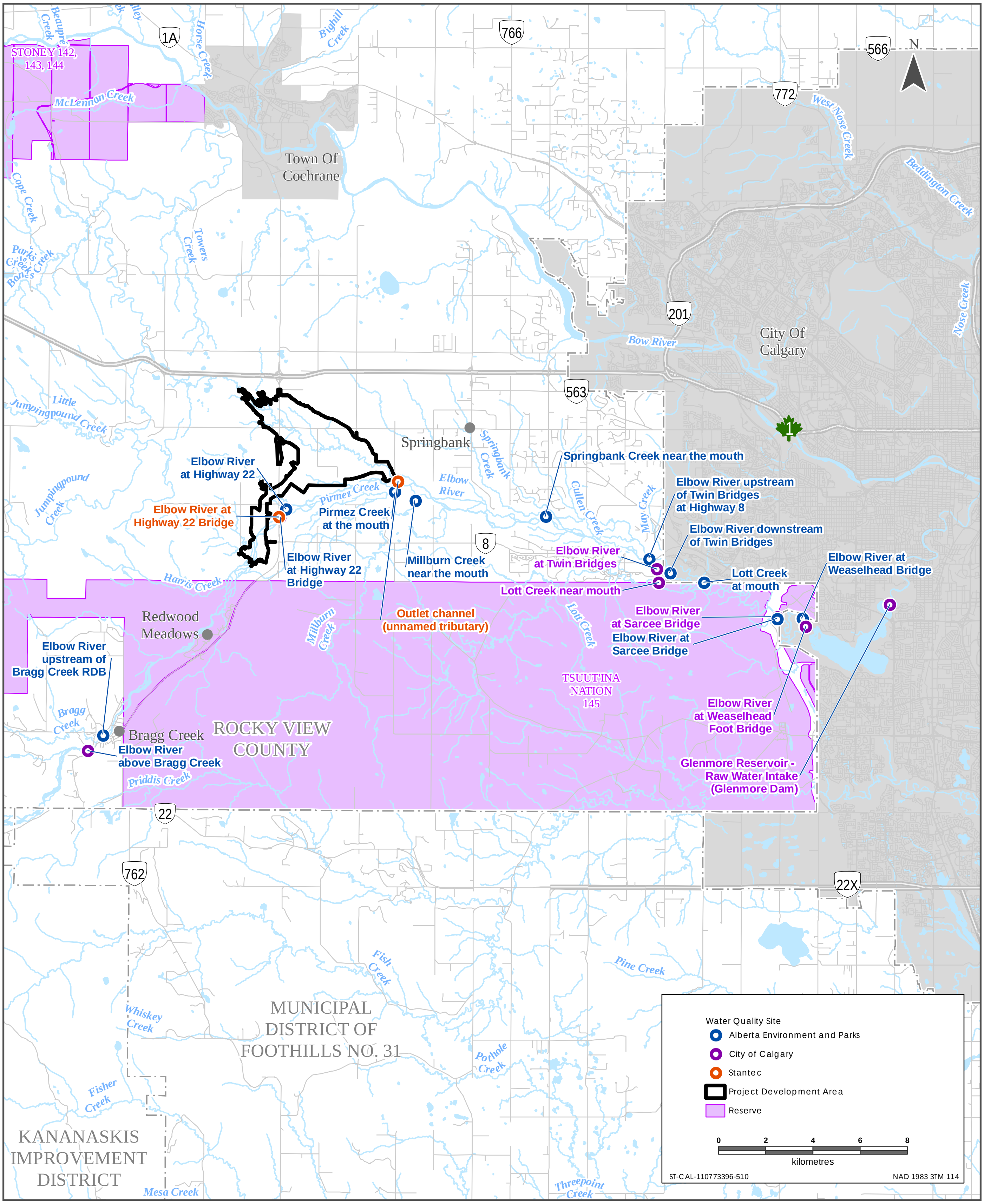
[c] Data for AEP site AB05BJ0290 Elbow River upstream of Twin Bridges at Highway 8, site AB05BJ0295 Elbow River downstream of Twin Bridges and the City site Elbow River at Twin Bridges were combined because the locations are close and water quality is assumed to be the same or very similar between the three sites.

[d] Data for AEP site AB05BJ0300 Elbow River at Sarcee Bridge and the City site Elbow River at Sarcee Bridge were combined because the locations are close and water quality is assumed to be the same or very similar between the two sites.

[e] Data for AEP site AB05BJ0320 Elbow River at Weaselhead Bridge and the City site Elbow River at Weaselhead Foot Bridge were combined because the locations are close and water quality is assumed to be the same or very similar between the two sites.

[f] Data for AEP site AB05BJ0020 Lott Creek at mouth and the City site Lott Creek near mouth were combined because the locations are close and water quality is assumed to be the same or very similar between the two sites.

[g] Data for the City sampling locations in the Glenmore Reservoir Water Treatment Plant at the raw water intake and dichlorination building were combined.



Sources: Base Data - ESRI, Natural Earth, Government of Alberta, Government of Canada
Thematic Data - ERBC, Government of Alberta, Stantec Ltd

Relevant Water Quality Sites in the Regional Assessment Area (from Volume 4, Appendix K, Figure 2-1)

Stantec

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT

Figure IR79-1

Question 80

Volume 3A, Section 7.2.2, Page 7.10

Alberta Transportation states that *water quality in the Elbow River upstream of Glenmore Reservoir* (referred to as upper Elbow River in this section) *is good in relation to aquatic ecosystem and human uses of water from the river*.

a. Explain why the upper Elbow River is defined differently here when compared to the upper and lower areas in the hydrology section.

b. Include a summary and characterization of current Elbow River water quality (current conditions and during flood conditions in Volume 3B), including quantification of specific physical (e.g., temperature and DO), chemical (e.g., nutrients and metals), and microbiological (e.g., fecal coliform and E. coli) parameters.

c. Assess baseline water quality for the entire RAA (TOR 3.5.1).

Response 80

a. The hydrology assessment divides the Elbow River watershed into two sections for assessing climate data. The demarcation between the two sections is approximately at Maclean Creek where the landscape transitions from the higher gradient Front Range (i.e., upper section) into the lower gradient Plains landform (lower section); see Volume 4, Appendix J, Section 2.2.2, page 2.5.

   For assessment of flows, Elbow River is divided into three sections based on hydrologic controlling structures (i.e., bridges) that "artificially control hydraulic geometry": Bragg Creek to Highway 22 bridge; Highway 22 bridge to Twin Bridges at Highway 8; Twin Bridges to Sarcee bridge (see Volume 4, Appendix J, Section 2.1).

   Climate data is not required for the water quality assessment and, therefore, the assessment area is not demarcated by the transition in landform.

   The uppermost water quality data location is Bragg Creek. Water quality data from this location reflects the influence of water quality originating in the upper sections of the watershed.

   For the water quality assessment, water quality data was obtained at the following locations: Bragg Creek; Highway 22; Twin Bridges; Sarcee Bridge; Weaselhead Bridge; and Glenmore Dam (see Volume 4, Appendix K, Section 2.2.1, Table 2-2; Figure 2-1). These locations are in reasonable proximity to the hydrology assessment locations used to assess flows.

b. Current water quality conditions for the mainstem Elbow River and Glenmore Reservoir are summarized in Volume 4, Appendix K, Section 3.2 (starting page 3.2), including Figures 3-1 through 3-36.

c. Relevant water quality sites in the RAA are discussed in Volume 4, Appendix K, Section 2.2., Tables 2-2 and 2-3, and Figure 2-1. Data from these RAA sites are used for the water quality assessment.

Question 81

Volume 3A, Section 7.4.2.1, Page 7.14

Alberta Transportation states that *water withdrawals for dust suppression and other construction needs can be required and can affect downstream water quality…*

a. Explain the appropriateness of water withdrawals for dust suppression during construction given recommendations from the South Saskatchewan Regional Plan and difficulties in obtaining water licenses.

b. Discuss whether there are alternative water sources for dust suppression during construction activities.

Response 81

a-b. Initial plans suggested sourcing water from the Elbow River for dust suppression and construction needs as a possible option, however, this is not the currently proposed plan. Water for dust suppression and other construction needs will be sourced and hauled in from a third-party permitted-supplier.

Question 82

Volume 3B, Section 7.1, Page 7.1

Alberta Transportation states that *an assessment of suspended sediment, temperature, dissolved oxygen, and metal methylation* was provided.

a. Provide an assessment (including quantification) for lead, arsenic, and cadmium (mercury methylation and suspended sediment completed), as well as for major ions, nutrients, bacteria, invertebrates, aquatic plants, algae, temperature, and DO for all phases (i.e., flood operation, post-flood operation, construction, and dry-operations) in the Elbow River, within the Project Reservoir (flood and post-flood), and at the Glenmore Reservoir. Identify any potential changes due to storage and release of flood water in the Project reservoir on receptors and relative to applicable guidelines.

Response 82

a. The assessment approach considered potential effect pathways and Project interactions with surface water quality. In some cases, Project operations and activities do not have pathways that would lead to measurable environmental effects and those pathways are not further assessed. The following lists the pathways that are and are not considered:

- Lead, arsenic and cadmium are not associated with reservoir operations (Volume 3B, Section 7.1.1.3) and, therefore, are not assessed.
- Mercury methylation is considered and discussed in Volume 3B, Section 7.4.4.
- Nutrients, some ions, total coliform bacteria and several metals are assessed in Volume 3B, Section 7.4.2 page 7.22-23. These parameters are closely associated with suspended sediment concentrations. Most of the suspended sediment (and consequently the associated parameters) diverted into the reservoir will be retained in the reservoir. For a design flood, 98% of the sediment is predicted to be retained, in the 1:100 year flood and in the 1:10 year floods, 88% and 95% of the sediment will be retained, respectively.
- The effects pathway associated with nutrients and coliform bacteria is associated with runoff and suspended sediment and is discussed in Volume 3A, Section 7.4 and in Volume 3B, Section 7.4.
- Because metals are usually associated with suspended sediment, the effects pathways for metal and suspended sediment are similar; this is discussed in Volume 3A, Section 7.4 and in Volume 3B, Section 7.4.
- Water temperature and dissolved oxygen are discussed in Volume 3B, Section 7.4.3 pages 7.24 and 7.25.
- Pathway analysis and residual effects are not predicted to have significant effect resulting in acute or chronic toxicity or changes in trophic structure (i.e., benthic invertebrates, aquatic plants, and algae; Volume 3A, Section 7.5, page 7.18 and Volume 3B, Section 7.6 page 7.34).

Question 83

Volume 3B, Section 7.2.2.2, Page 7.8

Alberta Transportation states that *the upper Elbow River dissolved oxygen concentrations varied seasonally, but were not associated with any apparent spatial pattern*.

a. Indicate when (e.g., time of day and associated temperature and solar radiation) dissolved oxygen concentration measurements were made and any implications that diurnal cycling of dissolved oxygen (in response to photosynthesis/respiration cycling, productivity, and temperature) may have on assessments and predictions.

b. What is the current understanding of the productivity or trophic status of the Elbow River? Include a discussion on photosynthesis/respiration cycling and influences on water quality parameters (e.g., nutrients, DO, EC, pH, metals, etc.) in the Elbow River.

Response 83

a. The dissolved oxygen data includes AEP water quality database, the City of Calgary (the City) water quality database, and Project-specific field data collected in 2016. A single measurement of dissolved oxygen was taken at each sampling location. The dissolved oxygen measurements by AEP and the City is represented by 3,460 data points, of which 1,632 had a time stamp (see Table IR83-1).

Table IR83-1 Seasonal Data Point Distribution for Dissolved Oxygen

Time of Day	Spring	Summer	Fall	Winter
Morning (07:00-09:59), percent of total data	32.8%	30.0%	32.0%	29.6%
Mid-day (10:00-13:59), percent of total data	60.6%	66.5%	67.7%	69.6%
Late Afternoon (14:00-16:00), percent of total data	6.2%	3.5%	0.3%	0.8%
Total number of measurements	482	603	294	253

The period between 07:00 and 14:00 is during the rising portion of the diurnal dissolved-oxygen flux as stream metabolism increases and aquatic plants and algae shift from respiration to photosynthesis. The lowest dissolved oxygen (DO) concentration occurs at night and early morning and the highest DO occurs at mid-day to late afternoon (Nimick et al. 2011).

The AEP sampling occurred mostly in early morning and in mid-day; therefore, it does cover the periods that would typically have the highest and lowest DO concentrations. The data collected may underestimate the peak DO concentration by a small amount. The range of DO sampled historically is representative of the range of DO concentrations expected over the highest and lowest periods of respiration within a day (see Figure IR83-1).

In Appendix K, Section 2.2.4.5, Page 2.23, both the environmental quality guidelines for Alberta surface waters (AB WQGs, ESRD 2014) and the Canadian water quality guidelines (CWQGs, CCME 2016) are described and applied to the water quality data. Since AB WQG and CWQG guidelines for dissolved oxygen are the same (6.5 mg/L and 9.5 mg/L for AB WQG and 6.5 mg/L and 9.5 mg/L for CWQG), only CWQG guidelines are shown on Figure IR83-1.

The range of diurnal DO fluctuation is a function of the trophic status, which changes with increasing phosphorus concentrations (see the response to b). As discussed in Volume 3B, Section 7.4.3, the Project is not expected to add nutrients to Elbow River or Glenmore Reservoir; therefore, the trophic status will not be changed, nor will the diurnal DO processes be affected.

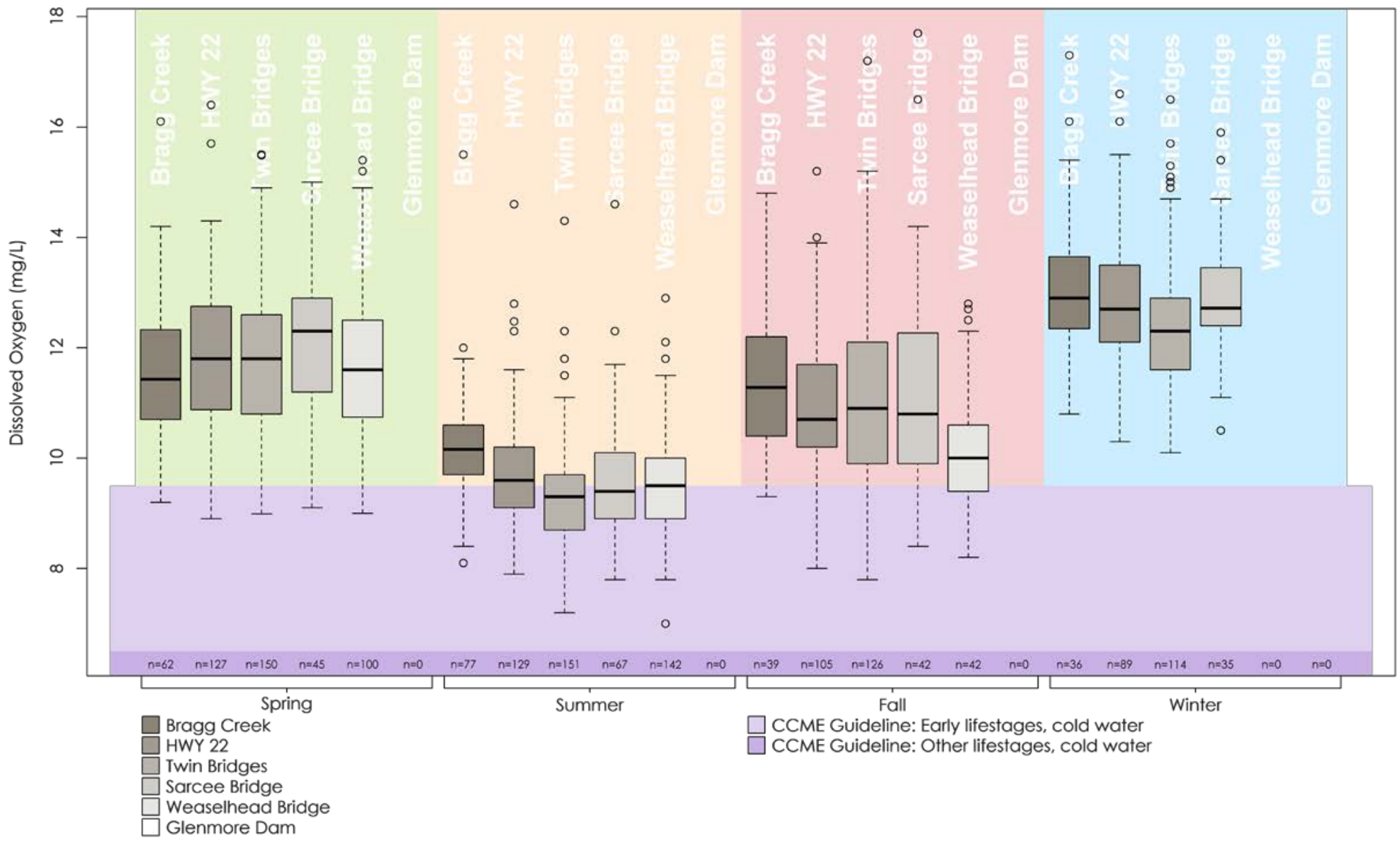


Figure IR83-1 **Dissolved Oxygen Concentration in the Elbow River Mainstem Sites and at the Glenmore Dam from 1979 to 2016.**

b. Trophic status is discussed in Volume 4, Appendix K, Section 2.2.4.6 page 2-29. In summary, the productivity or trophic status of an aquatic system is based on total phosphorus concentrations as follows (CCME 2018):

- ultra-oligotrophic: less than 0.004 mg/L
- oligotrophic: 0.004-0.010 mg/L
- mesotrophic: 0.010-0.020 mg/L
- meso-eutrophic: 0.020-0.035 mg/L
- eutrophic: 0.035-0.100 mg/L
- hyper-eutrophic: greater than 0.100 mg/L

Based on reported median total phosphorus concentrations, Elbow River is considered oligotrophic; however, the historical May and June median total phosphorus concentrations at Sarcee Bridge are considered eutrophic (see Volume 4, Appendix K, Figure 3.5). Low total phosphorus concentrations correspond with low productivity (CCME 2004). With increased phosphorus, the trophic status would trend towards eutrophic, and the photosynthesis/respiration cycling would be expected to increase. This would cause higher DO in the daytime and lower DO at night, compared to existing conditions. The trophic status will not change due to the Project; therefore, the water quality parameters that depend on the trophic status will not be changed.

REFERENCES

Nimick, D.A., C.H. Gammons, and S.R. Parker. 2011. Diel biogeochemical processes and their effect on the aqueous chemistry of streams: A review. Chemical Geology. Vol. 283: 3-17

CCME (Canadian Council of Ministers of the Environment). 2004. Canadian Water Quality Guidelines for the Protection of Aquatic Life: Phosphorus: Canadian Guidance Framework for the Management of Freshwater Systems. In: Canadian Environmental Quality Guidelines 2004, Canadian Council of Ministers of the Environment. Winnipeg.

CCME. 2018. *Canadian Environmental Quality Guidelines website*. Available at http://ceqg-rcqe.ccme.ca/en/index.html. Accessed October 2018.

Question 84

Volume 3B, Section 7.4.2, Page 7.22

Alberta Transportation states that *it is assumed the parameters likely behave similarly to suspended sediment during a flood because the physical mechanism of negatively charged suspended sediment particles attracting positively charged matter remains the same during flood conditions.*

a. **Clarify how some parameters, such as nutrient and bacteria, which are commonly associated with suspended sediments under normal/low flow, can be affected by re-suspension into the river column during flood or high flow conditions.**

b. **Clarify potential effects due to this process.**

Response 84

a. The mechanisms that cause some parameters to behave similarly to suspended sediment is the same under both high and low flow conditions (see discussion in Volume 3B, Section 7.4.2, page 7.22 and list of parameters in Volume 4, Appendix K, Section 3.2.2). Those parameters that are subject to resuspension during high flows will be transported downstream and deposited in low flow areas such as snyes (side channels), backwaters, the off-stream reservoir and Glenmore Reservoir.

b. The potential effects of re-suspended parameters are discussed in Volume 3B, Section 7.4.2, page 7.23. The resuspension and downstream transport of parameters originating within Elbow River (e.g., nutrients, bacteria and sediment) is an ongoing natural process and re-suspension versus deposition of these parameters is predicted to balance each other. For example, sections of the river with proportionally more depositional areas (e.g., Glenmore Reservoir), will act as a sink where these parameters will accumulate. The overall effect of the off-stream reservoir will either reduce or not change the total load of parameters associated with suspended solids, and the off-stream reservoir is expected to have no effect on dissolved parameters. A small, short-term increase in concentration and load when water in released back into Elbow River will be small compared to the concentrations and loads transported during a flood in the absence of the Project.

Question 85

<u>Volume 3B, Section 7.4.2, Page 7.21</u>

Alberta Transportation states that *It is anticipated that these suspended sediment concentrations during the last few days ofthe discharge can be controlled with the low level outlet gate operations (i.e., reducing flow rate) and, possibly, also with sediment and silt fences*.

a. Clarify to what degree (i.e., concentrations) suspended sediment concentrations can be reduced.

b. Describe the type, and number of sediment and silt fences proposed.

Response 85

a. The purpose of the Project is not to reduce sedimentation and improve water quality in the Elbow River; rather, the purpose is to mitigate flows in Elbow River to reduce the severity of floods. As a consequence of controlling hydrology in Elbow River, the temporary retention of diverted flood water in the off-stream reservoir will reduce total suspended solids (TSS) in the water when released back into Elbow River to levels far below the TSS concentrations when the flood water was diverted.

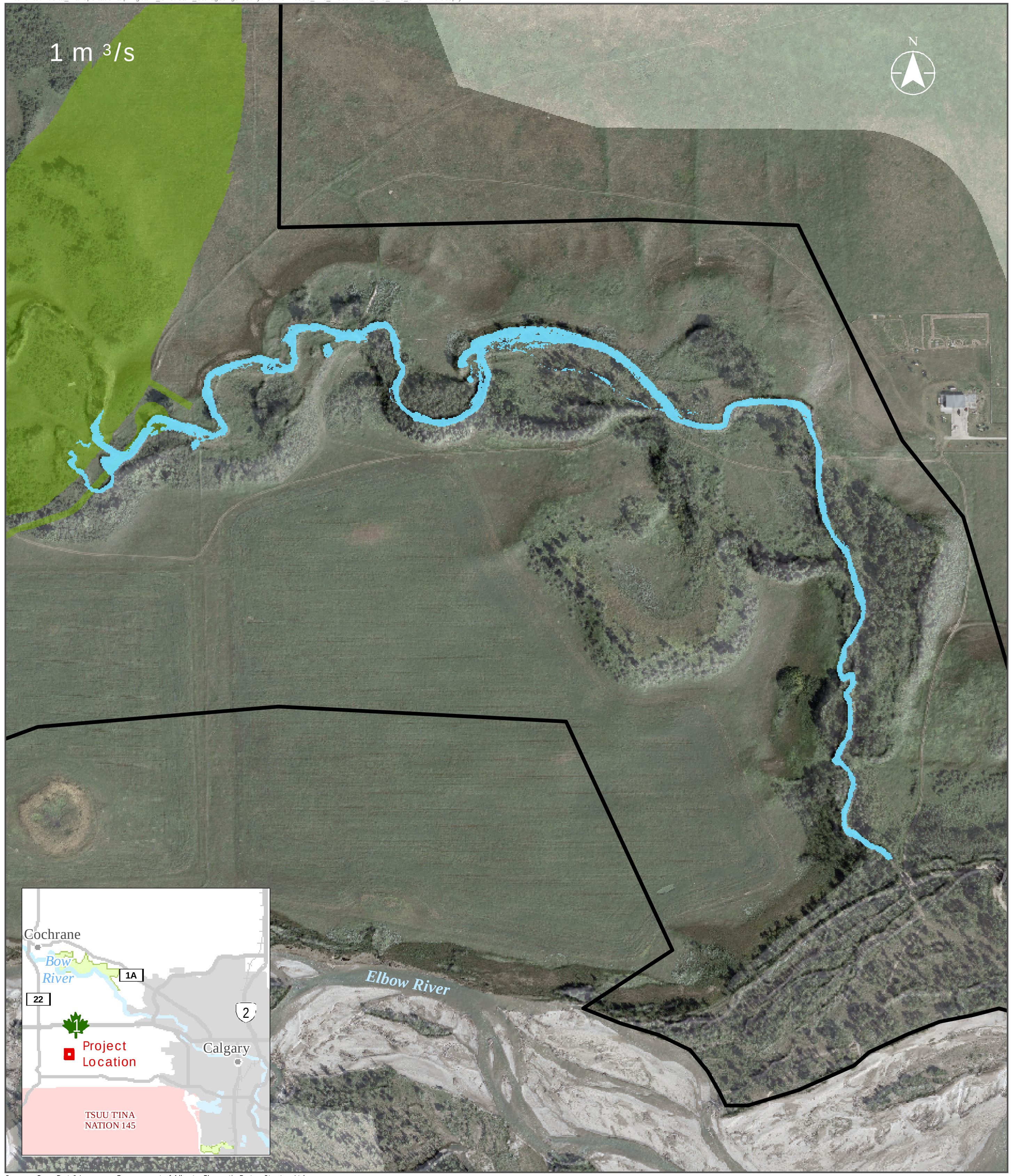
   To mitigate increasing TSS during the release of the retained water back into Elbow River, the return flow rate can be reduced by the outlet structure gate. This will reduce the potential for re-mobilization of sediments that have already settled out in the reservoir. Silt fences may be used as additional mitigation for sediment release from the reservoir at the final stages of water release from the reservoir. The silt fence can be used in the reservoir to help pool water in overland flow paths. The silt fences would also limit sediment runoff from rainfall on the deposits in the reservoir during post-flood operations. The arrangement and extent of any silt fencing, or other temporary sediment control measures, will not be known until post-flood monitoring can identify where these measures are required.

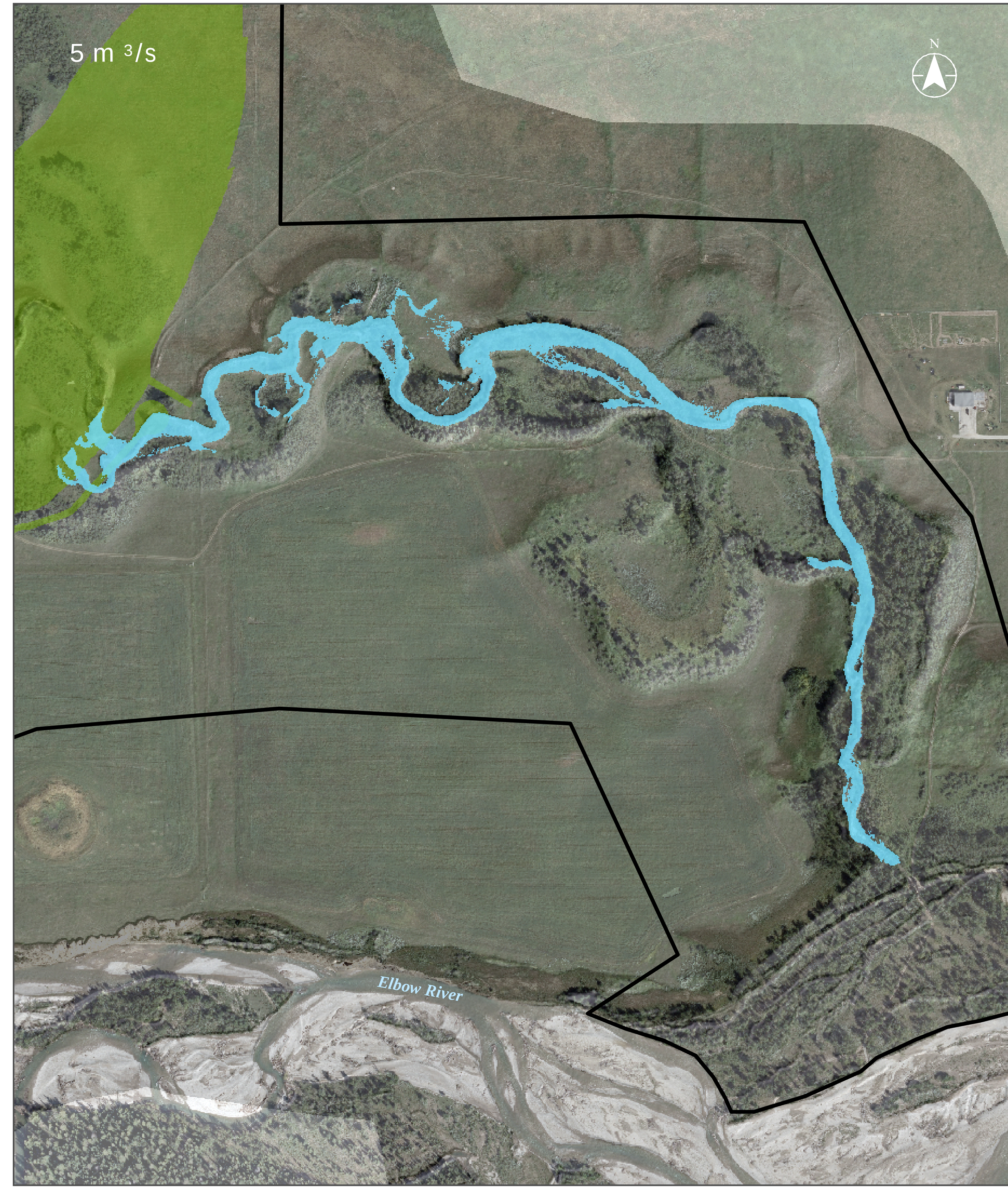
   For an effects assessment, it is adequate to understand that concentrations and loads will be reduced because of suspended sediment settling in the reservoir, without knowing the magnitude of that reduction. It is not practical at this time to determine the expected effectiveness of silt fencing and other temporary mitigation because the need for, and the specific design of sediment control measures, will not be known until post-flood monitoring. As part of the adaptive management process, monitoring would continue following the implementation of mitigation measures to assesses their effectiveness and identify adjustments that may be required.

b. The specific design of sediment control measures in the reservoir will not be known until post-flood monitoring. The use of sediment and silt fences will not be practical for the area downstream of the outlet structure because such fences are not designed to withstand the flow velocities that will be generated by the release of water from the reservoir back into Elbow River. However, the flow into the unnamed creek will spread out beyond the banks of the unnamed creek channel. The spread of the released water will slow down the flow in select areas and help settle-out sediments. Figure IR85-1, Figure IR85-2 and Figure IR85-3 show the spread of released water released into the unnamed creek channel (low-level outlet channel).

The follow-up and monitoring program for surface water quality (see the response to IR302, Appendix IR302-1) indicates that water sampling, including TSS, will be undertaken at the outlet structure (at the base of the reservoir) during water release. Should TSS levels be much greater than predicted, adaptive management measures would be implemented. Adaptive management measures will be implemented to control the flow rate: first, to reduce sediment erosion in the reservoir and, second, to increase sediment deposition before it leaves the reservoir.

W:\Clients\Alberta_Transportation\Springbank_Offstream_Storage\Figures\Hydro\110773396_770_FloodExtent_OC_1ms_5ms.mxd dcspry





Sources: Base Dat & Imagery - Government of Alberta; Thematic Data - Stantec Ltd.

Flood Extent
Off-Stream Storage Dam
Project Development Area

Flood Extent Data Created: 20160912

0 75 150 225 300
metres

110773396-770 REVA

NAD 1983 3TM 114

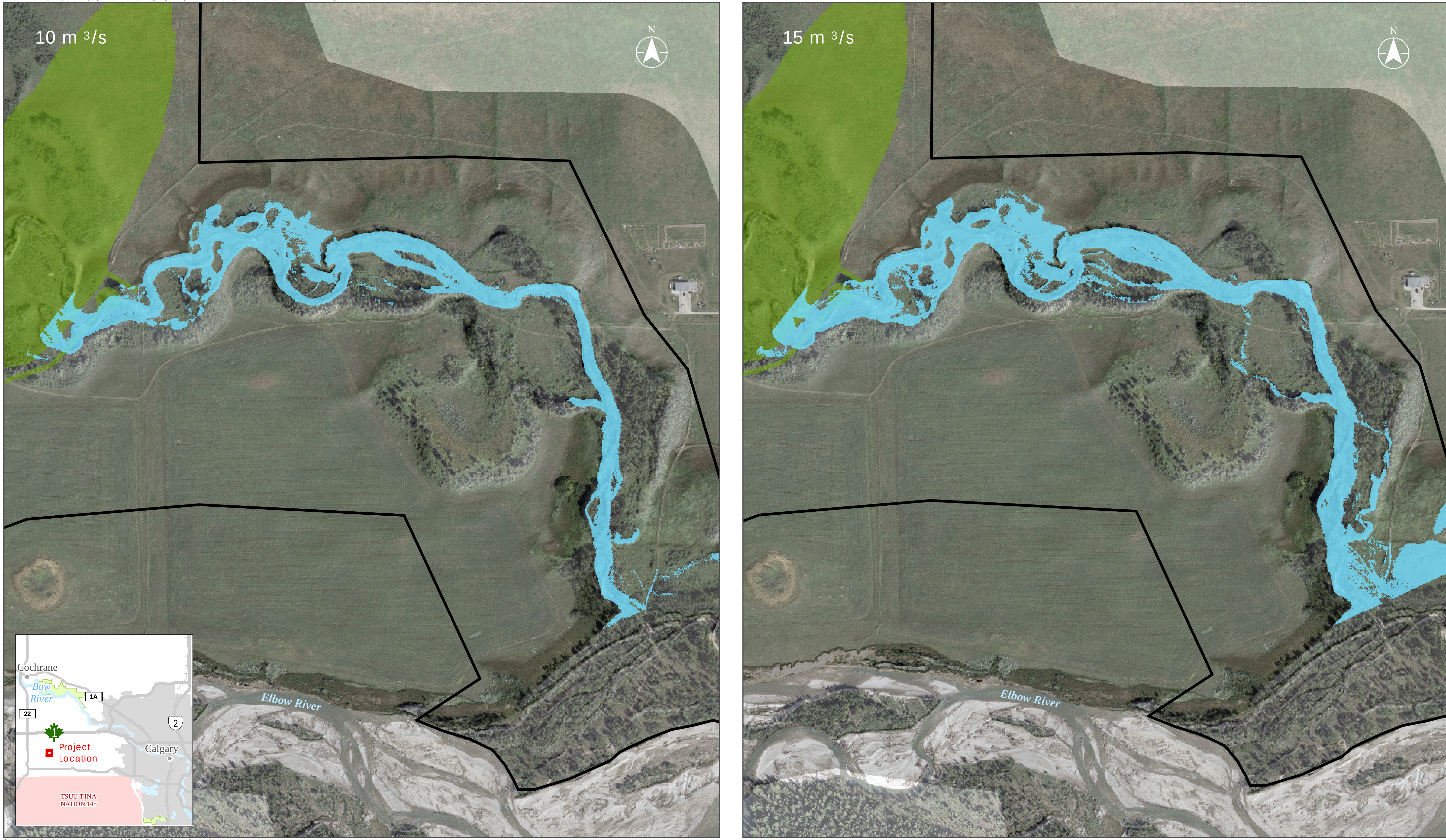
Stantec

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT

Flood Extents at the Low-Level Outlet Channel for $1\ m^3/s$ and $5\ m^3/s$

Figure IR85-1

W:\Clients\Alberta_Transportation\Springbank_Offstream_Storage\Figures\Hydro\110773396_771_FloodExtent_OC_10ms_15ms.mxd dcspry



Sources: Base Dat & Imagery - Government of Alberta; Thematic Data - Stantec Ltd.

Flood Extent
Off-Stream Storage Dam
Project Development Area

Stantec

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT

Flood Extent Data Created: 20160912

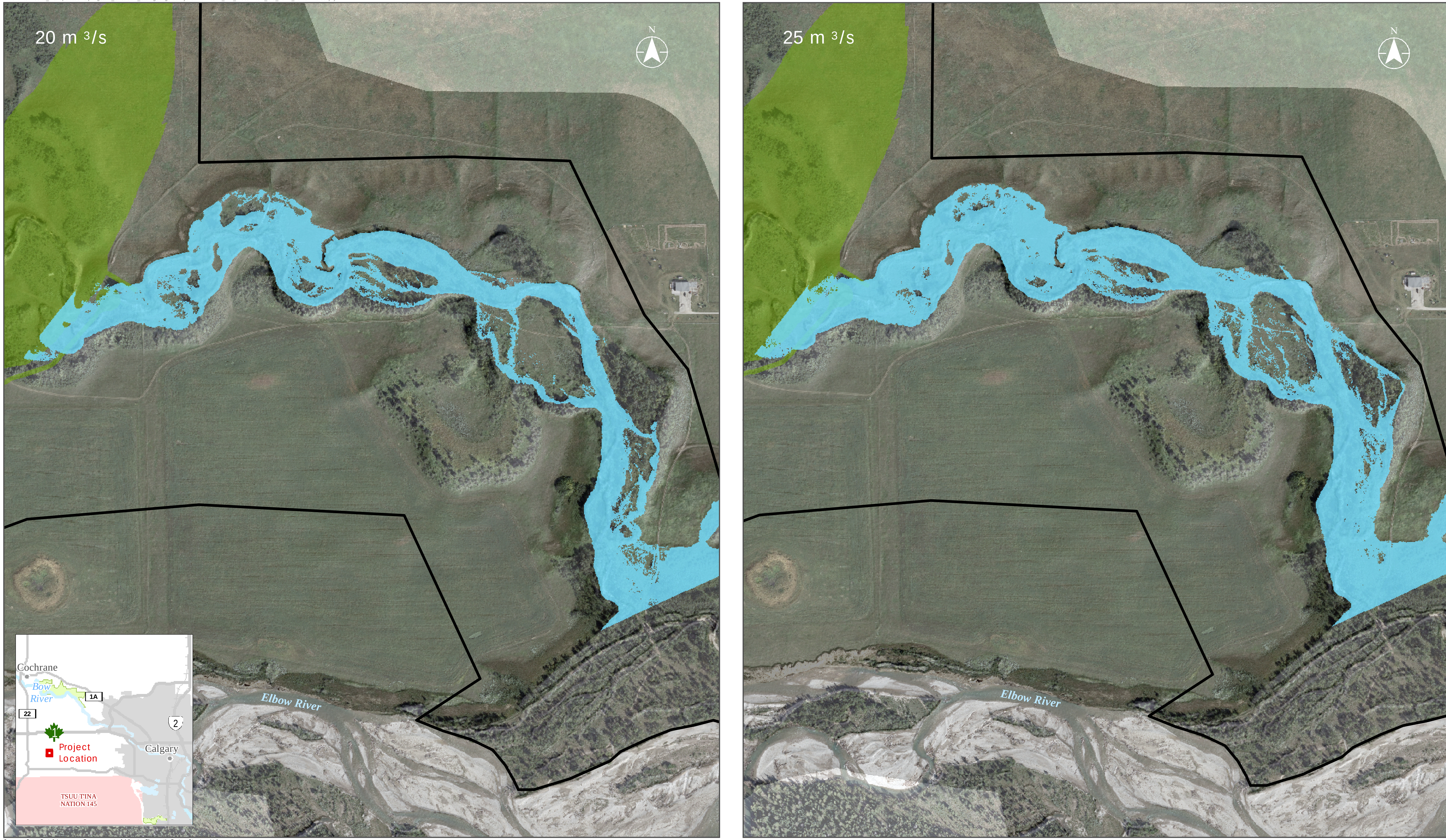
0 75 150 225 300
metres

110773396-771 REVA

NAD 1983 3TM 114

Flood Extents at the Low-Level Outlet Channel for 10 m^3/s and 15 m^3/s

Figure IR85-2



Sources: Base Dat & Imagery - Government of Alberta; Thematic Data - Stantec Ltd.

Flood Extent
Off-Stream Storage Dam
Project Development Area

Flood Extent Data Created: 20160912

0 75 150 225 300
metres

110773396-772 REVA

NAD 1983 3TM 114

Flood Extents at the Low-Level Outlet Channel for 20 m³/s and 25 m³/s

Stantec

Figure IR85-3

Question 86

Volume 3B. Section 7.4.2. Page 7.23

Alberta Transportation states that *reservoirs act as nutrient sinks with sedimentation and sediment water processes regulating the nutrient status of a reservoir*.

a. Provide estimated (modelled or calculated) water quality parameter concentrations in water retained within the reservoir and during release back to the Elbow River. Include physical, major ion, nutrient, metal, and microbiological parameters, and assess any potential effects on the Elbow River downstream (including at Glenmore Reservoir).

Response 86

a. Release of retained water will be controlled by the outlet structure gates in order to mitigate re-suspending sediments in the reservoir and manage TSS levels returning to Elbow River. Managing the rate of water release from the off-stream reservoir will reduce sediment resuspension and concentrations of TSS returning to the river during drawdown. This will also reduce concentrations of associated water quality parameters such as nutrients and metals (Volume 3B, Section 7.4.2, page 7.22 and 7.23).

Concentrations of water quality parameters in water retained in the off-stream reservoir will be dependent on the inflow concentrations of Elbow River under flood conditions as the reservoir fills. TSS concentrations released back to Elbow River will increase toward the end of the water release period from the reservoir for each of the three floods (Volume 3B, Section 6.4.3), as shown in Table IR86-1 through Table IR86-3.

Table IR86-1 Suspended Sediment Concentrations in Water Released from the Off-Stream Reservoir after a Design Flood

Location	Peak Suspended Sediment Conc. (g/m³)	Average Suspended Sediment Conc. (g/ m³)	Release Time (days)	Peak Suspended Sediment Load During Release (t/h)	Suspended Sediment Yield (kt)
Outlet structure	17,961	2,188	38	660	89.5
Unnamed creek channel confluence with Elbow River	17,955	2,173	38	653	89.7
Elbow River approximately 1 km downstream of the confluence	5,666	754	38	471	68.6

Table IR86-2 Suspended Sediment Concentrations in Water Released from the Off-Stream Reservoir after a 1:100 Year Flood

Location	Peak Suspended Sediment Concentration (g/m³)	Average Suspended Sediment Concentration (g/m³)	Release Time (days)	Peak Suspended Sediment Load During Release (t/h)	Suspended Sediment Yield (kt)
Outlet structure	20,789	7,333	38	627	220.0
Unnamed creek channel confluence with Elbow River	20,692	7,285	38	623	219.1
Elbow River approximately 1 km downstream of the confluence	4,704	1,576	38	437	150.5

Table IR86-3 Suspended Sediment Concentrations in Water Released from the Off-Stream Reservoir after a 1:10 Year Flood

Location	Peak Suspended Sediment Conc. (g/m³)	Average Suspended Sediment Conc. (g/m³)	Release Time (days)	Peak Suspended Sediment Load During Release (t/h)	Suspended Sediment Yield (kt)
Outlet structure	1,798	1,656	30	1.7	1.1
Unnamed creek channel confluence with Elbow River	1,798	1,657	30	1.7	1.1
Elbow River approximately 1 km downstream of the confluence	99	81	30	7.3	3.2

Water quality parameters will increase or decrease in relation to TSS concentrations as discussed in Volume 4, Appendix K, Section 2.2.4 (page 2.14) and Section 3.2.2 (see Table 3-1, page 3.8). Predicted changes to these parameters are discussed in Volume 3B, Section 7.2.2 page 7.7 and Section 7.4.2, page 7.20. The release of TSS associated water quality parameters will be controlled by managing the release of water from the reservoir through the outlet gate. This will minimize water quality changes in Elbow River.

As discussed in IR314a, most water quality parameters that enter the off-stream reservoir will be bound to sediments and settle out in the reservoir; thus, reducing suspended sediment loading to Elbow River when retained water is released. The sediment will settle and remain in the off-stream reservoir as follows:

- design flood,1.8% of suspended sediment will be returned to Elbow River
- 1:100 year flood, 11.7% of suspended sediment will be returned to Elbow River
- 1:10 year flood, 4.6% of suspended sediment will be returned to Elbow River

When water is released from the reservoir, erosional forces will cause sediments to be re-suspended toward the end of the water release period.

Parameters associated with suspended sediments are predicted to increase toward the end of the water release period similar to suspended sediment concentrations (Volume 3B, Section 7.4.2, pages 7.22 and 7.23). Metals loading associated with suspended sediments will increase with TSS; however, based on the small proportion of sediment returning to the river, the loading of these associated parameters is predicted to be equally small. These parameters are attached to sediment, which means they will not be readily bioavailable. The release of water from the reservoir is predicted to have no effect on dissolved metals in Elbow River.

Nutrients entering the off-stream reservoir will largely be particle-bound and associated with suspended sediments; these concentrations will settle out and be unavailable for biological uptake. The off-stream reservoir is predicted to have no effect on soluble parameters such as dissolved nutrients. Therefore, concentrations returning to Elbow River are predicted to be similar to when they entered the reservoir (Volume 3B, Section 7.4.2. page 7.23).

Because the reservoir is shallow and because of wind action on the water surface, water is predicted to remain well oxygenated. Under oxygenated conditions, particulate-bound nutrients that accumulate in the reservoir sediments will stay in particulate form rather than dissolved form; the diffusion of nutrients into the water column will not occur and, therefore, nutrients will not become available for biological uptake.

The magnitude of effect from parameters associated with suspended sediment is considered low (Volume 3B, Section 7.4.2., pages 7.22 and 7.23); duration is small and infrequent, limited to a flood periodicity greater than 1:10 year flood, and reversible.

Based on the response to IR326 and on predictions in Volume 3B, Section 7.4.4, page 7.29, updated predictions for methylmercury concentrations under the three floods are as follows:

- design flood, 0.00068 to 0.0017 µg/L
- 1:100 year flood, 0.0008 to 0.0024 µg/L
- 1:10 year flood, 0.00085 to 0.0024 µg/L

These estimated low and high methylmercury concentrations are conservative and the potential upper limits of these concentration are based on analytical detection limits. The upper limits for the 1:100 year and 1:10 year floods are above the Alberta Environmental Quality guidelines (0.001 µg/L [chronic] and 0.002 µg/L [acute]; GOA 2018); however, these estimated concentrations are below the Canadian Council of Ministers of the Environment (CCME) Canadian Water Quality Guideline for the Protection of Aquatic Life (0.004 µg/L, CCME 2003).

The release of water from the reservoir is not predicted to contribute to an increase in any biological parameters in Elbow River. The response to IR 83b states the baseline trophic status of Elbow River is oligotrophic and productivity is low. Biological activity and nutrient cycling during the retention period in the reservoir is predicted to be minimal. Due to the management of water release, there will be a reduction in nutrient load to the river. The risk for cyanobacteria is low because of low availability of phosphorus, nitrogen and carbon (see the response to IR303a). Because of the infrequent nature of reservoir operation (less frequent than once in ten years), any changes will be occasional. Therefore, the release of water from the off-stream reservoir will not result in a change in trophic structure in Elbow River or Glenmore Reservoir.

REFERENCES

CCME (Canadian Council of Ministers of the Environment). 2003. Canadian Water Quality Guidelines for the Protection of Aquatic Life: Inorganic Mercury and Methylmercury Factsheet. http://ceqg-rcqe.ccme.ca/download/en/191. Accessed October 2018.

Government of Alberta. 2018 Environmental Quality Guidelines for Alberta Surface Waters. Water Policy Branch. Alberta Environment and Parks. Edmonton, Alberta.

Question 87

<u>Volume 3B. Section 7.4.3. Page 7.25</u>

Alberta Transportation states that *for the design flood, the release of retained water…is higher in the more likely floods and smaller in the unlikely design flood*.

a. Discuss implications of changes in total loading patterns of water quality parameters in the Elbow River (and Glenmore Reservoir) as a result of water retention and release from the Project Reservoir post-flood.

Response 87

a. The statement in the preamble quoted above is followed in by additional text on the same page, which gives context:

   "During an Elbow River flood without the Project in place, water temperatures are expected to increase and dissolved oxygen concentrations decrease as floodwaters reach Elbow River floodplains or the Glenmore Reservoir. Compared to these conditions, the effect of the Project during a flood is anticipated to be of low magnitude, temporary and localized to the area where the outlet channel meets the Elbow River. The Project is not anticipated to affect temperature and dissolved oxygen in the Elbow River."

   Thus, effects on temperature and dissolved oxygen are not expected in Elbow River and Glenmore Reservoir:

   - Nutrients are predicted to deposit in the off-stream reservoir with sediments; total phosphorus will be largely bound with sediments or be in the organic form and not available for uptake by plants or algae. As such, nutrient cycling will be limited and biological processes (i.e., photosynthesis and respiration) will not develop in a manner that affects oxygen levels.
   - Water temperature in the off-stream reservoir is dependent on residence time. If flow is decreased from the reservoir, retention time is increased, allowing for water temperature to increase. However, it is not expected that the water temperature in the reservoir will be outside of the range of Elbow River historical variation.
   - Due to low biochemical oxygen demand (BOD), low sediment oxygen demand (SOD) and the influence of wind mixing and shallow water levels, oxygen concentrations in the off-stream reservoir are not predicted to become anoxic; changes in dissolved oxygen are expected to be smaller than currently observed in Glenmore Reservoir (Volume 3B, Section 7.4.3).
   - If low oxygen levels in the off-stream reservoir occur prior to water release, these levels will be attenuated as water is released into unnamed creek, which has a gradient of greater than 0.8 % over the lower 2 km before the confluence with the Elbow River (Volume 4, Appendix J, Section 3.3, Page 3.5). Turbulence generated is predicted to aerate water before it enters Elbow River.

   Compared to the sediment load in the Elbow River without diversion (Volume 3B, Section 6.4.3, Table 6-6), the Project will reduce sediment in Elbow River by 50% for the design flood, 65% for the 1:100 year flood, and 5% for the 1:10 year flood. Most of this sediment will settle and remain in the off-stream reservoir; consequently, parameters associated with sediment concentrations will also remain in the reservoir:

   - 1.8% of sediment that enters the reservoir will return to the river for a design flood

- 11.7% of sediment that enters the reservoir will return to the river for a 1:100 year flood
- 4.6% of sediment that enters the reservoir will return to the river for a 1:10 year flood

Any sediment related parameters that are released with suspended sediments will be equally small. Furthermore, these constituents will be sediment bound (i.e., meaning they will not be readily bioavailable) and, therefore, effects will be minimal in the river. The release of water is predicted to have no effect on dissolved parameters in Elbow River.

Implications for methylmercury loading are discussed in the response to IR326, in particular:

- total mercury concentrations in Elbow River are low and generally below detection limits.
- in surface water systems, methylmercury is generally about an order of magnitude lower than total mercury
- the estimated low and high methylmercury concentrations are predicted to be below the Canadian Water Quality Guideline for the Protection of Aquatic Life (0.004 µg/L)
- loading of these levels will not increase concentrations in Elbow River or Glenmore Reservoir; concentrations will remain below guideline levels

---

Question 88

Volume 3B. Section 7.5. Page 7.34

Alberta Transportation concludes that *the effect of the Project on water quality is not significant because the change in water quality is not anticipated to cause acute or chronic toxicity or change the trophic status of the Elbow River or Glenmore Reservoir*.

a. Clarify how conclusions were determined on trophic status and toxicity when parameter concentrations were not estimated and productivity (e.g., macrophytes, periphyton, biomass, invertebrates, etc.) was not assessed.

Response 88

a. Project interactions (Volume 3A, Section 7.3 and Volume 3B, Section 7.3) and effect pathways (Volume 3B, Section 7.4.2 and Volume 3B, Section 7.4.1) are identified to determine the potential for water quality in Elbow River to be affected by the Project. A full assessment is completed only if there are pathways for trophic status and toxicity to be affected by changes in water quality.

In the pathway discussion (Section 7.1.1), it is determined that the only Project pathway for toxicity is metal methylation and only mercury methylation has a potential pathway. The assessment shows that concentrations of methyl mercury would not be toxic. The Project is not predicted to cause other constituents (e.g., metals, hydrocarbon, chemicals) to increase in concentration and have residual effects that result in toxicity to aquatic life.

The Project pathway that may result in trophic structure changes to Elbow River would include an increase in nutrient levels in the reservoir that are released into the river. Nutrient loads in the river system are the potential cause of eutrophication. Nutrients are predicted to settle with sediments and be retained in the reservoir; therefore, nutrients will be reduced in the river system downstream of the unnamed creek during floods, compared to the nutrient levels in Elbow River without the Project. Only small amounts of sediment and, by association nutrients, will be returned to the river. For a design flood, only 1.8% of suspended sediments will exit the reservoir; for the 1:10 year flood and 1:100 year flood, 4.6% and 11.7% of the sediment will exit the reservoir, respectively (Volume 3B, Section 7.4.2, page 7.23).

The response to IR83b states the baseline trophic status of the Elbow River is oligotrophic and productivity is low. Due to the infrequent operation of the reservoir and the management of water release, there will be a reduction in nutrient load to the river. This will not result in a change in trophic structure in Elbow River or Glenmore Reservoir (Volume 3B, Section 7.4.2, page 7.23).

Question 89

Volume 4, Appendix K, Table 3-1, Page 3.9

a. All of the columns for dissolved oxygen and temperature, say dissolved oxygen and temperature respectively. Provide the information for these parameters and update the table.

Response 89

a. Table 3-1, page 3.9, under the subheading for Temperature and Dissolved Oxygen, has incorrect entries related to the seasonal variability metric (SVM) and total suspended sediment (TSS). See Table IR89-1 for corrections, in red.

Table IR89-1 Seasonal Variation Metric and Distance from TSS SVM Results for Dissolved Oxygen and Temperature (correction to Volume 4, Appendix K, Table 3-1)

Parameter	Variation Pattern (SVM Distance from TSS)	Variation Pattern Category	Seasonal Pattern	Spatial Pattern (from upstream to downstream)	Comments
Dissolved Oxygen	1.58	moderate	none	none	-
Temperature	2.77	distant	none	positive	-

Question 90

Volume 4, Appendix K, Section 3.2.2.1, Page 3.13

Alberta Transportation states that *the upper Elbow River mainstem is not reported to have substantial macrophyte (aquatic plant) growth in literature*…

a. **Provide the reference(s) for this statement. Is this consistent for periphyton and algae? Explain.**

Response 90

a. Based on available literature, information is scarce regarding periphyton or algae in Elbow River. But, periphyton was observed at all benthic invertebrate sampling reaches in fall 2016, as stated in Volume 4, Appendix M, Section 3.2.2, page 3.33:

> "A visual assessment at each site on the Elbow River showed that there was zero to low periphytic algae growth on the substrates in the upper reaches 1 and 2, at sites ER1 and ER2, while low to moderate algae growth was observed in the lower reaches at all sites except Site ER10 (located just downstream of the Glencoe Golf Course), which had a moderate to heavy growth of periphytic algae."

Question 91

Volume 1, Section 3.4.1, Page 3.33
Volume 1, Section 3.5.1, Table 3-8, Page 3.35

Alberta Transportation states *During dry operation, the diversion inlet gates will close and the service spillway gates will open (lowered)*. This statement is inconsistent with Volume 1, Section 3.5.1, Table 3-8 which indicates that *for Flow Rate < 160 m^3/s the right gate will be raised and the flow will be through left spillway*.

a. **Clarify the inconsistency.**

b. **Describe expected spillway gate configuration at a flow < 160 m^3/s during Dry- operation service spillway maintenance activities.**

c. **Does the spillway gate configuration at a flow < 160 m^3/s during Dry-operation service spillway maintenance activities influence the effectiveness of fish passage mitigation? If this does not influence the effectiveness of fish passage explain how this conclusion was reached. If it does effect the effectiveness of fish passage then evaluate the effects on each indicator of fish population and explain how these effects can be mitigated.**

Response 91

a. During normal dry operations, both lift gates are lowered and flush with the riverbed. In low flow conditions that would not allow sufficient water depth (18 cm) over both of the diversion gates to facilitate fish passage, the right gate will be raised. This will channel the flow of the river through a smaller area, increase water depths, and allow for fish to move up and downstream of the structure.

b. Each of the service spillway gates can be isolated from the flow using temporary measures that divert flow into the opposite gate for which maintenance is to be performed. This allows maintenance to be executed at any gate location while maintaining sufficient depth for fish passage.

c. The spillway gate configuration at a flow of less than 160 m^3/s during dry operation service spillway maintenance activities does not influence the effectiveness of fish passage mitigation. Details for this assessment are provided in Appendix IR91-1. As with normal dry operations during low flows, and further to information provided in b., spillway maintenance activities will be carried out under isolation and flow will be diverted into the opposite gate. This will produce the same effect as regular low-flow operations by channeling flow through a smaller area, thereby increasing the flow depth, and facilitating fish passage through the instream structure. Both gates of the spillway are hydraulically connected in the stilling basin, and the engineered fish passage mitigation measures will function as designed, regardless of which gate is open or closed.

Question 92

<u>**Volume 3A, Section 8, Report Section 8.2.2**</u>

Requirements specified in ToR 3.6.1 Baseline Information should be reviewed. The Desktop review provides a general overview of ecology and habitat requirements of fish species and relative abundance of fish expected to occur in the LAA. For each survey site habitat quality was rated for fish groups, not for fish species.

Baseline information that describes the species composition, distribution, abundance, movements, habitat use, habitat quality, and life history parameters of fish populations currently residing within the LAA are not fully presented. There is no comprehensive discussion of the ecology of species populations identified as indicator fish species to be used by the effects assessment.

a. Based on the review, identify gaps in the baseline information that may hinder the ability to evaluate Project effects.

b. Identify specific components of the baseline information data gap that that may hinder the ability to evaluate Project effects (e.g., timing and duration of Bull Trout population movements in the vicinity of the diversion structure, location and size of Mountain Whitefish spawning habitat sites downstream of the diversion structure, distribution of the Rainbow Trout population relative to the location of the diversion structure).

Response 92

a-b. The baseline information collected for aquatic ecology does not have data gaps that hinder the ability to evaluate Project effects.

The assessment of aquatic ecology uses desktop and field analyses to evaluate Project-related effects, and the assessment relies on the Project data to addresses the Project-related effects using Fisheries and Oceans Canada's pathway of effects (DFO 2014) to indicate which Project activities will or may result in an effect. The aquatic ecology assessment describes how those pathways can be broken and discusses the residual effects, in a qualitative manner, the following:

- the area of habitat that will be altered/lost by construction
- changes to water quality
- changes to habitat from the alteration of flow (based on hydrological modelling) during flood and post-flood operations

Additional analyses may be undertaken upon progression of the Project designs to calculate loss in an Application for Authorization under the *Fisheries Act* and support an associated offset measures plan.

REFERENCES

DFO (Fisheries and Oceans Canada). 2014. Pathways of Effects. Accessed: October 2018. Available at: http://www.dfo-mpo.gc.ca/pnw-ppe/pathways-sequences/index-eng.html.

Question 93

Volume 3A, Section 8.4.2.1, Pages 8.49 and 8.50
Volume 3A, Section 8.4.3.8, Page 8.55

Alberta Transportation states *During dry operation of the project, the physical structure may be a barrier to upstream fish migration for large fish by creating an area of shallow water over the concrete gates, with depths shallower than 18 cm, that may impede the upstream movement of large fish such as bull trout, brown trout, or mountain whitefish, during late summer spawning*

migrations. The transition from the concrete gates to the spilling basin may also create a drop that is too tall for small fish to jump up (Section 8.4.2.1) and that Boulders would be added to increase the bed roughness of the channel immediately downstream of the diversion structure, which would increase water depths and reduce velocities, and Boulder V-weir structures would be constructed in the channel downstream of the gates to provide slower velocity and deeper resting zones (Section 8.4.3.8).

a. Provide the rationale for the use of physical works in the Elbow River channel downstream of the service spillway and stilling basin as a mitigation measure to provide safe unhindered upstream and downstream fish passage through the service spillway and stilling basin.

b. Provide empirical evidence that illustrates how mitigation measures in the Elbow River channel downstream of the service spillway and stilling basin mitigate water depths shallower than 18 cm that occur within the service spillway and how mitigation measures in the Elbow River channel downstream of the service spillway mitigate a water elevation drop between the service spillway and the stilling basin.

c. Discuss whether Elbow River bed material transport through the service spillway area during Dry Operation and during Flood and Post-Flood Operation will influence the performance of mitigation measures in the Elbow River channel downstream of the service spillway and within the stilling basin. The discussion should include an evaluation of the expected life span of the mitigation measures in terms of structural stability and as-built specifications. Use experience gained from other Alberta Transportation mitigation sites to inform the discussion.

Response 93

a. The proposed engineered fish passage measures are designed to maintain sufficient depth for fish passage. Working in conjunction with gate operations, these physical works (diversion structure, service spillway and stilling basin) are necessary to allow the movement of fish up and downstream in Elbow River during low flow periods. The minimum governing criteria for depth and flow calculated to maintain serviceability and fish passage through the instream works of the Project requires a depth of 18 cm over the service spillway and stilling basin at a calculated river low-flow of 0.8 m^3/s. This design is hydraulically similar to the existing geometry and profile of the river with the same velocity and depth characteristics as the river upstream and downstream of the diversion structure so that use of built fishways can be avoided. Further details and engineering design related to fish passage is in the response to IR91 and Appendix IR91-1.

b. The proposed mitigation measures were modelled using Flow 2D software to ensure their conformity to the design parameters. Results of this model are included in the response to IR91 (Appendix IR91-1, Attachment IR91-1B and Attachment IR91-1C). A water surface profile at a low flow of 0.8 m^3/s demonstrates a minimum depth of at least 19 cm over the v-weirs and stilling basin.

c. The service spillway elevation matches the existing bed grade and thalweg as well as bankfull width. These features will allow preferential flow through the instream structures, maintain hydraulic connectivity up and downstream, and move most sediment through the service spillway and stilling basin during dry operations and during post-flood operations. During flood operations, the service spillway gates are raised and limit the amount of sediment that passes through the service spillway. Sediment deposition behind the service spillway and stilling basin is not expected to hinder the performance of these features, and the concentration of flow through them should maintain the engineered profile up to the diversion operational flow of 160 m^3/s. Bedload is also expected to move through unhindered up to the 160 m^3/s threshold. The mitigation measures in the stilling basin are constructed of Class 2 riprap, which is sized for resiliency to flows up to the 1:100-year flood. Operationally, flows in the river of up to 760 m^3/s are reduced to 160 m^3/s during diversion, which will further maintain the stability of these measures. Further information can be found in the response to IR91 (Appendix IR91-1, Attachment IR91-1B).

   The life span of the mitigation infrastructure cannot be estimated since the actual frequency and severity of floods is not known; however, it will be monitored for the life of the Project and appropriate repairs will be completed, when required, to maintain functionality. Comparable mitigation projects in Alberta do not exist because there are no off-stream reservoirs within the province.

Question 94

Volume 3A, Section 8, Report Section 8.4.4.2, Page 8.58

Alberta Transportation states *During construction, fish passage concerns would be mitigated with passage around the site*.

a. Provide information that demonstrates safe, unhindered upstream and downstream fish passage during operation of the Elbow River diversion channel. The information should indicate whether the diversion channel will operate during the entire period of river diversion and what measures will be applied to provide suitable water velocities and water depths for upstream and downstream passage of each indicator fish species and life stage.

b. If there are periods when the diversion channel is not operating and/or effective fish passage cannot be provided by the diversion channel at all flows, identify the duration and timing of hindered fish passage and indicate the indicator fish species and life stage that will be affected.

c. If safe, unhindered upstream and downstream fish passage during operation of the Elbow River diversion channel cannot be provided revise the effects assessment of fish passage during construction.

Response 94

a. During construction, a temporary diversion channel will be excavated to direct flow away from the construction footprint of the diversion structure and minimize work completed in the active channel of the river. The diversion channel geometry has been designed to mimic the natural channel form and bankfull width of the river and will have the same bed substrate as the river main channel. Based on the channel dimensions and substrate characteristics, the hydraulic conditions in the temporary diversion channel will be similar to the natural channel in the Elbow River in order to facilitate fish movements.

b-c. The temporary diversion will be established prior to introducing flow through it and will be in operation during construction of the service spillway and its associated instream structures. Flow will be returned to the main channel and through the completed service spillway prior to decommissioning of the temporary diversion. At no time would blockage of flow and fish passage occur during construction of the instream works. A fish salvage will be conducted at the time of dewatering of the temporary isolation of the diversion channel and fish returned to the Elbow River.

Question 95

Volume 3A, Section 8.4.4.2, Pages 8.60

Alberta Transportation states *With mitigations, fish migrations past the structure would not be impeded in a manner that would affect the sustainability of the fish populations, the distribution, or abundance of fish, including fish that support CRA fishery, in the LAA*.

Discussion of Project effects on fish passage focuses on a comparison of pre-construction conditions to post-construction conditions of the Elbow River channel downstream of the service spillway. The general conclusion from the discussion, for modelled discharges, is that pre- and post-construction conditions of the Elbow River channel are similar.

Alberta Transportation states that *During discharges at 69.5 m^3/s (BSP2-3Q10max)..... Fish movement would be possible over the structure along the margins....* (Page 8.60).

Fish passage through the service spillway during Dry Operations may be the most important potential effect of the Project on the health of Elbow River fish populations, but a limited evaluation of the issue is presented.

a. Provide a table that summarizes fish passage requirements of each indicator fish species and life stage. The table should include the period when passage is required, the direction of passage, the expected size range of fish that require passage (ensure that this information conforms to baseline information), and the estimated swimming ability of each indicator fish species life stage.

b. Provide a table that summarizes water velocity and water depth values modelled by Volume 4, Appendix M, Attachment 8A Fish Passage Analyses for post-construction conditions specific to the service spillway structure and specific to the stilling basin structure. In order to establish precision of the model outputs, the summary should include the average and range of each modelled value. Use 95% Confidence Interval as the metric for range.

c. Provide illustrations of model results for post-construction conditions specific to the service spillway structure and stilling basin structure. Ensure illustrations are of sufficient scale to allow clear identification of preferred fish movement routes within the service spillway and within the stilling basin (i.e., zones that provide suitable water velocity and suitable water depth for fish passage).

d. Based on the above information conduct an evaluation of the Project effects on fish passage within the service spillway and within the stilling basin. Ensure the evaluation includes each indicator fish species and life stage.

Response 95

a-b. Fish passage criteria and abilities are presented in the response to IR91 (and further discussed in Appendix IR91-1, Table 1) and presented here as Table IR95-1. Table IR95-1 summarizes the ability of fish species to pass through the instream Project components considering both water depth and velocities. This fish passage criteria also considers burst and sustained swimming speeds of several fish species at different sizes and life stages. Katapodis and Gervais (2016) reported the swimming capabilities of the species of interest for the Project, which are grouped under “pike – J-4b” as a surrogate for anguilliform fish in the Elbow River and “salmon & walleye – J-5b”, can act as a surrogate for trout species in the Elbow River).

This analysis was undertaken for all identified biologically sensitive periods (BSPs) of Elbow River fish species, which include attributes such as spawning, migration, and incubation. Fish passage ability was considered primarily for upstream movement. Because flow is unimpeded, there will be no impact to downstream passage. Katapodis and Gervais (2016) presents curves representing the swimming abilities of fish at different sizes. Table IR95-1 summarizes the swimming capability of 250 mm fish. Larger fish (1,000 mm) have greater sustained and burst swim speeds and will pass the instream Project structures, while 25 mm fish may not. Fish of this size are immature and do not need to move upstream to spawn at this life stage.

Table IR95-1 2D Hydraulic Assessment Results of Instream Components for Fish Passage During Low Flow (0.8m³/s)

Section Number	Description	Max. Velocity (m/s)	Min. Water Depth (m)	Pike Species Pass?	Salmon and Walleye Species Pass?
1	Stilling Basin	1.07	0.19	Yes	Yes
2	Rock V-Weir 1	1.10	0.19	Yes	Yes
3	Rock V-Weir 2	1.10	0.19	Yes	Yes
4	Rock V-Weir 3	1.15	0.21	Yes	Yes
5	Natural Riverbed	0.63	0.18	Yes	Yes

For each BSP, relevant flow rates were identified and confidence bands for these flows estimated. The hydraulic model assessed the average flow for each BSP, but the model did not run the 95% confidence interval flows on either side. Generally, these 95% confidence interval flow ordinates fall within the already analyzed range of flows with the exception of the low 95-percentile flow of the lowest flow and the high 95-percentile flow of the highest flow (Table IR95-2). Consideration of these additional flows would not alter the assessment of effects on fish and fish habitat.

Table IR95-2 Confidence Intervals for Best Fit Distribution of Selected Biologically Sensitive Period

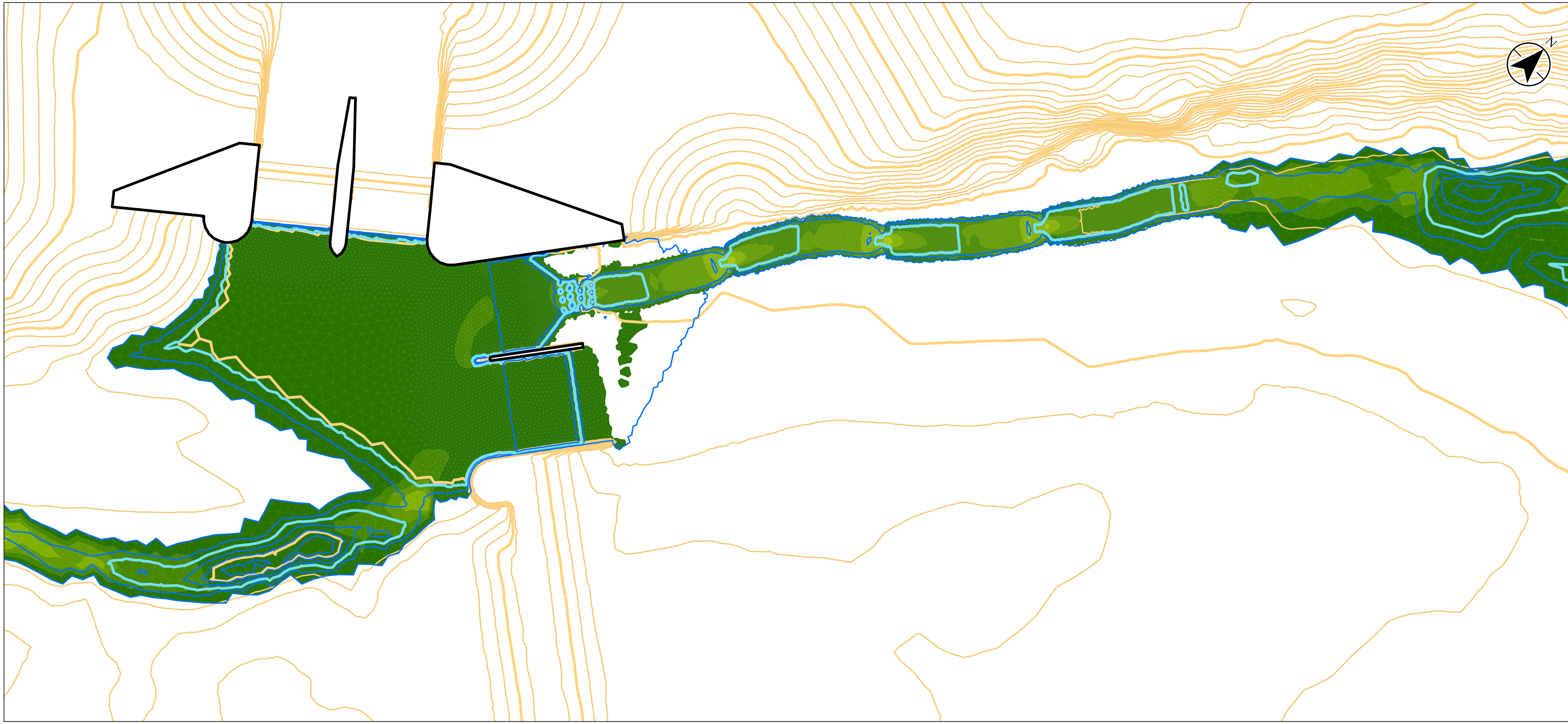
Biologically Sensitive Period (BSP)	3 day, 10 year minimum daily-mean flow (minimum flow)	Best Fit Distribution (m^3/s)	Lower 95% Confidence Interval (m^3/s)	Upper 95% Confidence Interval (m^3/s)
BSP4	$3Q10_{min}$	0.8	0.7	1.0
BSP3	$3Q10_{min}$	2.4	2.1	2.6
BSP1	$3Q10_{min}$	2.8	2.7	2.9
BSP2	$3Q10_{min}$	3.5	3.2	3.8
BSP4	$3Q10_{max}$	9.8	8.2	11
BSP3	$3Q10_{max}$	15	12	18
BSP2	$3Q10_{max}$	70	59	79
BSP1	$3Q10_{max}$	76	62	89

c. Results of the dry operation fish passage evaluation are included in Table IR95-1 and Figure IR95-1 (a replication of the fish passage simulation figure for a 0.8 m^3/s flow presented in Appendix IR91-1, Attachment IR91-1C). Table IR95-1 summarizes the results of the 2D modelling of the reach, instream structure, and engineered fish passage mitigations. Even under higher flows, the modelled velocity distribution demonstrates an abundance of areas below 1 m/s that will allow for all of indicator species (grouped under 'pike' and 'salmon & walleye') at life stages of 25 mm, 250 mm and 1,000 mm (as per Katapodis and Gervais 2016) to move up and downstream of the service spillway and stilling basin. Figure IR95-1 demonstrates the ability for the noted species in Elbow River to move up and downstream of the service spillway and stilling basin.

d. Based on the responses to a., b. and c., the spillway gate configuration at a flow of less than 160 m^3/s during dry operation and service spillway maintenance activities does not influence the effectiveness of fish passage mitigation. The 2D model results are provided in the response to IR91, as Appendix IR91-1, Attachment IR91-1C1. The results are shown twice at different scales: first, to show the effects of the service spillway, stilling basin, and engineered fish passage mitigations; and second, at a scale that demonstrates the equivalence of the engineered works to the existing natural features of the river downstream.

REFERENCES

Katapodis and Gervais. 2016. Fish Swimming Performance Database and Analyses. DFO Can. Sci. Advis. Sec. Res. Doc. 2016/002 vi + 550p.



Legend

Model Domain Lines

Depth Contours (0.1 m interval)

All depth contours

0.2 m depth contour

Bed Contours (1 m interval)

Intermediate

Index

Velocity (m/s)

3.5 - 3.75
3.25 - 3.5
3 - 3.25
2.75 - 3
2.5 - 2.75
2.25 - 2.5
2 - 2.25
1.75 - 2
1.5 - 1.75
1.25 - 1.5
1 - 1.25
0.75 - 1
0.5 - 0.75
0.25 - 0.5
0 - 0.25
0

0 20 40 Meters

1:1,000 (At original document size of 11x17)

Notes
1. Coordinate System: NAD 1983 3TM 114

Stantec

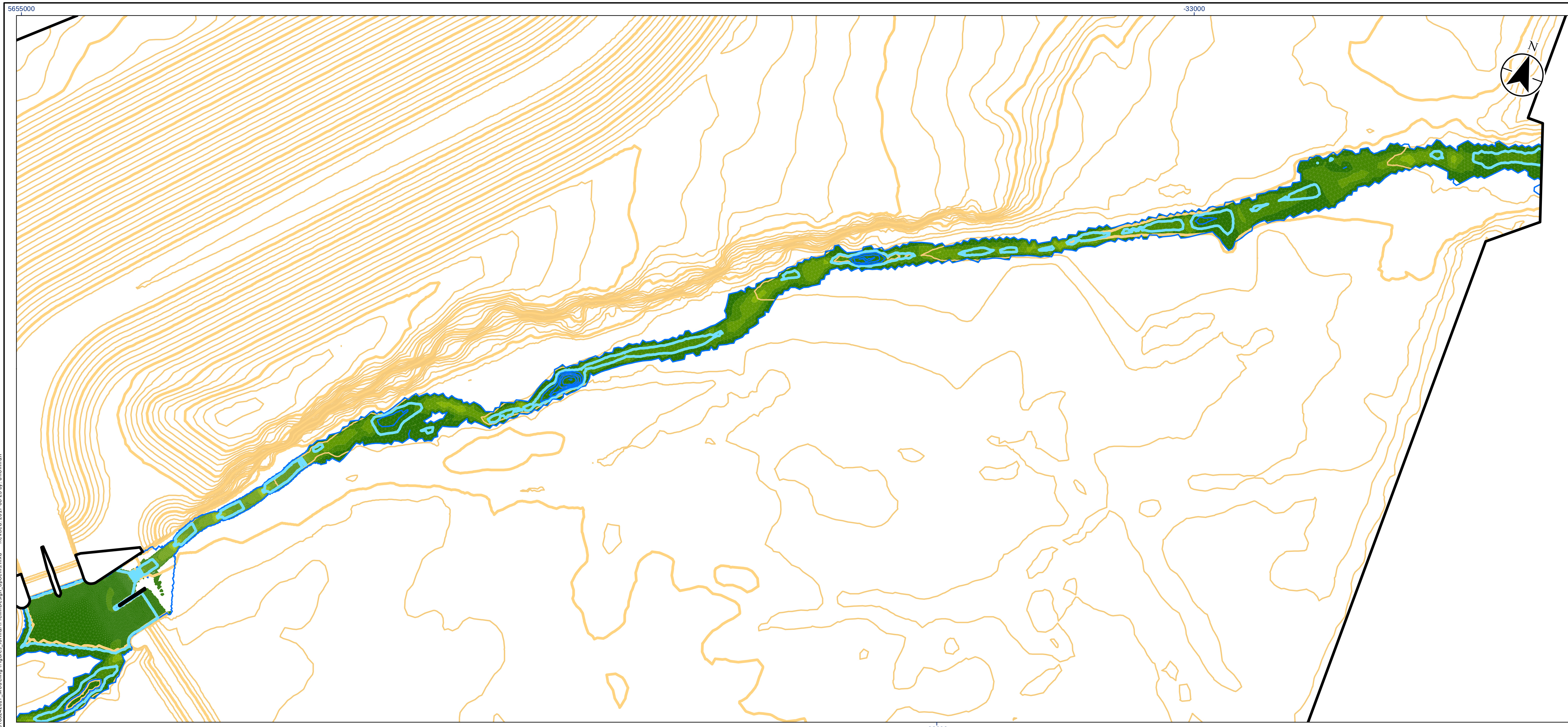
Project Location 110773396
City of Calgary
Alberta
Prepared by DEH on 2017-08-23
Technical Review by ABC on 2017-02-xx
Independent Review by ABC on 2017-02-xx

Client/Project
Alberta Transportation
Springbank Off-Stream Reservoir (SR1)

Figure No.
1 of 2

Title
Figure IR95-1a: Fish Passage Simulation Preliminary Design, 0.8 cms

U:\110773396\component_work\dams_diversion\hydrotechnical\analysis\Local_Hydraulics_Analysis\05242017_Modeling\Figures_format\PrelimDesign_0p8cms_Zoom.mxd Revised: 2017-08-23 By: dhoffman



Legend

Model Domain Lines

Depth Contours (0.2 m interval)

All depth contours

0.2 m depth contour

Bed Contours (1 m interval)

Intermediate

Index

Velocity (m/s)

3.5 - 3.75
3.25 - 3.5
3 - 3.25
2.75 - 3
2.5 - 2.75
2.25 - 2.5
2 - 2.25
1.75 - 2
1.5 - 1.75
1.25 - 1.5
1 - 1.25
0.75 - 1
0.5 - 0.75
0.25 - 0.5
0 - 0.25
0

0 60 120 Meters

1:3,000 (At original document size of 11x17)

Stantec

Project Location
City of Calgary
Alberta

110773396
Prepared by DEH on 2017-08-23
Technical Review by ABC on 2017-02-xx
Independent Review by ABC on 2017-02-xx

Client/Project
Alberta Transportation
Springbank Off-Stream Reservoir (SR1)

Figure No.
2 of 2

Title

Figure IR95-1b: Fish Passage Simulation Preliminary Design, 0.8 cms

Notes
1. Coordinate System: NAD 1983 3TM 114

U:\110773396\component_work\dams_diversion\hydrotechnical\analysis\Local_Hydraulics_Analysis\05242017_Modeling\Figures_format\PrelimDesign_0p8cms.mxd Revised: 2017-08-23 By: dhoffman

Question 96

<u>Volume 3B, Section 8.2.2, Page 8.6</u>

Alberta Transportation states that auxiliary spillway may also activate for smaller flood events if the conveyance capacity is reduced by debris and sediment at the diversion inlet and service spillway and operations of the gates are not adjusted.

a. Estimate the frequency of occurrence of auxiliary spillway activation for smaller flood events. Consider blockage of the service spillway by large woody debris at all high flow events, including flows less than 160 m^3/s. Use experience gained from other water diversion projects located in Alberta.

b. Discuss the implications of auxiliary spillway activation on permanent alteration of fish habitat using the pathway effects approach. Consider erosional effects associated with overland flow, and volume of sediments generated by erosional effects.

c. Identify mitigation measures that could be applied.

d. Evaluate residual effects on each indicator fish species and life stage caused by auxiliary spillway activation.

Response 96

a,c. The term ‘smaller flood’ in this context refers to floods that are not as large as the design flood.

The gate bays of the service spillway have been designed to promote the passage of woody debris during flood operations. Woody debris does not begin to mobilize in notable amounts until floods greater than flows of 160 m^3/s. Debris-induced activation is possible of the auxiliary spillway during large floods and it is designed with a concrete core; however, its activation from debris is part of the Project design mitigation to minimize risk to public safety during a flood. As such, activation of the spillway is considered in the effects assessment as a component of flood operations (Volume 3B, Section 8.2).

The service spillway is designed to pass debris through the gate bay openings and over the pneumatic crest gates. This operation was reviewed in the physical hydraulic model (see the response to IR454, Appendix IR454-1). Comparable water diversion projects in Alberta do not exist because there are no off-stream flood storage reservoirs within the province. Typically, irrigation diversions do not actively divert during flood flows of the design flood magnitude and, thus, do not provide good reference points.

In summary, blockage of the service spillway is not expected during smaller floods and the Project design incorporates mitigation measures to prevent its occurrence. Because this is an unplanned event for which mitigation is provided, it is not possible to provide the frequency of occurrence for auxiliary spillway activation during smaller floods.

b,d. Considering the Fisheries and Oceans Canada's pathways of effects (DFO 2014), water released from the auxiliary spillway will spill into the river floodplain behind the berm. Due to the flood conditions occurring in Elbow River and the adjacent floodplain when water may be released through the auxiliary spillway, the consequence of overland erosion will be minimal or not occur over its short travel distance. Natural variability in habitat change due to flood processes will be much higher than possible effects from water spilling over the auxiliary spillway. Therefore, an effect on fish and fish habitat is well within the magnitude of natural change caused by the flood. The linkage between water released from the auxiliary spillway and effects on fish and fish habitat during a flood is considered weak and effects are unlikely. Because flood water released through the auxiliary spillway will not cause an effect on fish and fish habitat, none of the resident fish life stages will be affected.

REFERENCES

DFO (Fisheries and Oceans Canada). 2014. Pathways of Effects. Available at: http://www.dfo-mpo.gc.ca/pnw-ppe/pathways-sequences/index-eng.html

---

Question 97

Volume 3B, Section 8.2.2.2 , Page 8.12
Volume 3B, Section 8.2.4.2, Page 8.16

The extent, complexity, and duration of Post-flood repairs and maintenance activities requires careful consideration to ensure adequate mitigation.

a. Describe mitigation measures that will be used to avoid adverse effects to fish habitats during instream removal of sediment deposits located upstream of the service spillway and diversion inlets, as well as from the reservoir.

b. Describe mitigation measures used to ensure unhindered upstream and downstream fish passage through the service spillway during debris removal and infrastructure repairs.

c. Assess the effectiveness of mitigation measures to reduce or eliminate the potential effects.

d. If mitigation measures are not completely effective evaluate the residual effects of post-flood repairs and maintenance activities.

Response 97

a. Removal of sediments upstream of the diversion structure will be done outside the restricted activity period and when flows in the river have subsided sufficiently to execute the work safely. The removal of sediment would begin with an assessment of the volume to be removed, and area of removal, and depths of removal. No sediment would be removed from within the wetted edge of the watercourse without isolation or diversion and only if those sediments are found to affect the serviceability of the diversion structure, or if they are creating a barrier to fish passage. Any diversion of the watercourse from its post-flood position would need to consider fish passage and be executed to comply with any and all required provincial or federal regulatory approvals (e.g., Alberta Code of Practice for Outfall Structures on Waterbodies, Fisheries and Oceans Canada "Measures to Avoid Causing Harm to Fish and Fish Habitat") to perform identified maintenance work.

b. Procedures related to operation and maintenance of the Project structures during post-flood operations are designed to reduce the potential effects of the Project on the aquatic environment. Maintenance required on the Project will comply with any and all conditions in applicable regulatory approvals (also see the response to a.). These procedures include maintenance plans that are based on best management practices for working around water. Post-flood repair and maintenance activities that require instream work will be isolated and done in dry conditions. Connectivity of the watercourse for fish passage will be maintained throughout the duration of any sediment removal activities. Mitigation includes:

   - the duration of all work done below the highwater mark of watercourses will be minimized.
   - water intake pipes, used for dewatering isolated work areas, will be screened to prevent entrainment or impingement of fish.
   - pump intakes, used for dewatering isolated work areas, will be operated in a manner that prevents disturbance to the channel bed and entrainment or impingement of fish.
   - fish that may become isolated within maintenance areas will be salvaged and returned to the Elbow River.
   - accumulated sediment and excess spoil will be removed from the isolated area before removing the isolation.

   Further details of mitigation measures related to fish passage are described in Volume 1, Attachment A, Section A.5.2.1.

c. The final Project design will be supported by federal and provincial permitting applications and construction environmental management plans to provide detailed protocols for implementation of mitigation measures, environmental adaptive management, and effectiveness monitoring to ensure potential residual effects are avoided or limited on aquatic resources. Provincial and federal mitigation are standard and proven mitigation measures and are effective in preventing effects on fish. During maintenance activities, upstream movement of fish during post-flood operations would not differ from upstream and downstream movement during dry operations.

d. Residual effects of post-flood operations (which includes maintenance and monitoring activities) is described in Volume 3B, Section 8.2.5. The assessment determined that the Project would not result in a destruction of fish habitat in that fish passage would not be prevented during post-flood operations. With maintenance on the diversion structure and mitigation, upstream and downstream movement of fish during post-flood operations would not differ from movement during dry operations.

Question 98

Volume 3B, Section 8.2.2.3, Page 8.11

Alberta Transportation states *Sediment removal is likely to be an ongoing maintenance concern in the diversion channel and in the Elbow River immediately upstream from the auxiliary spillway and diversion structure*.

The Project has the potential to cause a backwater effect during Dry Operation, as well as Flood and Post-flood Operation and has implications to upstream and downstream fish habitats. In addition to fish passage through the service spillway and stilling basin.

a. Estimate spatial extent (i.e., upstream distance and surface area) of the backwater effect on the Elbow River channel for each Project Phase.

b. Evaluate the effects of changes in channel morphology in the upstream backwater zone for each indicator fish species and life stage. Include a discussion of the duration of effect in terms of predicted number of years of altered channel morphology.

c. Evaluate the effects of increased suspended sediment concentrations and the deposition of sediment on fish habitat in the upstream backwater zone and downstream of the diversion structure for each indicator fish species and life stage.

d. Discuss how changes may influence the ability of fish to pass the service spillway and stilling basin. Evaluate the effectiveness of fish passage mitigation given the expected changes to channel morphology caused by the backwater effect.

Response 98

BACKGROUND INFORMATION

Backwater is defined as the area upstream of the diversion structure and floodplain berm where the water surface elevation is "artificially" raised over pre-Project conditions. To determine the backwater area, 2D hydraulic model results for the pre-Project conditions were compared against the results for the post-project (flood operations) conditions. The area where the water surface elevation is greater for flood operations than for the pre-Project conditions is the backwater area.

a. Backwater effects for the three floods are further discussed in the response to IR265. Figure IR265-1, Figure IR265-2, and Figure IR265-3 of response IR265 display results of the hydraulic model defining these locations for the 1:10 year, 1:100 year and design year flood peak flows. The results are summarized in Table IR98-1.

   During both dry operation and post-flood (and when the water flow in the river is greater than 70 m^3/s), water from Elbow River will be allowed to pass through the diversion structure unimpeded and the floodplain berm will have no effect on river levels; therefore, no backwater effect is predicted. With river water flows between 70 m^3/s and 160 m^3/s (the criteria for diversion into the reservoir to begin), the floodplain berm will partially block overland flow in the floodplain and will have a slight increase in backwater; however, the area of the backwater effect will be less than that of the 1:10 year flood.

Table IR98-1 Backwater Effects from the Project

Flood	Peak Flow (m^3/s)	Length of Backwater Along Channel Centerline (m)	Area of Backwater (ha)
1:10 year	200	190	10.8
1:100 year	765	500	21.2
Design flood	1240	500	23.5

b-c. The geomorphic processes in Elbow River are active and changes in bed structure and channel morphology occur with regular frequency (i.e., temporary changes in stream flows, regardless of magnitude, will cause bed sediments and gravels to be mobilized or deposited resulting in habitat changes). The channel currently exhibits wandering gravel-bed morphology and is dynamic and laterally mobile. The degree of potential geomorphic effects on the river channel during a flood will depend on the magnitude and duration of the flood and the volume of material transported during the flood. In addition, size of the sediment deposited upstream of the diversion structure will also be important in terms of the ability of flow to re-entrain the material during the receeding limb of the hydrograph, as well as re-entrainment of sediment during subsequent floods less than

160 m^3/s (i.e., dry operations). All these factors make predicting the duration of potential geomorphic changes, as well as the magnitude of these changes, difficult.

Backwater effects during floods of greater than 160 m^3/s will result in the deposition of bedload sediments on fish habitat upstream of the service spillway and diversion inlet forebay area. However, during the receding limb of the flood hydrograph and for floods less than 160 m^3/s, the river will erode a new channel through deposited sediments with attributes similar to pre-operation conditions. The river is dynamic in this reach, even without the diversion structure in place, and habitat is not “stable” but adjusts as flood and sediment pulses move down through the system.

Fish habitat in Elbow River upstream of the service spillway and diversion inlet at Reach 2 (Volume 4, Appendix M, Section 3.1.4, page 3.12; Reach 2) is described as follows:

- R3 run habitat comprised 85% of overall habitat area (depths [0.3 m to 0.75 m], slow to fast water velocity, coarse substrate [gravel to cobble] with low instream cover)
- R2 run habitat comprised 12% of overall habitat area (moderate depths [0.75 m to 1.0 m], slow to fast water velocity, coarse substrate [cobble to boulder], moderate instream cover from substrate and depth.
- The balance of other 3% habitat area included a small side channel.
- Pool areas and water depths greater than 1.0 m were absent.
- Channel substrates included boulders (8%), cobble (42%), large gravel (34%), small gravel (13%) and fines (3%).

Changes to these channel units and associated fish habitat will affect all life stages of resident fish habitat. Any backwater effects to channel morphology are expected to be attenuated with the same frequency as channel forming flows (i.e., in a frequency of 1 to 2 years (Volume 4, Appendix J, Section 2.2.6, page 2.18). Therefore, the duration of effects on fish habitat are predicted to be in the range of 1 to 2 years. However, depending on the magnitude of the peak flow and the size and volume of sediment deposited within the backwater, the duration of the effect may change. It will also be dependent on the magnitude of the subsequent streamflow during post-flood operations.

Fish habitat in Reach 2 is poor to moderate except for migration habitat (Table IR98-2) and comprising coarse substrate that would be similar to the material that is expected to aggrade as a result of backwater effects. Backwater effects from flood operations are not expected to degrade existing habitat upstream of the diversion inlet, given that the area does not currently offer instream and nearshore habitat complexity. Reforming channel flows are likely to result in habitat of similar quality and fish migration is expected to be maintained.

Table IR98-2 Fish Habitat Quality in Elbow River at Reach 2 Upstream of the Service Spillway and Diversion Inlet

Habitat Type	Forage Fish	Coarse Fish	Sport Fish
Spawning	poor	moderate	moderate
Overwintering	moderate	poor-moderate	poor-moderate
Rearing	poor-moderate	poor-moderate	poor-moderate
Migration	good	good	good

d. The backwater effect will primarily occur upstream of the service spillway and diversion intake forebay area (see additional explanation of the backwater effect in the response to IR73b). The service spillway and stilling basin are near bed grade and will promote preferential flow through the structures and downstream despite any backwater effect (i.e., are designed to accept flood flows without impeding bedload sediment transport). The deposition from the backwater effect in flood operations is, therefore, not expected to affect hydraulics in the stilling basin and will not result conditions that impede fish passage.

Question 99

Volume 3B, Section 8.2.2.3, Page 8.10
Volume 3B, Section 6.4.4.1, Table 6-10, Page 6.54
Volume 3B, Section 6.4.4.3, Figures 6.29 to 6.31

Alberta Transportation states Volume 3B, *Section 6 (Hydrology) indicates that changes in morphology in Elbow River may result in reduced mobilization on bar heads and a decrease degradation and aggradation. Modelling (see Section 6) shows that for the 1:10 year flood, the pattern of erosion of bar heads and subsequent deposition downstream would be maintained during active diversion, albeit with a moderate reduction in magnitude of approximately 24%*.

a. Provide an estimate of the total LAA surface area downstream of the diversion that will be affected by a reduction in channel morphology processes caused by active diversion of flows >160 m^3/s for a 1:10 year flood. An estimate can be generated using values presented in Table 6-10 of Volume 3B, Section 6 (Hydrology) and spatial areas illustrated on maps of Elbow River Net Bed Morphology Changes With and Without Diversion presented in Figures 6.29 to 6.31 of Volume 3B, Section 6 (Hydrology).

b. Estimate the surface area of fish habitats downstream of the diversion that would be susceptible to channel aggradation and to channel degradation by indicator fish species and life stage.

c. Evaluate the effects of changes in channel morphology caused by active diversion of flows >160 m³/s on each indicator fish species and life stage. Include a discussion of the duration of effect in terms of predicted number of years of altered channel morphology following the diversion. Include a discussion of long-term consequences caused by elimination of flood events > 160 m³/s. Discuss the effects for the river section that likely will be subjected to the greatest potential effect (i.e., immediately downstream of the diversion structure).

Response 99

a. An estimate of morphologic change was based on comparing results of changes in Elbow River bed morphology during the 1:10 year flood without diversion and with diversion. Of the hydrology LAA area, approximately 24% of the bed would have changes in bed elevation of greater than 20% when comparing with the Project to without the Project. Examining the actual bed elevation differences, bed elevation differences less than 0.2 m accounts for 99.0% of the overall area. Therefore, the overall impact is not anticipated to result in morphological change in the river.

b. The river channel including the area near the diversion inlet and downstream to Glenmore Reservoir is approximately 1,071,311 m². Approximately 257,115 m² of the bed area will experience elevation differences (i.e., aggradation and degradation) of less than 0.2 m. A change less than 0.2 m on bar heads is considered a small change to habitat that is not detrimental to fish habitat. Changes to species-specific habitat of this small magnitude on bar heads is not possible to determine. Only 1% of this area will experience channel elevation differences greater than 0.2 m (i.e., 2,571 m²). See c. for further discussion.

c. The following subheadings capture key aspects of responding to this part of the IR.

CHANGE IN CHANNEL MORPHOLOGY CAUSED BY ACTIVE DIVERSION OF FLOWS GREATER THAN 160 M³/S

The only effect on fish habitat associated with eliminating the peak flows greater than 160 m³/s will be reduced mobilization on gravel bar heads and subsequent decrease in the magnitude of degradation and aggradation of those gravel bars. For the three assessed floods, erosion and deposition of bar heads will be maintained, although the reduction in magnitude of erosion and deposition will be as follows (Volume 3B, Section 8.2.2, Page 8.10):

- design flood will decrease aggradation and degradation 65% compared to no diversion
- 1:100 year flood will decrease aggradation and degradation 5% compared to no diversion
- 1:10 year flood will decrease aggradation and degradation 24% compared to no diversion

From Volume 3B, Section 8.2.2, page 8.11:

> "During floods, flows of approximately 160 m^3/s, which are close to the 1:10 year flood would continue in Elbow River downstream of the diversion structure. These flows are considered channel forming and would shift bed materials which would maintain overwintering and spawning habitat and shallow side-channel and nearshore rearing habitats. Given the low probability of the design flood and the 1:100 year flood, the reduction in magnitude of erosion and deposition is unlikely to occur at a frequency to negatively affect overwintering habitat, such as the scouring of pools and deeper runs for trout species, nor negatively affect spawning habitat in the Elbow River. Sediment removal is likely to be an ongoing maintenance concern in the diversion channel and in the Elbow River immediately upstream from the auxiliary spillway and diversion structure.
>
> The reduction in floods over 160 m^3/s may cause a stabilization of banks and a corresponding increase in directly overhanging vegetation, However, due to the limited nature of this interaction and the presence of channel forming flows up to the 1:10 flood (160 m^3/s), the effect is likely to be not significant."

Effects on the River Downstream of the Diversion Structure

Shear stress from water released from the reservoir will mobilize bed sediments and change the morphology of the unnamed creek. However, bed material is predicted to remain in the unnamed creek and minimal interaction with the Elbow River is expected (Volume 3B, Section 8.2.2, page 7.10). The transport and deposition of sediments from the release of water will result in a localized gravel fan at the confluence of the unnamed creek with Elbow River associated with three assessed floods:

- design flood gravel fan will be approximately 500 m^2 and approximately 0.05 m to 1.0 m deep.
- 1:100 year flood gravel fan will be approximately 150 m^2 and approximately 0.05 m to 0.17 m deep.
- I:10 year flood will not result in a gravel fan.

Duration of Effects

The predicted gravel fan size for resulting from the release of water associated with the three floods is well within the expected range of aggradation and degradation of Elbow River. Any resulting gravel fan would interact with flow in the Elbow River and potentially temporarily modify the location of the active channel of Elbow River. However, the fan's area and depth are unlikely to result in any permanent alteration. As a result, any fan deposited at the confluence is likely transient in nature and subsequent higher flows in the Elbow River would remobilize the deposited material downstream. Based on the model results, no long-term effect is expected in the Elbow River.

Elbow River flows below 1:2 year frequency (i.e., bankfull flood frequency) are primarily the flood frequencies that are responsible for maintaining river channel shape: this means that such flows have the energy to form a river channel, gravel bars and maintain pool depths (further details can be found in the response to IR349). Therefore, the Elbow River channel morphology will maintain its baseline nature. Any potential changes in river channel morphology that occur during diversion and water release operations are expected to be reversed during the next bankfull flow in the river. Therefore, effects are not permanent and the probable duration period will be until bankfull flow returns. (Volume 3B, Section 6.4.4, page 6.52 provides a detailed discussion on the environmental effects of eliminating peak flood flows above 160 m^3/s.)

Due to the limited nature of this interaction and the presence of river channel forming flows up to 160 m^3/s, the effect is not significant. Given the low probability of the design flood and the 1:100 year flood, the reduction in magnitude of erosion and deposition is unlikely to occur at a frequency to negatively affect overwintering habitat, such as the scouring of pools and deeper runs for trout species, nor negatively affect spawning habitat in the in Elbow River.

HABITAT CHANGES FOR RESIDENT FISH SPECIES

Habitat for this section of the river is discussed in Volume 4, (Appendix M, Section 3.1.8, page 3.20 [Reach 6: Elbow River]). The river channel at this location is approximately 25 m to 38 m wide; in September 2016, it had a wetted width between 15 m and 22 m with depths up to 1.0 m. Fish habitat was comprised primarily of run habitat (i.e., R2 and R3 category types at 39% and 33% of total wetted area), riffles (20%) and pools (8%). A small side channel was present in this section of the river.

Increased suspended sediment concentrations and the deposition of sediment on substrates could affect the quality of fish habitat in the unnamed creek and in the river downstream of its confluence with the unnamed creek. Given the low probability of diversion occurrence (less than once in ten years) and with the implementation of mitigation measures, the potential change in sediment and turbidity that may result downstream is not expected to result in residual effects on aquatic ecology, given the slow rate of draining of the reservoir (Volume 3B, Section 8.3.2, page 8.12).

Fish habitat is considered good for all resident fish in this section of the river (Table IR99-1)

Table IR99-1 Fish habitat in Elbow River in the Vicinity of the Confluence with Unnamed Creek (Low-Level Outlet Channel)

Habitat Type	Forage Fish	Coarse Fish	Sport Fish
Spawning habitat	good	good	good
Overwintering habitat	good	good	good
Rearing habitat	good	good	good
Migration habitat	good	good	good

Changes to habitat would primarily affect sport fish species, such as brown trout, brook trout, and mountain whitefish. Downstream in the river, brown trout, brook trout, rainbow trout, and mountain whitefish are the most abundant sport fish species. Bull trout, which is a species at risk, is less abundant downstream with only a few observations, likely due to natural changes in habitat associated with elevations in the river (Paul and Post 2001).

REFERENCES

Paul, A.J., & J.R. Post. 2001. Spatial Distribution of Native and Nonnative Salmonids in Streams of the Eastern slopes of the Canadian Rocky Mountains. Transactions of the American Fisheries Society. 130(3):417-430.

Question 100

Volume 3B, Section 8.2.2.3, Page 8.12

Alberta Transportation states *The increased turbidity and the deposition of sediment on substrates could affect the quality of fish habitat in the low-level outlet channel and in Elbow River downstream of the low- level outlet. Given the low probability of diversion occurrence and with the implementation of mitigation measures, the potential change in sediment and turbidity that may result downstream is not anticipated to result in residual effects on aquatic ecology given the slow rate of planned post flooded reservoir drainage*.

a. Compare the predicted suspended sediment concentrations released by the Low-level Outlet discharge during Post-Flood River to the Elbow River background suspended sediment concentrations.

b. Consider the effects of sediment release from the Low-level Outlet for 30 days when the Elbow River flow is < 20 m^3/s.

c. Using the above information quantify the effects of predicted suspended sediment concentration on each indicator fish species and life stage using an accepted stress index metric.

d. Estimate the spatial extent of suspended sediment effect and sedimentation effect on Elbow River fish habitat downstream of the diversion.

e. Estimate the expected duration of effect following completion of the off-stream reservoir release period in days, months and years.

f. Using this information evaluate effects of increased suspended sediment concentrations and the deposition of sediment on fish habitat for each indicator fish species and life stage.

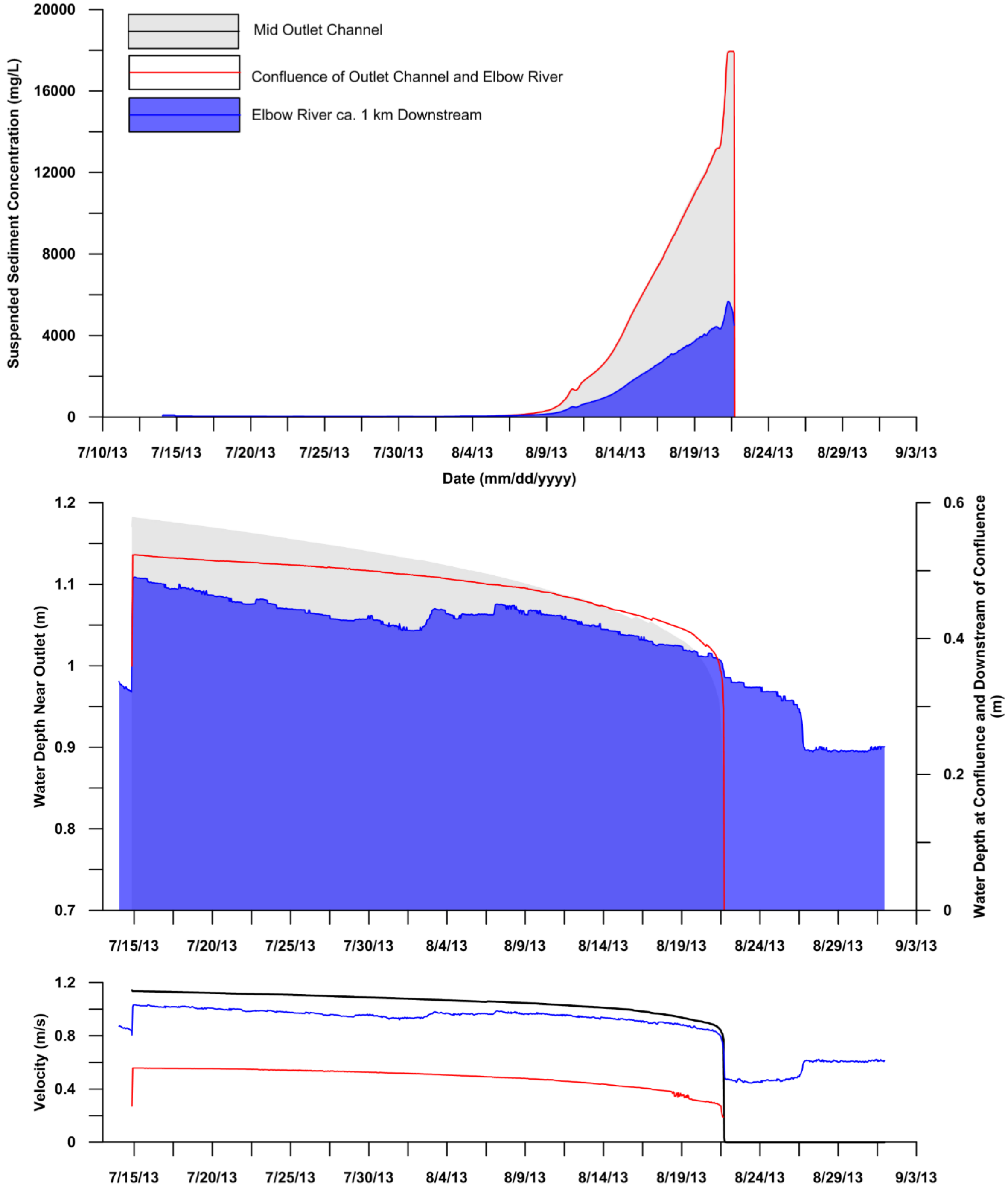
Response 100

a. Predicted peak and average suspended sediment concentrations for the water released from the reservoir, the confluence of the unnamed creek channel (low-level outlet channel) with Elbow River, and in Elbow River 1.0 km downstream of the confluence are provided in Table IR100-1 (which combines information from Volume 3B, Section 6, Table 6-6, Table 6-7, Table 6-8 and Table 6-9) and shown graphically in Figure IR100-1, Figure IR100-2 and Figure IR100-3.

Table IR100-1 Suspended Sediment Concentrations in Release Water and Downstream (from Volume 3B, Section 6, Table 6-7, Table 6-8, and Table 6-9)

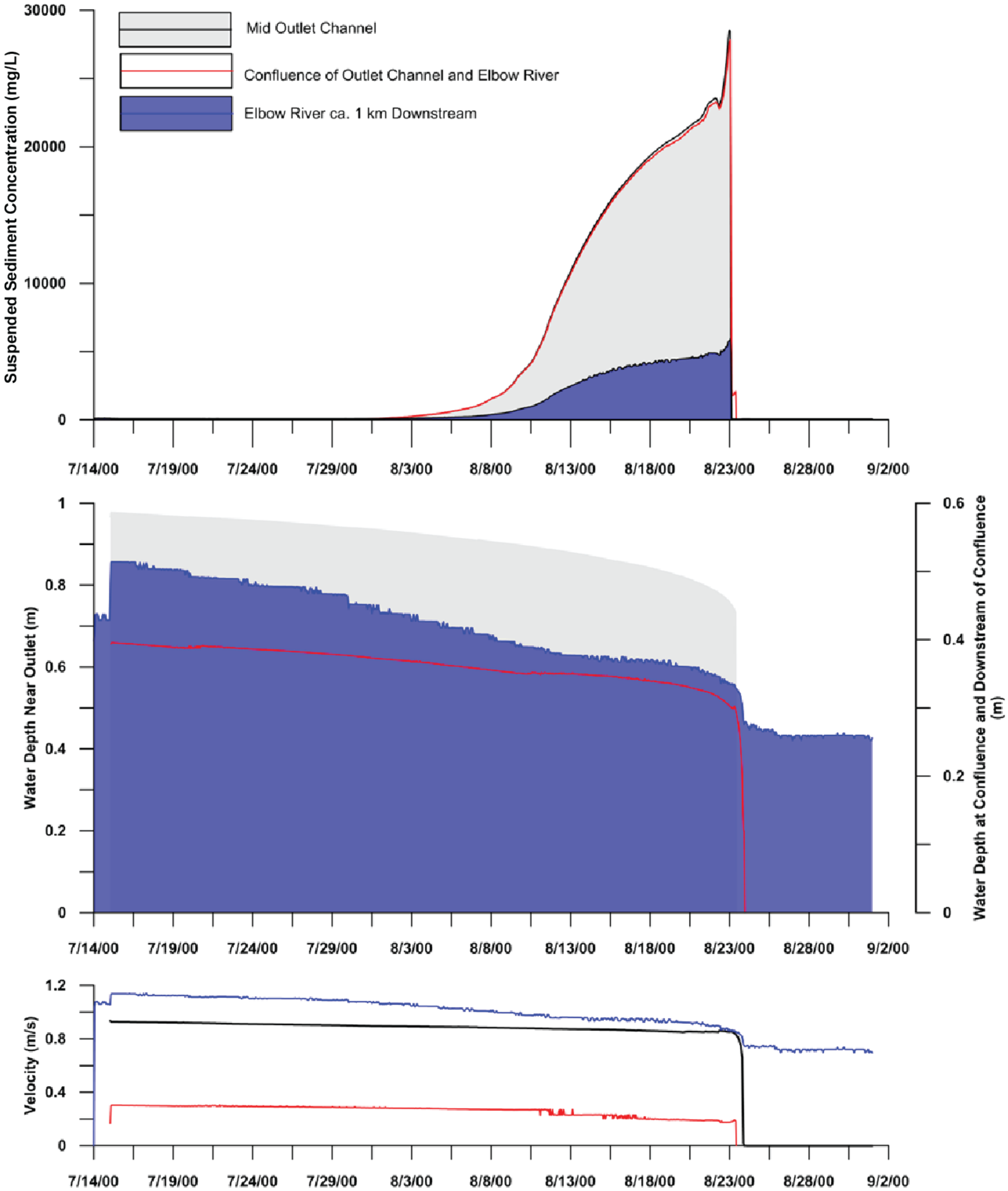
Location	Design Flood Suspended Sediment Concentration (mg/L)			1:100 Year Flood Suspended Sediment Concentration (mg/L)			1:10 Year Flood Suspended Sediment Concentration (mg/L)		
	Peak	Average	Release Time from the Reservoir (days)	Peak	Average	Release Time from the Reservoir (days)	Peak	Average	Release Time from the Reservoir (days)
Outlet structure	17,961	2,188	38	20,789	7,333	39	1,798	1,656	30
Confluence of the unnamed creek channel with Elbow River	17,955	2,173	38	20,692	7,285	39	1,798	1,657	30
Elbow River 1.0 km downstream of confluence	5,666	754	38	4,704	1,576	39	99	81	30
Background Elbow River [1]	50	16	--	50	16	--	50	16	--
Estimated for Elbow River during Flood	139,682	--	--	77,649	--	--	4,818	--	--

NOTES:
-- no data
[1] Historical monthly suspended concentration in August without the 2013 data at Highway 22



NOTE: outlet channel is the unnamed creek

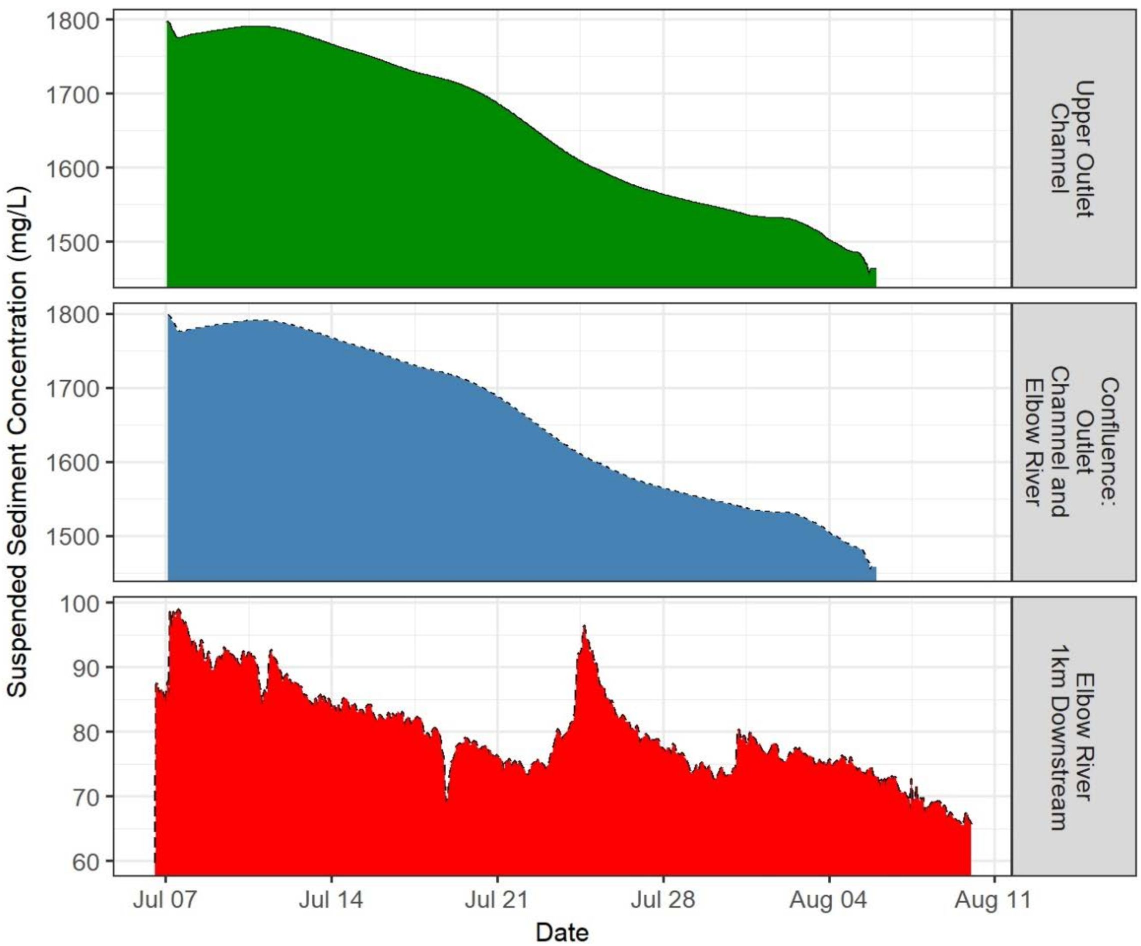
Figure IR100-1 Suspended Sediment Concentrations in Released Water Associated with a Design Flood



NOTE: outlet channel is the unnamed creek

Figure IR100-2 Suspended Sediment Concentrations in Released Water Associated with a 1:100 Year Flood

Natural Resources Conservation Board
May 2019



NOTE: outlet channel is the unnamed creek

Figure IR100-3 Suspended Sediment Concentrations in Released Water Associated with a 1:10 Year Flood

b-c. Release of sediment into the Elbow River when flows are less than 20 m^3/s could affect the quality of fish habitat in the Elbow River downstream of the confluence with the unnamed creek.

Given the infrequency of diversion and water release (one in ten years), and with operation of the outlet structure manage the release of water from the reservoir, the potential change in suspended sediment concentrations downstream (given the stated release rates in Table IR100-1) is not anticipated to result in residual effects on aquatic ecology, except for the 1:100 year and design floods. These residual effects are lower than if there were no Project.

A number of summary reports have been published on the effects of suspended sediment on fish and fish habitat (Bash et al. 2001; Birtwell 1999; Newcombe and McDonald 1991). However, these summaries were either for different specific activities, different types of sediment, different exposure duration and levels of suspended sediment; therefore, the conclusions in those reports are not necessarily relevant to what fish may be exposed to in the Elbow River.

For these reasons, a generalized risk evaluation reported by Birtwell (1999) is used to assess effects instead of a stress index metric. Details for Birtwell 1999 are presented in Table IR100–2. Only the 1:10 year flood is assessed because the 1:100 year and design floods are rare and would likely cause higher level effects on fish populations in Elbow River without the Project compared to with the Project. Without the Project, these higher effects due to increased river velocities, habitat alteration, and overland flooding of agricultural and urban environments can result in decreases in trout populations (Jowett and Richardson 1989) and water quality (Talbot et al. 2018).

Table IR100–2 Risk to Fish from Suspended Sediment Increases

Suspended Sediment Increase (mg/L)	Risk to Fish and Fish Habitat
0	No risk
<25	Very low risk
25-100	Low risk
100-200	Moderate risk
200-400	High risk
>400	Unacceptable risk
SOURCE: Birtwell (1999)	

The duration of increased suspended sediment is not accounted for in this risk matrix. Although the duration of increased suspended sediment can increase the potential for an effect on aquatic biota, this effect can vary depending sediment and oxygen concentrations in the water column. Suspended sediment levels are not uniform within a river system and organisms have the ability to move to areas with lower suspended sediment levels, thus reducing the risk to these organisms. Indicator species are exposed occasionally to much higher suspended sediment levels, especially during spring freshet and flooding, than would occur with release of reservoir water. For this reason, the discussion focuses on sediment concentration.

For August (expected time of water release), historical river data suggests that monthly suspended sediment concentrations (not including the 2013 data) averaged 16 g/m^3 with a maximum of approximately 50 g/m^3, at Highway 22 (Volume 3B, Section 6.4.3.3, page 6.43). Suspended sediment would not be evenly distributed throughout the water column and in differing locations.

At 1.0 km downstream of the confluence of the unnamed creek (low-level outlet channel) with the river, the average suspended sediment concentrations in Elbow River is predicted to be 81 mg/L for a 1:10 year flood. Based on this prediction, there may be an increase of 65 mg/L from the normal average of 16 mg/L in suspended sediments during a 1:10 year flood. Based on Table IR110-1, the overall increase in suspended sediments of 65 mg/L is considered a low risk to resident fish.

The predicted average concentration of suspended sediment released from the reservoir and historical river averages for suspended sediment are compared in the discussion below for each indicator fish species. Peak predicted suspended sediment concentrations are not used because these levels would only occur at the end of the release period, and this additional amount of suspended sediment for a short time of exposure would have minimal effect on fish populations.

BROWN TROUT

Release of reservoir water will not coincide with brown trout spawning, so it is anticipated that spawning adults, eggs and newly emerged fry will not be at risk. There would be a low risk to fry, juveniles and adults with a potential increase of 65 mg/L suspended sediment.

BULL TROUT

Bull trout spawn upstream of the reservoir; therefore, there is no risk to spawning adults, eggs and emerging fry. Rearing, juveniles and adults would be at low risk with a potential increase of 65 mg/L suspended sediment.

MOUNTAIN WHITEFISH

Release of water will not coincide with mountain whitefish spawning, a late fall spawner, so it is anticipated that spawning adults, eggs and newly emerged fry will not be at risk. There would be a low risk to rearing fry, juveniles and adults, having a potential increase of 65 mg/L suspended sediment.

RAINBOW TROUT

Rainbow trout spawn during the spring and prior to when water would be released from the off-stream reservoir. Therefore, there is no risk to spawning redds, eggs and newly emerged fry. There would be a low risk to rearing fry, juveniles and post-spawning adults with a potential increase of 65 mg/L suspended sediment. There is the potential that floods of 1:10 year and greater without the Project would have a larger effect on rainbow trout eggs and newly emerged fry than would occur with the Project. This is due to higher discharges (Q) that would occur during floods on more sensitive life history stages of rainbow trout than if no diversion occurred. Ewing et al. (2019) reported density of age-0 of spring spawning rainbow trout decreased with increasing spring Q_{max}. Because spring Q_{max} would be reduced due to diversion of flood water, it is assumed that effects on rainbow trout age-0 class would also be reduced.

d. During a 1:10 year flood, suspended sediment in water released from the reservoir would decrease by approximately 95% between the confluence unnamed creek with Elbow River and 1 km downstream of the confluence (Volume 3B, Section 6.4.3.4). During a 1:100 year flood, suspended sediments would decrease by 31% over the same distance (Volume 3B, Section 6.4.3.3). Suspended sediment related to the release of water from the reservoir would be expected to further decrease with distance from the confluence; potential effects on fish would similarly decrease. Fish species within Elbow River experience natural prolonged fluctuations in suspended sediment concentration related to 1) higher flow rates, but less than 1;10 year flood, in the river, 2) specific locations in the river during spring freshets, and 3) shorter durations during large precipitation events.

e. The Project will increase suspended sediment concentrations with the peak release of suspended sediment at the end of the period of water release back into Elbow River. See Figure IR100-1, Figure IR100-2 and Figure IR100-3 for duration periods.

   Most suspended sediment released from the reservoir is expected to be fine (i.e., silts and clays) with minimal deposition downstream in Elbow River. Channel forming flows occur in Elbow River with a frequency of between 1 and 2 years (less than 160 $m^{3/}s$); therefore, deposited sediments are predicted to be mobilized due to natural river processes within the same period of time (i.e., 1 to 2 years).

Reducing the reservoir release rate will cause effects from suspended sediments to be extended in duration and potentially result in effects on fish during biologically sensitive periods as discussed in IR295:

"Managing the operational release rates to minimize effects on water quality during the period of reservoir drawdown discussed here (i.e., June 20 through December 7), must consider biological sensitive periods in Elbow River. Drawing down the reservoir with a slower operational release rate will reduce total suspended sediments in the river; however, this may mean TSS is increased during a sensitive period when effects are greater. The period during late summer (i.e., August) is when water temperatures in Elbow River are elevated; the combined effect of sediment and elevated temperatures may affect the ability for resident fish to consume oxygen (Servizi and Martens 1990; Henley et al 2000). The period of time between October through November is when mountain whitefish and brown trout are spawning and suspended sediments can cause harm to newly spawned eggs."

Where effects extend into biologically sensitive periods (i.e., during the fall from October through December), effects on resident fish spawning activity and the survivability of eggs may occur. The duration effects will last through winter and into early spring when juvenile fish emerge. However, AEP will manage the release rate in a manner that mitigates detrimental effects to resident fish populations in Elbow River.

f. See response to b. to d.

REFERENCES

Bash, J.; C. Berman and S. Bolton. 2001. Effects of turbidity and suspended solids on salmonids. Final Research Report, Research project T1803, Task 42. Prepared for the Washington State Transportation Commission.

Birtwell I. 1999. The effects of sediment on fish and fish habitat. Fisheries and Oceans Canada, Canadian Stock Assessment Secretariat, Research document 99/139.

Ewing, T., J. Borawa, R.Jr. Creed and J. Rash. 2019. Effect of spring discharge and adult abundance on population abundance of two southern Appalachian rainbow trout populations. Journal of the southeastern Association of fish and Wildlife Agencies. 6: 67-73.

Jowett, I. and J. Richardson. 1989. Effects of a severe flood on instream habitat and trout populations in seven New Zealand rivers. New Zealand Journal of Marine and Freshwater Research. Volume 23:11-17.

Newcombe C. and D McDonald. 1991. Effects of suspended sediments on aquatic ecosystems. North American Journal of Fisheries Management. 11:72-82.

Talbot, C., E. Bennett, K. Cassell, D. hanes, E. Minor, H. Paerl, P. Raymond, R. Vargas, P. Vidon, W. Wollheim and M. Xenopoulos. 2018. The impact of flooding on aquatic services. Biogeochemistry 141:439-461.

Question 101

Volume 3B, Section 8.2.2.3, Pages 8.11 and 8.12
Volume 3B, Section 7.4.3, Page 7.24

Alberta Transportation states *As the water from the reservoir is released, it would mix with Elbow River water. Generally, temperature in the river can increase as a result of this release and dissolved oxygen concentrations can decrease. The effect on dissolved oxygen is expected to be localized because of rapid aeration of water… For additional details on changes in temperature and dissolved oxygen, see Volume 3B, Section 7.4.3*.

The change in water temperature of retained water was not quantified by Volume 3B, Section 7.4.3.

a. **Estimate water temperatures of the reservoir based on historical air temperatures and wind data for the study area. Use this information to predict water temperature of retained water released to the Elbow River.**

b. **Provide water temperature sub-lethal and lethal thresholds for each indicator fish species and life stage.**

c. **Based on this information evaluate the effects of elevated water temperature on the health of fish and fish use of habitats for each indicator fish species and life stage.**

Response 101

a. As discussed in Volume 3B, Section 7.4.3, page 7.24 and 7.25, water temperature in the reservoir can increase if the air temperature is sufficiently warm. However, the water temperatures in the Elbow River are expected to similarly rise during the summer months, which will result in a minimal temperature differential between the two water bodies. Thus, changes in river water temperatures originating from mixing with reservoir water would be temporary and localized due to rapid mixing.

b. Four fish species (bull trout, rainbow trout, brown trout and mountain whitefish, all of which are salmonids) are selected as indicator species. Data on sublethal and lethal temperature thresholds for fish is limited and can vary based on their geographic location and species. Temperature thresholds are influenced by the amount of time that the temperature is at a threshold level, the level of dissolved oxygen, and availability of food supply.

Only upper water temperatures thresholds are discussed below because water released from the reservoir is not expected to be of a lower temperature than in the river (due to solar heating while the water is retained in a static condition in the reservoir).

BULL TROUT

Water temperature studies related to the health of bull trout have generally focused on temperature preferences and not on lethal and sublethal temperature levels. A lab experiment on age-0 bull trout predicted an upper lethal incipient temperature of 21.9º C for 60 days with feeding ceasing at 22 º C The upper threshold increased to 23.7 º C for 7 days (Selong et al. 2001). In Montana, juvenile bull trout are rarely found in areas of rivers and streams where the temperature exceeds 15ºC (Fraley and Sheppard 1989; Swanberg 1997) reported larger and smaller fish began migrating upstream to cooler water temperatures when water temperature increased to 17ºC ± 2°C, with larger fish beginning upstream movement at cooler temperatures than smaller bull trout.

RAINBOW TROUT

Rainbow trout can tolerate temperatures up to 24ºC when oxygen levels are sufficient for survival (Nelson and Paetz 1992; Eaton and Scheller 1996). In a California stream, the upper lethal limit for rainbow trout is considered greater than 25ºC (Matthews et al. 1997). A laboratory experiment reported by Coghlan and Ringler (2005) observed growth of large rainbow trout as being positive at 15ºC, slightly negative at 20ºC and strongly negative at 25ºC. Rainbow trout at 2-3 months old maximum critical temperature was reported as 26.3ºC and as high as 29.35ºC (± 0.58°C), based on summaries from Bjornn and Reiser (1991) and McCullough (1999).

BROWN TROUT

A maximum temperature tolerance of 24.1°C is reported by (Eaton and Scheller 1996) for brown trout in general. Maximum tolerance levels eggs and alevins has been reported 15ºC, and for age 1+ and 2+ brown trout as 24.8ºC (±1.56 º C), as summarized by Bjornn and Reiser (1991) and McCullough (1999).

MOUNTAIN WHITEFISH

Mountain whitefish have a lower upper temperature tolerance than other salmonid species (Beckman et al. 2013). In Colorado, the maximum upper temperature for successful incubation is 8.4ºC while the sublethal upper or acute water temperature threshold for fry is 21.6ºC and 16.8ºC as the upper chronic level which can affect growth (Beckman et al 2013). A maximum temperature tolerance of 23.1°C is reported (Eaton and Scheller 1996) for mountain whitefish.

c. Water temperatures within Elbow River will elevate in the summer period due to its wide flood plain that facilitates solar radiation to warm the water. Water temperature in the reservoir will also become elevated over time. Fish habitat within the aquatic ecology LAA is primarily run habitat interspersed with short riffle areas; thus, rapid mixing of the outflowing reservoir water and river water is expected. Fish that may be present in the confluence of the unnamed creek with Elbow River are not restricted from moving to other areas widely available within the river system. Released water from the reservoir will be oxygenated as it passes through the unnamed creek, thereby reducing potential effect from the release of slightly warmer water into the river. Therefore, potential effects are predicted to be localized, of low magnitude and temporary for all fish species and life stages.

REFERENCES

Bjornn, T. C. and D. W. Reiser. 1991. Habitat requirements of salmonids in streams. American Fisheries Society Special Publication 19:83-138.

Coghlan, S. and N. Ringler. 2005. Temperature dependent effects of rainbow trout on growth of Atlantic salmon parr. Journal Great Lakes Research 31:386-396

Eaton, J. and R. Scheller. 1996. Effects of climate warming on fish thermal habitat instreams of the United States. Limnology and Oceanography, 4l(5),1109-1115

Fraley, J., and B. Sheppard. 1989. Life history, ecology, and population status of migratory bull trout (*Salvelinus confluentus*) in the Flathead Lake and River system, Montana. Northwest Sci 63:133-143

McCullough, D. A. 1999. A review and synthesis of effects of alterations to the water temperature regime on freshwater life stages of salmonids, with special reference to chinook salmon. US Environmental Protection Agency. EPA 910-R-99-010, Region 10, Seattle, Washington.

Nelson J. and M. Paetz. 1992. *The Fishes of Alberta*. 2nd Edition. University of Alberta Press. 437 pp.

Selong, J. H., T. E. McMahon, A. V. Zale and F. T. Barrows. 2001. Effect of Temperature on Growth and Survival of Bull Trout, with Application of an Improved Method for Determining Thermal Tolerance in Fishes. Transactions of the American Fisheries Society 130:1026–1037.

Swanberg TR. 1997. Movements of and habitat use by fluvial bull trout in the Blackfoot River, Montana. Trans Am Fish Soc 126:735-746.

Question 102

Volume 3B, Section 8.2.4, Page 8.13

Spillways on water control structures can cause an increase in dissolved gas pressure, also referred to as total gas pressure (TGP). Excessive TGP is potentially harmful to fish and other aquatic organisms. Elevated TGP conditions are known to extend long distances downstream in flowing water because dissolved gases are not easily released from dilution in fluvial environments.

a. Provide an evaluation of the effects of elevated TGP on indicator fish species populations. The evaluation should include:

i. Estimates of TGP levels for expected flood flows caused by differences between the spillway gate crest water elevation and stilling basin water elevation.

ii. Estimated downstream extent of elevated TGP levels within the Elbow River.

iii. Evaluation of consequences to fish habitat use, consequences to fish health, and long-term consequences to fish population health for each indicator fish species.

b. If a residual effect is identified, complete a residual effects evaluation.

Response 102

BACKGROUND INFORMATION

Concerns regarding total gas pressure (TGP) levels are typically associated with spillways of hydroelectric dams or other large, on-stream dam structures with hydraulic head of sufficient height to result in high enough pressure and mixing to result in entrainment and super-saturation of air. Because the Project's diversion structure, does not share engineering design features of the same larger magnitude as other waterworks projects, TGP is not identified as a pathway of potential effects for aquatics resources. However, a discussion is nonetheless provided below identifying the potential sources of TGP and how the Project design provides mitigation in the unlikely event that TGP occurs.

a. i. Elevated levels of TGP are influenced by the height and design of the spillway (Ruggles and Murray 1983). During flood operations, both the diversion inlet and service spillway direct flow through a spillway and stilling basin. Table IR102-1 and Table IR102-2 provide the expected water surface drop across the spillway systems at the peak of the flood diversion. For the service spillway, the maximum water surface elevation drop is 3.9 m. For the diversion inlet, the maximum water surface drop is 1.7 m. These service level drops would not result in TGP levels that would cause an effect on fish. Levels of TGP in water once in the reservoir can dissipate more easily than in riverine environments, which further facilities a decrease in TGP levels associated with the structure. Height and design of the diversion inlet will prevent elevated levels of TGP that could harm or cause mortality in fish.

Table IR102-1 Water Surface Elevation Drop across Service Spillway during Flood Operations

Flood	Headwater Elevation (m)	Tailwater Elevation (m)	Water Surface Drop (m)
1:10 year	1,212.5	1,211.7	0.8
1:100 year	1,215.8	1,211.9	3.9
Design Flood	1,215.8	1,213.1	2.7

Table IR102-2 Water Surface Elevation Drop across Diversion Inlet Spillway during Flood Operations

Flood	Headwater Elevation (m)	Tailwater Elevation (m)	Water Surface Drop (m)
1:10 year	1,212.5	1,211.0	1.5
1:100 year	1,215.8	1,214.1	1.7
Design Flood	1,215.8	1,214.1	1.7

As shown in Volume 3B, Section 6.4.2.1, Table 6-4, water is predicted to be held static in the reservoir between 20-43 days (depending on the volume of water diverted), allowing a portion of the TGP in the water to be released back into the atmosphere. (Note that if release time is accounted for, the total time water is in the reservoir is from 58 to 82 days.)

Water outflow from the reservoir into the Elbow River would be through the outlet structure with its base even with the reservoir bottom, thereby draining water from the lower depth of the reservoir, and it will mix water with air. Therefore, the amount of TGP would also be limited in the release water from the reservoir. Water would flow into the unnamed creek channel, which also reduces flow velocity and reduce the amount of TGP in water being released back into Elbow River.

ii.-iii. The design of the outlet structure incorporates 1) a low drop height for water released from the reservoir; 2) the outlet drawing water from the bottom of the reservoir; and 3) use of flow deflectors. This mitigates the potential for elevated levels of TGP. TGP levels in the released water from the reservoir are expected to be similar to those within the receiving waters of the Elbow River. As such, the water released into Elbow River will not have TGP levels that would harm fish.

b. Due to the nature and design of the Project, any potential increase in levels of TGP are predicted to be negligible to minimal. The water released from the reservoir is predicted to have similar conditions to the receiving waters of Elbow River and, therefore, residual effects are not anticipated on fish populations, fish habitat use, and fish health.

REFERENCES

Ruggles, C.P. and D.G. Murray. 1983. A review of fish response to spillways. Can. Tech. Rep. Fish. Aquat. Sci. No. 1172. ix + 31 p.

Question 103

<u>Volume 3B, Section 8.2.4.3, Page 8.17</u>
<u>Volume 3B, Section 6.4.3.1, Table 6-6, Page 6.28</u>

Alberta Transportation states *The mortality from entrainment is dependent on the number of fish entering the reservoir and those fish returned to Elbow River during draining of reservoir*, that *During post- flood operations, stranding in the reservoir is expected to cause mortality of fish that do not swim out of the reservoir during post-flood draining*, and that *The number of fish potentially lost is unpredictable and is based on the ability to rescue fish, which is related to reservoir ponding areas, drawdown rate, and sediment deposition in the reservoir*.

a. Provide an estimate of the portion of fish passing the facility that will be entrained into the diversion canal at each of the flood flow levels. Assume that the portion of fish that are entrained equals to the portion of water that is diverted. Estimate the portion of the fish population that may be entrained based on the spatial distribution of fish species populations in the Elbow River.

b. Predict the potential for survival of each indicator fish species and life stage entrained into the reservoir using assumptions for residence times and a suspended sediment concentrations presented in Volume 3B, Table 6-6.

c. Evaluate the effects of fish entrainment into the diversion canal on the health of each indicator fish species population. Discuss the expected portion of the population entrained (i.e., population mortality rate) and the frequency of occurrence of entrainment events. Include a discussion of additive mortality rate (mortality rate caused by entrainment + natural population mortality rate).

d. Provide an estimate of the portion of fish that will pass through the service spillway. For the estimate assume that the portion of fish passing the through the service spillway is equal to the portion of water that is passed. Estimate the portion of the fish population that may pass through the service spillway based on the spatial distribution of fish species populations in the Elbow River.

e. Predict the potential for survival of each indicator fish species and life stage that must pass over the spillway when the gates are in the raised position.

f. Evaluate the effects of population health from fish passage through the service spillway on each indicator fish species. Discuss the expected portion of the population injured or killed (i.e., population mortality rate) and the frequency of occurrence of events. Include a discussion of additive mortality rate (mortality rate caused by entrainment + natural population mortality rate).

Response 103

a. Studies suggest that fish tend to occupy river margins and floodplain areas during floods (Jowett et al. 1994; Kwak 1988). Thus, there will be a lower abundance of fish attempting to travel in the area of the service spillway during floods.

   As stated in Volume 3B, Section 8.2.4.1, a conservative entrainment estimate of 80% applies to a design flood, which is based on the assumption that there is a linear relationship between diversion rates into the diversion structure and fish being swept into the diversion channel. This linear relationship assumption suggests that varying percentages of diversion rates will result in similar population percentages of fish entrainment (i.e., 80% diversion will result in 80% fish entrainment). Diversion rates can vary between 0% and 80%. A diversion rate of approximately 20% is likely for a 1:10 year flood.

   Modelling to confirm this assumption incorporate numerous factors: site specific habitat and flood streamflow conditions; fish spatial distribution and habitat use; behavior during flooding (such as movement into the flood fringe); use of refuge habitat; and fish moving away from the maximum flows in the river (i.e., the thalweg) that will be directed into the diversion structure. Uncertainty in these parameters will add or compound uncertainty in model results. Because of the unique nature of the Project design, and uncertainties regarding fish displacement and entrainment in the diversion structure, modelling would not provide meaningful results.

b. Activation of the diversion channel and possible displacement and entrainment of fish into the reservoir would not substantially increase effects on fish from suspended sediment concentrations than would occur within the Elbow River during a flood because the origin of suspended sediment entering the reservoir will be from Elbow River. However as stated in Volume 3B, Section 6.4.3, page 6.26:

   "During retention of water in the reservoir, a portion of the suspended sediment would permanently settle at the bottom of the reservoir. The locations of sedimentation are determined by circulatory patterns within the reservoir during active water inflow and retention, as influenced by existing topography. Sedimentation depths would be determined, in part, by concentration, water depth, the effects of the underlying topography and residence time in the reservoir. The longer the residence time, the greater the deposition."

This deposition of sediment in the reservoir would reduce the effects of suspended sediment on fish over their retention time.

Water temperature in the reservoir can increase during water retention if air temperatures are sufficiently warm; however, water temperature is unlikely to reach levels causing fish mortality.

Potential loss of dissolved oxygen may occur due to low velocity of water in the reservoir. However, wind mixing is expected to replenish loss of dissolved oxygen within the reservoir (Volume 3B, Section 7.4.3, page 7.2.4). Therefore, there should be no residual effects on fish due to dissolved oxygen concentrations in the reservoir.

Newcombe and Jensen (1996) reported that the severity of ill effect on fish that are exposed to suspended sediments in freshwater in depends on:

- species, life stage, particle size, duration of exposure, and concentration of suspended sediment
- sediment concentration and duration of exposure
- juvenile life history stages relative to adults

Given these dependencies and the modelling limitations described in response a., predictions for quantitative populations of fish that are entrained in the reservoir would be highly uncertain and the modelling results would not be meaningful.

c. During the diversion of a portion of Elbow River flows during a flood, some fish (at any of their life stages) will be carried through the diversion channel and into the off-stream reservoir. It is not known what percentage of fish would then remain in the diversion channel and what percentage would be carried into the off-stream reservoir. However, it is likely that fish carried into the diversion channel during the final period of diversion have a greater chance of being stranded in the channel than during initial operation.

Furthermore, extended periods of trapping in isolated pools (both within the channel and the off-stream reservoir) can lead to death by asphyxiation, elevated temperatures, starvation, or increased predation. The overall mortality from the entrainment is dependent on the number of fish entering the reservoir during flood operation that are not able to return to Elbow River during reservoir draining. A fish rescue to remove fish from the reservoir and return them to the Elbow River will occur during reservoir draining, if safe.

d-f. During diversion, some fish will pass over the service spillway. The potential exists that some fish may be harmed; however, Elbow River fish species (e.g., mountain whitefish and rainbow trout) have evolved to pass downstream of small waterfalls and fast water in mountain cascades. Serious harm to fish is not predicted to occur from passing over the service spillway.

As indicated in the response to IR91, the spillway gate has a configuration to pass fish during low flows and will maintain fish passage. (Details are provided in the response to IR91, Appendix IR91-1).

Studies suggest that fish tend to occupy river margins and floodplain areas during floods (Jowett et al. 1994; Kwak 1988). Thus, there will be a lower abundance of fish attempting to travel in the area of the service spillway during floods. During diversion, the service spillway gates will rise and could pose a temporary barrier to fish. It is expected that the service spillway would be raised for a short duration (i.e., days, refer to Volume 1, Section 3, Table 3-9); the duration will not result in a destruction of fish habitat by preventing fish passage.

REFERENCES

Jowett, I.G., and J. Richardson. 1994. Comparison of habitat use by fish in normal and flooded river conditions. New Zealand Journal of Marine and Freshwater Research, 28(4) 409-416.

Kwak, T. 1988. Lateral Movement and Use of Floodplain Habitat by Fishes of the Kankakee River, Illinois. The American Midland Naturalist, 120(2) 241-249.

Newcombe, C.P. and J.O.T Jensen. 1996. Channel suspended sediment and fisheries: a synthesis for quantitative assessment of risk and impact. Fisheries Management 16(4) 693-727.

Question 104

Volume 3C, Section 1, Section 1.2.4, Page 1.25

Alberta Transportation lists *projects that have the potential to act cumulatively with residual environmental effects from the Project.*

a. Describe any cumulative effects of Glenmore Dam and Reservoir operations on aquatic ecology.

Response 104

a. Cumulative effects on aquatic ecology are not anticipated between the Project and Glenmore Dam and Glenmore Reservoir. Specifically, regarding potential pathways arising from direct Project effects, effects on water quality and fish mortality are not anticipated to interact with the Glenmore Dam and Glenmore Reservoir. Further details regarding such potential cumulative effects are discussed in the surface water quality and aquatic ecology sub-sections of Volume 3C, Section 1.2 and 1.3.

Question 105

Volume 4, Appendix M, Attachment 8A.

This attachment consists of two documents, the Springbank Off-stream Storage Project (SR1) – Hydraulic Modelling to Support Fish Passage Assessment and SR1: Fish Passage Flows Analysis. SR1: Fish Passage Flows Analysis generated estimates of Elbow River discharge which were used as a basis of hydraulic modelling by the Springbank Off-stream Storage Project (SR1) – Hydraulic Modelling to Support Fish Passage Assessment.

The precision of hydraulic modelling output can be influenced by the precision of the input data and the accuracy of the hydraulic modelling output can be influenced by the accuracy of the input data.

a. **Identify the precision of the digital terrain model and illustrate the triangular mesh size used in the model domain for the service spillway, stilling basin and surrounding river channel.**

b. **Comment on the change in the hydraulic model output that would result by replacing the average river discharge (each of 8 values) presented in SR1: Fish Passage Flows Analysis Table 4 with the Upper 95% Confidence Interval value and the Lower 95% Confidence Interval value associated with each average river discharge.**

c. **Comment on the effects of ice and the effects of large woody debris within the service spillway gate structure on the accuracy of the hydraulic model output for water velocity and water depth.**

d. **Indicate whether hydraulic modelling assumed *flow through right gate and flow through left gate*.**

e. **If modelling assumed flow through both right and left spillway gates, comment on applicability of model outputs if spillway operation < 160 m^3/s will use *right gate raised, flow through left gate*.**

Response 105

a. The base digital terrain model was produced from light detection and ranging (LiDAR) data with 35 cm horizontal and 20 cm vertical and supplemented with topographic survey using GPS Real Time Kinematic (RTK) method with 2 cm horizontal and 3 cm vertical accuracy. Because of the blended source data, the composite digital terrain model has a precision of +/- 20 cm vertical.

   The model triangular mesh has a size of 1 m in the service spillway, stilling basin and river main channel area in the vicinity of the diversion structure. The mesh is 0.5 m within the low-flow channel designed for fish passage. The mesh is 3 m for the unaltered river channel elsewhere in the model. The mesh size is illustrated in Figure IR105-1.

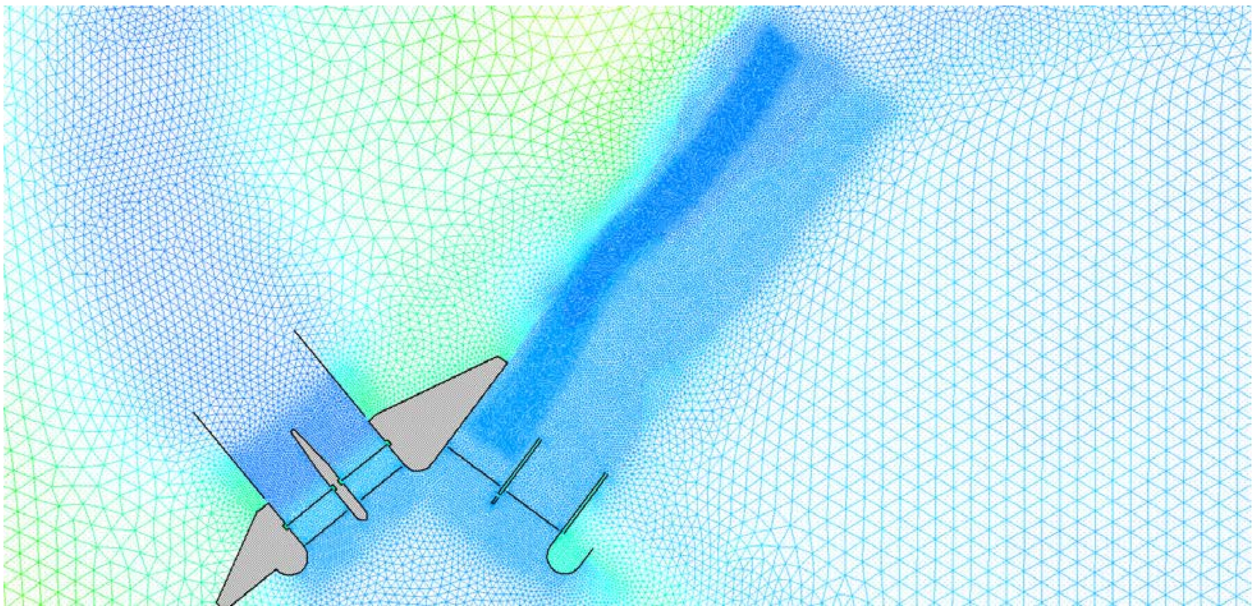


Figure IR105-1 Mesh Size for the Service Spillway and Stilling Basin

b. The presented model results range from 0.8 m^3/s to 76 m^3/s with a range of flows in between. At the low range, the 95% confidence limit of the lowest flow is 0.7 m^3/s. The hydraulic model results and evaluated effects will not meaningfully vary from the presented 0.8 m^3/s. At the high end, the 95% confidence limit of the highest flow is 90 m^3/s. The depth of flow will slightly increase with a marginal increase in channel velocities, but the flow will not increase above the existing channel velocities. In between, the 95% confidence limit discharges will range between the presented results. The results of the assessment will not change within the expected range.

c. Accumulation of large woody or ice may affect the results of the hydraulic model; however, these phenomena are not possible to replicate with certainty. The service spillway is designed to mimic the bankfull width of the river channel. At flows relevant to the fish passage analysis, the service spillway does not represent an obstruction to flow. Effects from debris and ice are expected to mimic natural conditions and are not expected to materially affect the findings of the assessment.

d. The hydraulic model assumed both service spillway gates are in the lowered position and, therefore, can allow flow. As a strategy to improve fish passage, the stilling basin of the right gate would be infilled with material to concentrate flows in the left gate during very low flows (Q less than 0.8 m^3/s). During larger discharges, both gates are expected to allow flow.

e. At flows less than 160 m^3/s, neither gate is expected to be raised.

Question 106

<u>Volume 1, Section 7.4, Table 7-3, Page 7.11</u>

Alberta Transportation states that Tsuut'ina Nation has indicated that they *should be a decision maker and want the SR1 project to require Tsuut'ina's "Consent" as part of the current process.*

a. Provide comments on Tsuut'ina's request to be consented as part of the current Project process.

Response 106

a. The Supreme Court of Canada has been clear that the honour of the Crown requires a meaningful, good faith consultation process. The scope of the duty is proportionate to a preliminary assessment of the strength of the case supporting the existence of the right, and to the seriousness of the potentially adverse effect upon the right. The Crown is not under a duty to reach an agreement; rather, the commitment is to a meaningful process of consultation in good faith. Further, Indigenous groups do not have a veto over Crown decisions that potentially impact their rights (see *Haida Nation* v *British Columbia (Minister of Forests)*, 2004 SCC 73).

   The Government of Alberta's Policy on Consultation with First Nations on Land and Natural Resource Management, 2013 specifically states that the duty to consult does not give First Nations a veto over Crown decisions and that First Nation consent is not required as part of Alberta's consultation process.

   The Government of Alberta is committed to renewing and improving the relationship with Indigenous groups and this includes working with Indigenous groups towards reconciliation. With respect to the principles of the *United Nations Declaration on the Rights of Indigenous*

Peoples (UN Declaration), Alberta is engaging with Indigenous leaders and representative groups to explore how best to implement the UN Declaration principles in a way that is consistent with the Canadian Constitution and Alberta law.

Alberta Transportation is continuing to work with the Tsuut'ina Nation to respond to and address their concerns with the Project.

Question 107

Volume 1, Section 7.4, Table 7-4, Page 7.35
Volume 4, Part 1 Appendices, Section 3.1.4, Page 3.23

Alberta Transportation states that *Stoney Nakoda Nation confirmed the SR1 project is in their Traditional Territory. They want to be able to complete an internal Cultural Review of the project area with Elders.*

The Stoney Nakoda Nation feel a Cultural Use Study, a Stoney Hydrology report, and a wildlife impacts study are required.

a. **Provide an update on Stoney Nakoda Nation's request for Cultural Review with Elders, a Stoney Hydrology report, and a wildlife impacts study, in addition to studies completed in the EIA.**

Response 107

a. At the first meeting with Stoney Nakoda Nations on October 20, 2014, a request was made for a cultural assessment and review with Elders. At this meeting, Alberta Transportation requested a description of work and a budget. Later, during further consultation meetings with the Stoney Nakoda Nations a request was made to Alberta Transportation to fund a Traditional Use Study (TUS). Alberta Transportation requested budgets for the Stoney Nakoda Nations' TUS work first during a meeting on May 4, 2016, with follow up emails June 27, 2016, September 13, 2016, and October 7, 2016. Stoney Nakoda Nations provided a budget for the work on October 14, 2016 which was approved by Alberta Transportation the same day. A revised budget with additional work was received from the Stoney Nakoda Nations on October 30, 2016 and approved on October 31, 2016. Stoney Nakoda Nations completed a drive through of the PDA October 20, 2016, and they conducted their field work between October 24-28 and October 31-November 4, 2016, for a total of 10 site visit days. While the field work was completed for this study and multiple requests have been made to Stoney Nakoda Nations, no report has been received by Alberta Transportation.

During a meeting between Alberta Transportation and Stoney Nakoda Nations on September 13, 2018, Stoney Nakoda Nations indicated they were working to complete their TUS and submit it to Alberta Transportation for use, by the end of 2018. No report has been received from Stoney Nakoda Nations.

Hydrology and wildlife concerns have been discussed at meetings with Stoney Nakoda Nations and were assessed: these are in Volume 3A, Sections 6 and 11 and Volume 3B, Sections 6 and 11.

During the September 13, 2018 meeting, Stoney Nakoda Nations also committed to providing a work plan and proposed budget for any additional work they required. Stoney Nakoda Nations did not provide specific details to what this additional work would include. This budget was subsequently requested by Alberta Transportation in emails on October 24, 2018 and December 18, 2018 and in person on December 19, 2018. As of March 31, 2019, this budget has not been provided and, following discussions with Stoney Nakoda Nations during a meeting on February 22, 2019, is not expected.

Question 108

Volume 1, Section 7.4, Table 7-4, Page 7.36

Alberta Transportation states that Stoney Nakoda Nation has *expressed concerns with the Stoney lack of mapping capability and requested some assistance understanding the SR1 mapping.*

a. **Comment on whether Alberta Transportation is planning to review the SR1 mapping with the Stoney Dakoda Nation and if this has been conducted.**

Response 108

a. Maps of the Project area were reviewed with Stoney Nakoda Nations beginning with the first consultation meeting on October 20, 2014. At each additional meeting, maps of the Project area were provided and discussed.

Stoney Nakoda Nations requested assistance in creating maps for their TUS report. An offer to provide maps and assist with mapping was made during a meeting with Stoney Nakoda Nations on September 14, 2017. Follow-up emails were sent on September 17 and October 6, 2017, with pdf. and KMZ. map files. Mapping assistance from DEMA Land Services and Stantec was also offered, as well as a recommendation for a company capable of assisting with GIS mapping. During site visits, an application called "Avenza Maps" was also used and shown to Stoney Nakoda Nations, which provided real time location information in relation to the map and Project components. To date, Stoney Nakoda Nations has not pursued Alberta Transportation's offer to assist in creating maps. At a meeting held on June 4, 2018, Stoney Nakoda Nations confirmed they had received the maps from Alberta Transportation.

Question 109

Volume 1, Section 7.4, Table 7-4, Page 7.36

Alberta Transportation states that Stoney Nakoda Nation has indicated the *desire to do a site visit with Elders* and that *at the time of the request Alberta Transportation's agreement with landowners for access had expired. Any additional access will need to be requested on an owner by owner basis*.

a. Provide an update on Stoney Nakoda Nation's request for site visits with Elders.

Response 109

a. At a meeting held on June 4, 2018 between Stoney Nakoda Nations, Alberta Transportation, and Stantec, Stoney Nakoda Nations expressed they were still interested in undertaking a site visit with Elders. Alberta Transportation indicated that Stoney Nakoda Nations should propose a budget for what they would like to do and where they would like to go. Alberta Transportation expressed its willingness to assist in requesting permission to access the land from the relevant landowners. At this meeting, Stoney Nakoda Nations said they would submit a proposal once they discussed where the Elders would like to go.

On September 13, 2018, Alberta Transportation met with Stoney Nakoda Nations to discuss the further work, including site visits, Stoney Nakoda Nations wished to undertake. During this meeting, the Stoney Nakoda Nations committed to providing a budget to complete their TUS, with the expectation that the TUS would be submitted by the end of 2018. Alberta Transportation asked if Stoney Nakoda Nations still wished to undertake additional site visits with Elders and did not receive a response.

Alberta Transportation asked for a budget again by email on October 24, 2018 and December 18, 2018, and in person on December 19, 2018. On December 19, 2018, Stoney Nakoda Nations indicated they would send a budget. As of March 31, 2019, this budget has not been provided and following discussions during a meeting on February 22, 2019, a budget is not expected.

Question 110

Volume 1, Section 7.4, Table 7-4, Page 7.39

Alberta Transportation indicates that the Stoney Nakoda Nation has informed Alberta Transportation that *there are two trap lines out there and Stoney members use the area for trapping*. Alberta Transportation stated *there are no registered traplines within the PDA. Alberta Transportation has requested the locations of the two traplines and were the Stoney members trap in order to determine if there is potential impact from the project.*

a. Discuss potential impacts on the two traplines.

b. Provide proposed mitigation measures for potential impacts.

Response 110

a. At a meeting on 4 June 2018, Stoney Nakoda Nations confirmed that the two traplines are located west of Bragg Creek and there are no active traplines in the PDA. No potential effects on the two traplines are anticipated.

b. No effects on the two traplines located west of Bragg Creek are anticipated and, therefore, no mitigation measures are proposed.

Question 111

Volume 1, Section 7.4, Table 7-7, Page 7.55
Volume 4, Appendix B, Section 3.1.1, Page 3.6

Alberta Transportation states that the Kainai First Nation requested *clarification as to why Kainai First Nation* was (is) *being asked for comments on the EIA, given that the EIA does not conform to the EIS guidelines*.

a. Provide information on areas that do not conform to EIS guidelines in the EIA.

b. Discuss whether further study or work would be carried out to address these deficiencies.

Response 111

a. The clarification from the Kainai First Nation refers to the EIA submitted in October 2017, not the March 2018 EIA currently under review. On 16 November 2017 the Canadian Environmental Assessment Agency (CEA Agency) informed Alberta Transportation that the EIA did not fully conform to the requirements in the "*Environmental Impact Statement pursuant to the Canadian Environmental Act, 2012, for the Springbank Off-stream Reservoir Project*.' In the 16 November, 2017 communication, the CEA Agency requested a number of updates.

b. All areas of non-conformance are addressed in the revised EIA submitted to the CEA Agency, the Natural Resources Conservation Board (NRCB) and AEP on 26 March 2018. The March 2018 EIA was deemed to conform to the EIS guidelines by the CEA Agency on 30 April 2018. As part of the CEA Agency process, Kainai First Nation completed a review of the March 2018 EIA and provided a final Traditional Use Study and technical review to CEA Agency and Alberta Transportation June 25, 2018.

Question 112

Volume 1, Section 1.4.1, Pages 1.14 to 1.17

A discussion of necessary Crown land dispositions was not provided as outlined in the Terms of Reference, Sections 2.4.[C] and 3.10.1[B].

a. Provide the information as indicated in the Terms of Reference.

Response 112

a. Following Project approval, all land in the PDA will be acquired by Alberta Transportation. Dispositions will be required for roads and infrastructure throughout the PDA where there are permanent and temporary Project components such as (see the response to IR363, Figure IR363-1):

- access roads
- bridges
- culverts
- floodplain berm
- diversion structure
- low-level outlet works, including the unnamed creek
- temporary work space (staging areas)
- spoil sites
- borrow source

Since filing of the EIA, Alberta Transportation has created a draft post-construction land use document for the Project (Appendix IR2-1). This document provides the draft principles of future land use for the PDA, which was developed through the engagement process and includes feedback received by First Nations and stakeholders. The principles apply to the land use area (LUA) outlined in yellow in Figure 1 of Appendix IR2-1. The primary use of all lands within the PDA, including the LUA, is for flood mitigation. In light of the primary use, the safety of anyone with access or land users will be an overriding factor.

In general, only uses and activities that have a minimal impact on the land will be allowed. Therefore, the availability of surface dispositions will be limited.

Question 113

Volume 3A, Section 12.4.2, Page 12.24 and Figure 12-5, Page 12.25
Volume 3A, Section 12.4.2.1, Page 12.31
Volume 3A, Section 12.4.2.2, Pages 12.34 to 12.35
Volume 3B, Section 12.2.2.1, Page 12.6
Volume 3B, Section 12.2.2.2, Page 12.7

Alberta Transportation states *AEP would own and manage these areas. Area D, dam and reservoir infrastructure: there is no public access and would be fenced for public safety and security purposes*.

On page 12.31 Alberta Transportation states that *some recreational boating (e.g., kayaking, canoeing, rafting) does occur on the river in the PDA and LAA and the right of safe public navigation of any waterway must be maintained during the construction and operation of the Project (Transport Canada 2014)*.

Alberta Transportation states in Section 12.4.2.2 that *AEP would avoid the substantial interference with public navigation of the Elbow River through the following design practices:*

- ***As part of construction, a permanent portage will be developed around the in-stream water intake components.***
- ***Signs will be installed along the Elbow River channel and on the dam. Multiple signs will be placed upstream and downstream of the water intake components on both banks of the Elbow River. These signs will warn users on the Elbow River that they are approaching in-stream water intake components and of the associated danger with this infrastructure and direct them to a portage location. A floating, high visibility boom will be in place upstream and downstream of the water intake components.***

Areas B, C, and D will be restricted to public access using barbed wire fencing, gates and signs indicating “Danger” and “No Trespassing”.

Similar wording referring to the permanent portage is included in Volume 3B, Section 12.2.2.1, Page 12.6. Similar mitigation wording on public access, fencing and signage is included in Volume 3B, Section 12.2.2.2, Page 12.7.

a. **Explain how restricting access to Area D with barbed wire fencing maintains the right of safe public navigation on the Elbow River.**

b. **Clarify why the bed and shores of the Elbow River (upstream and downstream of the diversion structure) are included as dam and reservoir infrastructure with restricted public access.**

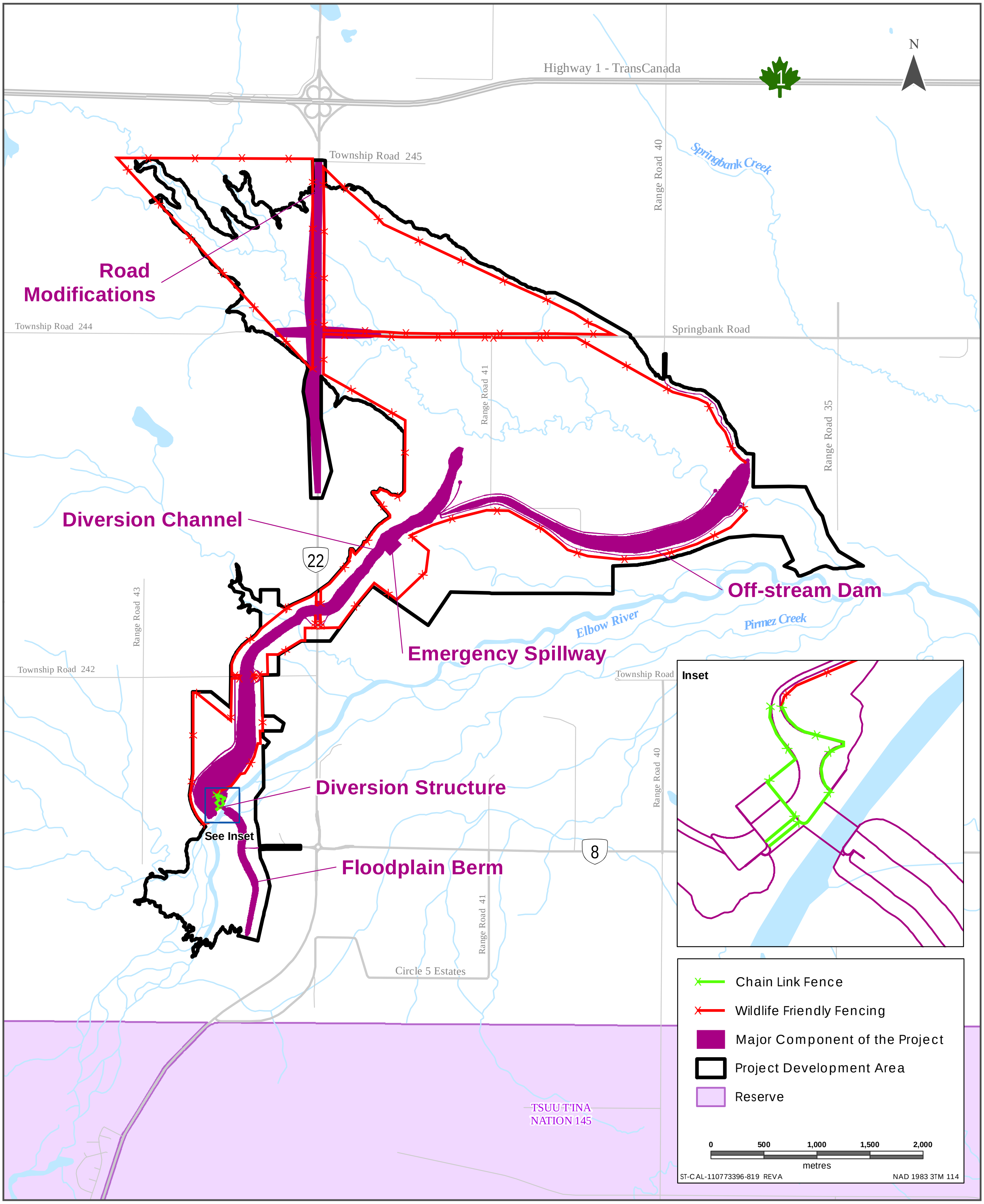
c. **Describe the location of the portage relative to Area D and the PDA, and explain how it will be accessible to the public.**

Response 113

a. Access along Elbow River will not be restricted and safe public navigation will be maintained. Fencing will not be placed directly in Elbow River or within its beds and shores. Fencing will only be located around physical dam structures. The location of barbed wire fencing (also referred to as wildlife-friendly fencing) is shown in Figure IR113-1.

b. The beds and shores of the Elbow River do not have public access restrictions, except for where there is Project infrastructure.

c. Figure IR113-2 provides the preliminary location of the portage. The exact location of will be subject to final design. Signage along the river bank will also be installed identifying access to the upcoming portage location, both upstream and downstream of the diversion channel. The portage will be accessible to the public by foot from within the beds and shores of Elbow River



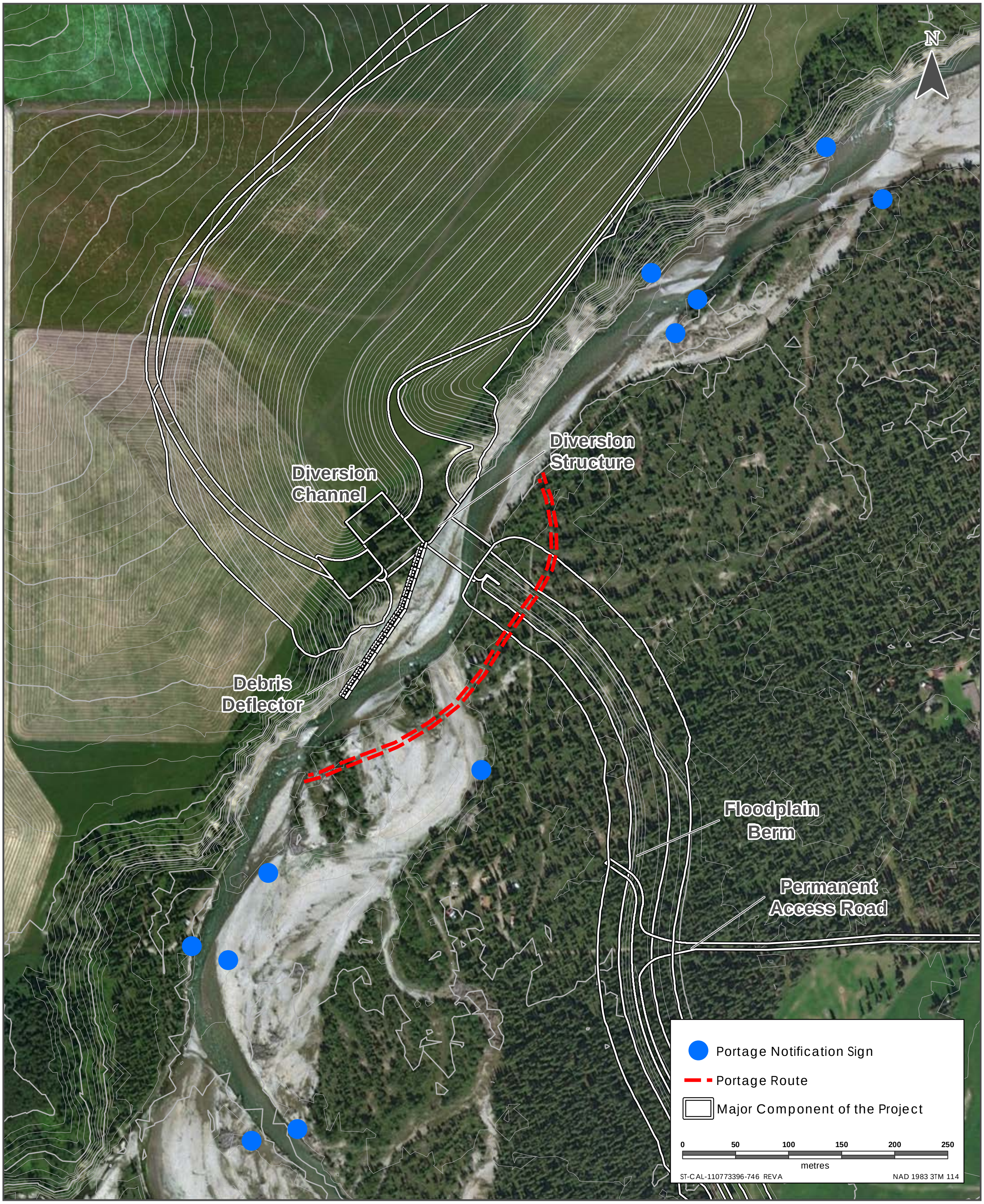
Sources: Base Data - Government of Alberta, Government of Canada, Thematic Data - Stantec Ltd.

Proposed Location of Project Fencing

Stantec

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT

Figure IR113-1



Sources: Thematic Data - Stantec Ltd. Imagery: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Location of Proposed Portage Signage and Route

Stantec

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT ENVIRONMENTAL ASSESSMENT

Figure IR113-2

Question 114

Volume 3A, Section 12.2.2.1, Figure 12-2, Page 12.14 and Page 12.18
Volume 3A, Section 16.2.3.1, Page 16.10
Volume 1, Section 2.2.6.2, Page 2.30
EIS Summary, Section 3.6.3.3, Page 3.29
Volume 3A, Section 16.2.3.1, Page 16.11
Volume 3A, Section 16.2.3.1, Table 16-5, Page 16.12

Under the heading Aggregate Development, Alberta Transportation states *Alberta Transportation holds a disposition reservation (DRS) for surface material extraction in the LAA, in NW-11-024-04 W5M. There are no other quarries or pits in the assessment areas*.

Alberta Transportation states *Township Road 242, west of Highway 22 functions as a two-lane roadway. It primarily serves a small number of country residential dwellings and the Copithorne gravel pit*.

Alberta Transportation states *Table 16-5 lists the AADT volumes on Township Road 242 west of Highway 22. The average annual growth rate between 2003 and 2015 was 126.3%, but from 2003 to 2014 it was 19%. It is speculated that the increase in the growth rate on Township Road 242 between 2014 and 2015 can be attributed to the Copithorne gravel pit operations*.

Figure 12-2 shows the PDA, LAA and RAA and the Township and Range Roads. Township Road 242 is shown extending beyond the LAA and ending prior to the RAA. The only road shown that connects Township Road 242 to other township roads is Highway 22.

a. **Provide the legal land location of the Copithorne gravel pit.**

b. **Describe the Copithorne gravel pit location relative to the PDA, the LAA and RAA for:**

   i. **Land Use and Management**

   ii. **Air Quality and Climate**

   iii. **Acoustic Environment**

   iv. **Infrastructure and Services**

c. **Explain when the Copithorne gravel pit began operation and its life expectancy.**

d. **Update any Aggregate Development sections throughout the EIA.**

Response 114

a. The legal land location of the Copithorne gravel pit is SW-18-024-04-W5M.

b. Table IR114-1 and Figure IR114-1 provide the location of the Copithorne gravel pit relative to the PDA, the LAA, and RAA for the requested valued components (VCs).

Table IR114-1 Location of the Copithorne Gravel Pit in Relation to Selected Valued Components (VCs)

Valued Component	Selected VC Boundaries Relative to the Copithorne Gravel Pit		
	PDA	**LAA**	**RAA**
Land Use and Management	Outside (4.7 km west of the PDA)	Outside (3.71 km west of the LAA)	Within[1]
Air Quality and Climate		Within (LAA and RAA boundaries are the same)	
Acoustic Environment		Outside (1.71 km west of the LAA)	Within
Infrastructure and Services		Within (LAA and RAA boundaries are the same)	

NOTES
[1] The RAA boundary for land use and management intersects the Copithorne gravel pit.

c. The current approval holder for the Copithorne gravel pit is the Municipal District of Rocky View No. 44 and is being operated under EPEA Approval No. 15427-02-00. The original application for this pit is not available on the AEP Authorization Viewer portal; therefore, the operation date and predicted life expectancy is unknown.

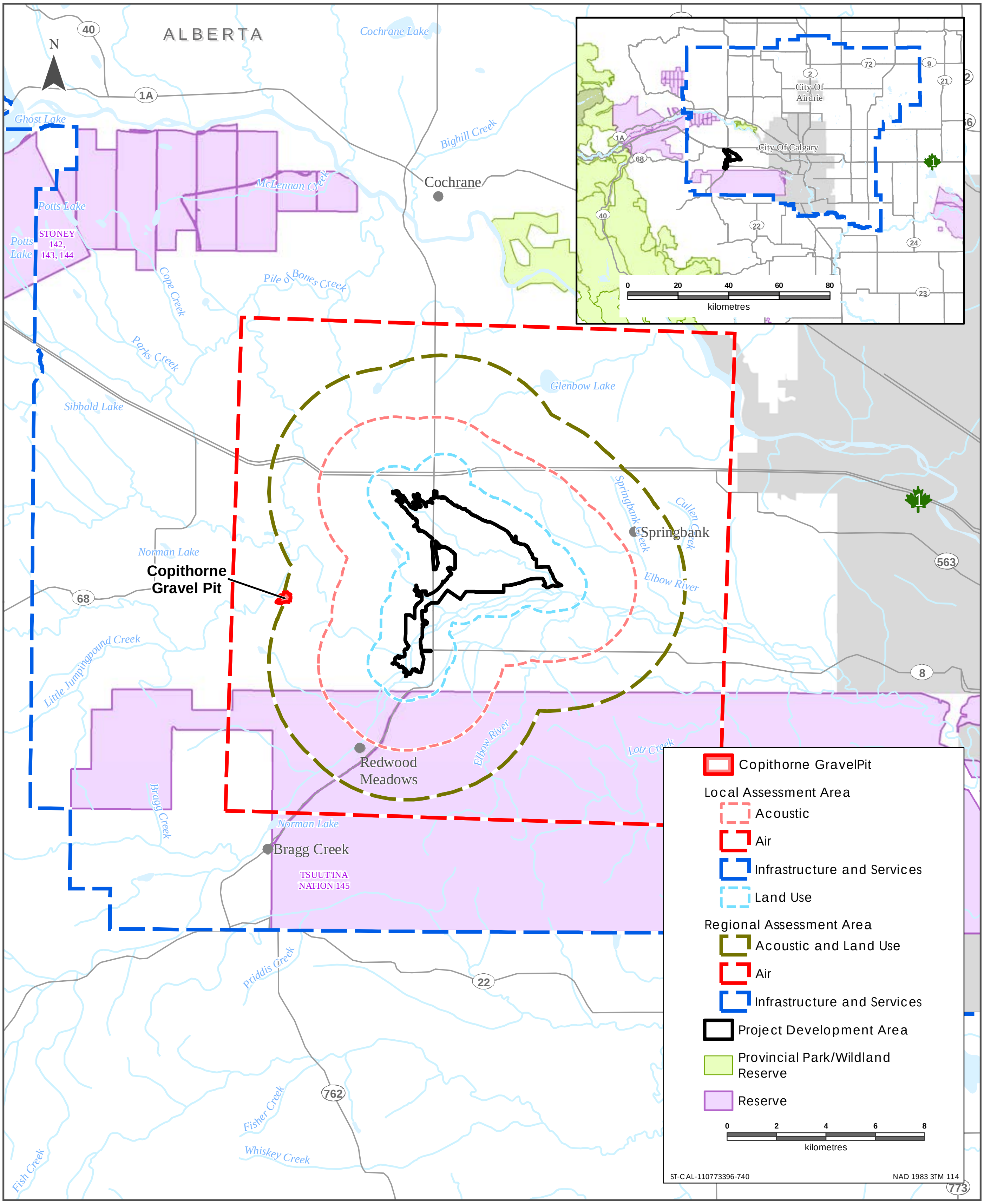
d. Volume 3A, Section 12.2.2.1, page 12.18 should be revised to read as follows (strikeout for outdated text and red for new text), in order to include the Copithorne gravel pit:

"Aggregate Development

The Copithorne gravel pit is located 4.7 km west of the PDA (SW-18-024-04W5M). The current approval holder is the Municipal District of Rocky View No. 44, and the gravel pit is operated under EPEA Approval No. 15427-02-00. Alberta Transportation holds a disposition reservation (DRS) for surface material extraction in the LAA, in NW-11-024-04 W5M. ~~There are no other quarries or pits in the assessment areas."~~

REFERENCES

Alberta Environment and Parks Authorization Viewer. Last accessed on October 25, 2018. https://avw.alberta.ca/ApprovalViewer.aspx



Sources: Base Data - ESRI, Natural Earth, Government of Alberta, Government of Canada
Thematic Data - ERBC, Government of Alberta, Stantec Ltd

Location of the Copithorne Gravel Pit in Relation to Selected VC Boundaries

Stantec

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT

Figure IR114-1

Question 115

<u>Volume 4, Appendix N, Attachment 12A, Section 12A.3.3, Table 12A-3 and Table 12A-4, Pages 12A.8 to 12A.13</u>

Table 12A-4 identifies business, institutional and recreational organization receptors in the LAA and RAA by name, as well as listing residential receptors. Table 12A-3 lists landowners within the PDA, but does not include if there are residences (or business, institutional and recreational organization receptors) on those land parcels.

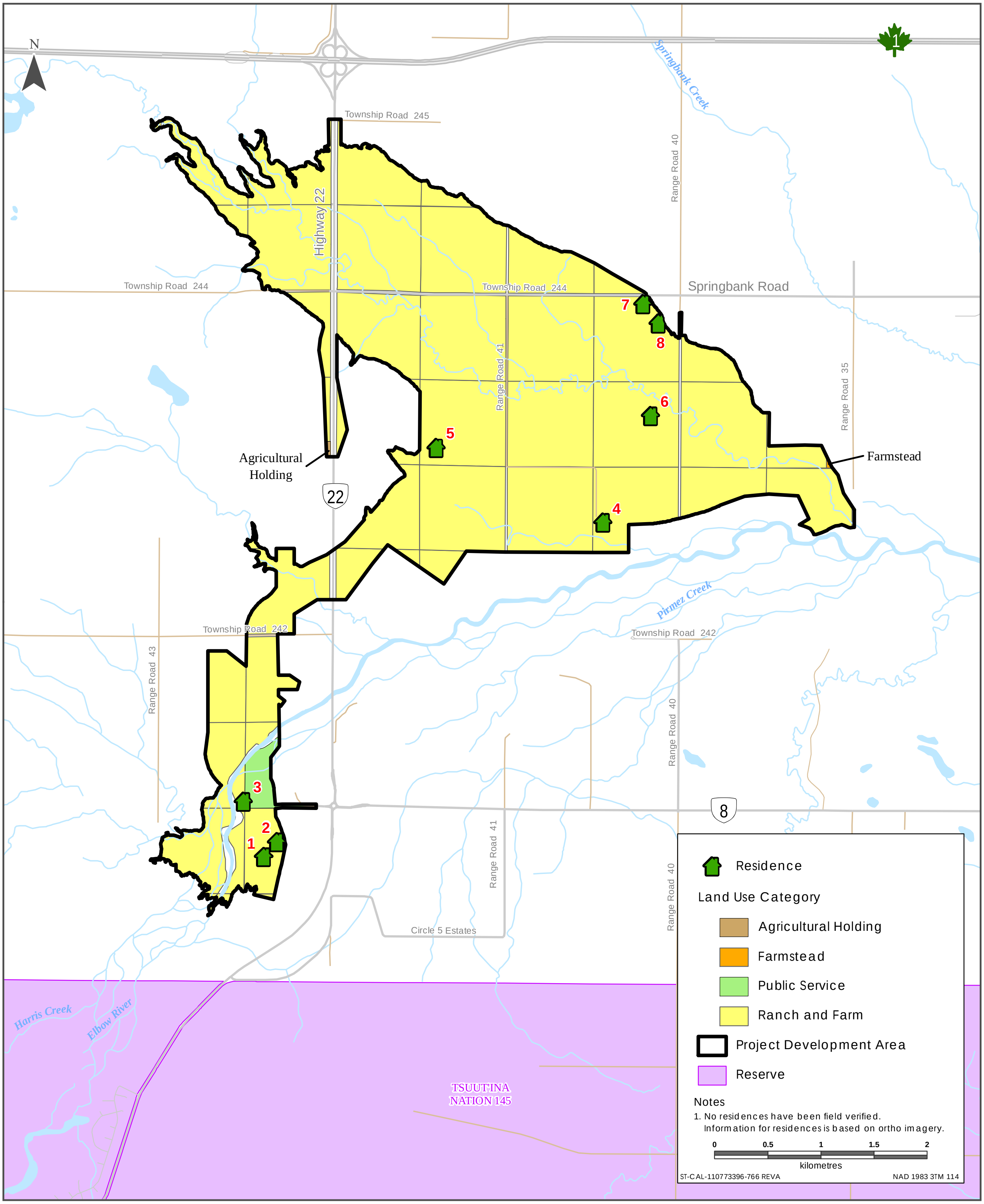
a. Identify the current land use for each land parcel within the PDA, and identify the land parcels within the PDA that contain residences.

Response 115

a. The privately-owned land within the PDA lies within land use districts identified by the Rocky View County Land Use Bylaw (Bylaw C-4841-97), which specifies the types of development allowed in each land use district and provides planning guidance for development in those areas. Current land use within the PDA is dominantly designated as “ranch” and “farm”. There is a small area within the southern portion of the PDA designated as “public service”; a small part of the eastern edge of the PDA is designated as “farmstead”; and a small part of the western edge of the PDA is designated as “agricultural holding”. There are also eight residences within the PDA. Figure IR115-1 provides the current land use and residences found within the PDA. Legal land locations of the current residences in the PDA are in Table IR115-1.

Table IR115-1 Legal Locations of Current Residences within the PDA

Residence ID	Legal Location
1	NE-3-24-4 W5
2	NE-3-24-4 W5
3	SW-10-24-4 W5
4	NE-13-24-4 W5
5	SE-23-24-4 W5
6	SE-24-24-4 W5
7	NE-24-24-4 W5
8	NE-24-24-4 W5



Sources: Base Data - Government of Canada. Thematic Data - Government of Alberta

Existing Land Use and Residences in the PDA

Stantec

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT

Figure IR115-1

Question 116

Volume 3A, Section 12.4.2.1, Page 12.32 Volume 1, Section 2.2.6.2, Page 2.30

Alberta Transportation states that *an overpass would be constructed at the intersection of Highway 22 and Springbank Road.*

On page 2.30 Alberta Transportation states *Design option 2 maintains existing the Springbank Road except for the modifications necessary to permit an at-grade intersection with raised Highway 22. Design option 2 is the preferred option for Springbank Road*.

a. Describe the intersection proposed at the junction of Highway 22 and Springbank Road.

Response 116

a. The statement in Volume 3A, Section 12.4.2.1, Page 12.32 is incorrect. An overpass will not be constructed at the intersection of Highway 22 and Springbank Road. Rather**,** the at-grade intersection of Highway 22 and Springbank Road (Township Road 244) will be raised approximately 5 m for an approximate 500 m stretch to maintain traffic operations during a design flood along Highway 22 and up to a 1:50 year flood along Springbank Road. For floods larger than a 1:50 year flood, Springbank Road will be at least partially submerged, and traffic will be detoured to Highway 22 by means of Range Road 40 and Township Road 250. Culverts in the raised road embankment are sized at 3.67 m to facilitate filling and draining of the reservoir during a flood.

Question 117

Volume 3A, Section 16.1.4.1, Page 16.4
Volume 3A, Section 16.1.4.1, Figure 16-1, Page 16.5

Alberta Transportation indicates the *RAA follows the boundary of Rocky View County, and includes the City of Calgary. The only Aboriginal Reserve in the RAA is Tsuu T'ina Nation 145.* Figure 16-1 shows the RAA includes a portion of the Stoney Nakoda Nation's land.

a. Clarify which Aboriginal Reserves are located within the RAA for infrastructure and services.

Response 117

a. The statement in Volume 3A, Section 16.1.4.1 on Page 16.4 is not correct. That sentence should be revised as follows: "~~The only Aboriginal Reserve in the RAA is Tsuu T'ina Nation 145~~. The RAA contains the entirety of Tsuut'ina Reserve 145 and an approximately 4,941.5 ha portion of Stoney Reserve 142, 143, 144 (see Volume 3A, Section 16, Figure 16-1)."

Question 118

Volume 3A, Section 16.2.3.1, Page 16.11 and Table 16-5, Page 16.12
Volume 1, Section 2.2.6.3, Page 2.30 and 2.31
EIS Summary, Section 3.6.3.3, Page 3.29
SR1 – Annex 2: A) Early Technical Issues, Response 1, Pages 1 to 11

Alberta Transportation states *Table 16-5 lists the AADT volumes on Township Road 242 west of Highway 22. The average annual growth rate between 2003 and 2015 was 126.3%, but from 2003 to 2014 it was 19%. It is speculated that the increase in the growth rate on Township Road 242 between 2014 and 2015 can be attributed to the Copithorne gravel pit operations.*

On pages 2.30 and 2.31 Alberta Transportation states that *design option 1 maintains the existing Township Road 242 alignment, but with a bridge crossing over the diversion channel. Design option 1 is the preferred option for Township Road 242.*

In the EIS Summary Alberta Transportation states *Design option 1 is the preferred option for Township Road 242. It provides the least disruption to the existing travel distance and the least requirement for new road construction*.

In the Early Technical Issues response Alberta Transportation states *For the Township Road 242 options, the environmental evaluation was based on the overall effects on undisturbed land, where a higher potential for environmental effects exists. As a result, the construction of the bridge crossing over the channel diversion on the existing Township Road 242 alignment (Option 1) has less environmental impact than Option 2 and 3 that traverses undisturbed land*.

a. Provide the construction costs for the three design options for Township Road 242.

b. Describe how Copithorne gravel pit access was or was not a factor in the design option decision for Township Road 242.

Response 118

a. The planning level construction costs for the three options are listed in Table IR118-1.

Table IR118-1 Construction Costs for the Township Road 242 Options

Option 1 Maintain the existing Township Road 242 alignment with the construction of the bridge crossing over the channel diversion	$6.2 million
Option 2 Realign Township Road 242 using Range Road 43, approximately 1,600 m north of the existing intersection of Highway 22 and Township Road 242.	$4.8 million
Option 3 Realigns Township Road 242 from the intersection of Range Road 43 connecting to Highway 22 approximately 800 m north of the existing intersection of Highway 22 and Township Road 242	$3.1 million

b. The Copithorne gravel pit was not a factor in any of the design option decisions. The only reference to the pit in any reporting was related to traffic counts and the number of commercial vehicles on Township Road 242 that could potentially be attributed to pit operations.

Question 119

Volume 3A, Section 16.3, Page 16.13
Volume 3A, Section 16.2.3.1, Table 16-3, Page 16.10
Volume 3A, Section 16.2.3.1, Page 16.9
Volume 3A, Section 16.4.2.3, Page 16.17

Alberta Transportation states *Project would require approximately 450 workers. It is assumed that nearly all of the construction workers would live within daily commuting distance*.

Alberta Transportation states Highway 22 is a two-lane undivided rural highway. Alberta Transportation has plans for twinning the highway on its current alignment in the next ten years, although a date for the twinning has not been set.

On page 16.17 Alberta Transportation states *Employee commuter traffic and traffic delivering construction materials, supplies and services to the site may increase traffic volumes; however, with mitigations described above and the capacity of the local road network, the traffic associated with the Project can easily be accommodated.*

a. Quantify worker commuting trips per day on Highway 22 when the construction work force is at its peak and clarify if this is during 24 hour construction.

b. Quantify construction vehicle trips per day on Highway 22 when the work force is at its peak.

c. Provide the AADT volume required to twin Highway 22.

d. Describe how the traffic associated with the Project will be accommodated on a two-lane highway that has (or is projected to have) high enough traffic volumes that highway twinning is planned in the next ten years.

Response 119

a. Volume 3A, Section 16.3, page 16.13 and Volume 3A, Section 17, page 17.26 state that the Project would require approximately 450 workers. This number is incorrect. The Project's peak workforce (the workforce of the month that the most persons were employed) is estimated at 515 persons, comprising 360 direct construction workers and another 155 persons employed by contractors (additional details provided in the response to IR191).

   The average annual daily traffic (AADT) in 2016 was 12,850 (north bound traffic) and 11,860 (south bound traffic) on Highway 22. As a conservative estimate, it is assumed that the 515 workers make two trips per day. Therefore, the commuting trips per day is 1,030. This represents an 8% (north bound) and 8.7% (south bound) potential increase in traffic. It is assumed the peak would occur during 24-hour construction.

b. Because the construction contractor's planned means of execution is not known yet for the Project, the number of construction vehicle trips per day on Highway 22 is unknown.

c. As of April 2018, Alberta Transportation no longer uses a traffic volume threshold for twinning highways. Instead, Alberta Transportation uses the level of service (LOS) criteria for each highway service classification (GoA 2018). Additionally, twinning of highways is also based on provincial priority and the availability of funding. Due to the need of other highway projects in the province, twinning of Highway 22 between Highway 1 and Highway 8 will not occur in the near future.

d. The functional planning study for the twinning of Highway 22 was completed. Project-associated traffic will not generate additional highway traffic volumes that would trigger the need for highway twinning. This is because traffic associated with the Project will be a minor fraction of the total traffic volumes currently on the highway.

REFERENCES

GoA (Government of Alberta). 2018. Alberta Transportation Highway Geometric Design Guide. Available at: http://www.transportation.alberta.ca/Content/docType233/Production/HGDG_chap-a.pdf

Question 120

<u>Volume 3A, Section 16.2.3.1, Page 16.9</u>

Alberta Transportation states that *Highway 22 is a two-lane undivided rural highway. Alberta Transportation has plans for twinning the highway on its current alignment in the next ten years, although a date for the twinning has not been set*.

It is reasonable to assume the future cost of twinning Highway 22 through the PDA would be greater with the Project (e.g., additional costs to raise a twinned highway across the reservoir and a second Highway 22 bridge over the diversion channel).

a. Justify whether (or not) these additional costs for Highway 22 twining should be included as Project costs.

Response 120

a. The additional costs for future work on Highway 22 should not be included as part of Project costs. The date for the twinning of Highway 22 is indeterminate and is based on a number of factors, including traffic volumes, which may not occur for another 25 or 30 years, if at all. Therefore, it is difficult to assign and include these as Project costs. It is also possible that an alternate route may be preferable to the costs of twinning and raising a portion of Highway 22. These are future considerations to be analyzed and will be decided upon at a later date as part of a separate Alberta Transportation capital plan.

Question 121

<u>EIS Summary, Section 3.6.3.2, Page 3.24 and Volume 1, Section 2.2.6.2, Page 2.30</u>
<u>EIS Summary, Section 3.6.3.1, Page 3.24 and Volume 1, Section 2.2.6.1, Page 2.27</u>

Alberta Transportation discusses the option of raising Springbank Road above the 2013 flood level to maintain traffic during a flood event and states *The road embankment would be classified as a dam under the Dam and Canal Safety Guidelines, leading to higher engineering, construction, safety, maintenance, and licensing costs that for a typical roadway*.

Alberta Transportation also states *Design Option 1 raises Highway 22 above the reservoir design flood level…The design elevation allows 0.5m for freeboard and 1.0m for the pavement structure depth above flood design level, which results in an embankment height of approximately 5 m at the Springbank Road intersection. The length of the raised roadway is approximately 1,800 m*.

a. Explain why the raised Highway 22 is not classified as a dam under the Dam and Canal Safety Guidelines.

b. Provide added costs if the Highway 22 road embankment was classified as a dam.

Response 121

a. Hydrologic routing of the 2013 design flood indicates that the existing drainage infrastructure, including the 3 m diameter culvert, maintains a head differential across the embankment of less than 1 m. Because the roadway will not retain water and does not cause an imbalance of head across the embankment, classification as a dam is not appropriate.

b. As described in Part a, Highway 22 is not classified as a dam and therefore costing of the Highway 22 road embankment has not been provided.

Question 122

Volume 1, Section 3.2.2 and 3.2.3, Page 3.11

Alberta Transportation states that the design maximum flow for the diversion channel is 600 m^3/s and that the design discharge capacity of the emergency spillway is 354 m^3/s. The emergency spillway is designed to operate when the diversion inlet gates cannot be closed, and the capacity of the reservoir is exhausted.

a. Describe how the emergency spillway, with a 354 m^3/s capacity, will accommodate the maximum diversion channel flow of 600 m^3/s?

Response 122

a. The design capacity of the emergency spillway is 354 m^3/s at a water surface elevation of 1,212.0 m, which occurs at the maximum pool elevation during the routing of the 24-hour PMF if the diversion inlet gates fail to close. This is illustrated with the reservoir routing for the probable maximum flood (PMF) presented in Figure IR122-1, where the peak reservoir elevation in the reservoir is reached well after the maximum inflow rate peaks. Based on this analysis, the emergency spillway does not need to accommodate the maximum diversion operation flow of 600 m^3/s.

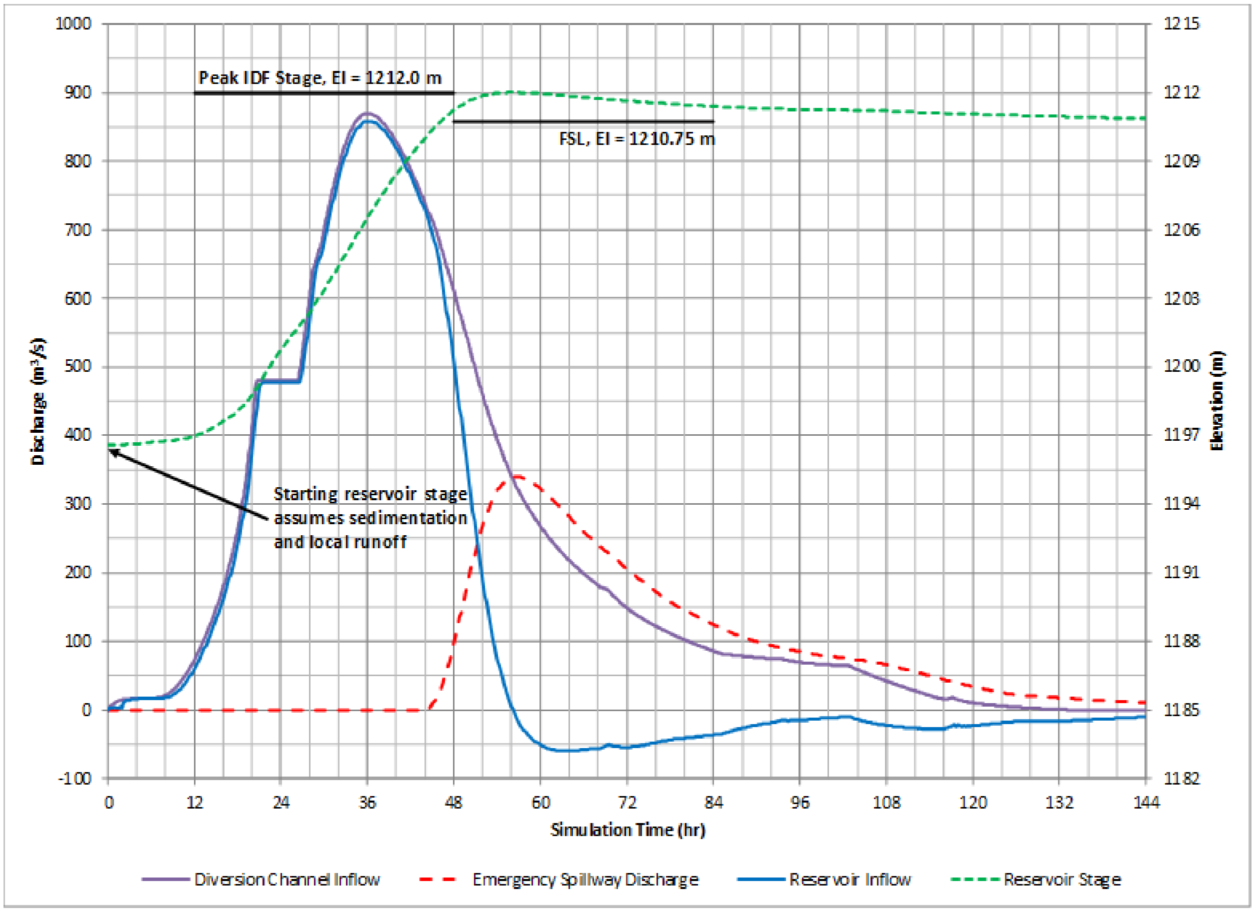


Figure IR122-1 Reservoir Inflow Routing for the Probable Maximum Flood with No Diversion Inlet Gate Closure

---

Question 123

Volume 3A, Section 15.2.1, Page 15.9 and Volume 4, Appendix O, Human Health and Risk Assessment Technical Data Report, Section 2.6.1, Page 2.7
Volume 3A, Section 3.4.3.3, Page 3.47
Volume 3A, Section 3.4.3.3, Page 3.48
Volume 4, Appendix O, Human Health and Risk Assessment Technical Data Report, Section 3.4, Figure 3-2, Page 3.13

Alberta Transportation states that *particulate matter is also modelled to address dust concerns in the post-flood operations phase, where high winds during dry periods can cause wind erosion and dust storms and that the COPC from air emissions in the HHRA are those associated with gasoline and diesel combustion exhaust during the construction phase (i.e., CACs, VOCs, PAHs*

***and trace metals), and particulate matter in the air resulting from dust storms during the post-flood operations phase*.**

In Section 3.4.3.3 Alberta Transportation states *Project emissions during construction are associated with the operation of the off-road construction equipment and earth moving activities for the construction of the major components of the Project. The following emissions sources due to construction activities are estimated:*

- ***Diesel combustion exhaust emissions from off-road construction equipment and haul trucks***
- ***Fugitive dust emissions from scraping, bulldozing and grading of topsoil and overburden***
- ***Mechanically generated dust by off-road equipment in transition***
- ***Fugitive dust emissions from truck loading and unloading***
- ***Mechanically generated dust by truck traffic along haul roads***
- ***Fugitive dust emissions from wind erosion on topsoil and overburden stockpile***

On page 3.48 Alberta Transportation states *Most of the $PM_{2.5}$ and TSP emissions are associated with the fugitive haul road dust emissions.*

In Volume 4 Alberta Transportation states:

- ***Project Phase: Construction***
- ***COPC Source: Haul Road Dust***
- ***COPC: PM2.5***
- ***Exposure Media: Ambient Air***
- ***Exposure Route: Inhalation of Air***
- ***This exposure pathway is operable for Residents (all age groups) and Indigenous Receptors (all age groups).***

In portions of Volume 4 (Appendix O) and Volume 3A (Sections 3 and 15), Alberta Transportation suggests that the $PM_{2.5}$ road dust emissions both were and were not included in the Human Health Risk Assessment (Appendix O).

a. Clarify if $PM_{2.5}$ haul road dust emissions were included in the Human Health Risk Assessment (Appendix O) and Volume 3A, Section 15. Determine if the proposed mitigations for $PM_{2.5}$ emissions continue to be appropriate.

Response 123

a. $PM_{2.5}$ emissions are included in the inhalation pathway in the HHRA. Haul road dust emissions are included in the for exposure to $PM_{2.5}$. For example, as indicated in Volume 3A, Section 3.4.5.3, page 3.74, "The maximum predicted 1-hour $PM_{2.5}$ concentration of 314 µg/m³ occurs along the northwest PDA boundary near the north end of the haul road that is parallel to Highway 22 (Figure 3-17)."

This same concentration (314 µg/m³) is used (Volume 4, Appendix O), as indicated in Table A-7, where the 1-hour exposure concentration for $PM_{2.5}$ at the maximum point of impingement (MPOI) of 3.1E+02 (which is µg/m³ written in scientific notation) is used to predict a maximum exposure ration (ER) of 3.9 for the Application Case. This exposure ratio is the value shown in Volume 4, Appendix O, Section 6, Table 6-1, page 6.3 and in Volume 3A, Section 15.4.4.1, Table 15-11, page 15.45.

As indicated in Volume 3A, Section 3, Table 3-15, page 3.50, dust emissions from haul roads represent approximately 75% of total Project-related emissions of $PM_{2.5}$. Therefore, the proposed mitigation measures for $PM_{2.5}$ emissions continue to be appropriate.

Question 124

Volume 4, Appendix O, Human Health and Risk Assessment Technical Data Report, Section 6.2.1, Page 6.4.

Alberta Transportation states *For $PM_{2.5}$,…ERs are greater than 1.0 at 18 residential receptor locations (including SR38). These receptor locations do not include Indigenous receptor locations, or institutional facilities such as schools.*

a. What are the specific health effects of $PM_{2.5}$ on receptor SR38 (Camp Gardner)?

Response 124

a. Table IR124-1 lists the relevant information at special receptor (SR) SR38.

Table IR124-1 Predicted $PM_{2.5}$ Concentrations and Exposure Ratios at Receptor SR38 (Camp Gardner)

Averaging Period	Guideline[1] (µg/m³)	Concentration (µg/m³)			Exposure Ratio (ER)		
		Base Case	Project Alone	Application Case	Base Case	Project Alone	Application Case
1-h	80	14	70	83	0.18	0.87	1.0
24-h	28	12	13	24	0.43	0.45	0.86
Annual	10	3.8	2.6	6.4	0.38	0.26	0.64

NOTE:
[1] Guideline for 1-h exposure duration is Alberta Ambient Air Quality Objective (Alberta Government 2016) while guidelines for 24-h and Annual are Canadian Ambient Air Quality Standards (ECCC 2013, CCME 2014)

Several studies have linked fine particulate matter (PM_{10}) with various health effects, but predominantly to the respiratory and cardiovascular systems (World Health Organization [WHO] 2005). The epidemiological evidence shows adverse effects of particulate matter following both short-term and long-term exposures, and there is little evidence to suggest a threshold below which no adverse health effects would be anticipated (WHO 2005).

The 1-hour exposure at SR38 (83 µg/m^3) is predicted to be slightly above the Alberta ambient air quality objective (AAAQG) (Alberta Government 2017) of 80 µg/m^3, resulting in an ER of 1.0. The evidence for health impacts of $PM_{2.5}$ is typically based on exposure periods of 24 hours or longer. As noted by Alberta Environment (2007), the AAAQG of 80 µg/m^3 for 1-hour averaging periods is derived as a statistical equivalent of the 24-hour averaging period and, therefore, the 24-hour predictions are considered more appropriate for describing health effects.

As indicated in the table, the maximum 24-hour concentration of 24 µg/m^3 is below the guideline of 28 µg/m^3. This concentration is also less than WHO (2005 air quality guideline of 25 µg/m^3, which reflects the relationship between the distributions of 24-hour means (and its 99th percentile) and annual average concentrations.

Based on their review of the scientific literature, WHO (2005) concludes that exposures to annual mean concentrations of $PM_{2.5}$ of 10 µg/m^3 are below the mean for most likely effects. The predicted annual concentration of $PM_{2.5}$ at SR38 (6.4 µg/m^3) is below this threshold.

Based on the above, no health effects are expected at SR38.

REFERENCES

Alberta Environment. 2007. Alberta Ambient Air Quality Objectives, Fine Particulate Matter (PM2.5). Available at: https://open.alberta.ca/dataset/87c6de7a-ae19-49e1-bbc2-82dc81ff3fbe/resource/bc913b0f-e76c-4361-bb98-e671a2dd8e9d/download/2007-aaqo-fineparticulatematter-feb2007.pdf Accessed: October 2018

Alberta Government. 2017. Alberta Ambient Air Quality Objectives and Guidelines Summary. Updated July 30, 2017. ISBN 978-1-4601-3485-6 (PDF). Available at: https://open.alberta.ca/dataset/0d2ad470-117e-410f-ba4f-aa352cb02d4d/resource/97d1afdf-b66b-4805-be41-a5a3f589c988/download/aaqo-summary-jun29-2017.pdf Accessed: October 2018

CCME (Canadian Council for Ministers of the Environment). 2014. Canadian Ambient Air Quality Standards for Fine Particulate Matter and Ozone. Available at: http://www.ccme.ca/en/resources/air/pm_ozone.html Accessed: October 2018.

ECCC (Environment and Climate Change Canada). 2013. Canadian Ambient Air Quality Standards. Available at: http://www.ec.gc.ca/default.asp?lang=En&n=56D4043B-1&news=A4B2C28A-2DFB-4BF4-8777-ADF29B4360BD . Accessed: October 2018.

WHO (World Health Organization). 2005. WHO Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulfur dioxide, Global Update 2005. WHO/SDE/PHE/OEH/06.02

Question 125

<u>Volume 4, Appendix O, Human Health and Risk Assessment Technical Data Report, Section 6.2.1, Page 6.4.</u>

Alberta Transportation states *Short term exposures to DEP were assessed by comparing 1-hour concentrations to the acute (2-hour) DEP exposure limit. The ERs at multiple residential locations were higher than the benchmark of 1.0; the ERs at Indigenous receptor locations and schools were less than 1.0*.

a. What are the specific health effects of DEP on receptor SR38 (Camp Gardner)?

Response 125

a. Table IR125-1 lists the relevant information for diesel exhaust particulate (DEP) at Receptor SR38.

Table IR125-1 Predicted DEP Concentrations and Exposure Ratios at SR38

Averaging Period[1]	Guideline[2] (µg/m³)	Concentration (µg/m³)			Exposure Ratio (ER)		
		Base Case	Project Alone	Application Case	Base Case	Project Alone	Application Case
1-h	n/a	1.9	10	11	n/a	n/a	n/a
2-h	10	1.8	9.5	10	0.18	0.95	1.0

NOTES:
[1] Previously, assessed health risk was based on 1-hour concentrations; however, now assessed by the more appropriate 2-hour concentrations, which are consistent with the Health Canada guideline
[2] Guideline based on 2-hour toxicological reference value (TRV) recommended by Health Canada (2016)

Health Canada (2016) has recommended a short-term exposure limit or toxicological reference value (TRV) of 10 µg/m³ for 2-h exposures. To derive the TRV, Health Canada relied on three studies conducted with healthy or mildly asthmatic participants in which increased measures of airway resistance were observed at 100 µg/m³ DEP for a 2-hour exposure period. An additional three studies reported respiratory inflammation in healthy subjects exposed to 100 µg/m³ DEP for 2 hours. A composite uncertainty factor of 10 was applied to account for further susceptibility in the population due to age, disease status, genetic factors, and due to extrapolation from a lowest observed adverse effect level (LOAEL) to a no observed adverse effect level (NOAEL). From this, Health Canada derived a short-term exposure (2 hour) guidance value of 10 µg/m³ DEP (i.e., 100 µg/m³/10).

As indicated in Table IR125-1, the predicted 2-hour exposure to DEP at SR38 is 10 µg/m³, which is equivalent to the TRV. Based on these results, significant health effects are not expected at SR38.

REFERENCES

Health Canada. 2016. Human Health Risk Assessment for Diesel Exhaust. Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Ontario.

Question 126

<u>Volume 3A, Section 15.4.4.1, Page 15.46; Volume 3A, Section 15.4.4.1, Page 15.46</u>
<u>Volume 4, Appendix O, Human Health and Risk Assessment Technical Data Report, Section 6.2.1, Page 6.4</u>

Alberta Transportation states that *For $PM_{2.5}$, the short-term (1-hour or 24-hour) and long term (annual) ERs are greater than 1.0 at 16 residential receptor locations* (Volume 3A) and that *for $PM_{2.5}$, the short-term (1-hour or 24-hour) and long term (annual) ERs are greater than 1.0 at 18 residential receptor locations* (Volume 4).

a. Clarify the number of residential receptors where ERs are greater than 1.0.

Response 126

a. There are 18 special receptor (SR) locations where the exposure ratios (ERs) for $PM_{2.5}$ are greater than 1.0 (SR04, SR05, SR09, SR10, SR11, SR12, SR13, SR14, SR15, SR16, SR18, SR19, SR20, SR25, SR36, SR38, SR40 and SR41). Of these, 16 are residences, one is a commercial business (SR25), and one is a camp (SR38).