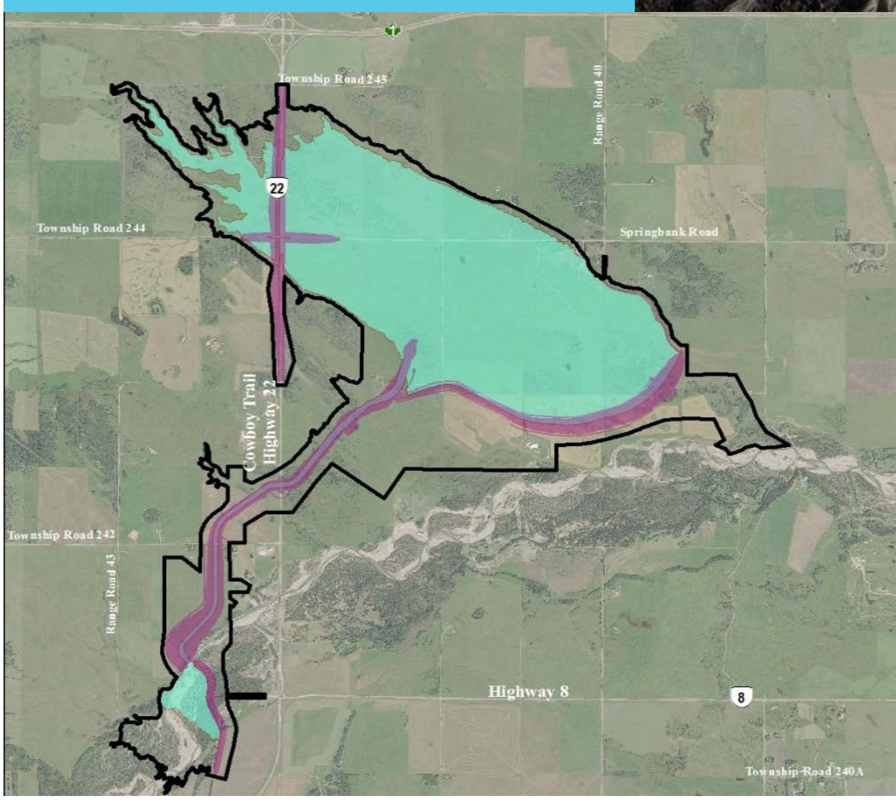
Alberta Transportation Springbank Off-stream Reservoir Project



Response to NRCB and AEP Supplemental Information Request 2 November 18, 2019

June 2020

Introduction

The Springbank Off-stream Reservoir Project (the Project; SR1) is located in the Springbank area of Rocky View County 15 km west of the City of Calgary, Alberta. The Project is a flood diversion system that will divert excess flood water from Elbow River to an off-stream reservoir where it will be held until the risk of flooding has passed. At that time, the retained flood water will be returned to Elbow River in a controlled manner.

The Project consists of a diversion structure on Elbow River that controls how much flood flow is diverted, and how much is allowed to pass downstream. The excess flood water is sent northwards down the 4,700 m long diversion channel to an off-stream reservoir (no permanent pool) that is formed by a dam impoundment across the glacial meltwater valley of the unnamed creek, an adjacent tributary to Elbow River. When a decision has been made to release water in the reservoir back into the river, the dam's low-level outlet opens to release the water down the unnamed creek natural channel.

This section outlines updates to the Project that have occurred since filing the environmental impact assessment (EIA) in March 2018 and the addendum on the debris deflector in May 2018. These updates are the result of feedback from regulators, Indigenous groups and stakeholders as well as advances in Project design. An evaluation of each Project change relative to the conclusions of the EIA for each valued component (VC) is provided in Table 1. Where applicable, the effects of certain updates are described in greater detail in individual responses to this document, which contains responses to Round 2 Alberta Environment and Parks (AEP) and Round 2 Natural Resources Conservation Board (NRCB) information questions.

CHANGES TO THE PROJECT

OPERATIONAL RULES

Based on feedback from Fisheries and Oceans Canada (DFO), the Impact Assessment Agency of Canada, and AEP (obtained through the first round of information requests), Alberta Transportation was asked to explore the possibility of releasing water from the reservoir earlier, relative to the release timing described in the EIA. Revised modelling was undertaken to explore whether an earlier release of water from the reservoir while water is still cool and oxygenated and when Elbow River is still turbid would have less of an impact on fish and aquatic biota in the river compared to releasing later in the season when released water may be warm and relatively more turbid than water in Elbow River. In addition, it is expected that an earlier release time will result in a reduced spatial extent of sediment deposition within the reservoir due to the reduced amount of time that water spends in the reservoir.

As a result, Alberta Transportation is introducing a new operational rule for releasing flood waters from the reservoir earlier, at a time when the flows in Elbow River are below 160 m^3/s (following the peak of flood flow in Elbow River). This flow coincides with Glenmore Reservoir's lower elevation outlet capacity (described further in the response to AEP Question 65). This is also the highest flow in Elbow River that does not require Glenmore Reservoir to use its remaining flood storage. The operational rules for the new early release scenario and the late release scenario (introduced in the EIA) are briefly discussed below and are further described in the responses to NRCB Question 17, NRCB Question 30, AEP Question 63, AEP Question 65, and AEP Question 67.

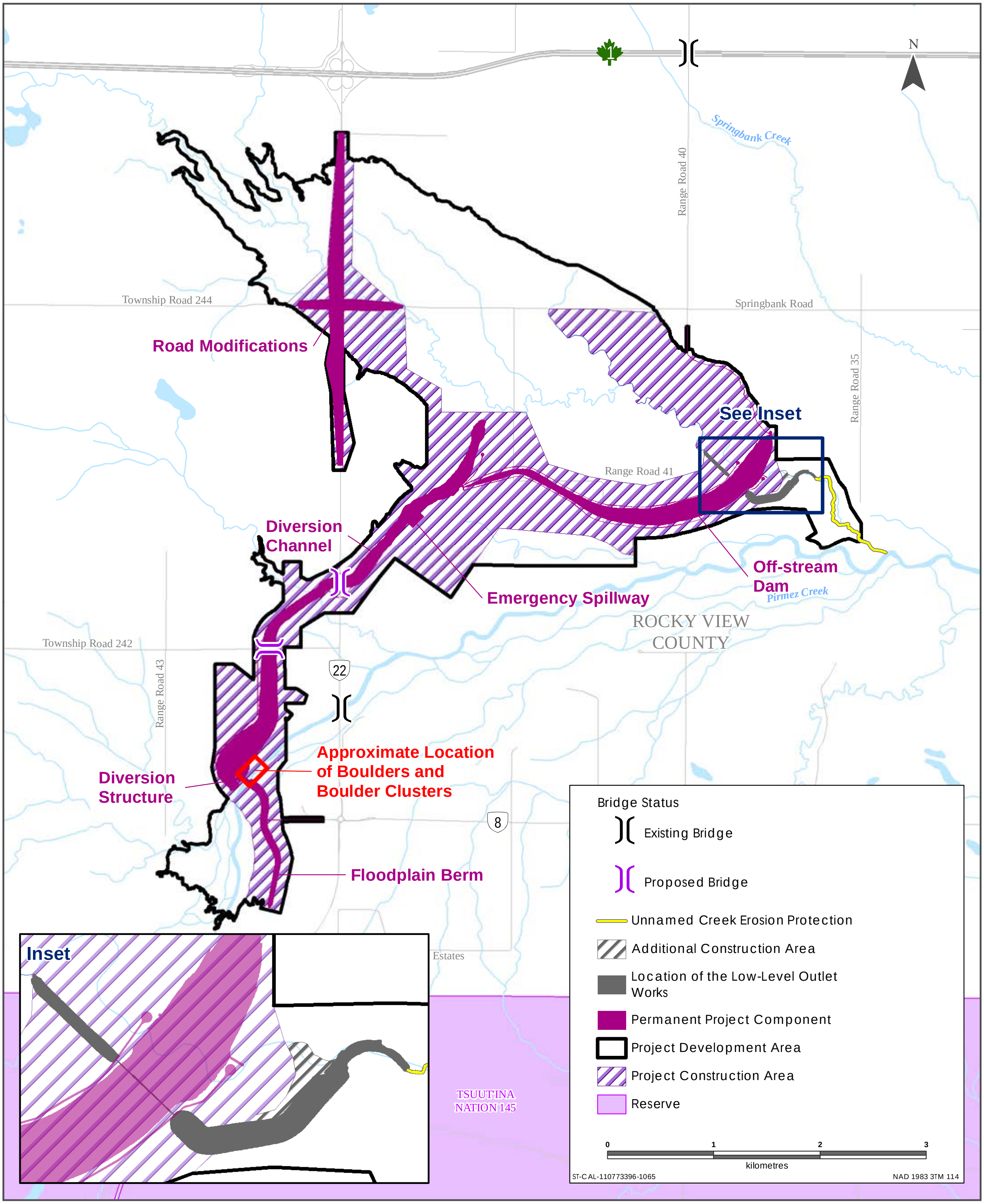
Early release has the reservoir discharging when flows in Elbow River fall below 160 m^3/s. Releases from the reservoir would be staged such that flow in Elbow River would not exceed 160 m^3/s downstream of the river's confluence with the unnamed creek. During a design flood, this would result in flows remaining at 160 m^3/s for approximately 8 hours longer than without the Project. During the 8 hours, the rate of water release from the low-level outlet would increase to a maximum of 23.85 m^3/s, after which both flows in Elbow River and the reservoir decline. The rate of 23.85 m^3/s is not the maximum release capacity (that capacity is 27 m^3/s) of the low-level outlet channel; rather it is the modelled as the most likely operating release rate.

Late release has the reservoir discharging when flows in Elbow River are below 20 m^3/s. The objective of this release rate was to maintain a maximum flow in Elbow River of 47 m^3/s. An important difference between late release presented here and the one presented in the EIA is that the outflow duration is less due to the updated outflow hydrograph.

STRUCTURAL CHANGES

The low-level outlet works (LLOW) is a gated concrete structure near the east end of the dam embankment that controls the discharge of the flood waters back into Elbow River through the existing unnamed creek. The works consist of an approach channel, discharge gate, gatehouse, discharge conduit and outlet channel into the unnamed creek. Since filing the EIA, Alberta Transportation has made three structural changes (see Figure 1) to the Project which are described below in greater detail:

1. additional disturbance from change in location of the LLOW
2. unnamed creek erosion protection
3. revision to the construction area footprint at the outlet channel downstream of the LLOW



N
Springbank Creek
Range Road 40
Township Road 244
Springbank Road
Range Road 35
Road Modifications
See Inset
Range Road 41
Diversion
Channel
Emergency Spillway
Off-stream
Dam
Pirmez Creek
ROCKY VIEW
COUNTY
Township Road 242
Range Road 43
22
Approximate Location
of Boulders and
Boulder Clusters
Diversion
Structure
8
Floodplain Berm
Inset
Estates
TSUUT'INA
NATION 145
Bridge Status
Existing Bridge
Proposed Bridge
Unnamed Creek Erosion Protection
Additional Construction Area
Location of the Low-Level Outlet Works
Permanent Project Component
Project Development Area
Project Construction Area
Reserve
0
1
2
3
kilometres
ST-CAL-110773396-1065
NAD 1983 3TM 114

ADDITIONAL DISTURBANCE FROM CHANGE IN LOCATION OF THE LLOW

The revised LLOW is approximately 190 m southwest from the original design location. The LLOW was moved based on further engineering review of the foundation soils. The revised location provides better foundation conditions (e.g., glacial till versus fine-grained soils and granular deposits) with reduced risks for additional settling during construction. In addition, a mid-slope gate tower was added to provide for a second (back-up) gate to improve operations reliability.

The previous location was aligned with the unnamed creek and required limited intake and exit channels to connect with the existing unnamed creek stream channel. The revised location is located upland from the unnamed creek and requires the construction of channels from the unnamed creek (in the reservoir) to the LLOW and from the LLOW back to the unnamed creek (outside the reservoir).

The unnamed creek will be diverted through the channel to the LLOW from a point approximately 500 m upstream of the low-level outlet to allow for better drainage and flow out of the reservoir. To reduce erosion, water released through the low-level outlet will follow a constructed channel which will convey flows back to the unnamed creek approximately 700 m downstream from where it was located in the original design (i.e., now closer to Elbow River).

UNNAMED CREEK EROSION PROTECTION

The original design did not include any alterations to the existing unnamed creek beyond the immediate dam and low-level outlet. Since filing the EIA, Alberta Transportation, as a result of feedback from regulators, Indigenous groups and stakeholders, has revised the design to include measures to reduce erosion along the full length of the unnamed creek and to further mitigate sediment mobilization in the unnamed creek and reduce sediment input into Elbow River (see Figure 1).

REVISION TO THE CONSTRUCTION AREA FOOTPRINT DOWNSTREAM OF THE LLOW

The construction area at the downstream end of the unnamed creek has slightly increased by 4.8 ha compared to what was identified in the EIA. This is a minor change in the construction area footprint that does not extend outside of the Project development area (PDA). Additionally, erosion mitigation measures along the banks of the unnamed creek will be installed as a way to reduce the risk of bank erosion and impacts to private property downstream of the PDA.

In Table 1, the changes to each VC associated with the construction footprint change has been captured under the "Structural Change" column.

NAVIGABILITY

Some Indigenous groups and stakeholders have identified navigation as important on this reach of Elbow River. In consultation with stakeholders, Alberta Transportation has elected to add five large boulders and three boulder clusters within the spaces between the fish passage structures downstream of the service spillway along Elbow River (Figure 1). Their purpose is to break-up the river currents and facilitate passage by small non-motorized water vessels such as canoes and kayaks during dry operations. More specifically, when recreational groups pass along this section of the river, the group lead can stop in the eddy of the boulder features and supervise the remaining members of the group as they pass over the service spillway. These boulders also will provide fish with additional resting refuge within the fish passage structures and improve their modelled performance. The additional boulders will not change the flow in Elbow River, except in the immediate next to the boulders, and they will not disrupt the function of the Project.

CHANGE IN EXTENT OF DIVERSION CHANNEL REVEGETATION

The design of the diversion channel includes the installation of riprap along the bottom of the diversion channel. To facilitate wildlife movement through the PDA, the riprap in portions of the diversion channel will be infilled with smaller diameter material, covered with topsoil, and seeded with grasses. In the EIA, it is assumed that the riprap along approximately 2.5 km of the diversion channel length would be infilled, covered with topsoil and reseeded. The portions of the diversion channel excavated through rock at the upstream end and the downstream end where exposed riprap is required for energy dissipation cannot be infilled and reseeded.

For operations and maintenance reasons, the length of the diversion channel where the riprap will be infilled, covered with topsoil, and reseeded has been reduced to two key areas for riprap (under bridges) and four key areas for revegetation totaling approximately 1.8 km in length (a reduction from 2.5 km). These key areas are identified as areas where wildlife would be more likely to cross the diversion channel (through a review of wildlife camera data, wildlife winter tracking data, and information provided by Indigenous groups). These locations will be discussed further with Indigenous groups.

NEW PROPERTY ACCESS CONFIGURATION

There have been approximately 10 property accesses identified close to the PDA that may require replacement or modification as a result of land procurement. The property accesses are to privately owned land, which often includes a residence or agricultural uses of that land. These replacements or modifications are required to maintain the access to parcels from the public right-of-way where land will not be acquired for the Project, but where all or a portion of that existing property access has been acquired. The exact locations, and number, of these access points and roadways cannot be confirmed until the land has been completely acquired by Alberta Transportation. It is estimated, there will be 1.1 ha of new access right-of-way associated with these changes that fall outside the PDA. This new access increases the total area of the PDA from 1,438 ha to approximately 1,439 ha.

REFERENCES

CCME (Canadian Council of Ministers of the Environment). 1999. Canadian Environmental Quality Guidelines: Water Quality Guidelines for the Protection of Aquatic Life. Canadian Council of Ministers of the Environment. Winnipeg.

Table 1 Implications of Project Changes to EIA Conclusions for Each VC

Valued Component	Operational Rule of Releasing Water When River Flows are Less than 160 m³/s (shortened retention time of water in the reservoir)	Structural Changes	Navigability	Change in Extent in Diversion Channel Revegetation	New Property Access Configuration
Air Quality and Climate	There is no effect on air quality, ambient light, or greenhouse gases.	There is no material change to the effects characterization for air quality, ambient light, or greenhouse gases. The small increase in footprint associated with the structural changes will not result in a material change to the amount of material (earth) to be moved, where it is moved to, nor the construction equipment (vehicles) required. As a result, the emission estimates and dispersion modelling remain valid.	No material changes to effects characterization. The additional work associated with navigation improvement that will be completed in Elbow River by construction equipment will be small in scale. There will not be a material change in air contaminants being released into the atmosphere and, as a result, the emission estimates and dispersion modelling remain valid.	There are no material changes to the effects characterization because there will be no increase in activities that would produce air emissions; activities producing air emissions could possibly decrease due to the decreased area for revegetation.	There is no material change to the effects characterization for air quality, ambient light, or greenhouse gases. The small increase in footprint associated with the new property access will not result in a material change to the amount of material (earth) to be moved, where it is moved to, nor the construction equipment (vehicles) required. As a result, the emission estimates and dispersion modelling remain valid.
Public Health	There is a positive change because there is a positive change to water quality.	Since there are no changes to air quality and climate, there are no changes to effects characterization.	Since there are no changes to air quality and climate, there are no change to effects characterization.	Since there are no changes to air quality and climate, there are no changes to the effects characterization.	Because there are no changes to air quality and climate, there are no changes to effects characterization.
Acoustic Environment	There is no increase in noise.	There are no material changes to the effects characterization. There will not be a material change in the construction noise as a result of the minor change in footprint area. As a result, the acoustics assessment in the EIA is unchanged.	There are no material changes to acoustic conclusions. The work that will be completed in Elbow River by construction equipment will be small. There will not be a material change in the construction noise associated with the overall construction of the Project.	There are no material changes to the effects characterization. The work associated with this change will not add to the overall construction noise.	Despite the small increase in footprint, noise emissions as a result of construction equipment (i.e., vehicles) required to build the access right-of-way will be temporary and localized. Mitigation measures will be applied, which will not change the effects characterization.
Hydrogeology	There are no material changes to effects characterization for groundwater levels. Shortening water retention time in the off-stream reservoir would decrease the duration of the effect on groundwater levels and, potentially, reduce the spatial extent of the effect. Groundwater quality will have a positive change. Shortening of the retention time in the off-stream reservoir would decrease the duration of time over which water may seep downward into the underlying sediments. Further, reducing the retention time would reduce the amount of time for geochemical reactions to take place.	There are no material changes to the effects characterization. There will be no change in the overall heads within the diversion channel or reservoir; the original assessment is unchanged.	There are no material changes to the effects characterization. The addition of the boulders in Elbow River will not interact with groundwater. The boulders would not change the underlying groundwater flow patterns or levels. The original assessment is unchanged.	There are no material changes to effects characterization for groundwater quality. The original assessment did not account for potential transpiration losses for seepage into the diversion channel. This was conservative in that it was assumed that all groundwater migrating toward the channel face would discharge into it. Thus, changes to the amount of revegetated area is not material to the assessment because it was conservatively not accounted for in the original assessment.	There are no material changes to the effects characterization. Changes to property access will not change potential interactions with groundwater because the access alone does not necessitate subsurface disturbance or activities that could affect groundwater.

Table 1 Implications of Project Changes to EIA Conclusions for Each VC

Valued Component	Operational Rule of Releasing Water When River Flows are Less than 160 m^3/s (shortened retention time of water in the reservoir)	Structural Changes	Navigability	Change in Extent in Diversion Channel Revegetation	New Property Access Configuration
Hydrology	There are no material changes to the effects characterization for hydrology regime. The shape of the hydrograph will change with new release rules. This in itself does not positively or negatively change the hydrology compared to the previous release rules. There may be change in sediment transport dynamics from bedload transport at flows at between bankfull and 160 m^3/s. There is the possibility of additional potential for bank erosion.	This is a positive change for hydrology. The structural changes to the low-level outlet and the erosion protection measures proposed for the unnamed creek will reduce erosion along unnamed creek and reduce the risk of sediment input in Elbow River.	The boulders neither improve nor adversely impact the hydrology relative to existing conditions. This localized positive change to the design is not expected to change the overall conclusions for the hydrology assessment.	There are no material changes to the effects characterization. Reducing the extent of revegetation within the diversion channel will not alter the flows of the water entering the reservoir or the sediment transport dynamics. The portions of the diversion channel that do not have vegetation will have riprap, which is not expected to change the hydrology and flow dynamics of the water passing through the diversion channel.	The new access right-of-way does not cross or intercept the reservoir or watercourses (i.e., tributaries).
Surface Water Quality	TSS will be greater in early release than in late release (as discussed in the response to AEP Question 65). Due to TSS deposition in the reservoir, the effect of late release is less than previously predicted. Therefore, the benefits of an early release may not be noticeable. Early release (1:100 year and design floods) are not rapid enough to release turbid water before Elbow River water improves (i.e., TSS in Elbow River decreases at a faster rate than in the reservoir). TSS aquatic life guidelines (CCME 1999) will be exceeded for all flood scenarios, except for the 1:10 year, late release. The difference in temperature between the released water and Elbow River water will be less during early release. Dissolved oxygen in released water and Elbow River water will be close in concentrations because both waters having cooler temperatures (see the response to NRCB Question 17). Physical and chemical reactions will have a shorter time period to modify nutrient and metals (including methylmercury) concentrations. These parameters will be less bioavailable (see the response to NRCB Question 16). Physical processes in the reservoir and interactions between the released water and Elbow River water may result in both positive and negative effects for early release. TSS and nutrients are predicted to not change Elbow River water in the 1:10 year flood; whereas an early release will have an effect on TSS in Elbow River for the 1:100 year flood (see the response to NRCB Question 65).	Erosion will be reduced along the unnamed creek and sediment input into Elbow River will be reduced. This is a positive change.	The addition of boulders and boulder clusters is not expected to affect Elbow River hydrology. There is no expected effect on surface water quality. There is no change to the effects characterization.	There are no material changes to the effects characterization. Reducing the amount of vegetated sections of the diversion channel will not affect water quality in the reservoir. The areas where revegetation will be reduced will have riprap to prevent erosion and, therefore, mitigate the effects of potential for increases in TSS.	The new access right-of-way does not cross or intercept the reservoir or watercourses (i.e., tributaries). Therefore, there is no interaction between the new access roads and any watercourse that would affect water quality.

Table 1 Implications of Project Changes to EIA Conclusions for Each VC

Valued Component	Operational Rule of Releasing Water When River Flows are Less than 160 m^3/s (shortened retention time of water in the reservoir)	Structural Changes	Navigability	Change in Extent in Diversion Channel Revegetation	New Property Access Configuration
Aquatic Ecology	There are no material changes to the effects characterization of aquatic ecology as a result of change in suspended sediment concentration. Water from the reservoir will consist of relatively high suspended sediment concentrations compared to Elbow River; these conditions are similar in nature to the effects that were presented in the EIA. Reduced water retention may benefit fish by returning fish to the river early and potentially reducing the risk of fish mortality. No material change to the effects characterization is proposed because the operational rule does not substantially change the duration to which fish are exposed to elevated suspended sediment levels (i.e., fish will still experience sublethal to lethal effects in the reservoir with a reduced duration). Given that there are no material changes to the effects characterization of the hydrology regime, there are no material changes to the effects characterization as it relates to fish habitat and fish passage.	There are no material changes to the effects characterization. The structural changes to the low-level outlet and the erosion protection measures proposed along unnamed creek will reduce erosion along unnamed creek and sediment input into Elbow River. The reduction in sediment in Elbow River will benefit the fish population.	There are no material changes to the effects characterization. The effects are positive because the modifications will provide fish with additional resting refuge within the fish passage structures.	Reducing the amount of vegetated sections of the diversion channel does not result in a material change to the effects characterization.	The new access right-of-way does not cross or intercept the reservoir or watercourses (i.e., tributaries).
Terrain and Soils	There are no changes to terrain stability and no material changes to the effects characterization. Reduction in water retention time could have a positive effect on predicted depth and extent of sediment deposits and, therefore, a reduced effect on soil quality and quantity. There are no changes to conclusions related to soil anoxia.	The structural changes would result in a small increase in the area of disturbed soil. Given the small area, this increase would not change the effects characterization.	There will be no soil disturbance.	There is no material change to the effects characterization. Reducing the revegetated areas within the reservoir may lead to a small reduction in the amount of topsoil that could erode during a flood.	The new access right-of-way will result in a small increase in the loss existing soil quality and quantity. Although there is a small increase, the EIA conclusion for soils is unchanged.
Vegetation and Wetlands	Potential effects on plant community and species could be reduced because the area of vegetation affected by sedimentation will be reduced, as well as the time vegetation is affected by inundation. Early release will not change the effects characterization for wetland function.	There are no material changes to the effects characterization. The small increase in area associated with structural changes to the low-level outlet and unnamed creek outlet channel are not expected to change effects characterization for community diversity. The small increase in construction areas has the potential to affect rare plants that have not been detected. There is a potential for a small increase in effect to traditional use plants. There are no material changes to effects characterization for species diversity. The increase in construction area will not interact with additional wetland communities.	The addition of boulders and boulder clusters to enhance navigation does not interact with vegetation.	There is no material change to the effects characterization. There will be a small reduction in the revegetated area of the diversion channel.	Disturbance of approximately 1.1 ha of vegetation associated with new property access will result in a small incremental increase in the potential to affect rare plants that have not been detected in those areas. However, the increase is not expected to result in a material change to the effects characterization.

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Table 1 Implications of Project Changes to EIA Conclusions for Each VC

Valued Component	Operational Rule of Releasing Water When River Flows are Less than 160 m^3/s (shortened retention time of water in the reservoir)	Structural Changes	Navigability	Change in Extent in Diversion Channel Revegetation	New Property Access Configuration
Wildlife and Biodiversity	Reduction in water retention time could also reduce the potential effect of sediment deposition on native vegetation communities that provide wildlife habitat (e.g., grassland and grazing ungulates). Reduced retention time will reduce the amount of particulate matter that will settle out and become sediment. A shorter retention time would reduce the number of days habitats are temporarily available to wildlife. Movement of wildlife would be improved because reduced retention time would reduce the number of days the reservoir waters would be a physical barrier and hinder terrestrial wildlife movement in the local assessment area (LAA). However, the distribution and depth of sediment can still create physical barriers to terrestrial wildlife movement during post-flood operations and dry operations after the flood. A reduction in retention time would not reduce mortality risk to migratory birds or small mammals because the primary concern is related to destruction of bird nests or animals drowning in diverted flood water upon initial contact. A shorter retention time could have a slightly positive effect on amphibian survival if fish are entrained for a shorter period (i.e., reduced predation). In addition, fewer dead fish might reduce the potential for scavenging and human-wildlife conflict. For wildlife health, the original retention time was too short to result in concerns related to production of methylmercury; an even shorter time period would further reduce the potential for methylmercury production. There would be no change in the effects characterization.	There are no material changes to the effects characterization. The structural changes will result in an additional direct loss of wildlife habitat. However, the small change in the construction footprint (approximately 4.8 ha) will not change the residual effects predictions for change in habitat or change in mortality risk. The installation of additional riprap along the unnamed creek has potential to add a small incremental barrier to local wildlife movement in the PDA, but this would not change residual effects predictions.	There are no material changes to the effects characterization. The installation of boulders will result in a negligible contribution to previously assessed residual effects on wildlife and biodiversity because of potential sensory disturbance associated with construction activities.	There are no material changes to the effects characterization. A change in the extent of revegetation along the diversion channel will not change conclusions from previously assessed residual effects on wildlife movement.	There are no material changes to the effects characterization. Disturbance of approximately 1.1 ha of vegetation associated with new property access will result in a small incremental increase in habitat loss in the LAA. Increased but minor sensory disturbance during operations, including small changes to movement and a very minor increase in mortality risk during operations (e.g., vehicle collisions for less mobile species).
Historical Resources	There is no effect on this VC.	Historical resource sites may be present in the area of the changes and could be impacted. Because this area is within the PDA, Alberta Transportation will complete Historical Resource Impact Assessment (HRIA) investigations in this area. During construction, monitoring will be implemented and if a historical resource is identified during construction work will stop and Alberta Culture Multiculturalism and Status of Women (Alberta Culture) will be notified. With monitoring and mitigation, there is no expected change to effects conclusions.	The addition of the boulders within the river does will not result in additional surface and subsurface disturbance.	Revegetation of portions of the diversion channel does not change the effects conclusions.	Once the exact location is determined and the access right-of- way is designed, Alberta Transportation will determine if an HRIA is required, with the assistance from Alberta Culture.

Table 1 Implications of Project Changes to EIA Conclusions for Each VC

Valued Component	Operational Rule of Releasing Water When River Flows are Less than 160 m^3/s (shortened retention time of water in the reservoir)	Structural Changes	Navigability	Change in Extent in Diversion Channel Revegetation	New Property Access Configuration
Traditional Land and Resource Use	Reduction in retention time could result in positive effects on fish population and habitat and reduce the time fish might be entrained. The reduced effects on vegetation and wildlife would result in a neutral to positive effect on availability of traditional resources for current use. Early release may result in Indigenous groups being able to access the area earlier for traditional use purposes, if outside the restricted high-flood risk timing window.	Additional disturbance from change in location of the low-level outlet and its joining with the unnamed creek and the addition of erosion protection in the unnamed creek have a potential to disturb current use sites identified by Indigenous groups. Alberta Transportation continues to work with Indigenous groups to identify suitable mitigation for cultural sites affected by the Project.	The addition of boulders and boulder clusters will not materially change the effects characterization.	A small reduction in the extent of the diversion channel to be revegetated will result in a small decrease in the area that could be revegetated with traditional use plants, but it does not result in change to the conclusions for traditional land and resource use.	Disturbance of approximately 1.1 ha associated with new property access is not expected to result in a material change to conclusions for traditional land and resource use.

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Acronyms

The following acronyms are used in this Supplemental Information Request.

AAAQO	Alberta Ambient Air Quality Objective
ACIS	Alberta Collision Information System
AEP	Alberta Environment and Parks
APEGA	Association of Professional Engineers and Geoscientists of Alberta
asl	above sea level
AVCPL	animal-vehicle collision prone locations
AWW	Alberta Wildlife Watch
BCA	benefit/cost analysis
BOD	biochemical oxygen demand
BSP	biologically significant periods
CDA	Canadian Dam Association
CEAA	Canadian Environmental Assessment Agency
CF	clear flow
CIAR	Canadian Impact Assessment Registry
COPC	chemicals of potential concern
DEM	digital elevation model
DFO	Fisheries and Oceans Canada
DHI	Danish Hydraulic Institute
DO	dissolved oxygen
ECCC	Environment and Climate Change Canada
ECO Plan	Environmental Construction Operations Plan
EIA	environmental impact assessment
ENFOR	Enforcement Occurrence Record
ER	exposure ratio
GOA	Government of Alberta
ha	hectare
HF	high flow
HHRA	human health risk assessment

HSC	habitat suitability criteria
HSI	habitat suitability index
HWM	high-water marks
IAAC	Impact Assessment Agency of Canada
IR	information request
KDE+	Kernel Density Estimate
km	kilometre
KWBZ	key wildlife and biodiversity zone
LAA	local assessment area
LLOW	low level outlet works
LWD	large woody debris
m	metre
m/s	metres per second
mm	millimetre
MT	mud transport
NRCB	Natural Resources Conservation Board
PDA	Project development area
$PM_{2.5}$	particulate matter less than 2.5 micrometers in diameter
POI	points of interest
RAA	regional assessment area
RBF	radial basis function
RFDAM	Rapid Flood Damage Assessment Model
SCRT	Specific Concern and Response Table
SEV	degree of severity
SoC	Statement of Concern
SR1	Springbank Off-stream Reservoir
TDG	total dissolved gas
TDR	technical data report
TGP	total gas pressure
TRV	toxicological reference value

TSP	total suspended particles
TSS	total suspended sediment
TUS	Traditional Use Study
U.S. EPA	United States Environmental Protection Agency
USACE	United States Army Corps of Engineers
WMMP	Wildlife Mitigation and Monitoring Plan
WSC	Water Survey of Canada
WSE	water surface elevation
ZOI	zone of influence
ZREC	reclaimed land

1 NATURAL RESOURCES CONSERVATION BOARD

Question 1

CEAA letter to AT, July 16, 2019, Overarching issues, 5, Page 2

CEAA states *while data from submissions from engagement with Indigenous groups is presented as discrete pieces of information, the analysis of this information requested by the Agency is not included in the response….[T]he Agency requested that Alberta Transportation present the input obtained from Indigenous groups, including a description of how that input was integrated into the responses for all information request items relating to effects of changes to the environment on Indigenous peoples (CEAA 2012 section 5(1)(c)) and potential impacts to Aboriginal and treaty rights. Additionally, the Agency indicated that points of disagreement between the views of Alberta Transportation and Indigenous groups should be presented, along with a description of efforts undertaken to reconcile these differences and a rationale for conclusions.*

a. **Provide the information obtained from Indigenous groups. Include a description of the environmental effects of the project on Indigenous peoples and the potential impacts to Aboriginal and treaty rights.**

b. **Provide details on points of disagreement on potential issues between Alberta Transportation and Indigenous groups, including descriptions of efforts undertaken to reconcile these differences and the rationale for the conclusions made.**

Response

This response was included in the April 8, 2020 filing. The text has not been altered. Appendices 1-1, 1-2 and 1-3 have not been included in this filing due to page length, see the April 8, 2020 filing for those appendices.

a. Table 1-1 provides a compiled list of information from Indigenous groups with respect to potential Project-related effects on Aboriginal and Treaty rights, the environment, and traditional uses. This information was obtained through Statements of Concern (SoC), engagement meetings, communications and Traditional Use Studies (TUS); the information provided by Indigenous groups has been compiled by Alberta Transportation into Specific Concerns and Response Tables (SCRT; provided in Appendix 1-3). The information provided by each Indigenous group is considered separately from other Indigenous groups. They have been appended to this response in Appendix 1-1, Appendix 1-2, and Appendix 1-3 as follows:

   - Appendix 1-1 contains an excerpt of Alberta Transportation's responses to the Round 1 CEAA Package 2 Information Requests (IRs) that are referenced in Table 1-1.

- Appendix 1-2 contains an excerpt of Alberta Transportation's responses to the Round 1 CEAA Package 3 IRs that are referenced in Table 1-1.
- Appendix 1-3 contains an excerpt of Alberta Transportation's responses to the Round 1 CEAA Conformity IRs that are referenced in Table 1-1.

Excerpts have been provided to focus the provided material on the information request. The previous information request responses being referenced in Appendix 1-1, Appendix 1-2, and Appendix 1-3 contained other responses not applicable to this information request and these other responses have not been provided.

Alberta Transportation commenced consultation with the Treaty 7 First Nations in August 2014 and with the additional Indigenous groups identified in the Canadian Environmental Assessment Agency (CEAA) Guidelines for the Project in October 2016. Consultation included discussion about the Project and the nature and extent of the exercise of Section 35 rights in relation to the Project, including the context and setting for traditional uses in the Project area. Alberta Transportation has been conducting Indigenous engagement prior to and throughout the environmental assessment process, which includes sharing of Project information and updates, on-going communication about the Project, face-to-face meetings, facilitation of site visits, and funding for Project-specific TUS. An overview of engagement activities with each participating Indigenous group as of December 2019 is included in Appendix 1-3 (from Alberta Transportation's response to CEAA Conformity IR2-01, Table 1-1). Alberta Transportation acknowledges that it is at the priority and discretion of each Indigenous group whether traditional knowledge information is provided.

These responses also include an analysis of the data received from Indigenous groups, including consideration of the potential environmental effects from the Project on Indigenous peoples and the potential impacts to Aboriginal and Treaty rights.

Table 1-1 Alberta Transportation's Response to Round 1 CEAA IRs and CEAA Conformity IRs

Topic	Round 1 CEAA IR Number (filed June 2019)	Round 1 CEAA IR Response Reference			CEAA Conformity IR Number (filed December 2019)	CEAA Conformity IR Response Reference		
		Appendix to this Question	Package	Page		Appendix to this Question	Package	Page
Impacts to Rights	IR2-01	1-1	2	1	Conformity IR2-01	1-3	2	1
Cultural Experience – Experiential Values and Importance of Water	IR2-02	1-1	2	46	Conformity IR2-02	1-3	2	43
Economic Opportunities	IR2-04	1-1	2	81	Conformity IR2-04	1-3	2	65
Indigenous and Community Knowledge	IR2-06	1-1	2	86	Conformity IR2-06	1-3	2	81
Effects on Traditional Land and Resource Use	IR2-07	1-1	2	93	Conformity IR2-07	1-3	2	95
Indigenous Health and Country Foods	IR2-08	1-1	2	97	Conformity IR2-08	1-3	2	142
Physical and Cultural Heritage	IR2-10	1-1	2	116	Conformity IR2-10	1-3	2	192
Wildlife – Culturally Important Species	IR2-11	1-1	2	145	Conformity IR2-11	1-3	2	213
Wildlife – Habitat Connectivity and Wildlife Movement	IR2-15	1-1	2	235	Conformity IR2-15	1-3	2	239

Table 1-1 Alberta Transportation's Response to Round 1 CEAA IRs and CEAA Conformity IRs

Topic	Round 1 CEAA IR Number (filed June 2019)	Round 1 CEAA IR Response Reference			CEAA Conformity IR Number (filed December 2019)	CEAA Conformity IR Response Reference		
		Appendix to this Question	Package	Page		Appendix to this Question	Package	Page
Groundwater – Culturally Sensitive Groundwater Resources	IR3-19	1-2	3	72	Conformity IR3-19	1-3	2	271
Fish and Fish Habitat – Fish Stranding	IR3-29	1-2	3	118	Conformity IR3-29	1-3	2	281
Fish and Fish Habitat – Westslope Cutthroat Trout	IR3-30	1-2	3	121	Conformity IR3-30	1-3	2	300
Cumulative Effects – Hydrology	IR3-41	1-2	3	209	Conformity IR3-41	1-3	2	303
Cumulative Effects – Water Management	IR3-42	1-2	3	213	Conformity IR3-42	1-3	2	321
					IR2-1, Appendices 1-1 and 1-2 (including SCRT and TUS Mitigation Responses)	1-3	2	-

b. Appendix 1-1, Appendix 1-2 and Appendix 1-3 providing data received from Indigenous groups regarding potential Project-related effects on Aboriginal and Treaty rights, the environment, and traditional uses. Appendix 1-3 also provides a discussion on areas of disparity between the views and conclusions of Indigenous groups and Alberta Transportation regarding these potential Project-related effects. It also discusses efforts to reconcile the disparities and a rationale if disparity in views remain. Table 1-1 provides reference to each of the disparity responses, which is provided as Appendix 1-3.

   Alberta Transportation is committed to continuing to work with interested Indigenous groups to try to seek mutually acceptable solutions to the issues, concerns or recommendations identified and those that remain unresolved will be tracked through Alberta Transportation's ongoing engagement.

Question 2

Supplemental Information Request 1, Question 14, Pages 2.22-2.23
Supplemental Information Request 1, Question 15, Page 2.24

Alberta Transportation states that 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.*

a. Provide the stamped, signed version of the report titled "Springbank Off-Stream Storage Project Interim Design Report" (Stantec Consulting Ltd. 2017b.).

Response

a. The draft report titled Springbank Off-Stream Reservoir Project Interim Design Report (Stantec Consulting Ltd. 2017b) was retitled Springbank Off-Stream Reservoir Project Preliminary Design Report and is currently in draft form on the NRCB Project registry: https://www.nrcb.ca/natural-resource-projects/natural-resource-projects-listing/83/springbank-off-stream-reservoir-project/documents/9078/20171114-at-eia-r-to-nrcb-re-draft-preliminary-design-report-dated-20170331. This draft report was provided for review because the AEP Dam Safety review team requested it, and a number of other EIA references, on November 1, 2017. The information in that draft report is the same as was available to the EIA authors referencing the draft report titled "Springbank Off-Stream Reservoir Project Interim Design Report" in the EIA.

The draft report title was changed from an Interim Design Report to a Preliminary Design Report because Alberta Transportation decided to advance the Project design from interim design to preliminary design in November 2017, without finalizing the Interim Design Report. This is a common approach in engineering design as a project's design evolves through increasing levels of detail and complexity: once a proponent knows they want to advance to the next level of engineering design, the previous design work is not finalized but rather incorporated and expanded upon in the next level of engineering design.

A stamped and signed version of the draft Interim Design Report is not available. As stated above, the document was not finalized because it evolved from interim design to preliminary design in draft form. This is appropriate in accordance from guidance from the Association of Professional Engineers and Geoscientists of Alberta (APEGA). The APEGA authentication test, which outlines when reports should be signed and stamped or not, identifies that authentication is not required for professional service output where the technical information is not complete for the final intended purpose of the output (APEGA 2019; page 14). The APEGA guidance also indicates that outputs of professional services provided for review or comment only (e.g., drafts) are incomplete and authentication is not required (APEGA 2019; page 16).

The draft Preliminary Design Report was referenced three times in the EIA. The following three excerpts presents each time the report was referenced and is followed by a reference to the associated information in the draft Preliminary Design Report on the NRCB registry.

<u>Volume 1, Section 2.2.1.3 of the EIA, pdf page 41 of 253</u>

"In 2017, the IBI Group (2017) prepared an updated benefit/cost analysis comparing the off-stream reservoir (SR1) and MC1 based on the SR1 Interim Design Report (Stantec 2017b) and the Opus Conceptual Design Report (Opus 2017)."

The cost information considered by the IBI Group in 2017 is in Section 13 of the draft Preliminary Design Report (pdf pages 211 to 213 of 3119). It was noted by IBI that the 2017 cost opinion was still in progress and under review when accessed (see response to Round 1 NRCB information request (IR)6, Appendix 6-1, pdf page 14 of 14), so values are slightly different between documents.

<u>Volume 1, Section 3.2.5.3 of the EIA, pdf page 79 of 253</u>

"The results of slope stability analyses presented in the Interim Design Report (Stantec 2017b) show that the proposed off-stream dam meets the required criteria for all identified load cases."

The slope stability analysis is presented in Section 10.3.5 of the draft Preliminary Design Report (pdf page 174 of 3119).

Volume 1, Section 5.0 of the EIA, pdf page 105 of 253

"The dam design parameters and construction activities that support dam safety are presented in Section 3.2.5. They are discussed in more detail in the Interim Design Report (Stantec 2017b), which includes the Interim Geotechnical Assessment Report as Appendix D."

The parameters discussed in Volume 1, Section 3.2.5 and their corresponding details in the draft Preliminary Design Report are:

- dam composition – Section 10.3 of the Preliminary Design Report (pdf page 169 of 3119)
- slope protection – Section 10.3.3.4 of the Preliminary Design Report (pdf page 173 of 3119)
- stability – Section 10.3.5 of the Preliminary Design Report (pdf page 174 of 3119)
- seepage – Section 10.3.6 of the Preliminary Design Report (pdf page 178 of 3119)
- seismic events – Section 6.7 of the Preliminary Design Report (pdf page 67 of 3119)
- construction activities – Section 10.3.8 of the Preliminary Design Report (pdf page 182 of 3119)

REFERENCES

APEGA (The Association of Professional Engineers and Geoscientists of Alberta). July 2019. Authenticating Professional Work Products. Accessed at: https://www.apega.ca/docs/default-source/pdfs/authenticating-professional-work-products.pdf

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Question 3

**Supplemental Information Request 1, Question 30, Pages 2.48-2.49
Supplemental Information Request 1, Appendix IR6-1, Page 5**

Alberta Transportation states that *The utility of using a benefit/cost analysis to compare SR1 to the preliminary cost estimates for the MC1 Option 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.

a. **Describe the weight placed on the benefit/cost analysis for MC1/SR1 in selecting SR1 (or rejecting MC1). If the benefit/cost analysis was not used in the site selection criteria explain why.**

b. **Comment on whether the updated benefit/cost analysis conducted in 2019 changes Alberta Transportation's assessment of site selection between SR1 and MC1 from a benefit cost perspective.**

c. **Provide the five reports listed in the page 5 footnotes of Appendix IR6-1.**

Response

a. The benefit/cost analysis (BCA) was one of several considerations in the selection of SR1. As outlined in AEP's document titled "Recommendation on the Elbow River Major Infrastructure Decisions" (AEP 2015), the decision factors considered in site selection between SR1 and MC1 are categorized as follows:

- project effectiveness
- environmental impacts
- construction and operation risks
- social and recreational values
- commercial and tourism values
- construction cost estimates
- construction timelines

The BCA is considered under the construction cost estimate. As such, it was a component in site selection.

Specific weightings were not applied to these factors, but the following is the process of how they were considered. During site selection, the initial determinant was whether a project would be effective in providing flood mitigation. If not, the project was rejected from further consideration. In making a recommendation based on the remaining six decision factors, AEP prioritized environmental impacts, construction and operation risks, construction timelines, and construction costs.

b. No, the updated BCA conducted in 2019 does not change the site selection between SR1 and MC1. As discussed in a., the BCA was not the only factor considered for site selection.

c. The following reports are referenced on page 5 of Alberta Transportation's response to Round 1 NRCB IR6, Appendix IR6-1 and are provided here as Appendix 3-1 to Appendix 3-5, respectively:

- Provincial Flood Damage Assessment Study (2015), Environment and Sustainable Resource Development. Prepared by IBI Group.
- Provincial Flood Damage Assessment Study City of Calgary: Assessment of Damages (2015), Environment and Sustainable Resource Development. Prepared by IBI Group.
- Benefit/Cost Analysis of Flood Mitigation Projects for the City of Calgary: Springbank Off-Stream Flood Storage (2015), Environment and Sustainable Resource Development. Prepared by IBI Group.
- Benefit/Cost Analysis of Flood Mitigation Projects for the City of Calgary: McLean Creek Flood Storage (2015), Environment and Sustainable Resource Development. Prepared by IBI Group.
- Benefit/Cost Analysis of Flood Mitigation Projects for the City of Calgary: Glenmore Reservoir Diversion (2015), Environment and Sustainable Resource Development. Prepared by IBI Group.

REFERENCES

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

Question 4

Volume 4, Appendix E, Attachment 3A Section 3A.3.3, Equation 3A.7, Page 3A.32
Section 3A.3.4, Equation 3A.10, Page 3A.39
Section 3A.3.6, Equation 3A.16, Page 3A.57
Volume 4, Appendix G, TDR, Attachment C, C.4, Table C-17, Pages C.67 to C.69
Supplemental Information Request 1, Question 16, Table IR16-2, Page 2.28

Soil silt content used in calculating emission rates are 6.9% to 8.5%, which are based on referenced numbers (Appendix E), while silt content of soils at the project site range from 14% to 66% (Appendix G, Table C-17).

a. Recalculate emission factors in equations 3A.7, 3A.10 and 3A.16 using the silt content of soil at the project site.

b. Update Table IR16-2, with the recalculated emission factors and any other related emission rate assessments in the EIA.

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a. The Terrain and Soils Technical Data Report (environmental impact assessment [EIA], Volume 4, Appendix G) describes the methods and presents the results of the detailed soil survey and soils mapping of the local assessment area (LAA). The soil samples analyzed for silt content (Appendix G, Table C-17) were collected to a depth of approximately 1.0 m below ground surface, which is limited to the topsoil and subsoil layers based on the measured topsoil and subsoil depths (Appendix G, Table 3-22, Figure 3-7 and Figure 3-8). The average measured topsoil depth in the Project development area (PDA) is 20 cm to 40 cm (Appendix G, Table 3-22 and Figure 3-7) and the average measured subsoil depth in the PDA is 10 cm to 30 cm (Appendix G, Table 3-22 and Figure 3-8). The analyzed soil profiles in Appendix G, which indicate higher silt content, are representative exclusively of the topsoil and subsoil layers and not of the underlying overburden and bedrock.

   Topsoil from the diversion channel, off-stream dam and floodplain berm will be stripped and stored at a temporary topsoil stockpile northwest of the diversion structure, thus exposing overburden at most construction areas. The excavated material from the diversion channel and borrow area will be used for the construction of the off-stream dam. The primary haul road for construction of the off-stream dam will be along the excavated diversion channel and will be comprised of aggregate material on top of overburden and bedrock.

   The silt content for the overburden material has not been analyzed and the design and specifications of the aggregate material that will be used for the haul roads are unknown at this time. Therefore, the fugitive dust emission factors (Volume 4, Appendix E, Attachment 3A) are calculated using typical or average mean silt content values for construction haul roads published by the United States Environmental Protection Agency (U.S. EPA) (8.5%, Table 13.2.2-1 in U.S. EPA 2006) and overburden (6.9%, Table 11.9-3 in U.S. EPA 1998).

   The fugitive dust emission factors for truck traffic on haul roads, off-road equipment in transition, and bulldozing and grading (Volume 4, Appendix E, Attachment 3A, Equations 3A.7, 3A.10 and 3A.16) do not need to be recalculated using the measured silt content of soils (Appendix G, Table C-17). The silt content values in Appendix G are representative of top and subsoil and not the underlying overburden and bedrock. In the absence of Project-specific measurements, the U.S. EPA recommended average silt content values (6.9% to 8.5%) are considered representative of the Project.

   During construction, adaptive management techniques will be used to help control the generation of airborne dust (see Volume 3A, Section 3.4.4.1 and Volume 3C, Section 2.2). Ambient air monitoring of particulate matter less than 2.5 micrometers in diameter ($PM_{2.5}$) and total suspended particles (TSP) concentrations will be used to assess the need for more rigorous dust mitigation. If the monitoring program indicates that the ground-level $PM_{2.5}$ and TSP concentrations are greater than Alberta ambient air quality objectives (AAAQO) (AEP

2019), additional mitigation to reduce dust emissions and maintain acceptable air quality will be implemented. The mitigation may include suspension of dust generating construction activities during periods of excessive winds, application of water to haul roads and silt fences and other erosion control methods such as mulching to prevent soil loss from stockpiles due to wind erosion.

b. Based upon the response provided in the response to a., Table IR16-2 does not require updating.

REFERENCES

AEP (Alberta Environment and Parks). 2019. Alberta Ambient Air Quality Objectives and Guidelines Summary. January 2019. Alberta Environment and Parks (AEP). Available at: https://open.alberta.ca/dataset/0d2ad470-117e-410f-ba4f-aa352cb02d4d/resource/4ddd8097-6787-43f3-bb4a-908e20f5e8f1/download/aaqo-summary-jan2019.pdf. Accessed: January 2020.

U.S. EPA (United States Environmental Protection Agency). 1998. AP-42, Fifth Edition Compilation of Air Pollutant Emission Factors. Volume 1, Chapter 11, Section 9. Western Surface Coal Mining. October 1998. United States Environmental Protection Agency (U.S. EPA). Available at: https://www3.epa.gov/ttn/chief/ap42/ch11/final/c11s09.pdf. Accessed: January 2020.

U.S. EPA. 2006. AP-42, Fifth Edition Compilation of Air Pollutant Emission Factors. Volume 1, Chapter 13, Section 2.2. Unpaved Roads. November 2006. United States Environmental Protection Agency (U.S. EPA). Available at: https://www3.epa.gov/ttn/chief/ap42/ch13/final/c13s0202.pdf. Accessed: January 2020.

Question 5

Supplemental Information Request 1, Question 42, Page 2.66
Supplemental Information Request 1, Appendix IR42-1, Figures 3-8, 3-10, and 3-12, Pages 3.15, 3.19, and 3.23

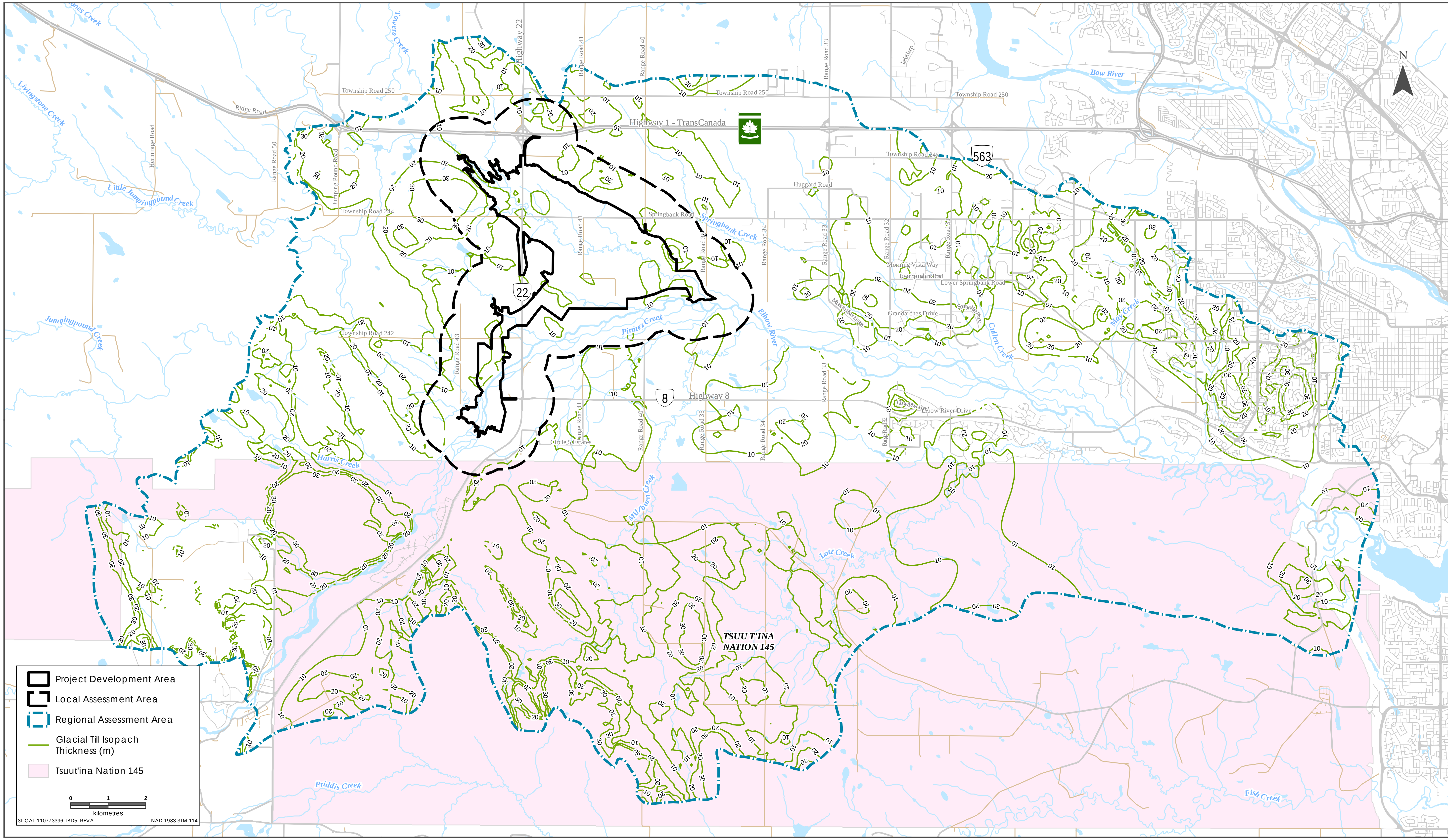
Figures 3-8, 3-10 and 3-12 in Appendix IR42-1 show isopach maps for glacial till, glaciolacustrine, and recent fluvial deposits. Contour labels are not shown for all areas in the expanded RAA and it is not obvious what they are.

a. Provide the missing labels for the isopach contours in the expanded RAA.

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a. The contour labels in Alberta Transportation's response to Round 1 Natural Resources Conservation Board (NRCB) information request (IR)42-1, Appendix IR42-1, Figures 3-8, 3-10 and 3-12 have been revised in the following figures: Figure 5-1, Figure 5-2, and Figure 5-3.



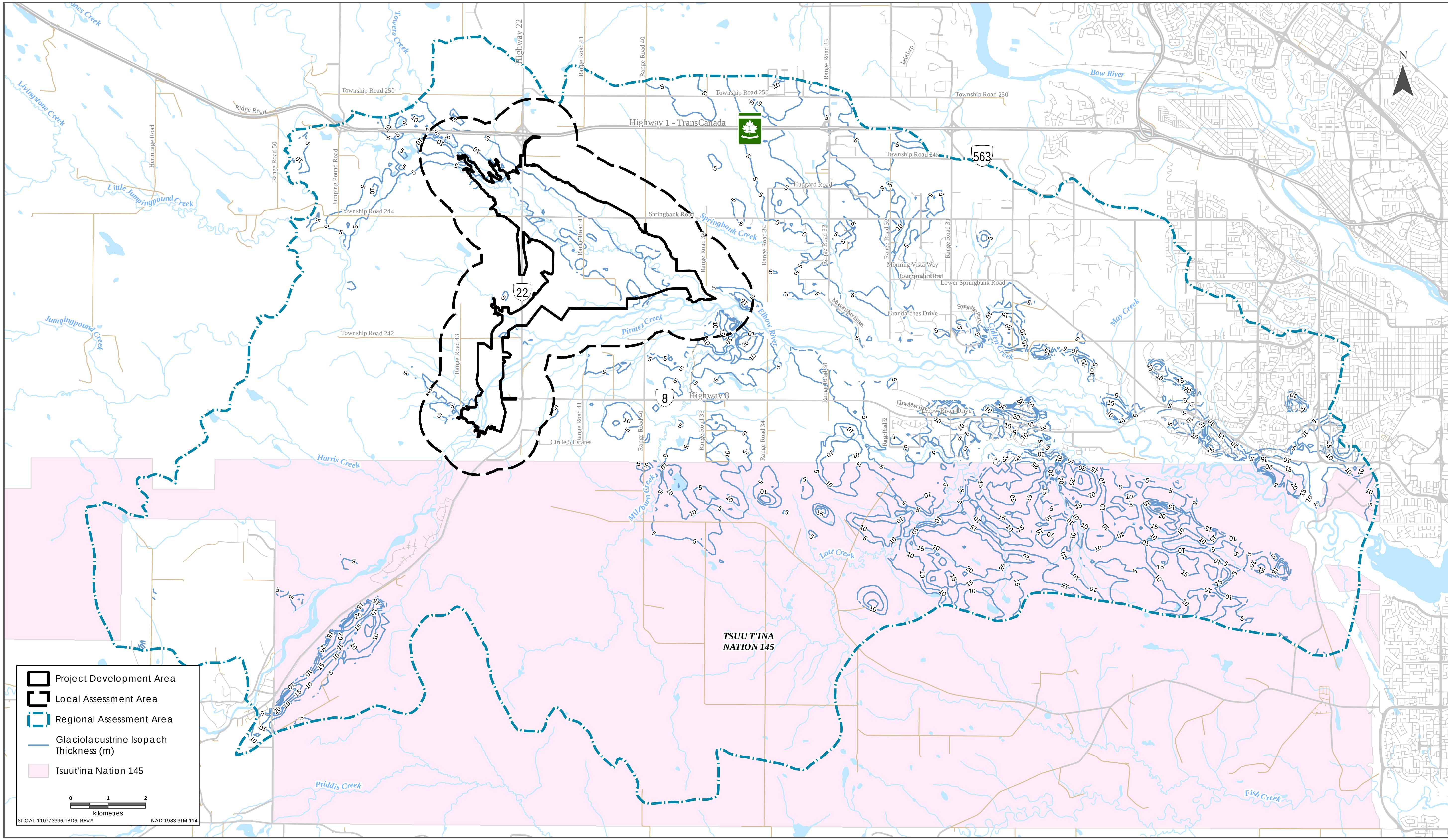
Sources: Base Data - Government of Alberta, Government of Canada. Thematic Data - Stantec Ltd.

Stantec

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT

Isopach Map of the Glacial Till

Figure 5-1



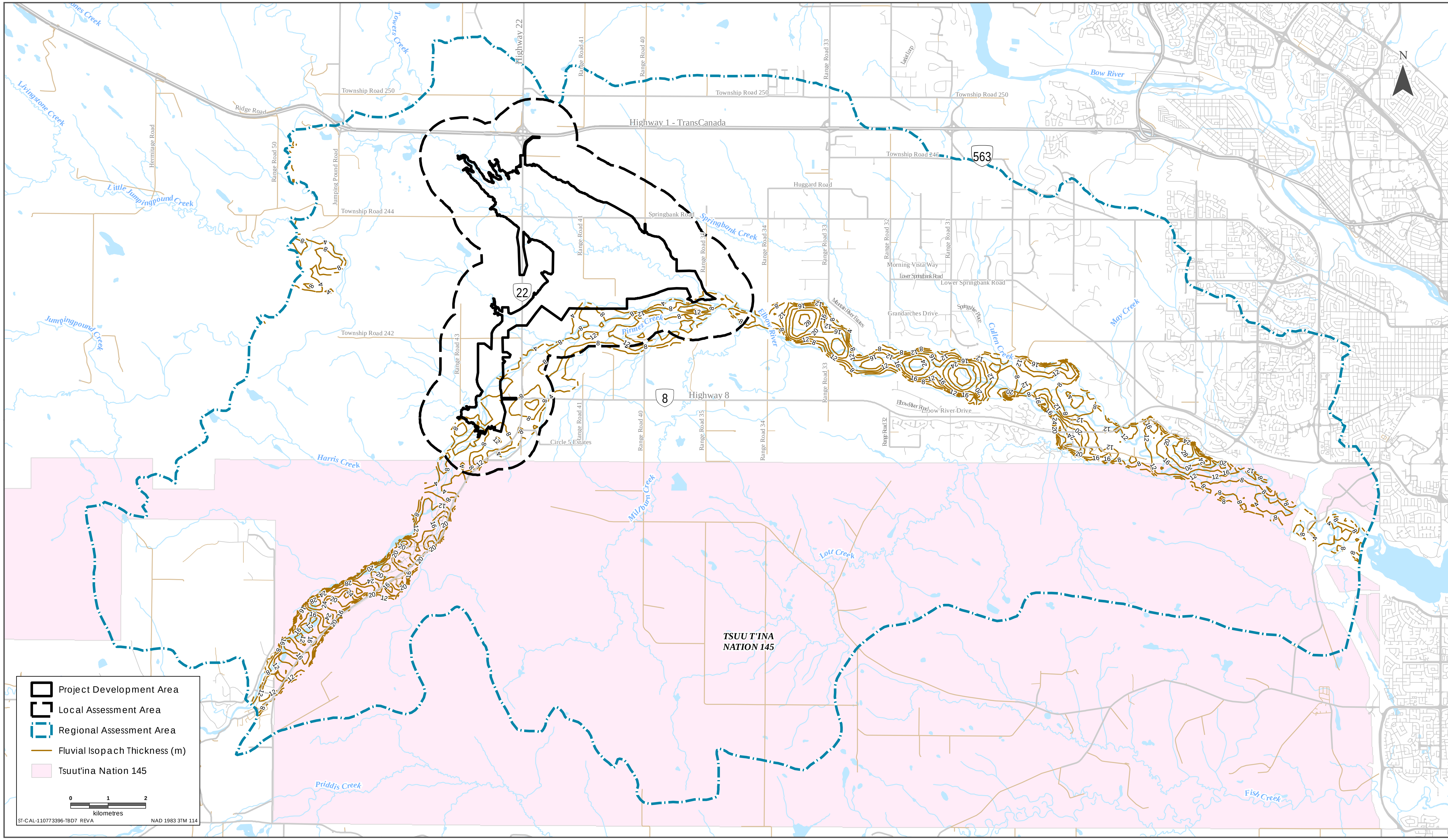
Sources: Base Data - Government of Alberta, Government of Canada. Thematic Data - Stantec Ltd.

Stantec

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT

Isopach Map of the Glaciolacustrine Deposits

Figure 5-2



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

Stantec

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT

Isopach Map of the Recent Fluvial Deposits

Figure 5-3

Question 6

**Supplemental Information Request 1, Question 42, Page 2.66
Supplemental Information Request 1, Appendix IR42-1, Figures 3-4 to 3-12, Pages 3.6 to 3.23, and Figures 4-5 to 4-11, Pages 4.9 to 4.12.**

Alberta Transportation used a mathematical model to depict the subsurface geologic setting and associated physical parameters that govern the flow of groundwater through porous media. Alberta Transportation states *the effects of fractures are not implemented explicitly using a numerical solution, [but] the numerical model accounts for increased permeability due to the bedrock fractures by including a higher hydraulic conductivity layer.*

Appendix IR42-1, Figures 4-5 to 4-11, depict spatially variable hydraulic conductivities that were assigned to the model layers, depending on the geologic materials represented in that layer.

a. Provide justification for the one order of magnitude difference in hydraulic conductivities between the upper portion of the fractured bedrock and the lower bedrock, as no monitoring wells were completed within the fractured bedrock.

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a. The question states that "no monitoring wells were completed within the fractured bedrock." This statement is incorrect. Five monitoring wells were completed within the upper fractured and weathered bedrock. These monitoring wells are MW16-1-15; MW16-5-11; MW16-18-10; MW16-21-11; and MW16-26-18. Borehole logs are included in the Hydrogeology Technical Data Report Update (TDR Update) (see Alberta Transportation's response to Round 1 AEP IR42, Appendix IR42-1), Attachment A.

   A total of 44 hydraulic conductivity tests were completed, including seven single-well response tests and 37 single packer permeability tests, to evaluate the hydraulic properties of the bedrock material. The results of the single-well response tests and packer permeability tests are presented in the TDR Update, Table 3-1 and Table 3-2. The hydraulic conductivity estimates, in conjunction with drilling observations and regional information, provide justification for the order of magnitude difference between the upper and lower bedrock.

Question 7

Supplemental Information Request 1, Question 42, Page 2.66
Supplemental Information Request 1, Appendix IR42-1, Figures 3-24, 3-25, and 3-26, Pages 3.50 to 3.52, and Table 2-1, Page 2.7

Alberta Transportation provides hydrographs of monitoring wells that were completed in unconsolidated deposits and bedrock in Figures 3-24, 3-25 and 3-26. There are inconsistencies between these figures and the monitoring wells are shown to have pressure transducers installed in Table 2-1.

The hydrograph for monitoring well MW16-8-19 is repeated several times in Figure 3-26. Table 2-1 shows that pressure transducers were installed in MW16-15-34, MW16-7-5 and MW16-18-6 and these are not shown in the referenced figures. Figure 3-24 includes a hydrograph for monitoring well MW16-17-5, however Table 2-1 shows that no pressure transducer was installed.

a. **Provide the hydrographs of monitoring wells MW16-15-34, MW16-7-5 and MW16-18- 6. In addition, clarify whether a pressure transducer was installed at MW16-17-5. If no transducer was installed at MW16-17-5 then correct and update the document.**

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a. There were errors that led to a discrepancy between TDR Update (see Alberta Transportation's response to Round 1 AEP IR42, Appendix IR42-1), Figure 3-24, Figure 3-25, and Figure 3-26 compared to page 3.50, page 3.52 and Table 2-1, page 2.7.

   A pressure transducer was installed in MW16-17-5 and not in MW16-7-5. Also, a pressure transducer was installed in MW16-18-10 and not in MW16-18-6. These errors have been corrected in Table 7-1 (indicated by **red** text).

   The hydrograph for MW16-8-19 appears in Figure 3-25 and Figure 3-26 multiple times as an error and, as a result, the hydrographs for MW16-15-34 and MW16-18-10 were not included. These two hydrographs are provided in Figure 7-1 and Figure 7-2.

Table 7-1 Monitoring Well Completion Details

Well Name	Borehole Name	3TM East[1]	3TM North[1]	Ground Elevation (m ASL)	Total Borehole Depth (m BGL)	Screen from (m BGL)	Screen to (m BGL)	Water Level Elevation - September 2016 (m ASL)	Completion Unit	Pressure Transducer/ Logger Installed	Response Test Completed
MW16-1-15	GW1	5659967.3	-33327.5	1211.71	16.8	12.2	15.2	1207.83	Sandstone	Yes	Yes
MW16-2-6	GW2	5659623.9	-31947.3	1204.26	13.7	3.1	6.1	1203.52	Glaciolacustrine Clay		
MW16-3-7	GW3	5659073.5	-31904.4	1201.07	7.6	3.7	6.7	1199.89	Glaciolacustrine Clay and Silt		
MW16-4-22	GW4	5658717.4	-32259.3	1204.30	22.9	18.6	21.6	1200.97	Sandstone		Yes
MW16-5-11	GW5	5658164.7	-31863.2	1210.63	22.9	8.2	11.3	1208.32	Sandstone		
MW16-6-11	GW6S	5658135.3	-31100.5	1195.44	10.7	7.3	10.4	1195.28	Glacial Till	Yes	
MW16-6-20	GW6D	5658133.9	-31100.4	1195.51	22.9	18.9	21.9	1195.37	Claystone/Siltstone	Yes	Yes
MW16-7-5	GW7	5658895.2	-31098.8	1199.28	9.1	2.1	5.2	1198.14	Glaciolacustrine Clay and Silt		
MW16-8-8	GW8S	5659641.1	-30875.7	1218.16	7.9	6.1	7.6	1212.02	Glacial Till	Yes	
MW16-8-19	GW8D	5659641.2	-30877.5	1218.13	20.4	16.5	18.6	1213.88	Sandstone	Yes	Yes
MW16-9-6	GW9	5659076.8	-30236.4	1204.52	6.1	4.3	5.8	1204.29	Glaciolacustrine Clay and Silt		Yes
MW16-10-15	GW10	5658478.2	-30461.4	1195.40	18.3	12.2	15.2	1192.75	Glacial Till		Yes
MW16-11-15	GW11	5657742.9	-30269.8	1193.68	15.2	11.6	14.6	1193.06	Glacial Till		
MW16-12-3	GW12	5657858.3	-29160.3	1189.98	12.2	1.5	3.1	1187.23	Glacial Till	Yes	
MW16-13-37	GW13	5659064.0	-29610.3	1222.34	37.2	33.5	36.6		Claystone		
MW16-14-33	GW14	5659018.4	-28592.2	1202.24	33.5	30.5	33.5	1175.75	Siltstone/Claystone		
MW16-15-34	GW15	5658214.9	-27818.8	1190.10	35	32.9	34.4	1172.94	Siltstone	Yes	
MW16-16-11	DC-9	5655154.3	-33453.6	1227.47	14.1	7.6	10.7	1226.12	Glacial Till		
MW16-17-5	DC-15	5656140.6	-33226.5	1213.52	11.2	3.7	5.2	1208.97	Glaciolacustrine Clay	Yes	
MW16-18-6	DC-21S	5656749.5	-32406.6	1216.04	6.1	4	5.5	1212.69	Basal Silt and Sand		
MW16-18-10	DC-21D	5656750.6	-32406.7	1216.03	12.5	9.1	10.6	1212.94	Claystone	Yes	Yes
MW16-19-8	DC-25S	5657262.2	-31684.6	1202.73	7.6	6.1	7.6	1198.88	Basal Silt and Sand		
MW16-19-19	DC-25D	5657263.2	-31684.5	1202.80	23.2	17.1	18.6	1200.02	Sandstone		Yes
MW16-20-21	D2	5657498.6	-31218.4	1206.60	21.3	19.8	21.3	1191.40	Sandstone		
MW16-21-11	D9	5656987.1	-30383.8	1202.61	14.1	9	10.5	1193.00	Sandstone		
MW16-22-26	D27	5656907.3	-29330.9	1190.70	27.4	22.9	25.9	1182.94	Glacial Till		
MW16-23-14	D36S	5657309.6	-29019.7	1190.54	14.0	11.0	14.0	1186.74	Glacial Till		
MW16-23-36	D36D	5657308.3	-29019.3	1190.56	45.7	35.7	37.2	1187.18	Siltstone		
MW16-24-30	D51	5657740.5	-28761.8	1194.50	30.8	29	30.5	1186.37	Sandstone		Yes
MW16-25-9	BS3	5658231.0	-29274.7	1197.44	9.4	6.1	9.1	1190.50	Glacial Till		Yes
MW16-26-18	H6	5659178.1	-32702.7	1204.56	18.3	15.8	18.3	1204.41	Claystone	Yes	
MW16-27-12	H9	5659766.2	-32702.3	1207.67	18.9	10.1	11.6	1207.45	Glacial Till		

[1] Coordinate system is NAD83 3TM 114

Stantec

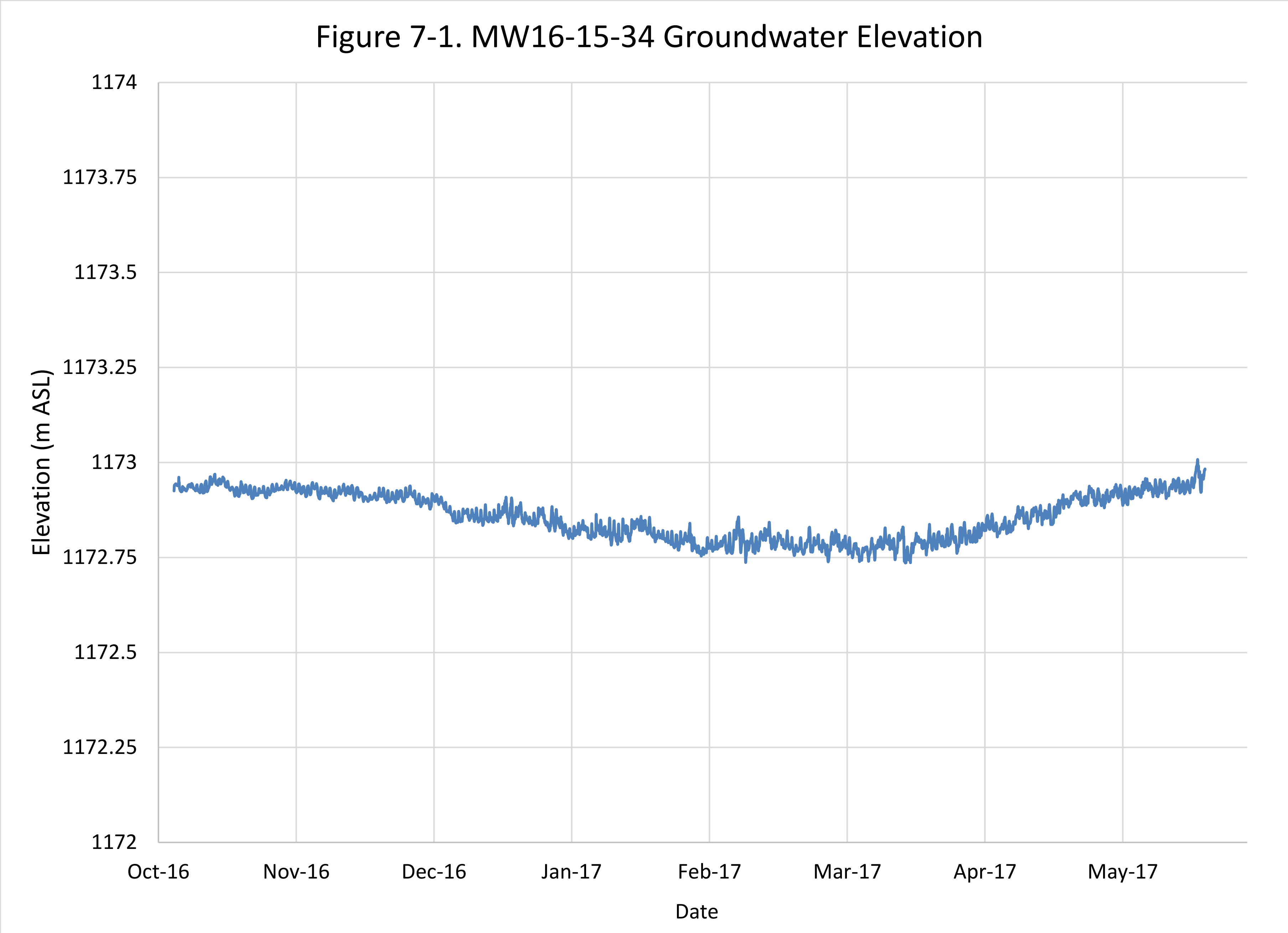


Figure 7-1. MW16-15-34 Groundwater Elevation
1174
1173.75
1173.5
1173.25
1173
1172.75
1172.5
1172.25
1172
Elevation (m ASL)
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Date

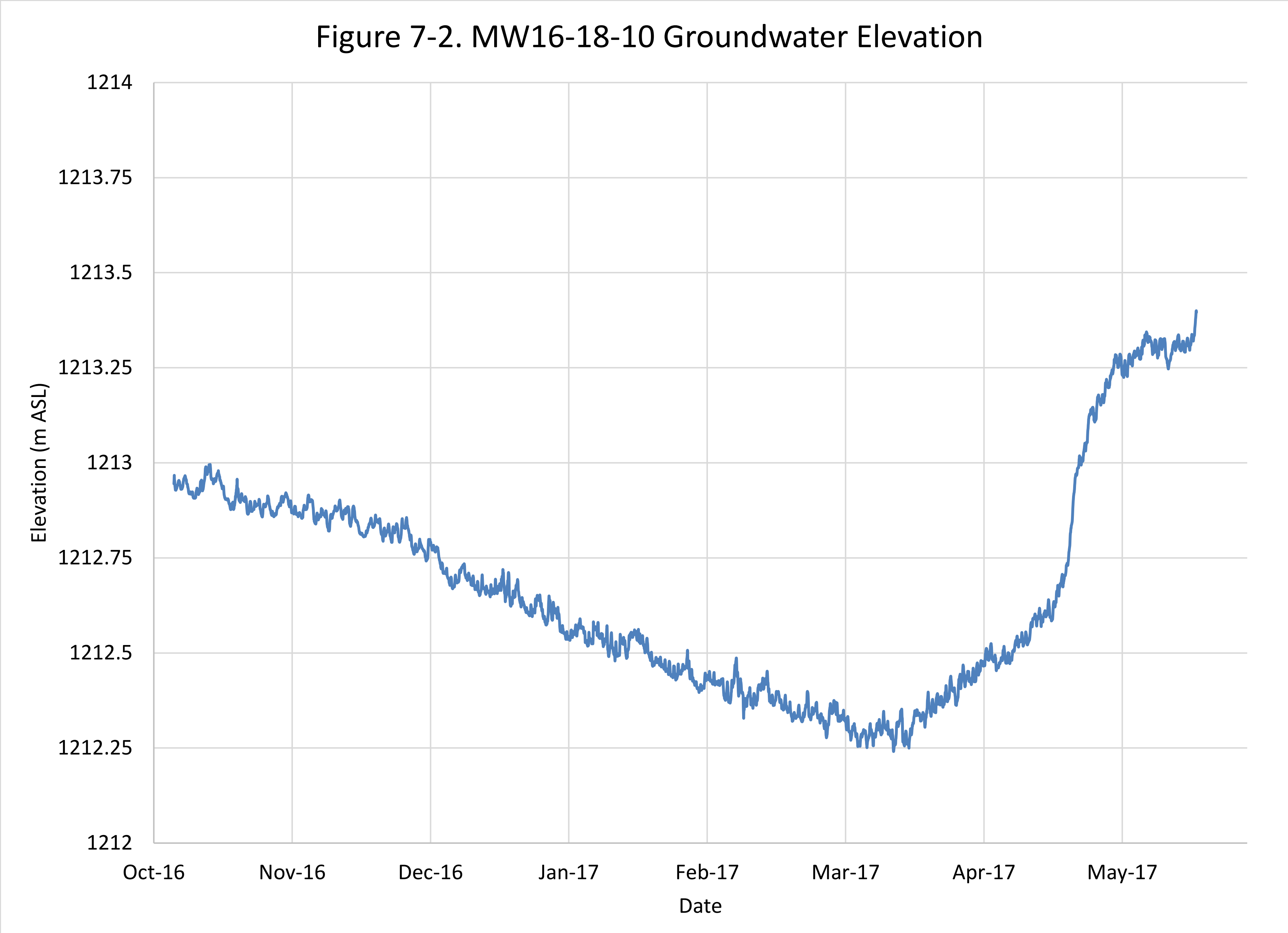


Figure 7-2. MW16-18-10 Groundwater Elevation
1214
1213.75
1213.5
1213.25
1213
1212.75
1212.5
1212.25
1212
Elevation (m ASL)
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Date

Question 8

Supplemental Information Request 1, Question 42, Page 2.66
Supplemental Information Request 1, Appendix IR42-1, Section 5 and Figure 5-13, Page 5.1 to 5.26

Appendix IR42-1, Section 5 summarizes the predicted effects of the project on water levels. Appendix IR42-1, Figure 5-13 displays simulated head increase up to 24m in the reservoir, yet after timestep 650 there is less than 0.5m of head increase adjacent to the reservoir.

a. Confirm the elapsed time associated with timestep 650.

b. Discuss why is there no propagation of drawdown away from the reservoir in Figure 5- 13. Comment on whether the lack of drawdown has been validated by approximating the problem with an analytical solution.

c. Discuss whether the settings that control the behavior of the phreatic surface are adversely affecting the simulated response to flooding.

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a. Each timestep is 0.5 hours. Therefore, timestep 650 represents an elapsed time of 325 hours from the start of the simulation run.

b. Propagation of groundwater level increases (i.e., a rise in the water table) away from the reservoir is limited by the low conductivity of the underlying material and the limited residence time of the water in the reservoir. The entire reservoir is underlain by both glaciolacustrine clay and till units, which are characterized as aquitard units, thus limiting the vertical recharge rate from the reservoir (when in operation) to the underlying aquifer. The low conductivity and transmissivity of these aquitard units, along with the relatively low conductivity of the upper bedrock, limits the propagation of effects on the water table away from the reservoir.

   The limited spatial extent of groundwater level increase away from the reservoir has been estimated using an analytical solution (in additional to the numerical model already presented). The analytical solution is based on a solution by Hantush (1967) for mounding calculations beneath a rectangular recharge area. The following parameter values were used in the analytical calculation:

   - aquifer hydraulic conductivity (K) = were varied from 1.4E-5 m/s to 1.4E-7 m/s to represent a potential range of values for sensitivity analysis
   - specific yield (Sy) = 0.17
   - recharge rate when reservoir is full = 6.75E-05 m/min

- length of the recharge area (X) = 5,000 m (idealized from the reservoir footprint)
- width of the recharge area (Y) = 2,000 m (idealized from the reservoir footprint)

Figure 8-1 through Figure 8-3 present the results of the analytical solution using the varied hydraulic conductivity values for the aquifer unit. Calculated hydraulic head profiles are presented for 42 days of retention in the reservoir, full level, and after 100, 365, and 1,000 days following release of retained water from the reservoir.

Figure 8-1 presents an idealized cross-section through the edge of the reservoir area showing the change in hydraulic head over space and time using the calibrated hydraulic conductivity (derived from the numerical groundwater flow model) of the upper bedrock aquifer (1.4E-6m/s).

Figure 8-1 shows that the analytical solution predicts that increases in groundwater levels greater than 0.5 m are limited to distances of approximately 150 m beyond the edge of the reservoir. The analytical solution, therefore, supports the limited propagation of effects similarly predicted in the numerical modelling results: in both the numerical model and the analytical solution, the effects of water level increases are limited to within the local area.

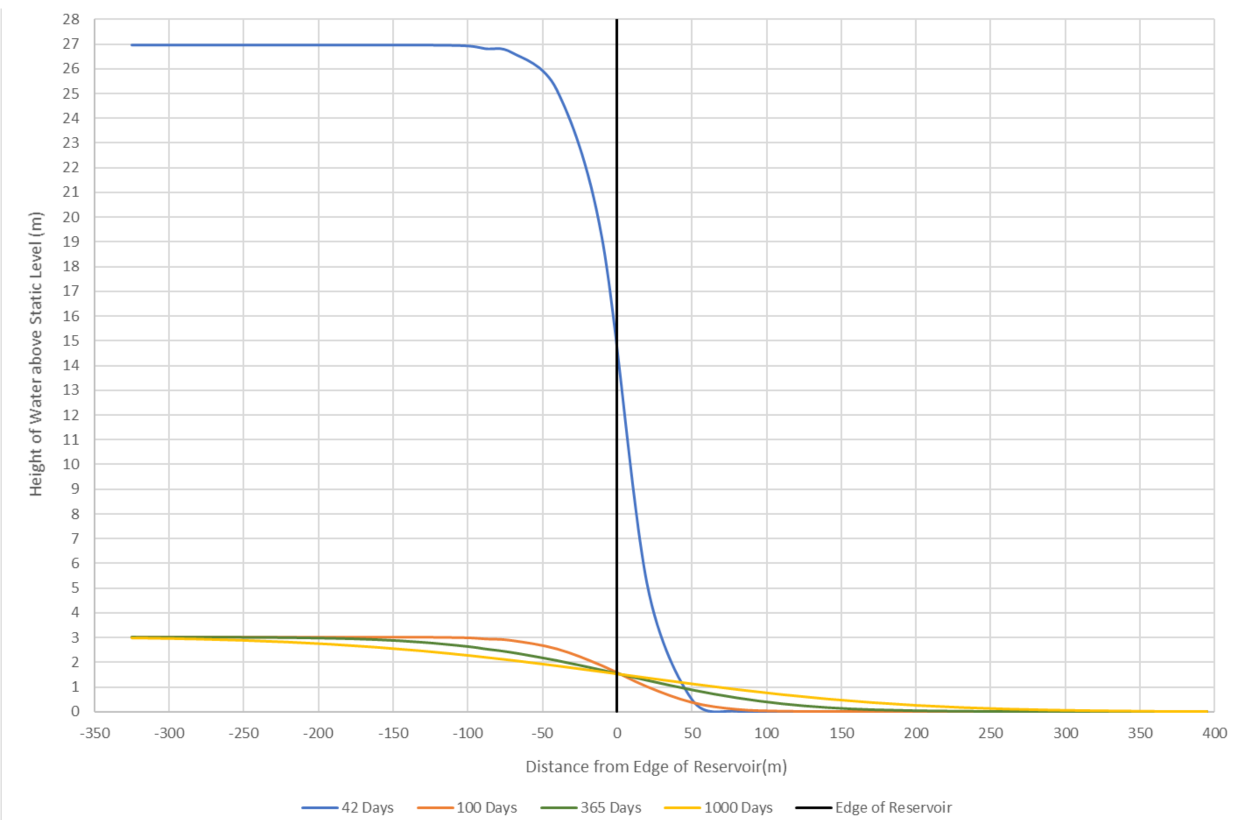


Figure 8-1 Estimated Change in Hydraulic Head at the Edge of the Reservoir using an Analytical Solution (Aquifer K = 1.4E-06 m/s)

The sensitivity of the analytical solution to changes in hydraulic conductivity is shown in Figure 8-2 and Figure 8-3. Figure 8-2 presents the results of the analytical solution using an order of magnitude lower hydraulic conductivity value of 1.4 E-7 m/s. The lower conductivity results in propagation of groundwater increases greater than 0.5 m to approximately 50 m from the edge of the reservoir.

In Figure 8-3, The propagation of effects predicted using the higher conductivity of 1.4 E-5 m/s shows increases of up to 0.5 m extending approximately 425 m from the edge of the reservoir.

As part of the numerical groundwater flow modeling, a similar sensitivity analysis was completed by varying the hydraulic conductivity of the subsurface units as were parameterized through calibration of the model. The sensitivity analysis conducted for both the analytical solution presented here, and the analysis conducted on the numerical model are in general agreement, indicating that the spatial extent of changes in groundwater levels are directly affected by the hydraulic conductivity assigned. However, in both analytical and numerical model simulations, effects on groundwater levels are limited to areas within the LAA over the range of values applied.

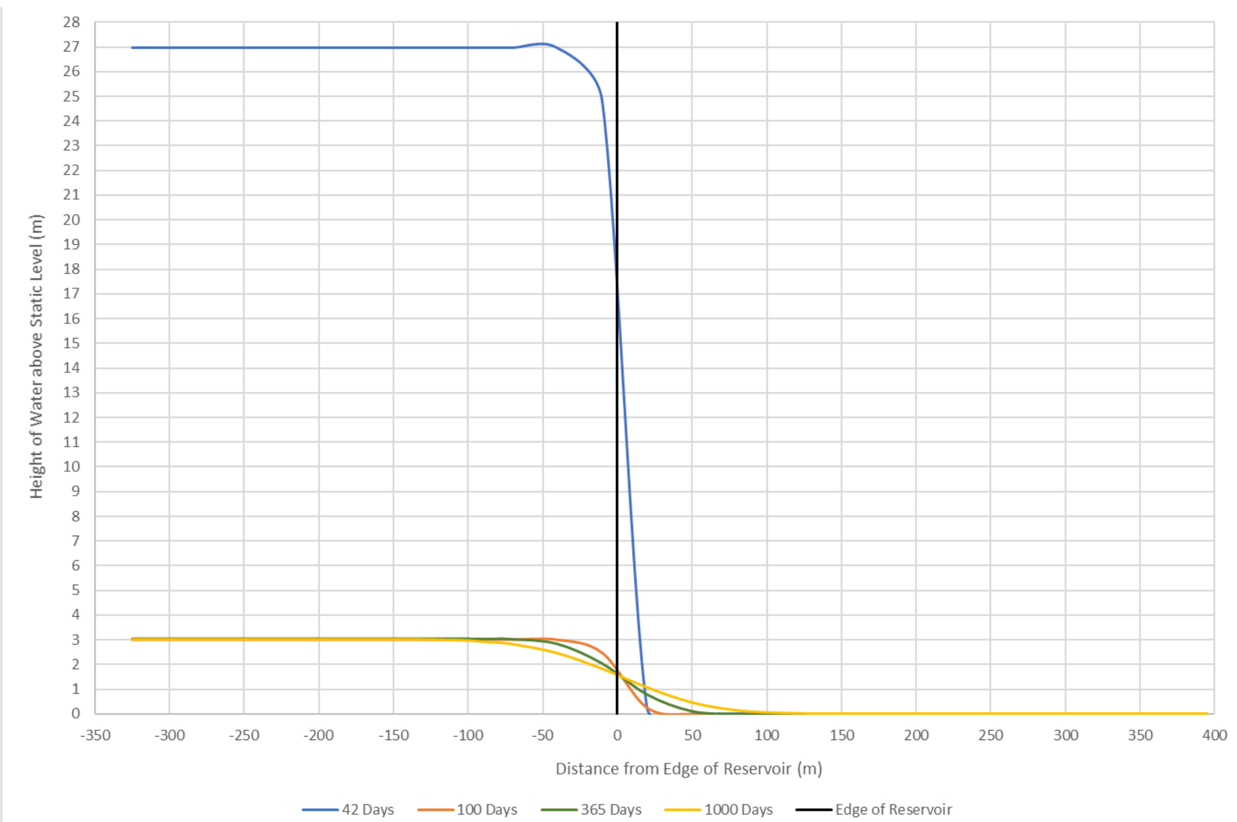


Figure 8-2 **Estimated Change in Hydraulic Head at the Edge of the Reservoir using an Analytical Solution (Aquifer K = 1.4E-07 m/s)**

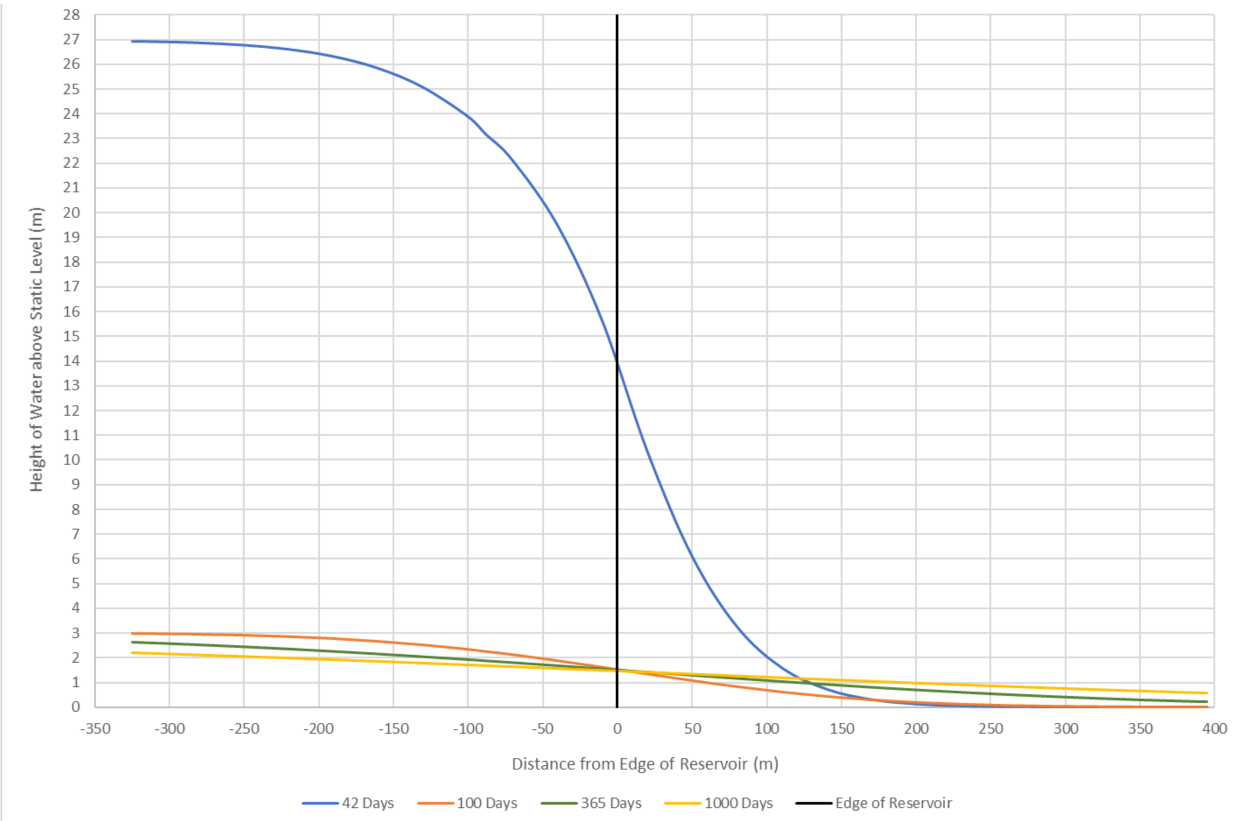


Figure 8-3 Estimated Change in Hydraulic Head at the Edge of the Reservoir using an Analytical Solution (Aquifer K = 1.4E-05 m/s)

c. When assigning the settings for the mode of behavior for the uppermost layer in the numerical model, three options within FEFLOW are available (phreatic, free and movable, and confined) and were considered for application in the numerical model. Selection of the most representative setting considered the regional groundwater flow regime, as was characterized during the baseline assessment, which was in general interpreted to be a semi-confined groundwater system with groundwater flow converging toward the Elbow River valley.

Water table conditions in the uppermost layer in the model domain are best represented by using phreatic mode settings in the FEFLOW model. The phreatic mode setting in FEFLOW is applicable to an unconfined layer and typically only applicable to the top slice or layer of the model. In phreatic mode, the model stratigraphy is not changed if the position of the water table changes relative to the model layers. As a result, partially saturated or unsaturated elements may occur in the model domain. If that happens during simulations, they are simulated by applying a partial-saturation approach; In partially dry elements, the conductivity in the element (in all directions) is reduced by multiplying the saturated conductivity with the saturation of the element. Saturation is calculated from the saturated thickness divided by element height. For completely dry elements (where hydraulic head is lower than the elevation of the bottom nodes), a minimum (residual) saturated thickness is used for the saturation calculation, known as the residual water depth. The residual water depth (by default, approximately 1 mm) is constant over the entire model domain.

There are other possible settings that can be used to describe the behavior of the top layer of the model. The closest alternative to phreatic mode is free and moveable mode. This mode is only available for the top slice of the model. In this mode, a movable slice tops an unconfined layer and follows the water table according to the free and movable method. The phreatic surface is considered by moving the top boundary of the model in a way that the elevation of the first model slice always corresponds to the water table elevation.

In a case where the water table drops below the first model layer, not only the first slice is moved, but underlying, dependent model layers may also move as a result. At each time step during simulations, material properties for each element are determined by the actual location of each computational layer during the timestep. For example, if the entire first stratigraphic layer is dry, the first computational layer will be in the second, underlying stratigraphic layer, inheriting all material properties of this layer. As the technique for moving the slices (known as best adaptation to stratigraphic data (BASD)) focuses on original slice elevations, for most of the elements this inheritance in parameters is unambiguous. However, in elements where the computational slice crosses an original slice location, an averaging of parameters from upper and lower layers is calculated. As a simple average is used, this can lead to making an aquitard overly conductive by artificially increasing its low conductivity values. As such, in an attempt to avoid this condition from happening, the free and moveable mode was not selected for use over the phreatic mode.

The third option for the setting in the top layer is the confined mode. This model setting applies only if there is confidence that the groundwater system is a confined aquifer system, which is not the case at a regional scale in the Elbow River valley system. In this mode, a confined slice cannot move. The layer below a confined slice is always treated as fully saturated. However, this mode does not represent conditions in the region, and it was not selected for use over the phreatic mode.

REFERENCES

Hantush, M.S., 1967. *Growth and decay of groundwater mounds in response to uniform percolation*, Water Resources Research, vol. 3, no. 1, pp. 227-234.

Question 9

Supplemental Information Request 1, Question 258, Page 5.57
Supplemental Information Request 1, Appendix IR42-1, Figure 5-4, Page 5.7

No time series plots are provided for the Points of Interest in Appendix IR42-1, Figure 5-4.

a. Provide the plots requested in Question 258.

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a. Figure 9-1 presents the locations of the points of interest (POI). The following discussion presents time series hydrographs for POI in areas near the diversion channel and reservoir. All timesteps referenced in Figure 9-2 to Figure 9-6 are one-hour increments of elapsed time since the start of the simulation for the design flood.

   Figure 9-2 presents hydrographs for three POI (24, 25 and 26) near the north side of the diversion channel. Point 26 shows the response to water levels in the channel resulting from the diversion of water from Elbow River. Point 25 is located approximately 10 m north of Point 26 and shows a delayed and dampened response, increasing approximately 4 cm beginning at timestep 605, followed by a gradual increase of 6 cm by timestep 1,300 (the end of the simulation). Point 24, located approximately 20 m from the channel, shows further dampening with effectively no response immediately after the diversion begins, followed by a lagged 8 cm increase by timestep 1,300.

   Figure 9-3 presents hydrographs for POI on the south side of the diversion channel. The results are similar to observations for the north side of the diversion channel, although a more immediate and higher magnitude response is observed at the nearest point (Point 27) to the channel. Point 27 on the south edge of the channel shows the water level response due to the diversion of water within the channel. Point 28 is located approximately 10 m from the channel and shows a dampened response, increasing a maximum of 60 cm between timestep 605 and 616, but decreasing over the remainder of the simulation. At Point 29, located approximately 20 m from the channel, no response to the diversion of water is observed.

   Figure 9-4 presents hydrographs for POI on the southeastern edge of the off-stream reservoir. Point 38 shows the response to the reservoir water reaching a maximum level of 1,207.3 m asl during the design flood, and following release of the water, remaining near the ground surface after the design flood has passed (to simulate continued near surface saturation). At Point 39, located approximately 10 m from the reservoir, an increase in hydraulic head of 2.1 m is followed by a gradual decrease (once water is released after the design flood) over the remainder of the simulation. Further dampening of effects on water levels is observed away from the reservoir, with only approximately 0.30 m of change at Point 40, located approximately 17 m southeast from the reservoir. The hydraulic head at Point 40 reaches a peak at timestep 900 and decreases gradually over the remainder of the simulation.

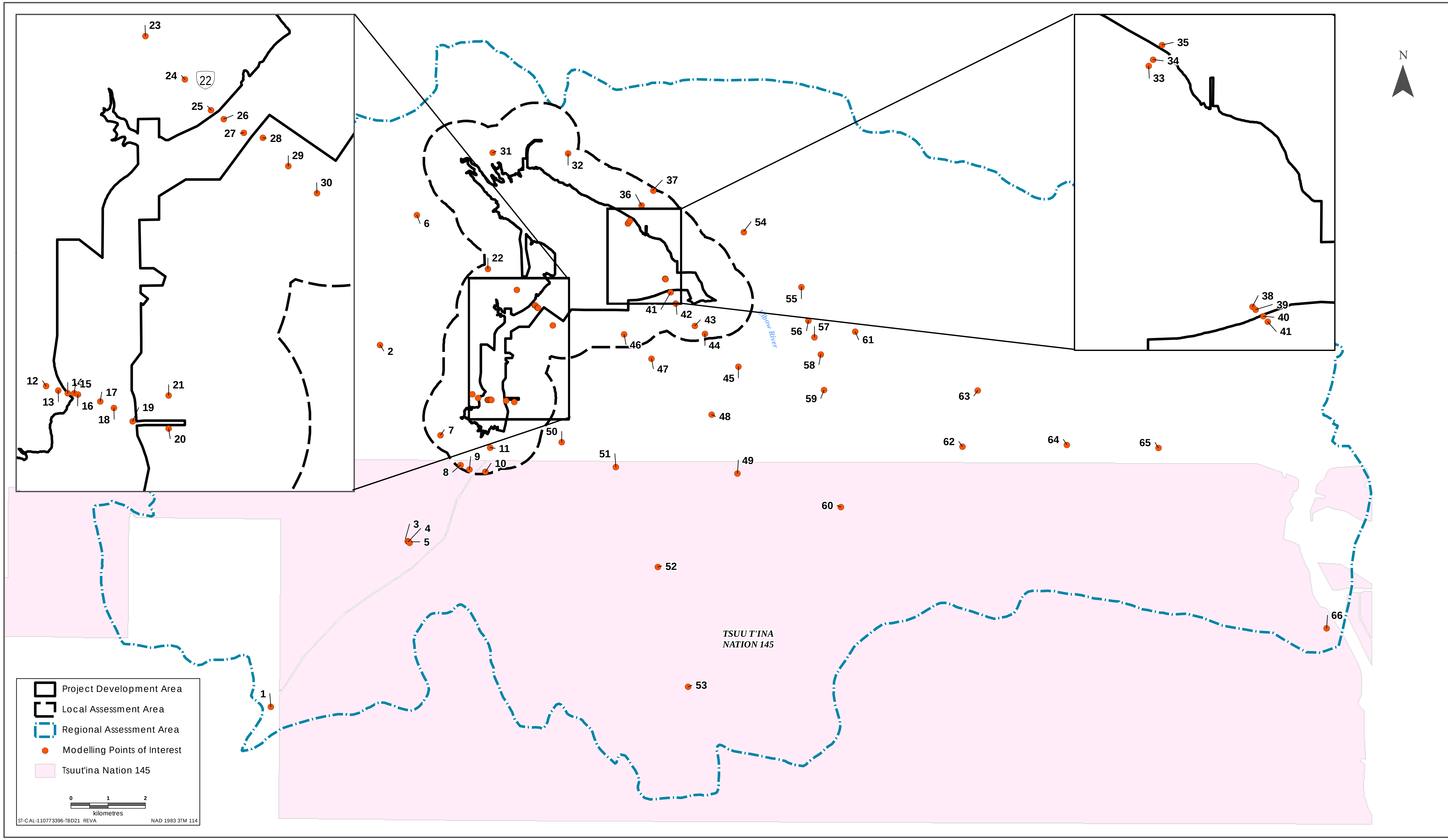
Figure 9-5 presents hydrographs for POI on the northeastern edge of the reservoir. Point 33 shows the response to retention of water when the reservoir water reaches a maximum level of 1,207.3 m asl (during the design flood) and remaining near the ground surface after the design flood has passed. At Point 34, located approximately 35 m from the reservoir, a maximum increase in hydraulic head of 0.56 m is followed by decreasing levels after the design flood has passed for the remainder of the simulation. Further dampening is observed away from the reservoir, with essentially no change in water levels noted during the design flood at Point 35, located approximately 90 m from the reservoir.

Figure 9-6 presents hydrographs for POI near Elbow River south of the LAA. Hydraulic head changes are observed in the alluvium as a result of changes in river stage during the design flood. Point 3, adjacent to the river, shows the response to the specified head over the transient flooding simulation. Point 4 and Point 5 show an initial increase between timestep 500 to 600 when the simulation is adjusting from the steady state hydraulic head values to the transient head values specified for the river. Following the initial increase, the dampening effect is observed in the sand and gravel aquifer at distances of 30 m and 60 m from the river, respectively.

The remaining POI are distributed throughout the model domain and show similar responses to those summarized above.

Table 9-1 presents a summary of the POI responses which can generally be categorized as follows:

- The response due to diversion or water retention is related to POI within areas where Project effects are observed.
- The response due to Elbow River water level change is related to POI within the area where changes resulting from transient boundary conditions in the river are observed.
- No response is related to POI where no Project effects are observed and no change due to river stage is observed.



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

Stantec

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT

Points of Interest Used for Interpretation of Time-Series Evaluation

Figure 9-1

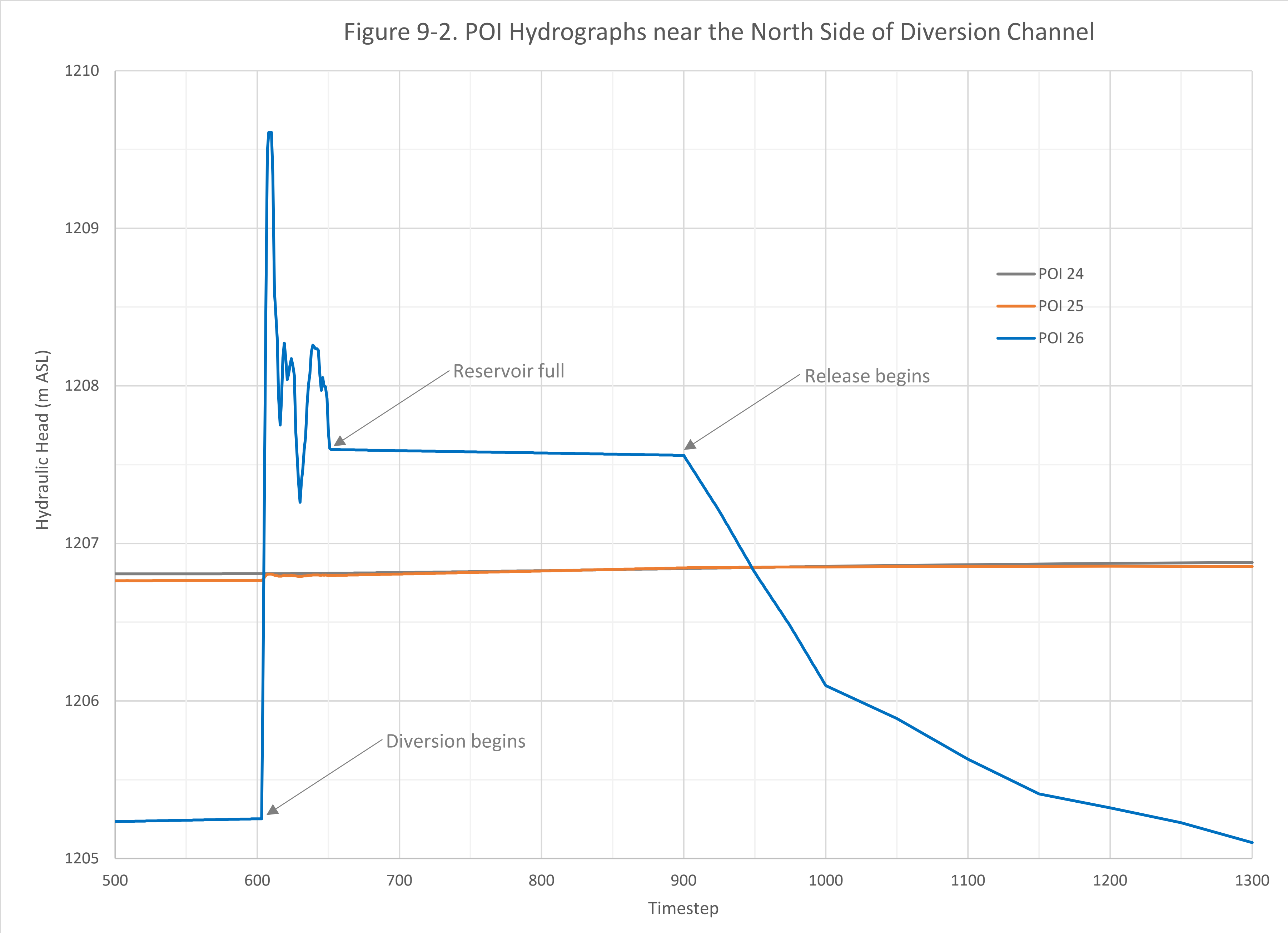


Figure 9-2. POI Hydrographs near the North Side of Diversion Channel
Hydraulic Head (m ASL)
1210
1209
1208
1207
1206
1205
500
600
700
800
900
1000
1100
1200
1300
Timestep
POI 24
POI 25
POI 26
Reservoir full
Release begins
Diversion begins

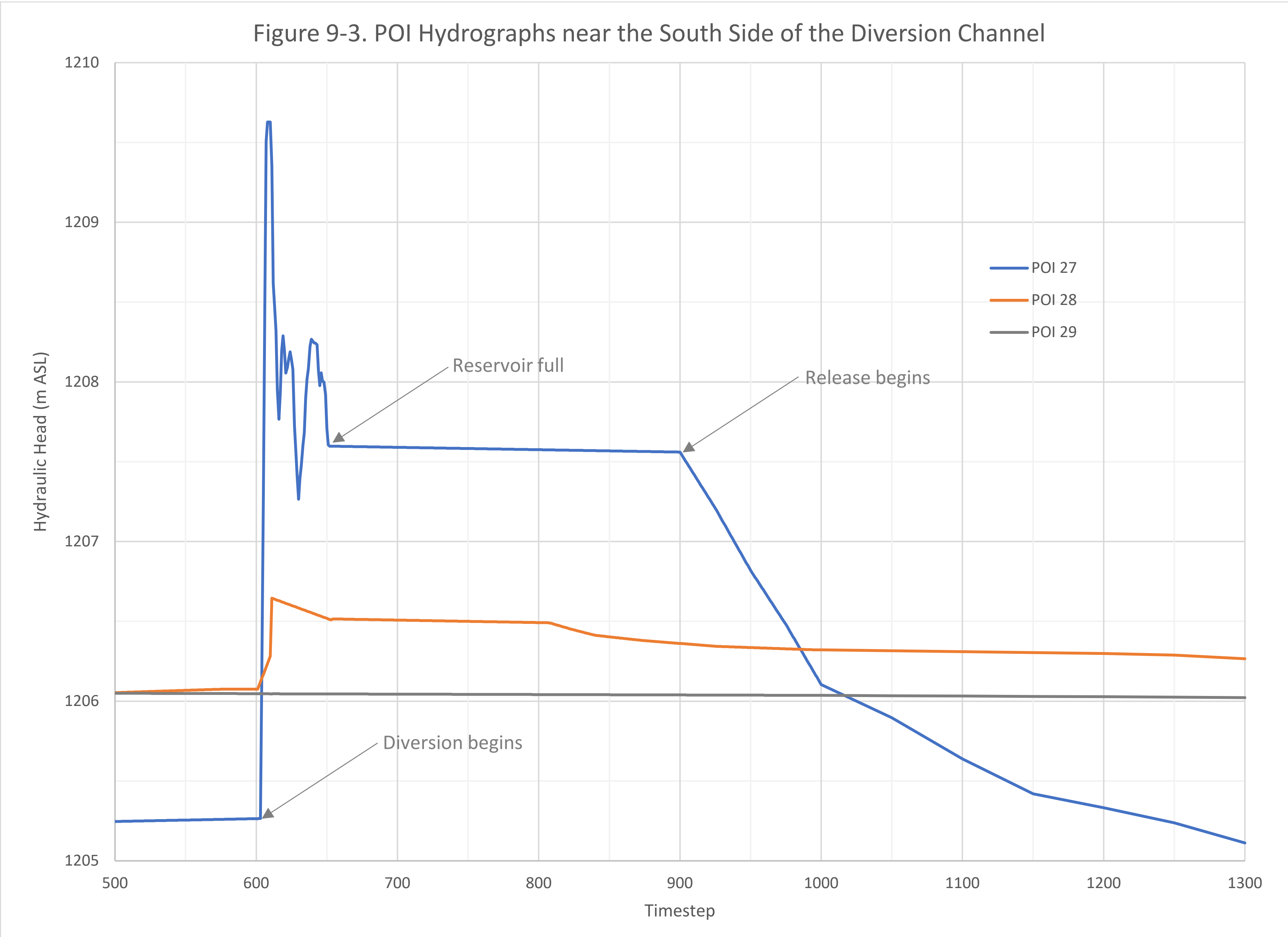


Figure 9-3. POI Hydrographs near the South Side of the Diversion Channel
1210
1209
1208
1207
1206
1205
Hydraulic Head (m ASL)
500
600
700
800
900
1000
1100
1200
1300
Timestep
POI 27
POI 28
POI 29
Reservoir full
Release begins
Diversion begins

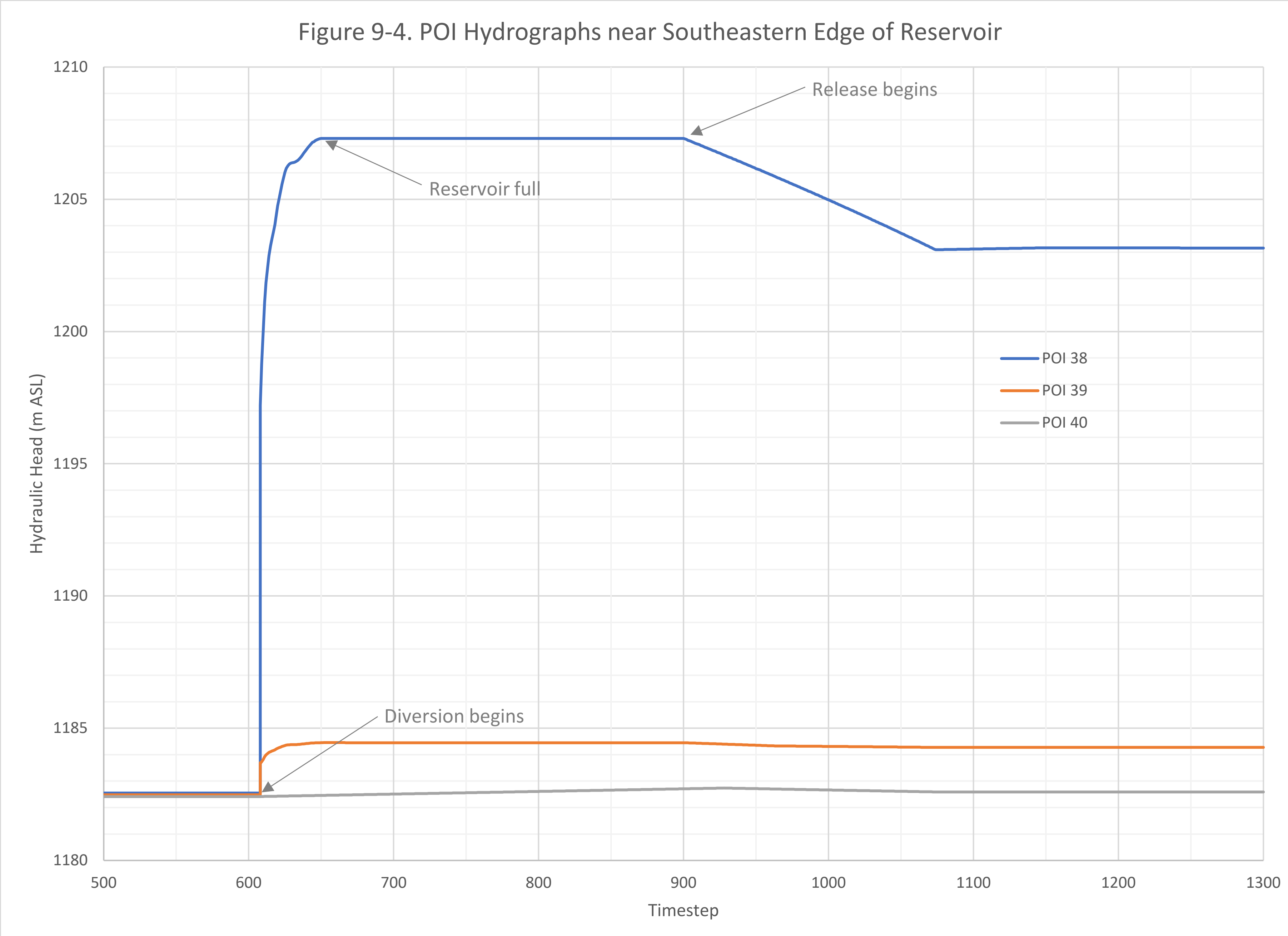


Figure 9-4. POI Hydrographs near Southeastern Edge of Reservoir
Hydraulic Head (m ASL)
1210
1205
1200
1195
1190
1185
1180
500
600
700
800
900
1000
1100
1200
1300
Timestep
Release begins
Reservoir full
Diversion begins
POI 38
POI 39
POI 40

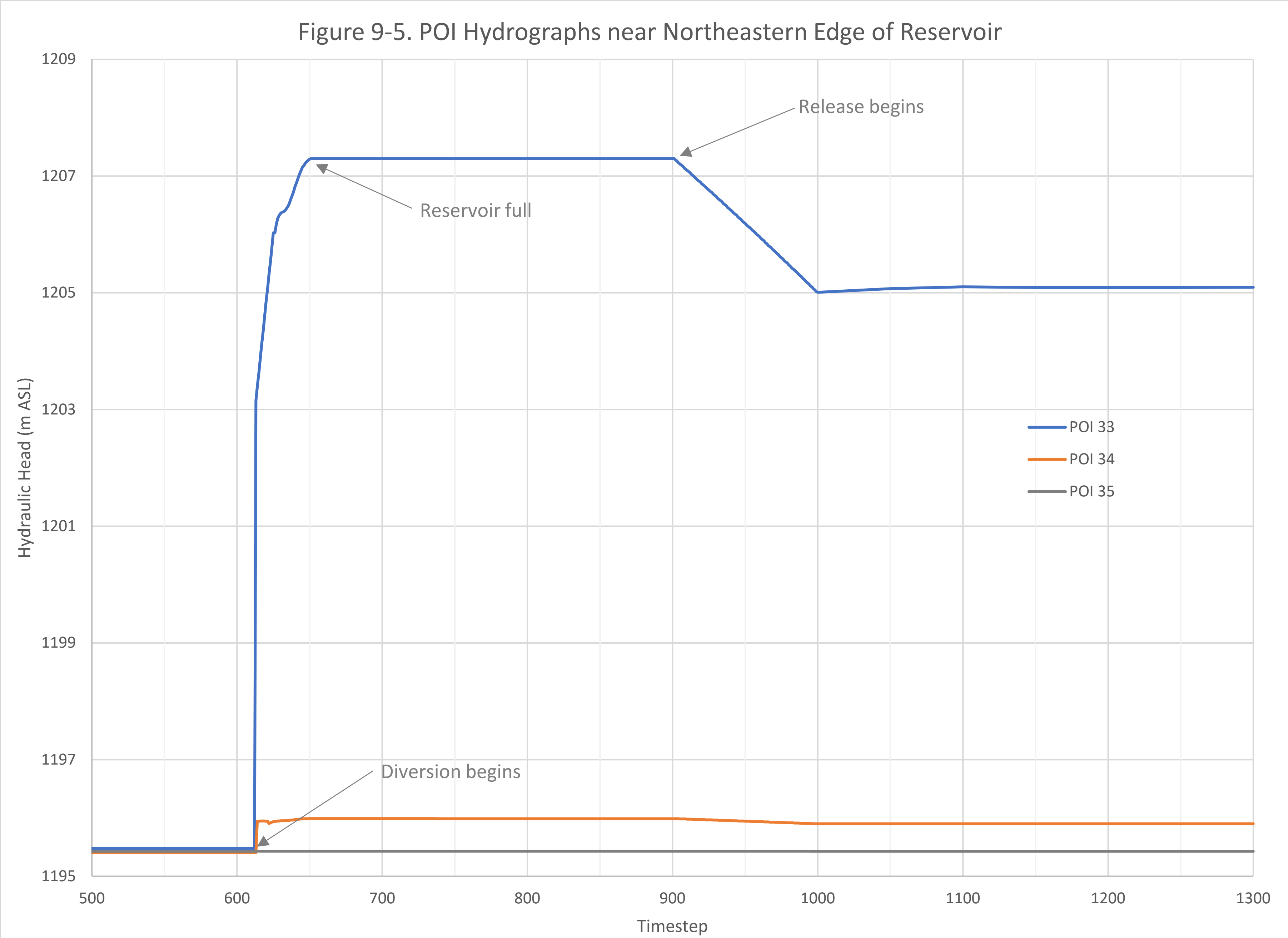


Figure 9-5. POI Hydrographs near Northeastern Edge of Reservoir
Release begins
Reservoir full
Diversion begins
POI 33
POI 34
POI 35
Hydraulic Head (m ASL)
Timestep
1209
1207
1205
1203
1201
1199
1197
1195
500
600
700
800
900
1000
1100
1200
1300

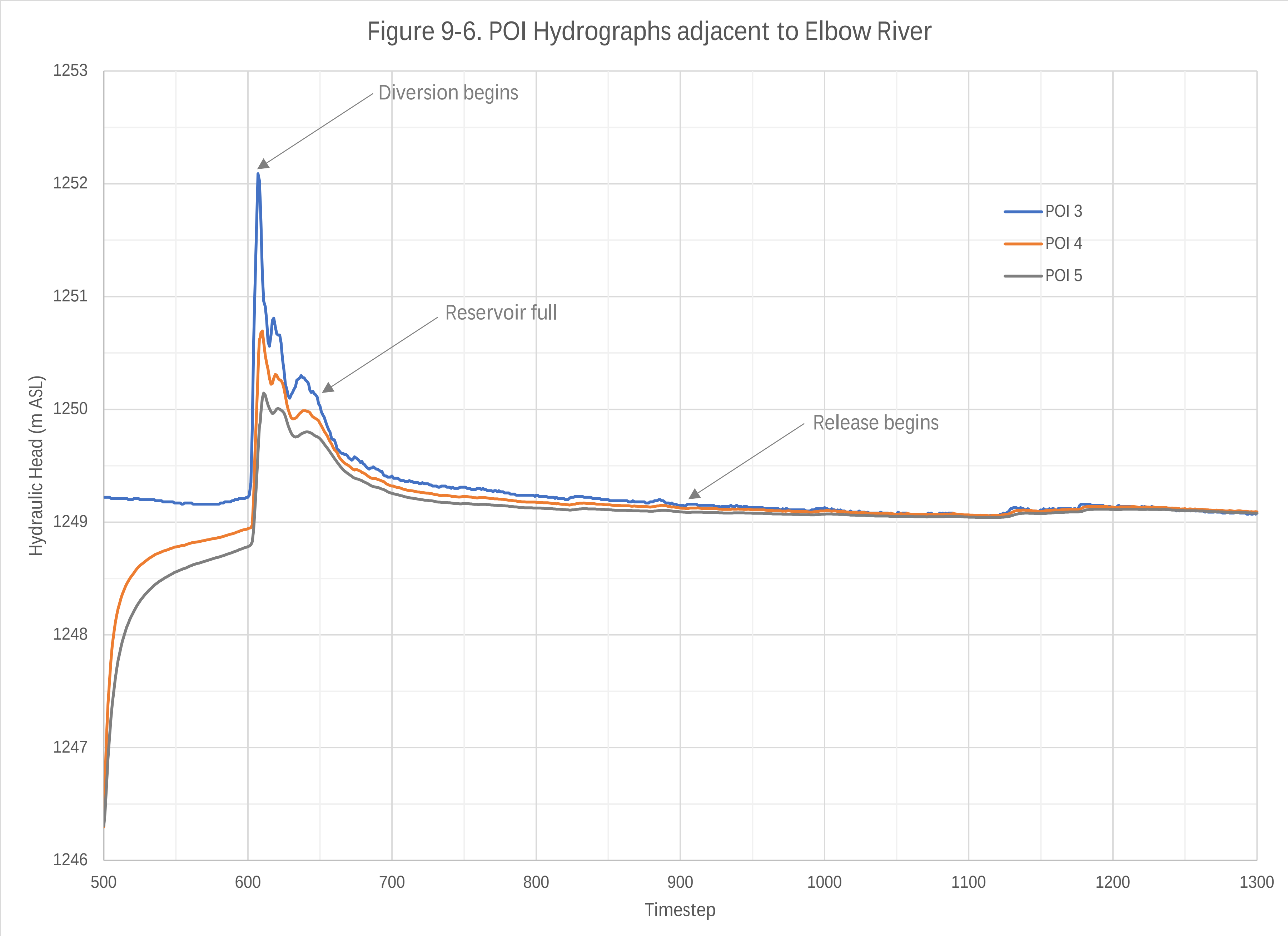


Figure 9-6. POI Hydrographs adjacent to Elbow River
Diversion begins
Reservoir full
Release begins
POI 3
POI 4
POI 5
Hydraulic Head (m ASL)
1253
1252
1251
1250
1249
1248
1247
1246
500
600
700
800
900
1000
1100
1200
1300
Timestep

Table 9-1 Summary of POI Hydrograph Response

Point of Interest	No Response	Flood Response	Response Due to Diversion or Water Retention in the Reservoir
1		X	
2	X		
3	X		
4		X	
5	X		
6	X		
7	X		
8		X	
9		X	
10			X
11		X	
12	X		
13	X		
14		X	
15		X	
16		X	
17		X	
18		X	
19		X	
20		X	
21		X	
22	X		
23	X		
24	X		
25			X
26			X
27			X
28			X
29	X		
30	X		
31	X		
32	X		
33			X
34			X

Table 9-1 Summary of POI Hydrograph Response

Point of Interest	No Response	Flood Response	Response Due to Diversion or Water Retention in the Reservoir
35	X		
36	X		
37	X		
38			X
39			X
40			X
41	X		
42		X	
43		X	
44	X		
45	X		
46		X	
47	X		
48	X		
49	X		
50	X		
51	X		
52	X		
53	X		
54	X		
55	X		
56		X	
57		X	
58	X		
59	X		
60	X		
61	X		
62	X		
63		X	
64		X	
65		X	
66	X		

Question 10

Response to CEAA IR, Package 3, Response IR3-17c, Page 68

Alberta Transportation states *given the intent of the model is to examine potential Project effects, it is not necessary to apply a variable recharge rate since it would not materially affect the net change in head when comparing pre-Project to post-Project conditions.*

a. Explain whether the effects of the off-stream reservoir can be evaluated adequately without changing the areal recharge rate.

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a. Effects related to operation of the off-stream reservoir can be evaluated without applying a temporally variable recharge rate. Groundwater recharge rates will vary over time regardless of Project operations because the recharge rates are influenced largely by external factors, including local climate conditions. Application of a constant areal recharge rate is considered appropriate for the numerical model and is representative of average conditions across the model domain. The intent of the effect's assessment is to compare pre-Project (existing conditions) to post-Project conditions. If the same temporally variable recharge rate were applied to both pre- and post-Project scenarios, it would not materially affect the net change in hydraulic head. In other words, if there are changes to the local groundwater levels as a result of variable recharge, those changes are not a result of Project operations, and therefore not related to Project effects.

Question 11

Supplemental Information Request 1, Question 253, Page 5.52
Supplemental Information Request 1, Appendix IR42-1, Section 2.2, Page 2.2, Section 4.4.1, Page 4.13, and Section 4.4.2, Page 4.20

Appendix IR42-1 describes the use of several types of specified head and specified flux boundary conditions. In section 4.4.1 of Appendix IR42-1 Alberta Transportation describes the use of specified hydraulic head boundaries *set within all model layers around the perimeter of the model domain*. Section 4.4.2 describes the assignment of a specified flux to the top slice of the numerical model to simulate recharge. In Appendix IR42-1, Section 2.2 describes the selection of the RAA boundaries to coincide with surface and groundwater flow divides in many parts of the model.

a. Groundwater flow divides represent areas of zero horizontal groundwater flux. Provide the rationale for applying specified hydraulic heads (a potentially infinite source/sink of water) to areas that are interpreted to be groundwater flow divides.

b. Provide detail on how the aerial recharge and specified head boundaries interact in each area of the model. Provide a steady state flow budget summarizing the flux at all model boundaries and showing the net water balance. Separate the surficial sediments from the bedrock boundaries in the flow budget.

c. Clarify whether the extensive use of specified hydraulic heads limits the capacity of the model to properly calibrate hydraulic conductivity and recharge. Provide details of the model sensitivity to the adjustable parameters including a table showing the local sensitivity of parameter values to steady state calibration data.

d. Comment whether the specified hydraulic heads around the model boundary in each layer affect the forward predictions of change in head during flooding. Provide a table or graph of the boundary conditions over time during the design flood event.

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a. The model domain for the groundwater regional assessment area (RAA) is based on the surface watershed boundary, which separates two neighbouring surface watersheds. In many cases, and at a regional scale, groundwater flow divides occur approximately beneath surface water divides. However, occasionally the groundwater divide may not coincide with the watershed boundary at the subwatershed scale. In that case, a recharge area for an aquifer in one watershed may extend partially into the adjacent watershed, and the type of boundary conditions that are specified along the perimeter of the domain would be different.

   During development of the model, no-flow boundary conditions were first tested by assuming the groundwater divide and the surface water divide are in the same location during the steady state model calibration. The model performance was evaluated through examination of calibration residuals using both specified head and no-flow boundary conditions. The evaluation also included examination of Darcy fluxes at nodes around the perimeter of the domain. Through this evaluation, it was determined that the model better represented measured conditions through use of specified heads around the model perimeter. Throughout the calibration process, it was also noted the location of the regional groundwater flow divide along the Elbow River valley did not change, regardless of the specification of boundary condition type.

Specified hydraulic heads do not necessarily mean there is an infinite source or sink in the groundwater flow model. Fluxes of groundwater in and of the model domain are still constrained by the hydraulic conductivity of the geologic materials, which in most areas of the domain (aside from the fluvial sediments in the Elbow River valley) are relatively low. In turn, the majority of the total subsurface fluxes in the model are through the fluvial sediments present within the domain. In short, the use of specified head boundary conditions in the model does not unduly affect its ability to simulate changes in groundwater levels due to operation of the Project.

b. Areal recharge is defined in the model as a constant, distributed source parameter, rather than a node-based definition, as is the case for other boundary conditions. Water can enter the model domain through distributed recharge and enter and exit the model domain through inflows at specified head nodes and through lateral fluxes in and out of the system.

Table 11-1 presents a summary of volumetric fluxes in, out, and within areas of the model domain during the calibrated steady state simulation. In addition to the total fluxes over the entire model domain, fluxes have also been separated into those within the fluvial unit, the clays/tills, and bedrock. Examination of the fluxes helps to understand how the different units within the domain interact with each other. Because the distribution of the geologic units is not contiguous across the domain for all units, in some areas the nature of the interactions is limited, as compared to other areas of the domain. For example, transfer of water in and out of the fluvial deposits can only occur within the limited, channel-confined areas where those deposits are present (e.g., generally limited to the Elbow River valley and within the unnamed creek in the reservoir area).

Table 11-1 Steady State Water Balances by Unit in the Modelling Domain

Units	Inflows (m^3/s)	Outflows (m^3/s)	Transfer between layers (m^3/s)	Balance (m^3/s)
Total model domain	2.062	2.060	N/A	0.002
Fluvial deposits	1.867	1.900	-0.033 (in)	–
Unconsolidated clays/tills	0.00003	0.00007	-0.00004 (in)	–
Bedrock	0.196	0.161	0.035 (out)	–
Summation	2.063	2.061	0.002	0.002
NOTES: N/A = not applicable; - = not calculated				

The water balances are within acceptable levels when considered over the entire model domain. The fluxes indicate that the majority of the groundwater flow within the domain occurs within the more permeable fluvial unit. Fluxes through the low permeability clays and tills are relatively low and do not constitute a significant proportion of the total fluxes into the system.

c. Specified head boundary conditions are used at the model domain boundary, along Elbow River, and along smaller unnamed creeks. Use of specified head boundary conditions to represent these features does not limit the ability of the model to change heads during calibration or during latter simulation runs (i.e., the model is not excessively constrained). In order to demonstrate that the model is not unduly constrained by specified head boundary condition nodes, an additional steady state simulation was completed using hydraulic conductivity values that were (unrealistically) increased by a factor of 1,000 for all model units other than the alluvial unit. The results of this simulation confirm that the simulated head varied at almost all points by changing the parameters of the model. Table 11-2 presents the steady state heads and a comparison of residual values for both the final calibrated run and the sensitivity run completed to evaluate the model response.

   Of the 72 calibration points almost all the residuals (observed values minus simulation results) changed significantly. Only six of 72 points did not change because they are located near a specified head location near a river or creek. Points located near the Project infrastructure did change, indicating the model's ability to respond to potential Project effects without being constrained by constant head boundaries.

d. The specified hydraulic heads along the model boundary perimeter would not affect the simulation of effects around Project infrastructure during simulated flood operations. The model was developed at the regional scale so that potential boundary effects would not be propagated to the simulated heads near the off-stream reservoir and diversion channel areas, which are interior within the model domain.

   Specified heads around the perimeter of the model domain were set to constant values for the transient simulations (i.e., the "hydrograph" for these boundary conditions would be a flat line). The exception would be for those nodes along the perimeter of the model representing Elbow River, where a time varying definition of the specified heads was applied. The "hydrograph" for the specified head nodes representing Elbow River were defined based on the hydrodynamic model simulations of the flood events derived from the surface water models. Figure 11-1, by way of example, presents a hydrograph for a time varying specified head node within Elbow River during the design flood.

Table 11-2 Comparison of Final Calibrated Heads and Sensitivity Run Heads

Calibration Point ID	Interpreted Head (m asl)	Calibrated Head (m asl)	Calibrated Residual (m)	Sensitivity Run with K x 1,000 Head (m asl)	Sensitivity Residual (m)	Change in Residual (m)
1	1330.26	1334.46	4.20	1320.39	-9.87	14.07
2	1361.43	1362.07	0.64	1362.07	0.64	0.00
3	1382.24	1391.63	9.39	1362.40	-19.84	29.23
4	1300.95	1300.99	0.04	1300.80	-0.15	0.19
5	1227.29	1229.58	2.29	1228.22	0.93	1.36
6	1246.93	1249.18	2.25	1243.76	-3.17	5.42
7	1182.86	1190.36	7.50	1189.27	6.41	1.08
8	1164.91	1177.52	12.61	1174.65	9.74	2.87
9	1132.71	1137.65	4.94	1134.29	1.58	3.36
10	1181.95	1184.83	2.88	1184.85	2.90	-0.01
11	1117.00	1123.27	6.27	1123.27	6.27	0.00
12	1110.85	1120.20	9.35	1109.71	-1.14	10.48
13	1105.19	1108.74	3.55	1108.74	3.55	0.00
14	1160.81	1166.27	5.46	1159.01	-1.80	7.26
15	1220.93	1225.16	4.23	1225.19	4.26	-0.03
16	1215.26	1227.94	12.68	1217.46	2.20	10.48
17	1243.81	1244.20	0.39	1232.51	-11.30	11.70
18	1236.33	1246.43	10.10	1230.73	-5.60	15.70
19	1228.81	1240.05	11.24	1226.71	-2.10	13.34
20	1161.71	1179.98	18.27	1176.45	14.74	3.53
21	1150.76	1165.84	15.08	1156.62	5.86	9.22

Table 11-2 Comparison of Final Calibrated Heads and Sensitivity Run Heads

Calibration Point ID	Interpreted Head (m asl)	Calibrated Head (m asl)	Calibrated Residual (m)	Sensitivity Run with K x 1,000 Head (m asl)	Sensitivity Residual (m)	Change in Residual (m)
22	1182.11	1193.73	11.62	1191.01	8.90	2.72
23	1173.73	1197.27	23.54	1181.10	7.37	16.17
24	1131.53	1159.67	28.14	1138.49	6.96	21.18
25	1141.89	1159.44	17.55	1130.38	-11.51	29.06
26	1104.37	1111.99	7.62	1108.70	4.33	3.29
27	1143.79	1156.17	12.38	1145.11	1.32	11.06
28	1183.33	1186.57	3.24	1183.90	0.57	2.66
29	1207.29	1210.35	3.06	1211.04	3.75	-0.69
30	1215.48	1221.06	5.58	1217.27	1.79	3.79
31	1255.60	1255.14	-0.46	1253.65	-1.95	1.49
32	1199.20	1205.13	5.93	1199.90	0.70	5.22
33	1219.80	1239.01	19.21	1232.77	12.97	6.23
45	1192.75	1195.00	2.25	1193.34	0.59	1.66
46	1193.06	1194.03	0.97	1190.86	-2.20	3.17
47	1207.83	1210.20	2.37	1208.31	0.48	1.90
48	1187.23	1189.60	2.37	1188.18	0.95	1.42
49	1226.12	1222.79	-3.33	1213.17	-12.95	9.62
50	1208.97	1209.38	0.41	1212.40	3.43	-3.02
51	1212.69	1210.65	-2.04	1208.40	-4.29	2.24
52	1198.88	1202.18	3.30	1202.18	3.30	0.00
53	1193.00	1195.86	2.86	1188.30	-4.70	7.56

Table 11-2 Comparison of Final Calibrated Heads and Sensitivity Run Heads

Calibration Point ID	Interpreted Head (m asl)	Calibrated Head (m asl)	Calibrated Residual (m)	Sensitivity Run with K x 1,000 Head (m asl)	Sensitivity Residual (m)	Change in Residual (m)
54	1186.74	1185.78	-0.96	1184.45	-2.29	1.33
55	1190.50	1191.67	1.17	1188.97	-1.53	2.71
56	1203.52	1204.01	0.49	1203.69	0.17	0.32
57	1209.22	1208.18	-1.04	1206.85	-2.37	1.34
58	1199.89	1200.16	0.27	1199.17	-0.72	0.98
59	1208.32	1203.91	-4.41	1198.05	-10.27	5.86
60	1195.28	1195.20	-0.08	1194.74	-0.54	0.46
61	1198.14	1198.79	0.65	1197.45	-0.69	1.34
62	1212.02	1217.55	5.53	1204.40	-7.62	13.15
63	1204.29	1204.07	-0.22	1195.18	-9.11	8.89
64	1175.75	1201.81	26.06	1188.15	12.40	13.66
65	1172.94	1190.55	17.61	1178.01	5.07	12.54
66	1191.40	1202.05	10.65	1193.72	2.32	8.33
67	1182.94	1183.26	0.32	1182.28	-0.66	0.99
68	1187.18	1185.78	-1.40	1184.44	-2.74	1.34
69	1186.37	1187.41	1.04	1185.70	-0.67	1.71
70	1204.66	1202.39	-2.27	1201.78	-2.88	0.61
71	1200.97	1202.27	1.30	1201.47	0.50	0.81
72	1213.88	1217.49	3.61	1204.40	-9.48	13.09

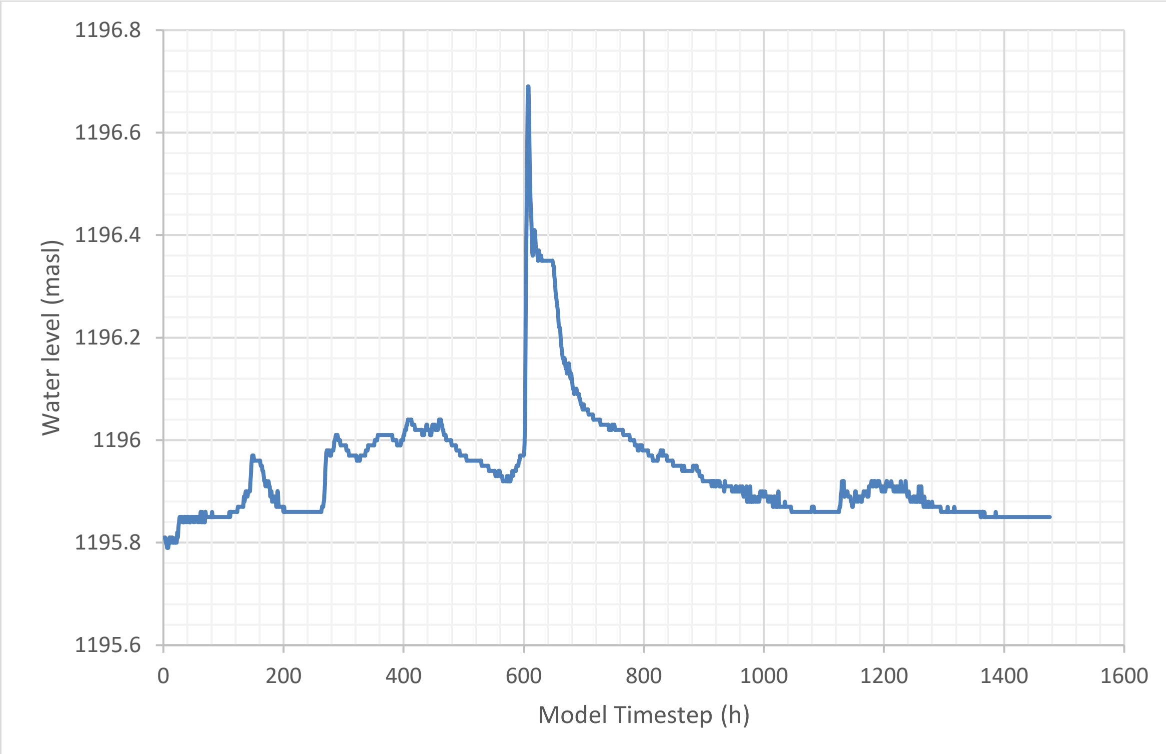


Figure 11-1 Time Varying Specified Head Conditions in Elbow River

Question 12

Supplemental Information Request 1, Question 56, Table IR56-1, Page 2.85

Alberta Transportation provided Table IR56-1 *Summary of Mean Peak Monthly Flow for Bragg Creek and Sarcee Bridge (1979-2016)*. Mean peak flows during the spring (April, May, and June) appear to be greater at Sarcee Bridge relative to at Bragg Creek (approximately 20%).

a. Provide an analysis of what this information provides in understanding the dynamics of flow (e.g., spring runoff, catchment areas, and storm events/floods, etc.) within the Elbow River and Elbow River watershed, particularly during May and June.

b. Describe how this information may affect specifics related to Project location, design, and to meet the purpose of the Project, including the modelling.

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a. In the EIA, Volume 3A, Section 6, mean monthly flow data, the standard deviation, monthly mean minimum and maximums and drainage areas were provided for the Bragg Creek and Sarcee Bridge Water Survey of Canada hydrometric stations in Elbow River. This data was then used to describe the hydrology of Elbow River.

   Elbow River exhibits a runoff regime characterized by low winter discharges and spring runoff dominated by snowmelt. Mean average monthly flows and mean peak monthly flows show distinct runoff patterns at the two Water Survey of Canada stations, relative location to the Elbow River watershed. The two stations are Elbow River at Bragg Creek (ID 05BJ004) and Elbow River at Sarcee Bridge (ID 05BJ010); the stations monitor watershed areas of 790.8 km^2 and 1,189 km^2 respectively. The Bragg Creek station is geographically situated much closer to the mountains and, thus, reflects hydrology typical of mountainous catchments. The Sarcee station is located further downstream and, in addition to the mountains, is also influenced by plains landscape hydrology.

   Winter flows at both stations are low, related to below freezing air temperatures and precipitation falling predominantly as snow. Spring flows increase first at Sarcee Bridge in March to April, which is a result of inputs land runoff over partially frozen ground with snowmelt occurring at progressively higher elevations in the upper basin as spring progresses. This pattern results in the snowpack in the non-mountainous part of the catchment being removed before the influx of most of the annual flow from the upper, and more mountainous, portions of the watershed in May, June and July.

   Approximately 54% of the annual flow volume occurs during May, June and July in the Elbow River watershed. Of this percentage, 25% of the annual flow typically occurs in June alone. The higher mean average monthly and mean peak monthly flows and their standard deviation values for both stations evident in June indicates this is the primary month for flood occurrence. The higher variability is related to annual variability in the actual date of freshet start. Approximately 94% of the annual runoff is sourced from the watershed upstream of Bragg Creek, with 6% contributed from the plains over the year. In some months, there is a net loss of up to 1.0% between Bragg Creek and Sarcee Bridge, as also noted by Hudson (1983). This loss is likely due to infiltration into the alluvium of the Elbow River valley floor (Hudson 1983). Summer recession begins in June with a rapid decline towards October and November. Over the long term, the increase in discharge between Bragg Creek and Sarcee Bridge during the summer recession is likely a result of groundwater inflows, rather than rainfall inputs on the plains (Hudson 1983).

Hydrologic response of Elbow River to storm events shows that sustained rainfall from stationary frontal systems over the foothills and plains can result in increased runoff during the summer months. For example, field data collected from Elbow River at Highway 22 during 2015 and 2016 showed marked differences in flow volumes between the two years, as a function of snowpack and rainfall differences. In 2015, the flow volume for May and June were 17% and 23% of the total annual flow, with July at 13%. Flow volumes in 2016 were 17% of the total annual flow in May, 15% in June and 24% in July. The increase in flow during July 2016 was a result of approximately 206 mm of rain falling over the month, as recorded at Calgary International Airport. This rainfall amount represents a 208% increase over the 1981 to 2010 climate normal rainfall of 66.9 mm. This example illustrates that the timing and generating mechanism of flow events in the Elbow River can be quite variable.

Generation of high flow events in the Elbow River Basin are complex with changes in magnitude reflecting different combinations of driving mechanisms. Early spring floods driven by snowmelt alone are typically small and occur soon after ice break-up (Hudson 1983). Increasing flood magnitudes reflect an increasing rainfall contribution in the upper watershed with additional inputs from the lower watershed (Hudson 1983). High magnitude events occur when substantial rainfall occurs during spring melt when higher elevation snowpack is isothermal, or close to isothermal. For example, in June 2013, heavy rainfall and rapidly melting snowpack in the Front Ranges of the Canadian Rocky Mountains resulted in widespread flooding in multiple watersheds, including Elbow River. Over 200 mm, and as much as 350 mm, of precipitation fell in watershed headwaters between June 19 and June 20 (Pomeroy et al. 2016).

The intensity of the 2013 storm was the result of coupling between upper and lower circulation systems. This coupling resulted in upslope winds from the east that were warm and moist, which raised the freezing level and resulting in rainfall rather than snowfall at high elevations (Pomeroy et al. 2016. Snowmelt over partially frozen soil at higher elevations may have increased runoff by up to 30%, in some areas (Pomeroy et al. 2016). The system persisted for over 36 hours (Pomeroy et al. 2016). Localized pockets of high intensity, convection-driven rainfall over the foothills and plains, as well as in the upper Elbow River watershed, also contributed to extreme runoff conditions. Pomeroy et al. (2016) concluded that the generation of high magnitude floods in the Elbow River watershed typically requires a combination of snowmelt, rainfall and rain-on-snow.

b. The Project has been designed to reduce flood flows in Elbow River regardless of when the flooding may occur. Mean monthly peak flows were not used in assessing Project location, design or purpose. The information presented in the response to a. does not affect the requested specifics.

The location of the Project was decided based on topographic constraints and, specifically, the presence of the natural off-stream basin that could be used for the off-stream reservoir. Its position relative to Elbow River allows the diversion of flood water by gravity from the river to the reservoir. The Project design capacity is the flood of record that occurred in 2013 and equivalent events. The annual flood magnitudes, flood frequency (return period) and the mean monthly spring run-off values—while utilized for the assessment of impacts as described in the EIA hydrology assessment—did not need to be factored into this design basis. The Project will divert all flood flows in excess of 160 m^3/s up to a maximum diversion flow capacity of 600 m^3/s regardless of when such events occur.

REFERENCES

Hudson, H.R. 1983. Hydrology and sediment transport in the Elbow River basin, S.W. Alberta. Ph.D. Thesis, The University of Alberta, Edmonton, Alberta.

Pomeroy, J.W., Stewart, R.E., Whitfield, P.H. 2016. The 2013 flood event in the South Saskatchewan and Elk River basins: Causes, assessment and damages. Canadian Water Resources Journal 41: 105-117

Question 13

Supplemental Information Request 1, Question 59, Page 2.91

Alberta Transportation states that *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 asses peak inflow into the outlet structure. During this event, the maximum flow rate from the reservoir is 13.3 m³/s.*

a. **Clarify in detail if similar percentage contributions from tributaries are to be diverted into the reservoir for the design flood and 1:100 year flood, and if these volumes were considered in designing the size/capacity of the reservoir (e.g., 13.3 m^3/s from the tributaries in a 1:10 year flood without diversion and a maximum diversion rate from the Elbow River for a 1:10 year flood is approximately 40 m^3/s, for a resulting total inflow to the reservoir of 53.3 m^3/s).**

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a. Provision for runoff from these tributaries is included in the sizing of the reservoir's active flood storage capacity (design volume). When assessing the stored volume of water from a 1:100 year flood, the runoff volume from one in 100 year, 6-hour rain event falling on those tributary catchments was added to the volume diverted from the river for a 1:100 year flood. The runoff simulation analysis was completed for stormwater contributions of the intersected tributaries during dry operations. A one in 10 year, 24-hour rain event is not analogous to a 1:10 year flood flow in Elbow River.

For the design flood, the amount of rainfall that fell on these upstream tributaries in 2013 was less than the amounts computed for the one in 100 year, 6-hour rainfall event. As a conservative approach (overestimating the tributary contribution) to the sizing of the reservoir, the one in 100 year, 6-hour rainfall runoff totals were added to the total volume diverted from the river in the 2013 flood simulations; this allowed determination of the total active reservoir capacity for flood mitigation needs and, ultimately, the size of the reservoir. See Alberta Transportation's response to Round 1 AEP IR268 for additional details.

Question 14

Supplemental Information Request 1, Question 62, Pages 2.97-2.98

Alberta Transportation states *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 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.*

a. **Explain why reducing changes caused by flooding on natural ecological (e.g., scouring) and geomorphic (e.g., altering river dynamics and bedload transport) processes are considered positive in direction. It may be from an anthropogenic standpoint, but is less obvious from a natural/environmental stand point.**

b. **Describe and explain how 160 m^3/s was determined to be adequate to maintain river ecological functions.**

Response

a. The overall effect on ecological and geomorphic processes of reducing the flood peak, for extreme floods, to 160 m^3/s for flows up to 760 m^3/s (thereby, reducing flows by up to 600 m^3/s) is neutral, although effects on some individual processes could be adverse. Within the regional assessment area (RAA) downstream of the Project, the ecological and geomorphic process in Elbow River have already been subjected to substantial change, primarily through the creation of Glenmore Reservoir.

   There are five ecologically important geomorphic processes that may be incrementally altered by decreasing peak flood flows in Elbow River: (1) overbank deposition, (2) bank erosion rates, (3) channel morphology, (4) scour and maintenance of large pools, and (5) maintenance and formation of side channels. Additional discussion on the effects on riparian vegetation from the reduction of flood peaks associated with the Project are provided in the response to AEP Question 103.

Overbank Deposition

Large floods add nutrients to the floodplain from suspended sediment deposits. These floods benefit the ecosystem and occur in rural and natural environments. In urban environments, like the City of Calgary, these ecological benefits from flooding are not readily realized. Flooding has an adverse effect on the environment by introducing contaminants and other anthropogenic materials found in most urban environments from the floodplain to the river. Flooding is also prevented by armouring of the banks and flood berms designed to protect infrastructure.

The Project will maintain some overbank deposition on the floodplain and in riparian areas, but at a reduced spatial extent and severity. Figure 14-1 and Figure 14-2 show an example of channel and floodplain cross-section and the cross-section view of Elbow River approximately 3.5 km downstream of the gate structure, at flows of 160 m^3/s (with the Project) and 760 m^3/s (without the Project). The cross-section shows a lower and upper floodplain. For a 760 m^3/s flow in the river (approximately a 1:100 year flood) at the diversion structure, 600 m^3/s would be diverted to the reservoir and 160 m^3/s would continue to flow downstream. This is the point on the operational spectrum where the maximum volume of water is being diverted into the reservoir. Should floods larger than 760 m^3/s occur (i.e., a flood above the maximum diversion capacity), then the service spillway gates begin to lower and more water is allowed to pass downstream. Figure 14-1 shows an example cross-section of the extent of inundation during 160 m^3/s and 760 m^3/s floods. The cross section shows none of the upper floodplain will be inundated for a flow of 160 m^3/s. Deposition in the lower floodplain will occur at 160 m^3/s, but to a lesser extent that the flow of 760 m^3/s.

Bank Erosion Rates

Bank erosion often introduces large wood to a river channel and provides complex vertical banks with overhanging roots. Bank erosion rates will likely decrease (due to the Project) during large flows because near-bank shear stresses are reduced. Bank erosion will be unchanged at flows up to 160 m^3/s, but they will decrease at flows above 160 m^3/s. The effect of decreased bank erosion is not expected to alter bank morphology significantly, particularly where the bank has been armoured.

Channel Morphology

The bed material of Elbow River is composed of coarse to very coarse gravel, with a median grain size (D_{50}) between 23 mm and 66 mm. These grain sizes are typically mobile at the annual flows observed in Elbow River. The morphology of Elbow River exhibits a pattern of medial bars, which indicates high sediment mobility. This morphology can still be maintained even when flows are reduced by up to 600 m^3/s, in the case if extreme floods. However, the reduction of the largest flows will decrease sediment transport rates during floods when the Project is operational, compared to existing conditions. Over time, this may result in a narrowing and simplification of the channel.

Scour and Maintenance of Large Pools

It is possible that a reduction in less frequent higher magnitude floods could reduce the formation of new large pools in Elbow River. However, the interaction of flow and other in-channel obstructions, such as large wood and hardened banks, can result in the formation of large pools during lower magnitude floods. Pool maintenance is typically accomplished by bankfull flows, which will still continue to occur with the Project.

Maintenance and Formation of Side Channels

Wandering gravel bed rivers, such as Elbow River, have side channels that provide important ecological value. These side channels are reactivated and enlarged during large flows. Hydraulic modelling has shown that the floodplain becomes inundated during flows of 160 m^3/s, activating many of the side channels, particularly in the lower floodplain (see Figure 14-1 and Figure 14-2). Figure 14-1 shows that most of the existing side channels in the lower floodplain are inundated during a 160 m^3/s flow. The depth of flow in the side channel is lower than at 760 m^3/s, but there should be sufficient flow to maintain the existing channel as long as upstream connectivity to the mainstem remains.

With the reduction of peak flows, the geomorphology of Elbow River between the Project and the Glenmore Dam will be simplified because the creation of new side channels or the activation of abandoned channels within the floodplain will be reduced. Also, large floods trigger avulsions that create side channels that provide important fish habitat. These floods also have high sediment transport rates that create large bars and produce heterogeneous bed sediment patterns. The frequency and magnitude of overbank deposition will be reduced as inundation of the floodplain decreases. The magnitude of the change to the geomorphology of Elbow River is moderate, the duration is long term, and the overall direction of the change is neutral. The effects of the Project on the geomorphology of Elbow River are summarized in Table 14-1, which is not provided in the EIA. Table 14-2 outlines the characterization of residual effects (Volume 3A, Section 6.1.5, Table 6.2).

Table 14-1 Project Residual Effects on Hydrology during Construction and Dry Operations

Residual Effect	Residual Effects Characterization							
	Project Phase	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socio-economic Context
Overbank Deposition	F/PF	N	L	LAA	LT	IR	R	D/U
Bank Erosion Rates	F/PF	N	L	LAA	LT	IR	R	D/U
Channel Morphology	F/PF	A	H	LAA	LT	IR	R	D/U
Scour and Maintenance of Large Pools	F/PF	N	M	LAA	LT	IR	R	D/U
Maintenance and Formation of Side Channels	F/PF	A	H	LAA	LT	IR	R	D/U
Overall Significance	F/PF	N	M	LAA	LT	IR	R	D/U

KEY

Project Phase
C: Construction
DO: Dry
F: Flood Operations
PF: Post-Flood Operations

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

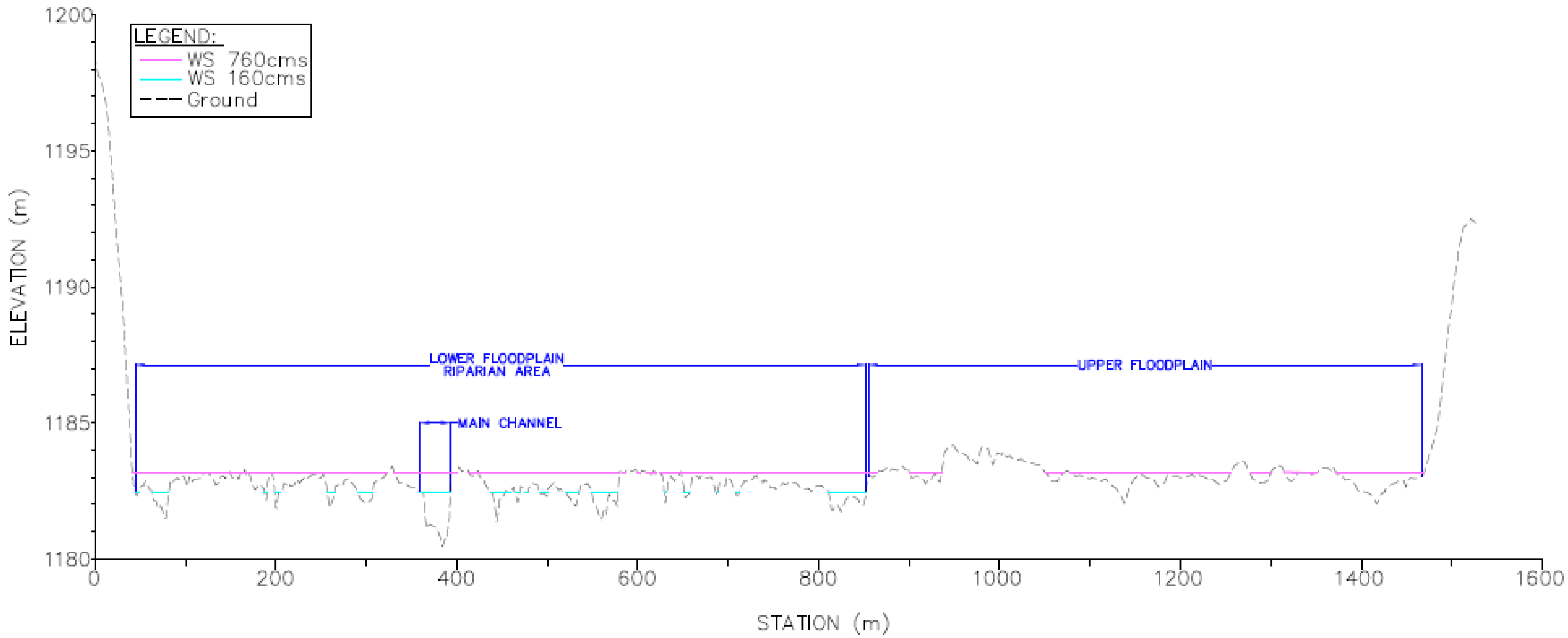
Duration:
ST: Short-term
MT: Medium-term
LT: Long-term

N/A: Not applicable

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

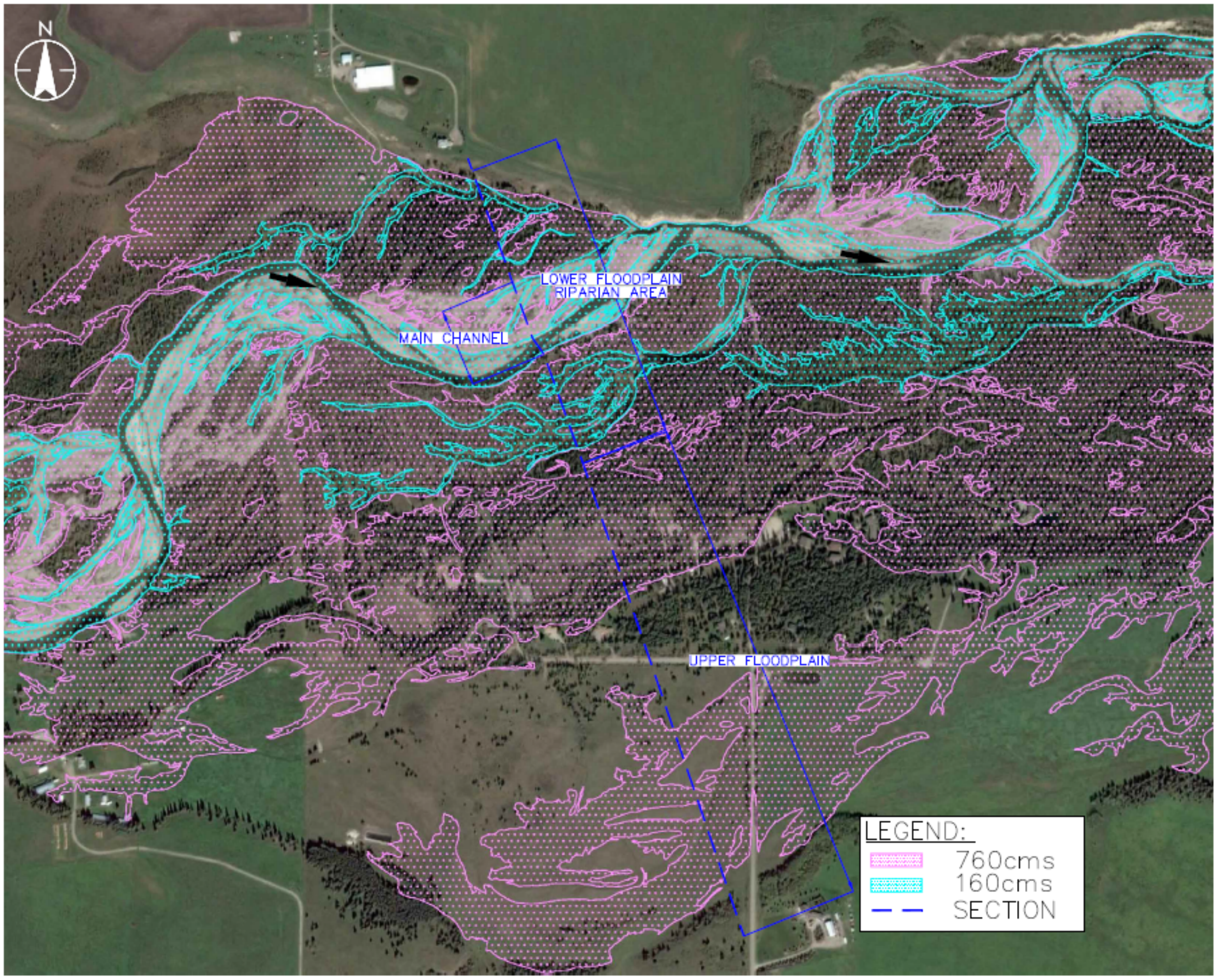
Reversibility:
R: Reversible
I: Irreversible

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



NOTE: cms = cm/s

Figure 14-1 Example Cross-Section from Elbow River Showing Difference in Flood Inundation (cross-section is approximately 4.5 km downstream of the diversion)



NOTE: cms = cm/s

Figure 14-2 Example Cross-Section View of Elbow River Showing Differences in Flood Inundation at 160 m³/s and 760 m³/s Flows

Table 14-2 Characterization of Residual Effects on Hydrology (from Volume 3A, Section 6.1.5, Table 6.2)

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Direction	The long-term trend of the residual effect	Positive – a residual effect that changes measurable parameters in a direction beneficial to hydrology relative to existing conditions Adverse – a residual effect that changes measurable parameters in a direction detrimental to hydrology relative to existing conditions Neutral – no net change in measurable parameters for hydrology relative to existing conditions
Magnitude	The amount of change in measurable parameters or the variable relative to existing conditions	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
Geographic Extent	The geographic area in which a residual effect occurs	PDA (disturbance area) – residual effects are restricted to the PDA LAA – residual effects extend into the LAA RAA – residual effects interact with those of other project or development in the RAA
Frequency	Identifies how often the residual effect occurs and how often during the Project or in a specific phase	Single event Multiple irregular event – occurs at no set schedule Multiple regular event – occurs at regular intervals Continuous – occurs continuously
Duration	The period of time required until the measurable parameter or the VC returns to its existing condition, or the residual effect can no longer be measured or otherwise perceived	Short-term – residual effect that lasts for several days Medium-term – residual effect that extends through several months Long-term – residual effect that extends through more than one year
Reversibility	Pertains to whether a measurable parameter or the VC can return to its existing condition after the project activity ceases	Reversible – the residual effect is likely to be reversed after activity completion and reclamation Irreversible – the residual effect is unlikely to be reversed

Table 14-2 Characterization of Residual Effects on Hydrology (from Volume 3A, Section 6.1.5, Table 6.2)

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Ecological and Socio-economic Context	Existing condition and trends in the area where residual effects occur	Undisturbed – area is relatively undisturbed or not adversely affected by human activity Disturbed – area has been substantially previously disturbed by human development or human development is still present
Timing	Periods of time where residual effects from Project activities could affect the VC	Seasonality – residual effect is greater in one season than another (e.g., spring/summer vs. fall/winter) Time of day – residual effect is greater during daytime or nighttime Regulatory – provincial or federal restricted activity periods or timing windows (e.g., migration, breeding, spawning) related to the VC Not applicable - the residual effect of Project activities will have the same effect on the VC, regardless of timing

b. The flood risk reduction objective of the Project is to limit flows downstream of Glenmore Reservoir to no more than 170 m^3/s during a flood that would be equivalent to the size of 2013 flood (event of record). The flow rate of 170 m^3/s is the flow at which the City of Calgary has identified that overland flood damages to private property begin to occur. The operational target of 160 m^3/s that the Project uses honours this design objective but is selected because it coincides with the maximum discharge capacity of Glenmore Reservoir's low-level outlet. The discharge was not chosen to maintain river processes and does not represent a geomorphic or ecological threshold. It does, however, coincide with a one in seven-year flood and does allow some inundation of riparian areas and channel maintenance processes downstream of the Project and upstream of Glenmore Reservoir.

As stated in a., the five geomorphic riverine processes that maintain the nature and ecology of Elbow River will be affected by limiting the river flow to 160 m^3/s. The magnitude of these changes relative to geomorphic processes are predicted to range from low to high (Table 14-1); such changes will consequently be transferred to other natural elements that depend on these ecological processes. For instance, changes in channel morphology will alter the diversity and character of channel units (e.g., depths, substrate particle size) and have a concomitant change in fish habitat.

Changes to ecological function associated with limiting flows in Elbow River to 160 m^3/s cannot be mitigated; however, changes can be offset through the *Fisheries Act* authorization process that is being undertaken for the Project.

Fish habitat enhancement efforts have been done previously by the province to address habitat loss as a result of riverine changes, as was done after the 2013 flood. As an example, AEP's Southern Alberta Fisheries Habitat Enhancement and Sustainability (FISHES) Program "*lead the development of a $10 million program to address impacts to fish and fish habitat as a result of the 2013 and 2014 flood events including impacts associated with recovery work. The new FISHES Program aims to mitigate the flood related effects on fish and fish habitat in the short term and to re-establish a healthy aquatic environment over the longer term.*" (Southern Alberta Fisheries Habitat Enhancement and Sustainability Program 2015).

Alberta Transportation will aim to offset the Project changes to fish habitat associated with limiting flows to 160 m^3/s. Geomorphic and ecological components will be ranked and prioritized as part of the *Fisheries Act* authorization process to determine the most effective offsetting approaches to undertake.

REFERENCES

Southern Alberta Fisheries Habitat Enhancement and Sustainability Program. 2015. A Guide to understanding and using the project selection and priority ranking tool. Alberta Environment and Parks, Calgary. 23 pages.

Question 15

**Supplemental Information Request 1, Question 67, Pages 2.101-2.102
Supplemental Information Request 1, Question 67, Figure IR67-1, Page 2.102**

Alberta Transportation states *there is no comparable data set in which to do an independent validation and that the calibration shows the simulation reproduces the measured water levels in terms of the variation magnitudes and phases, except at the peak.*

If a model is calibrated using a given set of data and the model is subsequently run to simulate the same scenario (from which the numbers were used to calibrate the model, as done in Figure IR67-1), it is a given that the model will produce similar results.

a. If the model has not been validated, quantify the expected error range or uncertainty/confidence in modelled numbers for the scenarios run with the model. Also, provide the associated level of confidence for each.

Response

a. Validation requires an independent dataset of velocity or water surface elevation (WSE), measured in the field at discharges within the range of flows modelled, for comparison with the model results. The MIKE 21 FM was validated using four surveyed high-water marks (HWM) within the study area after the 2013 flood (AESRD 2015).

The elevations of the surveyed HWMs are compared against the modelled peak water levels at the same locations for the 2013 flood. Table 15-1 and Figure 15-1 summarize the model validation results. A difference of less than 1% occurs between the modelled and surveyed HWMs. Figure 15-2 shows a trendline fitted to modelled WSEs versus surveyed HWMs. The trendline has a slope of 1 and coefficient of determination (R^2) of 0.9997, which indicates that the MIKE 21 FM model can accurately predict water levels.

Table 15-1 Results of MIKE 21 FM Model Validation to the Surveyed 2013 HWM

Surveyed Locations	Coordinates	Surveyed HWM (m)	Modelled HWM (m)	Difference (m)	Difference (%)
1	-11564.844 m E, 5651019.964 m N	1,082.50	1,082.87	0.37	0.03%
2	-11572.738 m E, 5650943.000 m N	1,082.45	1,082.85	0.40	0.04%
3	-14324.467 m E, 5652592.561 m N	1,092.34	1,092.75	0.41	0.04%
4	-16839.274 m E, 5653450.087 m N	1,105.83	1,105.88	0.05	0.00%

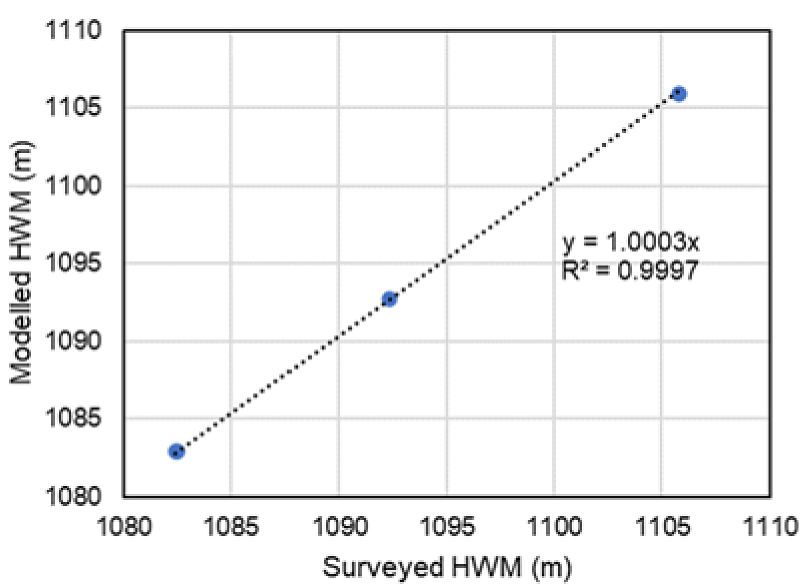


Figure 15-1 2013 Modelled versus Surveyed HWMs

The purpose of the modelling presented here is to compare a model of changes with the Project compared to conditions without the Project (baseline). Uncertainty between the model and an observation is less critical than understanding the sensitivities of the model output to the input parameters. The sensitivity analysis provides an understanding of the implication of uncertainty associated with assumptions made on model parameters to the modelled results (i.e., water surface elevation and velocity). The sensitivity analysis does not specifically provide confidence intervals or an expected error range but does indicate the level of uncertainty of model results related to their sensitivity to model inputs.

SENSITIVITY ANALYSIS OF MIKE 21 FM MODEL

The two main parameters that could potentially affect modelled WSEs are bed roughness and horizontal eddy viscosity. These two key parameters are important in the two-dimensional shallow water Navier-Stokes equations in MIKE 21 FM and are usually adjusted during model calibration. The updated model incorporated a LiDAR based digital elevation model and bathymetric survey information collected by AEP in 2016 (unpublished data). A 1-dimensional HEC-RAS hydraulic model of Elbow River, developed as a component of the unpublished Bow and Elbow River Hazard Study program, was also supplied by AEP.

Calibration involved the adjustment of the Manning coefficients (n) for the model, which are used to represent bed roughness for high flow events within the floodplain and main channel of Elbow River. For consistency with previous models of Elbow River, the new MIKE 21 FM model used the same Manning coefficients as were used in the HEC-RAS model.

The horizontal eddy viscosity affects the turbulence characteristics of flow. The horizontal eddy viscosity is used to calculate Reynolds stress components due to turbulent flow in the shallow water equations and, therefore, it is a key parameter in the MIKE 21 FM model. The Smagorinsky formulation is used to define the horizontal eddy viscosity as a function of current velocity in the model. The MIKE 21 default value of 0.28 is used as the Smagorinsky coefficient (C_s) in the model (DHI 2019).

While previously verified bed roughness coefficients (n) and recommended Smagorinsky coefficients (C) are used in the model, the sensitivity of the model to these coefficients was tested: the main channel *n* and Cs were adjusted ±10% in the model to evaluate the sensitivity of the model to these parameters.

The main channel *n* is the most effective roughness parameter affecting the entire hydrograph, including low and high flows. The modelling for a design flood (2013 flood), early release was selected as the baseline from which to perform the sensitivity analysis. The model underwent four runs, with each run reflecting a change in *n* or Cs. Hourly current velocity and water surface elevation time series were extracted at an arbitrary location in Elbow River downstream of the Bragg Creek station (-38846.642 m E, 5647943.380 m N). Table 15-2 presents a summary of the sensitivity of the modelled WSE at that location.

Table 15-2 Sensitivity of Water Surface Elevation

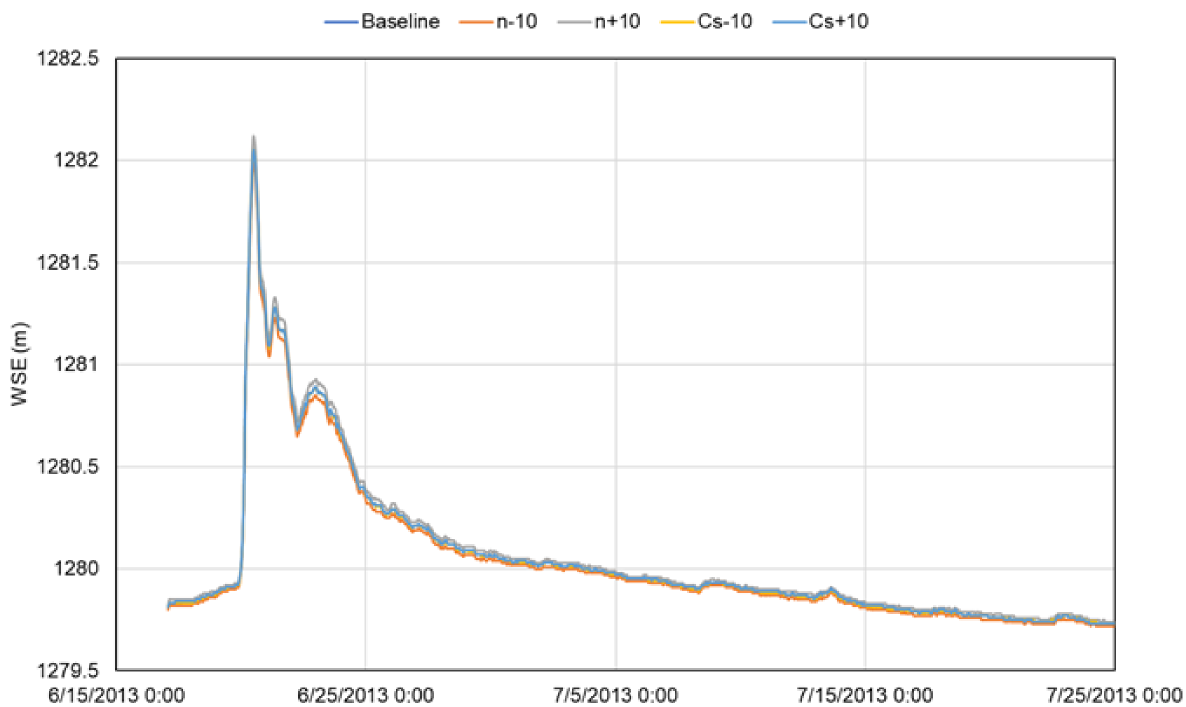
Modelling Scenario	Max WSE (m)	Avg WSE (m)	Min WSE (m)
Baseline ($n_{channel}$=0.045; C_s=0.28)	1,282.050	1,279.730	1,280.050
$n_{baseline}$ + 10% ($n_{channel}$ =0.05; C_s=0.28)	1,282.120 (+ 0.07)	1,279.740 (+0.01)	1,280.070 (+0.02)
$n_{baseline}$ - 10% ($n_{channel}$ =0.04; C_s=0.28)	1,282.000 (-0.05)	1,279.720 (-0.01)	1,280.033 (-0.017)
$C_{s(baseline)}$ + 10% ($n_{channel}$ =0.045; C_s=0.31)	1,282.050	1,279.730	1,280.051 (+0.001)
$C_{s(baseline)}$ - 10% ($n_{channel}$ =0.045; C_s=0.25)	1,282.050	1,279.730	1,280.049 (-0.001)
NOTES: Red indicates a positive value and blue indicates a negative value			

As shown in the table, WSE is more sensitive to bed roughness than horizontal eddy viscosity. The ±10% change in C_s does not affect the maximum (max) and average (avg) WSEs and only changes the minimum (min) WSE by 1 cm. On the other hand, the ±10% change in *n* resulted in changes in the max WSE of +7 cm and -5 cm, respectively; however, average WSE only changes ± 1 cm. Figure 15-2 presents WSE time series for the modelled scenarios. The lines for the Cs±10 are essentially equivalent to the baseline, so they are not distinguishable from the baseline line in the figure. Overall, changes in WSE are less than 1% and are, therefore, insensitive to the model inputs.

Table 15-3 presents a summary of the sensitivity analysis of the modelled current velocity at the Bragg Creek location. As shown in the table, like WSE, current velocity is more sensitive to bed roughness, compared to the horizontal eddy viscosity.

The results show that modelled current velocity is not sensitive (less than 1% difference) to a 10% change in C_s. Increasing and decreasing *n* by 10% changes the maximum current velocity by -0.173 m/s and 0.154 m/s, respectively and changes average current velocity by -0.062 m/s and +0.065 m/s, respectively.

Figure 15-3 presents current velocity time series the modelled scenarios. The lines for the Cs±10 are essentially equivalent to the baseline, so they are not distinguishable from the baseline line in the figure. Overall, current velocity is sensitive to changes in the bed roughness coefficient. A 10% change in *n* results in a 5% change in the maximum velocity and a 9% change in the average velocity.

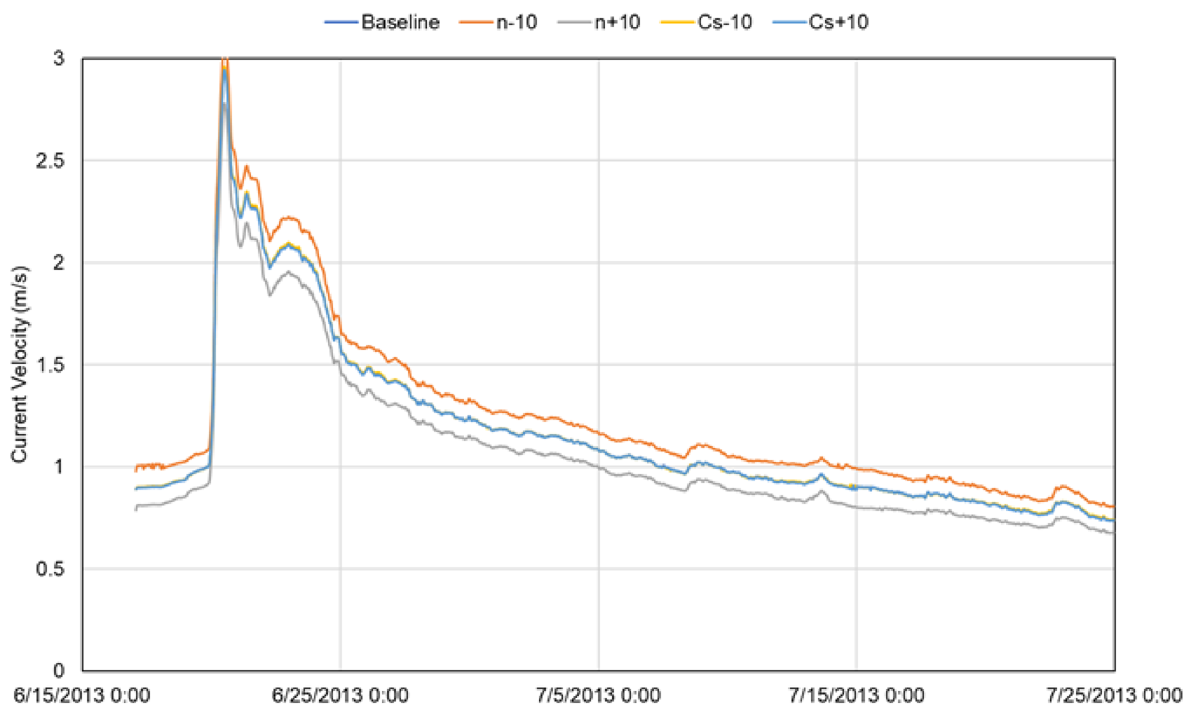


NOTE: not all lines are visible on the graph due overlap

Figure 15-2 Modelled Water Surface Elevation Time Series

Table 15-3 Sensitivity Analysis of Current Velocity

Modelling Scenario	Max Velocity (m/s)	Avg Velocity (m/s)	Min velocity (m/s)
Baseline ($n_{channel}$=0.045; C_s=0.28)	2.951	0.739	1.158
$n_{baseline}$ + 10% ($n_{channel}$=0.05; C_s=0.28)	2.778 (-0.173)	0.677 (-0.062)	1.066 (-0.092)
$n_{baseline}$ - 10% ($n_{channel}$=0.04; C_s=0.28)	3.105 (+0.154)	0.804 (+0.065)	1.248 (+0.090)
$C_{s(baseline)}$ + 10% ($n_{channel}$=0.045; C_s=0.31)	2.942 (-0.009)	0.737 (-0.002)	1.156 (-0.002)
$C_{s(baseline)}$ - 10% ($n_{channel}$=0.045; C_s=0.25)	2.960 (+0.009)	0.741 (+0.001)	1.159 (+0.002)
NOTES: Red indicates a positive value and blue indicates a negative value			



NOTE: not all lines are visible on the graph due to overlap

Figure 15-3 Modelled Current Velocity Time Series

SUMMARY

The model performed well when compared to the surveyed data. Results of the sensitivity analysis indicate the following:

- Model results are less sensitive to the Smagoirnsky coefficient and are more sensitive to bed roughness.
- 10% changes in Smagorinsky coefficient has insignificant effects on the modelled current velocity and water surface elevation.
- 10% changes in bed roughness results in less than 1% changes in water surface elevation; however, the changes result in a 9% change in average current velocity.

The sensitivity analysis shows that the model is not sensitive to the Smagoirnsky coefficient, but it is sensitive to changes in n, where changes in *n* produce an equal or lower percentage change in WSE or velocity. Manning's *n* values were obtained from a calibrated and validated HEC-RAS model used for floodplain mapping of Elbow River supplied by AEP.

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Question 16

Supplemental Information Request 1, Question 70, Page 2.107

Alberta Transportation states that *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….*

Some parameters may behave similar to sediment and/or be sediment related, that does not necessarily mean they are sediment bound and/or biologically unavailable. Any constituent still dissolved in water is available for biological assimilation (e.g., TDP).

a. Explain how all sediment related parameters are bound with sediment particles.

Response

a. ***WATER QUALITY ANALYSIS***

The strength and nature of the relationship between trace elements and total suspended sediments (TSS) in Elbow River are assessed using regression analysis and water quality data from the five following locations on the river:

- above Bragg Creek
- Highway 22 bridge
- Twin Bridges
- Sarcee Bridge
- Weaselhead Bridge

The regression analyses uses available historical Elbow River water quality data for parameters with at least 20 data values that corresponded with TSS from the same date and location. Due to variable sample sizes among sites, the water quality data are combined as one site for this analysis. Results are presented in Table 16-1.

For this analysis, TSS is the independent variable and all other parameters are dependent variables. The strength of the relationship between the independent and dependent variables (as reflected in the adjusted r^2 values) demonstrates how closely linked these parameters are to suspended sediments. Total parameters include all forms of the parameter: dissolved and forms bound to particles, including suspended sediments. Dissolved forms are not particle bound and, therefore, not assumed to be associated with TSS.

Total trace element concentrations generally have a stronger affinity for TSS than dissolved forms (significance with an alpha (p) of $p \leq 0.05$ and denoted in grey in Table 16-1). The strongest relationships are for total iron, vanadium, aluminum, cobalt, titanium, zinc, total phosphorus, and total nitrogen. Several of the dissolved parameters were also significantly associated with TSS (i.e., sulphate, magnesium, calcium), but demonstrated lower adjusted r^2 values than the total parameters mentioned here.

Below is a discussion on the physical and chemical properties associated with TSS that cause parameters to be associated with TSS.

Physical and Chemical Properties Associated with TSS

As shown in Table 16-1, some dissolved parameters can behave similarly to TSS. Below includes a discussion on how these properties affect TSS associated parameters.

A strong relationship between suspended sediments and trace elements (e.g., total metal, nutrient or ion concentrations in unfiltered water samples, including dissolved and particulate forms), is known to exist (Nasrabadi et al. 2016; Rugner et al. 2019). However, this relationship is complex and interactions between sediment and related parameters are controlled by physical and chemical properties. Beltaos and Burrell (2016) reported a strong association between suspended sediments and total metals and used the relationship to estimate metal levels. However, as environmental conditions that affect these physical and chemical properties change, so does the affinity between suspended sediments and trace elements.

Below is a list of properties that control for how trace elements react to suspended sediments; these properties can interact or act independent of each other. The physical and chemical conditions in the reservoir will determine how closely trace elements and suspended sediments are related.

Grain Size

Sediment-related trace element concentrations increase with decreasing particle grain size; smaller-sized particles have a proportionally larger surface for metal attachment. Surface area for coarse sand is approximately 10 cm^2 to 100 cm^2 per gram of sediment, whereas surface area for fine clay is approximately 10 m^2 to 40 m^2 per gram of sediment (Horowitz 1991). Therefore, as the proportion of finer grained particles (e.g., clay) in the water column increases, so does the total metal concentration.

ADSORPTION

This is a physical property where inorganic atoms or ions are held on to a solid surface due to the surface energy (i.e., ionic forces or bonding). It differs from absorption where an element is incorporated into the body of a solid (e.g., an absorbent sponge). Metals have a strong affinity and adhere to particles that have iron and manganese oxides.

CATION-EXCHANGE CAPACITY

Sediment particles have negatively-charged anionic sites that positively-charged cations can adhere to. Most metals have strong cation charges and replace weaker cations attached to the anionic sites. Because smaller particle sizes have proportionally larger surface areas, they also have a proportionally larger net charge and, therefore, can carry proportionally more cations.

ORGANIC MATTER

The relationship between organic matter and inorganic ions, including metals, depends on the type of suspended organic matter. The adsorption strength can vary from weak to strong and is dependent on factors such as the presence of inorganic sediment particles such as clay.

ELECTRON ACTIVITY (PH) AND REDOX POTENTIAL (EH)

In waters with lower pH levels (i.e., slightly acidic) and lower Eh levels (i.e., lower oxygen activity), metal ions become more soluble and are less likely to adsorb to particulate matter (Namiesnik and Rabajczyk 2010). Metals may oxidize and precipitate out of solution (and on particulate matter) in oxygenated waters. However, Fremion et al. (2016, 2017) demonstrated changes in pH and Eh resulted in an increase in soluble metals when sediments were resuspended and released from a reservoir on a French river.

Iron in fresh water reacts easily with oxygen-forming iron oxide precipitates on available surfaces including clay particles. These precipitates attract and collect trace elements from the water (Horowitz 1991).

NUTRIENT CYCLING

Nutrients, including nitrogen and phosphorus, undergo biological and chemical transformations (i.e., nutrient cycling).

Nitrogen associated with suspended sediment concentrations includes particulate organic nitrogen and ammonia and organic carbon adsorbed to inorganic particles (Wetzel 2001). The relationship between nitrogen and suspended sediment is dependent on how environmental conditions affect cycling: available oxygen, Eh, temperature, and decay of organic matter affect the form nitrogen takes. For example, under low redox conditions, anaerobic bacteria may convert nitrates to nitrogen gas in a biochemical transformation termed “denitrification”. Nitrogen cycling in the freshwater environment affects nitrogen partitioning between particulate and dissolved forms.

Particulate and dissolved forms of phosphorus are associated with available oxygen and Eh. Phosphorus co-precipitates with certain metals such as iron in the presence of oxygen and dissociates under anoxic conditions (Dodds 2002). Phosphorus forms originating from organic material (e.g., organism cells, enzymes) are associated with suspended sediments; however, environmental conditions and organic decay will affect phosphorus cycling and partitioning of phosphorus between particulate and dissolved forms.

CONCLUSION

Environmental conditions in the off-stream reservoir are generally not predicted to change physical and chemical properties of TSS in flood water in a manner that alters the relationship between suspended sediments and trace elements. Parameters that are strongly bound to suspended sediments in flood water will generally be strongly bound suspended sediments in the reservoir (i.e., sediment-bound and dissolved concentrations will be similar).

- The physical and chemical properties of suspended sediments in flood water (e.g., clay particles will remain the same size) is not expected to change in the reservoir. Therefore, adsorption and cation exchange capacity affecting sediment-bound trace elements is expected to remain the same.
- As water levels decrease toward the end of water release, the relative importance of sediment oxygen demand will increase oxygen consumption (e.g., sediment chemical processes) compared to the effect of wind action and reaeration. Consequently, the risk of anaerobic conditions increases (i.e., decreased availability of dissolved oxygen (DO) and decrease in redox potential) during the last few days before the reservoir is empty. This may affect nutrient cycling and cause the release of nutrients such as phosphorus and increase the mobility of metals into the water column over a short duration period of a few days.
- Many water quality constituents (i.e., metals) are associated with suspended sediments due to adsorption and cation-exchange capacity related forces. These processes represent strong binding mechanisms. Therefore, most constituents are expected to remain unavailable for biological uptake when water is in the reservoir. Fine suspended sediments (i.e., clays), will remain in suspension for most of the period water is in the reservoir. Biological activity resulting in algal growth and photosynthetic activity is expected to be suppressed with these elevated turbidity levels and, therefore, biologically-mediated pH levels are predicted to remain stable. Inorganic carbon (e.g., dissolved carbon dioxide and carbonates) are not expected to change greatly; partial pressure for carbon dioxide in the reservoir may change slightly from the river conditions but are not expected to shift pH to acidic levels.

- Changes to water quality associated with TSS associated constituents in the off-stream reservoir and downstream in Elbow River may occur over a short period of time during the last few days of water release. For most of the time water is being released from the reservoir, water quality is not predicted to change appreciably. Therefore, the conclusion in the EIA remains: effects on water quality due to TSS associated constituents is not significant (Volume 3B, Section 7.5, page 7.34).

Table 16-1 Relationship between Total Suspended Sediment Concentrations and Trace Element Concentrations

Parameter	Adjusted R^2	Intercept	Slope	*p*	N
Physical Parameters					
Turbidity	0.90634	-3.9789	0.79049	<0.00001	1,888
Specific conductance (field)	0.11009	380.13	-0.11756	<0.00001	1,369
Specific conductance (lab)	0.030233	391.48	-0.1196	0.000023303	553
pH (lab)	-0.00047128	8.2432	8.3047E-06	0.7285	1,868
Salinity and Ions					
Total alkalinity	0.24454	146.76	0.071711	<0.00001	1,264
Total dissolved solids	0.10287	222.99	-0.31189	0.011009	53
Dissolved sulphate	0.096904	61.068	-0.035308	<0.00001	1,309
Dissolved magnesium	0.089729	15.769	-0.0046606	<0.00001	1,305
Total hardness	0.086628	210.43	-0.05706	<0.00001	1,262
Dissolved calcium	0.083172	56.984	-0.013796	<0.00001	1,259
Dissolved fluoride	0.062324	0.26618	-0.000091859	<0.00001	1,289
Dissolved potassium	0.0070593	0.75928	0.00026073	0.0013843	1,305
Dissolved chloride	-0.0006615	2.4476	0.0002036	0.7137	1,310
Dissolved sodium	-0.00018573	3.015	0.00033959	0.38416	1,305
Nutrients and Carbon					
Total phosphorus	0.79949	0.0055388	0.00044709	<0.00001	2,227
Total nitrogen calc	0.38704	0.2227	0.0010866	<0.00001	1,230
Total Kjeldahl nitrogen	0.35484	0.12171	0.00088843	<0.00001	1,324
Total organic carbon	0.17375	1.3099	0.0049715	<0.00001	1,830
Total coliforms	0.15192	232.48	1.722	<0.00001	1,782
Dissolved phosphorus	0.038167	0.0028576	0.000011124	<0.00001	1,847
Total ammonia-n	0.021708	0.029311	0.000054139	0.00037301	534
Dissolved organic carbon	0.017685	1.252	0.0021651	0.21307	35
Nitrate+nitrite-n	0.0074866	0.079141	0.000076861	0.13337	170

Table 16-1 Relationship between Total Suspended Sediment Concentrations and Trace Element Concentrations

Parameter	Adjusted R^2	Intercept	Slope	*p*	N
Total ammonia-n (calc)	0.00075421	0.015506	2.3425E-06	0.1682	1,195
Nitrite	0.00016267	0.0016462	7.7038E-07	0.26185	1,598
Total inorganic carbon	-0.028179	36.267	-0.059606	0.63348	29
Nitrate	-0.0005748	0.10533	2.4437E-06	0.77311	1,597
Nitrate+nitrite-n (calc)	-0.0005229	0.1055	3.4939E-06	0.68291	1,595
Metals					
Total iron	0.91731	80.671	11.029	<0.00001	250
Total aluminum	0.87466	39.389	7.9273	<0.00001	248
Total vanadium	0.86118	0.27136	0.020482	<0.00001	249
Total cobalt	0.65991	0.29856	0.003403	<0.00001	249
Total titanium	0.5359	1.1609	0.062541	<0.00001	248
Total zinc	0.52186	1.7295	0.0435	<0.00001	249
Total chromium	0.45395	0.38754	0.0095103	<0.00001	251
Total barium	0.43529	64.243	0.18085	<0.00001	252
Total arsenic	0.36205	0.2841	0.0046549	<0.00001	252
Total copper	0.35946	0.68237	0.014359	<0.00001	251
Total lithium	0.2485	3.8907	0.0073039	<0.00001	246
Total strontium	0.20996	430.23	-0.5445	<0.00001	193
Total boron	0.13884	8.0123	0.010419	<0.00001	248
Total nickel	0.13181	0.86341	0.013262	<0.00001	251
Total manganese	0.096819	4.6426	0.24883	<0.00001	249
Total uranium	0.024811	0.40069	0.00048183	0.0074389	248
Total molybdenum	0.0061274	0.50504	-0.00058084	0.11305	249
Total selenium	-0.0036009	0.62205	-0.000096264	0.74851	251

NOTE:
Grey denotes a statistically significant relationship with suspended sediment with an alpha of $p<0.05$

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Question 17

Supplemental Information Request 1, Question 83, Pages 2.127-2.129
Supplemental Information Request 1, Question 83, Figure IR83-1, Page 2.127
Supplemental Information Request 1, Question 101, Pages 2.175-2.177

Alberta Transportation provided a description of dissolved oxygen (DO) measurements and changes to water temperature.

a. **Explain if there is a possibility for further decreases in DO concentration within the Elbow River during release of relatively warmer water from the reservoir and/or an increase in nutrient loading (and other sediment related parameters), given that summer DO concentrations are already relatively low at times.**

b. **Explain the effects to aquatic resources in the Elbow River due to changes in DO caused by reservoir water release during summer. Use the assumption that the existing aquatic biological community may already be stressed by low DO concentrations.**

c. **Quantify changes to reservoir water temperature and DO concentrations caused by differences (e.g., increases) in water retention periods.**

d. **Assess 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

a. ***POTENTIAL FOR DECREASE IN DO AND INCREASES IN NUTRIENTS***

The possibility of decreases in DO compared to that presented here are dependent on the size and nature of future floods, subsequent reservoir retention times, and the Elbow River flow regime during the reservoir release. The hydrodynamic modelling used to predict temperature and DO levels, presented below, are based on specific hydrographs for three floods (including the succeeding three month flows) and reservoir retention times based on those hydrographs: 1:10 year flood based on the 2008 hydrograph; 1:100 year flood based on a modified 2005 hydrograph; and a design flood based on the 2013 hydrograph. Each flood was modelled using an early and late release based on Elbow River flows (i.e., early reservoir release when Elbow River recedes to 160 m^3/s and late release when Elbow river recedes to 20 m^3/s; see Introduction section for a description of the off-stream reservoir early release and late release operating parameters). These modelling scenarios provide a select combination of the many possible conditions that may affect water DO levels in future floods. Reservoir filling and water release for each flood is summarized in Table 17-1.

Table 17-1 Durations to Divert, Retain and Release Water from the Reservoir for each Flood

Simulation	Time to Divert Flood Water (days)	Reservoir Hold Time (days)	Days Required for Release of all Water (days)	Days from Start of Flood until Water Release is Complete (days)
Early Release				
1:10 year flood	0.3	0	1.7	2.0
1:100 year flood	1.8	0	23.5	25.3
2013 flood	3.8	0	35.4	39.2
Late Release				
1:10 year flood	0.4	42.0	2.0	44.4
1:100 year flood	1.8	67.0	23.5	92.3
2013 flood	3.8	21.0	36.7	61.5

Future flood conditions and their associated hydrographs are expected to have unique features that affect how the reservoir will fill (i.e., rate and quantity of water), water retention times, and release durations. Annual temperature variability may result in reservoir water being exposed to higher than normal temperatures. Consequently, reservoir and release conditions may result in higher water temperatures and lower DO levels than presented here. In situations where DO levels are lower than predicted here, changes in redox potential may affect nutrient availability and result in elevated nutrient levels being released from the reservoir.

DO concentrations in the off-stream reservoir are not predicted to drop below 6 mg/L except during the last few days water is in the reservoir during the 1:10 year flood for late release when the DO level is predicted to drop to 2 mg/L (see discussion titled "*Dissolved Oxygen and Effects to Aquatic Biota*" below for DO guidelines and Figure 17-1, Figure 17-6, Figure 17-11, Figure 17-16, Figure 17-21 and Figure 17-26). Median DO concentrations generally range between 8 mg/L and 10 mg/L over this duration. During the 1:10 year flood, the amount of flood water diverted is small compared to the 1:100 year and design floods. Consequently, water levels are considerably shallower and thus warm more quickly (compared to larger floods) due to solar radiation and air temperature. The average water depth for the 1:10 year flood is 0.7 m compared an average depth of 8 m for the 1:100 year flood and 11 m for the design flood.

Warm water contributing to low DO levels may result in localized areas in the reservoir where redox conditions could conceivably cause the release of nutrients from sediments.

Nutrient water quality in the reservoir and Elbow River is discussed in the response to NRCB Question 18 and summarized as follows:

- DO is not predicted to affect nutrient levels. However, for a 1:10 year flood and late release, shallow water will be held in the reservoir for over 45 days, which will result in increased water temperatures and a drop in DO decreasing to about 2 mg/L by the time the reservoir is empty.
- Based on the 1:10 year flood for late release, some localized and shallow areas of the reservoir exposed to direct sunlight may have conditions where temperatures increase and DO temporarily decreases to the point of anoxia. In such cases, dissolved nutrients may come out of sediments and into the water column. Where these waters are reoxygenated in the reservoir, a portion of these nutrients may precipitate (i.e., become unavailable for biological processing); however, a portion will also be released to Elbow River.
- Because oxygen levels are not predicted to become depleted to the point of anoxia for the 1:100 year flood and design flood, nutrients are not predicted to mobilize or transfer from particulate forms. Therefore, dissolved nutrient levels are not predicted to increase.
- Nutrient concentration levels in water released from the reservoir will be influenced by 1) the nutrient concentrations in water diverted from the river; 2) the duration water is held and released from the reservoir; and 3) environmental conditions such as available DO.

The following discussion provides analysis to estimate the nutrient concentrations in released reservoir water and how that water compares with Elbow River water at the time water is released. The difference in water quality between the off-stream reservoir and Elbow River is dependent on the duration water is held in the reservoir, as well as the timing (i.e., when during the summer what is released) water is released to Elbow River. Nutrient water quality concentrations in Elbow River tend to decrease over the summer; median and 75th percentile nutrient concentrations in the river are higher in June than August. Therefore, it may be assumed releasing reservoir water later in the season may have a bigger impact when nutrient concentrations are low in the river.

However, nutrient concentrations in the reservoir also decrease and at a higher rate than observed in the river, as evidenced when comparing early release and late release for the 1:100 year and design floods. There are a few exceptions where nutrients are not predicted to decrease over time and these include dissolved nutrients (i.e., dissolved phosphorus and nitrate+nitrate in the 1:100 year flood for early and late release). Decreases in nutrient concentration are likely due to sedimentation and deposition in the reservoir.

b-c. ***DISSOLVED OXYGEN AND TEMPERATURE MODELLING RESULTS***

Water temperature, DO and biochemical oxygen demand (BOD) were modelled using the DHI oxygen eco-module attached to the MIKE 21 hydrodynamic model. The model was run for the 1:10 year flood, 1:100 year flood and design flood for both early and late release (six simulations in total). The time series results for water temperature, DO and BOD are provided for the following locations:

- the off-stream reservoir near the outlet
- Elbow River at the confluence with the unnamed creek where reservoir water enters the river
- Elbow River 300 m downstream of the unnamed creek
- Elbow River 13 km downstream of the unnamed creek at Twin Bridges
- Elbow River 24 km downstream at Sarcee Bridge

Elbow River water temperature and DO for the relevant diversion dates are used for the model boundary conditions.

Biochemical oxygen demand data was not available for Elbow River and, therefore, BOD was substituted with total organic carbon (TOC) for modelling purposes. The TOC equivalent for BOD was calculated using the equation provided in Lee et al. (2016): $y=0.77x-0.443$.

The modelling report (see the response to NRCB Question 15, Appendix 15-1) provides details of the 1) MIKE 21 hydrodynamic model and link to the ECO Lab module, 2) the sensitivity analysis, and 3) model assumptions and uncertainty.

Water temperature in Elbow River downstream of the unnamed creek (where reservoir water will be returned to the river) generally increases over the summer months with highest temperatures reaching or exceeding 15˚C. Median temperatures generally range between 9˚C and 13˚C from June through August. DO concentrations at the same location generally decrease over the summer as water temperatures rise. Median DO concentrations generally range between 8 mg/L and 10 mg/L over this duration.

The temperature, DO and BOD results are as follows:

1:10 Year Flood, Early Release

- Water will be diverted into the reservoir until flows in Elbow River recede to 160 m^3/s, at which point diverted water will be released back to the river. It will take approximately two days to fill and empty the reservoir. This duration does not appear to affect the temperature, BOD or DO in the reservoir or in the river once released (Figure 17-1 through Figure 17-5).

- Water temperature follows a sine wave pattern, oscillating as diel temperatures rise and fall with solar exposure and air temperatures.
- DO levels oscillate in response to water temperature: as diel water temperatures rise there is a short lag time before DO levels begin to decrease.

1:10 Year Flood, Late Release

- Water is held in the reservoir for 45 days before the reservoir is emptied (i.e., time to divert, hold and release water). Water temperatures increase over this duration at a rate higher than in the river. BOD levels decrease quickly after the first few days the reservoir is filled and DO decreases over a longer duration to approximately 2 mg/L by the end of the water release (Figure 17-6).
- As reservoir water is released to Elbow River, mixing causes Elbow River water temperature to increase 4˚C to 5˚C from about 15˚C to 20˚C and DO to decrease from 10 mg/L to 6 mg/L (Figure 17-7).
- The temperature effect in Elbow River is predicted to extend for at least 24 km to Sarcee Bridge; however, changes to DO are indistinguishable 13 km downstream of the unnamed creek at Twin Bridges (Figure 17-8 through Figure 17-10).

1:100 Year Flood, Early Release

- Water is held in the reservoir for 25 days before water release is complete (i.e., time to divert and release water). Water temperatures increase approximately 2˚C during this period from less than 5˚C to about 6.5˚C; increases in temperature appear to be limited due to higher water levels in the reservoir compared to the 1:10 year flood (Figure 17-11).
- DO levels decrease approximately 2 mg/L from about 12 mg/L to 10 mg/L over the 25 days water is held in the reservoir. BOD has an effect on the DO levels during the early duration of water retention in the reservoir while temperature appears to affect DO over the longer term.
- As water is released to Elbow River, changes to the river water temperature and DO are not apparent. Over the duration water is released, water temperatures in Elbow River increase slightly (less than a degree) and DO decreases slightly (less than 1 mg/L) (Figure 17-12).
- The effect on Elbow River is predicted to decrease downstream but small changes in temperatures (i.e., less than 1˚C) can be seen 24 km downstream at Sarcee Bridge (Figure 17-13 through Figure 17-15).

1:100 Year Flood, Late Release

- Water is held in the reservoir for 92 days before water release is complete (i.e., time to divert, hold and release water). Water temperature increases from about 4.5˚C to approximately 7.5˚C (Figure 17-16).
- DO levels decrease over this duration from 12 mg/L to approximately 7.5 mg/L. BOD has an effect on the DO levels during the early period of water retention in the reservoir, while temperature appears to affect DO over the longer term.
- The water temperature in the reservoir does not increase at the rate seen in Elbow River. Reservoir water released to Elbow River mixes with river water, which results in river water temperature decreasing by almost 4˚C from approximately 10˚C to 6.5˚C. Elbow River water temperatures increase slightly over the duration of water release (i.e., from August 7 to August 31). This may be due to water temperature increasing in Elbow River at a greater rate as water levels in the reservoir decrease (Figure 17-17).
- DO levels in Elbow River decrease slightly over the duration water is released from the reservoir. Changes in DO are more prominent as water temperatures increase.
- The effect in Elbow River is predicted to extend for at least 24 km to Sarcee Bridge (Figure 17-18 through 17-20).

Design Flood, Early Release

- Water is held in the reservoir for 39 days before water release is complete (i.e., time to divert and release water). Water temperatures increase slightly during this period. As in the 1:100 year flood, increases in temperature appear to be limited due to higher water levels in the reservoir compared to the 1:10 year flood for both early release and late release (Figure 17-21).
- Water temperature in the reservoir increases from about 7˚C to 9˚C. BOD is quickly exhausted during the first days water is in the reservoir and DO decreases from about 12 mg/L to 8 mg/L over the duration of water release.
- Slight effects on Elbow River water temperature and DO can be seen in the days after water release begins (i.e., approximately 2 to 3 days). Water temperatures in the reservoir increase at a slower rate than in the river and, therefore, have a cooling effect on Elbow River water temperatures through the summer as water is released. When water release is complete and the influence of the reservoir is removed, Elbow River water temperatures increase about 2˚C while DO levels increase about 2 mg/L (Figure 17-22).
- A shift in water temperature and DO at downstream locations is not seen at the end of water release (Figure 17-23 through 17-25).

Design Flood, Late Release

- Water is held in the reservoir for 61.5 days before water release is complete (i.e., time water is diverted, held and released). Water temperatures increase in the reservoir and DO concentrations decrease over time (Figure 17-26).
- Water temperature in the reservoir increases from about 7.5˚C to 9.5˚C while DO decreases from about 12 mg/L to almost 6 mg/L. The greatest decrease in DO in the reservoir is at the end of the drawdown period as the water level decreases and water temperature increases.
- Water temperatures in the reservoir do not increase at the same rate as in the river. When reservoir water is released and mixes with river water, the river temperature decreases by about 2˚C from 9˚C to 7˚C. By the end of water release, this mixing does not result in a change to river temperatures (Figure 17-27).
- Reservoir water mixing in Elbow River causes river water DO to decrease 1 mg/L to 2 mg/L over the duration of water release.
- Effects on the river are predicted to occur downstream of the unnamed creek. Temperature effects can be seen 24 km downstream at Sarcee Bridge, whereas DO effects are almost indistinguishable at 13 km downstream at Twin Bridges (Figure 17-28 through 17-30).

DISSOLVED OXYGEN AND EFFECTS TO AQUATIC BIOTA

Under most combinations of flood magnitude, early release, later release, DO is predicted to decrease in Elbow River; however, levels are not expected to have an effect on the sustainability of resident aquatic biota. For reference, the CCME (1999) aquatic life guidelines for cold water are 9.5 mg/L for early life stages (i.e., fish and invertebrates) and 6.5 mg/L for all other life stages. Cold water fish are those species with optimum temperature range between 4˚C and 15˚C; the fish resident to Elbow River are cold water species (Armantrout 1998).

Effects on aquatic biota from changes in DO in Elbow River are discussed as follows.

1:10 Year Flood, Early Release

- No change in DO in Elbow River expected from background levels of approximately 10 mg/L (Figure 17-2); there is no discernable effect on aquatic biota.

1:10 Year Flood, Late Release

- Decrease in Elbow River DO by 4 mg/L (from 10 mg/L to 6 mg/L) at the unnamed creek and 2 mg/L (from 10 mg/L to 8 mg/L) at 300 m downstream of the unnamed creek. This is expected to result in an oxygen stress condition on all life stages of fish and invertebrates for a duration of 2 days.

1:100 Year Flood, Early Release

- DO in the reservoir will decrease by 4˚C; over the duration water is being released (i.e., 24 days), DO in Elbow River will decrease by 1˚C to 2˚C. There is no discernable effect on aquatic biota.

1:100 Year Flood, Late Release

- DO in the reservoir will decrease by up to 2 mg/L; over the duration water is being released (i.e., 24 days), DO levels in Elbow River will decrease to 9 mg/L. A decrease in DO to 9 mg/L may be stressful for early life stages; however, the duration that DO levels in Elbow River are below the aquatic life guideline level of 9.5 is only 1 to 2 days at the end of the reservoir release period (Figure 17-17). Effects in Elbow River appear to be limited to 300 m downstream of the unnamed creek. Overall effects to aquatic biota are expected to be small and within natural variation.

Design Flood, Early Release

- DO in the reservoir will decrease by less than 2 mg/L; over the duration water is being released (i.e., 35 days), DO levels in Elbow River will decrease to between 9 mg/L and 9.5 mg/L. This decrease in DO is to levels just under the aquatic life guideline for early life stages; however, this will only continue for the last one or two days at the end of the duration of reservoir release (Figure 17-22). Overall effects on aquatic biota are expected to be small and within natural variation.

Design Flood, Late Release

- DO in the reservoir will decrease by about 3 mg/L; over the duration this water is released (i.e., 37 days), DO levels in Elbow River will decrease from less than 12 mg/L to almost 8 mg/L. A decrease in DO to almost 8 mg/L may be stressful for early life stages; however, the duration DO levels in Elbow River are predicted to be below the aquatic life guideline level of 9.5 is approximately one week at the end of reservoir release (Figure 17-27). Effects appear to be limited to 300 m downstream of the unnamed creek. Overall effects on aquatic biota are expected to be small and within natural variation.

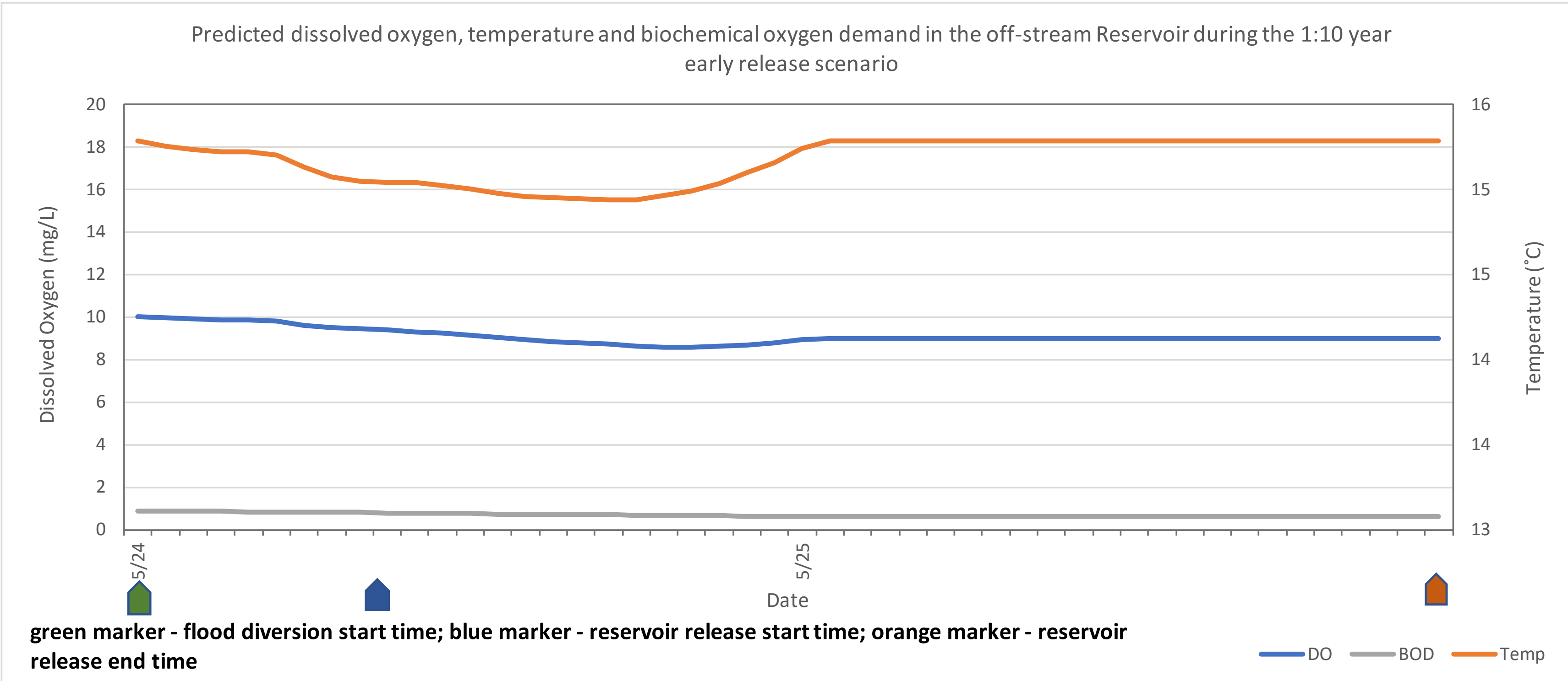
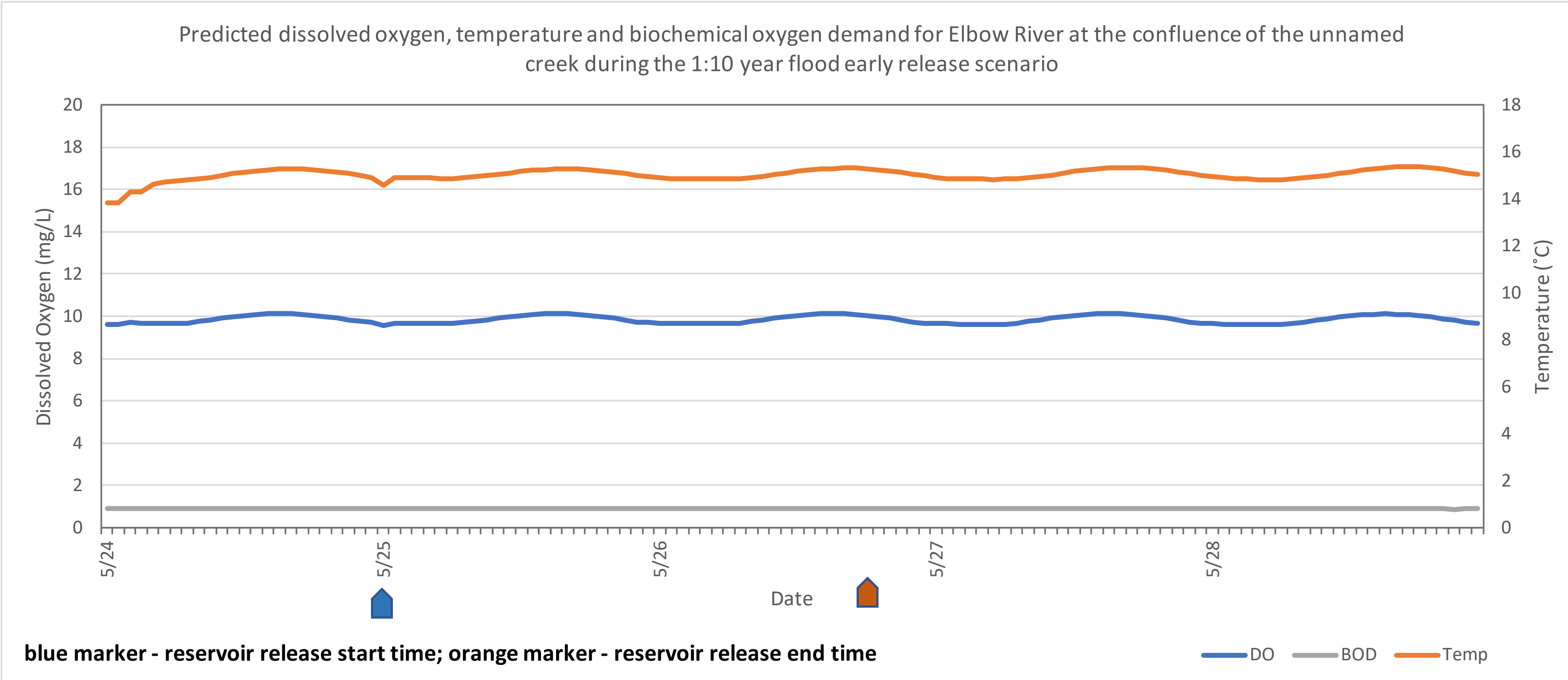


Figure 17-1 **DO, Temperature and BOD in the Off-Stream Reservoir, 1:10 Year Flood Early Release (water in the reservoir from May 24 to May 25)**



NOTE: DO oscillates in response to diel temperature fluctuations

Figure 17-2 DO, Temperature and BOD in Elbow River at the Confluence of the Unnamed Creek, 1:10 Year Flood Early Release (water release from May 25 to May 26)

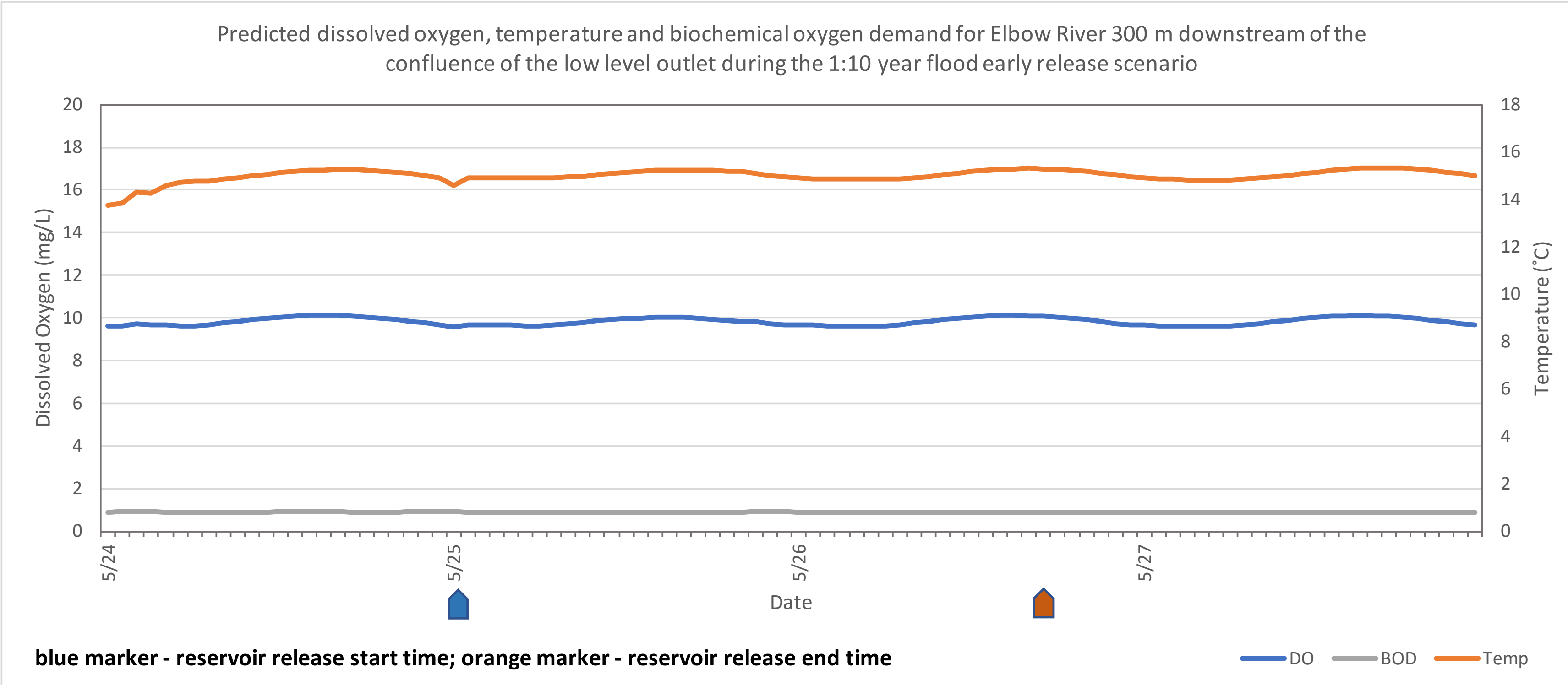


Figure 17-3 **DO, Temperature and BOD in Elbow River 300 m Downstream of the Unnamed Creek, 1:10 Year Flood Early Release (water release from May 25 to May 26)**

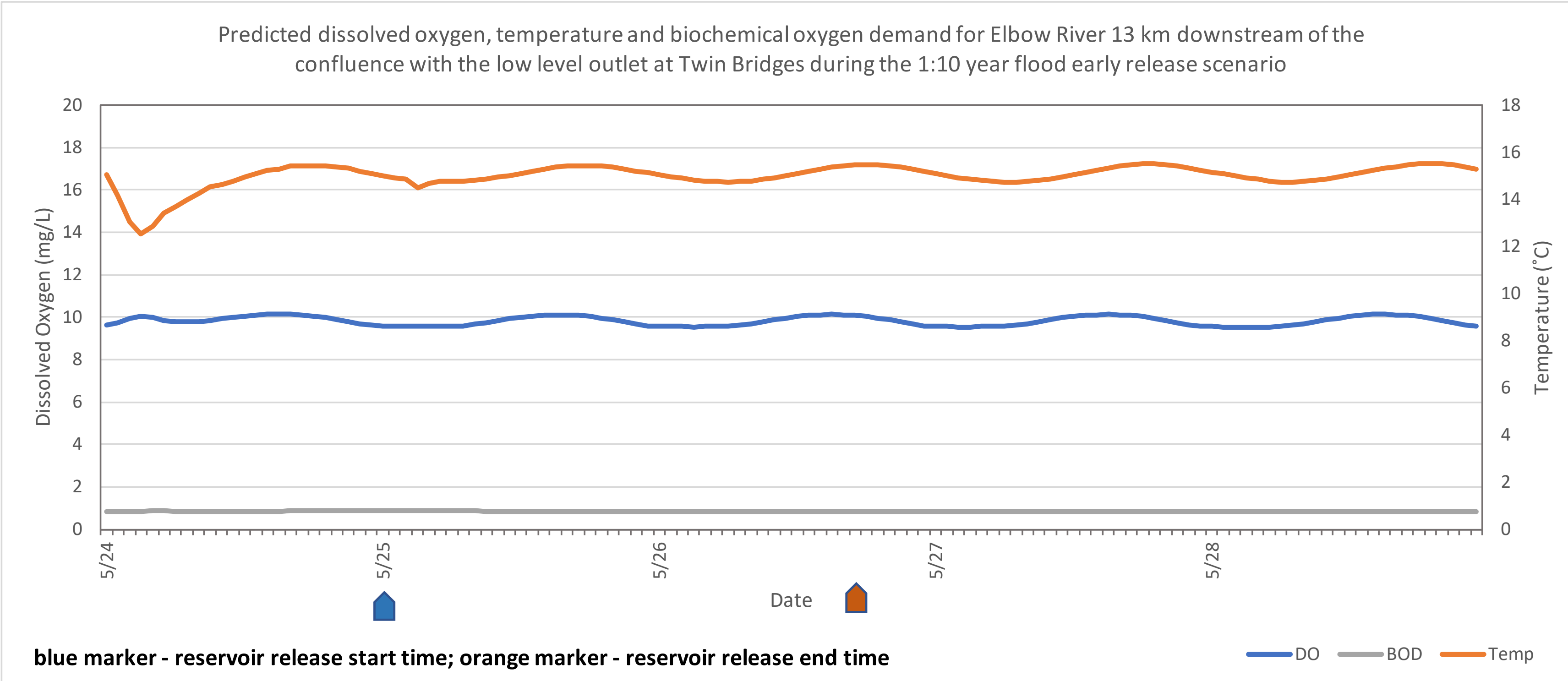


Figure 17-4 **DO, Temperature and BOD in Elbow River 13 km Downstream of the Unnamed Creek at Twin Bridges, 1:10 Year Flood Early Release (water release from May 25 to May 26)**

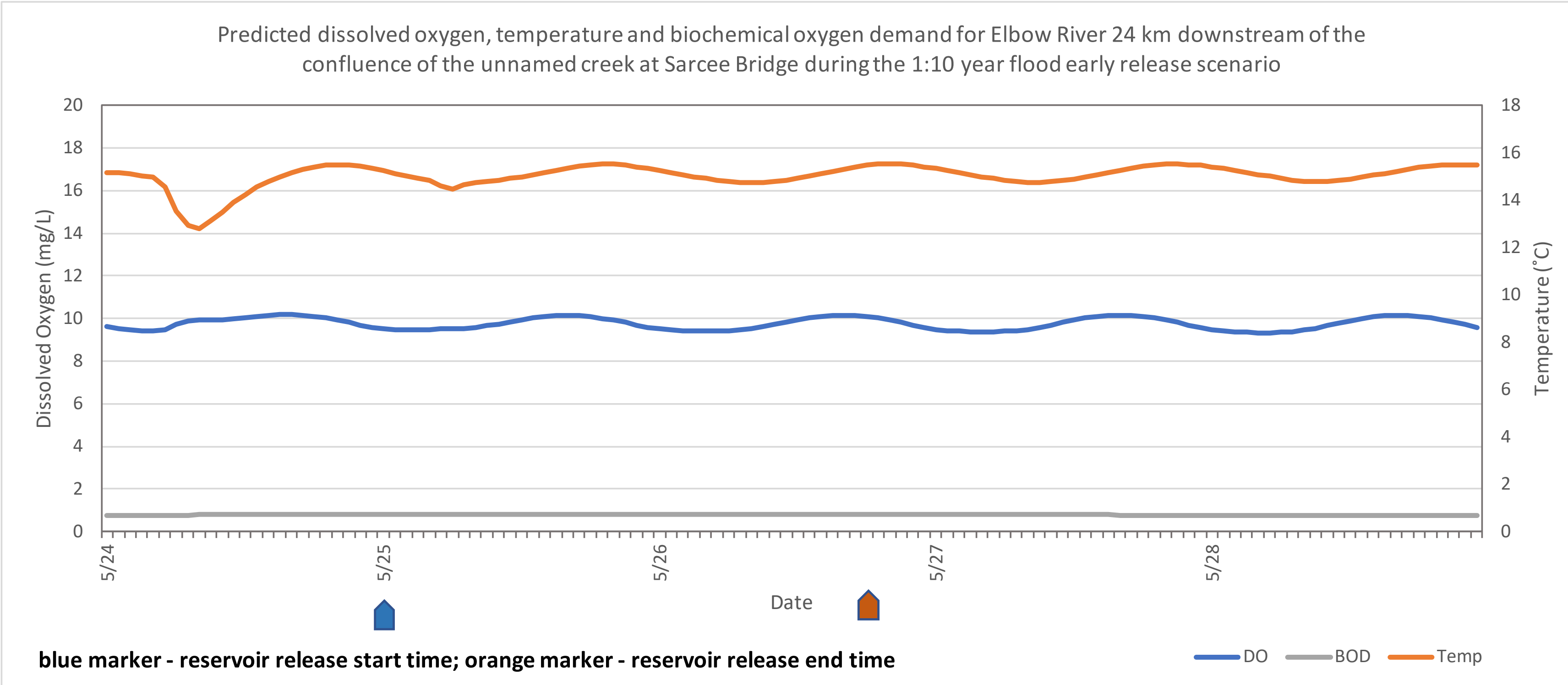


Figure 17-5 **DO, Temperature and BOD in Elbow River 24 km Downstream of the Unnamed Creek at Sarcee Bridge, 1:10 Year Flood Early Release (water release from May 25 to May 26)**

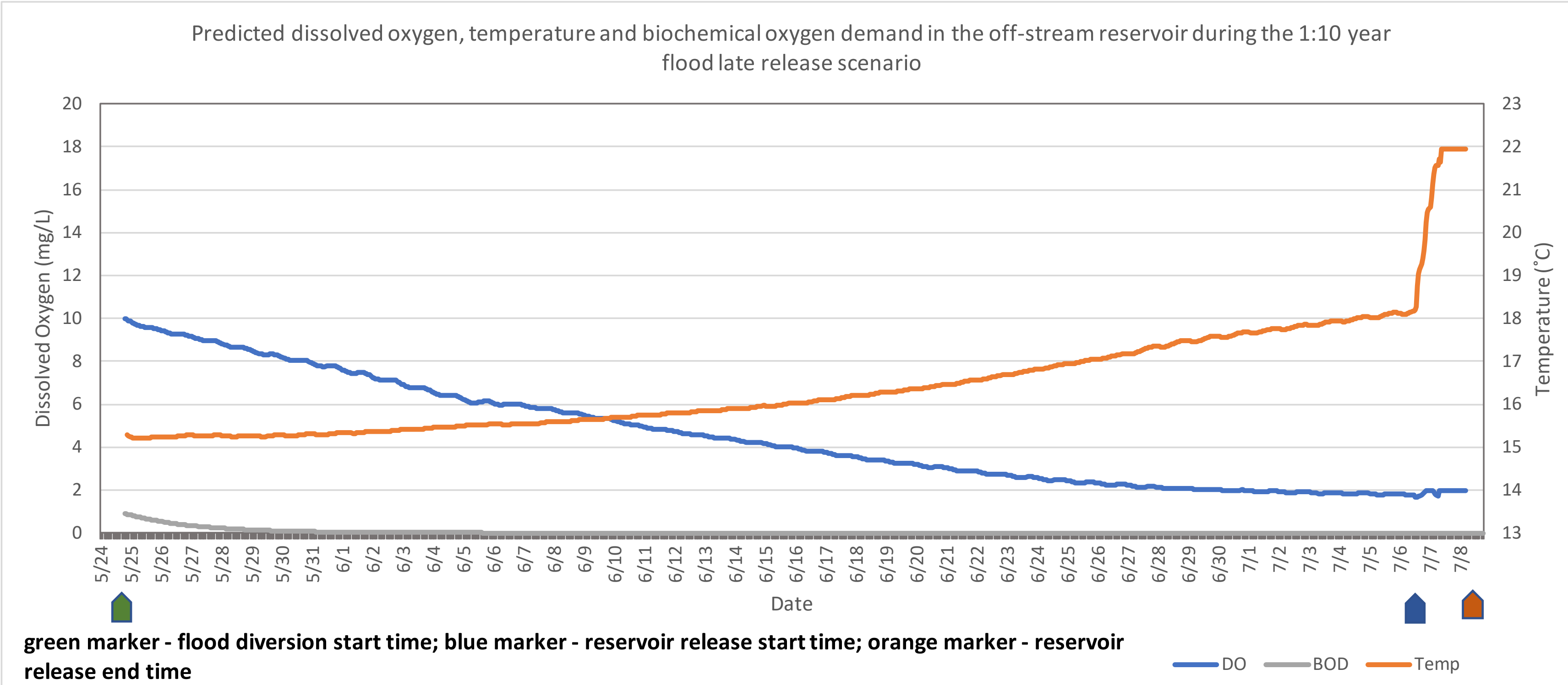
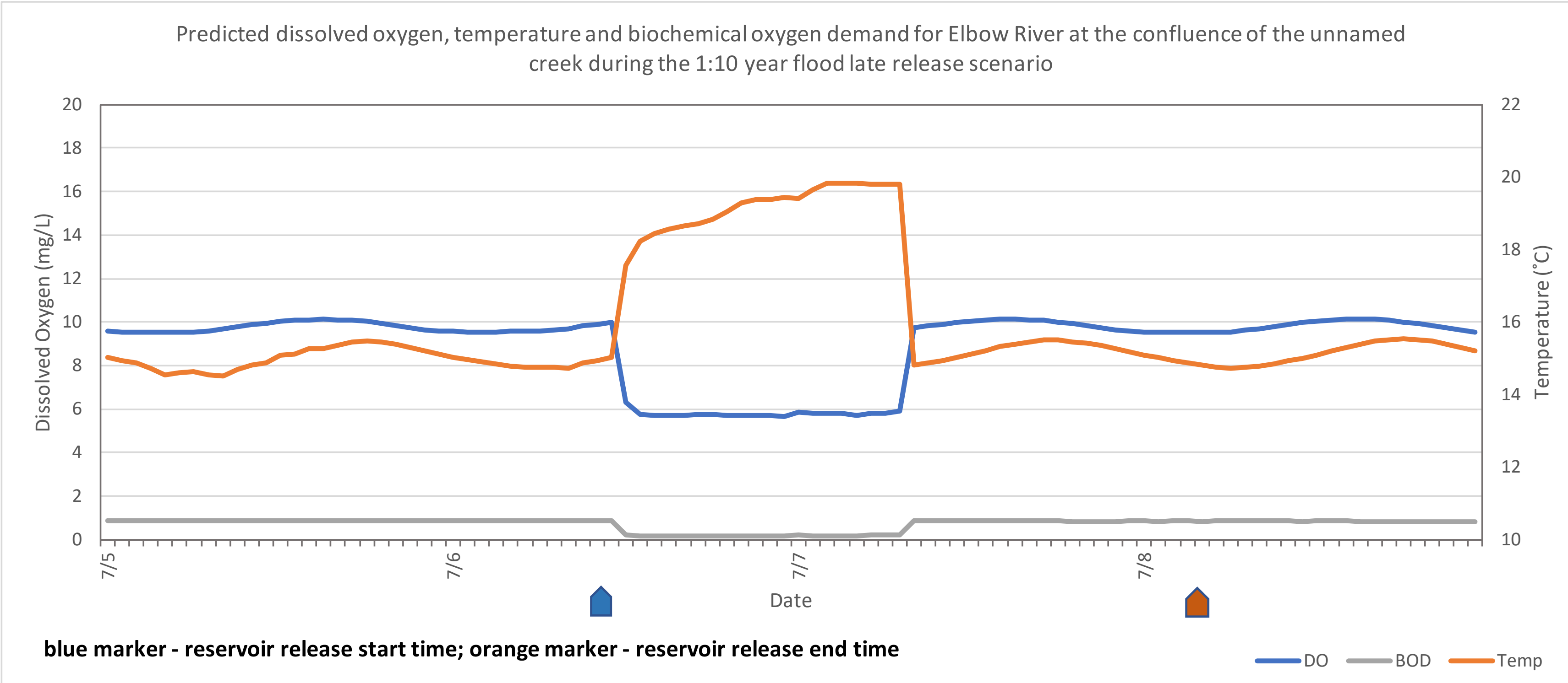


Figure 17-6 DO, Temperature and BOD in the Off-Stream Reservoir, 1:10 Year Flood Late Release (water is in the reservoir from May 24 to July 8; 45-day duration)



NOTE: DO oscillates in response to diel temperature fluctuations

Figure 17-7 DO, Temperature and BOD in Elbow River at the Confluence of the Unnamed Creek, 1:10 Year Flood Late Release (during water release from July 6 to July 8)

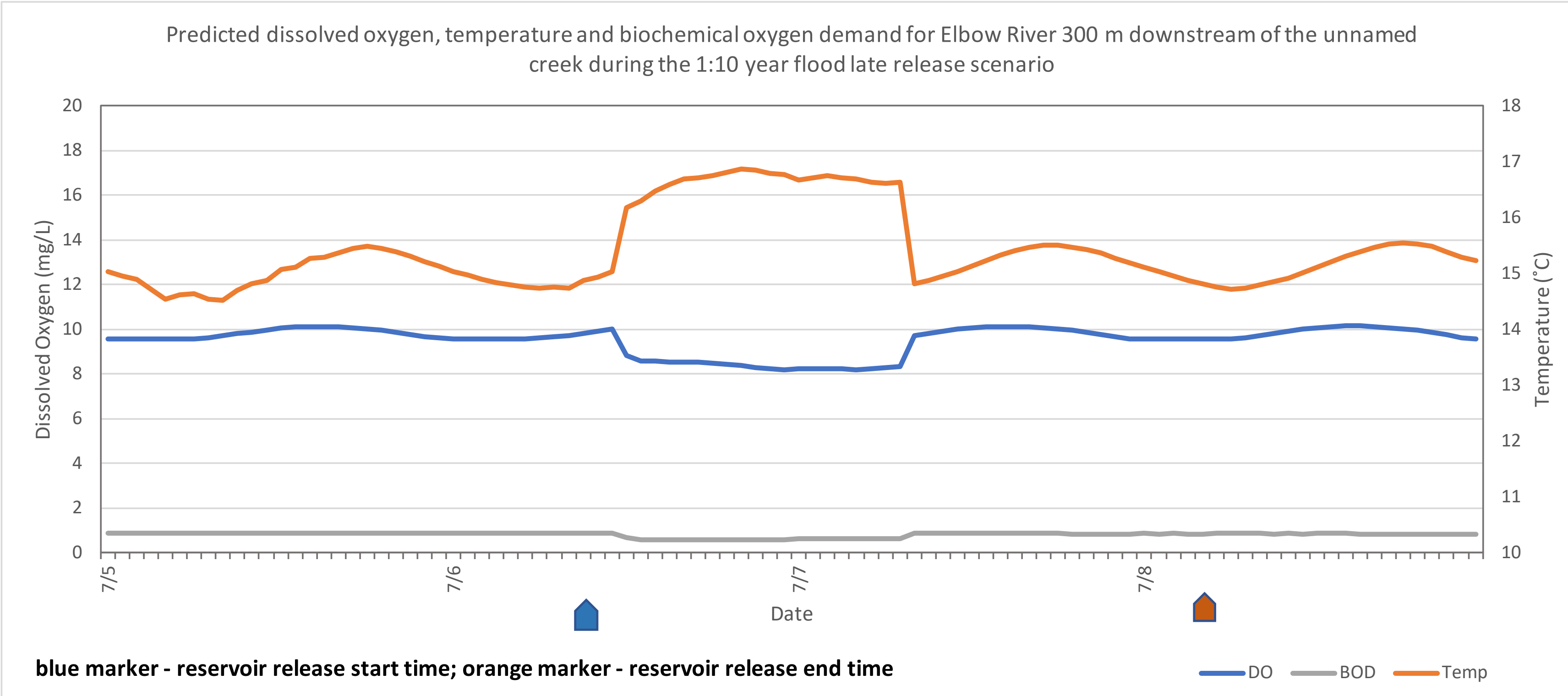


Figure 17-8 DO, temperature and BOD in Elbow River 300 m Downstream of the Unnamed Creek, 1:10 Year Flood Late Release (during water release from July 6 to July 8)

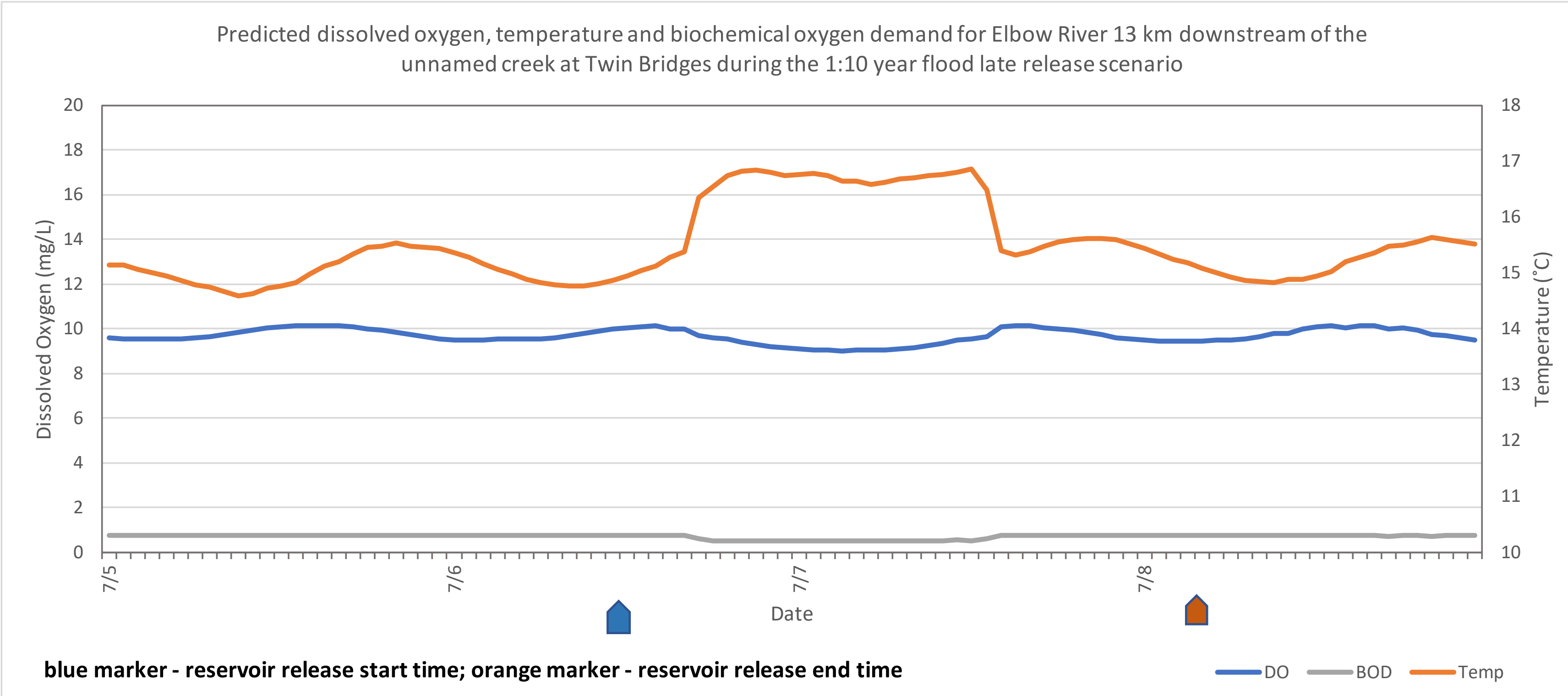


Figure 17-9 DO, Temperature and BOD in Elbow River 13 km Downstream of the Unnamed Creek at Twin Bridges, 1:10 Year Flood Late Release (during water release from July 6 to July 8)

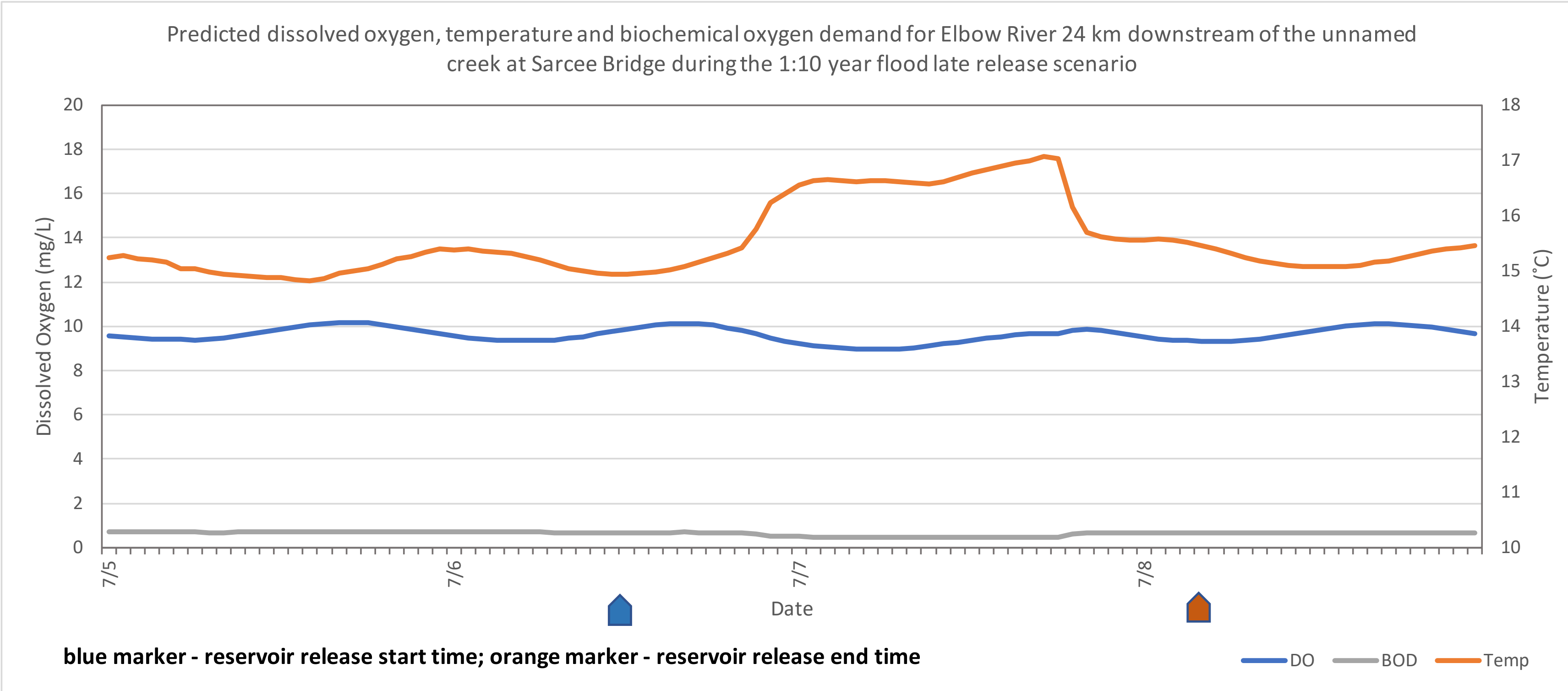


Figure 17-10 DO, Temperature and BOD in Elbow River 24 km Downstream of the Unnamed Creek at Sarcee Bridge, 1:10 Year Flood Late Release (during water release from July 6 to July 8)

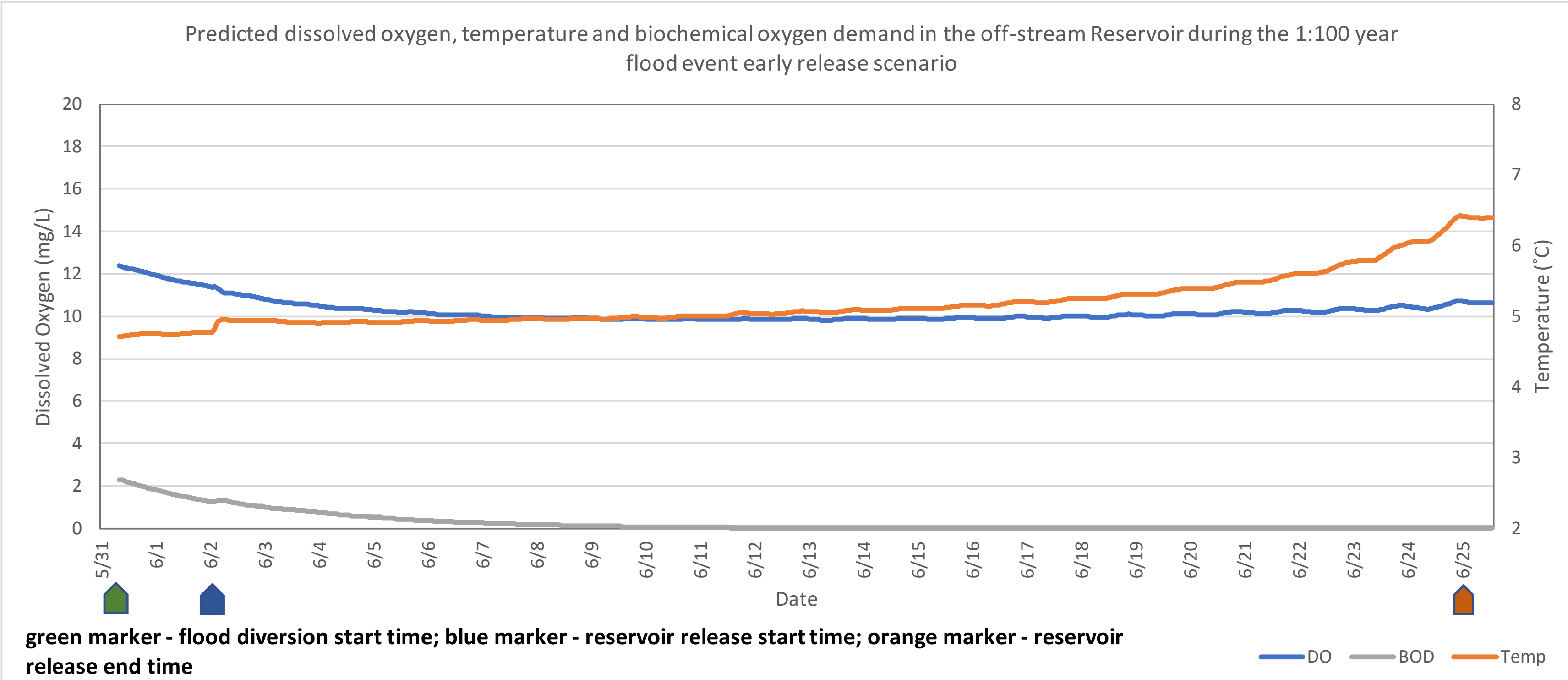
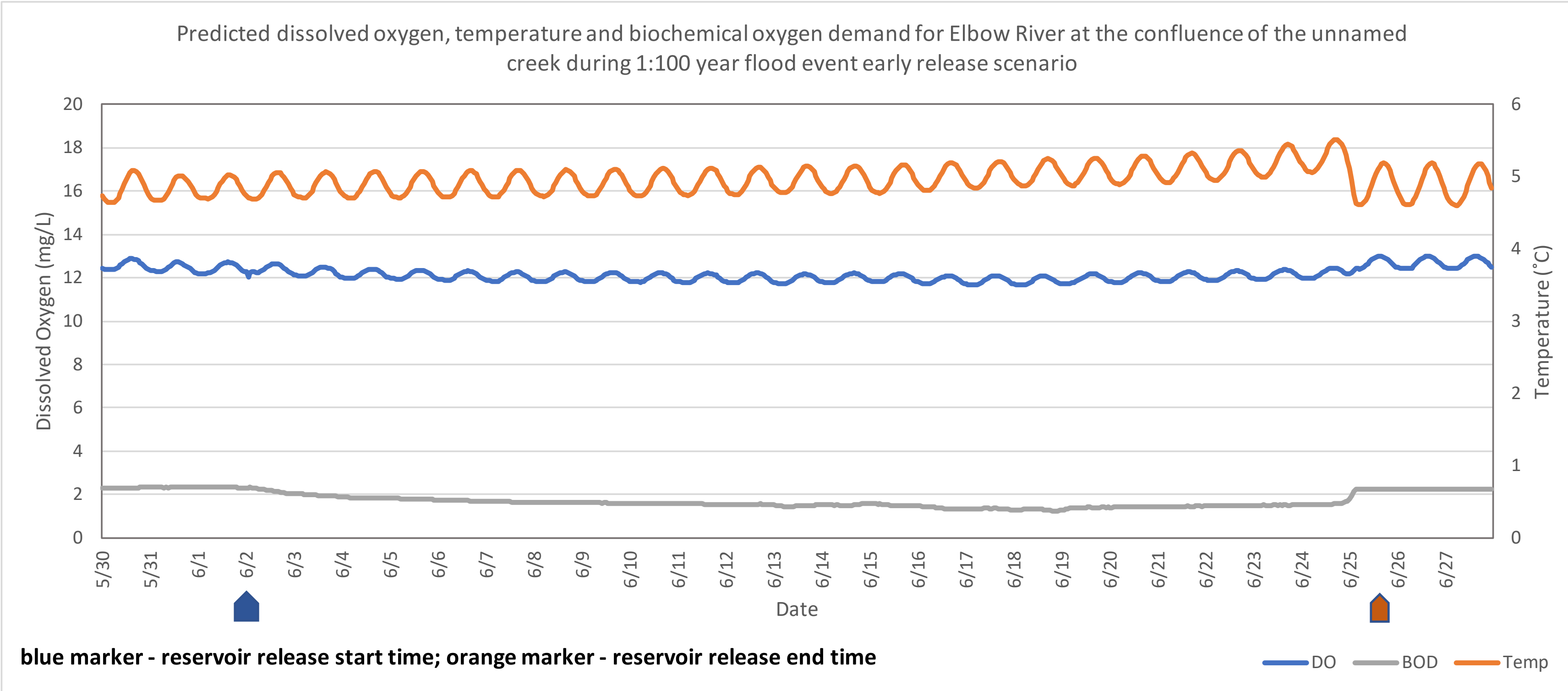


Figure 17-11 DO, Temperature and BOD in the Off-Stream Reservoir, 1:100 Year Flood Early Release (during water in the reservoir from May 31 to June 25; duration 25 days)



NOTE: DO oscillates in response to diel temperature fluctuations

Figure 17-12 DO, Temperature and BOD in Elbow River at the Confluence of the Unnamed Creek, 1:100 Year Flood Early Release (during water release from June 6 to June 25; duration 25 days)

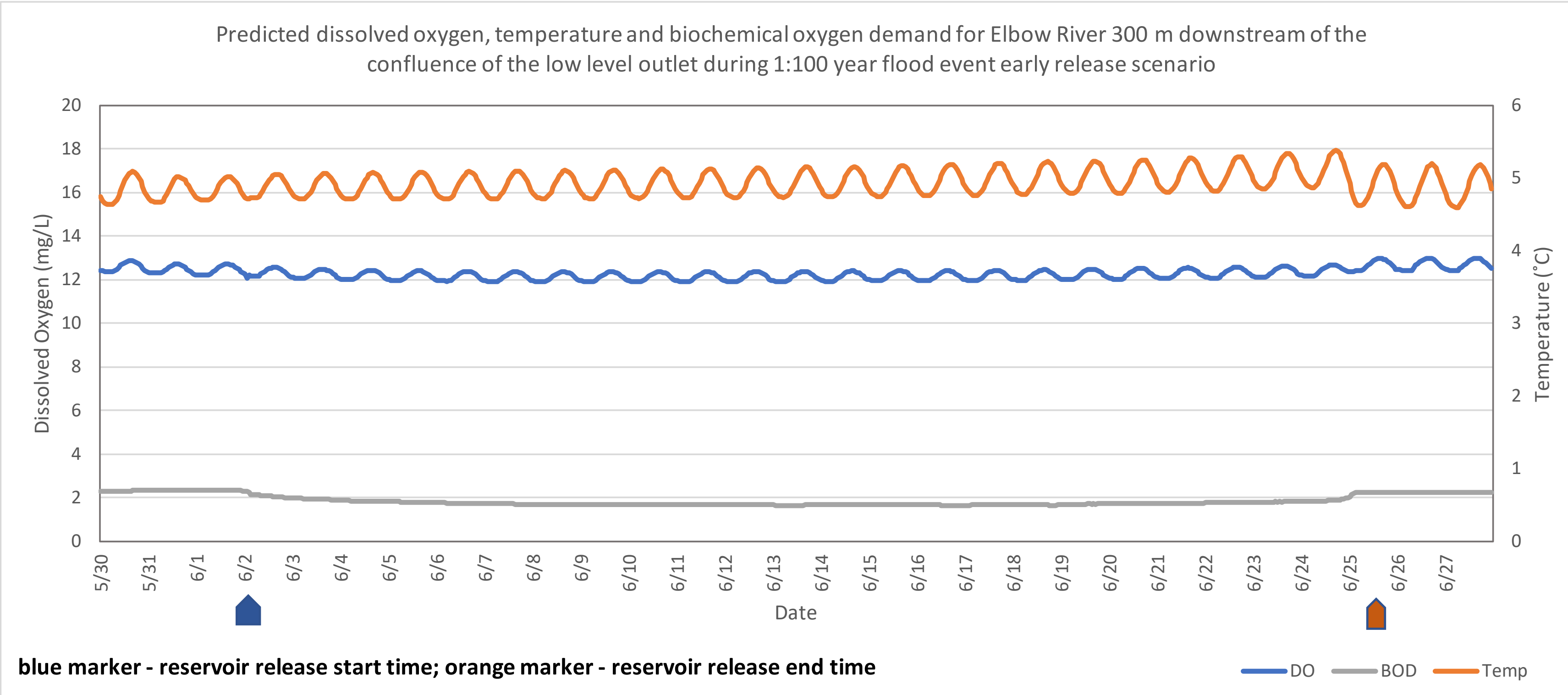


Figure 17-13 **DO, Temperature and BOD in Elbow River 300 m Downstream of the Unnamed Creek, 1:100 Year Flood Early Release (during water release from June 6 to June 25; duration 25 days)**

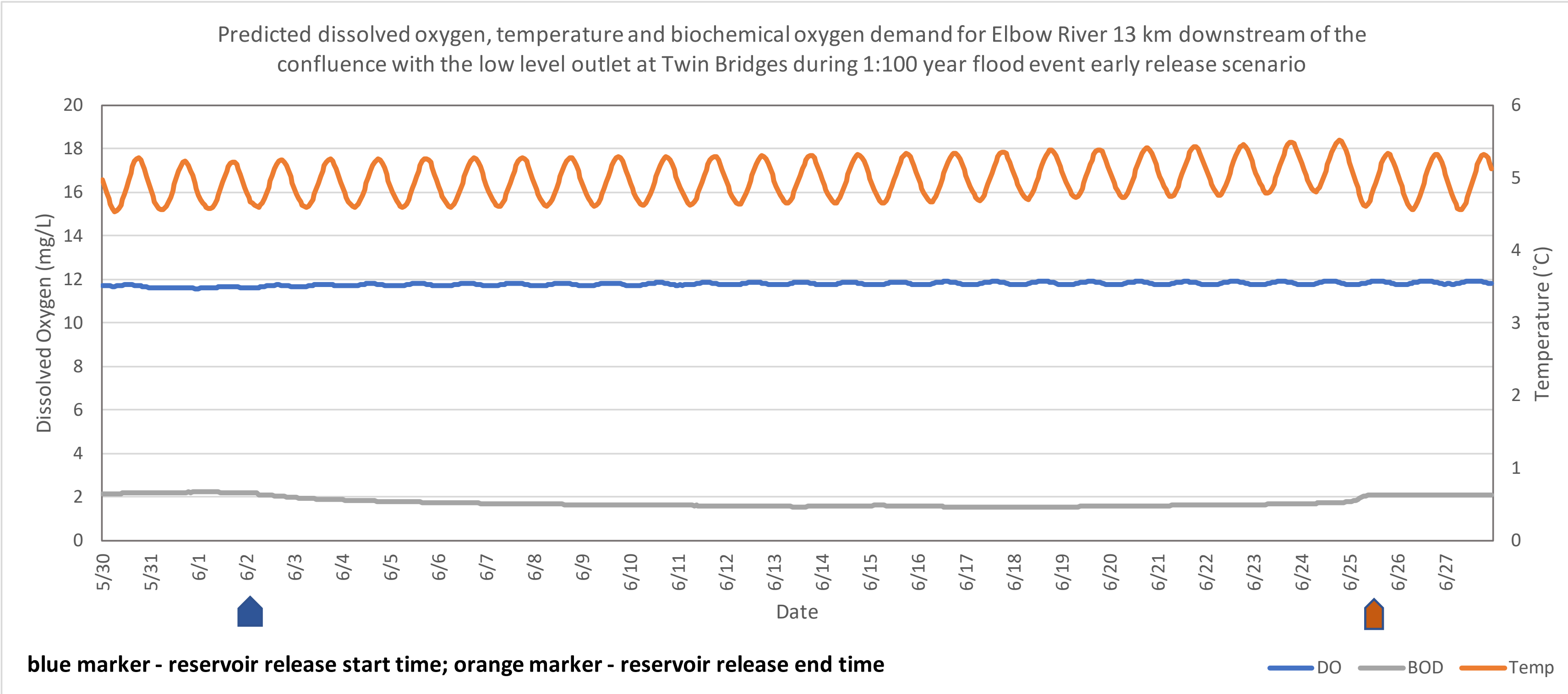


Figure 17-14 **DO, Temperature and BOD in Elbow River 13 km Downstream of the Unnamed Creek at Twin Bridges, 1:100 Year Flood Early Release (during water release from June 6 to June 25; duration 25 days)**

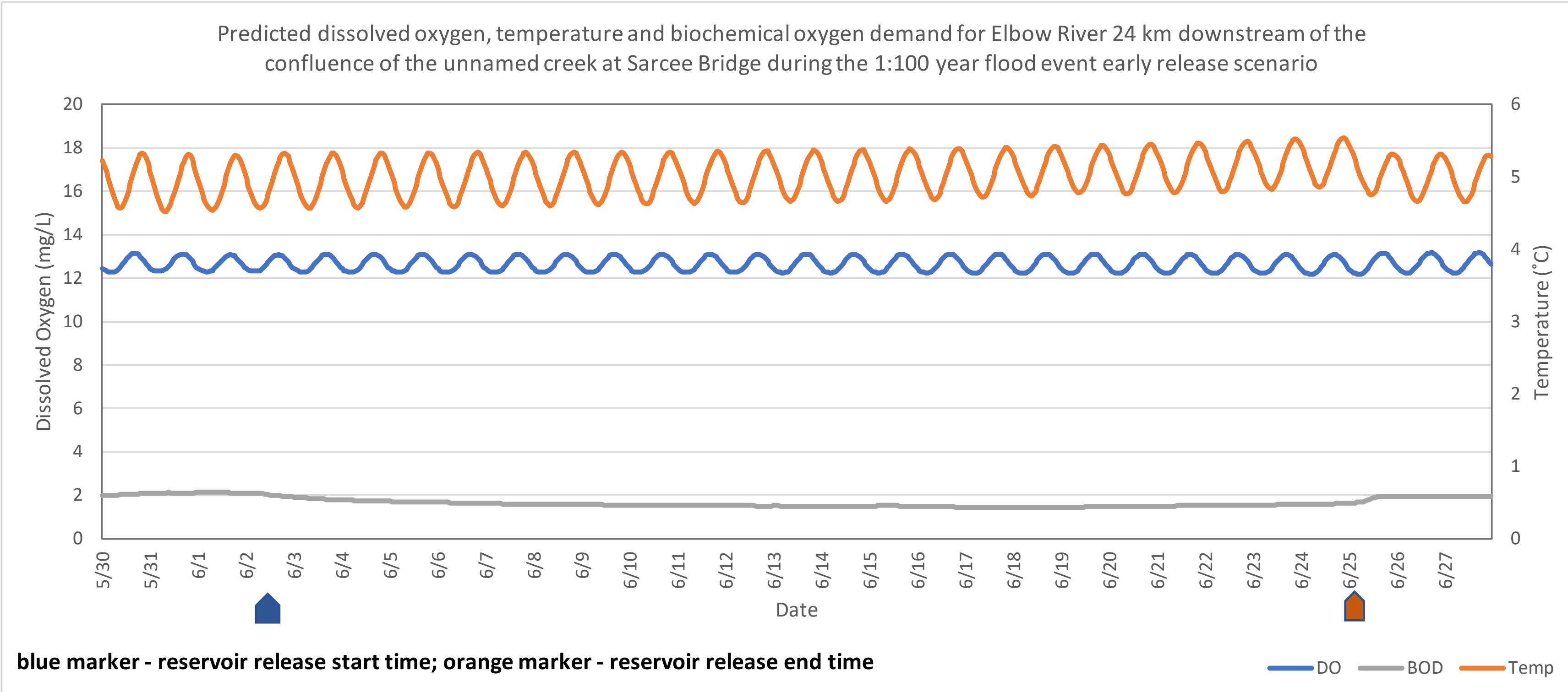


Figure 17-15 **DO, Temperature and BOD in Elbow River 24 km Downstream of the Unnamed Creek at Sarcee Bridge, 1:100 Year Flood Early Release (during water release from June 6 to June 25; duration 25 days)**

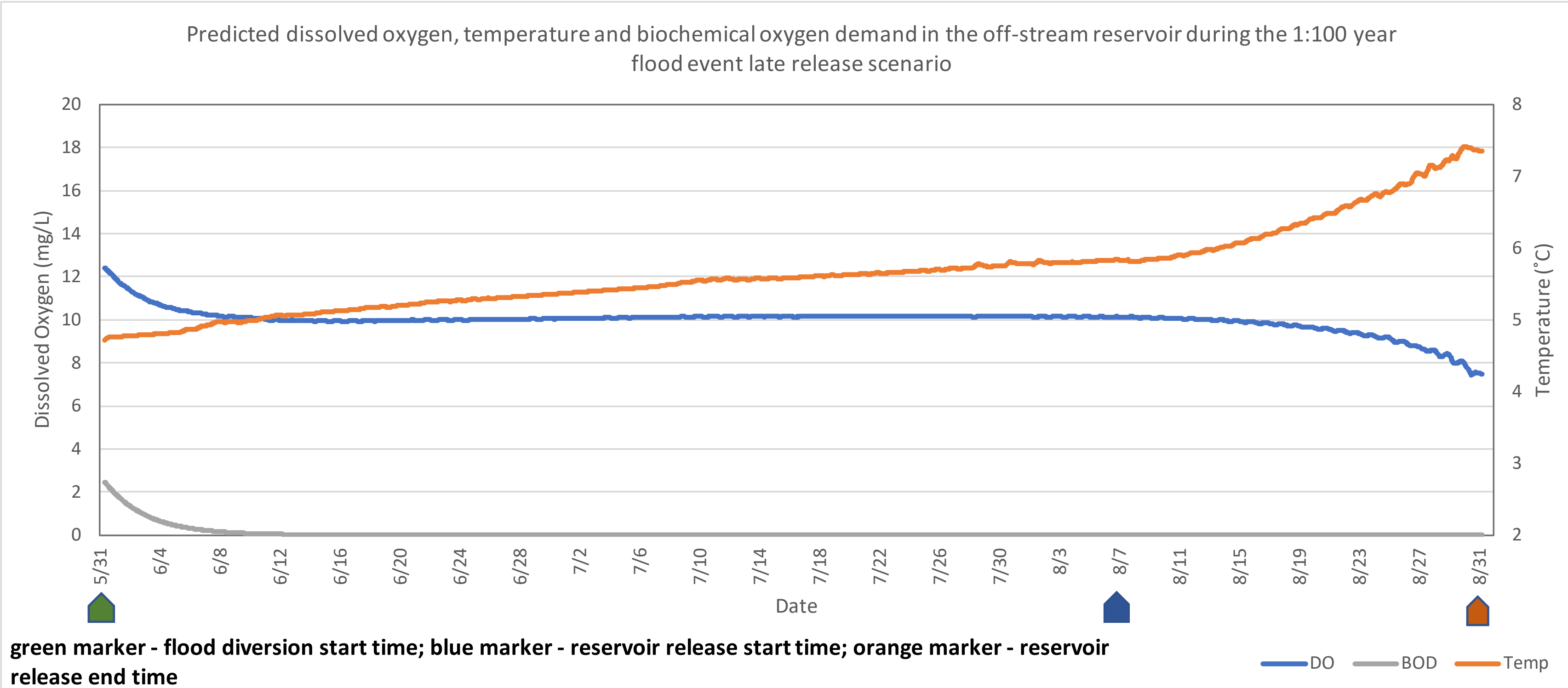
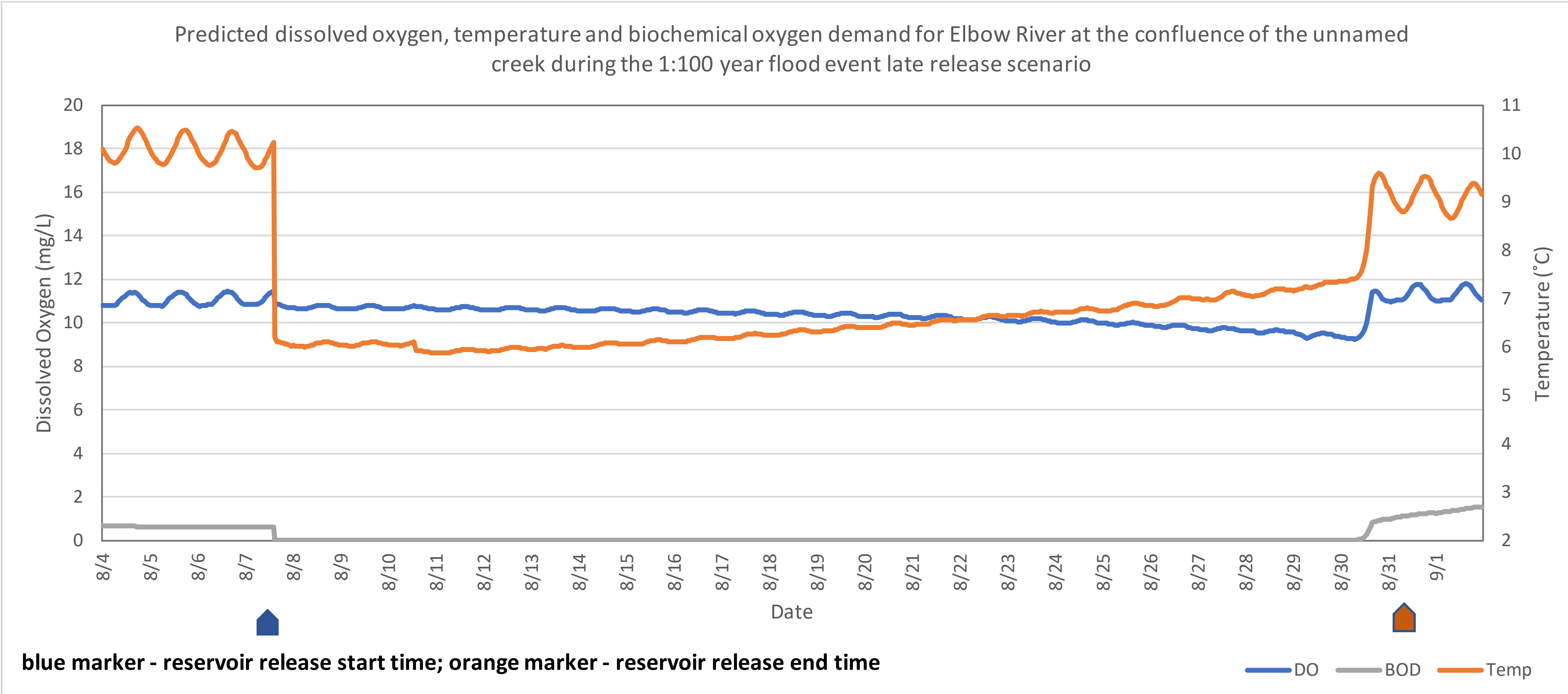


Figure 17-16 **DO, Temperature and BOD in the Off-Stream Reservoir, 1:100 Year flood Late Release (water is in the reservoir from May 31 to August 31; duration 92 days)**



NOTE: DO oscillates in response to diel temperature fluctuations)

Figure 17-17 **DO, Temperature and BOD in Elbow River at the Confluence of the Unnamed Creek, 1:100 Year Flood Late Release (during water release from August 7 to August 31; duration 24 days)**

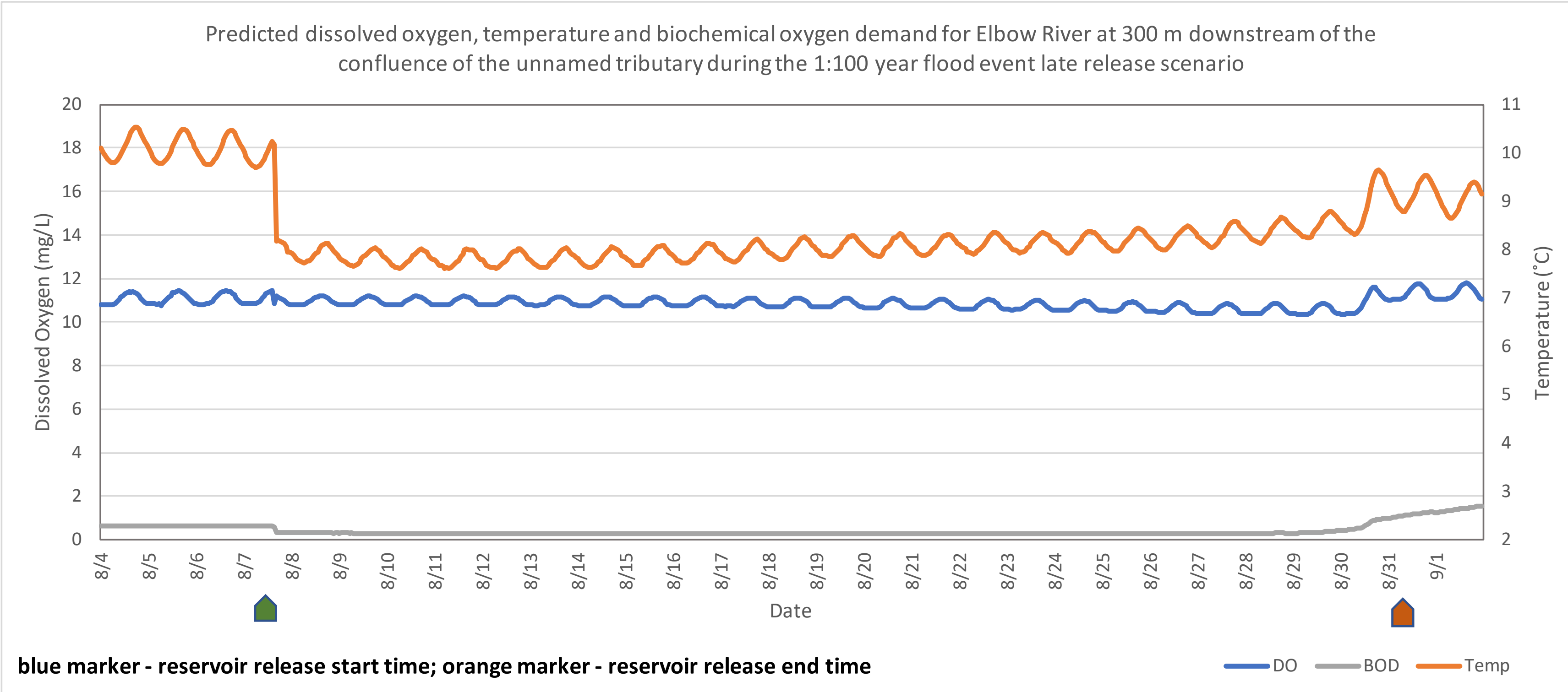


Figure 17-18 **DO, Temperature and BOD in Elbow River 300 m Downstream of the Unnamed Creek, 1:100 Year Flood Late Release (during water release from August 7 to August 31; duration 24 days)**

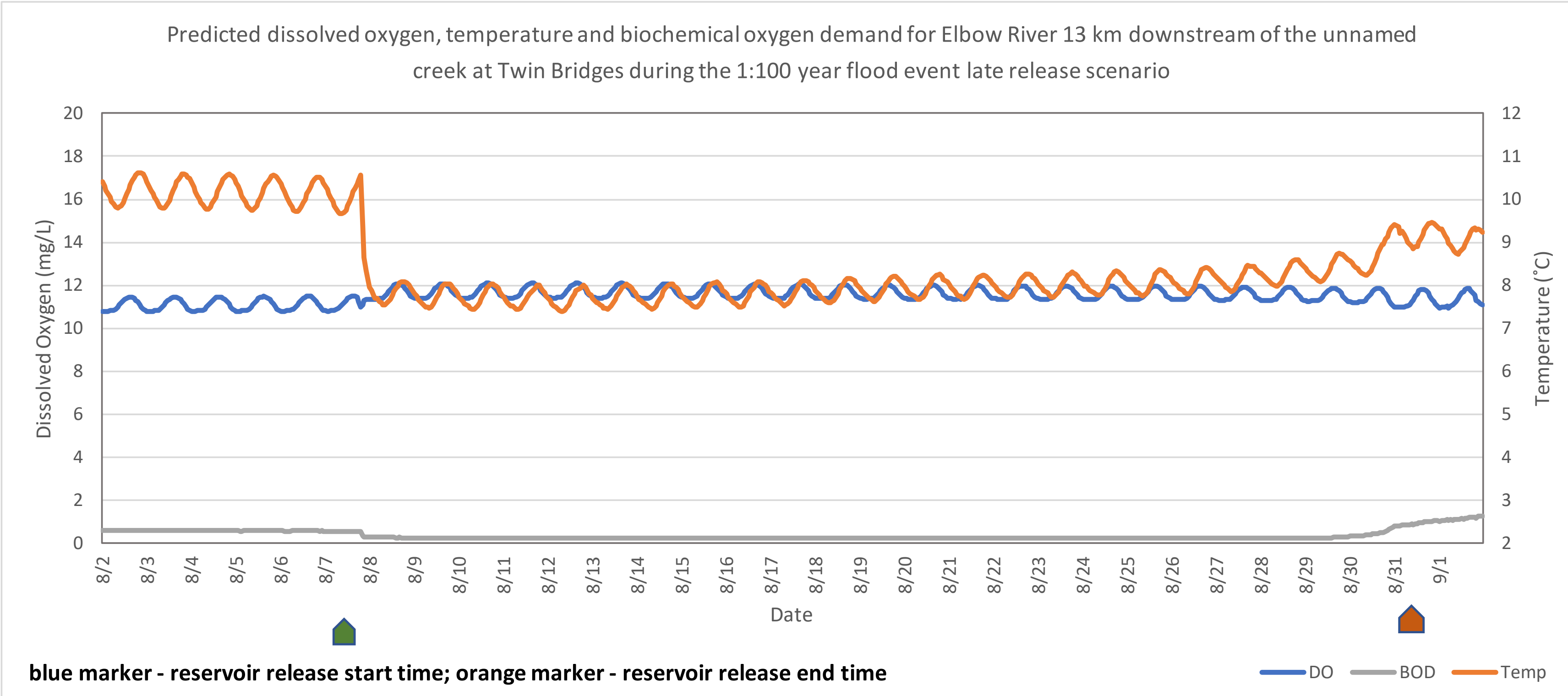


Figure 17-19 DO, temperature and BOD in Elbow River 13 km Downstream of the Unnamed Creek at Twin Bridges, 1:100 Year Flood Late Release (during water release from August 7 to August 31; duration 24 days)

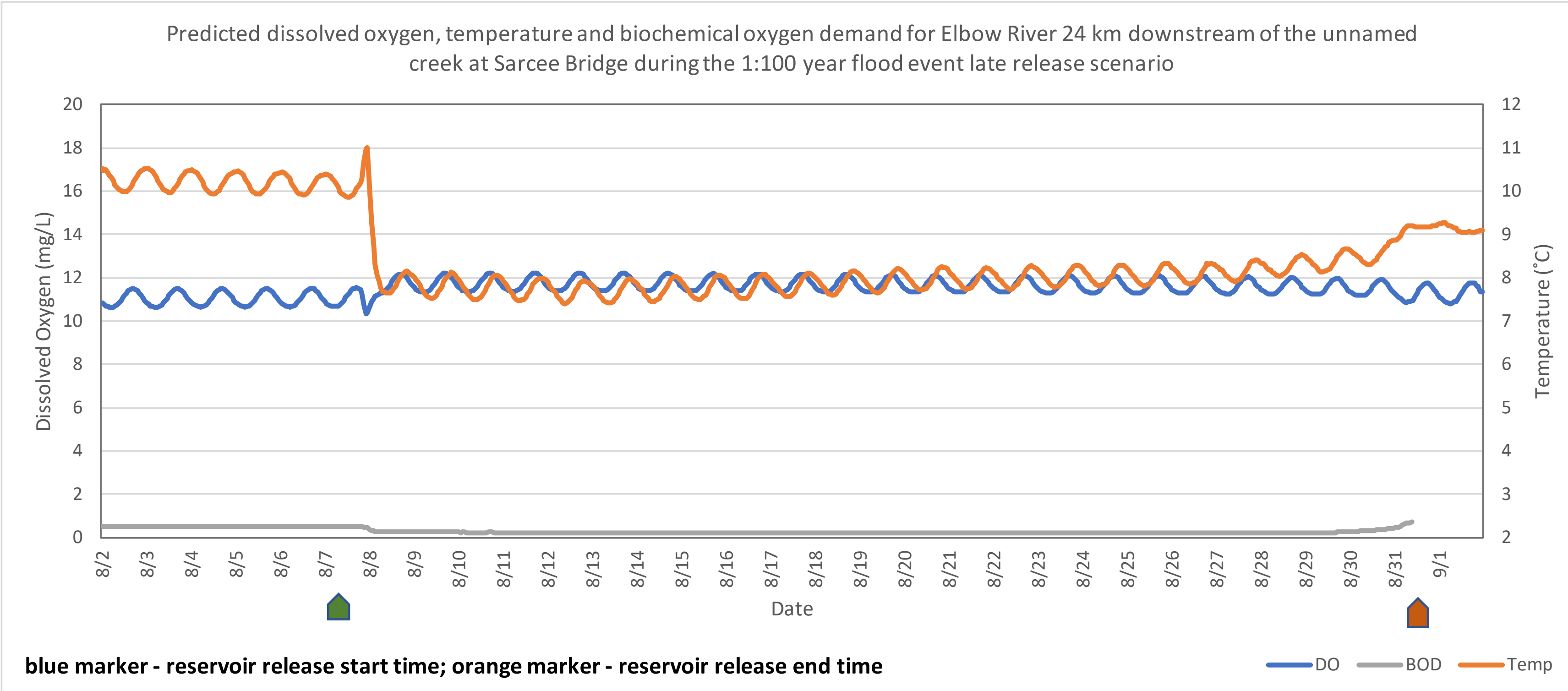


Figure 17-20 **DO, Temperature and BOD in Elbow River 24 km Downstream of the Unnamed Creek at Sarcee Bridge, 1:100 Year Flood Late Release (during water release from August 7 to August 31; duration 24 days)**

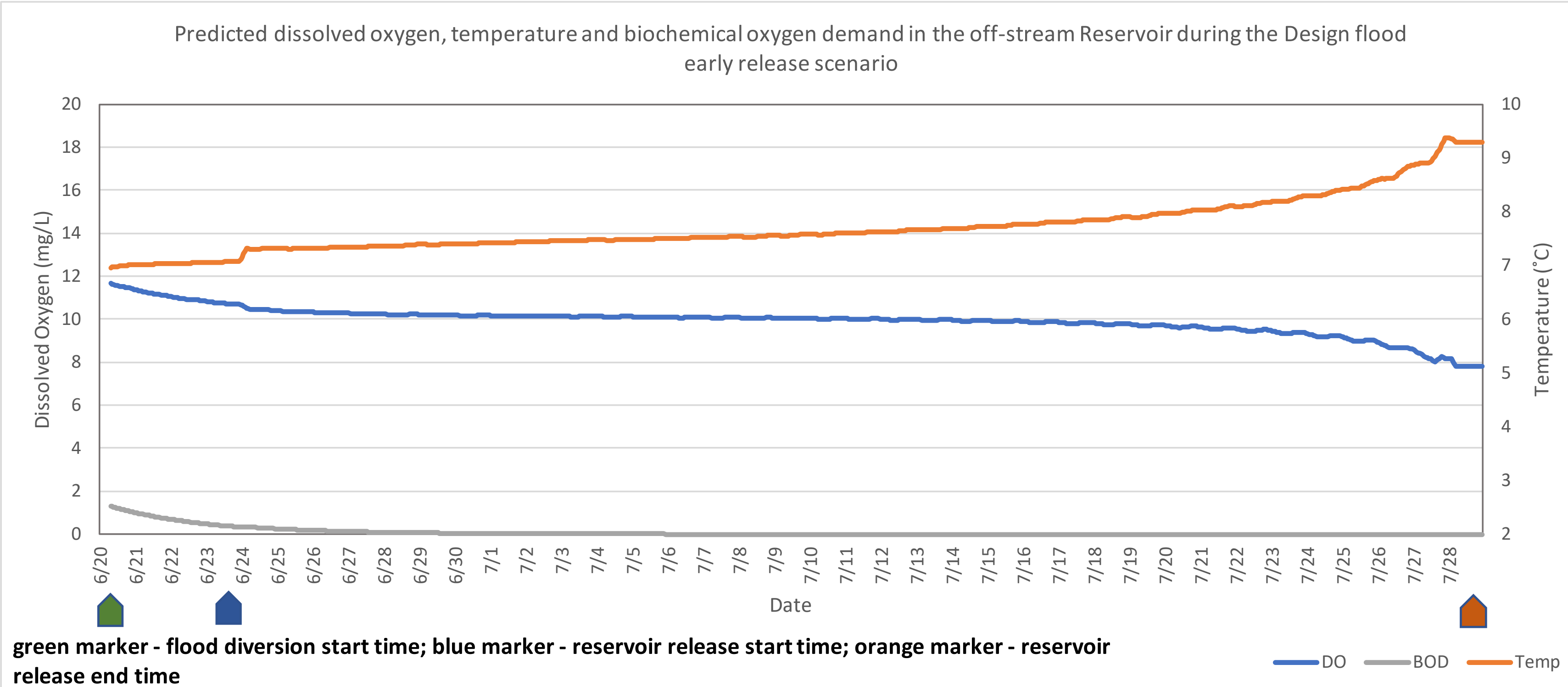
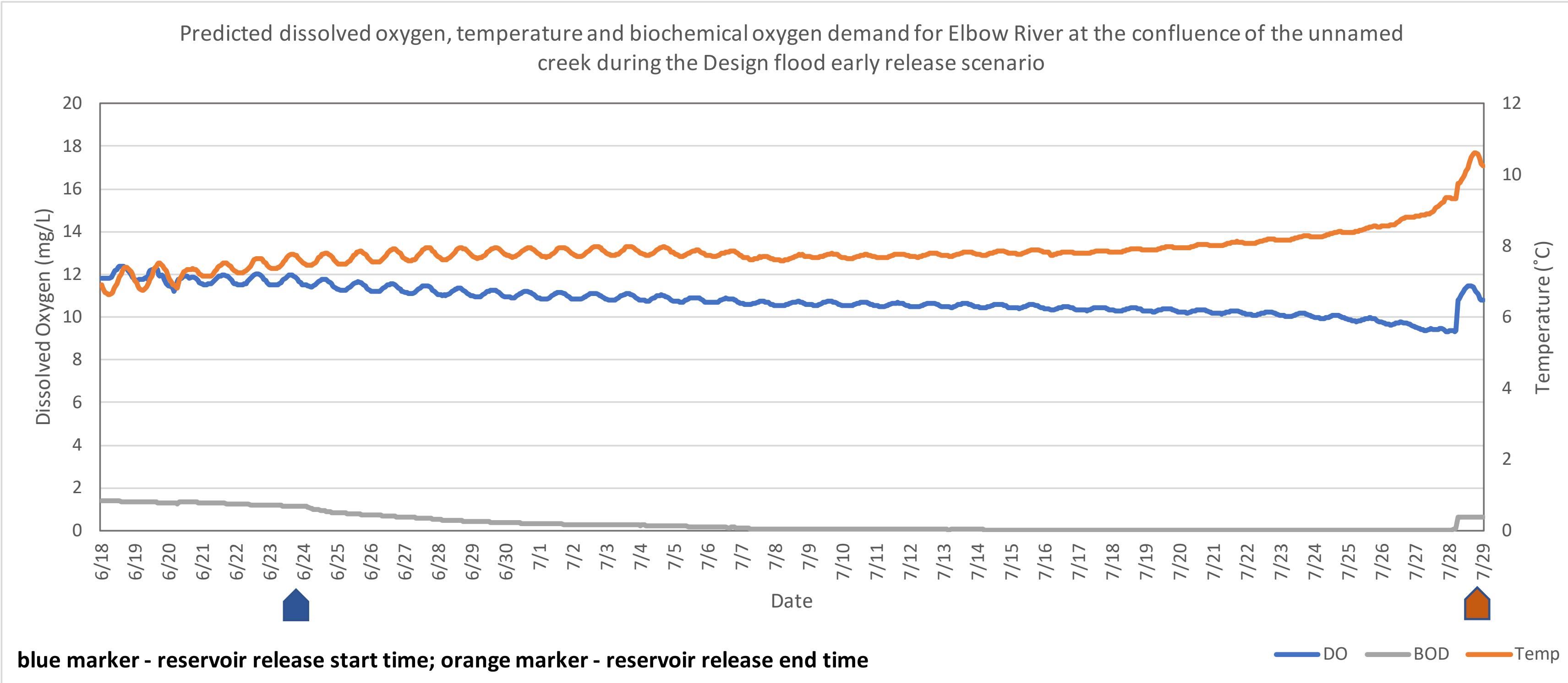


Figure 17-21 **DO, Temperature and BOD in the Off-Stream Reservoir, Design Flood Early Release (during the time water is in the reservoir from June 20 and July 28; duration 39 days)**



NOTE: DO oscillates in response to diel temperature fluctuations

Figure 17-22 **DO, Temperature and BOD in Elbow River at the Confluence of the Unnamed Creek, Design Flood Early Release (during water release from June 23 to July 28; duration 35 days)**

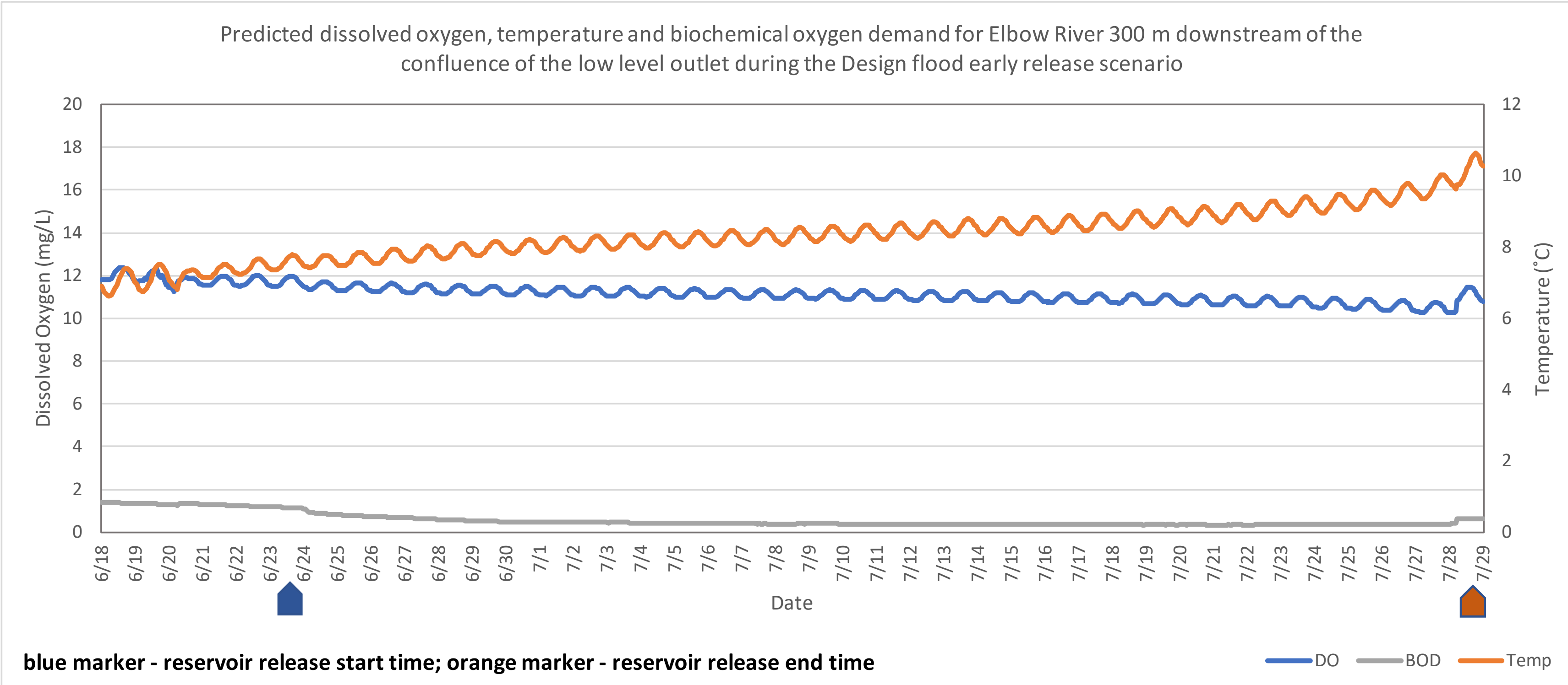


Figure 17-23 **DO, Temperature and BOD in Elbow River 300 m Downstream of the Unnamed Creek, Design Flood Early Release (during water release from June 23 to July 28; duration 35 days)**

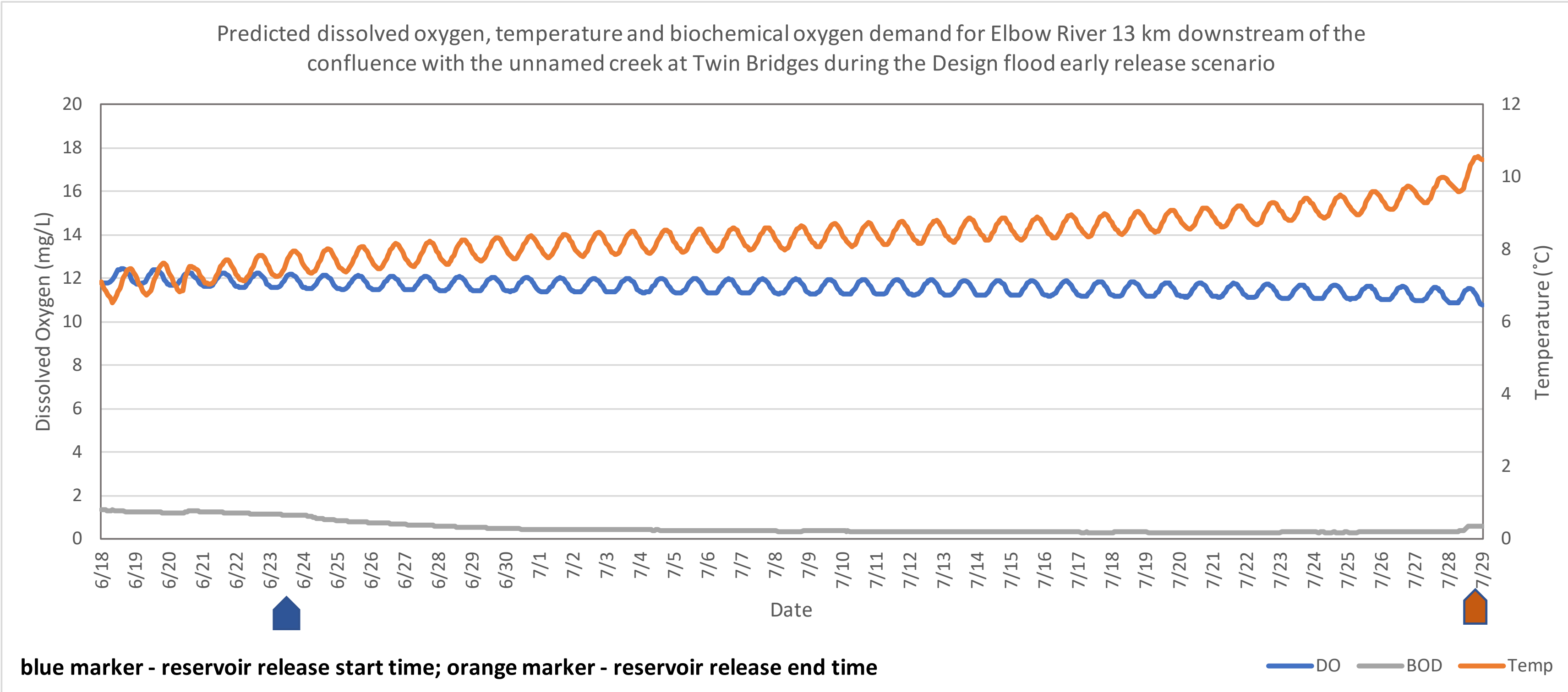


Figure 17-24 DO, Temperature and BOD in Elbow River 13 km Downstream of the Unnamed Creek at Twin Bridges, Design Flood Early Release (during water release from June 23 to July 28; duration 35 days)

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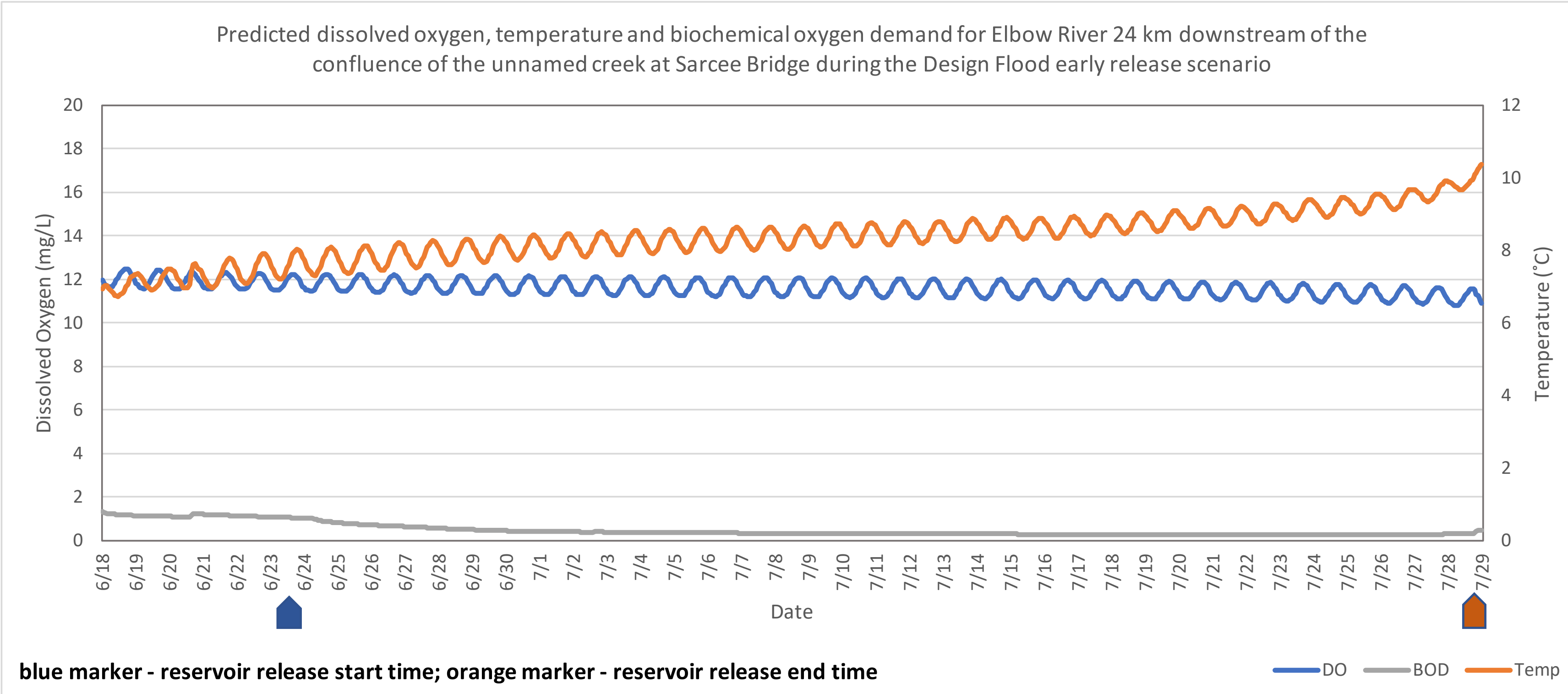


Figure 17-25 **DO, Temperature and BOD in Elbow River 24 km Downstream of the Unnamed Creek at Sarcee Bridge, Design Flood Early Release (during water release from June 23 to July 28; duration 35 days)**

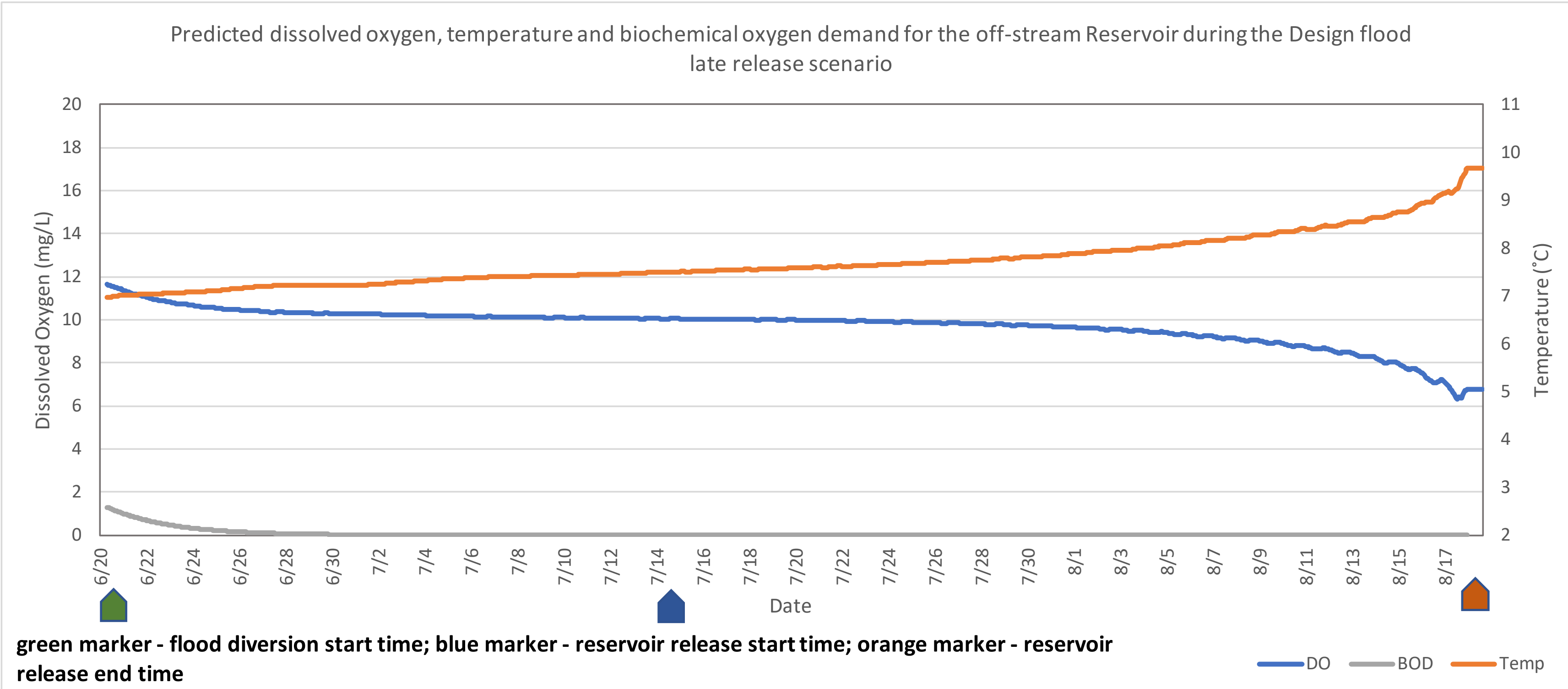
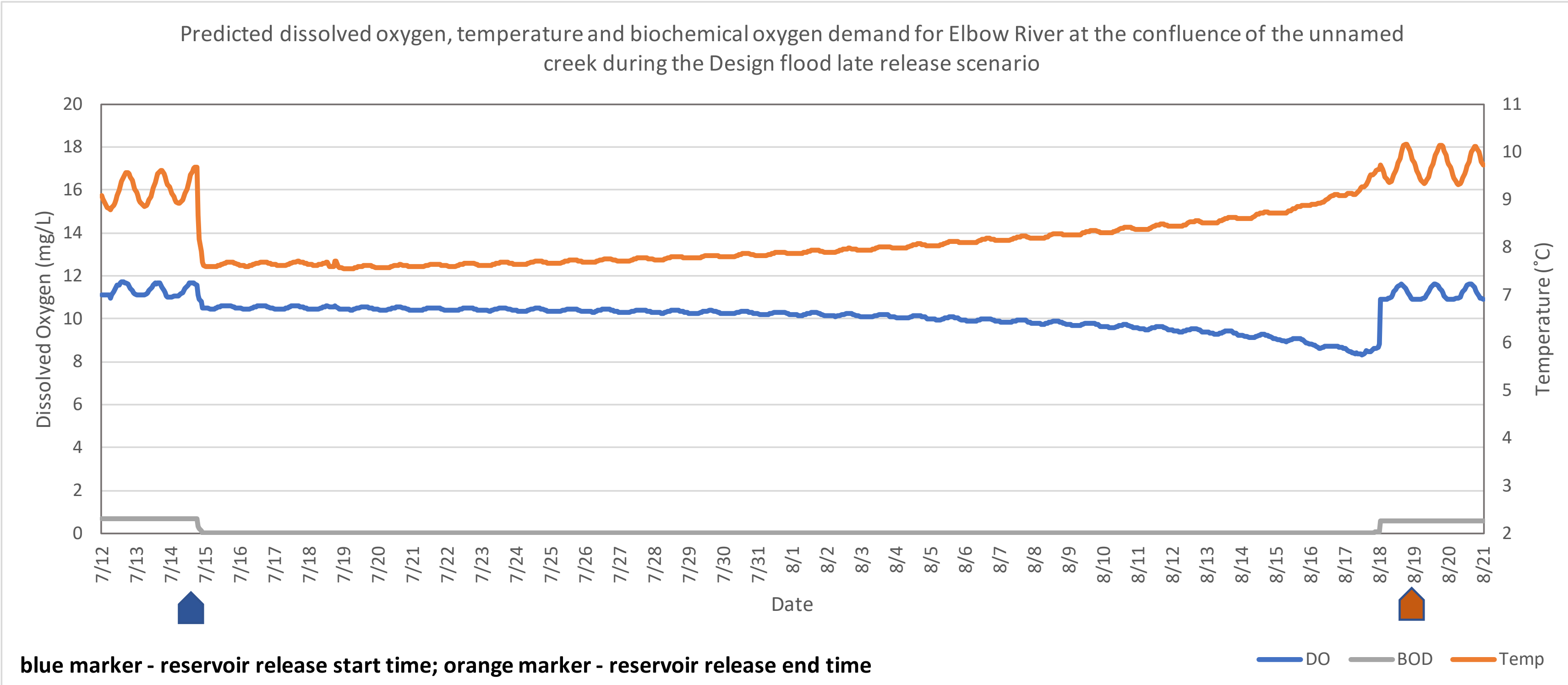


Figure 17-26 DO, Temperature and BOD in the Off-Stream Reservoir, Design Flood Late Release (during the period water is in the reservoir from June 20 to August 18; duration 59 days)



NOTE: DO oscillates in response to diel temperature fluctuations

Figure 17-27 **DO, Temperature and BOD in Elbow River at the Confluence of the Unnamed Creek, Design Flood Late Release (during water release from July 14 to August 18; duration 35 days)**

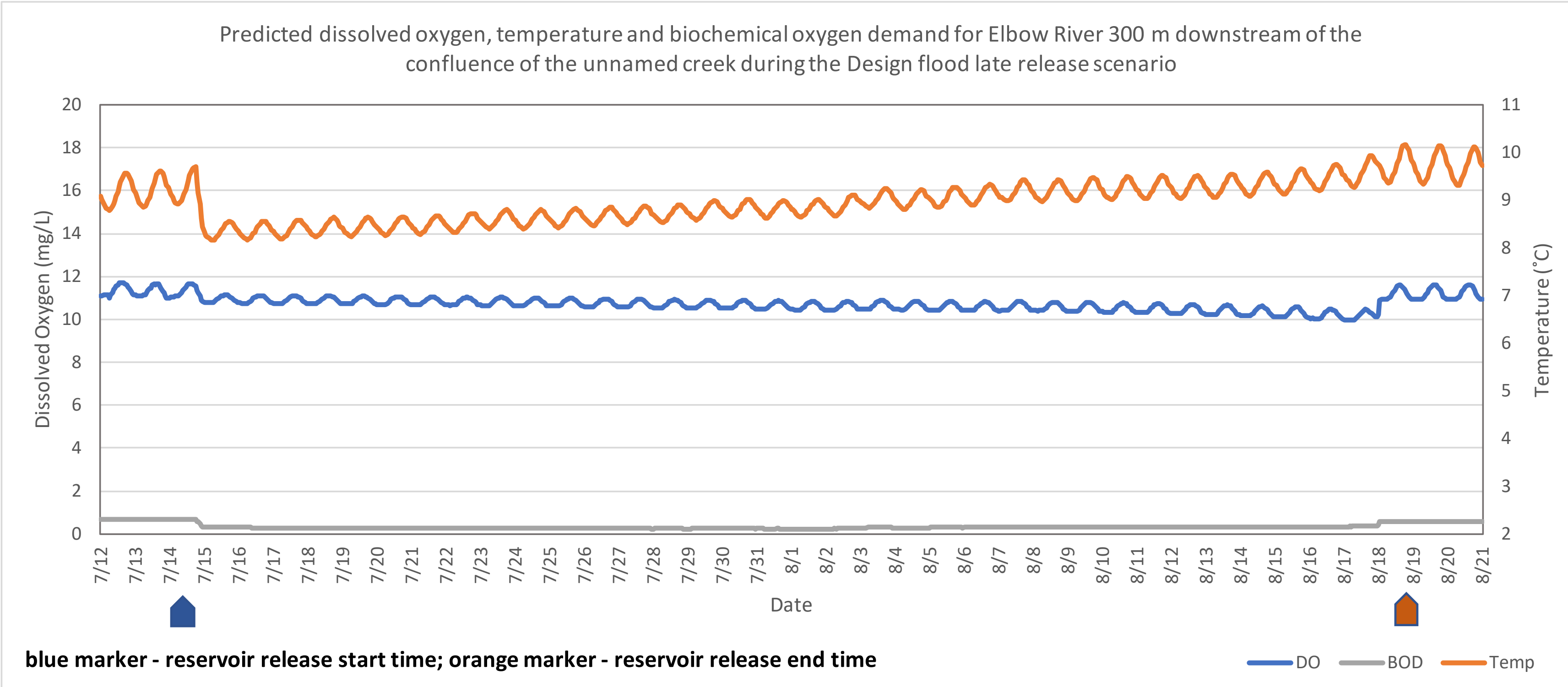


Figure 17-28 DO, Temperature and BOD in Elbow River 300 m Downstream of the Unnamed Creek, Design Flood Late Release (during water release from July 14 to August 18; duration 35 days)

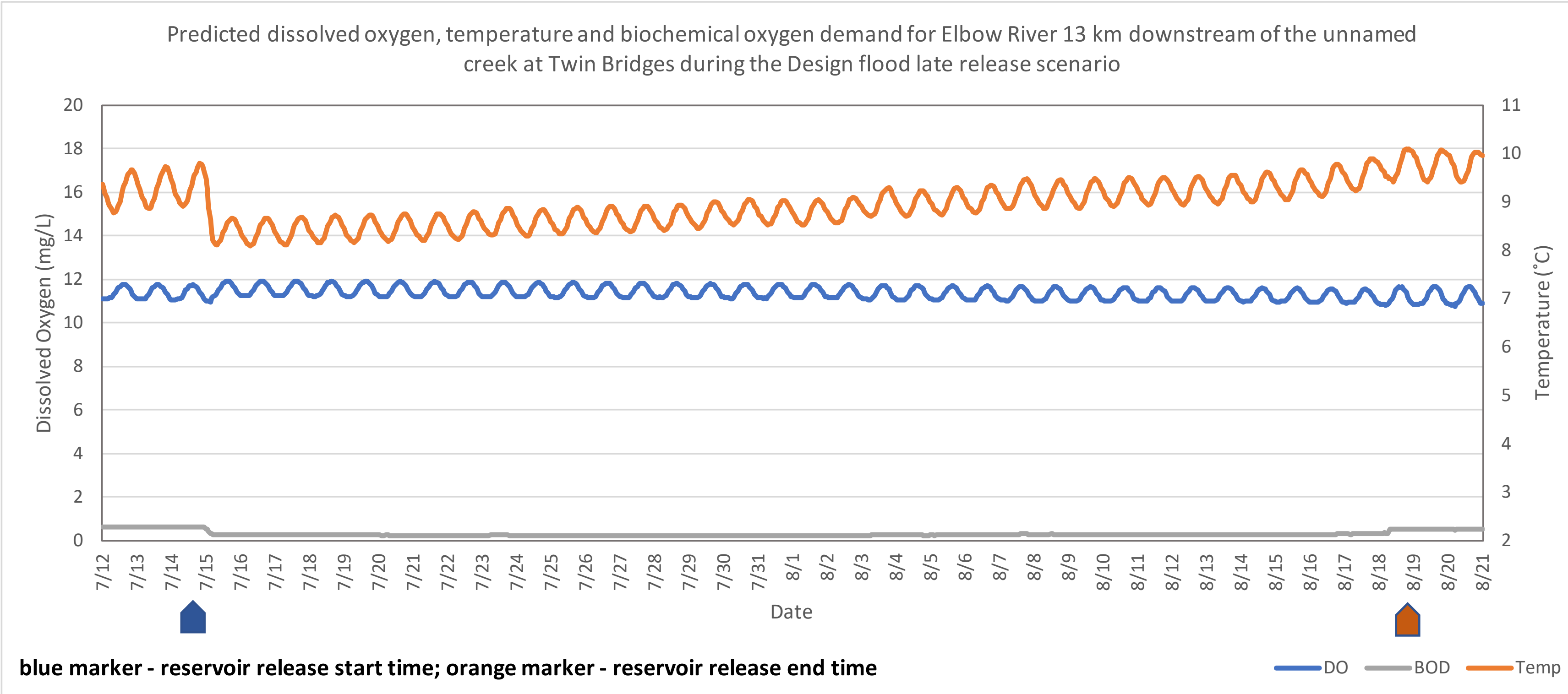


Figure 17-29 **DO, Temperature and BOD in Elbow River 13 km Downstream of the Unnamed Creek at Twin Bridges, Design Flood Late Release (during water release from July 14 to August 18; duration 35 days)**

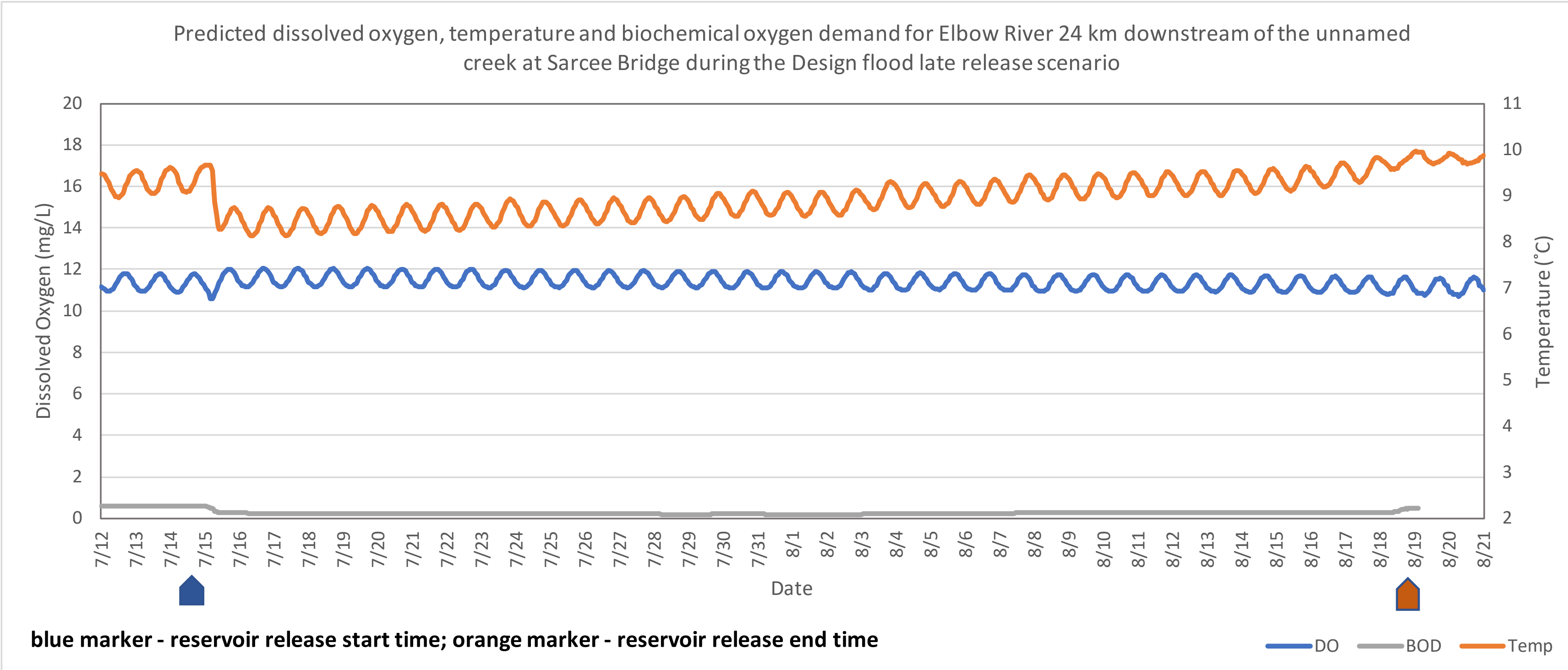


Figure 17-30 **DO, Temperature and BOD in Elbow River 24 km Downstream of the Unnamed Creek at Sarcee Bridge, Design Flood Late Release (during water release from July 14 to August 18; duration 35 days)**

d. ***THERMAL CHANGES AND EFFECTS ON FISH***

Water release may potentially occur any time between mid-May and the end of August. This period occurs from the end of the biologically sensitive period, BSP 1 (from April 2 to June 15), and through much of BSP 2 (from June 16 to September 25). During years when flood flows are sufficiently high for diversion into the reservoir, flood flows (even without the Project) will disrupt spring spawning and damage spawning redds and cause serious harm to most of the young of the year cohort (i.e., fall and winter spawned emerging fry and spring spawned eggs). Elevated temperatures pose the greatest risk to juvenile and adult cohorts. The species most likely to be affected during a vulnerable time period may be bull trout because they stage and migrate to upstream reaches below Elbow Falls as they prepare for spawning. Other fall spawning species (brown trout, brook trout, and mountain whitefish) will not actively stage until the end of BSP 2 or into BSP 3 (from September 26 to December 1), after the reservoir is empty.

Thermal tolerances for different life stages of resident Elbow River fish species are provided in Table 17-2. Predicted changes in water temperatures are expected to be small (as discussed in the responses to b. and c.) and not result in effects on resident fish, as discussed below.

1:10 Year Flood, Early Release

- There is no discernable change in temperature compared to background temperature levels of approximately 10˚C; there is no discernable effect to fish or their use of habitat.

1:10 Year Flood, Late Release

- Increase in Elbow River temperature by 5˚C (from 15˚C to 20˚C) at the unnamed creek. The temperature effect is predicted to decrease by 3˚C approximately 24 km downstream, at Sarcee Bridge. An increase in temperature of 5˚C may result in stress to resident fish for a duration of two days as water is released from the reservoir. However, 20˚C is lower than the ultimate incipient lethal temperature and the critical thermal maxima temperature for resident fish (Table 17-2). Twenty degrees Celsius is higher than the early life stage thresholds (i.e., optimum growth temperature and optimum egg development temperature); however, after a flood, many eggs and young of the year will be lost due to the destructive forces of natural flood flows and few early stages of fish are expected to survive and be exposed to these temperatures. An increase in temperature to 20˚C for two days is not expected to seriously affect the viability of the fish populations in Elbow River.
- Increases in Elbow River water temperature may cause resident fish to vacate shallower areas of the river to avoid elevated temperatures and seek out thermal refuges, including overbank shade, deep pools or groundwater seeps/inputs. Consequently, greater numbers of fish in these habitats may cause crowding, which could result in increased predation of some species.

1:100 Year Flood, Early Release

- Temperatures will increase by less than 1˚C in Elbow River from approximately 5˚C to 6˚C; there is no discernable effect to fish or their use of habitat.

1:100 Year Flood, Late Release

- Water temperature in the reservoir is predicted to increase at a rate less than in Elbow River. Consequently, river water temperatures are predicted to decrease when mixed with reservoir water. Therefore, there are no negative effects to fish or their use of habitat.

Design Flood, Early Release

- Water temperature in the reservoir is predicted to increase at a rate less than in Elbow River. Consequently, river water temperatures are predicted to decrease when mixed with reservoir water. Therefore, there are no negative effects to fish or their use of habitat.

Design Flood, Late Release

- Water temperature in the reservoir is predicted to increase at a rate less than in Elbow River. Consequently, river water temperatures are predicted to decrease when mixed with reservoir water. Therefore, there are no negative effects to fish or their use of habitat.

To summarize, thermal changes are predicted to most likely occur in the 1:10 year flood, late release. Water levels in the reservoir are shallow for the diversion of a 1:10 year flood and will be susceptible to increases in temperature from solar radiation and air temperatures. Effects to the river are only expected to last two days; however, they will extend downstream for at least 24 km. Reservoir water volumes and depths for the 1:100 year flood and design flood are expected to moderate solar effects on water temperatures. Therefore, reservoir water temperatures for the 1:100 year flood and design flood are expected to be similar or cooler than Elbow River water when released. Water temperature changes in Elbow River are not predicted to affect the viability of resident fish populations or aquatic biota.

Table 17-2 Thermal Tolerances for Fish Resident in Elbow River

Common Name	Scientific Name	OGT[1]	FTP[1]	UILT[1]	CTMax[1]	OS[1]	OE[1]
Longnose sucker	*Catastomus*	-	11.1	26.8	-	10	12.5
White sucker	*Catastomus commersoni*	25.5	23.4	27.8	31.6	15.83	15
Fathead minnow	*Pimephales promelas*	25.8	26.6	31.3	34.1	19.48	25
Longnose dace	*Rhinichthys cataractae*	-	15.3	-	31.4	11.7	15.6
Spottail shiner	*Notropis hudsonius*	27.3	16.6	33	33.2	19	20
Northern pike	*Esox lucius*	23	20.7	31	-	11.5	12.05
Burbot	*Lota*	16.6	13.2	23.3	-	1.15	7.5
Brook stickleback	*Culea inconstans*	-	21.3	30.6	-	13.13	18.3
Yellow perch	*Perca flavescens*	25.4	17.6	25.6	35	9.13	15
Trout-perch	*Percopsis omniscmaycus*	-	13.4	-	22.9	-	-
Brook trout	*Salvelinus fontinalis*	14.2	14.8	24.9	29.3	10.7	6.1
Brown trout	*Salmo trutta*	12.6	15.7	25	28.3	7.8	7.5
Bull trout	*Salvelinus confluentus*	13.2	-	20.9	26.4 (28.9)[2]	5-9	1.2-5.4
Mountain whitefish	*Prosopium williamsoni*	-	17.7	-	-	-	-
Cutthroat trout	*Oncorhynchus clarkii*	16.5	14.9	21.9	28	-	-
Rainbow Trout	*Oncorhynchus mykiss*	15.7	15.5	25	22.1	7	8.9

NOTES:

[1] Thermal limits (in degree Celsius) for fish from Hasnain 2010, for bull trout (Selong and McMahon 2001, DFO 2017) and mountain whitefish (Stevens et al. 2011):

- OGT: optimum growth temperature is the experimental temperature that supports the highest growth rate. Growth is reduced at both outer ranges of the data used to determine the optimum temperature
- FTP: final temperature preferendum is the temperature a species gravitates to when exposed to a full range of temperatures
- UILT: upper incipient lethal temperature is the temperature that 50% of fish survive for an extended period of time in an experiment
- CTMax: critical thermal maxima is the temperature at which a species loses its equilibrium (i.e., ability to remain upright)
- OS: optimum spawning temperature is the temperature most suitable for spawning based on peak activity
- OE: optimum egg development temperature is the temperature with the highest egg development rate

[2] Bull trout CTMax adjusted for acclimation; CTM at 8˚C = 26.4 and at 20˚C = 28.9

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Question 18

Supplemental Information Request 1, Question 86, Page 2.139

Alberta Transportation concludes that *therefore, concentrations returning to Elbow River are predicted to be similar to when they entered the reservoir.*

a. Describe how nutrient concentrations in water released from the reservoir will compare to water in the Elbow River at the time of release (i.e., when flow is <20 m^3/s and relatively more clear), not at the time of diversion (i.e., during flood conditions).

b. Explain how differences in timing of nutrient release may affect the Elbow River.

c. Provide/quantify expected nutrient concentrations for released water.

Response

BACKGROUND INFORMATION

Nutrient concentrations in water released from the reservoir will be influenced by the 1) nutrient concentrations in water diverted from the river, 2) duration water is in the reservoir and how quickly it is released reservoir, and 3) environmental conditions such as available DO. Water quality data available for Elbow River largely is for parameter concentrations in flows of less than 100 m^3/s; water quality data associated with flood conditions have not been collected. However, based on the relationships among water quality, suspended sediment concentrations, and flow in Elbow River, it has been possible to derive relevant nutrient concentrations during flood conditions.

Hydrodynamic modelling was done using the MIKE 21 modelling package developed by the Danish Hydraulic Institute (DHI) to characterize suspended sediment concentrations (see results discussed in responses to AEP Question 63 and Question 65). The MIKE ECO Lab module was paired with the MIKE 21 hydrodynamic model using the simple MIKE Eco Lab water quality template to calculate DO and BOD concentrations and water temperature within the study area. Historical water quality data for Elbow River boundary conditions were not suitable for using with other ECO Lab water quality modelling templates (i.e., nutrients). Each ECO Lab water quality template integrates the chemical and physical processes associated with a suite of parameters used for the model outputs. Due to the nature of these specific processes, the water quality templates cannot include parameter substitutes to complete the modelling (e.g., soluble reactive phosphorus cannot be substituted for orthophosphate in the model). Therefore, a statistical approach has been used, based on using the relationships among water quality, suspended sediment concentrations, and flow in Elbow River.

a-c. The following discussion provides analysis to estimate the nutrient concentrations in released reservoir water and how that water compares with Elbow River water at the time water is released.

PREDICTED NUTRIENT CONCENTRATIONS IN FLOOD WATER ENTERING THE RESERVOIR

Regression analysis was done to assess the influence of Elbow River flows (as the independent variable) on nutrient concentrations (the dependent variables) and derive nutrient concentrations under high flow conditions. The linear relationship (i.e., regression slope and intercept) between flow and median nutrient concentration provides a model relationship to calculate a predicted nutrient concentration for the three floods. These predicted nutrient levels are assumed to be the concentrations in water diverted into the reservoir.

Historical nutrient water quality data (i.e., for years 1979 through 2019) for Elbow River at Bragg Creek (approximately 12 km upstream of the diversion inlet) was used for the regression analysis. Nutrient parameters with at least 20 data points and corresponding mean daily flow data were included in the analysis.

Predicted nutrient concentrations are provided for median and peak flows in Elbow River for each flood:

- The peak river flow is used to predict the potential maximum concentration for each nutrient during a flood. However, the peak flow in the river generally lasts only a short duration and is not reflective of the river flows for the duration water is being diverted into the reservoir.
- The median river flow is used to predict the median nutrient concentration in the river for the duration water is being diverted. The median river flow more closely estimates nutrient concentrations of water mixing through the reservoir than the peak river flow.

The peak and median Elbow River flows for each flood are as follows:

- 1:10 year flood peak flow is 203 m^3/s; median flow is 186 m^3/s
- 1:100 year flood peak flow is 760 m^3/s; median flow is 291 m^3/s
- design flood peak flow is 1,170 m^3/s; median flow is 229 m^3/s

The results for the predicted nutrient concentrations in the reservoir are provided in Table 18-1. Nitrate+nitrite-n and ammonia have low adjusted R^2 values (i.e., the influence the independent variable has on the dependent variable) and results are not significant with an alpha of 0.05 (i.e., p-values are not significant). Nitrate+nitrite and ammonia are dissolved forms of nitrogen; the regression models for these two parameters indicate their concentrations are not strongly influenced by river flows. Therefore, their concentrations are not expected to increase in close relationship with river flows during a flood. This is in contrast with dissolved phosphorus, which is significantly correlated with river flow; however, the adjusted R^2 is lower than for total nutrients, which suggests that the flow relationship is weaker.

A weak relationship between dissolved parameters and river flow can be related to influences of groundwater and source water during runoff. As river water levels increase, dissolved nutrient concentrations from groundwater inputs become diluted. During high runoff events, sources of dissolved forms can become depleted. Therefore, the relationship between dissolved parameters may weaken at higher flows.

Table 18-1 Regression Analysis between Daily Mean River Flow (Independent Variable) and Nutrients (Dependent Variable) from Historical Water Quality Data (1979 through 2019), Elbow River at Bragg Creek

Parameter	Units	Adj R^2	Intercept	Slope	*p*	N	1:10 Year Flood		1:100 Year Flood		Design Flood	
							Peak Conc.	Median Conc.	Peak Conc	Median Conc.	Peak Conc.	Median Conc.
Total phosphorus	mg/L	0.1948	-0.0200	0.0026	<0.00001	300	0.4987	0.4545	1.9219	0.7228	2.9694	0.5646
Dissolved phosphorus	mg/L	0.1538	-0.0003	0.0002	<0.00001	146	0.0483	0.0442	0.1817	0.0693	0.2799	0.0545
Total nitrogen (calculated)	mg/L	0.2703	0.0309	0.0170	<0.00001	92	3.4850	3.1908	12.9623	4.9775	19.9385	3.9243
Nitrate+nitrite n	mg/L	0.0398	0.0988	0.0004	0.10534	43	0.1792	0.1724	0.3999	0.2140	0.5624	0.1894
Ammonia	mg/L	-0.0101	0.0206	0.0001	0.60985	75	0.0412	0.0394	0.0976	0.0501	0.1391	0.0438
Total Kjeldahl nitrogen	mg/L	0.2336	-0.0232	0.0134	<0.00001	120	2.7002	2.4683	10.1729	3.8771	15.6735	3.0466
Total organic carbon	mg/L	0.6820	0.7504	0.0649	<0.00001	109	13.9	12.8	50.08	19.6	76.7	15.6
Total coliforms	(CFU/100 mL)	0.4714	-20.9810	13.3410	<0.00001	131	2687	2457	10118	3858	15588	3032

NOTES:
Adj R^2 – the strength of the relationship between the independent and dependent variables
Intercept and Slope – the linear model inputs that express the relationship between the independent and dependent variables
P – the p-value stating significance with an alpha of 0.05, the number of independent and dependent pairs used in the regression analysis
Conc. – concentration

Water Quality Changes in the Reservoir

The main processes that affect nutrient concentrations when water is in the reservoir are oxygen availability and sedimentation, as described below:

- Phosphorus co-precipitates with certain metals, such as iron, in the presence of oxygen and dissociates under anoxic conditions (Dodds 2002).
- During oxygenated conditions, nitrate is the predominant form of dissolved inorganic nitrogen. During anoxic conditions, ammonium is the predominant form.
- During anoxic conditions, nitrate converts nitrogen gas through denitrification and is lost to the atmosphere.
- Nutrients originating from organic material (e.g., organism cells, enzymes) are associated with suspended sediments; however, environmental conditions (e.g., temperature, available oxygen) and organic decay will affect nutrient cycling and partitioning between particulate and dissolved forms.

The response to NRCB Question 17 discusses the predicted temperature and oxygen concentrations in the reservoir during the period water is held in the reservoir. DO in the off-stream reservoir is not predicted to become depleted:

- Generally, DO is not predicted to decrease to levels that affect nutrient concentrations (see discussion in response to NRCB Question 17). However, for the 1:10 year flood late release, shallow water will be held in the reservoir over 45 days. This will result in increased water temperatures and a drop in DO, decreasing to about 2 mg/L by the time the reservoir is empty.
- Based on the 1:10 year flood late release, some localized and shallow areas of the reservoir exposed to direct sunlight may have conditions where temperatures increase and DO temporarily decreases to the point of anoxia. In such cases, dissolved nutrients may come out of sediments and into the water column. Where these waters are reoxygenated in the reservoir, a portion of these nutrients may precipitate (i.e., become unavailable for biological processing); however, a portion will also be released into Elbow River.
- Because oxygen levels are not predicted to become depleted to the point of anoxia (for the 1:100 year and design floods), nutrients are not predicted to mobilize or transfer from particulate forms. Therefore, dissolved nutrient levels are not predicted to increase.

The association of water quality parameters, including nutrients, with total suspended sediments is discussed in the response to AEP Question 16. As water is held in the reservoir, a portion of nutrients that are bound to sediments and organic matter are expected to settle out, deposit and not return to the river when water is released. This will result in a reduction in overall nutrient concentrations over the duration water is held in the reservoir.

To assess potential nutrient concentrations released from the reservoir, regression analysis was done to determine the relationship between suspended sediments and nutrient concentrations. Regression statistics used to model the relationship between suspended sediments are provided in Table 18-2 and discussed in the response to AEP Question 16.

Table 18-2 Regression Analysis Statistics for Total Suspended Sediments (Independent Variable) and Nutrients (Dependent Variable) from Historical Water Quality Data (1979 through 2019)

Parameter	Units	Adj R^2	Intercept	Slope	*p*	N
Total phosphorus	mg/L	0.7995	0.0055	0.00045	<0.00001	2,227
Dissolved phosphorus	mg/L	0.0382	0.0029	0.00001	<0.00001	1,847
Total nitrogen (calculated)	mg/L	0.3870	0.2227	0.00109	<0.00001	1,230
Nitrate+nitrite n	mg/L	0.0075	0.0791	0.00008	0.13337	170
Ammonia	mg/L	0.0217	0.0293	0.00005	0.00037	534
Total Kjeldahl nitrogen	mg/L	0.3548	0.1217	0.00089	<0.00001	1,324
Total organic carbon	mg/L	0.1738	1.3099	0.00497	<0.00001	1,830
Total coliforms	CFU/100 mL	0.1519	232.48	1.722	<0.00001	1,782

The relationship between suspended sediments and dissolved nutrients is not significant and the relationship is weak (Table 18-2).

Suspended sediment modelling and predicted concentrations in the reservoir are discussed in the responses to AEP Question 63, Question 65 and Question 67. Peak and median nutrient water quality concentrations for water held in the off-stream reservoir are derived using the linear relationship between suspended sediments and nutrient concentration in Elbow River. This estimate was done for early and late release for each of the floods.

The predicted nutrient concentrations in the reservoir are provided in Table 18-3. The predicted peak and median reservoir nutrient water quality concentrations are compared with the monthly historical nutrient water quality data (i.e., for years 1979 through 2019). Water quality data for Elbow River at Twin Bridges (approximately 13 km downstream of the confluence of the unnamed creek with Elbow River, where reservoir water will be released) is used for comparison. Water quality during each late release is during the period of time when Elbow River flow is less than 20 m^3/s.

Table 18-3 Predicted Nutrient Concentrations from Regression Models and Peak and Median Suspended Sediment Concentrations in the Reservoir During Drawdown for Each Flood.

Operating Condition and Parameter	Units	1:10 Year Flood		1:100 Year Flood		Design Flood		Monthly Median Nutrient Concentrations (in brackets) and 75th percentile Concentrations for Elbow River at Twin Bridges (downstream of the Project)		
		Peak Conc.	Median Conc.	Peak Conc.	Median Conc.	Peak Conc.	Median Conc.			
Early Release Nutrient Concentrations										
Reservoir release dates		**May 25 to May 26**		**June 2 to June 25**		**June 23 to July 29**		**June**	**July**	**August**
Total phosphorus	mg/L	0.287	0.146	4.667	0.175	5.397	2.021	0.007 (0.027)	0.004 (0.009)	--
Dissolved phosphorus	mg/L	0.009	0.006	0.106	0.007	0.123	0.048	0.002 (0.007)	0.0015 (0.003)	--
Total nitrogen (calculated)	mg/L	0.904	0.564	11.513	0.634	13.283	5.105	0.262 (0.358)	0.236 (0.32)	--
Nitrate+nitrite n	mg/L	0.129	0.104	0.908	0.109	1.038	0.437	0.082 (0.089)	0.068 (0.097)	--
Ammonia n	mg/L	0.061	0.045	0.547	0.048	0.628	0.253	0.01 (0.025)	0.01 (0.03)	--
Total Kjeldahl nitrogen	mg/L	0.678	0.400	9.340	0.457	10.786	4.108	0.156 (0.32)	0.147 (0.215)	--
Total organic carbon	mg/L	4.4	2.9	52.8	3.2	60.9	23.6	1.96 (3.36)	1.33 (1.97)	--
Total coliforms	CFU/100 mL	1,309	771	18,069	882	20,865	7,945	288 (580)	326 (461)	--

Table 18-3 Predicted Nutrient Concentrations from Regression Models and Peak and Median Suspended Sediment Concentrations in the Reservoir During Drawdown for Each Flood.

Operating Condition and Parameter	Units	1:10 Year Flood		1:100 Year Flood		Design Flood		Monthly Median Nutrient Concentrations (in brackets) and 75th percentile Concentrations for Elbow River at Twin Bridges (downstream of the Project)		
		Peak Conc.	Median Conc.	Peak Conc.	Median Conc.	Peak Conc.	Median Conc.			
Late Release Nutrient Concentrations										
Reservoir release dates		**July 6 to July 8**		**August 7 to August 31**		**July 14 to August 20**		**June**	**July**	**August**
Total phosphorus	mg/L	0.006	0.006	0.175	0.025	3.186	0.691	--	0.004 (0.009)	0.003 (0.005)
Dissolved phosphorus	mg/L	0.003	0.003	0.007	0.003	0.074	0.018	--	0.0015 (0.003)	0.0015 (0.0025)
Total nitrogen (calculated)	mg/L	0.225	0.224	0.633	0.270	7.926	1.883	--	0.236 (0.32)	0.144 (0.196)
Nitrate+nitrite n	mg/L	0.079	0.079	0.109	0.083	0.644	0.201	--	0.068 (0.097)	0.055 (0.063)
Ammonia	mg/L	0.029	0.029	0.048	0.031	0.383	0.105	--	0.01 (0.03)	0.025 (0.5)
Total Kjeldahl nitrogen	mg/L	0.123	0.123	0.456	0.160	6.411	1.477	--	0.147 (0.215)	0.084 (0.12)
Total organic carbon	mg/L	1.3	1.3	3.2	1.5	36.4	8.9	--	1.33 (1.97)	1.05 (1.3)
Total coliforms	CFU/100 mL	236	234	880	307	12,402	2,855	--	326 (461)	308 (461)

NOTES:
-- data not relevant
Grey shaded cells are predicted nutrient concentrations greater than the historical 75th percentile Elbow River concentrations at Twin Bridges

Where the predicted reservoir median nutrient concentration is greater than the historical upper quartile (i.e., 75th percentile) concentration in the river, the results are shaded grey. The upper quartile Elbow River concentrations were used for comparison captures the relevant variability, but without including data influenced by late season irregular events such as storm runoff and outlier or anomalous data). Dodds and Oakes (2004) suggest the 75th percentile as a possible means to distinguish an upper nutrient threshold.

1:10 Year Flood, Early Release

- River flows rise to 203 m^3/s before quickly receding to 160 m^3/s (note that 160 m^3/s is the operational point when water can be released). Therefore, water is only held in the reservoir for a few hours before it is released.
- Due to this short duration, Elbow River water quality is expected to be similar to the water released from the reservoir.

1:10 Year Flood, Late Release

- Water is held in the reservoir for 42 days before being released in early July.
- Total and dissolved phosphorus are predicted to be released at concentrations greater than the historical 75th percentile for total and dissolved phosphorus concentrations in Elbow River at Twin Bridges.
- All other nutrient concentrations are predicted to be less that the historical 75th percentile concentrations for Elbow River.

1:100 Year Flood, Early Release

- Water is released from the off-stream reservoir soon after the water is diverted. It is released over a period of 23.5 days through June.
- Total phosphorus in the reservoir is predicted to be greater than six times the 75th percentile concentration (for Elbow River) in June when the reservoir water is released.
- All other nutrients are predicted to be less than two times the 75th percentile in the river.

1:100 Year Flood, Late Release

- Water is held in the reservoir for 67 days after it is diverted. It is released over a period of 23.5 days through August.
- Total phosphorus in the reservoir is predicted to be greater than five times the 75th percentile concentration (in Elbow River) in August when the reservoir water is released.
- All other nutrients are predicted to be less than 1.5 times the 75th percentile in the river.

Design Flood, Early Release

- Water is released over a period of 35 days from late June through July. Release begins soon after the water is diverted.
- Most nutrient parameters in the reservoir are predicted to be greater than 10 times the 75th percentile concentration (in Elbow River) in July when the reservoir water is released.
- Total phosphorus is predicted to be greater than 22 times the 75th percentile in the river.
- Dissolved parameters (nitrate+nitrate and ammonia) are predicted to be lower, but still at four and eight times greater than the 75th percentile in the river, respectively (however, the certainty is low regarding nitrate+nitrite and ammonia predictions as discussed above).

Design Flood, Late Release

- Water is held in the reservoir for 27 days. It is released over a period of 37 days from the middle of July through the middle of August.
- Total phosphorus in the reservoir is predicted to be greater than 13 times the 75th percentile concentration in the river during August when the reservoir water is released.
- Total Kjeldahl nitrogen and total nitrogen are 12 and nine times the 75th percentile concentration in the river.
- All other nutrients are predicted to be less than 1.5 times the 75th percentile in the river, while total organic carbon and total coliforms ware predicted to be between six and seven times the 75th percentile in the river.

To summarize, the median nutrient concentrations released from the reservoir during early release for the 1:100 year flood and design flood are greater than during late release (Table 18-3). Decreases in nutrient concentrations are due to suspended sediments and associated parameters (i.e., total nitrogen, total phosphorus) depositing in the reservoir during the time water is retained.

Early release may affect Elbow River water to a greater degree than late release. There are a few exceptions of dissolved nutrients not decreasing over time (i.e., comparing dissolved phosphorus and nitrate+nitrate between the 1:100 year early release and late release).

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Question 19

Supplemental Information Request 1, Question 92, Page 2.146
Supplemental Information Request 1, Question 342, Page 5.225

Alberta Transportation states that the *assessment of aquatic ecology uses desktop and field analyses to evaluate Project-related effects, and the assessment relies on the Project data to address 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*. In addition, Alberta Transportation also states that *surveys to generate quantitative population estimates of fishery resources were not conducted as part of the assessment.*

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 presented. A general description of fish species ecology and habitat requirements provides limited information and a coarse understanding of the Elbow River fish ecology, making it difficult to evaluate potential project effects.

a. **Explain how the baseline information can be used to adequately describe species composition, distribution, abundance, movement, habitat use, habitat quality, and life history parameters of fish populations actually residing within the LAA and evaluate the potential project effects.**

b. **Demonstrate that data summaries generated by the desktop review and from data collected by the field program is of sufficient quality to reliably describe the LAA fish community structure (i.e., species composition) and the LAA species population characteristics (spatial distribution, relative abundance, movements, habitat use and life history). Include a discussion of the:**

    i. **Current relevance of FWMIS information to describe existing fish resources.**

    ii. **Field program specifics, including sampling methods and timing.**

c. **Demonstrate that the fish data presented is accurate and sufficient to meet requirements in the Terms of Reference Section 3.6.1 and to permit confident evaluation of project effects on LAA fish species populations.**

Response

a. The methods used to determine how baseline information adequately describes fish species, composition, distribution, abundance, movement, habitat used and life history parameters of fish resident in the LAA are provided in Table 19-1. Where additional information has been provided to supplement one of these components, the additional assessment information and methods are also provided in Table 19-1. Additional analysis for fish distribution and movement and fish abundance are provided below in c.

   Fish habitat in Elbow River was surveyed and mapped between late October and early December 2019, as follows:

   - The bull trout spawning survey occurred during late October 2019 between Elbow Falls and the Gooseberry campground.
   - The brown trout and brook trout spawning survey occurred in November and early December in Elbow River between the Tsuut'ina Nation Reserve boundary near Redwood Meadows (approximately 2 km upstream of the Project site) and downstream, approximately 25 km away.
   - Detailed habitat mapping and profile measurements occurred in November 2019 in Elbow River between the Tsuut'ina Nation Reserve boundary near Redwood Meadows (approximately 2 km upstream of the Project site) and downstream, approximately 25 km away.

   The habitat data was digitized and put into GIS to support further analysis and reporting. Habitat quality and presumed habitat use was assessed using habitat suitability index (HSI) ratings for different life stages of resident fish populations including bull trout, mountain whitefish, rainbow trout and brown trout. Spawning surveys were conducted in fall 2019 and the results were documented. The habitat information and HSI analysis are presented in the response to AEP Question 69, Appendix 69-1.

   Fish field work to collect population data for resident fish community will be used to assess the abundance, density and composition of resident Elbow River fish populations; this field work is planned for July and August 2020. The results of this population assessment will be documented and provided to NRCB and AEP when complete.

Table 19-1 Baseline Information and Methods to Describe Fish Species, Composition, Distribution, Abundance, Movement, Habitat Used and Life History Parameters of Fish Resident in the LAA

Aquatic Ecology Baseline Information	Information Included in the Aquatic Ecology Assessment	Additional Assessment Information Provided
Species composition	Fish species composition assessment used from two sources: • historical data from the Alberta Fisheries and Wildlife Management Information System (FWMIS) for the years 1978 – 2015 • fish inventory sampling at Project sampling locations during fall 2016 and presented in the EIA (Volume 4, Appendix M, Section 3.1) The information collected in these two sources reflects spatial and temporal coverage that is needed to identify and characterize the resident fish community in the LAA suitable for planning Project mitigations and assessing residual effects.	N/A
Fish species distribution and movement	Fish species distribution was considered by assessing populations within three sections of Elbow River (EIA, Volume 3A, Section 8.2.2 Figures 5.2-4, 8.2-5 and 8.2-6): • the head waters to Elbow Falls • Elbow Falls to the diversion structure • the diversion structure to Glenmore Reservoir inlet	The distribution of resident fish in the LAA and upstream to Elbow Falls is presented for each biologically sensitive period. Resident fish distribution information is provided in Table 19-2 and in the response to AEP Question 69, Appendix 69-1[1]. Resident fish can move freely in Elbow River in the LAA and upstream to Elbow Falls, a distance of approximately 60 km. Barriers to fish movement do not exist within Elbow River between the falls and the downstream extent of the LAA at Glenmore Reservoir. Therefore, resident fish species can potentially be found anywhere within this reach. The distribution provides information on locations within the river for each resident species that has been found at different times of the year. It can be inferred that fish move between the areas in which they are identified throughout the year.

Table 19-1 Baseline Information and Methods to Describe Fish Species, Composition, Distribution, Abundance, Movement, Habitat Used and Life History Parameters of Fish Resident in the LAA

Aquatic Ecology Baseline Information	Information Included in the Aquatic Ecology Assessment	Additional Assessment Information Provided
Population abundance	The relative abundance of fish populations using FWMIS data are provided in the EIA (Volume 3A, Section 8.2.2 Figure 5.2-4, Figure 8.2-5 and Figure 8.2-6; and Volume 3B, Section 8.2, Figure 8.2-1).	Quantitative fish population abundances (i.e., population sizes) in Elbow River between the falls to Glenmore Reservoir was extrapolated using FWMIS data in the EIA from spawning survey data (Popowich and Eisler 2008) and spawning surveys conducted during late fall 2019. This information adequately characterizes the community in a manner needed to plan mitigation measures, adequately assess Project residual effects, and support a *Fisheries Act* Application and Offsetting plan[2].
Fish movement	–	The location of fish species during different biologically sensitive periods was assessed using available FWMIS data for Elbow River. The results are summarized in Table 19-2.
Fish habitat use	–	Habitat suitability index: see the response to AEP Question 69, Appendix 69-1[1].
Fish habitat quality	–	Habitat suitability index: see the response to AEP Question 69, Appendix 69-1[1].
Fish species life history parameters	–	Habitat suitability index: see the response to AEP Question 69, Appendix 69-1[1].

NOTES:
– no information included
[1] The results of the fish habitat assessment for fall 2019 is presented in response to AEP Question 69, Appendix 69-1 with maps and habitat suitability ratings to describe habitat use and habitat quality
[2] A fish population assessment is proposed for summer 2020; the result of the assessment will be provided to NRCB and AEP when reporting is complete
N/A = not applicable

b. As discussed in a., additional fisheries data are provided through field habitat mapping, HSI assessments and spawning surveys in response to AEP Question 69, Appendix 69- 1 or will be addressed during summer 2020 field work.

   i. AEP's online FWMIS database provides spatial and temporal distribution of resident fish species in Elbow River. This information is summarized in Table 19-2 and further discussed and presented in figures in response AEP Question 69, Appendix 69-1.

   ii. The field work for the fish population assessment is scheduled for summer 2020 (within the window of July 01 through September 15). Alberta Transportation has consulted with AEP fish biologists regarding the appropriate field methods for this assessment, and they will be conducted as follows:

      - Fish survey methods will be consistent with AEP standards (AEP 2019).
      - The survey method will use a balanced hierarchical random sampling design to selected river sample segments (i.e., 2 km sections of river serving as sample sites).
         - The sampling domain will include Elbow River between Elbow Falls and the inlet to Glenmore Reservoir, approximately 70 km.
         - The sampling domain will be divided into three sections in Elbow River: the upper one-third section, the middle one-third section, and the lower one-third section.
         - Four sample segments will be randomly selected within each of three river sections (12 sample segments in total).
      - Field crews will use small craft and backpack electrofishing methods to capture fish in each of the sample segments.
      - Crews will be staffed to handle and care for fish and manage fish health while electrofishing is being conducted.
      - Fish will be returned to the sampling segments within which they were captured.

c. The fish habitat survey and mapping conducted in fall 2019 was thorough and used appropriate field and assessment methods. Details on methods is provided in response to AEP Question 69, Appendix 69-1. Detailed habitat suitability maps assessments and maps for different life stages of bull trout, brown trout rainbow trout and mountain whitefish used relevant methods for the Elbow River fish community (see Appendix 69-1, Section 2.3).

FISH DISTRIBUTION AND MOVEMENT

Resident fish can move freely in Elbow River in the LAA and upstream to Elbow Falls, a distance of approximately 60 km. Barriers to fish movement do not exist within Elbow River between the falls and the downstream extent of the LAA at Glenmore Reservoir; therefore, resident fish species can potentially be found anywhere within this reach. Reviewing the FWMIS (AEP 2020) data for each biologically significant period (BSP; Table 19-2), resident fish are generally distributed in the downstream reaches in spring and move upstream in the summer. It is unclear where species overwinter; some species are likely to use the lower reaches in the river and Glenmore Reservoir during the winter months. Popowich and Paul (2006) reported bull trout appear to overwinter in the lower reaches of the river near Discovery Bay (a few kilometres above Glenmore Reservoir).

Table 19-2 Location of Recorded Fish Presence in Elbow River during Different Biologically Significant Periods

	BSP 1 April 2 to June 15	BSP 2 June 16 to Sept 25	BSP 3 Sept 26 to Dec 1	BSP 4 Dec 2 to April 1
Bull trout	From Elbow Falls to the Project area	Distributed throughout the river from Elbow Falls to Discovery Ridge area	In the upper reaches of the river below Elbow Falls	No records
Brown trout	Distributed from near Redwood Meadows to Glenmore Reservoir	Distributed throughout the river except the upper 10 km below the falls	Distributed throughout the river	One record near Sarcee Bridge
Cutthroat trout	One record just upstream of Glenmore Reservoir	No records	No records	No records
Cutthroat trout-rainbow trout cross breed	No records	No records	No records	No records
Mountain whitefish	Distributed from near Redwood Meadows to Glenmore Reservoir	Distributed throughout the river except the upper 10 km below the falls	Distributed throughout the river except the lower reach (approximately15 km) before Glenmore Reservoir	No records
Brook trout	Distributed from near Redwood Meadows to Glenmore Reservoir	Distributed throughout the river from the falls to Glenmore Reservoir	Distributed through the river	No records
Rainbow trout	Distributed from near Redwood Meadows to Glenmore Reservoir	Distributed throughout the river except the upper 10 km below the falls and the lower reach immediately above Glenmore Reservoir	Distributed sporadically throughout the river	No records

Table 19-2 Location of Recorded Fish Presence in Elbow River during Different Biologically Significant Periods

	BSP 1 April 2 to June 15	BSP 2 June 16 to Sept 25	BSP 3 Sept 26 to Dec 1	BSP 4 Dec 2 to April 1
Northern pike	No records	Immediately above Glenmore Reservoir	No records	No records
Burbot	In the Project area	Distributed sporadically between near Redwood Meadows to Glenmore Reservoir	Distributed sporadically from downstream of the Project site to Glenmore Reservoir	No records

FISH ABUNDANCE

Fish abundance in Elbow River was extrapolated from spawning survey data (Popowich and Eisler 2008), surveys conducted during late fall 2019, and relative abundance from historical data AEP 2017). The methods to derive fish population abundance and the results are presented here.

Bull trout are iteroparous (COSEWIC 2012), meaning that mature adults generally spawn every season. Johnston et al. (2007) reported adult female bull trout abundance in Smith-Dorrien Creek, Alberta, was approximately the same as the spawning redd counts. Considering male and female pairs, if every female spawned, the ratio of adult fish to number of spawning redds would be 2:1 (if the number of females and males were approximately the same).

However, some adults will be inactive for a year and miss a spawning period. Ratios above 2.0 indicate not all adult fish participated in or are represented in the spawning red count. Al-Chokhachy et al. (2005) reported the mean number of adult bull trout spawners per redd in eastern Oregon streams was 2.68 (upper and lower bounds of 1.2 and 4.3). Dunham et al. (2001) reported the ratio of adult bull trout population size to redd count varied between 2.6 and 2.8.

Popowich and Eisler (2008) reported the number of bull trout redds in Elbow River (all between Elbow Falls and Paddy's Flat Campground); documented redd counts were 46 (2002), 36 (2003), 21 (2004), and 32 (2006). In 2004, Elbow River was affected by high flows and redds were difficult to distinguish, possibly causing the lower redd count for that year. Considering a ratio for adult fish abundance and redd count between 2.0 and 2.8, abundances associated with Popowich and Eisler's (2008) four years of work (not including the low redd count in 2004) would be between 62 and 129. Adult fish abundance in this range is within the estimated bull trout population size of 50-250 mature adults in upper Elbow River (ASRD 2012). The last reported spawning survey redd count of 32 redds (Popowich and Eisler 2008) is used (Table 19-3).

Spawning survey work for brook trout and brown trout was completed during late November and early December 2019, over approximately 25 km of continuous habitat on Elbow River (i.e., from approximately 2 km upstream of the diversion inlet to the downstream extent of Elbow Springs Golf Course). This portion of the river has a lower gradient than upstream closer to Elbow Falls and, consequently, stream flows are slower, the channel is more braided, and bed substrates comprising of gavels is greater than in the upstream areas (EIA, Volume 4, Section 3.3, page 3.5 to page 3.7). The river upstream of Bragg Creek closer to Elbow Falls is influenced by constraints of the river valley walls and bedrock substrate. To assess and extrapolate the potential number of spawning redds in Elbow River, the following assumptions are used:

- The river transitions from high gradient (1.54%) to low gradient (less than 0.80%) between Elbow Falls and Bragg Creek.
- The lower gradient reach from just upstream of Bragg Creek and Glenmore Reservoir includes the majority of habitat suitable for brown trout and brook trout spawning; this reach is approximately 50 km long.
- The 25 km of Elbow River that included the brown trout and brook trout spawning assessment conducted in the fall of 2019 covered approximately half the 50 km reach considered to have the highest likelihood brown trout and brook trout spawning activity.
- The number of brown trout and brook trout spawning redds observed in fall 2019 represents half the spawning potential in these populations (i.e., multiplying the number of redds by a factor of 2 represents the total number of redds and spawning pairs in the population).

During the fall 2019 spawning survey, 118 brown trout redds were identified. Extrapolating the total abundance of brown trout redds from an observed redd density of 118 redds, an estimated 236 redds is predicted and 353 brook trout redds were identified.

Brook trout and brown trout are iteroparous species, generally spawning every fall. However, the ratio of adult spawners to redd count is uncertain (i.e., no literature evidence found), therefore, the ratio used for bull trout (i.e., 2.0 to 2.8) is also used in this assessment for brown trout and brook trout. Estimated adult brook trout and brown trout abundances are provided in Table 19-3.

The relative fish population abundances for brook trout, brown trout and bull trout reported in the EIA (Volume 3B, Section 8.2.4. Figure 8.2-1, page 8.17) comprise 70% of the fish community in Elbow River (see Table 19-4). Using this information, the population sizes for each of the other resident species is included in Table 19-4.

The data used to estimate the relative abundances for each species is discussed in the EIA (Volume 3A, Section 8.2.2, page 8.33). These data were derived from the Alberta FWMIS (AEP 2017) and using electrofishing "catch per unit effort" data from 1978 through 2015. These may underestimate small-bodied fish (e.g., Cyprinidae) abundances because these species are often not targeted in fish surveys. Fish surveys used to support development (i.e., permitting for road and pipeline crossings and flood mitigation) may focus on larger species, assuming mitigation measures put in place to protect these fish will protect all species present.

Table 19-3 Abundance of Adult Brook Trout, Brown Trout and Bull Trout Populations in Elbow River Based on Spawning Redd Counts

Species	Estimated Redd Count	Predicted Adults
Brook trout (*Salvelinus fontinalis*)	706[1]	1,412-1,977
Brown trout (*Salmo trutta*)	236[1]	472-661
Bull trout (*Salvelinus confluentus*)	32[2]	64-95
Total Adult Abundance (Comprising 70% of the population)		1,948-2,733
NOTES: [1] Redd count estimated from fall 2019 spawning survey of half potential spawning habitat in Elbow River [2] Data from Popowich and Eisler 2008		

Table 19-4 Relative Abundance and Predicted Adult Population Abundance of Fish Communities in Elbow River between Elbow Falls and Glenmore Reservoir

Family	Common Name	Species	Relative Abundance (percent)[1]	Calculated Relative Abundance[2]	Predicted Adult Population Abundance
Catostomidae (suckers)	longnose sucker	*Catostomus*	2.4	2.4	67-94
	mountain sucker	*Catostomus platyrhynchus*	--[3]	--	--
	white sucker	*Catostomus commersonii*	0.3	0.3	8-12
Cyprinidae (carps and minnows)	fathead minnow	*Pimephales promelas*	--	--	--
	lake chub	*Couesius plumbeus*	0.1	0.1	3-4
	longnose dace	*Rhinichthys cataractae*	7	7	195-273
	pearl dace	*Margariscus margarita*	--	--	--
	spottail shiner	*Notropis hudsonius*	--	--	--
Esocidae (pikes)	northern pike	*Esox lucius*	--	--	--
Gadidae (cods)	burbot	*Lota lota*	0.8	0.8	11-31

Table 19-4 Relative Abundance and Predicted Adult Population Abundance of Fish Communities in Elbow River between Elbow Falls and Glenmore Reservoir

Family	Common Name	Species	Relative Abundance (percent)[1]	Calculated Relative Abundance[2]	Predicted Adult Population Abundance
Gasterosteidae (sticklebacks)	brook stickleback	*Culaea inconstans*	0.1	0.1	3-4
Percidae (perches and darters)	yellow perch	*Perca flavescens*	--	--	--
Percopsidae (trout-perches)	trout-perch	*Percopsis omiscomaycus*	--	--	--
Salmonidae (trout, char, salmon and whitefish)	brook trout	*Salvelinus fontinalis*	16.1	49	1,412-1,977
	brown trout	*Salmo trutta*	42.8	16.1	472-661
	bull trout	*Salvelinus confluentus*	10.5	4.2	64-95
	mountain whitefish	*Prosopium williamsoni*	17.5	17.5	487-683
	rainbow trout	*Oncorhynchus mykiss*	2.4	2.4	67-94
	westslope cutthroat trout	*Oncorhynchus clarkii lewisi*	0.1	0.1	3-4

NOTES:
-- dashes represent fish species known to occur in the watershed but were not represented in FWMIS data used for this study
1 Relative abundance of resident fish species as described in Volume 3A, Section 8.2.4, Figure 8.2-1
2 Relative abundance of brook trout, brown trout and bull trout, based on redd survey data
3 Species may occur in the watershed but not recorded in Elbow River

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Question 20

Supplemental Information Request 1, Question 95, Pages 2.150-2.154
Response to CEAA IR, Package 3, Response IR3-26a, Page 114

Alberta Transportation states that *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, and that 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.*

a. Justify the use of the Pike Group swimming performance curve given that it is based on a derived equation intended to represent Northern Pike.

b. Demonstrate the ability to pass burbot through the instream works under each of the flow scenarios (as presented in IR3-26) using swimming performance data for Eel Group.

c. Justify the use of a minimum water depth of 0.18 m over the gate bays as criteria for successful fish passage, addressing water depth requirements for the individual Elbow River fish species and fish sizes predicted to require passage.

  i. Include the time period, flow regime (discharge), and hydraulics of the passage structure that will occur when fish passage is required.

ii. Identify limitations to fish passage for each fish species.

d. Provide a figure of sufficient scale to allow clear identification of preferred fish movement routes within the service spillway and the stilling basin.

Response

a. Northern pike that may encounter the Project were evaluated for fish passage capabilities through the 'pike group' swimming performance curve presented in the Fish Swimming Performance Database and Analyses (Katapodis and Gervais 2016). The 'pike group' serves as a surrogate for northern pike in an evaluation of swim performance. Salmonids and cyprinids (e.g., bull trout, brown trout, white sucker) that may encounter the Project were evaluated for fish passage capabilities using the 'salmon and walleye' swimming performance curve (Katapodis and Gervais 2016). Similarly, the 'salmon and walleye' group was used as a surrogate for various salmonid and cyprinid species in Alberta Transportation's response to Round 1 AEP IR91 and IR95. The general categories (i.e., surrogates) were required because of limited available data on the swimming performance of individual species.

   The database presented by Katapodis and Gervais (2016) is the most detailed information available, as of May 2020, to inform fish passage design. A Swim Performance Online Tool was published in January 2020 (DiRocco and Gervais 2020), which prompts species-specific inputs that generate a graphical interpretation of the dataset provided in Katapodis and Gervais (2016). This tool generates the same results that are achieved through the expanded dataset provided in the response to NRCB Question 21 or by a manual interpretation of the Katapodis and Gervais (2016) fish groups and datasets.

b. The ability of the instream works to pass all fish species found in Elbow River with fork lengths between 25 mm and 1,000 mm is presented in the response to NRCB Question 21. These results include those for burbot in sizes 25 mm, 250 mm and 1,000 mm.

c. Average body thickness of fish was used to derive the minimum design depth selection. A multiplier of 1.5 was applied to the average body thickness to select minimum design depth. Body thickness was considered for each category of fish presented in Katapodis and Gervais (2016), and the largest fish category was carried forward for design depth.

   - 25 mm fish length (assumed body thickness of 10 mm) = 15 mm minimum depth.
   - 250 mm fish length (assumed body thickness of 85 mm) = 127.5 mm minimum depth.
   - 1,000 mm fish length (assumed body thickness of 120 mm) = 180 mm minimum depth.

   A multiplier of 1.5 has been recommended for species-specific design criteria for culverts by the Maine Department of Transportation (2004), and it has been endorsed by several state and US federal resource and regulatory agencies. An equivalent, or more applicable guidance, document is not available in Canada for fish passage minimum depth criteria.

i. See the response to NRCB Question 21 for the time period, flow regime (discharge), and hydraulics of the passage structure that will occur when fish passage is required.

ii. The response to NRCB Question 21 demonstrates that fish passage is maintained during dry and post-flood operations for all species and sizes where passage is possible under existing (baseline) conditions. The fish passage structures will also improve passage for select species during dry and post-flood operations under select flow conditions.

d. See the figures that accompany the response to NRCB Question 21 for fish movement routes within the service spillway and stilling basin.

REFERENCES

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Question 21

Supplemental Information Request 1, Question 93, Pages 2.147 to 2.148
Response to CEAA IR, Package 3, Appendix IR26-1, Figure 1 and 2, Page 26-1.2

Alberta Transportation states in the SIR1 response that the *proposed engineered fish passage measures are designed to maintain sufficient depth for fish passage*. Alberta Transportation indicates in the CEAA IR response package that the fish swimming criteria used as a basis for fish passage structure design set minimum fish length at 250 mm.

a. Demonstrate that all fish sizes and fish swimming abilities of species expected to require upstream passage have been incorporated into the design and operation of the fish passage mitigation structures, including an evaluation of effectiveness to pass small fish (≤ 150 mm length) during all flow scenarios.

b. Discuss limitations to the effectiveness of upstream fish passage caused by design criteria of ≥ 250 mm fish length. Include a discussion of upstream fish during higher than low flow conditions.

c. Discuss the expected life span of the mitigation measures in terms of structural stability and as-built specifications.

Response

a. An expanded dataset, provided below, presents swimming performance for all fish species and life stages, at river flows that correspond to different seasons.

An assessment of fish passage mitigation measures was undertaken for three different fish sizes of 25 mm, 250 mm and 1,000 mm and for all fish species found in Elbow River, grouped by their swimming ability. The assessment was not limited to fish larger than 150 mm because the three sizes selected coincide with the swim ability test data collected and analyzed in Katapodis and Gervais (2016) which used 25 mm, 250 mm, and 1,000 mm to represent a range of fish sizes and life stages. Katapodis and Gervais (2016) also grouped all fish species into swim-ability groups of "eel," "salmon/walleye," and "pike". The database presented by Katapodis and Gervais (2016) is the most detailed fish swimming performance data available, as of May 2020, to inform fish passage design. These same groups were used in the analysis; each species found in Elbow River comprising these groups is presented in Table 21-1.

Table 21-1 Fish Species Found in Elbow River Grouped by Swim Ability

Fish Swim Ability Group	Species Found in Elbow River[1]
Eel	Burbot
Salmon and Walleye	Bull trout, brown trout, brook trout, mountain whitefish, rainbow trout, cutthroat trout, white sucker, yellow perch, spottail shiner, pearl dace, longnose dace, lake chub, fathead minnow, mountain sucker, longnose sucker
Pike	Northern Pike
NOTE: [1] Brook stickleback and trout-perch are also found in Elbow River; however, swim performance data are not available for these species. Fish passage conditions are not expected to be required for these species, as they are non-migratory.	
SOURCE: Katapodis and Gervais (2016)	

The analysis was run for 1 in 10-year 3-day high and low flow (3Q10max and 3Q10min) estimates for the four BSP as presented in Table 21-2, for a total of eight flow scenarios to evaluate fish passage conditions.

The biologically significant periods represent key seasonal times in the life stages of fish in Elbow River and are classified as follows:

- BSP-1 is from April 2 to June 15 (bull trout: incubation, fry, juvenile, adult, spawning; brown trout: fry, juvenile, adult; rainbow trout: incubation, fry, juvenile, adult, migration, spawning; mountain whitefish: fry, juvenile, adult).

- BSP-2 is from June 16 to September 25 (bull trout: migration, spawning, incubation, juvenile, adult; brown trout: fry, juvenile, adult; rainbow trout: incubation, fry, juvenile, adult; mountain whitefish: fry, juvenile, adult).
- BSP-3 is from September 26 to December 1(bull trout: incubation, adult, spawning; brown trout: incubation, fry, juvenile, adult, migration, spawning; rainbow trout: fry, juvenile, adult; mountain whitefish: incubation, fry, juvenile, adult, spawning).
- BSP-4 is from December 2 to April 1 (bull trout: incubation, fry, adult; brown trout: incubation, fry, juvenile, adult; rainbow trout: fry, juvenile, adult; mountain whitefish: incubation, fry, juvenile, adult). While these flows represent open water conditions, and analysis is provided, it must be noted that Elbow River is typically frozen to its bed during this period for much of its channel and passage; the river is highly restricted by ice.

Table 21-2 3Q10max and 3Q10min Flow Estimates for Biologically Significant Periods

Flows	BSP 1 (April 2 to June 15)	BSP 2 (June 16 to September 25)	BSP 3 (September 26 to December 1)	BSP 4 (December 2 to April 1)
3Q10max (m^3/s)	75.7	69.5	15	9.81
3Q10min (m^3/s)	2.8	3.47	2.38	0.8

Velocity and water elevation results were modelled using the same Flow two-dimensional (2D)-based hydraulic model that was used for Round 1 NRCB IR91 and IR93. These responses describe both existing hydraulic conditions in Elbow River, and those that will be present with the Project service spillway and fish mitigation structures (i.e., v-weirs) in place.

Figure 21-1 provides the modelled water depths up the centerline of the channel thalweg and Figure 21-2 shows the modelled velocities up the thalweg under these eight flow scenarios. While this information is useful in describing the hydraulic characteristics, it is necessary to consider the multi-dimensional nature of fish passage in a natural channel if the analysis is to consider fish of all species and sizes. Many fish would not pass the fish passage mitigation works up the centre of the thalweg because passage does not solely occur up the thalweg for all fish species throughout the entire wetted width of the channel.

Because passage does not solely occur up the thalweg for all fish species, the views in Figure 21-3 to Figure 21-10 were prepared from the hydraulic model results and show velocity throughout the entire wetted width of the channel. Depth contours show depths of 0.18 m, 0.13 m and 0.02 m, which are estimated to be the depth requirements for passage of fish with fork lengths that are 1,000 mm, 250 mm and 25 mm, respectively (as discussed in the response to NRCB Question 20).

Potential swim paths for each of the fish size categories are mapped in Figures 21-3 to 21-10. The paths incorporate the minimum depths required for passage and represent the lowest velocity over the shortest distance; low velocity areas and boulders, as rest areas, are part of the fish passage mitigation.

The swim paths that were established for each size category are further categorized for 'step' and 'pool' components, which separates the shorter high velocity areas (steps) from the longer moderate velocity areas (pools). This step length and pool length vary, depending on velocity and fish fork length as shown in Table 21-3.

Table 21-3 Pool and Step Length per Fish Size

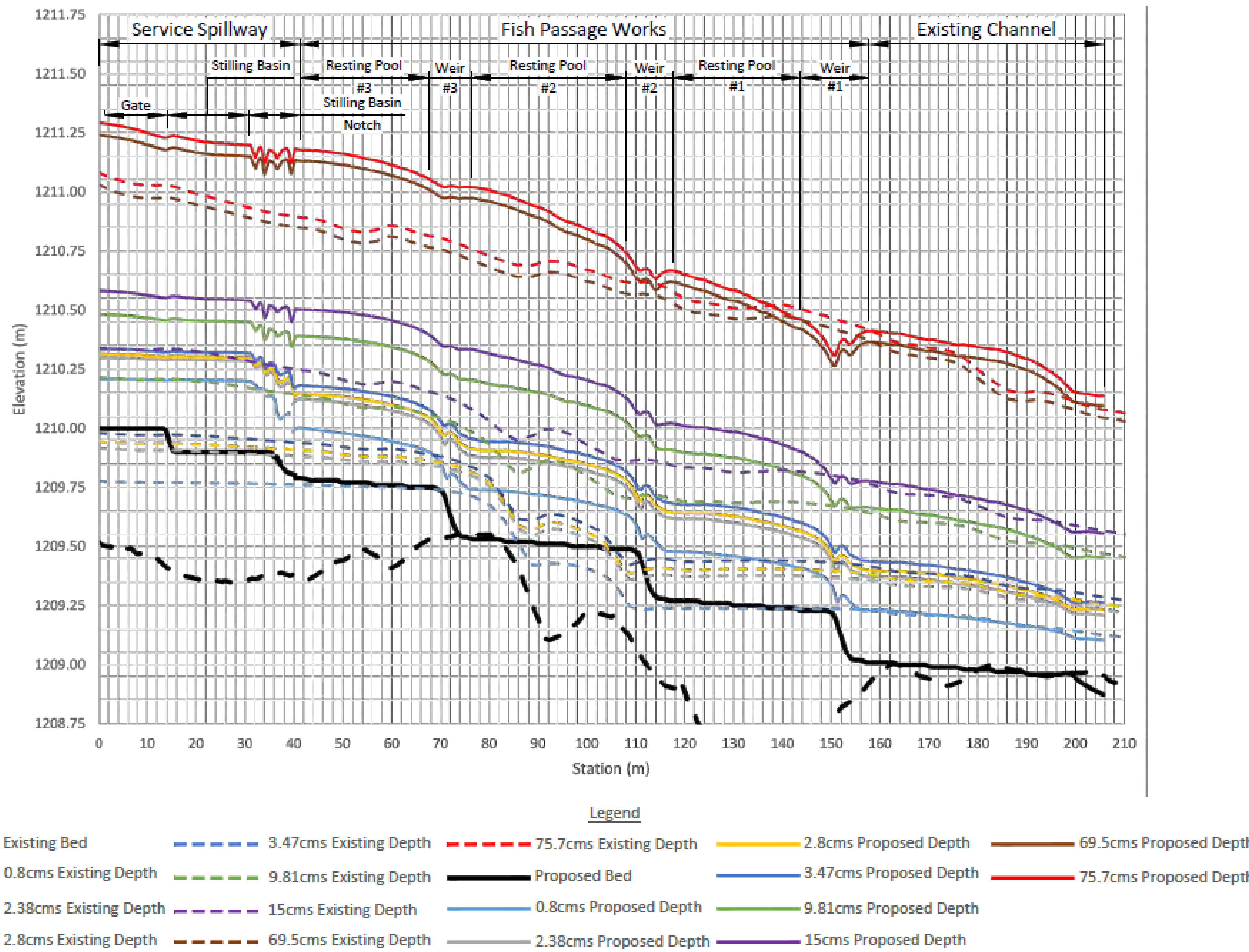
Fish Fork Length (mm)			
	25	250	1,000
Velocity for Step Length (m/s)	>1	>1.3	>2.5
Velocity for Pool Length (m/s)	<1	<1.3	<2.5

The paths are analyzed for distance and velocity and compared to the swim ability information in the fish swim performance database (Katapodis and Gervais 2016) for each of the species swim ability group. Appendix 21-1 provides fish passage results tables for each fish species group for five confidence intervals (95%, 75%, 50%, 25% and 5% pass). The tables also indicate the maximum modelled velocity along the respective step or pool and its associated swim path length. These values compare the velocity to swim distance information available in the fish swim performance database (Katapodis and Gervais 2016) to identify fish passage success or failure at both step and pool, where applicable. The passage rating is the result of these comparisons and is presented in each table as:

- N/N = no passage step/no passage pool. Fish Passage not achieved.
- N/Y - Y/N = no passage at either step or pool. Fish can pass one but not the other step/pool length. Fish passage not achieved.
- Y/Y = passage achieved (both step and pool).
- n/a = naturally low flows that correspond to overwintering periods where fish movement is limited (i.e., BSP-4).

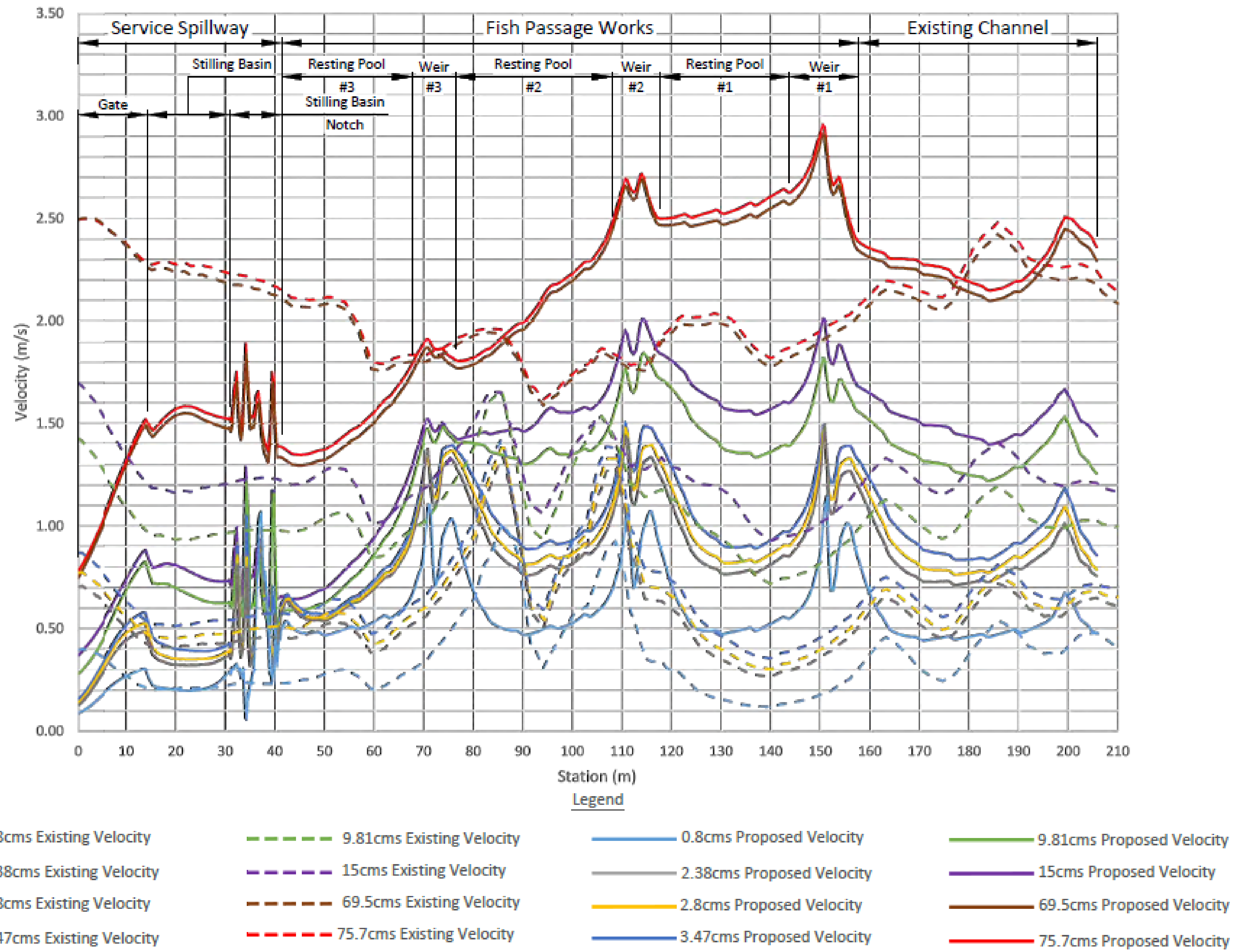
Green highlights in Appendix 21-1 show conditions where passage is achieved, and red highlights in Appendix 21-1 show where passage is not achieved.

The results demonstrate that fish passage is maintained during non-flood and post-flood operations for all species and sizes where passage is possible under existing (baseline) conditions. The proposed instream works also improve passage during non-flood and post-flood operations for select species under select flow conditions, where it could not be achieved under existing conditions. The fish passage mitigation structures, therefore, improve the hydraulic conditions for fish passage through this reach, over existing conditions.



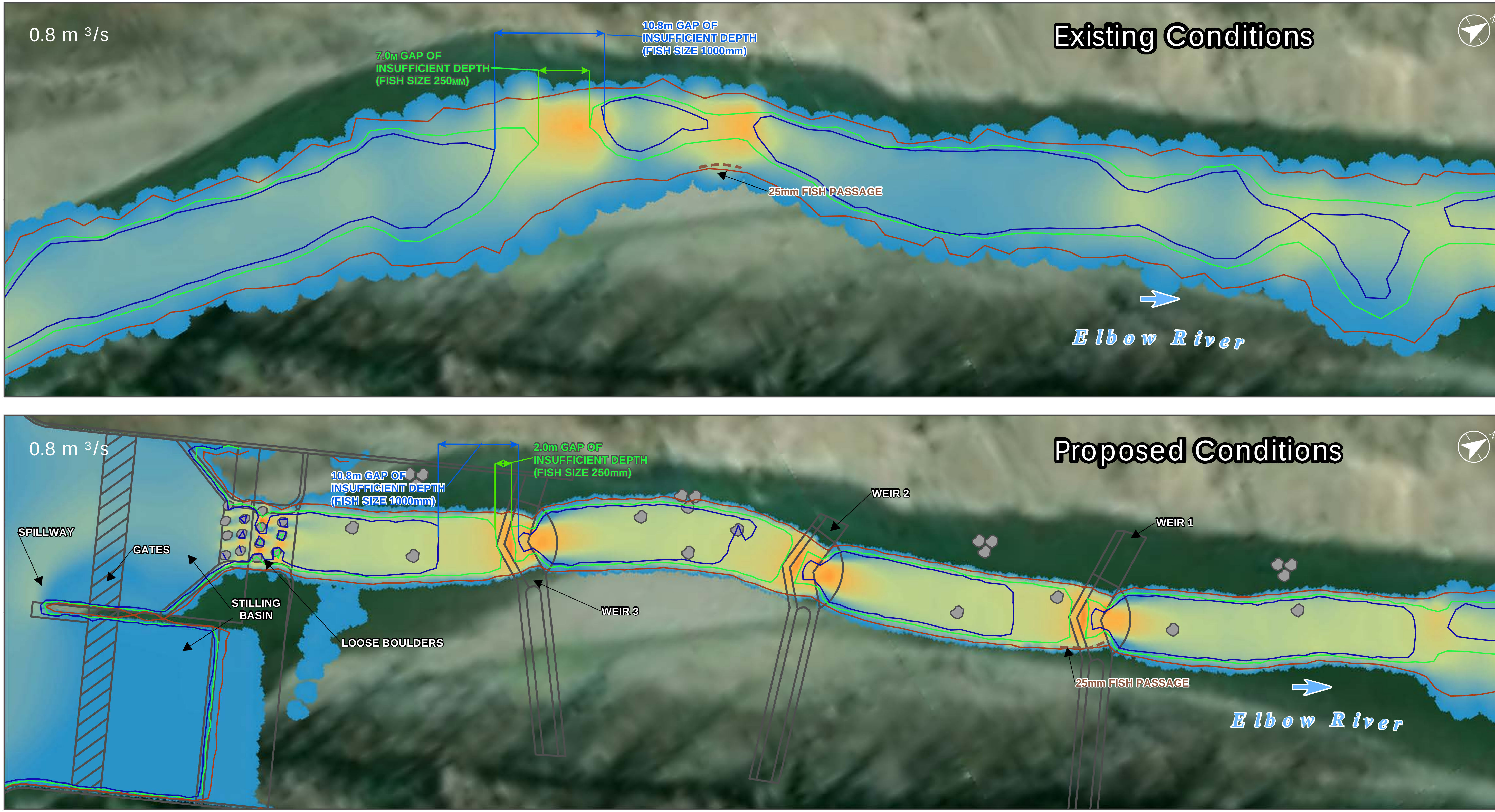
NOTE: cms = cm/s

Figure 21-1 Modelled Water Depths in the Thalweg Through the Service Spillway and Fish Passage Mitigations under Existing and Proposed Conditions



NOTE: cms = cm/s

Figure 21-2 Modelled Water Velocity in the Thalweg Through the Service Spillway and Fish Passage Mitigations under Existing and Proposed Conditions



Sources: Base Dat & Imagery - Government of Alberta; Thematic Data - Stantec Ltd.

Stantec

Velocity (m/s)
High : 1.5
1
0.5
Low : 0

Water Depth
0.02 m
0.13 m
0.18 m

Pool Length (Fish Size 1000mm)
Step Length (Fish Size 250mm)
Pool Length (Fish Size 250mm)
Step Length (Fish Size 25mm)
Pool Length (Fish Size 25mm)
Boulder (Rest Area)

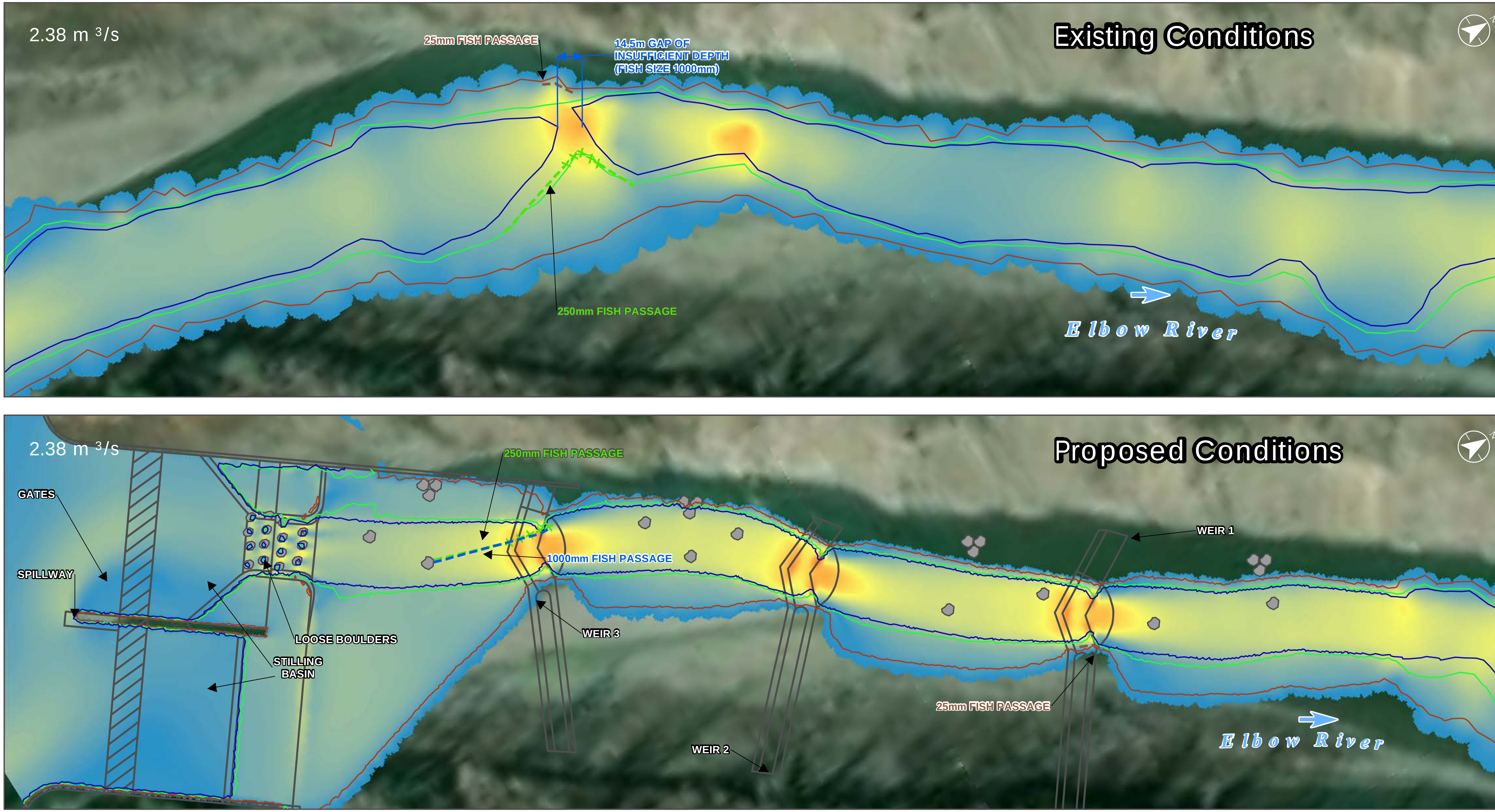
0 8 16 24 32
metres

110773396-971 REVA NAD 1983 3TM 114

Flow, Velocity, Depth, and Fish Passage for Existing and Proposed Conditions
1 in 10 year 3 Day Low Flow (3Q10min)= 0.8 m³/s
BSP4 (WINTER)

Figure 21-3

SPRINGBANK OFF-STREAM RESERVOIR - ALBERTA TRANSPORTATION



Sources: Base Dat & Imagery - Government of Alberta; Thematic Data - Stantec Ltd.

Stantec

SPRINGBANK OFF-STREAM RESERVOIR - ALBERTA TRANSPORTATION

Velocity (m/s)
High : 2
1.5
1
.5
Low : 0

Water Depth
0.02 m
0.13 m
0.18 m

Pool Length (Fish Size 1000mm)
Step Length (Fish Size 250mm)
Pool Length (Fish Size 250mm)
Step Length (Fish Size 25mm)
Pool Length (Fish Size 25mm)
Boulder (Rest Area)

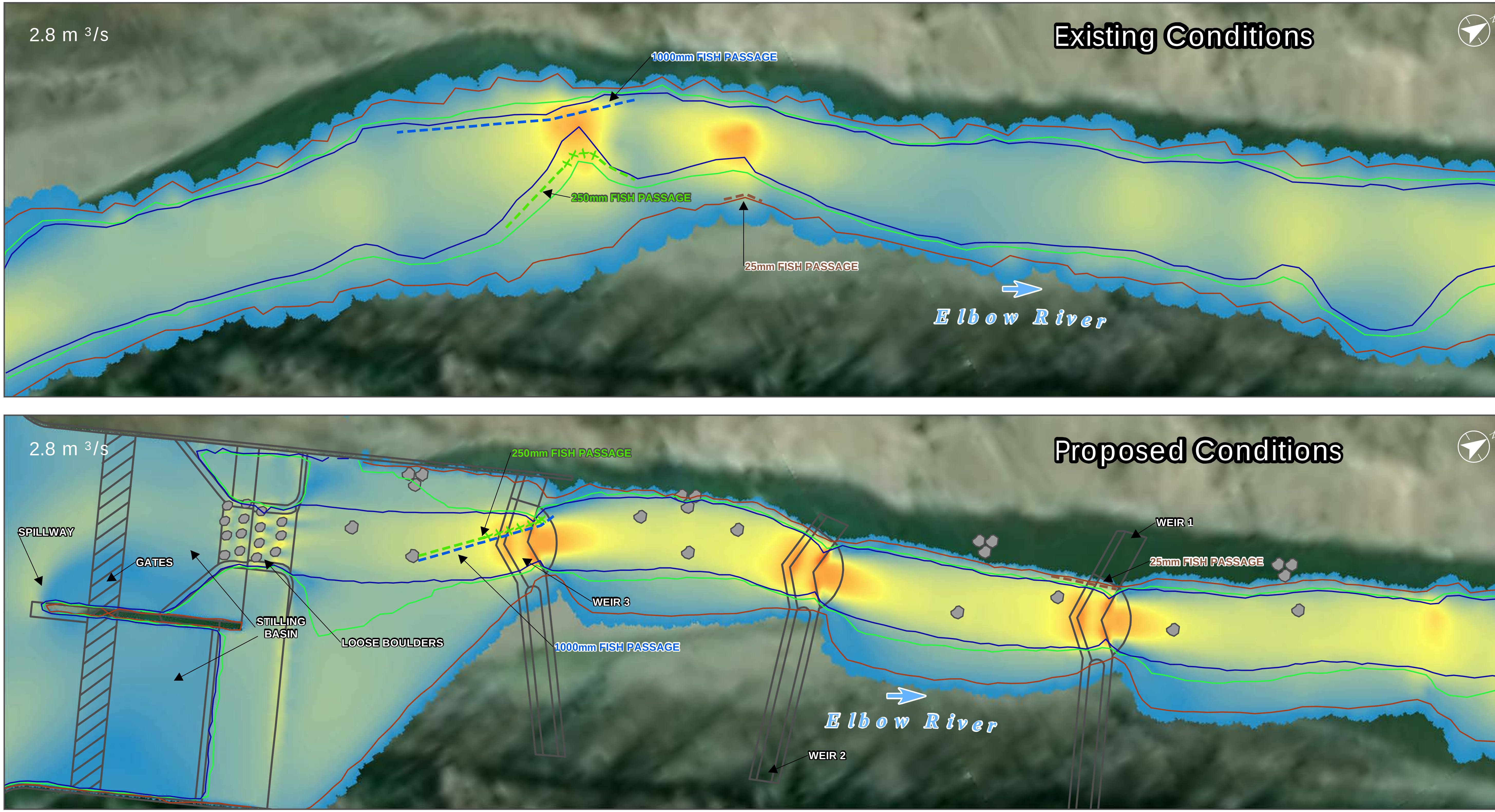
0 8 16 24 32
metres

110773396-973 REVA

NAD 1983 3TM 114

Flow, Velocity, Depth, and Fish Passage for Existing and Proposed Conditions
1 in 10 year 3 Day Low Flow (3Q10min)= 2.38 m³/s
BSP3 (FALL)

Figure 21-4



Sources: Base Dat & Imagery - Government of Alberta; Thematic Data - Stantec Ltd.

Stantec

Velocity (m/s)
High : 2
1.5
1
.5
Low : 0

Water Depth
0.02 m
0.13 m
0.18 m

Pool Length (Fish Size 1000mm)
xxxx Step Length (Fish Size 250mm)
Pool Length (Fish Size 250mm)
xxxx Step Length (Fish Size 25mm)
Pool Length (Fish Size 25mm)
Boulder (Rest Area)

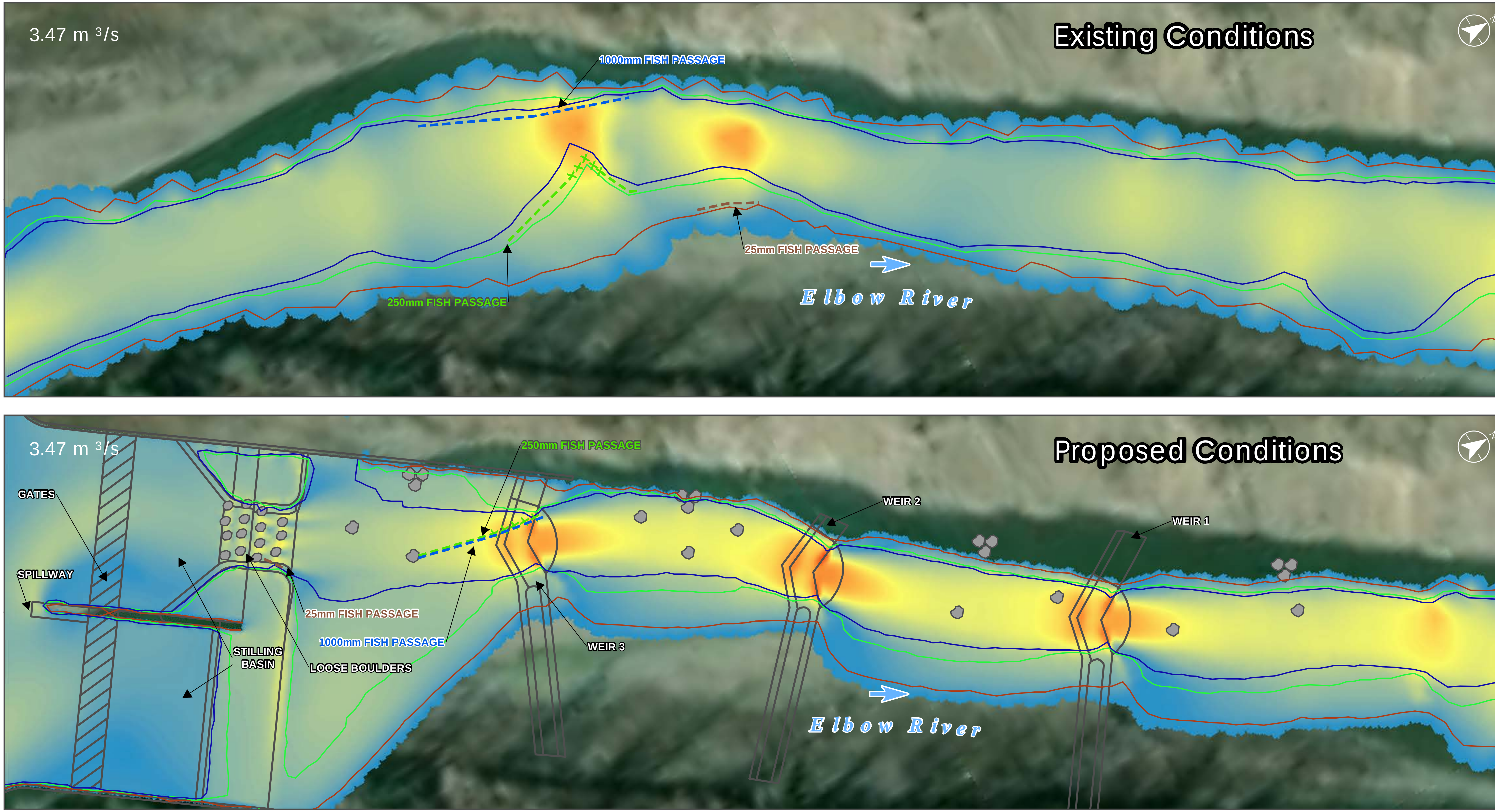
0 8 16 24 32
metres

110773396-972 REVA
NAD 1983 3TM 114

Flow, Velocity, Depth, and Fish Passage
for Existing and Proposed Conditions
1 in 10 year 3 Day Low Flow (3Q10min)= 2.8 m³/s
BSP1 (SPRING)

Figure 21-5

SPRINGBANK OFF-STREAM RESERVOIR - ALBERTA TRANSPORTATION



Sources: Base Dat & Imagery - Government of Alberta; Thematic Data - Stantec Ltd.

Stantec

SPRINGBANK OFF-STREAM RESERVOIR - ALBERTA TRANSPORTATION

Velocity (m/s)
High : 2
1.5
1
.5
Low : 0

Water Depth
0.02 m
0.13 m
0.18 m

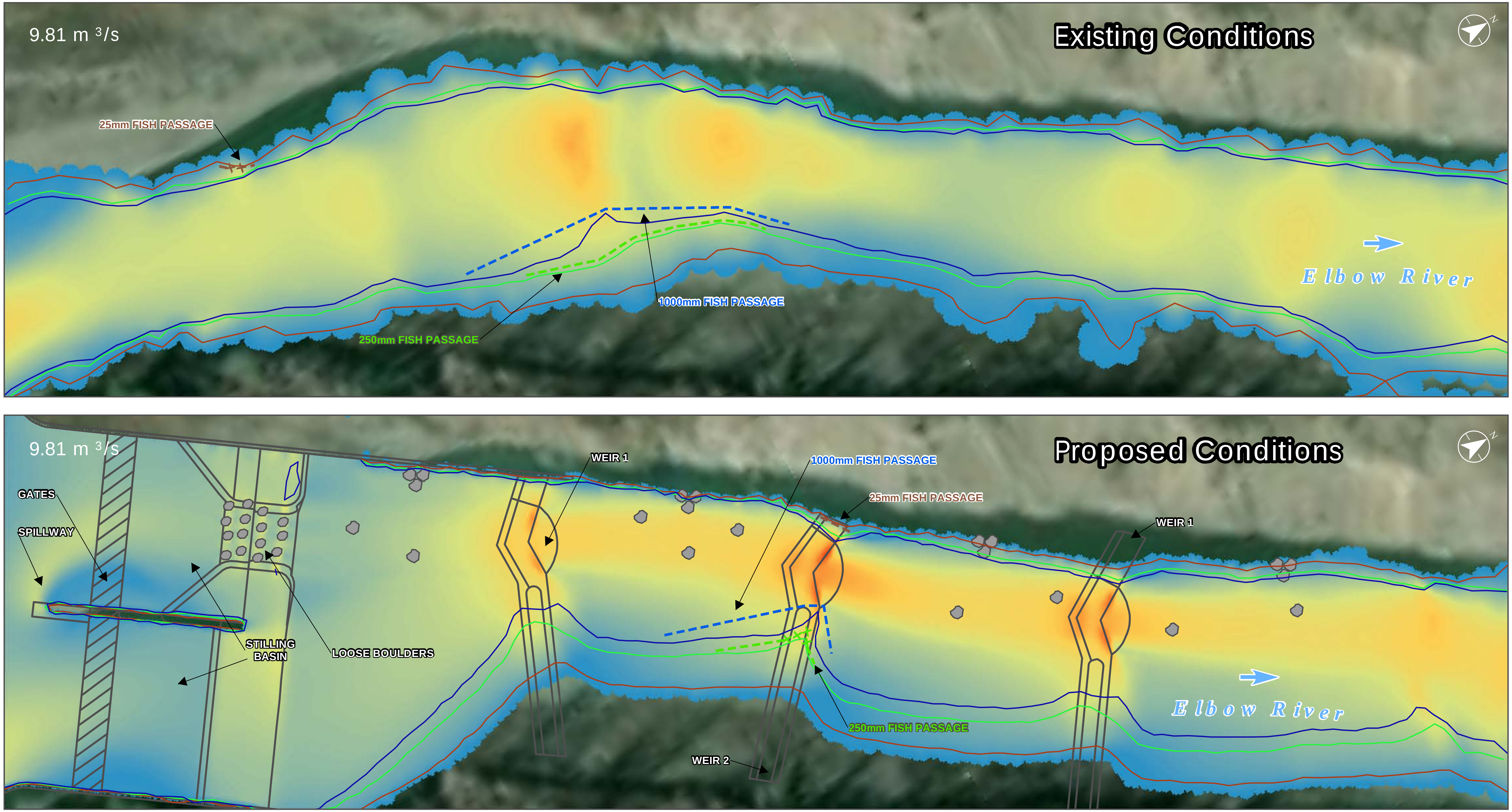
Pool Length (Fish Size 1000mm)
Step Length (Fish Size 250mm)
Pool Length (Fish Size 250mm)
Step Length (Fish Size 25mm)
Pool Length (Fish Size 25mm)
Boulder (Rest Area)

0 8 16 24 32
metres

110773396-974 REVA
NAD 1983 3TM 114

Flow, Velocity, Depth, and Fish Passage
for Existing and Proposed Conditions
1 in 10 year 3 Day Low Flow (3Q10min)= 3.47 m³/s
BSP2 (SUMMER)

Figure 21-6



Sources: Base Dat & Imagery - Government of Alberta; Thematic Data - Stantec Ltd.

Stantec

Velocity (m/s)

High : 2.5
2
1.5
1
0.5
Low : 0

Water Depth

0.02 m
0.13 m
0.18 m

Pool Length (Fish Size 1000mm)
xxxx Step Length (Fish Size 250mm)
Pool Length (Fish Size 250mm)
xxxx Step Length (Fish Size 25mm)
Pool Length (Fish Size 25mm)
Boulder (Rest Area)

0 8 16 24 32
metres

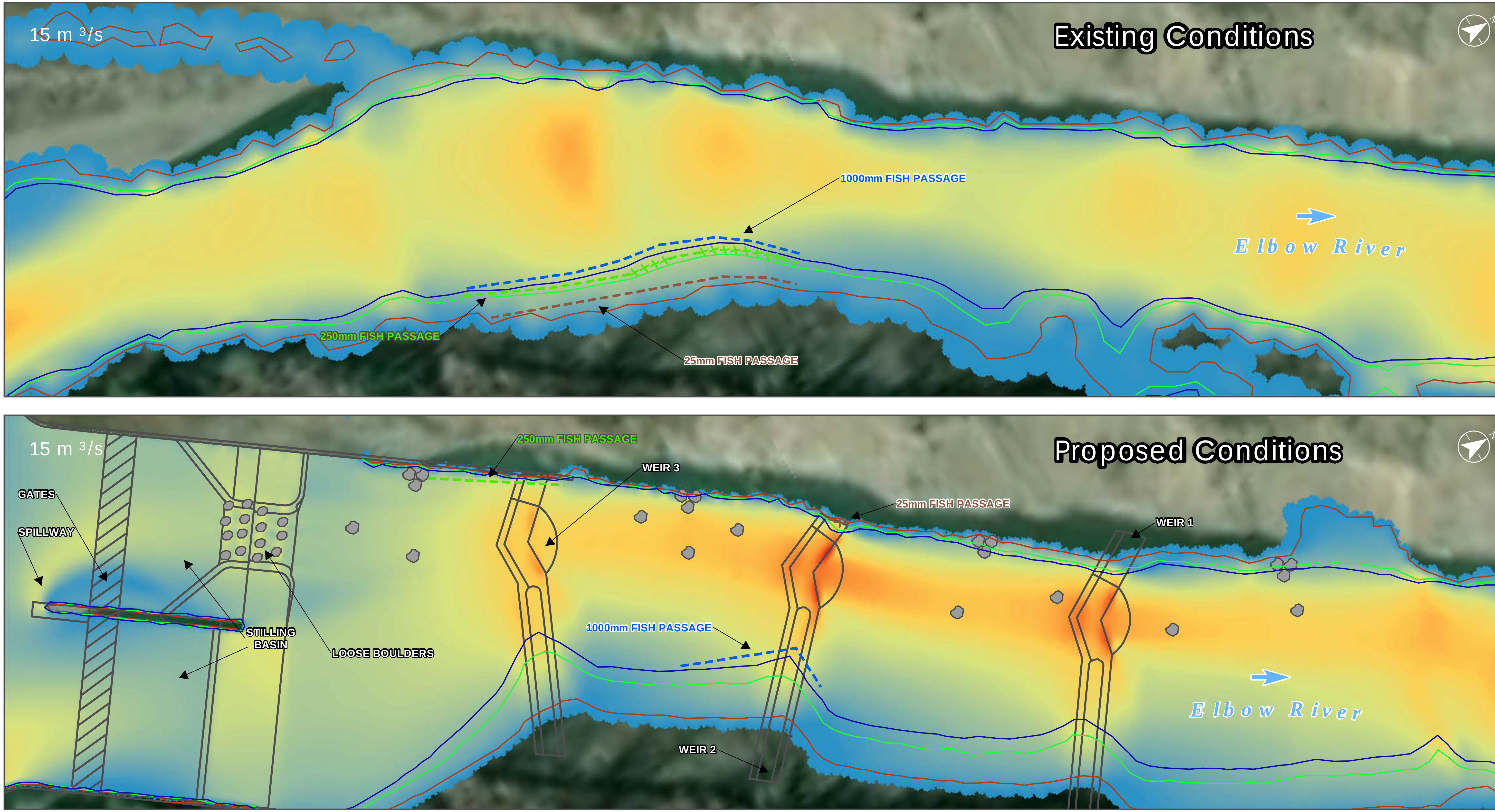
110773396-975 REVA

NAD 1983 3TM 114

Flow, Velocity, Depth, and Fish Passage
for Existing and Proposed Conditions
1 in 10 year 3 Day High Flow (3Q10max)= 9.81 m³/s
BSP4 (WINTER)

Figure 21-7

SPRINGBANK OFF-STREAM RESERVOIR - ALBERTA TRANSPORTATION



Sources: Base Data & Imagery - Government of Alberta; Thematic Data - Stantec Ltd.

Stantec

Velocity (m/s)

High : 2.5
2
1.5
1
0.5
Low : 0

Water Depth

0.02 m
0.13 m
0.18 m

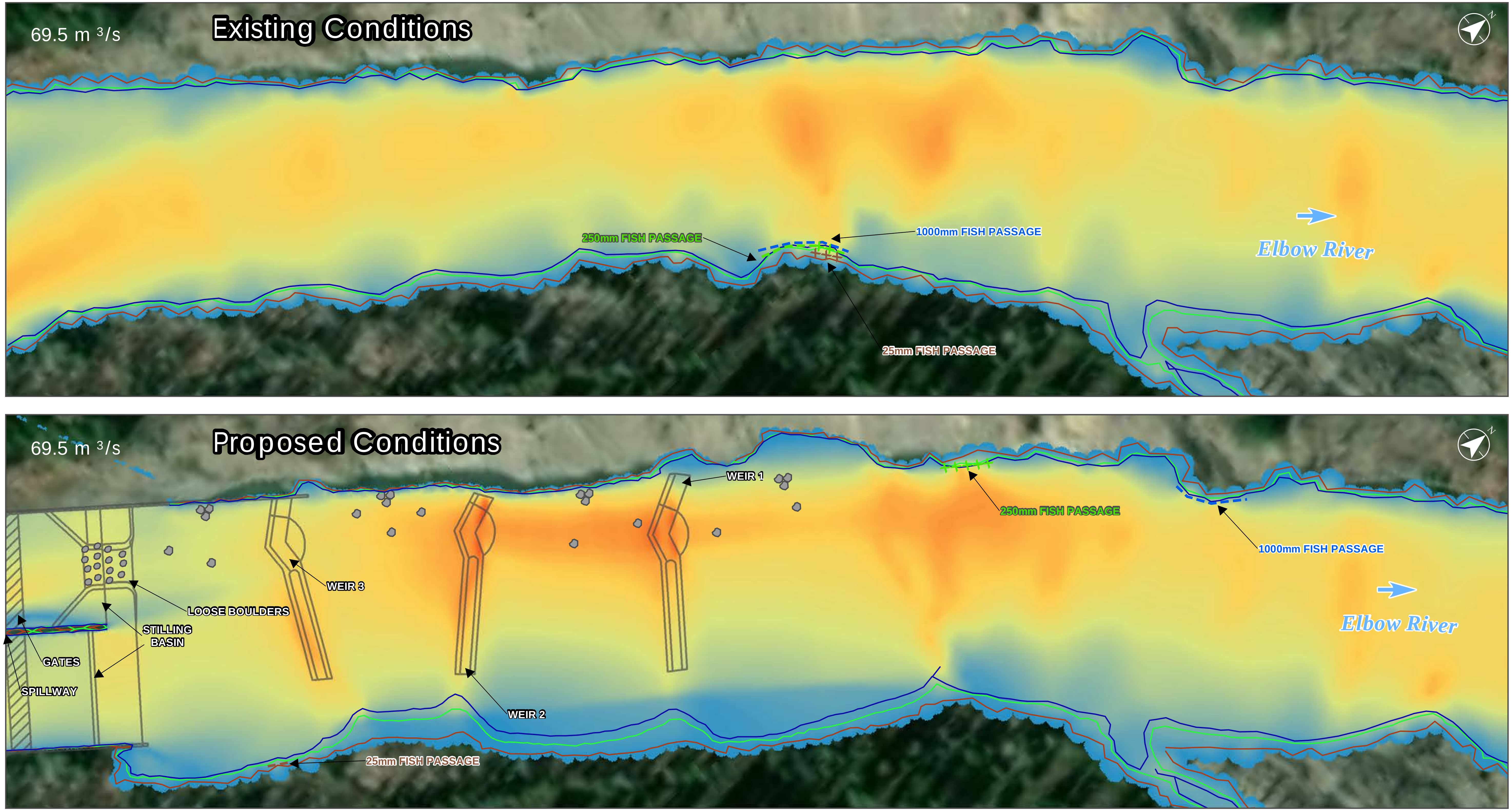
Pool Length (Fish Size 1000mm)
Step Length (Fish Size 250mm)
Pool Length (Fish Size 250mm)
Step Length (Fish Size 25mm)
Pool Length (Fish Size 25mm)
Boulder (Rest Area)

0 8 16 24 32
metres

110773396-976 REVA
NAD 1983 3TM 114

Flow, Velocity, Depth, and Fish Passage for Existing and Proposed Conditions
1 in 10 year 3 Day High Flow (3Q10max)= 15 m³/s
BSP3 (FALL)

Figure 21-8



Sources: Base Dat & Imagery - Government of Alberta; Thematic Data - Stantec Ltd.

Stantec

Velocity (m/s)
- High : 3.5
- 2.8
- 2.7
- 1.4
- 0.7
- Low : 0

Water Depth
- 0.02 m
- 0.13 m
- 0.18 m

- Pool Length (Fish Size 1000mm)
- Step Length (Fish Size 250mm)
- Pool Length (Fish Size 250mm)
- Step Length (Fish Size 25mm)
- Pool Length (Fish Size 25mm)
- Boulder (Rest Area)

0 10 20 30 40
metres

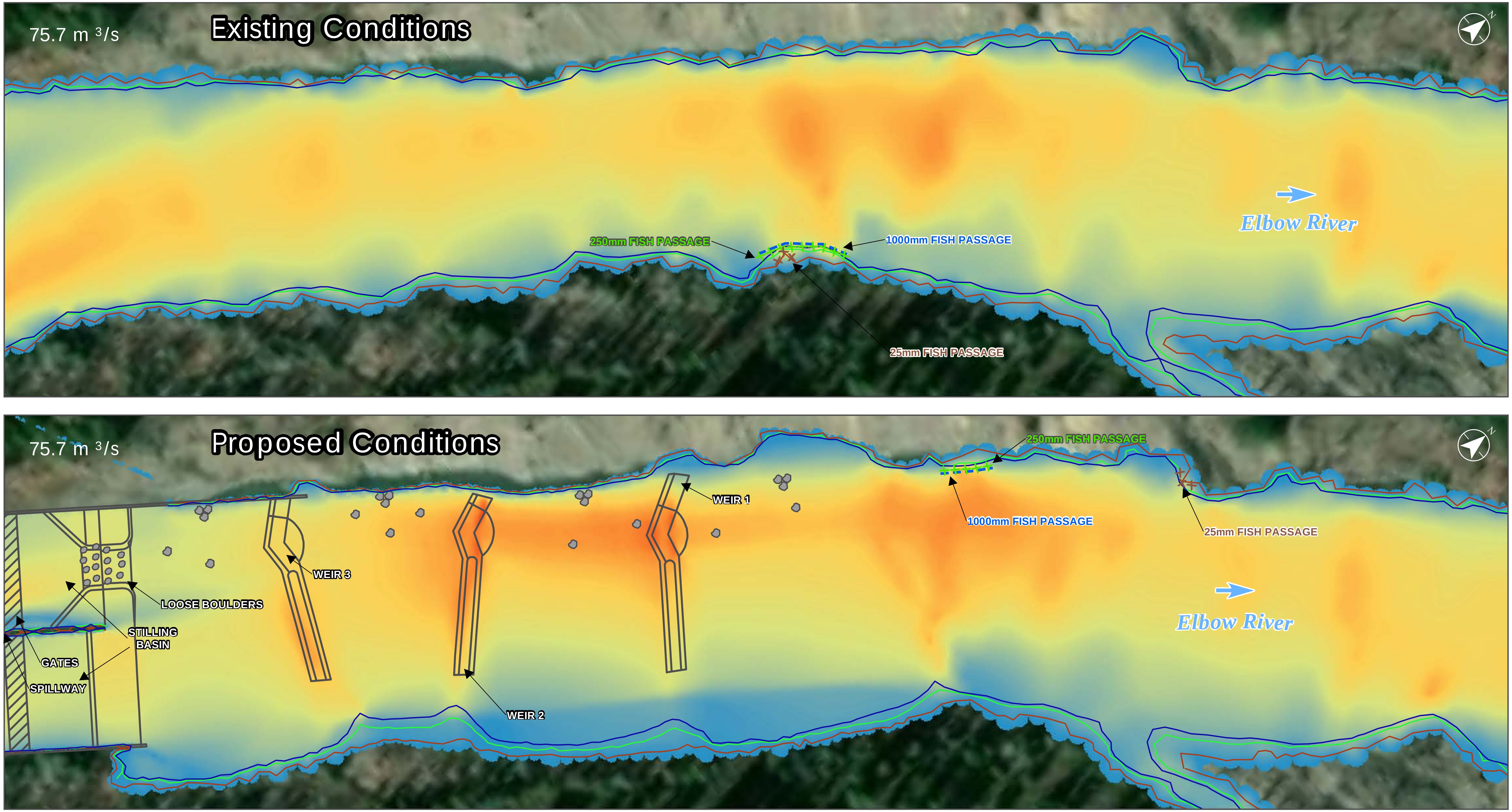
110773396-977 REVA

NAD 1983 3TM 114

Flow, Velocity, Depth, and Fish Passage for Existing and Proposed Conditions
1 in 10 year 3 Day High Flow (3Q10max)= 69.5 m³/s
BSP2 (SUMMER)

Figure 21-9

SPRINGBANK OFF-STREAM RESERVOIR - ALBERTA TRANSPORTATION



Sources: Base Dat & Imagery - Government of Alberta; Thematic Data - Stantec Ltd.

Stantec

Velocity (m/s)
High : 3.5
2.8
2.1
1.4
0.7
Low : 0

Water Depth
0.02 m
0.13 m
0.18 m

Pool Length (Fish Size 1000mm)
Step Length (Fish Size 250mm)
Pool Length (Fish Size 250mm)
Step Length (Fish Size 25mm)
Pool Length (Fish Size 25mm)
Boulder (Rest Area)

0 10 20 30 40
metres

110773396-978 REVA
NAD 1983 3TM 114

Flow, Velocity, Depth, and Fish Passage for Existing and Proposed Conditions
1 in 10 year 3 Day High Flow (3Q10max)= 75.7 m³/s
BSP1 (SPRING)

Figure 21-10

SPRINGBANK OFF-STREAM RESERVOIR - ALBERTA TRANSPORTATION

b. As discussed in the response to a., limitations to the effectiveness of upstream fish passage are not predicted for any species or size class during dry operations. In review of the hydraulic conditions presented in the response to a., hinderances to downstream migration of fish during dry operations are not predicted.

c. The engineered rock weirs have been designed for stability up to a 100-year flood in Elbow River (i.e., 600 m^3/s diverted and maximum flow through the service spillway of 160 m^3/s). The works may require repair or rebuilding during post-flood operation if a 100-year flood is exceeded. The expected life span of the structures is not known due to the uncertainty of flood occurrences.

REFERENCES

Katapodis and Gervais. 2016. Fish Swimming Performance Database and Analyses. DFO Can. Sci. Advis. Sec. Res. Doc. 2016/002 vi+550p.

Question 22

Supplemental Information Request 1, Question 98, Pages 2.159-2.161

Alberta Transportation states *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. Alberta Transportation also describes that 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.*

a. Demonstrate that the habitat assessment used as the basis for this statement quantified nearshore habitat complexity.

b. Demonstrate that sediment deposition upstream of the service spillway will not alter the channel gradient through the stilling basin fish passage structure.

c. Demonstrate that sediment deposition upstream of the service spillway will not cause sediment deposition in the stilling basin fish passage structure due to erosion of a new channel through the sediments deposited upstream of the service spillway.

Response

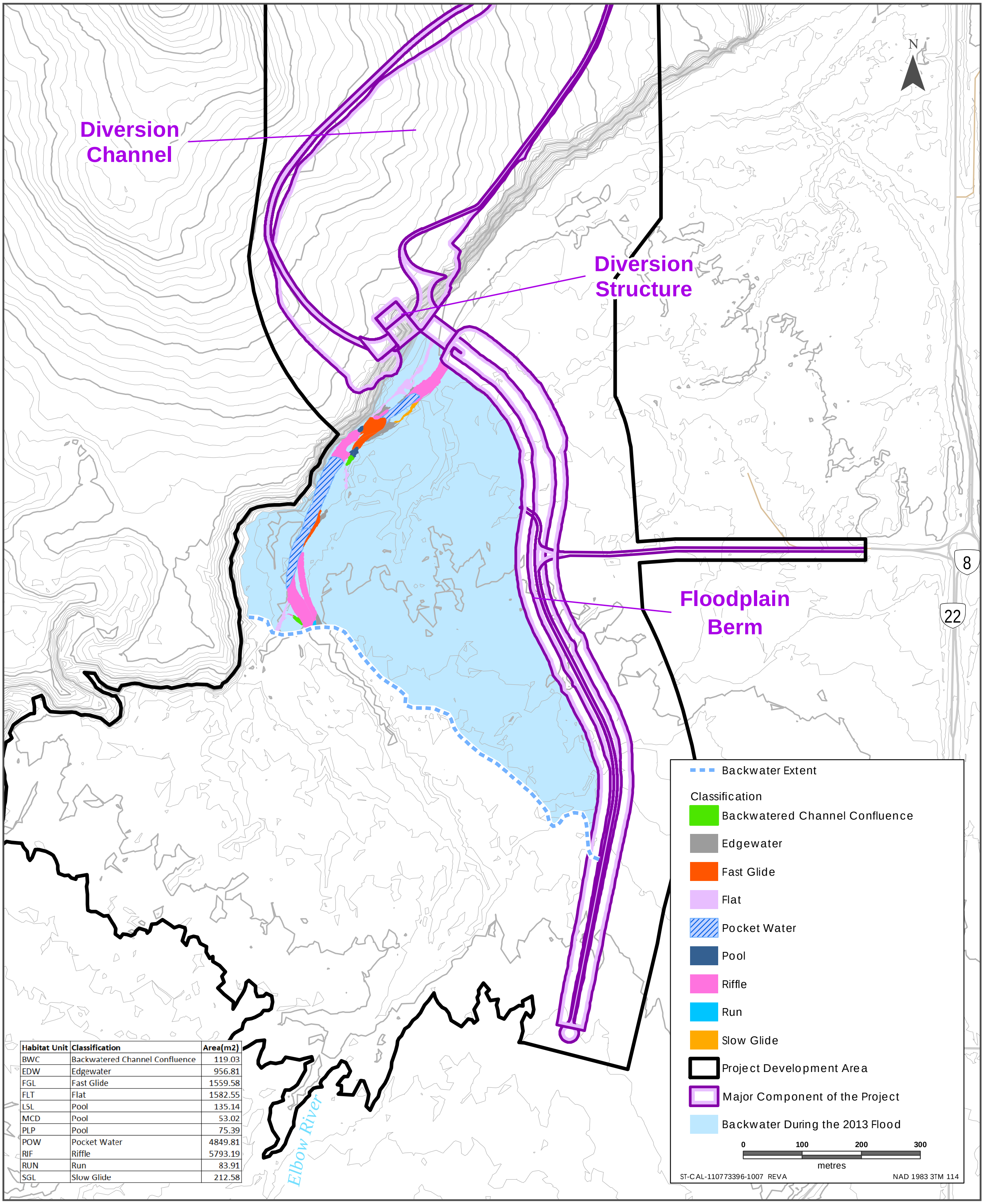
a. Fish habitat is characterized within representative reaches for the EIA (Volume 4, Appendix M), and these representative reaches are used to infer habitat throughout Elbow River.

   Comprehensive habitat mapping was subsequently completed for approximately 25 km of Elbow River habitat in November 2019; the mapping extended from Tsuut'ina Nation Reserve boundary near Redwood Meadows (approximately 2 km upstream of the Project location) to the Tsuut'ina Nation Reserve boundary of Elbow River adjacent to Discovery Ridge. Macrohabitat units were mapped and used to assess habitat suitability for key indicator species, which are presented in response to AEP Question 69, Appendix 69-1. Fish habitat units (including nearshore habitat) from the November 2019 survey are used to quantify the reach of Elbow River where backwater effects are predicted to occur during a flood. A map of habitat units and tabulated quantities derived from the November 2019 field results is presented in Figure 22-1.

b. Sediment deposition upstream of the service spillway is not expected to alter the channel gradient through the stilling basin and fish passage structures because those structures are downstream of the area where sediment deposition (as a result of backwater effects) is predicted to occur. The channel gradient upstream of the service spillway may decrease due to the deposition.

c. The design of the stilling basin considered the range of sediment transport rates expected for floods. The width of the stilling basin matches the existing bankfull width of Elbow River in the vicinity of the structure. During bankfull conditions, sediment transport within the area of the stilling basin is not predicted to change from existing conditions. The fish passage structures, downstream of the stilling basin, are designed as naturalized features; therefore, sediment movement through them is expected to occur. These structures raise the bed grade by 0.6 m over a distance of 45 m, compared to existing conditions. The sediment transport capacity though the fish passage structures is, therefore, increased slightly over existing conditions. However, in general, the bedload transport properties of the fish passage structure are expected to be similar to the Elbow River channel and its thalweg in this reach.

   During Project operations, when the service spillway gates are raised, it is expected that sediment will deposit upstream of the gates. When the Project stops diverting flood water, the service spillway gates drop to be flush with the bed. When the gate drops, flows are still high, but below 160 m^3/s (a one in seven-year flood), and sediment will be mobile through the stilling basin and fish passage structures. A channel will likely be eroded into sediment deposited upstream of the services spillway once the gates are lowered and flow is no longer diverted from Elbow River.



Habitat Unit	Classification	Area(m2)
BWC	Backwatered Channel Confluence	119.03
EDW	Edgewater	956.81
FGL	Fast Glide	1559.58
FLT	Flat	1582.55
LSL	Pool	135.14
MCD	Pool	53.02
PLP	Pool	75.39
POW	Pocket Water	4849.81
RIF	Riffle	5793.19
RUN	Run	83.91
SGL	Slow Glide	212.58

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

Elbow River Macrohabitat Distribution in Backwater Area

Stantec

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT ENVIRONMENTAL ASSESSMENT

Figure 22-1

Sediment deposition may affect the gradient through the service spillway and fish passage structures during very large, sustained floods with a receding limb that drops very quickly and leaving insufficient time to transport deposited sediments when the gate is lowered. This could potentially create a barrier to fish at low flows upstream of the service spillway, if the low-flow channel is wide and the depth is low. While possible, this is unlikely because receding limbs on the Elbow River hydrographs tend to be long in the days following large floods. The receding limbs of both the 2013 flood and a 2008 flood at Bragg Creek (05BJ004) are presented in Figures 22-2 and 22-3 respectively, along with the 160 m^3/s flow rate, signaling when the service spillway gates would lower.

Sediment could also be deposited within the fish passage structure eroded from deposits upstream of the service gates. This would occur if the flow following the peak does not have sufficient capacity to transport sediment through the service spillway and the fish passage structures. As described above, this is not likely and, if it occurs, it is not anticipated to affect the serviceability of the fish passage structures.

The fish passage structures confine low flow in the channel to less than half its bankfull width. The channel, service spillway and stilling basin upstream of these structures are of bankfull width and flow is wider and slower. Sediment particles that arrive at the fish passage structures will have already passed through the lower velocities within the service spillway and stilling basin and are expected to pass through the fish passage structures, where water velocities are higher.

The response to NRCB Question 21 presents velocities for a range of flows up to above bankfull. These results show that the velocities within the fishway are higher than through the service gates at a range in flows that include flows expected during the receding limb of the flood hydrograph (e.g., 15.0 m^3/s in Figure 21-8, 69.5 m^3/s in Figure 21-9 and 75.7 m^3/s in Figure 21-10). The stilling basin and fish passage structures have been designed to account for sediment transport through them. In addition to these design considerations, post-flood operations will include inspection of the fish passage structures, stilling basin, service spillway and diversion structure backwater area for deposition that can affect aquatic connectivity and passage. Should aquatic connectivity or fish passage be affected, then the operator will remove sediment, as necessary, to reinstate aquatic connectivity and fish passage.

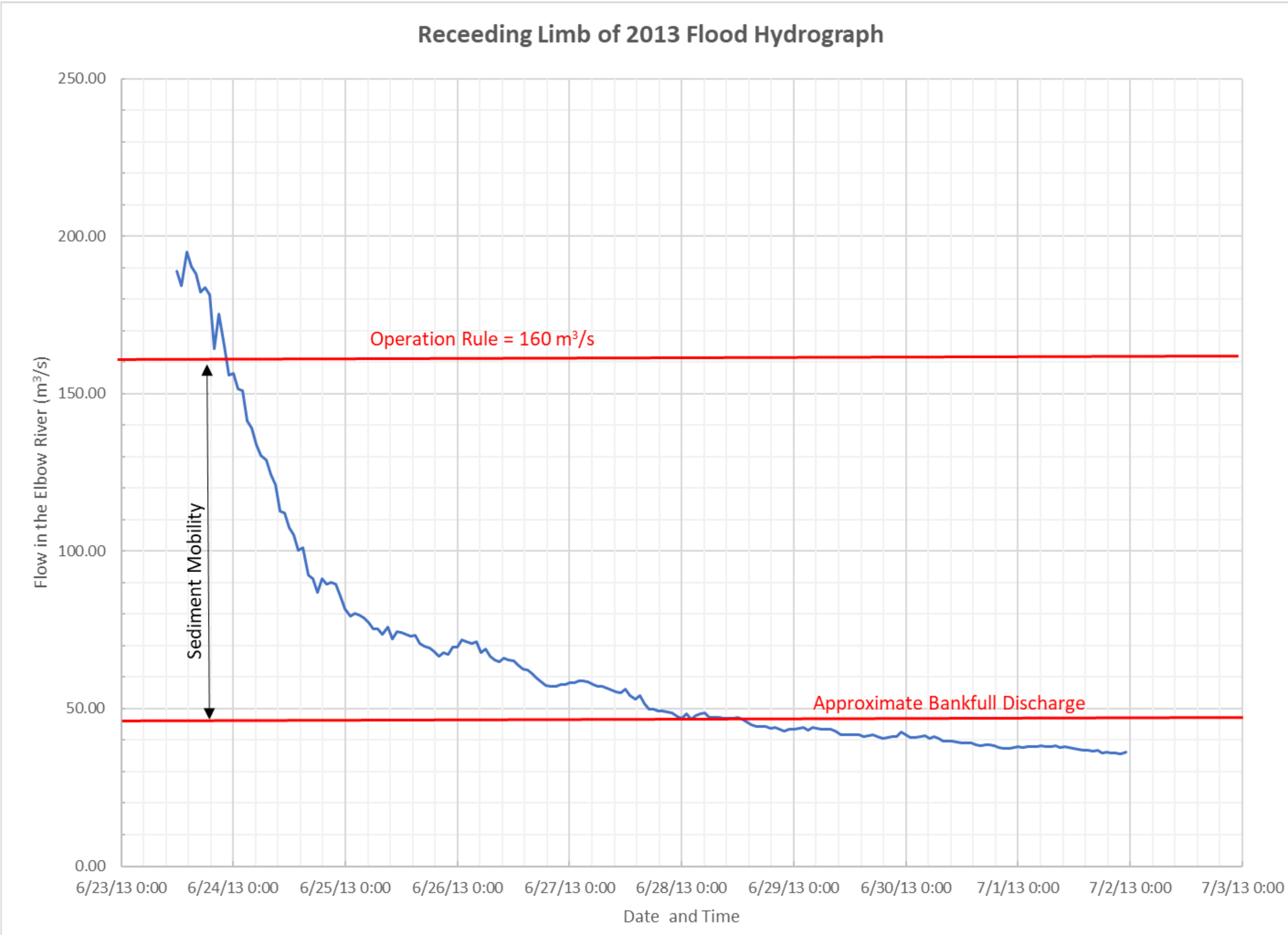


Figure 22-2 Receding Limb of the 2013 Hydrograph

Stantec

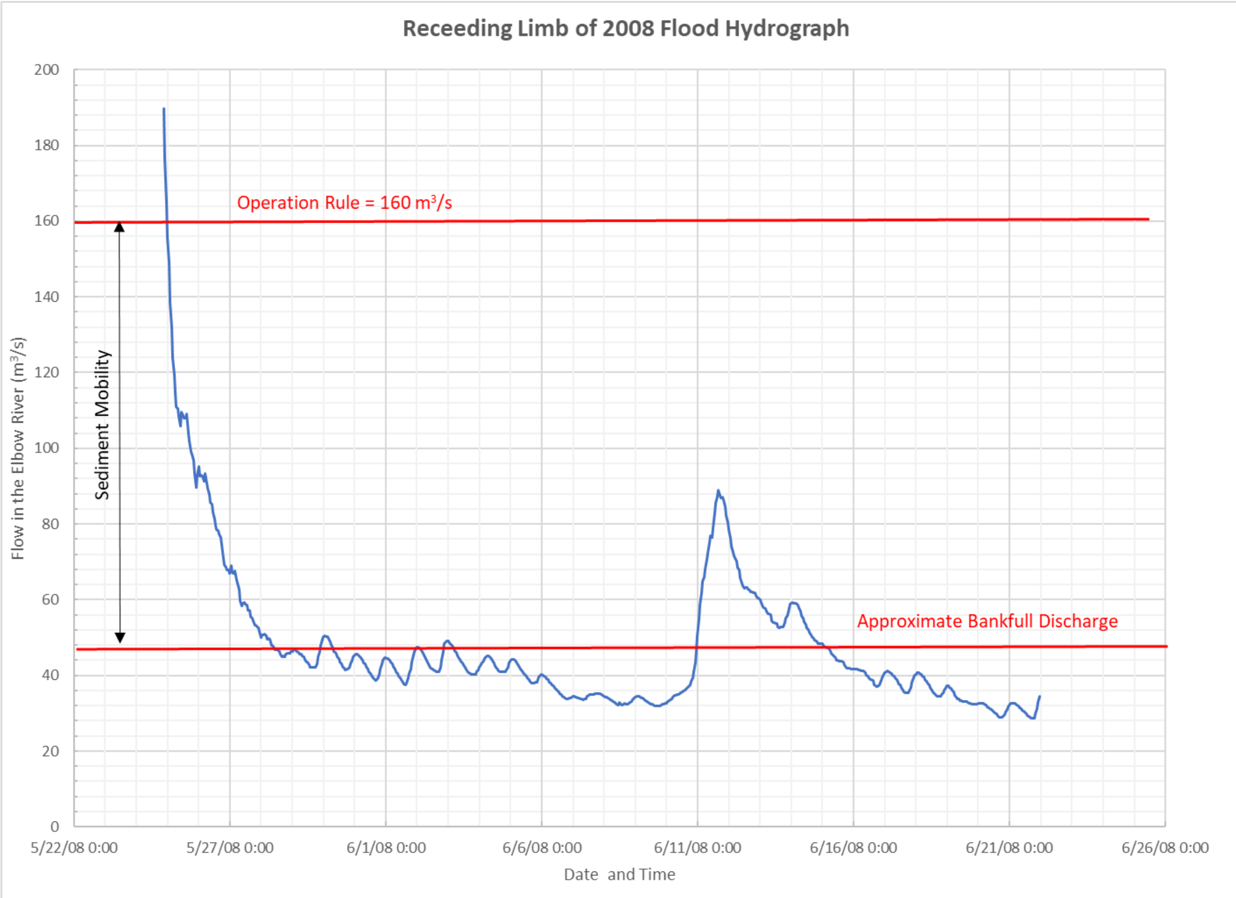


Figure 22-3 Receding Limb of the 2008 Hydrograph

Question 23

Supplemental Information Request 1, Question 99, Page 2.162

Alberta Transportation states that 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, and that a change less than 0.2 m on bar heads is considered a small change to habitat that is not detrimental to fish habitat.

Many species and life stages of fish populations that reside in the Elbow River utilize fish habitats defined by water depths less than 0.2 m (e.g., trout and mountain whitefish spawning areas, large-fish species rearing areas, and small-fish species habitat).

a. **Provide further justification that changes in fish habitat less than 0.2 m, including areas with water depths of less than 0.2 m, will not be detrimental to fish species.**

b. **Assess the effects of changes in channel morphology on each indicator fish species at each life stage.**

Response

Background Information

MIKE 21C modelling of Elbow River results are used to assess how bedform may change during each of the three floods, with and without the Project (modelling results and a discussion on the effects on river morphology are provided in Appendix 23-1: Bedload Model Technical Report). Three representative reaches were selected for higher resolution modelling to assess changes to channel units and fish habitat. Each representative reach is approximately 1 km long and includes at least two river meander lengths to reflect the variety of repeating morphological features in the river (e.g., riffles, runs, pools, flats, glides).

Selecting three smaller representative reaches allowed the model resolution to be fine enough to capture morphological details while ensuring the resultant grid was within the available limitations of computational power of the model. Inputs into the model for predicting bedform changes were Elbow River hydrographs, sediment loads and gradation, thickness of the surface and subsurface layers, Manning's 'M' roughness factors (an inverse calculation of the '*n*' coefficient), and upstream and downstream boundary conditions.

The modelled results were subsequently used to evaluate changes to fish habitat through HSI modelling (Appendix 23-2: Fish Habitat Suitability Index (HSI) analysis of Modelled Scenarios in Elbow River). Habitat suitability is assessed for the habitat within the wetted area of the Elbow River channel during a 7.4 m^3/s flow discharge after each flood (without the Project) and compared with habitat suitability at the same flow discharge after each flood, with the Project. Differences in HSI with and without the Project are used to quantify effects of the Project on fish habitat. A river discharge of 7.4 m^3/s is representative of low flow (during the fall) during sensitive life stages of mountain whitefish and brown spawning.

Hydraulic variables important to fish are predicted by each MIKE 21C surface morphology modelled output and carried forward into HSI calculations. Hydraulic variables for HSI calculations include wetted depth, velocity, and substrate size. HSI is a numerical index that describes the suitability of habitat (from 0 to 1, with 0 representing least suitable habitat and 1 representing most suitable habitat) to support a selected species or species life stage. HSIs were developed for each of four life stages (i.e., adult, juvenile, fry, and spawning) of four key indicator species (i.e., brown trout, bull trout, mountain whitefish, and rainbow trout) to calculate and compare the suitability of fish habitat after each of the three floods, with and without the Project.

An area-based metric of habitat suitability, called the weighted useable area (WUA), is used to compare how the HSI results varies between modelled reaches following each flood. Areas with higher WUA values provide more suitable habitat that support a specific life stage. WUA values are the final HSI measure of suitability for each study reach. A paired t-test is used to determine if the Project resulted in statistically significant changes to habitat suitability for each flood, fish species, and life stage. Significance of the t-test was set at $p<0.05$.

a. Wetted depth is the first habitat suitability criteria (HSC) in the HSI calculations for each indicator species and life stage (Appendix 23-2); shallow areas are included in the HSI calculations to assess relative importance of depth as it pertains to life stage (e.g., large fish rearing areas, small fish habitats). For example, juvenile brown trout HSI is calculated as follows:

$$HSI_{JUVENILE\ BNTR} = HSC_{DEPTH} \times HSC_{VELOCITY} \times HSC_{SUBSTRATE}$$

   Bathymetry (i.e., wet area and depths) associated with a modelled discharge of 7.4 m^3/s is calculated to assess whether subtle changes to depth would result in a change to overall fish habitat quality for indicator life species and life stages. The change in depths as a result of the Project is presented below in Table 23-1.

   Modelled average depths in Table 23-1 are used to compare HSI calculations for all key indicator species for adult, juvenile, fry and spawning life stages. The modelled differences in average depth in listed Table 23-1 are 0.12 m or less (i.e., this is a less change in depth, compared to 0.2 m, than presented in Alberta Transportation's response to Round 1 NRCB IR99).

   Paired t-tests of each flood (i.e., comparing a flood with and without the Project) were calculated for indicator fish species and their life stages (i.e., adult, juvenile, fry, and spawning life stages). These HSI statistical comparisons are presented in Appendix 23-2.

Table 23-1 Change in Depth as a Result of the Project

Reach ID	Modelled Flood	Wetted Area (m^2)	Average Depth (m)	Standard Deviation	Maximum Depth (m)
Reach 1	Baseline surface	73,737	0.25	0.19	1.21
	1:10 year flood (without the Project)	87,777	0.31	0.27	1.73
	1:10 year flood (with the Project)	73,005	0.30	0.26	1.73
	1:100 year flood (without the Project)	73,124	0.31	0.29	1.72
	1:100 year flood (with the Project)	112,920	0.22	0.20	1.79
	2013 flood (without the Project)	152,258	0.26	0.29	1.64
	2013 flood (with the Project)	114,917	0.27	0.28	1.94
Reach 2	Baseline surface	20,792	0.25	0.18	1.00
	1:10 year flood (without the Project)	54,539	0.15	0.13	0.63
	1:10 year flood (with the Project)	29,221	0.26	0.21	1.13
	1:100 year flood (without the Project)	83,948	0.11	0.12	1.21
	1:100 year flood (with the Project)	87,869	0.10	0.11	1.21
	2013 flood (without the Project)	48,161	0.16	0.25	1.51
	2013 flood (with the Project)	58,313	0.11	0.11	0.87
Reach 3	Baseline surface	44,693	0.27	0.24	1.22
	1:10 year flood (without the Project)	145,954	0.12	0.14	1.37
	1:10 year flood (with the Project)	116,308	0.13	0.14	1.53
	1:100 year flood (without the Project)	245,566	0.07	0.11	1.42
	1:100 year flood (with the Project)	105,625	0.13	0.12	0.89
	2013 flood (without the Project)	450,049	0.05	0.10	2.53
	2013 flood (with the Project)	316,164	0.07	0.11	1.57

A statistically significant difference in habitat suitability (i.e., lower suitability) is identified through HSI comparisons, with and without the Project, for the 1:10 year flood for the following species and life stages:

- brown trout fry life stage
- the bull trout juvenile and fry life stages
- rainbow trout fry life stage

Differences in habitat suitability, with the Project, were related to decreases in total wetted surface areas for these life stages; occasionally this was combined with higher water depths and velocities. The relative increase in depth and velocity results in a decrease in suitable areas for juvenile and fry life stages of key indicator species. For all other combinations of parameters (flood size, fish species, life stage, with or without the Project) do not result in a statistically significant difference in fish habitat suitability.

It is expected that a flood in May or June will coincide with bull trout and brown trout young-of-the-year emergence, and with rainbow trout egg development. The statistically significant HSI differences are identified for fish life stages that generally experience high levels of mortality during a natural flood event. With the Project, these cohorts may still be partially lost during a flood (i.e., less a than 10-year flood, with the Project). The lower habitat suitability that has been identified for these life stages may be unaffected by the difference in habitat quality if a cohort is lost during a flood.

The HSI results indicate that the Project will result in a quantifiable change in available habitat areas and decreased habitat quality in some areas of Elbow River for juvenile and fry life stages. The modelled bed elevation changes discussed in Appendix 23-2 will result in some statistically significant changes to habitat for juvenile and fry life stages, but these effects can be mitigated through the offsetting plan that will be developed in consultation with DFO. Alberta Transportation is committed to offsetting habitat loss through efforts that will enhance existing habitat or the creation of new habitats through the *Fisheries Act* authorization process. With the implementation of offsetting measures, it is expected that the productive capacity of fish species in Elbow River will continue with the Project. The Project is expected to operate infrequently, and the loss of habitat that would be experienced during operation is not expected to result in a significant residual effect on fish habitat.

b. Changes to fish habitat suitability is highly variable for the modelled reaches of Elbow River. For specific floods, the Project results in increases to habitat suitability for specific reaches and decreases in suitability for others. Statistically significant changes to habitat suitability are identified for the 1:10 year flood. This includes statistically significant differences in habitat suitability with the Project compared to without the Project for the brown trout fry life stage, the bull trout juvenile and fry life stages, and rainbow trout fry life stage. In all cases, changes to fish habitat suitability with the Project are related to decreases in total wetted surface areas; occasionally this was combined with higher depths and velocities. Higher depths and velocities are generally less suitable to juvenile and fry life stages of key indicator species.

Question 24

Supplemental Information Request 1, Question 100, Pages 2.166 to 2.175
Supplemental Information Request 1, Question 100, Table IR100-1, Page 2.167
Supplemental Information Request 1, Question 100, Table IR100-2, Page 2.171

Alberta Transportation provides Table IR100-1 and states that *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.*

a. Identify the effects, and evaluate the consequences, of a sediment release for a duration of 30 days comparing released water total suspended solids (TSS) to background Elbow River TSS concentrations.

Alberta Transportation provides Table IR100–2, which, as referenced, is not a risk evaluation based on a specific stress index metric.

b. Quantify the effects of predicted suspended sediment concentration on each indicator fish species and life stage using an accepted stress index metric.

c. Estimate the spatial extent of suspended sediment effect on the Elbow River fish habitat downstream of the diversion. Evaluate the effects of increased suspended sediment concentrations and the deposition of sediment on fish habitat for each indicator fish species at each life stage.

Response

a. Additional modelling using MIKE 21 FM-MT (mud transport) module was completed to investigate the changes in TSS due to the Project. The analysis includes an early release of water and a late release of water from the reservoir, for each of the three flood. Early release occurs when the flow in Elbow River decreases to less than 160 m^3/s. The rate of release from the reservoir slowly decreases to limit fish stranding in the reservoir.

   Late release occurs when the flow in Elbow River decreases to less than 20 m^3/s during the falling limb of the hydrograph.

   The analysis for both the early and late releases was completed hourly at 14 sites, between the low-level outlet and Glenmore Reservoir and is included in response to AEP Question 65a. The location of the sites is presented in response to AEP Question 65, Figure 65-1. The results of the analysis are presented in Figure 65-3 to Figure 65-8 and the maximum and average values during exceedances are presented in Table 65-1, Table 65-2, and Table 65-3. See responses to b. and c. regarding an evaluation of the consequences of releasing water into Elbow River.

b. The assessment of effects on resident fish in Elbow River from the release of water from the reservoir used work done by Newcombe and Jensen (1996), which evaluated how the relationship between the exposure concentration and duration of exposure to suspended sediment affected the degree of severity (SEV) of ill effects on fish. This work was used to develop a SEV index score to predict effects on fish based on level of exposure to TSS concentrations and the duration of exposure. The SEV index scale is provided in Table 24-1.

Table 24-1 Severity of Ill Effects (SEV) Scale Used to Assess the Level of Effects to Fish Exposed to Suspended Sediments

SEV[1] Score	Description of Effect
Nil Effect	
0	No behavioral effects
Behavioral Effects	
1	Alarm reaction
2	Abandonment of cover
3	Avoidance response
Sublethal Effects	
4	Short term reduction in feeding rates; short term reduction in feeding success
5	Minor physiological stress; increase in rate of coughing; increased respiration rate
6	Moderate physiological stress
7	Moderate habitat degradation; impaired homing
8	Indications of major physiological stress; long-term reduction in feeding rate; long term reduction in feeding success; poor condition
Lethal and Para-lethal Effects	
9	Reduced growth rate; delayed hatching; reduced fish density
10	0-20% mortality; increased predation; moderate to severe habitat degradation
11	>20-40% mortality
12	>40-60% mortality
13	>60-80% mortality
14	>80-100% mortality

NOTES:
[1] SEV: severity of ill effects is the level of effect to fish associated varying levels of exposure to total suspended sediments (Newcombe and Jensen 1996)

The SEV scores were calculated for three locations in Elbow River using the predicted median TSS concentration (i.e., exposure) and number of days of increased turbidity due to reservoir release (i.e., duration): at 1) the confluence of the unnamed creek with Elbow River (this is where water from the reservoir is returned to the river), 2) 1,000 m downstream of the confluence, and 3) 24,000 m downstream of the confluence, at the location of Sarcee

Bridge. For comparison, the SEV index score was calculated for the confluence of the unnamed creek with Elbow River during each flood without the Project (in the figures, this is labelled as no-Project). The results are presented in Table 24-2. In all cases, the suspended sediment concentrations are predicted to decrease over the duration fish are exposed; therefore, the median TSS concentration is more representative of the TSS concentrations over the duration fish are exposed to TSS than the peak concentration; therefore, the median TSS values were applied to calculate the SEV index scores. The peak TSS values are provided for reference. SEV index scores are provided for early and late release for each flood.

Lethal and paralethal SEV index scores are predicted for at least one fish life stage in Elbow River under background conditions (i.e., during each flood without the Project) for each flood (for eggs and larvae in the case of all floods; for adult non-salmonids in the case of the 1:100 year flood; and all life stages in the case of the design flood)(Table 24-2).

- For existing conditions, juvenile and adult salmonids are predicted to experience sub-lethal effects during a 1:10 year and 1:100 year flood and lethal to paralethal effects during a design flood, as demonstrated by the SEV index scores at the confluence of the unnamed creek with Elbow River.
- For existing conditions, eggs and larvae of all species are predicted to experience lethal and paralethal effects during all floods.
- For existing conditions, non-salmonid adults are predicted to experience sublethal effects during the 1:10 year flood and lethal and paralethal effects during both the 1:100 year flood and design flood.

For the 1:10 year flood, early release results in short-term exceedances of water quality guidelines in Elbow River. No exceedances in Elbow River are predicted for late release.

- During early release, reservoir water would be released soon after the flood diversion ceased, when flow in Elbow River decreases to 160 m^3/s. Elevated TSS concentration is predicted to occur based on exceedances of high-flow TSS guidelines.
- During late release, suspended sediments would settle in the reservoir during the period of time between water diversion (i.e., reservoir filling) and release. Suspended sediments in the water released into Elbow River would be similar to suspended sediments in the river. Therefore, reservoir water release does not increase TSS levels in Elbow River above exceedance levels (CCME 2002; see the response to NRCB Question 65b for predicted suspended sediment guideline exceedances in Elbow River) and SEV index scores for Elbow River during the 1:10 year flood, late release, is the same as in the river without the Project.

The SEV index scores for fish in the 1:100 year and design floods are in the "lethal and paralethal effects" range except for a few cases.

- Eggs and larvae for salmonid and non-salmonid fish is the most sensitive group with the highest SEV index scores; Newcombe and Jensen (1996) reported lethal thresholds for eggs and larvae occurred at low suspended sediment concentrations. However, during a flood, elevated flows are predicted to largely impact most eggs, and young of the year fish, including larvae, will experience mortality. The effects of elevated suspended sediments due to water released from the reservoir will generally not contribute additional lethality above that of natural flood conditions (i.e., Elbow River flows equal to or greater than 1:10 year flood without the Project).
- For the 1:100 year flood, all fish groups are predicted to experience lethal and paralethal effects during early release but not for late release. Juvenile and adult salmonids are predicted to experience sub-lethal effects during the 1:100 year flood for late release; this release has the longest reservoir hold time before water is released. In this case, much of the suspended sediment load settles in the reservoir and, therefore, reservoir water clears somewhat before being released to the river.
- For the 1:100 year flood and design flood (and for both early and late release), SEV index scores for fish in Elbow River do not decrease with distance from the confluence of the unnamed creek with Elbow River to Sarcee Bridge, 24 km downstream. Based on these SEV index scores, the fish community in Elbow River between the Project and Sarcee Bridge may experience a high mortality rate (i.e., up to 40% of the population) during the 1:100 year flood (early release) and the design flood (early release and late release).

The results of the SEV index score are specific to the concentration and duration of suspended sediment exposure and represent a single line of evidence. The SEV index scores do not account for the synergistic effects to fish associated water temperature and DO. However, the response to NRCB Question 17 assesses the effect of the Project on water temperatures and DO. In summary, changes in water temperature and DO in the off-stream reservoir for each flood are not predicted to change these water quality parameters in Elbow River in a manner that affects fish or aquatic biota.

Table 24-2 Results of SEV Index Scores Calculated for Natural Flood Conditions in Elbow River and Three Locations in the River During a Flood

Flood, Life Stage and Timing of Release	Confluence of Unnamed Creek[5] with Elbow River, without the Project				Confluence of Unnamed Creek[5] with Elbow River, with the Project				Elbow River 1,000 m downstream of Confluence with the Unnamed Creek[5], with the Project				Elbow River 24,000 m downstream of the confluence with the unnamed creek[5] (at Sarcee Bridge), with the Project			
	Peak TSS[1] mg/L	Med TSS[2] mg/L	Duration[3] days	SEV[4]	Peak TSS[1] mg/L	Med TSS[2] mg/L	Duration[3] days	SEV[4]	Peak TSS[1] mg/L	Med TSS[2] mg/L	Duration[3] days	SEV[4]	Peak TSS[1] mg/L	Med TSS[2] mg/L	Duration[3] days	SEV[4]
Early Release																
1:10 year flood	1,076	180	3		1,109	238	1.7		1,172	226	1.7		778	205	1.7	
Log$_e$ transformation[6]	--	5.19	4.09		--	5.47	3.71		--	4.42	3.71		--	5.32	3.71	
• Juvenile Salmonids				7				7				7				7
• Eggs and Larvae[7]				10				10				10				10
• Adult Salmonids				7				7				7				7
• Non Salmonids[8]				8				8				8				8
1:100 year flood	41,625	159	6.5		3,008	1,761	23.5		1,513	797	23.5		1,436	869	23.5	
Log$_e$ transformation[6]	--	5.07	5.05		--	7.47	6.34		--	6.68	6.34		--	6.77	6.34	
• Juvenile Salmonids				8				10				10				10
• Eggs and Larvae[7]				11				12				12				12
• Adult Salmonids				8				10				10				10
• Non Salmonids[8]				9				10				10				10
Design flood	128,166	996	5.75		6,281	4,177	35.4		2,970	1,779	35.4		3,062	1,726	35.4	
Log$_e$ transformation[6]	--	6.90	4.93		--	8.34	6.75		--	7.48	6.75		--	7.45	6.75	
• Juvenile Salmonids				9				11				11				11
• Eggs and Larvae[7]				11				14				14				14
• Adult Salmonids				9				11				10				10
• Non Salmonids[8]				10				11				11				11

Table 24-2 Results of SEV Index Scores Calculated for Natural Flood Conditions in Elbow River and Three Locations in the River During a Flood

Flood, Life Stage and Timing of Release	Confluence of Unnamed Creek[5] with Elbow River, without the Project				Confluence of Unnamed Creek[5] with Elbow River, with the Project				Elbow River 1,000 m downstream of Confluence with the Unnamed Creek[5], with the Project				Elbow River 24,000 m downstream of the confluence with the unnamed creek[5] (at Sarcee Bridge), with the Project			
	Peak TSS[1] mg/L	Med TSS[2] mg/L	Duration[3] days	SEV[4]	Peak TSS[1] mg/L	Med TSS[2] mg/L	Duration[3] days	SEV[4]	Peak TSS[1] mg/L	Med TSS[2] mg/L	Duration[3] days	SEV[4]	Peak TSS[1] mg/L	Med TSS[2] mg/L	Duration[3] days	SEV[4]
Late Release																
1:10 year flood	na	na	na		1,131	217	1.7		1,183	202	1.7		775	160	1.7	
Log$_e$ transformation[6]	--	na	na		--	5.38	3.71		--	5.31	3.71		--	5.08	3.71	
• Juvenile Salmonids				na				7				7				7
• Eggs and Larvae[7]				na				10				10				10
• Adult Salmonids				na				7				7				7
• Non Salmonids[8]				na				8				8				8
1:100 year flood	na	na	na		274	43	23.5		132	21	23.5		112	20	23.5	
Log$_e$ transformation[6]	--	na	na		--	3.76	6.34		--	3.04	6.34		--	3.00	6.34	
• Juvenile Salmonids				na				6				5				5
• Eggs and Larvae[7]				na				12				11				11
• Adult Salmonids				na				8				7				7
• Non Salmonids[8]				na				9				9				9
Design flood	na	na	na		6,523	1,569	36.7		3,348	875	36.7		3,369	846	36.7	
Log$_e$ transformation[6]	--	na	na		--	7.36	6.78		--	6.77	6.78		--	6.74	6.78	
• Juvenile Salmonids				na				11				11				11
• Eggs and Larvae[7]				na				14				14				14
• Adult Salmonids				na				10				10				10
• Non Salmonids[8]				na				11				11				11

NOTES:
-- empty table cell
na – not applicable; the SEV values for Elbow River flood without the Project are presented for early release at the confluence of the unnamed creek with Elbow River, without the Project
[1] Peak TSS: Peak total suspended sediment concentration fish are exposed to either in the reservoir or in Elbow River during water release
[2] Med TSS: Median Total suspended sediment concentration fish are exposed to either in the reservoir or in Elbow River; used to calculate severity of effect score
[3] Duration: Time frame, in days, that fish are exposed to suspended sediments either in the reservoir or in Elbow River
[4] SEV: Severity of effect to fish from exposure to total suspended sediment concentrations
[5] Unnamed creek: Unnamed creek conveys water between the reservoir low-level outlet channel and Elbow River
[6] Log$_e$ transformation: Median TSS and duration (in hours) are transformed using Log$_e$ to calculate the SEV index
[7] Eggs and Larvae: For both salmonid and non-salmonid species
[8] Non-Salmonids: Considers adult life stages

c. The spatial extent and concentrations of suspended sediment as it relates to effects on fish species and life stages are discussed b. Suspended sediment will have an acute effect on fish health and survival, whereas sediment deposition throughout Elbow River could have an effect on fish habitat.

Sediment deposition within Elbow River with and without the Project (in the figures, this is labelled as no-Project), for early release and late release, was modelled using MIKE 21 FM-MT, mapped and compared for analysis (Figure 24-1 to Figure 24-6) between the confluence of the unnamed creek with Elbow River to Glenmore Reservoir. Figure 24-1 to Figure 24-6 show the difference in deposition of suspended sediment with the Project and without the Project. For areas where the difference in suspended sediment deposition is +/- 5 mm, only the underlaying orthophoto is shown because this category is transparent. For the 1:10 year flood, the Project (relative to baseline Elbow River conditions (without Project) will not result in a measurable difference in sediment deposition in Elbow River (Figure 24-1 and Figure 24-2).

Figure 24-3 to Figure 24-6 show that net sediment deposition varies spatially downstream of the Project and shows locations of higher or lower sediment deposition relative to without the Project. The majority of the difference in deposition is predicted to occur within the floodplain and not within the bankfull channel. Floodplain habitat is accessed infrequently by fish in the spring when Elbow River is naturally turbid. Figure 24-3 to Figure 24-6 only show a few areas with a difference in deposition within the bankfull Elbow River channel. Where differences in suspended sediment deposition do occur, they are generally small (between 5 mm and 20 mm). Therefore, habitat alteration as a result of suspended sediment deposition is largely limited to the floodplain.

Table 24-3 shows the minimum, maximum and mean difference in suspended sediment deposition for each of the three floods, for early and late release. The values provided in Table 24-3 reflect results for the sediment modelling extent in Elbow River and adjacent floodplain downstream of the confluence and to Glenore Reservoir. The maximum and minimum difference in suspended sediment deposition for with the Project compared to without the Project is predicted to increase with larger floods, with up to 2.36 m less deposition in some locations and up to 1.86 m more deposition in other locations during the design flood for late release. The minimum and maximum changes in deposition occur within the floodplain and are not predicted to occur on the channel bed (see Figure 24-1 to Figure 24-6). The mean difference in deposition between downstream of the Project to Glenmore Reservoir is close to zero: the largest mean difference predicted is 13 mm for the design flood, late release.

The predicted sediment deposition patterns on the channel bed due to release of water from the reservoir are not expected to impact fish habitat in the downstream extent of Elbow River between the confluence and Glenmore Reservoir. Furthermore, changes in substrate and depth (i.e., bedform changes), with the Project, are included in the HSI values for key indicator species (i.e., brown trout, bull trout, mountain whitefish, and rainbow trout) at the adult, juvenile, fry, and spawning life stages. Further discussion on change to substrate and depth for each indicator species and each life stage within the bankfull areas, with the Project, is provided in the response to NRCB Question 23. Paired t-tests of each modelling scenario (i.e., with and without the Project for each of the three floods) did not demonstrate statistically significant changes to overall HSI for any of the indicator fish species or their life stages.

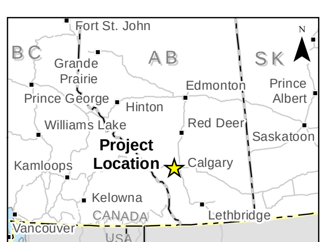
Table 24-3 Difference in Suspended Sediment Deposition, for Each Flood and for Each Release, Compared to Without the Project

Flood	Release Timing	Mean Difference (m)	Minimum Difference (m)	Maximum Difference (m)
1:10 Year	Early Release	<-0.001	-0.134	0.064
	Late Release	<-0.001	-0.123	0.098
1:100 Year	Early Release	-0.005	-1.106	1.159
	Late Release	-0.005	-1.106	1.159
Design Flood	Early Release	-0.012	-2.358	1.863
	Late Release	-0.013	-2.357	1.863

REFERENCES

CCME (Canadian Council of Ministers of the Environment). 2002. Canadian water quality guidelines for the protection of aquatic life: Total Particulate Matter. In Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

Newcombe, C.P., and J.O. Jensen. 1996. Channel Suspended Sediment and Fisheries: A synthesis for Quantitative Assessment of Risk and Impact. North American Journal of Fisheries Management. Volume 16(4): 693-727.



Highway
Road
Local Street
Railway
Tsuut'ina Nation Reserve

Low Flow Channel
Springbank Off-Stream Reservoir
Sediment Modelling Extent

Difference in Suspended Sediment Deposition from No-Project (m)

< -0.02
-0.02 - -0.01
-0.01 - -0.005
-0.005 - 0.005
0.005 - 0.01
0.01 - 0.02
> 0.02

Notes
1. Coordinate System: NAD 1983 UTM Zone 11N
2. Data Sources: Natural Resources Canada

0 0.5 1 1.5 2 2.5 3 km
1:60,000 (at original document size of 11x17)

Stantec
Alberta Transportation

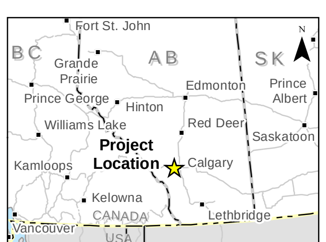
Project Location
Calgary,
Alberta

Project Number 110773396
Prepared by LTRUDELL on 20200505
Requested by LBURGE on 20200505

Client/Project/Report
Alberta Transportation
Springback Off-Stream Reservoir Project
Sediment Deposition Modelling

Figure No.
24-1

Title
Difference in River Deposition from No-Project on the Early Release Scenario for the 10-Year Flood Event



- Highway
- Road
- Local Street
- Railway
- Tsuut'ina Nation Reserve
- Low Flow Channel
- Springbank Off-Stream Reservoir
- Sediment Modelling Extent

Difference in Suspended Sediment Deposition from No-Project (m)

- < -0.02
- -0.02 - -0.01
- -0.01 - -0.005
- -0.005 - 0.005
- 0.005 - 0.01
- 0.01 - 0.02
- > 0.02

0 0.5 1 1.5 2 2.5 3 km

1:60,000 (at original document size of 11x17)

Notes
1. Coordinate System: NAD 1983 UTM Zone 11N
2. Data Sources: Natural Resources Canada

Stantec

Alberta Transportation

Project Location
Calgary,
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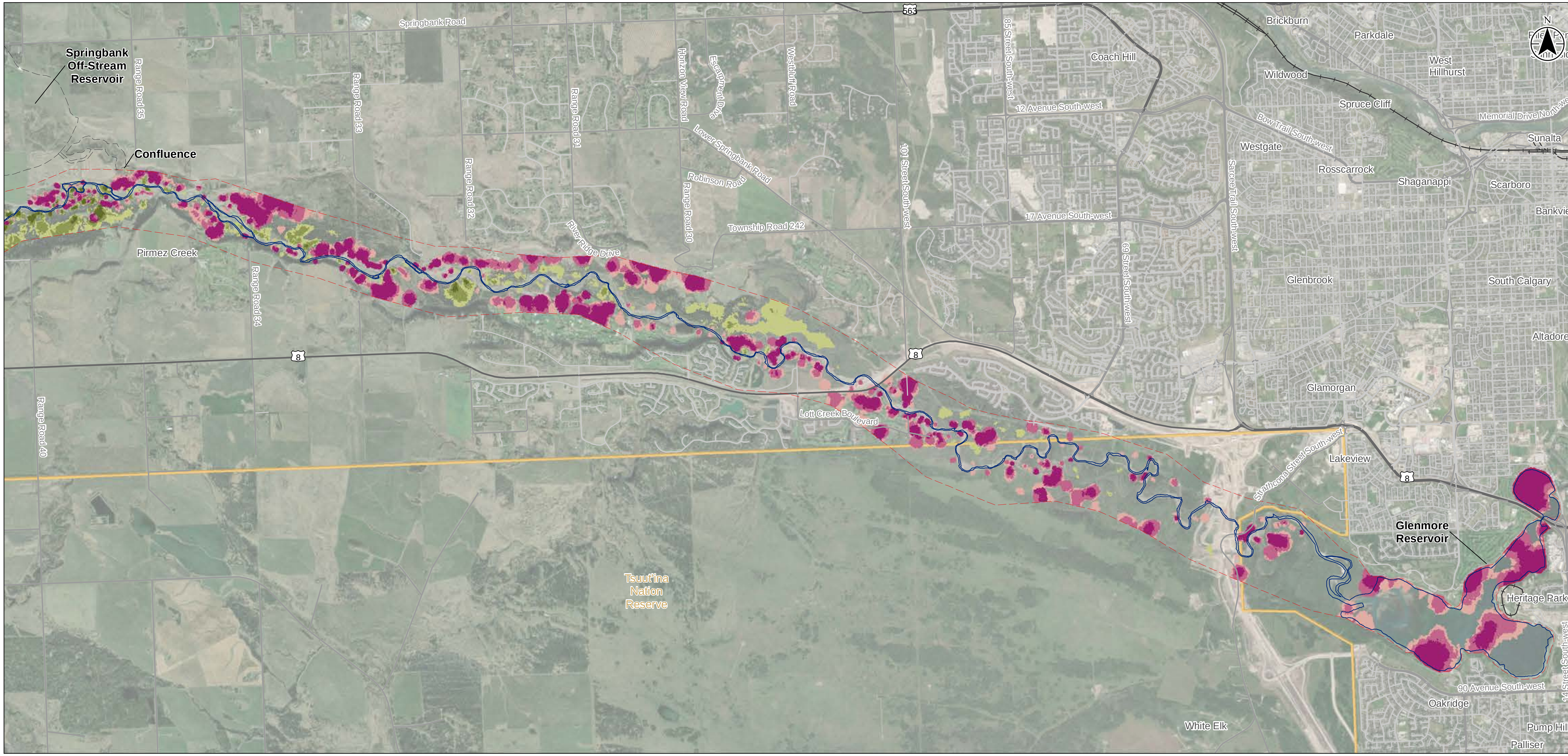
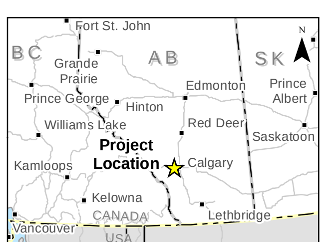
Project Number 110773396
Prepared by LTRUDELL on 20200505
Requested by LBURGE on 20200505

Client/Project/Report
Alberta Transportation
Springback Off-Stream Reservoir Project
Sediment Deposition Modelling

Figure No.
24-2

Title
Difference in River Deposition from No-Project on the Late Release Scenario for the 10-Year Flood Event





- Highway
- Road
- Local Street
- Railway
- Tsuut'ina Nation Reserve
- Low Flow Channel
- Springbank Off-Stream Reservoir
- Sediment Modelling Extent

Difference in Suspended Sediment Deposition from No-Project (m)

- < -0.02
- -0.02 - -0.01
- -0.01 - -0.005
- -0.005 - 0.005
- 0.005 - 0.01
- 0.01 - 0.02
- > 0.02

0 0.5 1 1.5 2 2.5 3 km

1:60,000 (at original document size of 11x17)

Notes
1. Coordinate System: NAD 1983 UTM Zone 11N
2. Data Sources: Natural Resources Canada

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Alberta Transportation

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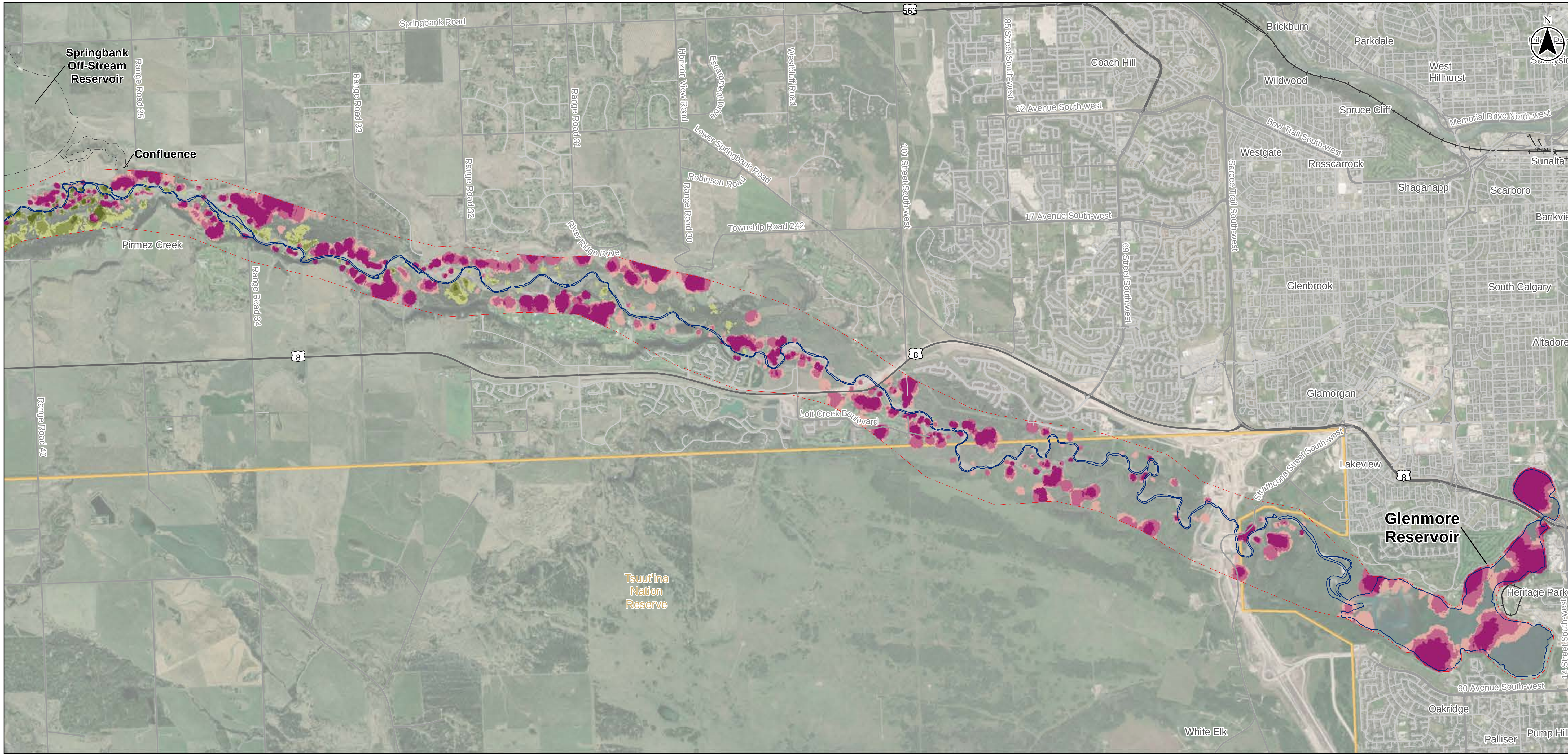
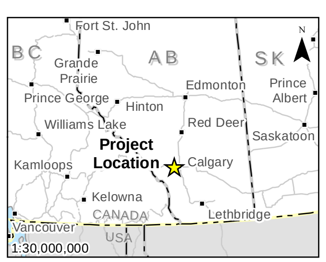
Client/Project/Report
Alberta Transportation
Springback Off-Stream Reservoir Project
Sediment Deposition Modelling

Figure No.
24-3

Title
Difference in River Deposition from No-Project on the Early Release Scenario for the 100-Year Flood Event





Highway
Road
Local Street
Railway
Tsuut'ina Nation Reserve
Low Flow Channel
Springbank Off-Stream Reservoir
Sediment Modelling Extent

Difference in Suspended Sediment Deposition from No-Project (m)

< -0.02
-0.02 - -0.01
-0.01 - -0.005
-0.005 - 0.005
0.005 - 0.01
0.01 - 0.02
> 0.02

Notes
1. Coordinate System: NAD 1983 UTM Zone 11N
2. Data Sources: Natural Resources Canada

0 0.5 1 1.5 2 2.5 3 km
1:60,000 (at original document size of 11x17)

Stantec

Alberta Transportation

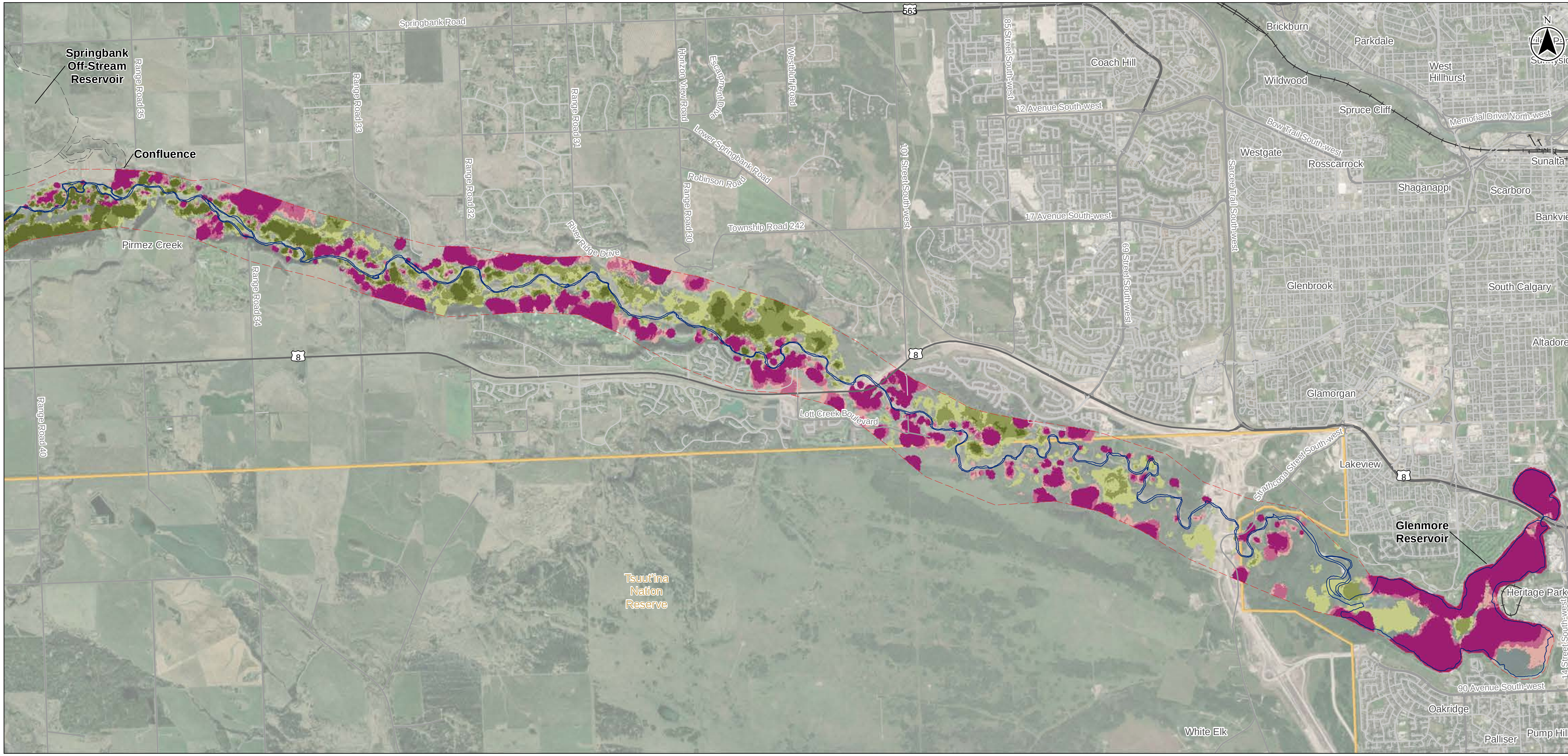
Project Location
Calgary,
Alberta

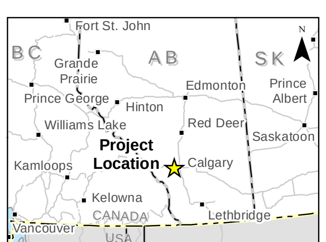
Project Number 110773396
Prepared by LTRUDELL on 20200505
Requested by LBURGE on 20200505

Client/Project/Report
Alberta Transportation
Springback Off-Stream Reservoir Project
Sediment Deposition Modelling

Figure No.
24-4

Title
Difference in River Deposition from No-Project on the Late Release Scenario for the 100-Year Flood Event





- Highway
- Road
- Local Street
- Railway
- Tsuut'ina Nation Reserve
- Low Flow Channel
- Springbank Off-Stream Reservoir
- Sediment Modelling Extent

Difference in Suspended Sediment Deposition from No-Project (m)

< -0.02 | -0.02 - -0.01 | -0.01 - -0.005 | -0.005 - 0.005 | 0.005 - 0.01 | 0.01 - 0.02 | > 0.02

0 0.5 1 1.5 2 2.5 3 km

1:60,000 (at original document size of 11x17)

Notes
1. Coordinate System: NAD 1983 UTM Zone 11N
2. Data Sources: Natural Resources Canada

Stantec
Alberta Transportation

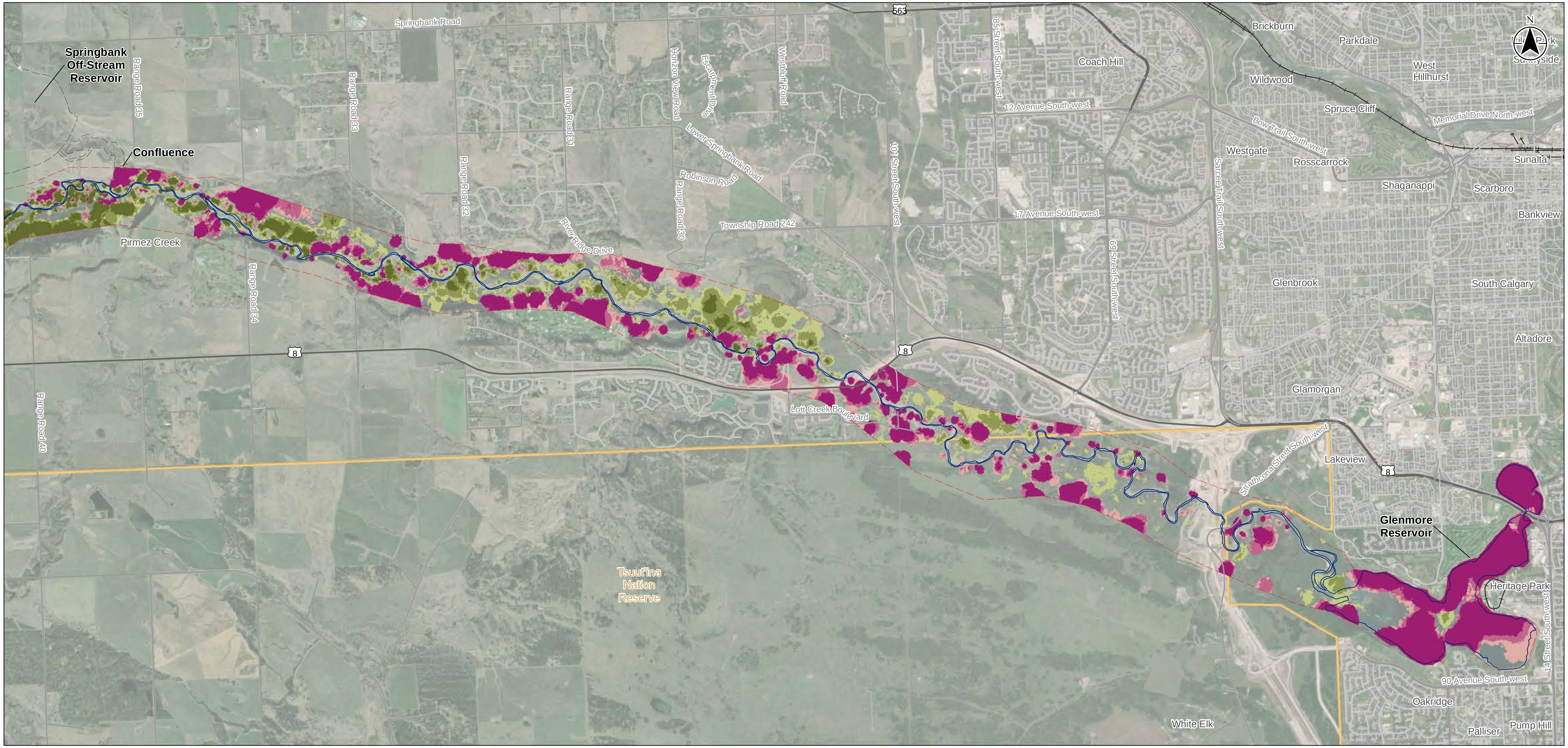
Project Location
Calgary, Alberta

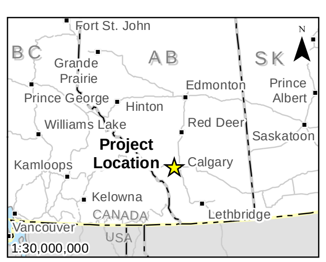
Project Number 110773396
Prepared by LTRUDELL on 20200505
Requested by LBURGE on 20200505

Client/Project/Report
Alberta Transportation
Springback Off-Stream Reservoir Project
Sediment Deposition Modelling

Figure No.
24-5

Title
Difference in River Deposition from No-Project on the Early Release Scenario for the 2013 Flood Event





Notes
1. Coordinate System: NAD 1983 UTM Zone 11N
2. Data Sources: Natural Resources Canada

Highway
Road
Local Street
Railway
Tsuut'ina Nation Reserve

Low Flow Channel
Springbank Off-Stream Reservoir
Sediment Modelling Extent

Difference in Suspended Sediment Deposition from No-Project (m)

< -0.02
-0.02 - -0.01
-0.01 - -0.005
-0.005 - 0.005
0.005 - 0.01
0.01 - 0.02
> 0.02

0 0.5 1 1.5 2 2.5 3 km
1:60,000 (at original document size of 11x17)

Project Location
Calgary,
Alberta

Project Number 110773396
Prepared by LTRUDELL on 20200505
Requested by LBURGE on 20200505

Client/Project/Report
Alberta Transportation
Springback Off-Stream Reservoir Project
Sediment Deposition Modelling

Figure No.
24-6

Title
Difference in River Deposition from No-Project on the Late Release Scenario for the 2013 Flood Event

Question 25

Supplemental Information Request 1, Question 102, Pages 2.178 to 2.180

Alberta Transportation provides discussion on identifying the potential sources of TGP and how the Project design provides mitigation in the unlikely event that TGP occurs.

Water entrainment depth, an important factor influencing total gas pressure (TGP), is not provided. TGP levels were not estimated for expected flood flows.

a. **Evaluate the potential for elevated TGP levels using project design features identified in USACE (2002).**

b. **Provide an evaluation of the effect and extent of elevated TGP on indicator fish species populations (including habitat use and health) in the Elbow River. Base the evaluation on estimates of TGP levels for expected flood flows caused by differences between the spillway gate crest water elevation and stilling basin water elevation.**

Response

a. Alberta Transportation is unable to obtain the referenced document USACE (2002) and received personal communication from the United States Army Corps of Engineers notifying that the report has not been cleared for public release (Heffron 2020, pers. comm). The predecessor document *Dissolved Gas Abatement Phase I* by the US Army Corps of Engineers (USACE 1997) was reviewed but this document does not provide a methodology for determining total gas pressure (TGP) levels for projects outside of the Columbia River system. The model presented in that document was created from empirical data observed within the Columbia River system and does not provide a representation of direct physical processes that could be translated to the Project components. However, it is noted in USACE (1997), Section 3.05 (c), that “tailwater depths … less than 20 feet (6.1 metres) will likely result in low total dissolved gas (TDG) concentrations.” This is because the TGP phenomenon requires the turbulent, air entrained water to plunge to great depths to raise the pressure to a sufficient level to raise TGP that is dissolved in the water. Tailwater depths, for the expected operating conditions, for the Project components are as follows:

   - For the service spillway, tailwater depths in the stilling basin will vary from 3.3 m for the 1:10 year flood to 5.0 m for the 2013 design flood.
   - For the diversion inlet, tailwater depths in the stilling basin will vary from 1.1 m for the 1:10 year flood to 5.7 m for the 2013 design flood.
   - For the low-level outlet works, tailwater depth in the stilling basin for the maximum discharge (27 m^3/s) is 0.75 m.

The Project's shallow stilling basins and tailwater depths, therefore, limit the pressure available to "force" entrained gases into solution.

To validate the conclusion that TGP will not be an issue at the Project, Alberta Transportation consulted Johnson (1984), which proposes that TGP downstream of a spillway and stilling basin are a function of:

- the initial dissolved gas concentration
- potential dissolved gas saturation concentration in the stilling basin
- length of time that the gas is being dissolved into flow
- hydraulic characteristics under which a specific structure is operating

The methods of that study were investigated for use in evaluation of the Project components and the following are limitations for applying these methods to the Project:

i. Initial dissolved gas concentrations within the water column for expected floods are not available.

ii. The coefficient (K) representing the impact of the hydraulic characteristics on TGP is based on empirical methods and is a function of an energy gradient parameter (ratio of hydraulic head to flow path length) and the compactness of the jet (ratio of shear perimeter to flow area). The Project operating parameters, specifically the energy gradient parameter, fall outside the window of the observed conditions and would require extrapolation beyond the reported results. Extrapolation is required because the relatively low hydraulic head available at each of the stilling basins produces energy gradient factors below those observed in the prototypes used for the study.

iii. The study does note that higher energy gradient factors produce higher K values. Therefore, the inverse can be assumed: lower energy gradient factors produce lower K values, which, in turn, indicate lower TGP levels.

Based on the stilling basin depth and tailwater recommendations provided in USACE (1997) and the factors driving TGP levels reported by Johnson (1984), the potential increase in levels of TGP during Project operations is predicted to be negligible to low.

b. Elevated TGP (or dissolved gas supersaturation [DGS]) is the supersaturation of gasses in water that can result in gas bubble trauma to fish. Symptoms can include an over-inflation of the swim bladder, bubbles under the skin or behind the eyes (pop-eye disease). Bubbles in the vascular system will cause embolisms and death.

Guidelines for DGS for the protection of Aquatic Life (CCME 1999) are based on the difference between total dissolved gas pressure in water and atmospheric pressure as a function of water depth and the partial pressure of DO. CCME (1999) states that a single guideline value is impractical due to wide ranging biological and environmental variables that influence the effect of DGS on fish; therefore, DGS calculations are based on water depth and partial pressure of oxygen. The change in TGP data assessing the threshold of effects for four salmonid fish species was included in CCME's (1999) review to develop the DGS guidelines:

- sockeye salmon (*Oncorhynchus nerka*) – threshold pressure change of 125 mm Hg
- cutthroat trout (*O.clarkii*) and rainbow trout (*O*. mykiss) – threshold pressure change of 115 mm Hg
- Chinook salmon (*O. tschawytscha*) – thresholds levels at 76 mm Hg to 78 mm Hg and again at 130 mm Hg to 140 mm Hg

Other fish species such as channel catfish (*Ictalurus punctatus*), black bullhead (*I. melas*) and northern pikeminnow (*Ptychocheilus oregonensis*) had similar threshold levels.

For water levels less than 1 m, the threshold for DGS is equivalent to approximately 103% at sea level (the percent difference between TGP and atmospheric pressure). For water levels deeper than 1 m, the threshold for DGS is a difference of 76 mm hg (or approximately 110% at sea level).

Based on the conclusion in the response to a., the Project operating parameters, specifically the energy gradient parameter, fall outside the window of the observed conditions that cause TDG at levels expected to affect fish. In other words, the elevation of the spillway gate crest over the stilling basin is not sufficiently high to generate TDG levels expected to affect fish health. The change in TGP due to Project components is negligible (i.e., no measurable change in habitat quality or conditions) to low (i.e., a quantifiable change but will not affect the extent of available habitat). Therefore, increases in TDG levels are not expected to surpass the DGS thresholds (CCME 1999) and adverse effects on fish are not expected to occur.

REFERENCES

CCME (Canadian Council of ministers of the Environment). 1999. Canadian water quality guidelines for the protection of aquatic life: Dissolved Gas Supersaturation. In: Canadian Water Quality Guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

Heffron, J. 2020. US Army Corps of Engineers. Personal communication, email dated March 19, 2020.

Johnson P.L. 1984. Prediction of Dissolved Gas Transfer in Spillway and Outlet Works Stilling Basin Flows. In: Brutsaert W., Jirka G.H. (eds) Gas Transfer at Water Surfaces. Water Science and Technology Library, vol 2. Springer, Dordrecht

USACE (United States Army Corps of Engineers). 1997. Dissolved Gas Abatement Study, Phase I Technical Report. U.S. Army Corps of Engineers Districts, Portland and Walla Walla, North Pacific Region, Portland OR.

Question 26

Supplemental Information Request 1, Question 104, Page 2.184

Alberta Transportation states that 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.

a. List the predicted residual project effects in the aquatics ecology LAA. Include indicators used for hydrogeology, hydrology, surface water quality, and aquatic ecology for project Construction, Dry-Operations, Flood, and Post-flood Operations.

b. Provide justification as to why a cumulative effects evaluation is not required where residual project effects are predicted.

c. Describe any cumulative effects of the Glenmore Dam and Reservoir operations on aquatic ecology.

Response

a. Predicted residual effects in the aquatic ecology LAA are summarized in Table 26-1, together with the pathways (indicators) used for hydrogeology, hydrology and surface water quality.

b. During a call on December 17, 2019 with NRCB and AEP, NRCB clarified that the purpose of this question is to understand the water-related effects of the Project on Glenmore Reservoir rather than the interaction of cumulative effects from Glenmore Reservoir and the Project on the environmental conditions in the RAA.

   The existing conditions described in the EIA for each VC account for the effects of past and current physical activities in the RAA and reflects changes to the environment resulting from the construction and operation of the Glenmore Reservoir. Each VC section of the EIA characterizes the effects of the Project when added to the effects of past and current physical activities for Project construction and dry operations (Volume 3A) and for flood and post-flood operations (Volume 3B).

   Two conditions must be met to initiate an assessment of cumulative effects on a VC:

   - The Project is assessed as having adverse residual environmental effects on a VC.
   - The adverse residual effects from the Project overlap spatially and/or temporally with residual effects of other physical activities on a VC.

   Where these two conditions are met, the effects of reasonably foreseeable planned activities added to those of the Project and past and current physical activities are described in Volume 3C.

Table 26-1 Predicted Residual Effects for the Project

Project Phase	Effect Pathway	Potential Effect	Residual Effect	Interaction with Glenmore Reservoir
Hydrogeology				
Construction and dry operations	Construction dewatering	Change in groundwater quantity	Short term residual effects on groundwater quantity within the LAA.	No interaction with Glenmore Reservoir.
		Change in groundwater quality	Short term residual effects on groundwater quality within the LAA, but neutral direction and low magnitude based on level of groundwater mineralization.	No interaction with Glenmore Reservoir.
	Seepage into the diversion channel	Change in groundwater quantity	Long term residual effect with neutral direction based on both seepage into the channel and infiltration back into subsurface and low magnitude based on estimated seepage rate of 0.026 m^3/s.	No interaction with Glenmore Reservoir.
		Change in groundwater quality	Long term residual effect within the LAA, neutral direction based on level of groundwater mineralization.	No interaction with Glenmore Reservoir.
Flood and post- flood operations	Hydraulic interactions	Change in groundwater quantity	Short to long term residual effects within the LAA resulting from groundwater recharge and discharge.	No interaction with Glenmore Reservoir.
	Infiltrations	Change in groundwater quality	Short term residual effect, both positive and adverse direction depending on water quality parameter being measured.	No interaction with Glenmore Reservoir.

Table 26-1 Predicted Residual Effects for the Project

Project Phase	Effect Pathway	Potential Effect	Residual Effect	Interaction with Glenmore Reservoir
Hydrology				
Construction and dry operations	Surface alteration and diversion	Change in hydrologic regime	No residual effect.	No interaction with Glenmore Reservoir.
		Change in sediment transport	No residual effect.	No interaction with Glenmore Reservoir.
	Construction activities	Change in hydrologic regime	No residual effect.	No interaction with Glenmore Reservoir.
		Change in sediment transport	No residual effect.	No interaction with Glenmore Reservoir.
Flood operations and post-flood operations	Water diversion and release (volume and timing)	Change in hydrological regime	Residual effect from the long-term alteration of Elbow River hydrological regime. Peak flows are reduced in Elbow River due to flow diverted into the reservoir. Summer flows increased as water in the reservoir is released back into Elbow River. Change in hydrologic regime is high in magnitude, with a frequency of multiple irregular events, and is of short-term duration.	The change in hydraulic regime resulting from the Project will interact with Glenmore Reservoir.
		Change in sediment transport: velocity, shear stress, and inundation	Residual effect from velocity and shear stress decrease during operations. Effects from decreasing velocity and shear stress at peak flows include decreased bank erosion rates, decreased scour and maintenance of large pools, decreased maintenance and formation of side channels. Change in sediment transport is moderate in magnitude, with a frequency of multiple irregular events, and is of short-term duration.	The change in sediment transport (velocity, shear stress, and inundation) resulting from the Project will interact with Glenmore Reservoir.

Table 26-1 Predicted Residual Effects for the Project

Project Phase	Effect Pathway	Potential Effect	Residual Effect	Interaction with Glenmore Reservoir
Flood operations and post-flood operations (cont'd)		Change in sediment transport: change in suspended sediment transport	Residual effect from decreased suspended load downstream of the diversion. Effects include changing overbank deposition patterns as inundation decreases because of the diversion and the change in timing of high suspended sediment concentrations. During a flood, the suspended sediment concentrations decrease. During release of water from the reservoir, the sediment concentrations are elevated. Change in sediment transport is moderate in magnitude, with a frequency of multiple irregular events, and is of medium-term duration.	The change in sediment transport (suspended sediment transport) as a result of the Project will interact with Glenmore Reservoir.
		Change in channel morphology	Residual effect from decreasing sediment transport during operations may change Glenmore Reservoir delta morphology. Alteration of sediment supply and transport rates may potentially alter the location and magnitude of bars and, thereby, alter delta morphology. Change in sediment transport related to the delta is low in magnitude, with a frequency of multiple irregular events, and is of medium-term duration.	The change in sediment transport and channel morphology is expected to interact with the Glenmore Reservoir delta.

Table 26-1 Predicted Residual Effects for the Project

Project Phase	Effect Pathway	Potential Effect	Residual Effect	Interaction with Glenmore Reservoir
Surface Water Quality				
Construction and dry operations	Construction water withdrawals	Change in water quality	No residual effects to water quality.	No interaction with Glenmore Reservoir.
	Construction activities	Change in suspended sediments	Negligible effects to water quality due to erosion and sediment control mitigations.	No interaction with Glenmore Reservoir.
	Weed management	Change in herbicide concentrations	No residual effects.	No Interaction with Glenmore Reservoir.
Flood operations and post-flood operations	Holding water in the reservoir and releasing later in the season	Change in water quality (sediment-related parameters)	Overall, reduction in sediment yield and sediment related constituents. Change in timing and duration of high suspended sediment concentrations and other water quality parameters. During the filling of the reservoir, suspended sediment concentrations decrease. During release of water from the reservoir, the sediment concentrations are elevated.	Negligible interaction with Glenmore Reservoir. Effects to water quality in Glenmore Reservoir predicted to not occur.
		Change in water temperature and DO	Temperature is predicted to rise, and DO is predicted to decrease in the reservoir; however, due to mixing, a negligible effect is predicted in the river.	Negligible interaction with Glenmore Reservoir.
		Change in rate of methylmercury generation	Potential risk of increased methylmercury in the reservoir; however, concentrations in the river are predicted to be below guidelines. Changes are predicted to be negligible.	Negligible interaction with Glenmore Reservoir.

Table 26-1 Predicted Residual Effects for the Project

Project Phase	Effect Pathway	Potential Effect	Residual Effect	Interaction with Glenmore Reservoir
Aquatic Ecology				
Construction and dry operations	Cleaning or maintenance of bridges or other structures entailing the following activities: • excavation • grading • use of industrial equipment • vegetation clearing • change in timing duration and frequency of flow • fish passage issues • organic debris management • placement of materials or structures in water	Permanent alteration of fish habitat	Instream habitat will be permanently altered due to changes in flows through the spillway gates and fish passage structures (i.e., v-weirs). The overall effect is relatively small and not predicted to affect the sustainability of resident populations. No residual effect.	No interaction with Glenmore Reservoir.
		Destruction of fish habitat	Direct permanent alteration of fish habitat within the construction footprint. Fish passage will not be affected. The overall effect is relatively small and not predicted to affect the sustainability of resident populations. No residual effect.	No interaction with Glenmore Reservoir.
		Death of fish	The Project is not predicted to affect the sustainability of resident fish. No residual effect.	No Interaction with Glenmore Reservoir.

Table 26-1 Predicted Residual Effects for the Project

Project Phase	Effect Pathway	Potential Effect	Residual Effect	Interaction with Glenmore Reservoir
Flood operations and post-flood operations	Cleaning or maintenance of bridges or other structures entailing the following activities • excavation • use of industrial equipment • water extraction • dredging • fish passage issues • organic debris management	Permanent alteration of fish habitat	Bedload movement will cause effects on fish habitat in the unnamed creek and downstream; effects are predicted to be high. Increased suspended sediments will result in negligible effects downstream. Changes to habitat are temporary, reversible and infrequent. There is no residual effect on aquatic ecology.	Negligible interaction with Glenmore Reservoir.
		Destruction of fish habitat	No residual effects predicted.	No interaction with Glenmore Reservoir.
		Death of fish	Fish mortality is predicted due to entrainment and stranding in the reservoir. The extent of fish mortality is not known; however, with mitigation to reduce fish mortality, effects are not significant. No residual effects are predicted.	No interaction with Glenmore Reservoir.
NOTE: Project residual effects that interact with Glenmore are described further in c.				

c. Table 26-1 identifies instances when the Project results in a residual effect to a water-related VC and also where that residual effect has the potential to interact with Glenmore Reservoir. For cases where there is an interaction, the nature of the Project effect and its influence on Glenmore Reservoir is described below.

HYDROLOGY

During flood and post-flood operations, some residual effects from the Project on Glenmore Reservoir will occur; the direction and magnitude of the effects are presented below.

CHANGE IN HYDROLOGICAL REGIME

The change in hydrological regime in Elbow River will result in the long-term alteration of Elbow River hydrological regime. Peak flows are reduced in Elbow River due to the temporary diversion of flows into the reservoir, and the flood hydrograph may be extended, depending on the timing of water release from the reservoir.

Project interactions with Glenmore Reservoir associated with hydrology is neutral because the effect will be infrequent. The inflow hydrograph into the reservoir will only be altered during Project operations. The hydrological regime is currently altered by Glenmore Dam and, therefore, the change is neither beneficial nor detrimental to hydrology.

CHANGE IN SEDIMENT TRANSPORT (EFFECTS FROM ALTERATION OF VELOCITY, SHEAR STRESS, AND INUNDATION)

The change in sediment transport as a result of hydrological changes in velocity, shear stress and inundation during flood operations may have a residual effect. Effects from decreasing velocity and shear stress at peak flows are decreased bank erosion rates, decreased scour and maintenance of large pools, decreased maintenance and formation of side channels within the delta of the reservoir. Change in sediment transport is moderate in magnitude, with a frequency of multiple irregular events, and is of short-term duration.

Project interactions with Glenmore Reservoir associated with sediment transport related to velocity, shear stress and inundation is neutral because the effect will be infrequent. Glenmore Reservoir is an actively managed system and, because of this, the effect of a reduction in velocity, shear stress and inundation has already been altered by the presence of Glenmore Dam and the change is neither beneficial nor detrimental to sediment transport.

CHANGE IN SEDIMENT TRANSPORT RESULTING FROM SUSPENDED SEDIMENT TRANSPORT

The change in sediment transport as a result of hydrological changes on suspended sediment transport during flood operations may have a residual effect on Glenmore Reservoir. The effects related to reduced suspended sediment transport include changing overbank deposition patterns as inundation decreases because of the diversion and the change in timing of high suspended sediment concentrations. During a flood, the suspended sediment concentrations decrease; during release of water from the reservoir, the sediment concentrations are elevated. Change in sediment transport is moderate in magnitude, with a frequency of multiple irregular events, and is of medium-term duration. Change in sediment transport is high in magnitude, with a frequency of multiple irregular events, and is of short-term duration.

Project interactions with Glenmore Reservoir associated with sediment transport related suspended sediment transport is neutral because the effect will be infrequent. Glenmore Reservoir is an actively managed system and, because of this, the effect of a potential reduction in suspended sediment has already been altered by the presence of Glenmore Dam and the change is neither beneficial nor detrimental to sediment transport.

Change in Sediment Transport Resulting in Change in Channel Morphology

The change in sediment transport as a result of changes in channel morphology may have a residual effect. The residual effect from decreasing sediment transport may result in changes to the morphology of the delta of Glenmore Reservoir. Alteration of sediment supply and transport rates may potentially alter the location and magnitude of bars and, thereby, alter delta morphology. Change in the morphology of the delta is low in magnitude, with a frequency of multiple irregular events and is of medium-term duration.

Project interactions with Glenmore Reservoir associated with sediment transport related to the morphology of the delta is neutral because the effect will be infrequent. Glenmore Reservoir is an actively managed system and, because of this, the effect of a potential change in the morphology of the delta has already been altered by the presence of Glenmore Dam and the change is neither beneficial nor detrimental to deltaic morphology.

Surface Water Quality

The following are residual effects associated with the Project that may interact with Glenmore Reservoir.

Change in Suspended Sediments and Sediment-Bound Constituents

Suspended sediments and associated water quality constituents will be released from the off-stream reservoir during water release. However, due to the deposition of suspended sediments and associated water quality constituents in the off-stream reservoir, the sediment and associated parameter yield entering the river will be less compared to concentrations without the Project (background values). If reservoir operations do not immediately initiate water release, the water release may occur at a time later in the summer when receiving water is clear and TSS is low. Releasing elevated TSS at a time when the river is clear will affect water quality. Changes to water quality in Elbow River are predicted to be short term and infrequent and, therefore, these changes are not predicted to have a significant effect on water quality in Elbow River.

Project interactions with Glenmore Reservoir associated with water quality is negligible. The amount of suspended sediments, and associated water quality constituents, accumulating in Glenmore Reservoir will also be less than accumulation without the Project (background values). Elevated TSS levels and associated constituents enter Glenmore Reservoir from the Project during the summer may temporarily change the timing of increases in reservoir turbidity and associated constituents. This effect is predicted to be short term and infrequent and not result in a change to the nature of water quality in Glenmore Reservoir.

CHANGE IN TEMPERATURE AND DISSOLVED OXYGEN

Water temperature in the off-stream reservoir will increase over time similar to Elbow River. Re-aeration due to wind action and atmospheric oxygen pressure gradient will elevate DO concentrations in the off-stream reservoir. DO levels are predicted to remain at levels that will not cause anoxic conditions or affect fish. Turbulence occurring as water is released from the reservoir will also increase oxygen levels as water enters Elbow River. Mixing of reservoir water and Elbow River water is predicted to mitigate any potential effects due to elevated water temperature and DO from reservoir water.

Project interactions with Glenmore Reservoir associated with water quality is negligible. Because water quality changes due to elevated temperature and DO are predicted to be not significant and have no residual effect on Elbow River, no effects on water quality in Glenmore Reservoir are predicted.

CHANGE IN METHYLMERCURY CONCENTRATIONS

Reservoir conditions are predicted to be conducive for some biological activity that may result in the transformation of mercury into methylmercury, but the increase in concentrations will be minor and concentrations will be less than regulatory guideline levels; however, under the longest predicted reservoir hold times, the highest predicted methylmercury concentration may reach provincial long-term guideline levels. After mixing in Elbow River, concentrations are predicted to decrease due to dilution and, therefore, concentrations in Elbow River are predicted to be below all guideline levels.

Project interactions with Glenmore Reservoir associated with water quality are negligible. Because water quality changes due to methylmercury are predicted to be not significant and have no residual effect on Elbow River, no effects on water quality in Glenmore Reservoir are predicted.

AQUATIC ECOLOGY

The following are residual effects associated with the Project that may interact with Glenmore Reservoir:

PERMANENT ALTERATION OF FISH HABITAT

Changes in river channel morphology from diverting flood flows above 160 m^3/s will result in downstream changes in overbank deposition, bank erosion rates, channel morphology, scour and maintenance of large pools, and maintenance and formation of side channels. The area and distribution of each type of channel unit (e.g., pools, riffles, glides) may change greatly; however, due to the infrequent periodicity of flood events greater than 160 m^3/s (i.e., approximate frequency of one in seven years), and channel forming flows will continue to occur even during diversion of water, the overall suitability of fish habitat in Elbow River is predicted to remain similar. Therefore, the overall effect of removing flood flows greater than 160 m^3/s is not significant.

The interaction of the Project with fish habitat in Glenmore Reservoir is predicted to be negligible and limited to the reservoir delta area where Elbow River enters the reservoir. Deposition of sediments in the delta area may accumulate during flood years, thus changing the nature of the delta. The continuation of channel forming flows between flood years (Elbow River flows less than 160 m^3/s) will maintain the nature of fish habitat in the delta.

Question 27

Supplemental Information Request 1, Question 153, Page 3.29

Alberta Transportation states that *since March 2018, Alberta Transportation has also received a final TUS from the Blood Tribe/Kainai, and technical reviews of the EIA from the Blood Tribe/Kainai, Piikani Nation, and Tsuut'ina Nation. Alberta Transportation has provided responses to the issues and concerns raised, where possible, both at meetings and in writing, and explained the proposed mitigation measures. Written responses to the technical reviews provided by the First Nations are forthcoming. Further consultation is anticipated to ensure all issues and concerns are responded to.*

a. Provide the final Traditional Use Study (TUS) from the Blood Tribe/Kainai.

b. Provide the technical reviews of the EIA from the Blood Tribe/Kainai, Piikani Nation, and Tsuut'ina Nation, and any other First Nations or Aboriginal communities that have provided such reviews.

c. Provide Alberta Transportation's written responses to the technical reviews.

d. Confirm any TUS reports Alberta Transportation expects will be provided by other Treaty 7 First Nations and any other First Nations or Aboriginal communities required to be consulted.

Response

This response was included in the April 8, 2020 filing. The text has not been altered. Appendices 27-1, 27-2 and 27-3 have not been included in this filing due to page length, see the April 8, 2020 filing for those appendices.

a. Alberta Transportation provided funding to Kainai First Nation to complete a TUS for the Project and a copy of the final TUS has been filed with the Agency and is available on the Canadian Impact Assessment Registry (CIAR) for the Project (CIAR #47). A copy of this TUS is provided as Appendix 27-1.

b. Technical reviews or SoCs were submitted to the Impact Assessment Agency of Canada (IAAC) by Kainai First Nation, Piikani Nation, Tsuut'ina Nation, Ermineskin Cree Nation, Louis Bull Tribe, Samson Cree Nation, Montana First Nation, and Métis Nation British Columbia. These documents are available on the IAAC Registry for the Project (https://iaac-aeic.gc.ca/050/evaluations/document/exploration/80123?culture=en-CA) and a copy of each document is in Appendix 27-2, as indicated below:

   1. Kainai First Nation (CIAR #47):
      - EIS Table of Technical Comments - Ermineskin Cree Nation and Blood Tribe
      - PGL - EIS Technical Review and Information Requests
   2. Piikani Nation (CIAR #48):
      - Technical Review of EIS
   3. Tsuut'ina Nation (CIAR #50):
      - Technical Review of Revised Environmental Impact Statement
      - PGL - EIS Technical Review and Information Requests
      - RJH Consultants EIA Dam Safety Information Deficiency Analysis
   4. Ermineskin Cree Nation (CIAR #46):
      - EIS Table of Technical Comments - Ermineskin Cree Nation and Blood Tribe
      - PGL - EIS Technical Review and Information Requests
   5. Louis Bull Tribe (CIAR #49):
      - EIS Review Submission
   6. Samson Cree Nation (CIAR #52):
      - Springbank Off-Stream Reservoir Project Written Submission

7. Montana First Nation (CIAR #51):
   - MSES Review of Alberta Transportation's Springbank Off-stream Reservoir Project Environmental Impact Assessment
8. Métis Nation British Columbia (CIAR #1153):
   - Springbank Off-Stream Reservoir Technical Review

c. Alberta Transportation prepared written responses to each submission in the interest of furthering Indigenous engagement and responding to the stated concerns of Indigenous groups. Alberta Transportation continues to engage with Indigenous groups on these written responses and will provide opportunities for Indigenous groups to share their comments, concerns, and feedback in person and in writing, at the discretion of each Indigenous group. Alberta Transportation's written responses to the Indigenous groups' technical submissions or SoCs are provided in Appendix 27-3, and includes the following:

1. Kainai First Nation:
   - Response to Kainai First Nation Technical Comments: Statement of Concern, dated June 15, 2018
   - Response to EIS Technical Review and Information Requests by PGL, dated June 15, 2018
2. Piikani Nation:
   - Response to Piikani Nation Statement of Concern, dated June 2018
3. Tsuut'ina Nation:
   - Response to 2nd EIS Sufficiency Review, dated April 16, 2018
   - Response to EIS Technical Review and Information Requests by PGL, dated June 15, 2018
   - Response to RJH Consultants EIA Dam Safety Information Deficiency Analysis dated June 14, 2018
4. Ermineskin Cree Nation:
   - Response to Ermineskin Cree Nation Technical Comments: Statement of Concern, dated June 15, 2018
   - Response to EIS Technical Review and Information Requests by PGL, dated June 15, 2018

5. Louis Bull Tribe:
    - Response to Louis Bull Tribe's EIS Review Submission, dated June 18, 2018
6. Samson Cree Nation:
    - Response to Samson Cree Nation Statement of Concern, dated June 25, 2018
7. Montana First Nation:
    - Response to Montana First Nation Statement of Concern, dated June 25, 2018
8. Métis Nation British Columbia:
    - Response to Métis Nation British Columbia Statement of Concern, June 2018

d. In addition to the Kainai First Nation TUS noted above, Alberta Transportation has provided funding to the following Indigenous groups to complete TUS for the Project:

- Tsuut'ina Nation
- Siksika Nation
- Piikani Nation
- Stoney Nakoda Nations
- Ermineskin Cree Nation
- Louis Bull Tribe
- Montana First Nation
- Métis Nation of Alberta, Region 3

Piikani Nation, Ermineskin Cree Nation, and Louis Bull Tribe have submitted their TUS directly to the IAAC. Each of these TUS are available on the IAAC Project Registry (https://iaac-aeic.gc.ca/050/evaluations/document/exploration/80123?culture=en-CA) as CIAR #48, CIAR #46, and CIAR #1228, respectively. A copy of each TUS has been appended to this Question as Appendix 27-1.

Tsuut'ina Nation's TUS was submitted to Alberta Transportation in confidence and cannot be disclosed or disseminated by Alberta Transportation to other parties.

The terms of use for the Métis Nation of Alberta, Region 3 TUS stipulate that the report may not be transmitted in any form without the prior written consent of Métis Nation of Alberta, Region 3. Alberta Transportation will request permission of Métis Nation of Alberta, Region 3 to provide a copy of their TUS to the NRCB.

Alberta Transportation received a Joint Interim TUS from Kainai First Nation and Siksika Nation in 2017, which Alberta Transportation is treating as a confidential document pending further direction from both Kainai First Nation and Siksika Nation on terms of use of the interim TUS. As noted, the final Kainai First Nation TUS has been filed and a copy is included in Appendix 27-1. Siksika Nation has indicated to Alberta Transportation that it intends to complete a final TUS in the near future.

Stoney Nakoda Nations and Montana First Nation have not completed a TUS to date. Stoney Nakoda Nations have reported to Alberta Transportation that they do not intend to complete a TUS for the Project. At a meeting held with Samson Cree Nation on November 26, 2019, Alberta Transportation offered to fund a TUS; Samson Cree Nation is considering this offer but to date has not submitted a request.

Alberta Transportation has provided a written response to the TUS submitted by Kainai First Nation, Piikani Nation, Tsuut'ina Nation, Ermineskin Cree Nation, Louis Bull Tribe, and Métis Nation of Alberta, Region 3. Alberta Transportation has met with Kainai First Nation, Tsuut'ina Nation, Ermineskin Cree Nation, and Louis Bull Tribe to discuss these written responses and a copy of each is included in the response to NRCB Question 1, Appendix 1-3. Alberta Transportation is committed to offering to meet with Piikani Nation and Métis Nation of Alberta, Region 3 to discuss their respective written responses.

REFERENCES

Canadian Impact Assessment Registry (CIAR) 2019. Available at: https://ceaa-acee.gc.ca/050/evaluations/proj/80123?culture=en-CA. Accessed January 2019

Question 28

Supplemental Information Request 1, Question 342, Page 5.227
Supplemental Information Request 1, Question 342, Table IR342-1, Page 5.226
Supplemental Information Request 1, Question 342, Table IR342-2, Page 5.227

Alberta Transportation presents new information in Tables IR342-1 and IR342-2 that quantifies the status of bull trout and westslope cutthroat trout populations and states that *population level fisheries data was not collected in the Elbow River*. There is an absence of information for fish species other than trout.

a. **Explain how the new data (Tables IR342-1 and IR342-2) was incorporated into the effects assessment.**

b. **Discuss how the variability and level of detail in information used for the population estimates, including the absence of population estimates for fish species other than trout, influences the reliability of the conclusions of the effects assessment.**

Response

a-b. The methods used to determine how the baseline information describes fish species, composition, distribution, abundance, movement, habitat used and life history parameters of fish resident to the LAA are provided in the response to NRCB Question 19, Table 19-1. Also, Elbow River fish population estimates are provided in NRCB Question 19, Tables 19-3 and 19-4 and the discussion there includes 1) assessment of relevant aquatic ecology and fisheries sensitive to the Project operations; 2) appropriate mitigation measures; and 3) determination of residual effects that may require a *Fisheries Act* authorization with suitable offsets.

In the period July to September 15, 2020, field work to obtain fish population data for the resident fish community will be collected to further characterize and assess the composition, abundance and density of resident trout and non-trout fish populations. The fish population data will be documented and provided to NRCB and AEP when complete.

Question 29

Supplemental Information Request 1, Question 346, Page 5.233

Alberta Transportation states that *large woody debris taken from the debris deflector, intake structure, and gates will be removed from the beds and shores and will not be reintroduced downstream in the river*.

a. **Quantify the amount of woody debris that will be removed from the system downstream of the project relative to the total amount that would be available without the project.**

b. **Evaluate how the loss of woody debris recruitment to the lower Elbow River will affect fish habitat and aquatic productivity.**

Response

a. ***QUANTIFICATION OF LARGE WOODY DEBRIS (BASELINE)***

A quantitative estimate of large woody debris (LWD) in the study reach was made by measuring the bulk aerial extent (m^2) of major debris accumulations observed in aerial photography after the 2013 flood. LWD estimates are provided in Table 29-1, within Elbow River from Redwood Meadows to the proposed diversion inlet location (Reach A) and Bragg Creek (Balsam Avenue Bridge) to Redwood Meadows (Reach B).

Areas used to derive LWD estimates are presented in Figure 29-1 and Figure 29-2. Estimates are provided relative to the 2013 flood level, and the 2-year flood level (Table 29-1). The aerial imagery suggests that some LWD remained impinged within the floodplain following the 2013 flood, which suggests that some LWD will persist in the upstream reaches and will remain immobile during a future flood. For this reason, LWD quantification within the 2013 extent has been categorized as "mobile" (i.e., could mobilize downstream during a flood) and "immobile" (i.e., sufficiently anchored and unlikely to move downstream during a flood). LWD in the 2-year flood level is entirely mobile (i.e., could mobilize downstream during a flood), and representative of LWD that could offer fish habitat potential.

Table 29-1 Quantification of Large Woody Debris for Representative Reaches in Elbow River without the Project

Reach[1]	2013 Flood Extent LWD (m^2)		2-Year Flood Extent LWD (m^2)
	Mobile	Immobile	
Reach A	48,993 m^2	24,978 m^2	8,942 m^2
Reach B	14,355 m^2	35,977 m^2	1,446 m^2

NOTES:
[1] Reaches are categorized as follows:
Reach A is Redwood Meadows to the diversion inlet
Reach B is: Balsam Avenue Bridge in Bragg Creek to Redwood Meadows

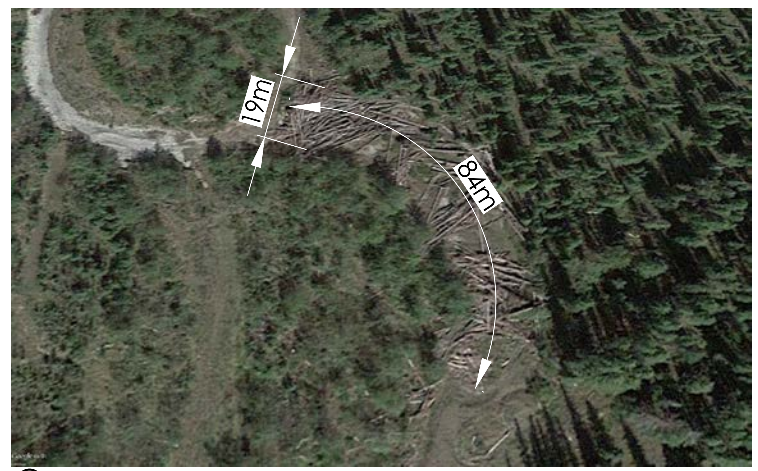
ESTIMATING LARGE WOODY DEBRIS LOSS (WITH THE PROJECT)

The channel morphology of Elbow River plays an important role in quantifying LWD loss as a result of the Project; the following provides further information on considerations for LWD transport and loss.

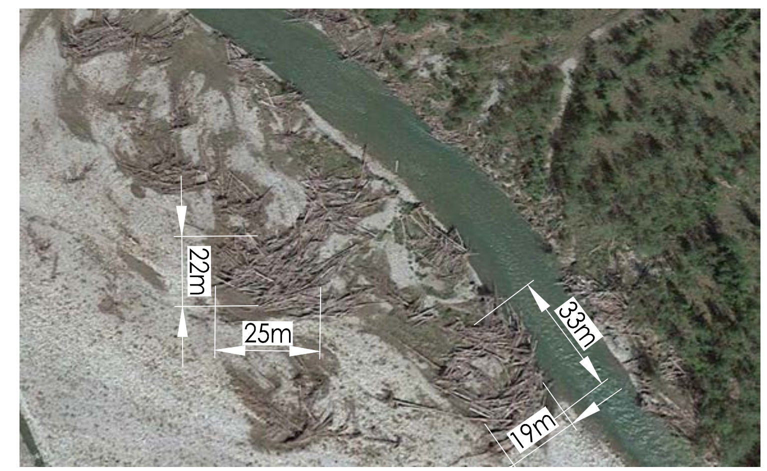
Reach A is characterized as having a very wide, braided channel. Observations of LWD within Reach A after the 2013 flood suggest that Reach A effectively served as a trap for a large percentage of the woody debris that would have otherwise been mobilized to the site of the proposed diversion structure. LWD in Reach A is positioned throughout the channel such that it could be readily mobilized, but it would take a flood flow greater than that which put it there to generate enough water depth to lift the wood off the high bars and overbank areas. These high bars and shallow overbank areas also contain established vegetation and terrain features the present a greater potential for snags on trees and terrain features, lessening the potential for all the wood in Reach A to mobilize.

Reach B is relatively more confined than Reach A, due to the presence of floodplain terraces and valley walls. Flood depths at Reach B are deeper than Reach A, and the presence of less woody debris left in Reach B following the flood suggests transport is higher in this reach. There is a considerable amount of woody debris anchored to the forest and high floodplains within the reach, but the wood that is within the 2-year water level in Reach B is more likely to mobilize in the next large flood.

Ⓐ DEBRIS JAM AT NOSE OF A BENCH (DEBRIS JAM DIMENSIONED)



Ⓑ IMMOBILE DEBRIS JAM IN SIDE CHANNEL (DEBRIS JAM DIMENSIONED)



Ⓒ MOBILE DEBRIS ON GRAVEL BAR (DEBRIS JAM DIMENSIONED)

Ⓓ DEBRIS JAM ALONG RIVER BANK (DEBRIS JAM DIMENSIONED)

Ⓔ MOBILE DEBRIS JAMS IN SIDE CHANNEL (DEBRIS JAM DIMENSIONED)

Ⓕ DEBRIS JAM IN OVERBANK (DEBRIS JAM DIMENSIONED)

Ⓖ MOBILE DEBRIS SCATTERED THROUGHOUT GRAVEL BAR (DEBRIS JAM DIMENSIONED)

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Legend

- EXTENT OF 2013 FLOOD
- REACH A
- REACH B

Client/Project

Alberta Transportation

Springbank Off-Stream Reservoir (SR1)

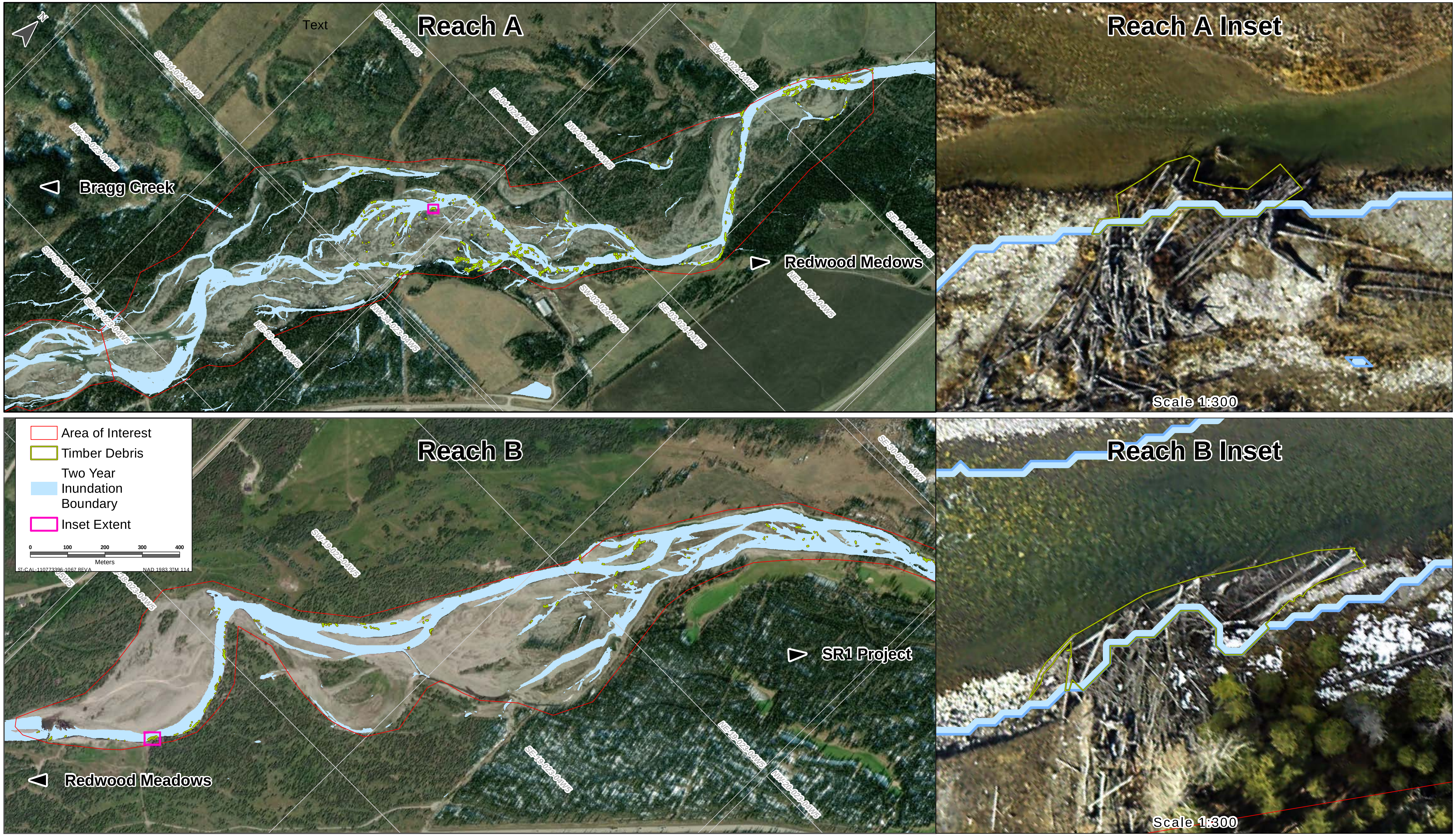
Project No. 110773396

Title

Large Woody Debris within the 2013 Flood Extent of the Elbow River

Revision	Date
	2018.06.05
Reference Sheet	Figure No.
	29-1

2020.05.21 10:18:22 AM



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

Figure 29-2: Large Woody Debris Quantification within the 2-Year Flood Extent of the Elbow River

The diversion structure will be located at the downstream end of Reach A, within a reach of Elbow River that is relatively more confined and analogous to Reach B. LWD arriving at the diversion structure from both reaches is considered in this response.

The debris deflector is designed to prevent debris from entering the diversion inlet during a flood. Observations from the physical model suggest that hydraulics at the diversion inlet during flood operation will encourage LWD to accumulate at the debris deflector (left downstream bank), while some LWD may continue to move past the debris deflector on the right downstream bank. Observations made during testing using the physical model of the diversion structure suggest that the quantity of LWD that accumulates at the debris deflector is roughly proportional to the ratio of flow that is being diverted through the diversion inlet versus what is allowed to pass downstream. This observation is supported by the principles that the wood requires depth and secondary currents to mobilize, both of which are a function of flow rate in a river channel; or in this case, a split in the flow rate.

LWD quantity within the 2-year flood limit was used to estimate proportional LWD loss because LWD within the 2-year flood level generally offers fish habitat in the form of cover. It is expected that for some floods, larger quantities of LWD could mobilize and be captured by the debris deflector, but only a portion of this LWD would be fish habitat in without the Project. From the quantified LWD estimates in Table 29-1, LWD within Reach B at the 2-year flood level is analogous to the amount of woody debris (that could offer fish habitat) that would be mobilized during a flood. A conservative estimate of LWD loss for different return periods of river flows is provided in Table 29-2.

Table 29-2 Estimate of LWD Loss Relative to Flood Return Periods

Return Period (year)	Instantaneous Peak Discharge (m^3/s)	Corresponding Flow that is Diverted to the Reservoir (m^3/s)	Proportion of LWD Captured at the Debris Deflector (%)	Proportion of LWD that would Move Downstream in the Presence of the Project (%)
1:500	1,800	600	33	67
1:200 (design flood)	1,110	600	55	45
1:100	765	600	78	22
1:50	530	370	70	30
1:20	330	170	51	49
1:10	200	40	20	80
1:5	140	0	n/a	100
1:2	70	0	n/a	100

b. The debris deflector will capture LWD quantities that are proportional to the magnitude of flow that is being diverted to the reservoir. It is anticipated that some of the LWD captured on the debris deflector will re-enter the river and pass downstream naturally after the flood has passed and the diversion gates are lowered to allow normal passage of water into Elbow River. However, a conservative assumption is made that all captured LWD will be removed from the diversion inlet during post-flood maintenance operations.

   Despite removal of LWD during post-flood operations, potential impacts to fish habitat and aquatic productivity are not anticipated due to a change in woody debris availability downstream of the Project. This is because the Project will operate infrequently, and loss of LWD is only associated with relatively high magnitude floods.

   Fish habitat complexity in downstream areas will be maintained with the presence of the Project through geomorphic changes to the channel, vegetation establishment over time, and instream LWD that is maintained in the areas downstream of the Project. A prediction of potential impacts to fish habitat as a result of LWD loss carry some uncertainty; this is because quantification was conducted through aerial imagery and a qualitative review of an analogous study area upstream.

   It is possible that some LWD is not visible through the aerial imagery, or some areas may mobilize differently than predicted through the desktop evaluation of impingement locations. Furthermore, LWD that is transported downstream during a flood may deposit at a different flood level relative to the baseline quantification, particularly in large floods where LWD may get deposited above the ordinary high-water mark.

   Pre-construction habitat mapping is being completed for the extent of Elbow River from Bragg Creek to Glenmore Reservoir. LWD that offers fish habitat is considered through HSI rankings associated with this fieldwork. While LWD is not directly quantified within this field survey, it is considered through habitat evaluation and HSI ranking.

   A survey of post-flood habitat will be compared with baseline habitat information to monitor habitat changes as a result of the Project, including the change to fish habitat complexity (LWD presence). Habitat changes will be monitored through compliance monitoring programs associated with the Project *Fisheries Act* authorization.

Question 30

Supplemental Information Request 1, Question 348, Page 5.235

Alberta Transportation states *suspended sediment concentrations in the water from the off-stream reservoir is predicted to increase during the last few days and that without mitigation the resulting increase in the Elbow River of suspended sediment concentrations is likely to exceed the Canadian Water Quality Guideline*.

a. Delineate and quantify the downstream extent of total suspended solid (TSS) concentrations that exceed water quality guidelines for the protection of aquatic life for the 1:10 and 1:100 flood events.

b. Provide an evaluation of impacts downstream from the release of turbid water over an extended period of time for fish survival, fish habitat, and aquatic productivity. The severity of ill effects dose-response curve can be used to evaluate impacts on fish survival.

c. Provide estimated frequency of flood water release during the period of September 01 to October 31 for the 1:10 and 1:100 year flood event.

d. Describe where and when Elbow River mountain whitefish and brown trout populations spawn in the Elbow River downstream of the outlet structure.

e. Evaluate effects of elevated suspended sediment levels and increased duration of elevated suspended sediment concentrations on species populations (i.e., mountain whitefish and brown trout) potentially using the portion of the Elbow River below the outlet structure for spawning during post-flood reservoir draining.

Response

a. For TSS predictions, an updated MIKE 21 FM- MT (mud transport) model was developed for the 1:10 year, 1:100 year and the design flood (2013) hydrographs. Three scenarios are modelled as follows:

- without the Project
- early release
- late release

For early release, water starts to drain from the reservoir back into Elbow River when the flow in Elbow River is less than 160 m^3/s, and the draining continues until the reservoir is emptied. For late release, water starts to drain when the flow in Elbow River flow is less than 20 m^3/s.

The downstream extent of TSS concentrations that exceed water quality guidelines for the protection of aquatic life for the three floods are discussed in the response to AEP Question 65a. In summary, the results show that exceedances occur from the LLOW to Glenmore Reservoir following a 1:10 year flood for early release only; a 1:100 year flood for both early and late release; and design flood for both early and late release. The 1:10 year flood with late release did not result in any exceedances.

The TSS concentrations in the water quality guidelines for the protection of aquatic life vary depending on conditions in the waterbody being evaluated. To delineate and quantify the downstream extent of TSS concentrations, the following categories are used:

- Clear flow (CF) indicates that the background is less than 25 mg/L. If any exceedance lasts longer than 24 hours, the long-term guideline is triggered and a change in TSS of 5 mg/L or more is an exceedance for the entire time series.
- High-flow (HF25) indicates that the background is between 25 mg/L and 250 mg/L. Change in TSS of more than 25 mg/L is an exceedance.
- High-flow (HF250) indicates background is greater than 250 mg/L. Change in TSS of more than 10% of background is an exceedance.

The results of without the Project model are used to represent background conditions for identifying which water quality exceedance category to use for determining TSS exceedances.

The model was run for the 1:10 year flood and 1:100 year flood hydrographs for both early and late release (four different scenarios). The guidelines used for establishing exceedances varied during the flood because background TSS concentrations would be expected to vary during a flood. The locations of the selected model nodes that are used is presented in AEP Question 65, Figure 65-1. The model nodes are distributed in Elbow River starting immediately downstream of the confluence of the unnamed creek with Elbow River and extend downstream to Glenmore Reservoir. Table 30-1A presents the results for the 1:10 year flood and Table 30-1B for the1:100 year flood. Both tables show the predicted hours of guideline exceedance and which guideline category is applicable at the time of the exceedance. For example, in Table 30-1A at P08, during early release, no exceedances are predicted to occur during CF conditions, one hour of exceedances are expected to occur during high-flow (HF25) conditions when background TSS is between 25 mg/L and 250 mg/L, and for 12 hours during high-flow (HF250) conditions when background TSS is greater than 250 mg/L. In Table 30-1A and Table 30-1B, for the early release, only the applicable guideline exceedances are shown. Generally, during early release, background TSS levels do not meet the CF criteria, thus only high-flow guideline exceedances are shown. CF exceedance are predicted only for P18, P19 and P21 during early release, indicating that without the Project (background) value is less than 25 mg/L and the predicted with Project value is more than 5 mg/L greater. By the time the released water reaches these downstream locations, the elevated TSS for without the Project is CF (i.e., less than 25 mg/L), thus resulting in a CF exceedance. The predicted exceedances do not occur concurrently.

Table 30-1A Estimated Exceedance Time of Water Releases for the 1:10 Year Flood

Site	Distance Downstream from Low Level Outlet (m)	Early Release – Hours of Exceedance			Late Release		
		CF	HF25	HF250	CF	HF25	HF250
P08	0	0	1	12	-	-	-
P09	50	0	1	11	-	-	-
P10	150	0	0	1	-	-	-
P11	300	0	1	10	-	-	-
P13	1,000	0	2	2	-	-	-
P15	3,000	0	7	3	-	-	-
P16	6,000	0	8	2	-	-	-
P17	9,000	0	8	1	-	-	-
P18	13,000	0	8	1	-	-	-
P19	24,000	11	10	0	-	-	-
p21	Glenmore Reservoir	12	14	4	-	-	-

NOTES:
CF = clear flow guidelines; HF25 = background TSS between 25 mg/L and 250 mg/L; HF250 = background TSS greater than 250 mg/L

Table 30-1B Estimated Exceedance Time of Project Releases for the 1:100 Year Flood

Site	Distance Downstream from Low Level Outlet (m)	Early Release – Hours of Exceedance			Late Release		
		CF	HF25	HF250	CF	HF25	HF250
P08	0	0	538	18	530	-	-
P09	50	0	535	17	494	-	-
P10	150	0	533	18	462	-	-
P11	300	0	534	18	485	-	-
P13	1,000	0	535	17	484	-	-
P15	3,000	0	535	18	492	-	-
P16	6,000	0	536	17	496	-	-

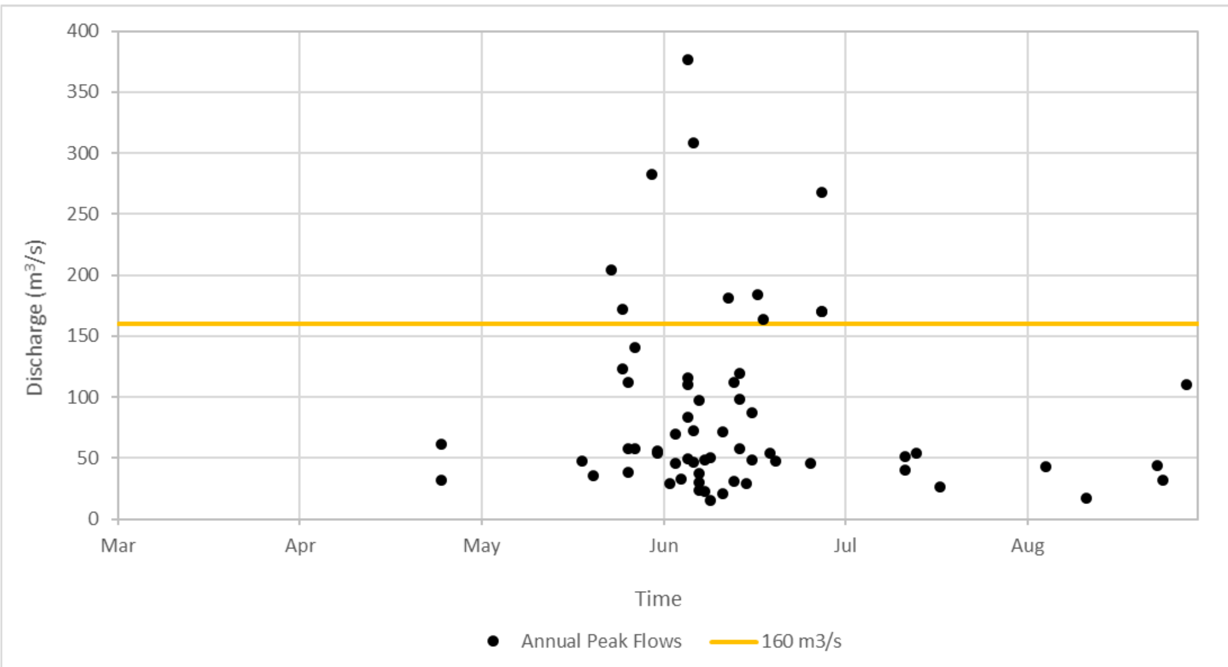
Table 30-1B Estimated Exceedance Time of Project Releases for the 1:100 Year Flood

Site	Distance Downstream from Low Level Outlet (m)	Early Release – Hours of Exceedance			Late Release		
		CF	HF25	HF250	CF	HF25	HF250
P17	9,000	0	537	16	476	-	-
P18	13,000	6	529	15	465	-	-
P19	24,000	39	522	14	488	-	-
P21	Glenmore Reservoir	91	476	15	489	-	-
NOTES: CF = clear flow guidelines; HF25 = background TSS between 25 mg/L and 250 mg/L; HF250 = background TSS greater than 250 mg/L							

b. The assessment of effects on resident fish in Elbow River from the release of retained water is described in the response to NRCB Question 24. That assessment used work done by Newcombe and Jensen (1996) who studied and reported on the effects of suspended sediment exposure on fish health. That work was used to develop a SEV index score to predict effects on fish based on level of exposure to suspended sediments (i.e., TSS concentration) and the duration of exposure. SEV index scores for fish in Elbow River downstream of the Project during reservoir water release are provided in the response to NRCB Question 24b. In summary, for the 1:10 year flood, both early and late release result in suspended sediment concentrations in reservoir water similar to the concentrations in Elbow River. During both early and late release, reservoir water would be released over a two-day period. During late release, suspended sediments would settle in the reservoir during the period of time between water diversion (i.e., reservoir filling) and release. Suspended sediments in retained water released into Elbow River would be similar to suspended sediments in the river. Therefore, reservoir water release does not increase TSS levels in Elbow River (see the response to AEP Question 65c) and SEV index scores for Elbow River following the 1:10 year flood for late release is the same as in the river without the Project. The SEV index scores for fish in the 1:100 year and design floods are all generally in the "lethal and paralethal effects" range, except for a few cases.

Effects of sediment deposition on habitat and aquatic productivity are discussed in the response to e.

c. The duration of early release and late release for the three floods do not extend into September. An analysis of peak flow occurrence are plotted in Figure 30-1. From the figure, all Elbow River flows above the 160 m^3/s Project operational threshold occur prior to the end of June. Based on this data, the flows before to the end of June are driven by snowmelt and/or rain-on-snow processes. These processes result in larger peak flows (Figure 30-1). Floods that occur in July or later are primarily driven by rainfall, and they result in much lower peaks.



NOTE: The 2013 flood is not included to provide better scale for the remaining peak flows

Figure 30-1 Annual Peak Instantaneous Flow Plotted by Month (1950 to 2018)

Based on this analysis, the likelihood of releases from the reservoir in September to October would be low and, therefore, are not assessed.

To address the concerns regarding the potential impacts due to releases from the reservoir, a mean monthly flood frequency analysis of stream flows in Elbow River at Bragg Creek hydrometric station (Water Survey of Canada [WSC] 05BJ004) was conducted for the months of May to August. This period is deemed to be the most likely timeframe during which floods would occur. The period of record assessed for the hydrometric station is 1934 to 2018. For each month in the Elbow River flow record, average monthly flows were determined for the period of record, and then the average for each month was fit to the Log Pearson Type III distribution to determine return period flows. Results are provided for the three floods, without the Project, and for early release and late release with the Project.

Table 30-2 presents return periods of discharge in Elbow River by month, for May to August. Table 30-3 presents the mean monthly flows when water is discharged from the low-level outlet. Table 30-4 presents the estimated return period of each flow in Table 30-3 based on the return period results presented in Table 30-2.

A return period is directly related to the monthly annual exceedance probability. For example, for any given month, a 1:100 year flood has a 1% monthly annual exceedance probably of 0.01, or 1%. The results show that during August, discharge during release within Elbow River downstream of the diversion has a return period of greater than 1,000 years for late release associated with the design flood (Table 30-4).

Table 30-2 Mean Monthly Discharge for Each Return Period for Elbow River at Bragg Creek

Return Period	Discharge (m^3/s)			
	May	June	July	August
1:2 year	12.8	23.3	14.4	8.7
1:3 year	15.8	28.7	17.7	10.1
1:5 year	19.1	34.7	21.1	11.7
1:10 year	23.6	42.6	25.1	13.8
1:20 year	28.1	50.2	28.7	15.8
1:50 year	34.1	60.3	32.9	18.6
1:100 year	38.9	67.9	35.7	20.7
1:200 year	43.8	75.7	38.3	22.9
1:1,000 year	56.0	94.4	43.6	28.3
1:2,000 year	61.6	103	45.6	30.8

Table 30-3 Estimated Mean Monthly Flows for Floods, Early Release and Late Release

Month	Mean Monthly Flows (m^3/s)								
	Design Flood			1:100 Year Flood			1:10 Year Flood		
	Without the Project	Early Release	Late Release	Without the Project	Early Release	Late Release	Without the Project	Early Release	Late Release
May	17.52	17.52	17.52	46.04	37.17	37.17	29.62	26.54	29.31
June	77.36	63.19	57.86	61.48	70.64	57.91	37.97	-	37.97
July	21.25	38.80	33.16	29.47	-	29.47	16.99	-	24.62
August	14.07	-	30.41	17.03	-	29.54	9.15	-	-

Table 30-4 Estimated Return Period Equivalent

Month	Return Period (years)								
	Design flood			1:100 year flood			1:10 year flood		
	Without the Project	Early Release	Late Release	Without the Project	Early Release	Late Release	Without the Project	Early Release	Late Release
May	>3	>3	>3	>200	>50	>50	>20	>10	>20
June	>200	>50	>20	>50	>100	>20	>5	-	>5
July	>5	>100	>50	>20	-	>20	>2	-	>5
August	>10	-	>1000	>20	-	>1000	>2	-	-

d. Brown trout in southern Alberta generally spawn in October and November on riffle and runs with gravel and cobble substrate. Mountain whitefish in southern Alberta spawn in September and October in riffle and run habitat with small gravel substrates, often in tributaries (EIA, Volume 3A, Aquatic Ecology, Section 8.2.2.3). Both brown trout and mountain whitefish have the potential to spawn throughout the entire extent of Elbow River between Elbow Falls and Glenmore Reservoir (AEP 2020).

Some localized areas are present throughout Elbow River that offer relatively high-quality spawning habitat that has been scored through the use of a HSI model. HSI is a numerical index that describes the suitability of habitat (from 0 to 1, with 0 representing least suitable habitat and 1 representing most suitable habitat) to support a selected species or species life stage. Brown trout and mountain whitefish HSI calculations for spawning life stages (see the response to AEP Question 69, Appendix 69-1) that is consistent with previously developed suitability criteria for both species (Addley et al. 2003; Fernett et al. 1990; EMA 1994). Each HSI index was derived based on suitability criteria for habitat variables that are important to a specific life stage (e.g., depth, velocity, substrate composition, and/or total cover criteria). Furthermore, HSI scores were applied to fish habitat units that were mapped in fall 2019 in the main stem of Elbow River between the Tsuut'ina Nation Reserve boundaries of Redwood Meadows and Discovery Ridge (Appendix 69-1, Attachment E and G). Mapped habitat features with higher HSI values are areas with higher ecological importance. A habitat map displaying calculated HSI values for spawning life stages is provided in Appendix 69-1 to spatially illustrate the relative importance of each habitat feature to the spawning life stage of brown trout and mountain whitefish.

Brown trout spawning surveys were completed in fall 2019 in the main stem of Elbow River between the Tsuut'ina Nation Reserve boundaries of Redwood Meadows and Discovery Ridge (Appendix 69-3). These spawning surveys compliment the HSI maps for the brown trout spawning life stage. A total of 115 brown trout redds were identified along a 24 km stretch of river making up the study area (Appendix 69-3, Attachment A). Redds were irregularly distributed throughout the entire study reach, but present in relatively high concentrations in the uppermost reach of the study area (from Redwood Meadows downstream for approximately 1.5 km), and the section of river upstream from its confluence with Pirmez Creek (for an extent of approximately 1 km). HSI values for these areas were correspondingly high (between 0.5 and 1.0).

Mountain whitefish spawning surveys were not completed, because mountain whitefish do not construct redds; therefore, the eggs are not readily visible while ground truthing the river. Mountain whitefish spawning surveys are typically done through the use of kick nets to collect and identify eggs, and such sampling techniques pose undue disturbance to the eggs during the spawning life stage. An application for a Fish Research License was made to AEP in fall 2019 to conduct kick net surveys to document mountain whitefish spawning activities. Approval was not received due to the sensitive timeframe in which data would inherently be collected and the potential disturbance that kick netting could pose to fish eggs.

e. Early release and late release of water from the reservoir will occur between late May and late August. For example, the flood with the longest time of being mitigated by the Project is the 1:100 year flood, late release, which could occur between August 7 and August 31. This reservoir water release coincides with BSP 2, which includes brown trout and mountain whitefish adult, fry, and juvenile life stages.

   Further details on the effects of suspended sediment as it pertains to life stages of fish species in Elbow River are described in the response to NRCB Question 24. In summary, for the 1:10 year flood, short duration TSS exceedances of water quality guidelines are predicted for early release and no exceedances are predicted for late (see Table 30-1A and response to AEP Question 65).

   The SEV index scores for fish in Elbow River during the release of reservoir water in the 1:100 year and design floods are all generally in the "lethal and paralethal effects" category. SEV index scores remain elevated in Elbow River between the confluence of the unnamed creek (i.e., where reservoir water enters the river) and Sarcee Bridge (24 km) downstream. This effect with SEV index scores occurs for both with and without the Project. Brown trout and mountain whitefish use Elbow River habitats upstream and downstream of the Project (i.e., their distribution persists upstream of the Project during BSP-2, as indicated in Alberta Transportation's response to NRCB Question 19). During release of water into Elbow River, portions of the brown trout and mountain whitefish populations will be upstream of the release and not exposed to elevated suspended sediments.

   Therefore, it is assumed that the population will recover following a flood such that aquatic productivity is maintained; however, the quantitative impacts to population as a result of these effects is uncertain.

Sediment deposition within Elbow River, with and without the Project (for both early and late release) is modelled, mapped and compared for analysis (NRCB Question 24, Figures 24-1 to 24-6). For the 1:10 year flood, the Project (relative to baseline Elbow River conditions without the Project) will not result in a difference in sediment deposition in Elbow River. The 1:100 year flood and design flood, with the Project (compared to baseline Elbow River conditions without the Project), will result in additional deposition outside of the summer low-flow channel within Elbow River. These deposits do not result in a material change to fish habitat; therefore, deposition of fine sediment on the channel bed due to water release is not expected to impact brown trout and mountain whitefish spawning habitat potential in the downstream extent of Elbow River.

REFERENCES

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Question 31

Supplemental Information Request 1, Question 350, Pages 5.245-5.247

Alberta Transportation states that *the potential for 80% of fish being displaced is considered conservative and high, that the relationship between fish displaced and percent of flow is likely less than 1:1, and that development of a new model would not reduce uncertainty in the assessment.*

a. Outline mitigation measures and monitoring programs to be implemented to ensure survival of fish entrained into the diversion channel, excluding efforts associated with fish rescue.

Response

a. Design mitigation will reduce the risk of effects on fish for the time that they are entrained in the reservoir. The following are the mitigation measures that are included in the engineering design:

- The diversion channel has been designed to accommodate fish passage; design mitigation includes appropriate channel configuration and grade to reduce the risk of stranding.
- The contours and elevations of the reservoir (i.e., bowl shape) will result in water pooling in the deeper, central area of the reservoir. This will maintain an area of elevated water depths where fish will find more suitable refuge where there are lower temperatures and cover.

In addition to design mitigation, a Draft Fish Rescue and Fish Health Monitoring Plan is provided in Appendix 31-1, which describes commitments to mitigate and monitor the potential effects of flood operation on fish health within the reservoir and after the fish have been released back into Elbow River. The objective of the fish rescue efforts is to relocate fish as quickly as possible to Elbow River, and monitoring efforts will determine the health of fish upon return into the river. Flood operation will limit the opportunity to monitor fish within the diversion channel upon activation of the Project (i.e., immediately following diversion from Elbow River); rather, monitoring efforts are timed to coincide with reservoir water release. The diversion channel is included in fish rescue and monitoring efforts during water release.

Fish health monitoring will be conducted within Elbow River (i.e., from the confluence of the unnamed creek with Elbow River to Glenmore Reservoir) to identify fish that may have been entrained in the reservoir and record their physical and behavioural condition. Fish health monitoring provides an indication of the extent of Project-related effects for compliance with the Project *Fisheries Act* authorization.

Question 32

Supplemental Information Request 1, Question 351, Page 5.248

Alberta Transportation states that *areas within the reservoir will be graded to provide positive drainage and reduce stranding of fish during release of stored flood water from the reservoir* and that a fish monitoring program and rescue plan will mitigate impacts caused by fish entrainment.

a. Provide examples of, and discuss, the effectiveness of fish rescue operations in large impoundments dominated by silt substrates and those that are subjected to rapid dewatering.

b. Quantify the likelihood of survival of fish trapped within the reservoir that are subjected to predicted TSS concentrations for the duration of the water retention period using the severity of ill effects dose-response curve.

Response

a. Four examples of other-project fish-out or large-scale fish rescues are provided as it relates to the Draft Fish Rescue and Fish Health Monitoring Plan (see the response to NRCB Question 31, Appendix 31-1):

- Fish rescue during Little Bow Reservoir Dam Rehabilitation Works for Alberta Transportation – Vulcan County, Alberta (Klohn Crippen Berger 2014)
- Fish Salvage in Lac de Gras for Diavik Diamond Mine Construction – Northwest Territories (Jaques Whitford 2002)
- Fish-Out of the Bay-Goose Basin in Third Portage Lake for Agnico Eagle Mines Limited (North-South Consultants Inc. 2010)
- King Richard Creek Fish Salvage for Mt. Milligan Copper Gold Project (AMEC 2011)

In these examples, fish rescues were completed in advance of dewatering for the purposes of dam rehabilitation or mine construction. Fishing equipment and methods varied by program to address project-specific constraints: area, depth, terrain (e.g., ability to wade in deep accumulations of organics or sediment), flow, and species sensitivity.

The fishing protocol developed within the fish rescue plan for this Project considers such constraints for maximizing program efficiency (i.e., duration, catch-per-unit-effort) and decrease the risk of fish mortality (e.g., use of electrofishing units rather than gill nets).

The effectiveness of fish rescue efforts for the Project are independent of survival rate of fish that are entrained in the reservoir. However, TSS concentrations in the reservoir may influence fish survival, despite an effective rescue program.

Example 1: Fish rescue during Little Bow Reservoir Dam Rehabilitation for Alberta Transportation – Vulcan County, Alberta (Klohn Crippen Berger 2014)

Fish rescues were undertaken in Little Bow Reservoir in 2013 for dam rehabilitation. Rescue efforts occurred concurrently as water levels were drawn down. Rescue efforts were initiated with monitoring along the perimeter of the reservoir to identify areas where isolated pools were located. Twenty-eight pools ranging from 285 m^2 to 31,251 m^2 were monitored for fish stranding, and 282 fish were observed and rescued from the isolated pools during water drawdown. An additional 294 fish were caught within the main body of the reservoir during water drawdown. Fishing was primarily done using seine nets and dip nets; these methods are the same as for the Project (Draft Fish Rescue and Fish Health Monitoring Plan, Appendix IR 31-1).

The rescue efforts for the Project also include the use of electrofishing equipment (tote or boat) to allow crews to safely access deeper portions of the reservoir that might not be effectively achieved through the exclusive use of seine nets.

Example 2: Fish Salvage in Lac de Gras for Diavik Diamond Mine Construction, Northwest Territories (Jaques Whitford 2002)

An inlet of Lac de Gras underwent fish rescue to prepare it for mine construction activities in the lake. Rescue efforts extended for 40 consecutive days, and fishing equipment included the use of gill nets, trap nets, minnow traps, and angling. Fish survival was approximately 50%; 2,526 live fish (out of 5,049 fish captured) were released to another portion of the lake during the program. Captured fish were transferred to a holding tank before release, and handling time upon capture was reduced to improve fish survival.

The Draft Fish Rescue and Fish Health Monitoring Plan for the Project (Appendix 31-1) differs from this example because the Project will not include the use of gill nets; injury and mortality risk to fish increases with time that the nets are left in the water. Net deployment within the Project reservoir would require relatively long intervals (i.e., greater than two hours) between retrieval efforts due to the size of the reservoir and travel to retrieve the nets.

For this Project, boat electrofishing and tote electrofishing are the primary methods of fish capture and supplemented by the use of seine nets, standard Gee-style minnow traps, and hand capture. It is expected that water depths in the reservoir will be conducive to boat electrofishing during initial fish efforts, and tote electrofishing and netting will be used as water levels are drawn down to allow foot access. Voltage and amperage settings can be adjusted on electrofishing units to reduce the risk of injury to fish (Government of Alberta 2012). Similar to the Diavik mine program, the fish rescue plan for the Project has been developed in a manner that reduces handling time (i.e., minimal fish measurements proposed) in an effort to reduce stress and injury to fish during transfer to holding tanks and release.

Example 3: Fish-Out of the Bay-Goose Basin in Third Portage Lake for Agnico Eagle Mines Limited (North-South Consultants Inc. 2010)

The Third Portage Lake fish-out occurred over a 26-day period. Fishing equipment included the exclusive use of gill nets. Mitigation for fish mortality during this program included frequent checks of the gill nets and minimizing the number of nets that were deployed to maximize the frequency at which the field crews could check and retrieve nets. In addition, holding tanks with cold water were used to transfer fish, and water was replaced frequently (e.g., usually midday) to minimize stress to fish as a result of depleted DO concentration and increased water temperature in the holding tanks.

For this Project, the crew size could include up to 30 people (concurrently) to decrease holding times for individual fish and decrease duration of the overall fish rescue program. Fish rescued during reservoir water drawdown will be temporarily held in buckets or totes with fresh river water and aerated with a battery-operated air pump before they are transferred to large-capacity aerated tanks on shore. Designated field staff will be responsible for transferring fish from the buckets or totes to a larger capacity holding tank to reduce stress to fish during transfer. Retention time in the buckets or totes will be kept to a minimum before transferring to a large capacity holding tank that is aerated for transfer. Water in buckets and totes will be replenished frequently. Water temperatures, DO, and fish behaviour will be monitored in the holding tanks such that relocations are done in a timely manner to reduce stress to fish.

Example 4: King Richard Creek Fish Salvage for Mt. Milligan Copper Gold Project (AMEC 2011)

A fish rescue was conducted throughout King Richard Creek prior to loss of the channel for mine construction. The fish rescue program was completed with backpack electrofishing from a boat, minnow traps, and shoreline fishing (i.e., angling) over a period of 18 days. Only two incidental mortalities were recorded from a total of 759 fish captured (99.7 % survival). Survival was likely influenced by efforts that were made to reduce holding time during relocation. Holding tanks and buckets were used and replenished with fresh water frequently.

These mitigation measures align with the efforts that are described in the Draft Fish Rescue and Fish Health Monitoring Plan for the Project (Appendix 31-1).

b. The assessment of potential effects on Elbow River resident fish from dewatering of the reservoir used work done by Newcombe and Jensen (1996), who studied and reported on the effects of suspended sediment exposure on fish health. Newcombe and Jensen (1996) evaluated how the relationship between the exposure concentration and duration of exposure affected the SEV of ill effects to fish. This work was used to develop an SEV index score rating to evaluate the predicted level of effect to fish from a level of exposure to suspended sediments and the duration of the exposure. The SEV index scale is provided in Table 32-1.

Table 32-1 Severity of Ill Effects (SEV) Scale Used to Assess the Level of Effects on Fish Exposed to Suspended Sediments

SEV[1] Score	Description of Effect
Nil Effect	
0	No behavioral effects
Behavioral Effects	
1	Alarm reaction
2	Abandonment of cover
3	Avoidance response
Sublethal Effects	
4	Short term reduction in feeding rates; short term reduction in feeding success
5	Minor physiological stress; increase in rate of coughing; increased respiration rate
6	Moderate physiological stress
7	Moderate habitat degradation; impaired homing
8	Indications of major physiological stress; long-term reduction in feeding rate; long term reduction in feeding success; poor condition
Lethal and Para-lethal Effects	
9	Reduced growth rate; delayed hatching; reduced fish density
10	0-20% mortality; increased predation; moderate to severe habitat degradation
11	>20-40% mortality
12	>40-60% mortality
13	>60-80% mortality
14	>80-100% mortality

NOTE:
[1] SEV: Severity of Ill Effects; this is the level of effect to fish associated varying levels of exposure to TSS (Newcombe and Jensen 1996)

SEV scores were calculated for the off-stream reservoir using the predicted median TSS concentration (i.e., exposure) and number of days of increased turbidity due to reservoir release (i.e., duration). The results are presented in Table 32-2, which lists the peak and median suspended sediment concentrations predicted in the off-stream reservoir during each flood (TSS modelling results provided in the responses to AEP Question 63, Question 65, and Question 67). In all cases, suspended sediment concentrations are predicted to decrease over the duration fish are exposed. Therefore, the median TSS concentration is less

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biased than the peak concentration and is applied to the SEV index scores. SEV index scores are provided for early and late release suspended sediment model results for each of the three floods.

The predicted SEV index scores for fish in the reservoir are generally in the "sub-lethal effects" category for the 1:10 year flood and in the "lethal and para-lethal effects" category for the 1:100 year and design floods. SEV index scores are different for different life stages of fish as follows:

- Eggs and larvae for salmonid and non-salmonid fish is the group with the highest SEV index scores. However, during an extreme flood in Elbow River, mortality of fish eggs and larvae would be naturally higher than during a more typical flood due to increased bottom scour and increased TSS concentrations. The effects of elevated suspended sediments in the reservoir are, therefore, not expected to harm eggs and larvae above the mortality rate that would occur in the river during a flood without the Project. In other words, Elbow River flows equal to or greater than 1:10 year flood (with or without the Project) will result in the loss of most young-of-year fish and, therefore, few if any will be entrained in the reservoir and experience the effects of elevated suspended sediments in the reservoir.
- Juvenile and adult salmonids are predicted to have SEV index scores indicating sub-lethal effects during the 1:10 year flood for both early release and late release. Non-salmonids are predicted to have SEV index scores indicating lethal and para-lethal effects on fish.
- All fish groups are predicted to experience lethal and para-lethal effects during the 1:100 year flood and design flood. Based on these SEV index scores, the portion of the Elbow River fish community entrained in the off-stream reservoir during a 1:100 year or design flood may experience a high mortality rate (see the response to NRCB Question 24 for SEV index scores in the river during a flood with and without the Project).

  The results of the SEV index score are specific to the concentration and duration of suspended sediment exposure and represent a single line of evidence. The SEV index scores do not account for the synergistic effects to fish associated with changes in water temperature and DO. Late-season water temperatures and DO levels may interact with low suspended sediment levels in a manner that results in greater effects to fish than cool water and high DO levels earlier in the season when suspended sediments are elevated.

Table 32-2 Predicted SEV Index Scores Calculated for the Off-stream Reservoir

Life Stage, Flood and Release Condition	Peak TSS[1] mg/L	Med TSS[2] mg/L	Duration[3] days	SEV[4]
Early Release				
1:10 year flood	625	481	2.0	
Log_e transformation[5]	--	6.18	3.87	
• Juvenile Salmonids				8
• Eggs and Larvae[6]				10
• Adult Salmonids				8
• Non Salmonids[7]				9
1:100 year flood	10,357	3,746	25.3	
Log_e transformation[5]	--	8.23	6.41	
• Juvenile Salmonids				11
• Eggs and Larvae[6]				13
• Adult Salmonids				11
• Non Salmonids[7]				11
Design flood	22,513	4,740	39.2	
Log_e transformation[5]	--	8.46	6.85	
• Juvenile Salmonids				12
• Eggs and Larvae[6]				14
• Adult Salmonids				11
• Non Salmonids[7]				11
Late Release				
1:10 year flood	532	43	44.4	
Log_e transformation[5]	--	3.76	6.97	
• Juvenile Salmonids				8
• Eggs and Larvae[6]				13
• Adult Salmonids				8
• Non Salmonids[7]				10
1:100 year flood	10,335	1,121	92.3	
Log_e transformation[5]	--	7.02	7.70	
• Juvenile Salmonids				11
• Eggs and Larvae[6]				>14
• Adult Salmonids				11
• Non Salmonids[7]				12

Table 32-2 Predicted SEV Index Scores Calculated for the Off-stream Reservoir

Life Stage, Flood and Release Condition	Peak TSS[1] mg/L	Med TSS[2] mg/L	Duration[3] days	SEV[4]
Design flood	22,513	4,423	61.5	
Log$_e$ transformation[5]	--	8.40	7.30	
• Juvenile Salmonids				11
• Eggs and Larvae[6]				14
• Adult Salmonids				11
• Non Salmonids[7]				11

NOTES:
-- empty table cell
[1] Peak TSS: Peak total suspended sediment concentration fish are exposed to either in the reservoir or in Elbow River during water release
[2] Med TSS: Median total suspended sediment concentration fish are exposed to either in the reservoir or in Elbow River; used to calculate severity of effect score
[3] Duration: Time frame in days fish are exposed to suspended sediments either in the reservoir or in Elbow River
[4] SEV: Severity of effect to fish from exposure to total suspended sediment concentrations
[5] Log$_e$ transformation: Median TSS and duration (in hours) are transformed using log$_e$ to calculate the SEV index
[6] Eggs and Larvae: For both salmonid and non-salmonid species
[7] Non Salmonids: Considers adult life stages

References

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Question 33

Supplemental Information Request 1, Question 353, Page 5.257

Alberta Transportation states that *conditions and engineering criteria for fish passage are well understood and are incorporated into the service spillway structure design* and that *thresholds for water level, as indicated by the pressure transducer, will indicate when volumes of water over the diversion gates and v-weirs are inadequate for fish passage and gate operations are required.*

a. Justify and explain how a good understanding of conditions and engineering criteria for fish passage will ensure, with certainty, upstream and downstream fish passage of all Elbow River fish species at all life stages under all flow conditions.

b. Describe if a monitoring program that quantifies actual fish passage is proposed. If no monitoring program that quantifies actual fish passage is proposed then explain why not.

Response

a. As stated in Alberta Transportation's response to Round 1 AEP IR353, conditions and engineering criteria for fish passage are well understood. However, a good understanding of conditions and engineering criteria for fish passage will not ensure fish passage; fish passage conditions will be evaluated through monitoring. An expanded dataset for fish swimming performance calculations is presented in response to NRCB Question 21. This expanded dataset discusses fish passage capabilities for all resident fish species and life stages, at flows that correspond to different seasons. Also discussed are hydraulic conditions (i.e., high and low water depths and flow velocities) in Elbow River through the service spillway, stilling basin and fish passage v-weirs, and resident fish passage capabilities (i.e., fish passage criteria). The assessment for fish passage demonstrates that fish passage is maintained for all species and sizes for of floods where passage is possible under existing (i.e., without the Project) conditions. The proposed works also improve passage for select species under selected flow conditions, where passage could not be achieved under existing conditions. The fish passage mitigation structures, therefore, improve the hydraulic conditions for fish passage through the Project reach compared to existing conditions.

b. A monitoring program that includes quantifying actual fish passage (e.g., tag and recapture, telemetry study) is not proposed. Instead, conditions for fish passage (i.e., depth, velocity, connectivity through the service spillway and v-weirs) will be monitored following construction of the Project to evaluate and confirm that fish passage criteria have been met. A monitoring plan will be finalized for review and approval by DFO as part of the *Fisheries Act* authorization. The following monitoring commitments will be proposed in the Fish Passage Monitoring Plan for approval through the *Fisheries Act* authorization and are subject to change based on the outcome of consultation with DFO:

METHODS

- Fish passage monitoring will include a combination of water depth, velocity and flow measurements to evaluate the physical conditions of Elbow River and compare these conditions to the expected swim performance data (Katapodis and Gervais 2016), which was used as the basis of the fish passage design.
- Velocities will be measured using an acoustic doppler current profiler (ADCP) and depth will be measured by manual transects.
- The use of sonar technology and underwater cameras may be employed at the structures to observe movement and behaviour of individual fish as they encounter and pass the v-weirs and spillway.
- Conditions for background fish movement and passage through different shallow channel units will be assessed at reference sites approximately 1 km upstream of the Project.
- Water depth, velocity and flow will be measured at the reference sites at the same time as conditions through the spillway and v-weirs for comparison.

The monitoring program will aim to target all fish species that encounter the weir. Underwater camera imagery and sonar technology will provide a non-invasive approach to evaluating passage for resident fish and their life stages; however, species identification may be limited to visual constraints associated with using the equipment. Water depth, velocity and flow data will confirm that physical conditions required for passage are being met (i.e., suitable for species-specific fish swimming performance data).

TIMING AND FREQUENCY

- Field-based passage monitoring efforts are required for Years 1 and 2 post-construction to provide opportunity to adjust fish passage structures, if necessary.

- Monitoring efforts (i.e., water depth and velocity measurements, deployment of sonar devices and underwater cameras) will be conducted for Year 1 and Year 2 post-construction during the following BSPs:
  - BSP-1 from April 2 to June 15 (bull trout: incubation, fry, juvenile, adult, spawning; brown trout: fry, juvenile, adult; rainbow trout: incubation, fry, juvenile, adult, migration, spawning; mountain whitefish: fry, juvenile, adult)
  - BSP-2 from June 16 to September 25 (bull trout: migration, spawning, incubation, juvenile, adult; brown trout: fry, juvenile, adult; rainbow trout: incubation, fry, juvenile, adult; mountain whitefish: fry, juvenile, adult)
  - BSP-3 from September 26 to December 1 (bull trout: incubation, adult, spawning; brown trout: incubation, fry, juvenile, adult, migration, spawning; rainbow trout: fry, juvenile, adult; mountain whitefish: incubation, fry, juvenile, adult, spawning)
- Baseline field-based hydrology (i.e., water depth, velocity and flow) for different shallow channel units will be collected at the diversion structure location prior to construction during the BSPs.

ANALYSIS AND INTERPRETATION

- Field measurements for velocity and depth at each BSP will be plotted for the Project area and the reference location for a given flow. The data will be mapped such that a visual interpretation is available to identify potential swim paths or areas that may pose a challenge for fish passage.
- Velocity data and potential swim paths will be reviewed and compared to the Fish Swimming Performance Database (Katapodis and Gervais 2016). If newly published swim performance data are available at the time of the monitoring program, additional data sources will be considered, and they may supersede the Katapodis and Gervais data.
- The magnitude of velocity, depth, and distance will be considered for different surrogate species groups (i.e., pike, salmon and walleye, eel groups) referenced by Katapodis and Gervais (2016) to provide insight into fish passage conditions of fish species known to occur in Elbow River near the Project. The size classes are 25 mm, 250 mm, 1,000 mm.
- Potential swim paths and corresponding fish passage conditions at the Project location will be compared with swim paths and fish passage conditions at the reference location to investigate whether the conditions presented within the localized area of the v-weirs and service spillway align with conditions in Elbow River, without the Project (baseline), for a given BSP and flow. Velocities and fish passage conditions will be compared to baseline conditions if flows are comparable at the time that the seasonal measurements were obtained.
- Sonar data and underwater camera recordings will be reviewed, and incidental recordings will supplement an evaluation of fish passage conditions.

References

Katapodis and Gervais. 2016. Fish Swimming Performance Database and Analyses. DFO Can. Sci. Advis. Sec. Res. Doc. 2016/002 vi+550 p.

Question 34

Supplemental Information Request 1, Question 357, Pages 5.279 to 5.280

Alberta Transportation states that *bull trout are not expected to spawn in the portion of the Elbow River that is in the PDA or downstream of the of the PDA; however, they may migrate upstream through the PDA to upstream spawning locations and downstream after spawning, but this is not confirmed* [Page 5.279] and that *[m]uch of Elbow River, from the Elbow River falls to Glenmore reservoir, could be used for migration during various life history stages*.

a. **Map and describe fish habitat areas (i.e., physical locations, including ecologically important areas) used by bull trout populations in the Elbow River. Include spawning, nursery, rearing, food supply and migration areas, on which the bull trout population depends.**

b. **Summarize data gaps in bull trout fish habitat information (including spawning, nursery, rearing, and food supply), migration areas and the presence of known ecologically important areas. Evaluate how these data gaps influence the effects assessment.**

c. **Map and describe existing fish habitat areas including mountain whitefish. Include ecologically important areas, used by each of the fish species populations identified in Response 357b. Include spawning, nursery, rearing, food supply and migration areas, on which each population depends directly or indirectly in order to carry out their life processes.**

d. **Summarize data gaps in fish habitat information used by each fish species population identified in Response 357b including spawning, nursery, rearing, food supply and migration areas, and evaluate how these data gaps influence the effects assessment.**

Response

a. Bull trout habitat associated with the main stem of Elbow River between the Tsuut'ina Nation Reserve boundaries of Redwood Meadows and Discovery Ridge was mapped in the fall of 2019 (see the response to AEP Question 69, Appendix 69-1). HSIs were developed for the following four bull trout life stages: adult, juvenile, fry (considers nursery and rearing requirements), and spawning. HSIs were applied to the 2019 habitat dataset to determine the suitability of each mapped habitat feature for a specific life stage (Appendix 69-1, Attachment F). HSI is a numerical index that describes the suitability of habitat (from 0 to 1, with 0 representing least suitable habitat and 1 representing most suitable habitat) to support a selected species or species life stage. Each HSI index was derived based on suitability criteria for habitat variables that are important to a specific life stage (e.g., depth, velocity, substrate composition). Mapped habitat features with higher HSI values are areas with higher ecological importance.

For each life stage, a habitat map displaying calculated HSI values is provided in the response to AEP Question 69, Appendix 69-1, Section 3.3. The maps illustrate the relative importance of each habitat feature to a specific life stage. Total surface area for each HSI value of bull trout adult, juvenile, fry, and spawning life stages is also provided in Appendix 69-1. With the exception of flood-formed channels that are disconnected at the upstream extent, all other mapped channels may provide important migratory routes for bull trout, depending on the time of year and condition of the channel (i.e., active vs. inactive flows).

b. Data gaps from the baseline information presented in the EIA, Volume 4, Appendix M with respect to mapping and describing bull trout habitat have been addressed through the additional information provided in habitat mapping and HSI values that are presented in Appendix 69-1, Attachment F, which includes a spatial presentation of ecologically important areas for bull trout in Elbow River.

   The most relevant bull trout suitability criteria (Addley et al. 2003) has been incorporated into HSIs for each life stage. The sources of information that were used to develop habitat suitability criteria do not have data gaps that would limit generating bull trout HSI calculations; however, the quality of some bull trout spawning areas may be overestimated (i.e., more conservative in nature) due to the following data gaps:

   - Groundwater upwelling is commonly associated with spawning habitat selection in bull trout (Baxter and McPhail 1999; Roberge et al. 2002; Baxter and Hauer 2000; Ripley et al. 2005); however, groundwater data was not used as a habitat suitability criterion for bull trout. Groundwater data over an extended distance (such as between Elbow Falls and Glenmore Reservoir) would require infrared flyovers. In the absence of groundwater data, a conservative approach to spawning habitat was considered in developing the bull trout HSI (see the response to AEP Question 69, Appendix 69-2 and Appendix 69-3).
   - Spawning suitability surveys in Elbow River were completed in November 2019 and, therefore, the bull trout spawning period was not targeted. Habitat potential is likely overestimated as a result of an absence of visual observations of bull trout redds or fish inventories.

   HSI values are not derived for the extent of the upper Elbow River (between Gooseberry Campground and Elbow Falls).

c. HSI is calculated for mountain whitefish, brown trout, and rainbow trout and for the life stages adult, juvenile, fry (includes nursery and rearing requirements), and spawning life stages, consistent with previously developed suitability criteria for each species (Addley et al. 2003; Fernet et al. 1990; EMA 1994). Mapped habitat information is used to determine the species and life-stage specific suitability value of each mapped habitat feature. Whitefish habitat maps are provided in Appendix 69-1, Attachment G; brown trout in Appendix 69-1, Attachment E; and rainbow trout in Appendix 69-1, Attachment H. Total surface area for each HSI value of mountain whitefish adult, juvenile, fry, and spawning life stages is provided in Appendix 69-1, Section 3.3.

Food supply was not characterized or quantified by the 2019 habitat assessments because it was not considered necessary information for the development of HSI indices. Except for flood-formed channels that were disconnected at the upstream extent, all other mapped channels may provide important migratory routes for mountain whitefish, brown trout, and rainbow trout, depending on the time of year and condition of the channel (i.e., active versus inactive flows).

d. The sources of information that were used to develop habitat suitability criteria for mountain whitefish, brown trout, and rainbow trout do not have data gaps that would limit generating HSI calculations. However, Project-specific habitat mapping was limited to the boundaries of Tsuut'ina Nation Reserve boundaries of Redwood Meadows and Discovery Ridge; additional habitat mapping efforts are planned for summer 2020, which may lead to slight adjustments in the total surface area for each HSI value.

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Question 35

Supplemental Information Request 1, Question 415, Page 6.134

Alberta Transportation states the *Enforcement Occurrence Record (ENFOR) data were not used in this assessment because the majority of records do not provide spatial locations of animal occurrences and can only be extracted using broad geographic areas (e.g., wildlife management units (WMU)), which extend beyond the wildlife LAA and wildlife RAA* and that *with the potential for there to be managed access to the PDA, human-grizzly bear conflict and conflicts with other wildlife species could increase; however, the frequency of grizzly bear use is expected to be low based on the information presented in Volume 3A, Section 11.2.2.2, page 11.28, which indicates the wildlife LAA provides relatively low suitability habitat. In addition to the mitigation commitments in Volume 3B, Section 11, Alberta Transportation (and AEP for operations) will implement beneficial management practices designed to reduce potential increase in human-wildlife conflict (e.g., signage, safety, education).*

a. **Describe how discrepancies between AEPs and Alberta Transportations information on grizzly bear use of the project area changes conclusions on impacts to grizzly bears (e.g., human-bear conflict, mortality, etc.).**

b. **Detail a plan to proactively reduce human-bear interactions and how these will be minimized and monitored.**

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a. During a call on December 19, 2019 with AEP and NRCB, the NRCB expressed an interest in what data sources were used for the assessment. The wildlife assessment included a brief discussion of grizzly bear movement based on a small sample of telemetry information provided by AEP, but it did not provide a detailed assessment of grizzly bear movement in the LAA. Alberta Transportation received personal communication on February 6, 2020 from AEP indicating that the data sources used in the assessment were appropriate (Jurijew 2020, pers. comm). Based on this clarification, Alberta Transportation understands that there is no discrepancy between AEP and Alberta Transportation's information on grizzly bear use of the Project area.

As part of the literature review and field surveys undertaken for the preparation of the grizzly bear assessment, it was confirmed that grizzly bears have used both the LAA and RAA. Specifically, potential effects of the Project on grizzly bear habitat, movement and mortality risk were based on the following available sources of information:

- scientific literature (see the EIA, Volume 4, Appendix H, Section 11A.2.5) and other literature cited in Volume 3A, Section 11
- Draft Alberta Grizzly Bear Recovery Plan (AEP 2016)
- Alberta Fisheries and Wildlife Management Information System (FWMIS)
- Alberta Wildlife Sensitivity Data (grizzly bear core and secondary recovery zones)
- Eastern Slopes Grizzly Bear Project (Herrero 2005)
- Wildlife Habitat Assessment Jumpingpound Pipeline Region (Collister and Kansas 1997)
- Highway 22:14 and 22:16 Highway Twinning and Interchange Reconfiguration Environmental Overview Assessment (EBA 2010)
- Bear Hazard Assessment Update for the Greater Bragg Creek Area of Southern Alberta (Jorgenson 2016)
- Stoney Nakoda Nations Cultural Assessment for enhancing grizzly bear management programs through the inclusion of cultural monitoring and traditional ecological knowledge (Stoney Consultation Team 2016)
- grizzly bear telemetry data provided by AEP (Paczkowski 2016 and Stenhouse 2016 pers. comm), which is discussed in Volume 3A Section 11.2.2.5 (Wildlife Observations)
- remote camera survey results (see Volume 4, Appendix H, Section 3.6)

Alberta Transportation's response to Round 1 AEP IR415 suggested that historical sightings and occurrences in the Enforcement Occurrence Records (ENFOR) database indicate grizzly bear use is known to be greater than reported wildlife assessment in the EIA. However, the ENFOR database provided to Alberta Transportation by AEP did not include bear-human conflicts other than animal-vehicle collisions. AEP has since confirmed that no additional bear-human conflict information is available in the ENFOR database for the Project area (Jurijew 2020, pers. comm).

Given that the ENFOR database did not include additional data on bear-human conflicts, the data sources listed above are appropriate to inform the change in mortality risk associated with the Project.

b. Mitigation to reduce potential human-bear interactions during construction and dry operation is described in Volume 3A, Section 11.4.4.2 as well as in the draft Wildlife Mitigation and Monitoring Plan (WMMP) (see Alberta Transportation's response to Round 1 AEP IR425, Appendix IR425-1) including:

- Waste will be stored in wildlife-proof containers and wildlife awareness training will be provided to staff on site to reduce human-wildlife conflict (e.g., bears, see Jorgenson 2016).
- Personnel will not be permitted to have dogs at the construction site. Firearms are not permitted in project vehicles or on the construction footprint, or at associated project facilities. Incidents with wildlife will be reported to an Alberta Transportation representative.
- Sightings of species of interest will be reported to the environmental inspector(s) or designate. Protection measures might be implemented, and the sighting will be recorded.
- If previously unidentified listed or sensitive wildlife species or their site-specific habitat (e.g., dens, nests) are identified during construction, then the occurrence will be reported to the environmental inspector(s) or designate.
- Unanticipated wildlife issues encountered during construction will be discussed and resolved by the environmental inspector(s) or designate, wildlife resource specialist(s), and the responsible regulatory agencies, if necessary.
- Unauthorized vehicles will be prevented from access from public roads by using gates.

For further clarification, if a bear-human interaction occurs, the incident would be reported to the Environmental Inspector and AEP (Fish and Wildlife).

The mitigation proposed to reduce potential Project effects on grizzly bears aligns with best management practices designed to reduce mortality risk to grizzly bears (e.g., Alberta Bear Smart Program) (GOA 2011), including the overriding objective to reduce attractants within the Grizzly Bear Recovery Support Zone (AEP 2016). Further details related to mitigation to reduce human-bear conflict will be provided in the final WMMP, which will be prepared in consultation with provincial and federal regulators as well Indigenous groups.

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Question 36

**Supplemental Information Request 1, Question 425, Page 6.147
Supplemental Information Request 1, Appendix IR425-1, Pages 1.1 to 9.2**

Alberta Transportation states a *draft wildlife mitigation and monitoring plan…in Appendix IR425-1. The final plan will be developed following Project approval and based on provincial and federal approval conditions.*

a. **Provide details on what would be included within biodiversity monitoring plans for birds and amphibians in the monitoring program (which may consider the use of bioacoustics).**

b. **Describe specifics on how comparisons and assessments were completed for bird and amphibian species richness between baseline, construction and dry operation, flood and post-flood operations, and how these will be incorporated into the mitigation and monitoring plan.**

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a. During a call on December 19, 2019 with AEP and NRCB, AEP clarified that this question is referring to the WMMP. Alberta Transportation also clarified that mitigation for birds and amphibians will be included in the WMMP. On-site monitoring for birds and amphibians during construction will be implemented where required; for example, for active raptor nests in the area and for amphibians that would need to be moved out of harm's way if they occurred within the fenced construction footprint.

b. Migratory birds and amphibians (e.g., northern leopard frog) are assessed for all Project phases relative to existing conditions (see the EIA, Volume 3A, Section 11.4 and Volume 3B, Section 11.3). Estimates of bird species richness are provided in Volume 4, Appendix H, Table 3-1 and, for amphibians, in Volume 4, Appendix H, Section 3.2, Table 3-3 and Table 3-4. The wildlife assessment uses a habitat-based approach that quantifies how much bird or wetland habitat is affected during each Project phase and then relates that habitat type to the birds or amphibians known to use it based on habitat associations. Although the Project will result in the loss and alteration of bird and amphibian habitat, bird and amphibian species richness (i.e., the number of bird and amphibian species in the LAA) is not expected to change because there will be other suitable habitats available within the LAA and RAA. If any amphibian or bird species at risk are identified during pre-construction wildlife surveys, post-construction monitoring during dry operations will be considered as part of the final WMMP, which will be completed in discussions with regulators and in consultation with Indigenous groups.

   As stated in the response to a., bird and amphibian mitigation monitoring will be completed during construction, as described in the WMMP. In addition, a habitat-based assessment will be conducted during post-flood operations, which will include potential post-flood effects on amphibians and birds, as described in Section 7.2.1 of the draft WMMP (see Alberta Transportation's response to Round 1 AEP IR425, Appendix IR425-1). Specifically, the post-flood habitat assessment would be completed following complete release of water from the off-stream reservoir. The assessment will be completed at least twice: 1) immediately following the draining of the reservoir when it is safe to enter the reservoir and 2) an assessment completed the following spring. The assessment will evaluate the status of revegetation and change in habitat suitability for key wildlife indicators and species of management concern, with a focus on wetland-dependent species and ground-nesting birds.

Question 37

Supplemental Information Request 1, Question 428, Pages 6.153 to 6.155
Supplemental Information Request 1, Appendix IR425-1, Pages 1.1 to 9.2

Alberta Transportation states that *remote cameras are a common tool used to determine potential effects of human development on wildlife as well as to evaluate the effectiveness of mitigation measures (McCollister and van Manen 2010; Barrueto et al. 2014; Burton et al. 2015; Andis et al. 2017; Caravaggi et al. 2017). The purpose of the remote camera monitoring program (as part of the draft wildlife mitigation and monitoring plan; see Appendix IR425-1) is to verify predictions related to residual effects of the Project on wildlife movement in the wildlife LAA, particularly for ungulates such as deer and elk.*

a. **Describe how remote camera data could provide quantitative information on wildlife movement to support impact predictions.**

b. **Clarify how data from remote cameras will be used to test wildlife impact predictions (e.g., detail the relationship between camera trap detection and the ecological parameter of interest, such as habitat use and movement).**

c. **Demonstrate that baseline camera data is sufficient to detect changes in habitat use and movement in follow-up and monitoring programs.**

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a. The remote camera data will provide photographs of species occurrence (e.g., elk) and behavioural response at specific locations along the diversion channel. Behavioural responses will be classified as the following: approaches, successful crossings, and deflections (Simpson et al. 2016). The crossing success rate (%) will be calculated by dividing the number of successful crossings by the total number of approaches at each location along the diversion channel (Simpson et al. 2016; Sawyer et al. 2012). The same metric will be used as the performance measure to assess mitigation effectiveness for the Highway 22 bridge over the diversion channel and at select locations of wildlife-friendly fencing. Crossing success rate targets (% crossing) will be identified in the final WMMP.

   As discussed, Section 7.1.12 of the draft WMMP (see Alberta Transportation's response to Round 1 AEP IR425, Appendix IR425-1), limitations related to study design, including sample size (i.e., number of cameras), camera placement, timing, frequency and duration of the monitoring program will be identified following consultations with regulators and Indigenous groups and discussed in the final WMMP.

b. As discussed in Section 1.1 and 7.0 of the draft WMMP, the remote camera monitoring program will be designed to evaluate the effectiveness of proposed mitigation in reducing potential Project effects on wildlife movement, which is accounted for in the residual effect prediction for change in wildlife movement. The specific metrics used to assess wildlife movement in the LAA during construction and dry operations—discussed in the draft WMMP (see Section 7.1.14) and the response to Round 1 AEP IR428—will include a relative abundance index such as photographic rate (i.e., number of detections per 100 camera-days) and crossing success rate defined in a. of this response. The number of detections at each camera location during construction and dry operations will be compared to baseline detection rates for target species as a way to evaluate change in seasonal habitat use (e.g., along Elbow River, east and west of Highway 22, north of Township Road 244 and along Springbank Road).

c. Although the remote camera monitoring program will provide quantitative information related to mitigation effectiveness (i.e., crossing success at various Project component structures), the ability to detect changes in animal abundance in the LAA might be limited because of the short, four-season duration of the baseline remote camera survey that was completed for the Project and reported on in the EIA wildlife assessment. However, based on those results, which included 3,207 camera-days of survey effort captured over four seasons, some of the target wildlife species are relatively abundant in the LAA, such as white-tailed deer, mule deer and elk (see EIA, Volume 4, Appendix H, Section 3.6.1). Based on the 10 cameras deployed, estimates of detected occupancy rates (proportion of sites that recorded at least one photograph) across all seasons was 100%, 80% and 80% for white-tailed deer, mule deer and elk, respectively.

   Species that are relatively common and have moderate or high detectability compared to rare species typically require fewer cameras and shorter sampling periods (i.e., survey effort) to provide reliable estimates of animal occupancy (Shannon et al. 2014).

   The remote camera monitoring program, which will include deployment of additional cameras, will reliably detect focal wildlife species habitat use and activity for species known to be relatively abundant in the LAA (i.e., ungulates).

   Consultation with regulators and input from Indigenous groups regarding design of the remote camera monitoring program will provide the necessary information to identify limitations of the study design and effectively evaluate mitigation proposed to facilitate wildlife movement in the LAA.

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Question 38

**Supplemental Information Request 1, Question 447, Page 7.42
Volume 3A, Section 15.7, Page 15.65**

Alberta Transportation discusses the exposure ratio (ER) for short term exposures to $PM_{2.5}$ and diesel exhaust particulate (DEP). A discussion on chronic effects to the residential receptor (SR19) is not provided, which has an exposure ratio greater than 1.

a. **Discuss $PM_{2.5}$ (chronic) risk results for residential receptor SR19 in the conclusion section of the Public Health Report (Volume 3A, Section 15.7), or provide rational for its exclusion.**

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a. The calculated exposure ratio (ER) is greater than 1.0 for chronic exposures to $PM_{2.5}$ at sensitive receptor location 19 (SR19) during the 36-month construction phase; however, an ER greater than 1.0 does not necessarily indicate that adverse health effects are expected to occur, nor are the health risks considered unacceptable (GoA 2011). Rather, in these situations further considerations are needed to assess the nature and likelihood of potential adverse human health effects, such as spatial extent of exceedance, magnitude of exceedance, potential mitigation measures, and uncertainties in toxicity. When these factors are considered, the following is noted:

   - SR19 (the only sensitive receptor location with an exceedance of the chronic ER for $PM_{2.5}$) is located approximately 53 m from the boundary of the PDA and roadways (i.e., limited spatial extent relative to the human health risk assessment [HHRA] LAA).
   - The ER at SR19 for construction is 1.3, based on a predicted annual average concentration of $PM_{2.5}$ of 13 μg/m^3 and a chronic exposure limit of 10 μg/m^3.
   - The source of $PM_{2.5}$ at SR19 is primarily fugitive dust from soil. Fugitive dust emissions can be effectively mitigated using industry best practice mitigation measures, such as frequent road watering or application of dust suppressants. The construction schedule may also be adjusted to reduce the number of dust-generating vehicles operating in an area during dry periods with high wind conditions. Although standard dust suppression

measures were considered as part of the modelling, adaptive management will be used to adjust the types and intensity of mitigation. Real-time $PM_{2.5}$ monitors will be deployed in the areas of concern to indicate when these more intensive dust mitigation measures may be needed. The construction contractor, as per the Construction Works Master Specifications Environmental Section 01391 (see EIA, Volume 4, Supporting Documentation, Document 11), will implement an ambient air monitoring program during construction that will include continuous monitoring of $PM_{2.5}$. The use of real-time monitoring results to trigger more intensive dust mitigation measures is expected to maintain annual $PM_{2.5}$ concentrations below the exposure limit of 10 µg/m^3 at SR19.

- Epidemiological studies, which rely on ambient air monitoring systems to estimate population average exposure, provide evidence of both cardiovascular and respiratory health effects from chronic exposure to $PM_{2.5}$, although the risks for PM-related health effects are relatively small by traditional epidemiological standards (Health Canada 2013).
- Both Health Canada (2016) and the World Health Organization (WHO 2006) noted a number of studies that suggest particulate from inert crustal material (i.e., dust from soil) is less toxic than particulate associated with urban environments, upon which the chronic exposure limit is based. This suggests that the exposure limit of 10 µg/m^3 may be overly conservative (an overestimate) for exposure to $PM_{2.5}$ from fugitive dust, which is the primary source of $PM_{2.5}$ at SR19.

As noted in Volume 3A, Section 3.4.3.3, the air emissions associated with Project construction are typical for a construction site that involves surface disturbances and associated earth moving activities. The primary source of annual $PM_{2.5}$ concentrations is dust from soil. the spatial extent of concentrations that are greater than this exposure limit is minimal. Real-time $PM_{2.5}$ monitors will be used to identify the need for more intensive dust mitigation measures to prevent elevated exposures. As a result, the Project is not expected to result in an unacceptable chronic risk to human health. This supports the original conclusion in the conclusion section on Public Health (Volume 3A, Section 15) which states, in part, that the effects from air quality are not significant for the construction and dry operations phases.

REFERENCES

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Question 39

Response to CEAA IR, Package 3, Response IR3-32a, Page 130

Alberta Transportation provided quantitative risk estimates for hexavalent chromium and trivalent chromium to provide estimates of risk associated with anticipated airborne exposure during the construction phase.

a. Clarify whether life-time exposure or a three-year construction exposure were used in the above risk estimate.

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a. The chronic risk estimates are conservatively based (exposures are overestimated) on life-time exposure. The annual average concentrations are compared directly to the chronic toxicological reference value (TRV) (i.e., no amortization of exposures was used). This means that the health risk assessment assumes people will be exposed to hexavalent chromium emissions from construction for approximately 80 years, whereas the construction period is actually three years.

2 GENERAL

2.1 SOCIO-ECONOMIC

Question 40

Supplemental Information Request 1, Question 165, Page 3.57
Supplemental Information Request 1, Question 179, Page 3.75
Supplemental Information Request 1, Question 181, Page 3.79

In question 181 Alberta Transportation states *the types of measures that fail as the intensity of the flood increases include lower dykes (less that 1:50 year), flood outfall gates and temporary barriers*.

In question 165 Alberta Transportation states *AMEC (2014) recommended that assessments of SR1 and MC1 Option be progressed until such time that one becomes preferred*.

In question 179 Alberta Transportation states *RFDAM provides an estimate of flood damage for 12 return periods and allows for the computation of annual damage. It is predicated on myriad of qualified assumptions, and no uncertainty factor is applied to the values*.

a. Indicate if the following probabilities and their values were estimated: the probability of the structure failing

   i. to work at all;

   ii. to work partially;

   iii. in a controlled manner;

   iv. in an uncontrolled manner.

b. Indicate if these probabilities and values are factored into the cost benefit analysis and if so how they impacted the cost benefit analysis. If they were not factored into the cost benefit analysis, explain why they were excluded.

c. If the probabilities were deemed to be zero in the cost benefit analysis, provide the evidence and explain the procedures undertaken to assure the structure's design will work as intended. For example, reviews of similar weirs, assessments of contractors with expertise to construct these weirs, potential of conditions/events when the weir will not work properly, feasibility assurance mechanisms in the project's identification and design, and post-construction testing procedures that will assure the weir will work properly after it is constructed.

d. Identify events that will delay the successful construction and operationalizing of this non-conventional structure working and therefore delay of benefits in the cost benefit cash flow. Evaluate the probability and length of the delay. Estimate the impact on the cost benefit analysis.

e. The SIR response refers to the McLean Creek project in the cost benefit analysis. Assess whether the McLean Creek project might have similar probabilities of failure and/or delay in consideration of its more conventional dam and spillway design.

f. Provide an assessment of whether the factors (a) through (e) impact the relative merits of the Springbank Project in the cost benefit analysis.

Response

a. The probability of failure for the described events were not estimated for SR1 or the MC1 Option. The SR1 design follows a standards-based approach, as detailed in the Canadian Dam Association (CDA) Dam Safety Guidelines (2007), which utilizes specified loadings (earthquake/floods) with very low probabilities of occurrence (approximately 1 x 10^{-6} in a given year) and then provides factors of safety for stability and strength that further reduce the probability of failure under that loading. The CCDA Dam Safety Guidelines (2007) and Alberta Dam and Canal Safety Directive (Government of Alberta 2018) dictate design requirements and procedures to reduce failure probabilities to very low likelihood. Potential operations failures are addressed with redundancies, as described in the response to c.

b. Failure probabilities were not factored into the BCA. As indicated above in the response to a., failure probabilities were not explicitly estimated and, following the design standards, not expected to change the relative merits of the projects from a BCA perspective.

   The UK's "Multi-Coloured Manual" (Flood and Coastal Erosion Risk Management: A Manual for Economic Appraisal (Penning-Rowsell et al. 2013)) states that, for BCA:

   > "We suggest that uncertainty is only important if its resolution would make a difference to which option is chosen: that is, whether the preferred option is 'robust' to remaining uncertainty. Therefore, we recommend that appraisal should be an iterative process of progressively refining the estimate to the benefits and cost of the alternative options being considered. At each stage it is necessary to decide whether any reductions in the uncertainty concerning the estimates of the benefits of the option justify the costs of the work necessary to improve those estimates. In summary, project appraisal itself should be pursued only in so far as its benefits justify its costs. The effort expended on appraisal must be proportionate to the task in hand: we should not extravagantly pursue details that will not affect the decision that we are about to make: an appraisal and its techniques should themselves be the subject of some sort of analysis of costs and benefits."

Including failure probabilities in the BCA would not have affected the relative merits of either project and are, therefore, not included.

c. The failure probabilities are not deemed to be zero and failure risk (probability combined with consequences) was not included in the BCA.

   Industry design standards, including the CCDA Dam Safety Guidelines (2007) and Alberta Dam Safety and Canal Directive (Government of Alberta 2018), dictate design requirements and procedures to reduce failure probabilities to a very low likelihood, as described in response to part a.

   With regards to operations failures, factors of safety to cover uncertainty and redundant systems are provided. The capacity of the reservoir to retain water includes a 25% increase over the required capacity for mitigation of a 2013 flood to account for the potential for sediment and debris to reduce capacity of the reservoir. In addition, there are several other redundancies and factors of safety built into the design and its operation to reduce the risk of failure to operate, and these are discussed below.

   Operation of the Project requires opening of the diversion inlet gates to allow for flood flows to enter the diversion channel and reach the off-stream reservoir. The diversion inlet includes two 20 m by 4 m steel vertical lift gates operated by electrically operated wire rope hoists. The proposed gate systems and operating conditions are commonly applied for hydraulic structures in flood control, water supply and hydroelectric installations. For example, vertical lift gates with wire rope hoists are used for flow control at the spillway for the Oldman River Dam in southern Alberta. The following redundancies and operating procedures are provided:

   - multiple gates

     Two gates are provided in the design with independent hoists. Should one gate fail to open, the second gate could allow for diversion of partial flood flows.

   - remote and local operations

     Standard gate operation will occur through the control panel in the control building. If the control panel fails, local controls at the hoist can open and close the gates.

   - backup power

     The gate hoists and controls will be powered from the electric grid. Backup power will be provided by an onsite generator should the grid power fail.

   - testing and maintenance

     The gates will be commissioned and tested upon construction completion. In addition, they will be tested prior to flood season.

Control of flows into the diversion channel is achieved through operation of the service spillway gates. The service spillway includes two 24 m by 5 m pneumatically operated steel crest gates. The gates are raised through inflating an air bladder beneath a steel gate leaf. The gates control flow into the channel by lowering and raising the upstream water surface elevations. The proposed gate systems and operating conditions are commonly used in hydraulic structures for flood control, water supply, and hydroelectric installations. The following redundancies and operating procedures are provided:

- multiple gates

  In the event of bladder failure of one gate, the second gate could operate to raise water surface elevations and achieve diversion rates for a significant range of floods.

- backup power

  The bladders are inflated using an electrically-powered air compressor. Similar to the diversion inlet gates, should the primary power feed fail, the backup generator could supply power.

- backup air supply

  Should the air compressor fail, a portable compressor could be utilized to operate the gates.

- testing and maintenance

  The gates will be commissioned and tested upon construction completion. In addition, they will be tested prior to flood season.

d. Each of the Project components are conventional hydraulic structures and are commonly used in water control facilities in Alberta, throughout Canada and the United States. For example, the Paddle River Dam, in Alberta, provides an example of earth dam construction and low-level outlet works similar to the Project. The Portage Diversion, in Manitoba, provides an example of a large flood control diversion and canal system. The potential causes for construction delays that are common with construction of dams, canals and spillway structures include, but are not limited to:

- weather

  Higher than usual precipitation could lead to delays in placement of earth embankments. Extended periods of cold weather could limit time periods for placement of earth embankments and concrete structures. The proposed schedule accounts for the typical variation in lost time for weather. However, a low probability weather season (less than 5%) could delay construction up to a year.

- regulatory delays

  The impacts and probability are difficult to estimate but are comparable to typical development projects in Alberta.

- Elbow River flooding

  Construction of the diversion channel and off-stream dam would be unaffected by Elbow River flooding. For the diversion structure, a flood could result in damage to a partially complete structure and require reconstruction of some or all elements. Given the hydrology of Elbow River basin and the expected construction schedule for the Project, the flood risk at the diversion structure is likely limited to a two-month period per year. Construction of the service spillway, the element most vulnerable to flooding during construction, will likely occur over a single year's time starting in July and ending the following July. In the past, flood flows in excess of the anticipated temporary coffer dam protection level have only been observed in the months of May and June. Further, the service spillway structure represents less than 5% of the total Project costs, and reconstruction efforts could likely be implemented within the existing schedule timelines.

Delays would not significantly alter the benefit/cost ratio because costs and benefits are discounted at the same rate. The ratio is the benefits divided by the costs. Therefore, if both are delayed by the same amount of time, the ratio between them would be unchanged. However, the net present value would be reduced for any project if the benefits and costs were further in the future due to discounting. This is the intent of discounting: benefits today are worth more than benefits in the future.

e. The MC1 Option did not progress beyond the conceptual design stage and, therefore, the probabilities of failure are not evaluated. Failure analysis was not part of the BCA because both structures would need to be designed to the same federal and provincial standards for dam safety. Compared to SR1, the MC1 Option does have a higher risk of failure during construction because it is located within Elbow River; the duration during which the instream works are not complete spans several flood seasons and there would be greater consequences (compared to SR1) from a failure. MC1 Option project components are conventional so it can be assumed that construction delays would be similar to those listed for SR1 in d., with the exception of Elbow River flooding.

f. No, factors a. through e. above do not impact the relative merits of the Project in the BCA. The BCA is not intended to provide any insight on failure probabilities because no specific or unique failure probabilities were identified. The risks factors discussed above were considered in the site selection for SR1, as discussed in the response to NRCB Question 3.

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Question 41

Supplemental Information Request 1, Question 184, Page 3.84

Alberta Transportation states *Flood damage estimation and benefit/cost analysis methodologies associated with flood damage reduction studies are well-established in literature and have been recently formalized by virtue of the Government of Canada's publication: Canadian Guidelines and Database of Flood Vulnerability Functions, Public Safety Canada, March 2017, authored by IBI Group*.

a. Confirm that Public Safety Canada / Federal Government did not publish the document *Canadian Guidelines and Database for Flood Vulnerability and Database of Flood Vulnerability Functions (March 2017)*. Correct the SIR response to indicate that the publication has not yet been released.

b. Confirm that Natural Resources Canada is undertaking a review and edit of this document before its potential release.

Response

a-b. Yes, Public Safety Canada / Federal Government did not publish the document *Canadian Guidelines and Database for Flood Vulnerability and Database of Flood Vulnerability Functions (March 2017)*. IBI Group authored the draft document for Natural Resources Canada and Natural Resources Canada is still reviewing the referenced document before its potential release; it is not published at this time.

Question 42

Supplemental Information Request 1, Question 194, Pages 3.93 and 3.94

Alberta Transportation indicates that the costs associated with relocating the pipelines are covered by the project and included in the cost-benefit analysis. They also indicate that the companies will absorb the loss of income due to disruption in the pipeline flow during relocation.

Loss of income by the companies who own and operate the pipelines is technically a societal cost for the purpose of the cost-benefit analysis.

a. Calculate the loss of income imposed to the companies who own and/or operate the pipelines to be relocated. Add this loss of income to the costs in the cost-benefit analysis. How has the cost-benefit analysis changed? Explain.

Response

a. Discussions with pipeline operators indicate that efforts are made to minimize or eliminate the need for disruption in the pipeline flow during relocation to minimize or eliminate loss of income. Some pipeline operators indicated that the costs associated with minimizing or eliminating the disruption will be included in the agreement costs between the pipeline operator and the proponent, and agreement costs were included in the construction estimate and the BCA for the Project. Pipeline operators indicated that estimates of loss of income or actual loss of income values from past relocations are not made publicly available.

To further examine this topic, the following question was explored: what magnitude of additional cost (such as loss of income) would be required to change the BCA results? A review of the BCA scenarios indicates that an increase in construction costs would need to be over $40 million during the first year of construction to reduce the Project BCA ratio by 0.1. Although pipeline operators did not provide loss of income estimates, the discussions did not suggest loss of income due to pipelines affected by the Project would be in the millions of dollars range. As such, the addition of any potential pipeline owner/operator loss of income that is not already accounted for is not expected to impact the BCA.

Question 43

Supplemental Information Request 1, Question 196, Page 3.95

Alberta Transportation indicates that the costs associated with relocating utilities are covered by the project and included in the cost-benefit analysis. Alberta Transportation goes on to indicate that utility companies will absorb the loss of income due to disruption of infrastructure services.

Loss of income by the utility companies is technically a societal cost for the purpose of the cost-benefit analysis.

a. Calculate the loss of income imposed to utility companies whose infrastructure would have to be relocated. Add this loss of income to the costs in the cost-benefit analysis. How has the cost-benefit analysis changed?

Response

a. The utilities located near the Project include electricity, telephone and internet (EIA, Volume 1, Section 3.2.8). Discussions with utility companies operating near the Project indicate that loss of income could be related to service outages or loss of subscribers (if subscribers were to move away from the Project area).

   For service outages, the utility companies indicated that proven methods are available to relocate utilities with no loss of service, by only disconnecting the existing utility line once the new utility line is in place and ready to operate. Based on this, utility companies indicated service outages should not occur or will be minimal.

   For loss of subscribers, the utility companies generally assume that although an individual subscriber may move to a new location, they will still need their service and no loss of income is expected. Based on this, utility companies indicated loss of income because of loss of subscribers will be minimal.

   Similar to the discussion in AEP Question 42, a review of the BCA scenarios indicates that an increase in construction costs would need to be over $40 million during the first year of construction to reduce the Project BCA ratio by 0.1. Therefore, the loss of income by a potential utility company is not expected to impact the BCA.

Question 44

Supplemental Information Request 1, Question 197, Page 3.96
Supplemental Information Request 1, Appendix IR17-1, Table 17-25, Page 17.36

Alberta Transportation indicates that Table 17-25 in Appendix IR17-1 lists the Project costs that are estimated to be procured in the LAA, and that information is aggregated by major cost category, not by sub-components. The proponent also states *The cost of traffic accommodation (including traffic detours, land closures, etc.) is embodied in the information provided in Table 17-25, including the following cost items: "construction services" and "engineering services". The updated Table 17-25 is based on the current cost estimate ($312.2 million, exclusive of land cost)*.

a. The proponent did not clarify if these costs were included in the cost-benefit analysis. Clarify if the costs associated with traffic detours during construction, road realignments, and modifications were included in the cost-benefit analysis. If these costs were not included in the cost-benefit analysis explain why they were excluded.

b. The total costs included in Table 17-25 add up to $224 million, but the cost quoted by the proponent in their response is $312.2 million. Clarify what is the correct value of the current cost estimate. Correct the table or the response so that the correct value is indicated.

Response

a. The costs for traffic accommodation are included in the costs for the construction of the proposed roadway and bridge works and, therefore, are included in the BCA.

b. The correct value for the current capital cost estimate for the Project is $312.2 million, exclusive of land cost (see Alberta Transportation's response to Round 1 NRCB IR17 and the associated Appendix IR17-1 and Round 1 NRCB IR35, Appendix IR35-2). The cost is based on a Class B (+/- 15% accuracy) estimate of construction costs. Final Project costs will not be known until after land acquisition is complete, construction is tendered and complete, and regulatory conditions are known.

   The $224 million in Table 17-25 of Appendix IR17-1 is a subset of the $312.2 million, because Table 17-25 is the estimated breakdown of the Project's construction expenditures that will be incurred only within the LAA. The $224 million value for the LAA is calculated as follows:

   - The capital cost estimate for the Project is $312.2 million, exclusive of land costs.
   - The assessment of economic impact of the Project, addressed in Appendix IR17-1 (Assessment of Potential Effects on Employment and Economy) excludes contingency costs because such costs are not associated with identified expenditure on goods, services, or equipment but rather potential costs that have not been identified (i.e., they may or may not occur). This reduces the estimated construction costs by $32.2 million in contingencies to $280 million, as indicated in Table 17-14 and Table 17-15 of Appendix IR17-1.
   - It is estimated that 80% of construction expenditures will occur within the LAA, with the remaining 20% occurring elsewhere in Alberta. Therefore, the Project's construction expenditures in the LAA are estimated to be 80% of $280 million, or $224 million, as shown in Table 17-25 of Appendix IR17-1.

3 AIR

3.1 AIR QUALITY ASSESSMENT

Question 45

Supplemental Information Request 1, Question 209, Page 4.9

The following observations regarding the rationale that odours will not be generated are:

- **A comparison of the Springbank Reservoir to the Glenmore Reservoir is not reasonable given that the Glenmore Reservoir will have a constant inflow and outflow whereas the Springbank Reservoir will be stagnant for many weeks during the warmest time of the year.**
- **There is no guarantee that wind action will occur at sufficient velocity to stir the reservoir. If a wind action occurs late in the detention time there is the potential to destabilize stratification such that odours are released. There are several examples of this phenomenon in Alberta reservoirs (some are called lakes) as follows:**

  i. **Henderson Lake in Alberta;**
  ii. **Sunshine Lake in Okotoks;**
  iii. **Jesse Lake in Bonnyville; and**
  iv. **Bridlewood in Calgary.**

a. **Respond to the original question. What measures would be considered to mitigate air quality if anaerobic or anoxic conditions occurred?**

Response

a. A monitoring program will be conducted to inform operations and adaptively manage odours, if they occur, when the off-stream reservoir is in operation. The monitoring program will include collecting water samples for the duration that water is in the reservoir to assess nutrient concentrations (as described in response to NRCB Question 18) and oxygen levels. Water samples may be collected from the reservoir to test for algal growth (e.g., blue green algae and chlorophyll *a* if odours are detected).

   If odours are detected or public complaints regarding odours are received, odour surveys/inspections will be undertaken to investigate the sources causing the odours. The surveys will be done to determine what portion of the reservoir may be generating odours or identify odours that may be coming from other nearby sources.

Due to the volume of retained water in the reservoir, large-scale water treatment to eliminate odour is not feasible; instead, adaptive management options will be undertaken. If odours are identified, the source will be investigated and mitigation measures such as aeration may be applied. Aeration will increase oxygen levels to reduce anoxic conditions near the sediment–water interface and the subsequent release of odour-causing gases.

As water is released, and immediately afterward, the area will be inspected for ponded or pooled water in low-lying areas. Trenching or grading will be done to facilitate the drainage of these areas to mitigate the potential for standing water to stagnate and generate odours.

Although Alberta Transportation will be prepared to adaptively manage for odours, conditions in the reservoir are not predicted to generate odours, unlike the conditions found in the waterbodies mentioned in the question; the following describes their condition.

Henderson Lake

- approximately 25 ha with an average depth of 2.6 m (Phostock 2020)
- originally a slough and developed as a lake approximately 100 years old (Crowson 2012)
- receives water from St. Mary's irrigation system and local runoff from lawns, a golf course and parks (Phostock 2020)
- lake water is highly enriched with phosphorus from years of accumulating runoff contributing to the development of plant and algal growth that cause odours (Phostock 2020)
- due to the lake's age and productivity, substrates are likely highly organic

Sunshine Lake (this response reflects Sunshine Lake in High River and not in Okotoks)

- approximately 5 ha and shallow (depth undetermined) (Google Earth 2020)
- artificial lake in suburban environment developed in 1997 (University of Calgary 2003)
- functions as a stormwater retention pond and receives runoff from nearby neighborhoods (University of Calgary 2003)
- due to the lake's age and location, sediments are likely high in nutrients and organic matter contributing to the development of plant and algal growth that causes odours

Jessie Lake

- approximately 1,235 ha (Wikipedia 2016) with a maximum depth of 1.7 m (Henry 2019)
- Jessie Lake is a permanent kettle lake (i.e., no substantial outflow), supporting waterfowl and fish communities (Wikipedia 2016)
- receives runoff from nearby agricultural lands and adjacent suburban neighborhoods (MacEachern 2018; LICA 2019)

- highly enriched with phosphorus (Henry 2019; LICA 2019)
- due to the lake's location, area land use and waterfowl presence, lake sediments are likely highly enriched with nutrients and organic matter; this facilitates the development of plant and algal growth that contributes to odours

Bridlewood Creek Wetlands

- approximately 6 ha (City of Calgary 2018) and shallow
- functions as a stormwater management pond, designed to collect runoff from across the community (City of Calgary 2004)
- the Bridlewood community was developed in 1997 (City of Calgary 2018)
- receives stormwater from James McKevitt road (LaPlante et al. 2018) and runoff from adjacent neighborhoods
- due to the lake's connection with local wetlands and its receiving function for suburban runoff, this waterbody was designed to capture nutrients and organic matter that contribute to plant and algal growth, which results in odours

In all these cases, the waterbodies receive annual inputs of nutrients and organic matter. These contribute to the development of organic and anoxic sediments resulting in hydrogen sulphide generation or, with a high phosphorus load, facilitating algae growth and decay.

The off-stream reservoir will hold water for a short residence time (i.e., from two days to a maximum of 92 days[1]) with a low frequency of use. Therefore, organic matter deposition will be limited and mature waterbody sediments are not expected to develop. As discussed in Alberta Transportation's response to Round 1 AEP IR303, cyanobacteria growth (one of the main factors causing odours) is not anticipated to develop to levels causing odour effects during the short retention time in the off-stream reservoir. The off-stream reservoir will be not retain water permanently and is, therefore, not expected to have conditions that will cause odours (e.g., plant and algal growth and decay).

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[1] Hydrodynamic modelling was conducted to assess different operational drawdown option for the off-stream reservoir. This modelling differs slightly from what was done for either the EIA, Round 1 NRCB and AEP IRs or Round 1 Canadian Environmental Assessment Agency (CEAA) IRs in that the current modelling accounts for reservoir release rates and uses an updated outflow rating curve, which is based on revised engineering design. The ramping rates are applied to limit the risk of fish stranding on the descending limb of the outflow hydrograph. These updates resulted in a slightly longer drawdown duration for one of the floods. The longest drawdown duration of the six operational scenarios modelled (i.e., including reservoir filling, reservoir retention time and drawdown duration) is 92 days, compared to 84 days as stated in the EIA.

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Question 46

Supplemental Information Request 1, Question 210a, Page 4.11

Alberta Transportation states the current speed limit on Highway 22 is 80 km/hour which is incorrect. The current speed limit on the segment of Highway 22 (between the Highway 8 and Highway 1 intersections) is 100 km/hour.

a. Update the SIR response using the correct and current Highway 22 speed limit of 100 km/hour.

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a. The response to Round 1 AEP IR210a is revised below for the current Highway 22 speed limit of 100 km/h and the current 24-hour AAAQO for $PM_{2.5}$ of 29 µg/m³ (AEP 2019); revised text is in **red**. The change in assumed speed limit does not change the conclusion of the response.

Vehicles traveling through the project development area (PDA) on Highway 22 and Springbank Road will be in the PDA for only a few minutes and exposure of the passengers to particulate matter less than 2.5 micrometres in diameter is short term. In particular, the following describes the presence of the public in the PDA during construction:

- The current speed limit on Highway 22 is **100 km/h**, but this will be reduced to 60 km/h on a segment of Highway 22 along the bridge construction area for raising of Highway 22. Considering the segment of Highway 22 between the intersection with Highway 8 and the bridge construction area (approximately 4 km), the time a vehicle travels along this segment will be approximately **2.4 minutes** (4 km/**100 km**/h x 60 min/h) when travelling at **100 km/hr**. At a speed limit of 60 km/h along the bridge construction area on Highway 22 (approximately 3 km), the time a vehicle travels along this segment would be 3 minutes (3 km/60 km/h x 60 min/h). In total, the travel time along Highway 22 will be approximately **5.4 minutes.**
- The speed limit on Springbank Road is 80 km/h and, at this speed, the travel time through the PDA is about 4.5 minutes (6 km/80 km/h x 60 min/h).

The predicted maximum 1-hour $PM_{2.5}$, 24-hour $PM_{2.5}$ and total suspended particles (TSP) concentrations for the Application Case along the sections of Highway 22 and Springbank Road that intersect the PDA are presented in Table 46-1. The maximum predicted concentrations along the road sections are greater than the Alberta ambient air quality objectives (Alberta Ambient Air Quality Objectives [AAAQO]; [**AEP 2019**]) for 24-hour average $PM_{2.5}$ **(29 µg/m³)** and TSP (100 µg/m³), and greater than the Alberta ambient air quality guideline (Alberta Ambient Air Quality Guidelines [AAAQG]; [**AEP 2019**]) for 1-hour average $PM_{2.5}$ concentrations (80 µg/m³). Elevated total suspended particulate (TSP) and $PM_{2.5}$ concentrations will be addressed through ambient air monitoring and adaptive management.

Table 46-1 Maximum Predicted Concentrations along Sections of Highway 22 and Springbank Road that Intersect the PDA (Application Case), Revision to Round 1 AEP IR210, Table IR210-1

Substance	Averaging Period	Maximum Predicted Concentration (µg/m³)		AAAQO/G (µg/m³)
		Highway 22	Springbank Road	
TSP	24-hour	200 to 400	350 to 500	100
$PM_{2.5}$	1-hour	120 to 200	70 to 90	80
$PM_{2.5}$	24-hour	60 to 100	30 to 40	**29**

This ends the revision of the Round 1 AEP IR210 response.

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4 WATER

4.1 HYDROGEOLOGY

Question 47

Supplemental Information Request 1, Question 216, Page 5.8 – 5.9

Alberta Transportation states *a. Poroelastic response of an aquifer "loading effect" is generally limited to cases where the aquifer is fully confined over a wide area. By contrast, the groundwater regime in the RAA is characterized as an unconfined to semi-confined system, as is discussed in Section 3.2 of the Hydrogeology TDR Update (see the response to IR42, Appendix IR42-1). While some localized subsurface pressure response is expected near the Project components, regional scale poroelastic response within the bedrock aquifer is not expected to occur due to a lack of regional scale confinement.*

b. A regionally mappable clay layer does not exist underneath the fluvial deposits of the Elbow River. In general, the fluvial deposits of the Elbow River directly overlie bedrock.

c. Potential changes in groundwater levels are assessed by the numerical groundwater model, as described in the Hydrogeology TDR Update. However, changes in groundwater levels within the bedrock are not expected to be caused by poroelastic response because the bedrock is not regionally confined.

d-e. A draft groundwater monitoring plan for changes in groundwater levels is presented in the response to IR46, Appendix IR46-1. While poroelastic pressure response in the bedrock is not anticipated, monitoring of bedrock is included as part of the draft groundwater monitoring plan.

The most dangerous area of the potential loading effect is in the low topography area to the East and South-east of the off-stream dam. It is very likely the groundwater is under a confined condition due to its location in the relative low land area, especially when it is under the condition of a flood.

The potential loading effect is not related to the whole RAA with an area of approximately 43,050 ha. The groundwater as a whole maybe in the conditions of unconfined or semi-confined, but for the site specific issues, groundwater is very likely in the confined condition. Therefore, the potential loading effects to the East and South-East of the off-stream dam are valid.

From the East half of the off-stream reservoir to the East boundary of the RAA, the bedrock underneath is the Paskapoo formation (figure 3-4, Appendix IR42-1).In the western plains of Alberta the Paskapoo is characterized by buff-weathering, light grey to greenish thick bedded, calcareous quartz/chert sandstone, with interbedded light grey to greenish or brownish, soft, calcareous, sandy siltstone (Williams and Dyer, 1930; Allan and Sanderson, 1945; Glass, 1990). It

contains significant hydrogeological resources which are currently being exploited for agricultural, municipal and industrial uses.

The geological and hydrogeological characteristics of the Paskapoo formation support the potential groundwater pressure connection between the off-stream reservoir to the East and South-East of the off-stream dam through the loading effect when the reservoir is in use.

a. **Simulate the loading effect of the Springbank Off-Stream Reservoir on the confined aquifer to the East and South-East low topography areas of the off-stream dam.**

b. **Predict the potential artesian areas under the loading conditions in the area to the East and South-East of the low topography areas of the off-stream dam.**

c. **Assess the environmental impact of the loading effect.**

d. **Propose a monitoring plan for the loading effect and explain how this plan was derived.**

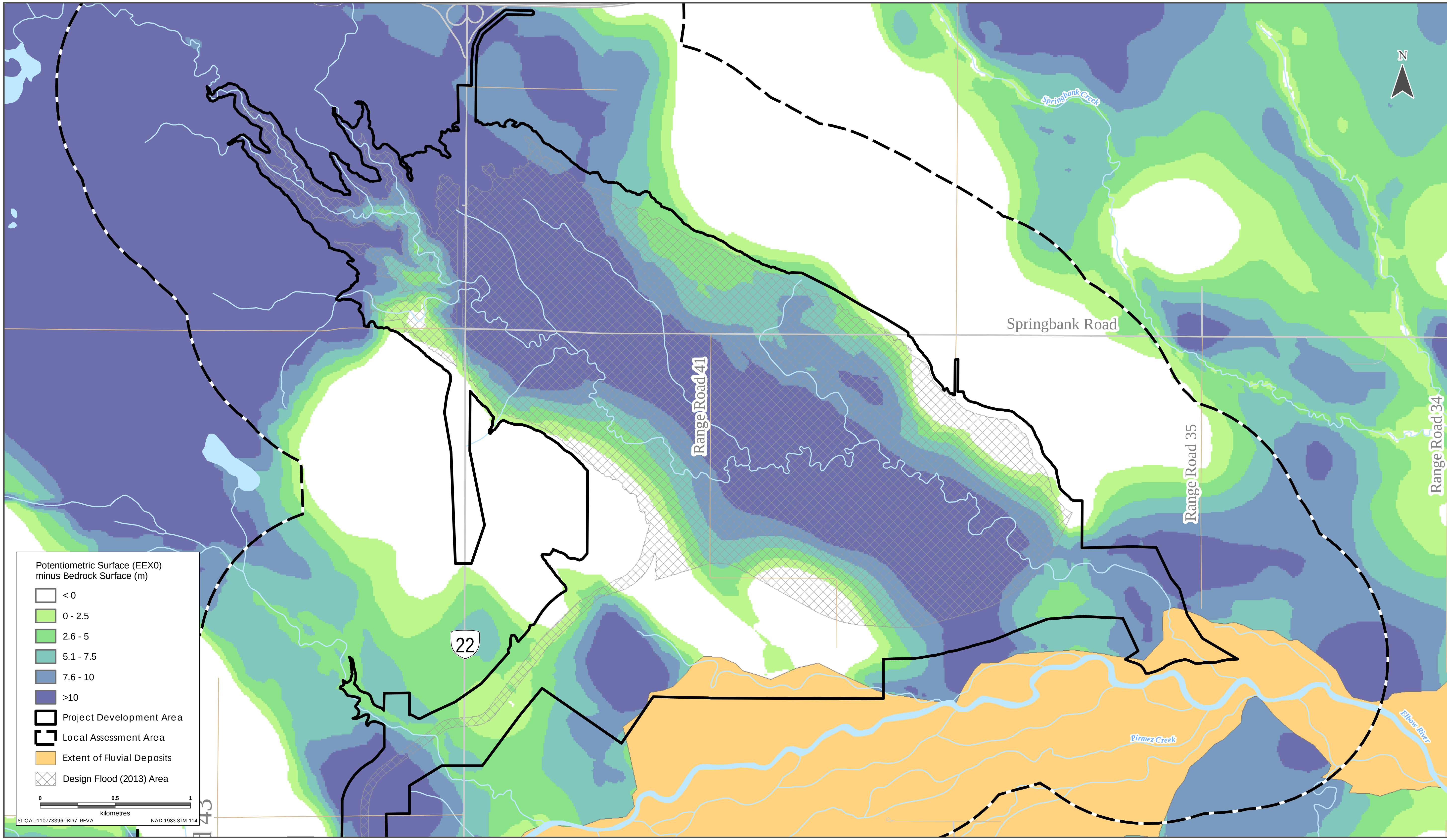
e. **Design a mitigation plan for the loading effect.**

f. **If Alberta Transportation decides not to do the analysis based on the same unconfined/semi-confined condition in the RAA, provide the contingency plan to deal with the potential groundwater "gush out" to the East and South-East of the off-stream dam should this occur.**

Response

a. Loading effects have been simulated using a conservative modelling approach (overestimates effects) whereby all the pressure head in the reservoir is transferred down to the bedrock unit as though there were 100% loading efficiency. In other words, the loading pressure was applied as a specified head boundary condition directly to the bedrock unit as if none of the incremental total stress is absorbed by the overlying unconsolidated deposits. With the incremental reservoir pressure applied directly to the bedrock unit, the model was run in steady state mode to simulate a worst-case scenario of the design flood water levels being held permanently within the reservoir (in fact, the water will be released in three months or less). The results of this simulation are presented below.

   Figure 47-1 presents the potentiometric surface (simulated result from the EEX0 (average flow conditions, without the Project) subtracted from the top of bedrock elevation. The figure indicates that the potentiometric surface is at a higher elevation than the top of bedrock (confined aquifer condition) beneath the majority of the off-stream reservoir area but is unconfined along the entire northeast and southwest sides of the reservoir.



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

Potentiometric Surface (EEX0) minus Bedrock Surface
showing Confined Bedrock Aquifer Areas

Figure 47-1

Elbow River fluvial deposits incise into bedrock within the river valley, and there is no lateral confinement in a southern direction. There is an area southeast and east of the dam near Range Road 35 that is under confined conditions as shown in Figure 47-1. A small increase in the area of confined conditions is expected during flood operations because the potentiometric surface is below the top of bedrock (unconfined aquifer condition) immediately to the northeast and southwest of the reservoir and will remain that way during flood operations.

The increase in pressure resulting from the conservative simulation of loading effects is presented in Figure 47-2, which presents the difference in hydraulic head in the bedrock aquifer when running the model in steady state mode with the boundary condition applied to the surficial deposits in layer 1 versus the boundary condition applied to the bedrock to simulate conservative loading. The results of this simulation indicate a modest increase in magnitude and extent of confined conditions to the south and east of the reservoir area. The increase in the confined aquifer area remains within the LAA and the increase in groundwater levels does not necessarily represent an adverse effect unless flowing artesian conditions occur.

Figure 47-3 presents the potentiometric surface of the conservative loading simulation subtracted from the topography digital elevation model (DEM). The figure shows areas of potential flowing artesian conditions (areas where potentiometric surface is above the ground surface) in the low-lying area to the south and east of the dam. Other areas of potential flowing artesian conditions away from the PDA are the result of natural hydrogeological processes and not a result of Project effects.

The limited propagation of loading effects is also supported by the results of local scale modelling using PLAXIS 2D software. While the intent of the PLAXIS model was to assess geomechanical response of the subsurface under additional stress from the dam itself for design, it does serve as a surrogate for further understanding the potential effects on groundwater levels due to the loading effect. The results of the geotechnical simulations are discussed below as well as in response to AEP Question 56.

The finite element model was developed to represent drainage effects, and load increment and timestep mechanics of the dam. The PLAXIS model considers loading in the unconsolidated clay and till in the dam foundation. The model does not consider the buildup of pressure in the bedrock aquifer based on the relatively low compressibility of the bedrock and the outlet for excess loading pressure (i.e., a drained condition). Unconfined areas of the aquifer—to the southwest and northeast of the reservoir and areas to the southeast where the bedrock subcrops and groundwater discharges to Elbow River—allow relief of potentially confined pressure due to loading. This understanding has been applied to the PLAXIS model and is consistent with the hydrogeological conceptual site model. This is because the additional mechanical loads due to the weight of the dam would be similar to the mechanical loads (weight) due to water in the reservoir.

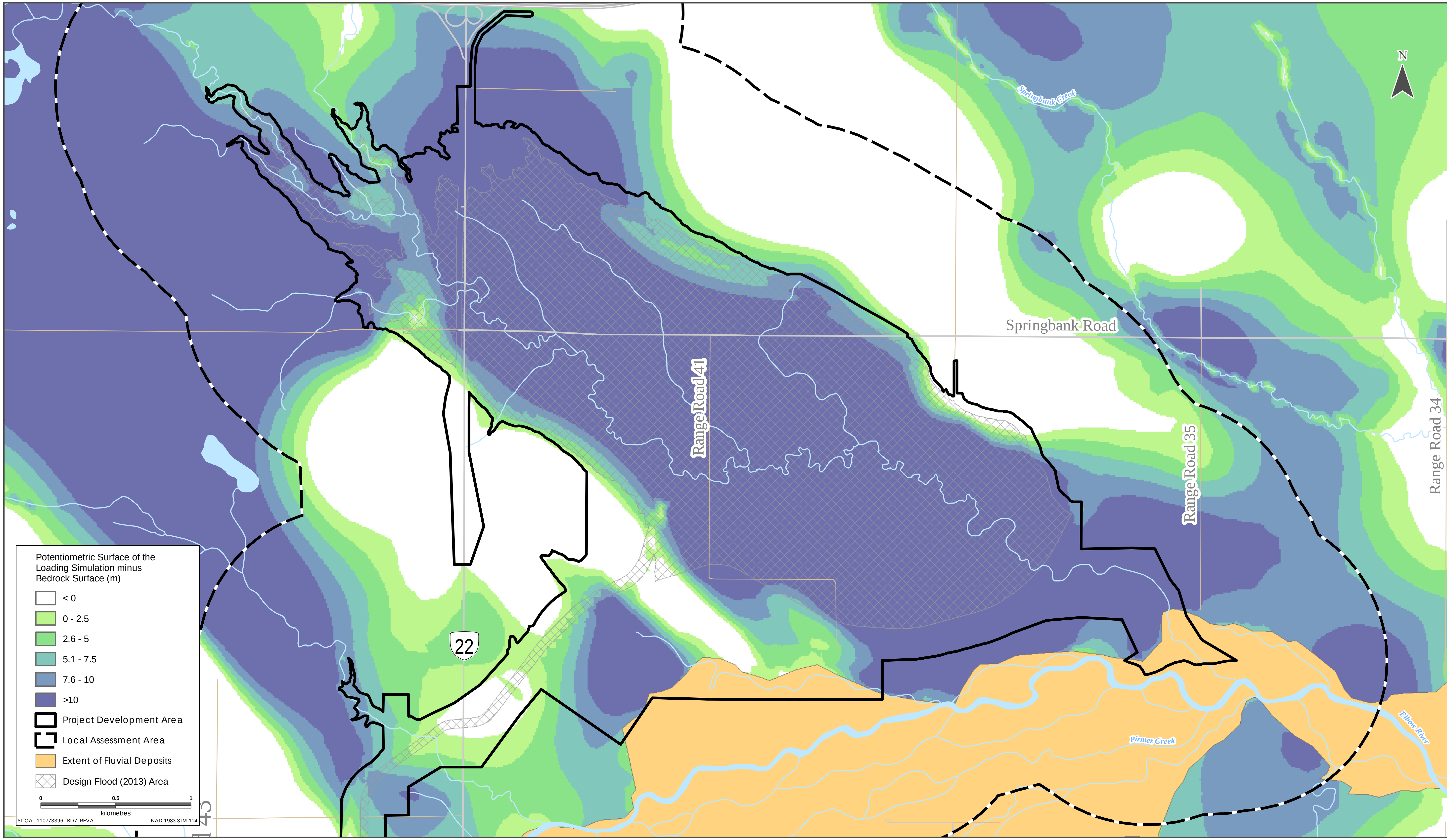
The model parameters to represent the stiffness and shear strength of the material were developed based on lab testing of each geological unit. Permeability parameters were also used to model pore pressure dissipation. Permeability values used were based on laboratory measurements, field tests and engineering experience with field performance.

The pore pressure dissipation rate is sensitive to the stiffness (modulus) assigned to the material. Because over consolidated clays demonstrate a change in stiffness as the loading changes, the soil moduli were varied to match the observed soil performance. This method better accounts for soil behavior over a range of stress, as compared to a single compression modulus. This refinement was applied for both the glaciolacustrine and till material in the foundation.

Results from 1-D consolidation tests were used to model the compressibility of the glaciolacustrine and till material under increasing load steps. The relevant soil compressibility parameters and associated laboratory test results were reviewed to provide representative inputs into the model. To account for variation in the compression moduli, the stresses were adjusted for each loading stage in the model. The underlying sandstone/shale bedrock was modelled with linear elastic model elements.

The PLAXIS model was set up to represent staged construction of the dam over three construction seasons. Each horizontal layer of the dam embankment represents a one-month time-step during the May to October construction season. A winter shut down follows each construction season with seven months separating seasons where pore pressures continue to dissipate. As additional lifts of embankment are constructed, the underlying soils experience increased load. The soil is compressed by this added load, and the fluid in the pores (voids) picks up a portion of that load. The loading effects on pore pressure are considered in both the unsaturated and saturated material.

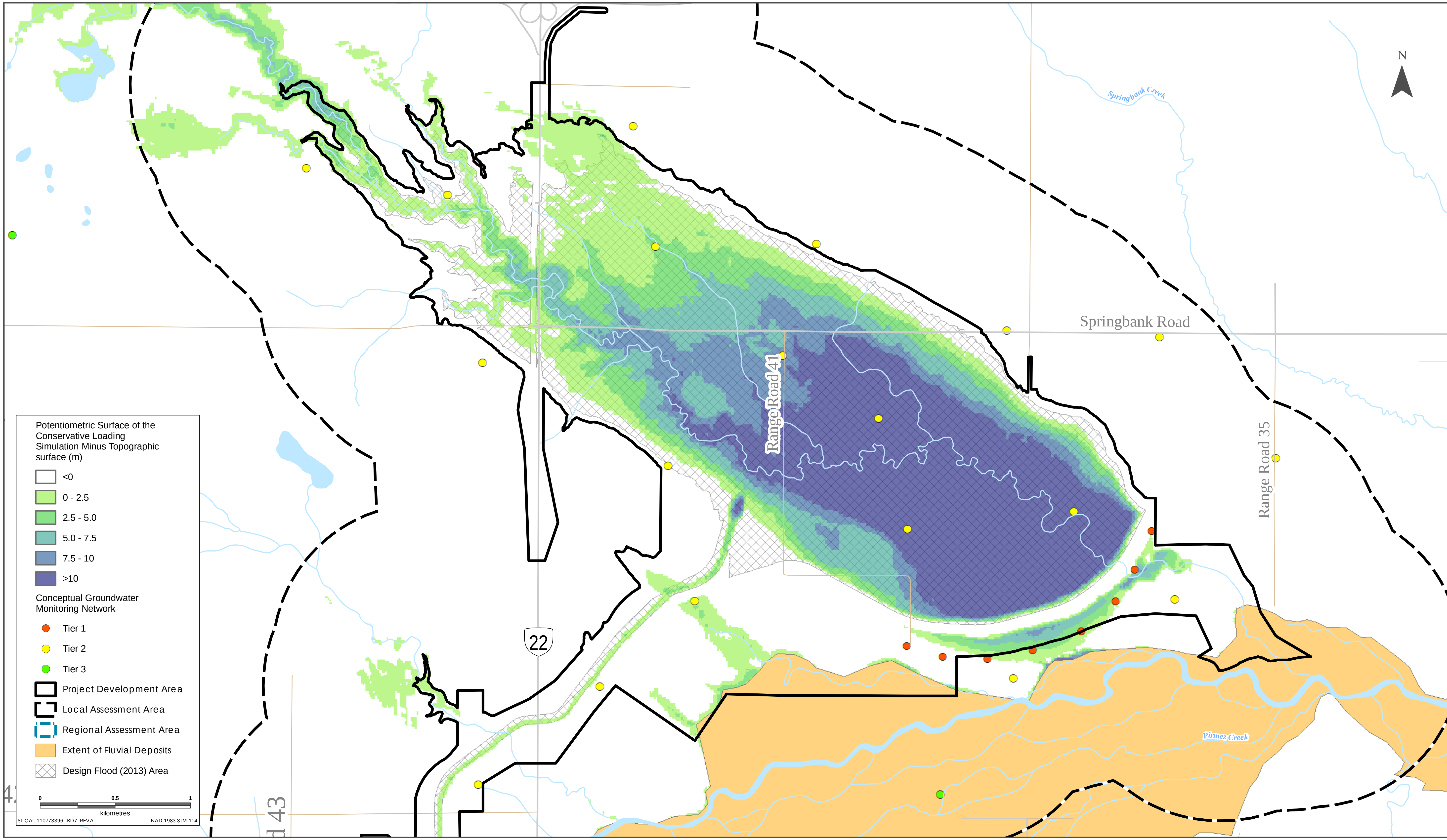
A number of cross sections through the dam are evaluated; however, the cross section at Station 22+500 is a typical analysis and is discussed in this response. Figure 47-4 shows the location of the cross-section through dam for a post-construction PLAXIS model scenario. The solution mesh for the cross section is shown in Figure 47-5.



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

Potentiometric Surface of the Conservative Loading Simulation minus Bedrock Surface showing Confined Bedrock Aquifer Areas

Figure 47-2



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

Stantec

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT

Potentiometric Surface of the Conservative Loading Simulation minus Topographic Surface

Figure 47-3

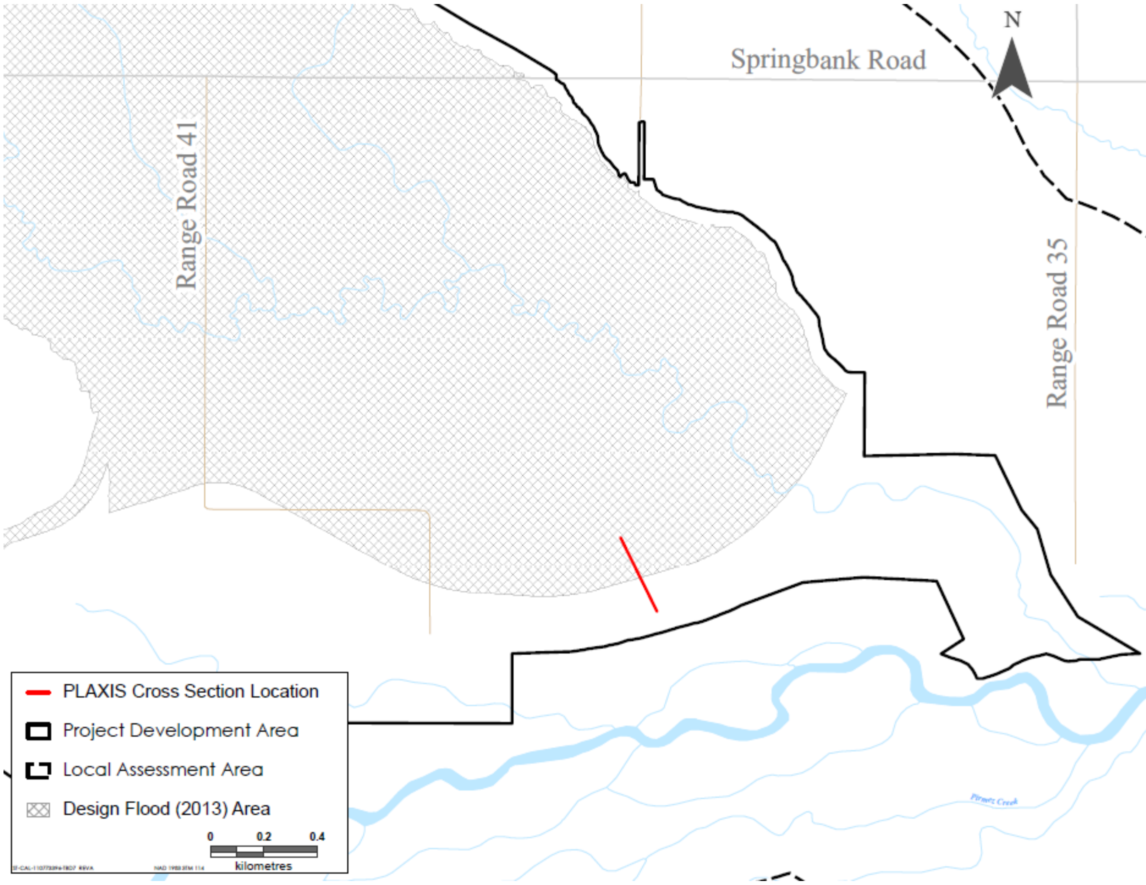


Figure 47-4 PLAXIS Model Cross-Section Location

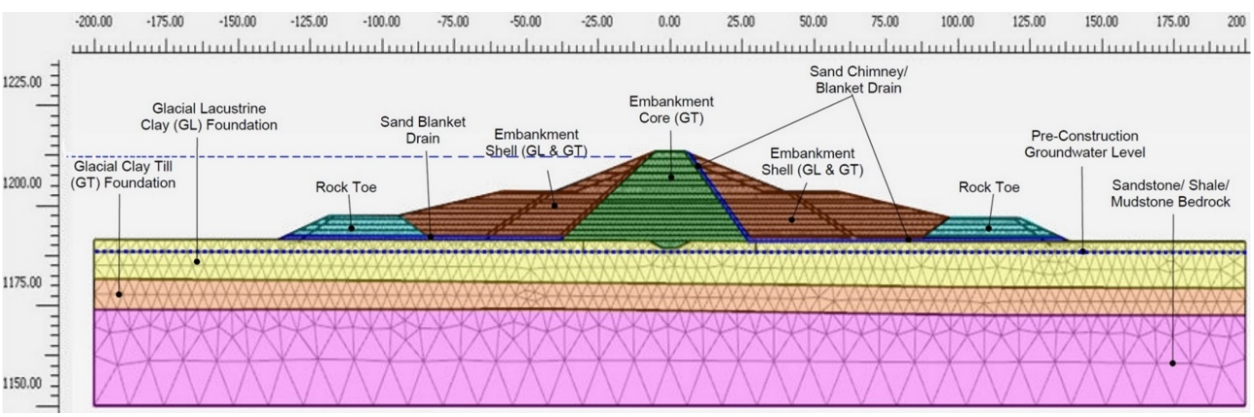


Figure 47-5 PLAXIS Model Configuration

The modelling results are presented in cross-section in Figure 47-6. The figure presents a local-scale cross-section through the dam showing the PLAXIS computed porewater pressure in the flood season seven months after the completion of construction. The equipotential pressure lines are roughly horizontal where hydrostatic conditions exist, and no loading pressure effects are predicted. A buildup of pressure due to loading is observed beneath the dam. A pressure of 10 kilopascals (kPa) is equivalent to that exerted by approximately 1 m of water. The pressure increase beneath the midpoint of the dam is approximately 170 kPa or 17 m of water, but the excess pressure only propagates approximately 50 m to the south from the reservoir beyond the toe of the dam, at which distance pressures return to hydrostatic conditions. If the bedrock were under fully confined conditions such that excess loading pressure could build up (not supported by the conceptual model which has unconfined areas and outcrop/subcrop pressure relief), limited propagation of pressures in the bedrock would be expected as well.

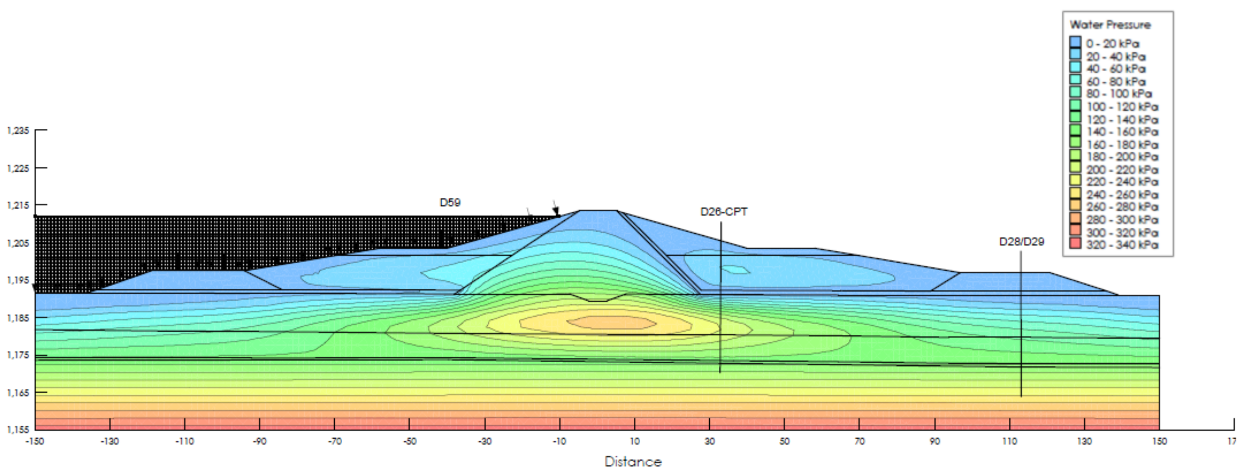


Figure 47-6 PLAXIS Modelled Porewater Pressure due to Loading

The PLAXIS modelling results indicate that the loading effects (related to construction of the dam) are only expected to propagate up to approximately 50 m to the south from the reservoir beyond the toe of the dam. The results, while not a direct simulation of loading effects due to the retention of water, further support the conclusion that the loading effects related to the retention of water in the reservoir are limited to the LAA. This is because the additional mechanical loads due to the weight of the dam would be similar to the mechanical loads due to water in the reservoir.

b. It is assumed that "potential artesian areas" refers to potential flowing artesian areas (hydraulic head above ground surface) rather than simply artesian (hydraulic head above the top of the aquifer). Figure 47-3 shows the areas of potential flowing artesian conditions or potential areas where "gush out" could occur (areas where potentiometric surface is above the ground surface) using the conservative, steady state loading effect simulation described in the response to a. Potentially flowing artesian areas are observed in the low-lying area to the south and east of the dam. There is currently one residence and one water well (associated with that residence) in the potential artesian area south of the dam within the PDA. However, the residence will be vacated prior to construction.

c. The modelling to support this response (see the response to a.) is more conservative than what was done in the Hydrogeology TDR Update (see Alberta Transportation's response to Round 1 NRCB, IR42, Appendix 42-1). The loading effect simulation results presented in response to AEP Question 49 indicate that the potential effects and potential for "gush out" remain within the LAA and do not extend in a southerly direction across the Elbow River valley.

   The results indicate that there would not be a decrease in the yield of groundwater supply wells to the point where they can no longer be used; rather, groundwater quantity would be increased. The residual effects on groundwater quality during flood and post-flood operations also continue to be not significant because changes in groundwater quality at existing wells would not deteriorate to the point where it becomes non-potable or cannot meet the Guidelines for Canadian Drinking Water Quality (Health Canada 2019) for a consecutive period exceeding 30 days (for those parameters which don't already, under existing conditions, exceed those guidelines).

   Under the conservative scenario, the overall significance determination for the hydrogeology effects assessment does not change and remains not significant. The determination is based on effects on groundwater quantity and quality.

d. The potential loading effect will be monitored as part of a groundwater monitoring plan. The conceptual groundwater monitoring network layout is presented in Figure 47-3. While the final position of monitoring wells will need to consider the practical field constraints, land access, and other pragmatic considerations, the intent will be to position a number of monitoring wells in areas capable of detecting water level change that is potentially attributable to loading effects.

   Tier 1 monitoring wells or piezometers will be located within or immediately adjacent to Project infrastructure (dam, diversion intake and channel). Pore pressures adjacent to the dam (including the contribution of potential loading effects) will be monitored at the Tier 1 monitoring wells. Near-continuous pressure measurement will be obtained using data logging probes that automatically collect and record at frequent intervals. Telemetry systems may also be deployed for some or all wells with data loggers such that near real-time monitoring would be possible. As shown in Figure 47-3, the Tier 1 monitoring wells are situated in the area of potential flowing artesian conditions to the south and east of the dam.

   Tier 2 wells located near the wetted perimeter (the edge of the reservoir area inundated during a design flood) and Tier 3 wells situated between the Project and potential receptors would also have continuous water level monitoring during floods. Several of the Tier 2 wells would be strategically situated in areas where potential loading effects may be expected, as is indicated by the steady state loading effect simulation. This data will be compared to baseline water levels to monitor potential effects, including the potential contributions of the loading effect.

e. Impacts from flowing artesian conditions or "gush out" are not anticipated because, even if incremental pressures capable of producing flowing artesian conditions were to occur, the low permeability lacustrine clay and till overlying bedrock (aquitard units) would limit the potential for groundwater discharge to surface, particularly over the relatively short time that the reservoir will be retaining water. However, should flowing artesian impacts be identified during flooding or during water retention, the following mitigation would be used.

- If temporary groundwater discharge to surface is identified during operational monitoring events or by affected landowners, the focus will be on containing and controlling the flow of discharging groundwater. Groundwater discharge at ground surface would be directed to Elbow River or its tributaries through conveyance measures, including shallow ditches or temporary piping. Erosion control and water quality monitoring would be conducted to protect the receiving waterbody and verify that the water quality is appropriate for discharge. Groundwater discharging to ground surface would be of quality similar to baseline conditions (i.e., it would not be floodwater) and it would likely be of better quality than water in Elbow River during a flood.
- Should a temporary increase in hydraulic head result in flowing artesian conditions in a domestic water well(s), control measures would be put in place. The primary control method would be to pump the well to decrease the hydraulic head and control potential flows out of the well casing. This could be completed with an existing submersible pump, depending on the existing pump capacity and the discharge rate required for control, or a new pump may be temporarily installed. Pumped water would be discharged into Elbow River or its tributaries. Erosion control and water quality monitoring would protect the receiving waterbody and verify that the water quality is appropriate for discharge. Damage to domestic wells is not anticipated as a result of incremental pumping, but repair or replacement of domestic wells would be considered should it occur.
- If a flowing well cannot be controlled through pumping (due to its condition, configuration of pump and header lines, or casing/screen completion issues), or if well damage occurs as a result of increased aquifer pressure, well abandonment will be considered to control the flow and discharge of groundwater. Well abandonment would be completed using standard practices in accordance with the *Water Act* (Ministerial) regulations and, when complete, would seal the existing pathway through the low permeability clays/tills. Water wells would be replaced when the flood has passed. Replacement wells would be completed such that future flowing artesian pressures could be controlled at the well head to limit the potential for this impact to occur during subsequent floods.

f. The loading effect has been conservatively modelled and potential areas where flowing artesian conditions could develop have been identified to the east and southeast of the off-stream dam. However, the clay and till above bedrock would limit the potential for groundwater discharge to surface or "gush out", given their low hydraulic conductivity relative to the short-term retention of water in the reservoir. Should temporary groundwater discharge be observed at locations where the overlying clays/tills are not intact (e.g., spring locations, improperly completed domestic wells), the mitigation measures listed in the response to e. would be implemented until the pressure subsides, following complete release of retained water back into Elbow River.

REFERENCES

Health Canada. 2019. Guideline for Canadian Drinking Water Quality. Available at: https://www.canada.ca/content/dam/hc-sc/migration/hc-sc/ewh-semt/alt_formats/pdf/pubs/water-eau/sum_guide-res_recom/sum_guide-res_recom-eng.pdf

Question 48

Supplemental Information Request 1, Question 217, Page 5.9 – 5.13
Supplemental Information Request 1, Appendix IR42-1, Figure 5-7, Page 5.13
Supplemental Information Request 1, Appendix IR42-1, Figure 5-9, Page 5.16

Figure 5-7 in Appendix IR42-1 is the Simulated Net Change in Head for the PPX0/EEX0 Scenario. There is positive drawdown (white area) along the edge of the diversion channel (the channel). The water level is higher along the edge of the channel (Figure 5-9 in the Appendix IR42-1) than the water levels further away from the channel, which will prohibit the discharge of the groundwater to the channel.

a. These anomalies will underestimate the groundwater seepage to the channel.

  i. Are these anomalies related to geological change or are they related to grid size change? Explain.

  ii. Provide the updated seepage number after the anomaly problems are fixed. Explain this number.

  iii. Provide an analysis of the size of the impact the anomalies have on the groundwater seepage estimation to the channel.

b. Provide groundwater flow directions on Figure 5-7 of Appendix IR42-1 to confirm if the local groundwater flow directions are towards the channel.

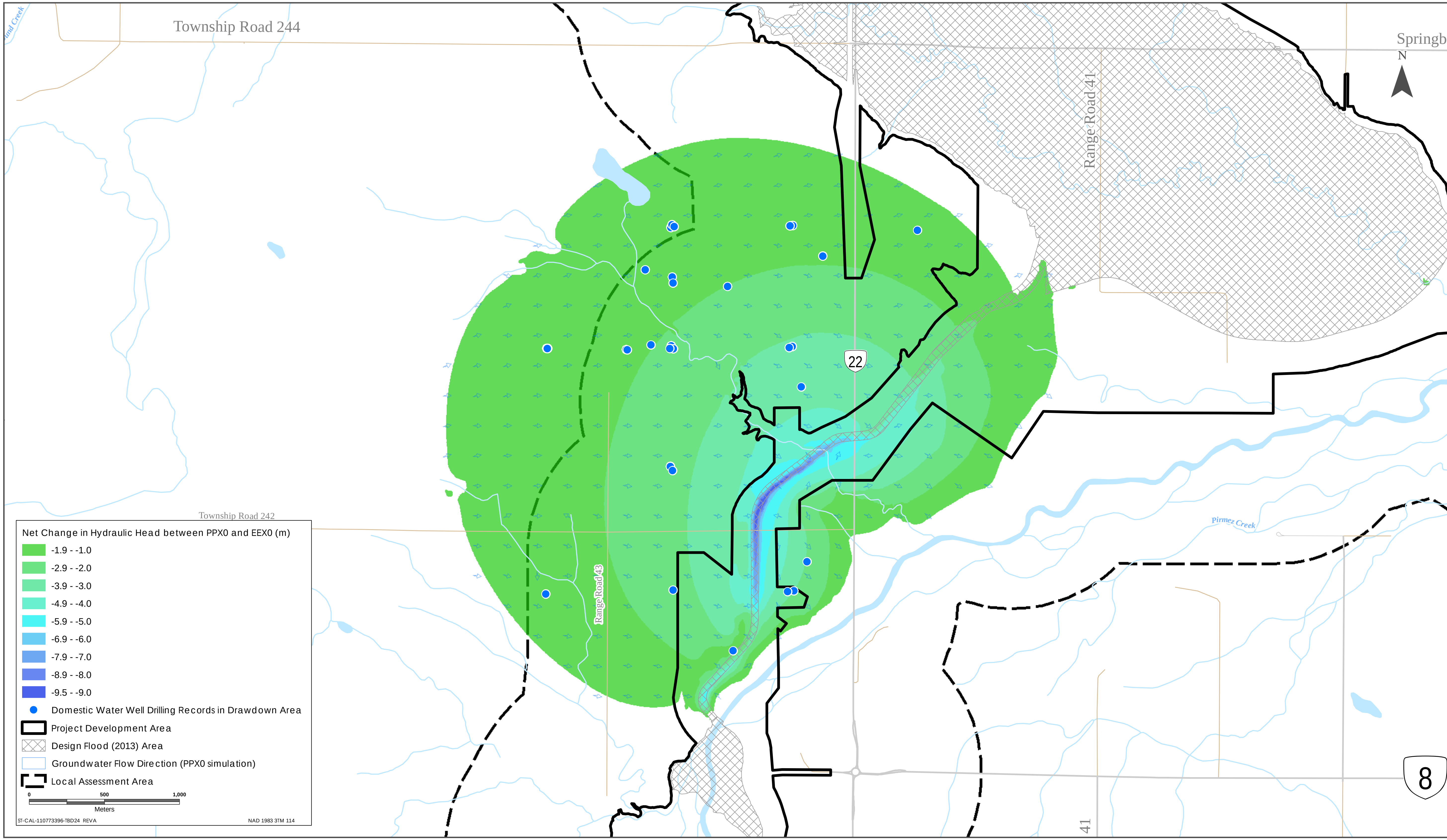
Response

a. i. The anomalies observed in the drawdown along the diversion channel, as shown in Figure 5-7 of the Hydrogeology TDR Update (see Alberta Transportation's response to Round 1 IR42, Appendix IR42-1), were not due to geological change or grid size. A review of the anomalies along the diversion channel revealed that nodes had previously been set as fixed seepage nodes such that the nodes remained active even as the water level surrounding the channel decreased. This resulted in artificially high hydraulic heads at the perimeter of the diversion channel. The application of seepage nodes has been corrected, allowing the model to determine which seepage nodes should remain active as the water level drawdown progresses.

Figure 48-1 presents an updated version of Figure 5-7 in Appendix IR42-1 (the Hydrogeology TDR Update). The figure shows the net change between the PPX0 scenario (average flow conditions with the Project) and the EEX0 simulation (average flow conditions for the existing environment (i.e., baseline conditions)). The correction of the seepage nodes has resulted in elimination of the previous anomalies and differences in the drawdown rate observed around the channel. The maximum drawdown adjacent to the channel remains similar to that described in the TDR Update, however the lateral extent of the drawdown extends farther to a maximum of approximately 1 km beyond the LAA as shown in Figure 48-1.

Although the drawdown extends farther than previously modelled, an assessment of the effect is not significant because the drawdown would not decrease the yield of groundwater supply wells to the point where they would no longer be able to be used. Analysis of domestic water well records within the expanded drawdown area confirmed that there are 58 well records, which are shown in Figure 48-1. Water level data were available for 33 of the records and the available head for 32 of the 33 records ranged from 10 m to 91 m below ground surface, with an average depth of 38 m. The remaining well record is a shallow, large diameter well (GIC well ID 1063104) completed to 4.9 m depth with approximately 1.8 m of available head. This well is located approximately 200 m from the channel and, because it is within the PDA, would be decommissioned prior to the dry operation phase.

Although not anticipated, should drawdown result in a well(s) no longer being useable, mitigation measures would be used to ensure an adequate supply of water to affected landowners. Depending on the particular circumstance, mitigation could include either recompletion of the existing well to a deeper interval or abandonment of the existing well and replacement with a deeper well.



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

Stantec

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT

Simulated Net Change in Head for the PPX0/EEX0 Scenario

Figure 48-1

ii-iii. The estimated groundwater seepage rate into the channel is 0.026 m^3/s, based on the net flux at nodes within the diversion channel that were extracted from the updated PPX0 simulation (groundwater conditions under non-flood average flow conditions in Elbow River). This change in groundwater discharge into Elbow River would not be perceptible, given the mean monthly flows in Elbow River are approximately 3 m^3/s to 4 m^3/s during winter months when flow is the lowest.

b. Groundwater flow directions for the PPX0 simulation have been added to Figure 48-1. The flow directions confirm that groundwater flow is toward the diversion channel on the hydraulically upgradient side and directions are variable on the southeast side of the diversion channel, either following the natural gradient of the existing environment (baseline) or directed toward the diversion channel.

Question 49

Supplemental Information Request 1, Question 230, Page 5.27 – 5.28
Supplemental Information Request 1, Appendix IR42-1, Figure 3-20, Page 3.41

Alberta Transportation states *a. The bedrock varies from unconfined to semi-confined to confined across the groundwater RAA …*

The site specific issue such as the loading effects to the East and South-East of the off-stream dam is not relevant to the whole RAA with areas of approximately 43,050 ha.

a. **Subtract Figure 3-20 of the potentiometric surface of the upper bedrock in Appendix IR42-1 by the bedrock top structure, hatch and the confined areas. Note, the confined area will be much larger when the reservoir is under usage.**

b. **Explain if it is in the confined condition to the East and South-East of the off-stream dam.**

c. **Simulate the loading effect if it is in the confined condition to the East and South-East of the off-stream dam.**

d. **Subtract the water level in bedrock under the situation of loading effect by the DEM.**

e. **Estimate the area of the potential artesian areas.**

f. **What is the highest water level above DEM in the potential artesian areas?**

g. **Propose a monitoring plan to monitor the potential loading effect and explain how this plan was created.**

h. **Design a mitigation plan to reduce or eliminate the potential artesian impact and explain how this plan was created.**

Response

a. The response to AEP Question 47 (Figure 47-1) presents the potentiometric surface (simulated result from the EEX0 average flow conditions, without the Prokect) subtracted from the top of bedrock elevation. The figure indicates that the potentiometric surface is at a higher elevation than the top of bedrock (confined aquifer condition) beneath the majority of the off-stream reservoir area, but it is unconfined along the entire northeast and southwest sides of the reservoir. Elbow River fluvial deposits incise into bedrock within the river valley, and there is no lateral confinement in a southern direction. Therefore, the statement that "the confined area will be much larger when the reservoir is under usage" is not correct. A small increase in the area of confined conditions is expected during flood operations because the potentiometric surface is below the top of bedrock (unconfined aquifer condition) immediately to the northeast and southwest of the reservoir and will remain that way during flood operations.

b. There is an area southeast and east of the dam near Range Road 35 that is under confined conditions, as shown in the response to AEP Question 47 (Figure 47-1).

c. The results of a conservative loading model simulation are presented in response to AEP Question 47.

d. AEP Question 47 (Figure 47-3) presents the potentiometric surface of the conservative loading simulation subtracted from the topography DEM.

e. AEP Question 47 (Figure 47-3) shows areas of potential flowing artesian conditions (areas where potentiometric surface is above the ground surface) in the low-lying area to the south and east of the dam where potential flowing artesian conditions could occur. Other areas of potential flowing artesian conditions away from the PDA are not a result of the Project.

f. The highest hydraulic head above ground surface to the south and east of the dam is 9 m, as indicated in AEP Question 47 (Figure 47-3). Based on the conservative simulation, the areas of highest head above ground surface warrant additional monitoring consideration, as discussed in the response to g.

g. The potential loading effect will be monitored as part of a groundwater monitoring plan. A discussion of how the monitoring program will address the potential loading effects is presented in the response to AEP Question 47d.

h. No flowing artesian impacts or "gush outs" are anticipated, based on the information presented above. However, a mitigation plan to address potential flowing artesian conditions is presented in the response to AEP Question 47e.

Question 50

Supplemental Information Request 1, Question 237, Page 5.36

Alberta Transportation states *The original groundwater LAA did include the area over which potential "loading effects" could occur…*

Alberta Transportation did not complete the potential loading effects analysis. It is only argued that the bedrock is under unconfined or semi-confined conditions in the whole Regional Assessment Area (RAA), so it is impossible to have a loading effects in the RAA. The problem is that potential loading effects to the East and South-East of the off-stream dam may exist when the off-stream reservoir is under usage.

a. **Modify the extent of the LAA to the East and South-East of the off-stream dam to include the area affected by the potential loading effects.**

b. **Analyse the impact of the LAA change to the land purchase and management.**

Response

a. The assessment of the loading effects presented in the responses to AEP Question 47, Question 49, Question 53 and Question 56 does not change the extent of the LAA for hydrogeology.

b. The LAA has not been changed as a result of the additional model simulations of the loading effect and, therefore, there are no resulting impacts to land purchase and management. The management and mitigation of potential effects on groundwater will be implemented adaptively in response to changes in groundwater levels, regardless of whether those changes occur within, or beyond the LAA (i.e., effects management is not limited to the LAA).

Question 51

Supplemental Information Request 1, Question 240, Page 5.37 – 5.38

Alberta Transportation states *b-c. There are no differences in the model at local versus regional scales because these two scales are fully accounted for.*

The RAA covers an area approximately 43,050 ha. The regional geological model can not capture the important features which are valuable to the local impact assessment, such as the diversion channel and the off-stream dam seepages' prediction, and the potential loading effects analysis to the East and South-East of the off-stream dam.

a. Compare the following wells' drilling logs vs the geological units at the same location from the RAA geological model. How big is the difference between:

i. MW16-16-11, MW16-18-10;

ii. MW16-24-30, MW16-23-26, MW16-22-26?

b. Explain the impact on the diversion channel and the off-stream dam seepages' prediction.

c. Evaluate the impact on the potential loading effects delineation, monitoring and mitigation.

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a. The geological model accurately represents the borehole drilling data.

The drilling logs have been interpreted in the context of the local geological/hydrogeological setting to determine the hydrostratigraphic units that govern groundwater flow. The stratigraphic contacts for each borehole log are used to create the geological contact surfaces and generate volumes in the geological model. The geological model uses implicit modelling to accurately represent the drilling logs. The implicit modelling approach uses algorithms to create three-dimensional (3D) surfaces and volumes directly from measured data and user interpretation. The only difference between the borehole logs and modelled geology is a result of the interpolation which is accomplished using radial basis functions (RBF). RBF's are a group of functions used to generate values for the surfaces that define the 3D model. The values generated are a function of the distance to a data point. This interpolation would not change, whether modelling at a local or regional scale.

The export of the model to FEFLOW uses a minimum unit thickness of 0.1 m and a very closely spaced supermesh to represent the PDA so that the detail of the geological model is not lost.

i. Figure 51-1 presents a comparison between the lithology described at MW16-16-11and MW16-18-10 and the geological model. The vertical borehole traced for both records are presented in the figures with the lithological units represented by the colours presented in the legend. The model represents the borehole lithology with the contacts varying slightly due to the interpolation between boreholes described above.

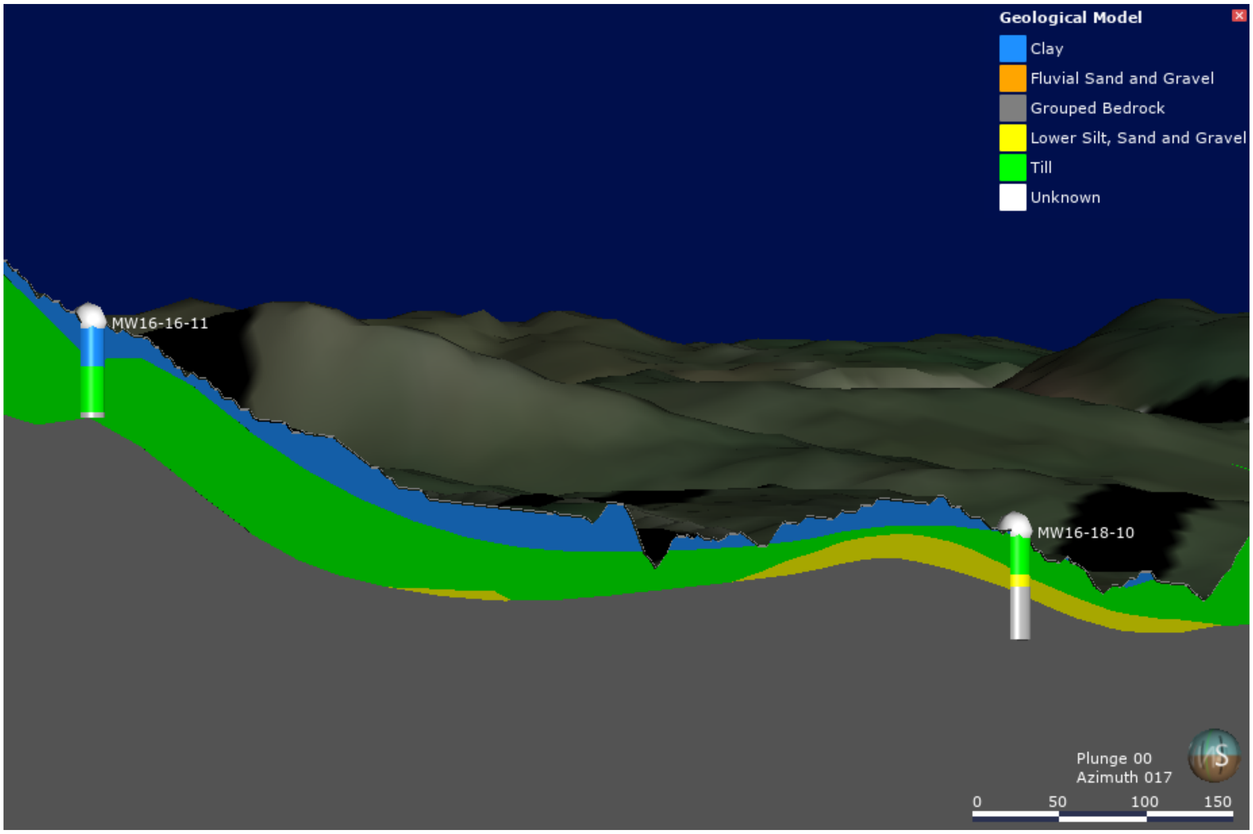


Figure 51-1 Comparison between Borehole Data and Geological Model for MW16-16-11 and MW16-18-10

ii. Figure 51-2 presents a comparison between the lithology described at MW16-24-30, MW16-23-26, MW16-22-26 and the geological model.

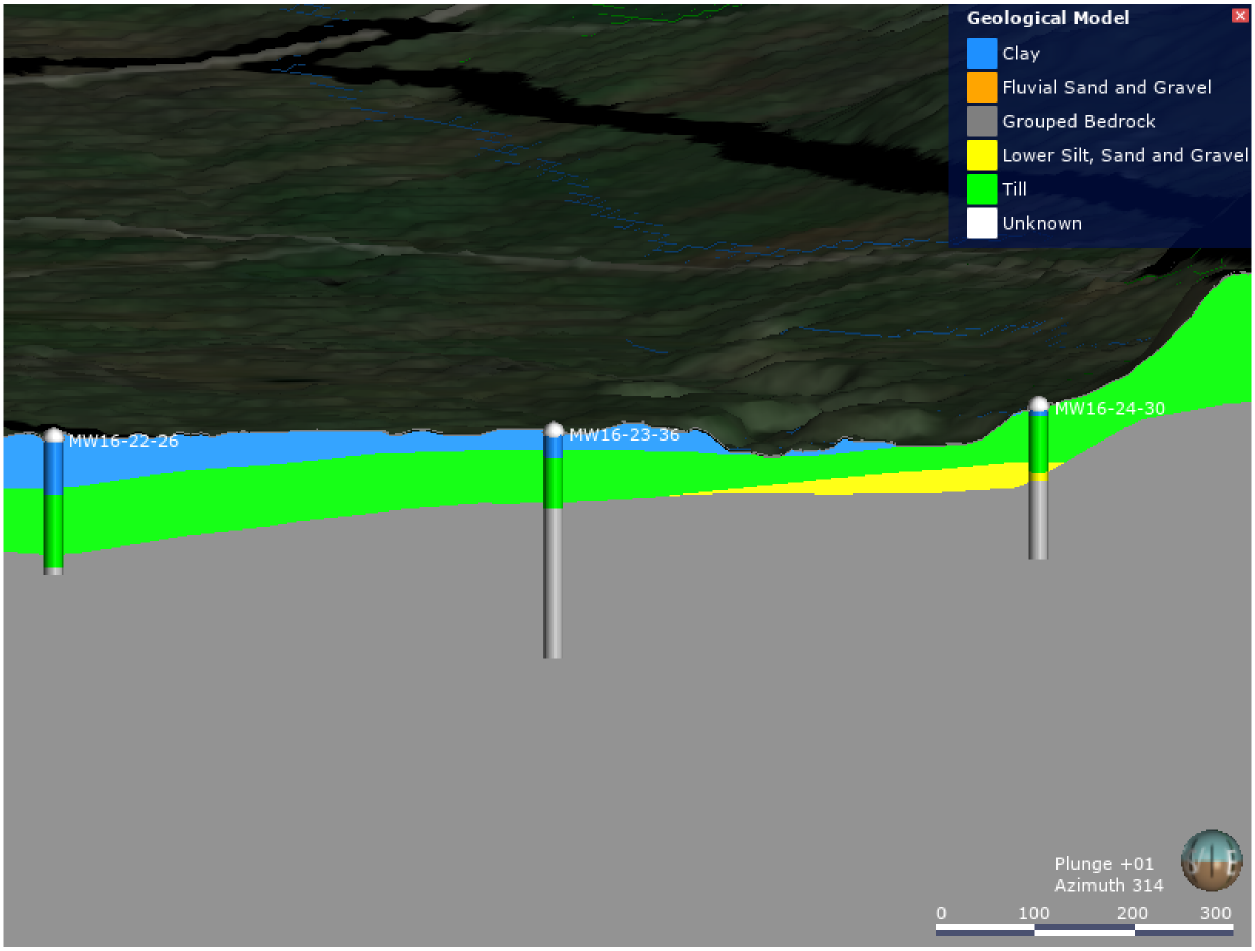


Figure 51-2 Comparison between Borehole Data and Geological Model for MW16-22-26, MW16-23-36, and MW16-24-30

b. Because the geological model accurately represents the borehole drilling data at a local scale there is no impact on the diversion channel and the off-stream dam seepage prediction.

c. Because the geological model accurately represents the borehole drilling data at a local scale there is no impact on the delineation of potential loading effects, or on plans for monitoring and mitigation of potential effects on groundwater. Monitoring and mitigation plans will continue to focus on areas where there are potential risks to groundwater, considering both the locations of potential receptors and areas more susceptible to effects on groundwater (e.g., existing domestic wells near Project infrastructure, existing spring locations or topographically low areas immediately adjacent to Project infrastructure). The monitoring and mitigation plans put into place will allow for ongoing monitoring of groundwater conditions and adaptive management of effects, should they be detected and require implementation of active measures.

Question 52

Supplemental Information Request 1, Question 248, Page 5.48;
Supplemental Information Request 1, Appendix IR42-1, Page 4.8
Supplemental Information Request 1, Appendix IR42-1, Figure 4-10, Figure 4-11, Page 4.12
Supplemental Information Request 1, Appendix IR42-1, Table 3-1, Page 3.33

Alberta Transportation states *Section 4.3.2 of the hydrogeology TDR Update (see the response to IR42, Appendix IR42-1) describes the parameterization of model layers. Hydraulic conductivity values for each of the model layers was parameterized based upon the hydraulic framework developed within the 3D CSM and on results of the steady state calibration runs.*

The undifferentiated bedrock unit was represented in the model with two layers, and the upper layer of the bedrock (Layer 6) was assigned higher hydraulic conductivity values to reflect the potential for this unconformable surface to be fractured and of higher permeability than the underlying bedrock (Layer 7). P.4.8 of Appendix IR42-1.

The assigned conductivities in Layer 6 and Layer 7 are 1.4E-6 m/s and 2.7469E-7 m/s, respectively (Figure 4-10 and Figure 4-11 of Appendix IR42-1). The Paskapoo formation, which is an aquifer in the Province of Alberta, has a magnitude of only one to two smaller than that of the only tested conductivity of 1.5E-5 m/s (MW15-24-30, Table 3-1 of Appendix IR42-1).

a. Explain why the Paskapoo formation, which is an aquifer in the Province of Alberta, is not separated from the rest of the bedrock.

b. Explain what the impact is when a lower conductivity for the model calibration and prediction has been assigned.

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a. The Paskapoo Formation can broadly be considered an aquifer in Alberta due to its use for water supply; however, lithologically it is a highly heterogenous formation with several subunits of variable permeability. Although the term Paskapoo Aquifer is often used, as Lyster and Andriashek (2012) state, much of the formation is made up of muddy sedimentary rock that makes up the Lacombe Member that, due to its lower bulk hydraulic conductivity, is considered an aquitard. It is the higher transmissivity sand units within the Paskapoo Formation that can generally be considered aquifers in the Province of Alberta. The Haynes Member of the Paskapoo Formation, also known as the Haynes Aquifer, is the sandstone dominated member (Lyster and Andriashek 2012) and it is not present in the RAA. It is the Lacombe Member of the Paskapoo Formation that subcrops beneath the RAA, and as such, contiguous, regional scale sandstone units are not expected in the RAA.

All bedrock units, including the Brazeau, Wapiabi, Coalspur and Paskapoo Formations in the RAA, were found to have similar lithologies (alternating sandstone, siltstone and claystone), and are inferred to have similar hydraulic properties. This inference is supported by regional mapping by HCL (2002), which indicates that the permeable units of the Brazeau, Coalspur and Paskapoo Formations have a similar range of apparent transmissivity in the RAA. As such, for the purposes of numerical modeling, the Paskapoo Formation has not been subdivided from the rest of the bedrock units.

b. As shown in the subcrop map in response to AEP Question 55 (Figure 55-1), there were 19 Project monitoring wells completed within the subcrop area of the Paskapoo Formation. Seven of the monitoring wells were completed into bedrock of the Paskapoo Formation and hydraulic conductivity testing was completed on three monitoring wells (MW16-6-20, MW16-8-19, and MW16-24-30). In addition, the 37 single-packer permeability tests completed as part of the geotechnical field program were conducted on boreholes completed into the Paskapoo Formation; there is confidence with the conductivity values used for the initial conditions in the numerical model and the calibrated hydraulic conductivity values. There is a range of hydraulic conductivity in the Paskapoo Formation with higher values in the permeable sandstone and lower in the siltstone/claystone; however, given the nature of the channelized, discontinuous sand units within the formation, it is the bulk hydraulic conductivity that governs groundwater flow at the scale of the assessment boundaries.

   Model sensitivity analysis was conducted as part of the TDR Update, Appendix E (see Alberta Transportation's response to Round 1 NRCB IR42, Appendix IR42-1) to examine the effect of hypothetically increasing the permeability of both the till and bedrock units within the model well beyond the values that were calibrated for these layers within the RAA. During the sensitivity analysis, the hydraulic conductivity values for these units were increased by a factor of 1,000 (well beyond the respective range of natural variability of these geologic materials). The sensitivity analysis results suggest that the model simulations are most affected by how the hydraulic conductivity values have been assigned. The higher conductivity values (relative to the calibrated values) in the model sensitivity runs lead to further propagation of effects. However, even when increasing the hydraulic conductivity values of the low conductivity units, the modelled effects remain within the LAA and north of Elbow River.

REFERENCES

HCL (Hydrogeological Consultants Ltd.). 2002. M.D. of Rocky View No. 44 Part of the South Saskatchewan River Basin Tp 021 to 029, R25 to 29, W4M & Tp 023 to 029, R01 to 06, W5M Regional Groundwater Assessment. March 2002.

Lyster, S. and Andriashek, L.D. 2012. Geostatistical rendering of the architecture of hydrostratigraphic units within the Paskapoo Formation, central Alberta; Energy Resources Conservation Board, ERCB/AGS Bulletin 66, 103 p.

Question 53

Supplemental Information Request 1, Question 250, Page 5.49 – 5.50

Alberta Transportation states *c. Two layers were created for the bedrock unit.*

a. What is the thickness assigned to the upper bedrock layer (Layer 6)? Explain.

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a. The thickness of the upper bedrock layer (Layer 6) in the updated model presented in the Hydrogeology TDR Update (see Alberta Transportation's response to Round 1 NRCB IR42, Appendix IR42-1) is 8 m. The thickness was used to approximate the highly weathered and fractured upper portion of the bedrock. While the fractured bedrock extends deeper than 8 m, the upper portion is expected to have more connected and open fractures (i.e., not re-mineralized) than the lower bedrock. The borehole log observations and hydraulic conductivity testing results within the upper bedrock indicate that the change is gradational. To address the variability, the thickness of the upper bedrock layer was varied from 5 m to 20 m during model calibration. A layer thickness of 8 m yielded the best calibration results and was carried forward in the subsequent simulations.

Question 54

Supplemental Information Request 1, Question 251, Page 5.50
Supplemental Information Request 1, Appendix IR42-1, Figure 5-3, Page 5.5

Alberta Transportation states *c. The time varying boundary conditions were applied to the uppermost layer of the model. This was done to simulate the effect of temporary retaining water on the land surface in the off-stream reservoir.*

The time varying boundary conditions should be match to the reality. If the river cuts to the second or third layers of the model, the river boundary should be applied to all of the second and third layers. Similarly, some areas in the off-stream reservoir have bedrock out-crops, and in this case, the time varying boundary conditions should be applied from the top to the bedrock layers. Otherwise, the model can not mimic real situations.

For potential loading effects simulation to the East and South-East of the off-stream dam, it is the pressure response instead of the water particle movement; to evaluate the potential loading effects from the conservative point of view, the boundary condition in Figure 5-3 (Appendix IR42-1) should be applied in the confined bedrock layer in the area of the off-stream reservoir.

a. Apply the boundary condition in Figure 5-3 (Appendix IR42-1) from the top layer to the bedrock layer in the area of the off-stream reservoir, then simulate the loading effects to the East and South-East of the off-stream dam.

b. Provide a map to show the area of the potential loading effects.

Response

a. The boundary condition from the top layer of the model (i.e., the incremental pressure due to the retention of water in the reservoir) was applied to the bedrock layer under the footprint of the reservoir (full stage) to simulate the loading effects. The results of this conservative modelling approach, whereby all the pressure head in the reservoir is transferred down to the bedrock unit as though there were 100% loading efficiency, are presented in the response to AEP Question 47. The pressures used to simulate loading were applied, and the model was run in steady state mode, resulting in a worst-case scenario representing permanent retention of water (not the actual situation; water will be released back into Elbow River in three months or less) and the resulting pressure effects.

b. The areas of potential loading effect are discussed in the response to AEP Question 47, Figure 47-1, Figure 47-2 and Figure 47-3.

Question 55

Supplemental Information Request 1, Question 255, Page 5.53 – 5.54
Supplemental Information Request 1, Appendix IR42-1, Table 3-1, Page 3.33

Alberta Transportation states *c. However, the behavior of a given water bearing bed within a thick formation like the Paskapoo can vary significantly from the average vertical and horizontal hydraulic conductivity. The low permeability is consistent with available data for the eastern part of the RAA.*

a. The only tested conductivity in the Paskapoo formation can be found in the eastern part of the RAA and has a value of 1.5E-5 m/s (MW16-24-30, Table 3-1 of Appendix IR42-1). Was other tested data available for the Paskapoo formation in the RAA? If so, explain why this data was not included in the RAA and the implications its exclusions may have. If there was no further tested data in the RAA to support the above statement, modify the conductivity for Paskapoo formation to reflect the practical situation in the RAA instead of the summarized conductivity from all the bedrock layers.

b. Re-do the calibration and prediction, including the seepage amount under the off-stream dam. Explain the calibration and prediction methodology used.

c. Analyze and explain the differences of the calibrations and predictions for both the lower and higher conductivities for Paskapoo formation.

Response

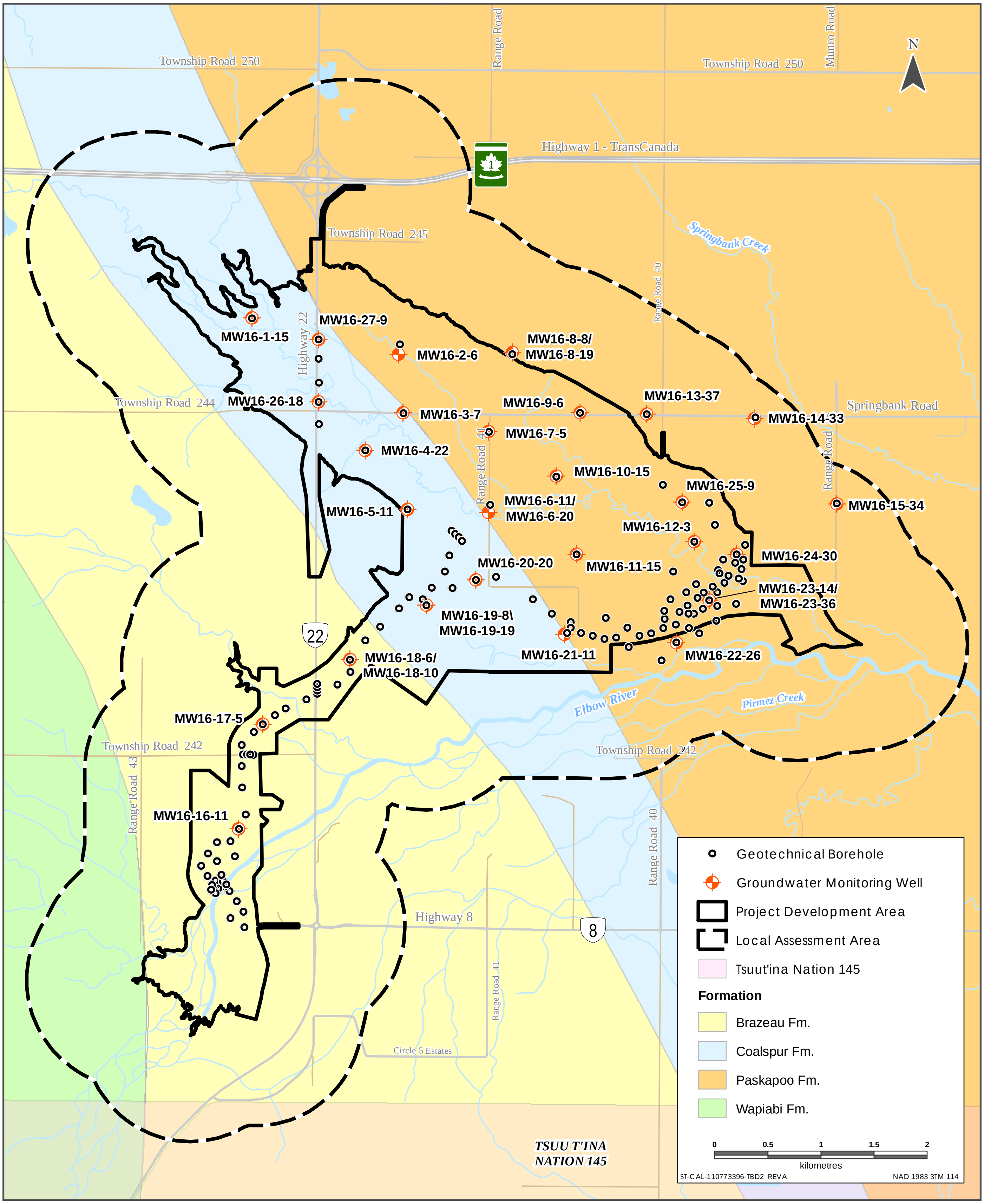
This response was included in the May 15, 2020 filing. The text has not been altered.

a. As shown in the bedrock subcrop map in Figure 55-1, there were 19 Project monitoring wells completed within the subcrop area of the Paskapoo Formation. Seven of the monitoring wells were completed into bedrock of the Paskapoo Formation and hydraulic conductivity testing was completed on three monitoring wells (MW16-6-20, MW16-8-19, and MW16-24-30). In addition, the 37 single-packer permeability tests completed as part of the geotechnical field program were conducted on boreholes completed into the Paskapoo Formation; there is confidence in the conductivity values used for the initial conditions in the numerical model and the calibrated hydraulic conductivity values.

   There is a range of hydraulic conductivity in the Paskapoo Formation with higher values in the permeable sandstone and lower in the siltstone/claystone; however, given the nature of the channelized, discontinuous sand units within the formation, it is the bulk hydraulic conductivity that governs groundwater flow at the scale of the assessment boundaries.

b. Based on the response to a., the model calibration and prediction have not redone because the hydraulic conductivity value applied in the model considered a range of estimates derived from multiple single well tests and isolation packer tests. However, the sensitivity analysis presented in the TDR Update, Attachment E (see Alberta Transportation's response to Round 1 NRCB IR42, Appendix 42-1) examines hypothetical changes to the modelled hydraulic conductivity values, as summarized in the response to c.

c. As stated in the response to a., there is confidence in the conductivity values used for the initial conditions in the numerical model and the calibrated hydraulic conductivity values. However, the model sensitivity analysis presented in the TDR Update, Attachment E does examine the hypothetical effect of increasing the permeability of both the till and bedrock layers within the model. The hydraulic conductivity values for these units were increased by a factor of 1,000 (well beyond the expected range of natural variability of these geologic materials). The sensitivity analysis results suggest that the model simulations are most affected by parameterization of hydraulic conductivity values, and the higher conductivity values lead to further propagation of effects and, in turn, a larger area of effects. However, even when increasing the hydraulic conductivity values of the low conductivity units, the modelled effects remain within the LAA and north of Elbow River.



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

Groundwater Monitoring Well and Geotechnical Borehole Locations Relative to Bedrock Subcrop

Stantec

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT

Figure 55-1

Question 56

Supplemental Information Request 1, Question 257, Page 5.56
Supplemental Information Request 1, Appendix IR42-1, Figure 5-7, Page 5.13
Supplemental Information Request 1, Appendix IR42-1, Figure 5-9, Page 5.16

Alberta Transportation states *a, c. The numerical model was run using unconfined conditions given the limited lateral extent of confining layers*

The regional model has an area of approximately 43,050 ha. The RAA has the limitation that it is unable to solve the problems for Diversion Channel seepage and the potential loading effects to the East and South-East of the off-stream dam. Not only is it not efficient, but the site specific problems are overlooked. The drawdown and groundwater level anomaly along the diversion channel (Figure 5-7, and Figure 5-9 of the Appendix IR42-1) may also belong to the regional model limitation as well.

As per the September 6, 2018 meeting between Alberta Environment and Parks, Alberta Transportation and Stantec two local models were recommended and are required to understand and solve the diversion channel seepage and the potential loading effects. Provide:

a. A local model for diversion channel seepage prediction.

b. A local model around the off-stream dam for loading effects analysis and prediction.

Response

a. The drawdown anomalies along the diversion channel are addressed and corrected in the response to AEP Question 48. The anomalies have been resolved and an updated seepage prediction has been made such that creation of a separate local scale model is not needed. Review of the anomalies along the diversion channel revealed that further optimization of the position of seepage face nodes along the channel was required to smooth the numerical solution in this area. The nodes had previously been set as fixed seepage nodes such that the nodes remained active even as the water level surrounding the channel decreased. This resulted in artificially high hydraulic heads at the perimeter of the diversion channel. The application of seepage nodes has been corrected, allowing the model to determine which seepage nodes should remain active as the water level drawdown progresses. The anomaly was not due to a limitation resulting from the size of the regional scale model; therefore, a local-scale model is not required and would not improve the seepage prediction.

The updated seepage estimate as a result of the correction to the application of seepage nodes is 0.026 m^3/s compared to the 0.013 m^3/s presented in the Hydrogeology TDR Update (see Alberta Transportation's response to Round 1 IR42, Appendix IR42-1). The change in groundwater discharge into Elbow River would not be perceptible, given that mean monthly flows in Elbow River are approximately 3 m^3/s to 4 m^3/s during winter months.

b. The loading effect has now been simulated through application of the total stress attributable to the retention of water in the reservoir (i.e., the weight of the water) directly to the bedrock unit in the regional model to simulate the potential local-scale loading effects. The results of this simulation are presented in the responses to AEP Question 47, Question 49, and Question 54. For the simulation, all of the pressure head in the reservoir would be transferred down to the bedrock unit as though there were 100% loading efficiency and the model simulation was run to steady state to provide a highly conservative, worst-case scenario representing perpetual storage of water within the reservoir.

The figures presented in the response to AEP Question 49 show localized areas of potential flowing artesian conditions due to loading in areas to the south and east of the dam. Monitoring and mitigation measures to address potential flowing artesian conditions are presented in response to AEP Question 47. While additional monitoring and mitigation may be required, even under the conservative loading scenario, the overall significance determination for the hydrogeology effects assessment does not change and is not significant.

The limited local-scale effects are also supported by local-scale modelling. A local-scale model in PLAXIS simulated the loading effects beneath the dam and retained water in the reservoir. While the intent of the geotechnical model was to assess geomechanical response of the subsurface under additional stress from the dam itself, it does serve as a surrogate for further understanding of the potential effects on groundwater levels due to the loading effect.

The PLAXIS model considers loading in the unconsolidated clay and till. The model does not consider the buildup of pressure in the bedrock aquifer based on the relatively low compressibility of the bedrock and the outlet for excess loading pressure (i.e., a drained condition). Unconfined areas of the aquifer—to the southwest and northeast of the reservoir and areas to the southeast where the bedrock subcrops and groundwater discharges to Elbow River—allow relief of potential confined pressure due to loading. This understanding has been applied to the PLAXIS model and is consistent with the hydrogeological conceptual site model. This is because the additional mechanical loads due to the weight of the dam would be similar to the mechanical loads (weight) due to water in the reservoir. The PLAXIS model is summarized in response to AEP Question 47.

Various scenarios were modelled to represent the phases of construction and operation of the dam. Figure 56-1 shows the location of a cross-section through the dam for a post-construction PLAXIS model scenario. The modelling results are presented in cross-section in Figure 56-2. The figure presents a local-scale cross-section through the dam showing porewater pressure at three years after construction is completed. The equipotential pressure lines are roughly horizontal where hydrostatic conditions exist, and no loading pressure effects are predicted. A buildup of pressure due to loading is observed beneath the dam. A pressure of 10 kPa is equivalent to that exerted by approximately 1 m of water. The pressure increase beneath the midpoint of the dam is approximately 170 kPa or 17 m of water, but the excess pressure only propagates approximately 50 m to the south from the reservoir beyond the toe of the dam, at which distance pressures return to hydrostatic conditions. If the bedrock were under fully confined conditions such that excess loading pressure could build up (not supported by the conceptual model which has unconfined areas and outcrop/subcrop pressure relief), limited propagation of pressures in the bedrock would be expected as well.

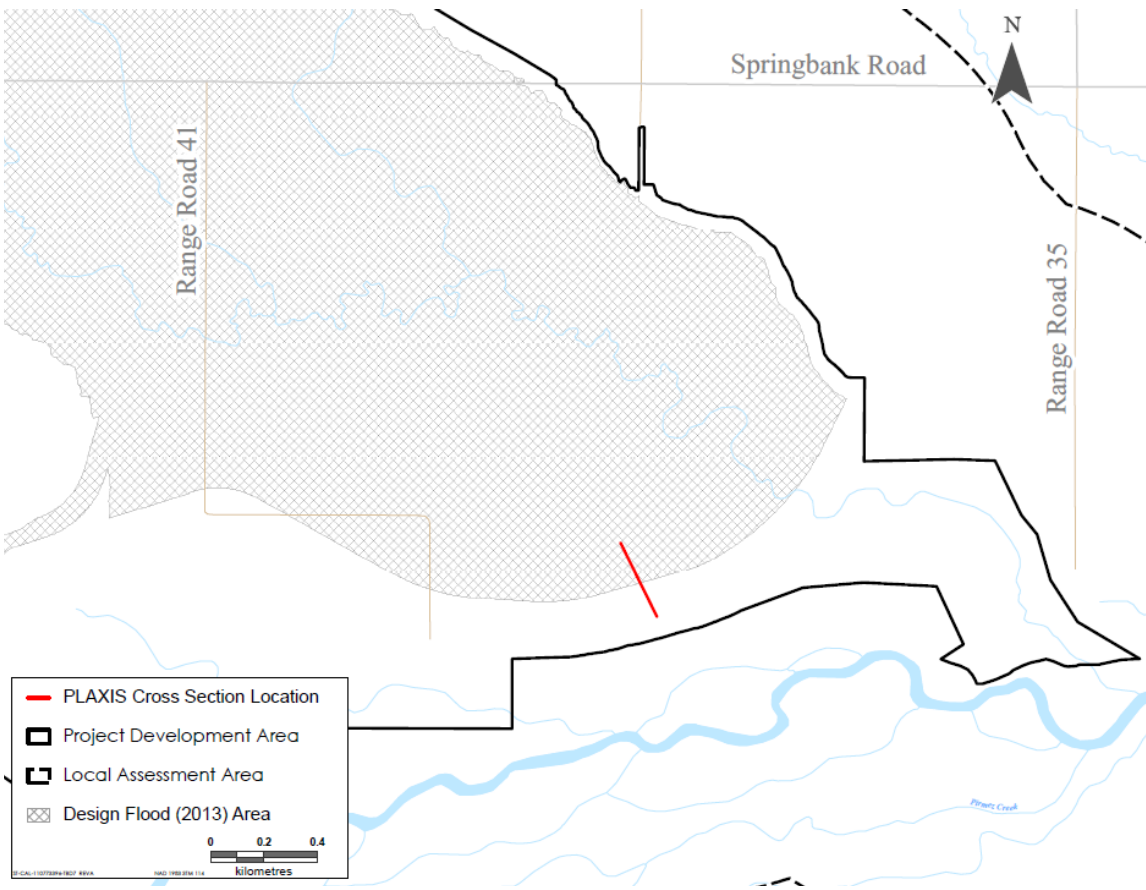


Figure 56-1 **PLAXIS Model Cross-Section Location**

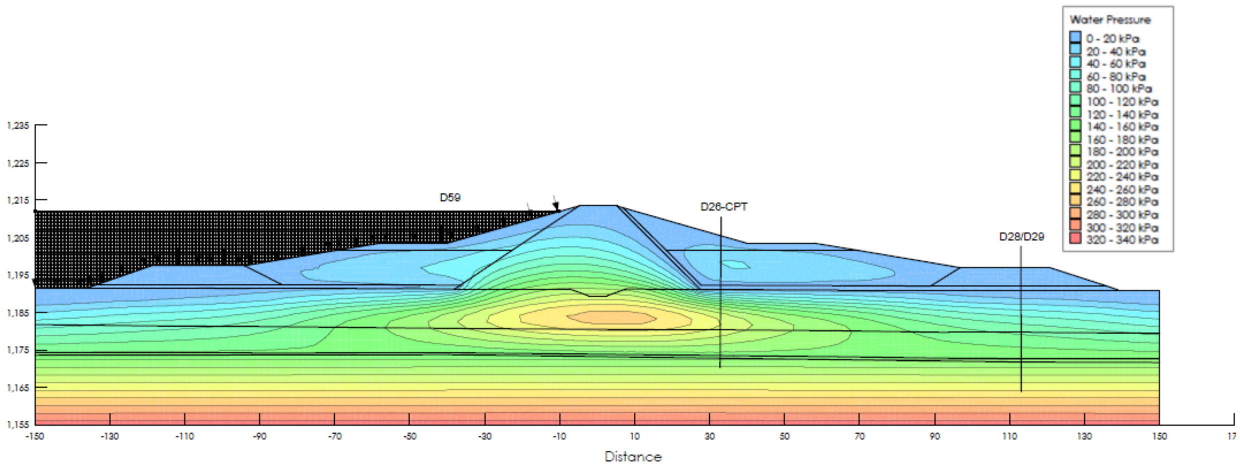


Figure 56-2 PLAXIS Modelled Porewater Pressure due to Loading

Two different methods were used in the simulation: 1) regional-scale groundwater flow model in the Hydrogeology TDR Update, with the addition of the total stresses applied directly to the bedrock and 2) the PLAXIS model. Both results indicate limited propagation of effects away from the reservoir, within the LAA. The overall significance determination for the hydrogeology effects assessment does not change and is not significant.

Ongoing monitoring during flood operations will identify propagation of the loading effect, if realized, and the potential effects can be adequately addressed through the mitigation measures. Mitigation measures to address potential effects are included in the draft groundwater monitoring plan. Mitigation specific to potential flowing artesian conditions resulting from loading are presented in the response to AEP Question 47.

4.2 HYDROLOGY

Question 57

Supplemental Information Request 1, Question 261, Page 5.68

Alberta Transportation states *The runoff volume related to the 2013 flood was calculated based on the hydrograph at Glenmore Reservoir, and the off-stream reservoir is designed to accommodate such a flood.*

a. Provide the data source of the hydrograph at the Glenmore Reservoir.

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a. The initial inflow hydrograph for the 2013 flood into the Glenmore Reservoir was an estimate provided by the City of Calgary. The hydrograph was based on calculations using Glenmore Reservoir level (change in retained volume) and outflow.

   The Water Survey of Canada released hydrograph data in January 2017 for the two upstream hydrometric stations at Bragg Creek and Sarcee Bridge. A comparison of this updated data to the initial estimates confirmed no changes to the Project design or hydrology assessment are required.

   See Alberta Transportation's response to Round 1 AEP IR260 for additional detail on the hydrograph comparison.

Question 58

Supplemental Information Request 1, Question 269, Page 5.83
Supplemental Information Request 1, Appendix IR302-1, Page 4.3
Supplemental Information Request 1, Question 276, Page 5.94

Alberta Transportation has referred to Appendix IR302-1 in SIR1 question 269 response. Alberta Transportation states in the Surface Water Monitoring Plan (Appendix IR302-1, page 4.3) *maintenance activities in the PDA to prepare the infrastructure for the next flood that would have a portion of its waters directed into the off-stream reservoir (from a decade to decades in the future).*

Alberta Transportation also states *The operation of the reservoir will occur infrequently (once every ten years), so the nature of the change is not anticipated to change the water quality of Elbow River or Glenmore Reservoir.*

a. Explain what is meant by the next diversion will occur *from a decade to decades in the future*?

b. Explain what is meant by the operation of the reservoir will occur *once every ten years*?

c. In both of these cases, are the terms *decade* and *once every ten years* referring to 1:10 year flood events when the flow will exceed 160 m^3/s which is close to the 1:10 year flood event? If so, then this is an incorrect interpretation of the definition of a 1:10 year flood event, to address frequency of maintenance activities and risk associated with water quality. The term 1:10 year flood indicates the probability of occurrence of that flood in a given year.

d. Provide the timeline by which the maintenance activities will be completed after a flood, so that the infrastructure is prepared for the next 1:10 year or bigger flood events that may occur the following year.

e. Explain what types of impacts the project may have on downstream licence withdrawals in the event the project is in operation more frequently (for example, with less than ten years gap in-between operations).

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a. The reference to "decade to decades" is a qualitative description of the frequency of operation of the Project, based on the current understanding of flood frequency. The flow threshold for activation of the Project is 160 m^3/s, which has an annual exceedance probability of 1:7 or 14%.

b. Over the available period of records of the last 105 years, Elbow River flows exceeded 160 m^3/s approximately 10 times, which averages to once every 10 years. This is an approximation because, as can be seen in Figure 58-1, there have been spans of 30 or more years which did not have flooding large enough that would have triggered Project flood operations. Conversely there was a period between 2005 and 2011 where the Project would have operated three times.

c. As described in the responses to a. and b., the flood scenarios are used to qualitatively describe the Project's expected frequency of operation. As stated in the response to a., the operational threshold of 160 m^3/s is equivalent to a 1:7 year flood flow and has an approximately 14% chance of occurring in any given year.

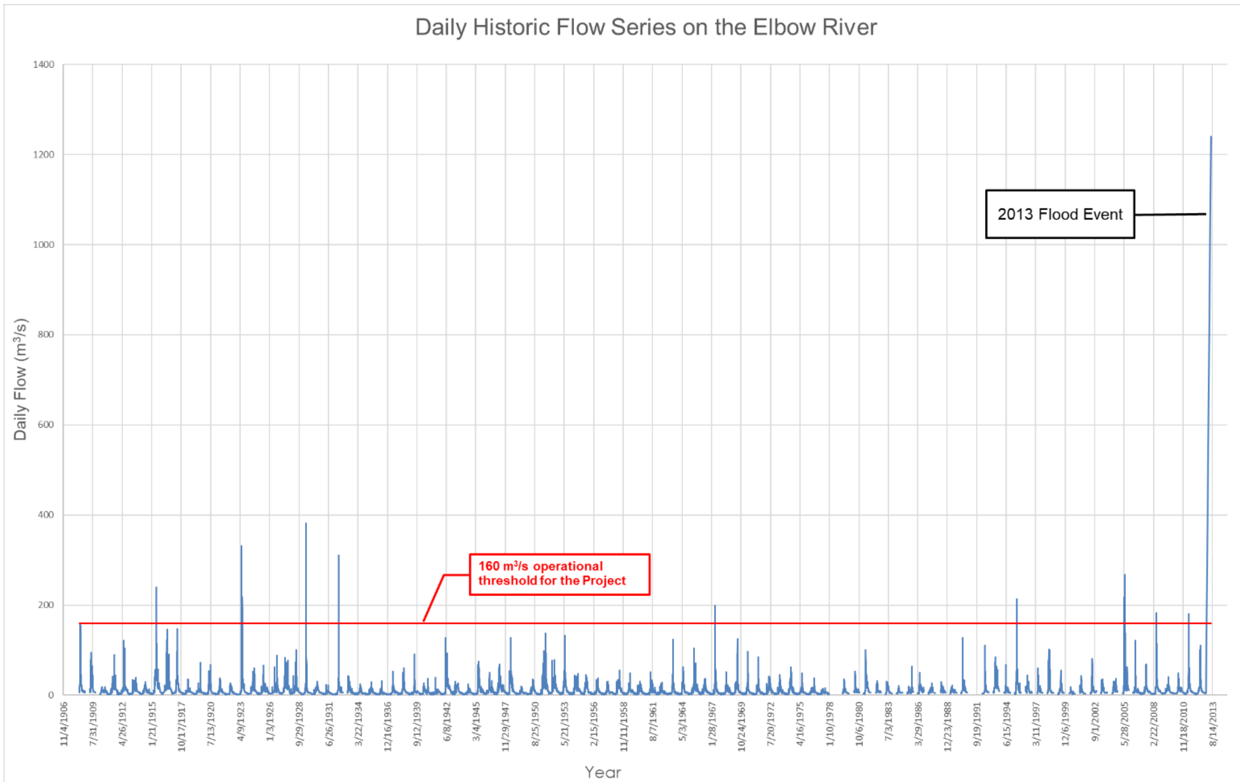


Figure 58-1 Historic Flows in Elbow River

d. Post-flood maintenance activities would be completed in the same year as a flood event, following full drawdown of the reservoir and once the risk of additional floods have passed. Depending on the magnitude of the flood and its impacts, maintenance activities could range from days to months.

Annual inspections will be carried out in advance of each flood season, so the Project is prepared for operation. Any maintenance activities identified by the inspections will be completed prior to the onset of the flood season.

e. Flood operations of the Project will only occur when river flows are greater than 160 m^3/s so that flood flows in the river remain at 160 m^3/s, leaving ample surface water available for downstream users. Available withdrawal rates for licences downstream of the Project total a maximum of 13.35 m^3/s. This equates to roughly 8.3% of the available 160 m^3/s total river flow while the project is diverting. The largest licence on Elbow River is the City of Calgary, which can divert up to 12.74 m^3/s.

Regardless of the Project's frequency of operation, downstream withdrawal licences will not be curtailed or affected since diversion during Project operation does not occur until flows on the river exceed 160 m^3/s and that flow will be maintained, even with diversion.

In addition, the holder of the largest of the downstream water licence receives a direct benefit in water security from the project as they will no longer need to allocate as much active storage in Glenmore Reservoir to flood control. Other downstream water licence holders with infrastructure on the Elbow River will receive a direct benefit from the Project by its reduction in flood risk to their infrastructure.

Question 59

Supplemental Information Request 1, Question 272, Page 5.86

a. **The response to SIR1 question 272 is not relevant to the question asked. Provide the correct response.**

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a. the Hydrogeology TDR Update (see Alberta Transportation's response to Round 1 NRCB IR42, Appendix 42-1) provides additional baseline and modelling results, that replaces the Hydrogeology TDRs provided in the EIA, Volume 4, Appendix I.

The Project has the potential to change groundwater quantity through groundwater seepage into the diversion channel when dry (i.e., when the Project is not in operation). Groundwater seepage into the dry diversion channel would occur only in areas where the diversion channel is excavated to an elevation below the water table. Groundwater that seeps into the diversion channel (when dry) would infiltrate back into the groundwater system at a downstream location that is not saturated or continue to flow by gravity down the diversion channel and into the off-stream reservoir. Once there, groundwater seepage collected in the off-stream reservoir may infiltrate back into the ground (returning to the groundwater system) or, where the local infiltration capacity is exceeded, continue to flow overland into existing surface water drainage courses. There, groundwater seepage would become part of the surface water system, eventually draining through the outlet structure. The rate of groundwater seepage has been estimated to be small (approximately 0.013 m^3/s) relative to the baseline surface water flows (approximately 4 m^3/s during low flow winter months) in the local area, as is presented in the Hydrogeology TDR Update, Section 5.5.1.

To better understand how groundwater might react due to the Project during dry operations, a finite element subsurface flow and transport system (FEFLOW) groundwater model was developed to simulate current conditions and Project conditions. The modelling found that the net change in hydraulic head attributable to the Project during dry operations are limited to areas within and adjacent to the diversion channel (Figure 59-1).

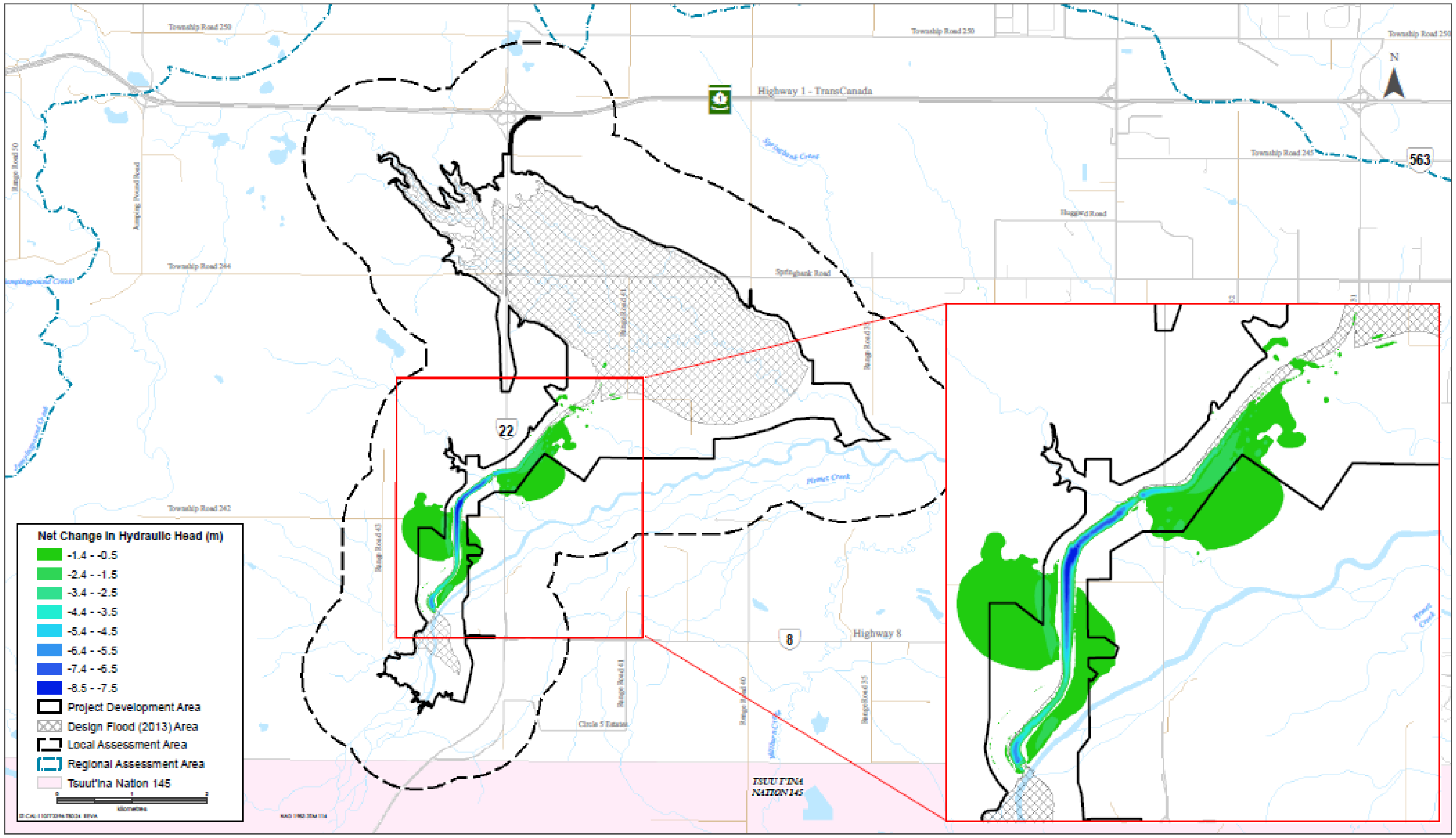


Figure 59-1 Simulated Net Change in Hydraulic Head

In southwestern areas of the diversion channel (near the inlet structure), net negative changes in groundwater levels of up to 7.5 m are predicted due to the incision of the diversion channel into the ground surface below the groundwater table level. Excavation of the diversion channel results in seepage at the face, causing localized lowering of the groundwater table as groundwater discharges into the dry channel. The extent of the changes in potentiometric head (i.e., the elevation of the water table) are limited to near the diversion channel and well within the LAA.

Question 60

Supplemental Information Request 1, Question 274, Page 5.88
Supplemental Information Request 1, Appendix IR274-1, Table IR274-1, Page 274-1.1
Supplemental Information Request 1, Appendix IR274-1, Table IR274-2, Page 274-1.15

a. Identify the ten groundwater and six surface water licences located within the PDA that will be affected, in Table IR274-1 and Table IR274-2 of Appendix IR274-1.

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a. The six affected surface water withdrawal licenses referenced in Alberta Transportation's response to Round 1 AEP IR274c are provided in Table 60-1, which also includes one additional surface water license not originally referenced in IR274c, Appendix IR274-1, Table IR274-2; this is highlighted in **red**.

   The ten affected groundwater license holders within the PDA referenced in IR274c are provided in Table 60-2.

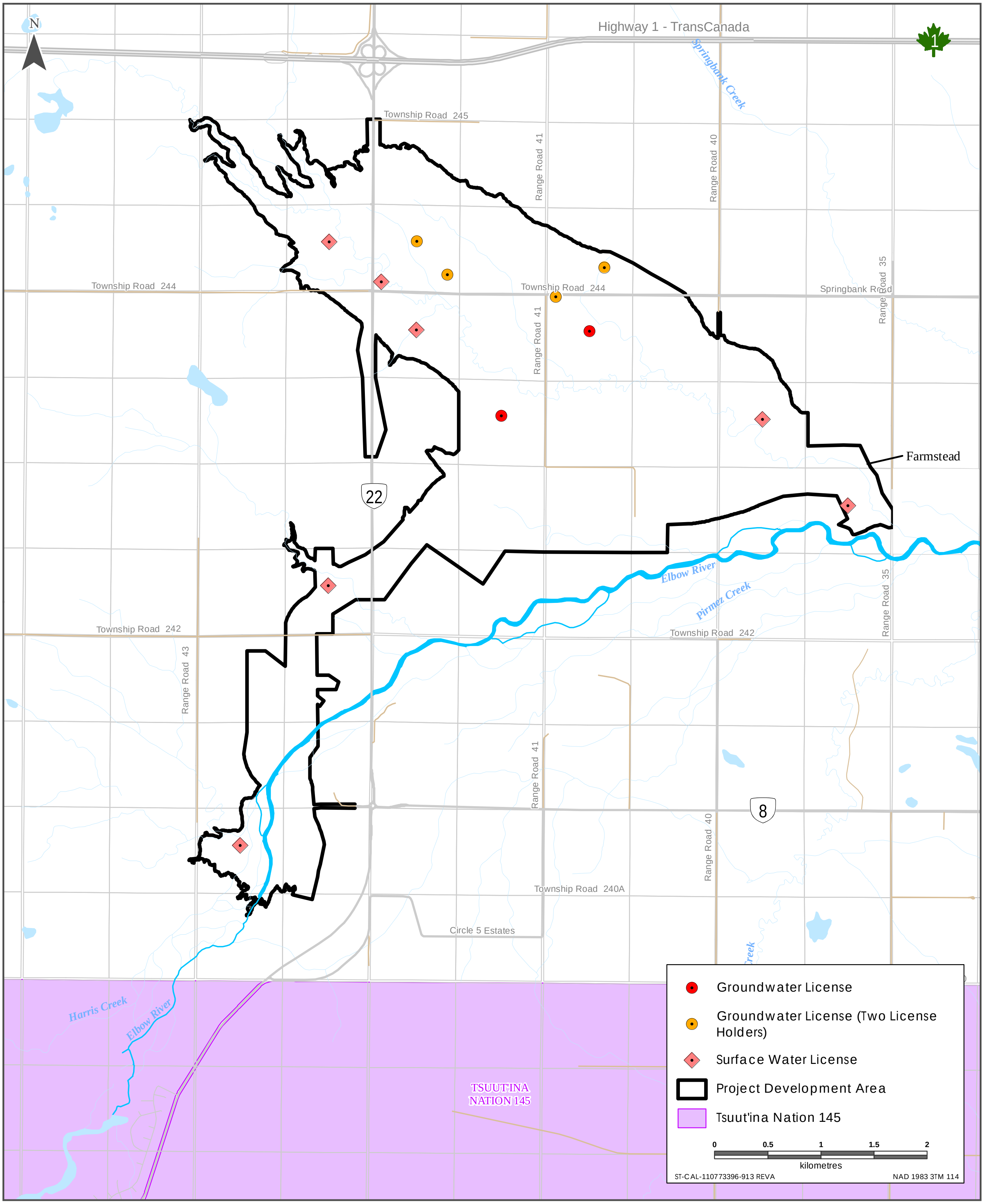
   Figure 60-1 provides the location of the groundwater and surface water licenses within the PDA. The ten groundwater license holders share six groundwater licenses, which are shown on Figure 60-1. Refer to Table 60-2 for groundwater license details.

Table 60-1 Surface Water Licences and Allocations in the PDA

Priority	Applicant	Project	Interim_licence_number	Approval ID	Latitude	Longitude
19880318005	ALBERTA TRANSPORTATION	ALTA TRANSPORTATION, WR, 41777	14359	23525	51.0679	-114.4657
19641231087	COPITHORNE, ROBERT	COCHRANE/FARM UNIT/COPITHORNE ROBERT - F00163401	00163401 00 00	163401	51.071202	-114.460933
19631231195	MARSHA WAGNER	CALGARY/FARM UNIT/WAGNER MARSHA-F00183452	00183452 00 00	183452	51.071262	-114.472721
18940701056	GARDNER CATTLE COMPANY LTD	CALGARY/FARM UNIT/GARDNER CATTLE CO - F00160591	00160591 00 00	160591	51.04919	-114.402784
19981229540	**COPITHORNE, BRIAN**	**COCHRANE/FARM UNIT/COPITHORNE BRIAN - F00163271**	**00163271 00 00**	**163271**	**51.0201**	**-114.484139**
19821231076	COPITHORNE, SAM	COCHRANE/FARM UNIT/COPITHORNE SAM - F00161652	00161652 00 00	161652	51.05644	-114.41432
19661231058	COPITHORNE, ROBERT	COCHRANE/FARM UNIT/COPITHORNE ROBERT - F00163401	00163401 00 00	163401	51.04215	-114.472543

Table 60-2 Groundwater Licences and Allocations in the PDA

Priority	Applicant	Project	Interim_licence_number	Approval ID	Latitude	Longitude
19890417014	COPITHORNE, ROBERT	COPITHORNE, WR, 23670	16787	27702	51.0684	-114.4568
19890417014	COPITHORNE, BRIAN	COPITHORNE, WR, 23670	16787	27702	51.0684	-114.4568
19890417013	COPITHORNE, ROBERT	COPITHORNE, WR, 23670	16786	27703	51.0666	-114.4422
19890417013	COPITHORNE, BRIAN	COPITHORNE, WR, 23670	16786	27703	51.0666	-114.4422
19611231213	COPITHORNE, ROBERT	COCHRANE/FARM UNIT/COPITHORNE BRIAN - F00163271	00163271 00 00	163271	51.071202	-114.460943
19611231214	COPITHORNE, BRIAN	COCHRANE/FARM UNIT/COPITHORNE BRIAN - F00163271	00163271 00 00	163271	51.071202	-114.460943
19890417010	COPITHORNE, ROBERT	COPITHORNE, WR, 23670	16784	27705	51.0691	-114.4357
19890417010	COPITHORNE, BRIAN	COPITHORNE, WR, 23670	16784	27705	51.0691	-114.4357
19821231072	COPITHORNE, ALAN	COCHRANE/FARM UNIT/COPITHORNE ALAN - F00161619	00161619 00 00	161619	51.05649	-114.449413
19601231161	COPITHORNE, KATHLEEN	BRAGG CREEK/FARM UNIT/COPITHORNE KATHLEEN - F00163116	00163116 00 00	163116	51.063666	-114.437635



Sources: Base Data - Government of Canada. Thematic Data - Government of Alberta

Groundwater and Surface Water Licenses within the PDA

Stantec

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT

Figure 60-1

Question 61

Supplemental Information Request 1, Question 289, Page 5.114

Alberta Transportation states *The influence of all aspects of water operations on hydrology, due to the combined operations of the Project and the Glenmore Reservoir*.

a. This sentence is not complete. Provide the complete sentence and fully address the questions asked in 289(a).

Response

a. The sentence should not have been included in the response. Alberta Transportation's response to Round 1 AEP IR289(a) should have read:

"~~The influence of all aspects of water operations on hydrology, due to the combined operations of the Project and the Glenmore Reservoir~~. The analysis of the influence of the operation of the Project on hydrology included Glenmore Reservoir."

Since filing the responses to the Round 1 IRs in June 2019, Alberta Transportation has examined different release scenarios from the Project to evaluate how this would change total suspended sediment flowing into Elbow River. These examinations are the result of discussions with DFO and AEP and involve considering an earlier release of water from the reservoir than was assumed in the EIA or the Round 1 IRs. The modelling results related to an earlier release revise the response to Round 1 AEP IR289a. See the response to NRCB Question 15, Appendix 15-1 for the additional modelling. For early release, water is released while the flow in Elbow River is still high, but below 160 m^3/s. This allows for water with high TSS from the reservoir to enter water with high TSS in Elbow River. The modelling includes Glenmore Reservoir and describe the impact of the off-stream reservoir flood operation on Glenmore Reservoir in terms of hydrology and sedimentation.

4.3 SURFACE WATER QUALITY

Question 62

Supplemental Information Request 1, Question 293, Page 5.124—5.130
Volume 3A, Section 6, Figure 6-12, Page 6.31
Volume 4, Appendix J, Section 2.4.2, Page 2.32

Alberta Transportation identified the boundary condition of the three modelling domains. No tributaries were identified. For example, for Model Domain (I) there were no tributaries identified to supplement the flow and suspended sediment loading coming from the upstream boundary condition at Bragg Creek. However, Figure 6-12, V. 3A, S06 includes five tributaries in the local assessment area. Furthermore, Vol 4-J page 2.32 indicates that the flow of tributaries between Bragg Creek and Sarcee Bridge was estimated.

a. Indicate how the flow and sediment from tributaries were considered in the model input.

b. If no tributaries were considered, explain why not and include the implications for sediment transport and water quality.

c. How would this affect the uncertainty of the modelling results?

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a. Hydrologic modelling was undertaken to understand the flow contributions from the tributaries to the Elbow River mainstem. Flow and sediment from tributaries were not considered in the Mike21 MT model.

b. The contribution of flow and sediment from the tributaries entering Elbow River downstream of the Project are not changed by the Project and, therefore, would not be relevant for the assessment. The relative contribution of flow from tributaries downstream of the Project is approximately 10% of the total flow in the mainstem for the three hydrographs assessed.

   The timing of the peak flows from the tributaries would likely occur prior to the Elbow River peak flow; thus, their contributions to sediment transport and water quality would likely occur prior to Project operation. The contribution of flow and sediment from tributaries upstream of the Project are accounted for in the model input as the information used is representative of all upstream contributions.

c. One of the objectives of the Mike21 MT model is to model effects of the Project on flow and sediment transport in Elbow River relative to baseline conditions. Contributions of flow and suspended sediment from the tributaries to Elbow River are not changed by the Project. These contributions potentially have different timing (peak prior to the Elbow River peaks) and are minor contributors to sediment transport and water quality (i.e., TSS) relative to what would be in the Elbow River mainstem. Therefore, not including the tributaries in the Mike21 MT model does not add to the model uncertainty related to predictions.

Question 63

Supplemental Information Request 1, Question 295, Page 5.131—5.134

Alberta Transportation discussed the implications of using different lengths of time to drain the reservoir (SIR1 295 [a]). However, the different scenarios presented with variations of gate openings do not provide the estimation of the TSS concentrations expected.

a. For the three scenarios (release gate at 75%, 50%, and 25% open), indicate the predicted average and maximum TSS concentrations:

   i. leaving the reservoir; and

   ii. in the Elbow River 1 km below the confluence with the unnamed Creek

b. Compare and discuss these results with the previously provided results when the gate is 100% open.

Response

a. The results below are provided from the updated MIKE 21 FM-MT model. Table 63-1 provides the predicted average (mean) and maximum (max) TSS concentrations: 1) leaving the LLOW and 2) in Elbow River 1 km below its the confluence with unnamed creek (1 km downstream) for the design flood. The 25% gate open condition was not run because that condition results in a release duration of 142 days, to November 13, for early release and to December 4 for late release. Therefore, the 25% gate open condition is not practical to implement.

   Table 63-1 shows the duration of the release time (i.e., the time it takes for the reservoir to empty) increases from 35.4 days, when the LLOW gate is 100% open, to 70.8 days, when the gate is 50% open, for early release. Late release shows a similar trend, but typically takes almost one day longer than for early release. The table also highlights the reduction in both maximum and average TSS the longer water is held in the reservoir as a result of particles settling out of the water column.

Table 63-1 Predicted Maximum and Average TSS Concentrations (mg/L) for the Low-Level Outlet Gate Openings During Water Release Following a Design Flood

Low-Level Outlet Gate Open Percentage	Location	Early Release (Elbow River Flow is Less Than 160 m^3/s)			Late Release (Elbow River Flow is Less Than 20 m^3/s		
		Duration of Release (Days)[1]	Max. TSS (mg/L)	Mean TSS (mg/L)	Duration of Release (Days)[1]	Max. TSS (mg/L)	Mean TSS (mg/L)
100%	Low-level outlet	35.4	12,359	5,738	36.7	6,959	2,626
	1 km d/s[2]		2,970	1,794		3,348	1,215
75%	Low-level outlet	47	12,113	4,997	47.6	6,920	2,326
	1 km d/s[2]		2,419	1,389		2,814	967
50%	Low-level outlet	70.8	12,088	4,007	71.4	6,907	1,914
	1 km d/s[2]		1,967	941		2,227	656

NOTES:
[1] Duration of release is calculated using the time to drain the reservoir
[2] 1 km d/s = 1 kilometre downstream of the confluence of the unnamed creek with Elbow River

b. The predicted average and maximum TSS concentrations in the river depend upon the opening percentage of the low-level outlet gate. For both late release and early release, the predicted average and maximum TSS concentrations decline slightly with reduction in percentage of gate opened because the reduced release rates result in longer retention time for water in the reservoir: the longer retention time leads to an increase in the volume of suspended sediment settled from the water column, resulting in corresponding lower TSS values within the water column of water that is discharged to the river.

For all scenarios (three floods, two release options), there is a substantial reduction in maximum and mean TSS in Elbow River 1 km downstream, relative to the low-level outlet, due to dilution and advection processes within Elbow River. The higher average and maximum values during early release is related to the high TSS levels in Elbow River because the release occurs while the river is still in flood.

Question 64

Supplemental Information Request 1, Question 296, Page 5.138

Alberta Transportation states *In this study, the dry, flood and wet depths were set to 0.01, 0.05 and 0.1 m, respectively*.

a. Confirm that the depth of 0.05 m represents flood and 0.1 m wet conditions.

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a. The default value for flooding depth (h_{flood}) is 0.05 m and for wetting depth (h_{wet}) is 0.1 m. These values are the recommended values in the Mike 21 Flow Model FM user guide (DHI 2017). The "dry, flood and wet depth" terms represent technical terms specific to the DHI modelling software and are used for computational purposes when a cell in the model is either "dry, flood or wet". These terms do not represent water depths specific to the Project during dry, flood or wet conditions.

REFERENCES

DHI. 2017. MIKE 21 Flow Model FM, Hydrodynamic Module, User Guide. Available at: https://manuals.mikepoweredbydhi.help/2017/Coast_and_Sea/MIKE_FM_HD_2D.pdf.

Question 65

Supplemental Information Request 1, Question 297, Page 5.140—5.142
Supplemental Information Request 1, Question 293, Page 5.124
Supplemental Information Request 1, Appendix IR302-1, Table 9-1, Page 9.4.
Volume 3B, Section 6.4.3.2, Figure 6-15, Page 6.36.

Alberta Transportation indicates through their responses variations of this statement: *Potential changes in water quality (i.e. concentrations and loads) associated with increases in TSS at the end of the period of water release from the reservoir are expected to be small compared to what could be expected during a flood in the absence of the project*. Alberta Transportation explains the effect of the project by having a net reduction of the annual TSS. However, this reduced load is moved from a short high-flow period to a longer clear flow period, and at a more sensitive time of the year for nutrient uptake. The guideline exceedances during the time of release still need to be well characterized for evaluation of the project. As per Table 9-1 in Appendix IR302-1 different exceedance levels are appropriate depending on the background TSS conditions. Without the project, the background concentration is high. However, the post-flood operations will release peak TSS concentrations under a clear period and for over 24 hours.

The report shows results up to 1 km downstream from the release stating this is *i.e. the farthest point in Elbow River downstream where suspended sediment was modelled*. However, the model domain (SIR1 293) is up to the Glenmore Reservoir. The modelling results showed that for the last days of release the sediment concentration would be significantly higher than the background concentration producing guideline exceedance at 1 km below the release (e.g. Figure 6-15, Vol 3B).

a. **What is the spatial extent for potential adverse effects of sediment released from the off-stream reservoir for each flood scenario (i.e. what is the most downstream location where guidelines are exceeded)?**

b. **For how many days does the model predict exceedances of instream guidelines for each flood scenario? Identify the change in exposure time for the project (post-flood operations) and current conditions (flood without the off-stream reservoir).**

c. **Provide graphs and maps to understand the extent of the guideline exceedances.**

Response

a. An updated MIKE 21 FM - MT (mud transport) module modelled the without the Project (no Project) for early release (provided in further detail in the Introduction section) and late release for each of the three floods. Early release entails release of water when the flow in Elbow River decreases to less than 160 m^3/s. The rate of release slowly decreases to limit fish stranding.

   Late release occurs when flow in Elbow River is less than 20 m^3/s.

   The following CCME TSS guidelines for the protection of aquatic life are used to determine exceedances during the release of water held in the reservoir:

   1. CF indicates that the background is less than 25 mg/L. If any exceedance lasts longer than 24 hours, the long-term guideline is “triggered” and a change in TSS of 5 mg/L or more is an exceedance for the entire time series.
   2. High-flow indicates that the background is between 25 mg/L and 250 mg/L. Change in TSS of more than 25 mg/L is an exceedance.
   3. High-flow indicates background is greater than 250 mg/L. Change in TSS of more than 10% of background is an exceedance.

Exceedances calculated as occurring prior to release from the LLOW are likely due to reworking of deposited fine-grained sediment by Elbow River and are excluded. The results without the Project for each of the three floods are used as baselines to predict exceedances. The predicted exceedances, therefore, capture the effect of the Project.

Exceedances are predicted at 12 sites in Elbow River between the low-level outlet and Glenmore Reservoir. The locations of the sites are shown in Figure 65-1.

Figure 65-2 shows an enlarged view of one of the plots generated to show TSS concentration at the sites for each flood and for early release and late release. Figure 65-3, Figure 65-4 and Figure 65-5 show the predicted TSS values and the predicted exceedances over time at the 12 sites for the three floods, respectively for early release. Figure 65-6, Figure 65-7 and Figure 65-8 show the predicted TSS values and the predicted exceedances over time at the 12 sites for the three floods, respectively, for late release.

The results show exceedances for the 1:10 year early release; 1:100 year early release and late release; and design flood early release and late release. The 1:10 year late release does not result in any exceedances. Figure 65-2 shows an enlarged view of one of the plots generated to show TSS concentration at the sites for each flood and for early release and late release. The example plot is taken from Figure 65-5, Site 13 (in Elbow River 1 km downstream of its confluence with the unnamed creek).

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

Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

P08-P20 Sample Locations From Mike 21 MT Model

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ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESEVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT

Figure 65-1

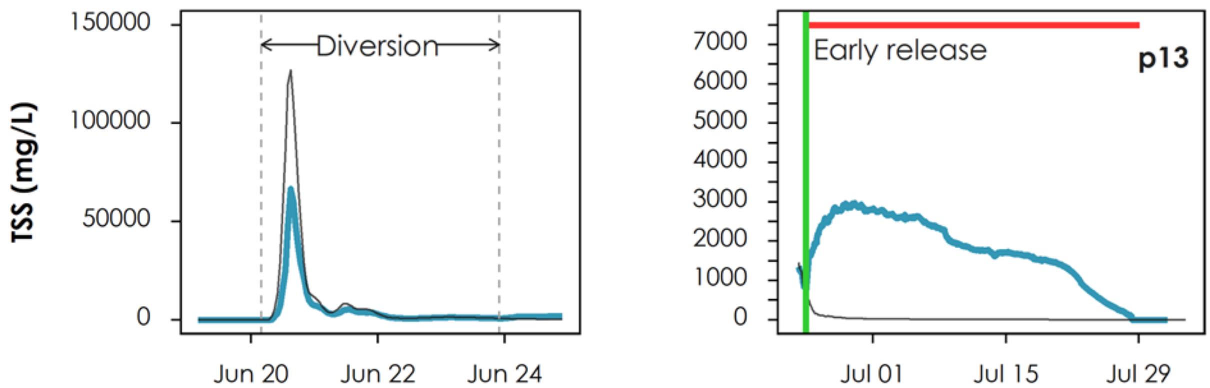

Figure 65-2 Example Diagram of Exceedance Plots

In Figure 65-2, the x-axis shows time and the y-axis shows the predicted TSS concentrations, in mg/L. The first plot on the left shows the predicted concentrations of without the Project (baseline) represented by the black line and early release with the Project is represented by the blue line. The plot shows the predicted TSS values while the flows are being diverted into the reservoir; this period is indicated by the vertical dashed grey lines. No releases from the reservoir occur during this period of time. The differences observed between the black and blue lines highlight the reduction in TSS concentrations in Elbow River as a result of the Project.

The plot on the right provides a view of the TSS concentrations during early release; the start of the release is represented by the vertical green line (Figure 65-2). Without the Project (black line) and with the Project (blue line) TSS concentrations are provided. A horizontal red line shows the period during which the TSS water quality guidelines for the protection of aquatic life are exceeded, but it does not differentiate between the type of exceedance.

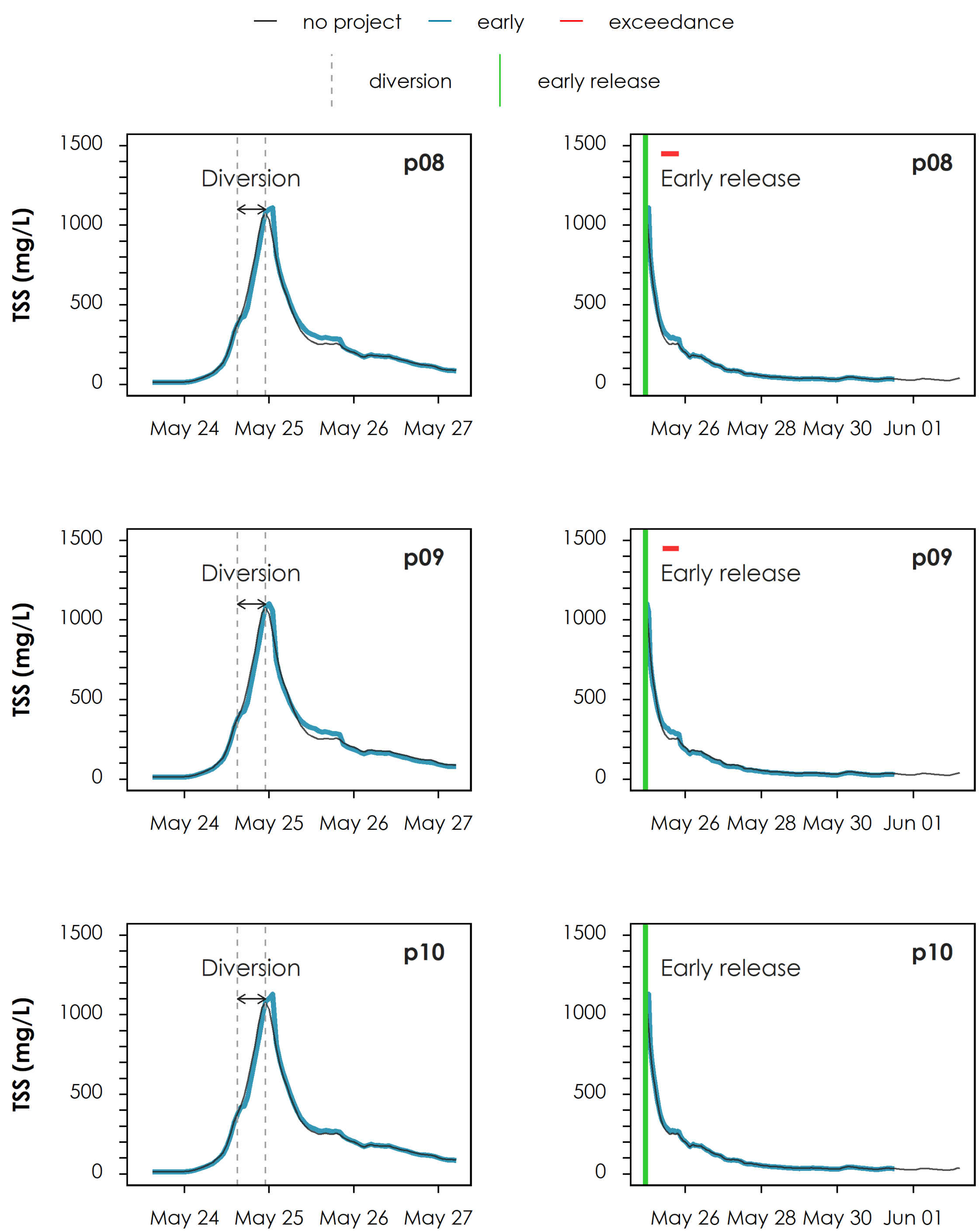

Figure 65-3 **Exceedances and TSS Concentrations for Early Release at Locations between LLOW and Glenmore Dam for the 1:10 Year Flood**

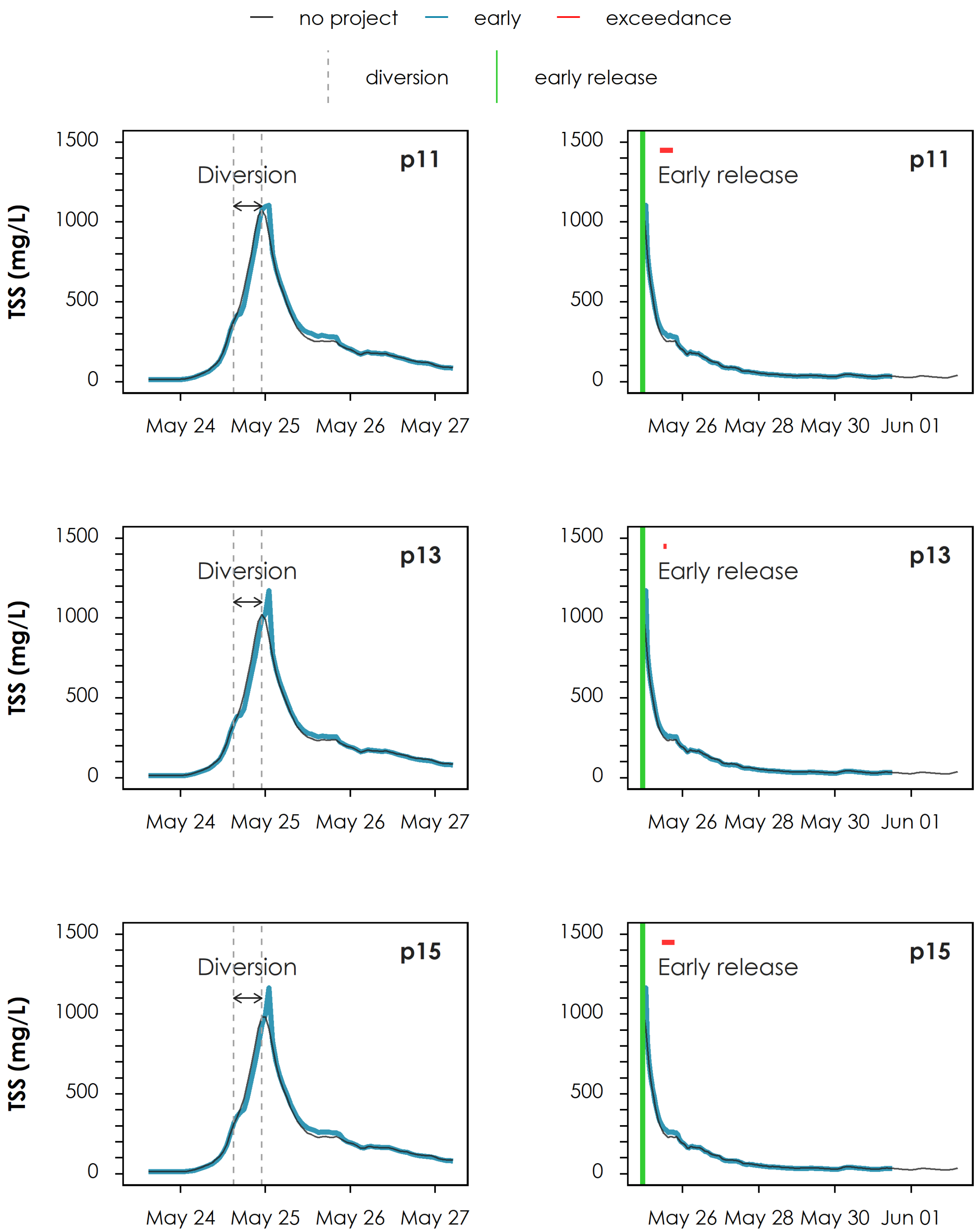

Figure 65-3 **Exceedances and TSS Concentrations for Early Release at Locations between LLOW and Glenmore Dam for the 1:10 Year Flood (cont'd)**

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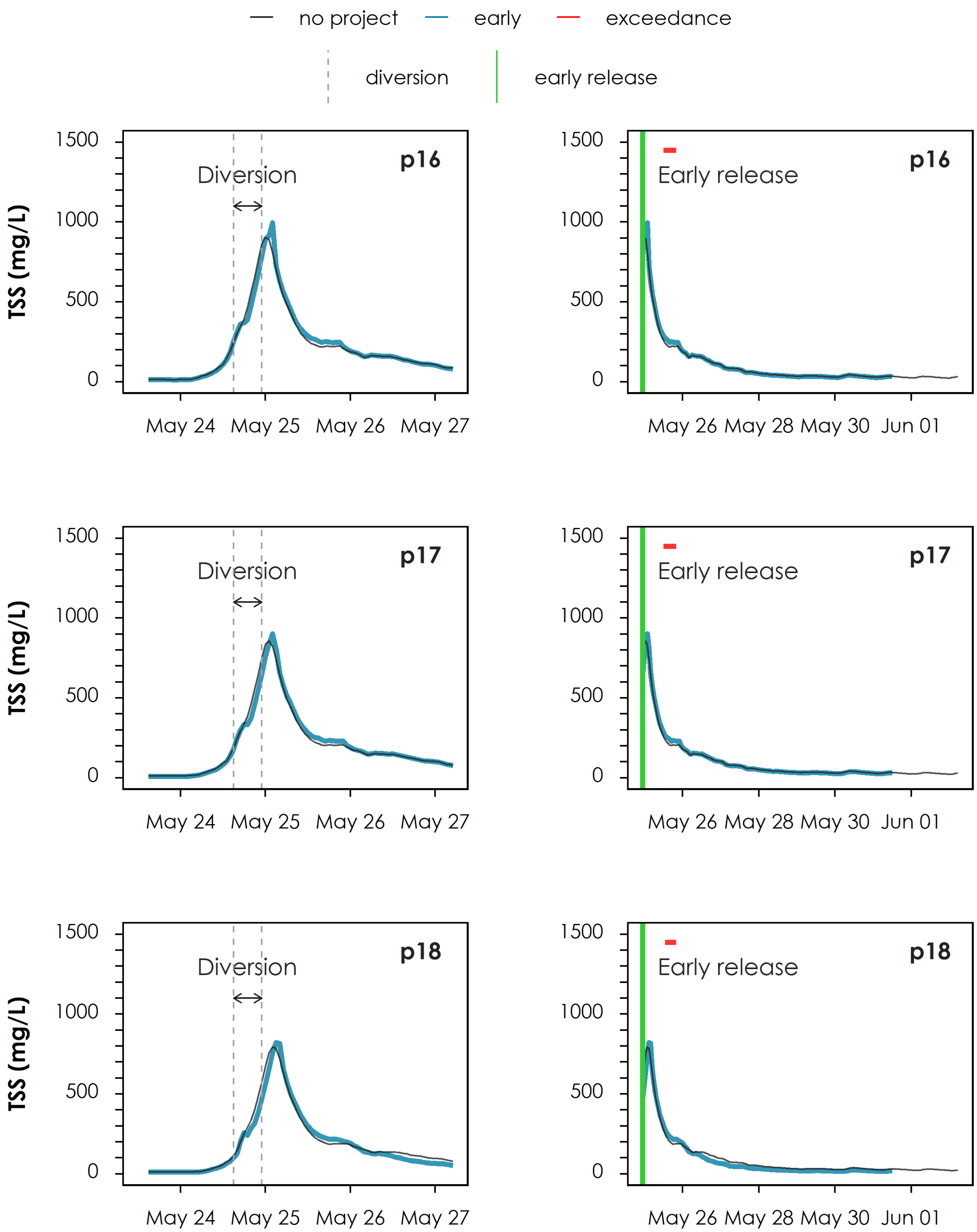


Figure 65-3 Exceedances and TSS Concentrations for Early Release at Locations between LLOW and Glenmore Dam for the 1:10 Year Flood (cont'd)

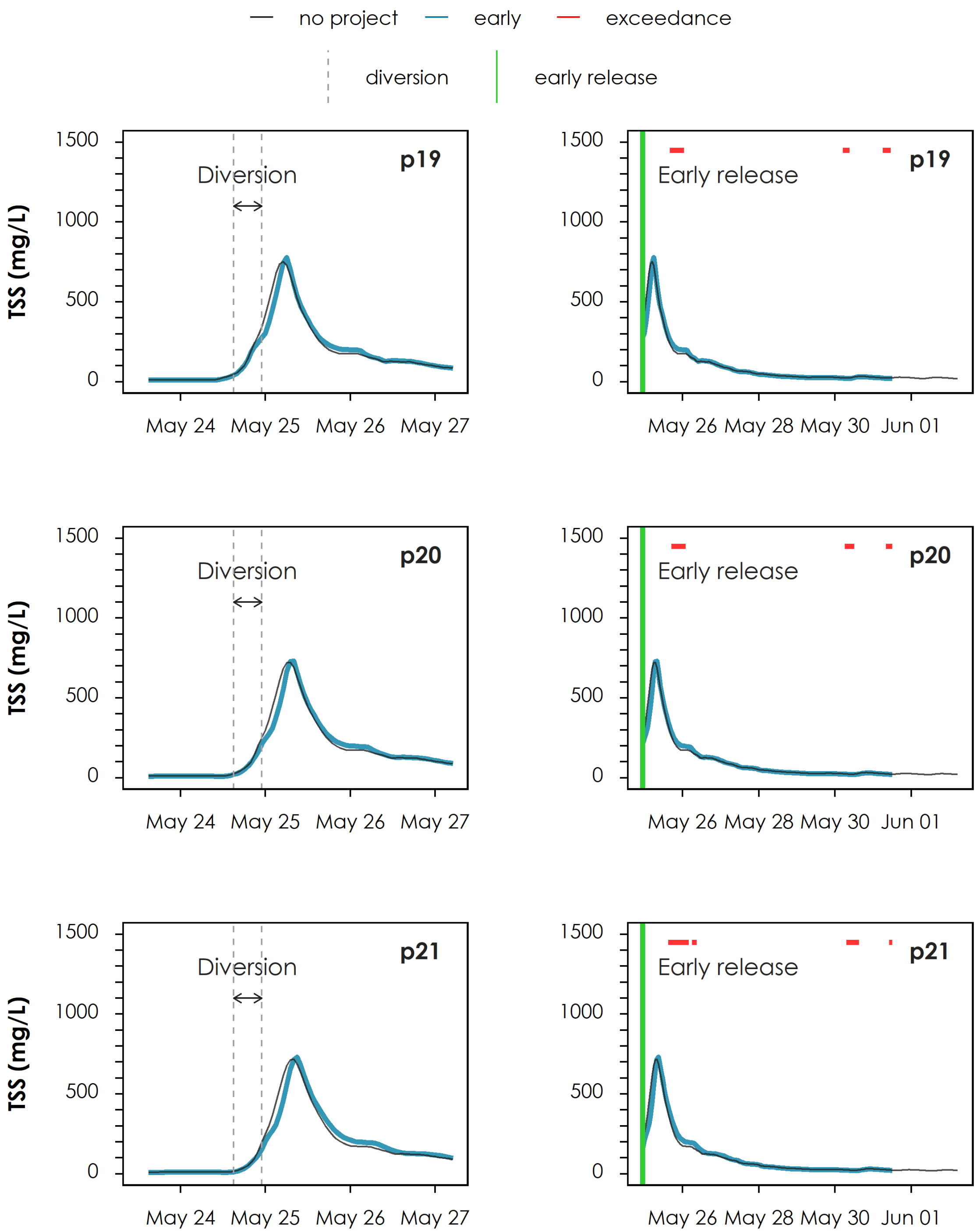


Figure 65-3 **Exceedances and TSS Concentrations for Early Release at Locations between LLOW and Glenmore Dam for the 1:10 Year Flood (cont'd)**

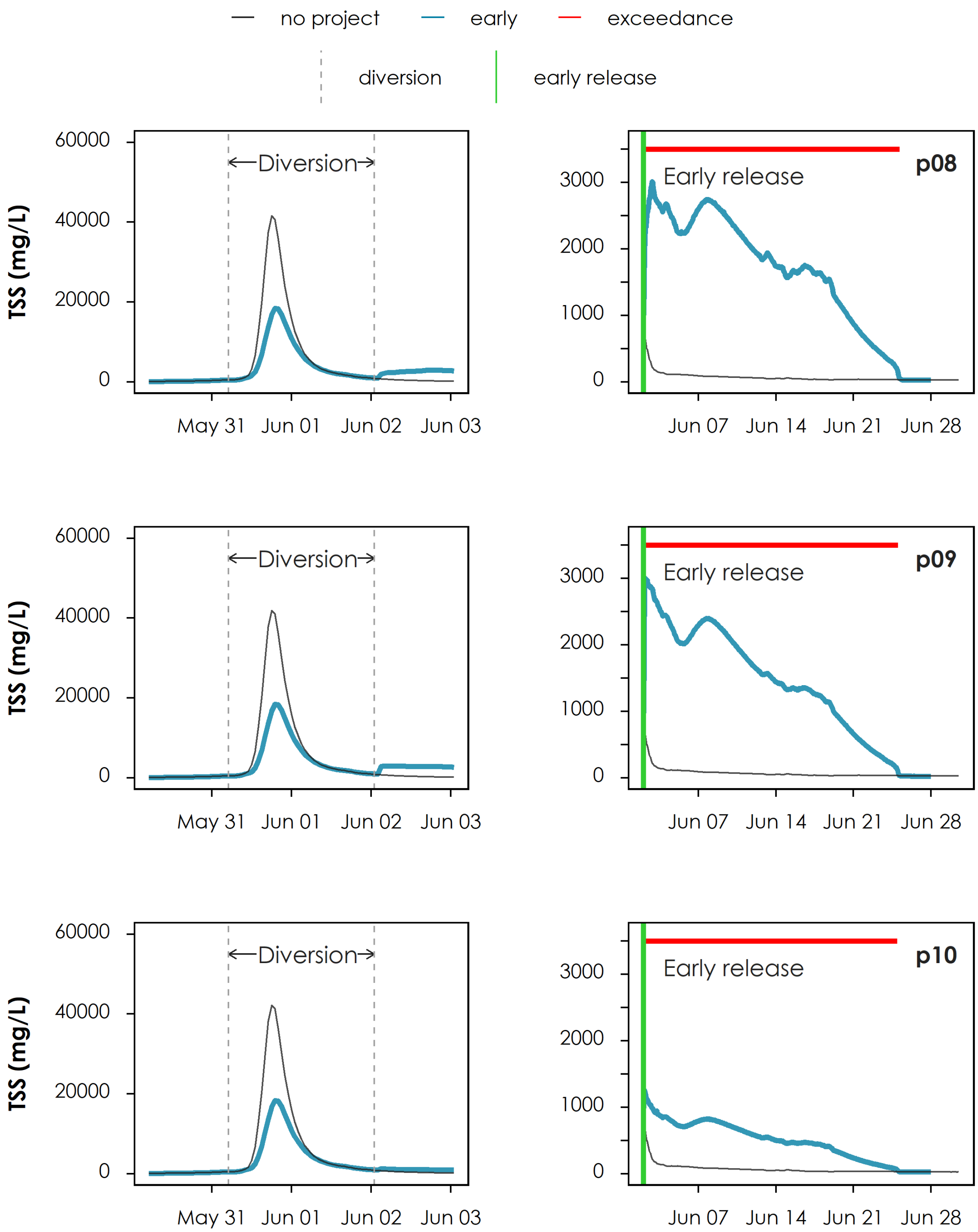


Figure 65-4 **Exceedances and TSS Concentrations for Early Release at Locations between LLOW and Glenmore Dam Predicted for the 1:100 Year Flood**

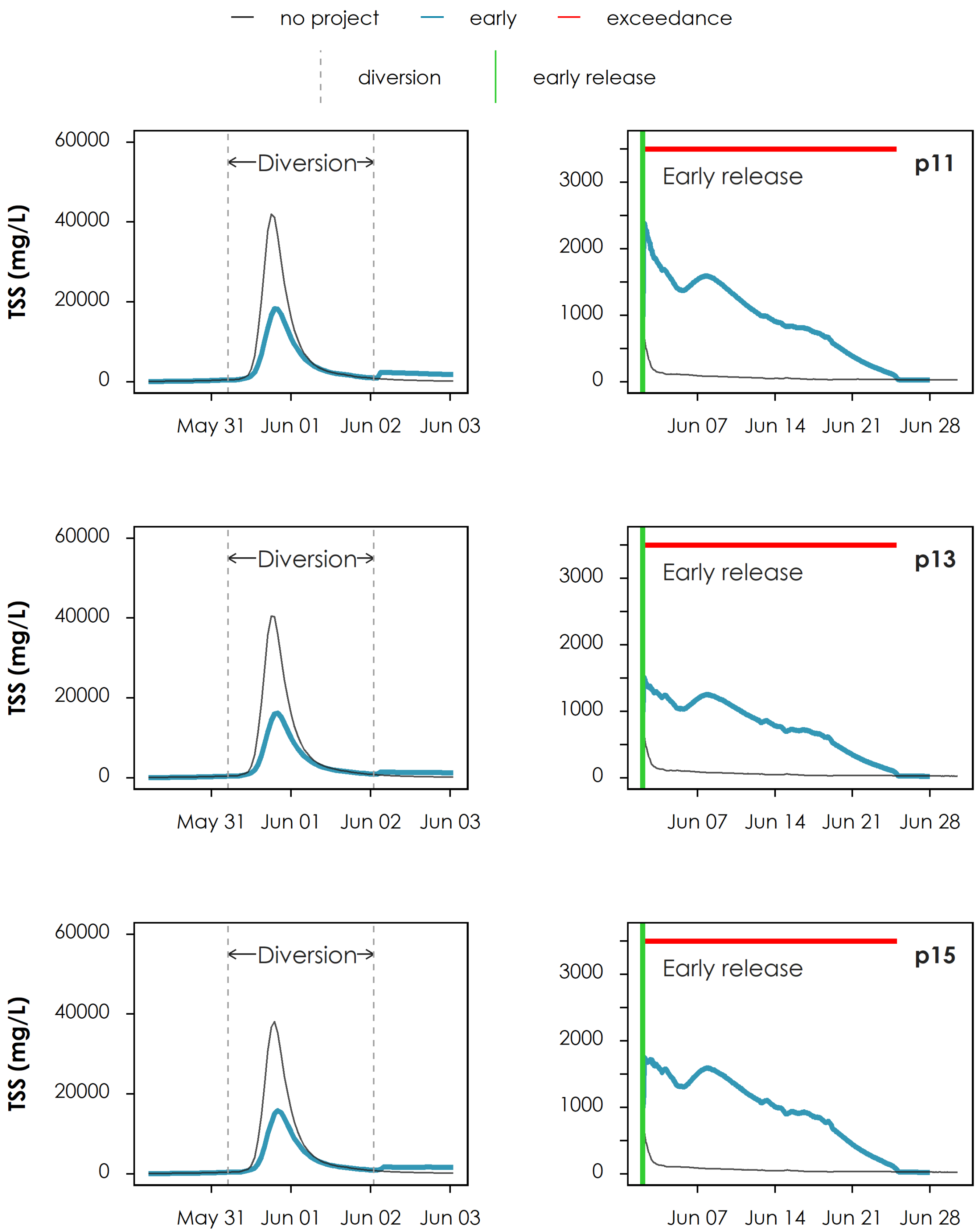


Figure 65-4 **Exceedances and TSS Concentrations for Early Release at Locations between LLOW and Glenmore Dam Predicted for the 1:100 Year Flood (cont'd)**

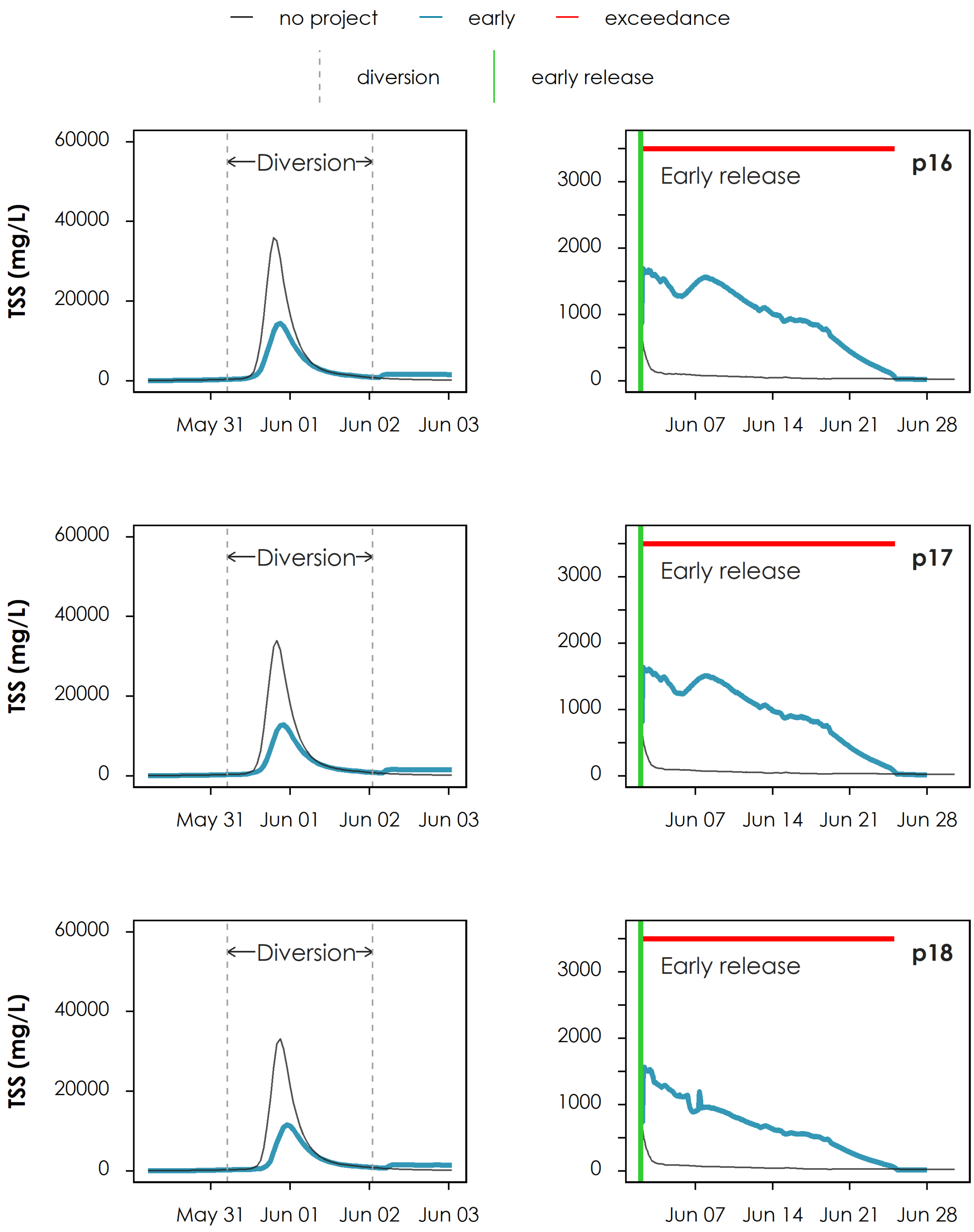


Figure 65-4 **Exceedances and TSS Concentrations for Early Release at Locations between LLOW and Glenmore Dam Predicted for the 1:100 Year Flood (cont'd)**

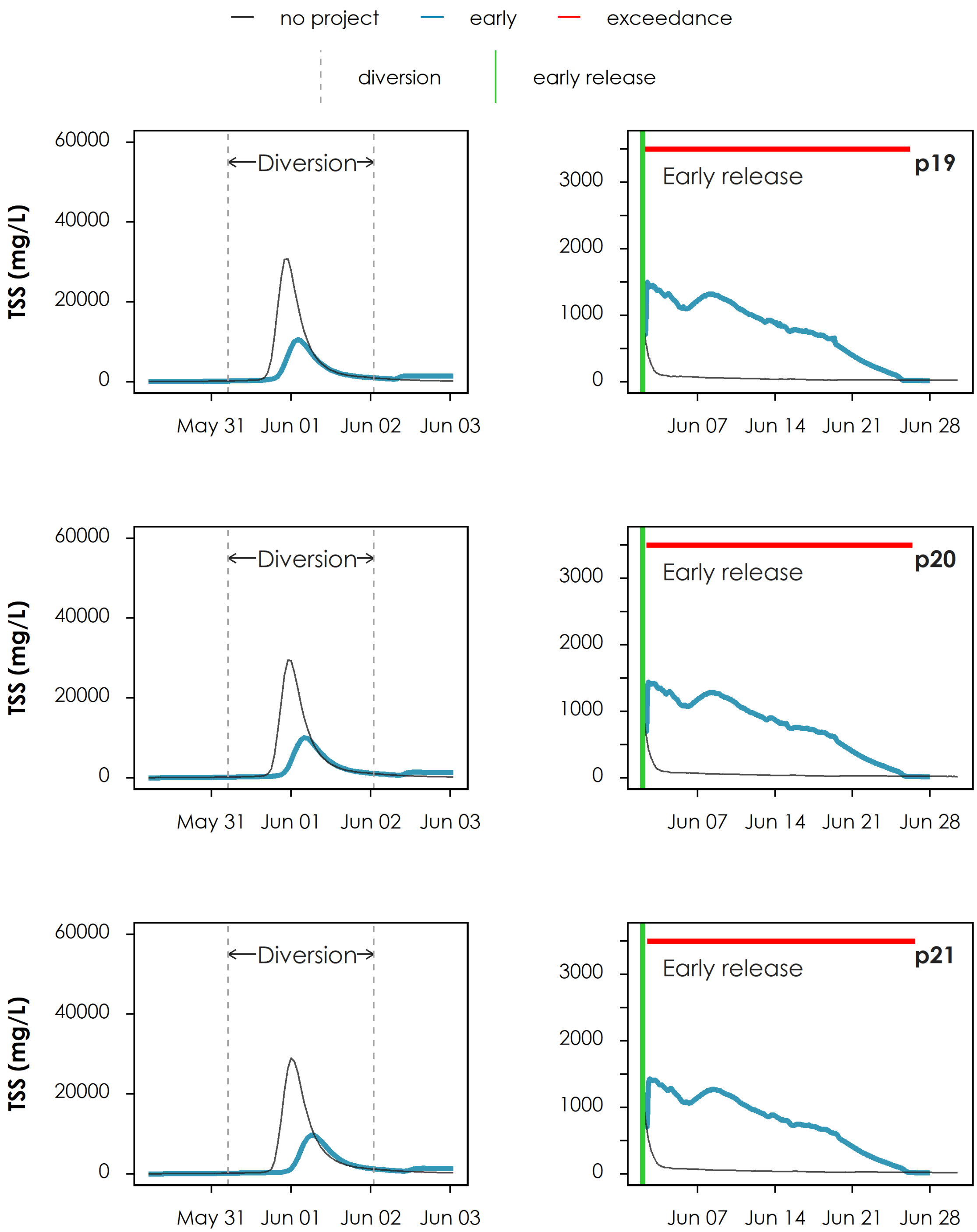


Figure 65-4 **Exceedances and TSS Concentrations for Early Release at Locations between LLOW and Glenmore Dam Predicted for the 1:100 Year Flood (cont'd)**

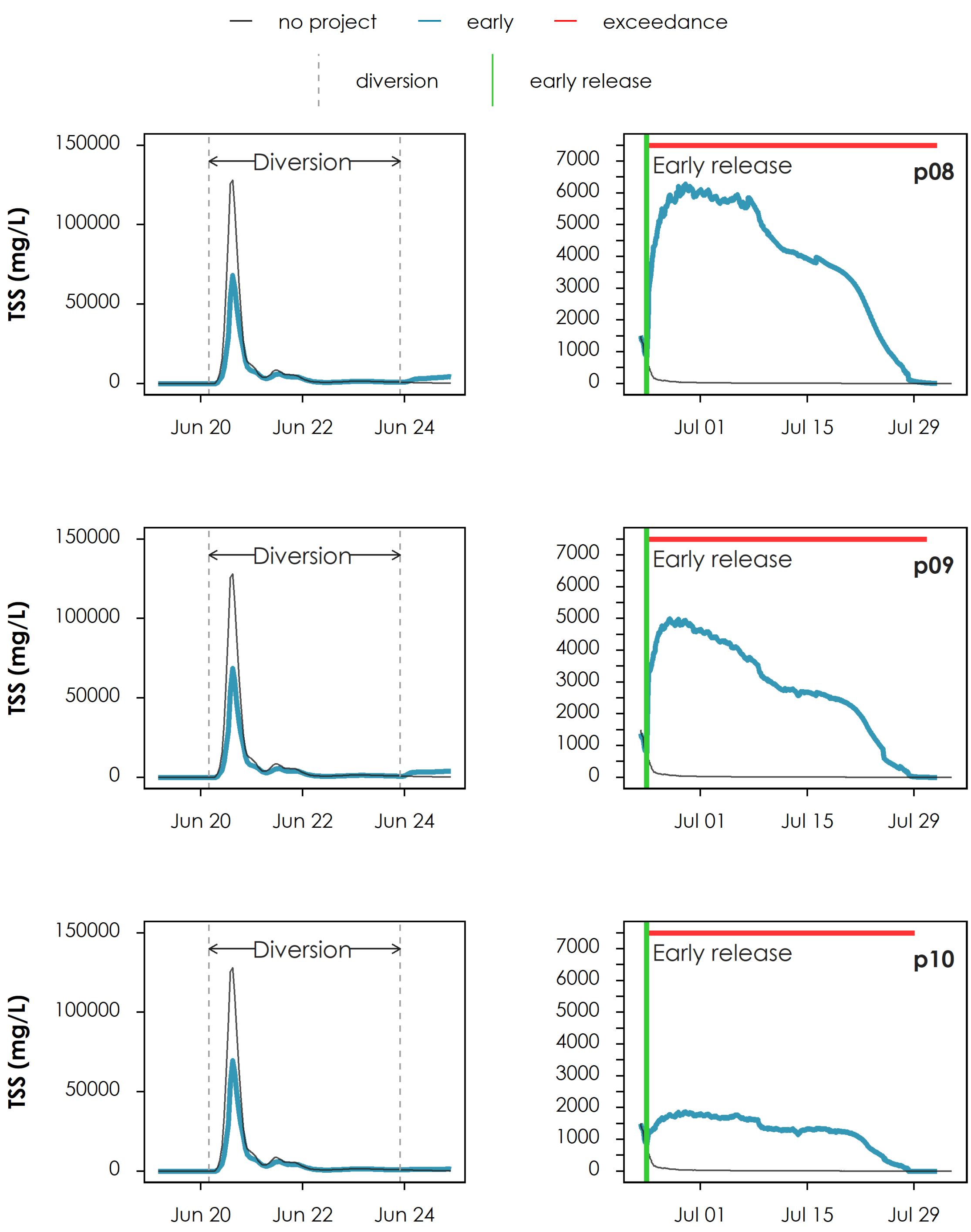


Figure 65-5 Exceedances and TSS Concentrations for Early Release at Locations between LLOW and Glenmore Dam Predicted for the Design Flood (2013)

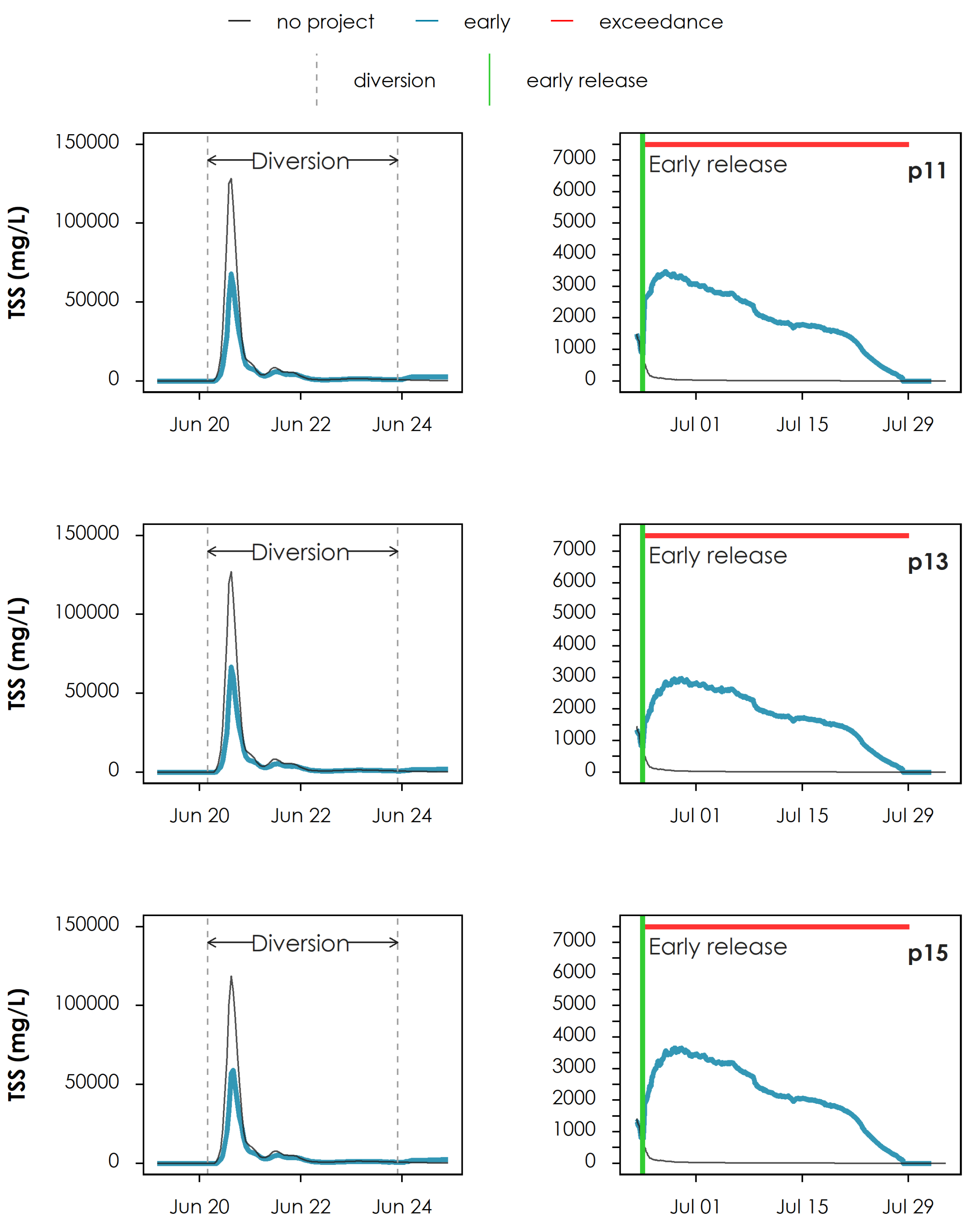


Figure 65-5 Exceedances and TSS Concentrations for Early Release at Locations between LLOW and Glenmore Dam Predicted for the Design Flood (2013) (cont'd)

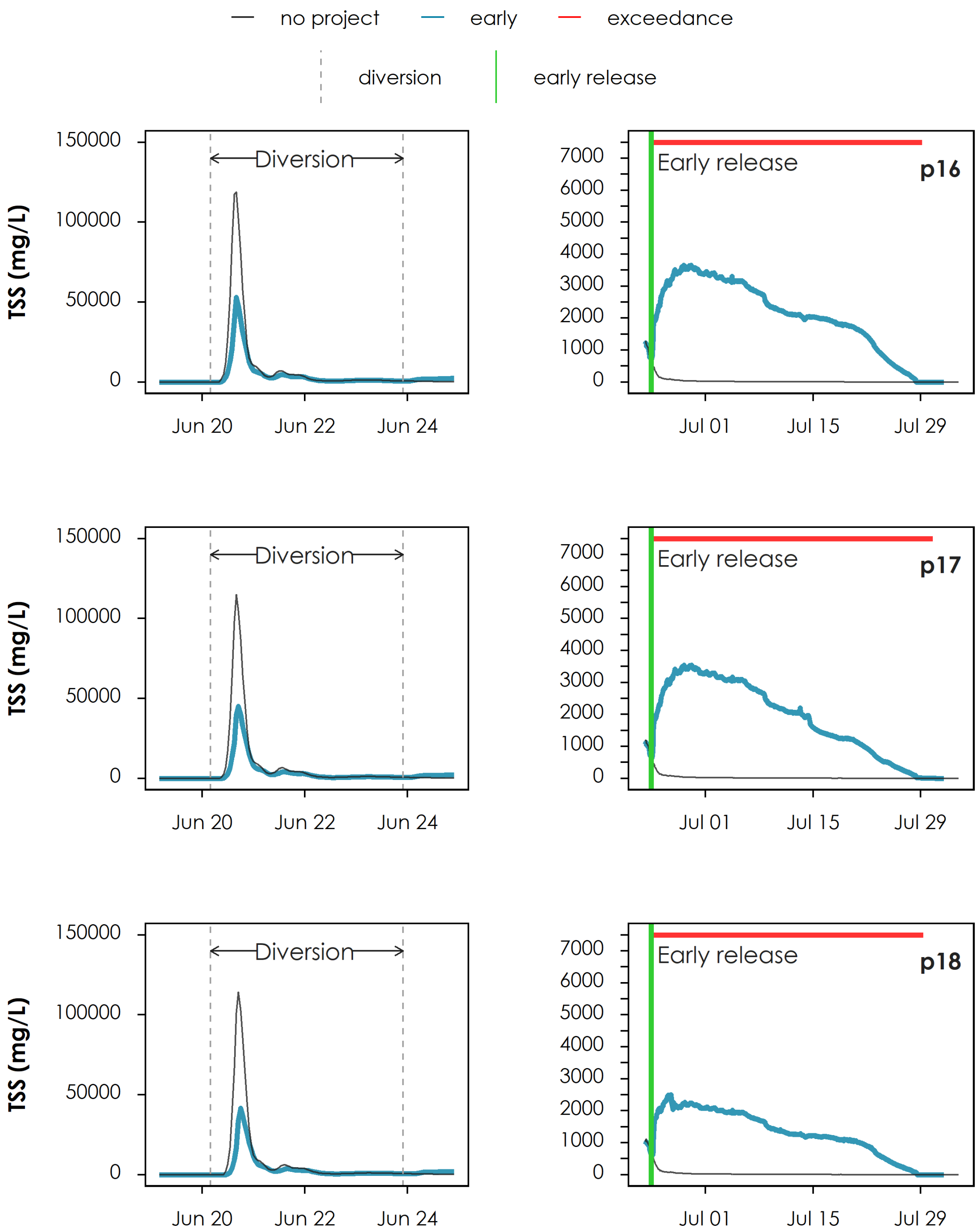


Figure 65-5 **Exceedances and TSS Concentrations for Early Release at Locations between LLOW and Glenmore Dam Predicted for the Design Flood (2013) (cont'd)**

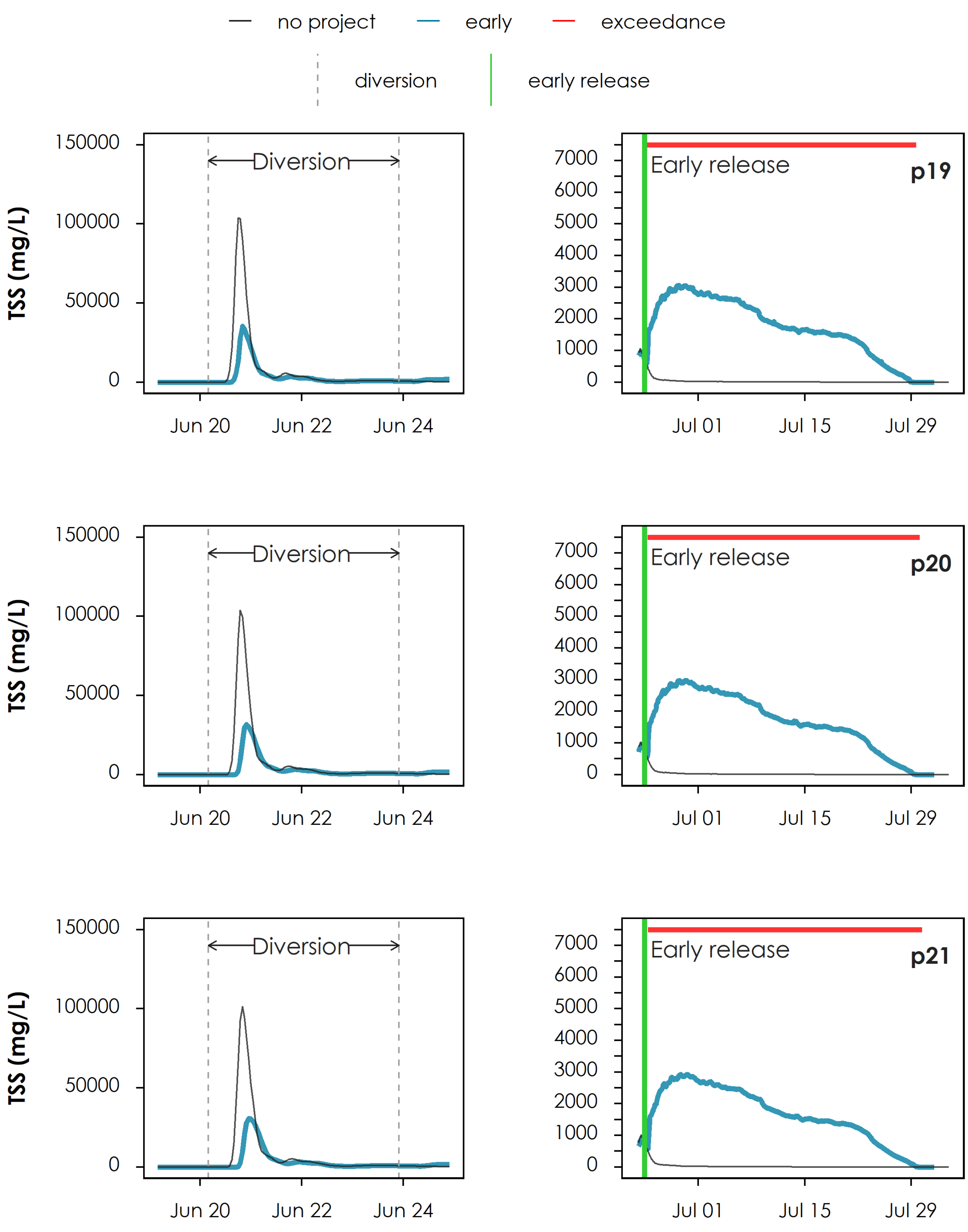
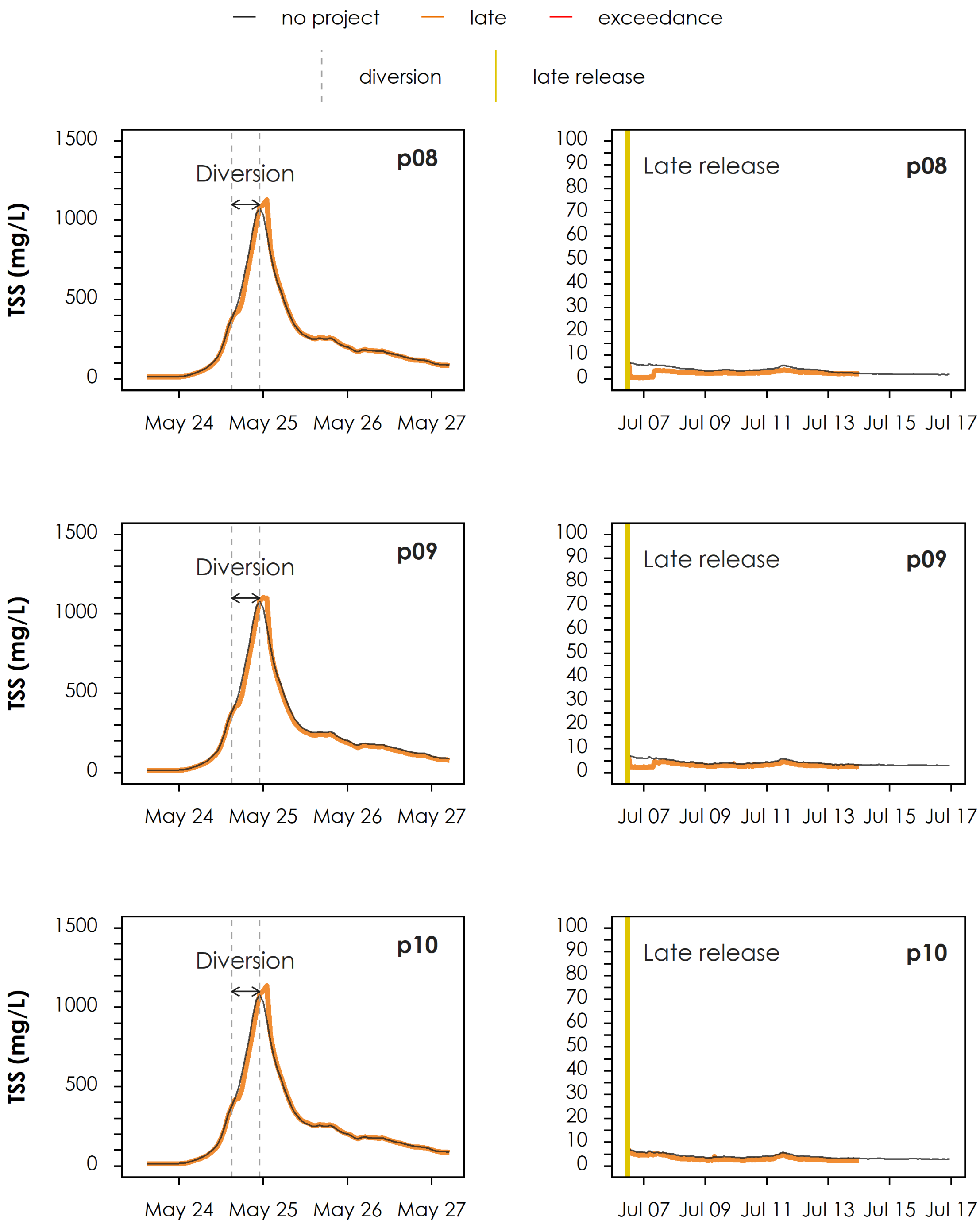
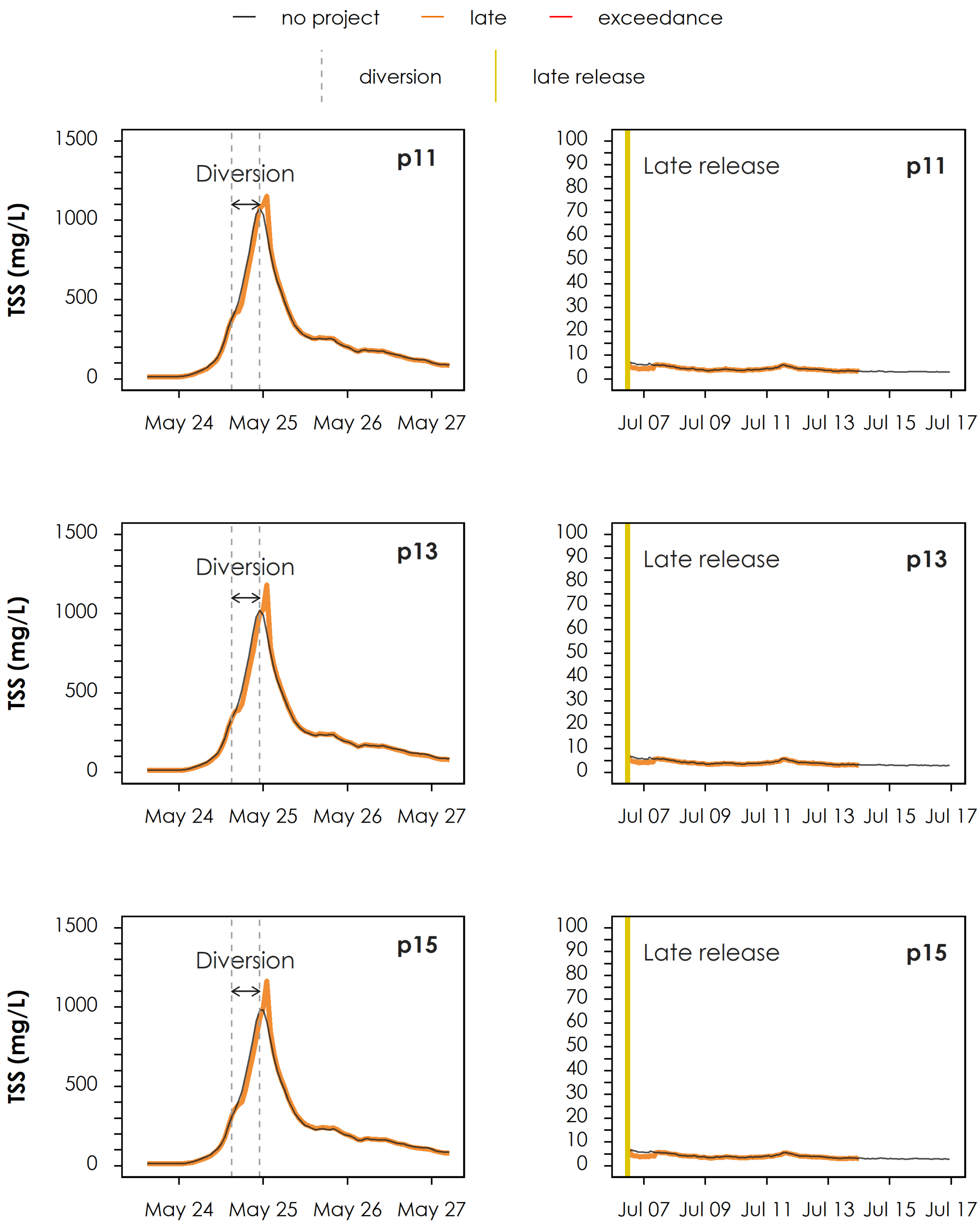


Figure 65-5 Exceedances and TSS Concentrations for Early Release at Locations between LLOW and Glenmore Dam Predicted for the Design Flood (2013) (cont'd)



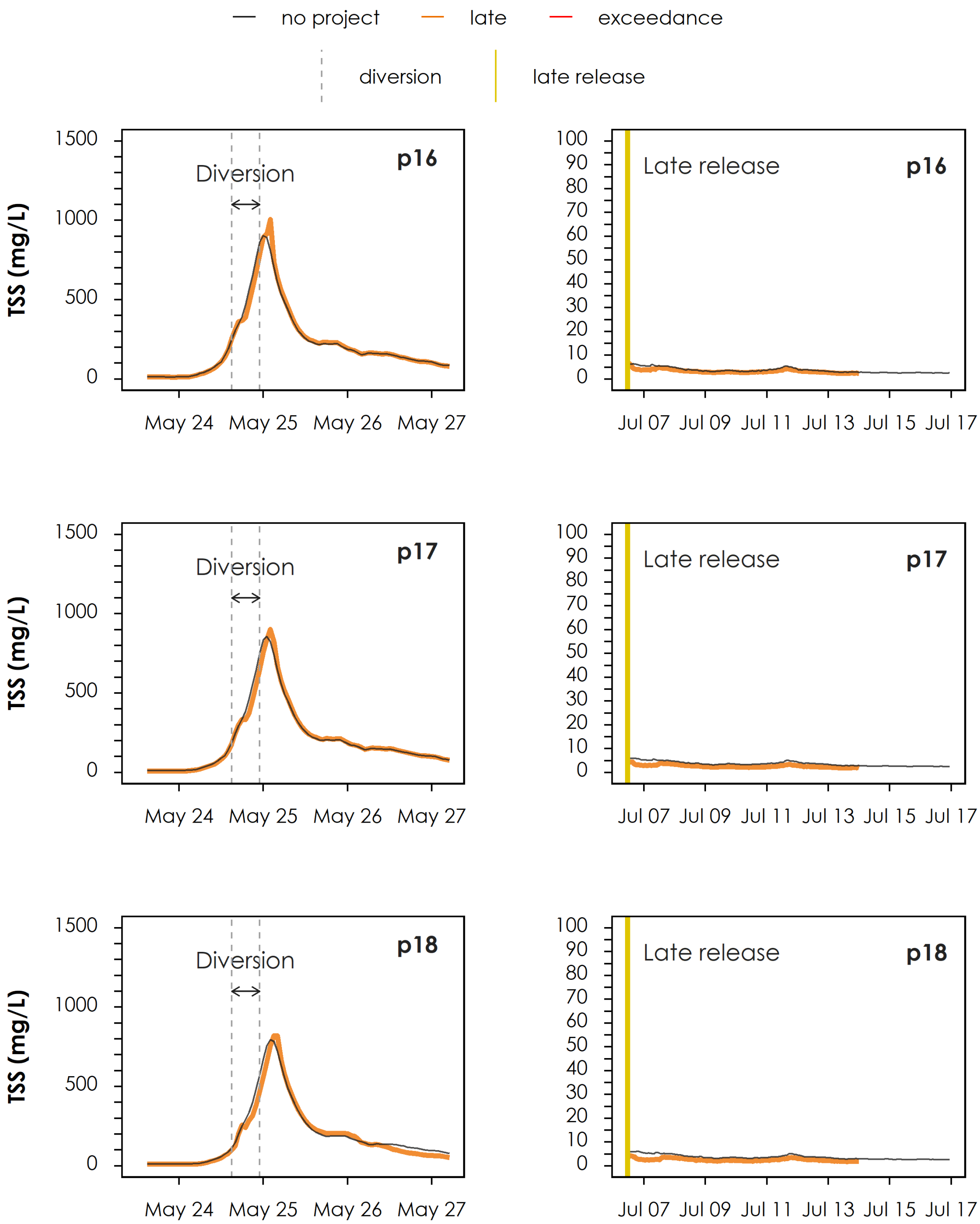
NOTE: At the beginning of late release, the TSS concentrations are initially low due to the long water residence time in the reservoir

Figure 65-6 Exceedances and TSS Concentrations for Late Release at Locations between LLOW and Glenmore Dam for the 1:10 Year Flood



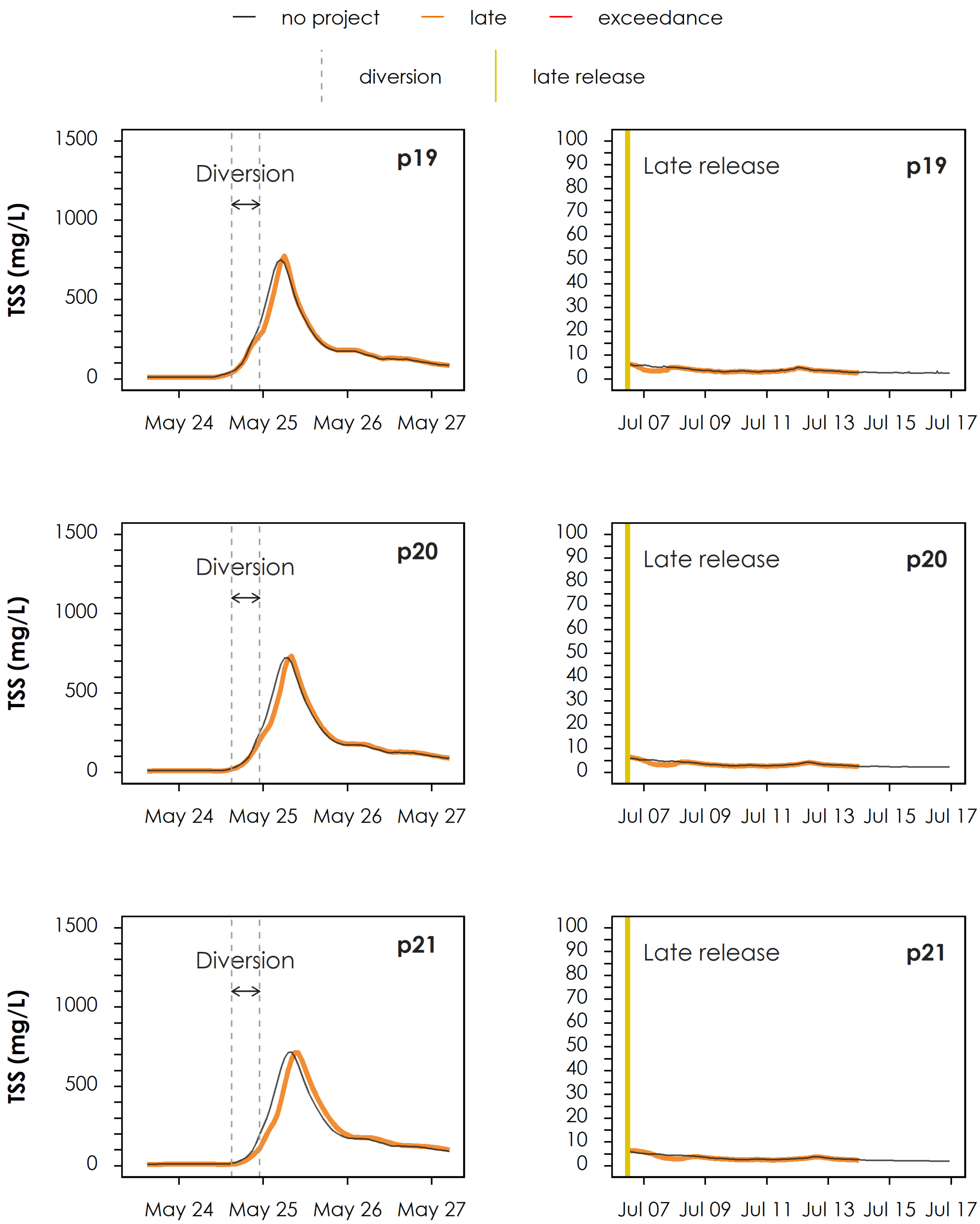
NOTE: At the beginning of late release, the TSS concentrations are initially low due to the long water residence time in the reservoir

Figure 65-6 Exceedances and TSS Concentrations for Late Release at Locations between LLOW and Glenmore Dam for the 1:10 Year Flood (cont'd)



NOTE: At the beginning of late release, the TSS concentrations are initially low due to the long water residence time in the reservoir

Figure 65-6 Exceedances and TSS Concentrations for Late Release at Locations between LLOW and Glenmore Dam for the 1:10 Year Flood (cont'd)



NOTE: At the beginning of late release, the TSS concentrations are initially low due to the long water residence time in the reservoir

Figure 65-6 Exceedances and TSS Concentrations for Late Release at Locations between LLOW and Glenmore Dam for the 1:10 Year Flood (cont'd)

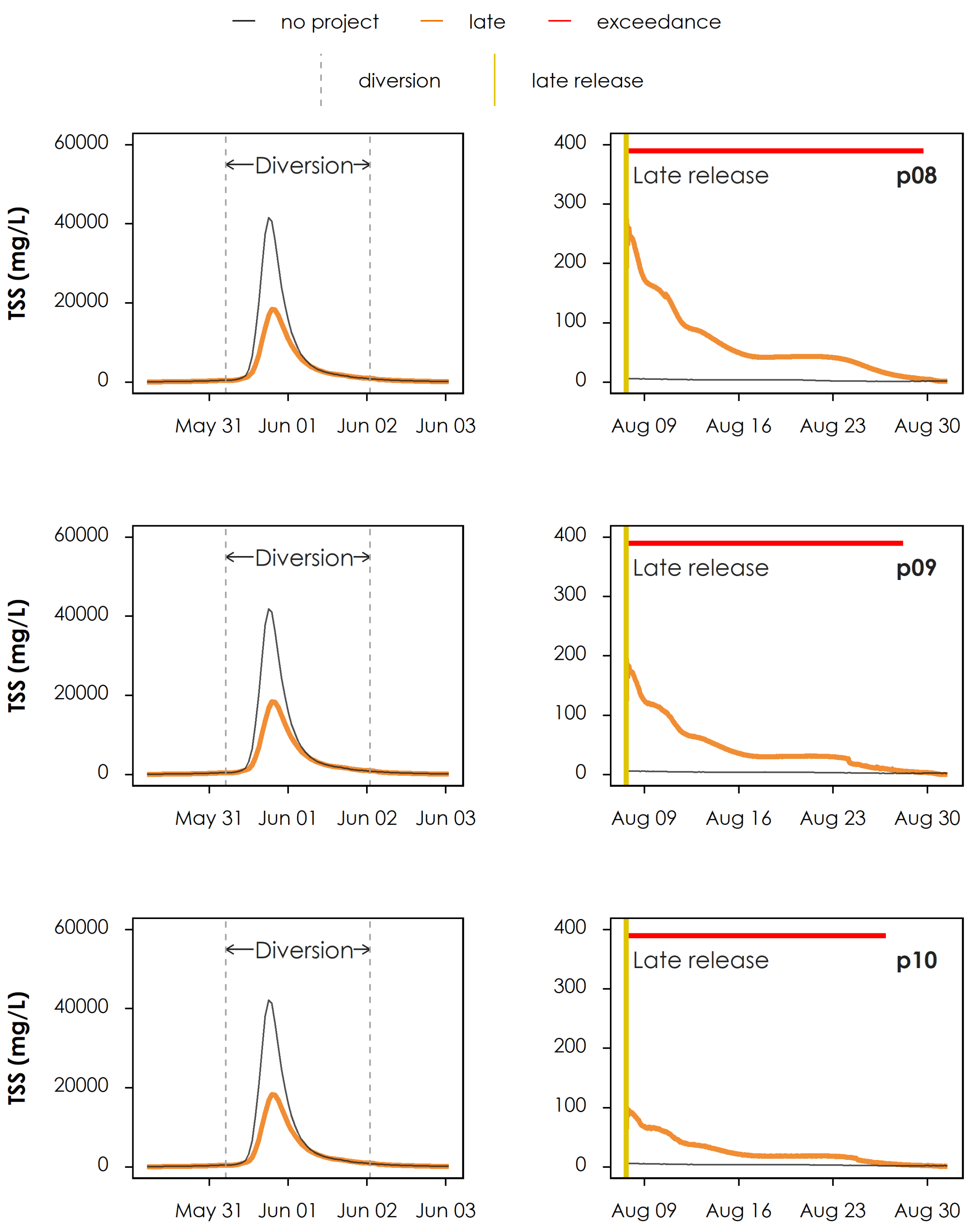


Figure 65-7 **Exceedances and TSS Concentrations for Late Release at Locations between LLOW and Glenmore Dam Predicted for the 1:100 Year Flood**

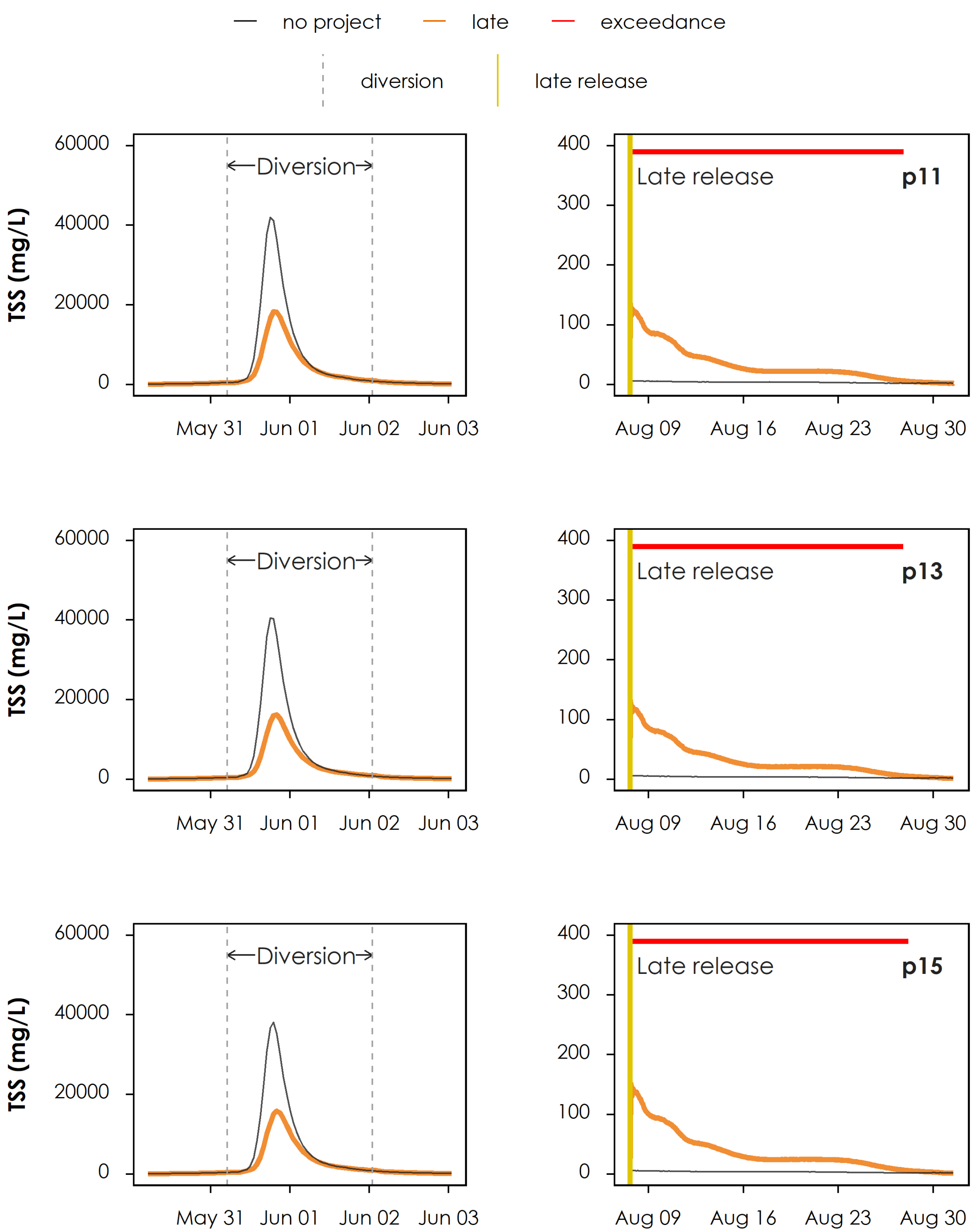


Figure 65-7 Exceedances and TSS Concentrations for Late Release at Locations between LLOW and Glenmore Dam Predicted for the 1:100 Year Flood (cont'd)

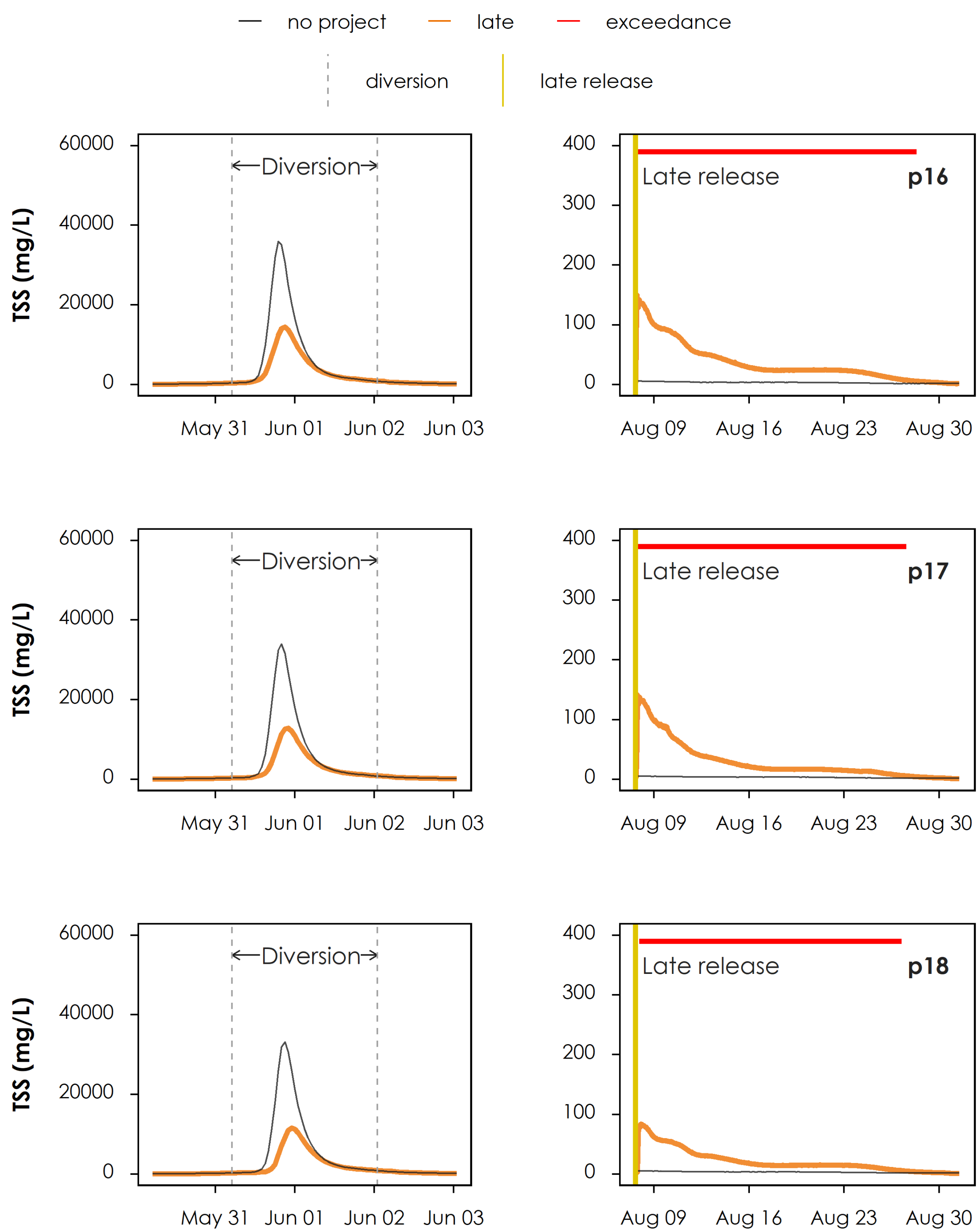


Figure 65-7 Exceedances and TSS Concentrations for Late Release at Locations between LLOW and Glenmore Dam Predicted for the 1:100 Year Flood (cont'd)

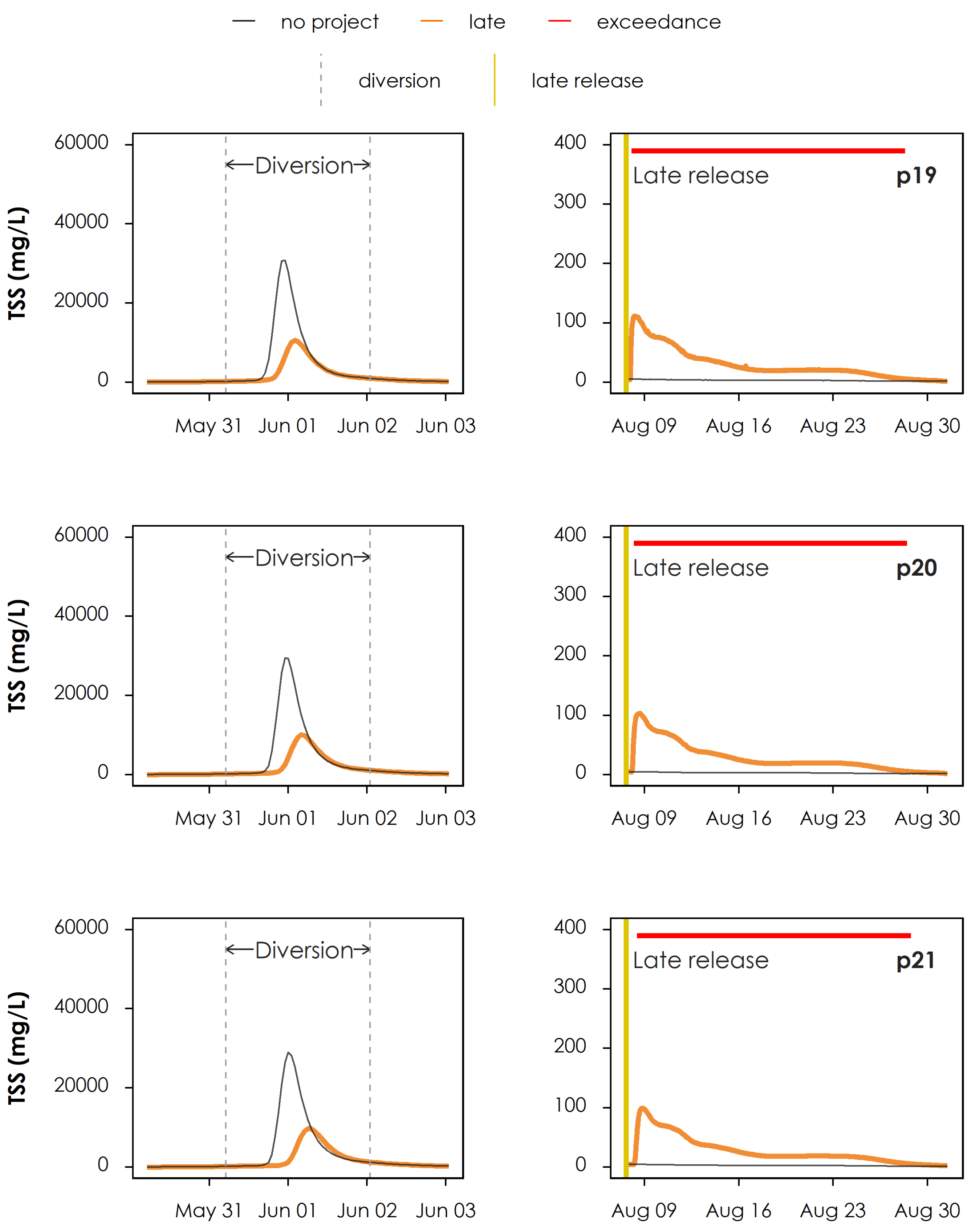


Figure 65-7 **Exceedances and TSS Concentrations for Late Release at Locations between LLOW and Glenmore Dam Predicted for the 1:100 Year Flood (cont'd)**

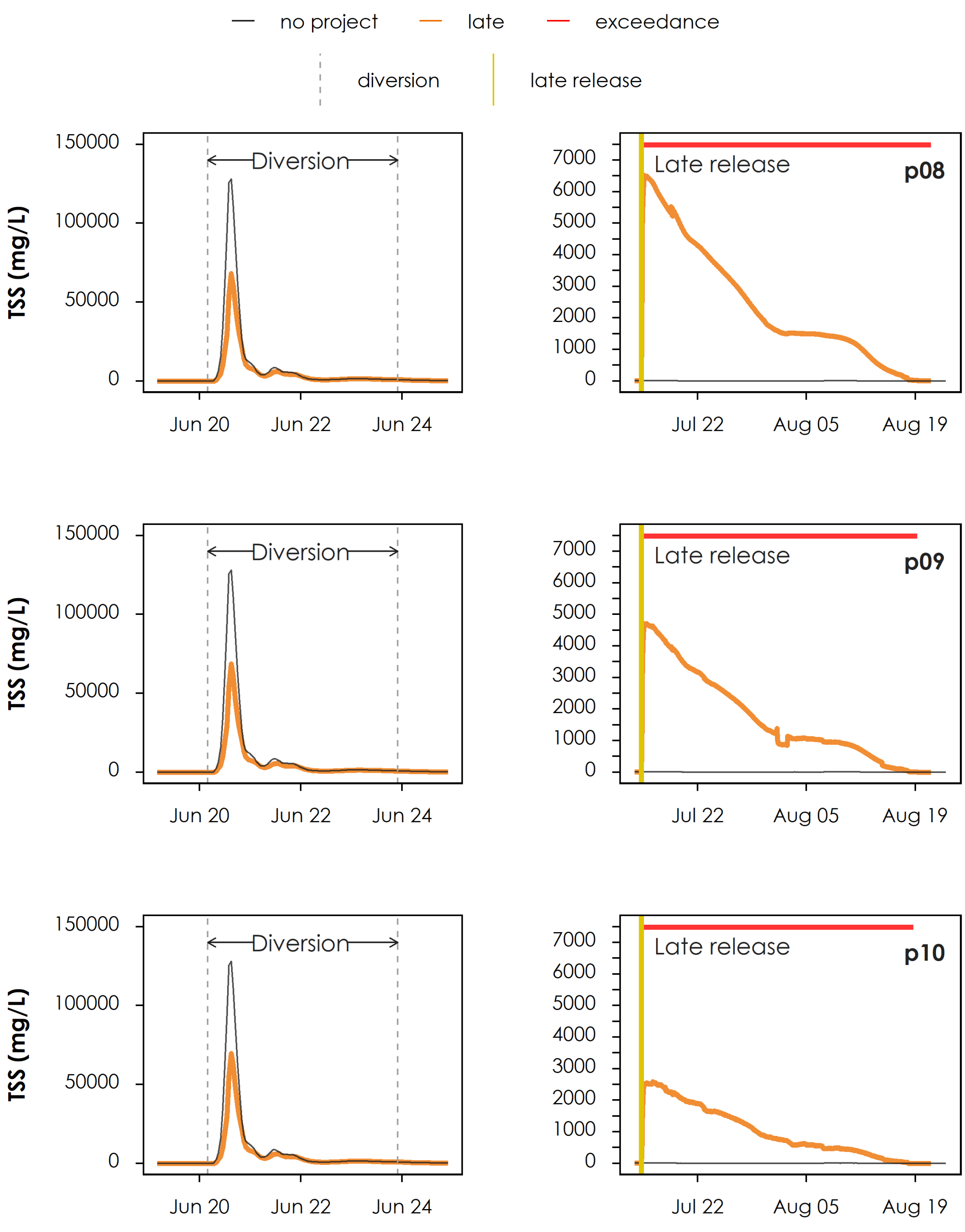


Figure 65-8 **Exceedances and TSS Concentrations for Late Release at Locations between LLOW and Glenmore Dam Predicted for the Design Flood (2013)**

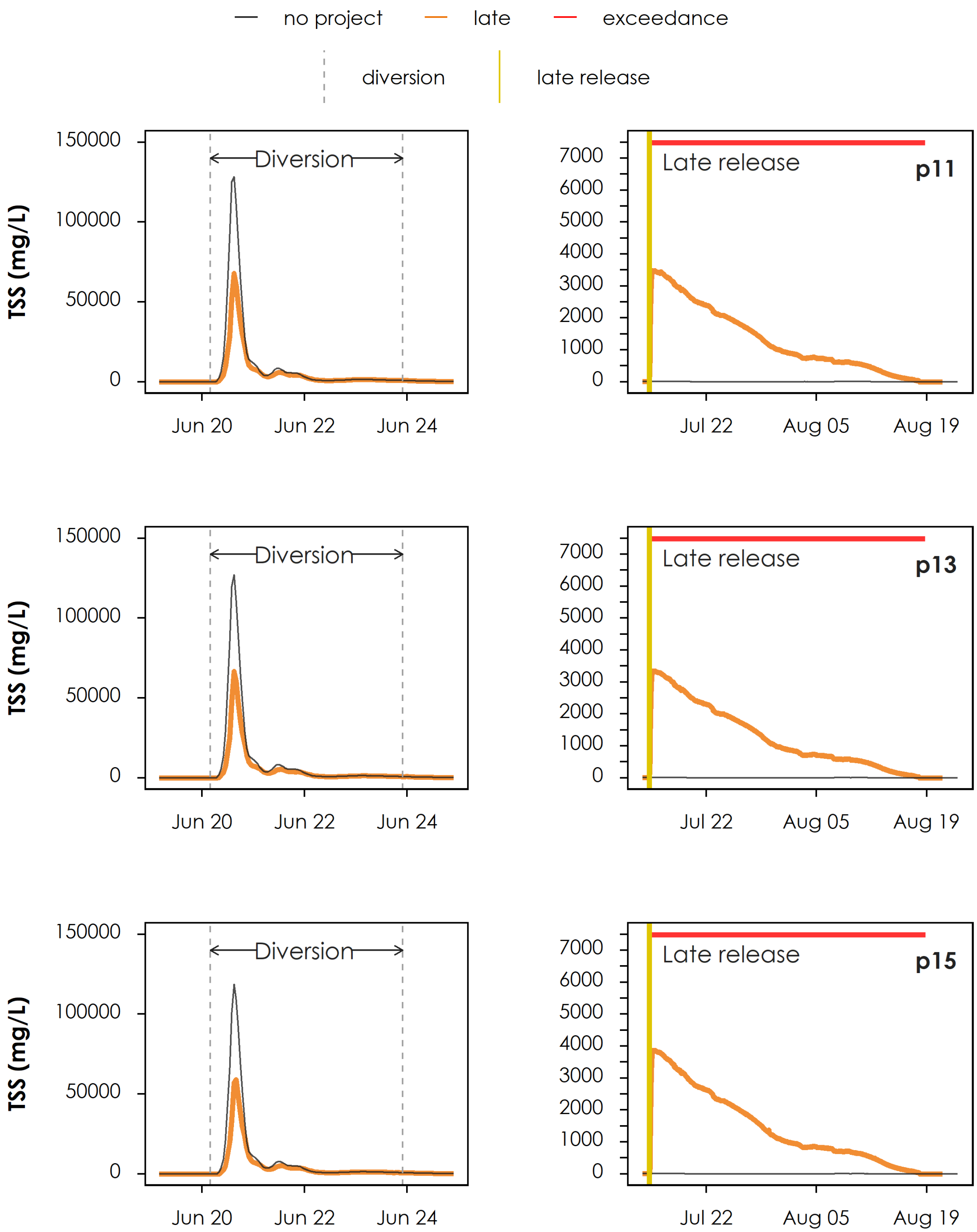


Figure 65-8 **Exceedances and TSS Concentrations for Late Release at Locations between LLOW and Glenmore Dam Predicted for the Design Flood (2013) (cont'd)**

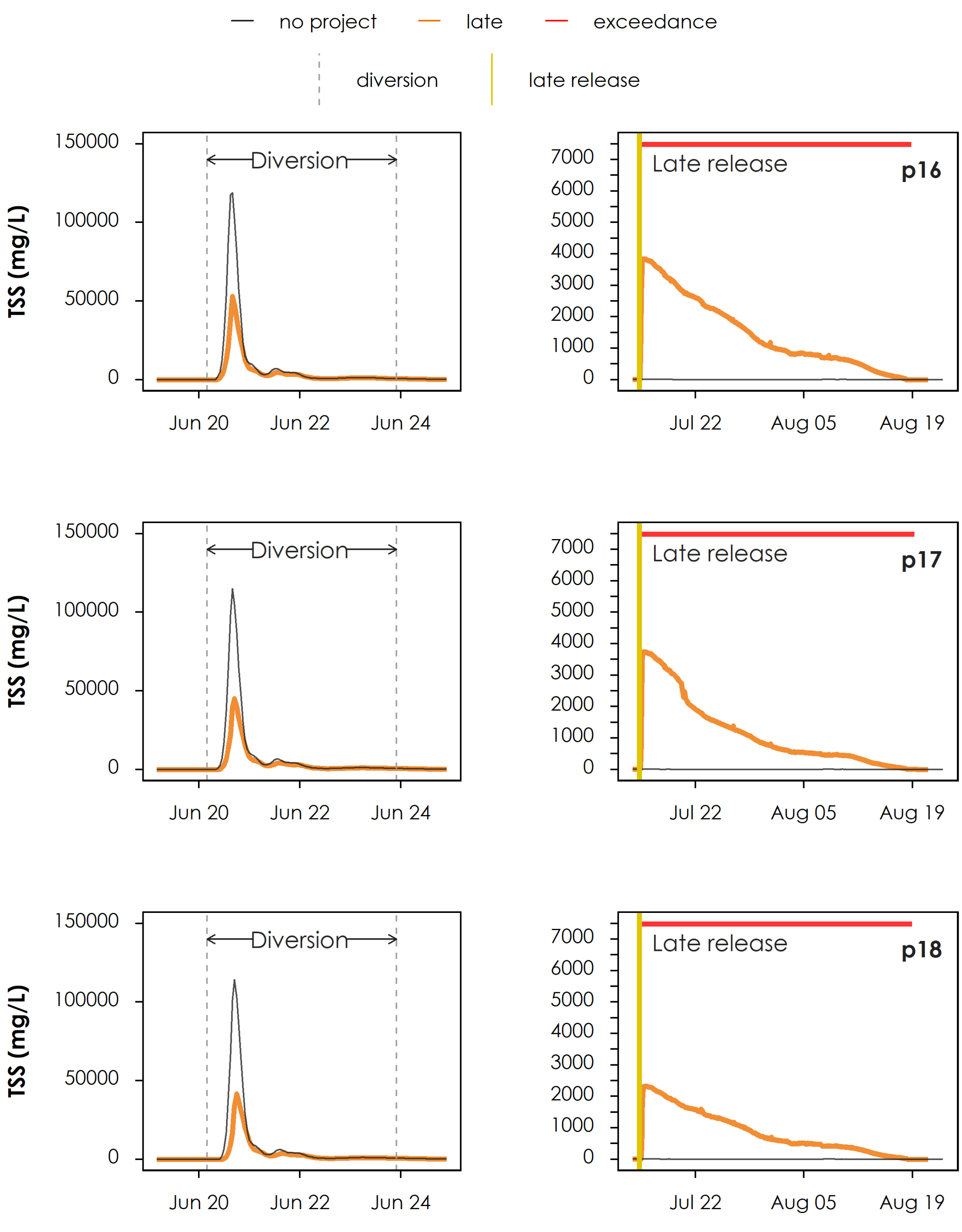


Figure 65-8 **Exceedances and TSS Concentrations for Late Release at Locations between LLOW and Glenmore Dam Predicted for the Design Flood (2013) (cont'd)**

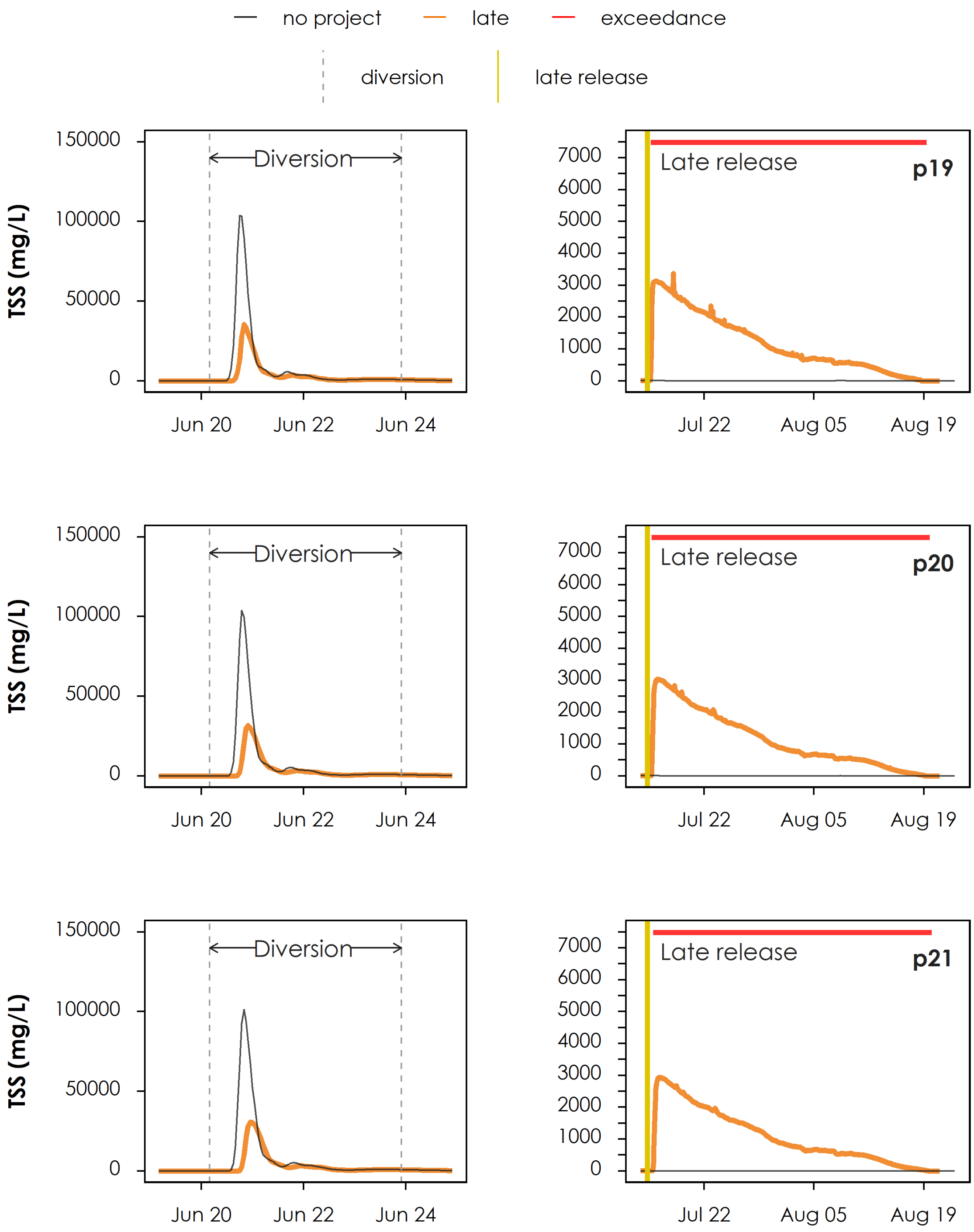


Figure 65-8 Exceedances and TSS Concentrations for Late Release at Locations between LLOW and Glenmore Dam Predicted for the Design Flood (2013) (cont'd)

b. Table 65-1, Table 65-2, Table 65-3, show the duration of exceedance (in days), mean TSS and maximum TSS predicted for the three floods, respectively, for each of the 12 sites. The calculation of exceedances uses the without the Project model results as the baseline; therefore, the time of exceedance captures the Project effect.

   In summary, for the 1:10 year flood, both early release and late release have suspended sediment concentrations in water similar to the baseline concentrations in Elbow River. The 1:10 year late release has no exceedances for the 12 sites analyzed. The 1:10 year early release has the lowest average exceedance time, for runs where exceedances where found, of 0.7 days. The 1:100 year flood has average exceedances of 23.9 and 20.2 days for early release and late release, respectively. The 2013 (design flood) results show average exceedances of 35.7 and 35.3 days for early release and late release, respectively.

c. Graphs and maps showing the extent of the guideline exceedances are provided in the response to a. See Figure 65-1 for the location of the 12 sites analysed and Figure 65-3 to Figure 65-8 for the TSS concentrations and exceedances for the three floods.

Table 65-1 1:10 Year Flood, TSS Exceedance and TSS Concentration Results

Site	Distance Downstream from Low Level Outlet (m)	Flood		Early Release			Late Release		
		Max. no Project (mg/L)	Max. With Project (mg/L)	Duration of Exceedance (Days)	Max. (mg/L)	Mean (mg/L)	Duration of Exceedance (Days)	Max. (mg/L)	Mean (mg/L)
P08	0	1,075.8	1,083.0	0.5	1,109.2	371.3	-	-	-
P09	50	1,078.3	1,084.0	0.5	1,056.0	369.7	-	-	-
P10	150	1,078.9	1,084.2	0.0[1]	1,131.1	1,131.1	-	-	-
P11	300	1,075.1	1,076.5	0.5	1,105.2	372.8	-	-	-
P13	1,000	1,022.8	993.9	0.2	1,172.2	497.9	-	-	-
P15	3,000	980.3	928.1	0.4	1,164.2	361.3	-	-	-
P16	6,000	863.5	786.1	0.4	995.6	332.2	-	-	-
P17	9,000	753.3	648.2	0.4	283.3	246.1	-	-	-
P18	13,000	574.8	471.6	0.4	817.0	300.3	-	-	-
P19	24,000	345.0	276.8	0.4	263.1	218.4	-	-	-
P20	Glenmore Reservoir Delta	252.9	212.2	0.5	285.3	222.2	-	-	-
P21	Glenmore Reservoir	201.2	155.8	0.8	415.6	248.3	-	-	-
Average		775.2	733.4	0.4	816.5	389.3	-	-	-

NOTE:
[1] At P10 there is one 1-hour exceedance during the early release

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Table 65-2 1:100 Year Flood, TSS Exceedance and Concentrations

Site	Distance Downstream from Low Level Outlet (m)	Flood		Early Release			Late Release		
		Max. no Project (mg/L)	Max. With Project (mg/L)	Duration of Exceedance (Days)	Max. (mg/L)	Mean (mg/L)	Duration of Exceedance (Days)	Max. (mg/L)	Mean (mg/L)
P08	0	41,624.9	18,383.2	23.2	3,008.2	1,764.4	22.1	274.5	66.3
P09	50	41,934.6	18,396.2	23.0	2,997.8	1,528.7	20.6	194.0	50.1
P10	150	42,193.4	18,333.3	23.0	1,253.4	541.5	19.3	95.5	30.6
P11	300	42,062.8	18,319.4	23.0	2,385.2	1,000.5	20.2	135.7	37.2
P13	1,000	40,548.2	16,247.4	23.0	1,513.1	800.7	20.2	132.2	35.8
P15	3,000	38,141.4	15,848.3	23.0	1,754.5	1,013.6	20.5	151.7	40.7
P16	6,000	35,991.7	14,464.7	23.0	1,633.9	967.1	20.7	149.9	40.0
P17	9,000	34,001.5	12,896.0	23.0	1,566.1	693.1	19.8	141.3	33.3
P18	13,000	33,243.6	11,635.0	23.5	1,495.7	841.6	19.4	84.0	25.4
P19	24,000	30,832.7	10,616.1	24.4	1,436.2	798.6	20.3	111.6	33.3
P20	Glenmore Reservoir Delta	29,505.5	10,089.3	24.6	1,427.5	788.8	20.3	103.2	31.8
p21	Glenmore Reservoir	29,068.3	9,722.0	26.0	6,029.8	822.0	20.4	99.3	30.5
Average		36,595.7	14,579.2	23.6	2,208.4	963.4	20.3	139.4	37.9

Table 65-3 Design Flood (2013), TSS Exceedance and Concentrations

Site	Distance Downstream from Low Level Outlet (m)	Flood		Early Release			Late Release		
		Max. no Project (mg/L)	Max. With Project (mg/L)	Duration of Exceedance (Days)	Max. (mg/L)	Mean (mg/L)	Duration of Exceedance (Days)	Max. (mg/L)	Mean (mg/L)
P08	0	128,166.0	68,078.8	38.0	6,280.7	3772.4	37.3	6,522.8	2,335.0
P09	50	128,167.0	68,748.4	36.8	4,991.0	2830.9	35.5	7,054.7	1,777.9
P10	150	128,006.0	69,531.6	35.1	1,866.7	1268.7	35.0	2,590.8	1,041.6
P11	300	128,378.0	67,835.0	35.1	3,472.1	1994.4	35.0	3,478.8	1,324.6
P13	1,000	127,105.0	66,575.5	35.1	2,970.0	1807.7	35.0	3,348.1	1,271.2
P15	3,000	118,693.0	58,847.7	35.2	3,658.9	2196.7	35.0	3,868.2	1,463.0
P16	6,000	118,864.0	53,122.8	35.2	3,650.7	2173.7	35.0	3,844.9	1,448.8
P17	9,000	114,892.0	45,056.1	36.5	3,545.5	1904.5	35.3	3,745.0	1,150.8
P18	13,000	114,142.0	41,516.6	35.3	2,505.3	1369.8	35.0	2,327.1	877.1
P19	24,000	103,846.0	35,501.5	35.5	3,062.1	1806.8	35.2	3,369.2	1,181.4
P20	Glenmore Reservoir Delta	103,764.0	31,686.0	35.8	2,972.6	1742.0	35.5	3,034.6	1,130.8
P21	Glenmore Reservoir	101,332.0	30,684.8	36.1	2,918.3	1695.3	35.5	2,938.7	1,092.5
Average		117,946.3	53,098.7	35.8	3,491.2	2,046.9	35.4	3,843.6	1,341.2

Question 66

Supplemental Information Request 1, Question 298, Page 5.142—5.143

Alberta Transportation described the potential effects of dissolved oxygen (DO) and temperature in the Elbow River. However, the explanation regarding the DO and temperature in the reservoir indicates that *changes in dissolved oxygen are expected to be smaller than currently observed in Glenmore Reservoir*.

a. **Clarify the method used to determine that changes in DO are expected to be smaller than currently observed in the Glenmore reservoir. Explain all uncertainty around this estimation.**

b. **Indicate the average BOD, and the minimum DO concentration expected in the off-stream reservoir. How can these values affect the assessment of the Project environmental effects on water quality? What measures would be considered to mitigate effects if they are observed?**

Response

a. Hydrodynamic modelling was completed to confirm the results in the EIA (Volume 3B, Section 7.4.3. pages 7.24 through 7.27). The modelling was done using the MIKE 21 modelling package developed by the DHI. The model was used to build a high-level water quality model (MIKE ECO Lab) of the study area and assess the effects of the Project on spatial and temporal variations of DO, BOD, and water temperature. Results of the temperature, DO and BOD modelling is provided in the response to NRCB Question 17.

   The MIKE ECO Lab module was paired with the MIKE 21 hydrodynamic model to calculate water quality concentrations and dilution ratios. The simple MIKE ECO Lab water quality template was used to calculate DO and BOD concentrations and water temperature within the study area. Current velocity, water depth, and atmospheric interactions were calculated in the hydrodynamic model and were updated in the MIKE ECO Lab at each time step. The hydrodynamic model includes the service spillway gates, diversion channel inlet structure, and the diversion channel outlet structure. The current velocity and water level in the hydrodynamic model were impacted by the operation of the diversion structures during a flood. Hourly flow in Elbow River and daily water level in Glenmore Reservoir were the upstream and downstream boundary conditions of the hydrodynamic model, respectively. For the 1:10 year (2008) and 2013 floods, the upstream flow boundary condition was obtained from the WSC station 05BJ004 in Elbow River at Bragg Creek. The downstream water level in Glenmore Reservoir was obtained from WSC station 05BJ008.

   The MIKE Eco Lab module boundary conditions were the monthly concentrations of the state variables (BOD, DO, and temperature) at the upstream boundary of the model in Elbow River at Bragg Creek. A Neumann boundary condition was used at the downstream boundary condition of the model allowing it to extract the concentration of the state variable from adjacent mesh elements.

The modelling report in the response to NRCB Question 15, Appendix 15-1 provides 1) details of the MIKE 21 hydrodynamic model and link to the ECO Lab module, 2) the sensitivity analysis, and 3) model assumptions and uncertainty.

b. Biochemical oxygen demand data was not available for Elbow River and, therefore, BOD was substituted with TOC for modelling. The TOC equivalent for BOC was calculated using the equation provided in Lee et al. (2016): y=0.77x-0.443.

The results of the BOD and DO modelling and potential effects to aquatic biota are provided in the response to NRCB Question 17. If DO issues are identified, adaptive management and mitigation measures such as aeration may be applied. If the issue is localized to a particular area of the reservoir, portable water aeration units may be used to mitigate the effects.

REFERENCES

Lee,J., S.Lee, S.Yu, and D.Rhew. 2016. Relationship between water quality parameters in rivers and lakes: BOD5, COD, NBOPs, and TOC. Environmental Monitoring and Assessment Vol 188: 252 (9 pages).

Question 67

**Supplemental Information Request 1, Question 309, Page 5.185-5.186
Supplemental Information Request 1, Question 325, Page 5.202-5.203
Supplemental Information Request 1, Question 309, Table IR309-1, Page 5.186
Volume 3A, Section 7.1.7, Page 7.9**

Alberta Transportation indicates that upon release of retained water from the off-stream reservoir predicted total suspended sediment (TSS) concentrations would be well below the predicted peaks for floods that would occur without the project in place. A similar statement is made in SIR1 325 and elsewhere.

In Table IR309-1 Alberta Transportation identifies TSS concentrations in at the end of the release period from the Off-Stream Reservoir at two locations, one at the release site and one at 1 km further downstream.

Alberta Transportation states *The assessment concluded that effects from the predicted sediment concentrations are not significant.* However, the assessment concluded that *"resulting increase in the Elbow River of suspended sediment concentrations is likely to exceed the Canadian Water Quality Guidelines.*

In spite of this, in Volume 3A of the EIA Alberta Transportation provides a significance definition as *a significant adverse residual effect on water quality is defined as a measurable change in water quality that:*

- ***exceeds an implemented water quality objective or site-specific water quality guideline for the protection of aquatic life or***
- ***contravenes a watershed management target or***
- ***causes acute or chronic toxicity to aquatic life or***
- ***changes the trophic status of a lake or stream.***

a. Total net load would be less during the flood year when the off-stream reservoir is in operation as indicated above. Justify and explain why there is no assessment of concentrations of TSS over time (monthly) in August and September at locations downstream of the reservoir from point of release to sites within 1 km of the Glenmore Reservoir.

b. Justify and explain why there was no peak and average values further downstream in the Elbow River, considering this section is approximately 11 km long.

c. Considering the definition of significance, clarify and explain how the TSS guidelines will be exceeded and yet the effects are not significant.

Response

a. Additional modelling using MIKE 21 FM-MT (mud transport) module was completed to investigate the changes in TSS due to the Project. The analysis includes early release and late release for each of the three floods. Early release entails the release of water when the flow in Elbow River decreases to less than 160 m^3/s. The rate of release from the reservoir slowly decreases to limit fish stranding in the reservoir.

   Late release occurs when the flow in Elbow River decreases to less than 20 m^3/s during the falling limb of the hydrograph. The EIA, Volume 3B, Section 6.4.1.4, Page 6.17 assesses TSS during August when water release (now referred to as late release) into Elbow River is expected to occur.

   The analysis for early release and late release are completed hourly at 14 sites, between the low-level outlet and Glenmore Reservoir and is included in response to AEP Question 65a. The location of the sites is presented in response to AEP Question 65, Figure 65-1. The results of the analysis are presented in Figure 65-2, Figure 65-3 and Figure 65-4 and the maximum and average values during exceedances are presented in Table 65-1, Table 65-2, and Table 65-3.

b. Analysis of model results is extended downstream to the Glenmore Reservoir. The results of the analysis are presented in response to AEP Question 65 in Figure 65-2, Figure 65-3, Figure 65-4, Table 65-1, Table 65-2, and Table 65-3.

c. The EIA (Volume 3B, Section 7.5) and Round 1 AEP IR 309 conclude that the effects of the Project on water quality as a result of suspended sediment is not significant. Although this determination did not address all of the criteria for the significance in the definition for water quality in Volume 3A, Section 7.1.7, the initial conclusion was, in part, based on the fact that the peak sediment concentrations at the end of (late) release from the reservoir were substantially lower than the peak sediment concentrations in the river during the respective floods without the Project. Further, it is stated in the EIA that 1) sediment peaks occurring at the end of release from the reservoir would only occur for a short time, 2) the reservoir operation would be an irregular and infrequent event, and 3) elevated suspended sediments could be further mitigated through varying the release rates.

   As outlined in a., additional modelling has been undertaken to assess the effects of sediment release from the Project on water quality, by evaluating two release timings (early and late). Using the significance definition for water quality in Volume 3A, Section 7.1.7, this updated assessment identifies that the potential exceedance of the TSS guidelines during water releases are significant, based on the TSS modelling results (see response to AEP Question 65).

   Table 67-1 updates Table 7-4 from the EIA (Volume 7B, Section 7.4.5) and presents an assessment of the Project residual effects, specifically on the change in suspended sediment transport based on the updated model results and analysis. Red text indicates a modification to the table compared to Table 7-4. As indicated in Table 67-1, although the TSS exceedances result in a significant effect on water quality, they are predicted to occur infrequently and are reversible. The magnitude and duration of the Project residual effects are reduced during the more frequent events such as the 1:10 year flood. Project residual effects increase during the less frequent, larger magnitude floods, such as the 1:100 year and design floods.

Table 67-1 Project Residual Effects on the Change in Suspended Sediment Transport (from Volume 3B, Section 6.4.5, Table 6.11)

Residual Effect	Residual Effects Characterization								
	Project Phase	Timing	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socio-economic Context
Change in Suspended Sediment Transport	F/PF	N/A	A	H	LAA	MT	IR	R	D, U

KEY

Project Phase
C: Construction
DO: Dry
F: Flood Operations
PF: Post-Flood Operations

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

Table 67-2 Characterization of Residual Effects on Hydrology (from Volume 3A, Section 6.1.5, Table 6.2)

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Direction	The long-term trend of the residual effect	Positive – a residual effect that changes measurable parameters in a direction beneficial to hydrology relative to existing conditions Adverse – a residual effect that changes measurable parameters in a direction detrimental to hydrology relative to existing conditions Neutral – no net change in measurable parameters for hydrology relative to existing conditions
Magnitude	The amount of change in measurable parameters or the variable relative to existing conditions	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
Geographic Extent	The geographic area in which a residual effect occurs	PDA (disturbance area) – residual effects are restricted to the PDA LAA – residual effects extend into the LAA RAA – residual effects interact with those of other project or development in the RAA
Frequency	Identifies how often the residual effect occurs and how often during the Project or in a specific phase	Single event Multiple irregular event – occurs at no set schedule Multiple regular event – occurs at regular intervals Continuous – occurs continuously
Duration	The period of time required until the measurable parameter or the VC returns to its existing condition, or the residual effect can no longer be measured or otherwise perceived	Short-term – residual effect that lasts for several days Medium-term – residual effect that extends through several months Long-term – residual effect that extends through more than one year

Table 67-2 Characterization of Residual Effects on Hydrology (from Volume 3A, Section 6.1.5, Table 6.2)

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Reversibility	Pertains to whether a measurable parameter or the VC can return to its existing condition after the project activity ceases	Reversible – the residual effect is likely to be reversed after activity completion and reclamation Irreversible – the residual effect is unlikely to be reversed
Ecological and Socio-economic Context	Existing condition and trends in the area where residual effects occur	Undisturbed – area is relatively undisturbed or not adversely affected by human activity Disturbed – area has been substantially previously disturbed by human development or human development is still present
Timing	Periods of time where residual effects from Project activities could affect the VC	Seasonality – residual effect is greater in one season than another (e.g., spring/summer vs. fall/winter) Time of day – residual effect is greater during daytime or nighttime Regulatory – provincial or federal restricted activity periods or timing windows (e.g., migration, breeding, spawning) related to the VC Not applicable - the residual effect of Project activities will have the same effect on the VC, regardless of timing

4.4 AQUATICS

Question 68

Supplemental Information Request 1, Question 342, Pages 5.225-5.228

Alberta Transportation states that no quantitative estimates of fish populations (i.e. mark recapture population estimates) were available, and instead used relative abundance. Relative abundance is not effective in detecting changes to fish populations in the absence of baseline data. Population estimates are therefore more appropriate in assessing impacts (changes) to fish populations pre and post dam construction and operation.

Alberta Transportation must undertake population estimates of fish populations both prior and following dam construction and operation. This approach will allow for the detection of differences in fish populations pre and post dam construction/operation to assess whether impacts to fish are as predicted.

a. Provide quantitative population estimates for the fish species found in the Elbow River.

Response

a. The methods used to determine baseline information and the description of fish species presence, composition, distribution, abundance, movement, habitat used and life history in the LAA are provided in the response NRCB Question 19, Table 19-1. Information used to address gaps in the fisheries information are also provided in Table 19-1 and subsequently discussed in that response. Elbow River fish population estimates are provided in NRCB Question 19, Table 19-3 and 19-4 and the discussion there includes 1) assessment of relevant aquatic ecology and fisheries sensitive to the Project operations; 2) appropriate mitigation measures; and 3) determination of residual effects that may require a *Fisheries Act* authorization with suitable offsets.

   In the period July to September 15, 2020, field work to obtain fish population data for the resident fish community will be collected in Elbow River to further characterize the composition, abundance and density of resident trout and non-trout fish populations. The fish population assessment will be documented and provided to NRCB and AEP when complete.

Question 69

Supplemental Information Request 1, Question 343, Pages 5.228-5.229

Alberta Transportation states that fish movement was determined from studies conducted by the Alberta Conservation Association on tributaries of the Elbow River upstream of the diversion structure (Fitzsimmons, 2008). This response does not include findings from Popowich and Paul 2006 reflecting bull trout utilization of the area below the proposed dam site. The time period when the dam would be in use (April-July) would encompass the migratory window for rainbow trout, cutthroat trout/cutthroat hybrids, and bull trout.

a. **How were migration patterns of fish species in the Elbow River determined apart from general life history patterns?**

b. **Re-evaluate fish presence, habitat utilization, and movement in the Elbow River including the work by Popowich and Paul (2006) *Seasonal movement patterns and habitat selection of Bull Trout (Salvelinus confluentus) in fluvial environments* attached. Use this new information as part of the environmental assessment (prediction of impacts) of this project.**

Response

a. Migration assessments for resident fish populations in Elbow River were not done for the Project. However, studies that were previously conducted by Popowich and Paul (2006) and Popwich and Eisler (2008) were reviewed and are summarized below. These studies provide information on migration patterns of bull trout in Elbow River to supplement the information that is presented in the EIA (Volume 3A and 3B, Section 8) regarding life history patterns. Information on fish movement in Elbow River is discussed in the context of fish distribution, which is discussed in the subsequent sections of this response.

MIGRATION INFORMATION

The results of resident bull trout movement patterns were assessed in Popowich and Paul (2006) and are reviewed here. Bull trout were radio tagged in September 2003 near known spawning grounds upstream of Paddy's Flat Campground (upstream of Bragg Creek). Radio tagged bull trout, following initial tagging efforts, moved to the lower main stem of Elbow River (including areas downstream of the Project site) where they remained for a period of six months and through the winter. A conservative evaluation of the tagging results suggests that this population of resident bull trout move to locations downstream of the Project site to find overwintering habitat during the fall. It can also be inferred that these fish migrate upstream past the proposed Project site in summer to spawn in the upper reaches of Elbow River.

Bull trout have also been reported by Popowich and Eisler (2008) to spawn in the upper reaches of Elbow River between Paddy's Flats and Elbow Falls. Spawning for this species typically occurs in August and September; however, timing may be watershed specific. Swanberg (2011) reported that a resident population in Montana migrated to spawning tributaries in early to mid-summer and remained for approximately nine to ten weeks before spawning in late September. These seasonal movements and spawning times may have evolved due to watershed-specific conditions (e.g., summer water temperatures). Popowich and Paul (2006) observed that resident bull trout population movements in Elbow, Sheep and Highwood rivers appeared to demonstrate an alternate year spawning strategy and that many fish did not demonstrate the expected upstream movement to spawning areas in mid-summer. The authors suggest that a smaller portion (i.e., less than half) of the population migrates upstream during the summer to spawn each year while returning to downstream habitats during November.

FISH DISTRIBUTION

In addition to the information on migration patterns that is offered through Popowich and Paul (2006) and Popowich and Eisler (2008), historical fish records in the Alberta FWMIS and spawning habitat suitability assessments are used to derive the distribution of resident fish in Elbow River.

The temporal and spatial distribution of resident fish records (summarized in Table 69-1) indicate the potential for seasonal fish movement. Bull trout demonstrate site fidelity and are known to return to seasonal habitats from year to year (Starcevich 2012) and will travel between the same overwintering and spawning areas each year. Resident Elbow River bull trout have been reported to spawn in the late summer in suitable habitat below Elbow Falls and upstream of the Project area (Popowich and Paul 2006; Popowich and Eisler 2008). Bull trout have also been reported downstream of the Project, close to Discovery Ridge (close to the city of Calgary) in late fall (Popowich and Paul 2006). Elbow Falls and Discovery Ridge are considered the general area of bull trout movement in Elbow River during the summer, Movement may be inferred through conservative assumptions to connect datasets (e.g., spawning observations, fish presence at various seasons) in a manner that represents seasonal movement. All bull trout habitat associated with the main stem of Elbow River between the Tsuut'ina Nation Reserve boundaries of Redwood Meadows and Discovery Ridge was mapped in the fall of 2019 (Appendix 69-1). HSIs were developed for each of four bull trout life stages (i.e., adult, juvenile, fry, and spawning) and applied to the 2019 habitat dataset to determine the suitability of each mapped habitat feature for a specific life stage (Appendix 69-1).

Table 69-1 Location of Recorded Fish Presence (AEP 2020) in Elbow River during Different Biologically Significant Periods

	BSP 1	BSP 2	BSP 3	BSP 4
	April 2 to June 15	June 16 to Sept 25	Sept 26 to Dec 1	Dec 2 to April 1
Bull trout	From Elbow Falls to the Project area	Distributed throughout the river from Elbow Falls to Discovery Ridge area	In the upper reaches of the river below Elbow Falls	No records
Brown trout	Distributed from the Project area near Redwood Meadows to Glenmore Reservoir	Distributed throughout the river except the upper 10 km below the falls	Distributed throughout the river	One record near Sarcee Bridge
Cutthroat trout	One record just upstream of Glenmore Reservoir	No records	No records	No records
Cutthroat trout- rainbow trout cross breed	No records	No records	No records	No records
Mountain whitefish	Distributed from the Project area near Redwood Meadows to Glenmore Reservoir	Distributed throughout the river except the upper 10 km below the falls	Distributed throughout the river except the lower reach (~15 kms) before the Glenmore Reservoir	No records
Brook trout	Distributed from the Project area near Redwood Meadows to Glenmore Reservoir	Distributed throughout the river from the falls to the Glenmore Reservoir	Distributed through the river	No records
Rainbow trout	Distributed from the Project area near Redwood Meadows to Glenmore Reservoir	Distributed throughout the river except the upper 10 km below the falls and the lower reach immediately above Glenmore Reservoir	Distributed sporadically throughout the river	No records
Northern pike	No records	Immediately above Glenmore Reservoir	No records	No records
Burbot	In the Project area	Distributed sporadically between the Project area near Redwood Meadows to Glenmore Reservoir	Distributed sporadically from downstream of the Project area to Glenmore Reservoir	No records

Project-specific spawning habitat suitability field work was conducted between Elbow Falls and Gooseberry Campground in late October 2019 (Appendix 69-2). Spawning habitat suitability was mapped along the entire extent of the survey area and is used to evaluate potential fish habitat use and distribution. Results of the fall spawning survey and a detailed habitat description from the fall 2019 fieldwork is presented in Appendix 69-1. Where possible, spawning habitat data were corroborated with other spawning studies and fish records (Popowich and Paul 2006; Popowich and Eisler 2008). Spawning surveys and spawning habitat suitability assessments were also conducted in November 2019 for the main stem of Elbow River between the Tsuut'ina Nation 145 Reserve boundary (upstream of the Project near Redwood Meadows) and the reserve boundary near Discovery Ridge (Appendix 69-3).

Field studies from fall 2019 supplement the findings from Popowich and Paul 2006. A summary of these field surveys as it relates to bull trout spawning is further described below.

Spawning Habitat Suitability in Elbow River, between Elbow Falls to Gooseberry Campground

Bull trout spawning habitat suitability field work was conducted in late October 2019 in known spawning areas between Elbow Falls and Gooseberry Campground. Few bull trout redds were positively identified, presumably because the time between spawning and the survey rendered redds difficult to identify (i.e., contrast between spawning gravel and surrounding habitat was difficult to distinguish). Despite the absence of identifiable redds, habitats suitable for bull trout spawning was reported in this river reach; this was corroborated with previous spawning surveys (Popowich and Paul 2006) conducted within the same reach (Appendix 69-2).

Redd Survey, Spawning Habitat Suitability Assessment, and Habitat Mapping Survey in Elbow River, between Tsuut'ina Nation 145 Reserve boundaries (Redwood Meadows to Discovery Ridge)

A redd survey (Appendix 69-3) was conducted between the Tsuut'ina Nation 145 Reserve boundary (upstream of the Project near Redwood Meadows), and the reserve boundary near Discovery Ridge in November 2019 to identify brown trout and brook trout redds. Results of the fall spawning surveys, fish presence, and habitat utilization identified through the fall 2019 fieldwork is presented in Appendix 69-3.

The observations by Popowich and Paul (2006) and field data collected in fall 2019 lead to a conservative assumption that a group of bull trout likely reside in the lower reaches of Elbow River (i.e., below the Project area) between late September and July for rearing and overwintering. A portion of this population will migrate upstream in summer to suitable spawning areas between Elbow Falls and Paddy flats.

b. Results of the bull trout spawning surveys that were undertaken by Popowich and Paul (2006) are summarized in the response to a.

BULL TROUT, RAINBOW TROUT, CUTTHROAT TROUT DISTRIBUTION AND POTENTIAL IMPACTS DURING PROJECT OPERATION

During a year in which the Project is operational for flood mitigation, the potential exists for reservoir water to be drawn down at a time that coincides with seasonal summer bull trout movement upstream through the Project area. Furthermore, overwintering areas may be impacted by a change in substrate composition in the downstream areas following flood operation. Likewise, water release also may correspond to rainbow trout and cutthroat trout fry incubation and rearing periods. Adults will generally seek refuge in floodplain habitat during a flood; and will likely exhibit similar behavior during water release. Bull trout adults that reside in the downstream reaches of Elbow River will seek refuge during flood operation, and migration timing may be delayed.

This behavior is expected during a natural flood event (i.e., as occurs without the Project). Likewise, a large proportion of incubating eggs and young of the year (of spring and summer spawning fish species) are expected to be lost as a result of natural flood scour and high sediment exposure (unrelated to Project operations) during a natural flood event. It is expected that a similar loss will occur during water release. The duration of water release might extend the effects of a flood relative to a natural flood; however, such timing will still encompass the same general life history stages of fish (e.g., bull trout migration, rainbow trout rearing).

The residual effects characterization associated with water release is summarized in Table 69-2 (an equivalent table is not in the EIA). Residual effects on fish presence and habitat use associated with water release are expected to be adverse in direction, moderate in magnitude, restricted to the LAA, and irregular in frequency when compared to background conditions (i.e., non-flood conditions). Given the infrequency of operation and the persistence and viability of fish populations in Elbow River, the effect is not significant and reversible.

Table 69-2 Residual Effects Characterization Associated with Water Release

Residual Effect	Residual Effects Characterization								
	Project Phase	Timing	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socio-economic Context
Change in fish presence and habitat utilization (including movement)	O	S/R	A	M	LAA	S	IR	R	U

KEY

Project Phase
C: Construction
O: Dry Operation

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
P: Permanent

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

N/A: Not applicable

WESTSLOPE CUTTHROAT TROUT PRESENCE

Genetically pure strain westslope cutthroat trout occur in localized stream habitats where introduced species such as rainbow trout are absent or in such low densities that hybridization has not occurred. As a result of hybridization and other environmental pressures, genetically pure westslope cutthroat trout are no longer present in Elbow River below Elbow River Falls and are only present in upper reaches of the Elbow River watershed above the falls (Alberta Westslope Cutthroat Trout Recovery Team 2013; DFO 2014).

Pure strain westslope cutthroat trout has been studied throughout southwestern Alberta using genetic testing and morphological analysis (Westslope Cutthroat Trout Recovery Team 2013) to determine their geographical extent. Based on this research, the closest known population of genetically pure westslope cutthroat trout is in Silvester Creek and Prairie Creek (DFO 2014), both of which are outside the RAA and would not be affected by the Project.

REFERENCES

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DFO (Fisheries and Oceans Canada). 2014. Recovery Strategy for the Alberta populations of Westslope Cutthroat Trout (*Oncorhynchus clarkii lewisi*) in Canada [Final]. Species at Risk Act Recovery Strategy Series. Fisheries and Oceans Canada, Ottawa. iv + 28 pp + Appendices.

Popowich, R.C. and A.J. Paul. 2006. Seasonal movement patterns and habitat selection of bull trout (Salvelinus confluentus) in fluvial environments.

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Swanberg, T.R. 2011. Movements of and Habitat Use by Fluvial Bull Trout in the Blackfoot River, Montana. https://doi.org/10.1577/1548-8659(1997)126<0735:MOAHUB>2.3.CO;2

Question 70

Supplemental Information Request 1, Question 344, Page 5.230
Supplemental Information Request 1, Question 343, Table IR343-1, Page 5.229
Volume 3A, Section 8.4.2.1, Page 8.49
Volume 3A, Section 8.4.3.8, Page 8.55

Alberta Transportation states that flow would be manipulated (by raising the right gate of the dam) to maintain 20 cm of flow through the fish passage.

Based on this response, fisheries understands that fish passage design will only allow passage of fish in certain size ranges. This creates potential barriers to fish passage which would subsequently impact fish populations (sport and non-sport fish).

a. If non-sportfish are unable to pass, what are the impacts to populations both up and downstream of the diversion structure?

b. Describe mitigation measures to address low water depth which would be a passage restriction to large fish (such as bull trout) during low flow.

c. Describe which of these species moves through the area of the diversion structure where migration may be affected during the times described in the table.

d. Specify the degree to which fish passage will be provided under various flow conditions (species and size ranges for sport and non-sport fish) and develop a monitoring plan to determine effectiveness of fish passage to assess the extent to which the dam is a barrier to fish passage. Include frequency, time of year, and techniques used to monitor.

Response

BACKGROUND INFORMATION

The service spillway gates, when they are in their lowered position, have a very broad, flat profile. When flows are lower than 4 m^3/s, it is possible that depths over the lowered gates will be too shallow for fish to pass. This effect can be seen in the figures that accompany the response to NRCB Question 21. When flows in Elbow River drop below 4 m^3/s, and through the low-flow periods of the winter months, the operator can raise the right (south) gate to ensure all flow passes through the left (north bay where the thalweg is) to maintain aquatic connectivity with sufficient depth for passage through the reach (provided the river is not frozen to bed at these times).

The fish passage analysis presented in Alberta Transportation's responses to Round 1 AEP IR344 and IR343 considered the low flow analysis of fish passage using a 3Q10min condition (0.8 m^3/s); that is, a low flow that has a 10% chance of happening at any given year over three consecutive days. It is important to note that 0.8 m^3/s is an extremely conservative low-flow estimate and has occurred once within the available period of record (1934 to 2018) for Elbow River at Bragg Creek mean daily flows. Flows of 0.8 m^3/s correspond to the biologically significant period 4 (BSP-4): BSP-4 is associated with the overwintering period of fish species, during a time of year when fish movement is limited and much of Elbow River is frozen to bed. Furthermore, the fish passage evaluation presented in Alberta Transportation's response to Round 1 AEP IR91 and IR95 was limited to adult size salmon and walleye group, and pike group of 250 mm fork length.

To supplement the conservative assumptions made in Alberta Transportation's responses to Round 1 AEP IR343 and IR344, an expanded dataset is provided in the response to NRCB Question 21, which:

- discusses fish passage conditions at 3Q10min and 3Q10max at each BSP
- evaluates additional fish body sizes to demonstrate fish passage conditions for different size classes and life stages
- compares fish passage conditions to conditions that are expected without the Project in place

a. The expanded fish passage dataset demonstrates fish passage during non-flood and post-flood operations for all species and sizes, (including non-sportfish), for conditions at floods where passage is possible under existing (i.e., baseline) conditions. The proposed works also improve passage during non-flood and post-flood operations for select species under select flow conditions, where it could not be achieved under existing conditions. The fish passage mitigation structures, therefore, improve the hydraulic conditions for fish passage through this reach, over existing conditions. For this reason, impacts to fish populations (including non-sportfish populations) as a result of fish passage limitations are not predicted.

b. Given the expected fish passage conditions, mitigation measures will be limited to adjusting the configuration of the v-weirs or increasing boulder placement to create refuge to facilitate improved passage, if required. A Fish Passage Monitoring Plan will be developed in consultation with DFO as part of the Project *Fisheries Act* authorization (draft commitments, including methodology requested herein, are included in the response to NRCB Question 33) to monitor the effectiveness of the v-weirs post-construction and post-flood.

c. The expanded fish passage dataset (see the response to NRCB Question 21, Table 21-1) considers all fish species and life stages that are known to occur in Elbow River through swim ability groups of "eel," "salmon/walleye," and "pike" at 25 mm, 250 mm, and 1000 mm fork lengths for fish passage analysis. These swim ability groups correspond with the database presented by Katapodis and Gervais (2016), which also groups various fish species into swim ability groups. This dataset provided by Katapodis and Gervais (2016), which is the most detailed fish swimming performance data available, as of May 2020, was used to inform fish passage design.

d. The response to NRCB Question 21 (Table 21-1) demonstrate that fish passage is maintained during non-flood and post-flood operation for all species and sizes where passage is possible under existing (baseline) conditions. The fish passage structures will also improve passage during non-flood and post-flood operation for select species under select flow conditions. Fish passage under various floods is tabulated in response to NRCB Question 21 (Table 21-1). A Fish Passage Monitoring Plan will be developed in consultation with DFO as part of the *Fisheries Act* authorization to monitor the effectiveness of the v-weirs during non-flood and post-flood.

REFERENCES

Katapodis and Gervais. 2016. Fish Swimming Performance Database and Analyses. DFO Can. Sci. Advis. Sec. Res. Doc. 2016/002 vi+550p.

Question 71

Supplemental Information Request 1, Question 347a, Page 5.234
Volume 3A, Section 8.4.4.2, Page 8.58

Alberta Transportation provided a brief quantification of fish habitat primarily based on a brief survey and a desktop exercise. This question has not been answered sufficiently. Alberta Transportation needs to conduct habitat assessment and mapping to determine baseline habitat downstream of the dam site. Changes may be modelled and offsetting needs to be determined.

a. Identify plans to offset losses in the productivity of the fish habitat identified.

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a. Alberta Transportation has engaged Fisheries and Oceans Canada (DFO) to discuss the criteria to offset fisheries-related effects. AEP will be engaged to discuss how these measures may complement local fisheries objectives. These offsetting options will be presented to Indigenous groups for input and feedback regarding how to best support fisheries important to their cultural needs.

   A preliminary list of fish habitat offsetting options is provided below. This list may change through consultation with regulators and Indigenous groups; as suitable offsets for the Project are defined, some of these options will be eliminated.

In-Kind Habitat Offsets

Constructed Fish Habitat (Side Channel and Constructed Stream Channel Habitat)

- Constructed side channel habitat and artificial stream channels are effective ways to create habitat that will benefit select life stages (e.g., rearing and feeding habitat, cool water refuge, overwintering habitat) of certain species within the Elbow River valley.
- Constructed side channel habitat has been successfully employed in southern Alberta (e.g., Quarry Park Offset on Bow River); construction techniques for in-kind equivalent habitat are well known (i.e., replacing lost metres of habitat area with constructed metres of habitat).

Constructed habitat may benefit certain species (e.g., brook trout, rainbow trout) more than native bull trout or whitefish; important limiting habitat features (e.g., spawning habitat for fish) may be difficult to recreate in off-stream or constructed side channels without careful environmental considerations (e.g., groundwater flows, gravel source, annual stream flow regime).

Habitat Improvement Offsets

Elbow Lake – Bragg Creek Trail

- Upgrades to the hiking/ATV trail between Elbow Lake and Bragg Creek could be implemented, including tributary crossings, runoff and erosion areas. These upgrades will help reduce sediment yield into the upper reaches of Elbow River and its more sensitive fish habitats.

McLean Creek Erosion and Sediment Control Mitigations (Bridges and Approaches)

- McLean Creek watershed is a local favorite off-road use area; the trails experience heavy use including fording many creeks, draws, and runoff areas. Consequently, these areas generate heavy sediment loads for McLean Creek and Elbow River.
- There is an opportunity to develop permanent trail crossings (bridges and fords) and repair washouts and vulnerable areas. This would reduce the sediment load and associated impacts to resident fish in Elbow River.

Stream Connectivity Repairs

- Damage to culverts and stream crossings during the 2013 flood resulted in smaller creeks and tributaries in the upper foothill watersheds becoming isolated and causing fish migration issues (e.g., tributaries to the Sheep and Highwood rivers, upper Willow Creek near Indian Graves and Trout Creek, among other areas).
- Fixing un-owned stream crossings will restore fish passage to headwater habitats.

Repair Fords in Area Watersheds to Reduce Sediment Yields into Fish Habitats

- Upper Elbow River watershed will need some repairs due to forest management and oil and gas activity.
- The road along the Ghost River upstream of Waiparous into Ghost Wilderness Area (at least three crossings) could be repaired.
- Three Point Creek and Sheep River watershed need repairs due to various agricultural activities.

Fish Passage between Upper and Lower Kananaskis Lakes

- There could be an investigation into fish passage issues between upper and lower Kananaskis Lakes where fish may occasionally become isolated. Corrective measures could be provided to improve passage to protect fish.
- This option might not be feasible under the *Fisheries Act*, which does not allow proponents to receive offsetting credit for restoring habitat belonging to another entity.

Complementary Offset Measures

Forest Hydrology and Water Quality Study of the Upper Elbow River Watershed

- This study would help to better understand the City of Calgary's source water protection needs in the Elbow River watershed and facilitate future planning needs that may have cumulative effects with the off-stream reservoir operations.
- Information to manage and protect Elbow River watershed hydrology and water quality will benefit resident fish populations as well as the City of Calgary's drinking water.

Conclusion

As noted above, this list may change through consultation with regulators and Indigenous groups; as suitable offsets for the Project are defined, some of these options will be eliminated. Details for each relevant offsetting option, including a full offsetting plan, will be developed and submitted with the application for authorization under the *Fisheries Act*. The offsetting plan will be developed with AEP to make sure the plan meets their fish management objectives and will be made available once complete.

Question 72

Supplemental Information Request 1, Question 348a, Pages 5.235-5.236
Volume 3B, Section 8.2.2, Page 8.6
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 6.29-6.31, Pages 6.63-6.65

Alberta Transportation states that the impact to fish from the slow release of sediment-laden (potentially high temperature and poor quality water) water from the dam into the side channel and the Elbow River would not be anticipated to result in residual effects on aquatic ecology.

This question has not been answered sufficiently. There appears to be a determination that the release of water from the reservoir that is potentially of poor quality and higher temperatures will not be harmful to fish. This is likely incorrect.

a. **Provide a follow-up monitoring plan to identify potential impacts to fish. Describe the surveys/reports that are to be used.**

b. **Assess water quality conditions that could occur in the dam when in use. Reference those water quality conditions to the potential impacts to fish:**

   i. **in the dam reservoir area; and**

   ii. **potential change in water quality in the Elbow River due to dam water releases.**

c. **Discuss the impacts to fish resulting from the slow rate of release of turbid water over an extended period of time. Consider the severity of ill effects (SEV) dose-response curve which indicates elevated negative impacts to fish with increasing duration of high sediment events.**

d. **What are the impacts to fish due to the operation of the auxiliary spillway?**

Response

a. Fish survival will be monitored in Elbow River upon water release, as outlined in the Draft Fish Rescue and Fish Health Monitoring Plan (provided in response to NRCB Question 31, Appendix 31-1). Monitoring efforts will be undertaken in the downstream portion of Elbow River (i.e., from the confluence of the unnamed creek with Elbow River to Glenmore Reservoir) to identify fish condition during reservoir water drawdown. The intent of this monitoring effort is to identify fish in Elbow River that exhibit stress through behavioural indicators related to the following events:

   - fish capture and relocation from the reservoir into Elbow River, including exposure to high concentrations of suspended sediment during the water retention period in the reservoir

- exposure to high concentrations of suspended sediment in Elbow River as a result of reservoir water release
- exposure to high concentrations of suspended sediment in Elbow River as a result of a flood (i.e., baseline sediment concentrations during a flood)

Monitoring of fish health in the downstream extent of Elbow River will be carried out by two boat crews immediately following reservoir water drawdown, or at the soonest time that it is safe to enter the river upon reservoir water release. This section of the river is approximately 18 km in length and is divided into two reaches, and one boat crew will be assigned per 9 km reach. Each boat crew will consist of a boat operator and a person to observe for fish. It is expected that mortalities and fish that are experiencing stress will be visible at the surface; underwater cameras will also be employed if practical.

Rather than capturing fish and relying on physiological indicators that are derived through laboratory analyses, the scope of the fish health monitoring program will use behavioural indicators; specifically, oxygen uptake (breathing rate), swim performance and avoidance behaviour are suitable indicators of fish health and stress that can be utilized in natural rivers and lakes. They do not require the capture of fish where undue stress could lead to a further deterioration of health. Fish stress and fish health indicators will be ranked with an evaluation matrix that is further described in response to NRCB Question 31, Appendix 31-1.

b. i-ii. Suspended sediments water quality and associated parameters are discussed in response to NRCB Question 16; effects to fish are discussed in response to NRCB Question 24 (in Elbow River) and NRCB Question 32 (the off-stream reservoir):

- Environmental conditions in the off-stream reservoir are generally not predicted to change physical and chemical properties of TSS in flood water in a manner that alters the relationship between suspended sediments and trace elements. Parameters that are strongly bound to suspended sediments in flood water will generally be strongly bound suspended sediments in the reservoir (i.e., sediment bound and dissolved concentrations going into the reservoir will be similar to concentrations going out of the reservoir). These results are further described in the response to NRCB Question 16.
- The predicted SEV index scores for fish in the reservoir are generally in the "sub-lethal effects" category for the 1:10 year flood and in the "lethal and para-lethal effects" category for the 1:100 year and design flood, further described in response to NRCB Question 24 and Question 32.
- The SEV index scores for fish in the river during the 1:10 year flood are largely in the sub-lethal category; however, for the 1:100 year and design floods SEV index scores are often in the "lethal and para-lethal effects" category, further described in the response to NRCB Question 24 and Question 32.

Temperature and DO and effects on fish and aquatic ecology are discussed in the response to NRCB Question 17:

- Under most early release and late release for all floods, assessed DO is predicted to decrease in Elbow River; however, levels are not expected to have an effect on the sustainability of resident aquatic biota. For reference, the CCME (1999) aquatic life guidelines for cold water are 9.5 mg/L for early life stages (i.e., fish and invertebrates) and 6.5 mg/L for all other life stages.
- Predicted changes in water temperatures are expected to be small and not result in effects on resident fish.

Nutrient water quality in the reservoir and Elbow River is discussed in the response to NRCB Question 18:

- Nutrient concentration levels in water released from the reservoir will be influenced by the nutrient concentrations in water diverted from the river, the duration that water is held and released from the reservoir, and environmental conditions such as available DO.

The following discussion provides analysis to estimate the nutrient concentrations in released reservoir water and how that water compares with Elbow River water at the time water is released.

The difference in water quality between the off-stream reservoir and Elbow River is dependent on the duration water is held in the reservoir and when water is released back into Elbow River. Nutrient water quality concentrations in Elbow River tend to decrease over the summer; median and 75th percentile nutrient concentrations in the river are higher in June than August. Therefore, releasing reservoir water later in the season may have a bigger impact because river nutrient concentrations are expected to be low in the river relative to concentrations earlier in the season. However, nutrient concentrations in the reservoir also decrease over time and at a higher rate than observed in the river, as evidenced when comparing early release and late release for the 1:100 year and design floods. There are a few exceptions of dissolved nutrients (i.e., dissolved phosphorus and nitrate+nitrate in 1:100 year early release and late release). Decreases in concentration over time are likely due to sedimentation and deposition in the reservoir.

Water quality samples will be collected in the reservoir and Elbow River during water release to monitor and identify potential for nutrient-related changes (see Table 72-1 for monitoring details). Operational management of the reservoir and release of water to Elbow River will be dependent on Elbow River discharge (i.e., flows below 160 m^3/s) and coordination with Glenmore Reservoir (e.g., available storage capacity, downstream flood management within Calgary, and potential need for emergency response).

Analytical results from water quality monitoring will be provided to downstream water users (e.g., Calgary water treatment plant at Glenmore Reservoir) so they can manage their water treatment options.

Table 72-1 Water Quality Parameters Frequency and Location Monitoring

Monitoring Parameter	Frequency	Location[1]
Total Suspended Sediments and Turbidity	Daily	Res, O-C, u/s
Temperature	Daily	O-C, u/s
Dissolved Oxygen	Daily	O-C, u/s
Conductivity	Daily	O-C, u/s
pH	Daily	O-C, u/s
Discharge	Daily	O-C, u/s
Major Ions	Weekly	Res, O-C
Total and Dissolved Metals	Weekly	Res, O-C
Nutrients	Weekly	Res, O-C
Methylmercury	Weekly	Res, O-C
Hydrocarbons	Weekly	Res, O-C

NOTE:
[1] O-C – outlet channel (including in the unnamed creek); u/s – Elbow River upstream of the intake structure; Res – off-stream reservoir

c. Effects on resident fish from releasing water from the reservoir to Elbow River uses work done by Newcombe and Jensen (1996), who studied and reported on the effects of suspended sediment exposure on fish health. Newcombe and Jensen (1996) evaluated how the relationship between the exposure and duration of suspended sediment affected the SEV of ill effects to fish. This work was used to develop a SEV index score rating to evaluate the predicted level of effect to fish from a level of exposure to suspended sediments and the duration of the exposure. SEV index scores for fish in Elbow River downstream of the Project during water release are provided in the response to NRCB Question 24b.

d. The auxiliary spillway is reserved to convey excess flood flow without overtopping failure, or circumvention of the floodplain berm. The use of the auxiliary spillway is a contingency measure for the off-stream dam safety. In the rare event that the auxiliary spillway is required during flood operation, excess flood flow will be directed overland. Loss of fish due to stranding is likely to occur if fish are mobilized to overland areas.

REFERENCES

CCME (Canadian Council of Ministers of the Environment). 1999. Canadian water quality guidelines for the protection of aquatic life: Dissolved oxygen (freshwater). In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

Newcombe, C.P., and J.O. Jensen. 1996. Channel Suspended Sediment and Fisheries: A synthesis for Quantitative Assessment of Risk and Impact. North American Journal of Fisheries Management. Volume 16(4): 693-727.

Question 73

Supplemental Information Request 1, Question 349, Page 5.241-5.242

Alberta Transportation states that flows over 160 m^3/s are considered channel forming.

Since the Elbow River routinely experiences flows >160m^3/s altering and/or suppressing the flow regime would affect the quality and quantity of fish habitat downstream in the long term. Prevention of bedload movement would result in the permanent loss and alteration of fish habitat. The alterations that occur include the increasing embeddedness of bed material and increased siltation. This change in substrate would reduce the availability of fish habitat, spawning habitat, and reduce the productivity of the river (i.e. invertebrate communities) which would subsequently impact fish populations.

Operation of the dam will alter channel forming flows downstream of the project site. This includes changes to (reduction) the movement of bed materials and outright loss of woody debris.

a. **Map fish habitat downstream of the diversion structure. In addition, conduct an assessment of how habitat would decline over time.**

b. **What evidence is being cited to conclude that flows over 160 m^3/s are considered channel forming and would shift bed materials to maintain habitat?**

c. **Is the proposed flow level adequate to maintain riverine processes?**

d. **Assess the changes to the reduction of movement of bed materials and loss of woody debris. In addition, assess the subsequent impacts to fish habitat over time resulting from dam operation.**

e. **Map fish habitat upstream and downstream of the diversion structure to provide baseline information for comparison when assessing post dam operations.**

Response

a. ***FISH HABITAT MAPPING***

Fish habitat mapping was conducted within the main stem of Elbow River in fall 2019 between the Tsuut'ina Nation Reserve boundaries of Redwood Meadows and Discovery Ridge to document pre-construction baseline habitat information and inform Project-related monitoring during construction and operation (e.g., identify temporal changes to habitat with the Project). A total of 830 ha of surface water was mapped during the field survey, and a habitat map book displaying georeferenced channel types within the area surveyed in the fall of 2019 is provided in Alberta Transportation's response to AEP Question 69 (Appendix 69-1, Attachment B).

Fish habitat mapping are further characterized using a HSI model for the following key indicator species: bull trout, brown trout, rainbow trout, and mountain whitefish. The adult, juvenile, fry, and spawning life stages are evaluated through HSI values for each indicator species. HSI rankings are overlaid on the georeferenced habitat results to provide a visual interpretation of habitat potential for each indicator species and life stage (Appendix 69-1, Attachment E to H).

CHANGE IN FISH HABITAT WITH THE PROJECT

MIKE 21C model results for Elbow River were used to assess how bedform may change during each flood (i.e., a 1:10 year, 1:100 year, and 2013 floods), with and without the Project (modelling results and a discussion on the effects to river morphology are provided in Appendix 23-1: Bedload Model-Technical Memo). MIKE 21C modelling was completed for baseline surface and each flood to assess temporal changes to Elbow River, with the Project.

The MIKE 21C modelled results were subsequently used to evaluate changes to fish habitat through HSI modelling (Appendix 23-2: Fish Habitat Suitability Index (HSI) analysis of Modelled Scenarios in Elbow River). Habitat suitability is assessed for the habitat within the wetted area of the Elbow River channel during a 7.4 m^3/s flow discharge after each flood and compared with habitat suitability at the same flow discharge after each flood, with the Project. Differences in HSI, with and without the Project, are used as a means to quantify effects of the Project on fish habitat.

Hydraulic variables important to fish are predicted by each MIKE 21C surface morphology modelled output and carried forward into HSI calculations. Hydraulic variables for HSI calculations include wetted depth, velocity, and substrate size. HSI is a numerical index that describes the suitability of habitat (from 0 to 1, with 0 representing least suitable habitat and 1 representing most suitable habitat) to support a selected species or species life stage. HSIs were developed for each of four life stages (i.e., adult, juvenile, fry, and spawning) of four key indicator species (i.e., brown trout, bull trout, mountain whitefish, and rainbow trout) to calculate and compare the suitability of fish habitat between the modelled scenarios, with and without the Project.

An area-based metric of habitat suitability called the WUA is used to compare how the HSI results varied between modelled reaches for each flood. WUA values are the final HSI measure of suitability for each study reach (i.e., areas with higher WUA values provide more suitable habitat that support a specific life stage). A paired t-test is used to determine with the Project resulted in statistically significant changes to habitat suitability for each flood, fish species, and life stage. Significance of the t-test is set at $p<0.05$.

The HSI results suggest that the Project will result in a quantifiable change in available habitat areas (i.e., footprint) and decreased habitat quality in some areas of Elbow River for juvenile and fry life stages. Statistically significant changes to habitat suitability are identified for 1:10 year flood. This included statistically significant decreases in habitat suitability, with the Project, for the brown trout fry life stage, the bull trout juvenile and fry life stages, and the rainbow trout fry life stage. In all cases, changes to fish habitat suitability, with the Project, were related to decreases in total wetted surface areas combined with higher depths and velocities in some areas that are generally less suitable to juvenile and fry life stages of key indicator species. For all other combinations of floods, fish species, and life stage, with the Project results do not have a statistically significant change to fish habitat suitability.

The modelled bed elevation changes will result in some statistically significant changes to habitat for juvenile and fry life stages, but these effects can be mitigated through the offsetting plan that will be developed in consultation with DFO. Alberta Transportation is committed to offset habitat loss through efforts that will enhance existing habitat or the creation of new habitats through the *Fisheries Act* authorization process. With the implementation of offsetting measures, it is expected that the productive capacity of fish species in Elbow River will persist with the Project. The Project is expected to operate infrequently, and the loss of habitat that would be experienced during operation is not expected to result in a significant residual effect on fish habitat.

b. From the literature, bankfull flow is generally accepted to be the channel forming flow (Andrews 1980). The mean annual flood is sometimes used as an unbiased estimate of bankfull flow (Dury 1961). The mean annual flood for Elbow River at Bragg Creek WSC station (ID# 05BJ004) is approximately 70.9 m^3/s for the period of record (1935 to 2015). Over the period of record, a peak flow of 70.9 m^3/s or greater has occurred in 27 years (42%) over the 65-year record available for instantaneous flows. Based on this, channel forming flows are likely to be closer to 70.9 m^3/s, which will continue to occur with the Project. Over the 81 years of maximum annual flow record, 70.9 m^3/s was exceeded in 28 years (35%).

Examination of the annual instantaneous peak flow data show that a peak flow of 160 m^3/s or greater has occurred in 12 years (18%) during the 65-year record. When the maximum annual flow record (maximum annual daily discharge) is examined, 160 m^3/s was exceeded 5 years (6%) over the 85 years of record. The record shows that when flows are greater than

160 m^3/s, they typically do not remain above 160 m^3/s for more than one day. The frequency at which Elbow River experience flows of 160 m^3/s or greater suggests that it is does not represent the channel forming flow, as discussed below.

c. The operation of the off-stream reservoir will alter the hydrological regime of Elbow River downstream of the Project site. As explained above in the response to b., the change in the hydrological regime will not alter channel forming flows. However, as explained in more detail in the response to NRCB Question 14, the geomorphology of Elbow River may simplify over time due to the reduction of these infrequent but large magnitude floods. Very large floods trigger avulsions that create side channels that provide fish habitat. These floods also have high sediment transport rates that create large bars and produce heterogeneous bed sediment patterns. The frequency and magnitude of overbank deposition will be reduced as inundation of the floodplain decreases. However, most channel processes are anticipated to be maintained at flows of 160 m^3/s or less (refer to response for NRCB Question 14 for an extended explanation).

d. An assessment of changes to bedload and subsequent changes to fish habitat as a result of the Project is described in the response to NRCB Question 23a.

A quantitative estimate of LWD, and corresponding loss as a result of flood operations of the Project, is described in the response to NRCB Question 29. The debris deflector will capture LWD quantities that are proportional to the magnitude of flow that is being diverted to the reservoir. It is anticipated that some of the LWD captured on the debris deflector will re-enter the river and pass downstream naturally when the flood has passed and the diversion gates are lowered to allow normal passage of water down Elbow River. However, all captured LWD will be removed from the diversion inlet during post-flood maintenance operations.

Despite removal of LWD during post-flood operations, potential impacts to fish habitat and aquatic productivity are not anticipated due to a change in woody debris availability downstream of the Project. This is because the Project will operate infrequently, and loss of LWD is only associated with relatively high magnitude floods.

Fish habitat complexity in downstream areas will be maintained with the Project through geomorphic changes to the channel, vegetation establishment over time, and instream LWD that is maintained in the areas downstream of the Project. A prediction of potential impacts to fish habitat as a result of LWD loss carry some uncertainty; this is because quantification was inferred through aerial imagery (further details provided in Alberta Transportation's response to NRCB Question 29).

Through the desktop evaluation of impingement locations, it is possible that some LWD is not visible through the aerial imagery, or some areas may mobilize differently than predicted. Furthermore, LWD that is transported downstream during a flood may deposit at a different flood level relative to the baseline quantification, particularly in large floods where LWD may get deposited above the ordinary high-water mark.

Pre-construction habitat mapping is being completed for Elbow River from Bragg Creek to Glenmore Reservoir. LWD that offers fish habitat is considered through HSI rankings associated with this fieldwork. While LWD is not directly quantified within this field survey, it is considered through habitat evaluation and HSI ranking.

A survey of post-flood habitat will be compared with baseline habitat information to monitor habitat changes as a result of the Project, including the change to fish habitat complexity related to the presence of LWD presence. Habitat changes will be monitored through compliance monitoring programs associated with the Project *Fisheries Act* authorization.

e. A total of 830 ha of surface water was mapped during the fall 2019 field survey, and a habitat map book displaying georeferenced channel types within the area surveyed in the fall of 2019 is provided in Alberta Transportation's response to AEP Question 69 (Appendix 69-1, Attachment B).

REFERENCES

Andrews, E. D. 1980. Effective and bankfull discharges of streams in the Yampa River basin, Colorado and Wyoming. Journal of Hydrology, vol. 46, no. 3, pp. 311–330, DOI: 10.1016/0022-1694(80)90084-0.

Dury, G.H. 1961. Bankfull discharge -- an example of its statistical relationships. Bull. Int. Assoc. Sci. Hydrol., VI: 45--55.

Question 74

Supplemental Information Request 1, Question 350, Pages 5.245-5.248

Alberta Transportation states that fish entrainment could be up to 80%, but would likely be lower.

This question has not been answered sufficiently. Fish could be entrained at a higher rate than discussed, and the entrainment rate is not necessarily linear. Alternative rates of entrainment should be considered in regard to potential population level effects due to potential losses resulting from mortality, and also from physical impacts to fish when diverted (i.e. injury, diminished reproductive capacity).

a. Explain the modeling of fish entrainment (up to 80%). Is there experimental data which supports linear rates of entrainment relative to flow?

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a. Fish entrainment was considered by assessing the results of a literature review and was not modelled.

Because of the unique nature of the Project design, and uncertainties in fish behavior (e.g., how resident fish distribute through a river or use refuge habitat such as flood plain areas during a flood), information to quantitively estimate fish displacement and subsequent entrainment in the diversion structure is not available. Modelling without this quantitative information as input would not provide meaningful results.

The assessment uses the assumption that the proportion of the peak water volume diverted and the proportion of the resident fish community displaced and entrained during a flood has a 1:1 relationship (i.e., a 10% water diversion would result in a displacement and entrainment of 10% of the resident fish population; and 80% water diversion would result in a displacement and entrainment of 80% of the resident fish population). Due to the uncertainty discussed above, this assumption (i.e., there is a linear relationship between diversion rates and fish entrainment) cannot be tested using quantitative means. Therefore, a review of available literature was conducted to evaluate this assumption and summarize the reported nature of the relationship between water diversion and fish entrainment. The conclusion is that a 1:1 linear relationship is a conservative assumption (it likely overestimates that amount of entrainment). A discussion on the literature review that led to this conclusion follows.

Available literature on water diversions and fish entrainment was assembled using Google Scholar and reviewed. The relationship between fish entrainment and water diversion rates are not widely reported on in the literature (Moyle and Israel 2005). Many available papers do not consider entrainment rates or lack information relevant to evaluate entrainment rates or effects on fish populations. Eleven papers provide information to evaluate fish entrainment rates or comment on effects relevant to the Project (references summarized in Table 74-1). Of these 11 papers, nine were studies of irrigation diversions and two were studies of hydroelectric facilities.

In general, the authors found fish entrainment increases with water diversion volume (Spindler 1955; Sechrist and Potak Zehfuss 2010; Walters et al. 2012; Mathur et al. 2018); this relationship appears stronger at lower river flows (Mussen et al. 2013). Even though some authors reported a strong relationship between % of fish entrained and % of discharge diverted, there was always less than a 1:1 relationship between fish entrained and water diverted from a river. This suggests the 1:1 relationship used to assess effects to fish entrainment in the EIA is conservative (overestimates the effect).

Several of the studies reported entrainment rates for diversions occurring over a long period of time (e.g., irrigation season of four to five months and/or entrainment rates for an extended river reach with several diversions). Few authors reported on an entrainment rate for a single diversion site during a short-term event (e.g., period of a few days). Post et al. (2006) reported entrainment rates for salmonids in the Bow River at Carseland weir and irrigation diversion gate ranging from less than 1% over an irrigation season. Walters et al. (2012) reported entrainment of migrating chinook salmon smelt in a heavily diverted river (i.e., numerous diversion gates along the river) to be greater than 70% with a probability of 4% entrainment at any one diversion gate.

The proportion of resident fish displaced and entrained in the off-stream reservoir is difficult to predict based on this information. The amount of water diverted from Elbow River may be proportionally high, but for a relatively short period of time compared to durations reported in the literature. Peak diversion rates from Elbow River for each flood scenario are as follows:

- design flood
  - Up to 52% of flow diverted during peak discharge (3.75 days total time for diversion).
  - 600 m^3/s flow diverted as Elbow River flows increase up to an instantaneous peak discharge of 1,159 m^3/s.
- 1:100 year flood
  - Up to 78% of flow diverted during peak discharge (1.8 days total diversion time).
  - 600 m^3/s flow diverted as Elbow River flows increase up to an instantaneous peak flow of 765 m^3/s.
- 1:10 year flood
  - Up to 20% of flow diverted during peak discharge (0.38 days total diversion time).
  - 40 m^3/s flow diverted as Elbow River flows increase up to an instantaneous peak flow of 200 m^3/s.

The proportion of the Elbow River flow diverted is predicted to vary from zero to 20% of peak discharge for the 1:10 year flood, to 78% of peak discharge for the 1:100 year flood. These diversions are much higher than the diversion rates reported for single diversions (i.e., irrigation gates) in the literature (Table 74-1); however, they are also much shorter in duration than river diversions reported in the literature. During low flow periods in Bow River (i.e., late July through early October) in 2003, between 30% and 45% of the river discharge was diverted (and only 1% of fish entrained) at the Carseland weir diversion gate (Poste et al. 2006).

Post et al. (2006) reported fish entrainment rates in the Carseland weir diversion gate on Bow River to be less than 1% for salmonids (greater than 150 mm fork length) during the 2003 irrigation season (i.e., April to October; Table 74-2). Smaller fish were entrained at higher rates, especially for mountain whitefish. However, smaller fish make up a larger proportion of the population. Bow River population estimates for smaller fish were not available and, therefore, small fish entrainment rates were not calculated.

Considering the proportion of Elbow River flow predicted to be diverted during a flood (as discussed above) for a duration of less than four days, the proportion of resident Elbow River fish population entrained during a flooding event will be considerably less than that reported in Poste et al. (2006), wherein diversion and fish entrainment were considered over several months.

In summary, entrainment rates reported in the literature are lower than the diversion rates discussed above (i.e., less than 1:1). The diversion rates studied in the literature are generally lower than the proposed diversion rates for the Project and, the length of time for the diversion are much longer (i.e., months vs. days) in the previous studies. However, based on the work by Post et al. (2006), the proportion of the resident Elbow River fish population entrained in the diversion inlet will likely be less than 1% for fish that are greater than 150 mm long. If mortality of entrained fish is high, 1% of the population would be lost. The number of entrained small fish reported by Post et al. (2006) is higher than larger fish; however, the proportion of the overall resident fish population comprised of small fish cannot be calculated from this data.

AEP will apply an adaptive management approach to operating the reservoir. A fish monitoring plan is being developed to monitor fish health and fish populations during flood operations (as described in responses to NRCB Question 31 and AEP Question 77). The monitoring information will be used to inform actions to maintain fish population as developed under the *Fisheries Act* Authorization and offsetting plan (as described in the response to AEP Question 71).

Table 74-1 Summary of Stream Diversion and Entrainment Rates in Available and Relevant Literature

Reference	Diversion type	Drainage	Entrainment Rate	Conditions
Bahn 2007	Irrigation Diversions (multiple diversions)	Bitterroot River (MT): Lost Horse Creek Tin Cup Creek	• 2% to 3% of all trout sp. in basin.	• Entrainment significantly associated with: – discharge – upstream gradient – discharge ratio – length of irrigation season – temperature – diversion dam height – angle with downstream, thalweg
Carlson and Rahel 2007	Irrigation Diversions	Smith's Fork River Basin (WY)	• Bonnyville cutthroat trout (*Oncorhynchus clarkii*)– 1.2% to 3.3% entrainment rate. • Brown trout (*Salmo trutta*) – 0.4% to 1.2% entrainment rate (fish greater than 150 mm TL).	• Fish migrating (e.g., for spawning) during diversion are most susceptible to entrainment opposed to those not in their migration period.
Fincel et al. 2016	Hydro Dam	Missouri River (SD) Lake Oahe Dam	• Estimated entrainment rates for Rainbow Smelt (*Osmerus mordax*): • Summer 1997 – 439×10^6 Rainbow Smelt • Summer 1998 – 4×10^6 Rainbow Smelt • Summer 1999 – 2×10^6 Rainbow Smelt • Summer 2011 – (flood occurred) – 433×10^6 age-0 Rainbow Smelt – 231×10^6 adult Rainbow Smelt	• Entrainment highest during PM light time period (15:00 to 21:00 hours). • Entrainment rates for normal and high flows through a hydroelectric dam over a season.

Table 74-1 Summary of Stream Diversion and Entrainment Rates in Available and Relevant Literature

Reference	Diversion type	Drainage	Entrainment Rate	Conditions
Mathur et al. 2018	Pumping Facility	Susquehanna River (MD) Conowingo Pond - river impoundment	• American Shad (*Alosa sapidissima*) entrained in month of October: – 3.5% of juveniles – 3.9% adults	• Intake velocity 0.2 m/s to 0.9 m/s. • Highest entrainment rate during highest pumping rate, between 23:00 and 06:00 hours. • River flow - 650 m^3/s to 2,775 m^3/s. • Pumping Flow 113 m^3/s to 907 m^3/s.
McDougall et al. 2013	Run of the River Hydroelectric Facility	Winnipeg River (MB) between Pointe du Bois and Slave Falls	• Entrainment rate for tagged Lake Sturgeon (*Acipenser fulvescens*): – 27% of sub-adults – 8.7% of adults	• Winnipeg River mean flows 869 m^3/s (range 100 m^3/s to 2,600 m^3/s). • Entrainment rates for flows over a 10-month period through a run of the river hydroelectric facility (i.e., 100% flow through the facility).
Mussen et al. 2013	--	Laboratory experiment on irrigation pipe inlets	• Juvenile (12 cm to 14 cm) Chinook salmon (*Oncorhynchus tshawytscha*). • An increase in diversion rate (0.42 m^3/s to 0.57 m^3/s [35.7%]) resulted in an increase in entrainment rate from 0.9% to 1.7%).	• Simulated river current velocity – 0.15, 0.38, and 0.61 m/s. • Diversion velocity (0.46 m diameter pipe) at 0.15, 0.61 m/s. • Clear, turbid water and night treatments. • Threshold of risk to fish with within 36 cm of pipe intake with velocity of 0.74 m/s at pipe inlet. • Entrainment was highest under treatment combinations with lowest stream flow velocities and highest diversion rates.

Table 74-1 Summary of Stream Diversion and Entrainment Rates in Available and Relevant Literature

Reference	Diversion type	Drainage	Entrainment Rate	Conditions
Nobriga et al. 2004	Irrigation Diversion Pipes	Sacramento River Delta (CA)	• Entrainment rate included 23 fish entrained under screened treatment compared to 8,501 fish under unscreened treatment (all under 45 mm). Fish sp. included: – Threadfin shad (*Dorosoma petenense*) – Inland silverside (*Menidia beryllina*) – Striped bass (*Morone saxatilis*) – Delta smelt (*Hypomesus transpacificus*)	• Three diversion pipes 61 cm diameter. • Study in the delta of the Sacramento river affected by tidal movement. • 34 to 38 hours of monitoring entrainment the second week of July in 2000 and 2001.
Post et al. 2006	Irrigation Diversion	Bow River AB (Carseland Canal)	• Estimated Entrainment Rates over the 2003 irrigation season April to October: – Rainbow Trout: 3,996 fish entrained (42% >155 mm) – Brown Trout: 664 fish entrained (17% >150 mm) – Mountain Whitefish: 93,850 fish (0.5% >150 mm)	• During 2003 Bow River discharge was: – approximately 50 m^3/s in May – peaked at approximately 200 m^3/s in June – decreased to approximately 100 m^3/s in July – just over 50 m^3/s by October • Diversion rate 1.4 m^3/s to 37.7 m^3/s and represented a considerable proportion of river flow from July through October 2003 (between 30% and 45%).

Table 74-1 Summary of Stream Diversion and Entrainment Rates in Available and Relevant Literature

Reference	Diversion type	Drainage	Entrainment Rate	Conditions
Sechrist and Potak Zehfuss 2010	Irrigation Diversion	Sun River (MT)	• Entrainment rate of larger trout (>200 mm) – 2003 o Brown Trout 14.4 % o Rainbow Trout 4.3% – 2004 o Brown Trout 16.0 % o Rainbow Trout 2.6%	• Number of fish entrained related to proportion of river diverted. • 2003 diversion rate between 0.6 m^3/s to 6.7 m^3/s. • 2004 diversion up to 7.4 m^3/s. • Sun River discharge both years peaked at 39 m^3/s and dropped to 1.5 m^3/s for remainder of the season.
Spindler 1955	Irrigation Diversion	West Gallatin River (MT)	• Relationship between fish entrainment and volume of flow was expressed in the following regressions: – 1951 season: Y=10.2+0.429X – 1952 season: Y=3.0+0.67X Y=loss of legal sized game fish. X =volume of canal flow (cubic feet per second).	• Loss of legal sized fish was proportional to the volume of flow in irrigation canal.
Walters et al. 2012	Watershed Wide; Multiple Irrigation Diversions	Lemhi River (ID)	• Estimated entrainment of Chinook salmon (out migrating smolts) throughout the watershed was 71%. • Probability of entrainment at an individual diversion was 4% under high stream flow conditions.	• Watershed diversion generally less than 50% of flow. • Median stream flow conditions during study. • Entrainment probability was linear and somewhat less than one (i.e., probability of entrainment approx. 0.15 with 20% diversion to 0.6 with 80% diversion).

Table 74-2 Salmonid Fish Entrainment Rates in the Carseland Weir Diversion Gate on Bow River, April to October 2003

Fish Species	Estimated Population (>150 mm)	Total Fish Entrained	Entrainment Rate (fish >150 mm)	Month of Maximum Entrainment
Rainbow Trout (*Oncorhynchus mykiss*)	186,847	1,683 (42%) >150 mm 2,313 (58%) <150 mm	0.90%	August
Brown Trout (*Salmo trutta*)	25,001	116 (17%) >150 mm 548 (83%) <150 mm	0.46%	September
Mountain Whitefish (*Prosopium williamsoni*)	301,173	430 (0.5%) >150 mm 93,420 (99.5%) <150 mm	0.14%	September
SOURCE: Post et al. 2006				

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Question 75

Supplemental Information Request 1, Question 351, Pages 5.248-5.250
Volume 3B, Section 8.2.4.3, Page 8.17
Volume 3B, Section 6.4.3.1, Table 6-6, Page 6.2B

Alberta Transportation predicts that effects on fish would not meet the threshold that is considered serious harm to fish because fish rescues would be conducted to remove any stranded fish, eliminating mortality.

In general, rescuing stranded fish from pools in reservoirs is expensive, ineffective, and sometimes cannot be undertaken due to risks to human safety (i.e. inaccessibility due to mud). There are assumptions that very few or no fish will be stranded and that fish rescue is safe, feasible, and effective. Neither of these assumptions are likely correct based upon experience (i.e. periodic fish stranding in the Ghost Reservoir).

In addition, the response provided has not been answered sufficiently. It does not address potential harm to fish due to timing of sediment release, nor does it consider the effect of the sediment on entrained fish. It also does not address the potential impacts of failure to rescue stranded fish, which is not something considered in the document (but which commonly occurs in other dams during draining for maintenance work, i.e. fish cannot be reached safely to rescue them, and perish).

a. **Explain how this mortality risk can be classified as not significant given that mitigation relies on locating and rescuing an unknown number of fish by hand with an unspecified work force capacity working in a short time window during which reservoir water quality and capacity will support fish.**

b. **Estimate the mortality of fish due to dam operations, and evaluate the potential population level effects of this mortality.**

c. **Develop a mitigation plan to address mortality from stranding.**

d. **Develop a monitoring plan to assess the impact of dam operations on fisheries populations.**

Response

a. The mortality risk is not significant because the proportion of fish that may become entrained (and subsequently are at risk of sublethal and lethal effects in the reservoir) is expected to be low relative to the number of fish in Elbow River. This rationale is based on the literature review that is presented in the response to AEP Question 74 regarding fish entrainment studies and assumptions that have been made for entrainment in the reservoir.

In general, studies have found that fish entrainment increases as water diversion volume increases (Spindler 1955; Sechrist and Potak 2010; Walters et al. 2012; Mathur et al. 2018). The proportion of the resident Elbow River fish population entrained in the diversion inlet will likely be less than 1% for fish that are greater than 150 mm long. This assumption is derived in the response to AEP Question 74 and relies on previous findings for the Carseland weir diversion gate flow and entrainment percentages on the Bow River, where 30% to 45% of the river discharge was diverted, and only 1% of fish were entrained (Post et al. 2006).

Post et al. (2006) did not report data to estimate small fish population sizes or to evaluate the rate smaller fish (e.g., less than 150 mm long) were entrained in the diversion gates at Carseland Wier: however, they stated that more small fish were entrained in the irrigation channel than larger fish. The authors stated the diversion gates appeared to selectively entrain smaller fish of some species (e.g., mountain whitefish), but population survey data for Bow River was not adequate to determine how entrainment rates for larger fish and smaller fish compared. The larger number of entrained small fish is assumed to be due to smaller fish making up a larger proportion of each species population and the overall fish community (i.e., more small fish are entrained during diversion because there are more small fish than large fish in the river). The literature reviewed in the response to AEP Question 74 does not provide more insight into estimating entrainment rates for small fish during Project water diversion.

The assumption used here is that the proportion of large fish (larger than 150 mm) to small fish (less than 150 mm) entrained in the off-stream reservoir will reflect the make-up of the community in Elbow River. Therefore, the fish entrained in the off-stream reservoir will represent 1% of both large fish and small fish in the larger population. If mortality of entrained fish is high, no more than 1% of the population would be lost since only 1% of the fish population would be entrained.

Low estimates of fish entrainment are the primary reason for concluding that effects of entrainment are not significant, but additional mitigation and Project design measures (such as reservoir grading to reduce risk of stranding in pools and fish salvages) will be implemented to reduce the potential effects of entrainment on Elbow River fish populations.

Fish salvages are a standard method for mitigating effects on fish, and this will be implemented, considering lessons learned on previous successful and unsuccessful fish-outs. A Draft Fish Rescue and Fish Health Monitoring Plan (see the response to NRCB Question 31, Appendix 31-1) describes how the capture and relocation of fish that may become entrained in the reservoir following a flood could be carried out.

Methods described in the plan align with industry-standard protocol for successful fish-outs in lakes and waterbodies that were dewatered for mine construction (Jacques Whitford 2002; North-South Consultants Inc. 2010; AMEC 2011) and incorporates learnings from these and other fish rescues. Previous fish-outs have identified challenges in terms of accessing the waterbodies (i.e., ability to wade in heavy sediment) to effectively rescue fish.

Boat electrofishing has been incorporated into the fish rescue plan to address potential challenges that may arise during fish rescue efforts for the Project.

It is possible that lethal and sublethal effects as a result of TSS concentrations in the reservoir (further described in the response to NRCB Question 32) will lead to mortality of fish that become entrained; however, fish mortality within the reservoir is not significant because the proportion of fish that are likely to become entrained is low, relative to the populations of fish in Elbow River. Some uncertainty exists with this determination of significance due to a lack of data that exists for population abundances in Elbow River.

b. Several factors will influence fish survival in the reservoir, as shown in Figure 75-1.

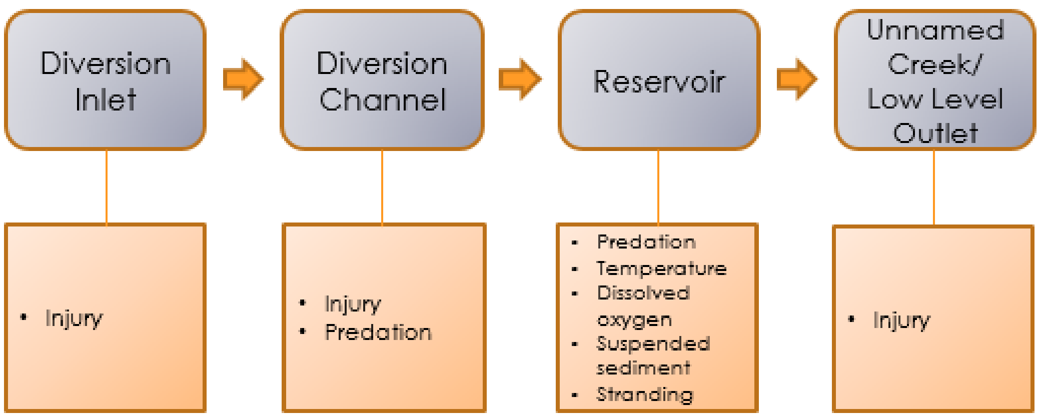

Figure 75-1 Factors that Influence Fish Mortality if Entrained in the Reservoir During Flood Operations

The risk of injury and mortality to fish in the reservoir is due to the following mechanisms:

- Body injury to fish may occur as a result of high flows and debris that will likely be encountered at the debris deflector and through the diversion inlet gates during flood operations.
- Predation (e.g., birds, predatory fish) during water retention in the reservoir, and stranding, may occur as water levels recede during water release.
- Injury may occur as fish move through the diversion channel, reservoir, and outlet channel.

- Lowered DO concentrations and elevated water temperature may occur, which can also adversely affect the physiology of fish, or lead to a synergistic adverse effect on fish that are exposed to high concentrations of suspended sediment.
- The SEV index evaluation is presented in Alberta Transportation's response to NRCB Question 32, which describes the ranges of mortality that could occur among fish that are entrained in the reservoir as a result of exposure to suspended sediment.

The biggest effect causing fish mortality is expected to be the duration and exposure of suspended sediments on fish in the reservoir. The expected mortality of fish that are entrained in the reservoir is described as follows:

- Mortality of 20% to 40% could occur for juvenile and adult salmonids that become entrained in the reservoir during a 1:100 year flood for both early and late release, as well as 20% to 40% mortality among juvenile and adult salmonids during late release for a design flood (see the response to NRCB Question 32).
- Mortality of 20% to 40% for adult salmonids and 40% to 60% for juvenile salmonids could occur following entrainment during the design flood, early release, as indicated in the response to NRCB Question 32.

Additional risks to fish survival such as those listed in Figure 75-1 will have a compounding effect on fish mortality during flood operations, and fish mortality may be higher than estimated here. Despite the uncertainty that exists in the mortality estimates for fish that are entrained in the reservoir, a reduction in fish populations in Elbow River is not significant because the portion of fish that are entrained in the reservoir is expected to be low relative to the overall populations in Elbow River. Such a reduction is not significant to the long-term sustainability or productivity of fish populations in Elbow River.

Fish abundance in Elbow River is extrapolated from spawning survey data, surveys conducted during late fall 2019, and relative abundance from historical data. Estimates of fish population abundance are presented in the response to NRCB Question 19, which estimates that Elbow River supports 1,948 to 2,733 adult salmonids (i.e., bull trout, brown trout, brook trout, rainbow trout and mountain whitefish). Under the assumption that flood operations would result in 1% entrainment of the Elbow River fish populations, flood operations would result in the entrainment of 20 to 28 adult salmonids in the reservoir. Considering a mortality rate of 40% to 60%, based on the highest predicted SEV scores (as discussed in the response to NRCB Question 32), the mortality of adult salmonids would be eight to11 fish.

Additional fish population data for Elbow River fish community will be collected in July and August 2020. The results of the fish population assessment will be used to validate the number of fish that potentially may be entrained in the reservoir during a flood. The results of this population assessment will be documented and provided to NRCB and AEP.

While it is expected that fish mortality due to entrainment in the reservoir will not result in a significant adverse effect to fish populations in Elbow River, an authorization under Section 34.4 of the *Fisheries Act* for the death of fish may still be required for the unavoidable loss of fish during flood operations. The fieldwork planned for population assessments and the subsequent assessment of fish mortality will also inform the *Fisheries Act* authorization application and will be used to support a discussion on the death of fish under Section 34.4 of the *Fisheries Act* authorization for the Project.

c. A Draft Fish Rescue and Fish Health Monitoring Plan is provided in the response to NRCB Question 31, Appendix 31-1; it describes the mitigation of potential effects of flood operation on fish. It includes commitments for workforce capacity, equipment, timing, and measurements and fish handling procedures that are required during fish rescue. The Draft Fish Rescue and Fish Health Monitoring Plan includes mitigation to reduce mortality and stranding of fish due to dam operations. Furthermore, it describes fish health monitoring efforts that will be undertaken in the downstream portion of Elbow River (i.e., from the confluence of the unnamed creek with Elbow River to Glenmore Reservoir) to identify fish condition during water release from the reservoir.

   The Fish Rescue and Fish Health Monitoring Plan will be finalized for review and approval by DFO as part of the *Fisheries Act* authorization. The results of the fish rescue and fish health monitoring efforts that occur during flood operations will be reported to DFO to ensure compliance with a pre-determined Project mitigation and offsetting plan.

   In addition to the Draft Fish Rescue and Fish Health Monitoring Plan, the following mitigation is included in the Project engineering design to address the risk fish mortality from stranding:

   - The diversion channel has been designed to accommodate fish passage; design mitigation includes appropriate channel configuration and grade to reduce the risk of stranding.
   - The contours and elevations of the reservoir (i.e., bowl shape) have been designed to pool water in the deeper, central area of the reservoir; this will maintain an area of elevated water depths where fish will find more suitable refuge where there are lower temperatures and cover.

d. The monitoring plan is also provided in the Draft Fish Rescue and Fish Health Monitoring Plan. Upon completion of fish rescues in the reservoir and release of rescued fish to Elbow River, fish health monitoring will be undertaken in the downstream reach of Elbow River. Data collected will provide information on effects that fish experience as a result of movement through Project infrastructure. Furthermore, monitoring efforts downstream of the Project will also account for effects on fish that are exposed to water from the reservoir that has re-entered Elbow River, which is predicted to have increased water temperature, reduced DO, and increased suspended sediment concentrations.

Observations during fish health monitoring efforts, including the number of mortalities, will be compared with baseline population data (described in the response to b.) to assess the impacts of reservoir operations on fish.

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Question 76

Supplemental Information Request 1, Question 353a, Page 5.257

Alberta Transportation states that monitoring would be conducted from shore.

This question has not been answered sufficiently and does not address what will happen if there are problems with operations or during periods when flows are low, or if v-weirs sustain damage and need maintenance.

a. Describe and explain what monitoring of fish passage will entail including frequency, time of year, and techniques.

b. Develop mitigation plans focused on the potential failure of fish passage.

Response

a. Conditions for fish passage (i.e., depth, velocity, connectivity through the service spillway and v-weirs) will be monitored in Year 1 and Year 2 following construction of the Project to evaluate and confirm fish passage criteria have been met. Draft commitments, including frequency, time of year, and techniques for fish passage monitoring are described in the response to NRCB Question 33. A monitoring plan will be finalized for review and approval by DFO as part of the *Fisheries Act* authorization.

b. An assessment of fish passage mitigation measures was undertaken for three different fish sizes of 25 mm, 250 mm and 1,000 mm and for all fish species found in Elbow River, grouped by their swimming ability (presented in the response to NRCB Question 21). Results of these calculations demonstrate that fish passage is maintained for all species and sizes for conditions at floods where passage is possible under existing conditions. The proposed instream works improve passage for some species under selected flow conditions, where passage could not be achieved under background conditions (i.e., conditions without the Project in place). The fish passage mitigation structures, therefore, improve the hydraulic conditions for fish passage through this reach, over existing conditions.

   Should fish passage not be achieved following construction (i.e., if passage structures do not perform comparably to the reference location in Elbow River or fish swimming performance data), adjustments will be made to the fish passage structures to improve fish passage. Adjustments could include re-configuring existing boulder clusters or adding boulders to the engineered rock weirs to improve velocity refugia for fish.

   The engineered rock weirs have been designed for stability up to a 100-year flood in Elbow River (i.e., 600 m^3/s diverted and maximum flow through the service spillway of 160 m^3/s). The integrity of the structures will be monitored by AEP Operations staff, based on flood activation. The works may require repair or rebuilding following high flows during post-flood operation if a 100-year flood is exceeded.

Question 77

Supplemental Information Request 1, Question 354, Pages 5.259-5.260

Alberta Transportation states that monitoring would be conducted from shore.

This question has not been answered sufficiently. Monitoring fish from shore will not identify signs of stress, injury, or mortality.

a. **Describe monitoring at the low level outlet and in the reservoir to identify signs of stress.**

b. **Develop a monitoring plan for the monitoring of fish conditions for the fish returning to the Elbow River using methods acceptable in fisheries science.**

c. **Will any monitoring be undertaken in the Elbow River to ascertain whether fish swimming out of the reservoir are exhibiting signs of stress or mortality after returning to the flowing watercourse? If monitoring is to be undertaken describe the monitoring plan that will be in place. If no monitoring is to be undertaken justify and explain the rationale behind not monitoring fish in the Elbow River to determine if fish are exhibiting signs of stress or mortality after returning to the flowing watercourse.**

Response

a-c. A Draft Fish Rescue and Fish Health Monitoring Plan is provided in the response to NRCB Question 31, Appendix 31-1, which describes the mitigation of potential effects from flood operation on fish and includes commitments for workforce capacity, equipment, timing, and measurements and fish handling procedures that are required during fish rescue. The Draft Fish Rescue and Fish Health Monitoring Plan expands upon the previous commitments made in Alberta Transportation's response to Round 1 AEP IR354, and it includes commitments to monitor fish health within Elbow River (i.e., from the confluence of the unnamed creek with Elbow River to Glenmore Reservoir) to identify fish that may have been entrained in the reservoir and record their physical and behavioural condition. Flood operations will limit the opportunity to monitor fish within the diversion channel, reservoir, including the low level outlet, and outlet channel upon activation of the Project (i.e., immediately following diversion from Elbow River); rather, monitoring efforts are timed to coincide with reservoir water drawdown and release.

Question 78

Supplemental Information Request 1, Question 356a, Page 5.261

Alberta Transportation states that the impacts of dam construction would be minimal in regard to affecting fish habitat.

This question has not been answered sufficiently as it does not account for potential negative impacts to fish movement or fish habitat during dam construction and operation.

a. **Provide an update to the summary table which shows the full range of magnitude for potential effects of the dam on fish habitat.**

b. **Describe what mitigation measures will be implemented to minimize impacts to habitat and fish movement during construction. The mitigation measures should take into account the construction activities and duration.**

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a-b. Table 78-1 presents an updated full range of magnitude for potential effects of the Project on fish habitat. The table also includes a list of mitigation measures to reduce effects on fish habitat and fish movement.

Table 78-1 Itemized Summary of Environmental Effects Assessment as it Relates to Fish and Fish Habitat

	Physical Activities	Potential Effect	Description of effect	Mitigation	Residual Effect	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological or Socio-economic Context	Timing	Significance of Residual Effect
Project Phase: Construction														
Construction	Instream construction (comprises temporary activities)	Change in fish habitat	Instream work can result in temporary disturbances to fish habitat.	• Construction activities near water will be planned and completed in the dry and isolated from watercourses to prevent materials such as paint, primers, blasting abrasives, rust solvents, degreasers, grout, other chemicals or other deleterious materials from entering the watercourse. • Clearing of riparian vegetation will be kept to a minimum. • Erosion and sediment control measures will be installed before starting work to prevent sediment from entering the water body. • Erosion and sediment control measures will be inspected daily and maintained during construction. • Erosion and sediment control measures will be repaired immediately if damage occurs. • Erosion and sediment control measures will be maintained and monitored until vegetation has become sufficiently re-established. • Works in water will be timed with respect to the restricted activity periods (RAPs) wherever possible. For Elbow River, the RAP is May 1 to July 15 and September 16 to April 15. Conditions of and use of restricted activity periods will be provided within further Project permitting and authorization under the *Fisheries Act*. The Elbow River RAP will be applied as an avoidance and mitigation measure. • Construction equipment will be mechanically sound with no oil leaks, fuel or fluid leaks. Equipment will be inspected daily and immediately repair any leaks. • A minimum 100 metre setback distance will be maintained between stored fuels and lubricants and rivers, streams and surface water bodies.	The Project has the potential to change fish habitat during instream construction because equipment will be working instream and access to habitat will be temporarily disturbed through isolation, diversion, and excavation works. Instream work can result in disturbance to the water quality, substrate availability, and flows that subsequently effect fish habitat. A change in fish habitat, and subsequently a change in fish distribution and behaviour. Residual effects related to instream construction are limited to the seasons where construction activities are scheduled to occur, and instream work will be scheduled to avoid the RAP of Elbow River. Residual effects with respect to a change in fish habitat are considered low in magnitude and are temporary in nature. Mitigation measures will be implemented to reduce the instream footprint to the extent possible, and work will be monitored to reduce the potential effects to fish habitat.	A	L	PDA	ST	S	IR	U	S/R	The residual effects on fish habitat as a result of instream construction are unlikely to pose a long-term threat to the persistence or viability of a fish species, including Species at Risk, in the RAA. Project related changes or loss of fish habitat must be offset to maintain the sustainability of resident fish populations. With the application of mitigation measures, and offsets, residual effects on fish habitat are predicted to be not significant.

Table 78-1 Itemized Summary of Environmental Effects Assessment as it Relates to Fish and Fish Habitat

	Physical Activities	Potential Effect	Description of effect	Mitigation	Residual Effect	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological or Socio-economic Context	Timing	Significance of Residual Effect
Construction (continued)	Instream construction (comprises temporary activities) (cont'd)	Change in fish habitat (cont'd)	Instream work can result in temporary disturbances to fish habitat. (cont'd)	• Machinery will arrive on site in a clean condition and be maintained free of fluid leaks, invasive species, and noxious weeds. • Personnel will be qualified to handle construction equipment fuels and lubricants to perform repairs. • Service vehicles will carry fuel spill clean-up materials. • Containment berms and impermeable liners will be installed around fuel and lubricant storage tanks. • Structures will be designed so that storm water runoff and wash water from the access roads, side slopes, and approaches will be directed into a retention pond or vegetated area to remove suspended solids, dissipate velocity, and prevent sediment and other deleterious substances from entering the watercourse. • Where instream works are required, non-toxic and biodegradable hydraulic fluids will be used in machinery. • Measures for managing water flowing onto the site (e.g., silt fences, turbidity barriers, pumping/diverting water to a vegetated area, constructing a settling basin, or other filtration system), as well as water being pumped/diverted from the site, will be implemented such that sediment is filtered out before the water enters a waterbody). • Whenever possible, machinery will be operated on land above the high-water mark in a manner that reduces disturbance to the banks and bed of the watercourses. • Isolation materials will be designed to reduce disturbance of the bed and banks of Elbow River and other watercourses. • The location of any instream works will be isolated from the watercourses using silt fences, temporary diversions, turbidity barriers, and clean granular berms.										

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	Physical Activities	Potential Effect	Description of effect	Mitigation	Residual Effect	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological or Socio-economic Context	Timing	Significance of Residual Effect
Construction (continued)	Instream construction (comprises temporary activities) (cont'd)	Change in fish habitat (cont'd)	Instream work can result in temporary disturbances to fish habitat. (cont'd)	• Building material used in watercourses (e.g., concrete, silt fences, turbidity barriers, and containment berms) will be used to prevent the release or leaching of substances that may be deleterious to fish into the water. • Before isolation and dewatering works commence, a qualified environmental professional will be retained to obtain applicable permits for relocating fish and to capture any fish trapped within an isolated/enclosed area at the work site and safely relocate them to an appropriate location in the same waters. • To allow for fish passage and construction of the structures in the dry, Elbow River will be temporarily diverted, and flows will be maintained downstream by the construction of a temporary bypass channel. • Excavated materials and debris will be stockpiled above the highwater mark so as to not enter the watercourse. Silt fences will be used to contain soil erosion. • During instream work, large woody debris pieces such as rootballs and logs over 50 cm in diameter, will be retained and relocated in the river downstream of the structure. • Clean granular fill with less than 5% fines passing the 80 mm sieve size will be used for instream work such as cofferdams, access ramps, river channel diversions. Fine grained soils may be used, provided only clean granular fill is exposed to the river at any time during construction and restoration operations. • Sediment and erosion control devices will be constructed to withstand anticipated flows during construction. If necessary, the outside face of granular berms may be lined with heavy polyplastic to make them impermeable to water.										

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Construction (continued)	Instream construction (comprises temporary activities) (cont'd)	Change in fish habitat (cont'd)	Instream work can result in temporary disturbances to fish habitat. (cont'd)	• The top bed substrate from a wetted channel will be stripped and stockpiled for later use as the top layer of reclaimed instream substrate to improve the recolonization rate and maintain average mobile substrate sizes. • Rootwads and large boulders that must be removed will be stored on-site for subsequent placement on reclaimed instream areas for cover habitat or for bank protection. • Water intakes pipes will be screened to prevent entrainment or impingement of fish. Entrainment occurs when a fish is drawn into a water intake and cannot escape. Impingement occurs when an entrapped fish is held in contact with the intake screen and is unable to free itself. Screens will comply with DFO's Freshwater Intake End-of-Pipe Fish Screen Guidelines. • Sediment-laden dewatering discharge will be pumped into a vegetated area or settling basin to allow sediment to settle out before returning it to the water body. Silt fences, turbidity barriers and clean granular berms will be used to contain the sediment and other deleterious substances and to prevent it from entering a watercourse or water body. • Energy dissipaters will be used at pump outlets to prevent erosion. • Pump discharge area(s) will be isolated to prevent erosion and the release of suspended sediments downstream. Any sediment build-up will be removed when the work is completed. • TSS levels will be controlled and reduced using silt fences and turbidity barriers so that water quality from care of water system discharges is made equal to or better than the initial water quality. TSS levels will be monitored by carrying out frequent water quality testing. • A monitoring program will be undertaken to identify if fish passage is impeded for migratory salmonids or movement of other fish species.										

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	Physical Activities	Potential Effect	Description of effect	Mitigation	Residual Effect	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological or Socio-economic Context	Timing	Significance of Residual Effect
Construction (continued)	Instream construction (comprises temporary activities) (cont'd)	Change in fish habitat (cont'd)	Instream work can result in temporary disturbances to fish habitat. (cont'd)	• Accumulated sediment and spoil build up within the isolated areas will be removed prior to removal of the isolation barriers. • When removing the isolation barriers, the downstream isolation barriers will be gradually removed first so as to equalize water levels inside and outside of the isolated area and to allow suspended sediments to settle prior to removing the upstream isolation materials. • The cleaning and removal of debris and sediment from sediment and erosion control devices will be conducted in a manner that will prevent materials from entering the water body. • Stream bank and bed protection methods (e.g., swamp mats, pads) will be used if rutting is likely to occur during access to the bed and shore. Temporary access structures will be used where steep and highly erodible banks are present. • After construction, disturbed areas will be stabilized and reclaimed. • Boulders will be added in the channel to increase the bed roughness immediately downstream of the diversion structure, which will increase water depths and reduce velocities to provide cover and facilitate fish passage. • Boulder V-weir structures will be constructed in the channel downstream of the gates to provide slower velocity and deeper resting zones and facilitate fish passage. • Fertilization of reclaimed areas in the immediate vicinity of a watercourse will not be allowed unless approved by DFO and AEP. • Streambanks and approach slopes will be revegetated using an appropriate native seed mix or erosion control mix. • Non-biodegradable erosion and sediment control materials will be removed once the site is stabilized.										

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	Physical Activities	Potential Effect	Description of effect	Mitigation	Residual Effect	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological or Socio-economic Context	Timing	Significance of Residual Effect
Construction (continued)	Instream construction (comprises temporary activities) (cont'd)	Change in fish habitat (cont'd)	Instream work can result in temporary disturbances to fish habitat. (cont'd)	• Herbicide use in the immediate vicinity of a watercourse will not be allowed unless approved by DFO and AEP. Weeds will be controlled during construction through multiple measures such as herbicide, mowing, wicking, and hand picking. After construction, disturbed areas will be stabilized and reclaimed.										
		Change in water quality	Instream work introduces a change in water quality as a result of increased sedimentation during construction.	• See mitigation above for "Instream Construction – Change in Fish Habitat". • See Alberta Transportation's response to Round 1 AEP IR 302, Appendix 302-1: Draft Surface Water Monitoring Plan.	The construction of the diversion structure (and associated temporary diversion channel) has the potential to change water quality temporarily by increasing suspended sediments for the duration of planned in-water activities. Change in water quality can subsequently affect fish behaviour and physiology. Residual effects related to instream construction are limited to the seasons where construction activities are scheduled to occur and residual effects are considered low in magnitude and temporary in nature. Total suspended solids will be monitored throughout instream work.	A	L	LAA	ST	S	R	U	S/R	The residual effects on water quality as a result of instream construction are unlikely to pose a long-term threat to the persistence or viability of a fish species, including Species at Risk, in the RAA. With the application of mitigation measures, residual effects on water quality are predicted to be not significant.
Project Phase: Dry Operation														
Operation	Maintenance (debris management, structural repair)	Change in fish habitat	Maintenance and repairs, or debris removal could require instream work. Instream work can result in temporary disturbances to fish habitat.	• See mitigation above for "Instream Construction – Change in Fish Habitat". • Where debris removal from the structures is required, debris removal will be timed to avoid disruption to sensitive fish life stages (i.e., outside the RAP), unless the debris and its accumulation is immediately threatening to the integrity of the structure or relates to an emergency (i.e., risk of structure failure).	The Project has the potential to change fish habitat during maintenance activities because equipment will be working instream and access to habitat will be temporarily disturbed through isolation, equipment access, and debris removal.	A	L	PDA	ST	S	IR	U	S/R	The residual effects on fish habitat as a result of instream work (associated with maintenance) are unlikely to pose a long-term threat to the persistence or viability of a fish species, including Species at Risk, in the RAA. With the application of mitigation measures, residual effects on fish habitat are predicted to be not significant.

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	Physical Activities	Potential Effect	Description of effect	Mitigation	Residual Effect	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological or Socio-economic Context	Timing	Significance of Residual Effect
Operation (continued)	Maintenance (debris management, structural repair) (cont'd)	Change in fish habitat (cont'd)	Maintenance and repairs, or debris removal could require instream work. Instream work can result in temporary disturbances to fish habitat. (cont'd)		Instream work can result in disturbance to the water quality, substrate availability, and flows that subsequently effect fish distribution and behaviour. Residual effects related to instream construction are limited to the seasons where maintenance activities are scheduled to occur. Instream work will be scheduled to avoid the RAP of Elbow River whenever possible. Residual effects are considered low in magnitude and are temporary in nature. Mitigation measures will be implemented to reduce the instream footprint to the extent possible, and work will be monitored to reduce the potential effects to fish habitat.									
		Change in water quality	Instream work introduces a change in water quality as a result of increased sedimentation during maintenance and repairs.	• See mitigation above for "Instream Construction – Change in Fish Habitat". • See Alberta Transportation's response to Round 1 AEP IR302, Appendix 302-1: Draft Surface Water Monitoring Plan.	Maintenance activities during dry operation will include instream work that has the potential to change water quality temporarily. Change in water quality can subsequently affect fish behaviour and physiology. Residual effects related to maintenance are limited to the seasons where instream work is scheduled to occur. Activities will be planned to avoid the RAP of Elbow River to mitigate potential effects related to a change in water quality. Residual effects are considered low in magnitude and are temporary in nature. Total suspended solids will be monitored throughout instream work.	A	L	LAA	ST	S	R	U	S/R	The residual effects on water quality as a result of instream work (associated with maintenance) are unlikely to pose a long-term threat to the persistence or viability of a fish species, including Species at Risk, in the RAA. With the application of mitigation measures, residual effects on water quality are predicted to be not significant.

Table 78-1 Itemized Summary of Environmental Effects Assessment as it Relates to Fish and Fish Habitat

<table>
<tr><th></th><th>Physical Activities</th><th>Potential Effect</th><th>Description of effect</th><th>Mitigation</th><th>Residual Effect</th><th>Direction</th><th>Magnitude</th><th>Geographic Extent</th><th>Duration</th><th>Frequency</th><th>Reversibility</th><th>Ecological or Socio-economic Context</th><th>Timing</th><th>Significance of Residual Effect</th></tr>
<tr><td>Operation (continued)</td><td>Permanent footprint in the Elbow River</td><td>Change in fish habitat</td><td>The footprint of the spillway, gates, and diversion inlet will permanently remove fish habitat from Elbow River.</td><td>A fish habitat offsetting plan is being prepared to mitigate habitat loss that will occur as a result of the Project footprint (presented below):
<table>
<tr><th>Project Component</th><th>Habitat Area (m²)</th><th>Habitat Type[2]</th></tr>
<tr><td colspan="3">Temporary Habitat Alteration</td></tr>
<tr><td>Berms to isolate channel</td><td>4,744</td><td>riffle, Run (R2 and R3) and gravel bar units
potential rearing habitat</td></tr>
<tr><td>Dry working space within the channel[1]</td><td>15,002</td><td>riffle, rapid, channel snye, and gravel bar units
potential rearing, spawning habitat</td></tr>
<tr><td>sub-total</td><td>19,746</td><td></td></tr>
<tr><td colspan="3">Permanent Habitat Alteration</td></tr>
<tr><td>V-weir fish passage structures</td><td>598</td><td>run (R2 and R3) and riffle units
potential spawning gravel habitat</td></tr>
<tr><td>Bank armour</td><td>1,458</td><td>gravel bar, bank, run (R2) units
potential limited bank cover and feeding habitat</td></tr>
<tr><td>sub-total</td><td>2,056</td><td></td></tr>
</table></td><td>The Project will result in habitat alteration and destruction associated with the permanent footprint in Elbow River. Alteration and loss of habitat will change fish habitat that is available in Elbow River for fish species to carry out spawning and rearing life history requirements. There will be a habitat offsetting plan that endeavours to mitigate the loss associated with the Project by offering fish habitat or a benefit to the fishery through separate works.

Residual effects are considered low in magnitude because the footprint of the structures will be offset through a benefit to the fishery.</td><td>A</td><td>L</td><td>PDA</td><td>P</td><td>S</td><td>I</td><td>U</td><td>S/R</td><td>The residual effects on fish habitat as a result of the placement of structures in water are unlikely to pose a long-term threat to the persistence or viability of a fish species, including Species at Risk, in the RAA. With the application of mitigation measures, including a habitat offsetting plan (and associated habitat monitoring for regulatory compliance), residual effects on fish habitat are predicted to be not significant.</td></tr>
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Table 78-1 Itemized Summary of Environmental Effects Assessment as it Relates to Fish and Fish Habitat

	Physical Activities	Potential Effect	Description of effect	Mitigation	Residual Effect	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological or Socio-economic Context	Timing	Significance of Residual Effect
Operation (continued)	Permanent footprint in the Elbow River (cont'd)	Change in fish habitat (cont'd)	The footprint of the spillway, gates, and diversion inlet will permanently remove fish habitat from Elbow River. (cont'd)	**Habitat Destruction** Debris deflector — 2,766 — • gravel bar and bank units • minimal habitat only during freshet Service spillway (with Obermeyer gates), stilling basin and bank modification — 2,970 — • run (R2 and R3), gravel bar and bank units • potential rearing habitat; gravel bar and bank habitat provide minimal high-water habitat Cut-off of unnamed channel — 300 — • shallow riffle, run, pool units • temporary habitat and generally poor for all life stages *sub-total* — *6,036* NOTES: [1] a diversion channel around the workspace of approximately 19,080 m^2 will be constructed to maintain Elbow River flows and fish passage; this area is not included in the habitat area calculations. [2] habitat types reflect water flows during late summer air photos.										

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	Physical Activities	Potential Effect	Description of effect	Mitigation	Residual Effect	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological or Socio-economic Context	Timing	Significance of Residual Effect
Operation (continued)	Permanent footprint in the Elbow River (cont'd)	Change in fish movement	The instream structures of the Project have the potential to impede fish passage.	• The Project has been designed to align with industry-standard fish passage design considerations that are outlined in Katapodis' Introduction to Fishway Design (1992). • Fish passage design relied on an analysis of the $3Q_{10min}$ to determine flows and depth that are acceptable for bull trout, which are known to migrate extended distances in the LAA. The Katapodis (1992) design criteria were used to develop the following design mitigation: – The spillway gates and stilling basin and are designed to provide adequate flow and water depth to facilitate resident fish passage under low-flow conditions. – Fish passage structures (i.e., v-weirs) will be constructed in the thalweg below the spillway gates and stilling basin to provide a "stepped" upstream approach to the gates under low flow condition. Each v-weir provides a pool adequate for resident fish to reach burst speed to jump and pass the weir. – The Project is designed to facilitate elevated river flows (i.e., up to 160 m^3/s) through the spillway gates in a manner that maintains a maximum velocity that is suitable to pass fish.	The Project has the potential to change fish movement through the introduction of permanent structures that pose a physical barrier to upstream fish passage, or a behavioural change as a result of the visual changes to the riverbed profile. A change to fish movement could have subsequent effects on fish distribution in Elbow River. The Project has been designed to reduce potential effects associated with a change to fish movement through design features that reduce physical barriers (i.e., depth, velocity) to fish. The fish passage design aligns with physical conditions that would be present in Elbow River in the absence of the Project. The residual effect of the instream structures on fish passage is neutral in direction, low in magnitude, restricted to the PDA, permanent in duration, and continuous in frequency.	N	L	PDA	P	C	I	U	S/R	The residual effects on fish passage as a result of the placement of instream structures in Elbow River are unlikely to pose a long-term threat to the persistence or viability of a fish species, including Species at Risk, in the RAA. With the application of mitigation measures, including fish passage design features, residual effects on fish movement are predicted to be not significant.
Project Phase: Flood Operation and Post-Flood Operation														
Flood Operation and Post-Flood Operation	Flood water diversion	Change in flow	A change in flow as a result of a reduction in maximum flood flows will occur with the Project. A change in flood flows will influence channel morphology and bedload movement, which could alter substrate composition, cover, fish habitat quality in Elbow River downstream of the Project.	• A habitat offsetting plan is currently being prepared to mitigate potential changes to fish habitat. Furthermore, a post-construction habitat monitoring plan will be implemented to monitor habitat in Elbow River as a result of flood operation. This habitat monitoring plan will evaluate habitat quality in relation to pre-construction conditions to determine whether the offsetting measures align with the changes that are observed in habitat following flood operation.	Channel-forming flows of 160 m^3/s will be maintained in Elbow River. Therefore, fish habitat will be maintained in a natural manner. The residual effect of change in flow (and subsequent change in channel morphology) is neutral in direction, low in magnitude, restricted to the LAA, long-term in duration, and irregular in frequency.	N	L	LAA	LT	IR	I	U	S	The residual effects on flow as a result of the reduction in maximum flood flows in Elbow River are unlikely to pose a long-term threat to the persistence or viability of a fish species, including Species at Risk, in the RAA. A habitat offsetting plan will also consider the alteration of downstream habitat as a result of the Project. including fish passage design features. Residual effects on flows are predicted to be not significant.

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	Physical Activities	Potential Effect	Description of effect	Mitigation	Residual Effect	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological or Socio-economic Context	Timing	Significance of Residual Effect
Flood Operation and Post-Flood Operation (continued)	Flood water diversion (cont'd)	Change in fish movement	Fish have the potential to be swept into the diversion inlet during flood operation, and fish may not be able to access areas upstream of the Project during flood operations.	• Mitigation is not proposed to prevent fish from becoming entrained in the reservoir; options of screening the intake would conflict with the flood protection objectives of the Project.	The Project has the potential to change fish movement during flood operations because the spillway gates will restrict fish movement to upstream areas. Resident fish will likely find refuge during a flood and will not be migrating or moving upstream at this time. The spillway gates will hinder upstream fish passage past the Project for the duration the gates are up during a flood (e.g., up to 3.75 days for a design flood). The residual effect of change to fish movement during flood operations is considered moderate in magnitude due to the natural behavior of fish during floods. Residual effects are restricted to the LAA, short-term in duration, and irregular in frequency. Design mitigation has been included to mitigate the potential effects to fish that are entrained, and a Fish Rescue and Fish Monitoring Plan included in response to NRCB Question 31 (Appendix 31-1) will be implemented during operation to further mitigate potential effects to fish that are displaced into the diversion inlet.	A	M	LAA	ST	IR	R	U	S/R	The residual effects on fish movement as a result of flood operations (and potential for fish to become swept into the diversion inlet) are unlikely to pose a long-term threat to the persistence or viability of a fish species, including Species at Risk, in the RAA. With the application of mitigation measures, including a Fish Rescue and Fish Monitoring Plan, residual effects on fish movement are predicted to be not significant.

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	Physical Activities	Potential Effect	Description of effect	Mitigation	Residual Effect	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological or Socio-economic Context	Timing	Significance of Residual Effect
Flood Operation and Post-Flood Operation (continued)	Flood water diversion (cont'd)	Fish entrainment	Fish have the potential to become entrained as they move through the diversion inlet and diversion channel into the reservoir.	• Mortality for fish displaced and entrained in the diversion inlet during a flood will be addressed through monitoring and fish rescue mitigations. • The diversion channel has been designed to accommodate fish passage; design mitigation includes appropriate channel configuration and grade to minimize the risk of stranding. • See mitigation above for "Flood Water Diversion – Change in Flow".	The residual effects of fish entrainment as a result of flood operations is adverse in direction, moderate in magnitude, restricted to the LAA, short-term in duration, and irregular in frequency. Design mitigation has been included to mitigate the potential effects to fish that are entrained, and a Fish Rescue and Fish Monitoring Plan included in response to NRCB Question 31 (Appendix 31-1) will be implemented during operation to mitigate the risk of fish becoming entrained as they move through the diversion channel, into the reservoir, and as they return into Elbow River upon reservoir drawdown.	A	M	LAA	ST	IR	R	U	S/R	The residual effects of fish entrainment as a result of flood operations are unlikely to pose a long-term threat to the persistence or viability of a fish species, including Species at Risk, in the RAA. With the application of mitigation measures, including a Fish Rescue and Fish Monitoring Plan, residual effects on fish entrainment are predicted to be not significant.
		Fish mortality	Fish have the potential to be injured or killed as they move through the inlet and diversion channel into the reservoir.	• See mitigation above for "Flood Water Diversion – Change in Flow".	The residual effects of fish mortality as a result of flood operations is adverse in direction, moderate in magnitude, restricted to the LAA, short-term in duration, and irregular in frequency. A Fish Rescue and Fish Monitoring Plan included in response to NRCB Question 31 (Appendix 31-1) will be implemented during flood and post-flood operations to further mitigate the risk of fish mortality as fish move through the diversion channel, reservoir, and are returned into Elbow River upon reservoir drawdown.	A	M	LAA	ST	IR	R	U	S/R	The residual effects of fish mortality as a result of flood operations are unlikely to pose a long-term threat to the persistence or viability of a fish species, including Species at Risk, in the RAA. With the application of mitigation measures, including a Fish Rescue and Fish Monitoring Plan (Appendix IR 31-1), residual effects on fish mortality are predicted to be not significant.

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	Physical Activities	Potential Effect	Description of effect	Mitigation	Residual Effect	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological or Socio-economic Context	Timing	Significance of Residual Effect
Flood Operation and Post-Flood Operation (continued)	Water retention in the reservoir	Change in fish movement	Fish that are displaced into the reservoir during flood operations may not be able to carry out their life history requirements (e.g., migration for spawning) or find appropriate habitat (e.g., cover) for the duration of water retention in the reservoir.	• Design mitigation will reduce the risk of effects to fish to the extent possible for the duration of time that they are entrained in the reservoir: – The diversion channel and reservoir are designed to grades that convey reservoir water to the center of the reservoir and avoid isolated pooling where fish may be trapped. – The contours and elevations of the reservoir (i.e., bowl shape) will result in water pooling in the deeper central area of the reservoir; this will maintain an area of elevated water depths where fish will find more suitable refuge including lower temperatures and cover. – Fish rescue efforts will be increased to the extent possible when safe to do so by increasing manpower to staff multiple fish rescue teams. This added manpower will mitigate potential effects to fish by increasing fish rescue efforts and the rate of capture to the extent possible. – Water temperature will be monitored in the reservoir during reservoir drawdown; further details related to the monitoring efforts are in Alberta Transportation's response to Round 1 AEP IR 302, Appendix 302-1 Draft Surface Water Quality Monitoring Plan. • The design mitigation, and fish rescues stated above will reduce the potential effects on fish as a result of change in movement, change in water quality, and fish mortality as a result of the activity.	The Project has the potential to change fish movement through flood operation because fish that become entrained in the reservoir will not be able to move to access habitats that are required to carry out their life history requirements. The residual effects of change in fish movement as a result of water retention in the reservoir is adverse in direction, moderate in magnitude, restricted to the LAA, short-term in duration, and irregular in frequency. Design mitigation has been included to mitigate the potential effects to fish that are entrained, and a Fish Rescue and Fish Monitoring Plan included in response to NRCB Question 31 (Appendix 31-1) will be implemented during operation to mitigate the risk that fish become entrained as they move through the diversion channel, into the reservoir, and as they return into Elbow River upon reservoir drawdown.	A	M	LAA	ST	IR	R	U	S/R	The residual effects on fish movement as a result of water retention in the reservoir are unlikely to pose a long-term threat to the persistence or viability of a fish species, including Species at Risk, in the RAA. With the application of mitigation measures, including a Fish Rescue and Fish Monitoring Plan included in response to NRCB Question 31 (Appendix 31-1), residual effects on fish movement are predicted to be not significant.

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	Physical Activities	Potential Effect	Description of effect	Mitigation	Residual Effect	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological or Socio-economic Context	Timing	Significance of Residual Effect
Flood Operation and Post-Flood Operation (continued)	Water retention in the reservoir (cont'd)	Fish mortality	Fish mortality may occur as a result of deteriorating water quality in the reservoir, injury, predation, and physiological stress.	• See mitigation above for "Water Retention in the Reservoir – Change in Fish Movement".	The residual effects of fish mortality as a result of water retention in the reservoir is adverse in direction, moderate in magnitude, restricted to the LAA, short-term in duration, and irregular in frequency. A fish habitat offsetting plan is being developed with consideration given to the potential loss of fish during flood operations.	A	M	LAA	ST	IR	R	U	S/R	The residual effects on fish mortality as a result of water retention in the reservoir are unlikely to pose a long-term threat to the persistence or viability of a fish species, including Species at Risk, in the RAA. With the application of mitigation measures, including a habitat offsetting plan, residual effects on fish mortality are predicted to be not significant.
		Change in water quality	Water retention in the reservoir will expose fish to relatively high concentrations of sediment for an extended duration of time relative to a natural flood event. Temperature may increase over time and DO may decrease over the duration of time that water remains within the reservoir. The changes to these water quality parameters can lead to physiological stress on fish.	• See mitigation above for "Water Retention in the Reservoir – Change in Fish Movement".	Water retention in the reservoir may cause an adverse effect on fish that become entrained in the reservoir during flood operation due to deteriorating water quality. It is expected that the magnitude of residual effects to fish that are entrained in the reservoir is moderate. The reservoir will be managed in a manner to optimize drawdown and reduce the amount of time water will be impounded. This will reduce the risk of water quality changes. Mitigation measures will be in place to rescue fish to the extent possible. Residual effects are expected to be short-term and irregular in frequency, because the effects are only anticipated during flood operations.	A	M	LAA	ST	IR	R	U	S/R	The residual effects on water quality as a result of water retention in the reservoir are unlikely to pose a long-term threat to the persistence or viability of a fish species, including Species at Risk, in the RAA. With the application of mitigation measures, including a habitat offsetting plan, residual effects on water quality are predicted to be not significant.

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Table 78-1 Itemized Summary of Environmental Effects Assessment as it Relates to Fish and Fish Habitat

	Physical Activities	Potential Effect	Description of effect	Mitigation	Residual Effect	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological or Socio-economic Context	Timing	Significance of Residual Effect
Flood Operation and Post-Flood Operation (continued)	Reservoir water drawdown and release	Change in fish habitat	Reservoir water drawdown and release may subsequently lead to an increase in suspended sediment in Elbow River. This increase in sediment has the potential to alter habitat quality, particularly with the deposit of fine sediments in Elbow River. This sediment release can change the quality of habitat available to fish.	• A habitat offsetting plan is currently being prepared to mitigate potential changes to fish habitat. Furthermore, a post-construction habitat monitoring plan will be implemented to monitor habitat in Elbow River as a result of flood operation. This habitat monitoring plan will evaluate habitat quality in relation to pre-construction conditions to determine whether the offsetting measures align with the changes that are observed in habitat following flood operation.	The residual effect on fish habitat as a result of reservoir water drawdown and release is adverse in direction, moderate in magnitude, restricted to the LAA, short-term in duration, and irregular in frequency. Adult fish will likely seek refuge during reservoir drawdown and release. Some loss of habitat may occur due to the influx of sediments and higher flows, and this change in habitat will likely cause fish to seek temporary refuge. Substrate changes as a result of the introduction of sediments is expected to be temporary in nature; the persistence of channel forming flows (160 m^3/s) even during flood mitigation operations in Elbow River will maintain fish habitat quality for salmonid species.	A	M	LAA	ST	IR	R	U	S/R	The residual effects on fish habitat as a result of reservoir water drawdown and release are unlikely to pose a long-term threat to the persistence or viability of a fish species, including Species at Risk, in the RAA. With the application of mitigation measures, including a habitat offsetting plan, residual effects on fish habitat are predicted to be not significant.
		Change in flow	Reservoir water release could alter fish movement patterns (or timing of movement patterns) due to a change in flow.	• Habitat offsetting is currently being prepared to mitigate potential loss that may result from a change in flow and subsequent change to fish movement patterns for fish that migrate during the summer.	The residual effects of change in flow as a result of reservoir water drawdown and release is adverse in direction, low in magnitude, restricted to the LAA, short-term in duration, and irregular in frequency. Flood operation of the Project has the potential to delay or disrupt movement patterns for fish during reservoir drawdown and release. It is expected that a change in movement will be limited to a group of fish, such as adult bull trout, that migrate from downstream sections of Elbow River to upstream areas. Migration timing for this group of fish may disrupted or delayed as a result of flood operation.	A	L	LAA	ST	IR	R	U	S/R	The residual effects on flow as a result of reservoir water drawdown and release are unlikely to pose a long-term threat to the persistence or viability of a fish species, including Species at Risk, in the RAA. With the application of mitigation measures, including a habitat offsetting plan, residual effects on flow are predicted to be not significant.

Table 78-1 Itemized Summary of Environmental Effects Assessment as it Relates to Fish and Fish Habitat

	Physical Activities	Potential Effect	Description of effect	Mitigation	Residual Effect	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological or Socio-economic Context	Timing	Significance of Residual Effect
Flood Operation and Post-Flood Operation (continued)	Reservoir water drawdown and release (cont'd)	Change in water quality (in the Elbow River)	Changes in the quality of water released into Elbow River has the potential to temporarily expose fish to changes in some constituents (e.g., TSS, temperature, DO) and affect fish health.	• Mitigation to ameliorate water quality will not be implemented. A surface water monitoring plan will be in place and water quality samples will be collected to assess indicator parameters. The analytical results of these samples will be provided to stakeholders (e.g., the City of Calgary water treatment facility at Glenmore Reservoir) to manage water use. The reservoir drawdown will be managed to the extent possible to increase the rate of release and reduce the duration that water is in the reservoir.	Fish are predicted to find refuge (e.g., in groundwater fed evulsions and side channels) and or move out of the release plume to the extent possible (e.g., move upstream or downstream into the Glenmore Reservoir). Smaller fish, such as cyprinid species, may not be able to move adequately to find refuge and experience greater stress than large-bodied fish. The effects on fish health due to exposure to elevated TSS and temperature, and low DO are predicted to be acute to those fish that cannot find refuge; however, population level effects are expected to be temporary with low magnitude, occurring infrequently (with a frequency of less than 1:7 years) and reversible. The effects associated with other water quality constituents are expected to be minor and not measurable. These effects are not predicted to have a population level effect on resident fish species.	A	L	LAA	ST	IR	R	U	S/R	Effects of water released from the off-stream reservoir and associated plume to resident fish will be greater on the small bodied fish species than large-bodied fish that can find refuge from elevated TSS and temperature and low DO conditions. The offsetting plan will take into account the effects to resident fish and provide measures to maintain a sustainable fish community in Elbow River. Therefore, the effects on resident fish populations from a water quality plume is considered not significant.
		Fish entrainment	As water levels recede during drawdown, fish may become entrained in isolated pools that are located in the reservoir.	• The low-level outlet will be operated in a manner that allows fish egress from the reservoir and downstream into the unnamed creek during release of water from the reservoir. This mitigation measure addresses potential entrainment, or mortality of fish as a result of entrainment or predation. • Drainage areas within the reservoir will be graded to reduce stranding of fish during release of retained flood water from the reservoir.	The residual effect of fish entrainment as a result of reservoir water drawdown and release is adverse in direction, moderate in magnitude, restricted to the LAA, short-term in duration, and irregular in frequency. Design mitigation has been included to mitigate the potential effects to fish that are entrained, and a fish rescue and fish monitoring plan will be implemented during operation to mitigate the risk that fish become entrained as they move through the diversion channel, into the reservoir, and as they return into Elbow River upon reservoir drawdown.	A	M	LAA	ST	IR	R	U	S/R	The residual effects of entrainment as a result of reservoir water drawdown and release are unlikely to pose a long-term threat to the persistence or viability of a fish species, including Species at Risk, in the RAA. With the application of mitigation measures, including a habitat offsetting plan, residual effects of entrainment are predicted to be not significant.

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Table 78-1 Itemized Summary of Environmental Effects Assessment as it Relates to Fish and Fish Habitat

	Physical Activities	Potential Effect	Description of effect	Mitigation	Residual Effect	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological or Socio-economic Context	Timing	Significance of Residual Effect
Flood Operation and Post-Flood Operation (continued)	Reservoir water drawdown and release (cont'd)	Fish entrainment (cont'd)	As water levels recede during drawdown, fish may become entrained in isolated pools that are located in the reservoir. (cont'd)	• During reservoir drawdown, fish monitoring will be necessary to identify isolated shallow areas that develop in the reservoir that could strand fish as the water levels drop. This monitoring will be done to inform fish rescue activities and will be directed by a qualified aquatic environmental specialist, professional fisheries biologist, or professional aquatic biologist. • Fish rescues will be conducted when safe and effective to do so. This mitigation measure is in place to address potential entrainment, impingement, or mortality of fish.										
		Fish mortality	As water levels recede during drawdown, fish may become stranded or trapped in sediment deposits in the reservoir such that mortality occurs. Fish may also be more vulnerable to predation during water drawdown. Mortality may also occur as a result of injury during travel through the low-level outlet, or through a sudden change in physical setting once re-introduced into Elbow River.	• Mitigation to address potential fish mortality is consistent with the measures that are proposed to mitigate "Reservoir water drawdown and release – Fish Entrainment" above.	The residual effect on fish mortality as a result of reservoir water drawdown is adverse in direction, moderate in magnitude, restricted to the LAA, short-term in duration, and irregular in frequency. Design mitigation has been included to mitigate the potential effects that lead to fish mortality, and a fish rescue and fish monitoring plan included in response to NRCB Question 31 (Appendix 31-1) will be implemented during operation to mitigate the risk of potential effects that lead to fish mortality during reservoir water drawdown and release.	A	M	LAA	ST	IR	R	U	S/R	The residual effects on fish mortality as a result of reservoir water drawdown and release are unlikely to pose a long-term threat to the persistence or viability of a fish species, including Species at Risk, in the RAA. With the application of mitigation measures, including a habitat offsetting plan, residual effects on fish mortality are predicted to be not significant.

Table 78-1 Itemized Summary of Environmental Effects Assessment as it Relates to Fish and Fish Habitat

***KEY** See individual chapters for detailed definitions **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 **Timing:** T: Time of Day S: Seasonality R: Regulatory 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:** U: Undisturbed D: Disturbed

REFERENCES

Katapodis, C. 1992. Introduction to Fishway Design. Department of Fisheries and Oceans, Freshwater Institute Central and Arctic Region. Available at: https://www.engr.colostate.edu/~pierre/ce_old/classes/ce717/Manuals/Fishway%20design%20Katopodis/1992%20Katopodis%20Introduction%20to%20Fishway%20Design.pdf . Accessed March 2020.

Question 79

Supplemental Information Request 1, Question 357a, Page 5.279

Alberta Transportation responded that bull trout spawn in the area upstream of Bragg Creek (Applied Aquatic Research 2008).

This question has not been answered sufficiently. There is evidence that bull trout migrate past the proposed dam location and inhabit the section below the dam, including spawning downstream (R. Popowich and A. Paul, 2006).

a. Map existing critical or sensitive areas used by bull trout including migration and spawning routes.

Response

a. A narrative description of bull trout movement in Elbow River, and mapped habitat is provided in the response to AEP Question 69 and Appendix 69-1. Migration assessments for bull trout (e.g., radio tagging, mark and recapture) and bull trout spawning surveys in Elbow River (e.g., redd checks during the bull trout spawning period) were not done. The distribution of resident fish was assessed by evaluating fish records in the Alberta FWMIS (AEP 2020) and bull trout presence reported in available reports (e.g., bull trout spawning locations).

A spawning suitability assessment (i.e., identification of potential redds and spawning habitat) was completed and is further described in the subsections that follow, including a discussion about migration routes.

BULL TROUT MOVEMENT

Bull trout are known to be more selective than brown trout and brook trout with regards to spawning habitat (Baxter and McPhail 1999; Fitzsimmons 2008; Raleigh et al. 1986) and have been previously identified to spawn in the upper reaches of Elbow River between Paddy's Flats and Elbow Falls (Popowich and Eisler 2008). Groundwater upwelling is commonly associated with spawning habitat selection (Baxter and McPhail 1999; Roberge et al. 2002), and it is likely that winter conditions in the upper reaches of Elbow River (between Paddy's

Flats and Elbow Falls) are more favourable for bull trout egg incubation relative to the downstream reaches of Elbow River.

Fish habitat was field evaluated in Elbow River during the fall (late October through early December 2019) including areas known to include historical bull trout spawning activity. Evidence of fall spawning activity (i.e., redd locations) was documented. Groundwater upwelling was observed in the fall of 2019 upstream of a known spawning area for bull trout previously identified by Popowich and Paul (2006) (Photo 79-1). Similar observations of groundwater upwelling were not observed in the downstream reaches of Elbow River in the fall of 2019. These field observations align with previous spawning surveys (Popwich and Paul 2006; Popowich and Eisler 2008), which suggest that bull trout spawning is limited to the upper reaches of Elbow River.

Photo 79-1 Groundwater Upwelling Observed within the Known Bull Trout Spawning Area of Elbow River (between Canyon Creek and Elbow Falls) in the Fall of 2019

REFERENCES

AEP (Alberta Environment and Parks). 2020. Fisheries and Wildlife Management Information System (FWMIS). Fish and Wildlife Internet Mapping Tool. Available at: https://www.alberta.ca/access-fwmis-data.aspx. Accessed in February 2020.

Baxter, J.S. and J.D. McPhail. 1999. The influence of redd site selection, groundwater upwelling, and over-winter incubation temperature on survival of bull trout (*Salvelinus confluentus*) from egg to alevin. Can. J. Ecology 77:1233–1239.

Fitzsimmons, K. 2008. Monitoring bull trout and cutthroat trout populations in Canyon Creek and Prairie Creek drainages, Elbow River, Alberta, 2005. Data report, D-2008-010, produced by the Alberta Conservation Association, Cochrane, Alberta, Canada. 27 pp+ App.

Popowich, R.C. and A.J. Paul. 2006. Seasonal movement patterns and habitat selection of bull trout (*Salvelinus confluentus*) in fluvial environments.

Popowich, R.C. and G. Eisler. 2008. Fluvial bull trout redd surveys on the Elbow, Sheep, and Highwood Rivers, Alberta. Submitted to Trout Unlimited Canada by Applied Aquatic Research Ltd. January 2008.

Raleigh, R., Zuckerman, L.D., Nelson, P.C. 1986. Habitat suitability index models and instream flow suitability curves: Brown trout. U.S. Fish and Wildlife Service Biological Report; 82(10.124).

Roberge, M., J.M.B. Hume, C.K. Minns, and T. Slaney. 2002. Life history characteristics of freshwater fishes occurring in British Columbia and the Yukon, with major emphasis on stream habitat characteristics. Can. Manuscr. Rep. Fish. Aquat. Sci. 2611: xiv + 248 p.

5 TERRESTRIAL

5.1 TERRAIN AND SOILS

Question 80

Supplemental Information Request 1, Question 374d, Page 6.33
Supplemental Information Request 1, Question 375c, Page 6.37
Supplemental Information Request 1, Question 376c, Page 6.39
Supplemental Information Request 1, Question 377c, Page 6.40
Supplemental Information Request 1, Question 378c, Page 6.43
Supplemental Information Request 1, Question 384d, Page 6.62
Supplemental Information Request 1, Question 385b, Page 6.63
Supplemental Information Request 1, Question 385d, Page 6.75

Alberta Transportation states in response to a number of different SIRs that *the soil analytical results of the screen soil...will be compared to the applicable guidelines*, but Alberta Transportation does not identify those guidelines.

a. Confirm that the soil data analyzed from all areas of potential environmental concern will be compared to "Alberta Tier 1 Soil and Groundwater Remediation Guidelines" (Alberta Environment and Parks, 2019, as amended) or "Alberta Tier 2 Soil and Groundwater Remediation Guidelines" (Alberta Environment and Parks, 2019, as amended).

Response

a. The generally accepted guidelines for the assessment and remediation of soil for sites in Alberta are the AEP, Alberta Tier 1 and Tier 2 Soil and Groundwater Remediation Guidelines, 2019 (AEP 2019 s). The AEP 2019 Guidelines provide limits for contaminants in soil and groundwater and are intended to maintain, improve, and/or protect environmental quality and human health at contaminated sites in general. The Tier 1 Guidelines are generic and developed to be protective of most sites and are to be used without modification. The Tier 2 approach allows for the consideration of site-specific conditions through modification of the Tier 1 Guidelines and/or removal of exposure pathways that may not be applicable to a site. If exposure pathways are excluded, the referenced guidelines by default become Tier 2. Exposure control is also a considered approach within the AEP 2019 Guidelines, which manages risk through exposure barriers or administrative controls based on a site-specific risk assessment. Alberta Transportation would consider using a Human Health and Ecological Risk Assessment and would develop site-specific criteria for the site. Knowledge gained in the application of the soil monitoring plan for the construction period will be used to determine whether Tier 1 or Tier 2 standards are likely to be appropriate guides for evaluating soil parameters. The soil monitoring program may indicate that it would be most appropriate to develop site-specific criteria for the site through a Human Health and Ecological Risk Assessment.

As discussed in Round 1 AEP IR377c, a risk management process will be implemented to evaluate the findings of the soil monitoring plan. If the soil samples meet the applicable guidelines, the soil may be used in construction. If the analytical results confirm that contaminants of potential concern (COPC) are above threshold levels, as outlined in the applicable guidelines, a risk analysis will be completed to determine subsequent actions and mitigations. The spectrum of remediation options includes avoidance of the material, encapsulation of the material, or removal of the material. If required, the soil will be disposed off-site at an approved facility, dependent on the identified COPC, or may be isolated on-site depending on the risk-assessment outcomes.

REFERENCES

GoA (Government of Alberta). 2019. Accessed at: https://www.alberta.ca/part-one-soil-and-groundwater-remediation.aspx?utm_source=redirector. Alberta Tier 1 and Tier 2 Soil and Groundwater Remediation Guidelines

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Question 81

Supplemental Information Request 1, Question 382a and Question 382c, Page 6.55

Alberta Transportation states that *removal of sediment from the reservoir to another off-site location is not planned*, but Alberta Transportation does not describe conditions where sediment removal or cleanup would be necessary.

a. Respond to the original SIR1 question 382c, by describing all potential conditions over the lifespan of the reservoir where sediment removal or partial removal would become necessary, regardless of whether it is planned or unplanned.

Response

a. The reservoir is designed to function as the equivalent of the Elbow River floodplain, and it will capture and retain coarse-textured flood sediment. The limited set of conditions where sediment might need to be redistributed within the reservoir area are associated with facilitation of surface drainage and reservoir function, as described in Alberta Transportation's response to Round 1 AEP IR382c.

The total active flood volume of the reservoir is 77,800,000 m^3. Modelling predicts that the volume of sediment that would be retained in the reservoir after a 2013 design flood, late release, would be 1,263,000 m^3 (this results in the largest volume of sediment deposition of the three floods). This volume of sediment is 1.6% of the reservoir volume.

The primary motive for action related to sediment would be to stabilize and hold sediments in place. Actions intended to support natural retention processes will include augmenting soil nutrient concentrations to assist vegetation establishment and the use of tackifiers (if required) to reduce risk of wind erosion.

When sediment accumulation in the reservoir reduces the reservoir capacity by 10% (only expected in the far future), the Government of Alberta will determine if sediment will be removed from the reservoir.

Question 82

Supplemental Information Request 1, Question 383g, Page 6.56
Volume 1, Section 4.5, Table 4-1, Page 4.2

Alberta Transportation did not define "appropriate facility" as stated in Table 4-1.

a. Respond to the original SIR1 question 383g to define appropriate facility.

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a. An "appropriate facility" as stated in the EIA, Volume 1, Section 4.5, Table 4-1 is an *Environmental Protection and Enhancement Act* (EPEA) recognized facility approved for disposal of waste stream material (i.e., sediment from a flood).

Question 83

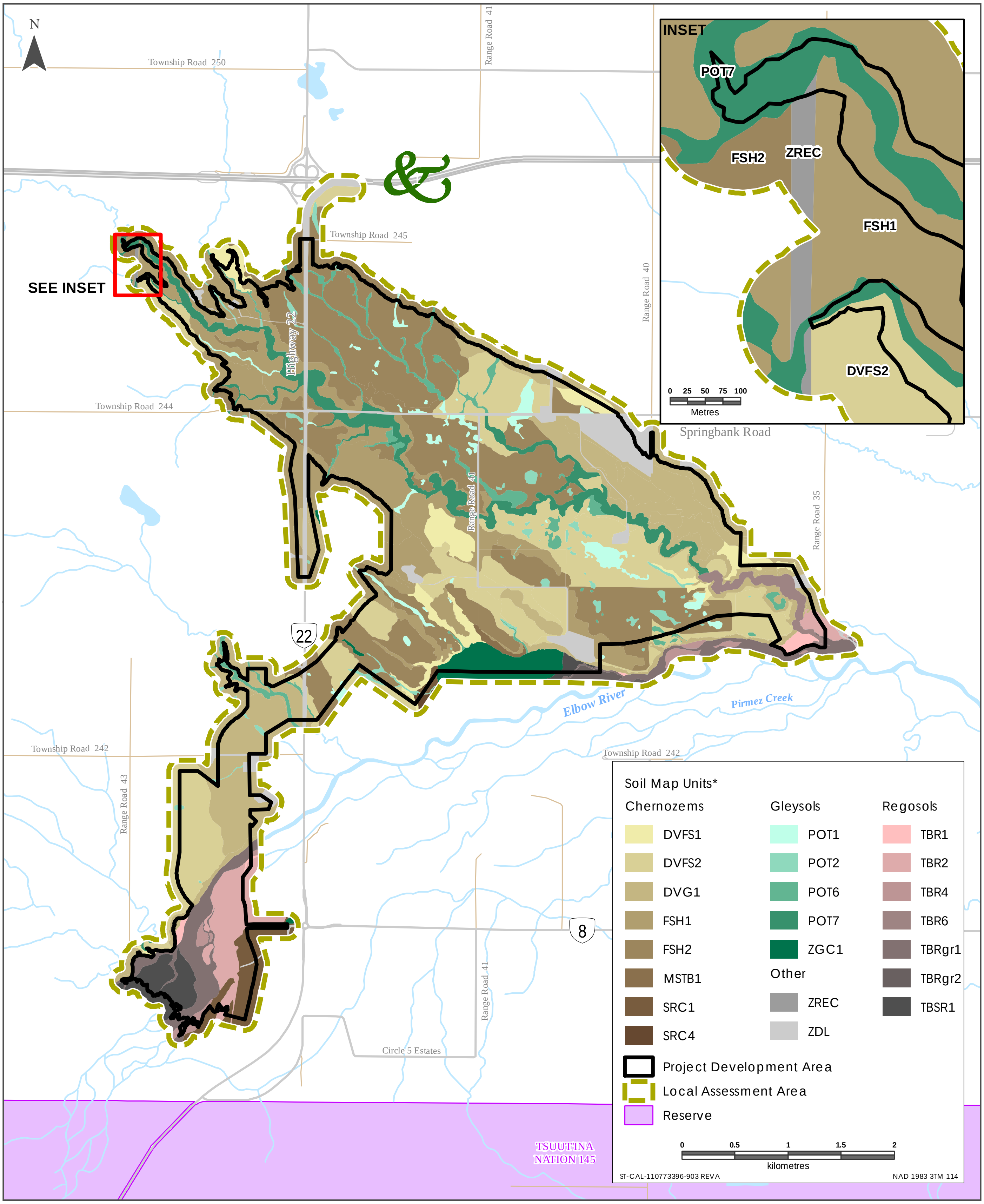
Supplemental Information Request 1, Question 385a, Page 6.63
Volume 3A, Section 9.2.4, Page 9.25

a. Respond to the original SIR1 question 385a and provide a map at a 1:5000 scale or finer resolution for the ZREC unit. The decision not to undertake higher resolution mapping due to the small size of the ZREC unit is not reasonable. Detailed mapping is required because Figure 9-5 (Volume 3A, page 9.25) does not clearly depict the location of the ZREC unit.

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a. A map (Figure 83-1) is provided at a scale of 1:5,000 to show the location of the ZREC map unit delineation.



Sources: Base Data - Government of Alberta, Government of Canada, Thematic Data - Stantec Ltd.
** Refer to Table 9-5 for Soil Map Unit descriptions.*

Soil Map Units in the Project Development Area and Local Assessment Area with a focus on ZREC in the Northwest

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ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT

Figure 83-1

Question 84

Supplemental Information Request 1, Question 388b, Page 6.83

a. Respond to the original SIR1 question 388b to describe mitigation measures related to potentially contaminated sediment.

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a. The need for, and type of, mitigation measures related to potentially contaminated sediment will be determined through implementation of the post-flood soil monitoring plan (information on the proposed soil monitoring plan is provided in the response to AEP Question 85).

   A component of the soil monitoring plan will include screening for evidence of potential soil contamination. In response to Round 1 AEP IR388a and based on the lack of any measurable soil contamination in the Elbow River floodplain at present, residual effects related to soil quality from contamination related to flood and post-flood phases are expected to be negligible. If monitoring finds contaminants of potential concern, appropriate mitigation will be identified and implemented. Depending on that risk assessment outcome, the spectrum of remediation options includes:

   - encapsulation of the material
   - removal of the material

   If required, the soil will be disposed offsite at a facility approved under EPEA for receiving contaminated soil, dependent on the identified material, or may be isolated onsite depending on the risk-assessment outcomes.

Question 85

Supplemental Information Request 1, Question 394c, Page 6.95

a. Respond to the original SIR1 question 394c to address how post-flood sediments will be monitored for potential contaminants of concern, even if the intent is that they will be left in place.

Response

a. Following each flood, an assessment of the deposited sediment will be undertaken. As part of the assessment, a risk analysis will be completed to determine subsequent actions and mitigations, which could include long term monitoring and, potentially, treatment and remediation, including the possible removal of contaminated sediment. This risk management approach allows the operator and regulator to work together to find a fit-for-purpose solution to address the contamination while considering site-specific conditions, the nature and extent of contamination, and potential exposure pathways.

   Chemical properties of sediment are expected to be similar to soils in the Elbow River floodplain, and will likely include high pH, high proportion of calcium carbonate minerals, and low nutrient concentration. Dynamic chemical properties, such as soluble salt, will involve visual assessment of salt patches (white crusts, dead vegetation) augmented by discrete sampling of soil or pore water in the saturated zone. Salinization would most likely be found around margins of the inundated area, where lateral spreading of groundwater allows capillary rise of saline groundwater into the soil profile (Hayashi et al. 1998).

   The protocols for detecting the presence of COPCs will include visual means to detect the presence of hydrocarbons and selective point sampling to detect the presence of salts, nutrients, or metals, where suspected. Soil with suspected hydrocarbons will be field-screened for presence of combustible headspace vapours (CHV) and volatile headspace vapours (VHV). Based on the results of the field screening, soil samples could be submitted for laboratory analysis, including, but not limited to, benzene, toluene, ethylbenzene and xylenes (BTEX), petroleum hydrocarbons (PHCs), fractions 1 to 4 (F1 to F4), salinity parameters (i.e., pH, conductivity, chloride, etc.), nutrients (i.e., total organic nitrogen, available phosphorus, nitrites and nitrates) and regulated metals.

REFERENCES

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Question 86

Supplemental Information Request 1, Question 407, Page 6.118
Supplemental Information Request 1, Appendix IR407-1, Section 7.3, Page 7.4

Alberta Transportation states: *Topsoil, and where applicable, subsoil that has been salvaged and stockpiled during construction will be replaced on the site prior to decompaction*.

a. Was the intent to decompact the site before replacement of the topsoil and subsoil on the surface? Explain.

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a. Prior to topsoil and subsoil replacement, the site will be decompacted by deep ripping with at least two passes at 90 degrees to each other and to a depth of 20 cm to 25 cm or greater to breakup hardpan layers. After the site has been decompacted and contoured, subsoil and topsoil will be replaced. Depending on site conditions, the environmental inspector may suggest further decompaction for the subsoil and the topsoil horizons.

5.2 VEGETATION

Question 87

Supplemental Information Request 1, Question 401, Page 6.105
Supplemental Information Request 1, Appendix IR2-1, Page 2
Volume 1, Section 1.3.2.1, Figure 1-8, Pages 1.12, 1.13

In the Supplemental Information Request responses regarding future land use of the Springbank off-stream Reservoir Project, Alberta Transportation has revised their comments from the original Environmental Impact Assessment to now state *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*.

Certain agricultural dispositions, approvals, or authorizations, such as grazing leases, grazing licenses, grazing permits, head tax grazing permits, farm development leases, cultivation permits, and hay permits exist and are utilized by Alberta Environment and Parks to provide the opportunity for agricultural activity while at the same time making provisions for conditional and/or unrestricted access to the lands for exercise of First Nations treaty rights such as hunting.

a. **Given the presence of such dispositions, approvals, or authorizations, has Alberta Transportation considered these possible tools as an opportunity to continue to enable agricultural use of lands within Area C or Area B of the Project area during periods when there is no risk of interfering with the Primary Use of the project area for flood mitigation? Explain why or why not.**

b. **Has Alberta Transportation considered the possible benefits in the use of certain agricultural dispositions, approvals, or authorizations as a mitigation measure in managing both potential fire hazard from unutilized vegetative biomass and to avoid the potential creation of favourable microsites for noxious weed colonization commonly associated with the non-use of vegetative biomass production over extended periods? Explain why or why not.**

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a. The Draft Guiding Principles and Direction for Future Land Use (see Appendix 87-1) no longer refers to land use areas by the letter categories Area A to Area D in the PDA. Alberta Transportation is awaiting feedback from Indigenous groups, sent to Indigenous groups via emails on November 13 and 15, 2019.

Alberta Transportation continues to actively engage Indigenous groups and stakeholders to identify options to utilize the Project area during periods when there is no risk of interfering with its primary use for flood mitigation. Potential land use options identified, including grazing permits for short-term grassland management, have been discussed as part of these engagement activities.

As engagement continues, this feedback will be used to refine and clarify the draft principles so as to determine how to appropriately manage the Project area for the identified secondary uses.

b. Alberta Transportation has considered the potential benefits of agricultural dispositions, approvals, or authorizations for managing vegetation, including weeds and biomass. These land use options could lower weed abundance, increase plant diversity (Blumenthal et al. 2012; Lancaster et al. 2015), lower weed control costs (Blumenthal et al. 2003) and reduce the risk of fire (Davies et al. 2010) or alter fire behaviour (Nader et al. 2007). Outcomes will vary depending on past land use (Renne and Tracy 2006), grazing intensity and animals used (Gibson 2009). However, and as identified in the response to a., Alberta Transportation is evaluating potential land use options and management approaches that reflect benefit to Indigenous groups and stakeholders. Engagement continues on these uses and Alberta Transportation will continue to work with AEP to determine appropriate management of the Project area. Some grazing through permit is being considered for the reservoir and, based on input from Indigenous groups, Alberta Transportation is evaluating opportunities for short-term use of culturally important grazing species such as bison and elk.

REFERENCES

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Lancaster, J., R. Adams, B. Adams, and P. Desserud. 2015. Long-term Revegetation Success of Industry Reclamation Techniques for Native Grassland: Foothills Fescue, Foothills Parkland and Montane Natural Subregions: Phase 1 – Literature Review and Case Studies – 2014. Prepared for: Land and Forest Policy Branch, Alberta Environment and Sustainable Resource Development.

Nader, G., Z. Henkin, E. Smith, R. Ingram, and N. Narvaez. 2007. Planned herbivory in the management of wildfire fuels: grazing is most effective at treating smaller diameter live fuels that greatly impact the rate of spread of a fire along with the flame height. Rangelands. 29: 18-24.

Renne, I.J. and B.F. Tracy. 2006. Disturbance persistence in managed grasslands: shifts in aboveground community structure and the weed seedbank. Plant Ecology. 190: 71-80.

Question 88

Supplemental Information Request 1, Question 407, Page 6.118
Supplemental Information Request 1, Appendix IR407-1, Page 7.2

Regarding seed mix selection for native areas, Alberta Transportation states pinegrass (Calamagrostis rubescens) and hairy wild rye (Leymus innovates) may be used as substitutes for species listed in the original species mix.

a. Given these two species are most commonly found in forested areas or on forest margins will they only be used in similar habitats for reclamation efforts or is the intent to utilize these species on areas where the site potential is open native grassland as well? Explain.

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a. Pinegrass (*Calamagrostis rubescens*) and hairy wild rye (*Leymus innovatus*) will be targeted for use in reclaimed forested areas impacted by the Project, not open native grassland. As indicated in the draft Vegetation and Wetland Mitigation, Monitoring and Revegetation Plan provided in Alberta Transportation's response to Round 1 AEP IR407, Appendix IR407-1, Alberta Transportation's custom seed mix will be adjusted in consideration of site-specific conditions of vegetation communities, input from Indigenous groups as to species that are culturally important to them, and representative community types for the Foothills Parkland Natural Subregion (DeMaere et al. 2012). Grass species typical of open native grassland in the Foothills Parkland Natural Subregion (e.g., foothills rough fescue [*Festuca campestris*] and slender wheatgrass [*Elymus trachucaulum*]) will be used to reclaim Project-disturbed native grassland communities.

References

DeMaere, C., M. Alexander and M. Willoughby. 2012. Range Plant Communities and Range Health Assessment Guidelines for the Foothills Parkland Subregion of Alberta. First Approximation. Publication No. T/274.

Question 89

Supplemental Information Request 1, Question 407, Page 6.118
Supplemental Information Request 1, Appendix IR407-1, Page 7.1

For revegetation efforts Alberta Transportation states a target of noxious weed abundance as being *equivalent or lower than surrounding undisturbed areas and do not account for more than 25% of the total vegetation cover*.

The *Weed Control Act* states that a person shall control a noxious weed that is on land the person owns or occupies and that a person shall destroy a prohibited noxious weed that is on land the person owns or occupies.

a. Given a noxious weed cover of 25% is significant and may incur the potential of receiving a weed notice from the weed inspector is such a threshold target suitable? Explain.

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a. Alberta Transportation will control weeds following the *Alberta Weed Control Act* Regulations and Rocky View County requirements. Following the *Alberta Weed Control Act*, all prohibited noxious weeds in the PDA will be destroyed and noxious weed growth and spread will be inhibited. A target abundance of noxious weeds is not identified in the *Alberta Weed Control Act* or by Rocky View County. Alberta Transportation will work with Rocky View County on identifying suitable weed control measures and acceptable noxious weed levels. Weeds were frequently observed in the PDA and cover ranged from 0% to 25% (see Alberta Transportation's response to Round 1 AEP IR406) and full removal may not be possible for all noxious weed occurrences.

5.3 WILDLIFE

Question 90

Supplemental Information Request 1, Question 408, Page 6.1119
Supplemental Information Request 1, Figure IR408-1, Page 6.121

The Elbow River valley serves as a key wildlife and biodiversity zone (KWBZ) which is an important movement habitat for numerous wildlife species. It was identified during a meeting between AEP and Alberta Transportation, as part of the SIR review in 2019 that numerous wildlife collisions have been observed at the bridge.

a. Explain why this area was not included in the EIA as a possible or potential wildlife collision prone location (Figure IR408-1).

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a. Alberta Transportation is aware of one meeting between Alberta Transportation and AEP, which was on September 27, 2018, where three data sources were discussed related to animal-vehicle collisions: ENFOR, the Alberta Collision Information System (ACIS) and Alberta Wildlife Watch (AWW). The rationale for using or not using each of these three sources of information is provided in Alberta Transportation's response to Round 1 AEP IR408, wherein it is stated that the animal-vehicle collision prone locations (AVCPL) for large-bodied animals provided in Figure IR408-1 are based on a two step analysis of the AWW data using the Kernel Density Estimate (KDE+) software, and animal carcass density (see Appendix B in GoA 2017). At the time of analysis, the area indicated by AEP was not identified as a possible or potential AVCPL because the number of animal-vehicle collisions did not meet the threshold (as defined in the analysis) to be identified as an AVCPL. The AWW Program will continue to monitor this area for determining in the future whether it meets the threshold of a collision-prone location.

REFERENCES

GoA (Government of Alberta). 2017. Alberta Wildlife Watch Program. Available at: https://open.alberta.ca/dataset/7c852b82-ecd3-4701-8d84-0b5addbe54ce/resource/d986571a-22bb-41ab-9630-cd4fa9c8cb7b/download/albertawildlifewatchprogramplan.pdf

Question 91

Supplemental Information Request 1, Question 409, Page 6.122

Montane elk study research publications were available at the time this EIA was written. These research publications could have been used to describe estimates of habitat use and avoidance as a result of human and vehicular access. These publications were not used in the EIA references (Authors Paton, Ciuti, Boyce, Muhly) for elk and grizzly bear (http://www.biology.ualberta.ca/www.montaneelk.com/updates.php).

a. Explain why the research publications of montane elk were not used in the EIA to inform expected impacts due to human and vehicular use.

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a. Research from the montane elk study, as well as other relevant literature, were used in the wildlife assessment: Paton 2012; Ciuti et al. 2012; Pruvot et al. 2014; Prokopenko 2016; Seidel and Boyce 2016 (see EIA, Volume 4, Appendix H, Attachment 11A, Section 11A.3). Specifically, the literature related to the montane elk study and other relevant regional information was used for development of the elk habitat suitability models (see Volume 4, Appendix H, Attachment 11A, Section 11A.2.4). The elk species account included references from the montane elk study as well as other research related to elk ecology and habitat requirements. The elk species account also includes habitat suitability rating adjustments related to human disturbances, including vehicle traffic (i.e., sensory disturbance).

   The potential direct and indirect effects of the Project on elk habitat are based on results of the elk winter and summer feeding habitat suitability maps, which were generated using the relevant montane elk research publications.

REFERENCES

Ciuti, S., J.M. Northrup, T.B. Muhly, S. Simi, M. Musiani, and J. A. Pitt. 2012. Effects of humans on behaviour of wildlife exceed those of natural predators in a landscape of fear. PLoS ONE 7(11): e50611.

Paton, D. 2012. Connectivity of Elk Migration in Southwestern Alberta. Master's Thesis – University of Calgary, Calgary Alberta

Prokopenko, C.M. 2016. Multiscale Habitat Selection and Road Avoidance of Elk on their Winter Range. M.Sc. Thesis. University of Alberta, Edmonton, AB.

Pruvot, M., D. Seidel, M.S. Boyce, M. Musiani, A. Massolo, S. Kutz, and K. Orsel. 2014. What attracts elk onto cattle pasture? Implications for inter-species disease transmission. P*reventative Medicine* 117: 326-339.

Seidel, D.P. and M.S. Boyce. 2016. Varied tastes: home range implications of foraging-patch selection. *Oikos* 125: 39–49.

Question 92

Supplemental Information Request 1, Question 409, Page 6.122
Supplemental Information Request 1, Question 410, Page 6.123
Supplemental Information Request 1, Figure IR411-2, Page 6.128

a. **Explain and clarify if the Wildlife Crossing Structures Handbook specifications will be adhered to for the crossing structure/culvert on highway 22 (Figure IR411-2 pg 6.128). If not, explain why these specifications will not be adhered to and the adequacy of the proposed design. https://roadecology.ucdavis.edu/files/content/projects/DOT-FHWA_Wildlife_Crossing_Structures_Handbook.pdf.**

b. **The current fencing in place for this culvert is designed for cattle and prevents most ungulate wildlife crossings. Will this fencing be modified to enable wildlife movement? If not, then explain why no modifications will be made.**

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a. The Wildlife Crossing Structures Handbook (Clevenger and Huijser 2011) is a compilation of projects completed by other jurisdictions, including the Netherlands, Spain and a few U.S. states (Arizona, Florida, Washington). It is not a regulatory document and has not been formally adopted by Alberta. However, Alberta Transportation has reviewed the handbook for guidance and the following dimensions and design principles for the as-designed underpass and culvert are consistent with its guidance:

    - Height (10 m) and width (24 m) of the Highway 22 bridge over the diversion channel (underpass) exceeds the recommended height (greater than 4 m) and width (greater than 10 m) for large mammal underpasses.
    - Cover along one or both culvert walls using salvage materials (logs, root wads, rocks, etc.) will be considered to encourage culvert use by small and medium-sized mammals. The width (3.67 m) and height (2.45 m) of the culvert that will be replaced at the bottom of the raised intersection on Highway 22, as shown in Alberta Transportations response to Round 1 AEP IR411, Figure IR411-2, aligns with the recommended dimensions for small and medium-sized mammals (e.g., coyote, fox) provided in the Wildlife Crossing Structures Handbook.

b. The current fencing in place for this culvert will be removed and replaced with wildlife-friendly fencing.

REFERENCES

Clevenger, A.P., and Huijser, M.P. 2011. Wildlife Crossing Structure Handbook Design and Evaluation in North America. 223 pp. Available at: https://roadecology.ucdavis.edu/files/content/projects/DOT-FHWA_Wildlife_Crossing_Structures_Handbook.pdf

Question 93

Supplemental Information Request 1, Question 412, Page 6.129

This question has not been answered sufficiently.

a. Explain in additional detail how and/or if wildlife crossing deterrent fencing will be used to guide animals to preferred crossing areas. Provide a map explaining where the project expects ungulate movement to be negatively impacted.

b. Explain how an increase in expected or unexpected vehicle wildlife collisions will be mitigated in the future.

c. Will adjoining land fencing also facilitate this intended movement? Explain why or why not.

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a. Wildlife-exclusion fencing (to guide animals to preferred crossing areas such as the Highway 22 bridge over the diversion channel) is not proposed as part of the Project. All fencing installed will be wildlife-friendly so as to facilitate free wildlife movement within the PDA. The effectiveness of the mitigation to facilitate wildlife movement in the PDA and wildlife LAA will be evaluated as part of the final WMMP.

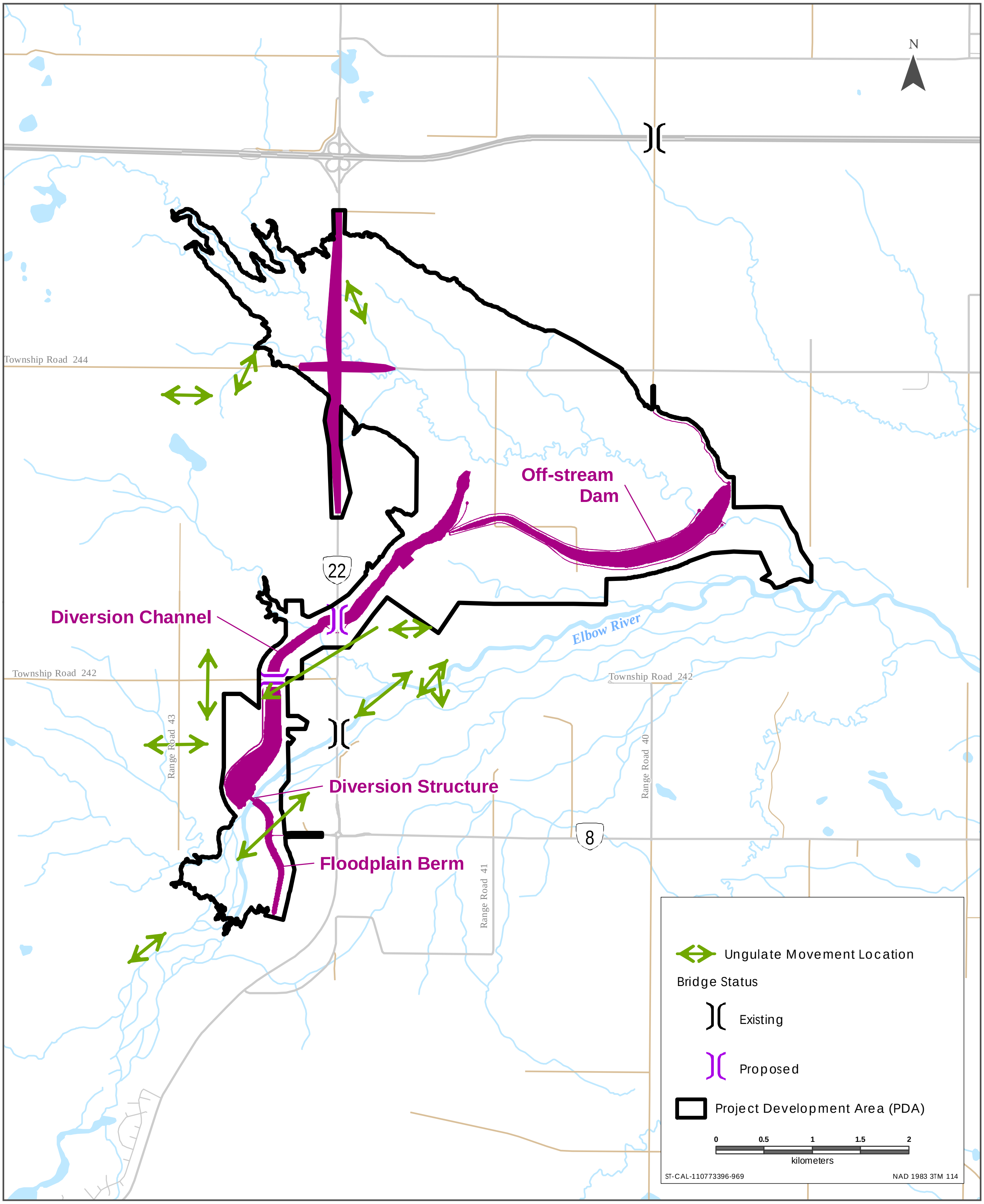
   Project structures have potential to create physical and sensory barriers to ungulate movement (e.g., elk, deer) (see EIA, Volume 3A, Section 11.4.3.3). Wildlife movement is expected to be affected where permanent Project structures (such as the diversion channel, floodplain berm, and off-stream dam) will be built.

Results from wildlife baseline surveys (e.g., winter tracking, remote camera) indicated the following locations where ungulates (deer, elk, moose) or their tracks were observed (see Figure 93-1):

- On Highway 22 approximately 1 km north of the Highway 22 bridge near Pirmez Creek. Elk tracks were observed crossing Highway 22 and continued heading southwest across Township Road 242. This travel route intersects the southern portion of the diversion channel footprint where elk movement will be altered during construction.
- East of Highway 22 between Springbank Road and the TransCanada Highway where elk were detected moving north and south along a wildlife trail. This area is adjacent to the section of Highway 22 that will be permanently raised during Project construction. Construction activities have potential to temporarily alter elk movement in this area.
- West of Highway 22 where deer and elk tracks were observed travelling east-west across Range Road 43 as well as north-south across Township Road 242 and 244. Construction of the diversion channel and construction activities associated with raising Highway 22 has potential to affect deer and elk movement near these areas.
- Along Elbow River and crossing Elbow River. Deer and elk movement along Elbow River will be altered during construction of the diversion structure and floodplain berm.
- Along the floodplain berm where deer tracks were observed (see Volume 4, Appendix H, Section 3.7.2, Table 3-11). Deer movement along Elbow River will be altered during construction of the diversion structure and floodplain berm.
- East of Highway 22 between the proposed diversion channel and Elbow River where moose tracks were observed travelling east-west. Construction activities have potential to affect moose movement during construction of the diversion structure.

The elk movement locations described above (e.g., across Highway 22 and Elbow River) were also identified in the Tsuut'ina Traditional Land Use Report as elk migration routes (Tsuut'ina Nation 2018).

The remote monitoring program will help determine whether ungulates continue to use these travel routes and provide data to evaluate their response when encountering Project components such as the diversion channel and floodplain berm during dry operations.



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

Ungulate Movement Locations
Observed During Wildlife Baseline Surveys

Stantec

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT

Figure 93-1

b. During construction, increases in Project-related traffic volumes will be managed through the Traffic Accommodation Strategy (see Volume 3A, Section 16.4.2.2), which will reduce potential mortality risk related to animal-vehicle collisions in the LAA. During dry operations, traffic volumes are expected to return to baseline conditions. The Project will not result in increases in traffic volumes (see Alberta Transportation's response to Round 1 AEP IR410d). There is no expected increase in wildlife collisions; however, unexpected increases would be addressed through adaptive management.

   In addition, there will be monitoring of animal-vehicle collisions as part of the AWW Program. The AWW Program is designed to identify animal-vehicle collision prone locations and to monitor and evaluate the effectiveness of mitigation (AEP 2017).

c. All fencing is described in Round 1 AEP IR413. Fencing has not been designed to guide wildlife movements. Fence types have been selected to not impede wildlife movement through the PDA.

REFERENCES

AEP (Alberta Environment and Parks). 2017. Alberta Wildlife Watch Program. Available at: https://open.alberta.ca/dataset/7c852b82-ecd3-4701-8d84-0b5addbe54ce/resource/d986571a-22bb-41ab-9630-cd4fa9c8cb7b/download/albertawildlifewatchprogramplan.pdf

Tsuut'ina Nation. 2018. Tsuut'ina Traditional Land Use Report for the Proposed Springbank Off-Stream Reservoir Project. Prepared by Tsuut'ina Nation and Trailmark Systems. Prepared for Alberta Transportation.

Question 94

Supplemental Information Request 1, Question 413, Page 6.130

Many other types of wildlife friendly fence designs are available.

a. Explain if gates, jump rails or drop sections of fences have been considered.

b. Explain if gates, jump rails or drop sections of fences will be used to further enhance ungulate movement at all times and/or at times when livestock are not required to be contained (in the event livestock use is permitted) in both internal and external project fences.

c. If gates, jump rails or drop sections of fences have not been considered, explain why not.

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a. and c. Other options are available, including gates, jump rails and drop sections that can facilitate or enhance wildlife passage where traditional barbed-wire fencing or wildlife-friendly fencing exists. However, gates, jump rails or drop sections of fences have not been considered because all barbed-wire fences will be removed in the PDA and replaced with wildlife-friendly fencing, which is expected to facilitate wildlife movement in the LAA. The final WMMP will describe opportunities to assess the effectiveness of the proposed wildlife-friendly fencing.

b. All internal (existing barbed wire) fencing to the reservoir will be removed. All fencing around the perimeter of the PDA, in the raised section of Highway 22, and along Springbank Road within the reservoir will be wildlife-friendly, which is designed to facilitate wildlife movement in the PDA and LAA. Wildlife-friendly fencing will contain livestock (as required) consistent with the direction identified in the Draft Guiding Principles and Direction for Future Land Use (see the response to AEP Question 87, Appendix 87-1), which states that grazing permits may be issued within designated zones, and at certain times, where determined by AEP, as the appropriate tool to manage grasslands for ecosystem health or wildfire mitigation.

c. Gates, jump rails and drop sections have not been included in the design of the wildlife-friendly fencing because the removal of internal barbed-wire fencing (within the PDA) and installation of wildlife-friendly fencing around the perimeter of the PDA will enhance wildlife permeability. However, monitoring the effectiveness of the wildlife-friendly fencing will be described in the final WMMP.

Question 95

Supplemental Information Request 1, Question 414, Page 6.132
Supplemental Information Request 1, Question 410c, Page 6.124

The response states the qualitative approach taken is sufficient and standard. However, this approach has created uncertainty on project effects to wildlife movement.

a. Explain how an enhanced assessment and monitoring design could have been utilized to better understand the impacts of the project. Explain why this approach was not taken.

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a. The potential effects of the Project on wildlife movement were assessed using a qualitative approach, which was enhanced with quantitative information from winter tracking surveys and remote camera data collected as part of the baseline surveys as well as available information from traditional use studies. To further enhance the assessment on wildlife movement would require additional quantitative data on animal movement within the LAA (e.g., daily and seasonal travel routes, daily distance travelled, movement rate), which is typically collected by government or academic institutions using telemetry (i.e., GPS collared animals).

   Although the EIA included a brief discussion of grizzly bear movement based on a small sample of telemetry information provided by AEP, it does not provide a detailed assessment of grizzly bear movement in the LAA (see Alberta Transportation's response to NRCB Question 35). AEP provided an elk study conducted in 1982 (Eslinger et al. 1982); however, it has limited utility to inform the wildlife assessment based on the date of the study, the limited number of radio-collared elk (total of seven collared elk, of which only two elk were from the nearby Jumpingpound herd), the type of radio collar (VHF) and the spatial distribution of the elk herds sampled, which did not overlap the LAA.

   The qualitative approach used to assess wildlife movement is consistent with provincial and federal EIAs previously completed for approved major projects where there is an absence of quantitative movement data within local assessment areas (Glacier 2006; CNRL 2012; Athabasca Oil 2013; Suncor 2017).

   Alberta Transportation has developed a draft WMMP (see Alberta Transportation's response to Round 1 AEP IR425, Appendix IR425-1). As described in the draft WMMP, potential Project effects on wildlife will be monitored. Monitoring would occur during construction, post-Project approval, and dry operations, primarily to determine the effectiveness of proposed mitigation measures and to confirm the conclusions of the assessment. At that time, monitoring results will be used to evaluate the effects of the Project and, if necessary, refine mitigation. Monitoring is not a component of baseline data collection. The AWW Program will also continue to monitor wildlife sightings along Highway 22 into the future.

   Some scientific uncertainty exists regarding wildlife movement because there is limited information available related to animal responses to Project components, such as the diversion channel. The final WMMP is being designed to evaluate how wildlife movement is potentially affected due to permanent Project structures and the relative effectiveness of proposed mitigation measures, which can be used to validate the assessment predictions.

REFERENCES

Athabasca Oil (Athabasca Oil Corporation). 2013. Application for Approval of the Hangingstone Expansion Project. Available at: https://dds.aer.ca/iar_query/ApplicationAttachments.aspx?AppNumber=1762708

CNRL (Canadian Natural Resources Ltd). 2012. Grouse In-Situ Oil Sands Project. Available at: https://dds.aer.ca/iar_query/ApplicationAttachments.aspx?AppNumber=1720859

Eslinger, D. H., K.P. Schmidt, and J.R. Gunson. 1982. Evaluation of microwave detector-scarers in prevention of elk damage to stacked feed. Alberta Energy and Natural Resources. Fish and Wildlife Division.

Glacier (Glacier Power Ltd.). 2006. Dunvegan Hydroelectric Project. Available at: https://iaac-aeic.gc.ca/052/details-eng.cfm?pid=2996

Suncor (Suncor Energy Inc.). 2017. Meadow Creek West Project. Available at: https://dds.aer.ca/iar_query/ApplicationAttachments.aspx?AppNumber=1899100

Question 96

**Supplemental Information Request 1, Question 415, Page 6.134
Volume 3A, Section 11.2.2.4, Page 11.28**

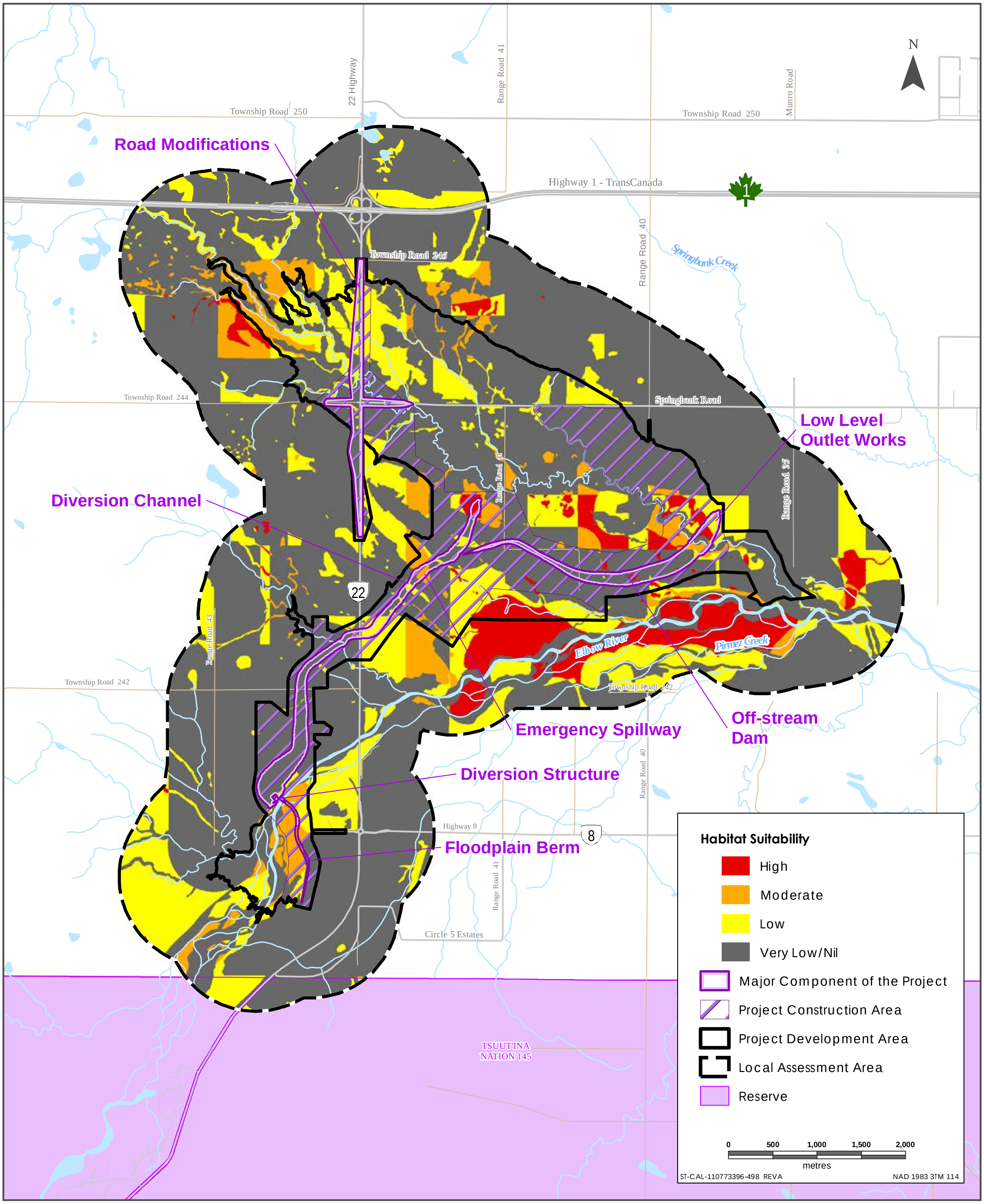
Alberta Transportation states *the frequency of grizzly bear use is expected to be low based on the information presented in Volume 3A, Section 11.2.2.4, page 11.28, which indicates the wildlife LAA provides relatively low suitability habitat*.

a. Explain how a major riparian watercourse movement corridor and KWBZ with native prairie uplands and abundant big game populations can be considered low suitability habitat for grizzly bear considering this habitat is known to support numerous adult and young grizzly bears and is adjacent to the draft recovery plan's identified support zone.

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a. The quoted statement applies to the wildlife LAA, wherein the LAA (4,860 ha) is dominated by agricultural land including tame pasture (27.3%), cropland (11.3%), hayland (9.7%) and disturbed land (6.1%)(see the EIA, Volume 3A, Section 11, Table 11-6). These non-native cover types were rated low or very low suitability, as described in Volume 4, Appendix H, Section 11A 2.5. There is higher value grizzly bear habitat in the LAA, including areas identified along Elbow River that provide both high and moderate spring feeding habitat suitability (see Figure 96-1, which is reproduced from Volume 3A, Section 11, Section 11.2.2.4, Figure 11-8).



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

Grizzly Bear Spring Feeding Habitat Suitability in the LAA – Existing Conditions

Stantec

Figure 96-1

As described in Volume 4, Appendix H, Section 11A 2.5, ecosites that contain preferred spring forage plants (e.g., grass, sedge, horsetail) are grassland and mature open forests along riparian areas and are rated as high suitability habitat prior to any applicable ratings adjustments for anthropogenic disturbance, which is assumed to reduce suitability. In addition, riparian areas and shrublands that might provide winter-killed ungulates or calves are also rated high prior to any applicable ratings adjustments for anthropogenic disturbance.

Only a small amount of the PDA (2.8%) overlaps the key wildlife and biodiversity zone (KWBZ) identified along Elbow River (see Alberta Transportation's response to Canadian Environmental Assessment Agency [CEAA] Annex 2, Question 27b). As discussed in Volume 3A, Section 11.2.2.1, the western boundaries of the wildlife LAA and wildlife RAA overlap the grizzly bear Support Zone identified in the draft Alberta Grizzly Bear Recovery Plan (AEP 2016), which identifies priority management actions to reduce attractants and bear-human conflict.

REFERENCES

AEP (Alberta Environment and Parks). 2016. Alberta Grizzly Bear (*Ursus arctos*) Recovery Plan (Draft). Alberta Environment and Parks, Alberta Species at Risk Recovery Plan No. 38. Edmonton Ab. 85 pp.

Question 97

Supplemental Information Request 1, Question 417, Page 6.316

The response has not included any impact assessment of on-foot human access to the site.

a. Explicitly describe and explain how foot or water-based access and recreation facilities will affect wildlife use, conflicts, and mortality.

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a. For safety reasons, there will be no public access when the reservoir is retaining water. Therefore, there is no potential effect of human foot or water-based access on wildlife during flood operations. The proposed Draft Guiding Principles and Direction for Future Land Use (see the response to AEP Question 87, Appendix 87-1) will address land-based access and will be refined following engagement with Indigenous groups and stakeholders. The primary land use will be for flood mitigation and when not being used for flood mitigation, secondary uses include First Nations' traditional activities such as hunting and traditional and medicinal plant gathering and low impact activities such as hiking and cross-country skiing.

There is potential for human-wildlife conflict and increased wildlife mortality risk (e.g., bears) during dry operations (between floods), which is discussed in the EIA, Volume 3A, Section 11.4.4; the reduction of on-site activity (i.e., after construction ceases) would reduce the likelihood of Project-related wildlife-human conflict. The extent of public access will be guided by the final principles for future land use; however, human-wildlife conflicts are not expected to increase relative to existing agricultural and residential land uses.

The Project will not change water-based access along Elbow River during dry operations and there will be no recreation facilities built within the PDA. Therefore, these activities were not assessed.

Question 98

Supplemental Information Request 1, Question 418, Page 6.316

a. **The term nuisance animal is not in the Alberta Wildlife Regulation and is a term used by the *Agricultural Pests Act* and regulations. Correct the response so that the correct regulation is referenced.**

b. **Explain how this term has been used in this section and the terminology around nuisance animal.**

It is noted in the response to this question that the proponent has not obtained all information available, nor gathered additional information with which to enable prediction of human wildlife conflicts.

c. **Explain the ability to predict these conflicts with the limited information provided and explain if this deficiency will be addressed. If this deficiency will not be addressed, explain why.**

d. **Confirm that the GOA is the authority and will take appropriate action as per established conflict wildlife policies and protocols where responsible.**

e. **Confirm that Alberta Transportation understands that all occupied dens are protected under the *Wildlife Act* and Regulation.**

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a. The term "nuisance" was not meant to be explicitly interpreted as per the definition defined in the *Agricultural Pests Act* but rather was used more broadly as discussed in the EIA, Volume 3A, Section 11.4.4.1, which states an increase in wildlife-human conflict could result in attractants (e.g., garbage) in the PDA that might cause unwanted wildlife to enter the construction area while humans are present. Nuisance animals would include species that might enter the construction area and result in a wildlife-human conflict such as a coyote or a bear. The response is not referring to a specific clause in legislation and the conclusions of the assessment are not changed.

b. See response to a. and Alberta Transportation's response to Round 1 AEP IR418a. The potential increase in wildlife mortality risk is assessed qualitatively. The removal of an animal involved in a wildlife-human conflict may require lethal means but also refers to other methods that could be used to resolve or reduce the risk of mortality. As stated previously in response to NRCB Question 35, any human-bear conflict would be reported to AEP (Fish and Wildlife).

c. The potential increase in wildlife mortality risk is assessed qualitatively. The assessment does not attempt to predict the number of human-wildlife conflicts (e.g., bear) but rather assumes there is a potential for increased risk of mortality because there will be increased human presence in areas where wildlife (e.g., bears) might occur as discussed in Volume 3A, Section 11.4.4. The EIA was prepared using available information, as discussed in the response to NRCB Question 35a. As indicated in that response, Alberta Transportation has not identified a deficiency to be addressed.

d. Alberta Transportation will implement mitigation that is consistent with established policies and protocols related to human-wildlife conflict. As stated in Alberta Transportation's response to Round 1 AEP IR415 and NRCB Question 35, Alberta Transportation has proposed mitigation to reduce human-wildlife conflicts. If a bear-human interaction occurs, the incident would be reported to the environmental inspector and AEP (Fish and Wildlife).

e. Alberta Transportation accepts that all occupied dens are protected under the Alberta *Wildlife Act* and Regulation.

Question 99

Supplemental Information Request 1, Question 419, Page 6.139

Native elk habitat is of much greater value than modified habitat.

a. Explain why native habitat will be replaced by modified habitats instead of being restored.

b. Explain the loss in habitat value that will occur as a result and provide a detailed map where this loss is expected. Note: the current descriptions are deficient.

c. Explain why Alberta Transportation is proposing actions that will degrade habitat and not proposing to restore these losses.

Response

This response was included in the May 15, 2020 filing. The text has not been changed but Figure 99-1 has been inserted which we note was not included in the May 15, 2020 filing.

a. Modified communities described in Round 1 AEP IR419 are early seral forested and shrubby communities temporarily disturbed by construction, or flood events. These areas are expected to be dominated by native grass and forb species following construction and flood events, which will provide potential foraging areas for elk.

   Restoration of habitat is not proposed because of the complexity involved in restoring habitat to conditions present prior to disturbance which can include challenges, such as:

   - the lack of availability of seed for all pre-disturbance species
   - some species are later seral species and do not establish readily following disturbance
   - the long time involved for complete restoration to occur
   - the potential for disturbance and disruption of restoration efforts by future flooding

   Reclamation of communities is more successful at establishing a trajectory toward a desired community type and reclamation would target species more resilient to future flooding.

   The Project revegetation plan has been developed to adaptively manage revegetation efforts, with the goal of revegetating high-quality areas with appropriate native seed mixes. There is greater likelihood of success with reclamation compared to restoration, and reclaimed areas will be supported by natural recovery, which is expected to occur over time.

   Reclamation of disturbed lands is standard practice for areas disturbed by development in Alberta (such as much of the existing PDA and wildlife LAA). Revegetation plans for the Project align with Alberta provincial guidance of returning land to an equivalent land capability (Province of Alberta 2019). Equivalent land capability means that after conservation and reclamation, the ability of land to support various land uses is similar to what existed prior to an activity being conducted on the land, but that individual land uses will not necessarily be identical.

   Alberta Transportation has prepared a Draft Vegetation and Wetland Mitigation, Monitoring, and Revegetation Plan (see Alberta Transportation's response to Round 1 IR407, Appendix IR 407-1). This plan will be revised and updated prior to construction and will include input received through ongoing discussion with regulators, including AEP, and Indigenous groups. Alberta Transportation will work with AEP and Indigenous groups to determine the desired reclamation conditions and modify seed mixes as applicable. With proposed mitigation, native species, including trees and shrubs, should re-establish on disturbed sites. Tree and shrub species are expected to re-establish through natural processes by root suckering (e.g., aspen [*Populous tremuloides*]), rhizomes (e.g., snowberry

[*Symphoricarpos occidentalis*], silverberry [*Elaeagnus commutata*]) and in time by seeds (e.g., white spruce [*Picea glauca*], red-osier dogwood [*Cornus stolonifera*]) (Esser 1994; Howard 1996a; Hauser 2007; Gucker 2012).

b. In the wildlife assessment, habitat value refers to the suitability of an area to support a specific life-requisites (e.g., food, cover) for a wildlife species. Habitat value was assessed for six key indicator species using habitat suitability models, which used a four-class rating scheme (high, moderate, low and very low/nil) to rate habitat suitability for each habitat type in the LAA (see EIA, Volume 3A, Section 11.2.1.3 and Volume 4, Appendix H, Section 11A.1.1).

   Additional detail regarding the change in elk winter feeding habitat (ha) suitability during construction and dry operations referred to in Round 1 AEP IR419 is provided in Table 99-1. During construction, the Project will directly and indirectly affect 116.9 ha of high suitability elk winter feeding habitat in the wildlife LAA. Of that, there will be a loss of 3.9 ha associated with permanent project components (see Figure 99-1), and a temporary loss of 53.7 ha for temporary components (i.e., temporary workspaces), which will be reclaimed. The remaining high suitability elk winter feeding habitat affected (59.3 ha) is due to zone of influence (ZOI) buffers used to estimate indirect habitat loss due to sensory disturbance. ZOI buffers of 250 m to 500 m were applied to anthropogenic features as well as to Project components during construction and dry operations, which reflects a reduction in habitat suitability due to sensory disturbance.

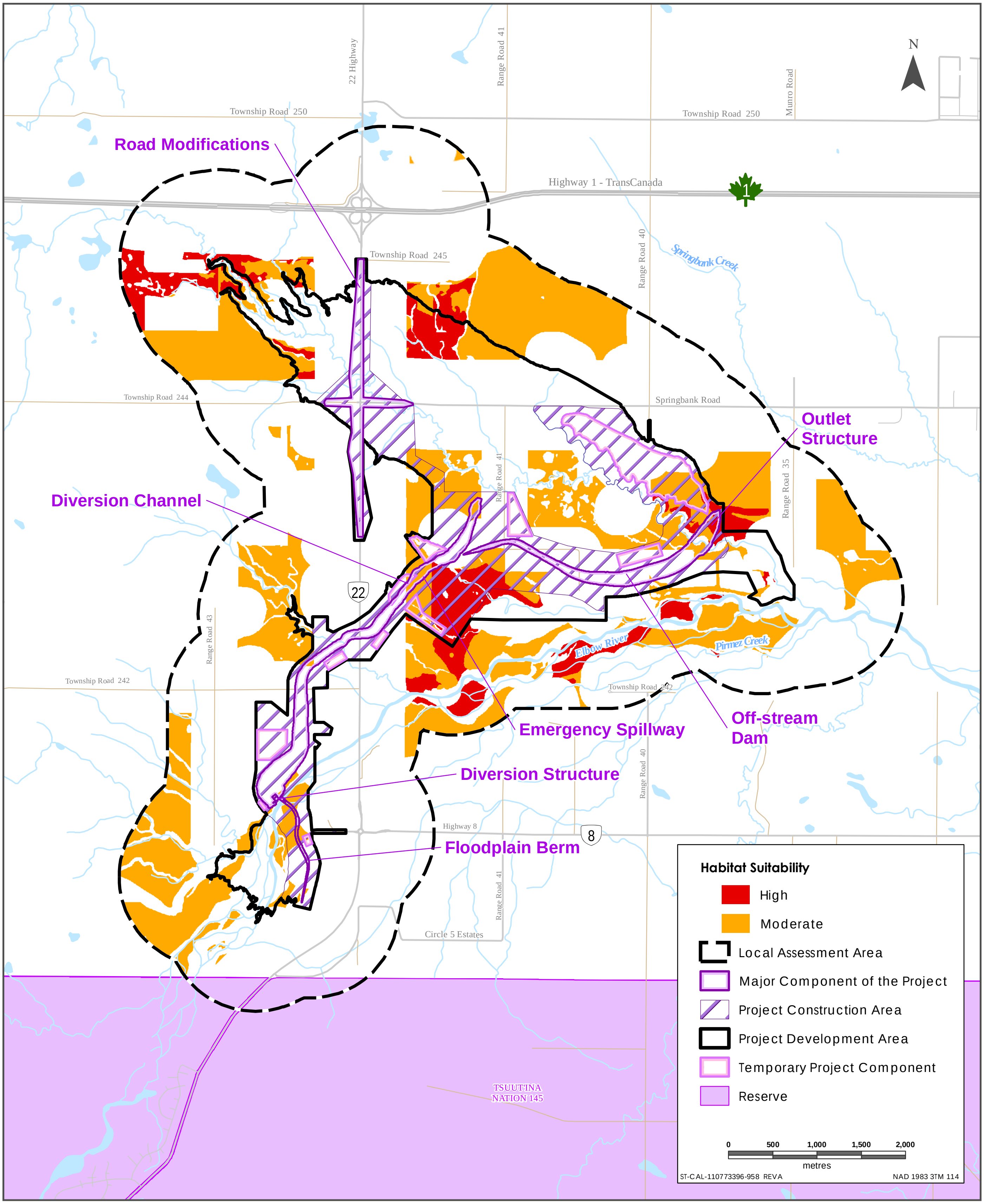
   The Project will directly affect 376.7 ha of moderate suitability elk winter feeding habitat in the LAA. Of that, there will be a loss of 20.6 ha associated with Project components, and a temporary loss of 106.3 ha within the construction area, which will be reclaimed. The remaining moderate suitability elk winter feeding habitat affected (249.8 ha) is due to ZOI buffers used to estimate indirect habitat loss due to sensory disturbance.

   The habitat value or suitability of reclaimed areas is accounted for in the suitability ratings in the elk winter feeding habitat suitability model: the amount of elk winter habitat available during dry operations reflects the habitat value of the reclaimed areas (i.e., temporary workspaces being reclaimed to grassland species) as well as the estimated indirect loss due to sensory disturbance. The application of the ZOIs for sensory disturbance to the major Project components (such as the dam) during the dry operations phase of the project is a conservative overestimation of the reduction in habitat suitability.

   The amount of high and moderate suitability elk winter feeding habitat affected during dry operations is primarily due to the estimated indirect loss due to sensory disturbance, which includes 67.4 ha and 218.2 ha of high and moderate suitability habitat, respectively (Table 99-1).

Table 99-1 Change in elk winter feeding habitat suitability in the LAA during construction and dry operations

Habitat Suitability Rating	Existing Conditions	Construction	Dry Operations	Change from Existing Conditions to Construction					Change from Existing Conditions to Dry Operations				
	ha	ha	ha	Direct Permanent Disturbance (ha)	Temporary Disturbance (ha)	Indirect Disturbance (ha)	Total Disturbance (ha)	Total Disturbance (%)	Direct Permanent Disturbance (ha)	Temporary Disturbance (ha)	Indirect Disturbance (ha)	Total Disturbance (ha)	Total Disturbance (%)
High	223.0	106.1	151.9	-3.9	-53.7	-59.3	-116.9	-52.4	-3.9	0.0	-67.4	-71.0	-31.9
Moderate	1,016.7	640.0	777.9	-20.6	-106.3	-249.8	-376.7	-37.1	-20.6	0.0	-218.2	-238.8	-23.5



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

Elk Winter Feeding Habitat Suitability in the LAA – Existing Conditions

Figure 99-1

c. The Project will directly and indirectly affect native grassland and elk habitat, but proposed reclamation is not considered to degrade elk habitat. Native and agronomic seed mixes will contain forage grass species used by elk, and they will provide suitable feeding habitat. Trees and shrubs will be allowed to naturally establish following construction and native seed mixes will be applied where needed. Alberta Transportation will consider recommended plant species by AEP to be included during reclamation to supplement natural re-vegetation of the area. These suggested plant species will be considered with those suggested by Indigenous groups.

   As described in the response to a., restoration of these areas to conditions identical to those prior to disturbance is not proposed.

REFERENCES

Esser, L.L. 1994. *Elaeagnus commutata*. In: Fire Effects Information System. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Services Laboratory. Available at: https://www.fs.fed.us/database/feis/plants/shrub/elacom/all.html. Accessed: January 2020.

Gucker, C. 2012. *Cornus sericea*. In: Fire Effects Information System. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Services Laboratory. Available at: https://www.fs.fed.us/database/feis/plants/shrub/corser/all.html. Accessed: January 2020.

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Howard, J.L. 1996a. *Populus tremuloides*. In: Fire Effects Information System. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Services Laboratory. Available at: https://www.fs.fed.us/database/feis/plants/tree/poptre/all.html. Accessed: January 2020.

Province of Alberta. 2019. Conservation and Reclamation Regulation. Alberta Regulation 115/1993 with Amendments up to and including Alberta Regulation 198/2019. Current as of December 5, 2019. Alberta Queen's Printer, Edmonton Alberta. Available online: http://www.qp.alberta.ca/documents/Regs/1993_115.pdf

Question 100

**Supplemental Information Request 1, Question 420, Page 6.140
Volume 3A, Section 11.4.2.3, Page 11.46**

Alberta Transportation states *However, crop and hayland are expected to become tame pasture over time, which provides suitable wildlife habitat for grassland-dependent species*. Tame pasture habitat types have an extremely low habitat value relative to native plant communities for most wildlife species.

a. Explain the statement and assessment of "suitable" as referenced above when it is expected that the conversion of habitat will have significant adverse impacts (see Volume 3A, Section 11.4.2.3, Page 11.46).

b. In addition, explain the basis for this assumption and identify where habitat value losses are expected. Support this explanation with a detailed map.

c. Explain why restoration of private crop and hay land to native prairie as a conservation measure was not proposed to offset native habitat that will be adversely affected by this project.

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a. The statement in the EIA, Volume 3A, Section 11.4.2.3, is intended to indicate that tame pasture provides relatively higher suitability wildlife habitat *compared to crop and hayland*—not relative to native plant communities. Tame pasture provides relatively lower habitat suitability compared to native plant communities for most wildlife species; however, tame pasture can provide suitable habitat for some wildlife species, such as deer or elk, as well as grassland bird species that are habitat generalists (e.g., vesper sparrow, savannah sparrow). It is expected that after reclamation, tame pasture will increase wildlife habitat suitability compared to crop and hayland, based on the reclamation seed mix, which will provide potential food sources and plant cover for various grassland-dependent wildlife species.

   The Project residual effects on change in habitat were considered in the determination of significance (see Volume 3A, Section 11.5), which states that with the application of mitigation and environmental protection measures, the residual environmental effects on wildlife are predicted to be not significant (i.e., the residual effects on change in habitat is unlikely to pose a long-term risk to the persistence or viability of a wildlife species in the RAA).

b. The assumption that some wildlife species use tame pasture is supported by the scientific literature related to habitat use of reclaimed areas or agricultural lands for various species. For example, savannah sparrow and other bird species (e.g., vesper sparrow) can breed in cultivated fields and lightly grazed pastures (Wheelwright and Rising 2008) and in reclaimed grasslands (Prescott and Murphy 1999). Pruvot et al. (2014) reported elk selected cattle pastures in southwestern Alberta depending on pasture and patch characteristics.

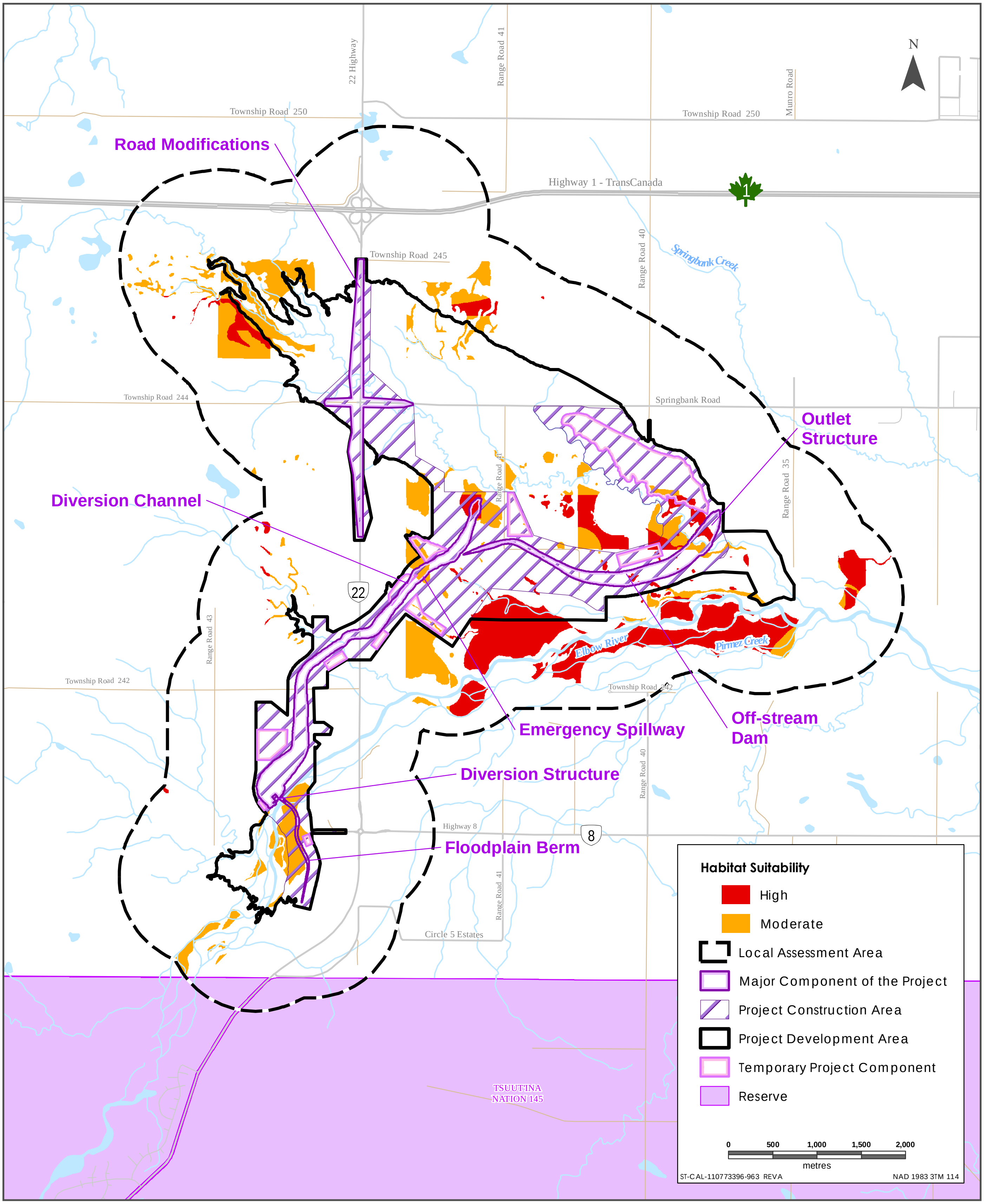
   The distribution of land cover types affected by the Project is provided in Volume 3A, Section 10, Figure 10-3. The relative value of each land cover type in the LAA to support wildlife is assessed as part of habitat suitability modelling. The habitat suitability modelling results for key indicator wildlife species are presented in the habitat suitability maps (see Volume 3A, Section 11, Figures 11-3 to 11-10). The potential loss or alteration of wildlife habitat is shown for each key wildlife indicator species where the Project construction area overlaps high, moderate, low or very low/nil habitat suitability classes and the area (ha) affected is provided in Volume 3A, Section 11.4.2, Table 11-13 and Table 11-16.

   Additional clarity regarding the locations of high and moderate suitability wildlife habitat for four key indicator species are provided in Figure 100-1 to Figure 100-5:

   - grizzly bear spring feeding habitat suitability
   - grizzly bear summer feeding habitat suitability
   - olive-sided flycatcher habitat suitability
   - northern leopard frog habitat suitability
   - sora habitat suitability

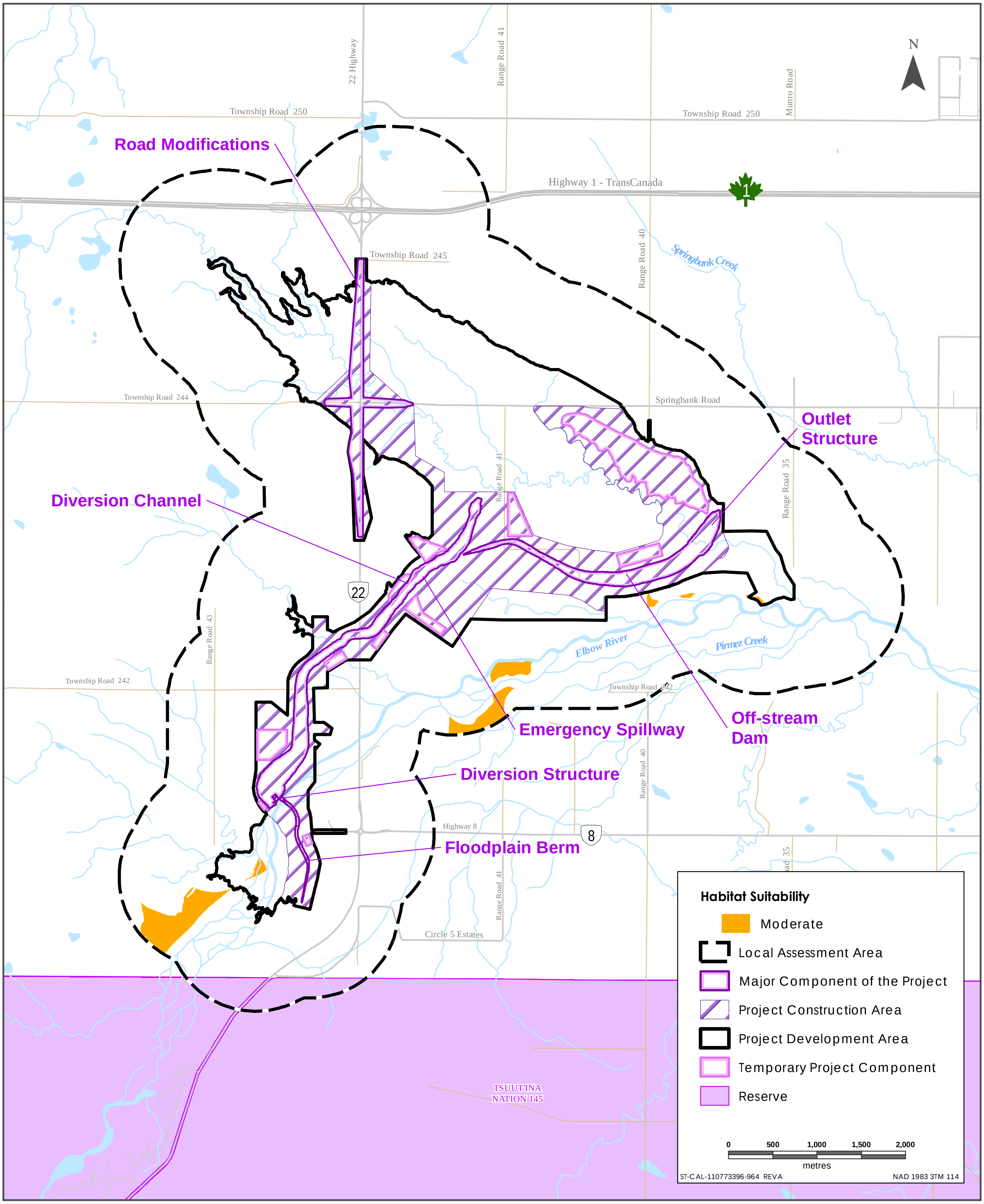
   The location of high and moderate suitability elk winter feeding habitat directly affected by the Project permanent structures is provided in the response to AEP Question 99, Figure 99-1. There is no high or moderate suitability breeding habitat for Sprague's pipit as described in Volume 3A, Section 11.2.2.4.

   During construction and dry operations, the Project will directly and indirectly affect habitat for key wildlife indicator species. However, direct habitat loss associated with permanent Project components is relatively small for grizzly bear (spring feeding habitat; see Figure 100-1), olive-sided flycatcher (Figure 100-3), northern leopard frog (Figure 100-4) and sora (Figure 100-5). The Project will not affect high or moderate suitability summer feeding habitat for grizzly bear (Figure 100-2). Most of the area affected is due to indirect loss associated with sensory disturbance and temporary losses within the construction area, such as temporary Project components (i.e., temporary workspaces), which will be reclaimed.



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

Grizzly Bear Spring Feeding Habitat Suitability in the LAA – Existing Conditions



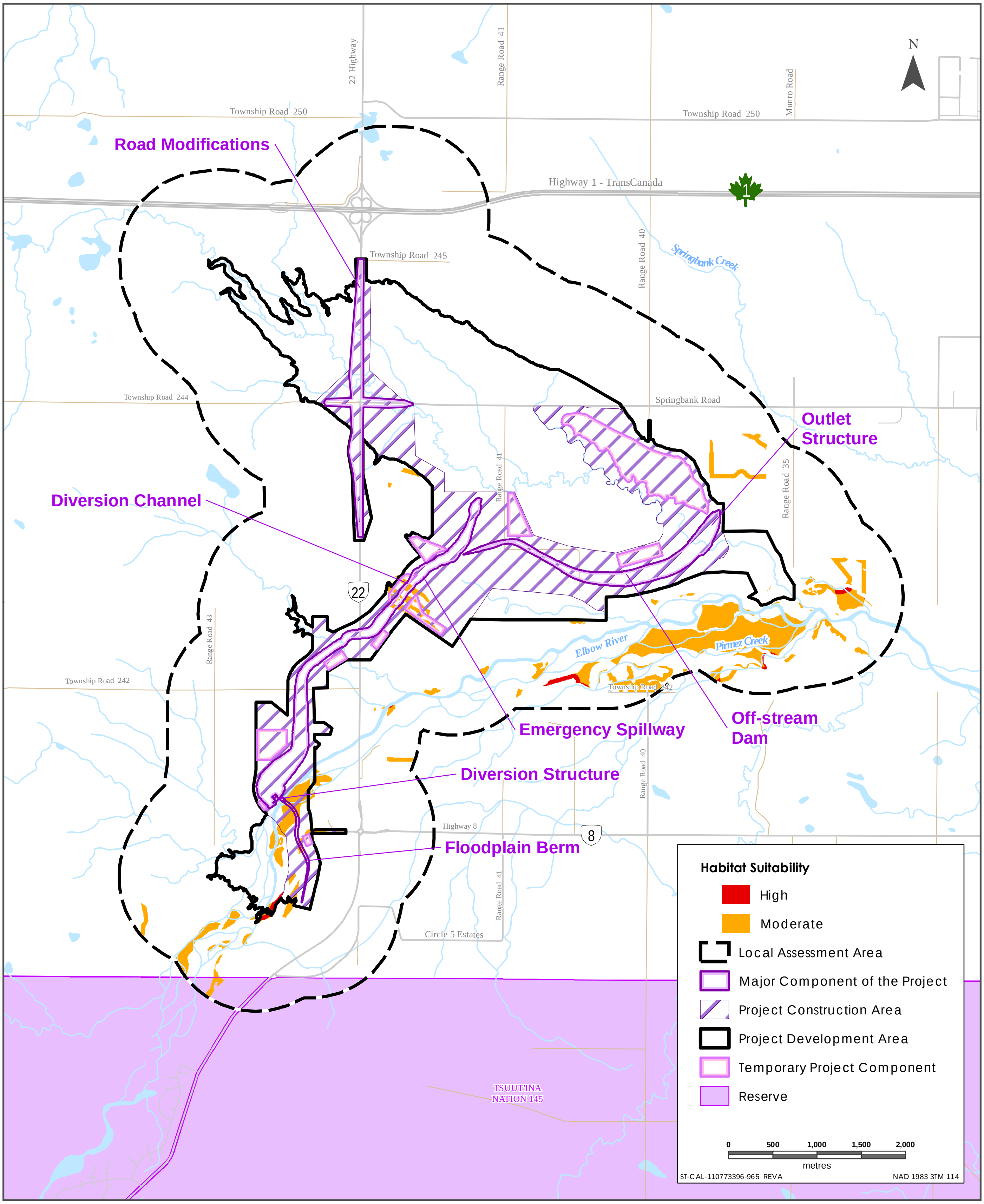
Sources: Base Data - Government of Alberta, Government of Canada, Thematic Data - Stantec Ltd.

Grizzly Bear Summer Feeding Habitat Suitability in the LAA – Existing Conditions

Stantec

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT

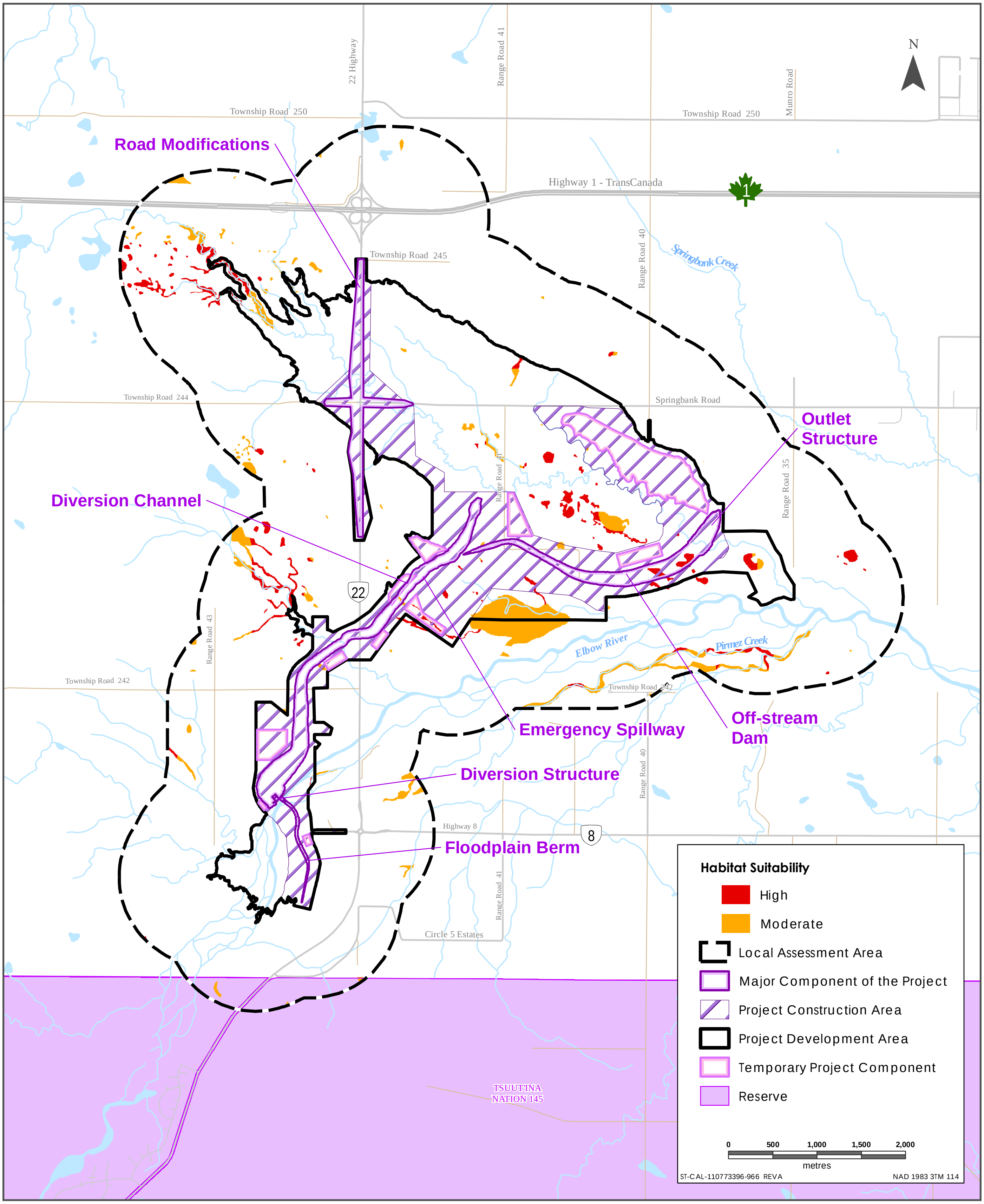
Figure 100-2



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

Olive-Sided Flycatcher Habitat Suitability in the LAA – Existing Conditions

Figure 100-3



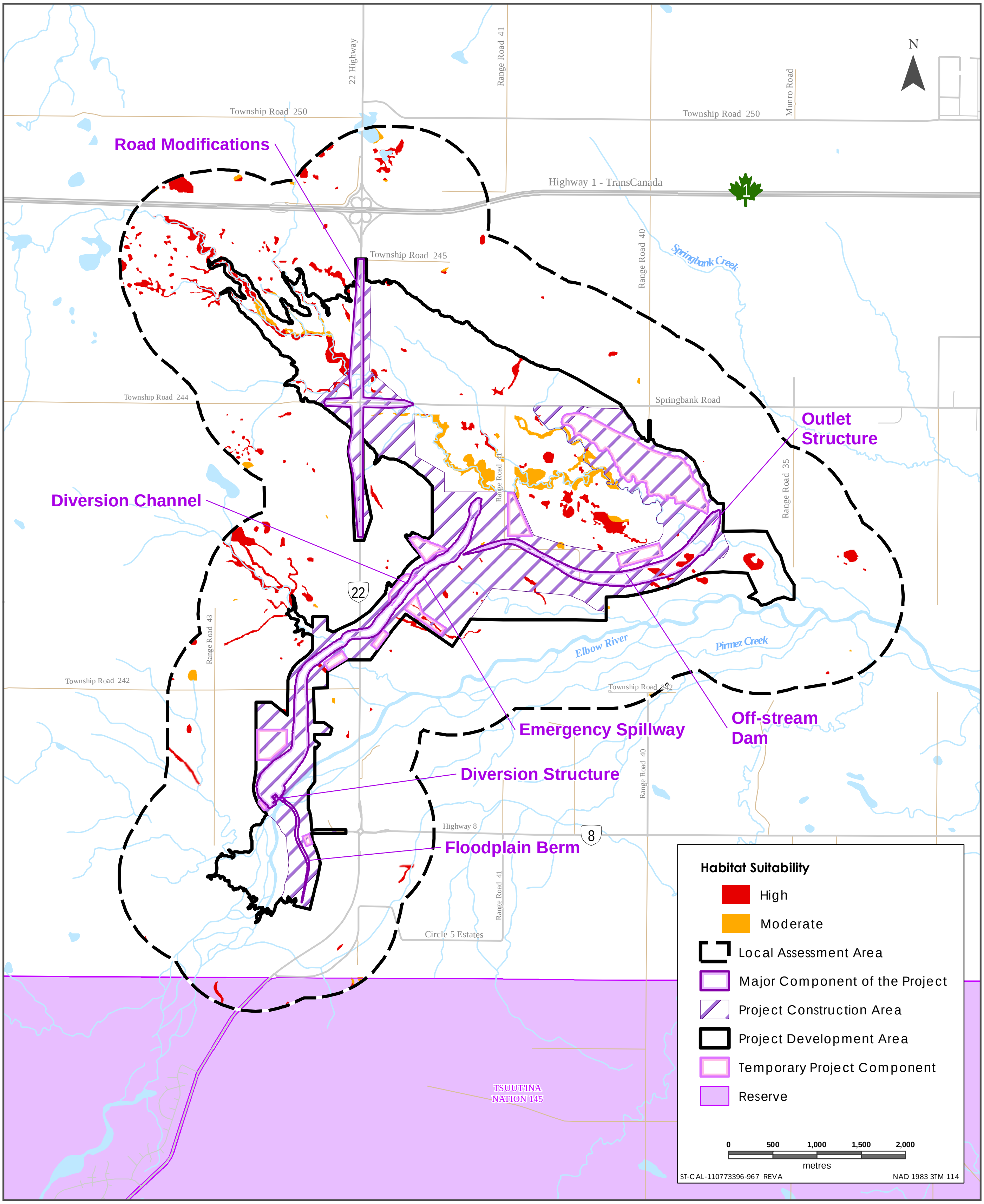
Sources: Base Data - Government of Alberta, Government of Canada, Thematic Data - Stantec Ltd.

Northern Leopard Frog Habitat Suitability in the LAA – Existing Conditions

Stantec

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT

Figure 100-4



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

Sora Habitat Suitability in the LAA – Existing Conditions

Stantec

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT

Figure 100-5

c. As described in the response to AEP Question 99, restoration of habitat is not proposed because of the complexity involved in restoring habitat to conditions present prior to disturbance. Instead, reclamation (stabilizing sites, controlling pollution, improving visual conditions and facilitation future land use) is favored over restoration in the reservoir.

   The Project revegetation plan has been developed to adaptively manage revegetation efforts, with the goal of revegetating high-quality areas with appropriate native seed mixes. There is greater likelihood of success with reclamation over restoration, and reclaimed areas will be supported by natural recovery, which is expected to occur over time. Hay and cropland areas will be reclaimed with the reclamation seed mix, which will provide potential food sources and plant cover for various grassland-dependent wildlife species. Alberta Transportation will consider recommended plant species by AEP to be included during reclamation to supplement natural re-vegetation of the area. These suggested plant species will be considered with those suggested by Indigenous groups.

REFERENCES

Prescott, D. R. C., and A. J. Murphy. 1999. Bird populations of seeded grasslands in the aspen parkland of Alberta. In Ecology and Conservation of Grassland Birds of the Western Hemisphere (P. D. Vickery and J. R. Herkert, Editors). Studies in Avian Biology 19:203-210.

Pruvot, M., D. Seidel, M.S. Boyce, M. Musiani, A. Massolo, S. Kutz, and K. Orsel. 2014. What attracts elk onto cattle pasture? Implications for inter-species disease transmission. P*reventative Medicine* 117: 326-339.

Wheelwright, N. T. and J. D. Rising. 2008. Savannah Sparrow (*Passerculus sandwichensis*), version 2.0. In the Birds of North America (A. F. Poole, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bna.45

Question 101

Supplemental Information Request 1, Question 421, Page 6.412

This response contradicts other sections of the EIA which acknowledge that sedimentation will destroy native communities and will require sediment removal and reseeding which cannot replace native grasslands.

Native seeding may not restore native grasslands and the statements made in reference to this may be misleading and misrepresenting regarding the assumed impacts to native habitat, habitat loss and replacement estimates.

a. Explain why Alberta Transportation does not acknowledge this loss and long term reduction in habitat values when native habitat is disturbed.

b. Explain if it is possible to increase the native grassland by 90.6 ha during dry operations if it is expected that some of this area will be modified, and cannot be restored, or may take decades to recover.

c. Explain these assumptions and clarify and correct the contradicting statements in the EIA.

d. Confirm that the methods used do not establish the confidence or ability to predict impacts. Explain why Alberta Transportation chose to limit its ability to inform this assessment.

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a. The assessment does acknowledge that during construction the Project will result in the alteration and loss of habitat including native grassland (see EIA, Volume 3A, Section 10.4.3; Volume 3B, Section 10.2.2; Volume 3A, Section 11.4.2.3, and Volume 3B, Section 11.3.2). The permanent and long-term loss of habitat, such as native grassland, will occur where there is overlap with permanent Project structures (e.g., diversion channel). However, reclamation of the construction area will result in changes that will vary. Grasslands are expected to re-establish within three years but resemble early seral communities for 12 years or more beyond construction. Tree and shrub communities will become grassland with trees and shrubs establishing naturally in time.

   The assessment also acknowledges that sediment deposition will reduce habitat suitability depending on sediment depth during post-flood operations (see Volume 3B, Section 11.3.2.3). Although this sediment deposition will temporarily reduce habitat suitability in the reservoir, it is expected these areas will be recolonized by vegetation from the surrounding area and seeded if revegetation targets are not met. Therefore, a long-term reduction in habitat value is not expected, especially for areas that receive less than 10 cm of sediment; however, areas that might receive deeper sediment (e.g., 10 cm to 100 cm or greater than 1 m) would require a longer recovery time for habitat to become suitable for wildlife. See the response to AEP Question 102 for details on expected vegetation recovery following floods.

   The assessment of post-flood operations incorrectly stated effects would be medium-term on vegetation and wetlands (Volume 3B, Section 10.2.5, Table 10-13) and short-term on wildlife and biodiversity (Volume 3B, Section 11.3.7, Table 11-7), sora (Volume 3B, Section 11.3.7, Table 11-9), and migratory birds (Volume 3B, Section 11.3.7, Table 11-11). However, based on the duration definition outlined in Volume 3B, Section 11.1.1.1, effects should have been listed as short-term (i.e., limited to flood operations) to long-term (i.e., extend beyond flood operations). Updated versions of Tables 10-13, 11-7, 11-9 and 11-11 are provided in Table 101-1 to Table 101-4 with the revisions highlighted in **red**.

Table 101-1 Project Residual Effects on Vegetation and Wetlands during Flood and Post-Flood Operations

Residual Effect	Residual Effects Characterization								
	Project Phase	Timing	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socio-economic Context
Change in Community Diversity	F/PF	N/A	A	L	PDA	**ST/LT**	S	R	D
Change in Species Diversity	F	N/A	A	M	PDA	LT	S	I	D
Change in Wetland Functions	F/PF	N/A	A	M	PDA	**ST/LT**	S	R	D

KEY
See Table 10-2 in Volume 3A of the EIA for detailed definitions

Project Phase
F: Flood Operation
PF: Post-flood Operation

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
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

Table 101-2 Project Residual Effects on Wildlife and Biodiversity during Flood and Post-Flood Operations

Residual Effect	Residual Effects Characterization								
	Project Phase	Timing	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socio-economic
Change in habitat	F	S	A	N-H	LAA	ST	IR	R	D
	PF	S/R	A	N-M	LAA	LT	IR	R	D
Change in movement	F	S	A	N-M	LAA	ST	IR	R	D
	PF	N/A	A	L-M	LAA	LT	IR	R	D
Change in mortality risk	F	S	A	N-M	PDA	ST	IR	R	D
	PF	S/R	A	N-M	RAA	LT	IR	R	D
Change in biodiversity	F	S	A	N	N/A	N/A	N/A	N/A	N/A
	PF	N/A	A	N	N/A	N/A	N/A	N/A	N/A
Change in wildlife health	F	S	A	N	N/A	N/A	N/A	N/A	N/A
	PF	N/A	A	N	N/A	N/A	N/A	N/A	N/A

KEY
See Table 11-5 in Volume 3A of the EIA for detailed definitions

Project Phase
F: Flood Operation
PF: Post-flood 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

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

N/A: Not applicable

Table 101-3 Project Residual Effects on Sora during Flood and Post-Flood Operations

Residual Effect	Residual Effects Characterization								
	Project Phase	Timing	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socio-economic Context
Change in habitat	F	S	A	H	LAA	ST	IR	R	D
	PF	S/R	A	M	LAA	LT	IR	R	D
Change in movement	F	N/A	A	L	LAA	ST	IR	R	D
	PF	N/A	A	L	LAA	LT	IR	R	D
Change in mortality risk	F	S	A	M	PDA	ST	IR	R	D
	PF	S/R	A	L	PDA	LT	IR	R	D
Change in wildlife health	F	S	A	N	N/A	N/A	N/A	N/A	N/A
	PF	N/A	A	N	N/A	N/A	N/A	N/A	N/A

KEY

See Table 11-5 in Volume 3A of the EIA for detailed definitions

Project Phase
F: Flood Operation
PF: Post-flood 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

Table 101-4 Project Residual Effects on Migratory Birds during Flood and Post-Flood Operations

Residual Effect	Residual Effects Characterization								
	Project Phase	Timing	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socio-economic Context
Change in habitat	F	S	A	L-M	LAA	ST	IR	R	D
	PF	S/R	A	L-M	LAA	**LT**	IR	R	D
Change in movement	F	N/A	A	L-M	LAA	ST	IR	R	D
	PF	N/A	A	L-M	LAA	**LT**	IR	R	D
Change in mortality risk	F	S	A	L-M	PDA	ST	IR	R	D
	PF	S/R	A	L	PDA	**LT**	IR	R	D
Change in wildlife health	F	S	A	N	N/A	N/A	N/A	N/A	N/A
	PF	N/A	A	N	N/A	N/A	N/A	N/A	N/A

KEY

See Table 11-5 in Volume 3A of the EIA for detailed definitions

Project Phase
F: Flood Operation
PF: Post-flood Operation

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
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

The determination of significance for vegetation and wetlands, as well as for wildlife and biodiversity, remains unchanged because although the duration of the effect might be long-term based on the estimated recovery time for areas that receive deeper sediment, the Project is still not expected to threaten the long-term persistence or viability of a plant species, community or wildlife species in the RAA. As discussed in the response to AEP Question 102, grassland communities should re-establish within three years, tree and shrub communities would be composed of 3 m tall trees and shorter shrubs about 10 years post-flood, 5 m tall trees about 20 years post-flood and 13 m tall trees about 50 years post-flood.

b. The analysis does not assume restoration of species composition to pre-disturbance, but it assumes areas will be reclaimed to a native grassland community dominated by native grasses and other native plant species, which will provide potential feeding habitat for ungulates (e.g., deer, elk). Volume 3A, Section 10, Table 10-12 shows an increase of 90.6 ha of native grassland following construction; much of this is the result of the removal of tree and shrub layers from forested and shrubland communities during construction and following floods. The areas are classed as native grassland because it is expected native grasses will be present or re-establish with proposed mitigation following construction and floods. Native species will be seeded where ground vegetation is below desired reclamation targets following construction or floods.

c. The EIA vegetation assessment and Alberta Transportation's response to Round 1 AEP IR421 do not contradict. Both documents identify a reduction in the area of forested and shrubland communities and changes in the abundance of native grassland. Existing native fescue grassland will be reduced by 8.9 ha following construction and native grassland area will increase by 90.6 ha due to the removal of trees and shrubs from forested and shrubland communities (Volume 3A, Section 10.4.3, Table 10-12 and Volume 3B, Section 10.2.2). Existing native communities affected by construction or floods are expected to remain as native communities following application of mitigation, including reclamation, although species composition may differ from pre-disturbance. Reclamation will target the re-establishment of native communities affected by construction and flood events (see Alberta Transportation's response to Round 1 AEP IR407, Appendix 407-1), which will provide potential feeding and nesting habitat for grassland dependent wildlife species. If native seeding alone cannot achieve reclamation targets in temporarily disturbed native communities then reclamation will be adjusted following an adaptive management approach. Tree and shrub species are expected to naturally re-establish in time following construction and flood events.

d. The methods used for the vegetation assessment and the wildlife assessment are in alignment with accepted environmental assessment methods in Alberta and are appropriate to predict Project residual effects. The ability to predict effects does not require the identification of all plant species that may establish in areas disturbed by the Project. As described above, vegetation is expected to establish with mitigation shortly after construction and flood events. A return of pre-disturbance communities is not expected; however, communities dominated by native plants will occur and these communities are expected to provide suitable habitat for wildlife. Prediction confidence is assessed as moderate for vegetation and moderate for wildlife (see Volume 3B, Section 10.4 and Volume 3B, Section 11.5 for flood and post-flood effects). Project mitigation (e.g., post construction and operation reclamation and monitoring, seed mix application, and adaptive management) are expected to promote the establishment of native vegetation communities following construction and floods. Effects are expected to be long-term for wildlife habitat as habitat features (e.g., cover and nesting tree and shrub communities) will occur over several years.

Question 102

Supplemental Information Request 1, Question 422, Page 6.144

The response indicates that reestablishment of habitat will take 10 years or longer. This long term impact has not been discussed in the EIA.

a. Explain the reduction in habitat values that are expected to persist >=10, 20, >50 years or longer. Provide a map to illustrate these areas in detail.

Response

This response was included in the May 15, 2020 filing. The text has not been changed but Figures 102-1, 102-2 and 102-3 have been inserted which we note were not included in the May 15, 2020 filing.

a. Changes in habitat values due to post-flood sediment deposition will depend on sediment depths within the reservoir, habitat type affected, and its relative value to specific wildlife species. As discussed in the EIA, Volume 3B, Section 10.2.2.3, tame pasture will be the most affected habitat type (69.5 ha) due to floods and sedimentation 10 cm or greater (see Volume 3B, Section 10.2.2.3, Table 10-11). Dominant species of the proposed agronomic seed mix, pubescent wheat grass (*Agropyron trichophorum*) and Dahurian wildrye (*Elymus dahuricus*), establish quickly (Tilley and St. John 2014; USDA 2018) and will likely provide ground cover within one growing season or sooner. Sheep fescue (*Festuca ovina*), another dominant plant of the agronomic seed mix, may require two to three years to mature (Ogle et al. 2010). These areas will provide potential feeding habitat for ungulates such as deer and elk and nesting habitat for grassland-dependent birds (e.g., savannah sparrow) in a relatively short time period. Therefore, effects of sediment deposition on habitat suitability values for these species are not expected to persist for greater than 10 years.

   Existing dominant grass and forb species are expected to disperse from surrounding areas or establish from the seedbank, rhizomes or root fragments. Smooth brome, a dominant grass of tame pasture areas of the PDA, reproduces by rhizomes, seed and tillers (Howard 1996b) and quackgrass, another dominant non-native grass of tame pasture area of the PDA, reproduces primarily by rhizomes, but also by seed (Snyder 1992). Smooth brome can be slow to establish (USDA 2006c) and quackgrass establishes quickly (USDA n.d); both species are expected to readily re-establish following floods and be abundant within two years following disturbance of tame pasture areas. Approximately 80 smooth brome plants per m^2 were observed within one year by Woodis and Jackson (2008) when lab grown, and Deutsch et al. (2010) observed percent cover increase by more than 400% within a year when grown in situ.

Buried native grass communities will likely establish shortly after flooding in reservoir areas with less than 10 cm of sediment and with seed mix application in areas of deeper sedimentation. Two of the seed mix species, slender wheatgrass (*Elymus trachycaulum*) and northern wheatgrass (*Agropyron dasystachyum*) establish and provide cover quickly (USDA 2006a, b) and other species, such as tufted hairgrass (*Deschampsia cespitosa*) typically establish within one to two years (USDA 2009). These areas will also provide potential feeding habitat for ungulates such as deer and elk and nesting habitat for grassland-dependent birds (e.g., savannah sparrow) likely within three years. Areas may, however, resemble earlier seral communities beyond 12 years after flooding. Late seral grassland communities have been observed 11 years to 12 years after minimal disturbance pipeline construction in southern Alberta (Lancaster et al. 2012); however, community alteration from the Project is expected to be higher magnitude and take longer to recover.

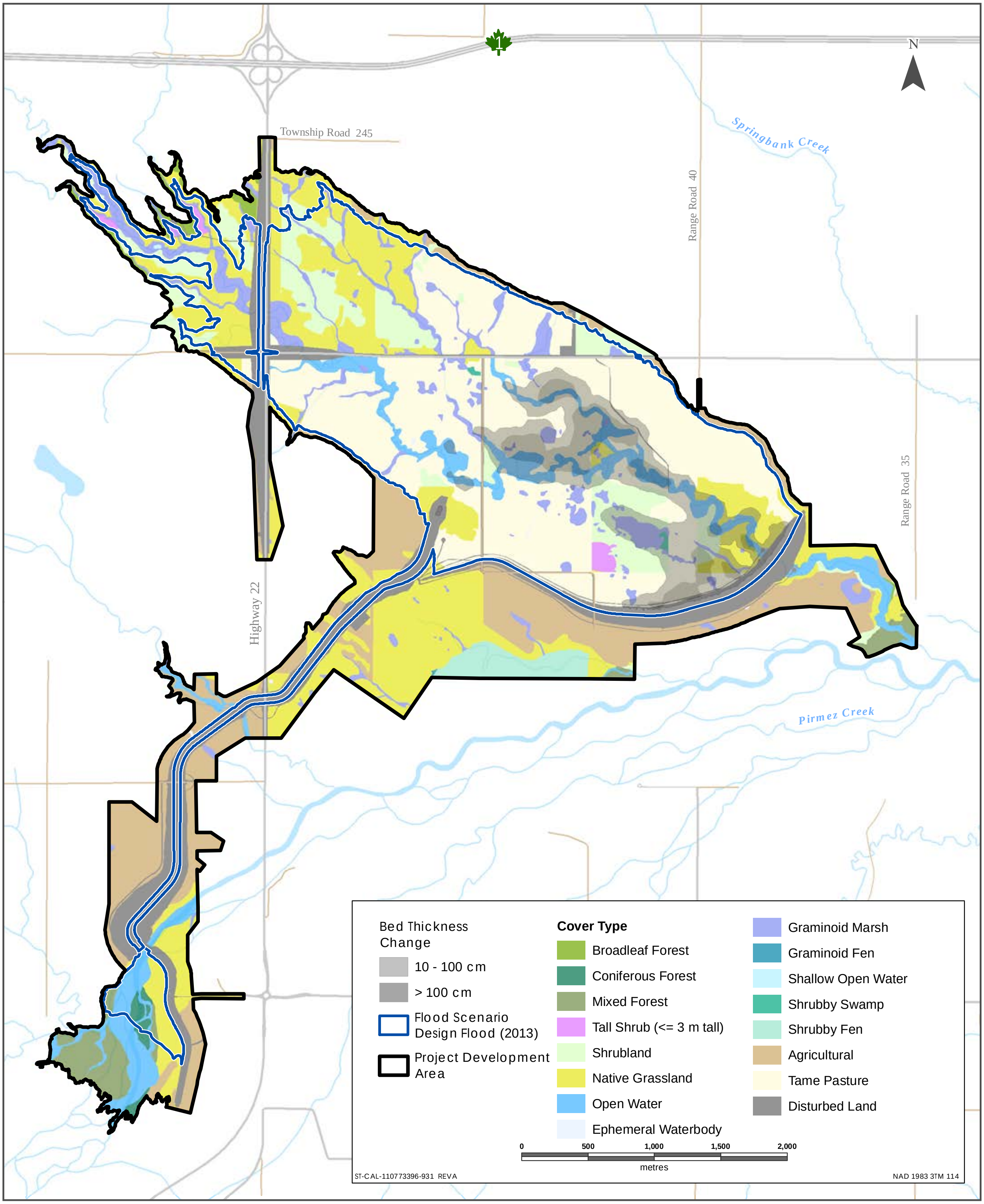
A reduction in shrub cover is expected following a 1:10 year flood, and shrub and tree cover following a 1:100 year flood and design flood. Snowberry (*Symphoricarpos occidentalis*), rose (*Rosa acicularis*), Bebb's willow (*Salix bebbiana*), and sandbar willow (*Salix exigua*) are dominant shrub species of potentially affected communities, and trembling aspen (*Populous tremuloides*) and balsam poplar (*Populous balsamifera*) are dominant tree species. These shrub and tree species regenerate primarily from buried rhizomes, roots or shoots (Tesky 1992; Crane 1990; Hauser 2007; Harris 1990; Howard 1996a; Anderson 2006) and are expected to quickly establish following floods if sediment depths are less than 10 cm. Areas that contain these shrub species will provide potential foraging habitat (i.e., browse) for ungulates, such as deer and elk, and security cover for various wildlife species, depending on shrub density.

Growth rates for all of the dominant tree and shrub species potentially affected by the Project were not identified from a literature review; however, snowberry can grow to a height of 9 cm to 18 cm in a single season (Hauser 2007) and readily regrows from rhizomes (McCarty 1967) and existing crowns (Romo et al. 1993). Aspen seedlings can grow up to 61 cm in a single growing season (Howard 1996a); however, average aspen growth rates are about 26 cm (Howard 1996a). Growth rates will vary in response to sediment depth (Frey et al. 2002), climatic conditions (Anyomi et al. 2012) and herbivory (Rhodes et al. 2018). Small stemmed trees and short shrubs are expected to establish in the first few years following floods with stands thinning within the first five to six years following a flood. Assuming a growth rate of 26 cm per year for aspen and balsam poplar, areas of complete tree loss would be composed of approximately 3 m tall trees and shorter shrubs about 10 years post-flood, 5 m tall trees about 20 years post-flood and 13 m tall trees about 50 years post-flood. In these areas, regenerating aspen and balsam poplar would provide potential nesting habitat for bird species associated with early seral aspen stands (Jarvi et al. 2018; Schieck and Song 2006; Hobson and Bayne 2000) and security cover for ungulates (e.g., deer, elk) in 10 to 20 years, depending on stem density (DeByle 1985). Tree and shrub re-establishment in areas with 10 cm or deeper sediment, will likely occur over a longer period and have lower densities. Because shrubs and trees will take relatively longer to re-establish in areas with 10 cm or deeper sediment, habitat suitability for wildlife species that use shrubs or trees for feeding or cover (e.g., deer, elk) or for nesting (e.g., alder flycatcher, least flycatcher, olive-sided flycatcher) will be reduced over a longer time period.

Wetlands are expected to persist following 1:10, 1:100 and design floods in areas with less than 10 cm of sediment, although plant composition may be altered. These areas will provide potential breeding and feeding habitat for wetland-dependent wildlife, such as waterfowl, waterbirds and amphibians. Shrubby swamps are expected to temporarily change to graminoid marshes following floods due to the loss of shrubs. Shrubs should re-establish naturally in less than 10 years because two of the dominant species, Bebb's willow and flat-leaved willow (*Salix planifolia*), reproduce rapidly by roots and seeds (Tesky 1992; Uchytil 1991). Information on the regeneration of basket willow (*Salix petiolaris*), another dominant shrub, was not found.

Sediment depths greater than 10 cm are expected to result in the loss of grasses, forbs and short shrubs. Grasses, sedges, forbs and shrubs are expected to re-establish in less than 10 years, provided post-flood topography supports wetland conditions, but cover may be lower than areas of shallower sediment. Dominant wetland sedges in the reservoir include water sedge (*Carex aquatilis*) and woolly sedge (*Carex pellita*) and common grasses include tufted hair grass (*Deschampsia cespitosa*) and Kentucky bluegrass (*Poa pratensis*). Water sedge and woolly sedge reproduce by seed and rhizome, and readily colonize disturbed areas (Hauser 2006; Flora of North America n.d.). Tufted hair grass and Kentucky bluegrass also frequently occur on disturbed sites (Walsh 1995; Uchytil 1993). New wetlands may also naturally establish in areas of suitable topography.

Overall, a reduction in habitat value that will persist for more than 10 years will only occur in areas that contain shrub and treed habitat. Habitat suitability for specific wildlife species will return to suitable conditions as succession progresses over the short and long-term. As described in the response to AEP Question 99a, restoration of these areas to conditions identical to those prior to disturbance is not proposed. Changes in vegetation cover due to flooding and sedimentation ten years, 20 years and 50 years after a design flood are shown in Figures 102-1, 102-2 and 102-3. Vegetation pre-design flood equals conditions established immediately following Project construction (i.e., forested and shrubland communities intersected by construction area are converted to native grassland). Wetland abundance in areas of 10 cm or greater sediment may also be different than displayed due to changes in topography post design flood.



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

Vegetation and Wetlands in the PDA Ten Years Post Design Flood

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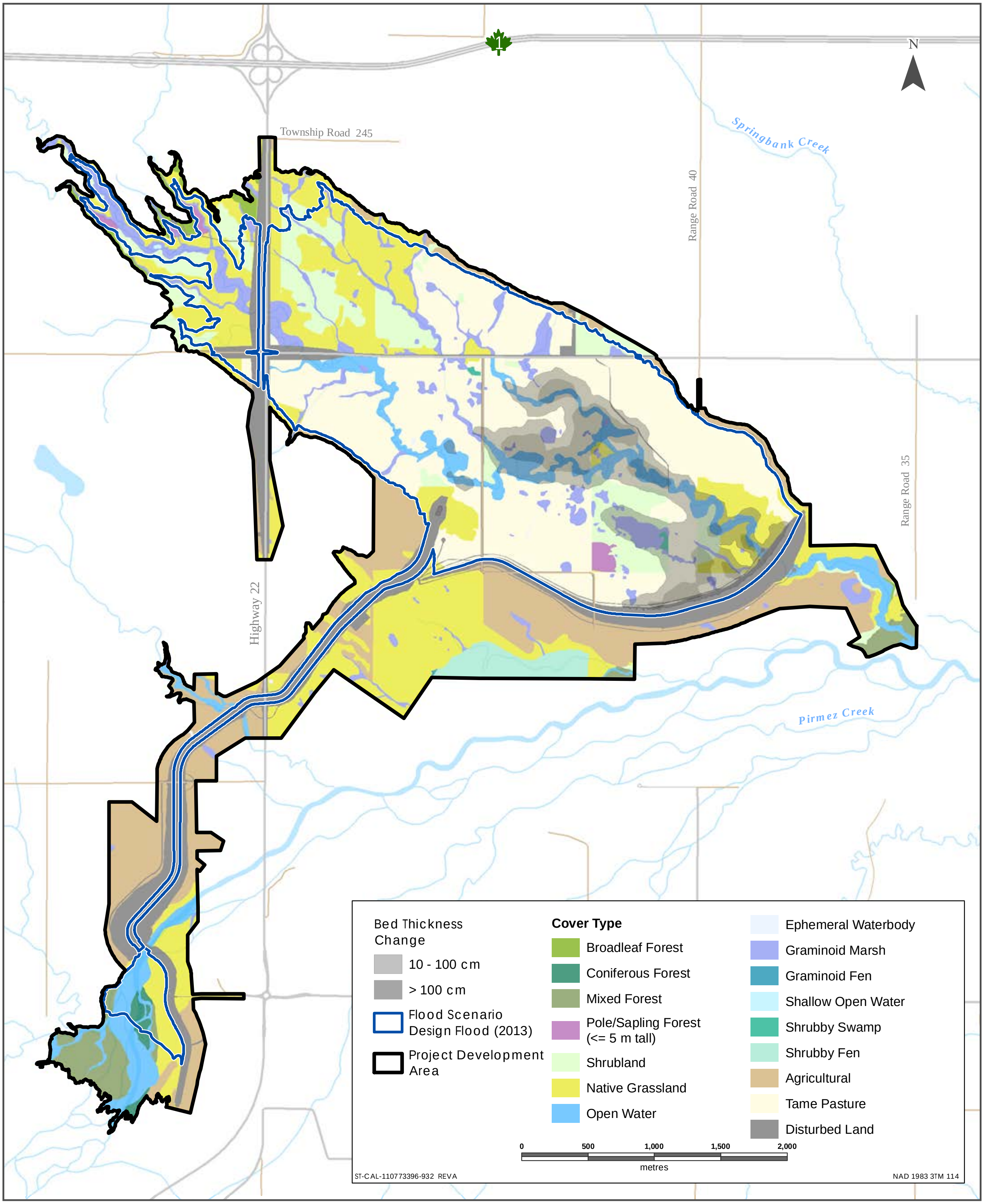
ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT

Figure 102-1



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

Vegetation and Wetlands in the PDA Twenty Years Post Design Flood

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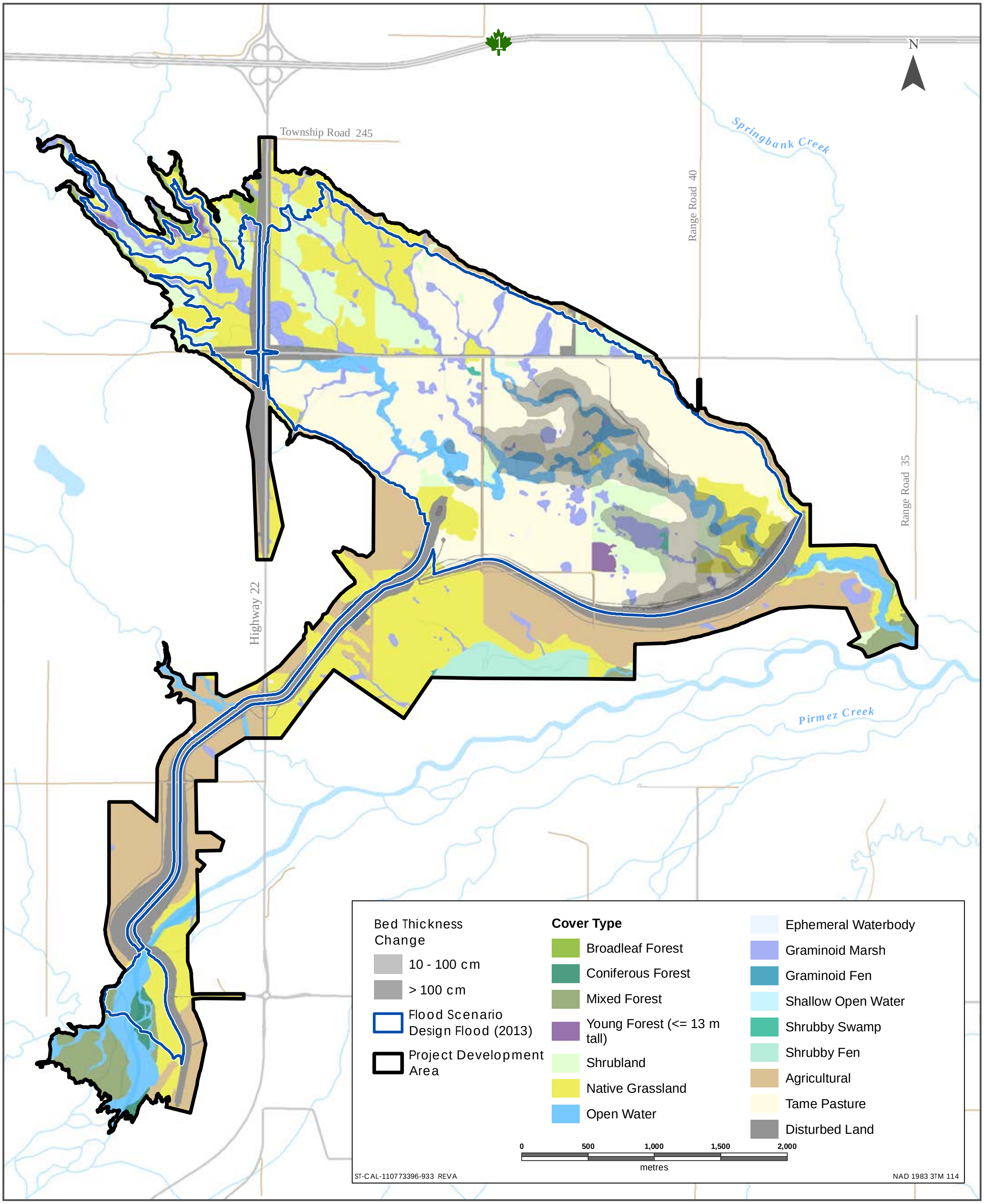
ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT

Figure 102-2



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

Vegetation and Wetlands in the PDA Fifty Years or Longer Post Design Flood

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Figure 102-3

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Question 103

Supplemental Information Request 1, Question 423, Page 6.145

Alberta Transportation states *Long-term changes in habitat conditions, such as scouring, plant cover, woody debris, supporting habitat functions (e.g., food sources, shelter), and health in downstream habitat are therefore also not expected to change in a meaningful way*.

a. Explain how limiting the Elbow River flow downstream of the diversion structure to 160m3/s will influence riparian habitat health downstream of the diversion channel to the Glenmore Reservoir and beyond.

b. Provide a map of the riparian habitat expected to receive and not receive overland flooding at 160, 200, 250, and 300 m3 flow rates. Explain how this modification of flow will affect the riparian health and function of affected wildlife habitat downstream of the project area to the distance expected to be influenced.

c. Explain in detail how something can change but not in a meaningful way. Define the term "meaningful" in both relative and absolute terms and provide examples to illustrate this as it relates to the question.

Response

a. ***RIPARIAN HEALTH***

Riparian health is the ability of a reach of stream, or an entire stream or a watershed composed of many streams, to perform several key ecological functions (Fitch et al. 2009):

- trap sediment
- build and maintain streambanks
- store flood water and energy
- recharge the aquifer
- filter and buffer water
- reduce and dissipate stream energy

- maintain biodiversity
- create primary productivity

Cottonwood (*Populus* spp.) trees are the dominant riparian tree found along alluvial floodplains (Braatne et al. 1996). Riparian cottonwoods support riparian health by contributing large woody debris, which creates diversity in aquatic habitats as well as providing food resources (e.g., insects) as well as nesting and perching sites for several bird species (Wilding et al. 2014; ACA and ASRD 2015; Hauer et al. 2016). In Alberta, 72% of birds found in cottonwood forests depend exclusively on these tree stands for survival (ACA and ASRD 2015). In addition, floodplain forests provide important winter habitat (i.e., food and cover) for ungulates such as elk (*Cervus canadensis*), moose (*Alces alces*), and deer (*Odocoileus* spp.) (ACA and ASRD 2015; Hauer et al. 2016). They also provide key habitats for large carnivores such as wolf (*Canis lupus*), grizzly bear (*Ursus arctos*) and cougar (*Puma concolor*) (Hauer et al. 2016).

Seasonal flooding maintains the health of riparian ecosystems by providing disturbance within a channel system and by providing water, sediment and nutrients (Peters et al. 2016). Specifically, riparian trees (e.g., cottonwood, balsam poplar) and shrubs (e.g., willow) are dependent on dynamic river flows and periodic floods to create conditions favorable for reproduction and recruitment (Rood et al. 2003; Peters et al. 2016). Changes in river flows due to natural causes (e.g., climate change) or anthropogenic development (e.g., dams) can affect structure and function of riparian communities (e.g., cottonwood forests), which provide diverse and important wildlife habitats (Poff et al. 1997; Rood et al. 2003; Rood et al. 2005; Rood et al. 2016; Peters et al. 2016). Regulated river flows such as those that occur on dammed rivers can affect riparian cottonwood forests by reducing the magnitude of peak flows that create newly exposed sediment necessary for seedling establishment and by releasing very low flows later in the summer, which can result in drought stress and potential mortality of mature cottonwood trees (Rood et al. 2003; Foster et al. 2018).

PROJECT OPERATIONS

The Project diverts up to 600 m^3/s from any flood that has a flow rate greater than 160 m^3/s. The Project holds this diverted flood water and releases it slowly through the dam's low-level outlet once the risk of flooding has passed. For early release, water begins to leave the reservoir after flows in Elbow River have dropped below 160 m^3/s.

FLOOD FREQUENCY AND RESIDUAL DOWNSTREAM FLOODING

A flow of 160 m^3/s is approximately a one in seven-year flood. Natural cottonwood recruitment appears to be associated with a one in five to one in ten-year flood (Mahoney and Rood 1998). Many of the key hydrological processes that maintain riparian health along Elbow River, while altered, will continue to occur.

The Project is designed to mitigate extreme flood events; therefore, the very high flow rates that occurred during the 2013 flood (peak of 1,240 m^3/s and return period of over 1 in 200-years) would have been reduced to approximately a 1 in 50 year flood with a peak of 640 m^3/s between the diversion structure and Glenmore Reservoir. Glenmore Reservoir's allocated storage would then reduce flows downstream of it to 160 m^3/s.

Reducing flood peaks in this manner will reduce the extent of bank erosion, channel migration, floodplain avulsions and other floodplain processes, which could affect riparian areas; but, the hydrologic regime of the water that will continue to flow downstream of the diversion structure during a flood will allow the seasonal flooding of riparian areas, with the potential for geomorphic change in these areas from intermittent large flood events. Overall, the Project's operations will likely be adequate to maintain riparian health along Elbow River. A detailed rationale for this conclusion is provided below.

EFFECTS ON RIPARIAN HABITAT FROM THE PROJECT

The literature's findings on flow regulation need to be interpreted relative to the Project's proposed operations because most studies were completed on watercourses regulated for both water supply and flood control, or solely water supply. Water supply reservoirs, like the Oldman Reservoir, need to establish and maintain a permanent pool for water supply or recreation. This type of reservoir can alter the flow regime of a watercourse year-round, every year, which is not the operational case for the off-stream reservoir. The Project only alters the hydrologic regime for flood events exceeding 160 m^3/s. If the Project had been in place since 2013, it would not have had any effect on the natural freshet processes and riparian flooding on Elbow River between July 2013 and May 2020.

Although the Project will result in lower flow rates downstream of the diversion structure during operation, which will result in a reduction in extreme peak flows that typically provide new sediment for cottonwood seedlings, flow rates in Elbow River downstream of the diversion structure are expected to provide adequate disturbance and water levels to maintain riparian ecosystems. As discussed in response to NRCB Question 14, a flow rate of 160 m^3/s does allow some inundation of riparian areas and channel maintenance processes.

Many documented instances of riparian cottonwood decline have been associated with water supply storage where minimum base flows have lowered the riparian water table (Clipperton et al. 2003). The release of retained floodwater will serve to raise and sustain the receding limb of the flood hydrograph at a stage when some floodplain flooding is still present and will ultimately result in sustained bankfull flows following a large flood and as the natural flood hydrograph continues to recede.

Stromberg and Patten (1990, 1991, 1996) have suggested that 40% to 60% of natural stream flow is necessary for healthy tree canopies and 74% to 313% of long-term average annual flows are needed for maximum growth. Flows beyond bankfull threshold may be especially valuable to cottonwoods and a model developed by Richter and Richter (2000) suggests that 125% of bankfull discharge is instrumental in driving channel processes that support the long-term survival of cottonwood forests. Bovee and Scott (2002) recommend a flow slightly greater than bankfull to balance flows that support riparian cottonwood seedling recruitment while meeting flood control objectives. Baseflow is increased (i.e., greater than 100% of natural flow on the receding limb) suggesting that Project operations have the potential to increase growth of cottonwood trees in the riparian areas.

Overall, flow rates downstream of the diversion structure are expected to be adequate for survival and maintenance as well as growth and development of cottonwoods in other riparian ecosystems in southern Alberta (Clipperton et al. 2003).

b. Figures 103-1a to 103-1i depicts areas predicted to receive overland flooding during the four flow rates of 160 m^3/s, 200 m^3/s, 250 m^3/s, and 300 m^3/s.

The results of the inundation modelling indicate that, without the Project, there will be an estimated 130.4 ha, 152.4 ha, 179.3 ha and 209.8 ha of riparian habitat inundated during the four flow rates, respectively (Table 103-1, Figure 103-2). During Project operations, diversion of flood waters will reduce the amount (ha) of riparian habitat inundated by 22 ha, 48.9 ha and 79.4 ha compared to baseline conditions (i.e., without diversion) for 200 m^3/s, 250 m^3/s, and 300 m^3/s flow rates, respectively.

Table 103-1 A Comparison of Estimated Riparian Habitat (ha) Inundated Without Project Diversion and With Project Diversion

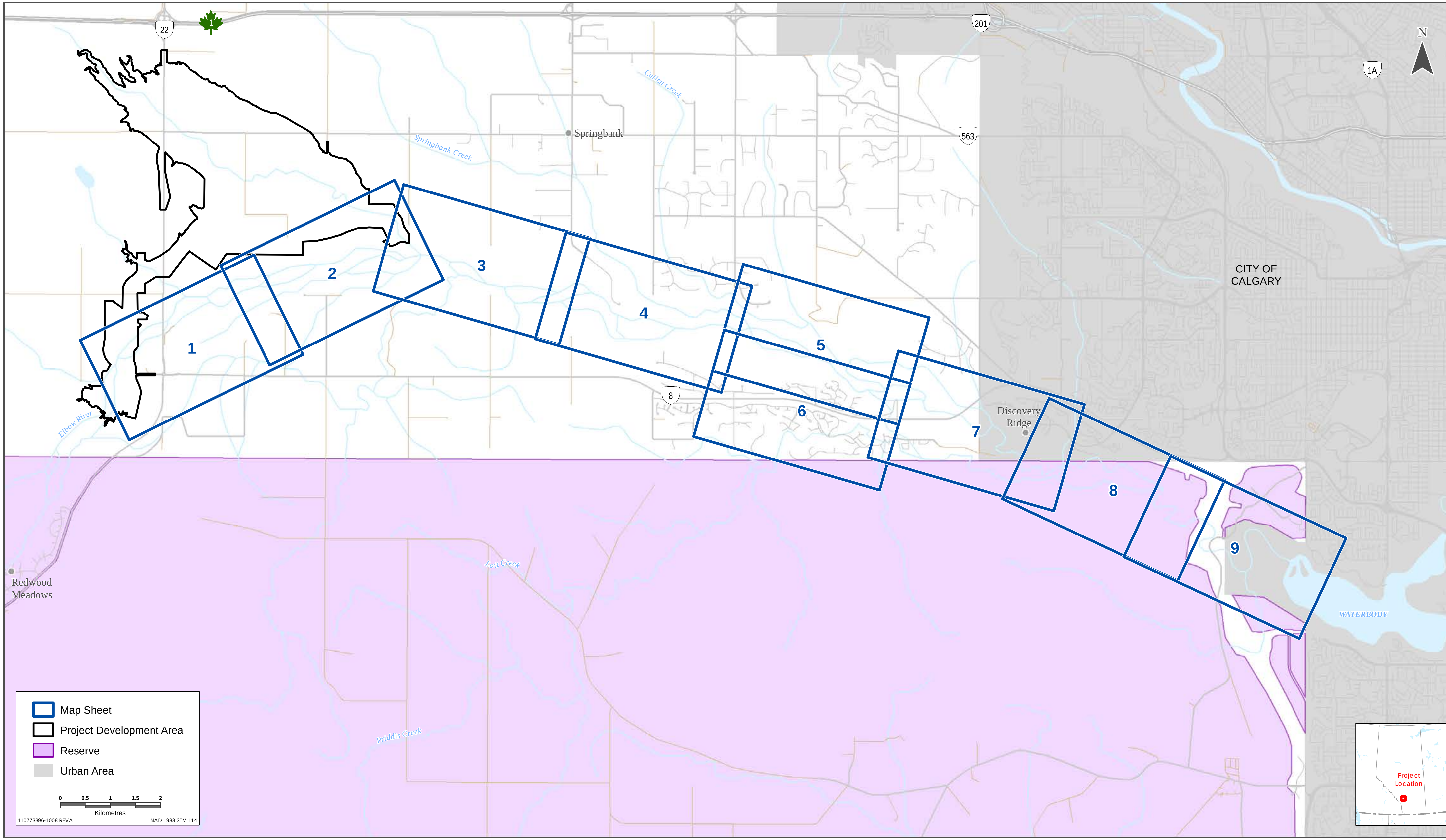
Without Diversion		With Diversion		
Flow Rate (m^3/s)	**Riparian Habitat Inundated (ha)[a]**	**Flow Rate Diverted (m^3/s)**	**Change in Riparian Habitat Inundated (ha)**	**Percent Change in Riparian Habitat Inundated (%)**
160	130.4	0	0	0.0
200	152.4	40	-22.0	-14.4
250	179.3	90	-48.9	-27.3
300	209.8	140	-79.4	-37.8

NOTE:
Riparian habitat estimated using the following land cover types: lotic (coniferous), lotic (deciduous), lotic (herbaceous), and lotic (shrub). See Volume 3A, Section 10.2.

During Project operations (and flow rates exceeding 160 m^3/s), the modified flow rate will result in fewer hectares of riparian habitat being inundated along Elbow River. However, as shown in Table 103-1 and Figure 103-2, the changes are relatively small compared to areas inundated without the Project, especially at lower flow rates. At higher flow rates (e.g., 300 m^3/s), there is a further reduction in riparian area inundated, especially in areas farthest from the main channel and side channels (see Figure 103-1a to 103-1i and response to NRCB Question 14). However, retention of water in the off-stream reservoir during diverted floods will reduce peak flows but will not reduce the occurrence of floods, which will continue to maintain wildlife habitat downstream of the diversion structure. Moreover, as discussed in response to NRCB Question 49, a moderate magnitude flood with recurrences of one in five to one in ten years has been reported to provide suitable conditions for cottonwood tree recruitment, which contributes to the maintenance of riparian habitat (Mahoney and Rood 1998).

Overall, the relatively small areas affected combined with the flow rates expected to continue during operations are not expected to substantially affect riparian structure and function downstream of the Project. The extent to which these estimated changes affect the availability of wildlife habitat depend on the magnitude (i.e., flow rates) of a flood in the future and the timing, frequency and duration of those floods. However, it is recognized, as discussed in response to NRCB Question 14a, that the geomorphology of Elbow River may simplify over time due to the reduction of peak flows, and the frequency and magnitude of overbank deposition will be reduced as inundation of the floodplain decreases.

Although there might be less riparian habitat inundated in a given year with the Project, riparian cottonwoods can reproduce asexually (clonal propagation) and these areas will remain hydrologically linked to the alluvial water table (Braatne et al. 1996); therefore, they will likely continue to provide suitable wildlife habitat within riparian areas.



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

Location and Extent of Riparian Habitat Inundated along Elbow River for Four Flow Rates, **Map 1**

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ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT

Figure 103-1

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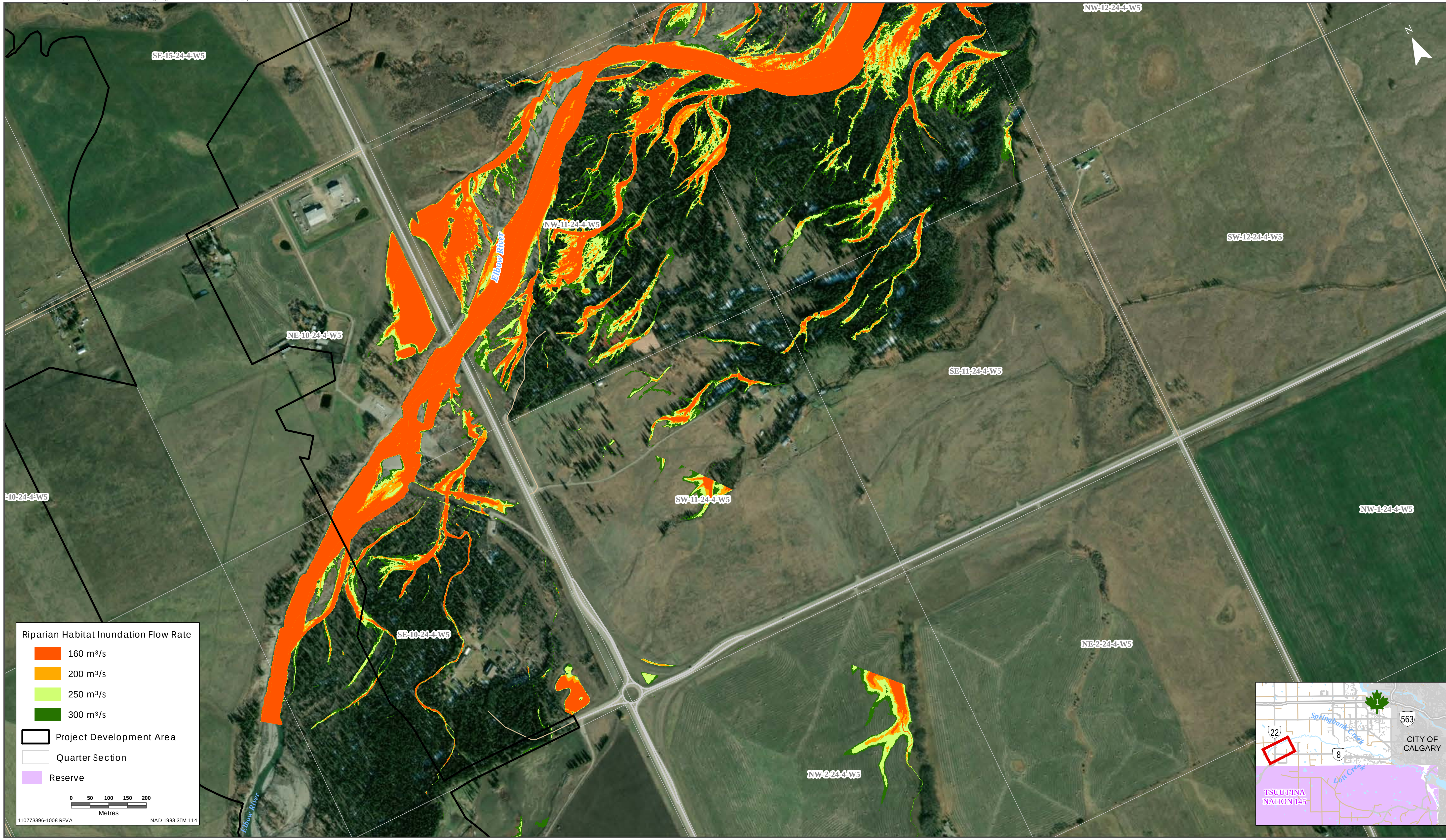

Sources: Base Data - Government of Alberta, Government of Canada. Thematic Data - Stantec Ltd.
Imagery: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Location and Extent of Riparian Habitat Inundated along Elbow River for Four Flow Rates, **Map 2**

Stantec

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESEVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT

Figure 103-1a

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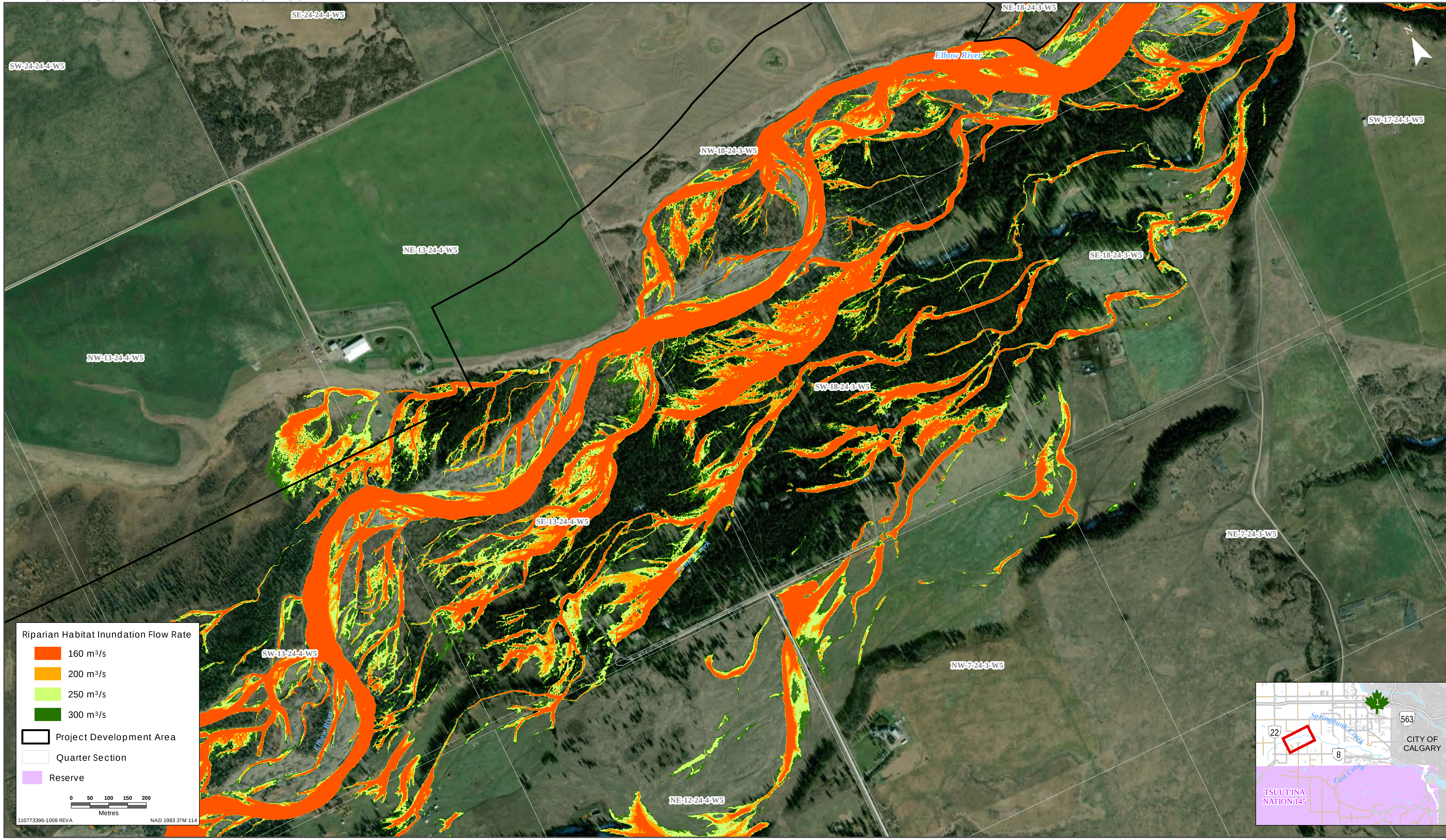

Sources: Base Data - Government of Alberta, Government of Canada. Thematic Data - Stantec Ltd.
Imagery: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Location and Extent of Riparian Habitat Inundated along Elbow River for Four Flow Rates, **Map 3**

Stantec

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESEVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT

Figure 103-1b

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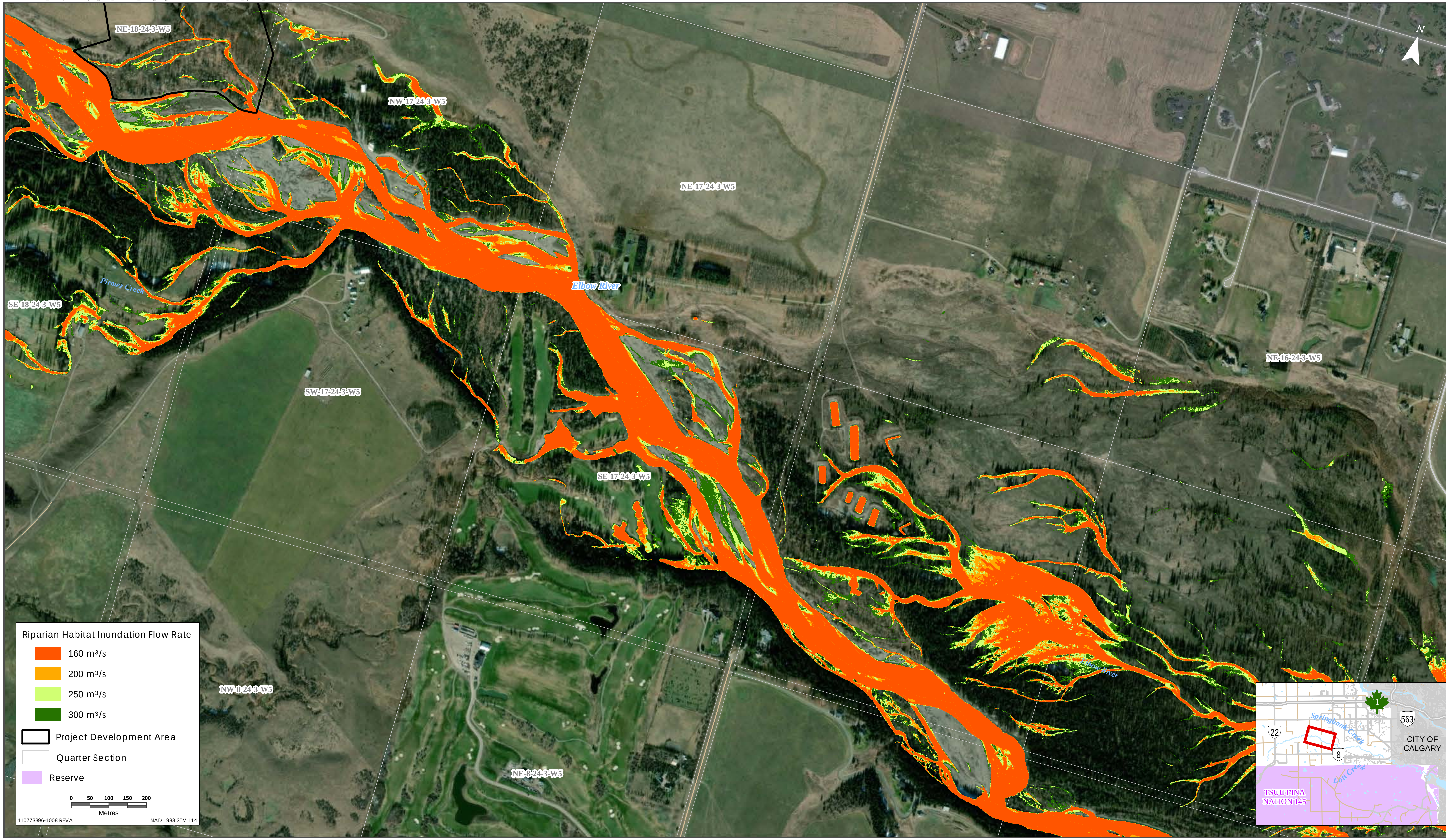

Sources: Base Data - Government of Alberta, Government of Canada. Thematic Data - Stantec Ltd.
Imagery: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Location and Extent of Riparian Habitat Inundated along Elbow River for Four Flow Rates, **Map 4**

Stantec

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESEVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT

Figure 103-1c

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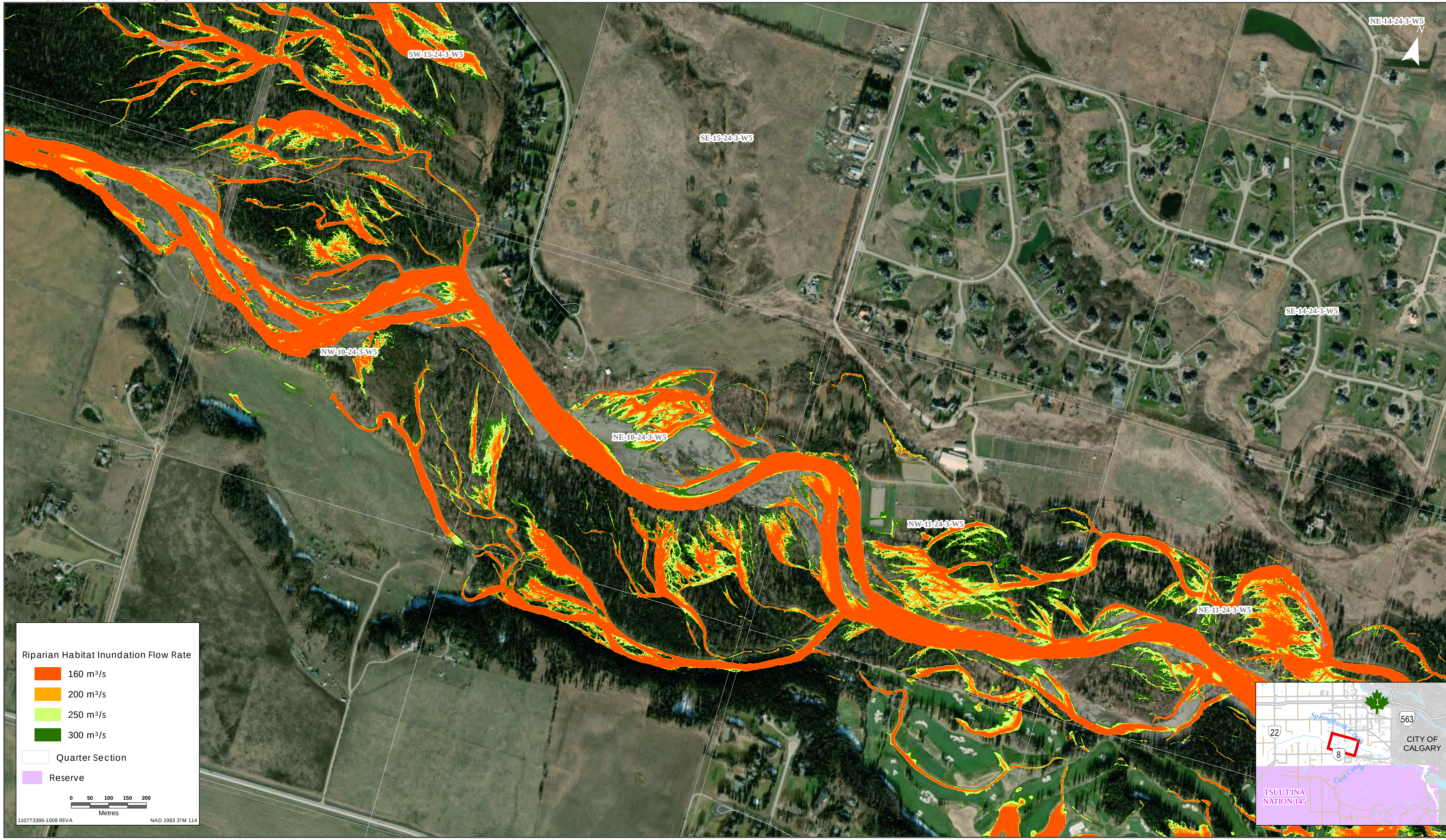

Sources: Base Data - Government of Alberta, Government of Canada. Thematic Data - Stantec Ltd.
Imagery: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Location and Extent of Riparian Habitat Inundated along Elbow River for Four Flow Rates, **Map 5**

Stantec

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESEVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT

Figure 103-1d

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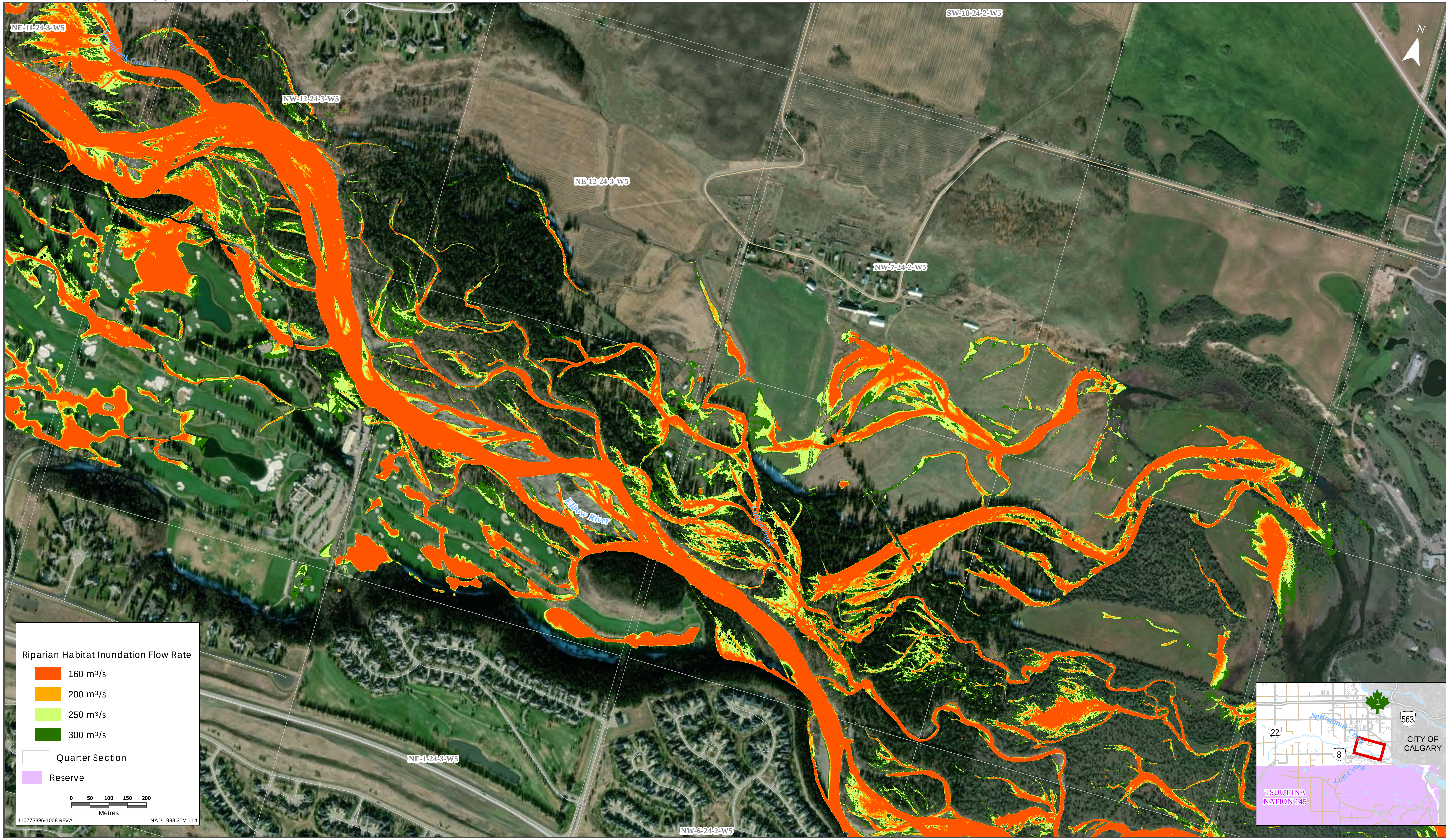

Sources: Base Data- Government of Alberta, Government of Canada. Thematic Data - Stantec Ltd.
Imagery: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Location and Extent of Riparian Habitat Inundated along Elbow River for Four Flow Rates, **Map 6**

Stantec

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESEVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT

Figure 103-1e

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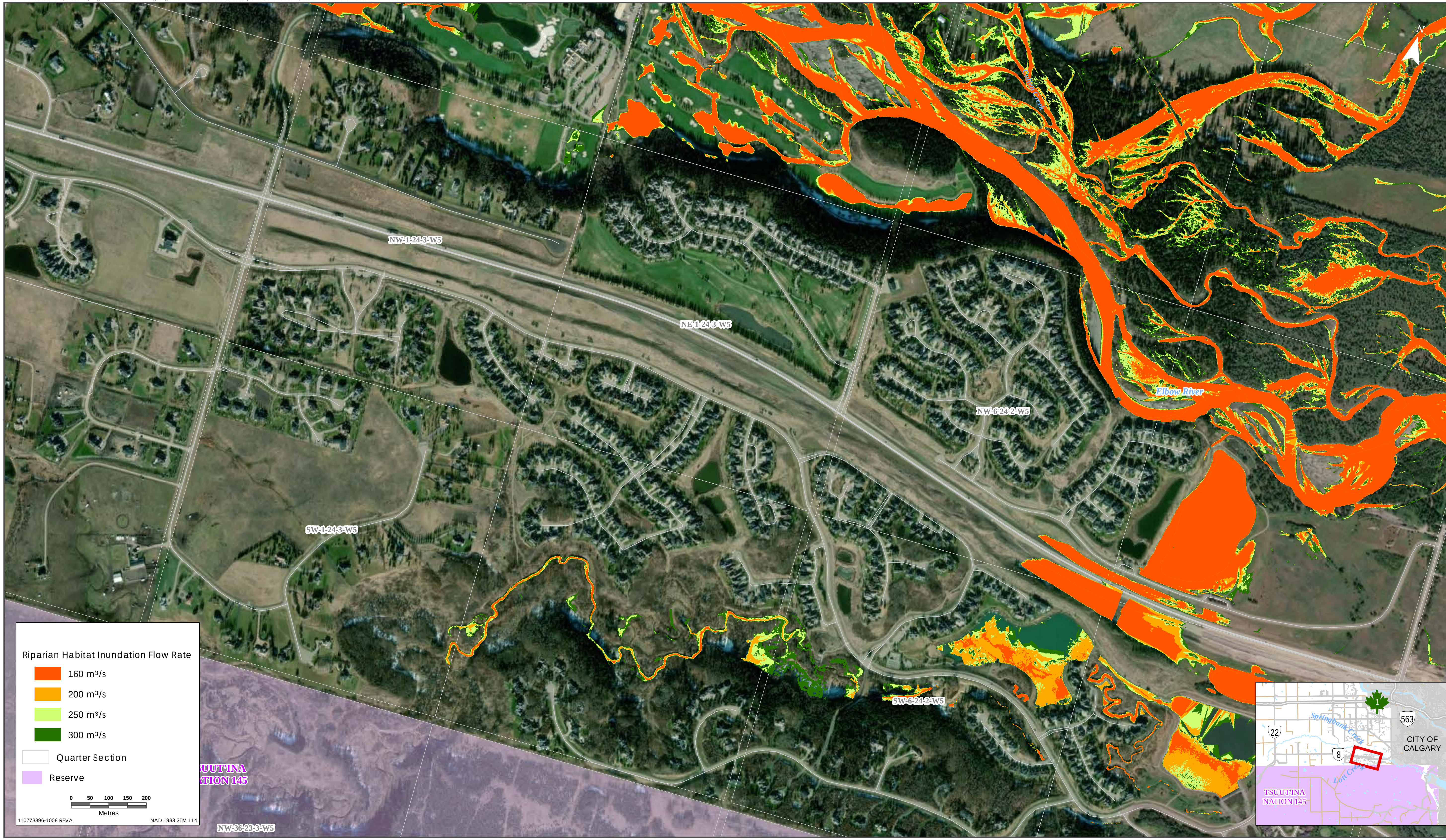

Sources: Base Data - Government of Alberta, Government of Canada. Thematic Data - Stantec Ltd.
Imagery: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Location and Extent of Riparian Habitat Inundated along Elbow River for Four Flow Rates, **Map 7**

Stantec

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESEVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT

Figure 103-1f

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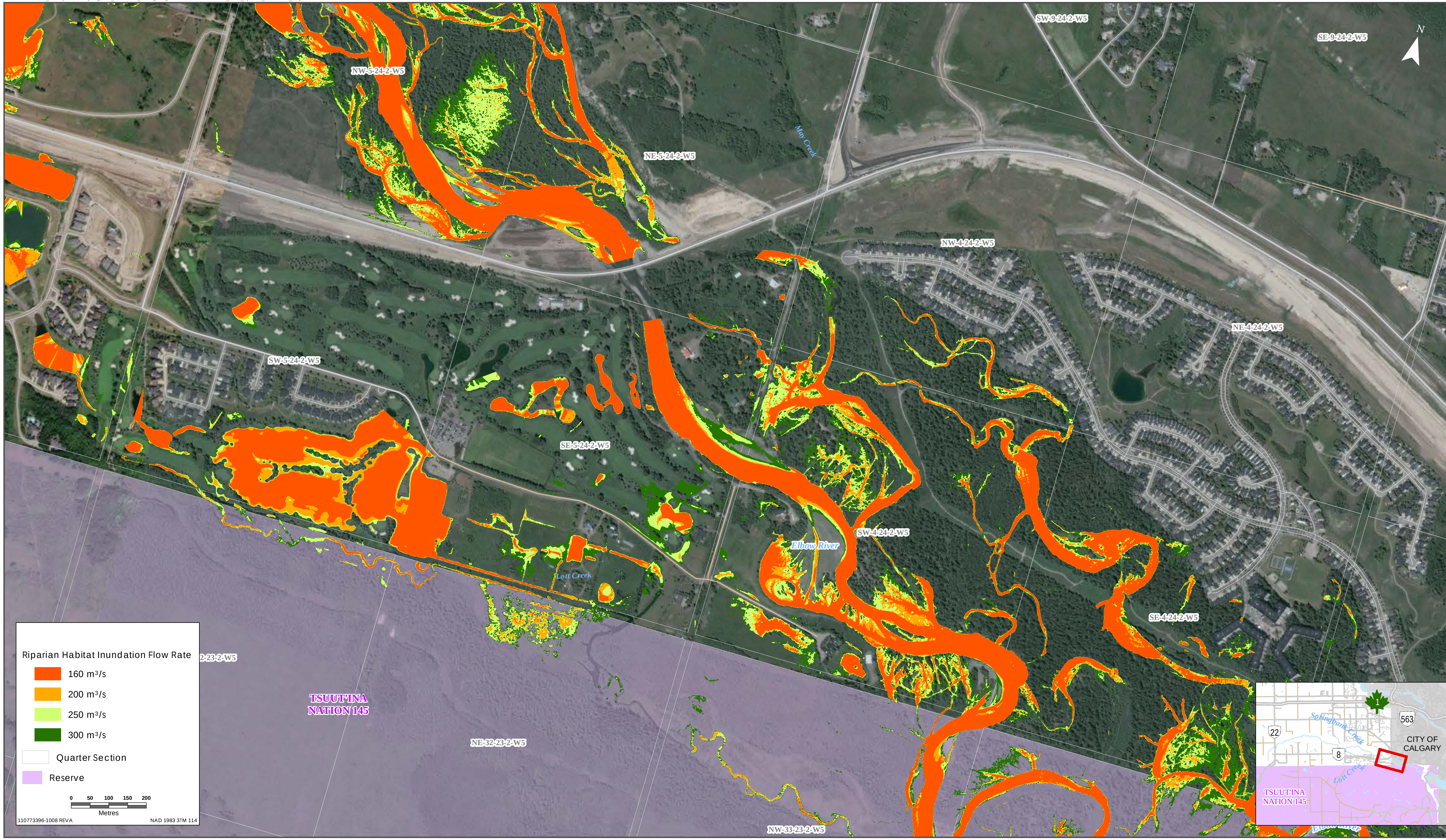

Sources: Base Data - Government of Alberta, Government of Canada. Thematic Data - Stantec Ltd.
Imagery: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Location and Extent of Riparian Habitat Inundated along Elbow River for Four Flow Rates, **Map 8**

Stantec

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESEVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT

Figure 103-1g

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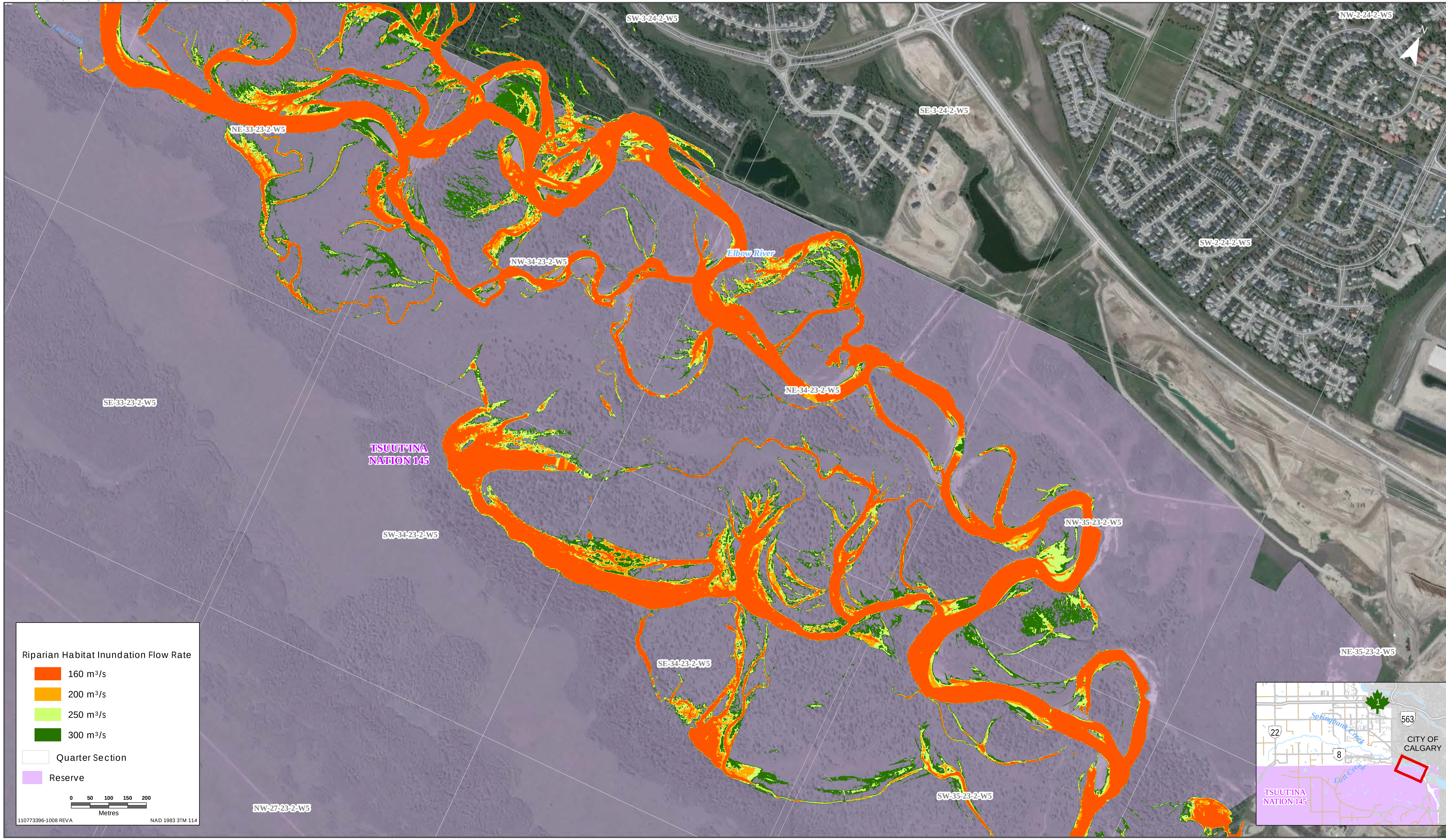

Sources: Base Data- Government of Alberta, Government of Canada. Thematic Data - Stantec Ltd.
Imagery: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Location and Extent of Riparian Habitat Inundated along Elbow River for Four Flow Rates, **Map 9**

Stantec

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESEVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT

Figure 103-1h

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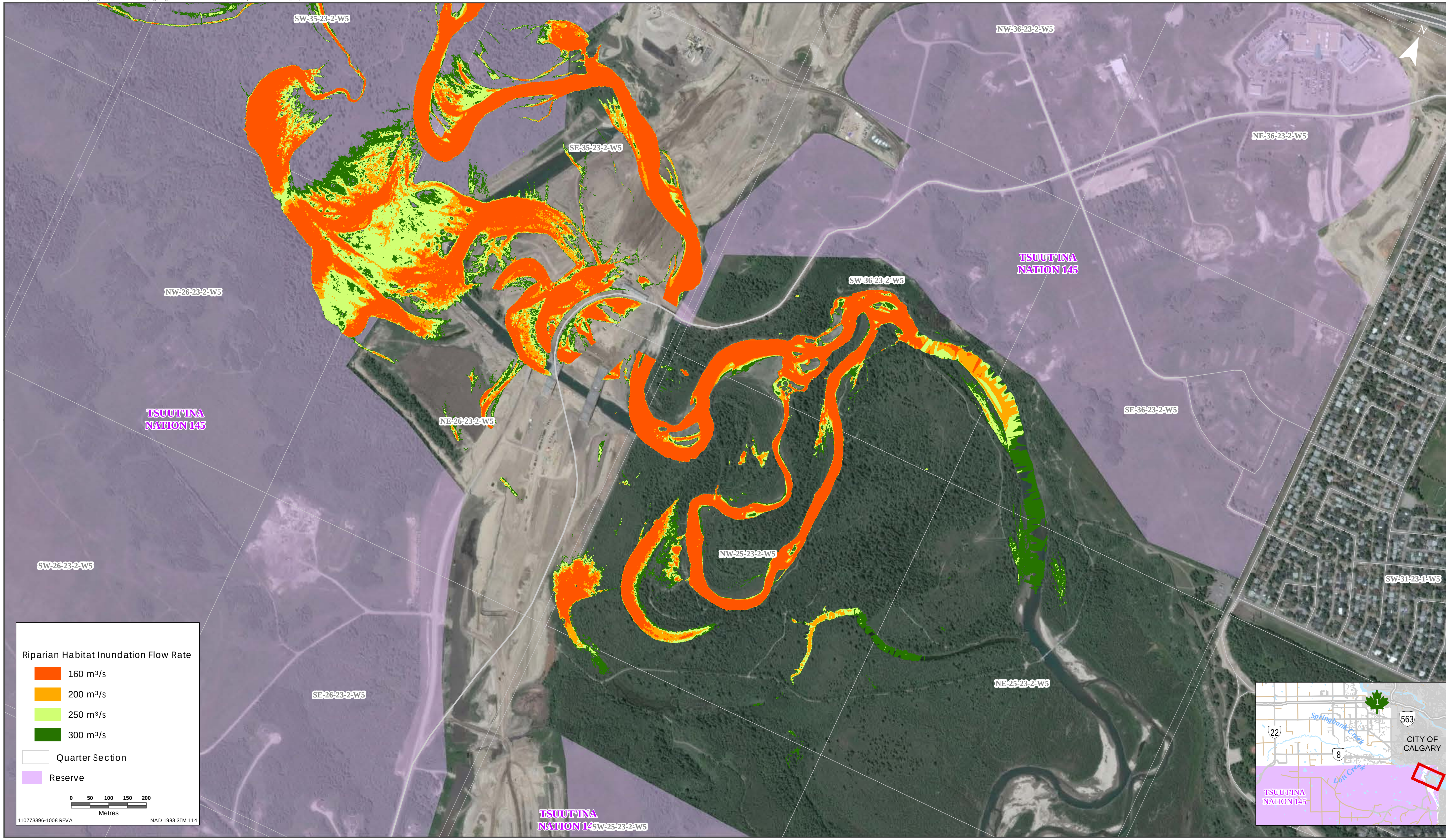

Sources: Base Data - Government of Alberta, Government of Canada. Thematic Data - Stantec Ltd.
Imagery: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Location and Extent of Riparian Habitat Inundated along Elbow River for Four Flow Rates, **Map 10**

Stantec

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESEVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT

Figure 103-1i

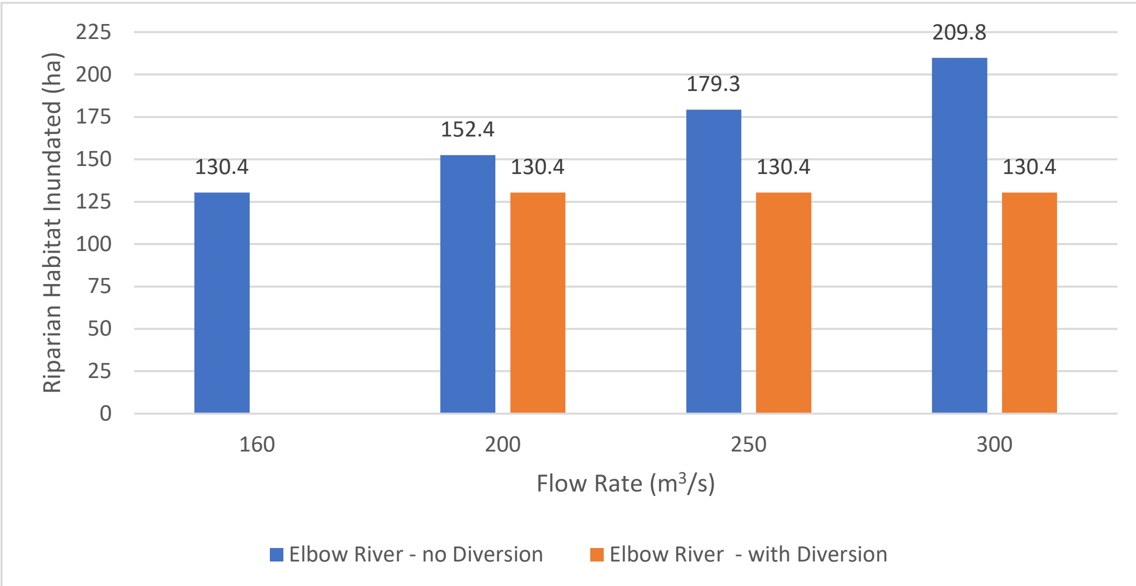

Figure 103-2 Estimated area (ha) of Riparian Habitat Inundated for Four Flow Rates

c. To clarify, "meaningful" was intended to convey that the predicted effects are relatively small compared to the long-term median flow values. This conclusion is also supported by the relatively small changes in riparian habitat inundation from the Project and the flow rates necessary to maintain healthy riparian ecosystems and wildlife habitats discussed in a. and b.

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Question 104

Supplemental Information Request 1, Question 426, Page 6.147

Alberta Transportation states that *the draft wildlife mitigation and monitoring plan…for construction and dry operations focuses on large mammals (e.g., deer, elk, grizzly bear) because they are species of management concern (SOMC) that are most likely to be affected by the Project through changes in movement and have the greatest uncertainty regarding responses to Project components.*

a. Explain how they have the greatest uncertainty and identify why these uncertainties remain.

b. How can these uncertainties be addressed via the post construction-monitoring plan?

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a. The greater uncertainty for large mammals such as deer and elk is related to the expectation that deer and elk are more likely to interact with Project structures more frequently based on the results of the baseline wildlife surveys completed in the LAA (see the EIA, Volume 4, Appendix H, Section 3.6 and Section 3.7).

   Some uncertainty associated with Project residual effects on change in wildlife movement remains because there is limited information on how wildlife such as deer and elk might respond to the presence of permanent Project structures, such as the diversion channel. Similarly, some uncertainty exists with respect to the effectiveness of certain mitigation measures, such as the filled riprap in the diversion channel because there is limited information available on how deer and elk might respond to these mitigation measures.

   The final WMMP will be developed in discussion with regulators and consultation with Indigenous groups and will be designed to evaluate whether Project structures such as the diversion channel create barriers to wildlife movement in the LAA.

b. The uncertainties associated with Project residual effects on change in wildlife movement will be addressed as part of the final WMMP, which will be implemented within an adaptive management framework. The results of the remote camera monitoring program (e.g., crossing success rates at bridge underpass, diversion channel or wildlife friendly fencing) will be used to verify predictions and evaluate the success of proposed mitigation. Where necessary, adjustments or improvements will be made to mitigation measures so that specific mitigation objectives (and targets) related to wildlife movement are met. These mitigation objectives and targets will be identified in the final WMMP.

Question 105

Supplemental Information Request 1, Question 427, Page 6.148

Alberta Transportation states *Given these mitigation measures, the Project will have no significant effects on wildlife habitat, movement, and mortality risk, and will not threaten the long-term persistence or viability of wildlife in the wildlife RAA. Based on this, no further mitigation for biodiversity is required.*

a. Explain the additional benefit if all disturbed habitats were restored to native habitat and conservation tools such as offset measures on adjacent lands were used.

b. Explain how unforeseen protected wildlife and/or habitat features will be dealt with if they are detected (e.g. nests or dens)?

c. Explain if an assessment of impact on wildlife values was completed for non-dam related post construction end land uses (e.g. recreation and access). If not, explain why not.

Response

This response was included in the May 15, 2020 filing. The text has not been changed but Figure 105-1 has been inserted which we note was not included in the May 15, 2020 filing.

a. If all existing disturbed land types (anthropogenically modified and agricultural) in the PDA and areas disturbed by the Project were restored, the abundance of native communities, and possibly species diversity, would likely increase. The greatest change would likely be the abundance of grassland and shrubby communities. Native forest would likely also increase over time. An increase in native grassland and shrub communities in the PDA could provide additional benefits such as increased vertical structure (cover) and habitat quality for certain wildlife species including species at risk that are dependent on intact native prairie (e.g., Sprague's pipit). However, there are challenges associated with habitat restoration, as discussed in response to AEP Question 99, and restoration is not proposed.

It is expected that, over time, reclamation of the PDA will provide suitable habitat for wildlife species that utilize grasslands such as elk, deer and grassland songbirds (e.g., savannah sparrow). With the application of mitigation, including the proposed reclamation, the Project will not threaten the long-term persistence or viability of wildlife species in the RAA.

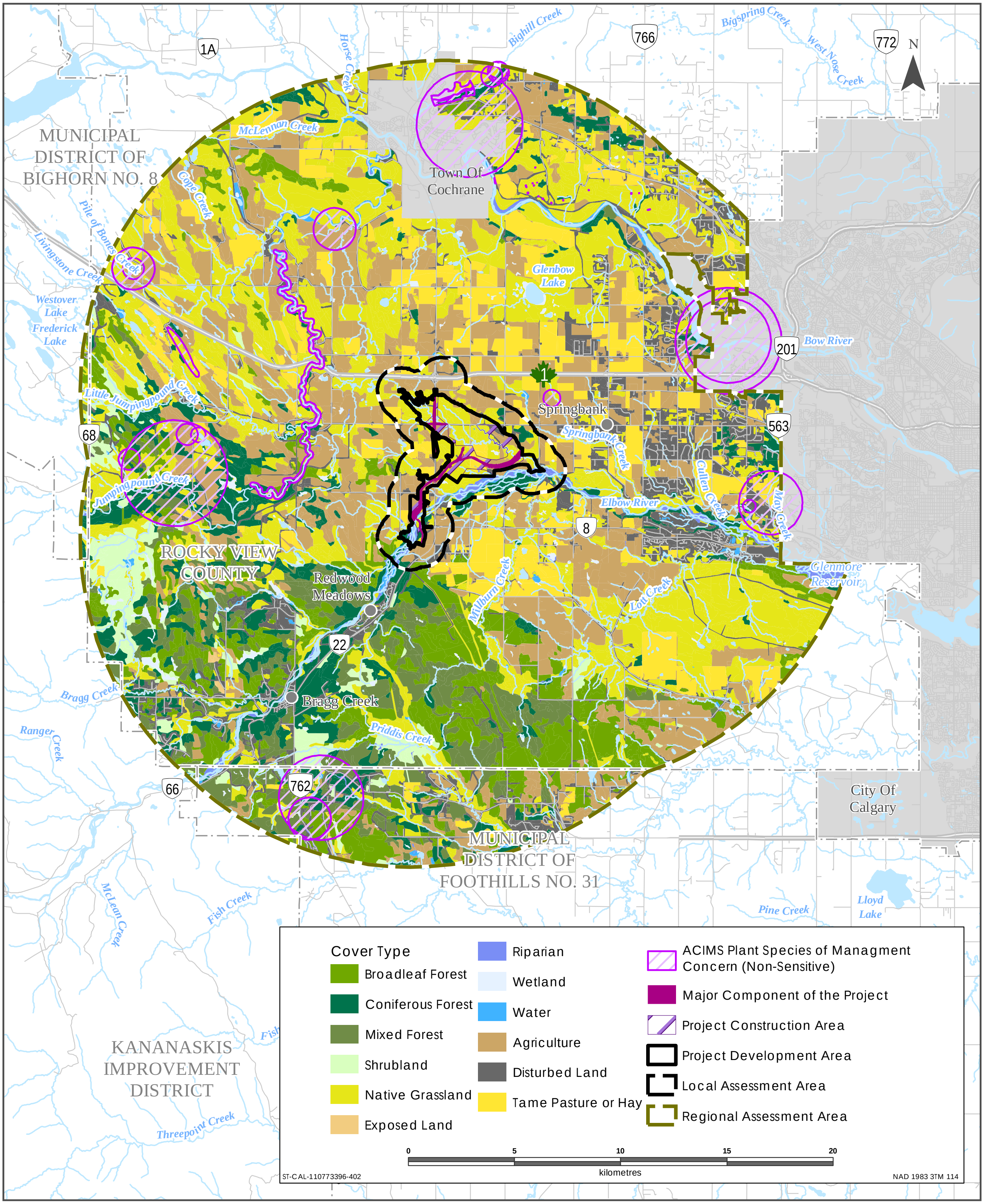
The potential benefits of offsets typically include no net loss or a net gain of habitat, which can be achieved through restoration or protection of areas outside the disturbed lands (i.e., avoided loss) (Moilanen and Kotiaho 2018). Securing additional land outside the PDA to offset Project development may increase the abundance of shrubby and forested areas in the RAA because these species recolonize currently anthropogenically modified areas. Most of the RAA has been converted to tame pasture and agriculture (Figure 105-1); without active reclamation efforts in offset areas, native grasses and forbs are not likely to be dominant in anthropogenically modified areas because non-native grasses are aggressive competitors (USDA 2006; Tannas 2003).

Offset measures are not proposed, as discussed in Alberta Transportation's response to Round 1 CEAA Package 2 IR2-17d, which states:

"Habitat offsets were not considered as a mitigation option for the direct loss of wildlife habitat including elk habitat because:

- There is no provincial offset policy or framework in place to allow for the consideration of offsets as a mitigation option for proposed developments.
- Currently, habitat offsets are only applied to wetlands as part of the Alberta Wetland Mitigation Directive (GoA 2018) or to wildlife species listed as endangered or threatened under Schedule 1 of the Species at Risk Act (SARA). Offsets under SARA are used only to address residual effects after applying avoidance and mitigation measures to comprehensively reduce the effects of the activity on species at risk individuals, residences and critical habitat (GoC 2016).
- Elk are currently listed as secure by AEP (2017) and are not listed as endangered or threatened under Schedule 1 of SARA (GoC 2019). There is currently no precedence for designating habitat-based offsets for a non-listed species.

Overall, habitat offsets were not considered as a mitigation option because the proposed mitigation strategies (e.g., avoid, minimize, reclaim, as well as Project design features) were determined to be adequate to reduce Project residual effects on wildlife habitat and elk movement to the extent that they do not threaten the long-term persistence or viability of wildlife including elk in the RAA (i.e., there is substantial habitat for elk in the RAA), as well as in consideration for the other reasons listed above. The Project will reclaim temporary workspaces using native species, which will reduce the direct loss of high and moderate suitability elk feeding habitat within the construction area."



Sources: Base Data - ESRI, Natural Earth, Government of Alberta, Government of Canada
Thematic Data - Alberta Environment and Parks (AEP), Alberta Conservation Information Management System (ACIMS), ERBC, Government of Alberta, Stantec Ltd

Vegetation and Wetlands in the Regional Assessment Area

Stantec

Figure 105-1

b. As described in Volume 3A, Section 11.4.2.2, as well as in the draft WMMP, pre-construction surveys will be conducted to identify wildlife features (e.g., nests, dens) and appropriate site-specific mitigation developed.

c. The Draft Guiding Principles and Direction for Future Land Use (see the response to AEP Question 87, Appendix 87-1) identified secondary uses and activities that have minimal impact on the land will be allowed (primary uses being flood mitigation). These low intensity activities and non-motorized access (e.g., hiking), suggests relatively low potential effects on wildlife and wildlife habitat. Although Alberta Transportation is aware that the PDA is currently being accessed by Indigenous groups, the extent and frequency to which the PDA is currently being accessed by Indigenous groups for traditional purposes such as hunting is unknown; therefore, it is difficult to determine if increased access to lands by Indigenous groups would result in an incremental increase in mortality risk to ungulates (e.g., deer, elk) due to hunting. As the land use principles are finalized, Alberta Transportation will continue to evaluate the potential effects of Indigenous groups use of the land and wildlife resources.

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Question 106

Supplemental Information Request 1, Question 428, Page 6.153

a. Explain and assess the adequacy and inadequacies of the proposed post construction-monitoring plan.

b. Explain if the timelines and methods proposed will enable clearly stated monitoring objectives to yield robust conclusions as per the last statement of this SIR response.

c. How does the proposed methods align with respect to similar monitoring programs effectiveness and designs used in other EIAs and wildlife mitigation and monitoring programs in Alberta?

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a. The draft WMMP is considered adequate to meet the stated mitigation and monitoring objectives and aligns with WMMPs completed for other similar approved projects. The final WMMP will be developed in consultation with provincial and federal regulators, as well as with Indigenous groups following Project approval. The adequacy of the WMMP will be assessed as part of the collaborative stakeholder and Indigenous engagement program. To ensure the WMMP is implemented in an effective manner, the identification of specific goals and objectives as well as an evaluation of study design will be discussed, including any limitations related to the monitoring study design.

b. Yes, the draft WMMP has identified goals and objectives that are linked to mitigation and monitoring, which will provide a robust evaluation framework. As stated in the response to a., the final WMMP will identify specific objectives and goals to address potential Project effects. The study design will include appropriate monitoring methods and performance measures designed to evaluate the effectiveness of proposed mitigation. The final WMMP will address the duration of the monitoring program, as well as identify reporting timelines. The WMMP will provide useful information to evaluate the accuracy of predictions and effectiveness of proposed mitigation.

c. Although the scope of WMMPs will vary with each type of project, the approach and methods outlined in the draft WMMP are similar to WMMPs completed for other projects in Alberta that are designed to evaluate the effectiveness of mitigation measures implemented to reduce potential project effects such as change in habitat, wildlife movement and mortality risk (Cenovus 2012; Statoil 2012).

REFERENCES

Cenovus (Cenovus FCCL Ltd.). 2012. Foster Creek Thermal Project Wildlife Mitigation and Monitoring Program. Prepared by Matrix Solutions Inc. Calgary, Alberta. 46 pp + Appendices.

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Question 107

Supplemental Information Request 1, Question 429, Page 6.155

The project should adhere to Environment and Climate Change Canada's (ECCC) habitat clearing recommendations for sediment removal during nesting periods and be in accordance with the *Migratory Bird Convention Act.*

a. Confirm that clarity will be the obtained from the ECCC regarding the habitat clearing guideline.

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a. Sediment removal from the reservoir is not anticipated, although it is on the spectrum of remediation options (see the response to AEP Question 84).

   Grading may occur to move the sediment away from areas where it affects the functionality of the Project components or blocks drainage (see Alberta Transportation's response to Round 1 AEP IR382). Alberta Transportation is aware of Environment and Climate Change Canada (ECCC) guidelines to reduce risk to migratory birds. As discussed in the EIA, Volume 3B, Section 11.3.8.2, if sediment partial clean-up activities are planned in the reservoir during the RAP for migratory birds, a qualified wildlife biologist will conduct a bird nest search to manage the risk of harm to nesting migratory birds. Alberta Transportation and AEP (as the operator) are aware of the *Migratory Birds Convention Act* and will communicate with ECCC, as needed, for construction and operations.

Question 108

Supplemental Information Request 1, Question 432, Page 6.189

Restoration of native habitat is very difficult and it is noted that the term reclamation is not equivalent to restoration.

a. Explain and assess if the stated conclusions on habitat modification impacts are underestimated to a degree that they cannot be informed via the assessment methods contained in the EIA.

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a. Habitat suitability models assess the ability of each habitat type (ecosite phase) to provide the necessary life requisites (e.g., food, cover) to meet seasonal habitat requirements using a four-class rating scheme: Class 1 = high habitat value; Class 2 = moderate habitat value, Class 3 = low habitat value and Class 4 = very low to nil habitat value. Change in habitat for key indicator species is presented and discussed in terms of changes in areas (ha) of high, moderate, low and very low to nil suitability habitat. In addition, change in habitat (ha) was assessed using habitat associations for other species of management concern.

   The assessment methods accounted for the ability of reclaimed lands to provide suitable habitat for key wildlife indicators (see Volume 3A, Section 11.4.1.1). The assessment quantifies the change in habitat suitability for each key indicator, based on vegetation changes resulting from disturbance and the subsequent change after reclamation.

   As stated in response to AEP Question 99, there is greater likelihood of success with reclamation, compared to restoration. Reclaimed areas will be seeded with a native seed mix and will be supported by natural recovery of trees and shrubs. Reclaimed areas will provide suitable habitat for a variety of wildlife species. Alberta Transportation will work with Indigenous groups and regulators to determine appropriate final seed mixes.

   The assessment methods and conclusions take into account both quantitative changes in habitat suitability classes for various species and the expected reclamation outcomes. As a result, they do not underestimate the Project residual effects on change in habitat.

Question 109

Supplemental Information Request 1, Question 434, Page 6.192

The response provided does not comply with the *Wildlife Act* and Regulation, which protects some of the habitat features identified. Preconstruction surveys will be critical to preventing destruction or disturbance of these protected species and habitat features.

a. Explain how Alberta Transportation will comply with the *Wildlife Act* and Regulation.

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a. Alberta Transportation will comply with the Alberta *Wildlife Act* and Regulation by conducting pre-construction surveys to identify wildlife features that are protected under the *Wildlife Act* (e.g., nests, dens) and develop appropriate site-specific mitigation to reduce any potential Project effects as described in the EIA, Volume 3A, Section 11 and in the draft WMMP.

Question 110

Supplemental Information Request 1, Question 435, Page 6.193

Frequent grizzly bear use has been confirmed along the Elbow River and surrounding habitat within the PDA, LAA, and RAA. This is important habitat for many species consistent with the associated KWBZ. The original SIR has not been answered and the methods used in the assessment as referenced in the response are also limited.

a. Why were impacts to movement and risk not further assessed or discussed?

b. Explain the rationale for adequacy of the assessment methods on grizzly movements along the Elbow River valley.

c. Does Alberta Transportation have confidence in their ability to understand impacts of the project on grizzly use and movement along the Elbow River? Explain.

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a-b. The potential effects of the Project on grizzly bear movement and mortality risk was assessed using the best available information. Alberta Transportation's response to Round 1 AEP IR435 indicated that the EIA, Volume 3A, Section 11.4.3.3, page 11.60 discusses potential Project effects on grizzly bear movement. Volume 3A, Section 11.2.2.5, page 11.38 also discusses grizzly bear movement based on radio-telemetry data provided by Stenhouse (2016, pers. comm) and Paczkowski (2016, pers comm.), which indicated grizzly bear movement through the LAA and RAA.

The potential effects on grizzly bear mortality risk are discussed in Volume 3A, Section 11.4.4. During construction, there is potential for increased mortality risk due to human-wildlife conflicts (e.g., bears). During dry operations, the reduction of on-site activity is expected to reduce the risk to grizzly bears compared to the construction phase. The mitigation described in Volume 3A, Section 11.4.4.2, is designed to manage human-wildlife conflict and reduce potential mortality risk on grizzly bear (e.g., waste will be stored in wildlife-proof containers and wildlife awareness will be provided to staff on-site).

The assessment includes information that was publicly available prior to the time of the EIA submission. Potential Project effects on grizzly bear movement are assessed qualitatively largely because there are no detailed studies available that identify grizzly bear-specific movement routes in the Project area, other than the radio-collared grizzly bear that was observed to travel through the LAA and RAA as well as the grizzly bears that were detected along Elbow River during the baseline remote camera survey (see Volume 4, Appendix H, Section 3.6 of the EIA).

c. The conclusions stated in the wildlife assessment related to potential Project effects on grizzly bear habitat, movement and mortality risk are robust, based on the assessment methods used and the information available at the time of preparation. The assessment recognized that there is some uncertainty related to wildlife movement and how various species (including grizzly bear) might respond to the diversion channel, floodplain berm and off-stream dam during dry operations (see Volume 3A, Section 11.6). The final WMMP (i.e., remote camera study) will help to better understand potential Project effects on grizzly bear use and movement along Elbow River, including assessment predictions and the effectiveness of mitigation measures.

References

Paczkowski, J. 2016. Wildlife Biologist, Alberta Parks. Personal communication, email.

Stenhouse, G. 2016. Wildlife Carnivore Biologist, Foothills Research Institute. Personal communication, email.

6 HEALTH

Question 111

Supplemental Information Request 1, Question 206, Page 4.4
Supplemental Information Request 1, Figure IR206-1, Page 4.4
Supplemental Information Request 1, Question 444, Pages 7.26-7.37
Supplemental Information Request 1, Figure IR444-2, Page 7.29
Supplemental Information Request 1, Figure IR444-3, Page 7.30
Volume 3A, Section 15.4.1, Tables 15-12, 15-13, 15-14, Pages 15-45 to 15-53

Alberta Transport states *During construction, activities between the diversion channel and the dam, there will be 24-hour continuous wind and air quality monitoring for $PM_{2.5}$ and TSP at Stations 1 and 2 along the haul road and at Station 3 near the borrow source area as illustrated on Figure IR206-1. The proposed locations of the air quality monitoring stations were selected based on modelling results.*

The results of the HHRA indicate the predicted air concentration exceeds the acceptable criteria at SR41 and SR19. Both locations are representative of permanent residences and close to other residences. The proposed monitoring stations are not in the vicinity of these locations.

a. Describe a monitoring program inclusive of the SR41 and SR19 locations.

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a. The proposed monitoring program has been adjusted to provide monitoring data representative of the SR41 and SR19 locations. The proposed monitoring program is explained in detail below.

   Three ambient air quality monitoring stations are proposed outside the PDA, as described in Alberta Transportation's response to Round 1 AEP IR206 and shown in Figure IR206-1. The ambient air monitoring will include monitoring of $PM_{2.5}$ and TSP. The locations of the air quality monitoring stations are based on the highest expected fugitive dust emissions generated by the haul trucks transporting earth material from the diversion channel to the dam, and the spatial distribution of maximum predicted $PM_{2.5}$ and TSP concentrations.

Two monitoring locations (Station 1 and Station 2) are proposed between the haul road from the diversion channel excavation work to the dam construction site and nearby residences, and one monitoring location (Station 3) is proposed between the borrow source area and nearby residences (see Alberta Transportation's response to Round 1 AEP IR206, Figure IR206-1).

The EIA, Volume 3A, Section 15, Table 15-13 indicates that the ERs for the predicted 24-hour $PM_{2.5}$ concentrations are greater than 1.0 at two human receptors (SR19 and SR41) for the Project Case. The highest ERs for 24-hour $PM_{2.5}$ concentrations are at human receptors SR19 and SR41 for both the Project Case and Application Case.

Receptors SR19 and SR41 are close together and, as a result, it is proposed that a single monitoring station will be sufficient to provide monitoring results representative of both locations. To provide additional monitoring results representative of residences, the preliminary recommended monitoring location for Station 1 is closer to human receptors SR19 and SR41, as shown in Figure 111-1. The exact locations of the monitoring stations will be determined during the development of the Environmental Construction Operations Plan (ECO Plan) by the construction contractor, regulatory guidance, and practical siting constraints such as land availability, site access, safety, availability of electrical power, and siting recommendations within the AEP Air Monitoring Directive. The ECO Plan will follow the requirements outlined in Alberta Transportation's ECO Plan framework (Volume 4, Supporting Documentation, Document 4) and Alberta Transportation's Civil Works Master Specifications for Construction of Provincial Water Management Projects (Volume 4, Supporting Documentation, Document 10) and any air monitoring conditions of Project approval required by regulatory agencies.

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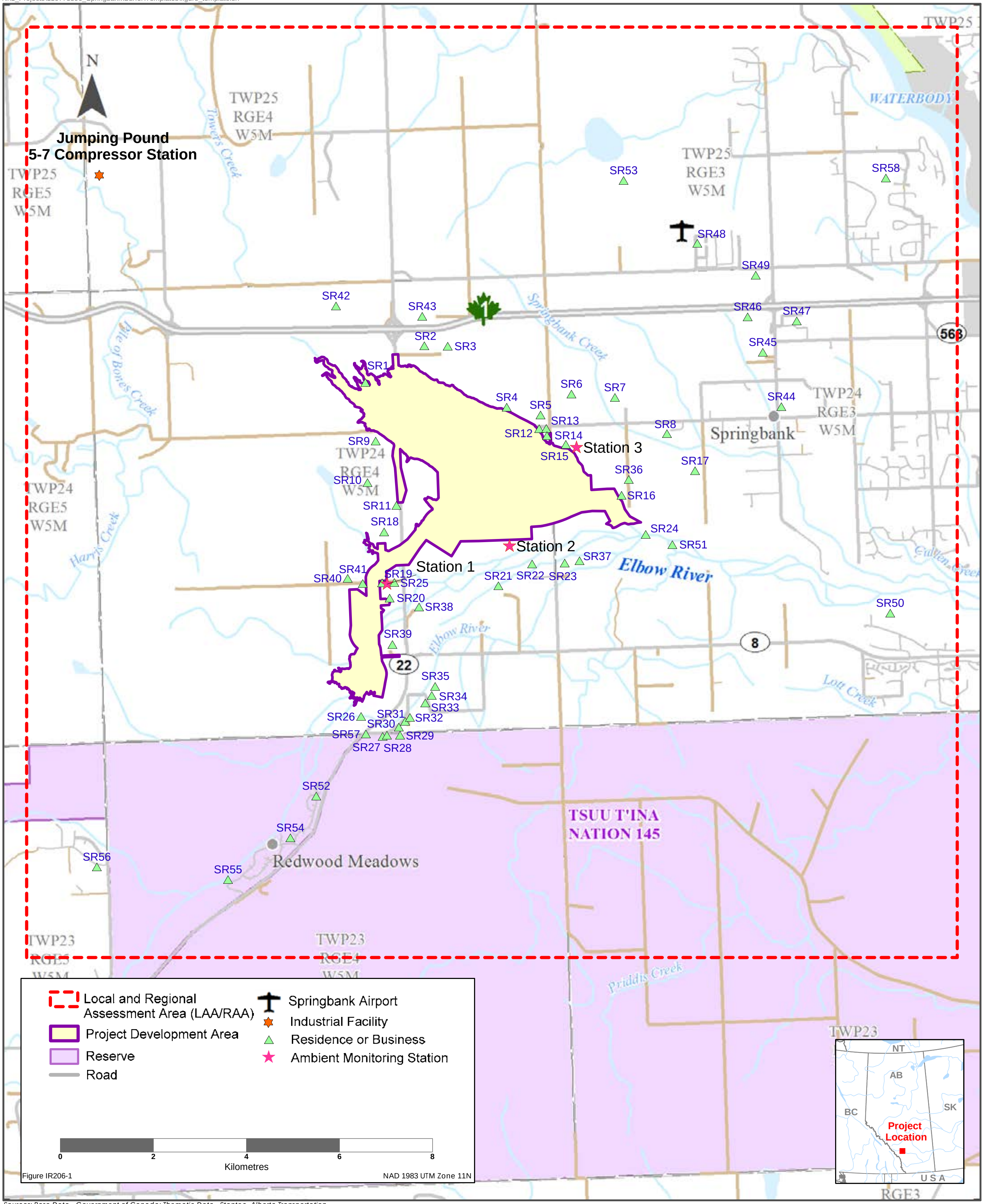

Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Updated Preliminary Locations of Ambient Monitoring Stations during Construction

Question 112

Supplemental Information Request 1, Question 448, Page 7.44
Volume 3A, Section 15.4.1.4, Page 15.39
Volume 3B, Section 15.4.1.4, Page 15.18
Volume 4, Appendix O

The conclusions of the HHRA are dependent on the predicted air dispersion modelling results. Through the SIR process, additional air modelling may be required for the air quality portions of the application thus generating new predicted air concentration data.

a. In the event that new or additional air dispersion data is generated for selected Chemicals of Potential Concern (COPC), compare the results to health-based Toxicological Reference Values (TRVs) and discuss the potential health impact or provide justification for not completing these steps.

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a. As of the date of this filing, no new or additional air dispersion modelling has been required or undertaken since the filing of the EIA.

7 ERRATA

Question 113

Supplemental Information Request 1, Question 206, Table IR206-1, Page 4.4

Alberta Transportation states the 24-hour Alberta Ambient Air Quality Objective (AEP 2019) for Fine Particulate Matter ($PM_{2.5}$) as 30 µg/m^3 in Table IR206-1. This is incorrect. The 24-hour AAAQO for Fine Particulate Matter ($PM_{2.5}$) is 29 µg/m^3.

a. Correct Table IR206-1 so that the correct value is referenced.

Response

This response was included in the May 15, 2020 filing. The text has not been altered.

a. The response to Round 1 AEP IR206, Table IR206-1 is revised below in Table 113-1 (see **red** text) to indicate the revised Alberta's Ambient Air Quality Objectives (AAAQO) (AEP 2019).

Table 113-1 Air Quality Objectives During Construction, $PM_{2.5}$ and TSP (revision to Table IR206-1)

Substance	Averaging Period	Measurement
Fine Particulate Matter – 2.5 microns or less ($PM_{2.5}$)	24-hour	**29 µg/m³**
Total Suspended Particulate Matter (TSP)	24-hour	100 µg/m³

REFERENCES

AEP (Alberta Environment and Parks). 2019. Alberta Ambient Air Quality Objectives and Guidelines Summary. January 2019. Alberta Environment and Parks (AEP). Available at: https://open.alberta.ca/dataset/0d2ad470-117e-410f-ba4f-aa352cb02d4d/resource/4ddd8097-6787-43f3-bb4a-908e20f5e8f1/download/aaqo-summary-jan2019.pdf. Accessed: January 2020.