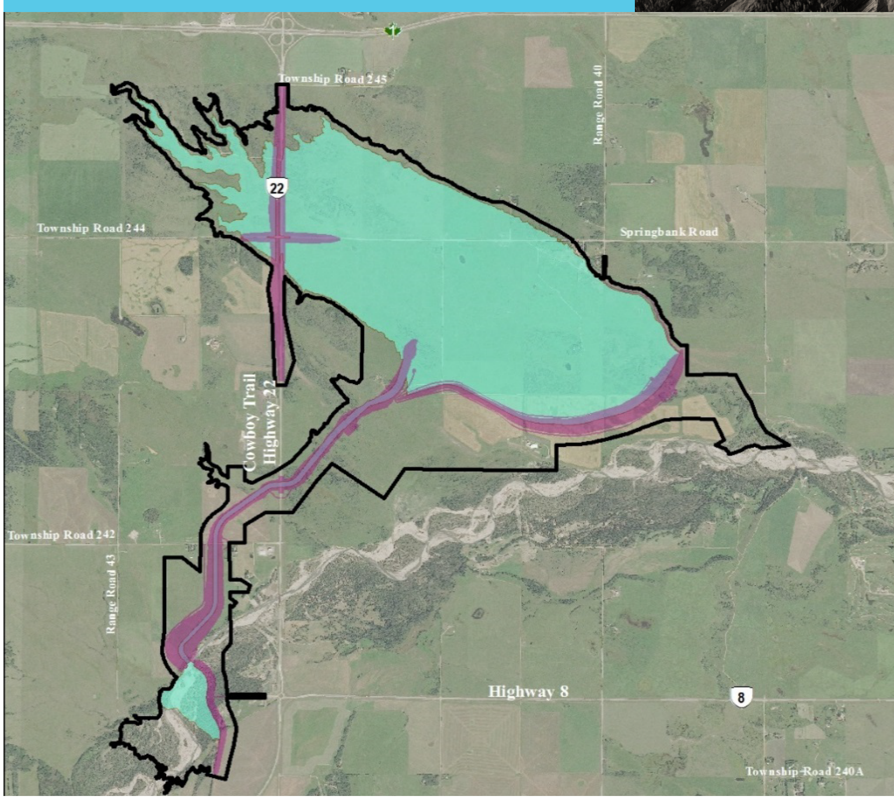
Springbank Off-stream Reservoir Project



Response to Impact Assessment Agency of Canada Information Request Package 4 – Technical Review Round 2, March 23, 2020

June 2020

Alberta Transportation

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.

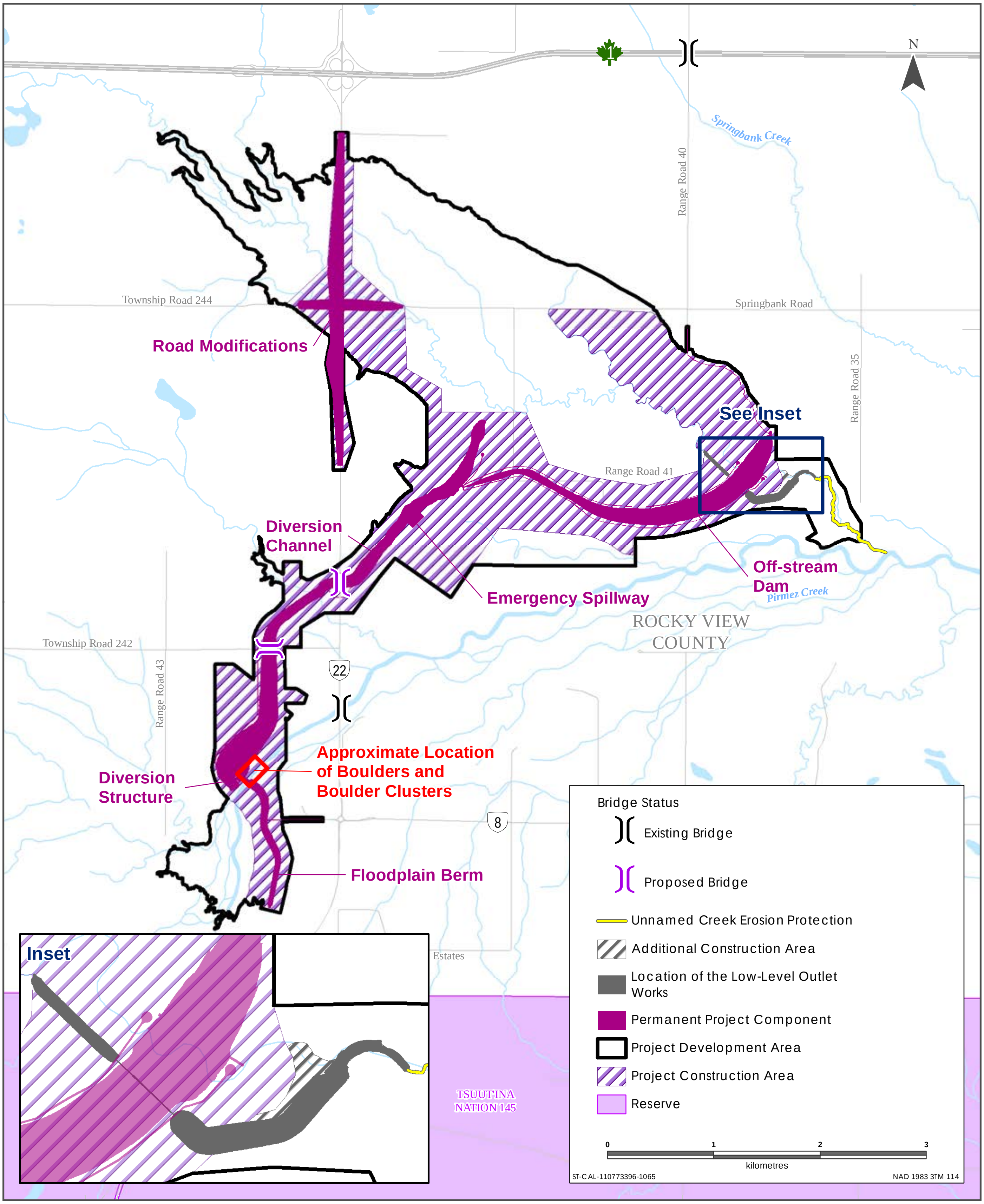
Early release has the reservoir discharging when flows in Elbow River fall below 160 m^3/s. Releases from the reservoir would be staged such that flow in Elbow River would not exceed 160 m^3/s downstream of the river's confluence with the unnamed creek. During a design flood, this would result in flows 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



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

SR1 Project Updates

Stantec

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT

Figure 1

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 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
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 m³/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.

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
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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Abbreviations

AAAQO	Alberta Ambient Air Quality Objectives
AEP	Alberta Environment and Parks
Agency/IAAC	Impact Assessment Agency of Canada
AIWC	Alberta Institute for Wildlife Conservation
AQMP	air quality management plan
CAAQS	Canadian Ambient Air Quality Standards
CAC	criteria air contaminant
CEAA 2012	*Canadian Environmental Assessment Act, 2012*
CCME	Canadian Council of Ministers of the Environment
CEI	Cochrane Ecological Institute
CWRS	Calgary Wildlife Rehabilitation Society
DFO	Fisheries and Oceans Canada
DHI	Danish Hydraulic Institute
DO	dissolved oxygen
ECCC	Environment and Climate Change Canada
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EIS Guidelines	Environmental Impact Statement Guidelines
EPEA	*Environmental Protection and Enhancement Act*
IR	Information Request
LLOW	low-level outlet works
PDA	Project development area
RAA	regional assessment area
SEV	severity of ill effects
TSS	total suspended solid
USACE	United States Army Corps of Engineers

USBR	United States Department of the Interior Bureau of Reclamation
WMMP	Wildlife Mitigation and Monitoring Plan

IR4-01: Project Operation – Release Scenarios

Sources:

EIS Guidelines

EIS Volume 1, Volume 2, and Volume 3

ECCC Technical Review, June 18, 2018

DFO ANNEX 2 Technical Review, June 19, 2018

IAAC Information Requests Related to the Environmental Impact Statement Round 1 Part 1, IR1-04; Round 1 Part 3, IR3-08, IR3-09, IR3-10, IR3-11

Alberta Transportation Responses to IR Round 1, SR1 CEAA IR Package 1, June 14, 2019

DFO Round 1 IR Completeness Review Comments, June 28, 2019

ECCC Round 1 IR Completeness Review Comments, July 3, 2019

Alberta Transportation Responses to IR Round 1, SR1 CEAA IR Package 1, June 14, 2019

Alberta Transportation Responses to IR Round 3, SR1 CEAA IR Package 3, June 14, 2019

ECCC Technical Review Round 2, February 6, 2020

DFO Technical Review Round 2, February 6, 2020

Context and Rationale:

The EIS Guidelines require a description of the operation of key Project components, multiple components of hydrology of the Elbow River watershed, and changes to water quality and quantity, fish and fish habitat, and vegetation.

The EIS presented a release scenario where floodwaters would be held in the reservoir until flows in the Elbow River return to below bankfull levels (20 m^3/s) and then released. Federal authorities and Indigenous groups have raised many concerns regarding holding the water in the reservoir for an extended period of time, including potential effects from releasing dirty floodwaters back into the clear/low-flow river water, the effects to the fish entrained in the reservoir, and the effects of the settling of sediment on vegetation in the reservoir. Fisheries and Oceans Canada noted that the objective should be to return turbid water back to the system as quickly as possible while a turbid high flow scenario still exists in the river.

The Agency understands that Alberta Transportation is working on a new release scenario where draw down occurs as soon as flows in the Elbow River drop below 170 m^3/s. Given this release model, clarity for draw down times for each flood scenario (1:10, 1:100, design flood) and an analysis of potential effects to VC are needed in order to determine changes to sediment deposition, potential effects to water quality and quantity, and potential effects to fish and fish habitat. Additionally, it was discussed in the February 2020 Technical Advisory Group Meeting that it is still unclear how the capacity of the low-level outlet (27 m^3/s) was determined.

This new release scenario requires the identification of mitigation measures for effects to VCs when draw down occurs as soon as flows drop below 170 m^3/s, where as the information and mitigation presented in the EIS considers effects to VCs from holding the water until flows in the river return to below bankfull levels. The Agency understands that the actual operational release rates from the off-stream reservoir will vary depending on the circumstances at the time of the diversion and this may result in a release timing between the two scenarios presented. To fully assess potential effects of the Project, it is necessary to understand how potential effects to various parameters and VCs and associated mitigation measures would change from operations through the full range of draw down and release scenarios.

<u>Information Requests:</u>

a) Describe operation of the Project for the proposed new release scenario where draw down occurs as soon as flows in the Elbow River drop below 170 m^3/s.

i. Describe the criteria that would be used to determine when and why this release scenario would be used as opposed to the one presented in the EIS.

b) For the draw down scenario described in part a), provide an analysis of potential effects and associated mitigation measures for the following parameters:

i. Fish and fish habitat, providing specific consideration for:

- **Temperature and dissolved oxygen in the reservoir.**
- **Newly listed Species at Risk Burbot – consider thermal tolerances identified by DFO and identify mitigation measure should temperatures exceed these levels.**
- **Measures to attract fish to the low level outlet to ensure minimal fish stranding in the reservoir.**

ii. Water quality, providing specific consideration for:

- **Water quality in the Elbow River at the time of release.**
- **Water quality in the reservoir and whether it will meet regulatory guidelines.**

iii. Sediment transport and deposition in the Elbow River

- **Settling of fine sediments on fish and fish habitat, including suitable spawning substrates and eggs.**

iv. Sediment deposition in the reservoir area and associated effects to vegetation and the current use of lands and resources for traditional purposes

c) For the draw down scenario described in a), provide a table with values demonstrating the total retention time for each flood scenario (1:10, 1:100, and design flood), including retention during flooding, draw down time, and any additional time needed for water left in the reservoir to dry out or be released.

d) Provide a rationale for the capacity of the low-level outlet (27 m^3/s).

e) Identify if any new or different mitigation would be required if draw down occurs at any point between the scenario described in a) and the scenario presented in the EIS.

Response IR4-01

a) The specific criteria for operation and release is presented in the operational flow chart in Figure 1-1. This flow chart was developed with Alberta Environment and Parks (AEP) and the City of Calgary, who operates Glenmore Reservoir, and shows how the two reservoirs interact in operation. The flow chart shows that the operational rule for releasing water from the Springbank Off-stream Reservoir Project (the Project) is when flows drop below 160 m^3/s in Elbow River, which is the early release scenario.

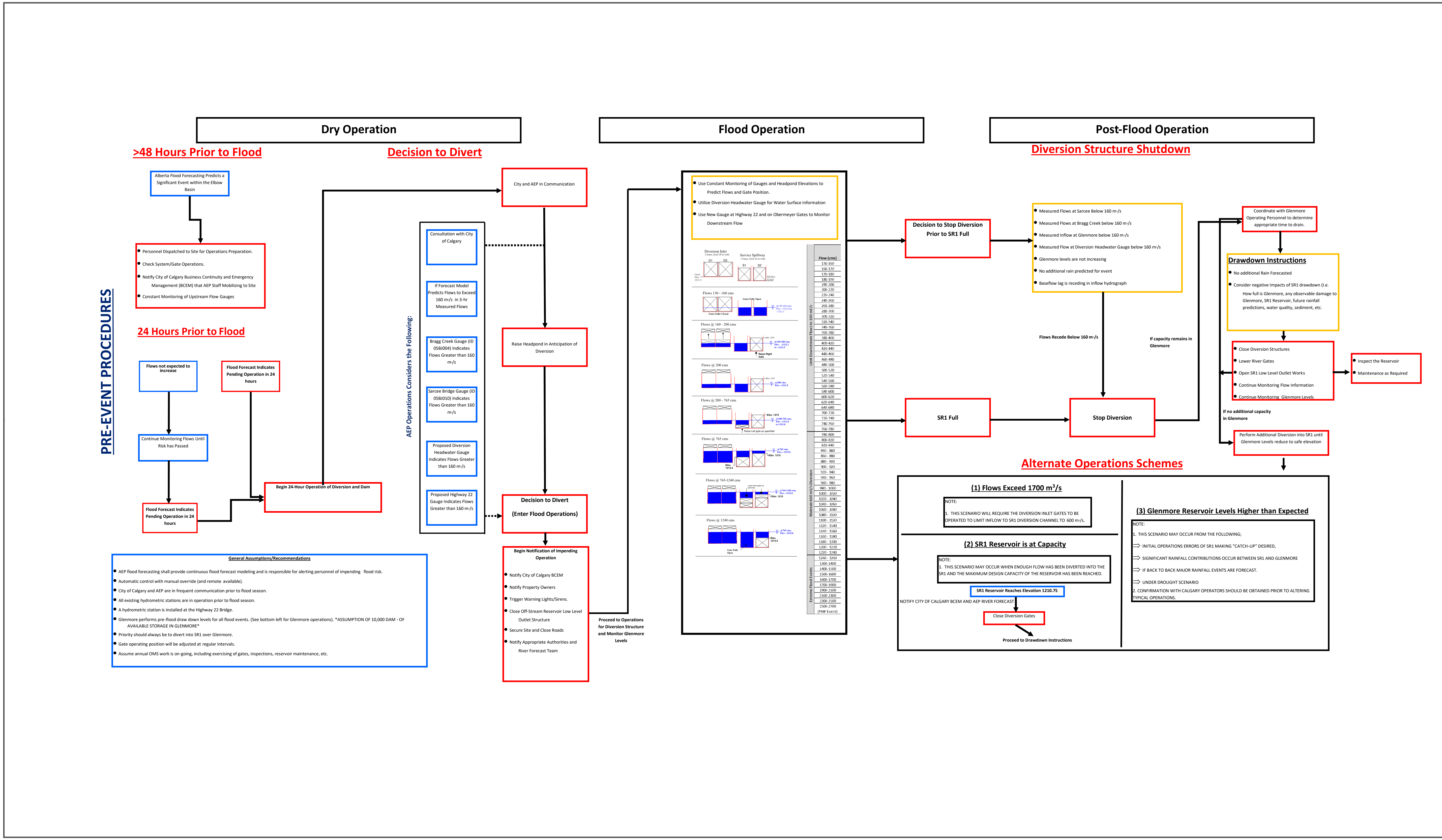
Flood damages begin to accrue downstream of Glenmore Reservoir when flows in the river exceed 170 m^3/s. Assuming Glenmore Reservoir's active flood storage capacity is full (as would be the case in the 2013 design flood), then the inflow rate to Glenmore Reservoir must not exceed this or additional water will spill and damages will accrue downstream. Glenmore Reservoir's low-level outlet's maximum capacity is 160 m^3/s. When the valve is fully opened, any flow arriving at Glenmore Reservoir that is in excess of 160 m^3/s will begin to fill the active storage, or spill over the top if the reservoir is already full. For this reason, the trigger to operate Project diversion of water into the off-stream reservoir is when the flow rate in Elbow River reaches 160 m^3/s. The earliest that water can, therefore, be released from the reservoir during a design flood (2013) would be when the flows drop below 160 m^3/s and the release would need to be done in such a way so that the release flow and Elbow River flow, combined, do not exceed 160 m^3/s in Elbow River. For this reason, the operational rule for release should also be 160 m^3/s. This allows the operators at Glenmore Reservoir to pass all water arriving at that reservoir without spilling or consuming active storage, should they need to.

Although the operational rule for releasing water from the Project is when flows in Elbow River drop below 160 m^3/s, Figure 1-1 outlines a number of decision points or criteria that would determine if water were to be held in the reservoir longer (i.e., holding water in the reservoir beyond the point where flows have dropped to 160 m^3/s) prior to release.

Conversely, the late release scenario, presented in the Environmental Impact Assessment (EIA), is based on keeping flows in Elbow River at or below bankfull flow rates (47 m^3/s), well below the 160 m^3/s limitation of the Glenmore Reservoir low-level outlet capacity.

b) This response is organized in the following sections:

- part i discusses effects on fish and fish habitat including:
  - temperature effects in the reservoir and Elbow River at the time of release
  - dissolved oxygen effects in the reservoir and Elbow River at the time of release
  - thermal tolerances for bull trout
  - mitigation to attract fish to the low-level outlet
- part ii discusses water quality in the reservoir and Elbow River at the time of release including:
  - suspended sediments
  - constituents associated with suspended sediments
  - nutrients
  - mercury and methylmercury
- part iii discusses sediment deposition in Elbow River as a result of reservoir water release, including potential effects to fish habitat
- part iv discusses sediment deposition in the reservoir area and associated effects on vegetation and the current use of lands and resources for traditional purposes



Sources: Created by Stantec, in collaboration with AEP and the City

Disclaimer: This diagram is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

Operational Flow Chart for the Project

Figure 1-1

i. *Fish and Fish Habitat - Temperature and Dissolved Oxygen in the Reservoir and Elbow River during the Time of Release*

Water temperature and dissolved oxygen (DO) were modelled using the Danish Hydraulic Institute (DHI) oxygen ECO Lab module attached to the MIKE 21 hydrodynamic model. The model was run for each of the 1:10 year flood, 1:100 year flood and design flood for early release and late release (six scenarios in total). See Table 1-1 for timing and duration for flood diversion, reservoir hold times and water release times. A discussion on temperature and DO modelling results is provided in Appendix 1-1. Details of the MIKE 21 hydrodynamic model, link to the ECO Lab module, model assumptions and uncertainty are included in Appendix 1-2. In general, the results are as follows:

- Water temperature and DO are most affected in the reservoir during 1:10 year flood, late release when water levels in the reservoir are shallow and reservoir water temperatures are affected by solar radiation and summer air temperatures. As water temperatures rise, DO decreases (i.e., warm water has a lower oxygen holding capacity).
- During the 1:100 year flood, early release, changes to water temperature and DO are predicted to be small and effects on Elbow River are likewise predicted to be small and decrease farther downstream from the Project site.
- During the 1:100 year flood, late release and the design flood, early release and late release, water levels in the reservoir are sufficiently deep that reservoir water temperatures do not increase at the same rate as in Elbow River. Therefore, water released from the reservoir has a slight cooling effect on the river. DO levels are predicted to decrease slightly but not affect DO levels to the extent that fish and aquatic life are threatened.

A summary of the modelling results is provided in Table 1-2. For comparison, water temperature and DO levels in Elbow River (from 1979 through 2019) are displayed in box and whisker plots in Figures 1-2 and 1-3 (a description of the box and whisker elements is provided in Figure 1-4).

Table 1-1 Flood Water Diversion and Reservoir Hold and Release Times for Floods

Scenario	Diversion Starts (date, time)	Diversion Ends (date, time)	Time to Divert Flood Water (days)	Reservoir Hold Time (days)	Release Start (date, time)	Release End (date, time)	Days Required to Release Water (days)	Days from Start of Diversion to Complete Reservoir Drawdown (days)
Early Release								
1:10 year flood	5/24/08 15:00	5/24/08 23:00	0.3	0	5/25/08 0:00	5/26/08 18:00	1.7	2.0
1:100 year flood	5/31/00 5:00	6/2/00 1:00	1.8	0	6/2/00 2:00	6/25/00 15:00	23.5	25.3
2013 flood	6/20/13 4:00	6/23/13 22:00	3.8	0	6/23/13 23:00	7/29/13 08:00	35.4	39.2
Late Release								
1:10 year flood	5/24/08 15:00	5/25/08 0:00	0.4	42	7/6/08 11:00	7/8/08 4:00	1.7	44.4
1:100 year flood	5/31/00 5:00	6/2/00 1:00	1.8	67	8/7/00 15:00	8/31/00 3:00	23.5	92.3
2013 flood	6/20/13 4:00	6/23/13 22:00	3.8	21	7/14/13 18:00	8/20/13 11:00	36.7	61.5

Table 1-2 Predicted Water Temperature and Dissolved Oxygen Changes in the Off-Stream Reservoir and Elbow River for Floods

Scenario	Predicted Temperature Response in the Reservoir	Predicted Dissolved Oxygen Response in the Reservoir	Predicted Temperature Response in Elbow River	Predicted Dissolved Oxygen Response in Elbow River	Downstream Extent of Temperature Effect	Downstream Extent of Dissolved Oxygen Effect
Early Release						
1:10 year flood	no measurable effect	no measurable effect	no measurable effect	no measurable effect	no measurable effect	no measurable effect
1:100 year flood	gradual increase of 2˚C, from less than 5˚C to about 6.5˚C	decrease of 2 mg/L, from about 12 mg/L to 10 mg/L	less than 1˚C increase over the duration water is released	less than 1 mg/L decrease over the duration water is released	24 km downstream	difficult to distinguish at 300 m downstream
2013 flood	gradual increase from about 7˚C to 9˚C	gradual decrease from about 12 mg/L to 8 mg/L	slight effect in the river, up to 2˚C by end of the release period	slight effect in the river, up to 2 mg/L by end of the release period	small effect at 13 km downstream	difficult to distinguish at 300 m downstream
Late Release						
1:10 year flood	gradual increase to 18˚C with a spike to 22˚C over the last two days of water in the reservoir	decrease to 2 mg/L over the duration water is in reservoir	increase of four to five degrees from about 15˚C to 20˚C for two days	decrease from 10 mg/L to 6 mg/L for two days	extends for at least 24 km to Sarcee Bridge	indistinguishable at 13 km downstream
1:100 year flood	gradual increase from about 4.5˚C to approximately 7.5˚C	gradual decrease from 12 mg/L to 7.5 mg/L, mostly at the first three to four days and final four days of release	decrease by almost 4 degrees from 10˚C to 6.5˚C during release	gradual decrease from approximately 11 mg/L to about 9 mg/L	decreases downstream for at least 24 km	decreases downstream at least 24 km

Table 1-2 Predicted Water Temperature and Dissolved Oxygen Changes in the Off-Stream Reservoir and Elbow River for Floods

Scenario	Predicted Temperature Response in the Reservoir	Predicted Dissolved Oxygen Response in the Reservoir	Predicted Temperature Response in Elbow River	Predicted Dissolved Oxygen Response in Elbow River	Downstream Extent of Temperature Effect	Downstream Extent of Dissolved Oxygen Effect
2013 flood	increase from about 7.5˚C to 9.5˚C	gradual decrease from about 12 mg/L to almost 6 mg/L	decrease by about two degrees from 9˚C to 7˚C, but gradually increasing over the duration water is released	gradual decrease during release from 11 mg/L to slightly above 8 mg/L	decreases downstream for at least 24 km	difficult to distinguish at 23 km downstream

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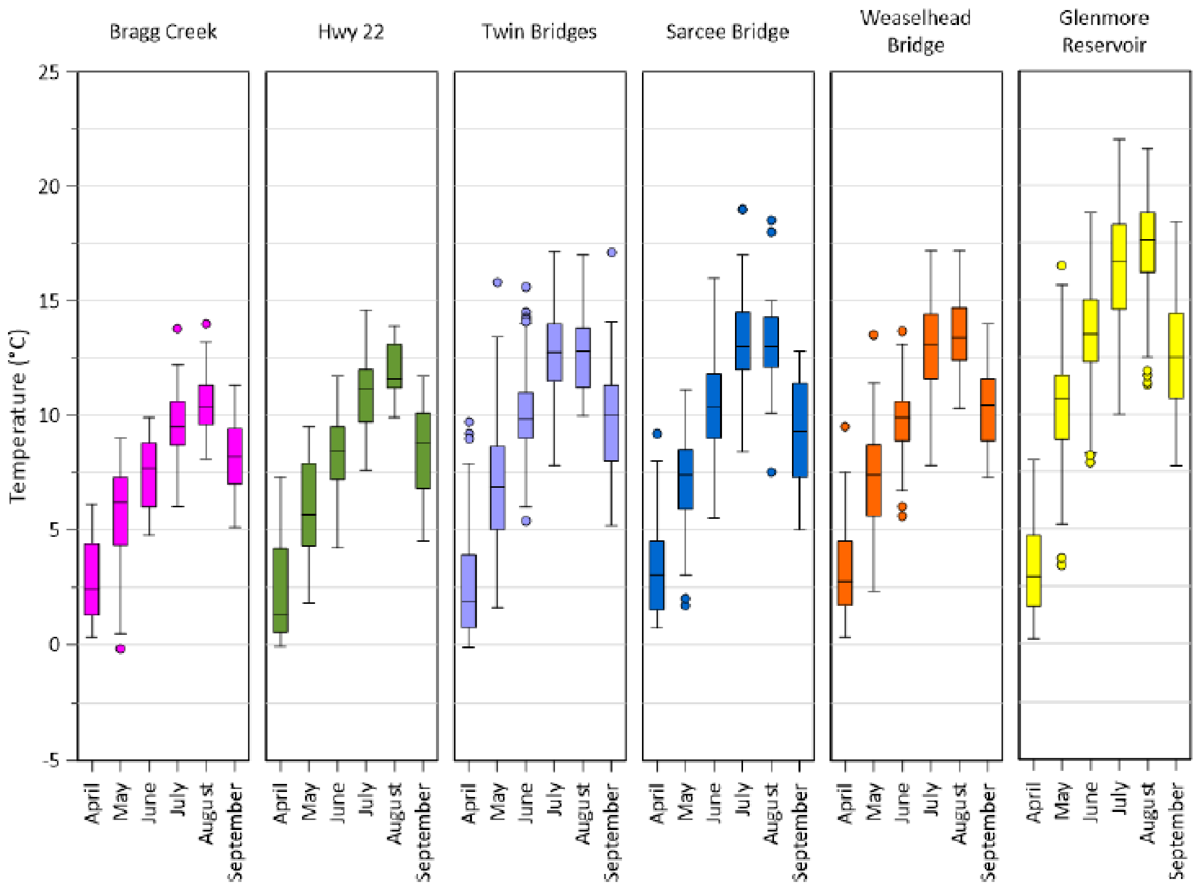

Figure 1-2 Historical Water Temperatures in Elbow River and Glenmore Reservoir (data range from 1979 through 2019)

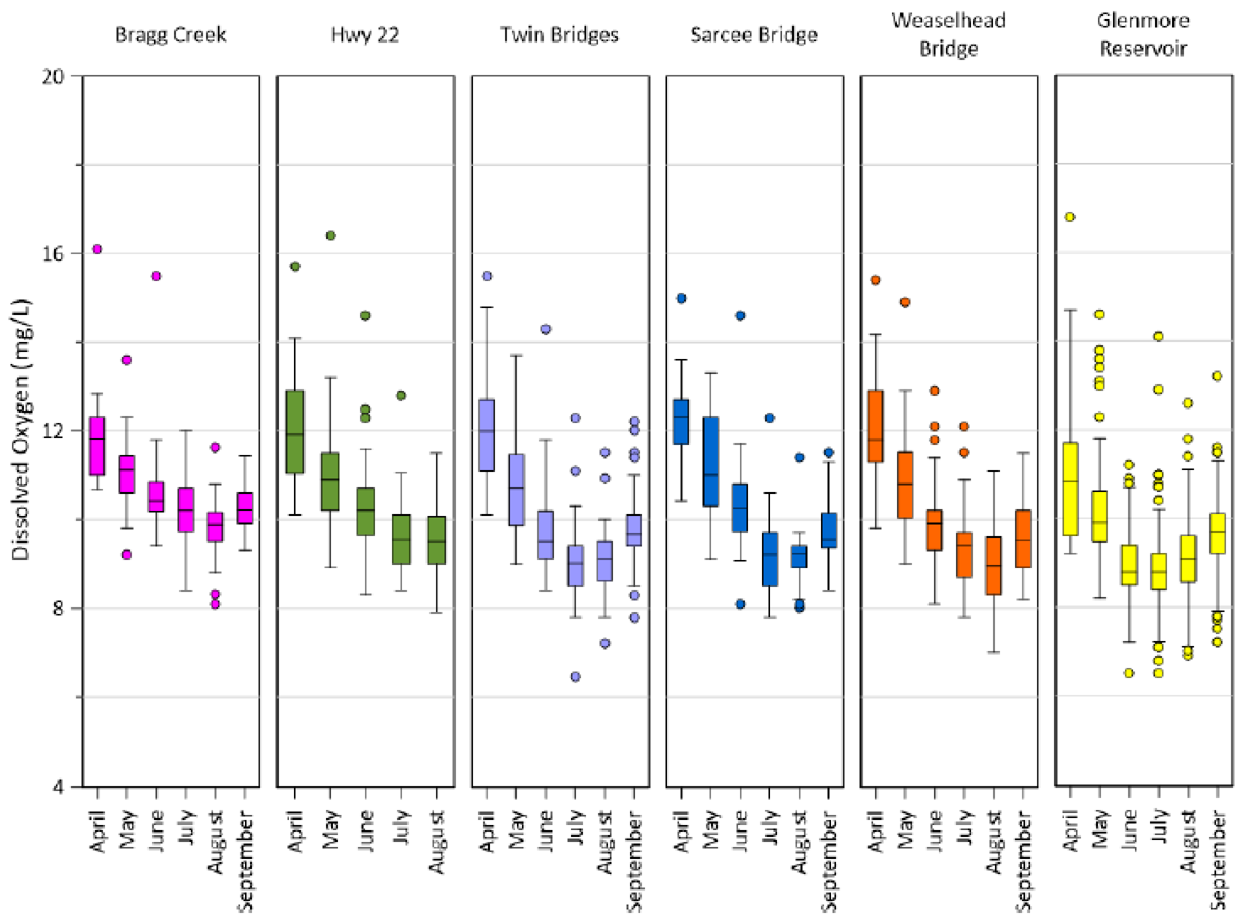

Figure 1-3 Historical Dissolved Oxygen Levels in Elbow River and Glenmore Reservoir (data range from 1979 through 2019)

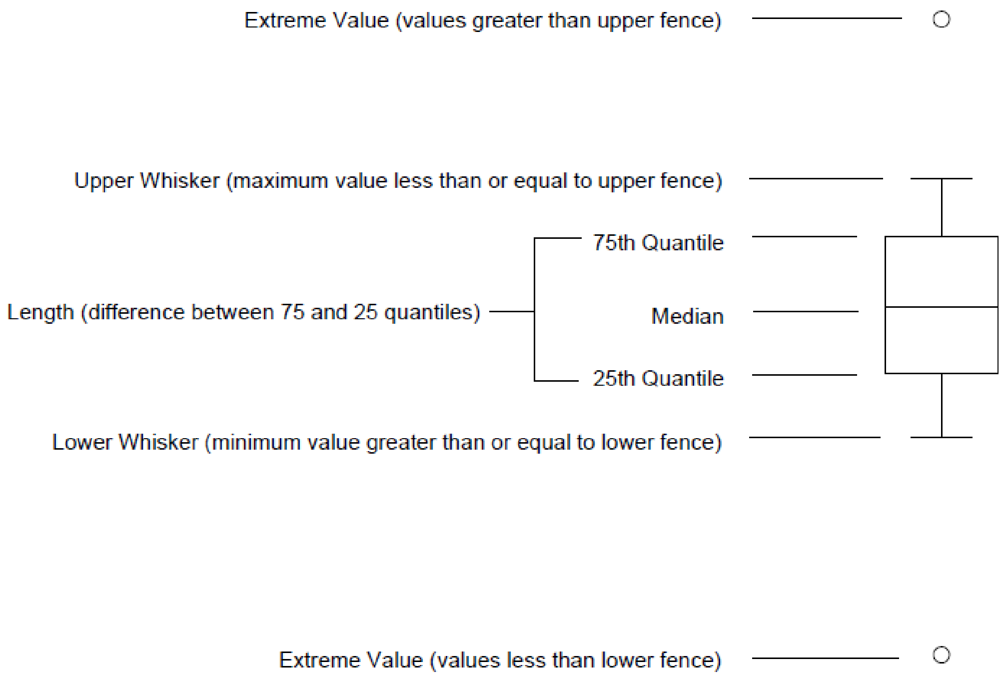

Figure 1-4 Description of Elements in Box and Whisker Plots

TEMPERATURE

Historical water temperatures in Elbow River downstream of the Project at Twin Bridges (13 km downstream of the unnamed creek where reservoir water will enter Elbow River) generally increases over the summer months with the highest temperatures reaching or exceeding 15˚C (Figure 1-2). Median historical temperatures at Twin Bridges generally range between 9˚C and 13˚C from June through August.

Thermal changes to water quality 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 on the river from released water are only expected to last two days; however, they will extend downstream for at least 24 km. Water temperatures will be monitored in the reservoir; however, due to the short duration, mitigations for increased water temperatures are not proposed or necessary.

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 reservoir water is released. Water temperature changes in Elbow River from the introduction of released water from the reservoir are not predicted to affect the viability of resident fish populations or aquatic biota. Water temperatures will be monitored because water temperatures are expected to increase more slowly in the reservoir than the river, mitigations are not expected to be necessary.

DISSOLVED OXYGEN

Median historic DO concentrations downstream of the Project at Twin Bridges generally range between 8 mg/L and 10 mg/L over the summer (from June through August).

The aquatic life guideline for DO (CCME 2002) for cold water freshwater environments is as follows:

- early life stages of fish and invertebrates, 9.5 mg/L
- other life stages, 6.5 mg/L

The greatest decrease in DO predicted in the reservoir is during the 1:10 year flood, late release. The reservoir water is shallow, held for several weeks (i.e., 42 days) and water temperatures rise considerably due to solar radiation and elevated air temperatures. Under these conditions, DO is predicted to decrease gradually over the duration water is held in the reservoir, to 2 mg/L. Releasing this water into Elbow River will cause a decrease in DO in Elbow River to 6 mg/L for a period of two days while the reservoir empties.

During the 1:100 year flood, late release, DO is predicted to decrease from 12 mg/L to 7.5 mg/L in the reservoir; DO is predicted to be below the CCME (2002) guideline of 9.5 mg/L for approximately one week before the reservoir is empty. This will cause the DO in Elbow River to decrease to 9 mg/L for the last two to three days water is being released; this is just below the CCME (2002) guideline of 9.5 mg/L. A decrease in DO in the river to 9 mg/L for two to three days may stress young resident fish, but it is not expected to cause an effect on Elbow River population.

Dissolved oxygen levels in the reservoir in the early release scenarios are not predicted to decrease to levels that will affect the viability of Elbow River fish populations. Dissolved oxygen will be monitored in the reservoir and Elbow River. Mitigations to increase DO levels in the reservoir are not considered practical.

BULL TROUT THERMAL TOLERANCE LEVELS

During a call on April 1, 2020 with the Impact Assessment Agency of Canada (IAAC), IAAC clarified that the question was intended to refer to bull trout rather than burbot.

Bull trout thermal tolerance levels (Selong and McMahon 2001; DFO 2017) are summarized as follows:

- Optimum growth temperature is the experimental temperature that supports the highest growth rate, which is 13.2˚C, for bull trout. Growth is reduced at both outer ranges of the data.
- Temperature preference is the temperature a bull trout gravitates to, which is less than 12˚C.
- Upper incipient lethal temperature is the temperature at which 50% of fish survive for an extended period of time in an experiment, which for young of the year is 20.9˚C for 60 days and 23.5˚C for 7 days (Selong and McMahon 2001). The upper incipient lethal temperature for juveniles and adults is slightly lower (DFO 2017).
- Critical thermal maxima is the temperature at which a species loses its equilibrium (i.e., ability to remain upright), which is 26.4˚C (acclimated at 8˚C) and 28.9˚C (acclimated at 20˚C).
- Optimum spawning temperature is the temperature most suitable for spawning, as measured by peak activity, which is 5˚C to 9˚C.
- Optimum egg development temperature is the temperature with the highest egg development rate, which is 1.2˚C to 5.4˚C.

Increases in water temperatures that exceed bull trout thermal tolerances are most likely to occur when water in the off-stream reservoir is shallow and held for a period of several weeks before being released, as is the case for the 1:10 year flood, late release (Table 1-1).

During the 1:10 year flood, late release, the reservoir water temperatures are predicted to increase to 22˚C for the last one to two days water is in the reservoir. This will cause water temperatures to exceed the upper incipient lethal temperature for bull trout for those one to two days when water is at its most shallow. Optimum spawning temperature and optimum egg development temperatures for bull trout are not relevant in the off-stream reservoir.

During the 1:100 year flood and design flood, water levels in the reservoir are sufficiently deep to prevent water temperatures from rising to levels considered detrimental to bull trout.

Mitigation to Attract Fish to the Low-Level Outlet

Alberta Transportation has considered using fish attractants to encourage fish in the reservoir to exit the low-level outlet. Attractants such as light are somewhat effective in attracting younger life stages of some species (Kelso and Rutherford 1986). However, as fish age, some species become negatively phototaxic (Feist and Anderson 1991). Vowles and Kemp (2012) found the addition of a light source delayed the downstream movement of brown trout (mean size, 242 mm length) through a downstream velocity gradient (i.e., through a flume). Without more study on this topic, the use of light as an attractant is expected to have positive and negative effects.

Chemical and food attractants are considered impractical; due to the movement of water in and around the low-level outlet: attractants will disperse into the flow out through the low-level outlet rather than disperse into the reservoir where fish are holding.

The use of electrical impulses during electrofishing may repel fish and be useful in "herding" fish toward the low-level outlet. However, electrical stimuli may induce stress on fish, causing them to seek refuge in deeper water or under cover rather than attempt to manage the additional stress of maneuvering through a velocity gradient in the low-level outlet.

The use of attractants to encourage fish to enter the low-level outlet appears to have the unintended consequence of hindering downstream fish passage (Vowles and Kemp 2012). Reducing stress on fish in the reservoir by not applying mitigations to encourage them to leave and allowing them to manage the downstream velocity gradient on their own seems to be the most effective option.

ii. ***Water Quality in the Reservoir and Elbow River at the Time of Release***

An early release of the reservoir provides some benefits to water quality over late release (i.e., temperature in the reservoir does not increase in the early release scenario compared to the 1:10 year flood late release scenario). However, in some cases, a late release has benefits over early release: during the 1:100 year flood, late release, there is more time for suspended sediments to deposit in the reservoir, thereby reducing effects to fish in the river and decreasing the concentration of nutrients released from the reservoir. Water quality in the reservoir and effects on Elbow River are discussed below.

Water quality will be monitored in the reservoir when water is being held and during reservoir drawdown. Early release is intended to avoid the effects associated with changing water quality.

Changes in water quality and effects on fish are discussed below.

SUSPENDED SEDIMENTS

An updated Mike 21 FM - MT (mud transport) module modelled without the Project (no Project), early release and late release for the 1:10 year, 1:100 year and the design flood (2013) hydrographs (see Appendix 1-2 for additional details). 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 the flow in Elbow River is less than 20 m^3/s.

To understand water quality related to total suspended solids (TSS), Canadian Council of Ministers of the Environment (CCME) TSS guidelines for the protection of aquatic life are used to determine exceedances during the release of water held in the reservoir:

- 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.

Exceedances calculated as occurring prior to release from the low-level outlet works (LLOW) are likely due to reworking of deposited fine-grained sediment by Elbow River and are excluded. The results from the no Project, 1:10 year, 1:100 year and design flood (2013) floods are used as baselines to predict exceedances. The predicted exceedances, therefore, capture the effect of the Project on TSS in Elbow River. Exceedances are predicted at 12 sites within Elbow River between the unnamed creek and the Glenmore Reservoir. The sites are distributed in Elbow River starting immediately downstream of the confluence of the unnamed creek with Elbow River and extend downstream to the Glenmore Reservoir. The locations of the sites are shown in Figure 1-5.

Figure 1-6 shows an example of one of the plots generated to show TSS concentrations at the sites for each flood and for early release and late release. Figure 1-7, Figure 1-8 and Figure 1-9 show the predicted TSS concentrations and the predicted exceedances over time at 12 sites for the 1:10 year, 1:100 year and design flood (2013) hydrographs, respectively for early release. Figure 1-10, Figure 1-11 and Figure 1-12 show the predicted TSS concentrations and the predicted exceedances over time at the 12 sites for the 1:10 year, 1:100 year and design flood (2013) hydrographs, 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.

In Figure 1-6, 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 no Project (i.e., baseline) represented by the black line and the early release of the Project case 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 Project 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 shows the TSS concentrations during early release; the start of the release is represented by the vertical green line (Figure 1-6). The no Project (black line) and 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 does not differentiate between the type of exceedance.

Table 1-3, Table 1-4, Table 1-5 show the duration of exceedance (in days), mean TSS and maximum TSS predicted for the 1:10 year flood, 1:100 year flood and design flood (2013) hydrographs, respectively, for each of the 12 sites. The calculation of exceedances uses the respective no Project model results as the baseline; therefore, the time of exceedance captures the Project effect.

In summary, for the 1:10 year flood, late release results show suspended sediment concentrations similar to the baseline concentrations in Elbow River. The 1:10 year flood, late release has no exceedances for the 12 sites analyzed. The 1:10 year flood, 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 the 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.

Spatially, the results show that exceedances occur from the LLOW channel to Glenmore Reservoir following a 1:10 year flood, early release only; a 1:100 year flood for both early release and late release; and design flood for both early release and late release. The 1:10 year flood, late release does not result in any exceedances.

The results of the no Project model are used to represent background conditions for identifying which water quality exceedance category to use for determining exceedances for each modelling scenario.

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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Figure 1-5

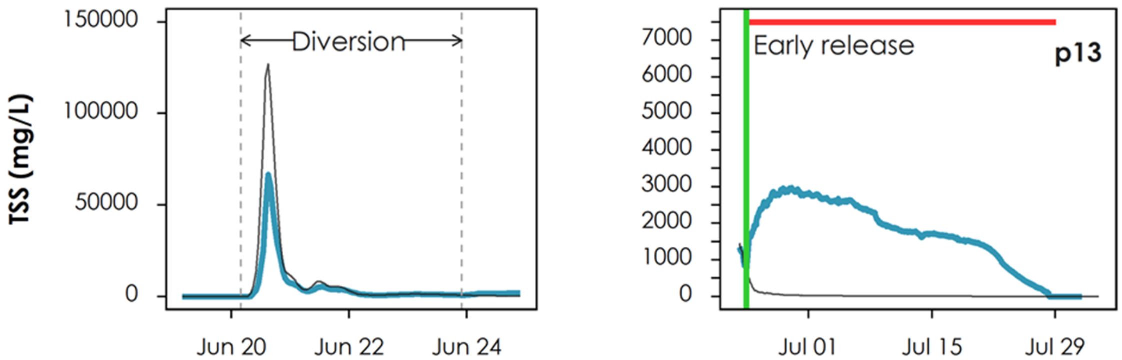


Figure 1-6 Example Diagram of Exceedance Plots

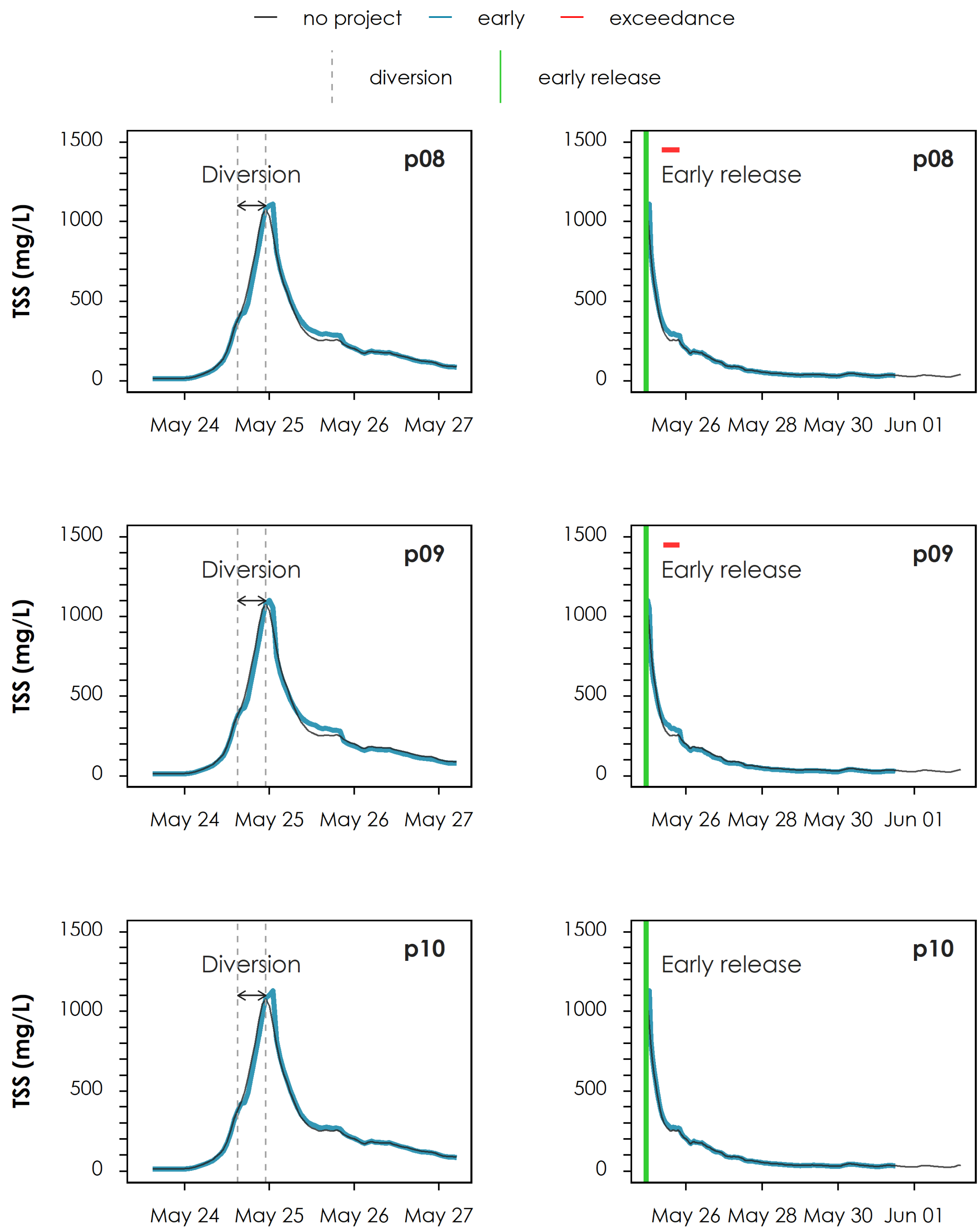


Figure 1-7 Exceedances and TSS Concentrations, Early Release for Locations Between the LLOW and Glenmore Dam for the 1:10 Year Hydrograph

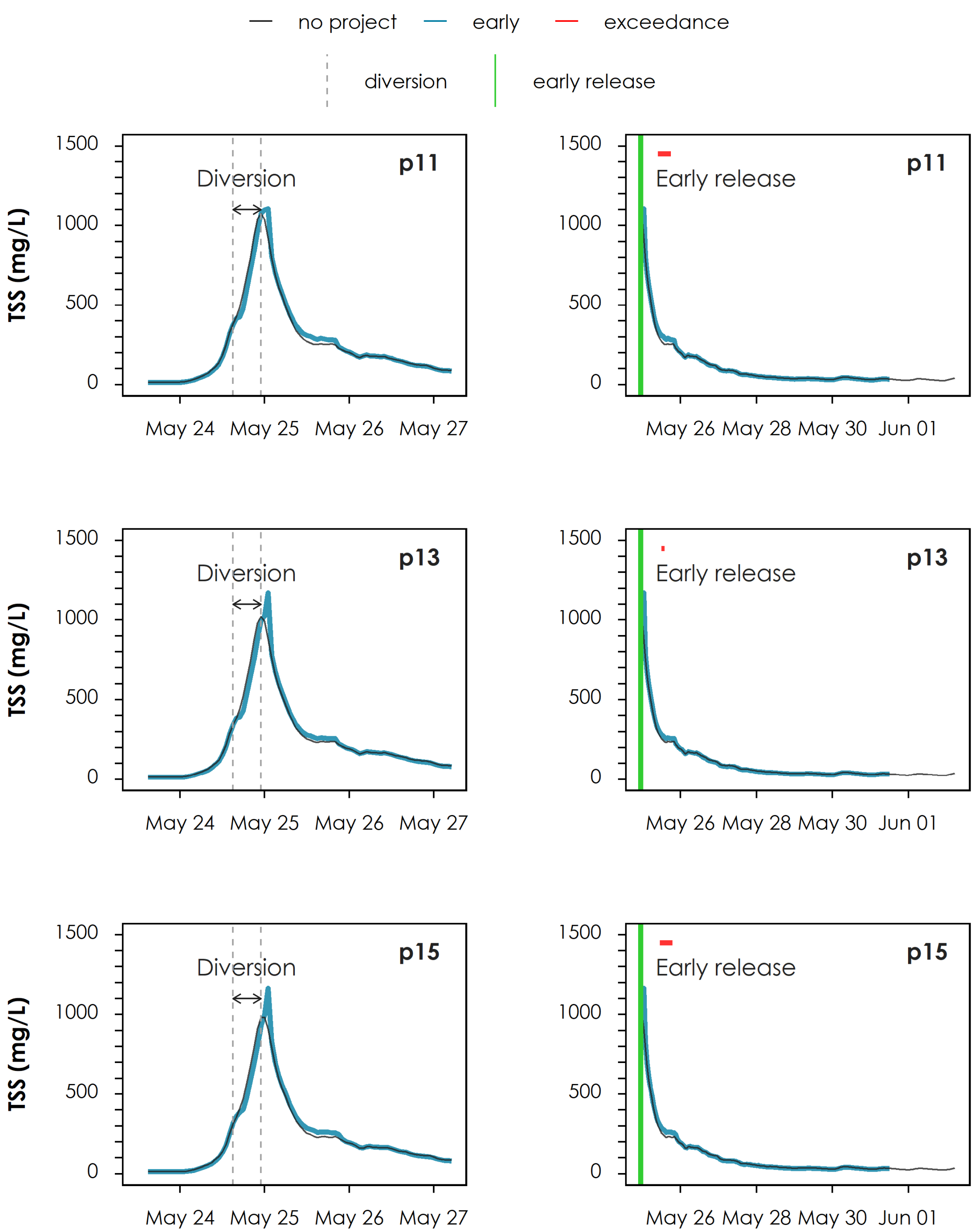


Figure 1-7 Exceedances and TSS Concentrations, Early Release for Locations Between the LLOW and Glenmore Dam for the 1:10 Year Hydrograph (cont'd)

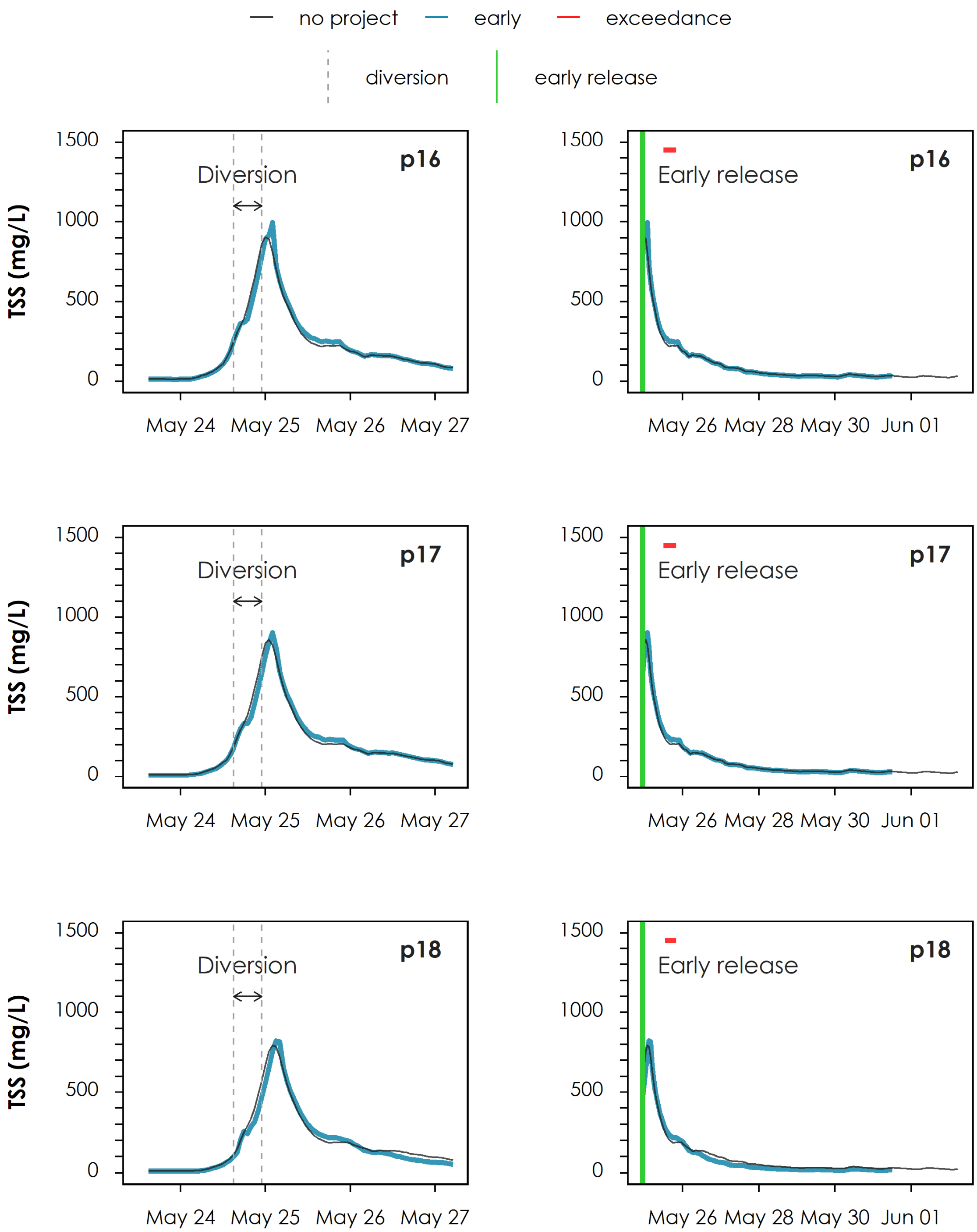


Figure 1-7 Exceedances and TSS Concentrations, Early Release for Locations Between the LLOW and Glenmore Dam for the 1:10 Year Hydrograph (cont'd)

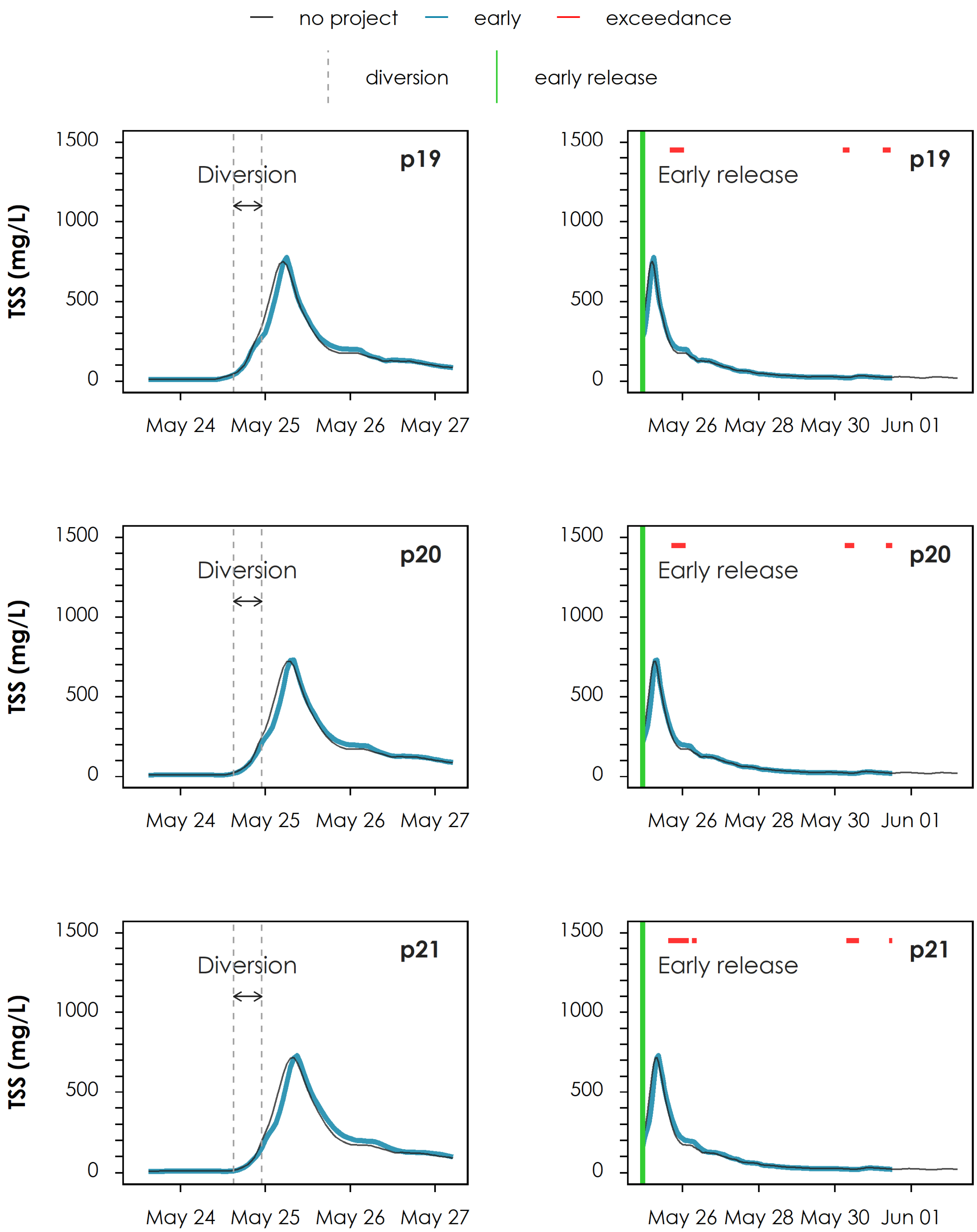


Figure 1-7 Exceedances and TSS Concentrations, Early Release for Locations Between the LLOW and Glenmore Dam for the 1:10 Year Hydrograph (cont'd)

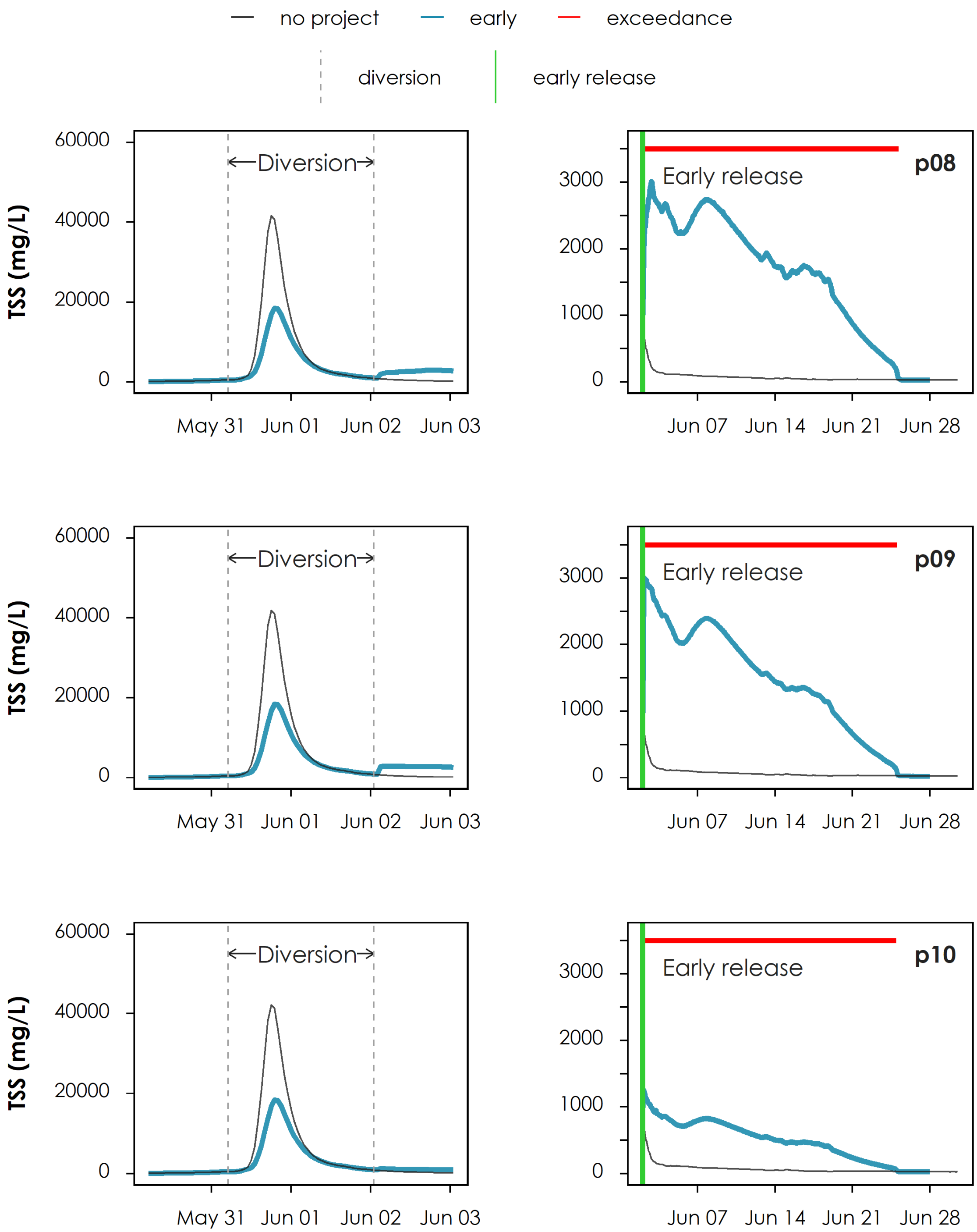


Figure 1-8 Exceedances and TSS Concentrations, Early Release for Locations Between the LLOW and Glenmore Dam Predicted for the 1:100 Year Hydrograph

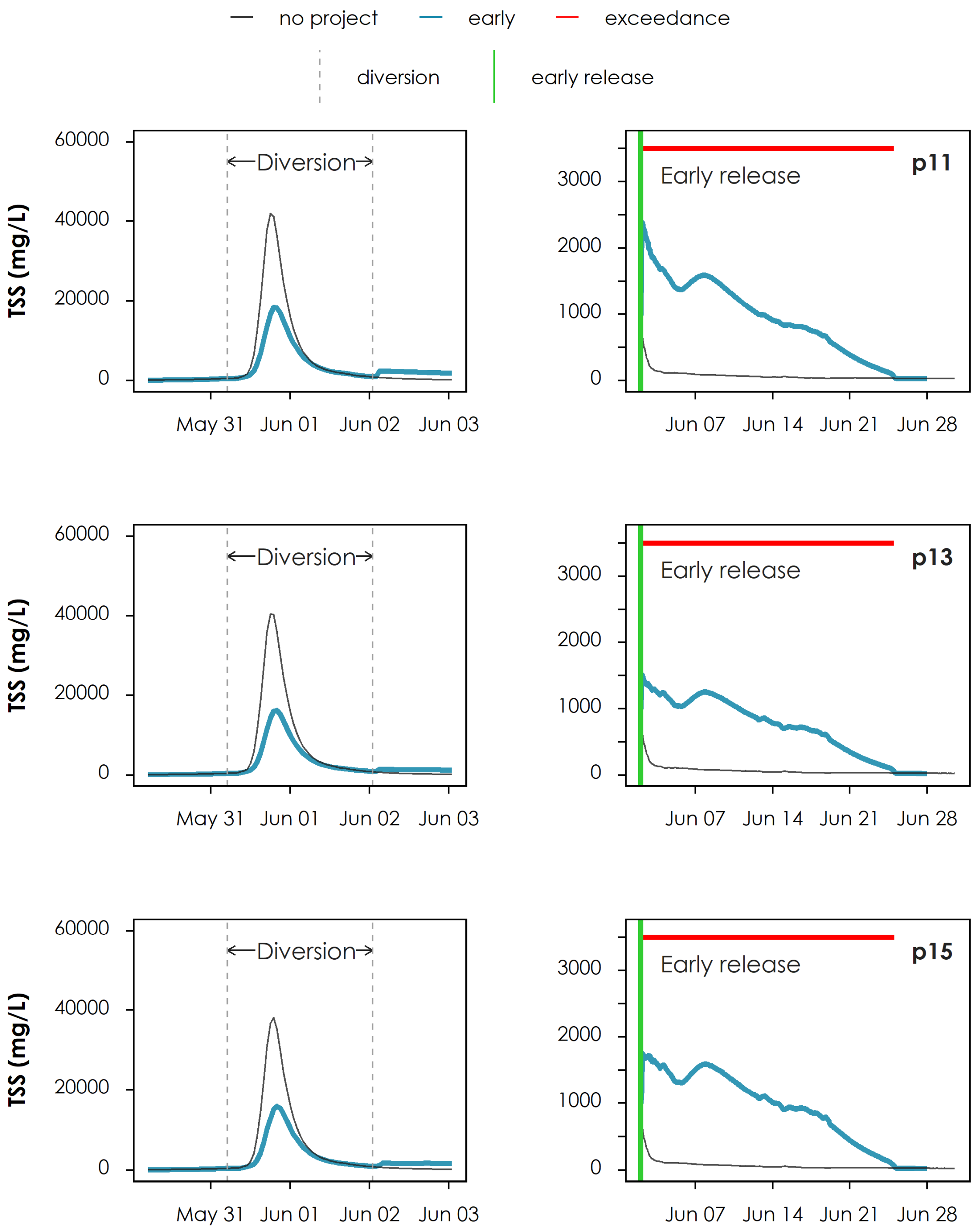


Figure 1-8 Exceedances and TSS Concentrations, Early Release for Locations Between the LLOW and Glenmore Dam Predicted for the 1:100 Year Hydrograph (cont'd)

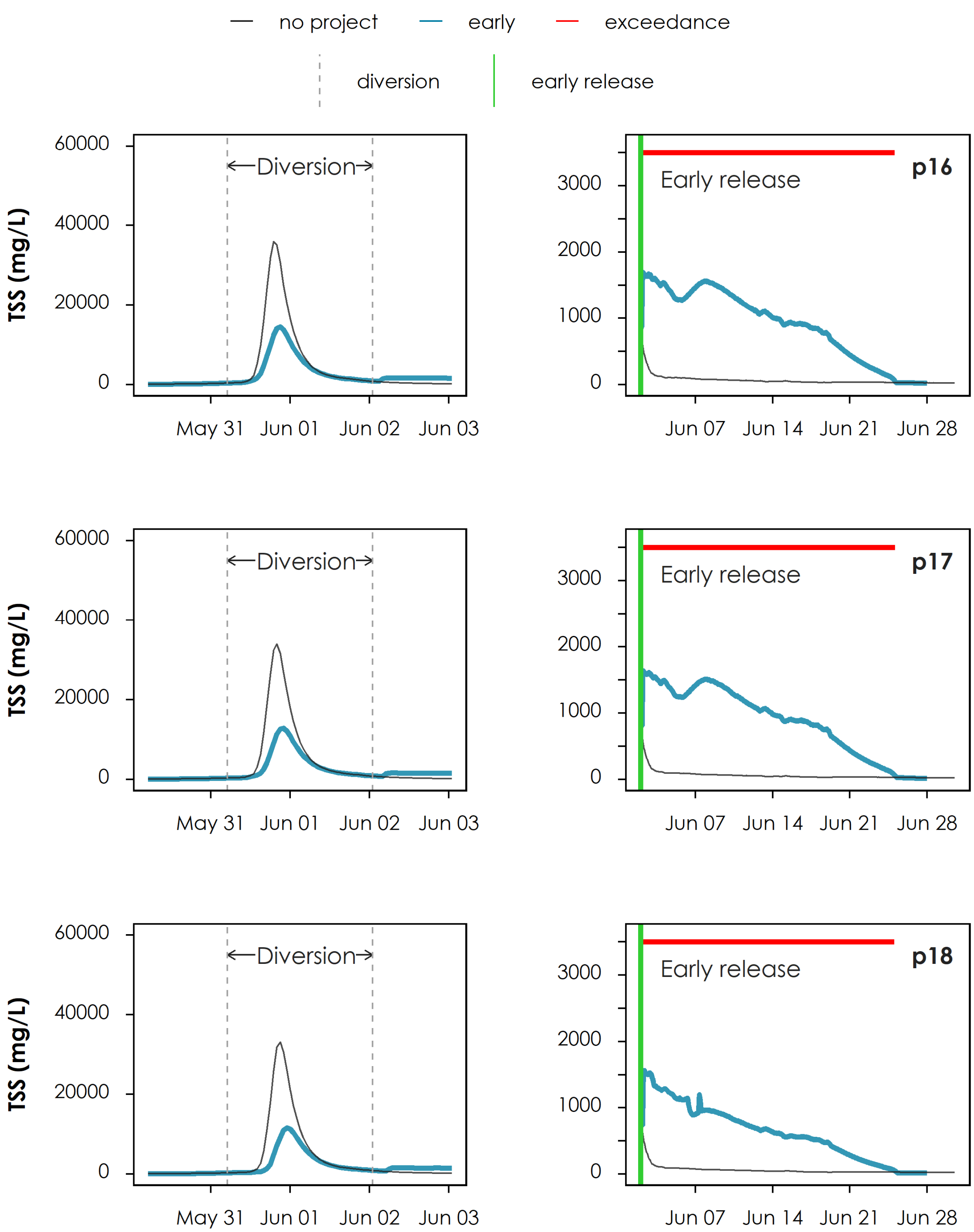


Figure 1-8 Exceedances and TSS Concentrations, Early Release for Locations Between the LLOW and Glenmore Dam Predicted for the 1:100 Year Hydrograph (cont'd)

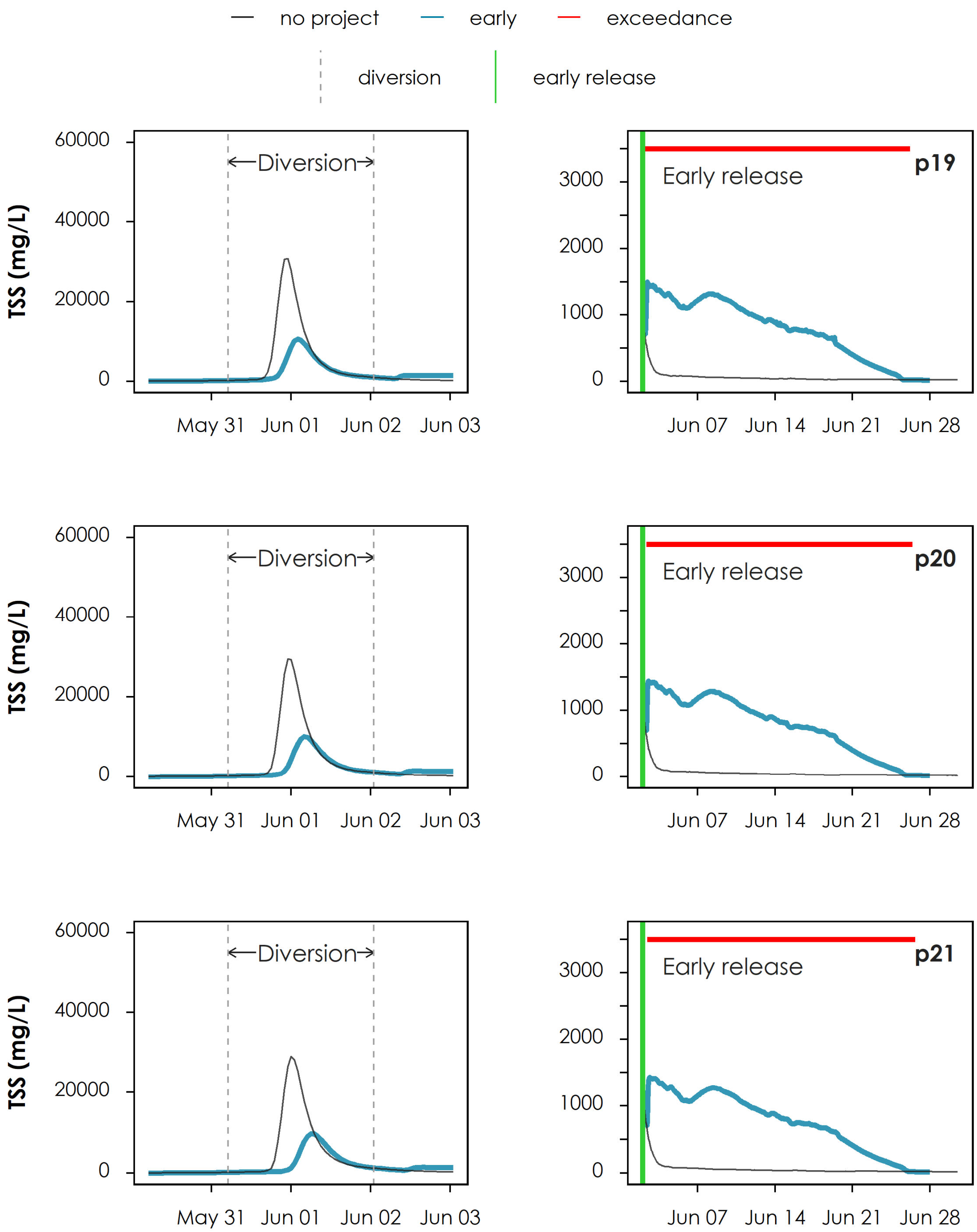


Figure 1-9 Exceedances and TSS Concentrations, Early Release for Locations Between the LLOW and Glenmore Dam Predicted for the Design Flood (2013)

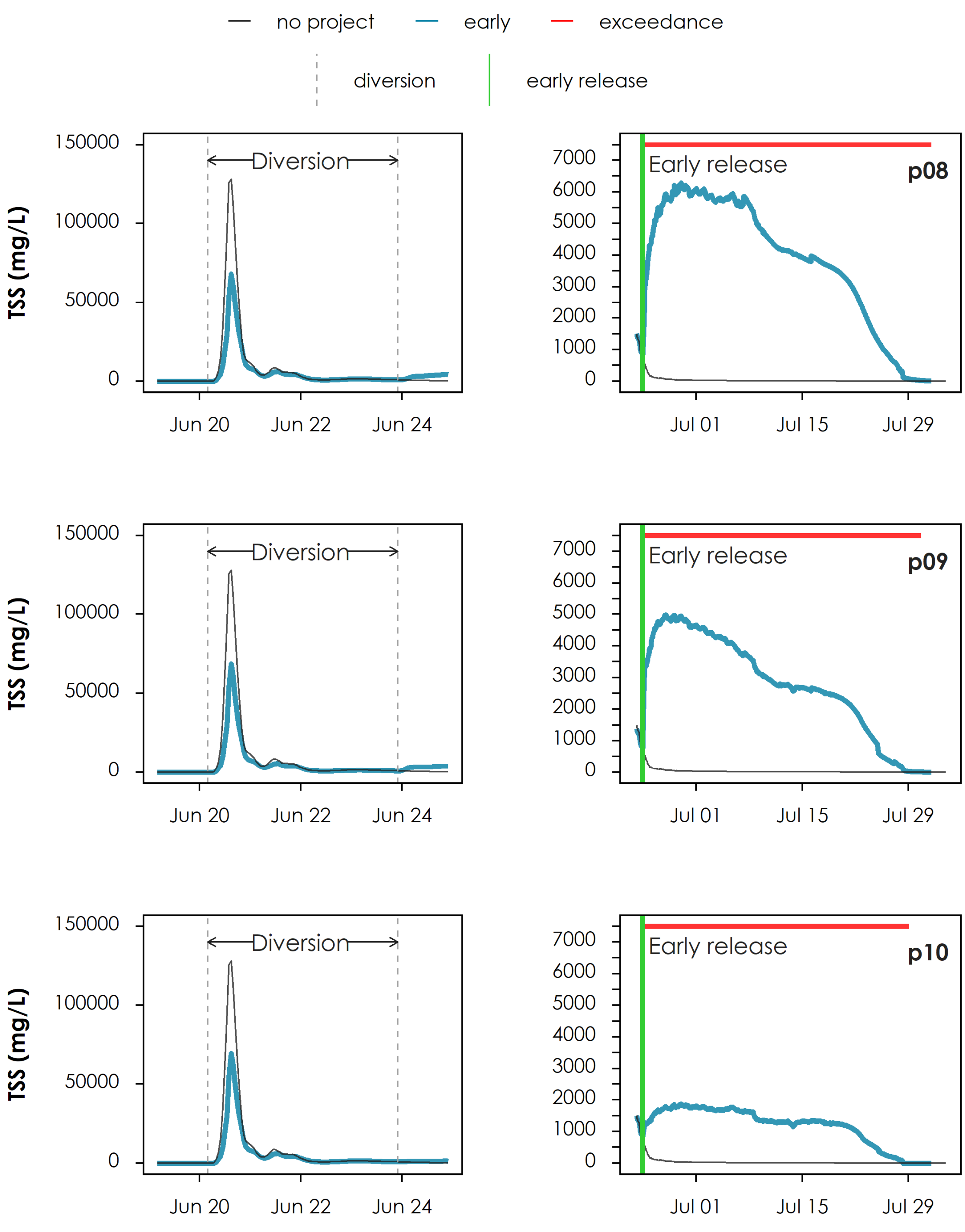


Figure 1-9 Exceedances and TSS Concentrations, Early Release for Locations Between the LLOW and Glenmore Dam Predicted for the Design Flood (2013) (cont'd)

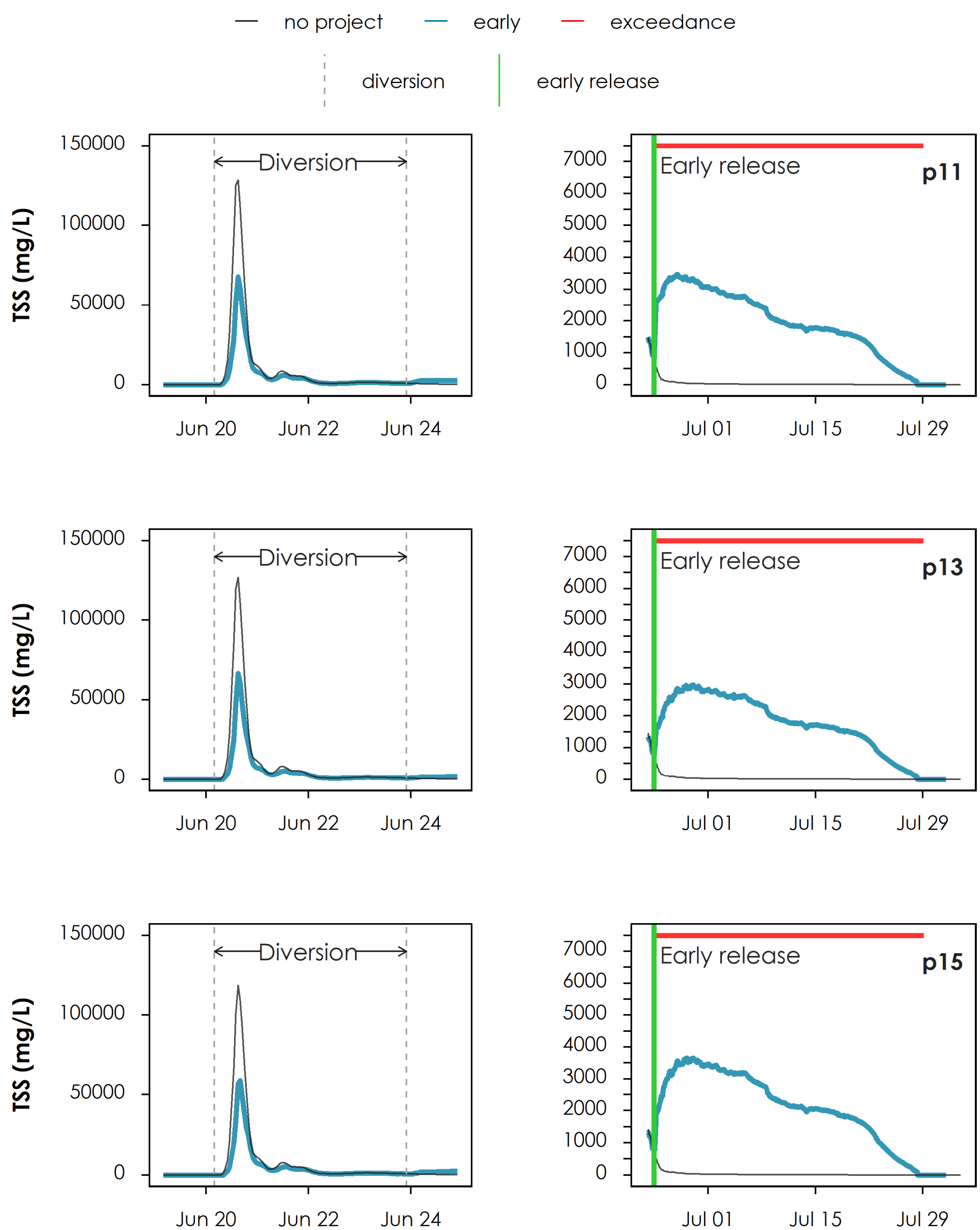


Figure 1-9 Exceedances and TSS Concentrations, Early Release for Locations Between the LLOW and Glenmore Dam Predicted for the Design Flood (2013) (cont'd)

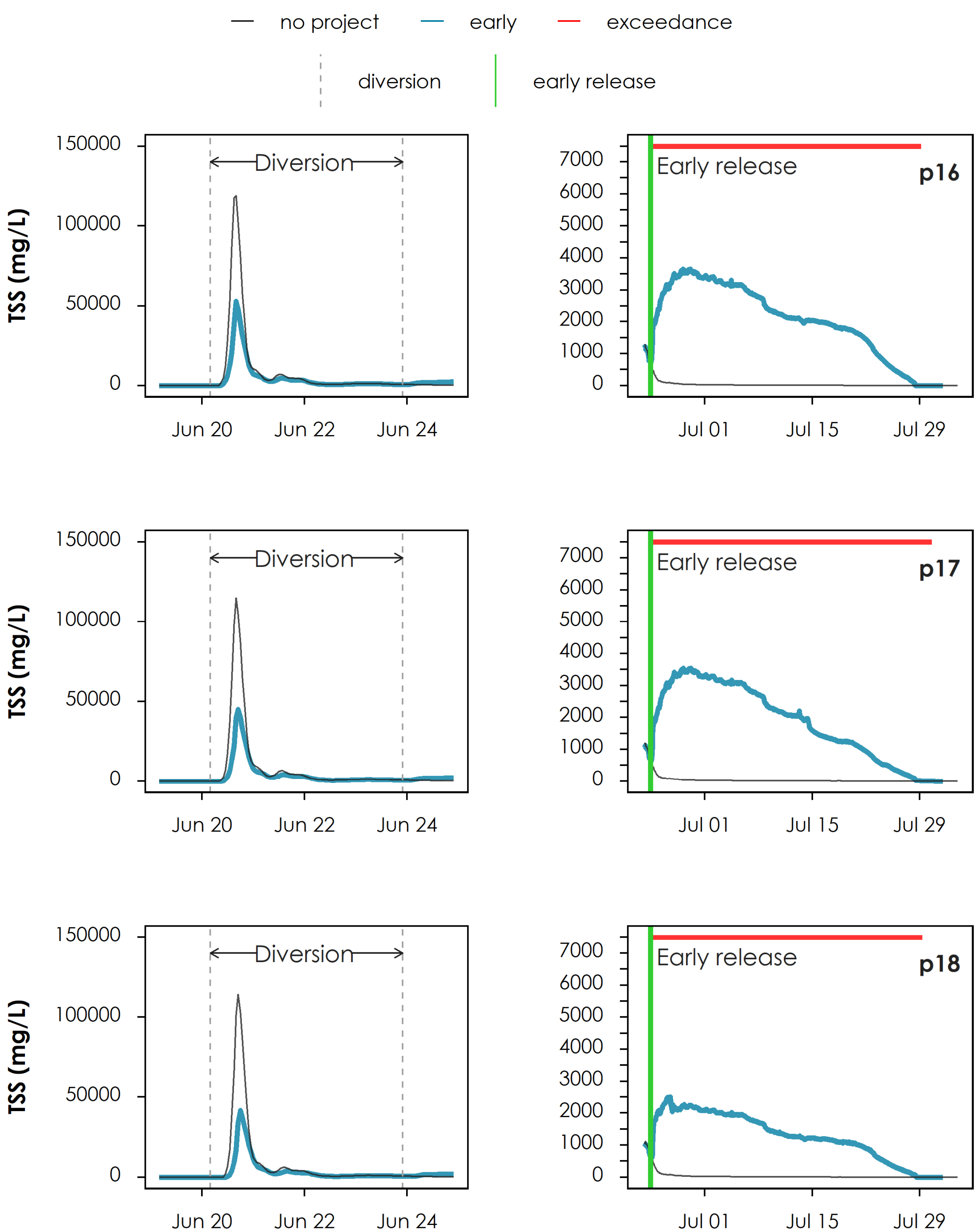


Figure 1-9 Exceedances and TSS Concentrations, Early Release for Locations Between the LLOW and Glenmore Dam Predicted for the Design Flood (2013) (cont'd)

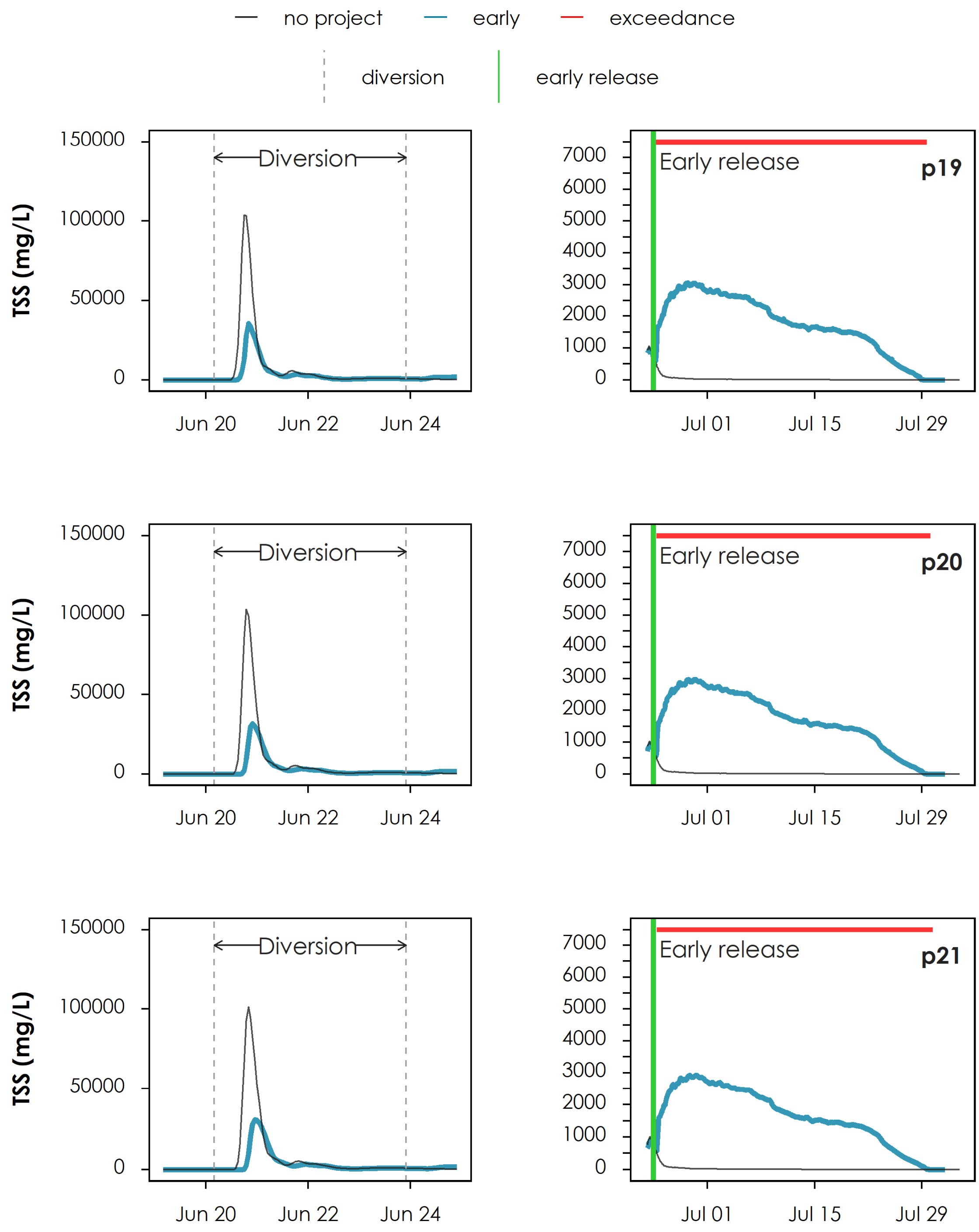
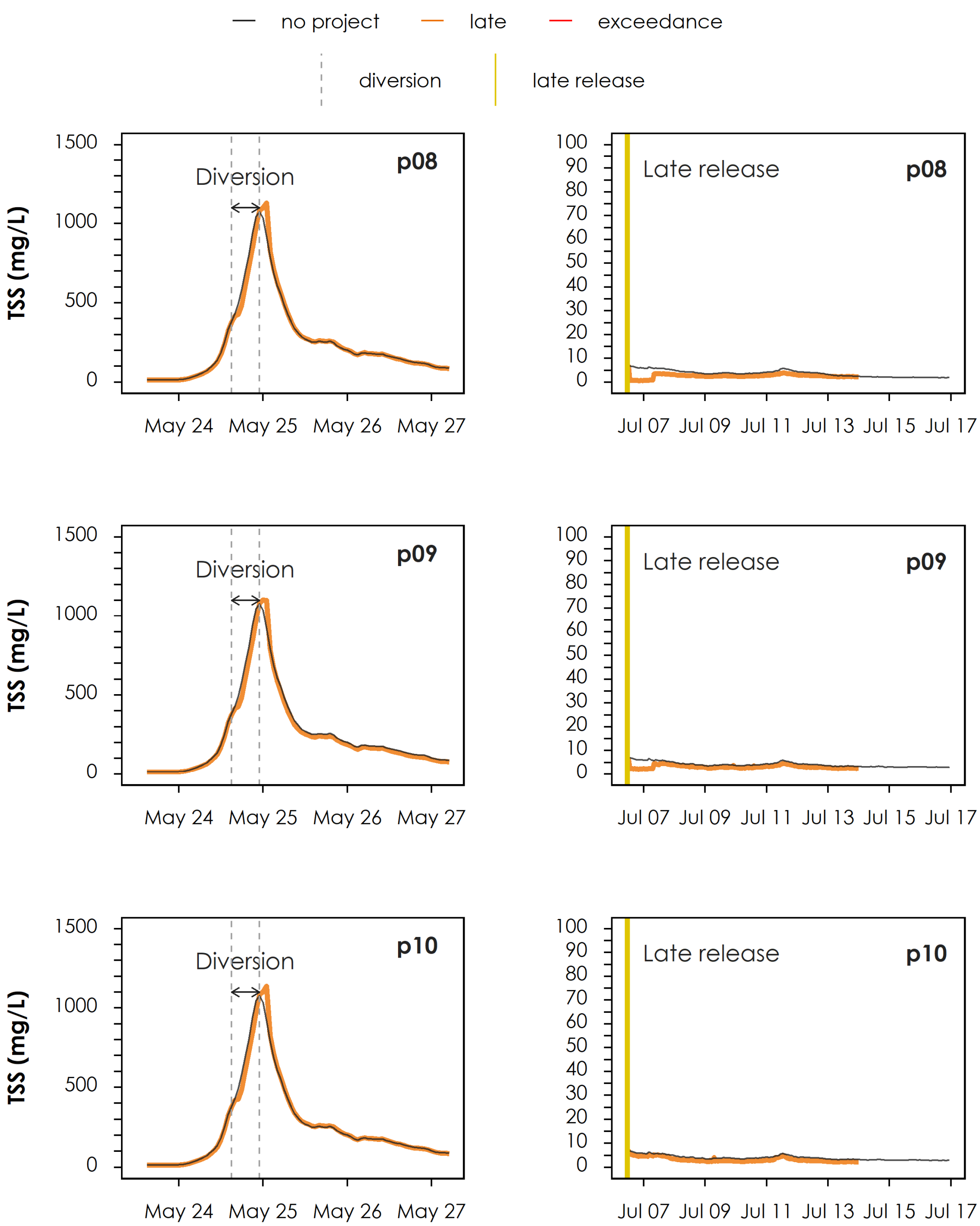
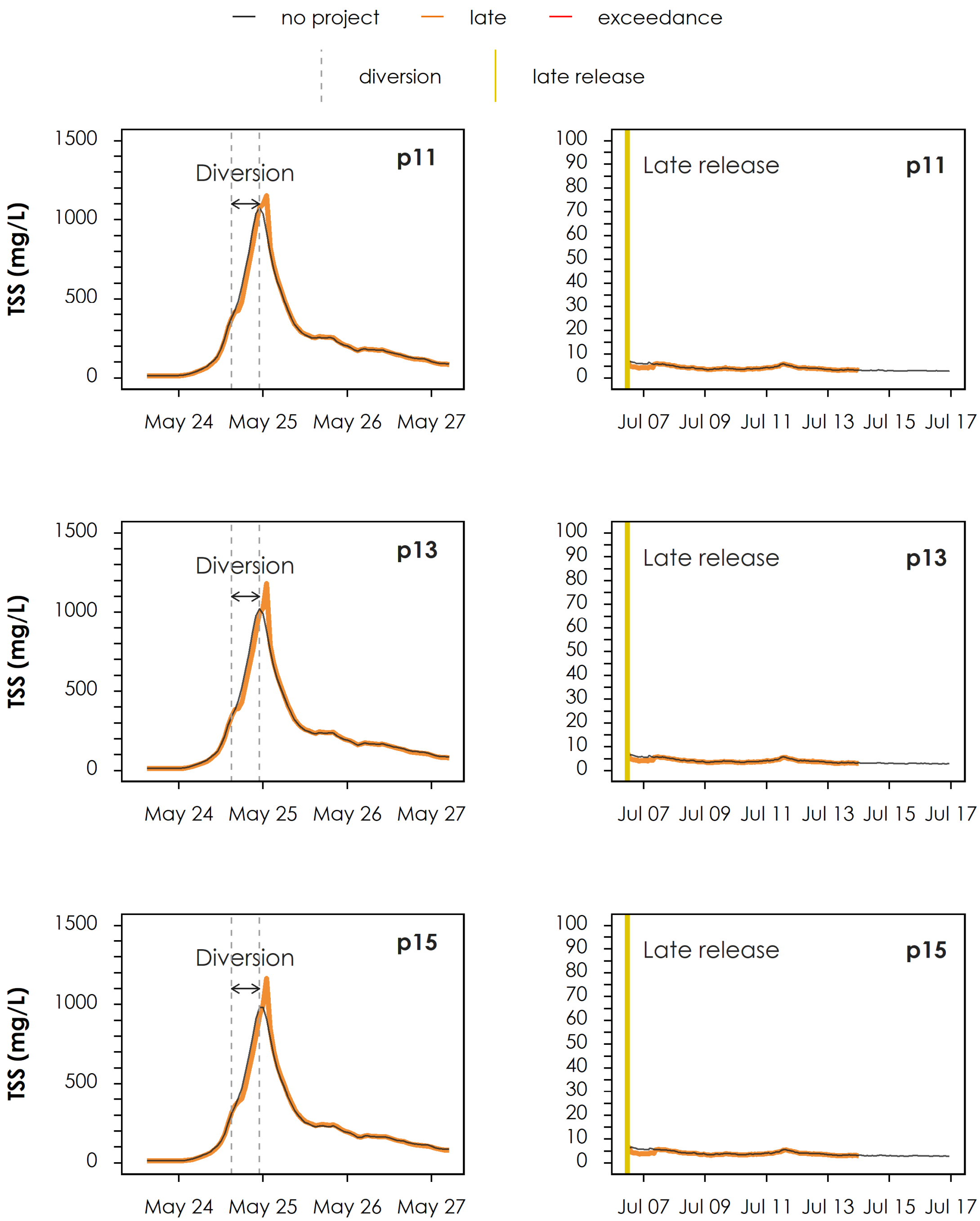


Figure 1-9 Exceedances and TSS Concentrations, Early Release for Locations Between the LLOW and Glenmore Dam Predicted for the Design Flood (2013) (cont'd)



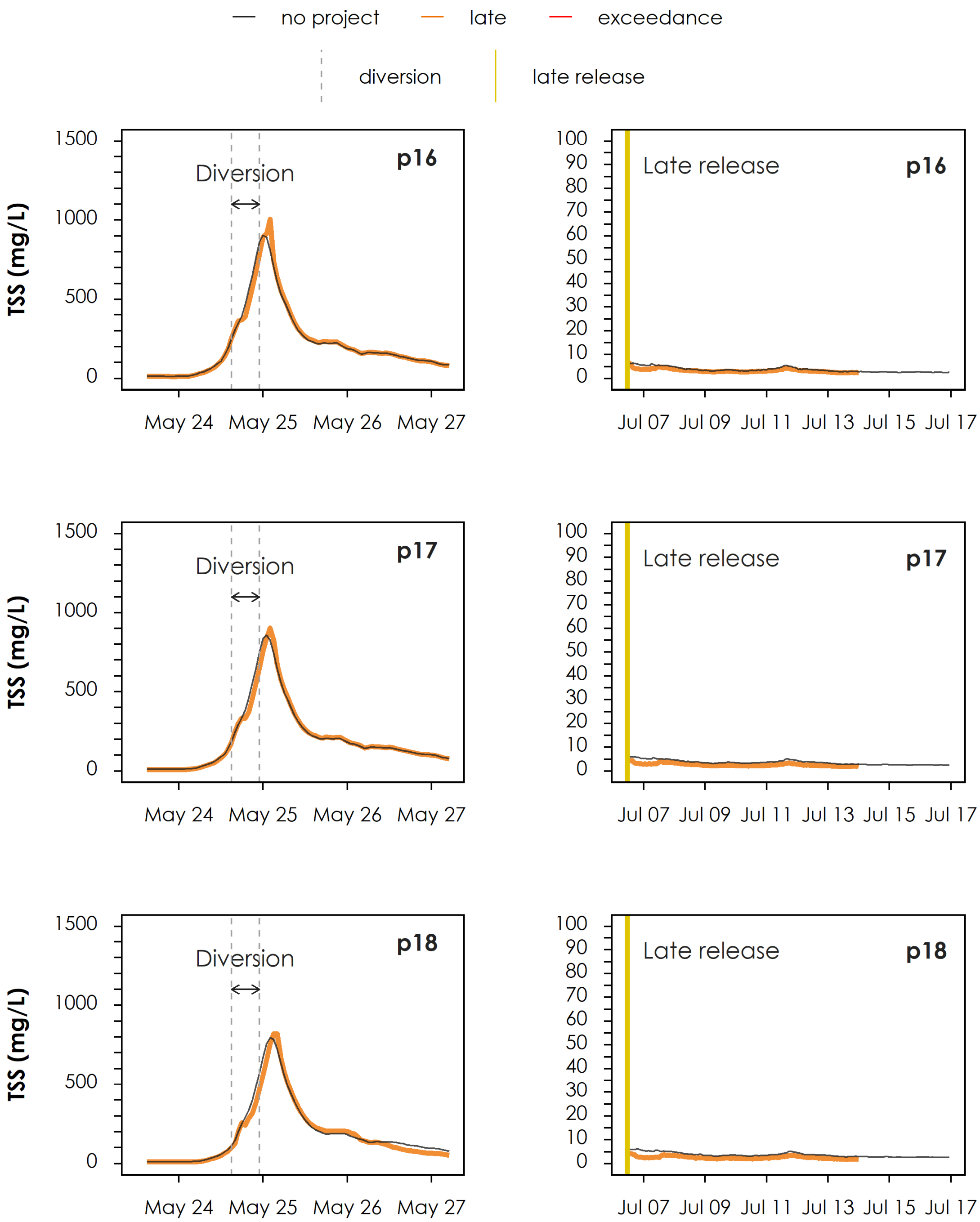
NOTE: at the beginning of late release, the TSS concentrations are initially low due to the residence time in the reservoir

Figure 1-10 Exceedances and TSS Concentrations, Late Release for Locations Between the LLOW and Glenmore Dam for the 1:10 Year Hydrograph



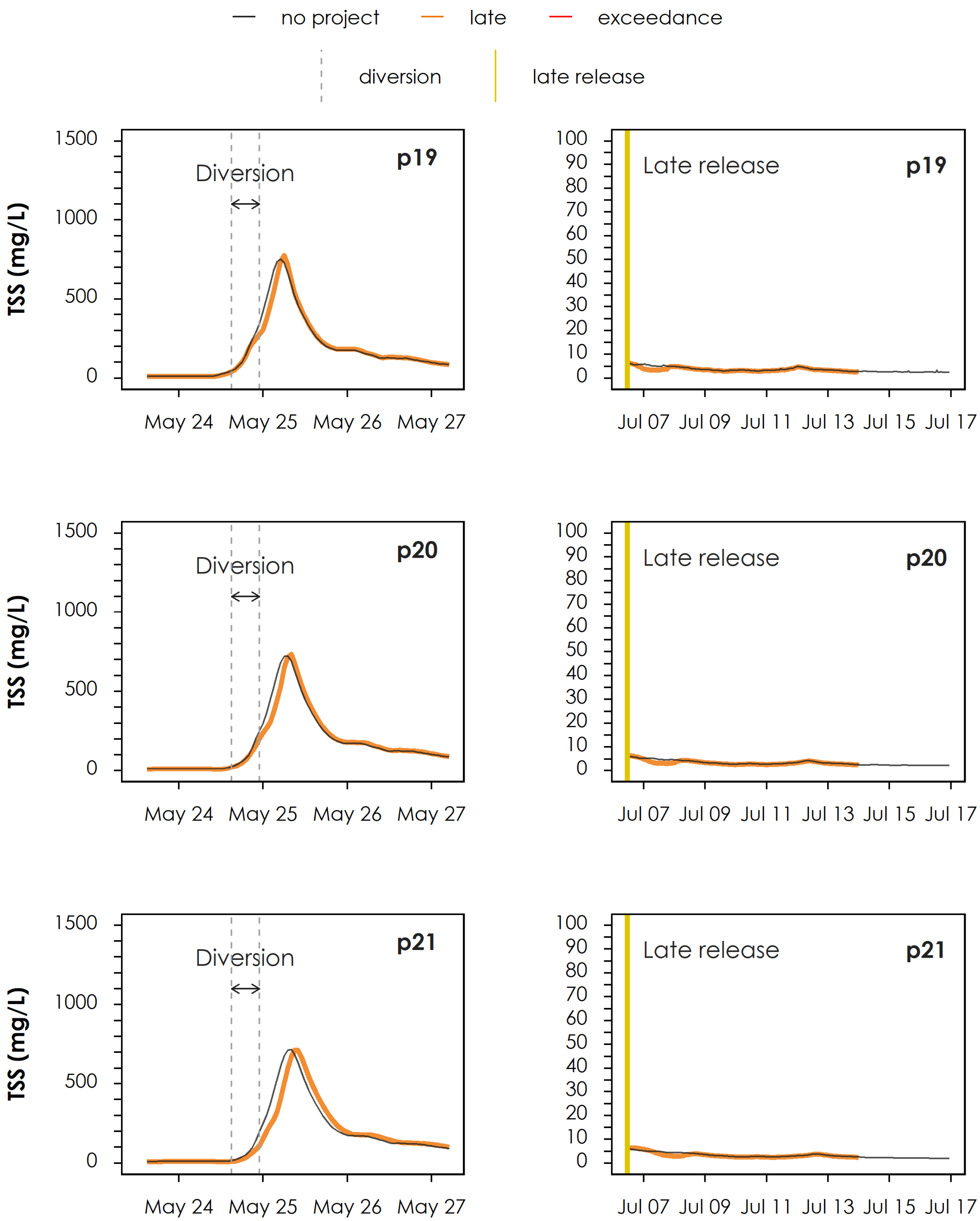
NOTE: at the beginning of late release, the TSS concentrations are initially low due to the residence time in the reservoir

Figure 1-10 Exceedances and TSS Concentrations, Late Release for Locations Between the LLOW and Glenmore Dam for the 1:10 Year Hydrograph (cont'd)



NOTE: at the beginning of late release, the TSS concentrations are initially low due to the residence time in the reservoir

Figure 1-10 Exceedances and TSS Concentrations, Late Release for Locations Between the LLOW and Glenmore Dam for the 1:10 Year Hydrograph (cont'd)



NOTE: at the beginning of late release, the TSS concentrations are initially low due to the residence time in the reservoir

Figure 1-10 Exceedances and TSS Concentrations, Late Release for Locations between the LLOW and Glenmore Dam for the 1:10 year Hydrograph (cont'd)

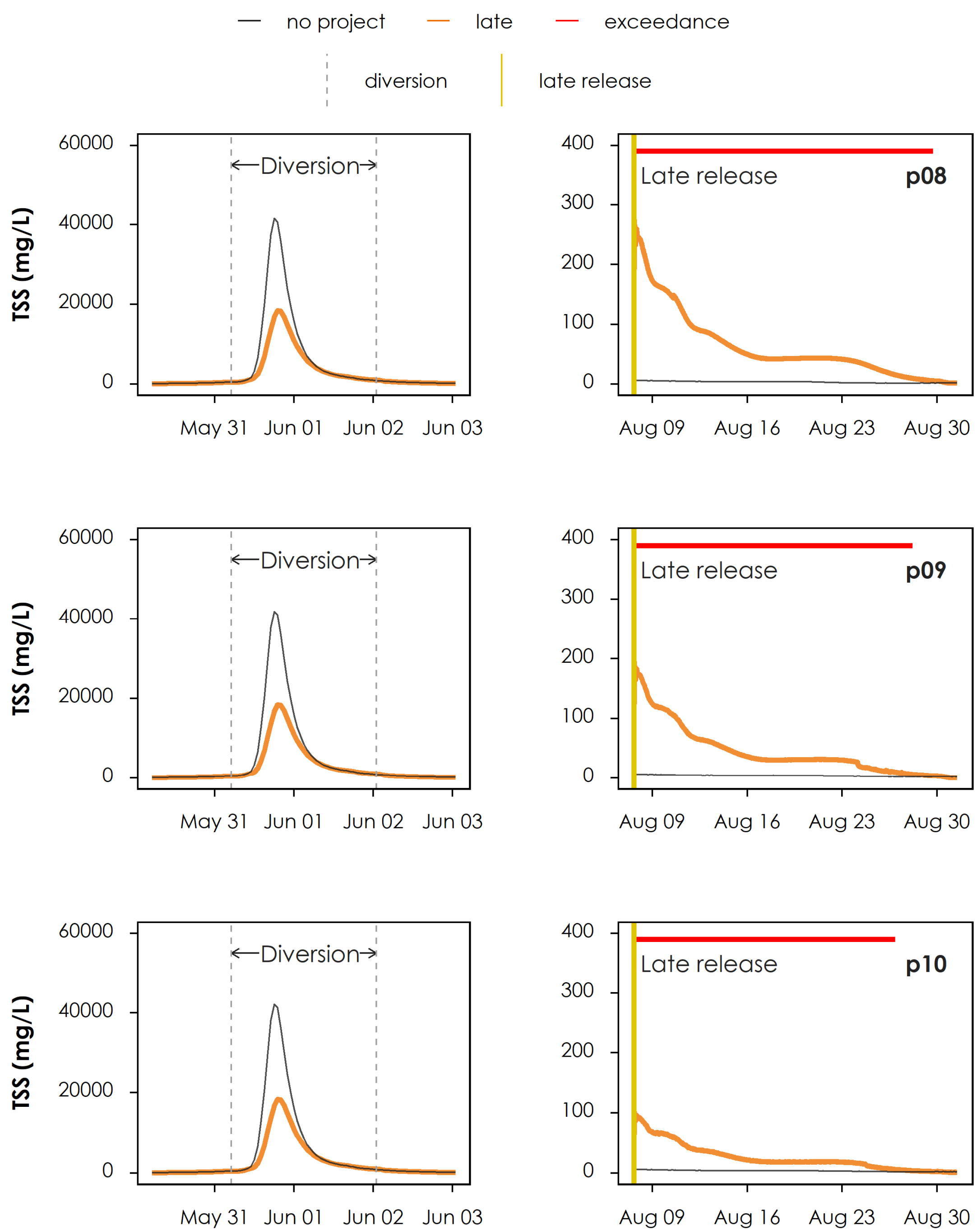


Figure 1-11 Exceedances and TSS Concentrations, Late Release for Locations Between the LLOW and Glenmore Dam Predicted for the 1:100 Year Hydrograph

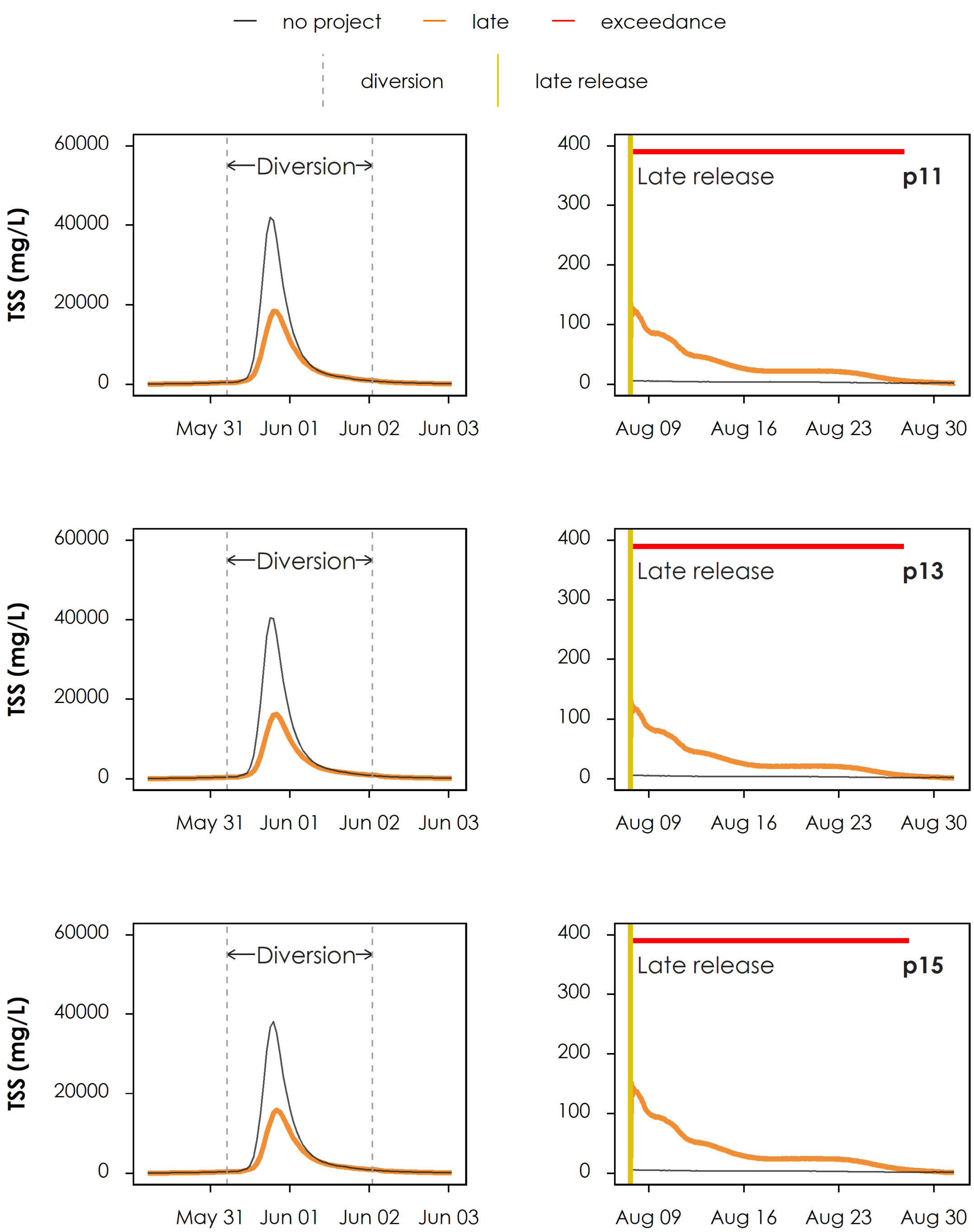


Figure 1-11 Exceedances and TSS Concentrations, Late Release for Locations Between the LLOW and Glenmore Dam Predicted for the 1:100 Year Hydrograph (cont'd)

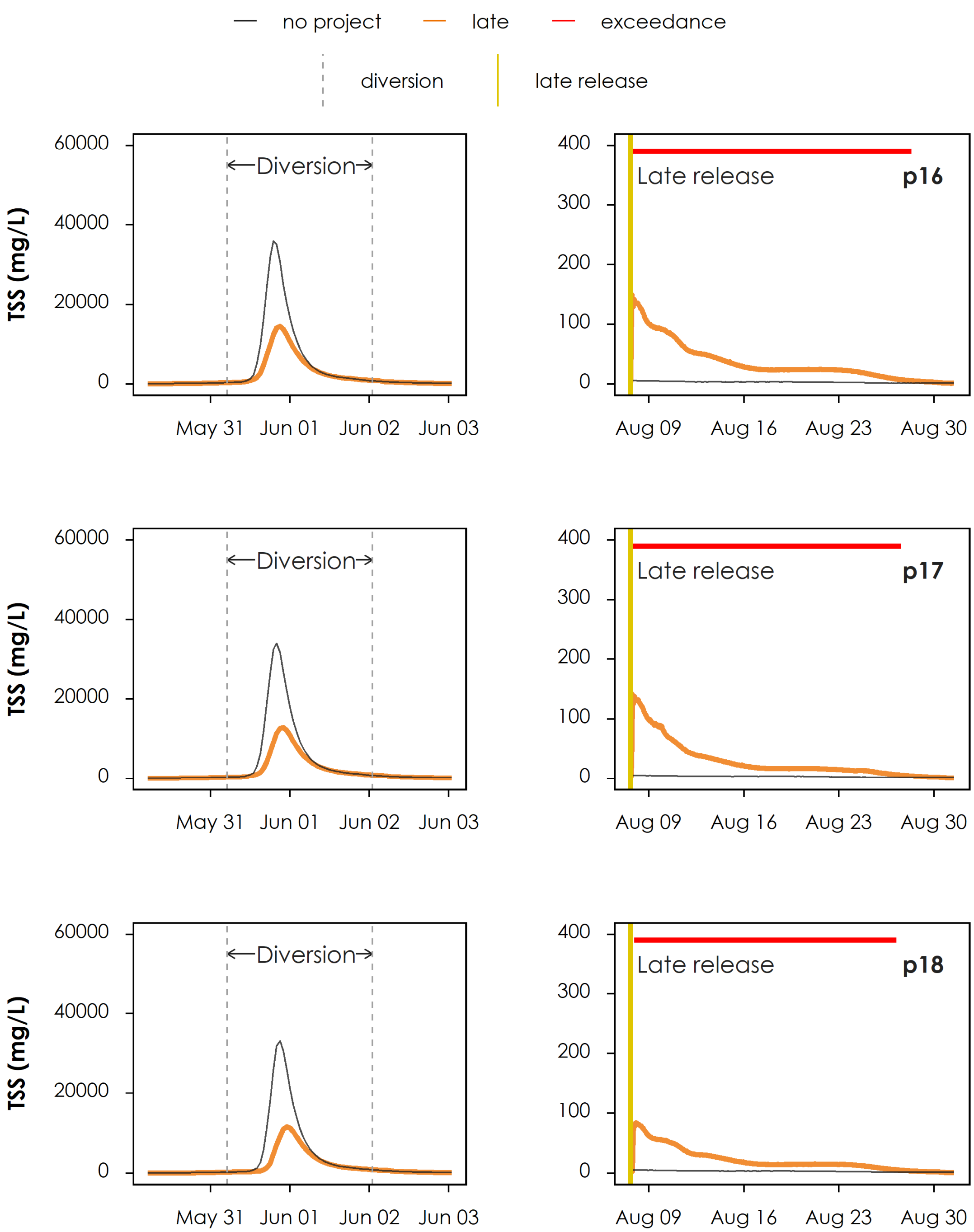


Figure 1-11 Exceedances and TSS Concentrations, Late Release for Locations Between the LLOW and Glenmore Dam Predicted for the 1:100 Year Hydrograph (cont'd)

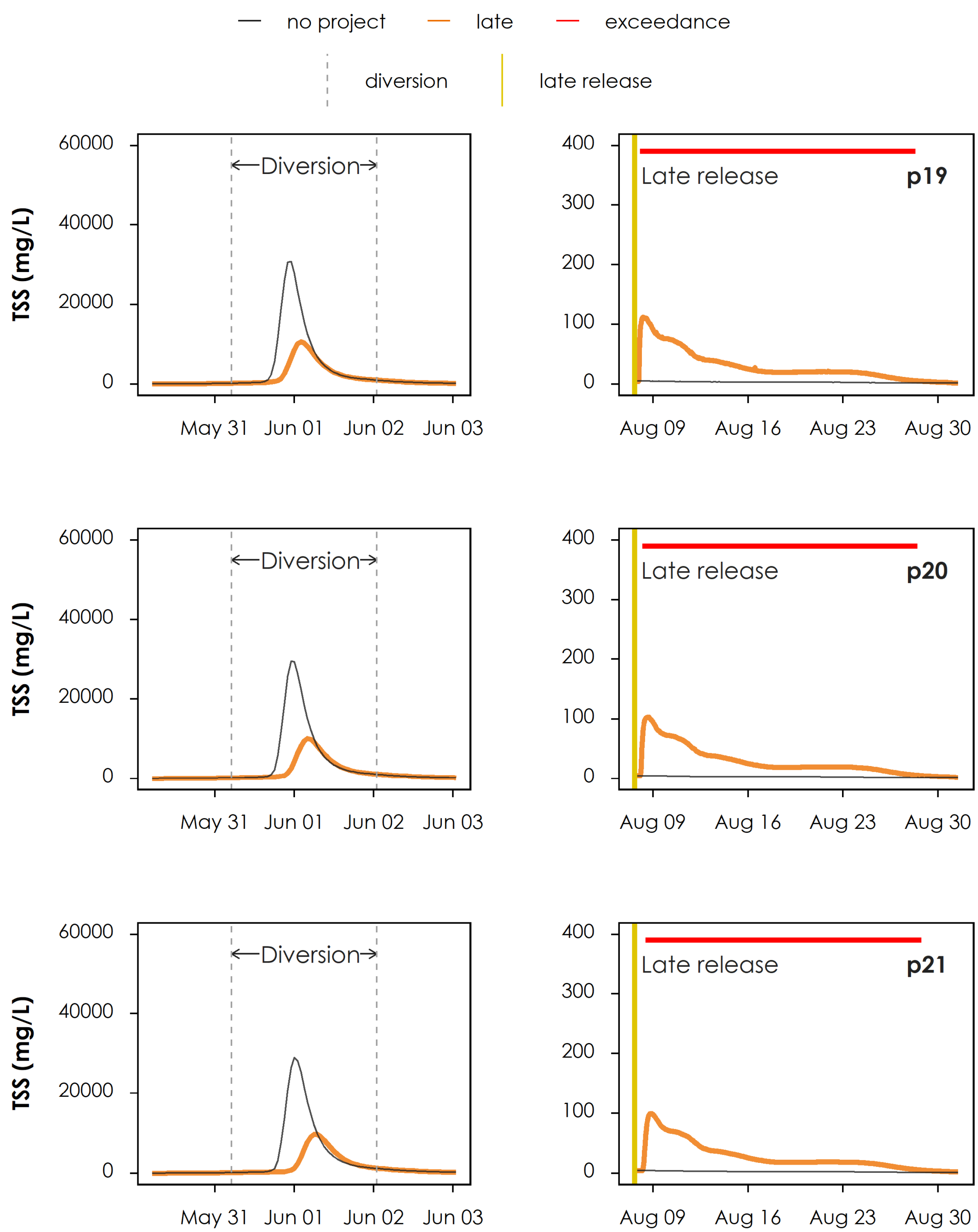


Figure 1-11 Exceedances and TSS Concentrations, Late Release for Locations Between the LLOW and Glenmore Dam Predicted for the 1:100 Year Hydrograph (cont'd)

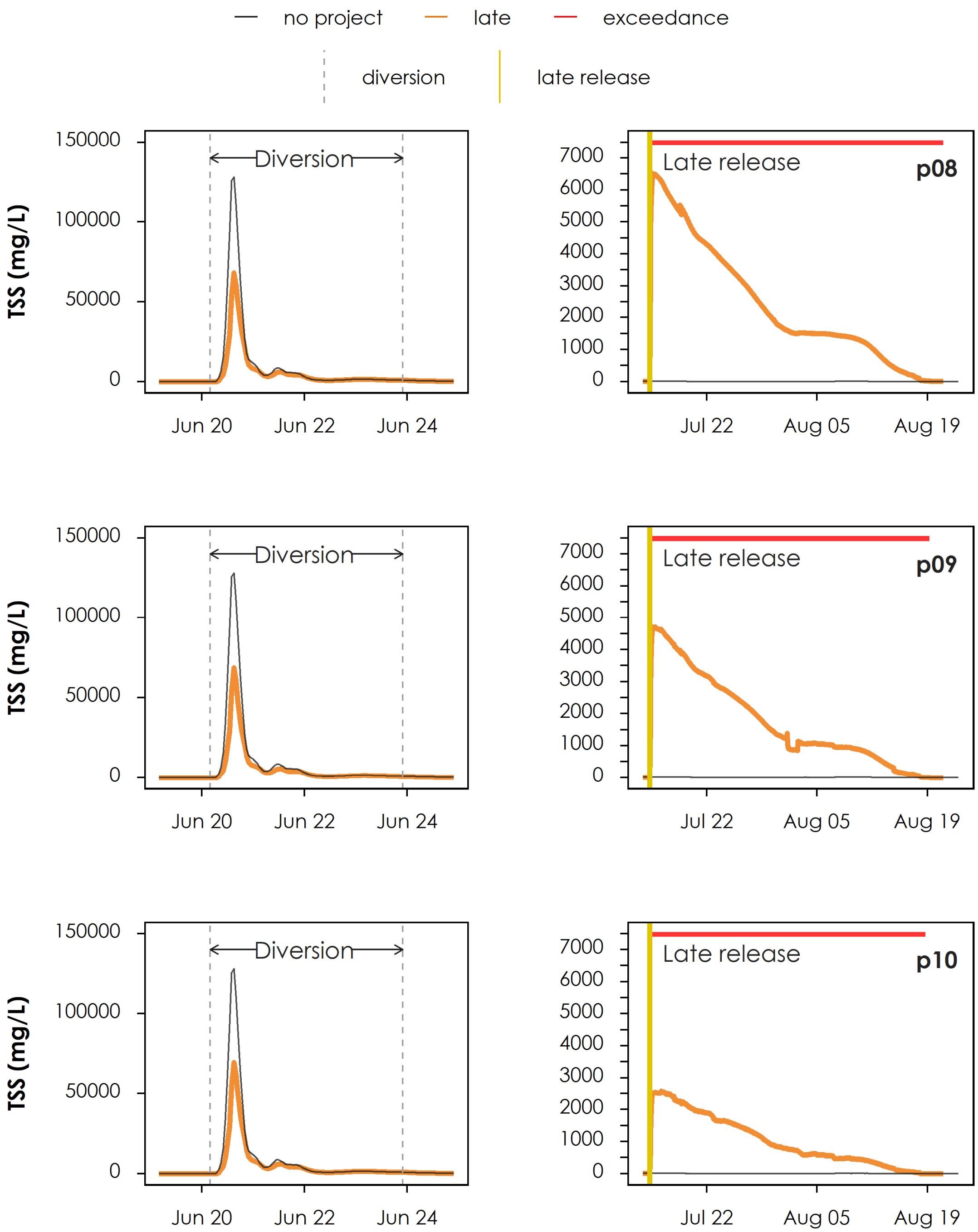


Figure 1-12 Exceedances and TSS Concentrations, Late Release for Locations Between the LLOW and Glenmore Dam Predicted for the Design Flood (2013)

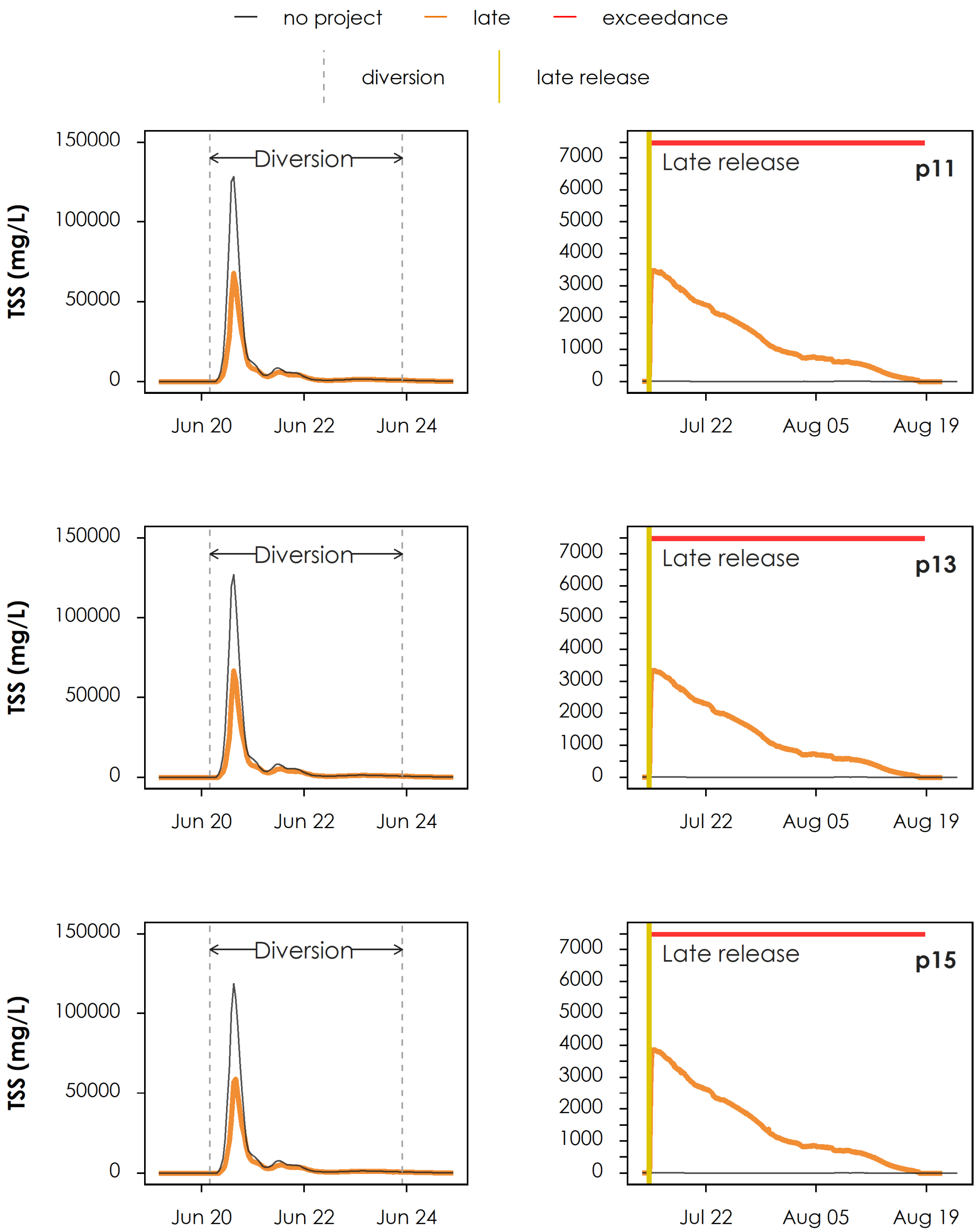


Figure 1-12 Exceedances and TSS Concentrations, Late Release for Locations Between the LLOW and Glenmore Dam Predicted for the Design Flood (2013) (cont'd)

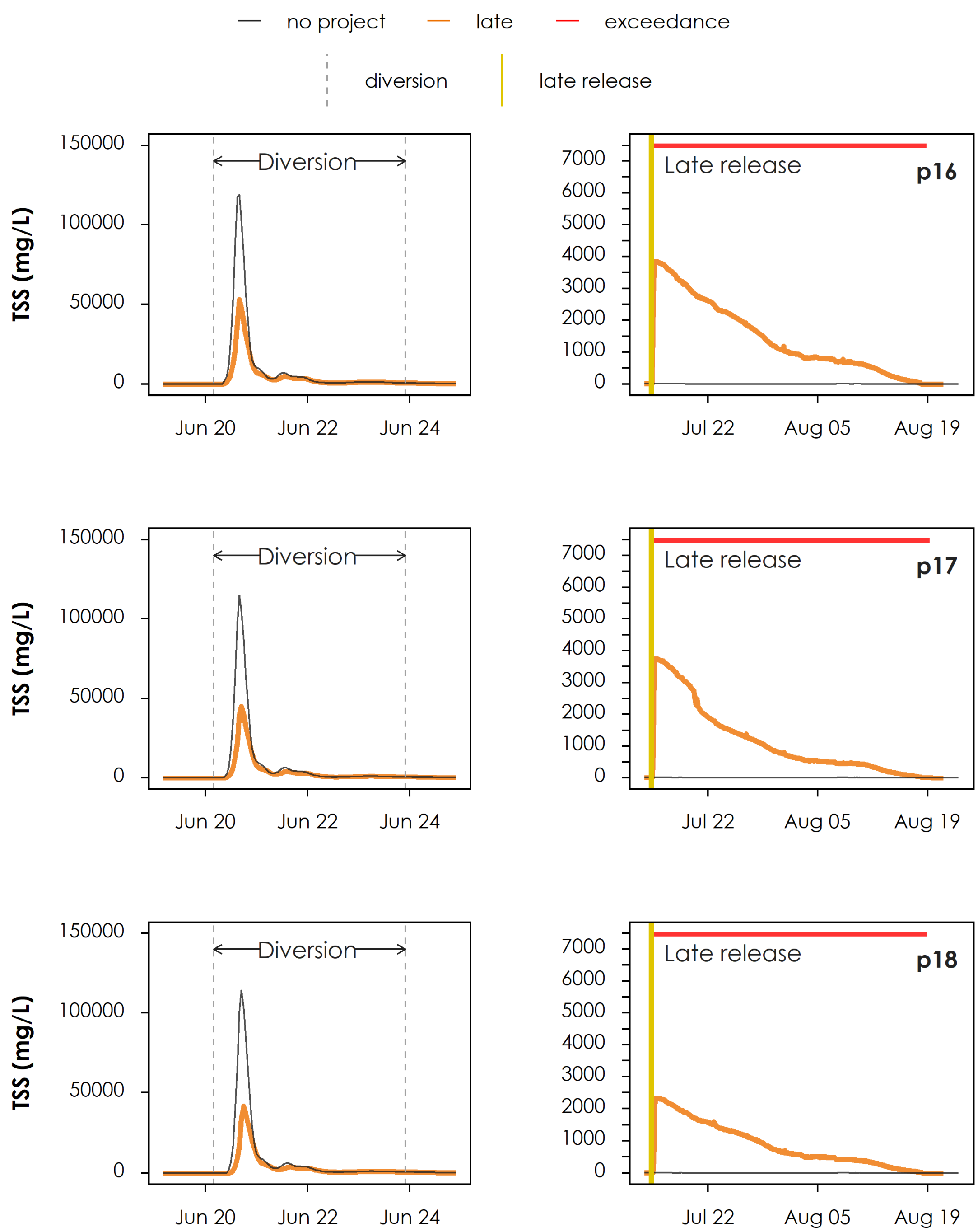


Figure 1-12 Exceedances and TSS Concentrations, Late Release for Locations Between the LLOW and Glenmore Dam Predicted for the Design Flood (2013) (cont'd)

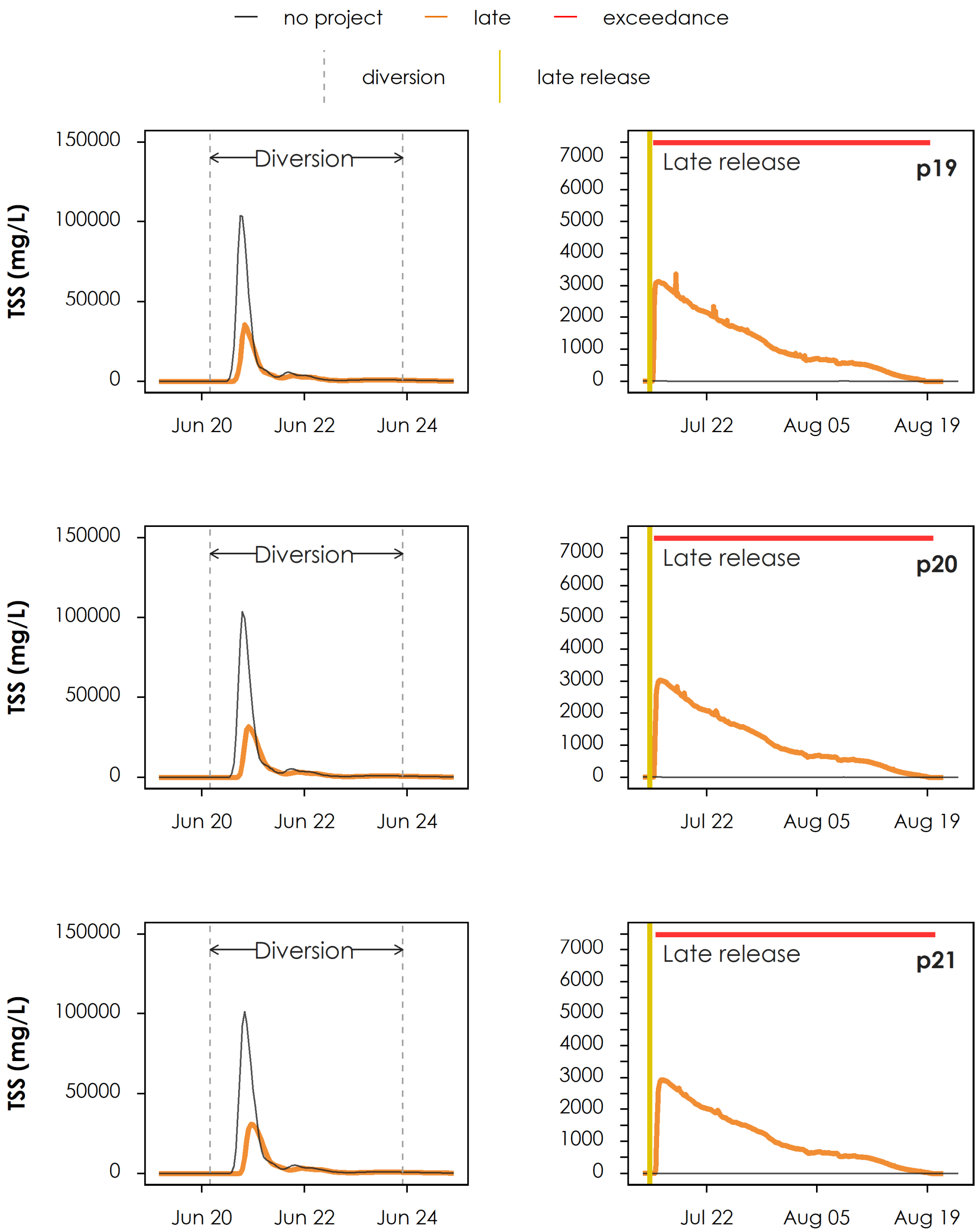


Figure 1-12 Exceedances and TSS Concentrations, Late Release for Locations Between the LLOW and Glenmore Dam Predicted for the Design Flood (2013) (cont'd)

Table 1-3 1:10-year TSS Exceedance and 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

Table 1-4 1:100-year 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 1-5 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

Sediment Related Effects to Fish

To assess effects on fish in Elbow River from suspended sediments during reservoir release, severity of ill effects (SEV; Newcombe and Jensen 1996) index scores were calculated for three locations using the predicted median TSS concentration (i.e., exposure) and number of days of increased turbidity due to reservoir release (duration of release): at 1) the confluence of the unnamed creek with Elbow River, 2) 1,000 m downstream of the confluence, and 3) 24,000 m downstream of the confluence at Sarcee Bridge. For comparison, the SEV index score is calculated for the confluence of the unnamed creek with Elbow River during each flood without the Project. A description of the SEV ratings is provided in Table 1-6 and the SEV index score results are presented in Table 1-7.

Table 1-7 provides both the peak and median suspended sediment concentrations predicted during each of the floods. In all cases, the suspended sediment concentrations are predicted to decrease over the duration fish are exposed; therefore, the median TSS concentration is considered less biased than the peak concentration and is applied to the SEV index scores. SEV index scores are provided for early release and late release suspended sediment model results for each flood.

In summary, lethal and paralethal SEV index scores are predicted for at least one fish life stage in Elbow River during background conditions (i.e., during each flood scenario without the Project). This includes eggs and larvae for both 1:100 year and design floods, adult non-salmonids for the 1:100 year flood, and all life stages for the design flood.

For the 1:10 year flood, both early release and late release, suspended sediment concentrations in reservoir water are similar to concentrations in Elbow River over the two-day release period. SEV index scores for early release and late release are the same as the SEV index scores for the 1:10 year flood without the Project.

The SEV index scores for the 1:100 year and design flood are in the "lethal and paralethal effects" range, except for a few cases. 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, 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 returned to the river. For the design flood (both early release and late release), SEV index scores for fish in Elbow River are in the lethal and paralethal range.

Effects on entrained fish are largely expected to be dependent on the level of exposure to and duration of TSS in the reservoir. Any effects are expected to be linear and increase with time and, therefore, the negative consequences of an early release are anticipated to be less than that predicted for the late release. Potential effects on fish will be mitigated through fish health monitoring and a fish rescue plan. The fish health monitoring and fish rescue plan is scalable and may be adjusted or increased as needed to resolve any uncertainty or unanticipated negative consequences on fish.

Table 1-6 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 Paralethal 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; this is the level of effect to fish associated varying levels of exposure to total suspended sediments (Newcombe and Jensen 1996)

Table 1-7 Results of SEV Index Scores for Flood Conditions in Elbow River

	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 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		1436	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		2970	1,779	35		3062	1,726	35	
Log$_e$ transformation[6]	--	6.90	4.93		--	8.34	6.73		--	7.48	6.73		--	7.45	6.73	
• 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
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

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Table 1-7 Results of SEV Index Scores for Flood Conditions in Elbow River

	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 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]
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 TSS and SEV values for each Elbow River flood without the Project are presented for early release at the confluence of the unnamed creek with Elbow River
[1] Peak TSS: Peak TSS concentration that fish are exposed to either in the reservoir or in Elbow River during reservoir drawdown
[2] Med TSS: Median TSS concentration that 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] 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

Constituents Associated with Suspended Sediments

The association between water quality constituents and suspended sediments is discussed in the Appendix 1-1. In summary, the results show total concentrations of trace elements (i.e., total metals or total nutrients) generally have a stronger affinity for TSS than dissolved forms. The strongest relationships between suspended sediments and other parameters (i.e., total metals or total nutrients) include total iron, vanadium, aluminum, cobalt, titanium, zinc, total phosphorus, and total nitrogen. Several dissolved parameters are also significantly associated with TSS (i.e., sulphate, magnesium, calcium), but suspended sediments do not have as strong an influence on these parameters.

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 to suspended sediments in the reservoir (i.e., sediment-bound and dissolved concentrations will be similar).

Many water quality constituents (i.e., metals) are associated with suspended sediments due to adsorption and cation-exchange capacity related forces. These processes are strongly 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 time water is in the reservoir. Biological activity resulting in algal growth and photosynthetic activity is expected to be suppressed with elevated turbidity levels and, therefore, biologically-mediated pH levels are predicted to remain stable. Inorganic carbon (e.g., dissolved carbon dioxide and carbonates) is not expected to change greatly; partial pressure for carbon dioxide in the reservoir may change slightly from the river conditions but is 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 as the reservoir is close to being emptied (i.e., last few days of reservoir drawdown). For most of the time water is being released from the reservoir, water quality is not predicted to change appreciably. Effects on water quality from sediment-associated parameters during early release are not predicted to be different than late release. Therefore, the conclusion in the EIA is unchanged (i.e., effects to water quality due to TSS associated constituents is not significant; Volume 3B, Section 7.5, page 7.34).

NUTRIENTS

The analysis and results for nutrient concentrations in the reservoir and in Elbow River during reservoir water release are discussed in Appendix 1-1 and summarized below.

The predicted nutrient concentrations in the reservoir are provided in Table 1-8. The predicted peak and median reservoir nutrient water quality concentrations are compared with the monthly nutrient water quality data (for years 1979 through 2019) (Table 1-8). Water quality data for Elbow River at Twin Bridges is used for this assessment. Water quality during each late release scenario is during the period of time when the flow in Elbow River is less than 20 m^3/s.

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 are used for comparison because this level is considered to capture much of the relevant variability without including data influenced by late season irregular events such as storm runoff, outlier or anomalous data. Dodds and Oakes (2004) suggest the 75th percentile as a possible means to distinguish an upper nutrient threshold.

To summarize, the effect of timing on the release of water from the reservoir is that nutrients during early release (e.g., early summer) have comparatively higher concentrations (i.e., compared to the historical 75th percentile levels in Elbow River) than concentrations during late release (i.e., late summer). The median nutrient concentrations released from the reservoir during early release (for 1:100 year flood and design flood) are greater than during late release (Table 1-5). Decreases in nutrient concentrations are expected to be due to suspended sediments and associated parameters (i.e., total nitrogen, total phosphorus) depositing in the reservoir. Early release may affect Elbow River water to a greater degree than releasing water later. There are a few exceptions of dissolved nutrients not decreasing over time (i.e., comparing dissolved phosphorus and nitrate+nitrite for the 1:100 year flood, early release and late release).

Table 1-8 Predicted Nutrient Concentrations from Regression Models and Peak and Median Suspended Sediment Concentrations in the Reservoir during Drawdown

Scenario	Units	1:10 Year Flood		1:100 Year Flood		Design Flood		Monthly Nutrient Concentrations: for 75th Percentile and Median (in brackets) Values for Elbow River at Twin Bridges		
		Peak Conc.	Median Conc.	Peak Conc.	Median Conc.	Peak Conc.	Median Conc.			
Early Release										
Reservoir release dates		May 25 to May 26		June 2 to June 25		June 23 to July 28		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	1309	771	18069	882	20865	7945	288 (580)	326 (461)	--

Table 1-8 Predicted Nutrient Concentrations from Regression Models and Peak and Median Suspended Sediment Concentrations in the Reservoir during Drawdown

Scenario	Units	1:10 Year Flood Peak Conc.	1:10 Year Flood Median Conc.	1:100 Year Flood Peak Conc.	1:100 Year Flood Median Conc.	Design Flood Peak Conc.	Design Flood Median Conc.	Monthly Nutrient Concentrations: for 75th Percentile and Median (in brackets) Values for Elbow River at Twin Bridges		
Late Release										
Reservoir release dates		July 6 to July 8		August 7 to August 31		July 14 to August 18		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	12402	2855	--	326 (461)	308 (461)

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

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MERCURY AND METHYLMERCURY

Early release is not predicted to increase the risk of methylation in the reservoir. Based on the discussion on DO above, DO levels in the off-stream reservoir are not predicted to become anoxic and, therefore, the risk of developing conditions conducive for mercury methylation is low. The highest risk for anoxic conditions is predicted for the 1:10 year flood, late release: water levels would be shallow (mean water depth less than 1 m) and DO decreased gradually over time. As the reservoir is being drawn down, small localized areas of the reservoir that are emptying may experience DO levels low enough to be anoxic. However, anoxic conditions in the whole reservoir for a 1:10 year flood are not expected. No early release will result in low DO conditions. Therefore, methylmercury is not expected to increase and effects on water quality, fish and the aquatic food web are not predicted to be affected by early release.

Water quality samples will be collected in Elbow River and the reservoir and analyzed for mercury and methylmercury. Proposed sampling and monitoring details are provided in the response to IAACIR4-02. Mercury and methylmercury water quality analytical results will be evaluated from samples collected in the off-stream reservoir and below the low-level outlet to determine if levels increase and trigger adaptive mitigation measures. Adaptive mitigation includes additional monitoring and water advisories as discussed in IAAC IR4-02.

iii. ***SEDIMENT DEPOSITION IN ELBOW RIVER AS A RESULT OF RESERVOIR WATER RELEASE***

Sediment deposition within Elbow River with and without the Project (for both early release and late release) is modelled using Mike 21 FM-MT, mapped and compared for analysis (Figure 1-13 to Figure 1-18) between the confluence of the unnamed creek with Elbow River to Glenmore Reservoir. Figure 1-13 to Figure 1-18 show the difference in deposition of suspended sediment between each scenario and the no Project condition. The areas where the difference in suspended sediment deposition is +/- 5 mm only the underlaying orthophoto is shown, as this category is transparent. For the 10-year flood, the results show that the Project relative to baseline Elbow River conditions (without Project) will not result in a measurable difference in sediment deposition in Elbow River (Figure 1-13 and Figure 1-14).

Sediment Deposition and its Potential Effects to Fish Habitat

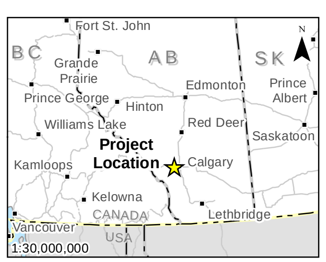
Figure 1-15 to Figure 1-18 shows that net sediment deposition varies spatially downstream of the Project and shows locations of higher or lower sediment deposition relative to the no Project condition. The vast majority of the difference in deposition is predicted to occur within the floodplain and not within the bankfull channel. Floodplain habitat is accessed infrequently by fish in the spring when Elbow River is naturally turbid. Figure 1-15 to Figure 1-18 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. The expected sediment deposition patterns will, therefore, have limited effects on fish (including fish eggs) and fish habitat (including spawning areas).

Table 1-9 shows the minimum, maximum and mean difference in suspended sediment deposition for without Project (no Project) and each of the three floods. The values provided in Table 1-6 reflect results for the sediment modelling extent in Elbow River and adjacent floodplain downstream of the Project. The maximum and minimum difference in suspended sediment deposition for without Project and with 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, 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 1-13 to Figure 1-18). The mean difference in deposition between the LLOW channel and the 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 Project and Glenmore Reservoir.

Table 1-9 Minimum, Maximum and Mean Difference in Suspended Sediment Deposition

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



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)

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Alberta Transportation

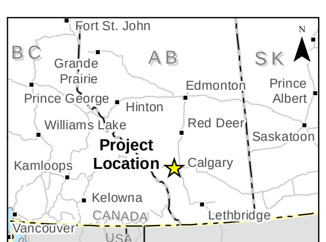
Project Location
Calgary, Alberta

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.
1-13

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
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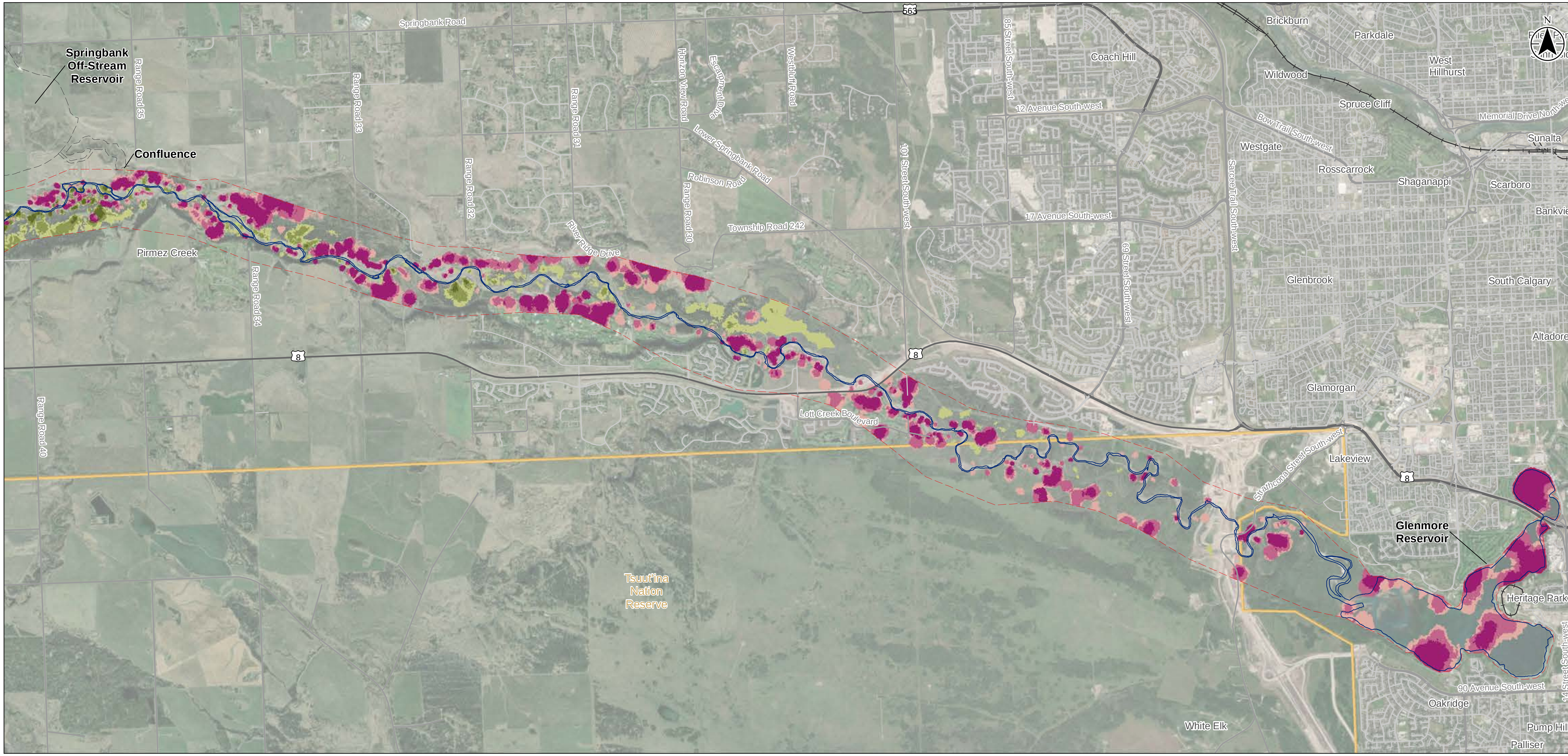
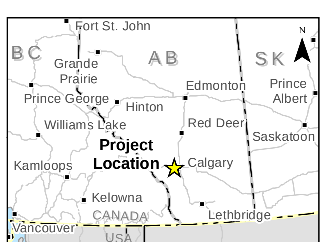
Springback Off-Stream Reservoir Project
Sediment Deposition Modelling

Figure No.
1-14

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

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)

Project Location
Calgary, Alberta

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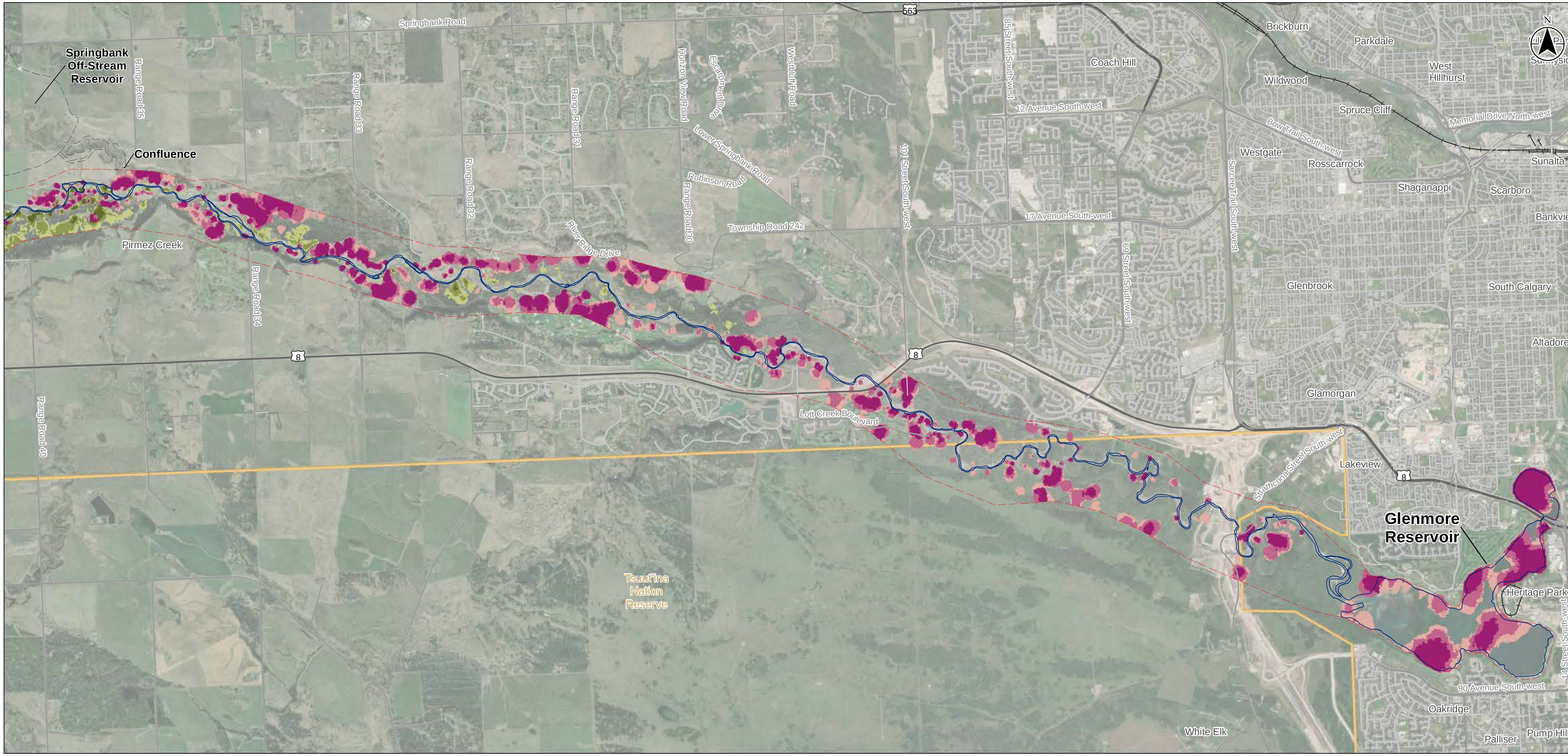
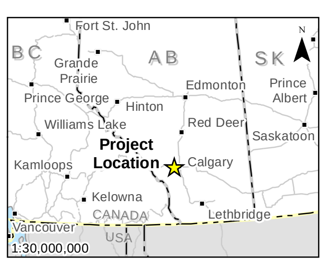
Prepared by LTRUDELL on 20200505
Requested by LBURGE on 20200505

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

Figure No.
1-15

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)

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Alberta Transportation

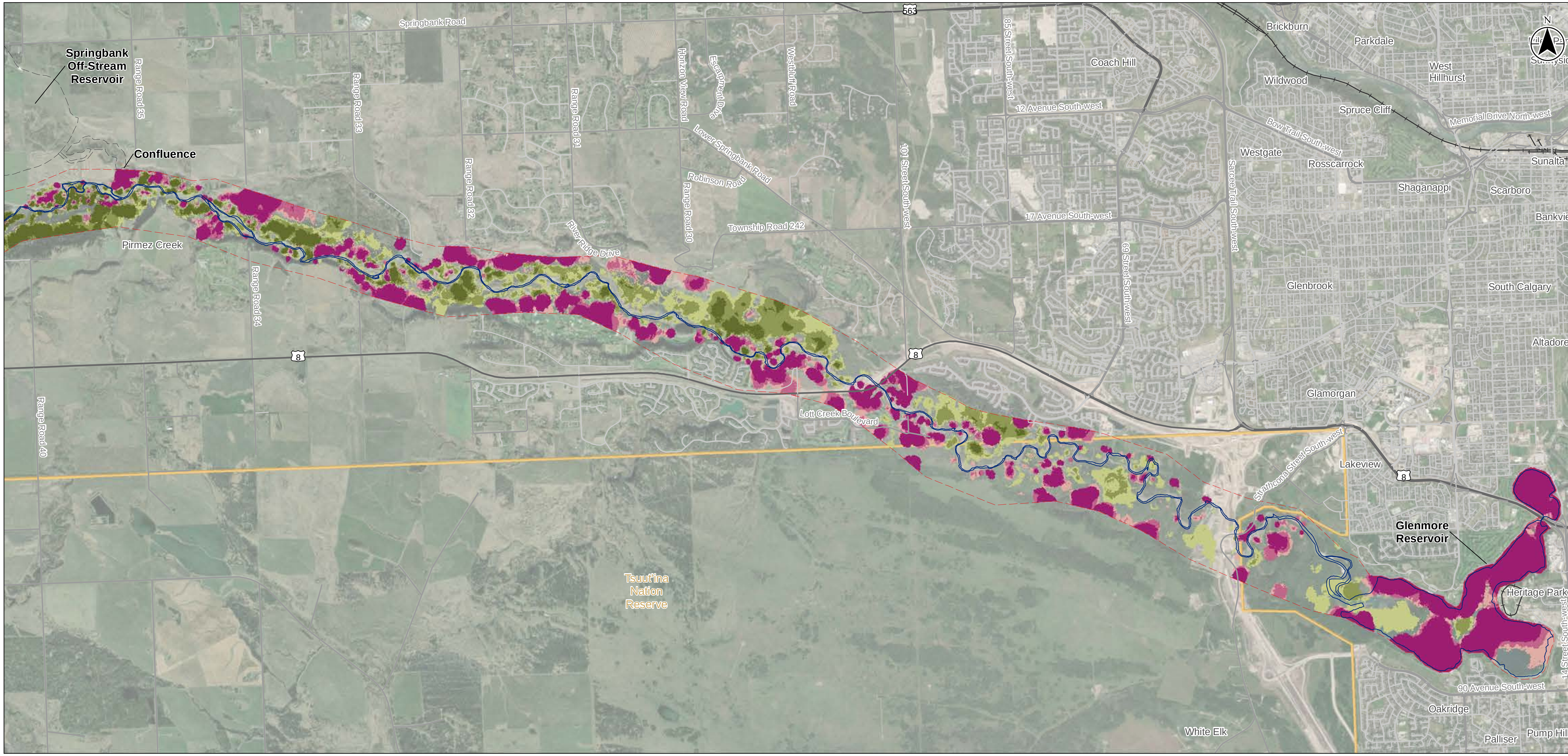
Project Location
Calgary,
Alberta

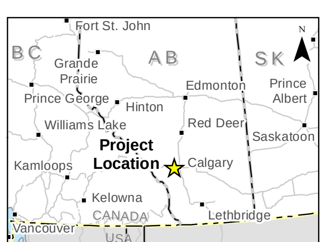
Project Number 110773396
Prepared by LTRUDELL on 20200505
Requested by LBURGE on 20200505

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

Figure No.
1-16

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

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Alberta Transportation

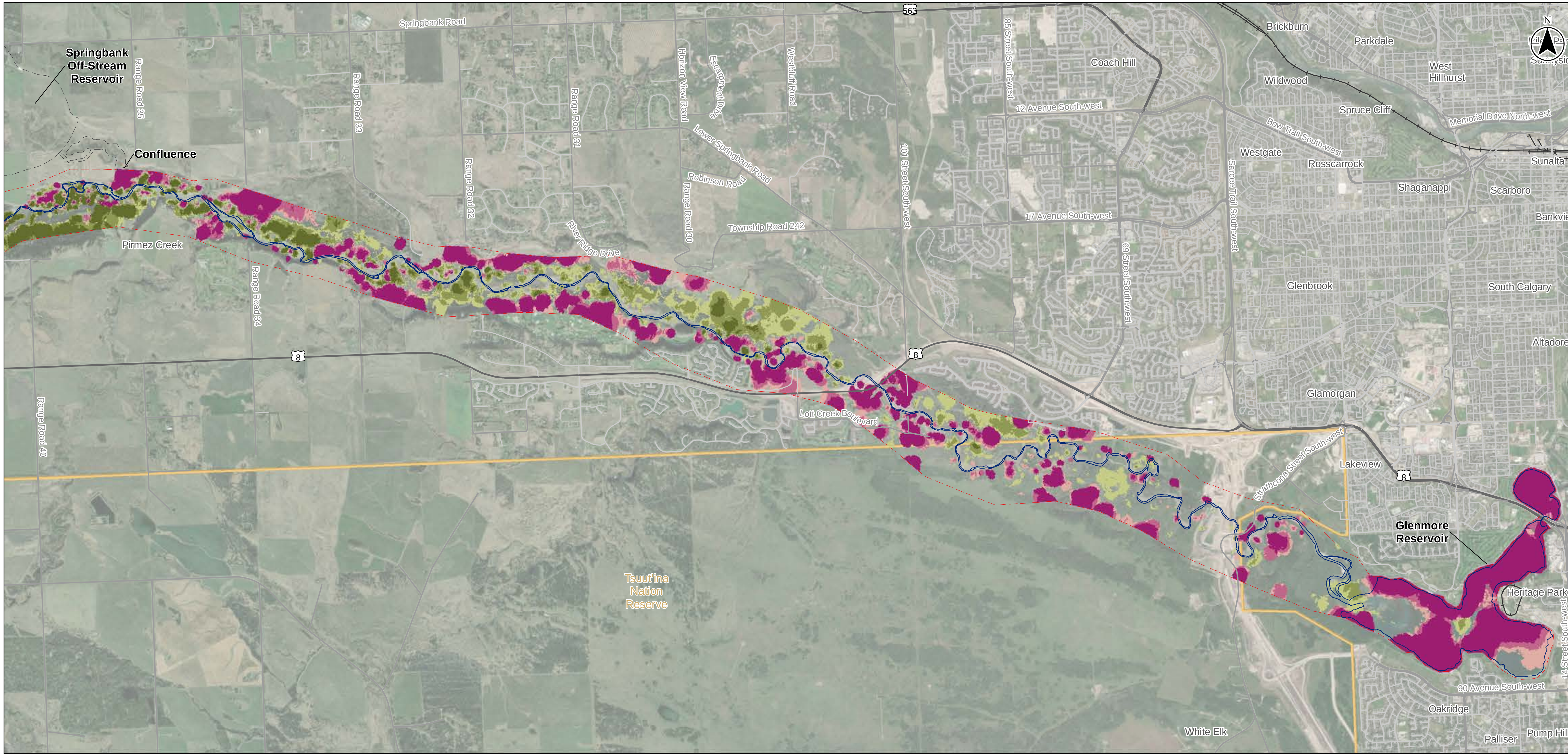
Project Location
Calgary,
Alberta

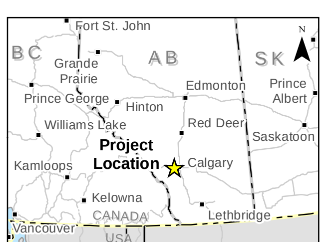
Project Number 110773396
Prepared by LTRUDELL on 20200505
Requested by LBURGE on 20200505

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

Figure No.
1-17

Title
Difference in River Deposition from No-Project on the Early Release Scenario for the 2013 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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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.
1-18

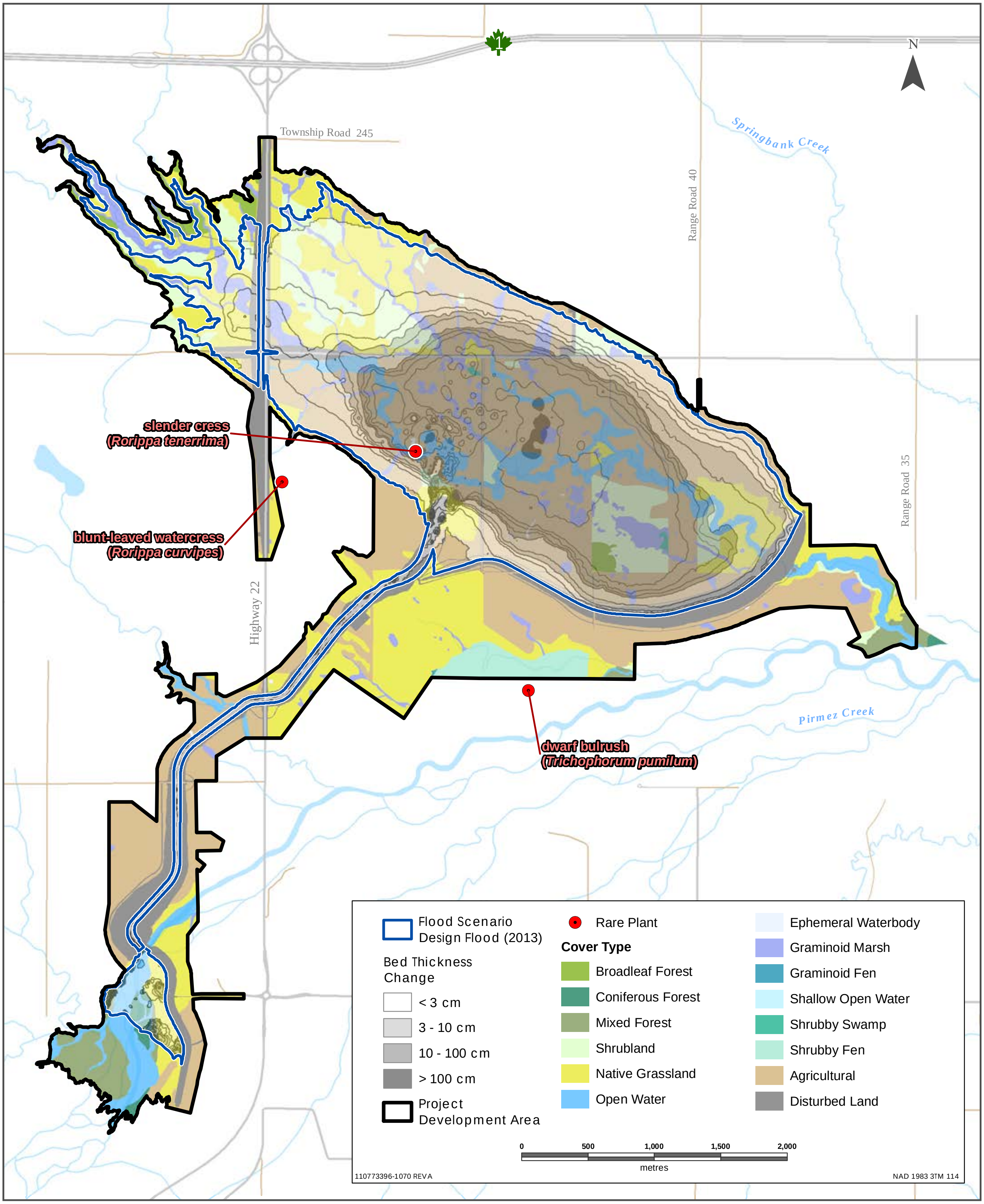
Title
Difference in River Deposition from No-Project on the Late Release Scenario for the 2013 Flood Event

iv. *SEDIMENT DEPOSITION IN THE RESERVOIR AREA AND ASSOCIATED EFFECTS ON VEGETATION AND THE CURRENT USE OF LANDS AND RESOURCES FOR TRADITIONAL PURPOSES*

Modelling results of the updated Mike 21 FM - MT (mud transport) module indicate sediment will be deposited over most of the reservoir for early release and late release during the design flood (Figure 1-19 and Figure 1-20). Deposition patterns, including sediment extent and depths, are similar between for both releases, with the greatest difference being the extent of sediment in the greater than 3 cm depth category: 318.06 ha early release and 268.75 ha late release (Table 1-10). Most of the sediment deposition is expected to range from 10 cm to 100 cm deep in the reservoir (319.03 ha, 39.07% for early release; 337.36 ha, 41.32% for late release). Sediment ranging from 3 cm to 10 cm deep will cover 15.22% to 18.96% of the reservoir for early release and late release, respectively. Sediment greater than 100 cm deep will cover 0.63% to 0.69% (Table 1-10), respectively. The sediment depth categories are based on a review of scientific literature and effects to plants.

No effect on plant communities is expected in areas of less than 3 cm of sediment deposition, following the findings of Wang et al. (2013); however, minor effects on germination of annual plants may occur. Following the results of Kui and Stella (2016), sediment deposition between 10 cm and 100 cm is expected to result in mortality of plants in the herb and short shrub strata, and tall shrub and trees are expected to survive. Complete vegetation loss, including herbs, shrubs and trees, is expected in areas of greater than 100 cm of sediment deposition.

Based on model results, most effects for early release and late release will be to agricultural land, 368.90 ha (98.72% of baseline area in the reservoir); followed by grassland, 119.21 ha (88.13% of baseline area in the reservoir) and shrubland, 78.17 ha (90.35% of baseline area in the reservoir) (Table 1-10). Portions of existing native grassland in the reservoir will also be affected in areas of greater than 3 cm of sediment deposition for early release and late release. Most of the baseline native grassland area, 57.99% to 62.78%; however, will receive less than 3 cm of sediment deposition and is not expected to be affected. Some shrubs may be lost in the reservoir because sediment deposition will be deeper than 10 cm for 16.63 ha (38.44% of baseline area in the reservoir) in early release and 16.91 ha (39.09% of baseline area in the reservoir) in late release. Minor tree loss is expected as only 0.03 ha of mixed forest (e4 Snowberry-silverberry Sw-Aw land cover type) will receive sediment deposition greater than 100 cm deep in both early release and late release (Figure 1-19 and Figure 1-20).



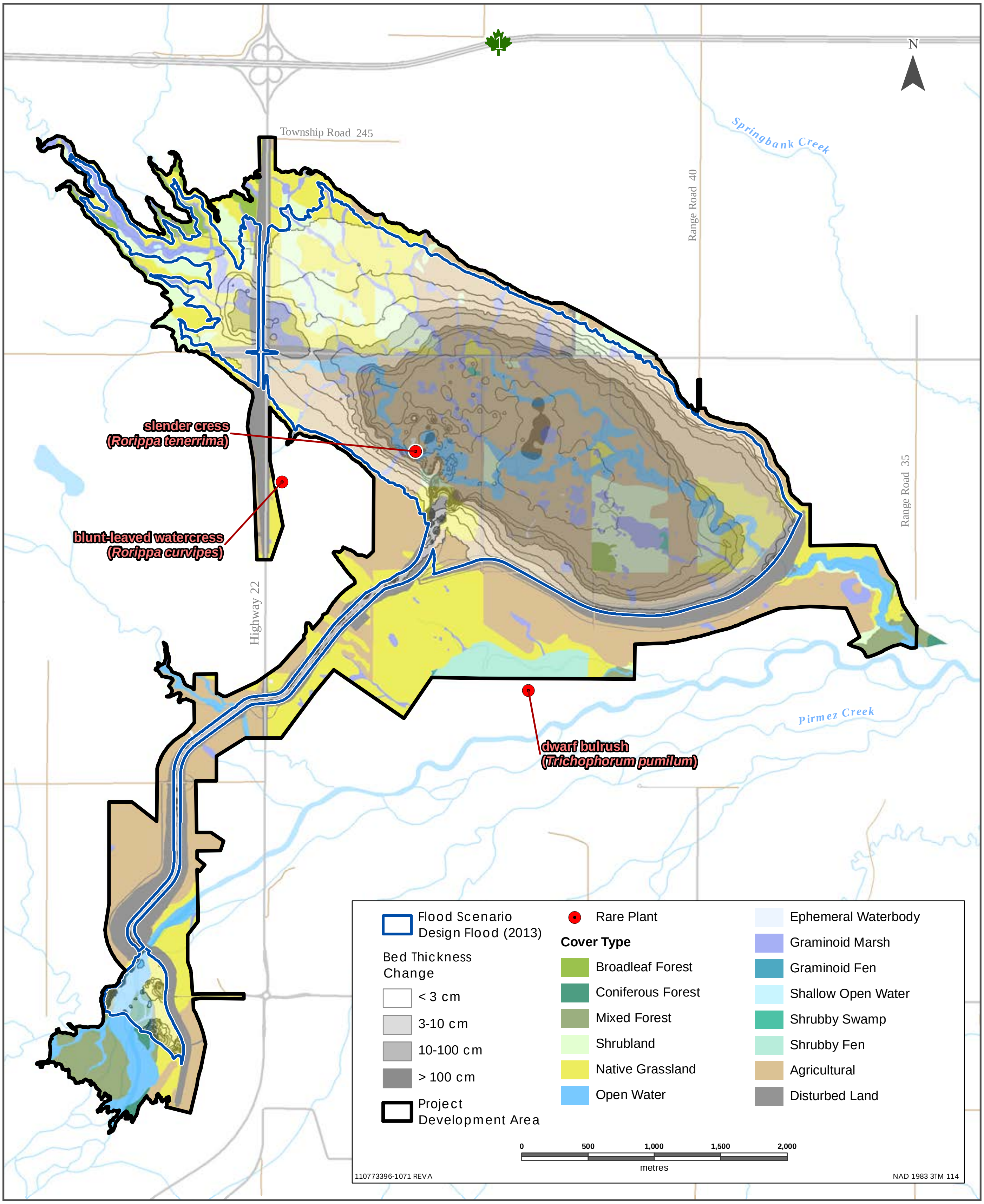
Sources: Base Data - Government of Alberta, Government of Canada, Thematic Data - Stantec Ltd.

Sediment Deposition Pattern in the PDA Early Release Flood

Stantec

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT

Figure 1-19



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

Sediment Deposition Pattern in the PDA Late Release Flood

Stantec

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT

Figure 1-20

The Project could lead to changes in habitat for traditionally used plant or animal species that support hunting, trapping and plant gathering activities. In both early release and late release, sedimentation could lead to effects on plant community diversity, plant species diversity, and wetland function, which could result in effects on wildlife habitat and wetlands. Based on model results, most effects for early release and late release will be to agricultural land.

For both early release and late release, traditionally used plant species are expected to re-establish by natural recruitment, and permanent loss of traditionally used plants is not predicted. Similarly, for both early release and late release, the amount of wildlife habitat affected is relatively small compared to the availability of wildlife habitat remaining in the regional assessment area (RAA) and the long-term persistence and viability of traditionally harvested wildlife species are unlikely to be affected.

Sediment depth is expected to be less for early release (see Figure 1-19) and, as a result, changes to vegetation, wildlife, and the current use of lands and resources for traditional purposes are expected to be less. The sediment depth is also provided for late release (see Figure 1-20). Alberta Transportation has developed a Draft Vegetation and Wetland Mitigation, Monitoring and Revegetation Plan provided in response to Round 1 AEP IR407, Appendix IR407-1, which includes monitoring vegetation re-establishment following a flood. Areas of sediment deposition where wind erosion may be an issue may be hydroseeded with native plant species and a tackifier to reduce erosion. An operation and maintenance plan for the reservoir will be developed that would include sediment stabilization and debris management. Disturbed areas will be monitored for noxious and prohibited noxious weeds and species controlled as identified in the Alberta *Weed Control Act* and associated regulations.

Table 1-10 Area of Vegetation and Wetland Land Units within Predicted Post-Design Flood Sediment Depth Levels in the Reservoir

Cover Type	Land Unit [1,2]	Baseline Condition (ha)	Area and Proportion of Vegetation and Wetland Covered by each Sediment Threshold, Early Release								Area and Proportion of Vegetation and Wetland Covered by each Sediment Threshold, Late Release							
			< 3 cm		3 - 10 cm		10 - 100 cm		> 100 cm		< 3 cm		3 - 10 cm		10 - 100 cm		> 100 cm	
			ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%
Broadleaf forest	d1 Pine grass Aw	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	e1 Snowberry-silverberry Aw-Pb	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	f2 Red osier dogwood Pb-Aw	7.07	0.00	0.00	0.00	0.00	3.54	50.06	0.00	0.00	0.00	0.00	0.00	0.00	3.54	50.06	0.00	0.00
Coniferous forest	g1 Horsetail Sw	3.14	3.12	99.23	0.02	0.77	0.00	0.00	0.00	0.00	3.12	99.23	0.02	0.77	0.00	0.00	0.00	0.00
Mixed forest	b3 Hairy wild rye Aw-Sw-Pl	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	e2 Snowberry-silverberry Sw	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	e4 Snowberry-silverberry Sw-Aw	1.55	0.57	37.07	0.31	20.21	0.63	40.49	0.03	2.23	0.57	37.07	0.31	20.21	0.63	40.49	0.03	2.23
	f1 Red osier dogwood Sw	0.91	0.31	34.54	0.36	39.91	0.23	25.54	0.00	0.00	0.31	34.54	0.36	39.91	0.23	25.54	0.00	0.00
Shrubland	e3 Shrubland - mesic/rich	6.89	1.76	25.48	0.40	5.74	3.20	46.42	0.00	0.00	1.76	25.48	0.00	0.00	3.59	52.16	0.00	0.00
	f3 Shrubland - subhygric/rich	79.62	38.68	48.58	4.08	5.13	29.99	37.67	0.06	0.07	36.12	45.37	6.47	8.13	30.17	37.89	0.06	0.07
Grassland	b5 Grassland – submesic/medium	6.37	1.08	16.93	4.48	70.34	0.81	12.74	0.00	0.00	1.01	15.88	4.23	66.38	1.13	17.73	0.00	0.00
	c1 Rough fescue	78.53	60.59	77.16	2.11	2.68	2.11	2.68	0.00	0.00	55.28	70.39	7.34	9.35	2.18	2.77	0.00	0.00
	d0 Grassland - mesic/medium [3]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	e0 Grassland - mesic/medium [3]	12.01	4.46	37.14	4.38	36.46	2.51	20.87	0.00	0.00	3.78	31.51	3.44	28.61	4.13	34.35	0.00	0.00
	f4 Grassland - subhygric/rich	35.13	15.89	45.22	12.03	34.23	5.51	15.68	0.11	0.30	15.46	44.01	11.43	32.55	6.52	18.57	0.11	0.30
	g0 Grassland - hygric/rich [3]	3.23	2.91	89.97	0.23	6.97	0.04	1.15	0.00	0.00	2.91	89.98	0.23	6.97	0.04	1.15	0.00	0.00
	Upland Subtotal	***234.46***	***129.37***	***55.18***	***28.39***	***12.11***	***48.56***	***20.71***	***0.20***	***0.08***	***120.33***	***51.32***	***33.84***	***14.43***	***52.15***	***22.24***	***0.20***	***0.09***
Open water	Open water	61.15	8.88	14.52	8.37	13.69	42.42	69.37	1.27	2.07	8.46	13.84	6.58	10.76	44.52	72.80	1.38	2.26
	Open Water Subtotal	***61.15***	***8.88***	***14.52***	***8.37***	***13.69***	***42.42***	***69.37***	***1.27***	***2.07***	***8.46***	***13.84***	***6.58***	***10.76***	***44.52***	***72.80***	***1.38***	***2.26***
Ephemeral waterbody	Ephemeral waterbody	0.39	0.06	16.15	0.00	0.00	0.33	83.85	0.00	0.00	0.06	16.15	0.00	0.00	0.33	83.85	0.00	0.00
Graminoid marsh	Temporary graminoid marsh	23.70	12.67	53.45	3.95	16.66	5.01	21.16	0.00	0.00	11.25	47.47	4.52	19.06	5.86	24.73	0.00	0.00
	Seasonal graminoid marsh	31.48	5.75	18.25	1.85	5.86	12.79	40.61	0.40	1.28	4.28	13.61	3.06	9.73	12.97	41.19	0.47	1.48
	Semi-permanent graminoid marsh	13.29	5.82	43.79	0.46	3.44	7.01	52.76	0.00	0.00	1.51	11.38	4.69	35.29	7.09	53.33	0.00	0.00
Shallow open water	Shallow open water with submersed and/or floating aquatic vegetation	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Shrubby swamp	Seasonal shrubby swamp	1.09	0.00	0.00	0.00	0.00	1.09	100.00	0.00	0.00	0.00	0.00	0.00	0.00	1.09	100.00	0.00	0.00
Graminoid fen	Moderate-rich graminoid fen	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Shrubby fen	Moderate-rich shrubby fen	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Wetland Subtotal	***70.11***	***24.30***	***34.66***	***6.25***	***8.92***	***26.23***	***37.42***	***0.40***	***0.58***	***17.11***	***24.41***	***12.27***	***17.50***	***27.34***	***38.99***	***0.47***	***0.67***

Table 1-10 Area of Vegetation and Wetland Land Units within Predicted Post-Design Flood Sediment Depth Levels in the Reservoir

Cover Type	Land Unit [1,2]	Baseline Condition (ha)	Area and Proportion of Vegetation and Wetland Covered by each Sediment Threshold, Early Release								Area and Proportion of Vegetation and Wetland Covered by each Sediment Threshold, Late Release							
			< 3 cm		3 - 10 cm		10 - 100 cm		> 100 cm		< 3 cm		3 - 10 cm		10 - 100 cm		> 100 cm	
			ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%
Agricultural	Dugout	0.40	0.00	0.00	0.00	0.00	0.40	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.40	100.00	0.00	0.00
	Tame pasture	373.29	104.76	28.06	66.76	17.88	193.84	51.93	3.14	0.84	83.51	22.37	76.65	20.53	204.87	54.88	3.47	0.93
Disturbed land	Disturbed land	77.09	50.76	65.84	14.52	18.84	7.58	9.83	0.11	0.14	39.34	51.03	25.43	32.99	8.09	10.49	0.11	0.14
	Anthropogenic Subtotal	***450.78***	***155.52***	***34.50***	***81.28***	***18.03***	***201.82***	***44.77***	***3.24***	***0.72***	***122.84***	***27.25***	***102.09***	***22.65***	***213.36***	***47.33***	***3.58***	***0.79***
	Grand Total	**816.5**	**318.06**	**38.95**	**124.30**	**15.22**	**319.03**	**39.07**	**5.11**	**0.63**	**268.75**	**32.91**	**154.77**	**18.96**	**337.36**	**41.32**	**5.63**	**0.69**

NOTES:
Calculations completed on non-rounded numbers. Values presented in table have been rounded.
[1] Upland land units (ecosites) were classified using Range Plant Communities and Range Health Assessment Guidelines for the Foothills Parkland Subregion of Alberta (ESRD 2012)
[2] Wetland land units classified using the Alberta Wetland Classification System (ESRD 2015)
[3] A zero ecosite phase indicates that the overstorey vegetation has been cleared or there has been high mortality in the overstorey, but ecosite moisture and nutrient regime remain unchanged

c) Table 1-1 provides values demonstrating the total retention time for each flood. The time required for the reservoir to fully dry out is unknown because the drying time will be influenced by several environmental factors external to Project operation. For example, it is expected that the unnamed creek will continue to receive some runoff as long as water remains within the watershed. In addition, there are a number of wetlands within the reservoir that undergo a natural cycle of wetting and drying.

The time required for wetlands to dry out is influenced by external environmental factors such as temperature and precipitation. Water loss from prairie pothole wetlands is largely from evapotranspiration (Keddy 2000) and weather conditions will drive the rate of water loss following a flood. Maximum wetland volumes following a design flood are provided in the response to Canadian Environmental Assessment Agency (CEAA) Conformity IR3-10. Average maximum depth and volume increases from ephemeral to semi-permanent wetland classes (Table 1-11) and the rate of water loss is expected to be more rapid for ephemeral and temporary wetland classes. Some wetlands will likely retain water for the duration of the growing season following a design flood, particularly seasonal to semi-permanent classes, with deeper areas potentially retaining water into the following year.

Table 1-11 Average Wetland and Dugout Surface Area, Volume and Depth

Wetland Class	Average Surface Area (ha)	Average Maximum Depth (m)	Average Maximum Volume (m^3)
Dugout	0.40	0.53	1319.45
Ephemeral waterbody	0.10	0.28	44.90
Temporary graminoid marsh	0.63	0.25	120.63
Temporary shrubby swamp	1.34	0.31	117.59
Seasonal graminoid marsh	0.78	0.48	568.91
Seasonal shrubby swamp	0.99	0.30	97.39
Semi-permanent graminoid marsh	2.23	0.60	1974.80
Shallow open water with submersed and/or floating aquatic vegetation	0.15	0.43	419.36

d) The capacity of the low-level outlet works is based on dam safety criteria for drawdown of reservoirs.

However, The Canadian Dam Association (2013) Guidelines and the Alberta Dam and Canal Safety Directive (Government of Alberta 2018) do not address requirements for sizing of outlet works or evacuation times for reservoirs.

In the absence of provincial and federal governing criteria, criteria from the United States Army Corps of Engineers (USACE) and the United States Department of the Interior Bureau of Reclamation (USBR) were reviewed. The USBR criteria are specified in ACER Technical

Memorandum No. 3 – Criteria and Guidelines for Evacuating Storage Reservoirs and Sizing Low-Level Outlet Works (USBR 1990). The USACE criteria are described in ER 1110-2-50, Low-Level Discharge Facilities for Drawdown of Impoundments (USACE 1975). The USBR criteria are the most recent and include the USACE criteria along with additional considerations; therefore, USBR criteria were followed for the design.

The USBR criteria for determining emergency evacuation periods are based on a combination of hazard and risk classifications. The USBR defines hazard as the consequence of having an adverse event and risk as the probability of occurrence of an adverse event. Both hazard and risk are each assigned a rating of "High", "Significant", or "Low" according to a listed set of criteria. The combination of these two factors then defines the evacuation criteria.

Given the "Extreme Hazard" classification and infrequency of planned operations, a "High-High hazard-risk" combination was selected. Table 1-12 provides the suggested drawdown criteria.

Table 1-12 Reservoir Drawdown Criteria

Evacuation Stage	Days
75% Hydraulic Height	10-20
50% Hydraulic Height	30-40
25% Hydraulic Height	60-80
10% Storage Volume	40-50

Based on the selected criteria, 90% of the reservoir volume is to be evacuated within 40 days, which corresponds to an average discharge rate of 20 m^3/s. Initial drawdown scenarios were modelled to determine a preliminary size of the hydraulic control section and calculated a maximum discharge rate at the full service level of approximately 27 m^3/s.

e) As discussed in b., different water quality parameters and their associated effects on fish and fish habitat respond in different ways depending on the flood and timing of release. During a 1:10 year flood, when water levels are shallow, a shorter hold time will reduce the risk of reservoir water temperatures increasing from solar radiation and seasonal increases in air temperature. Shorter hold times also reduce the risk of low DO. However, not all effects of a late release are detrimental. During the 1:100 year and design floods, water levels are deeper and prevent water temperatures from increasing as high as in Elbow River. With longer hold times associated with late release, suspended sediments settle in the reservoir and result in improved water quality (i.e., TSS and nutrients).

Although it is possible that a greater effect to one or more water quality parameters could occur somewhere on the spectrum between early release and late release, the results of the analysis described in b. for early release and late release do not suggest that valued components will respond to the reservoir drawdown timing in an unpredictable manner. As a result, no new or different mitigation would be required if drawdown of the reservoir occurs at a point between early release and late release. The mitigation measures and monitoring proposed for early release and late release would be applicable along the full spectrum of release scenarios, although the degree to which individual measures are applied will depend on the size of the flood and the timing of release.

Effects monitoring (i.e., monitoring for changes to water quality) will be used to determine if Project related changes occur in Elbow River. Where negative effects to the usability of Elbow River water are detected, AEP will provide information and advisories to local and downstream users, including the City of Calgary, so water use can be modified to mitigate negative consequences (e.g., avoid using water or increase treatment options). Monitoring is scalable if changes to water quality are detected; the spatial extent of monitoring sites and frequency of sampling can be increased on an as-needed basis.

Effects on entrained fish are largely expected to be dependent on the level of exposure to and duration of TSS in the reservoir. Any effects are expected to be linear and increase with time and, therefore, the negative consequences of an early release are anticipated to be less than that predicted for the late release. Potential effects on fish will be mitigated through fish health monitoring and a fish rescue plan. The fish health monitoring and fish rescue plan is scalable and may be adjusted or increased as needed to resolve any uncertainty or unanticipated negative consequences on fish.

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IR4-02: Mercury and Methylmercury

Sources:

EIS Guidelines Part 2, Section 6.2.2, 6.3.1, and 6.4

CEAA Annex 2: A) Early Technical Issues, December 19, 2017

EIS Volume 3B, Section 7

IAAC Technical Information Requests Round 1, Package 1, IR1-06

Alberta Transportation Responses to CEAA Annex 2: A) Early Technical Issues, May 11, 2018

ECCC Technical Review, June 18, 2018

Alberta Transportation Responses to IR Round 1, SR1 CEAA IR Package 1, June 14, 2019

ECCC Technical Review Round 2, February 6, 2020

Context and Rationale:

The EIS Guidelines require the identification of any potential adverse effects to fish and fish habitat, including the potential risk of production, increase, interaction, and accumulation of contaminants, including methylmercury. In IAAC Information Requests Related to the Environmental Impact Statement Round 1 Part 1, IR1-06, the Agency required the proponent to provide baseline methylmercury data in water of the Elbow River or describe a plan to collect such data prior to proceeding with the Project.

In response to IR1-06, Alberta Transportation described total mercury concentrations in the Elbow River to be below the analytical detection limit of 0.0000050 mg/L or 5 ng/L. Methylmercury in water was not specifically measured, but Alberta Transportation estimated methylmercury concentrations to be 1-15% of total mercury, based on literature values.

ECCC notes that the method detection limit of the laboratory total mercury measurements (0.000005 mg/L or 5 ng/L) is too high for total mercury measurements in natural water bodies. For analysis of natural waters, a method detection limit of 0.1 ng/L for total mercury and 0.02 ng/L for methylmercury is commonly achieved in academic, commercial, and government mercury analytical laboratories using cold vapor atomic fluorescence spectrophotometry and is appropriate for the Project.

Application of appropriate method detection limits during baseline sampling is needed to support adequate understanding of total mercury or methylmercury baseline conditions and to support the assessment of potential effects to fish and fish habitat, and associated monitoring.

Information Request:

a) **Provide a plan for collecting baseline data of total mercury and methylmercury in potentially impacted river water using an accredited laboratory with a method detection limit of 0.1 ng/L for total mercury and 0.02 ng/L methylmercury or lower and monitoring these concentrations post-flood.**

   - **Describe what adaptive mitigation measures could be implemented should increases in mercury or methylmercury in the reservoir water and food web in downstream ecosystems be observed.**

Response IR4-02

a) Water quality samples will be collected in Elbow River to establish baseline mercury and methylmercury levels in the river prior to Project construction. During reservoir operations (i.e., after water is diverted to the reservoir, while water is held in the reservoir and during reservoir drawdown), water samples for total mercury (ultra-low level) and methylmercury analysis will be collected at three locations at the following three locations:

   - Elbow River upstream of the intake structure (upstream)
   - off-stream reservoir
   - low-level outlet below the off-stream reservoir outlet gate

   All water quality samples collected will be sent to an accredited laboratory that has a detection limit of 0.1 ng/L, or lower, for total mercury and 0.02 ng/L, or lower, for methylmercury.

   Preventing water quality samples from becoming contaminated during ultra-low mercury and methylmercury sampling may be difficult given the environmental conditions in which samples are collected. Knowing what the potential sources of contamination are can help samplers limit the exposure. The following are potential sources of contamination that the samplers will try to avoid (US EPA 1996):

   - metallic equipment or structures like weirs, flumes, bridges or sampling devices (extendable sampling pole)
   - pipes, poles or wires
   - powdered sampling gloves
   - vehicle exhaust
   - atmospheric inputs of dust and dirt
   - cigarette smoke
   - sampler's breath, especially if they have mercury amalgam fillings

The following field sampling protocols and considerations are considered best practices, and will be implemented whenever possible to ensure proper collection methods (US EPA 1996; CCME 2011):

Pre-sampling and planning

- Samples will be collected in bottles provided from an accredited laboratory. These bottles will already contain the preservative provided by the laboratory, and they will come double bagged. While wearing clean, non-talc gloves, an employee will inspect the outer bag to ensure integrity.
- Sample bottles will remain double-bagged until the time of sampling to prevent exposure to contaminants.
- The employees will work in pairs and will follow the "clean hands/dirty hands" technique. One person will be the "clean hands" sampler and the other, the "dirty hands" sampler. The "dirty hands" sampler will prepare the sampling equipment (e.g., peristaltic-pump sampler, ISOMET sampler) and will open the outer bag. Only the "clean hands" sampler will have contact with the sample bottle; they are responsible for the collection of water.
- Employees will always wear clean, non-talc gloves when preparing the sampling equipment and collecting samples. If the "clean hands" sampler helps prepare the equipment or site, they will change their gloves so that they wear a new pair of clean gloves when handling the sample bottle. New gloves will be worn at each sampling location.
- Employees will choose a location that is far from known sources of contamination. Ideally, the sample location will not be within 100 m of infrastructure.
- Whenever possible, all equipment used for sampling (e.g., boats, ISOMET samplers, peristaltic-pump samplers) will be metal-free and washed at each location using water from the sampling site. This is done to minimize potential cross-contamination between sites. Should equipment with metal be used, this information will be recorded by the "dirty hands" sampler as a potential source of contamination.
- If tubing is required for sampling, for example with use of a peristaltic-pump, all tubing that will be used must be submerged in 5% to10% hydrochloric acid solution for 8 to 24 hours, rinsed, and purged with mercury-free air or nitrogen before being double bagged.
- Sampling locations will be collected in order of location least likely to be contaminated to location most likely to be contaminated.
- Whenever possible, an ISOMET sampler will be used to collect the water quality sample.

Sampling

- The "dirty hands" sampler will open the outer bag. Then, the "clean hands" sampler will open the inner bag, remove the sample bottle, and close the bag inside the outer bag. The "dirty hands" will then close the outer bag.
- when collecting samples directly in the water the "clean hands" sampler will:
  - stand downstream of the area they are collecting the sample from
  - collect the sample facing up-wind to prevent contamination
  - fill and preserve bottles according to instructions from the laboratory
- when collecting samples using an ISOMET sampler:
  - the "clean hands" sampler will be responsible for putting the sample bottle in the sampler
  - the "dirty hands" sampler will be responsible for holding the sampler, lowering it into the water at the desired depth, and manipulating the sampler to collect the water sample
- When collecting samples from a boat, it is preferable to use an electric motor or paddle the boat to the sampling location and not use a gas-powered motor. Should a gas-powered motor be required, the motor must be turned off away from where the sample will be collected, and the employees will paddle the boat to where the sample will be collected. The sample will be collected upwind and away from the boat.
- The "dirty hands" sampler will open the outer bag, the "clean hands" sampler will open the inner bag, place the sample bottle in the and close the bag. At this point the "dirty hands" sampler will close the outer bag.

Water quality samples will be collected weekly from the three locations listed above during the filling of the off-stream reservoir and when water is released from the reservoir. Should mercury and methylmercury be detected above background or guideline levels, sampling frequency may increase.

Mercury and methylmercury water quality analytical results will be evaluated from samples collected in the off-stream reservoir and below the low-level outlet to determine whether levels increase, which may trigger adaptive mitigation measures. Adaptive mitigation includes additional monitoring and water advisories.

Threshold triggers are used to indicate when increased monitoring should be implemented, prior to mercury and methylmercury exceeding regulatory guidelines. Relevant mercury and methylmercury guidelines are as follows:

- Canadian Council of Ministers of the Environment (CCME) freshwater guideline for the protection of aquatic life (CCME 2003):
  - total mercury: 26 ng/L
  - methylmercury: 4 ng/L, respectively

  These guidelines may not protect fish at higher trophic levels, or through the bioaccumulation of methylmercury.

- Environmental Quality Guideline for Alberta Surface Waters for the protection of aquatic life (Government of Alberta 2018):
  - total mercury: 5 ng/L (chronic) and 13 ng/L (acute)
  - methylmercury: 1 ng/L (chronic) and 2 ng/L (acute)
- Based on the more conservative Government of Alberta guideline, the following thresholds are suggested for this program:
  - below 2.5 ng/L (total mercury) and 0. 5 ng/L (methylmercury): weekly monitoring (2.5 ng/L total mercury and 0.5 ng/L methylmercury are half the Government of Alberta guideline level and established here as a monitoring target threshold to increase monitoring from weekly to twice weekly)
  - at or above 2.5 ng/L (total mercury) and 0. 5 ng/L (methylmercury): twice weekly monitoring
  - at or above 5 ng/L (total mercury) and 1 ng/L (methylmercury): daily monitoring
- When water sample analytical results are at or above 2.5 ng/L of total mercury or at or above 0.5 ng/L methylmercury (i.e., the monitoring target threshold) for two consecutive sampling events, the AEP will issue advisories that total mercury and methylmercury concentrations in Elbow River water have increased and that this may affect drinking water and fish tissue. Advisories will be issued until mercury and methylmercury levels decrease below the monitoring target threshold.
- Contingency for addition of monitoring location on Elbow River at Sarcee Bridge: Should mercury or methylmercury be detected in water samples collected from below the low-level outlet of the off-stream reservoir, an additional monitoring site approximately 20 km downstream will be added to the monitoring program. This will help indicate if the mercury or methylmercury has travelled downstream of the Project.

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IR4-03: Migratory Birds and Species at Risk

Sources:

EIS Guidelines Part 2, Sections 6.3.2, 6.3.3, 6.4

EIS Volume 3A, Section 11, Volume 3B, Section 11.3.4.1-2, and Volume 4, Appendix H

ECCC Technical Review, June 18, 2018

IAAC Information Requests Related to the Environmental Impact Statement Round 1 Part 1, IR1-07, IR1-08

Alberta Transportation Responses to IR Round 1, SR1 CEAA IR Package 1, June 14, 2019

IAAC Annex 1 – Gaps identified in Alberta Transportation's response to IR Round 1, Part 1, IR1-07

Alberta Transportation Responses to Agency Gaps - Package 1, Conformity IR1-07

ECCC Technical Review Round 2, February 6, 2020

Context and Rationale:

The EIS Guidelines require the identification of any potential direct and indirect adverse effects to migratory birds or their habitat, including staging and nesting areas, foraging groups, and landing sites, and to federally listed species at risk.

The EIS describes how the Project is predicted to increase bird and wildlife mortality risk in the project development area during a flood. IAAC Information Requests Related to the Environmental Impact Statement Round 1 Part 1, IR1-07, required Alberta Transportation to identify and describe mitigation measures that would be undertaken during operation to address the increase in mortality risk to birds listed under the *Migratory Birds Convention Act* and to any species listed in the *Species at Risk Act* and to provide a plan to avoid incidental take and mortality, given there is sufficient advanced notice of an impending flood. Alberta Transportation's response notes that there are no mitigation measures proposed during flood operations as it will not be possible to salvage eggs, nestlings, and amphibian species at risk due to safety concerns and the limited notice of impending flood events.

The Agency recognizes that due to safety concerns, effects to migratory birds and species at risk in the reservoir area during flooding are unavoidable and the frequency of flooding the reservoir will be low. However, the February 2020 Technical Advisory Group meeting and associated conversations identified some plans and measures that Alberta Transportation can take to minimize potential effects to migratory birds on a case by case basis. It is important for the Agency to understand how Alberta Transportation and/or Alberta Environment and Parks will endeavor to avoid potential effects to migratory birds and species at risk and comply with the *Migratory Bird Convention Act* and *Species at Risk Act*.

<u>Information Request:</u>

a) Provide the principles and criteria that will be used to select mitigation for the potential effects to migratory birds and species at risk present in the reservoir area during seasons when use of the Project is anticipated.

Response IR4-03

a) Overall, the success of mitigation efforts for migratory birds and species at risk requires:

- adequate flood forecasting to determine when salvage efforts are needed and to properly organize field crews
- identification of targeted salvage locations within the priority migratory birds and species at risk habitat areas, based on the rate of reservoir filling
- suitable survey, salvage and rehabilitation techniques to reduce potential effects on nesting migratory birds and species at risk within the reservoir during a flood

Salvage refers to relocating a migratory bird nest that contains eggs or chicks to a rehabilitation center that would otherwise be negatively affected during flood operations. Similarly, salvage refers to moving a species at risk (e.g., amphibians) that would otherwise be negatively affected during flood operations to an alternative release site outside the flood inundation areas (Randall et al. 2018).

Flood Forecast for Elbow River and Reservoir Filling

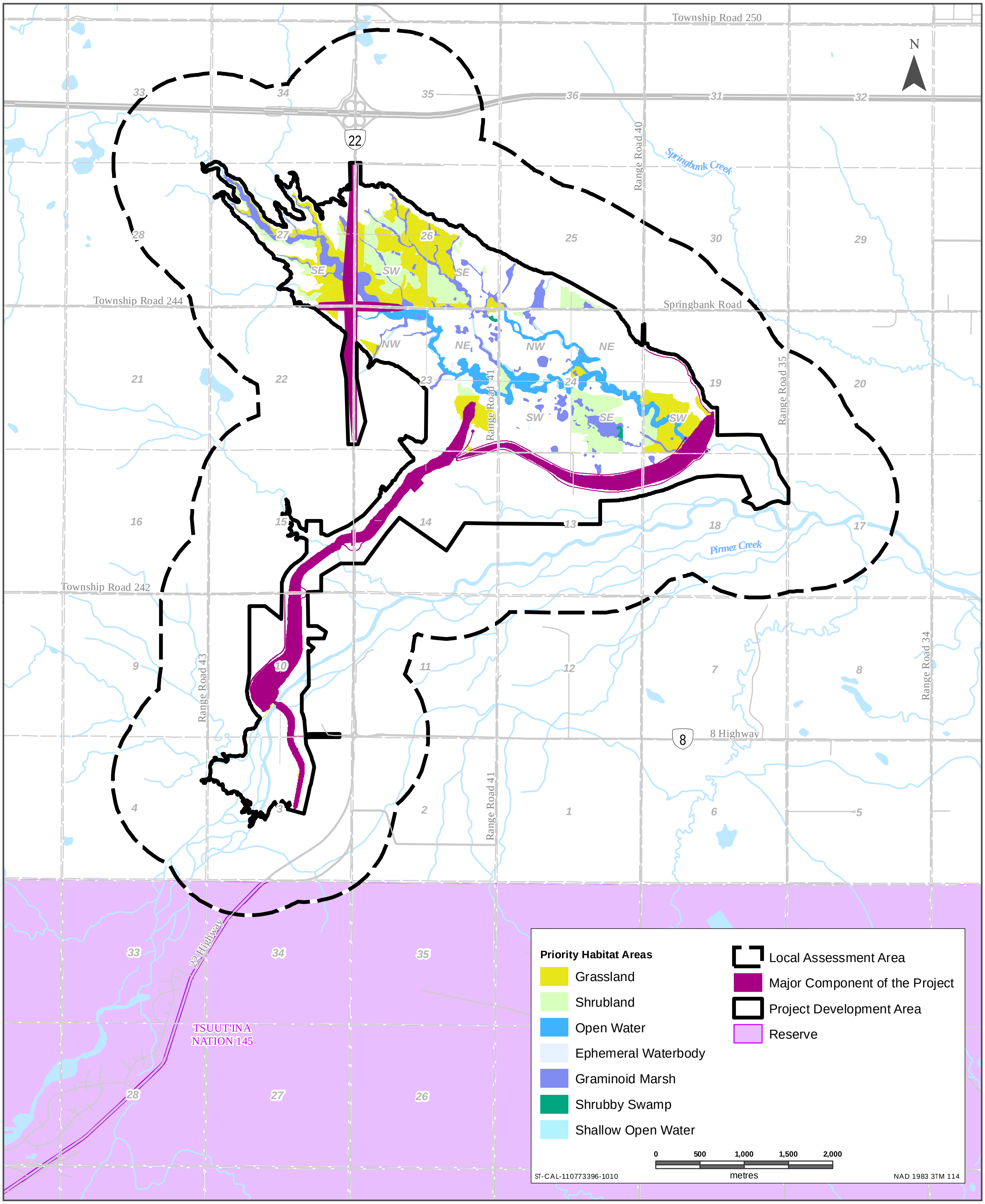
Flood forecasting for Project operations will be provided by AEP River Engineering and Technical Services. Forecasts will be based on modelled predictions that consider hydrometric, snowpack, precipitation and meteorological forecast. Correspondence with AEP River Engineering and Technical Services indicates that AEP will be able to provide an advance notice of two to three days for when Elbow River may exceed flows of 160 m^3/s. This notice will initiate migratory bird salvage in the reservoir area. Limiting the implementation of the salvage program during the advance flood warning period (two to three days) will reduce the uncertainty associated with salvaging in areas that may not receive flood waters (i.e., salvaging prior to the best available advance warning could result in unnecessary salvage efforts because there is uncertainty associated with predicting a future flood). This is also because birds and eggs have the potential to be harmed by the salvage efforts themselves, so there is a desire to limit the risk of harm that may be caused by undertaking salvage in areas that do not have flooding.

Migratory Bird Salvage during Flood Operations

Mitigation to reduce potential Project effects on migratory birds during flood operations will include the development and implementation of a bird salvage program (i.e., relocation of nests with eggs and/or chicks). Spatial and forecasting constraints, combined with estimated bird densities, will be used as criteria to identify where in the reservoir's footprint potential bird salvage could occur while protecting worker safety and feasibility of success.

Identification of Priority Habitat Areas

Based on the estimated breeding bird densities and habitat types available within the off-stream reservoir (see response to CEAA Conformity IR1-07), there are areas that are expected to contain relatively higher densities of bird nests compared to other habitat types (i.e., "hotspots"). Although results from the breeding bird baseline surveys indicated forested areas contained relatively higher breeding bird densities (357 to 587 territories/100 ha) (see response to CEAA Conformity IR1-07) compared to other habitat types, ground nesting birds are most at risk during flood operations. Therefore, shrublands, wetlands and grassland (i.e., native and reclaimed grassland) will be focused on during bird nest search efforts and salvage operations within the reservoir (see Figure 3-1). These priority habitat areas are expected to contain moderate densities of breeding birds (220 territories/100 ha to 357 territories/100 ha) based on previous baseline breeding bird surveys (see EIA, Volume 4, Appendix H, Section 3.0).



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

Priority Habitat Areas within the Reservoir and Potential Locations of Migratory Bird and Species at Risk Salvage Efforts

Stantec

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT

Figure 3-1

Wetlands that may contain amphibian species at risk will also be relocated to suitable areas outside the inundated reservoir, when encountered. Although these habitat types are distributed throughout the PDA, they are largely associated with the unnamed creek that passes through the middle of the reservoir. The unnamed creek contains riparian areas dominated by sedge marsh, grasslands and low shrub communities. Migratory birds frequently observed during baseline surveys in these habitat types included clay-colored sparrow *(Spizella pallida)*, savannah sparrow *(Passerculus sandwichensis)*, Lincoln sparrow (*Melospiza lincolnii*), yellow warbler (*Setophaga petechia*), and house wren (*Troglodytes aedon*) as well as three species of management concern: sora *(Porzana carolina*), alder flycatcher (*Empidonax alnorum*) and eastern kingbird (*Tyrannus tyrannus*) (see EIA, Volume 4, Appendix H, Section 3.0).

No ground-nesting bird species at risk or amphibian species at risk were identified during baseline wildlife surveys. However, bird species at risk will be rescued and any amphibian species at risk such as western tiger salamander (*Ambystoma mavortium*) or northern leopard frog (*Lithobates pipens*) will be relocated out of harms way if encountered during the salvage program.

Although other mitigation strategies such as deploying deterrents or removing habitat that provides high densities of breeding birds is possible, these approaches would require constant maintenance and reduce migratory bird breeding productivity for long periods of time, which reduces their suitability. In addition, these strategies are not consistent with the draft Guiding Principles and Direction for Future Land Use that require grassland and other wildlife habitats to be maintained to provide First Nation's activities such as hunting and potential grazing opportunities.

Bird nest searches are proposed to identify nesting locations and further refine priority areas where migratory bird and species at risk salvage efforts will be focused. Specifically, pre-construction bird nest search surveys, as discussed in the draft Wildlife Mitigation and Monitoring Plan (WMMP; see response to Round 1 CEAA Package 1 IR1-09, Appendix IR9-1) will be completed to provide additional information related to bird species occurrence and nest densities in each of the priority habitat types (i.e., grassland, wetland, shrubland). Although some of the areas affected a 1:100 year flood and design flood occur outside the construction footprint, the habitat types affected during construction and flood operations are the same. Therefore, results of pre-construction bird nest surveys will be used to refine potential bird nesting priority areas that might be affected during a flood.

To account for changes in habitat over time, the reservoir will be surveyed at regular intervals of approximately five years to update the understanding of habitat conditions and to recharacterize high priority areas.

IDENTIFICATION OF POTENTIAL SALVAGE LOCATIONS

The priority habitat areas of grassland, wetlands and shrublands along the unnamed creek will be targeted for nest salvage, based on estimated bird densities. However, the exact locations of bird salvage efforts will depend on the rate of reservoir filling: salvage efforts will be focused on priority habitats located in the lower portions of the reservoir nearest to the dam where the risk of mortality to ground-nesting birds will be relatively higher because those areas contain an abundance of high priority habitats and will be inundated relatively early during reservoir filling (e.g., SW-19-24-03W5M, SE-24-24-04W5M; see Figure 3-1). However, these areas will only be targeted for salvage efforts if it is safe to do so. Where possible (or If necessary), salvage efforts may include the middle and upper portions of the reservoir, depending on the rate of reservoir filling. Based on the estimated advance flood warning of two to three days, there would be approximately 24 to 36 hours of daylight available to implement the bird and species at risk salvage program during a flood response. The total number of nests potentially salvaged will depend on nest densities within priority areas and relative survey effort (i.e., number of field staff and the success of nest searches) within the constraints of worker safety.

NEST SEARCHES AND SALVAGE METHODS

Nest searches will be completed using a combination of passive detection techniques (observing bird behaviour and listening for bird song or calls) and systematically walking the salvage area to observe nests and nesting behaviour. A nest can be confirmed by:

- physically observing the nest structure (often identified by a flushing bird)
- observation of breeding behaviour (e.g., auditory signs [singing males, alarm calls, defense calls, screeching, begging vocalizations by nestlings])
- distraction displays
- nest defense behaviours (e.g., diving)
- birds carrying nesting material, food or fecal sacs
- observation of nestlings or fledglings
- repeated flying towards a specific location

While conducting nests searches, amphibians will be targeted during search efforts in areas of suitable habitats along the unnamed creek, including open water and wetlands such as graminoid marsh (see Figure 3-1).

As feasible, all chicks (i.e., hatchling, nestling, fledgling) and eggs will be rescued and transported to a local wildlife rescue center(s) following an approved salvage protocol. The salvage protocol will be developed in consultation with provincial and federal regulators as well as Indigenous groups and included in the final WMMP. The migratory bird and species at risk salvage program will provide opportunities for Indigenous groups to participate in salvage efforts as part of the Indigenous Participation Plan (IPP).

WILDLIFE PERMITS

Alberta Transportation and AEP (as applicable) will obtain any necessary provincial wildlife permits (e.g., collection license) to allow public handling and collecting of authorized wildlife species in consultation with AEP (Fish and Wildlife). Although Environment and Climate Change Canada (ECCC) does not issue salvage permits for migratory birds, they will be notified of any planned salvage program once the advance flood warning has been issued by AEP.

Amphibian species at risk will be relocated to areas of suitable habitat as close as possible but outside the inundated reservoir. Amphibians will be captured and relocated using dip nets. Plastic ziplock bags or containers will be used to transport individual amphibians. Handling will follow the Alberta Wildlife Animal Care Committee Class Protocol #003 - Capture and Handling of Amphibians (Government of Alberta 2012) and the CCAC Species Specific Recommendations on Amphibians and Reptiles (https://www.ccac.ca/Documents/Standards/Guidelines/Add_PDFs/Wildlife_Amphibians_Reptiles.pdf).

BUILDING COMMUNITY RELATIONSHIPS WITH WILDLIFE REHABILITATION CENTERS

A key component of the migratory bird and species at risk salvage program is the rehabilitation necessary to increase the chances of survival following field salvage efforts, which will require expertise from local wildlife rescue and rehabilitation centers. Therefore, Alberta Transportation and AEP (Operations) will establish and maintain working relationships with local wildlife rescue centers to facilitate bird salvage including species at risk, following Project approval. Alberta Transportation commits to an initial meeting with local rescue centers such as the Calgary Wildlife Rehabilitation Society (CWRS), Cochrane Ecological Institute (CEI) and Alberta Institute for Wildlife Conservation (AIWC) to provide an understanding of the goals and objectives of the bird and species at risk salvage program and describe the potential scale of a flood response. An initial meeting will provide opportunities for local centers to provide an overview of their existing staffing resources and facility capacity to assist with the migratory bird and species at risk salvage program and provide guidance related to field salvage protocols.

A preliminary discussion with the CWRS on April 21, 2020 indicated the success and cost of rescuing migratory birds will vary by species and age of bird (e.g., hatchling versus fledgling). In addition, there are logistical (e.g., facility capacity) constraints and financial considerations (e.g., facility, equipment and staffing costs) associated with bird rescue that need to be considered as part of a migratory bird and species at risk salvage program (Melanie Whelan, pers. comm 2020).

AIWC also provides services to rescue, rehabilitate, and release injured and orphaned wildlife. AIWC has an accredited veterinary hospital, which can provide professional consultation and care, where needed. The AIWC is permitted by both the federal and provincial governments to rehabilitate wildlife; however, they are not permitted to care for adult ungulates such as deer or moose, carnivores (e.g., bears, cougars) or other species such as coyote (AIWC 2020). In addition to migratory birds, the CEI has capacity to rescue and rehabilitate other wildlife species such as raptors (e.g., owl) as well as orphaned mammals (e.g., bear, ungulates) (CEI 2020).

In summary, the approach and criteria described above demonstrates due diligence because the mitigation is designed to comply as best as possible with the *Migratory Birds Convention Act* and the *Species at Risk Act* during a flood response.

REFERENCES

AIWC (Alberta Institute for Wildlife Conservation). 2020. Available at: https://www.aiwc.ca/

CEI (Cochrane Ecological Institute). 2020 Available at: https://ceinst.org/

Government of Alberta. 2012. Alberta Wildlife Animal Care Committee Class Protocol #003. Class Activity: Capture and Handling Amphibians. Available at: https://open.alberta.ca/dataset/3d6a3d31-7478-4558-aef8-2859a26db4c0/resource/36401970-021a-400d-b44c-ef8a9e2f2125/download/2005-alberta-wildlife-animal-care-committee-class-protocol-003-capture-handling-amphibians.pdf

Randall, L., N. Lloyd, and A. Moehrenschlager. 2018. Guidelines for Mitigation Translocations of Amphibians: Applications for Canada’s Prairie Provinces. Version 1.0. Centre for Conservation Research, Calgary Zoological Society. Calgary, Alberta, Canada. 94 pp.

Whelan, M. 2020. Director of Animal Care. Calgary Wildlife Rehabilitation Society (CWRS). Personal Communication, April 21, 2020.

IR4-04: Air Quality

Sources:

EIS Guidelines Part 2, Sections 6.1.1; 6.1.9; 6.2.1; 6.3.4; 8

EIS Volume A, Section 3, 5.4.4; Volume 3B, Section 3, 15.4.2.3; and Volume 6, Section 2.2

ECCC Technical Review, June 18, 2018

HC Comments on the EIS – June 15, 2018

IAAC Technical Information Requests Round 1, Package 3, IR3-35

Alberta Transportation Responses to IR Round 1, SR1 CEAA IR Package 3, June 14, 2019

ECCC Technical Review Round 2, February 6, 2020

Health Canada Technical Review Round 2,

Context and Rationale:

The EIS Guidelines require a description of baseline air quality levels and changes in air quality, as well as an assessment of the effects of changes to air quality on Indigenous peoples.

IAAC Information Requests Related to the Environmental Impact Statement Round 1 Part 3, IR3-35, required Alberta Transportation revise the air quality assessment to consider the 2017 Canadian Ambient Air Quality Standards (CAAQS) for nitrogen dioxide (NO_2) and provide specific measures to mitigate the potential risk for adverse health effects from air contaminants.

In response to IR3-35, Alberta Transportation describes the intent to develop a monitoring plan and potential air quality mitigation. Providing this draft air quality management plan would be beneficial for the Agency to understand proposed monitoring and mitigation for potential effects to Indigenous peoples' health.

Additionally, in response to IR3-35, Alberta Transportation noted that the Project is predicted to exceed the CAAQS for 1-hour NO_2 during the Application Case and for 24-hour and annual $PM_{2.5}$ in both the Project and Application case. Alberta Transportation proposed monitoring for $PM_{2.5}$ and the implementation of additional mitigation measures if the Alberta Ambient Air Quality Objectives (AAAQO) are exceeded; however, no visual monitoring is proposed. In the February 2020 Technical Advisory Group Meeting, Rocky View County identified the need for visual monitoring of dust and implementation of adaptive mitigation measures.

Alberta Transportation does not propose any monitoring or mitigation of NO_2 emissions. Health Canada noted that NO_2 is a non-threshold air contaminant, which means that health effects may occur at any level of exposure. Collecting NO_2 data is important even if there is no adaptive mitigation in place as this data can be reported and available for public knowledge and use.

Understanding potential exceedances in CAAQS is important for the Agency to understand the potential effects of changes to air quality on Indigenous peoples' health. Health Canada noted that the CAAQS are health and environment-based environmental quality guidelines intended to be benchmarks against which the Government of Canada and provincial and territorial governments can use to inform risk management decisions (e.g., regulation or other actions to reduce air pollution) as well as report on progress on reducing the health and environmental burden of air pollution. The CAAQS represent targets agreed upon by federal and provincial/territorial governments and a multi-stakeholder group. The program under which CAAQS exist (the Air Quality Management System or AQMS) was an approach championed by several parties including industry, environmental and health groups and some governments. As such, they have a broad basis of legitimacy and are the appropriate metric against which to assess environmental and health impacts of air pollution. The CAAQS are not designed to be pollute up to levels, but levels where increasing risk management and adaptive management should be used to implement mitigation to prevent an increased risk to human health.

Information Request:

a) Provide a draft air quality management plan that includes:

- **CAAQS as targets for implementation of the plan;**
- **consideration of visual monitoring and adaptive mitigations for PM2.5;**
- **commitments to continuous monitoring of NO2 and reporting to appropriate regulatory body and/or public source; and**
- **adaptive mitigation measures should NO2 exceed CAAQS.**

Response IR4-04

a) A draft air quality management plan (AQMP) is attached as Appendix 4-1. The draft AQMP is based on anticipated regulatory requirements for approvals and authorizations specific to the Project. The plan will be finalized following additional consultation with regulators, Indigenous communities and stakeholders and as an anticipated requirement of the *Environmental Protection and Enhancement Act* (EPEA) approval conditions.

The draft AQMP describes mitigation and monitoring for several criteria air contaminants (CACs) identified as being of potential concern or importance to the Project. The AQMP describes mitigation measures that will be implemented, monitoring methods, and adaptive management methods if CACs exceed targets, based upon both the Alberta Ambient Air Quality Objectives (AAAQO) and Canadian Ambient Air Quality Standards (CAAQS).

APPENDIX 1-1 WATER QUALITY MODELLING RESULTS

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT
Water Quality Modelling Results

Prepared for:
Alberta Transportation

Prepared by:
Stantec Consulting Ltd.

June 2020

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1.0 WATER QUALITY MODELLING

Hydrodynamic modelling was completed to confirm the predicted effects of the Project on the flood hydrology and suspended sediment concentrations reported in the environmental impact assessment (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 Danish Hydraulic Institute (DHI).

The MIKE ECO Lab module was paired with the MIKE 21 hydrodynamic model to calculate concentrations and dilution ratios for water quality (i.e., water temperature, dissolved oxygen [DO], biochemical oxygen demand [BOD]). 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 Water Survey of Canada (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 are 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 is used at the downstream boundary condition of the model allowing it to extract the concentration of the state variable from adjacent mesh elements.

The hydrodynamic modelling methods are reported in Appendix 1-2.

The model runs for water temperature, DO and BOD were completed for the 1:10 year flood, 1:100 year flood and design flood for early release and late release (six scenarios in total). Modelling results were provided for the following locations:

- 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.

2.0 TEMPERATURE AND DISSOLVED OXYGEN

2.1 DISSOLVED OXYGEN AND TEMPERATURE MODELLING RESULTS

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 affect the temperature, BOD or DO in the reservoir or in the river when water is released (Figure 2-1 through Figure 2-5).
- 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 reservoir drawdown is complete (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 reservoir drawdown (Figure 2-6).
- As reservoir water is released to Elbow River, mixing causes the 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 2-7).
- 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 (at Twin Bridges) of the unnamed creek (Figure 2-8 through Figure 2-10).

1:100 Year Flood, Early Release

- Water is held in the reservoir for 25 days before reservoir drawdown 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 are limited due to higher water levels in the reservoir compared to the 1:10 year flood (Figure 2-11).
- 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 reservoir water is released into Elbow River, changes to the river water temperature and DO are not apparent. Over water is released, water temperatures in Elbow River increase slightly (less than a degree) and DO decreases slightly (less than 1 mg/L) (Figure 2-12).
- 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 2-13 through Figure 2-15).

1:100 Year Flood, Late Release

- Water is held in the reservoir for 92 days before reservoir drawdown 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 2-16).
- 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 into 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 reservoir drawdown (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 2-17).
- 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 2-18 through Figure 2-20).

Design Flood, Early Release

- Water is held in the reservoir for 39 days before reservoir drawdown is complete (i.e., time to divert and release water). Water temperatures increase slightly during this period. Increases in temperature are limited due to higher water levels in the reservoir compared to the 1:10 year flood for both early release and late release (Figure 2-21).
- 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 reservoir drawdown.
- Slight effects on Elbow River water temperature and DO can be seen in two to three days after water release begins. 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. Once reservoir drawdown 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 2-22).
- A shift in water temperature and DO at downstream locations is not seen at the end of the reservoir drawdown (Figure 2-23 through Figure 2-25).

Design Flood, Late Release

- Water is held in the reservoir for 59 days before reservoir drawdown is complete (i.e., time water is diverted, held and released). Water temperatures increase in the reservoir and DO concentrations decrease over time (Figure 2-26).
- 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 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 the reservoir drawdown, this mixing does not result in a change to river temperatures (Figure 2-27).
- Reservoir water mixing in Elbow River causes river water DO to decrease 1 mg/L to 2 mg/L over the duration of reservoir drawdown.
- 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 2-28 through Figure 2-30).

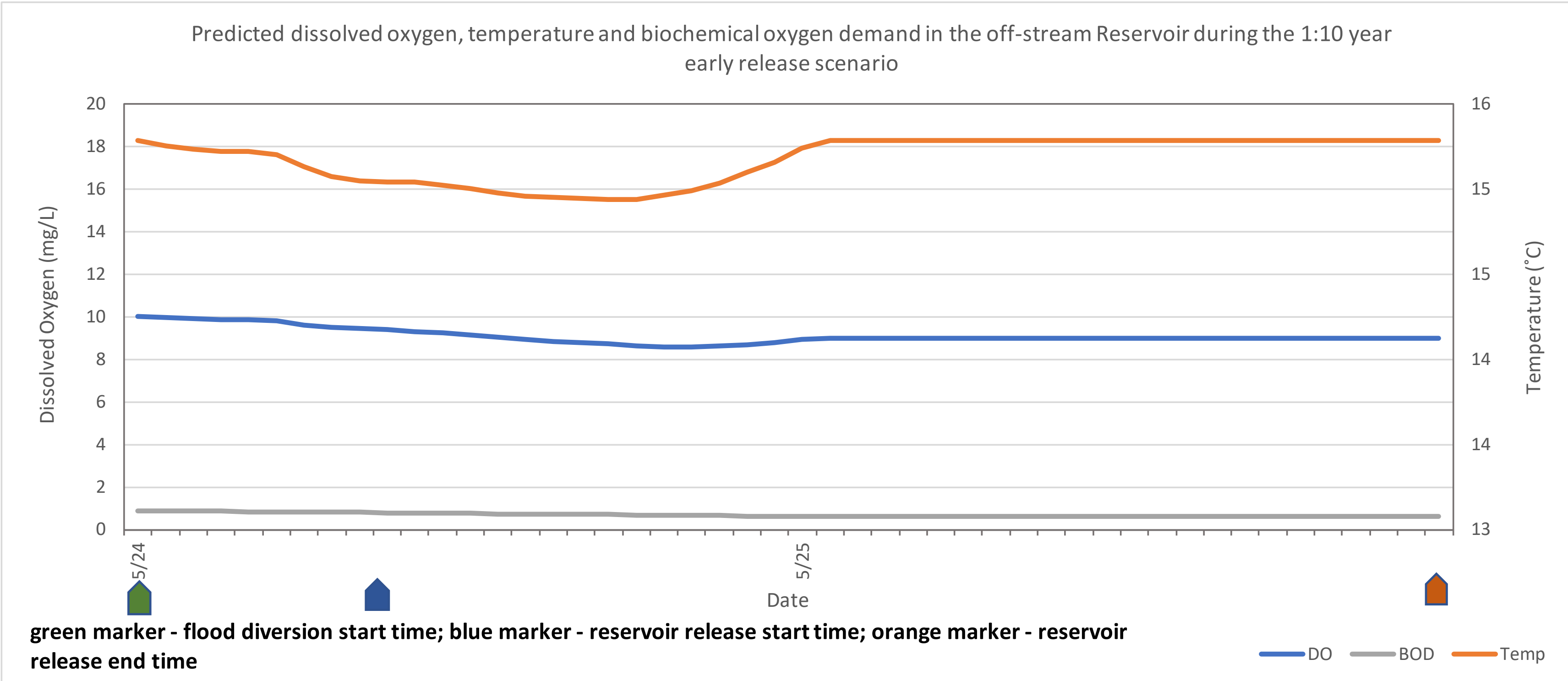
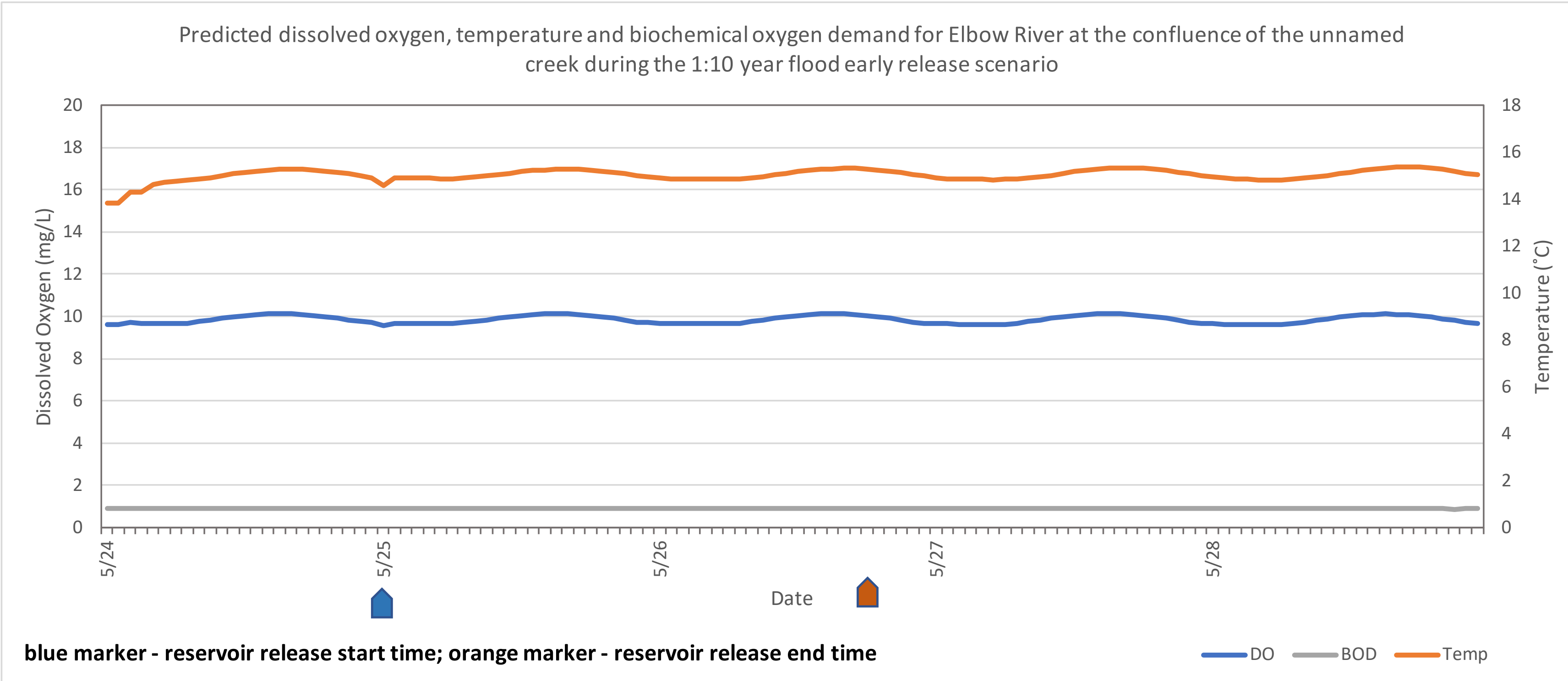


Figure 2-1 DO, Temperature and BOD in the Off-Stream Reservoir, 1:10 Year Flood for Early Release (water in the reservoir from May 24 to May 25)



NOTE: dissolved oxygen oscillates in response to diel temperature fluctuations

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

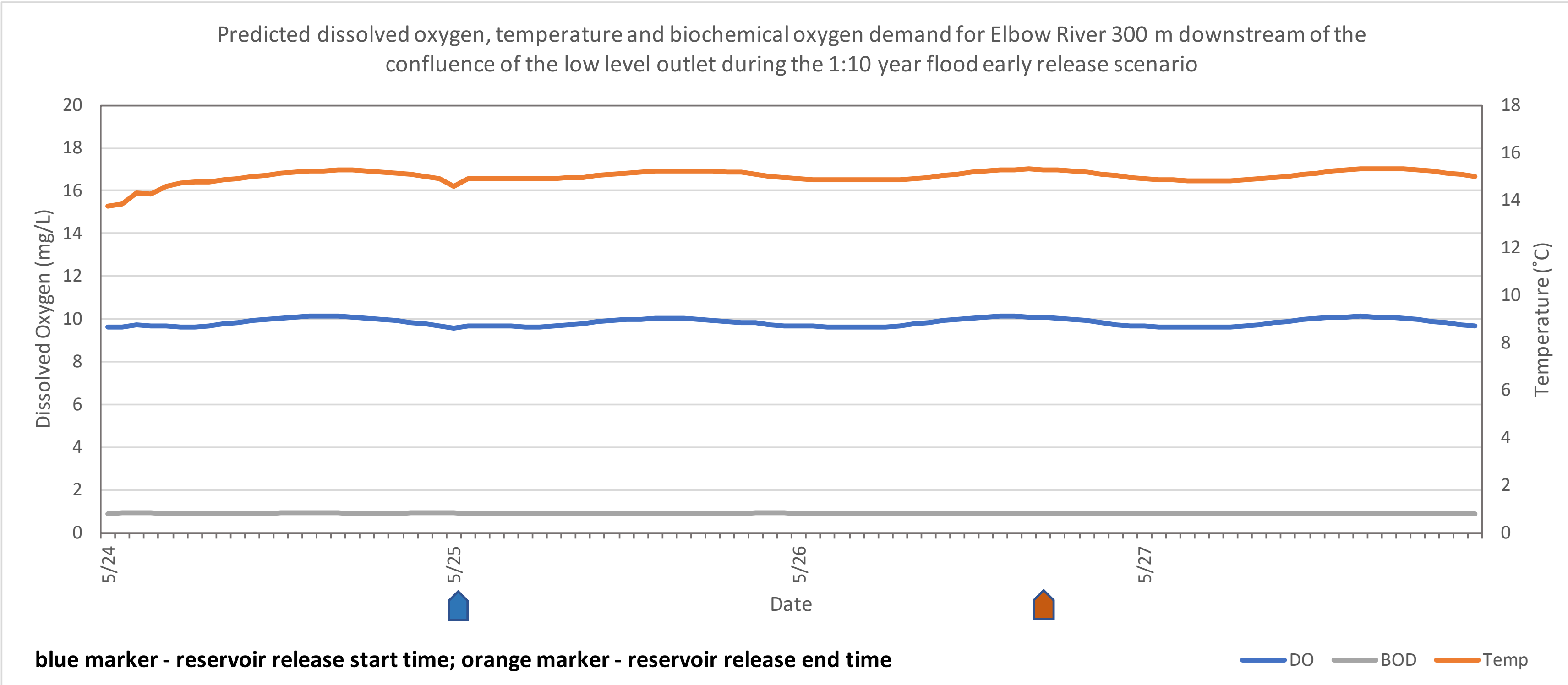


Figure 2-3 **DO, Temperature and BOD in Elbow River 300 m Downstream of the Unnamed Creek, 1:10 Year Flood for Early Release (water release from May 25 to May 26)**

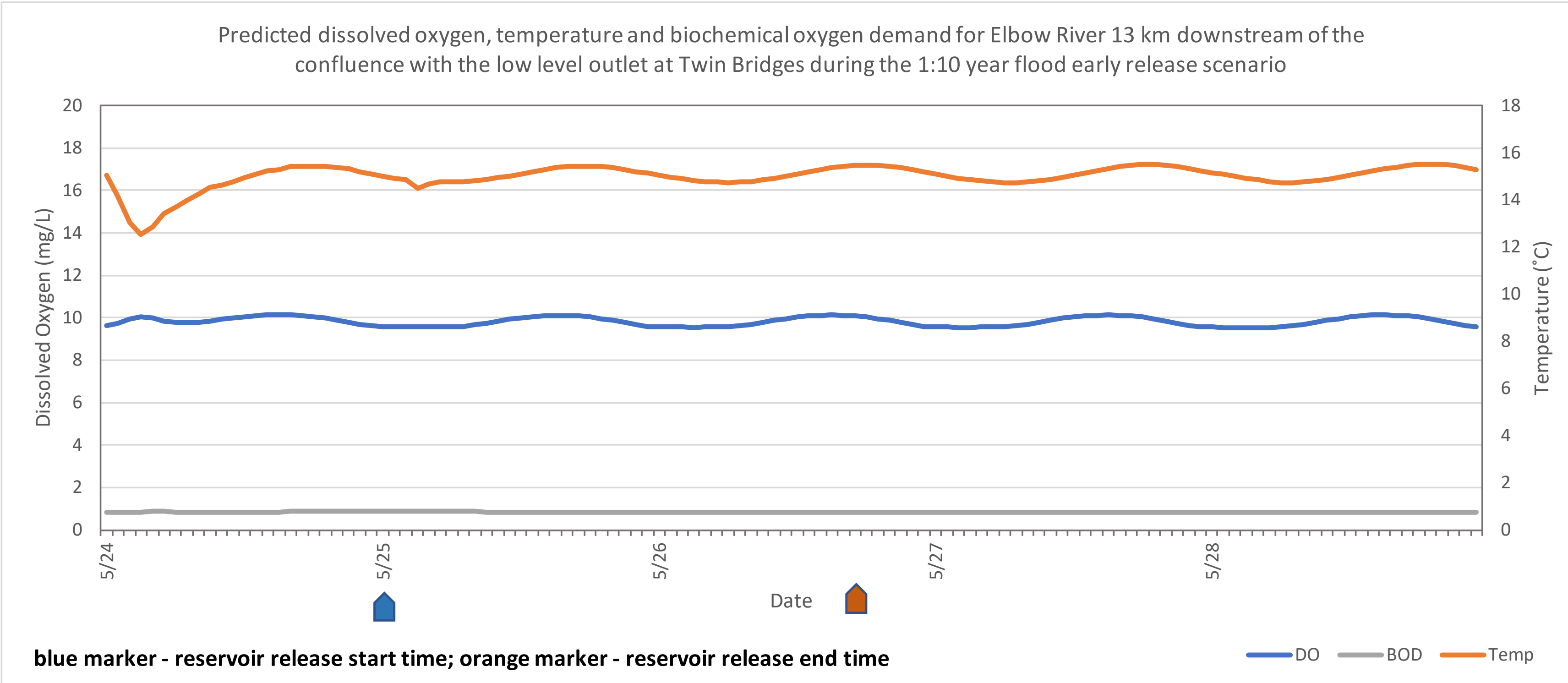


Figure 2-4 **DO, Temperature and BOD in Elbow River 13 km Downstream of the Unnamed Creek at Twin Bridges, 1:10 Year Flood for Early Release (water release from May 25 to May 26)**

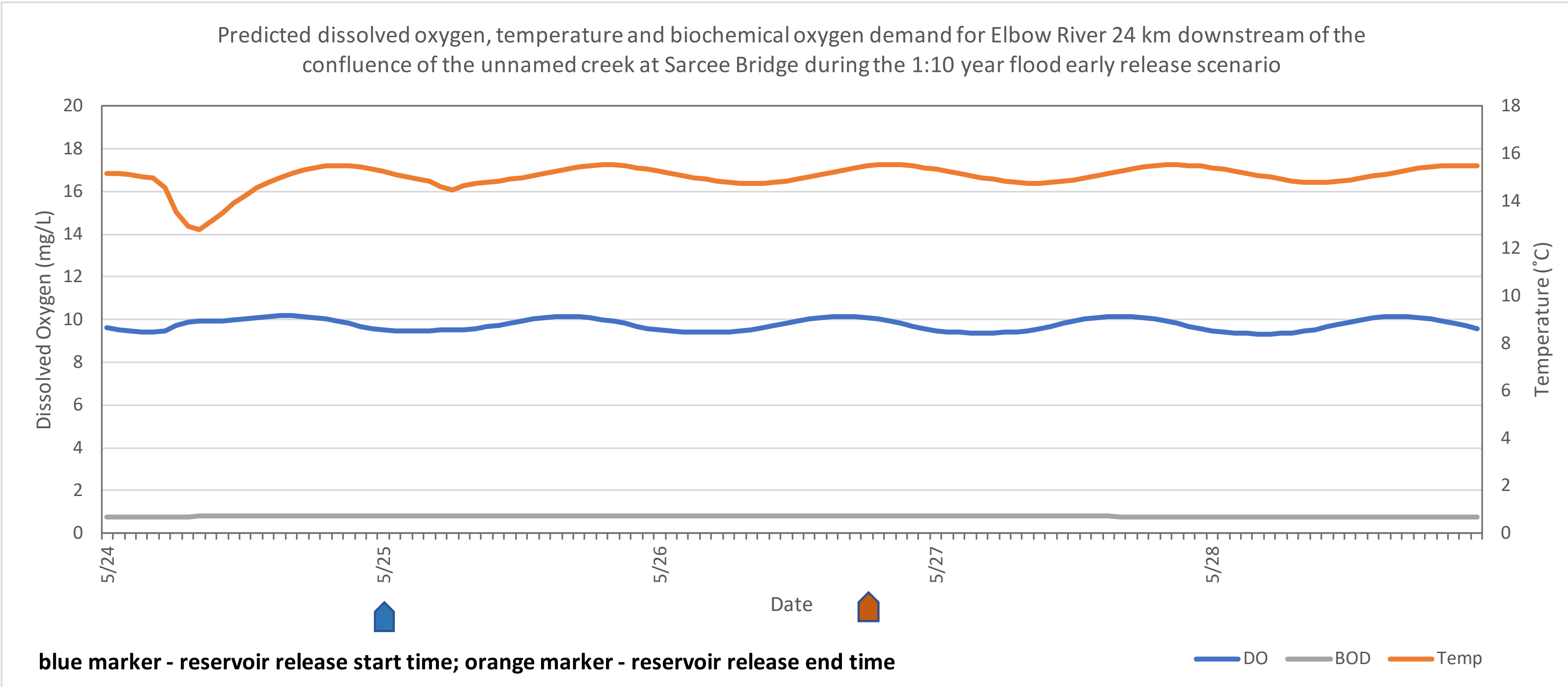


Figure 2-5 DO, Temperature and BOD in Elbow River 24 km Downstream of the Unnamed Creek at Sarcee Bridge, 1:10 Year Flood for Early Release (water release from May 25 to May 26)

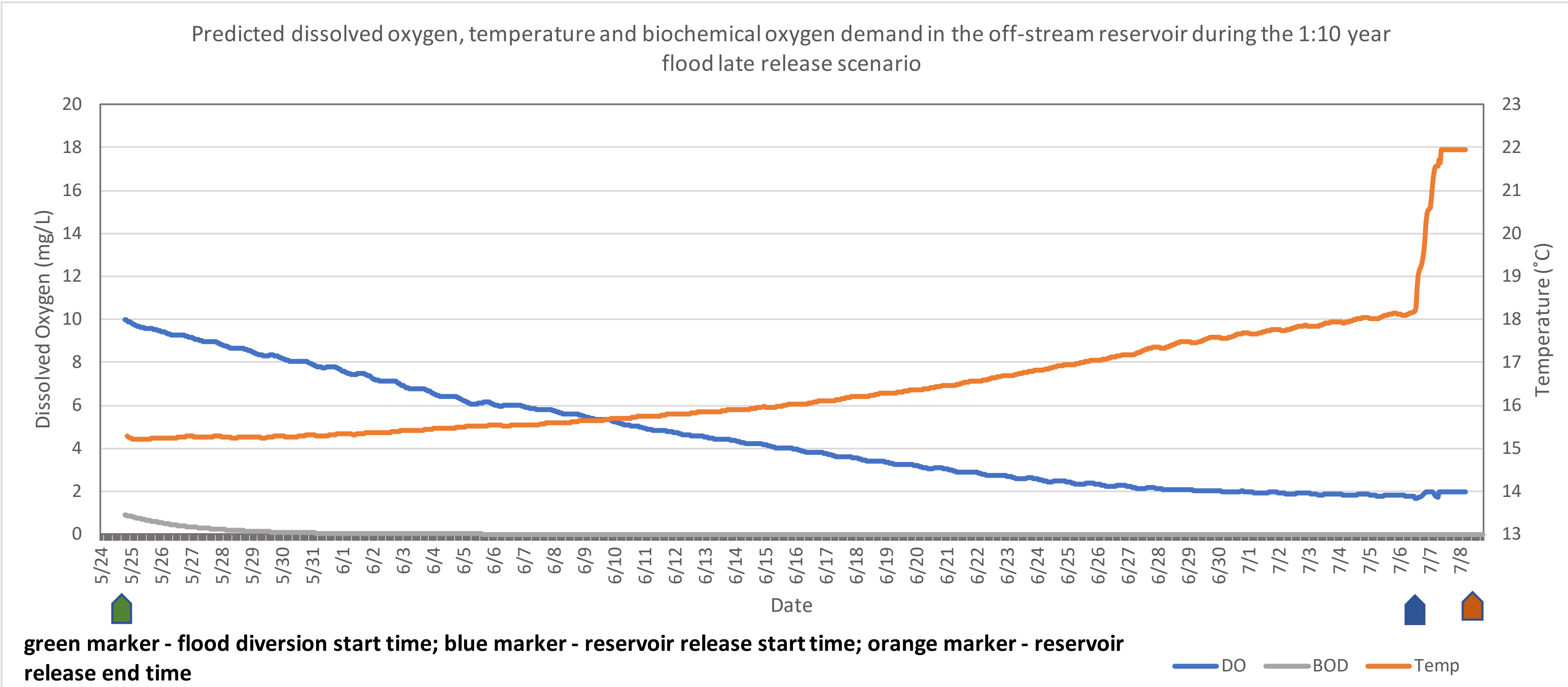
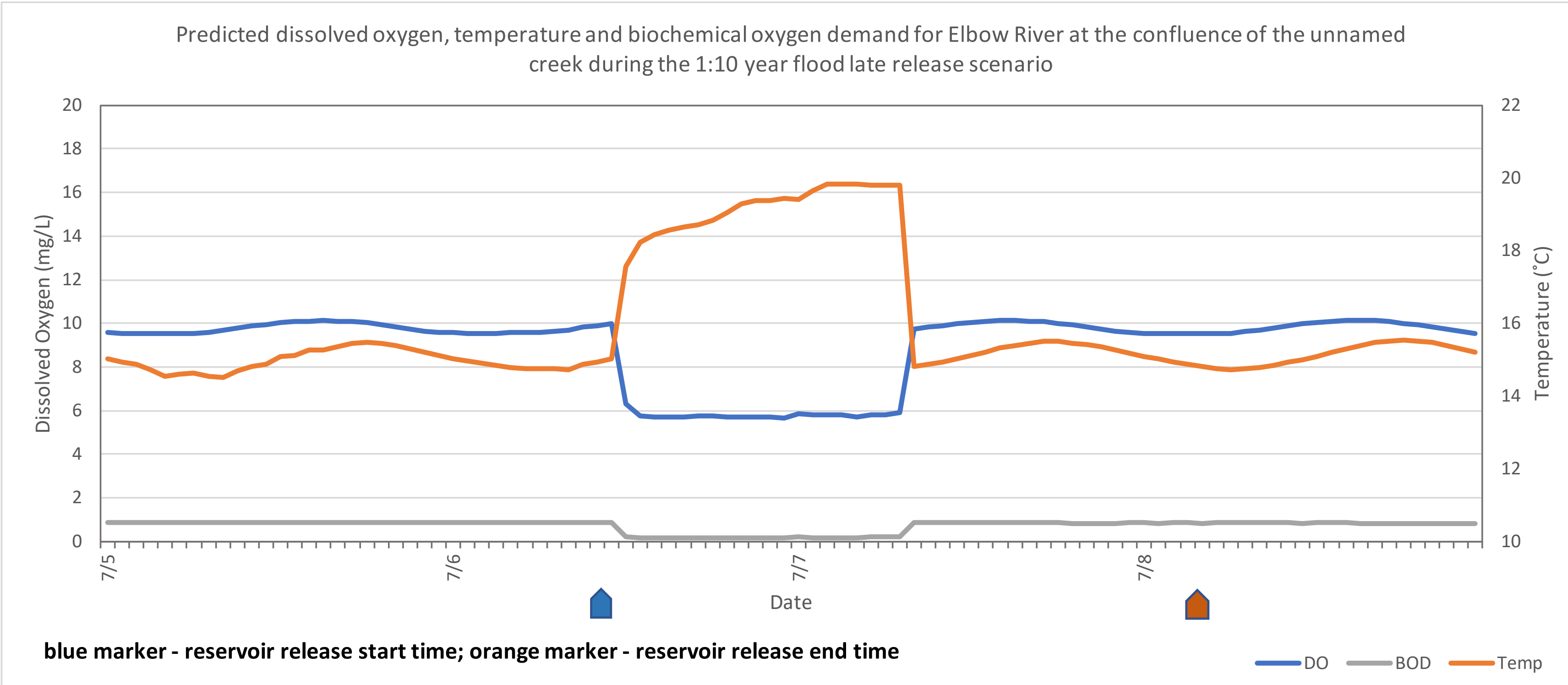


Figure 2-6 **DO, Temperature and BOD in the Off-Stream Reservoir, 1:10 Year Flood for Late Release (water is in the reservoir from May 24 to July 8; 45 day duration)**



NOTE: dissolved oxygen oscillates in response to diel temperature fluctuations

Figure 2-7 **DO, Temperature and BOD in Elbow River at the Confluence of the Unnamed Creek, 1:10 Year Flood for Late Release (during water release from July 6 to July 8)**

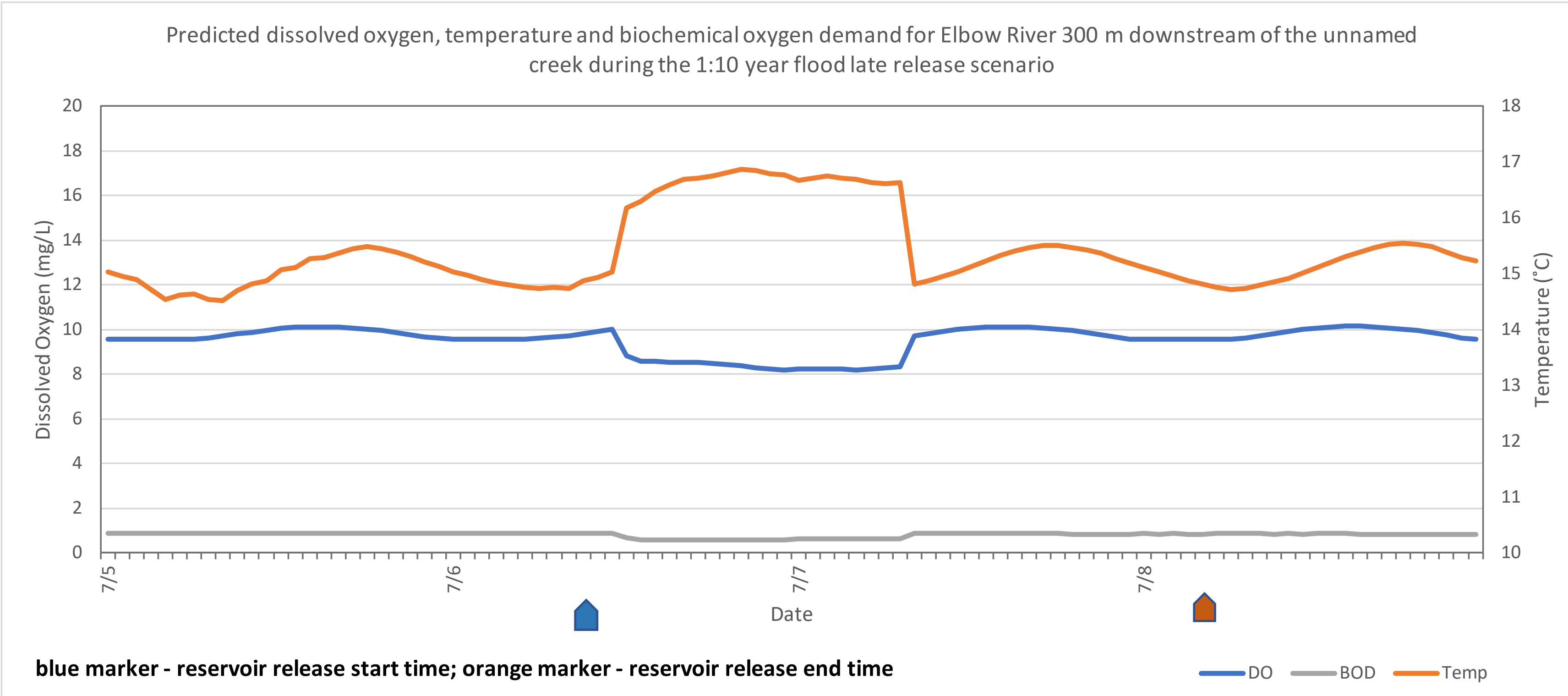


Figure 2-8 **DO, temperature and BOD in Elbow River 300 m Downstream of the Unnamed Creek, 1:10 Year Flood for Late Release (during water release from July 6 to July 8)**

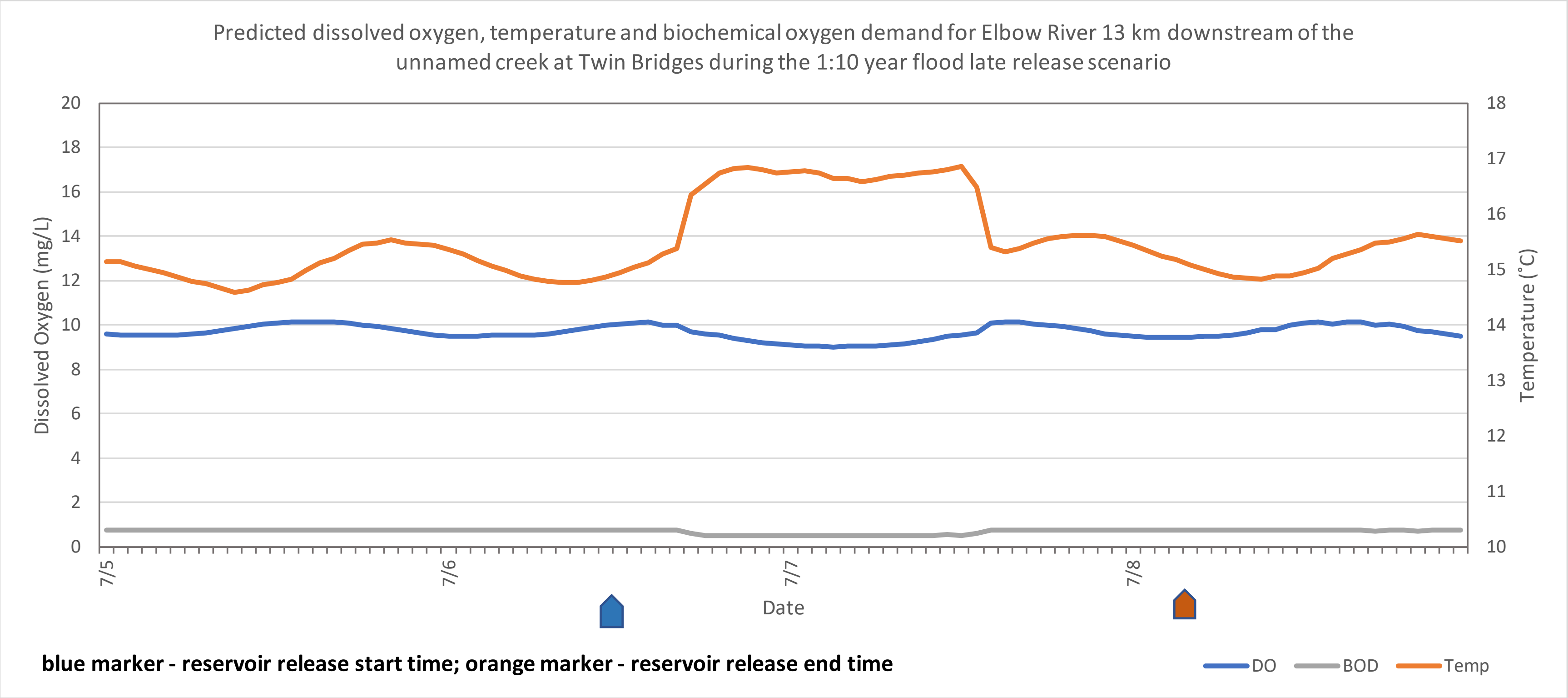


Figure 2-9 **DO, Temperature and BOD in Elbow River 13 km Downstream of the Unnamed Creek at Twin Bridges, 1:10 Year Flood for Late Release (during water release from July 6 to July 8)**

Temperature and Dissolved Oxygen
June 2020

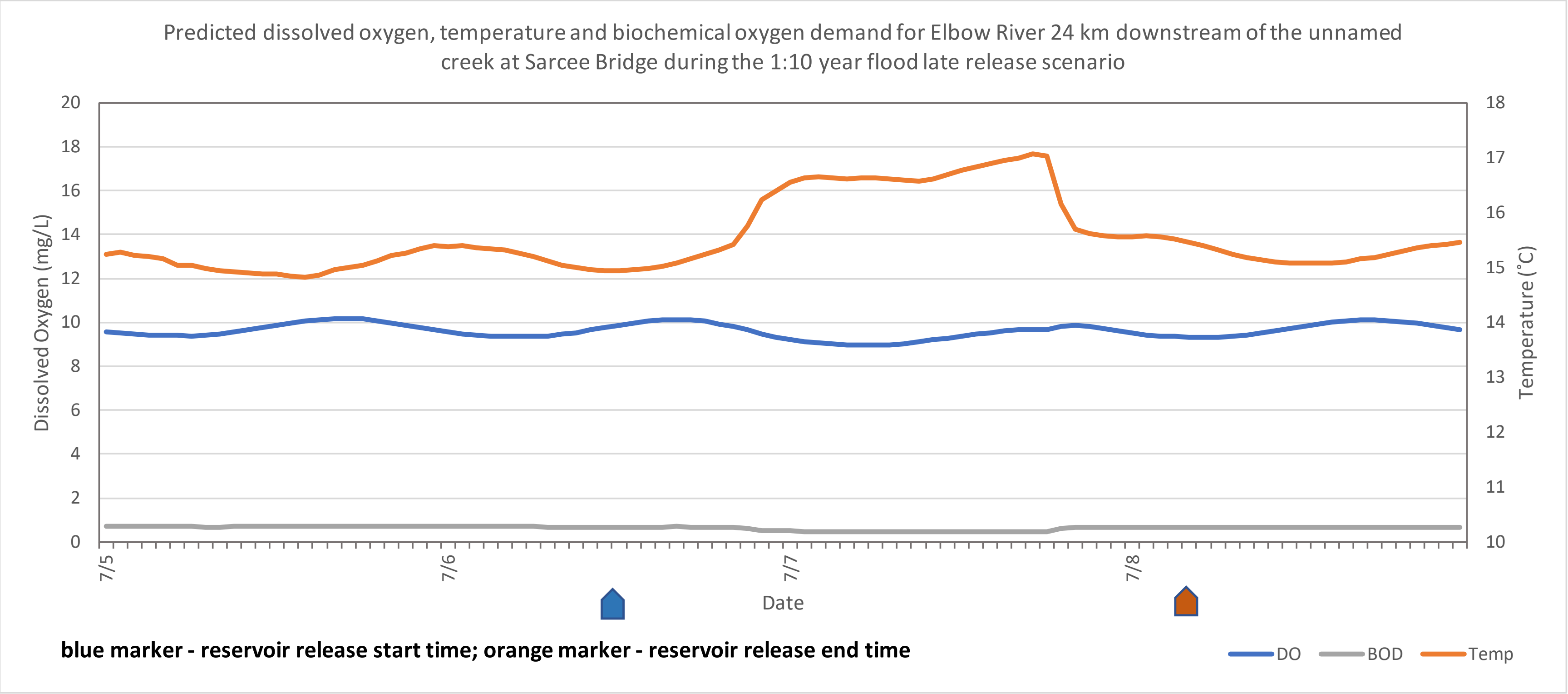


Figure 2-10 **DO, Temperature and BOD in Elbow River 24 km Downstream of the Unnamed Creek at Sarcee Bridge, 1:10 Year Flood for Late Release (during water release from July 6 to July 8)**

Stantec

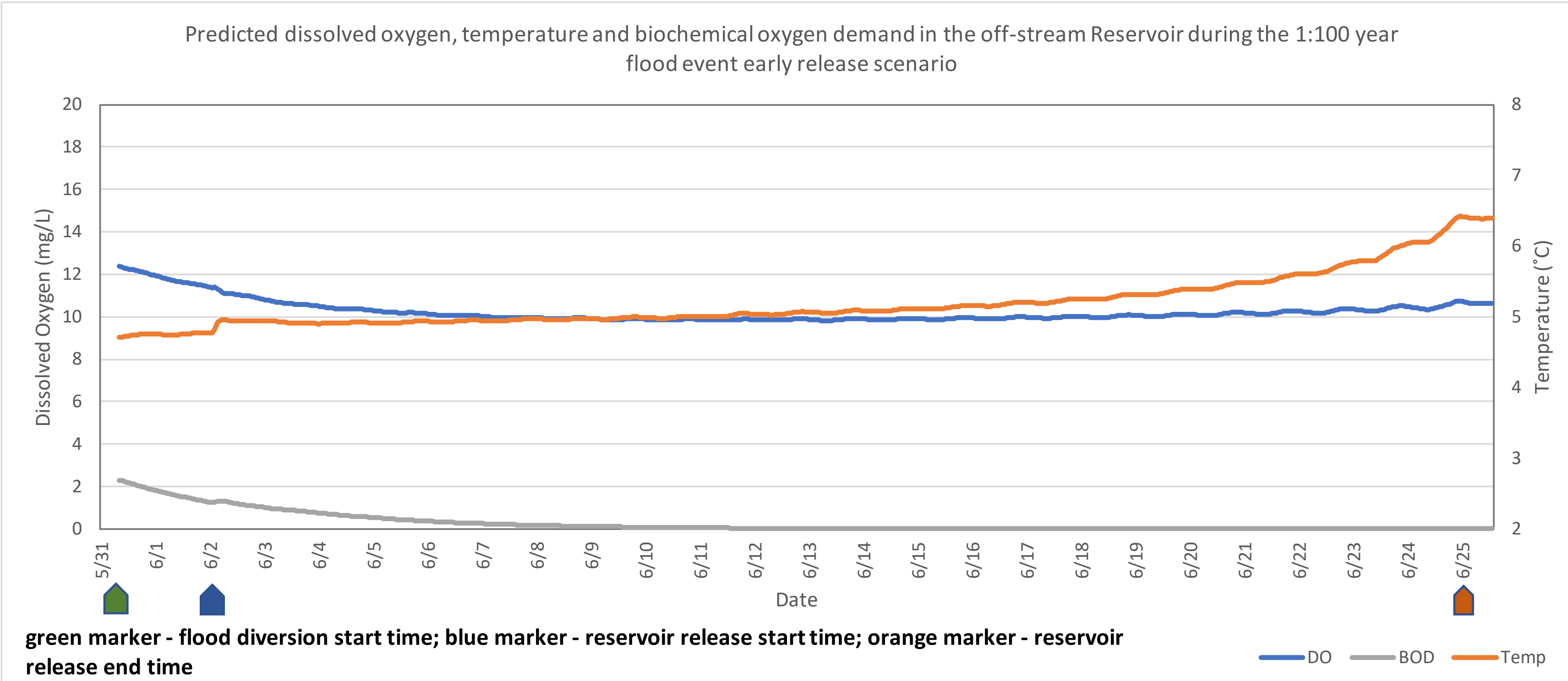
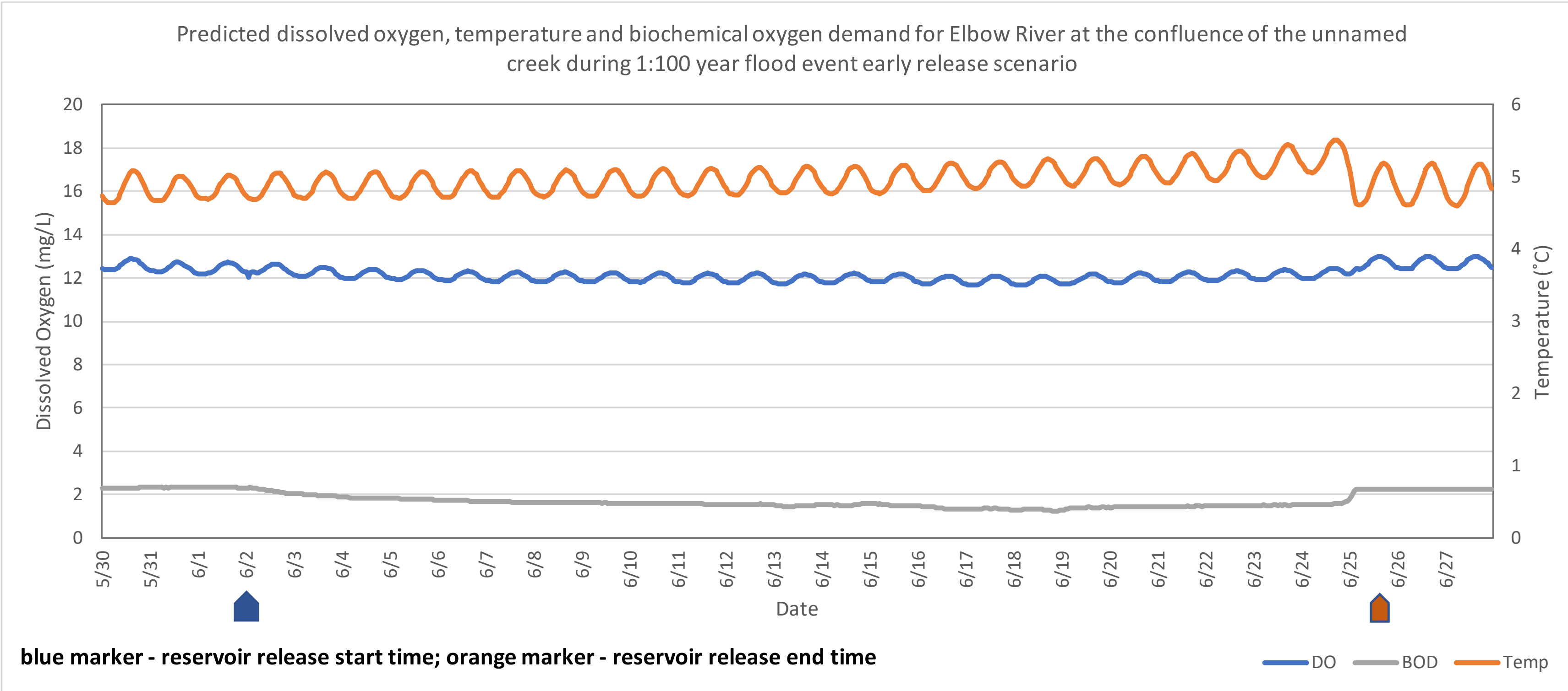


Figure 2-11 **DO, Temperature and BOD in the Off-Stream Reservoir, 1:100 Year Flood for Early Release (during water in the reservoir from May 31 to June 25; duration 25 days)**

Temperature and Dissolved Oxygen
June 2020



NOTE: dissolved oxygen oscillates in response to diel temperature fluctuations

Figure 2-12 **DO, Temperature and BOD in Elbow River at the Confluence of the Unnamed Creek, 1:100 Year Flood for Early Release (during water release from June 6 to June 25; duration 25 days)**

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT
WATER QUALITY MODELLING RESULTS

Temperature and Dissolved Oxygen
June 2020

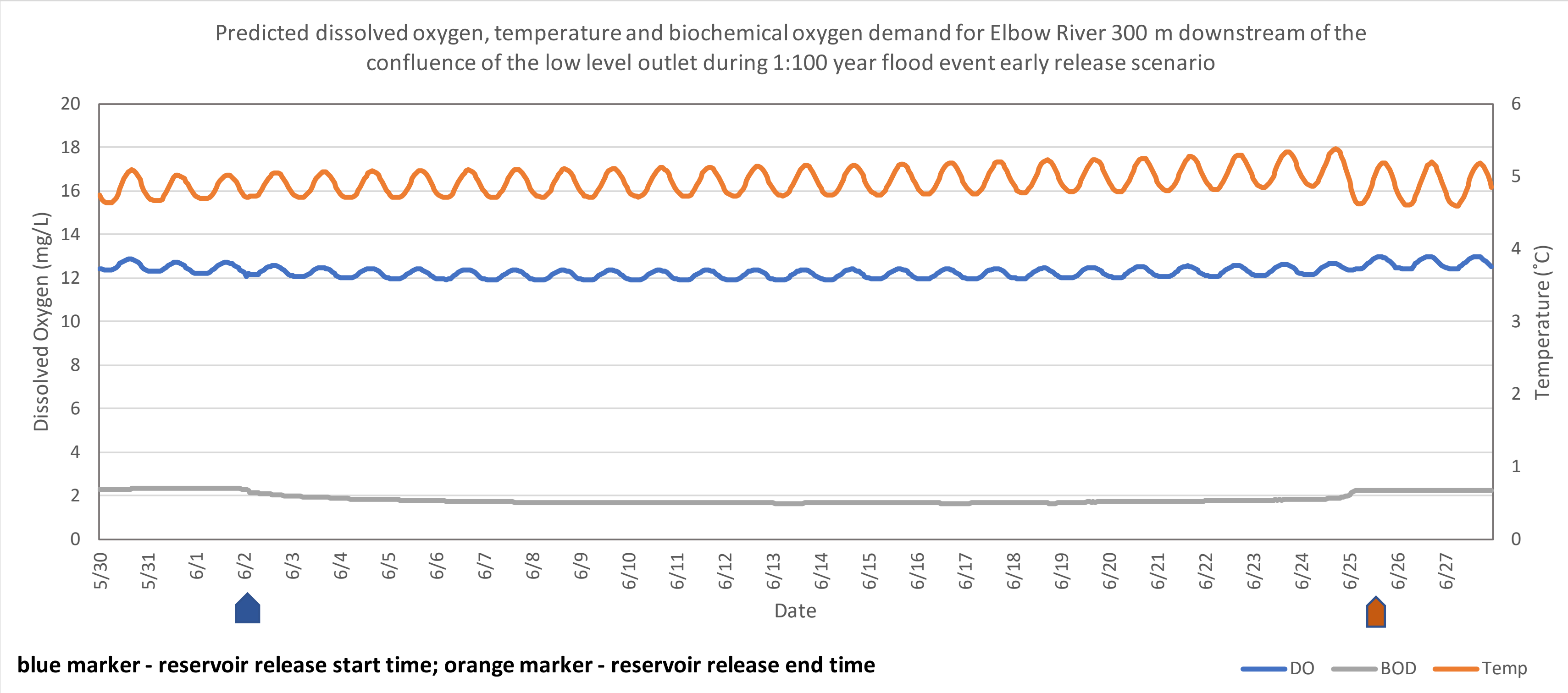


Figure 2-13 **DO, Temperature and BOD in Elbow River 300 m Downstream of the Unnamed Creek, 1:100 Year Flood for Early Release (during water release from June 6 to June 25; duration 25 days)**

Temperature and Dissolved Oxygen
June 2020

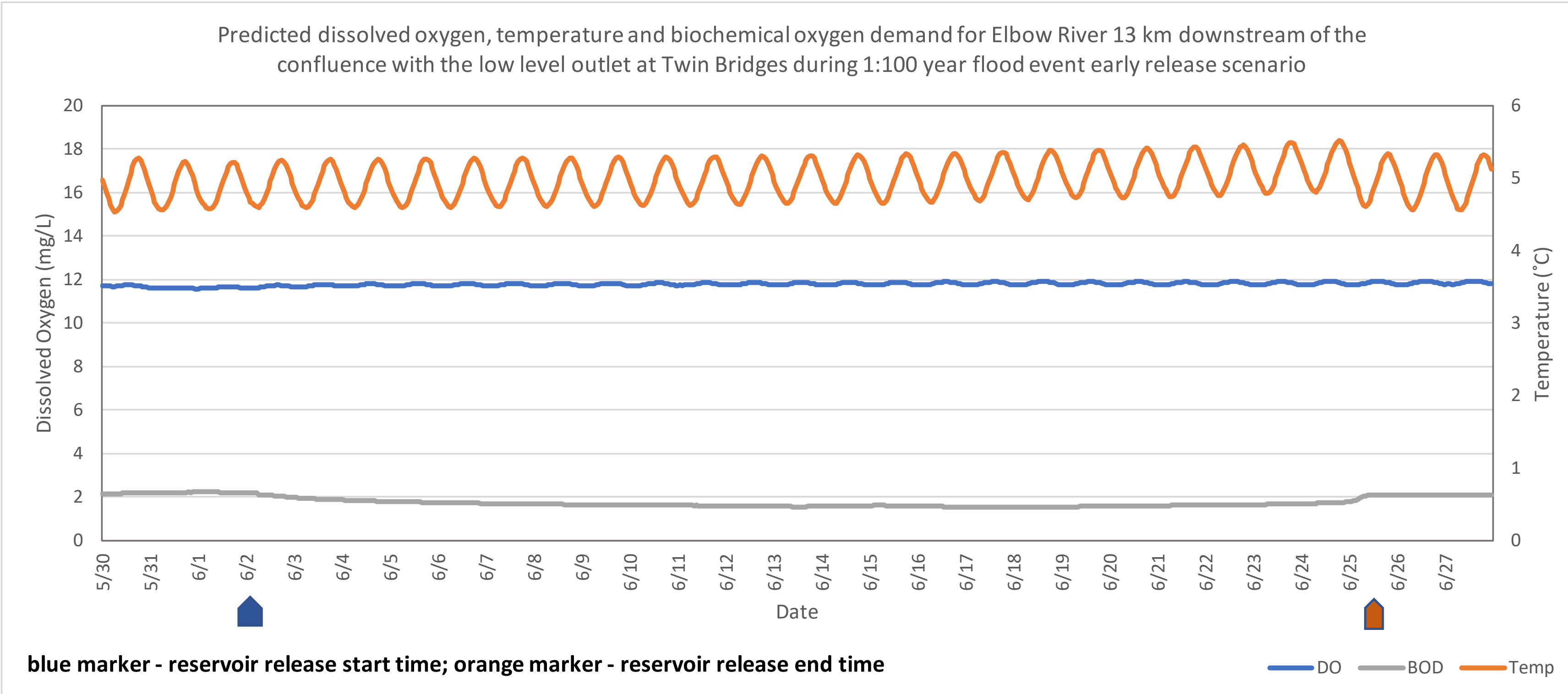


Figure 2-14 **DO, Temperature and BOD in Elbow River 13 km Downstream of the Unnamed Creek at Twin Bridges, 1:100 Year Flood for Early Release (during water release from June 6 to June 25; duration 25 days)**

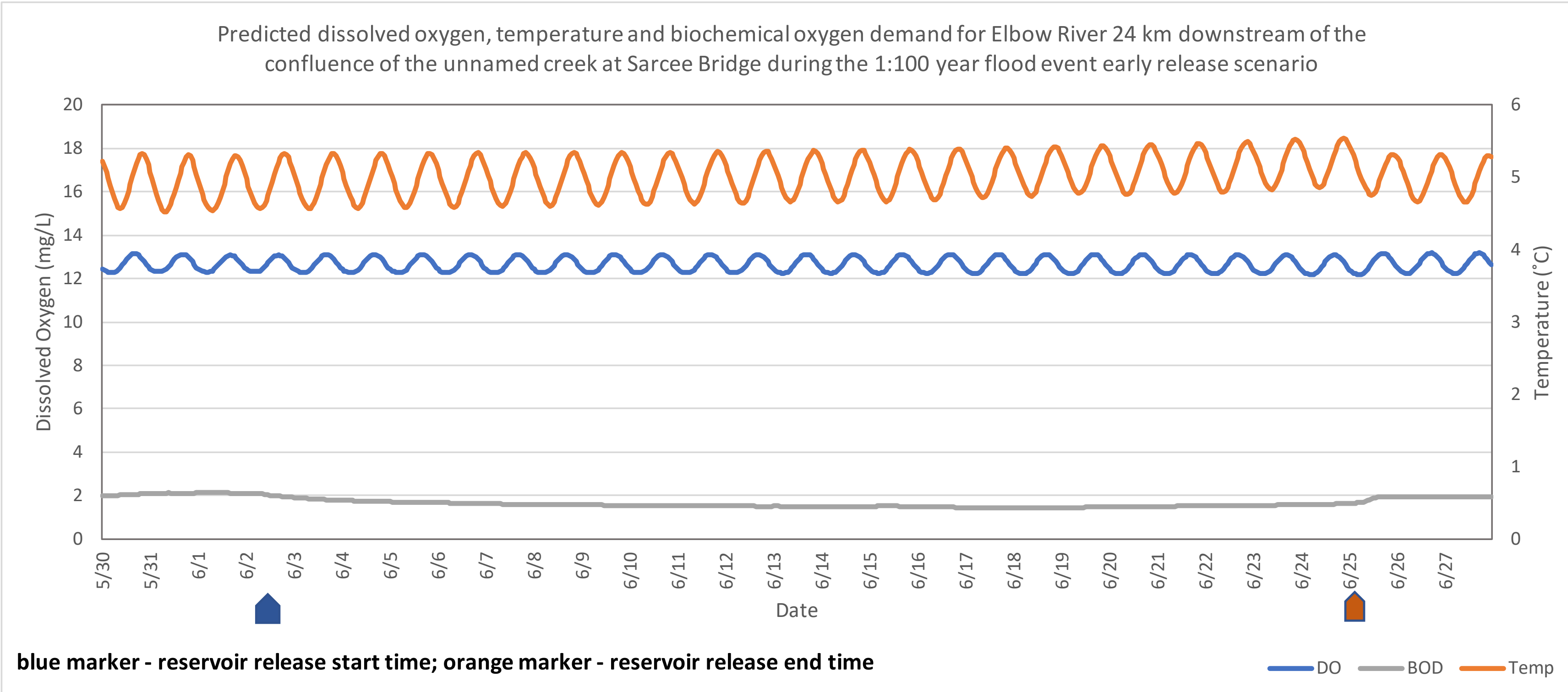


Figure 2-15 **DO, Temperature and BOD in the Elbow River 24 km Downstream of the Unnamed Creek at Sarcee Bridge, 1:100 Year Flood for Early Release (during water release from June 6 to June 25; duration 25 days)**

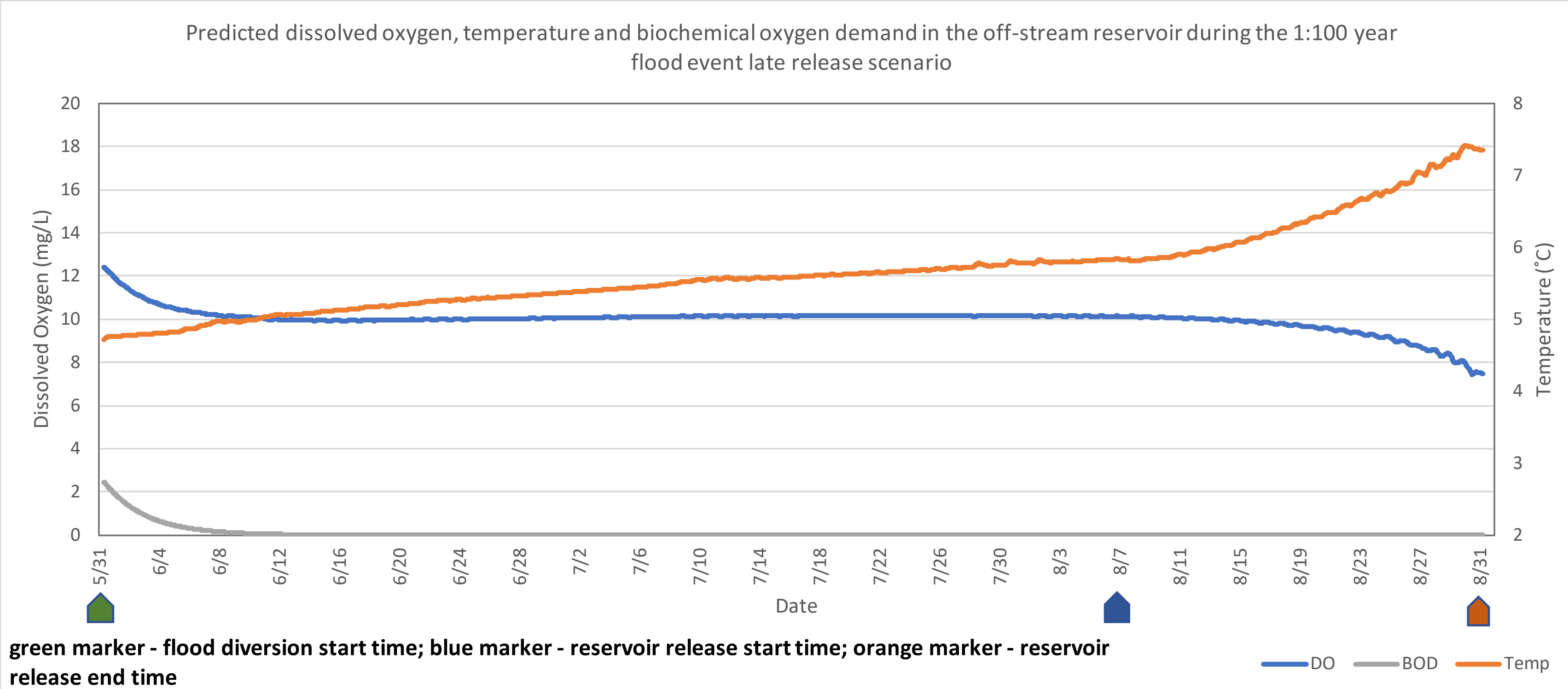
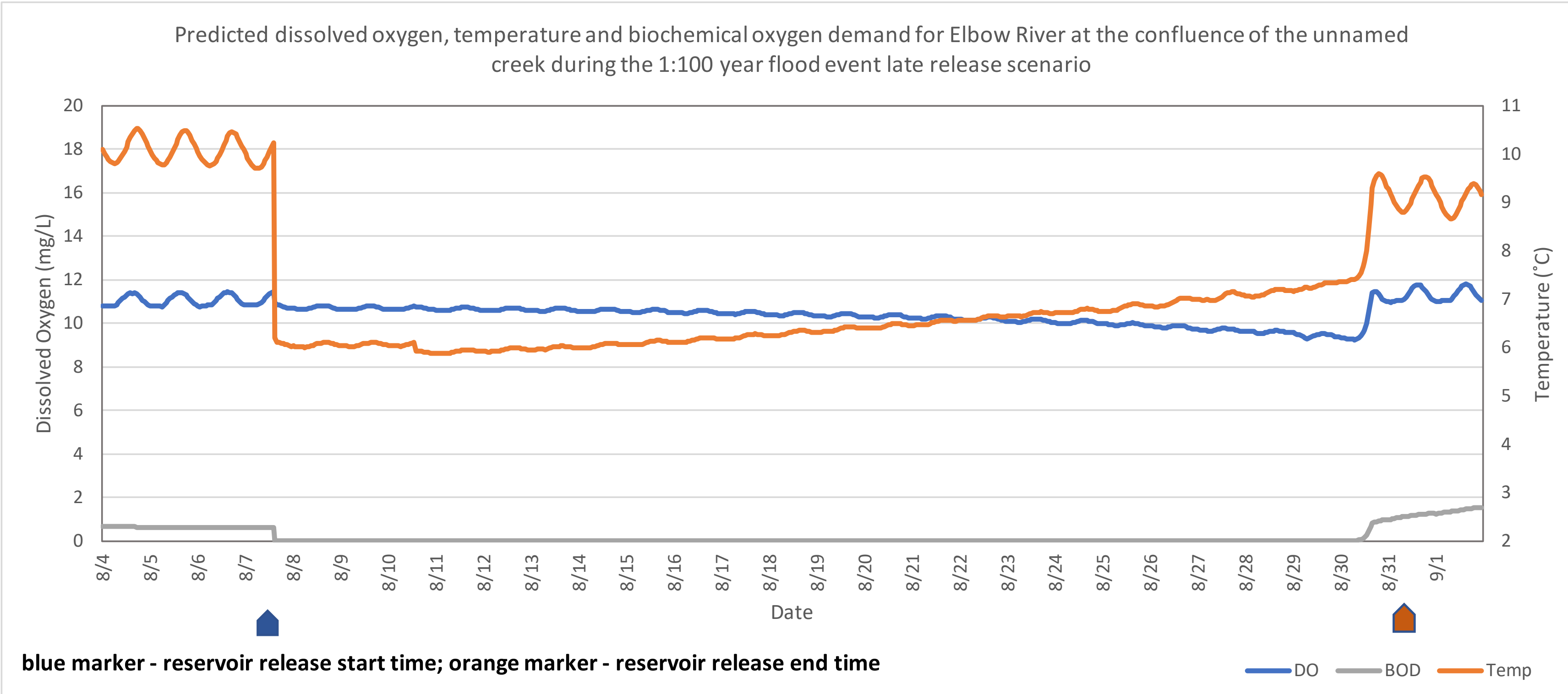


Figure 2-16 **DO, Temperature and BOD in the Off-Stream Reservoir, 1:100 year flood for Late Release (water is in the reservoir from May 31 to August 31; duration 92 days)**

Temperature and Dissolved Oxygen
June 2020



NOTE: dissolved oxygen oscillates in response to diel temperature fluctuations)

Figure 2-17 DO, Temperature and BOD in Elbow River at the Confluence of the Unnamed Creek, 1:100 Year Flood for Late Release (during water release from August 7 to August 31; duration 24 days)

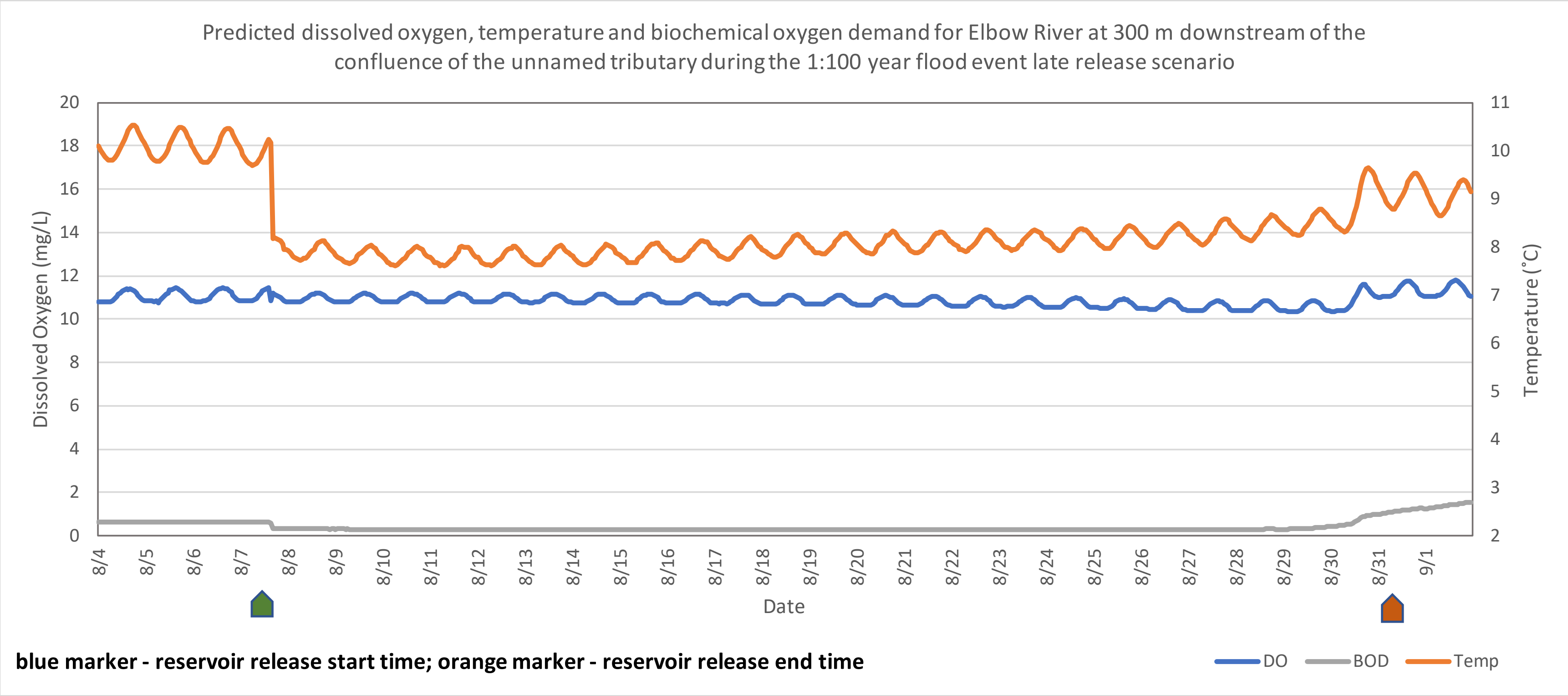


Figure 2-18 **DO, Temperature and BOD in Elbow River 300 m Downstream of the Unnamed Creek, 1:100 Year Flood for Late Release (during water release from August 7 to August 31; duration 24 days)**

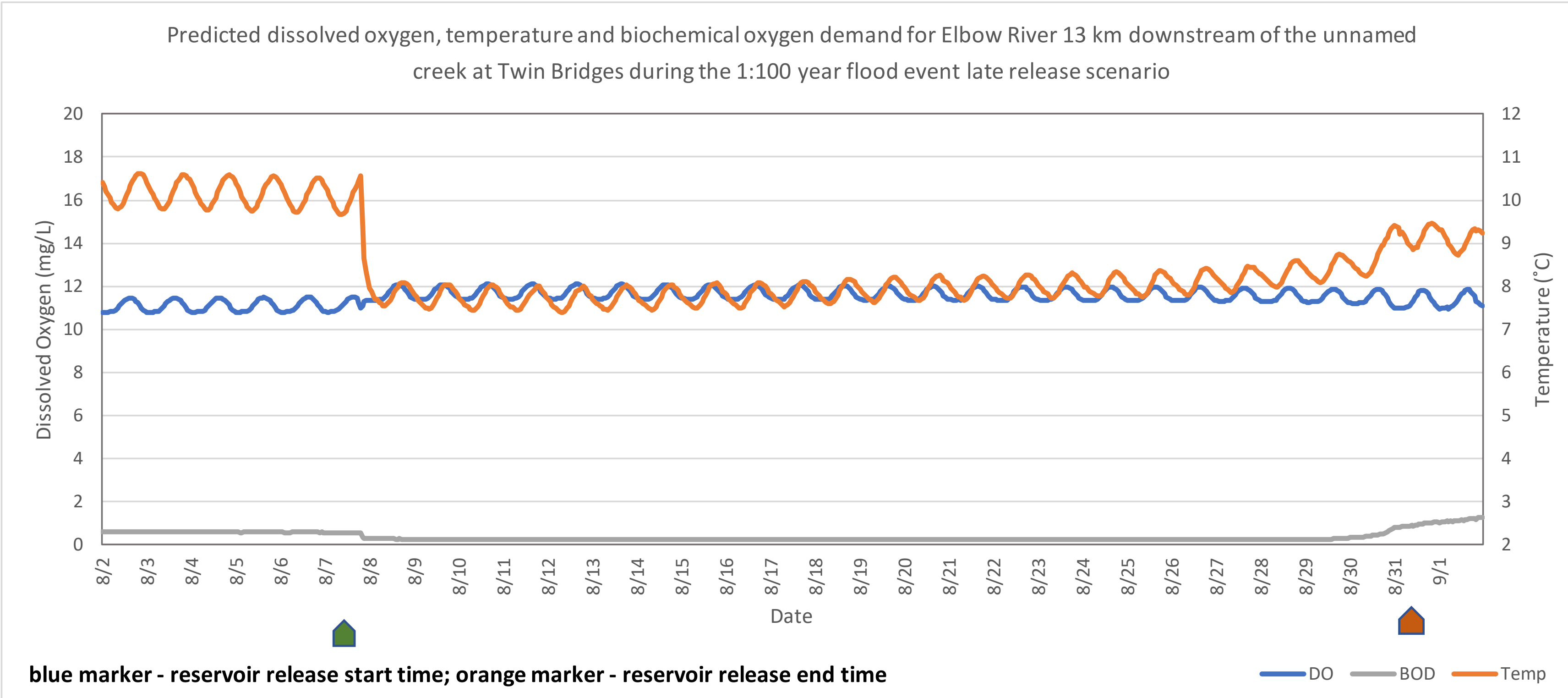


Figure 2-19 **DO, temperature and BOD in Elbow River 13 km Downstream of the Unnamed Creek at Twin Bridges, 1:100 Year Flood for Late Release (during water release from August 7 to August 31; duration 24 days)**

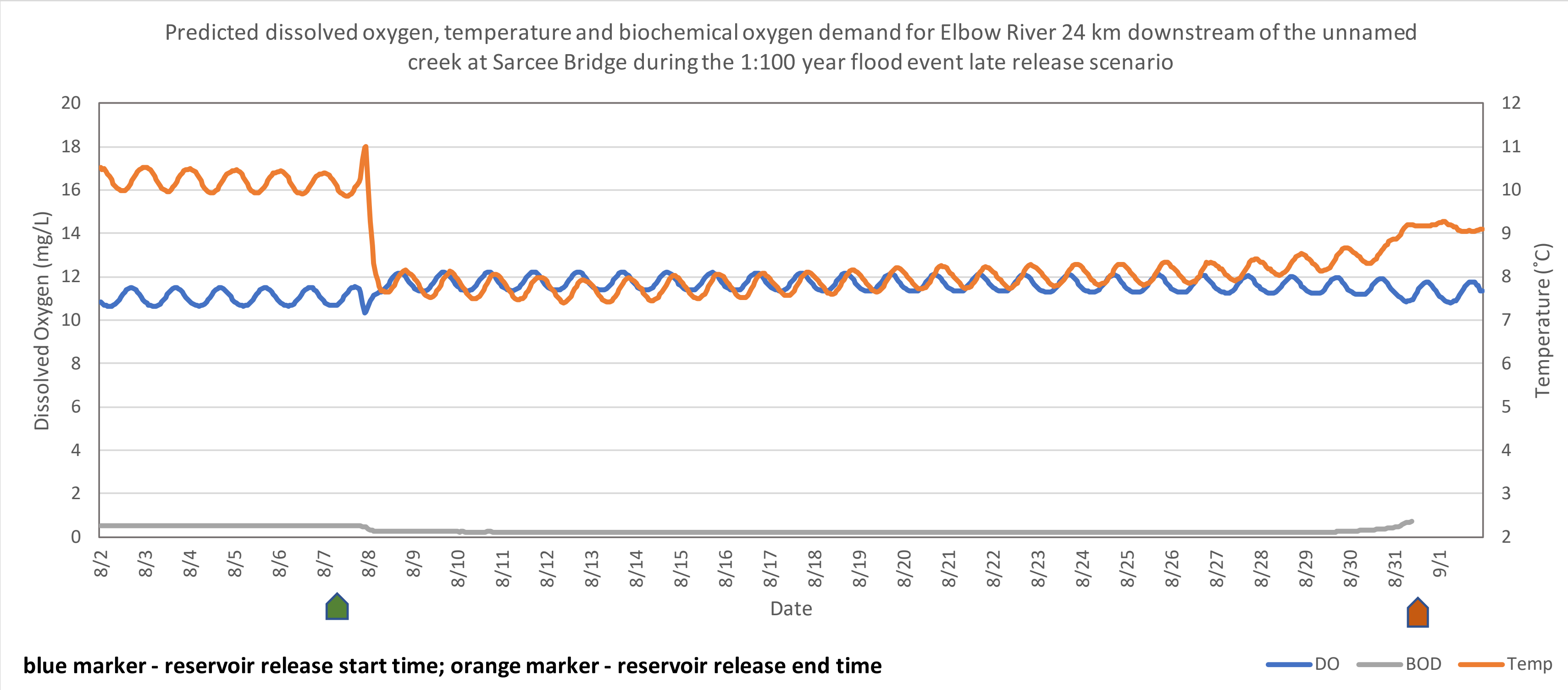


Figure 2-20 **DO, Temperature and BOD in Elbow River 24 km Downstream of the Unnamed Creek at Sarcee Bridge, 1:100 Year Flood for Late Release (during water release from August 7 to August 31; duration 24 days)**

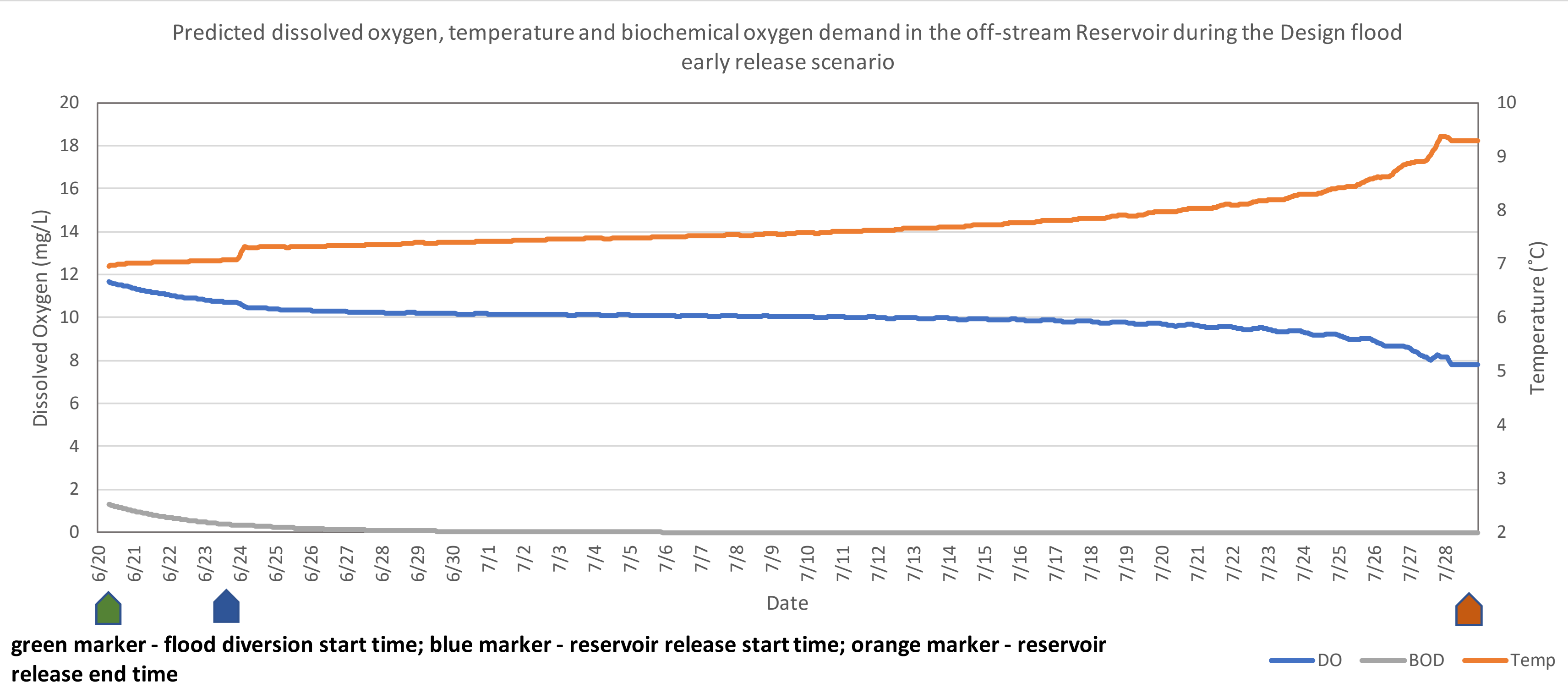
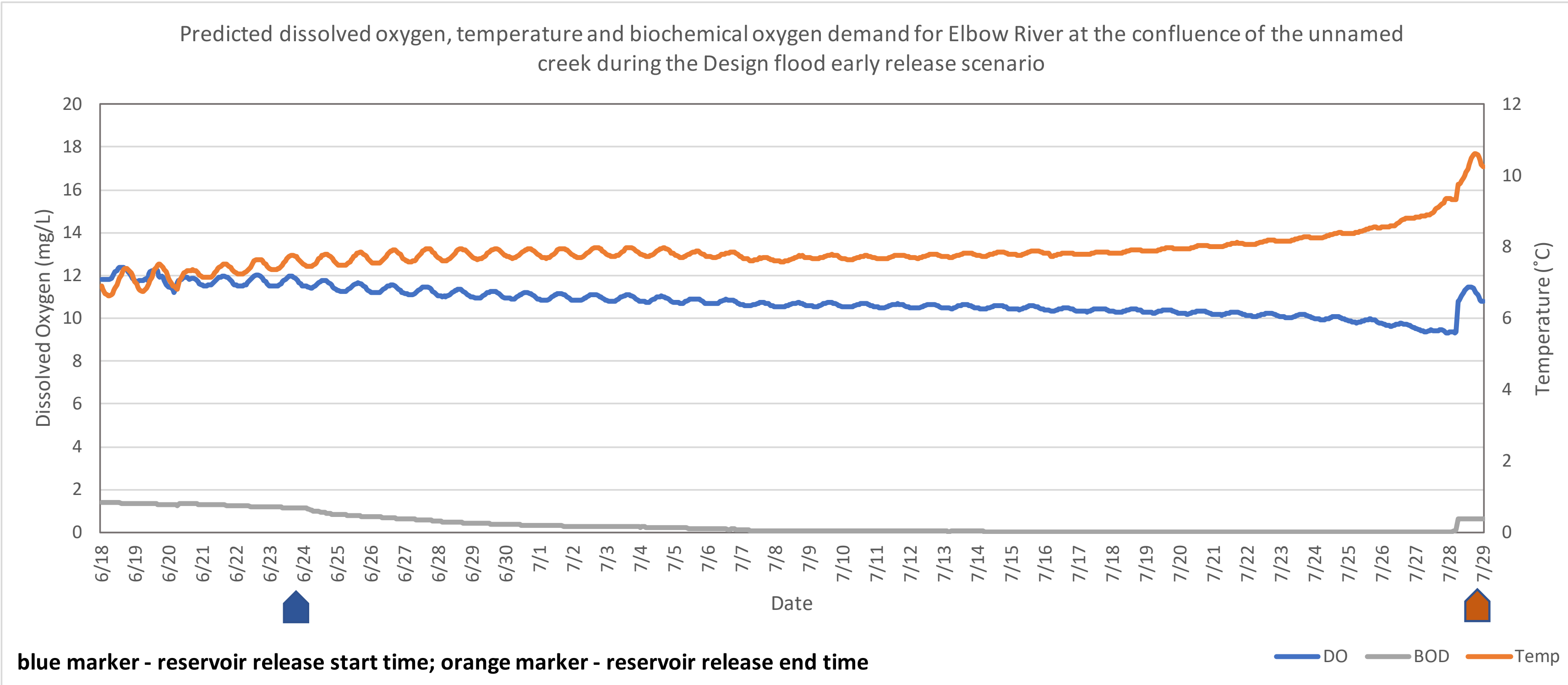


Figure 2-21 **DO, Temperature and BOD in the Off-Stream Reservoir, Design Flood for Early Release (during the time water is in the reservoir from June 20 and July 28; duration 39 days)**

Temperature and Dissolved Oxygen
June 2020



NOTE: dissolved oxygen oscillates in response to diel temperature fluctuations

Figure 2-22 **DO, Temperature and BOD in Elbow River at the Confluence of the Unnamed Creek, Design Flood for Early Release (during water release from June 23 to July 28; duration 35 days)**

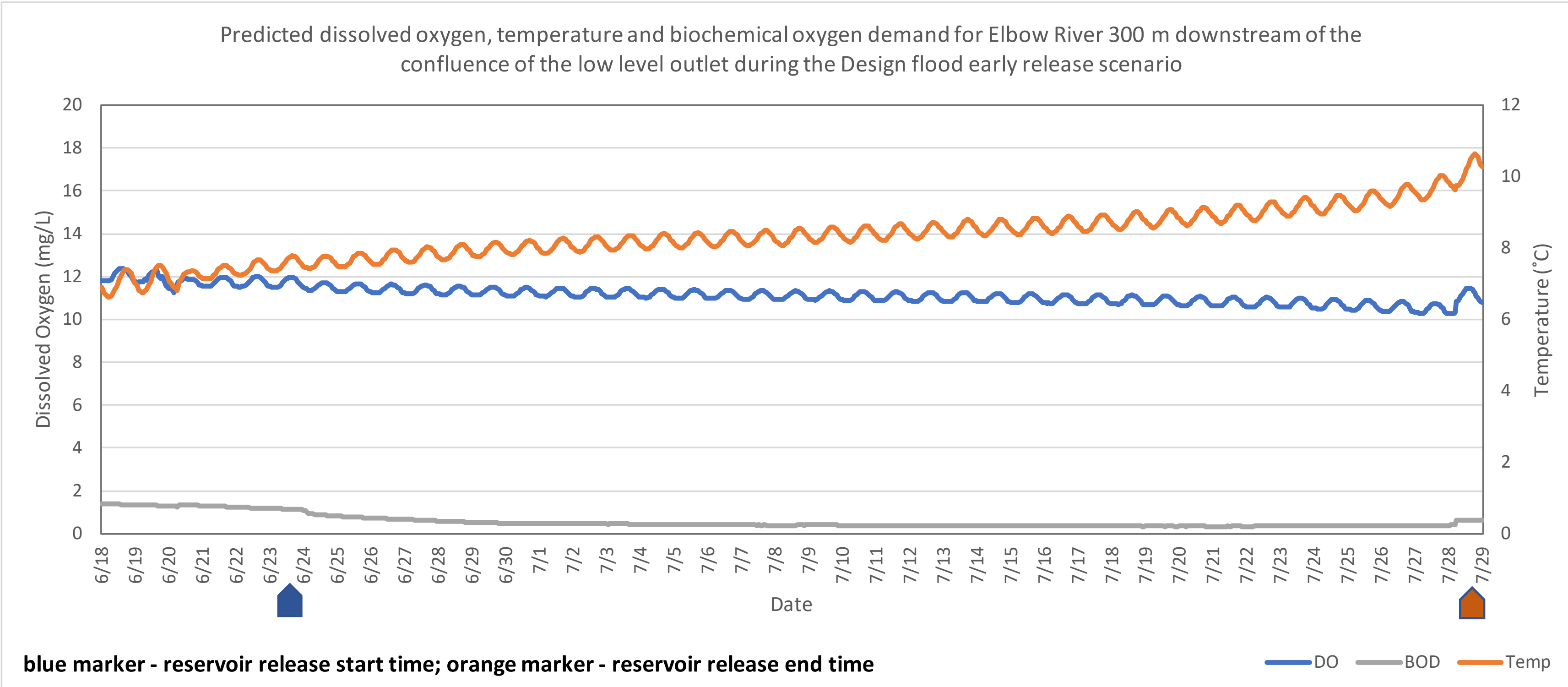


Figure 2-23 **DO, Temperature and BOD in Elbow River 300 m Downstream of the Unnamed Creek, Design flood for Early Release (during water release from June 23 to July 28; duration 35 days)**

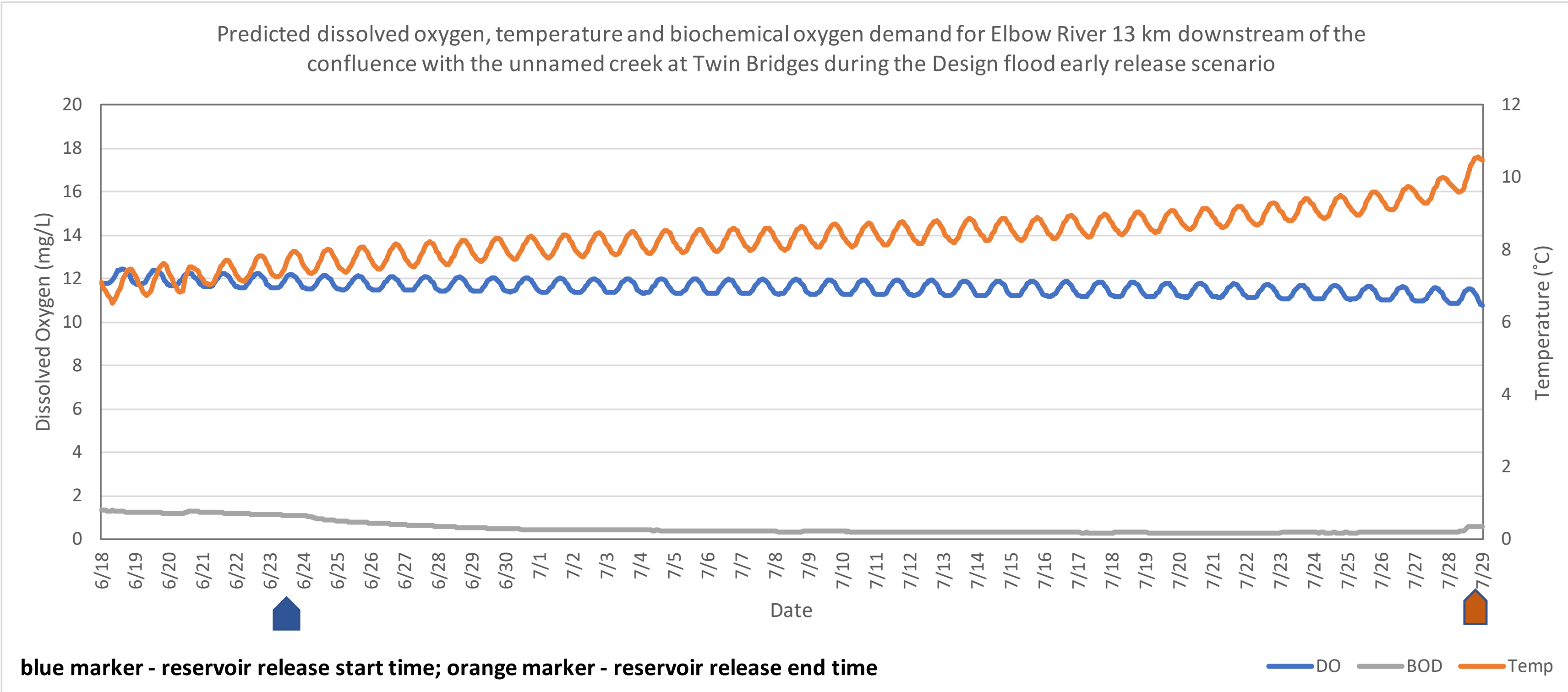


Figure 2-24 **DO, Temperature and BOD in Elbow River 13 km Downstream of the Unnamed Creek at Twin Bridges, Design Flood for Early Release (during water release from June 23 to July 28; duration 35 days)**

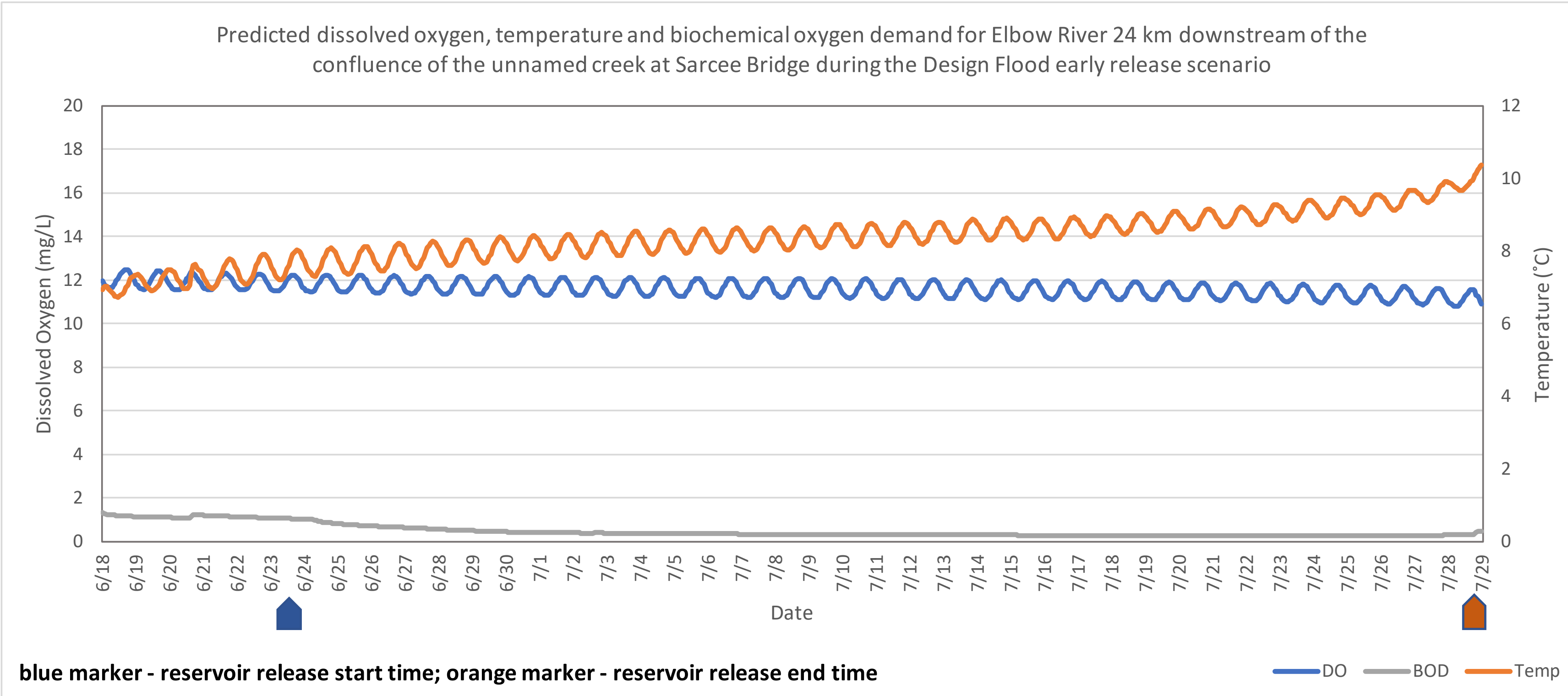


Figure 2-25 **DO, Temperature and BOD in Elbow River 24 km Downstream of the Unnamed Creek at Sarcee Bridge, Design Flood for Early Release (during water release from June 23 to July 28; duration 35 days)**

Temperature and Dissolved Oxygen
June 2020

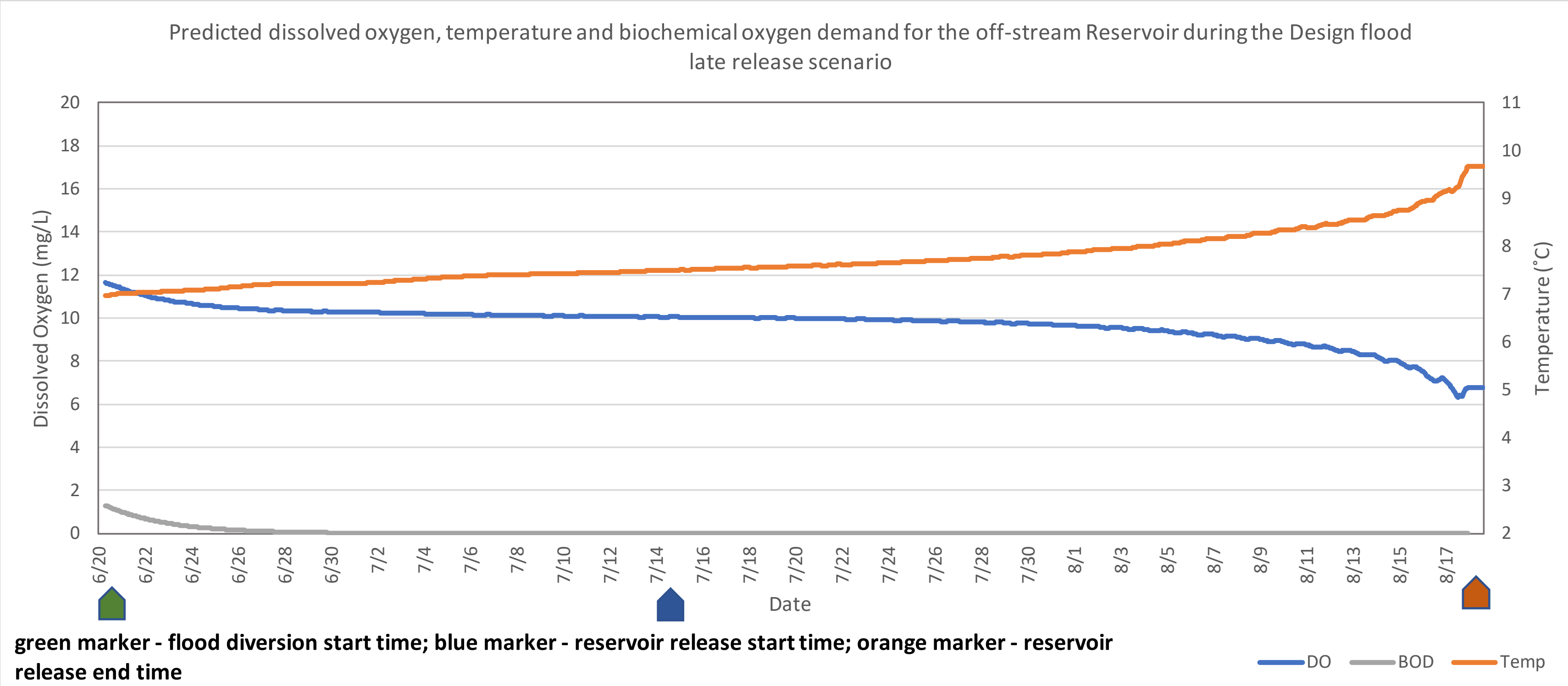


Figure 2-26 **DO, Temperature and BOD in the Off-Stream Reservoir, Design Flood for Late Release (during the period water is in the reservoir from June 20 to August 18; duration 59 days)**

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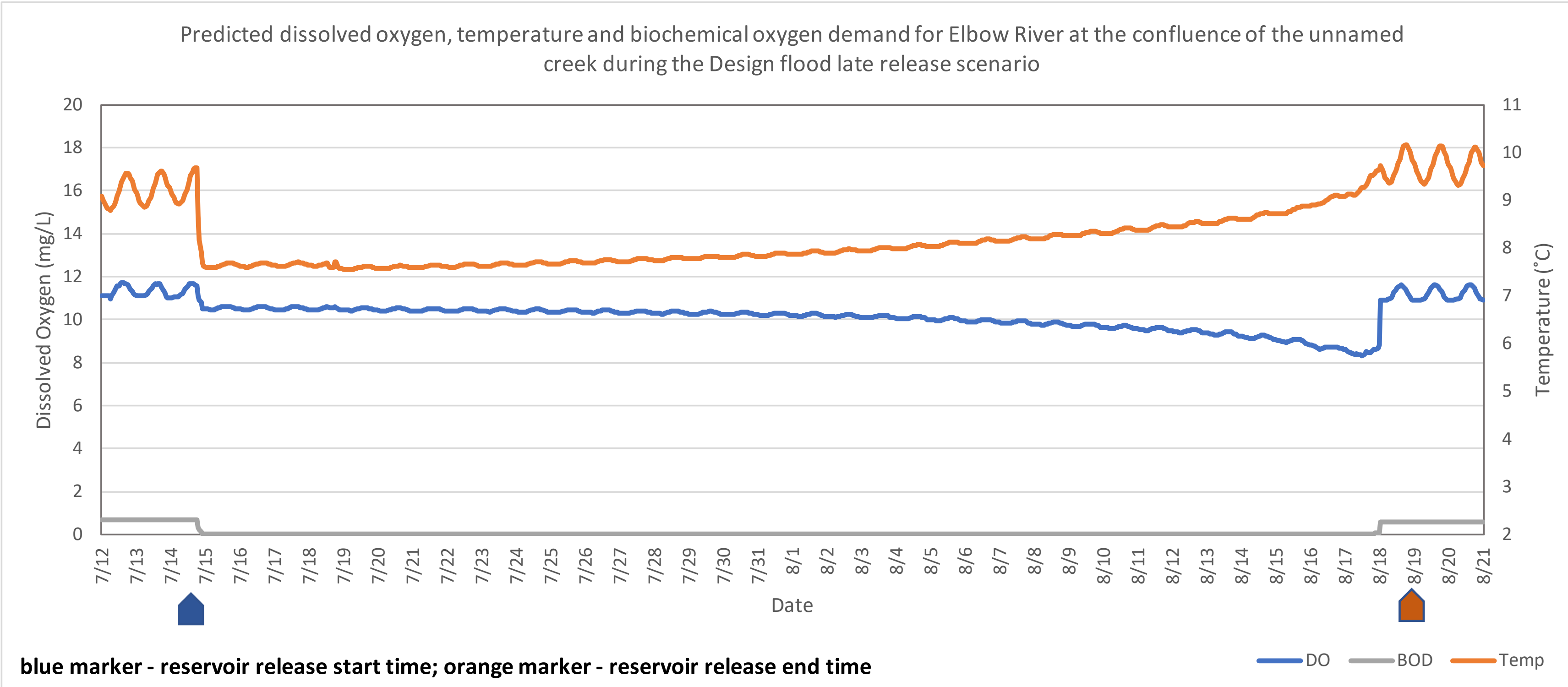

NOTE: dissolved oxygen oscillates in response to diel temperature fluctuations

Figure 2-27 **DO, Temperature and BOD in Elbow River at the Confluence of the Unnamed Creek, Design Flood for Late Release (during water release from July 14 to August 18; duration 35 days)**

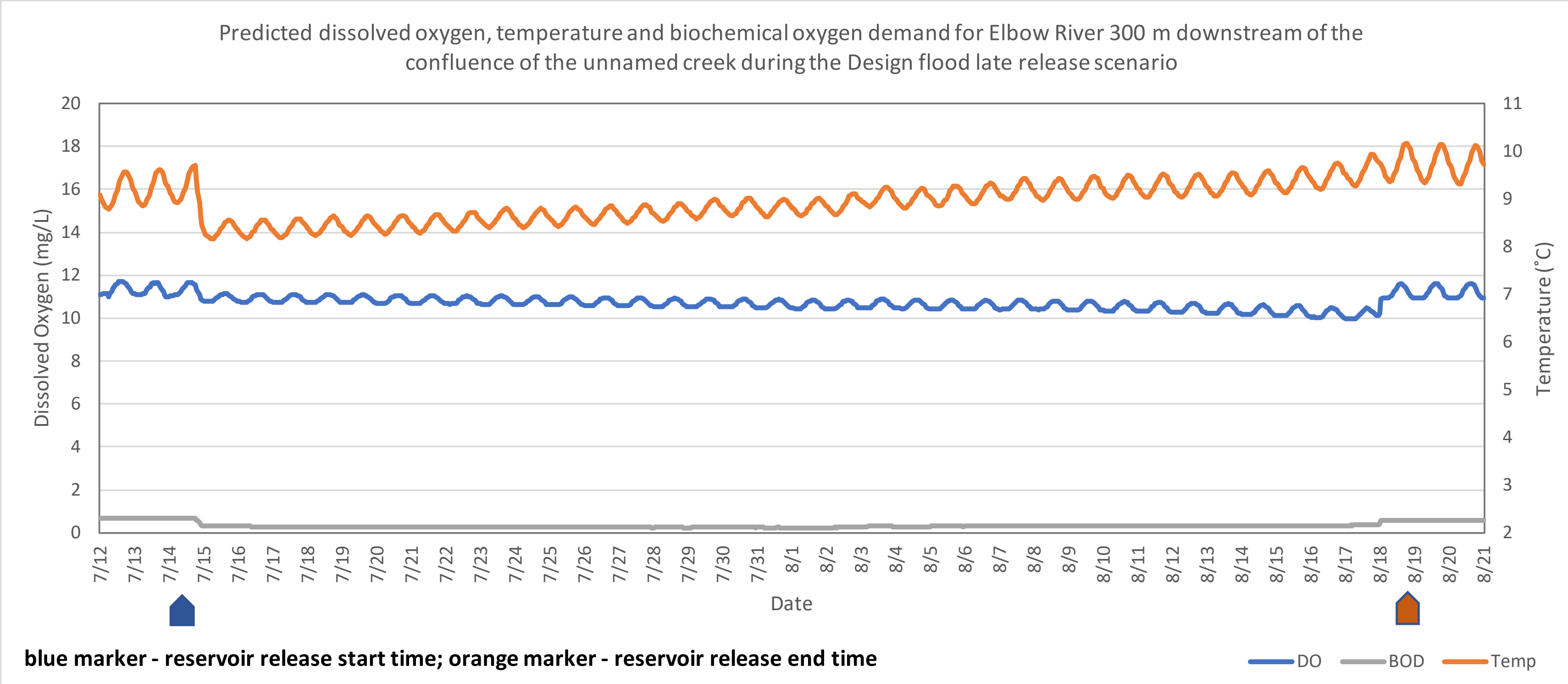

Figure 2-28 **DO, Temperature and BOD in Elbow River 300 m Downstream of the Unnamed Creek, Design Flood for Late Release (during water release from July 14 to August 18; duration 35 days)**

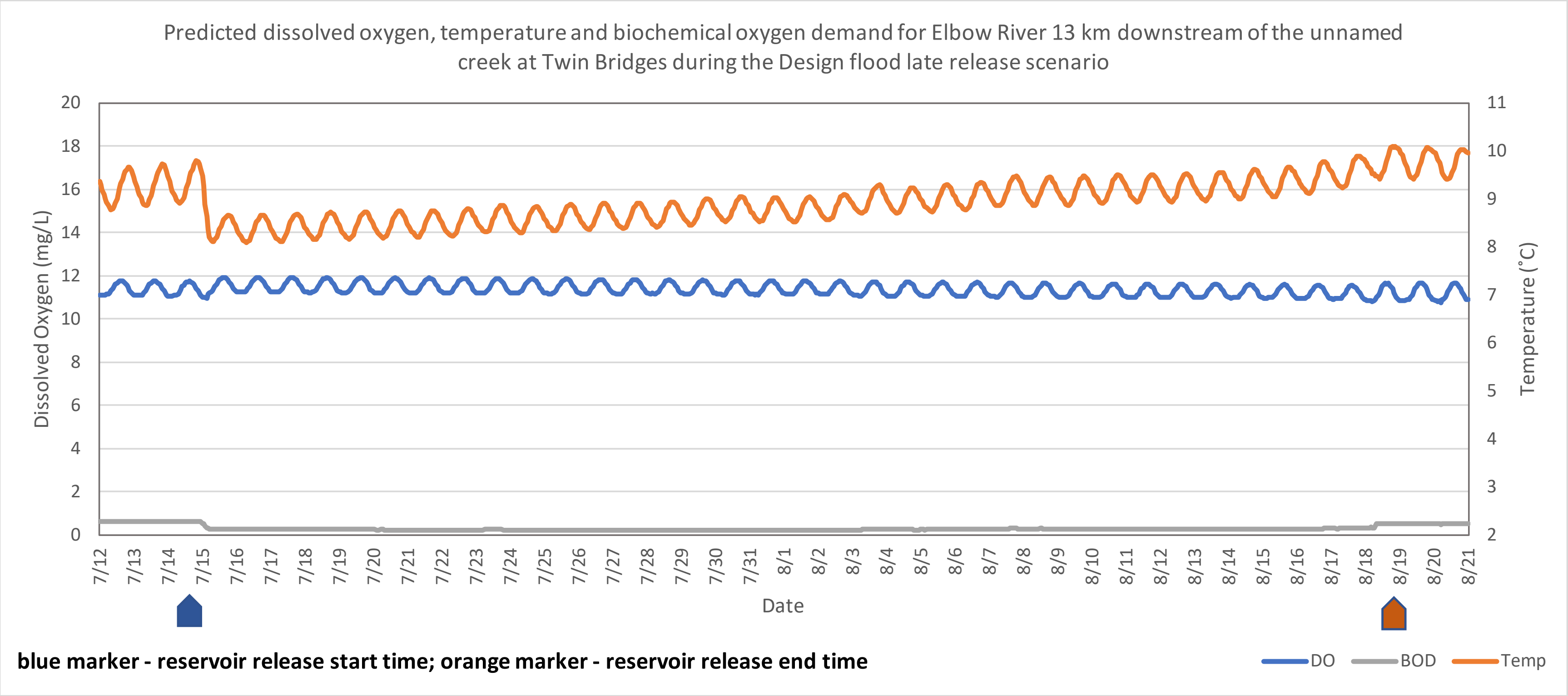

Figure 2-29 **DO, Temperature and BOD in Elbow River 13 km Downstream of the Unnamed Creek at Twin Bridges, Design Flood for Late Release (during water release from July 14 to August 18; duration 35 days)**

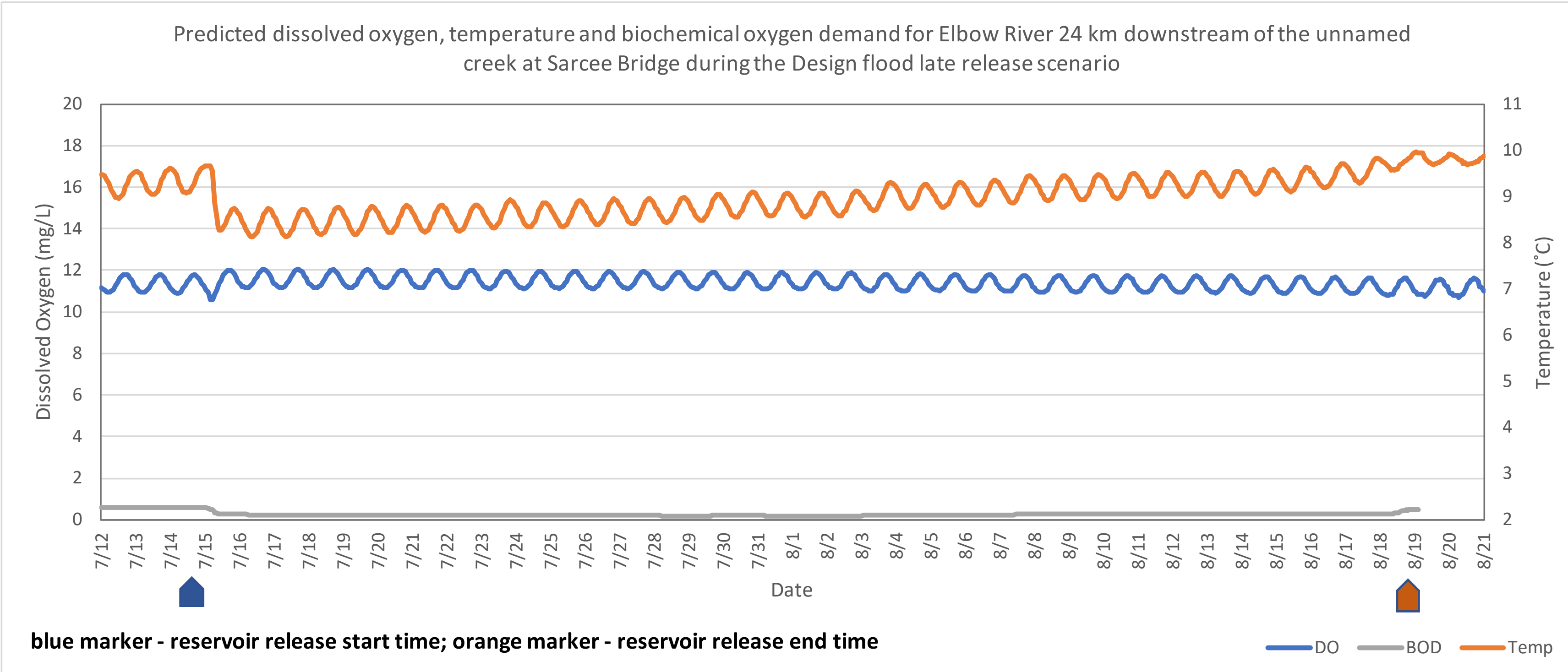

Figure 2-30 **DO, Temperature and BOD in Elbow River 24 km Downstream of the Unnamed Creek at Sarcee Bridge, Design Flood for Late Release (during water release from July 14 to August 18; duration 35 days)**

2.2 DISSOLVED OXYGEN AND EFFECTS TO AQUATIC BIOTA

Under most scenarios, 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 considered cold water species (Armantrout 1998).

1:10 Year Flood, Early Release

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

1:10 Year Flood, Late Release

- There is a 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 the 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 one to two days at the end of the reservoir release period (Figure 2-17). 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 2-22). 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 2-27). 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.

2.3 THERMAL CHANGES AND EFFECTS ON FISH

Reservoir drawdown 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), 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 2-1. Predicted changes in water temperatures are expected to be small, 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 on fish or their use of habitat.

1:10 Year Flood, Late Release

- Elbow River temperature will increase 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 2-1). 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 (without the Project) 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 on 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 on fish or their use of habitat.

To summarize, thermal changes are predicted to most likely occur in the 1:10 year flood for late release. Water levels in the reservoir are shallow for the diversion waters frpm a 1:10 year flood and will be susceptible to increases in temperature from solar radiation and air temperatures. Effects on 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 within the reservoir. 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 2-1 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 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 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 et al. 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

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT
WATER QUALITY MODELLING RESULTS

Temperature and Dissolved Oxygen
June 2020

3.0 NUTRIENT WATER QUALITY

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 dissolved oxygen. 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 is possible to derive relevant nutrient concentrations during flood conditions.

Historical water quality data for Elbow River boundary conditions were not suitable for using with 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 is used to assess nutrients, based on using the relationships among water quality, suspended sediment concentrations, and flow in Elbow River.

3.1 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 to calculate a predicted nutrient concentration for the three different floods in the river. 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) is used for the regression analysis. Nutrient parameters with at least 20 data points and corresponding mean daily flow data are included in the analysis.

Predicted nutrient concentrations are provided for median and peak flows in Elbow River for each scenario (rational provided below):

- 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 3-1. 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 3-1 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	2,687	2,457	10,118	3,858	15,588	3,032

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

3.2 NUTRIENT WATER QUALITY CHANGES IN THE RESERVOIR

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

- 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.

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. However, for the 1:10 year flood, the 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 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 reoxegenated 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.

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 estimate 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 3-2.

Table 3-2 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	2227
Dissolved phosphorus	mg/L	0.0382	0.0029	0.00001	<0.00001	1847
Total nitrogen (calculated)	mg/L	0.3870	0.2227	0.00109	<0.00001	1230
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	1324
Total organic carbon	mg/L	0.1738	1.3099	0.00497	<0.00001	1830
Total coliforms	(CFU/100 mL)	0.1519	232.48	1.722	<0.00001	1782

The relationship between suspended sediments and dissolved nutrients is not significant and the relationship is weak (Table 3-2).

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 is provided for early release and late release for each flood.

The predicted nutrient concentrations in the reservoir are provided in Table 3-3. The predicted peak and median reservoir nutrient water quality concentrations are compared with the monthly 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 late release occurs when Elbow River flow is less than 20 m^3/s.

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 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 (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.

Table 3-3 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 Nutrient Concentrations for the 75th Percentile and Median (in brackets) values 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 3-3 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 Nutrient Concentrations for the 75^{th} Percentile and Median (in brackets) values 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 for release scenario
Grey shaded cells are predicted nutrient concentrations greater than the historical 75^{th} percentile Elbow River concentrations at Twin Bridges

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 (1:100 year flood and design flood) are greater than during late release (Table 3-4). 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.

Releasing reservoir water early may affect Elbow River water to a greater degree than releasing it later. 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).

3.3 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 is modelled for early release and late release, based on Elbow River flows (i.e., early reservoir release when Elbow River flow recedes to 160 m^3/s and late release when Elbow River flow recedes to 20 m^3/s). These 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 3-4.

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. Additionally, 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, late release when the DO level is predicted to drop to 2 mg/L (see discussion titled "*Dissolved Oxygen and Effects to Aquatic Biota*" above for DO guidelines and Figures 2-1, 2-6, 2-11, 2-16, 2-21 and 2-26). 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 in the reservoir and thus warm more quickly (compared to larger flood scenarios) 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 summarized as follows:

- DO is not predicted to affect nutrient levels. However, for a 1:10 year flood, 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, 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 under most scenarios (i.e., 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 an estimate of the nutrient concentrations released in 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 when water is released 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, it may be assumed releasing reservoir water later in the season may have a bigger impact on low concentration river water quality.

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, early release and late release). Decreases in nutrient concentration are likely due to sedimentation and deposition in the reservoir.

Table 3-4 Durations to Divert, Retain and Release Water from the Reservoir for each Flood

Scenario	Time to Divert Flood Water (days)	Reservoir Hold Time (days)	Days from Start of Flood to Reservoir Drawdown is Complete (days)
Early Release			
1:10 year flood	0.3	0	2.0
1:100 year flood	1.8	0	25.3
2013 flood	3.8	0	39.2
Late Release			
1:10 year flood	0.4	42.0	44.4
1:100 year flood	1.8	67.0	92.3
2013 flood	3.8	21.0	61.5

4.0 TOTAL SUSPENDED SEDIMENTS

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

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

The regression analyses use 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 4-1.

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) is assumed to demonstrate 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.

As expected, total trace element concentrations generally had a stronger affinity for TSS than dissolved forms (significance with an alpha (p) of $p \leq 0.05$ and denoted in grey in Table 4-1). 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.

4.1 PHYSICAL AND CHEMICAL PROPERTIES ASSOCIATED WITH TSS

A number of physical and chemical properties associated with sediments (both suspended and deposited) can affect the nature and availability of associated water quality constituents for biological action. As shown in Table 4-1, some dissolved parameters can behave similarly to TSS.

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. The 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 onto 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.

4.1.1 Total Suspended Sediment effects on Water Quality

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 reservoir drawdown, 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 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 as the reservoir is close to being emptied (e.g., last few days of reservoir drawdown). 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 (i.e., effects to water quality due to TSS associated constituents is not significant; Volume 3B, Section 7.5, page 7.34).

Table 4-1 Regression Analysis Results Used to assess the Relationship between Total Suspended Sediment Concentrations and Trace Elements (i.e., Metals, Nutrients and Ions) Concentrations

Parameter	Adjusted R^2	Intercept	Slope	*p*	N
Physical Parameters					
Turbidity	0.90634	-3.9789	0.79049	<0.00001	1888
Specific conductance (field)	0.11009	380.13	-0.11756	<0.00001	1369
Specific conductance (lab)	0.030233	391.48	-0.1196	0.000023303	553
pH (lab)	-0.00047128	8.2432	8.3047E-06	0.7285	1868
Salinity and Ions					
Total alkalinity	0.24454	146.76	0.071711	<0.00001	1264
Total dissolved solids	0.10287	222.99	-0.31189	0.011009	53
Dissolved sulphate	0.096904	61.068	-0.035308	<0.00001	1309
Dissolved magnesium	0.089729	15.769	-0.0046606	<0.00001	1305

Table 4-1 Regression Analysis Results Used to assess the Relationship between Total Suspended Sediment Concentrations and Trace Elements (i.e., Metals, Nutrients and Ions) Concentrations

Parameter	Adjusted R^2	Intercept	Slope	*p*	N
Total hardness	0.086628	210.43	-0.05706	<0.00001	1262
Dissolved calcium	0.083172	56.984	-0.013796	<0.00001	1259
Dissolved fluoride	0.062324	0.26618	-0.000091859	<0.00001	1289
Dissolved potassium	0.0070593	0.75928	0.00026073	0.0013843	1305
Dissolved chloride	-0.0006615	2.4476	0.0002036	0.7137	1310
Dissolved sodium	-0.00018573	3.015	0.00033959	0.38416	1305
Nutrients and Carbon					
Total phosphorus	0.79949	0.0055388	0.00044709	<0.00001	2227
Total nitrogen calc	0.38704	0.2227	0.0010866	<0.00001	1230
Total Kjeldahl nitrogen	0.35484	0.12171	0.00088843	<0.00001	1324
Total organic carbon	0.17375	1.3099	0.0049715	<0.00001	1830
Total coliforms	0.15192	232.48	1.722	<0.00001	1782
Dissolved phosphorus	0.038167	0.0028576	0.000011124	<0.00001	1847
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
Total ammonia-n (calc)	0.00075421	0.015506	2.3425E-06	0.1682	1195
Nitrite	0.00016267	0.0016462	7.7038E-07	0.26185	1598
Total inorganic carbon	-0.028179	36.267	-0.059606	0.63348	29
Nitrate	-0.0005748	0.10533	2.4437E-06	0.77311	1597
Nitrate+nitrite-n (calc)	-0.0005229	0.1055	3.4939E-06	0.68291	1595
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

Table 4-1 Regression Analysis Results Used to assess the Relationship between Total Suspended Sediment Concentrations and Trace Elements (i.e., Metals, Nutrients and Ions) Concentrations

Parameter	Adjusted R^2	Intercept	Slope	*p*	N
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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APPENDIX 1-2 SUSPENDED SEDIMENT MODELLING APPROACH REPORT

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT
RESPONSE TO IMPACT ASSESSMENT AGENCY OF CANADA INFORMATION REQUEST PACKAGE 4 – TECHNICAL REVIEW ROUND 2, MARCH 23, 2020

Appendix 1-2 Suspended Sediment Modelling Approach Report
June 2020

SPRINGBANK OFF-STREAM RESERVOIR PROJECT
Suspended Sediment Modelling Approach Report

Prepared for:
Alberta Transportation

Prepared by:
Stantec Consulting Ltd.

June 2020

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1.0 INTRODUCTION

Alberta Transportation has proposed to construct flood mitigation infrastructure adjacent to Elbow River, approximately 15 km west of Calgary. The purpose of this infrastructure (a key feature of which is the off-stream reservoir that will temporarily retain water) is to divert water during extreme floods (i.e., flows in Elbow River become greater than 160 m^3/s and up to 760 m^3/s) to mitigate flooding downstream.

This technical memorandum summarizes the two-dimensional (2D) modelling approach used to model the effects of the Springbank Off-stream Reservoir Project (the Project) on suspended sediment processes within the model domain. This memo describes how the model was developed to evaluate the effects of the Project on suspended sediment concentration and deposition upstream and downstream of the Project during the 1:10 year, 1:100 year, and the 2013 floods. Late and early release from the off-stream reservoir were also modelled for each flood in order to assess the impacts of temporal variations of water released on suspended sediment concentration and deposition within Elbow River. The updated model was developed in response to information requirements from Alberta Environment and Parks (AEP) and Natural Resources Conservation Board (NRCB). Previous models used three separate model domains:

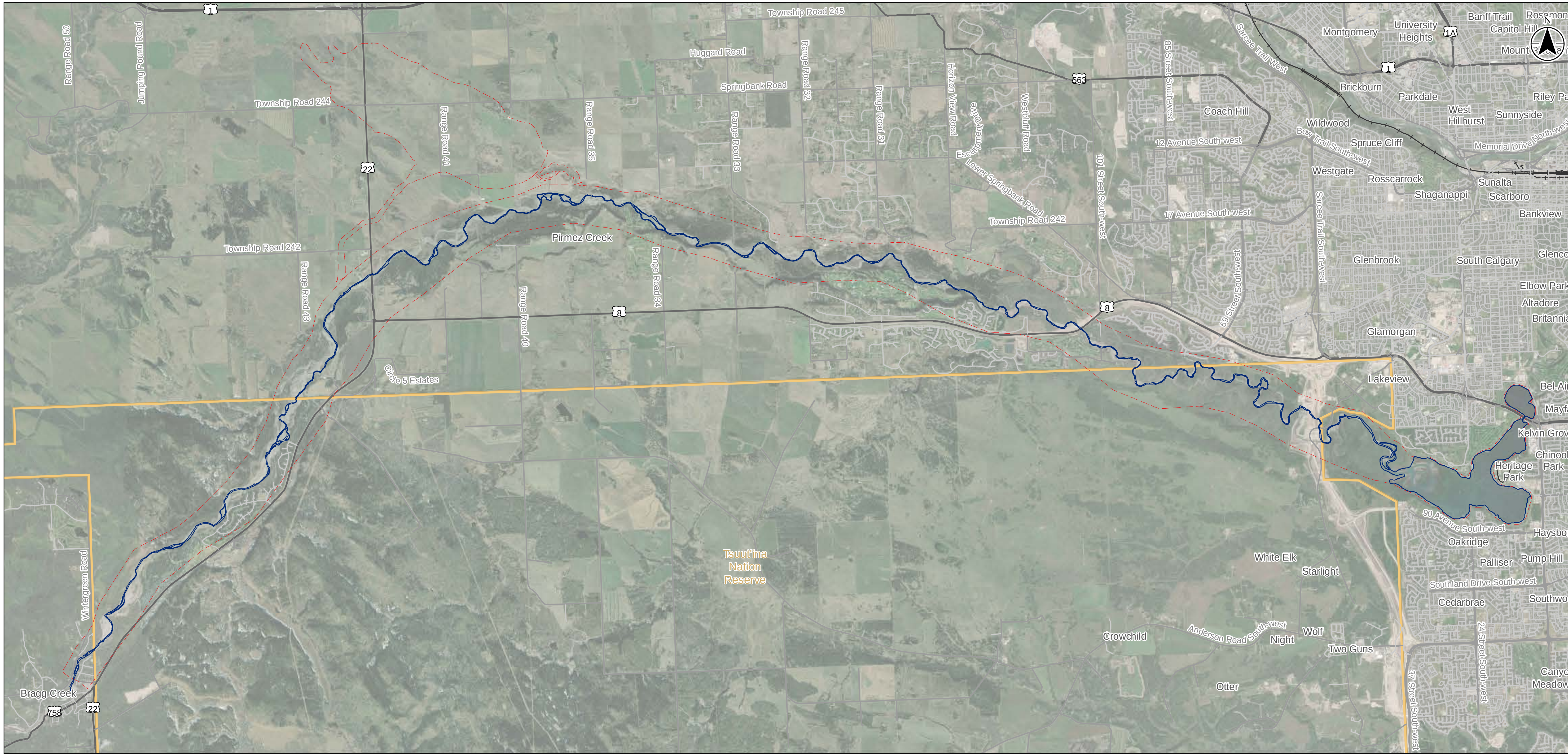
1. Elbow River
2. diversion structure diversion channel, reservoir and dam outlet
3. low-level outlet channel)

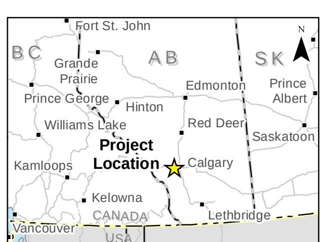
These three model domains are as described in the EIA, Volume 4, Appendix J, Section 2.4.1. The Elbow River domain included the channel only, did not include the floodplain, and was developed based on light detection and ranging (LiDAR). The new model is an improvement on the previous model because it incorporates:

- early release and late release and low-level outlet works rating curve
- the floodplain
- updated channel bathymetry
- updated single model domain
- utilization of cloud computing to efficiently run the larger model in the single domain

2.0 MODELLING EXTENT

The model extent includes an approximately 40 km reach of Elbow River, from Bragg Creek to Glenmore Dam. The model extent incorporates the Elbow River channel, the Elbow River floodplain inundated during the 2013 flood, the proposed spillway gates, diversion channel, floodplain berm and the low-level outlet works (LLOW) and the unnamed creek channel and Glenmore Reservoir. Figure 2-1 presents the model extent.





Highway
Road
Local Street
Railway
Tsuut'ina Nation Reserve
Low Flow Channel
TSS Modelling Extent

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
1:90,000 (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.
2-1

Title
The Project TSS Modelling Extent

3.0 MODELLING APPROACH

3.1 MODEL DESCRIPTION

A 2D hydrodynamic and sediment transport model was utilized to evaluate the effects of the Project on total suspended solids (TSS) during floods The MIKE 21 Flow Model Flexible Mesh (FM) and MIKE 21 Mud Transport Module (MT) were coupled to model hydrodynamics and sediment transport within the model domain. The MIKE 21 FM is a powerful commercial 2D finite volume model that solves the 2D incompressible Reynolds averaged Navier-Stokes equations under the Bossinesq and hydrostatic pressure assumptions. The model consists of continuity, momentum, and density equations and considers a turbulent closure scheme. The MIKE 21 MT module is an add-on module to MIKE 21 FM, which was used to assess suspended sediment transport, erosion, and deposition within the model domain, both with and without the Project. MIKE 21 MT solves 2D governing equations of cohesive sediment equations. The MIKE 21 MT module can include multiple fractions of suspended sediment, including non-cohesive sediment.

3.2 MODELLING SCENARIOS

The purpose of the modelling is to evaluate the effects of the Project on the distribution of TSS and geomorphological changes during 1:10 year, 1:100 year, the 2013 design floods. The model was run with and without the Project. Two release options from the reservoir were investigated:

- Early release refers to the release of water from the off-stream reservoir after the flood peak and when flow in Elbow River is less than 160 m^3/s.
- Late release refers to the release of water from the off-stream reservoir when flow in Elbow River is less than 20 m^3/s.

The low-level outlet gate at the reservoir was assumed to be fully opened during early release and late release. To evaluate the effects of release operations of the low-level outlet gate, the 2013 flood for early release and late release included additional model runs with the gate being 50% and 75% open. In total, 13 modelling runs were executed. Table 3-1 summarizes the modelling runs.

Table 3-1 Modelling Runs

Run Number	Modelling Scenario	Flood	Release Scenario	Low-Level Outlet Gate Opening
1	Without the Project	1:10 year	N/A	N/A
2	Without the Project	1:100 year	N/A	N/A
3	Without the Project	2013	N/A	N/A
4	With the Project	1:10 year	Early Release	100%
5	With the Project	1:100 year	Early Release	100%
6	With the Project	2013	Early Release	100%
7	With the Project	1:10 year	Late Release	100%
8	With the Project	1:100 year	Late Release	100%
9	With the Project	2013	Late Release	100%
10	With the Project	2013	Early Release	50%
11	With the Project	2013	Early Release	75%
12	With the Project	2013	Late Release	50%
13	With the Project	2013	Late Release	75%

3.3 MODEL SETUP

MIKE 21 FM and MT model set up and assumptions are discussed in the following sections.

3.3.1 MIKE 21 FM

Model Domain

Two model domains were created using the MIKE Zero mesh generator: a model domain without the Project and a model domain with the Project. The model domains include an approximately 40 km long reach of Elbow River, extending from Bragg Creek to Glenmore Reservoir. The model domain includes the extent of the 2013 floodplain. For model domain with the Project, the following are included: diversion inlet and outlet, and reservoir. A combination of unstructured mesh and rectangular mesh was used to create the model domain. The unstructured mesh was used within the channel, floodplain, the reservoir, and Glenmore Reservoir and the rectangular mesh was used within the diversion inlet and outlet to ensure an accurate bathymetry for these features. The model domain, without and with the Project, has 45,967 and 56,723 computational elements, respectively. Figures 3-1 to 3-4 shows model domain without and with the Project (in Alberta reference meridian 114 W coordinate system).

The following two open boundaries were included in the model domains:

- Upstream boundary condition is the flow measured in Elbow River at the Bragg Creek Water Survey of Canada (WSC) Station (05BJ004).
- Downstream boundary condition is the water level in Glenmore Reservoir.

For the model domain with the Project, the service spillway gates, diversion inlet gates, LLOW, and floodplain berm were included in MIKE 21. This approach allows modelling of a dynamic flood condition by creating more realistic backwater effects due to operation of the floodplain berm and the service spillway gates in Elbow River. Moreover, modelling the inlet and outlet diversion structures allow for the calculation of TSS in the model with fewer assumptions, including the definition of sediment rating curves at the inlet and outlet of the reservoir which are not known. Dike and gate structures were used in the MIKE21 FM to model the hydraulic structures. Inclusion in the model domain of the floodplain areas inundated during the 2013 flood improved modelling of flow conditions, especially for the 1:100 year and 2013 floods, as well as suspended sediment depositional processes.

Once the computational mesh was created, available bathymetric data was used to interpolate bathymetric data points in the MIKE mesh generator and create the bathymetry file required for the model. Attachment A provides a summary of the approach used to process the available bathymetric data. Mesh files are the primary input parameter of the MIKE 21 FM model.

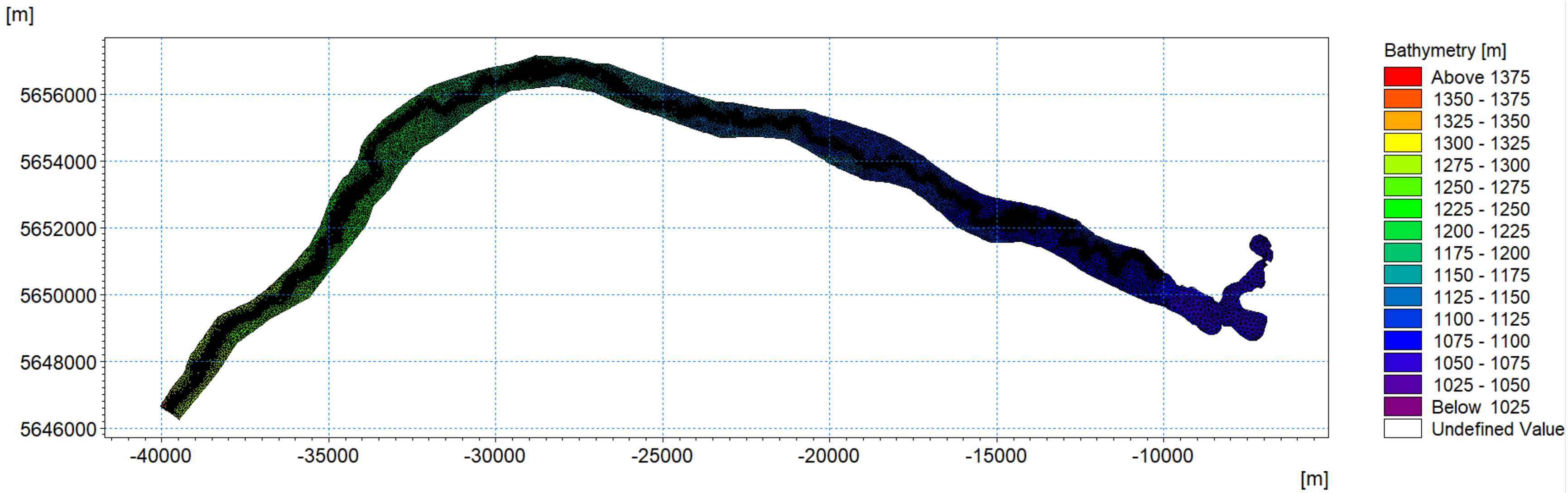


Figure 3-1 Model Domain Without the Project Showing the Location of the Computational Elements (with Computational Mesh)

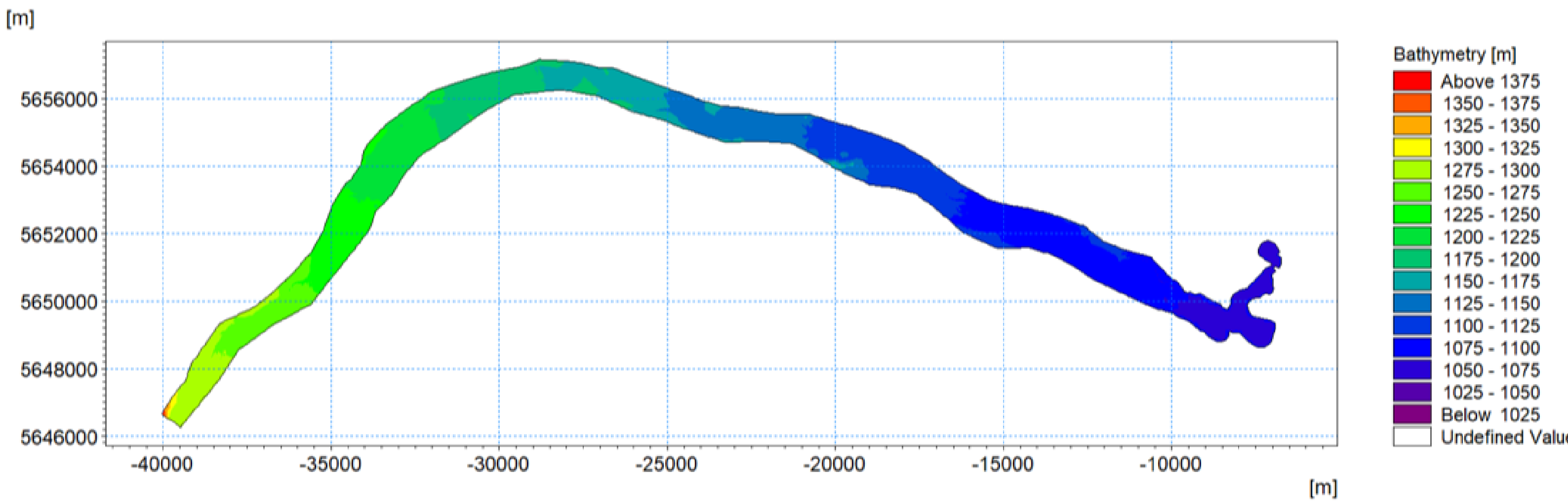


Figure 3-2 Model Domain Without the Project Showing the Location of the Computational Elements (without Computational Mesh)

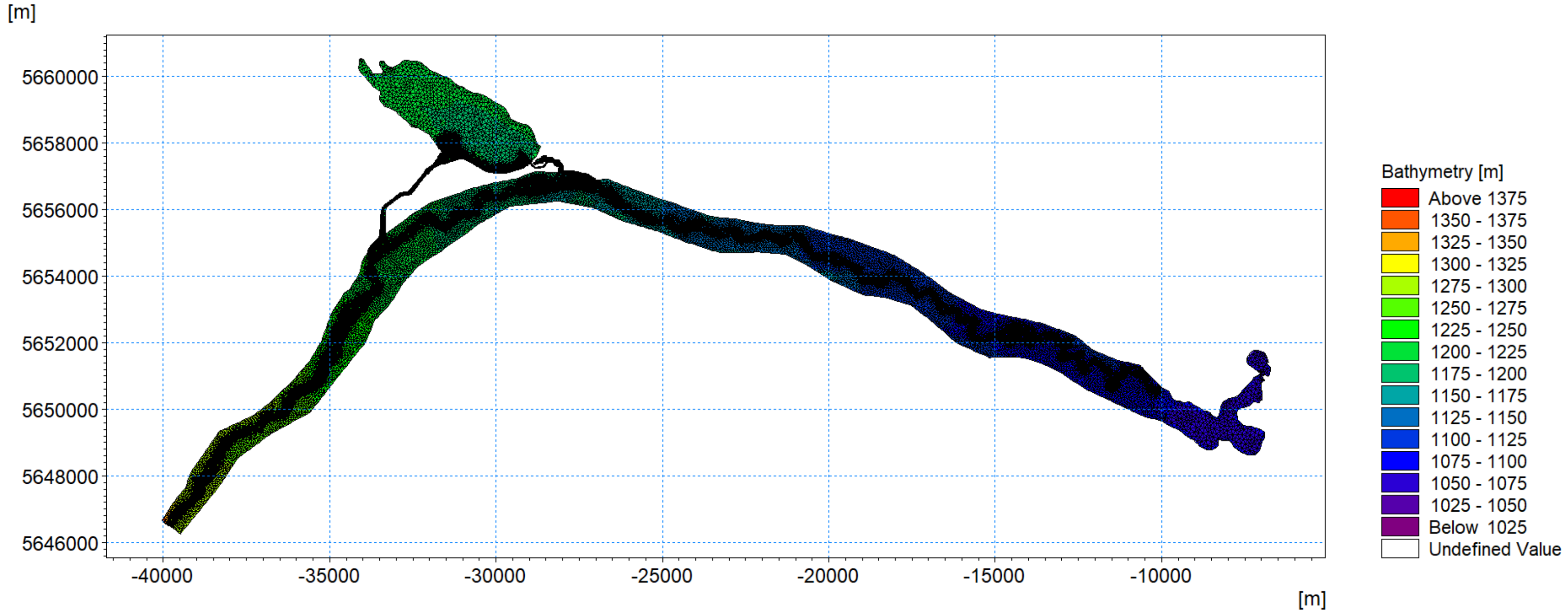


Figure 3-3 Model Domain with the Project, Location of the Computational Elements (with Computational Mesh)

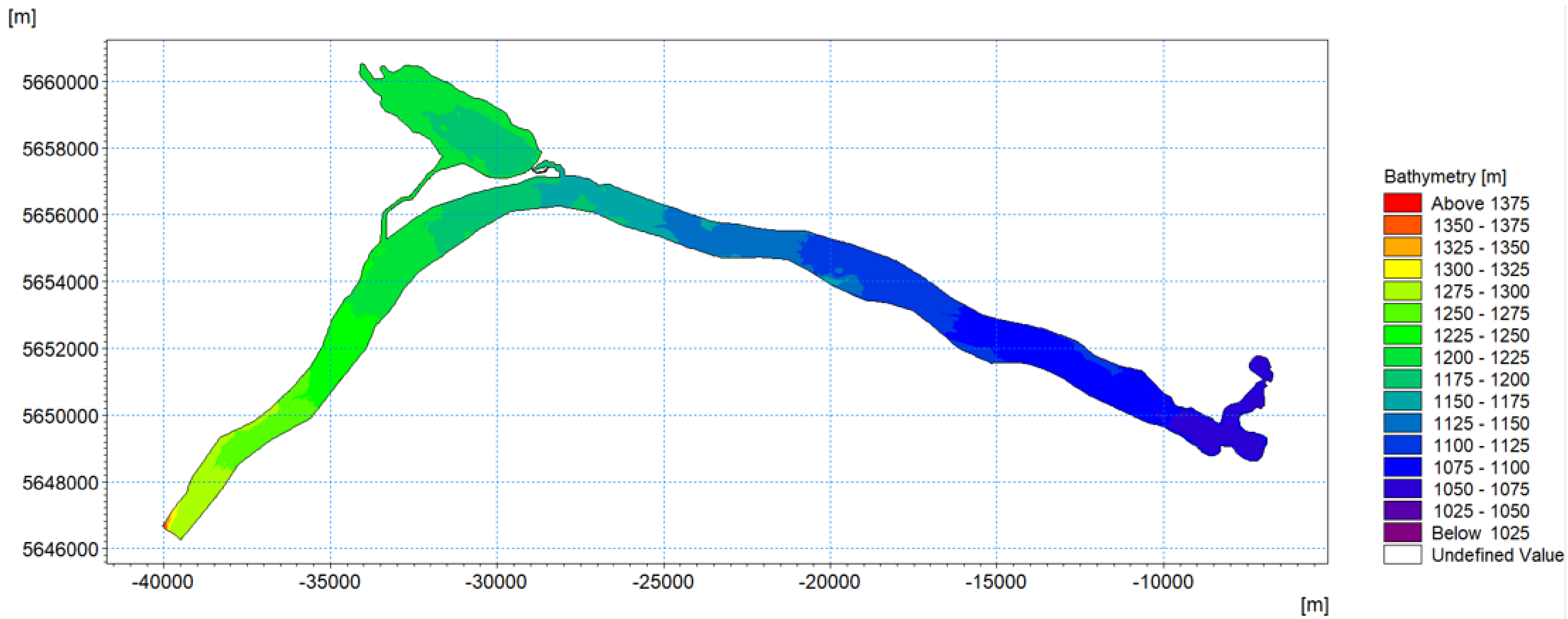


Figure 3-4 Model Domain with Project, Location of the Computational Elements (without Computational Mesh)

Bed Resistance

Bed resistance (M) is another important input parameter to the MIKE 21 FM. MIKE 21 FM uses a reciprocal form of Manning roughness coefficient (n) to represent roughness (M = 1/n). Bed resistance mainly affects hydrodynamic conditions within the river and floodplain. Spatially variable M values were used within the river, floodplain, diversion structures, and reservoirs. Figure 3-5 presents the final M values used in the MIKE 21 FM models. These values were verified during a model validation (see Section 3.4).

Horizontal Eddy Viscosity

Eddy viscosity is used to calculate Reynolds stress components in the shallow water equations. The turbulence model (Smagorinsky 1963) was selected in the MIKE 21 FM to calculate horizontal eddy viscosity at each time step. The required input parameters in MIKE 21 FM is the coefficient of Smagorinsky (C_s), the default value of 0.28 was used in the model (DHI 2019). A sensitivity analysis was conducted to evaluate the sensitivity of the model results to this default value (see Section 3.4).

Hydraulic Structures, Boundary Conditions, and Initial Conditions

The MIKE21 FM upstream and downstream boundary conditions were the hourly flow in Elbow River and daily water level in Glenmore Reservoir. May 2008 and June 2013 hourly observed flows at WSC Station 05BJ004 were used as the upstream boundary condition for the MIKE 21 FM model to model the 1:10 year and the 2013 flood. The 1:100 year hourly flow hydrograph was obtained from a previously developed HEC-HMS model used in the EIA. Figure 3-6 presents upstream flow boundary condition of the MIKE 21 FM for the 1:10 year, 1:100 year, and design floods.

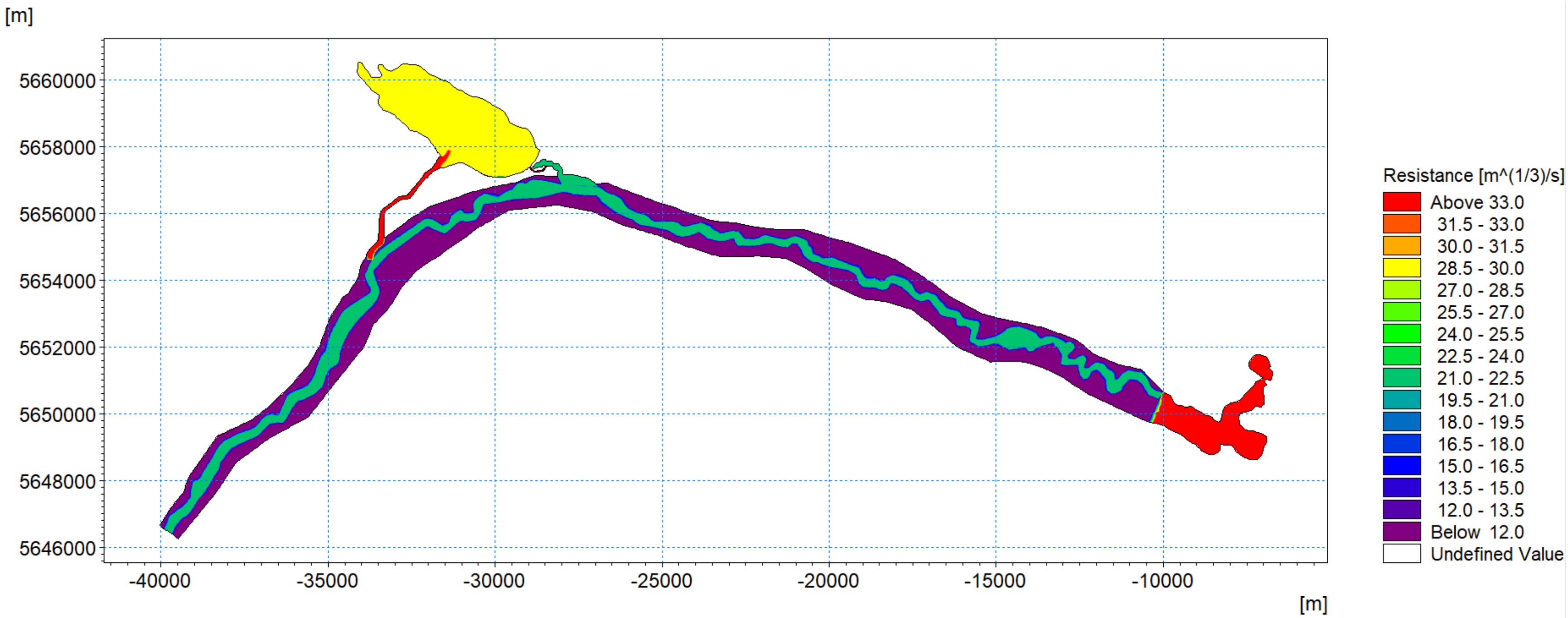


Figure 3-5 Bed Roughness Coefficient Within the Model Domain

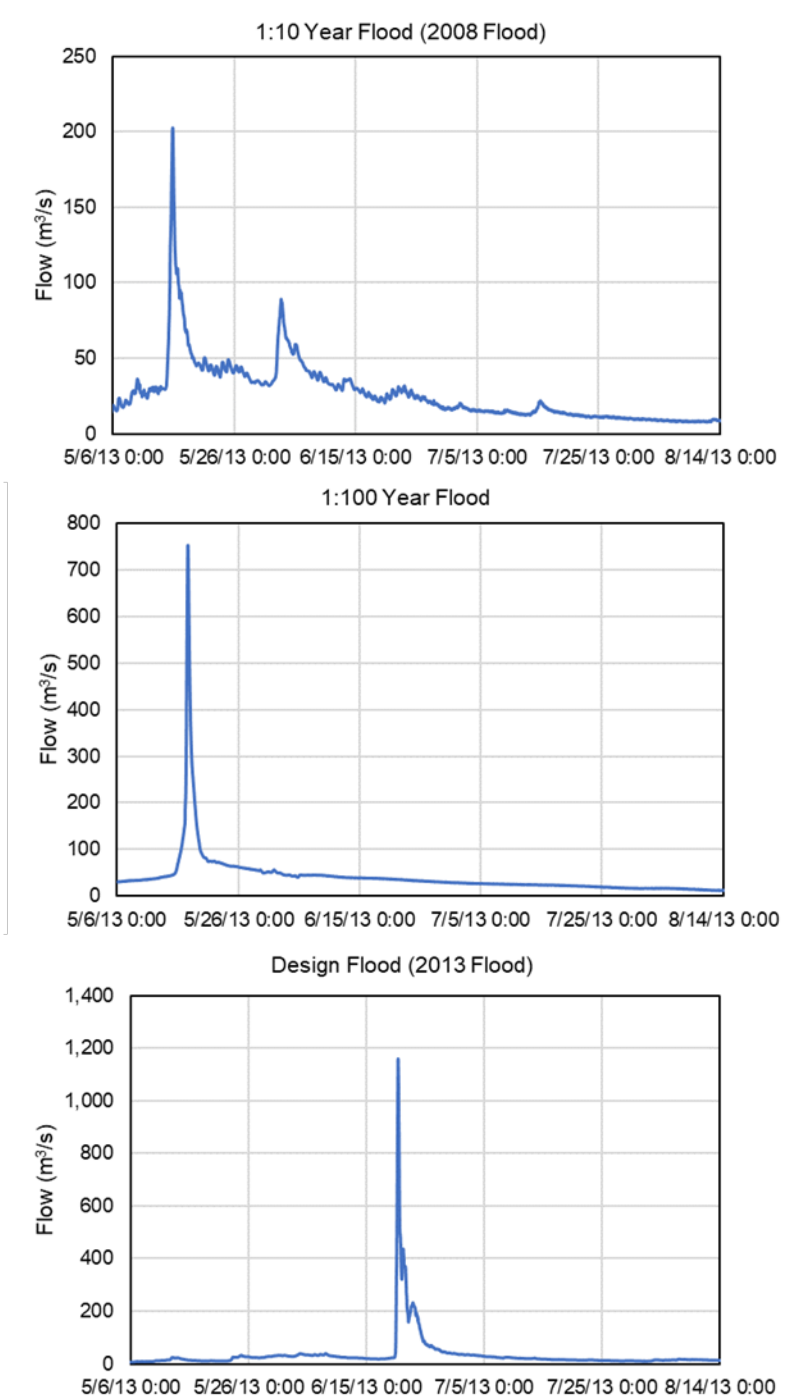


Figure 3-6 MIKE 21 FM Model Flow Boundary Condition

The downstream model boundary condition was daily water level in Glenmore Reservoir. For model runs without the Project, daily water level data was obtained from WSC station 05BJ008 for the 1:10 year (2008 flood) and the design flood (2013 flood). The downstream boundary of the model domain is located at the Glenmore Reservoir outlet. Historical records of water level at this location are available at WSC Station 05BJ008 for the period of 1976 to 2018.

Figure 3-7 presents a histogram of mean monthly, and maximum and minimum daily water levels in Glenmore Reservoir for the period of 1976 to 2018. The maximum water level of 1,077.43 m was observed on June 21, 2013 and the minimum water level of 1,071.41 m was observed on March 26, 1982. The average daily water level was 1,074.83 m for this period.

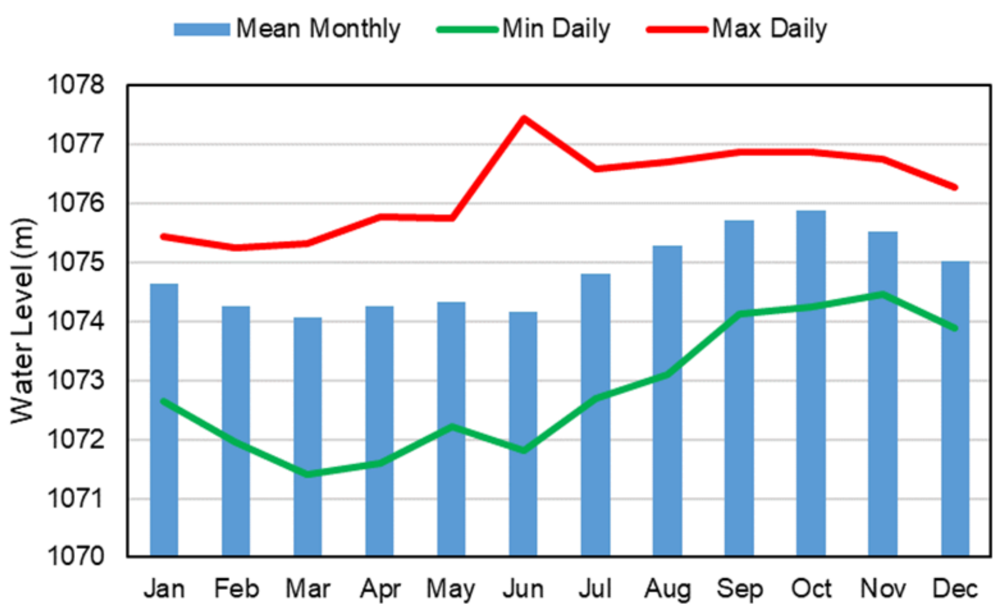


Figure 3-7 Mean Monthly, and Maximum and Minimum Daily Water Level in Glenmore Reservoir at WSC Station 05BJ008 for the Period of 1976 to 2018

For model runs, with the Project, and 1:100 year flood, water level in Glenmore Reservoir was calculated using the following reservoir routing equation:

$$\frac{\Delta S}{\Delta t} = I - O$$

where $\frac{\Delta S}{\Delta t}$ is the change in storage in the reservoir, *I* is the inflow to the reservoir, and *O* is the outflow from the reservoir. An hourly hydrograph of the flow downstream of the Project and provided storage-area and Glenmore Reservoir rating curve by the City of Calgary was used to route the reservoir and calculate water level in Glenmore Reservoir for model runs with the Project and the 1:100 year flood.

To evaluate the effects of the Project on hydrodynamics and sediment transport, the Elbow River gates, floodplain berm, diversion inlet gates, and low-level outlet gate were modelled in the MIKE 21 FM. Geometry and location of the hydraulic structures were defined based on the preliminary design drawings. Two gates with a “subset of water column” geometry and a top elevation of 1215 m were modelled at the location of the Elbow River gates. A dike structure was used to model the Elbow River floodplain berm. In addition, dike structures were used to model the diversion inlet and LLOW. Application of dike structures in MIKE 21 allows the user to assign a specific overtopping discharge time series to the structure. Based on the 2019 design criteria, flow hydrographs into the diversion inlet and from the outlet diversion were calculated and assigned to the associated hydraulic structures. Figure 3-8 to Figure 3-10 present hydrographs of the inlet diversion and LLOW for the three floods and two releases.

Initial conditions for water surface elevation (WSE) varied spatially within the model domain. Results from initial short runs for a few days were used to create the initial water surface in the model domain. This initial model runs allow the model to start running with a realistic water level distribution within the domain.

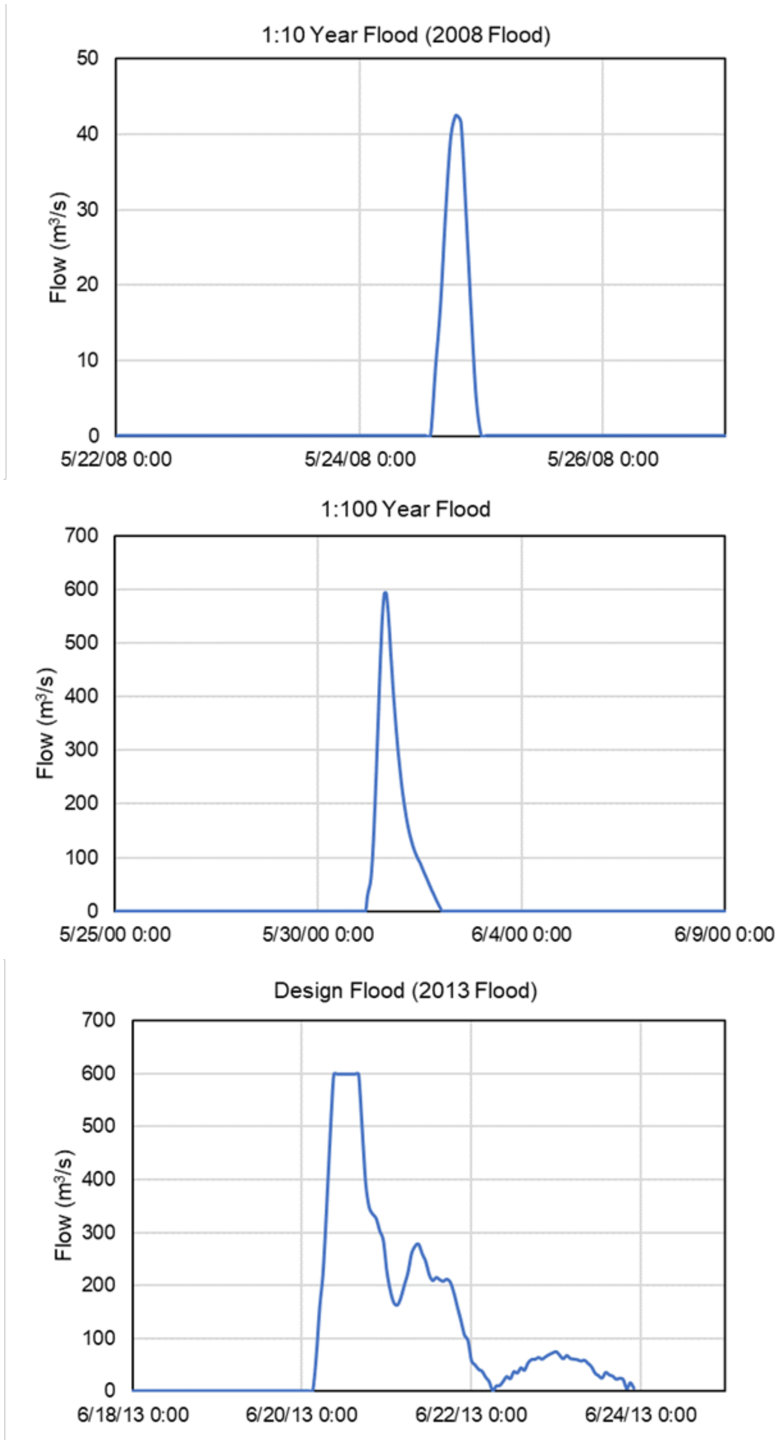


Figure 3-8 Inlet Diversion Hydrographs for the Three Floods

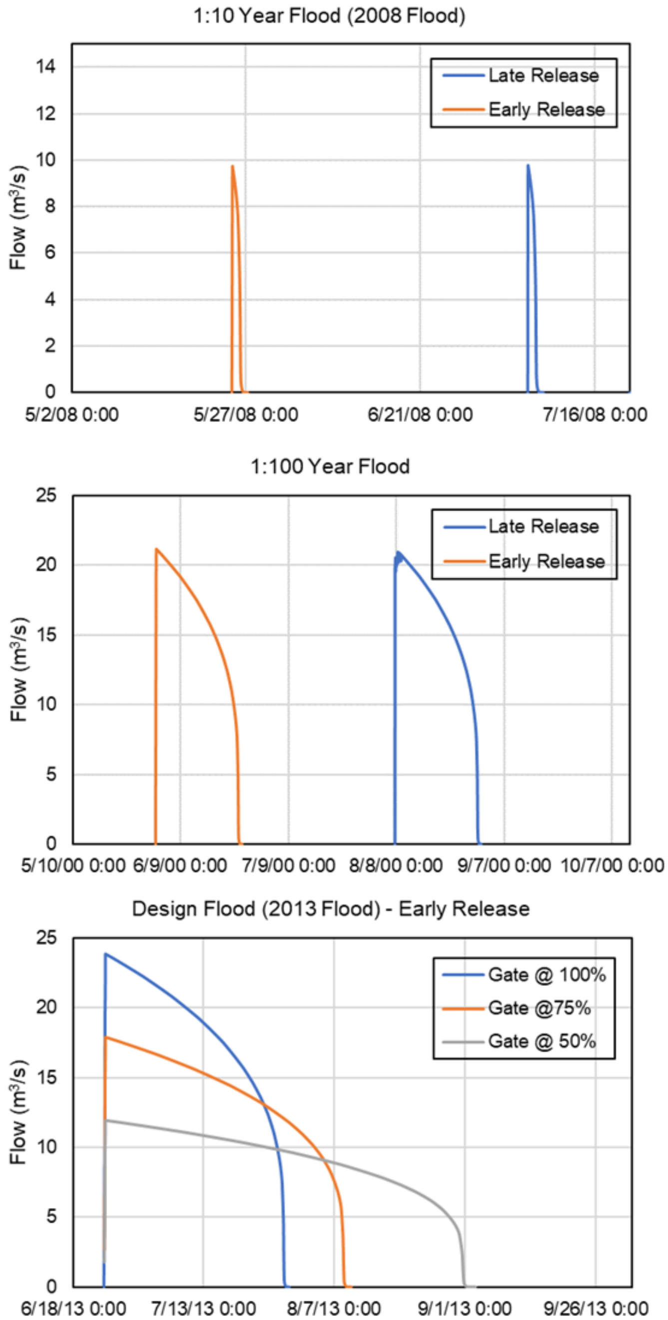


Figure 3-9 Early Release and Late Release, Low-Level Outlet Hydrographs for the Three Floods

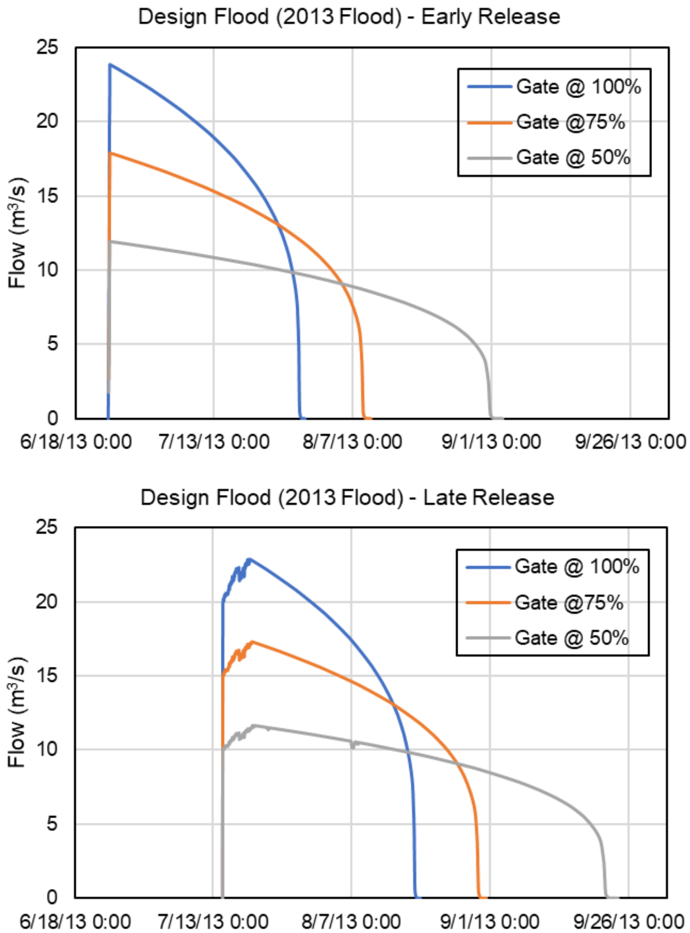


Figure 3-10 Low-Level Outlet Design Flow Hydrographs for Early Release and Late Release

3.3.2 MIKE 21 MT

The key input parameters to the MIKE 21 MT module were the model boundary conditions, bed erosion parameters, and water column parameters. A rating curve was developed using available the historical record of TSS in Elbow River at WSC station 05BJ004. Figure 3-11 presents developed TSS rating curve at this location. The upstream boundary condition of the MIKE 21 MT model was hourly TSS in Elbow River at Bragg Creek, calculated using the developed TSS rating curve and hourly flow hydrographs used at the downstream boundary of the MIKE 21 FM model. Suspended sediment in Elbow River near Bragg Creek were characterized using a study by Hudson (1983). According to Hudson (1983) suspended sediment consists of 18% clay, 47% silt, and 35% sand fractions with median grain size of 0.002 mm, 0.0205 mm, and 0.1625 mm, respectively. This information was used to develop a sediment boundary condition at the upstream boundary of the model domain. Figure 3-12 shows TSS boundary conditions in Elbow River for the three floods calculated using the TSS rating curve. A Neumann boundary condition was used at the downstream boundary condition in Glenmore Reservoir which uses adjacent computational element values to calculate TSS at the downstream boundary. Water column parameters were settling velocities and deposition characteristics of the suspended sediment. Stokes Law was used to calculate settling velocity of the suspended sediment fractions based on median grain size obtained from Hudson (1983). Bed parameters, including bed critical shear stress and erosion rate, were used in MIKE 21 FM.

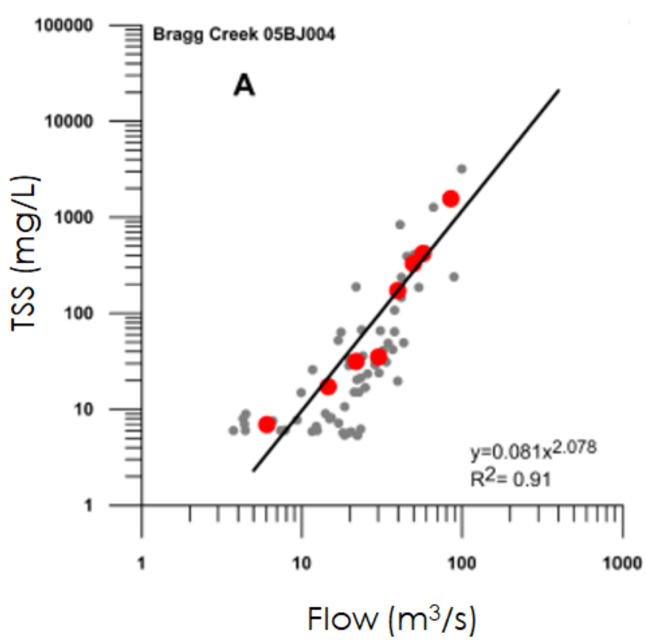


Figure 3-11 Suspended Sediment Versus Flow in Elbow River at Bragg Creek (EIA, Appendix J, Figure 3-12)

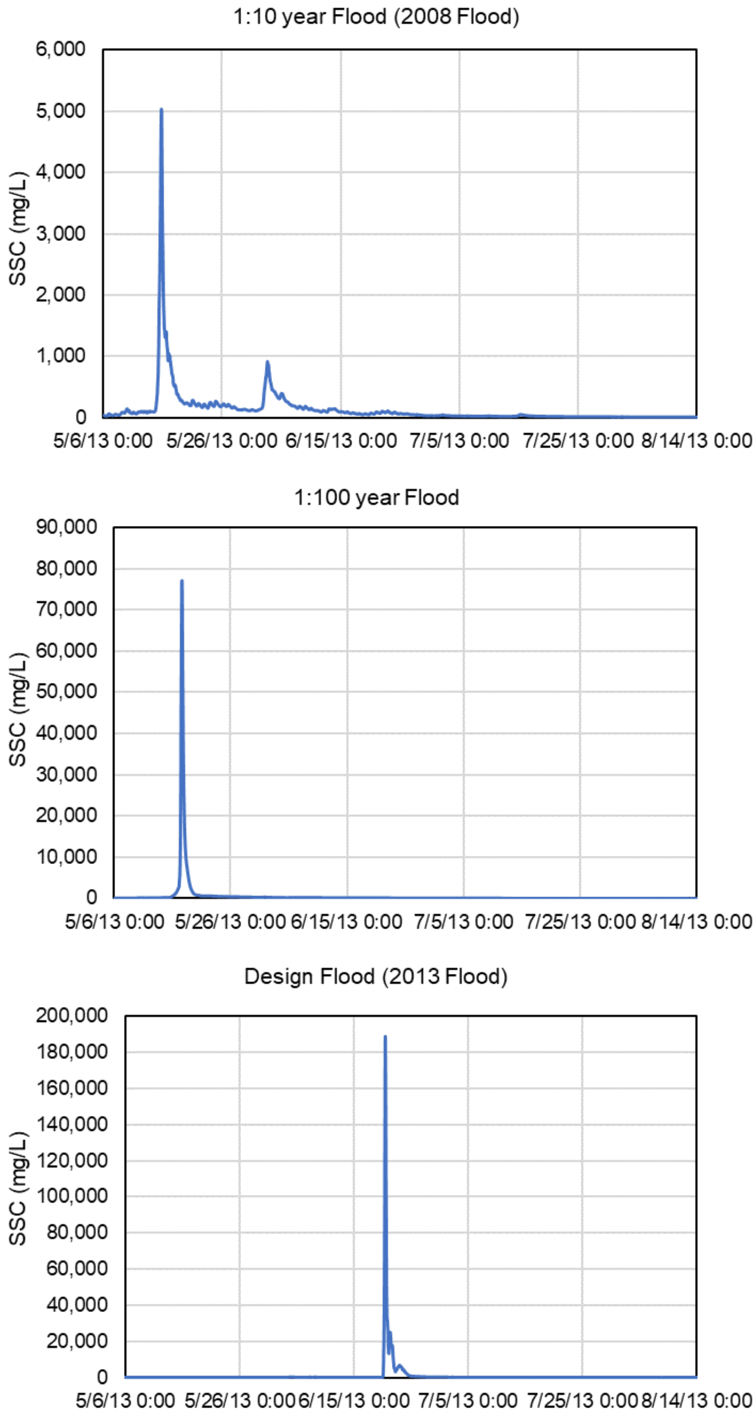


Figure 3-12 MIKE 21 MT Model TSS Boundary Condition

3.4 MODEL CALIBRATION, VALIDATION, AND SENSITIVITY ANALYSIS

An unpublished one-dimensional (1D) HEC-RAS hydraulic model, developed as part of the Bow and Elbow River flood hazard program was provided by AEP. Detailed calibration and validation were conducted on the HEC-RAS model to determine 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, the new MIKE 21 FM model used the same Manning coefficients as used in the HEC-RAS model. The MIKE 21 FM was validated using the surveyed high-water marks (HWM) as the flood hazard program. The HWMs were surveyed in July 2013 by the AEP to record the HWM due to the 2013 flood. The HWM were surveyed at four locations within the model domain after the 2013 flood. Surveyed HWMs were compared against the modelled peak water levels at the same locations. Table 3-2 and Figure 3-13 summarize the model validation results. As shown in the table and figure there is a good agreement between surveyed and modelled HWMs due to the 2013 flood with a difference less than 1% between the modelled and surveyed HWMs. In addition, Figure 3-13 shows that the fitted trendline to modelled versus surveyed HWM data points 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 within the model domain.

Table 3-2 Results of MIKE 21 FM Model Validation to Surveyed 2013 HWM

No.	Coordinates	Surveyed HWM	Modelled HWM	Difference (m)	Difference (%)
1	-11564.844 m E, 5651019.964 m N	1082.50	1082.87	0.37	0.03%
2	-11572.738 m E, 5650943.000 m N	1082.45	1082.85	0.40	0.04%
3	-14324.467 m E, 5652592.561 m N	1092.34	1092.75	0.41	0.04%
4	-16839.274 m E, 5653450.087 m N	1105.83	1105.88	0.05	0.00%

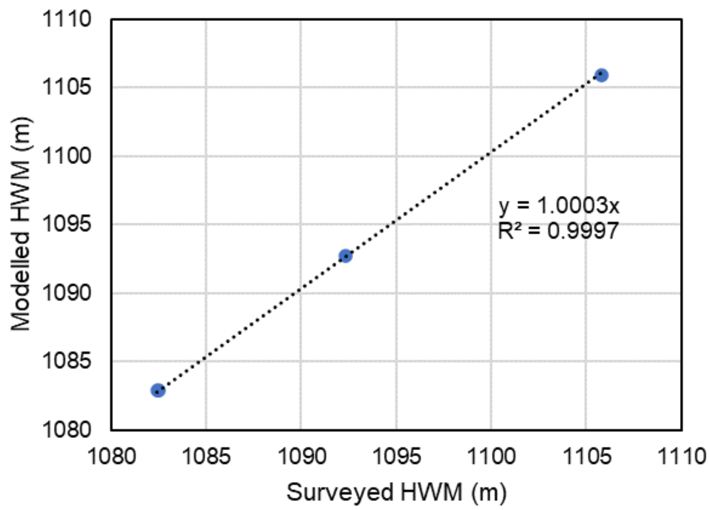


Figure 3-13 2013 Modelled versus Surveyed HWMs

The two main parameters affecting results of the MIKE 21 FM hydrodynamic model are bed roughness and horizontal eddy viscosity. A sensitivity analysis was conducted to evaluate the sensitivity of the model results to bed roughness and horizontal eddy viscosity. The horizontal eddy viscosity affects the turbulence characteristics of the flow in the MIKE 21 FM. The Smagorinsky formulation was used to define the horizontal eddy viscosity as a function of current velocity in the model. The recommended default value of 0.28 (DHI 2019) was used in the model. While previously verified bed roughness coefficients and recommended Smagroinsky coefficients were used in the model, the sensitivity of the model to these two main input parameters was tested.

Main channel *n* and C_s were adjusted ±10% in the model to evaluate the sensitivity of the model to these parameters. The 2013, early release modelling (see Section 3.2) was selected as the baseline scenario to perform the sensitivity analysis. To assess model sensitivity, hourly velocity and water surface elevation time series were extracted at an arbitrary location in Elbow River downstream of Bragg Creek (-38846.642 m E, 5647943.380 m N).

Table 3-3 presents a summary of the sensitivity of the modelled WSE at that location. The WSE is the elevation of the water surface that is predicted by the model. As shown in the table, WSE is more sensitive to bed roughness than the horizontal eddy viscosity. The 10% changes in Cs did not affect the maximum (Max) and average (Avg) WSEs and only changed the minimum (Min) WSE by 1 cm. Increasing and reducing *n* by 10% changed Max WSE by + 7 cm and - 5 cm, respectively; however, Avg WSE only changed ± 1 cm. Figure 3-14 shows the modelled scenarios. Overall, changes in WSE were less than 1% and are insignificant.

Table 3-3 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 m)	1,279.740 (+0.01 m)	1,280.070 (+0.02 m)
$n_{baseline}$ - 10% ($n_{channel}$ =0.04; C_s=0.28)	1,282.000 (-0.05 m)	1,279.720 (-0.01 m)	1,280.033 (-0.017 m)
$C_{s(baseline)}$ + 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)

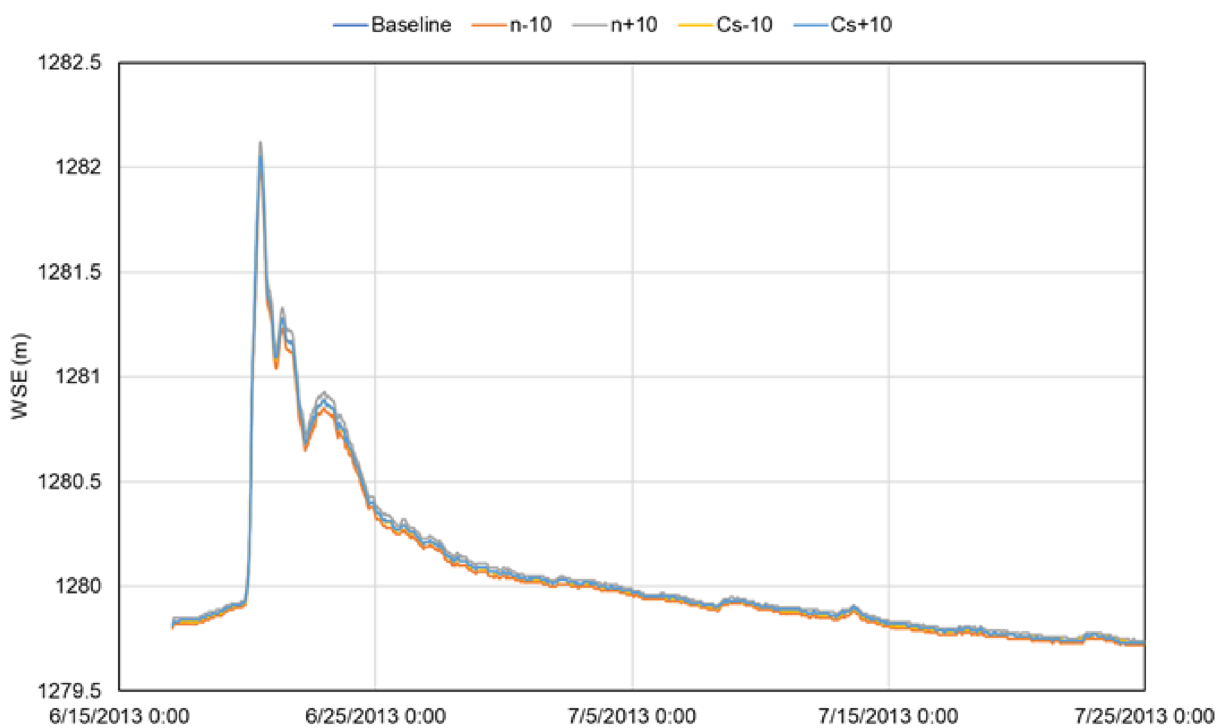


Figure 3-14 Modelled Water Surface Elevation Time Series

Table 3-4 presents a summary of the sensitivity analysis of the modelled velocity at this location. As shown in the table, like WSE, current velocity is more sensitive to bed roughness compared to the horizontal eddy viscosity. The 10% changes in C_s had an insignificant effect on the velocity (less than1%). Whereas, increasing and reducing *n* 10% changed the maximum current velocity by -0.173 m/s and 0.154 m/s, respectively. Also, average velocity changed -0.062 m/s and +0.065 m/s by increasing and reducing roughness coefficient by 10%, respectively. Figure 3-15 presents velocity time series for the modelled scenarios. Overall, velocity is sensitive to change in bed roughness coefficient. A 10% change in *n* resulted in 5% change in the maximum velocity and 9% in the average velocity.

Table 3-4 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)

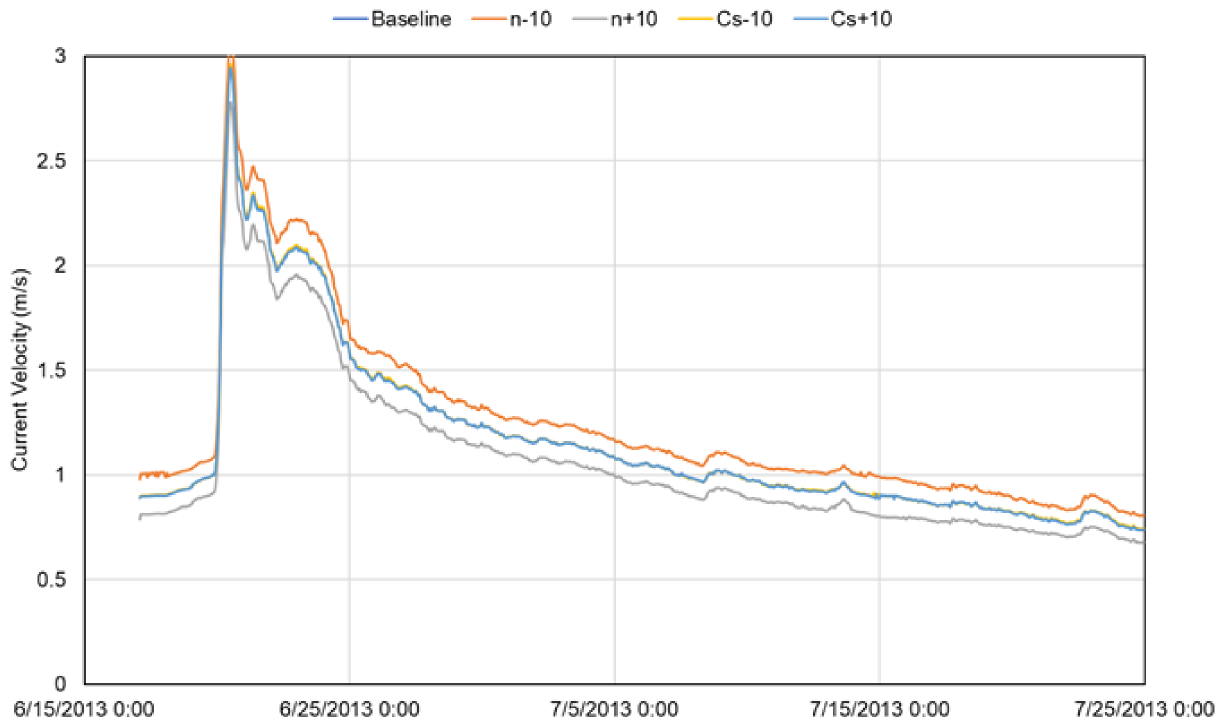


Figure 3-15 Modelled Current Velocity Time Series

4.0 SUMMARY

A 2D hydrodynamic and sediment transport model was developed using MIKE 21 FM and MT models to evaluate the effects of Project on suspended sediment concentration and deposition within Elbow River and potential impacts on Glenmore Reservoir. In total 13 scenarios, including 1:10 year, 1:100 year, and 2013 floods are modelled.

SPRINGBANK OFF-STREAM RESERVOIR PROJECT
SUSPENDED SEDIMENT MODELLING APPROACH REPORT

Summary
June 2020

4.2

5.0 REFERENCES

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Hudson, H.R. 1983. Hydrology and sediment transport in the Elbow River basin, SW Alberta. Unpublished PhD Thesis, The University of Alberta. 344 pp.

Smagorinsky, J. 1963. General circulation experiments with the primitive equations. Monthly Weather Review, 91(3): 99-164.

Attachment A BATHYMETRY SURFACE CREATION

A bathymetry surface was created for Elbow River extending from the headworks of Glenmore Reservoir upstream to the town of Bragg Creek. The bathymetry surface was used as an input into a two-dimensional (2D) hydraulic and sediment model in MIKE 21C. Data used to construct the bathymetry surface comprised:

- Surveyed cross sections collected by Alberta Environment and Parks (AEP) between October 2015 to August 2016.
  - Only survey points matching the description stream bottom and water level were used. Stream bottom is defined as a survey point below the water line and water level as a survey point where water meets the bank.
- Bathymetry contour data from Klohn Crippen Berger (KCB) captured post-flood 2013 conditions.
  - Contour data was provided as polylines at 0.5 m vertical interval.

The extent of the bathymetry surface that was created can be seen in Figure A-1.

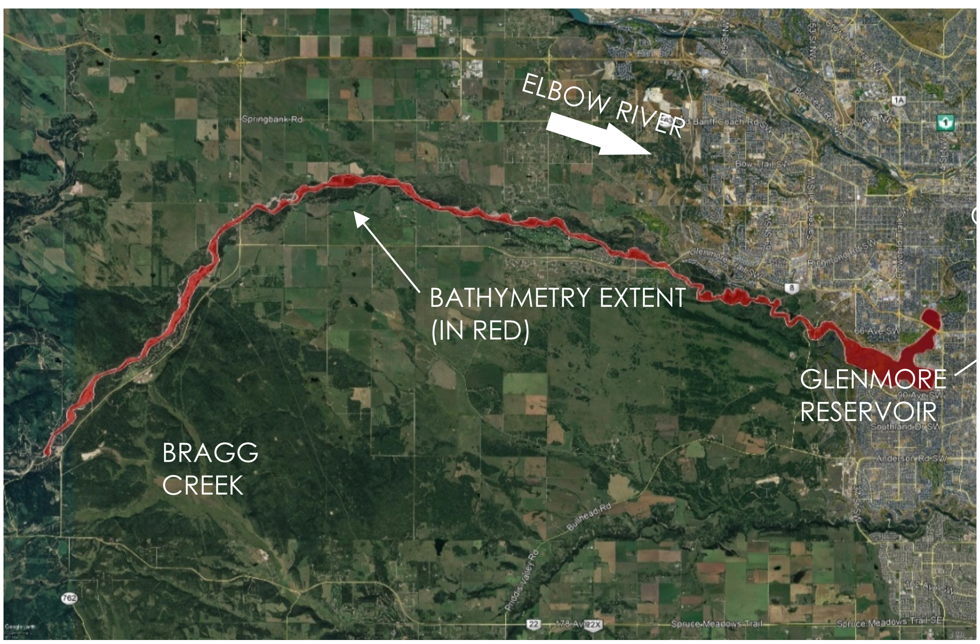

Figure A-1 Extent of Bathymetry Surface

The continuous bathymetry surface was created using Autodesk Civil 3D 2019 (Civil 3D). The process used in the creation of the bathymetry surface is outlined here:

1. AEP's survey points were imported into Civil 3D as coordinate geometry (COGO) points.
2. Water level points surveyed along the left bank, right bank and islands of Elbow River were linked together with a three-dimensional (3D) polyline, establishing a rough outline of the watercourse. Due to the limited water level points, 2016 aerial imaging and light detection and ranging (LiDAR) were used in determining the location of additional vertexes to better establish water's edge. The additional vertexes maintained the surveyed grades.
3. The thalweg of the watercourse was developed by drawing a continuous 3D polyline connecting the deepest stream bottom points throughout the study area. Due to the limited stream bottom points, the 2016 aerial and LiDAR were used to determine the location of additional vertexes along the thalweg.
4. Civil 3D Surface Creation Tool generated surfaces from data inputs such as COGO points and 3D polylines. The bathymetry surface was generated using the COGO points and 3D polylines produced in steps 1 to 3. The generated bathymetry surface required minor modifications such as:
   - surface triangles created outside the water level 3D polyline were deleted
   - surface triangles within the water level 3D polyline were swapped to ensure a continual downstream slope of Elbow River
5. Compared to AEP's survey points, KCB's bathymetry contour data provided more in-depth detail of Glenmore Reservoir's bathymetry. The bathymetry contour data provided by KCB was added to the bathymetry surface.

In order to produce an adequate MIKE 21C model that predicts impacts of the Project on Elbow River, the bathymetry surface was incorporated into the 2016 LiDAR image. The bathymetry surface was exported from Civil 3D as a geotiff, a format compatible with ArcGIS, at a grid spacing of 0.5 m. The exported geotiff was then used to incorporate the bathymetry surface into the 2016 LiDAR image.

APPENDIX 4-1 DRAFT AIR QUALITY MANAGEMENT PLAN

Appendix 4-1 Draft Air Quality Management Plan
June 2020

SPRINGBANK OFF-STREAM RESERVOIR PROJECT
Draft Air Quality Management Plan

Prepared for:
Alberta Transportation

Prepared by:
Stantec Consulting Ltd.

June 2020

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Abbreviations

AEP	Alberta Environment and Parks
AMD	Air Monitoring Directive
AQMP	Air Quality Management Plan
CAAQS	Canadian Ambient Air Quality Standards
CAC	criteria air contaminant
CCME	Canadian Council of Ministers of the Environment
CEAA	Canadian Environmental Assessment Agency
EIA	environmental impact assessment
ECCC	Environment and Climate Change Canada
ECO	Environmental Construction Operations
IAAC	Impact Assessment Agency of Canada
LAA	local assessment area
NRCB	Natural Resources Conservation Board
PAH	polycyclic aromatic hydrocarbon
PDA	Project development area
PM	particulate matter
$PM_{2.5}$	fine particles with an aerodynamic diameter of 2.5 µm or less
TLRU	traditional land and resource use
TSP	total suspended particulate
TUS	traditional use study

VOC	volatile organic compound
WISSA	Western Interprovincial Scientific Studies Association

1.0 INTRODUCTION

The draft Air Quality Management Plan (AQMP) has been developed for construction and operation of the Springbank Off-stream Reservoir Project (the Project). Project construction and operations are expected to affect key aspects of the quality of the air. The draft AQMP describes mitigation and monitoring for several criteria air contaminants (CACs) identified as being of potential concern or importance to the Project. These are a sub-set of the substances of interest listed in the Alberta Environment and Parks (AEP) terms of reference and CEA Agency guidelines. The draft AQMP provides mitigation measures that will be implemented, monitoring methods and targets for implementation of the draft AQMP, and adaptive management methods if CACs exceed targets.

This draft AQMP is based on anticipated regulatory requirements for approvals and authorizations specific to the Project. The plan will be finalized following additional consultation with regulators, Indigenous communities and stakeholders and as an anticipated requirement of the *Environmental Protection and Enhancement Act* (EPEA) approval conditions.

2.0 REGULATIONS, APPROVALS AND GUIDELINES

This draft AQMP meets the terms and conditions of anticipated approval by AEP and the Impact Assessment Agency of Canada (IAAC) for the Project. The approval conditions will define the scope of the draft AQMP once they are available.

2.1 PROVINCIAL AGENCY RESPONSIBILITIES AND REPORTING REQUIREMENTS

2.1.1 Construction and Dry Operations

Alberta Transportation will be responsible for final development of the AQMP and implementation during the construction phase and for a period of three years post-construction during the dry operations. After that, AEP will implement the AQMP during dry operations. The reporting requirements (i.e., number of reports, timing) will be determined following Project approval.

2.1.2 Flood and Post-Flood Operations

AEP will be responsible for implementing the AQMP during both flood and post-flood operations. The reporting requirements (i.e., number of reports, timing) will be determined following Project approval.

3.0 REGULATORY, INDIGENOUS AND PUBLIC STAKEHOLDER INPUT

Engagement with stakeholders, including landowners, municipalities, infrastructure companies and others has been ongoing since the fall of 2014. Table 3-1 lists the Indigenous groups that have been engaged on the Project.

Table 3-1 Indigenous Groups Identified for Engagement

Indigenous Group or Organization	Distance from Project
Treaty 7 Nations	
Tsuut'ina Nation	619 m
Stoney Nakoda Nations (Bearspaw First Nation, Chiniki First Nation, and Wesley First Nation)	28 km
Siksika Nation	78 km
Piikani Nation	144 km
Kainai First Nation (Blood Tribe)	170 km
Treaty 6 Nations	
Ermineskin Cree Nation	204 km
Louis Bull Tribe	207 km
Montana First Nation	194 km
Samson Cree Nation	198 km
Other	
Foothills Ojibway	No Reserve
Ktunaxa Nation	180 km
Métis Nation of Alberta, Region 3	N/A
Métis Nation British Columbia	N/A

3.1 ISSUES IDENTIFIED

Issues, concerns and recommendations related to effects of the Project on air quality were reported by the public through engagement with stakeholders, and by Indigenous groups through the Indigenous engagement program.

Engagement with the Indigenous groups potentially affected by the Project is ongoing and will continue as the Project progresses. Alberta Transportation will review Traditional Use Study (TUS) reports as they are made available by Indigenous groups. Relevant traditional land and resource use (TLRU) information, concerns, and recommendations received after the environmental impact assessment (EIA) was filed will be used for Project planning and implementation purposes, where applicable.

The public concerns related to air quality were related to construction dust and air pollution. There was also a public concern related to air quality and dust from the sediment left in the reservoir after a flood. Rocky View County identified the need for visual monitoring of dust.

Issues and concerns related to effects from the Project on air quality, as reported by Indigenous groups through the review of Project-specific and publicly available TLRU information, include:

- dust and air pollution during construction and operations
- the potential for contaminated dry dust
- flood residue spread by the wind
- wind-blown dust from the reservoir
- emissions as they relate to industrial development
- effects on air quality from the harvesting of trees
- greenhouse gas emissions related to development

3.2 ECONOMIC OPPORTUNITIES

Alberta Transportation is committed to Indigenous participation in the Project, including training, employment and contracting opportunities. Alberta Transportation is preparing an Indigenous Participation Plan (IPP) for the Project. The goal of the IPP is to create training and contracting opportunities with interested Indigenous groups potentially affected by the Project. Alberta Transportation aims to obtain Indigenous comment and feedback on the IPP, the final draft of which will identify how that feedback has been incorporated.

4.0 PROJECT DESCRIPTION

The Project consists of the construction and operation of an off-stream reservoir to divert and retain a portion of Elbow River flows during a flood. The diverted water will be released back into Elbow River in a controlled manner after the flows in Elbow River decrease sufficiently to accommodate the release of water from the reservoir. The reservoir will not hold a permanent pool of water.

4.1 PROJECT COMPONENTS

The primary Project components are:

- diversion structure on the main channel and floodplain of Elbow River
- diversion channel to transport partially diverted floodwater into the off-stream reservoir
- dam to temporarily retain the diverted floodwater in the reservoir
- low-level outlet in the dam to return retained water through the existing unnamed creek and back to the river when AEP Operations determines conditions are appropriate

4.2 PROJECT PHASES

4.2.1 Construction

The Project is scheduled to be able to accommodate a 1:100-year flood after two years of construction and be able to accommodate a design flood after three years of construction. Project construction may be continuous (24 hours per day), weather conditions permitting.

4.2.2 Dry Operations

Dry operation refers to Project operation between floods. During dry operation, the diversion inlet gates are closed, and the service spillway gates are open. The low-level outlet structure will remain open to carry the flow of the unnamed creek over which the dam will be built. The outlet gate system and its operation will be checked according to a routine maintenance schedule to be developed by AEP Operations.

The associated access roads, emergency spillway and reservoir will be inspected at the same time and repaired. The maintenance schedule will also include inspections of the diversion structure and the river channel upstream of it, the maintenance building, the floodplain berm, and the auxiliary spillway. Repairs and debris management will be completed, as necessary.

4.2.3 Flood Operations

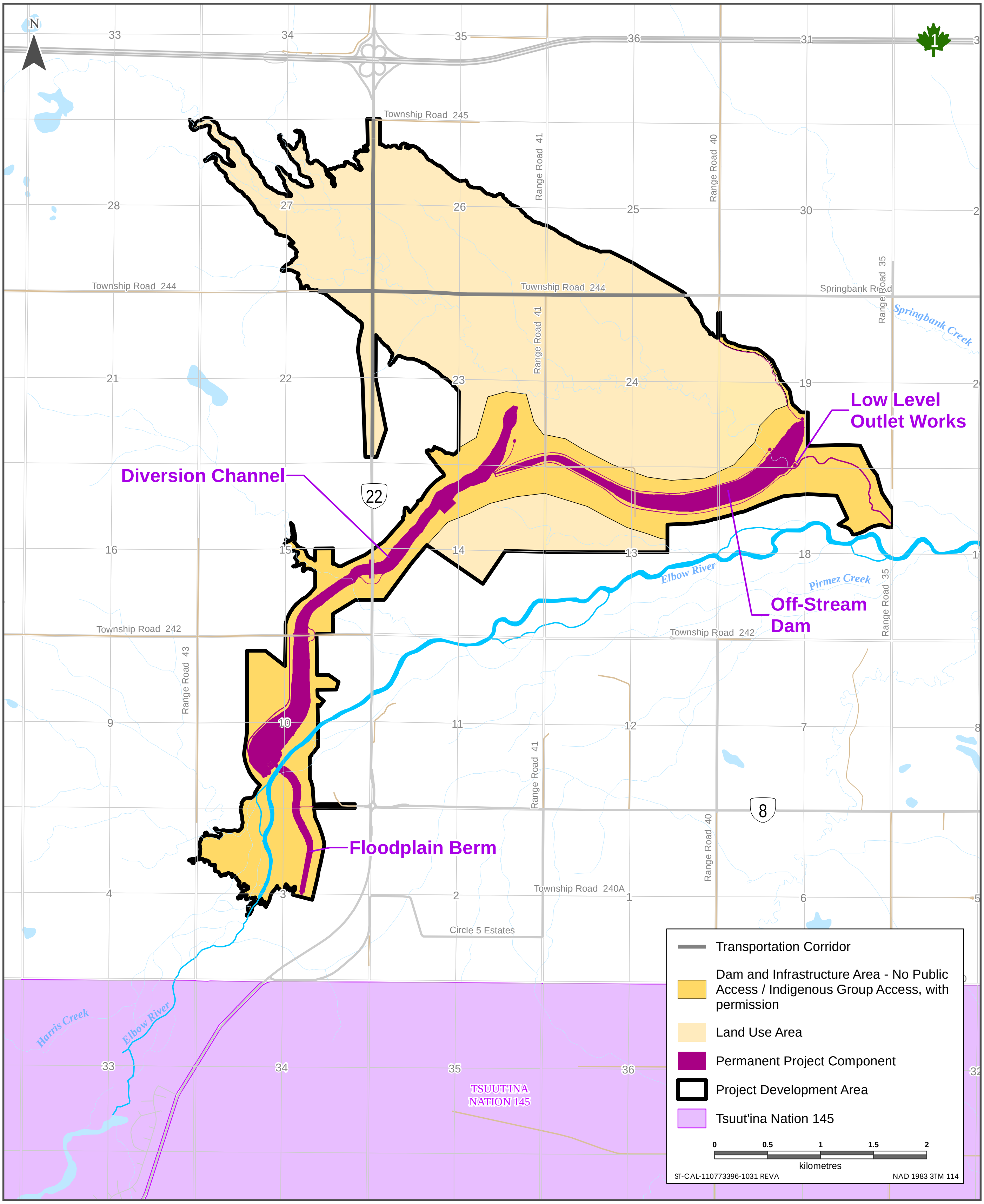
AEP Operations will be in communication with the City of Calgary Glenmore Dam operators in advance of and during the flood season each year. The need for flood operations will be determined through this communication, which will be informed by forecasted and measured flows on Elbow River at the diversion structure and upstream. AEP Operations staff, in communication with the City of Calgary Glenmore Dam operators, will decide when to open the diversion gates to commence partial diversion of flood water into the off-stream reservoir.

4.2.4 Post-Flood Operations

During post-flood operations, the diversion inlet gates are closed, and the service spillway gates are open (lowered to the riverbed). The gates of the low-level outlet structure will be opened to allow the floodwater retained in the reservoir to drain through the structure into the unnamed creek and then into Elbow River. The structure gates at the base of the reservoir will remain open after the reservoir has drained.

4.3 PREFERRED END LAND USE

Since filing the EIA, a draft post-construction land use document for the Project has been created. This document provides the draft principles of future land use for the Project, which was developed through the engagement process and includes feedback received by Indigenous Groups and stakeholders. The principles apply to the land use area (LUA) outlined in yellow in Figure 4-1. The primary use of all lands within the Project development area (PDA), including the LUA, is for flood mitigation. In light of the primary use, the safety of any person with access or land users will be an overriding factor.



Sources: Base Data - Government of Canada. Thematic Data - Government of Alberta

Land Use Area within the PDA

Stantec

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT

Figure 4-1

5.0 AIR QUALITY OVERVIEW

The following provide a summary of baseline air quality conditions and potential Project effects. See the EIA, Volume 3A, Section 3 for further detail. That section of the EIA provides baseline conditions for four aspects of the existing atmospheric environment: climate and meteorology, existing ambient air quality (including odour), existing light, and greenhouse gas emissions.

5.1 BASELINE CONDITIONS

Multiple information sources were used to characterize baseline conditions for air quality (also called background air quality) for six CACs, dustfall, eight volatile organic compounds (VOC), two polycyclic aromatic hydrocarbon species (PAH), and four metals. Details regarding the selected sites for background data from these information sources are provided in EIA, Volume 4, Appendix E.

Due to proximity of farms and ranch yards and nearby roads, a particulate matter (PM) monitoring program was conducted for $PM_{2.5}$, TSP, and dustfall. This 10-week monitoring program was conducted during dry summer months to coincide with the worst-case conditions for PM generation from activities that are common for a rural farm location. These measurements were combined with published ambient air quality data from regional air quality monitoring stations with longer records. For this assessment, some ambient air quality data were obtained from several stations in the National Air Pollution Surveillance (NAPS) ambient air quality monitoring network. Other data were obtained from the Western Interprovincial Scientific Studies Association (WISSA) monitoring program, or from scientific literature.

Baseline concentrations for the substances of interest are shown in Table 5-1. The identification of the monitoring stations and information sources for these baseline measurements are provided in EIA, Volume 4, Appendix E, Attachment 3D.

Table 5-1 Baseline Air Quality

Substance	Averaging Period	Background Concentrations (µg/m³)	AAAQO/AAAQG (µg/m³)	Comparison of Background to AAAQO/AAAQG (%)
CAC Gas				
NO_2	1-hour	9.59	300	3.2
	Annual	3.77	45	8.4
SO_2	1-hour	5.24	450	1.2
	24-hour	4.95	125	4.0
	30 day	3.08	30	10.3
	Annual	2.49	20	12.5
CO	1-hour	344	15,000	2.3
	8-hour	344	6,000	5.7
Particulate				
$PM_{2.5}$	1-hour	11.0	80	13.8
	24-hour	11.0	29	37.9
	Annual	3.50	-	-
TSP	24-hour	51.0	100	51.0
	Annual	16.2	60	27.0
Dustfall	30-day	17.7	53	33.4
VOC				
Acetaldehyde	1-hour	3.38	90	3.8
Acrolein	1-hour	0.29	4.5	6.4
	24-hour	0.048	0.40	12.0
Benzene	1-hour	0.81	30	2.7
	Annual	0.32	3	10.7
Ethyl Benzene	1-hour	0.19	2000	0.01
Formaldehyde	1-hour	9.9	65	15
Toluene	1-hour	1.0	1880	0.053
	24-hour	1.0	400	0.25
Xylenes	1-hour	0.22	2300	0.010
	24-hour	0.22	700	0.031
Styrene	1-hour	0.011	215	0.0051

Table 5-1 Baseline Air Quality

Substance	Averaging Period	Background Concentrations (µg/m³)	AAAQO/AAAQG (µg/m³)	Comparison of Background to AAAQO/AAAQG (%)
PAH				
Benzo(a)pyrene	Annual	0.000022	0.0003	7.3
Naphthalene	Annual	0.052	3	1.7
Metal				
Arsenic	1-hour	0.00050	0.1	0.50
	Annual	0.00016	0.01	1.60
Chromium	1-hour	0.00060	1	0.060
Manganese	1-hour	0.0045	2	0.23
	Annual	0.002	0.2	1.0
Nickel	1-hour	0.00036	6	0.0060
	Annual	0.00017	0.05	0.34

NOTES:
See EIA, Volume 4, Appendix E, Attachment 3D for details regarding the selection of the indicated background values.
- No data available

5.2 POTENTIAL PROJECT EFFECTS

The Project phases that have interactions with air quality are construction, dry operations, and post-flood operations.

5.2.1 Construction

The components and activities that may interact with air quality during construction are:

- clearing
- channel excavation
- water diversion construction
- dam and berm construction
- low-level outlet works construction
- road construction
- bridge construction
- borrow extraction
- reclamation

Atmospheric emissions during construction result from construction vehicle exhausts and from fugitive dust associated with construction activities. The magnitude of these emissions is directly related to the intensity of construction activity. The off-stream dam and berm construction, and the raising of Highway 22 (road construction) involve movement of the most material and, hence, these two activities are associated with the largest emissions during the construction phase. Smaller emissions are associated with other activities such as clearing, channel excavation, water diversion construction, low-level outlet construction, and bridge construction.

Laydown areas and reclamation are very minor sources of emissions. Laydown areas are designated areas for the receipt and storage of Project equipment and materials required for construction. These laydown areas would be prepared prior to the main construction activity period. Construction reclamation activities include reclaiming the laydown areas, temporary construction roads, and the borrow pit. These reclamation activities would occur after the main construction activity period. Since these activities do not overlap with the main construction period and, because they are also very small compared to other activities, they are not included explicitly in the assessment. In addition, emissions associated with on-highway vehicles transporting equipment and materials to the Project site are not included in the assessment since the associated emissions occur off site.

The ambient air quality assessment in the EIA and Alberta Transportation's response to Round 1 CEAA Package 3 IR3-35 addresses three cases: Base Case defined by existing emissions in the LAA, Project Case that considers only Project emissions, and Application Case that considers the combined effects of the Base Case and the Project Case. Background contributions (from emission sources outside the LAA) are considered for the Base Case and the Application Case. The Project Case provides an explicit indication of the Project's contribution.

The conclusion with respect to change in air quality is that the main sources of air emissions due to the construction are vehicle exhaust and fugitive PM. Because these emissions result from ground-based sources, the greatest air quality changes due to these emissions occur inside and near the PDA, decreasing to Base Case levels with increasing distance from the PDA.

The main finding is that predicted NO_2, TSP and $PM_{2.5}$ concentrations are greater than the regulatory criteria outside the PDA. In the Base Case, the highest predicted concentrations for all time averaging intervals occur on and near highways. This is consistent with motor vehicles being the highest emitter of both oxides of nitrogen and fugitive emissions of PM. In the Project Case, the highest concentrations occur along the PDA boundary in proximity to the busiest haul roads. For the Application Case, the highest concentrations occur along the PDA boundary in proximity to the busiest haul roads and along highways.

The highest predicted concentrations in the Project Case and Application Case all occur within a few hundred metres of the PDA. As such, they occur within or very near to the "exclusion zone" of modelled haul roads where predicted concentrations might not be valid because they are within the horizontal dimension of the volume sources (EIA, Volume 3A, Section 3.4.5.2). These high predicted concentrations should be considered conservative.

The air quality assessment uses emission algorithms developed by the United States Environmental Protection Agency (US EPA) to estimate fugitive dust emissions. There is substantial uncertainty associated with estimating fugitive dust emissions, which results in uncertainties in the associated ambient TSP and $PM_{2.5}$ concentration and dustfall deposition predictions. The assessment indicates a need for ambient monitoring during construction to confirm if the adopted dust control mitigation is adequate.

5.2.2 Dry Operations

During dry operations, associated activities would be limited to periodic inspections and routine maintenance. There are few interactions of the dry operations with air quality. These are discussed briefly in EIA, Volume 3A, Section 3.3.2.

5.2.3 Flood Operations

There are no interactions of the Project flood operations with air quality.

5.2.4 Post-Flood Operations

During release of impounded water from the off-stream reservoir back into Elbow River, sediment deposited into the off-stream reservoir will be exposed to the air and dried. During high winds, the surface of the dried sediment could be exposed to wind erosion. This interaction could lead to fugitive dust emissions and impacts on air quality under some meteorological conditions.

The effects of post-flood operations on air quality are examined in detail in EIA, Volume 4, Appendix E.

The ambient air quality assessment addresses three cases: Base Case defined by existing emissions in the LAA, Project Case that considers only Project emissions from a 1:100 year flood and a design flood (approximately 1:200 year). The Application Case considers the combined effects of the Base Case and the two Project Case scenarios. Background contributions (from emission sources outside the LAA) are considered for the Base Case and the Application Case. The Project Case provides an explicit indication of the Project's contribution.

The conclusions with respect to change in air quality from post-flood operations are, because these emissions originate at ground level, the greatest air quality changes due to these emissions occur inside and near the PDA, decreasing to Base Case levels with increasing distance from the PDA.

For both scenarios, predicted TSP concentrations for the Base, Project, and Application Cases are greater than the regulatory criteria outside the PDA; however predicted $PM_{2.5}$ concentrations are less than the regulatory criteria outside the PDA. For TSP, the highest predicted concentrations associated with the Project are found on and near the east PDA boundary.

The potential source of fugitive dust during post-flood operations is wind erosion of deposited sediments in the reservoir after they dry out, and when strong wind conditions occur. Given the expected low occurrence of floods that would result in substantial sediment deposition, it is expected that fugitive dust emissions during post-flood operations will not have a material adverse effect on air quality.

6.0 MITIGATION

Alberta Transportation will implement mitigation measures prior to the initiation of any ground disturbance activities. Mitigation will be continued during construction and post-flood operations.

6.1 CONSTRUCTION

Mitigation measures will be implemented to manage and reduce emissions during construction. The following mitigation options will be planned for the management of combustion emissions (i.e., construction vehicles) during the construction phase:

- To accommodate construction activities that may result in traffic line-ups, public traffic flows on Highway 22 will be maintained at all times, which may include short periods of time when flow is reduced to one-way traffic. Idling will be limited to the extent possible.
- The discharge of atmospheric contaminants from construction operations will be in accordance with regulatory requirements.
- Project construction vehicles will be required to meet current emission control standards.
- Engines and exhaust systems will be properly maintained. Equipment, including construction equipment, that shows excessive emissions of exhaust gases will not be operated until corrective repairs or adjustments are made.
- The concentration of sulphur in diesel fuel will not exceed 15 mg/kg.
- Construction vehicle idling times will be reduced to the extent possible in order to reduce emissions, as a best management practice.
- Cold starts will be limited to the extent possible to reduce emissions, as a best management practice.

The following mitigation measures are planned for the management of fugitive dust emissions during the construction phase:

- Dust generating construction activities will be suspended during periods of excessive winds when dust suppression measures are not working adequately.
- During dry periods, water will be applied to haul roads and/or disturbed areas to mitigate dust emissions. The application of water will be limited to non-freezing temperatures to prevent icing that can present a safety hazard. Watering is most effective immediately after application, and repeated watering several times a day may be required, depending on surface and meteorological conditions.

- Chemical dust suppressants will be applied to haul roads as an alternative option to watering. While chemical dust suppressants can be more effective at controlling fugitive dust than watering, they are also more expensive. Therefore, chemical dust suppression will be applied on an as-needed basis during high wind conditions or if PM concentrations are in exceedance of the Alberta Ambient Air Quality Objectives (AAAQO) and if an increase of watering is determined ineffective or unfeasible at the time. Examples of suppressants include chlorides, petroleum products, liquid polymer emulsions, and agglomerating chemicals. These suppressants, if required, will be applied, as per the manufacturer's recommendations, to preclude unintended environmental effects.
- If trackout and carryout of soils occurs, road cleaning will be conducted by manually picking up and sweeping material or by using rotary or vacuum street cleaning vehicles.
- Disturbed surfaces will be revegetated promptly following construction to prevent wind erosion and to control dust.
- Surfaces of temporary soil and overburden stockpiles will be stabilized during extended periods between usage, by means of vegetating or covering the exposed surfaces.
- Silt fences and other erosion control methods such as mulching and application of tackifiers will be used to prevent soil loss from soil stockpiles due to wind erosion.

6.2 DRY OPERATIONS

During dry operations (periods between floods), associated activities would be limited to periodic inspections and routine maintenance. There are few interactions of the Project dry operations with air quality, meaning mitigation measures are likely not necessary.

6.3 FLOOD OPERATIONS

There are no interactions of the Project flood operations with air quality; mitigation measures are not necessary.

6.4 POST-FLOOD OPERATIONS

A primary mitigation for dust emissions from wind erosion in the off-stream reservoir would be the re-establishment of vegetation cover (e.g., native grasses) after reservoir drainage. Natural revegetation success in the short term, however, is not assured, given initial high moisture contents and reduced energy input in the autumn. In the long term, it is assumed that revegetation would effectively eliminate the potential for windblown emissions when the vegetation is fully developed.

In the short term, when natural revegetation could be ineffective, a tackifier would be applied where required. Tackifiers are a sprayable erosion control product that bonds with the soil surface and creates a porous and absorbent erosion resistant blanket that can last for up to 12 months.

Reapplication of the chemical stabilizer at defined periods is necessary to maintain high control efficiency. The dilution ratio, chemical application rate and time between reapplications of a chemical stabilizer can be adjusted to achieve and maintain high levels of fugitive dust control. Frequent reapplication of a chemical stabilizer can maintain a control efficiency of 90%, even over a three-month summer period, with one initial application and one reapplication of typical latex based chemical stabilizers.

7.0 MONITORING

Monitoring will be implemented to maintain the quality of the air and, by extension, protect potentially sensitive receptors (e.g., human, wildlife, vegetation, soils or waterbodies). Monitoring will also determine the effectiveness of mitigation measures.

7.1 CONSTRUCTION

7.1.1 TSP and $PM_{2.5}$ Monitoring Near Project

The proposed air quality monitoring program is designed to meet expected provincial and federal monitoring and reporting conditions in the anticipated EPEA approval and to provide information on effectiveness of Project mitigation measures. Monitoring will be conducted according to the AEP Air Monitoring Directive (AMD) (AEP 2016). The rationale for monitoring and the parameters to be measured are described below.

For the Application Case (construction), the highest concentrations of $PM_{2.5}$ occur along the PDA boundary in proximity to the busiest haul roads and along highways. Air quality monitoring for $PM_{2.5}$ at these locations will facilitate the timely application of additional mitigation measures for fugitive dust should excessive $PM_{2.5}$ levels be measured. Haul roads and areas of major earthworks will also be subject to daily visual inspections of active areas (diversion structure, diversion channel, dam, low level outlet).

Alberta Transportation commits to measuring TSP and $PM_{2.5}$ at three monitoring locations. Monitoring for PM_{10} is not proposed because there are no AAAQO or Canadian Ambient Air Quality Standards (CAAQS) for PM_{10} and the proposed monitoring for TSP and $PM_{2.5}$ provides sufficient information to ensure the effectiveness of Project mitigation and evaluate potential effects on air quality. During construction, between the diversion channel and the dam, there will be 24-hour continuous wind and air quality monitoring for TSP and $PM_{2.5}$ at Station 1 and Station 2 along the haul road and at Station 3 near the borrow source area. These station locations are discussed further in the response to Round 2 AEP Question 111, Figure 111-1 (provided here as Figure 7-1).

Therefore, anticipated parameters for monitoring during construction are:

- TSP, continuous
- $PM_{2.5}$, continuous
- meteorology for wind speed, wind direction, temperature and other variables

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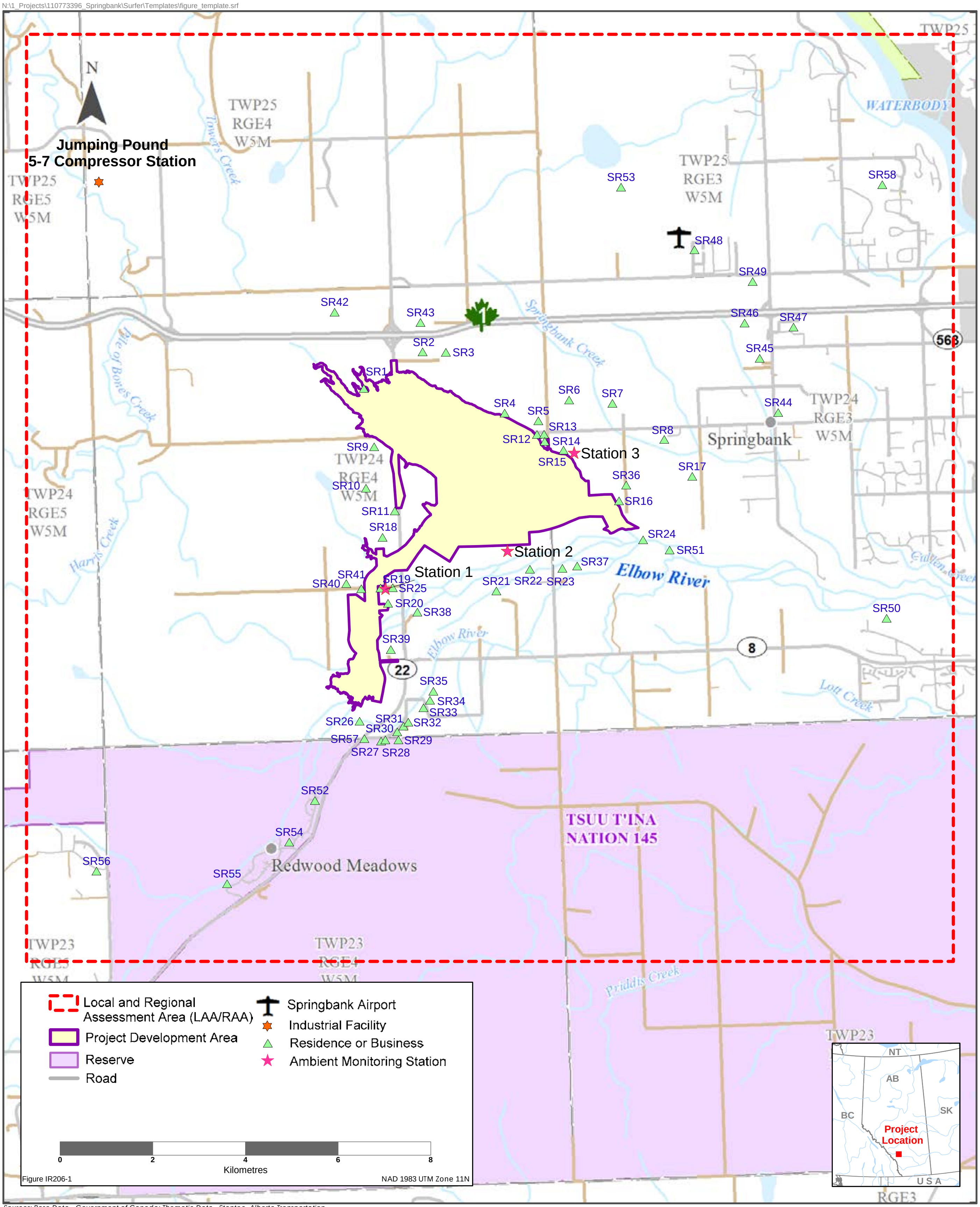

Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Updated Preliminary Locations of Ambient Monitoring Stations during Construction

While $PM_{2.5}$ is the substance of concern with respect to human health, TSP is a necessary accompaniment. $PM_{2.5}$ is mostly fine and ultra-fine material (less than 1 micron in aerodynamic diameter) and is mostly a by-product of combustion processes (e.g., biomass smoke, motor vehicle exhaust). Fugitive dust is mostly coarse material (greater that 10 microns in aerodynamic diameter) and is largely crustal in origin (e.g., pulverized rock, silts, clays). TSP monitoring results will provide a more direct indication of effects and effectiveness of dust control mitigations associated with fugitive dust.

The ratio of $PM_{2.5}$/TSP is a good diagnostic indicator of whether the source of $PM_{2.5}$ is fugitive dust or combustion-related (e.g., internal combustion exhaust, forest fire smoke). A low $PM_{2.5}$/TSP ratio (e.g., less than approximately 0.3) indicates more dust than combustion byproduct, and a high ratio (e.g., more than approximately 0.8) indicates more combustion byproducts than dust. Fugitive dust settles quickly and, thus, its effects are often localized. $PM_{2.5}$ settles slowly and can be transported greater distances. TSP is also a good indicator of nuisance dust effects, including soiling and visibility impairment. Measuring both TSP and $PM_{2.5}$ allows the determination of whether construction is indeed the source of $PM_{2.5}$ and, if so, that mitigation is targeting the appropriate activity.

Beta-attenuation monitors (EBAM) are suitable candidates for $PM_{2.5}$ and TSP monitoring. These are the same instruments used to measure baseline air quality (EIA, Volume 4, Appendix E, Attachment 3D). This allows for flexibility of deployment in proximity to sensitive receptors or areas of major earthworks. Power from the grid will be a requirement to run instruments. The EBAM monitor draws ambient air through a glass fiber filter tape; PM present in the ambient air is deposited onto the filter tape. The design of the "size selective" inlet allows particulate matter of the appropriate size range (TSP or $PM_{2.5}$) to pass through the unit, while removing larger particles. The loaded filter tape is then passed between a beta radiation source and detector. Beta particles (electrons) pass through the tape, but some are impeded (attenuated) by the accumulated PM. With proper calibration, the difference between a measured beta count value and the previous value is used to calculate the mass of particulate accumulated on the tape during the sampling interval. The mass of collected particulate and the flow rate are used to calculate the particulate concentration in the sampled ambient air.

The EBAMs will be set up to include onboard data logging capability and cellular modems for real-time telemetry. These data will be logged both locally and remotely on a server. This system will be capable of sending automatic alerts to staff when air concentrations exceed designated alert levels. These alerts can come in the form of emails or SMS text message and notify staff that action is required. These automatic alerts can be customized for any desired trigger level and location.

Triggers for $PM_{2.5}$ and TSP are based on the Alberta Ambient Air Quality Guidelines (AAAQG) and AAAQO:

- $PM_{2.5}$ 1-hour, first highest 80 µg/m^3
- $PM_{2.5}$ 24-hour, first highest 29 µg/m^3
- TSP 24-hour, first highest 100 µg/m^3

If measured TSP or $PM_{2.5}$ concentrations exceed the AAAQG or AAAQO, a sequence of specific actions will be triggered. The first step is to determine whether measurement error exists (i.e., confirm that the measurements are valid). If exceedances of the AAAQG or AAAQO are verified, then Alberta Transportation will investigate to determine possible causes of elevated particulate matter concentrations and determine the appropriate adaptive mitigation. Recent construction activities will be reviewed to determine which activities may have contributed to measured TSP and $PM_{2.5}$ concentrations. Records of dust control measures implemented on site will be maintained on daily basis and air quality results will be provided to Alberta Transportation within 12 hours of each work shift. Other non-Project causes will also be investigated to determine if there are unusual activities within the region that could be contributing, such as wildfire smoke, long-range transport of pollutants, or emissions from other nearby sources such as agricultural activities.

If the ambient monitoring program indicates that the ground-level $PM_{2.5}$ and TSP concentrations are greater than the AAAQO and that they are associated with the Project, additional mitigation to reduce dust emissions will be implemented. This mitigation may include increased watering of access roads, the spraying of surfactants, stabilizing soil stockpiles, silt fencing or the suspension of construction activity at the site. Water will be applied to haul roads and disturbed areas for mitigating dust emissions. Watering could be repeated several times a day during dry periods with periods of excessive winds when dust suppression measures may not work adequately.

7.1.2 $PM_{2.5}$ and NO_2 Monitoring to Evaluate Public and Community Exposure

Air quality monitoring for $PM_{2.5}$ and NO_2 is proposed to evaluate public and community exposure relative to both the AAAQO and the CAAQS at a monitoring location representative of area residences and nearby communities in the Project area.

The Application Case (construction) has the highest concentrations of NO_2 occurring along the PDA boundary close to the busiest haul roads and along highways. The most recent guidance from the Canadian Council of Ministers of the Environment (CCME) states “CAAQS were not developed as facility level regulatory standards. Rather, they are used by provinces and territories to guide air zone management actions intended to reduce ambient concentrations below the CAAQS and prevent CAAQS exceedances” (CCME 2019).

The CAAQS are not appropriate criterion to determine regulatory compliance or manage potential effects on air quality of a specific industrial Project and are not intended to apply along or adjacent to the boundary of the Project. CCME guidance on siting monitoring stations to evaluate and determine achievement of the CAAQS is clear that stations are to be located in areas representative of a broader geographical region. Monitoring locations to evaluate the CAAQS are intended to be located where people live and not located in areas unduly influenced by a nearby emission source.

Another consideration in using the CAAQS as triggers to adapt mitigation in the short-term is that, due to the complex statistical form of the CAAQS, an exceedance cannot be determined until three consecutive years of valid measurement have been collected. The 1-hr NO_2 CAAQS requires the average of the eighth highest daily 1-hour maximum value be determined for each year, then averaged over three consecutive years. The 24-hr $PM_{2.5}$ CAAQS requires that the eighth highest 24-hour average value be determined for each year, then averaged over three consecutive years. An individual one-hour or 24-hour measurement greater than the CAAQS does not equate to an exceedance of the CAAQS.

With respect to evaluating $PM_{2.5}$ and NO_2 concentrations relative to the CAAQS, monitoring is proposed at a location consistent with the CCME (2012) siting guidance document on CAAQS achievement determination. Consistent with the above guidance, a single continuous monitoring station to measure both NO_2 and $PM_{2.5}$ concentrations, which will be compared against the CAAQS, is proposed at a monitoring location that is representative of both nearby residential receptors as well as the nearby communities in the Project area.

A potentially suitable location for this monitoring station would be in Springbank, approximately 4.5 km east of Station 3, in a residential area, not near a highway nor immediately adjacent to the Project. The final monitoring station location would be determined in consultation with regulatory agencies and stakeholders. The proposed parameters to monitor air quality relative to the CAAQS are:

- NO_2, continuous
- $PM_{2.5}$, continuous
- meteorology for wind speed, wind direction, temperature and other variables

Both NO_2 and $PM_{2.5}$ are substances of concern with respect to human health. Measuring both allows for adequate monitoring of Project effects where people live. Meteorological measurements (e.g., wind speed, wind direction, temperature) are a necessary accompaniment. In conjunction with the concentration of NO_2 and $PM_{2.5}$, meteorology can indicate a source region and, with other information, a probable cause of an air quality event.

Meteorological information from this station can serve the same function for the $PM_{2.5}$ and TSP measured in proximity to sensitive receptors or areas of major earthworks: to determine the probable causes of events and identify the sources responsible for the event.

The most suitable platform for NO_2 and $PM_{2.5}$ monitoring is a fully enclosed heated trailer deployed to a fixed location for the duration of construction. Power from the grid will be a requirement to run instruments. Onboard data logging capability and cellular modem for real-time telemetry is required.

These data will be logged locally, and remotely on a server. This system will be capable of sending automatic alerts to staff when air concentrations exceed designated alert levels. These alerts can come in the form of emails or SMS text message and notify staff that action is required. These automatic alerts can be customized for any desired trigger level and location.

Measured pollutant concentrations will be evaluated against the AAAQO to trigger investigation, potential adaptive mitigation and reporting. Measured pollutant concentrations will also be compared to the 2020 CAAQS to evaluate potential effects on air quality however are not directly linked to adaptive mitigation. Triggers for NO_2 and $PM_{2.5}$ which will require investigation to determine the potential cause of elevated concentration measurement, adaptive management and reporting. The triggers are based on the AAAQO:

- NO_2 1-hour, first highest 300 µg/m^3
- $PM_{2.5}$ 1-hour, first highest 80 µg/m^3
- $PM_{2.5}$ 24-hour, first highest 29 µg/m^3

If measured NO_2 or $PM_{2.5}$ concentrations exceed the AAAQO, a sequence of actions will be triggered. The first step is to determine whether measurement error exists (i.e. confirm that the measurements are valid). If exceedances of the AAAQO are verified, then Alberta Transportation will investigate to determine possible causes of elevated NO_2 or $PM_{2.5}$ concentrations and determine the appropriate adaptive mitigation as necessary. For example, recent construction activities will be reviewed to determine what activities may have contributed to measured concentrations. Other non-Project causes will also be investigated to determine if there are unusual activities within the region that could be contributing such as wildfire smoke, long-range transport of pollutants, or emissions from other nearby sources such as agricultural activities.

The 2020 CAAQS for NO_2 and $PM_{2.5}$ will be employed to assess ambient data for comparison against the CAAQS:

- NO_2 1-hour, 98% D1HM, 3-year average 113 µg/m^3
- NO_2 Annual, 1-year average 32 µg/m^3
- $PM_{2.5}$ 24-hour, 98th percentile, 3-year average 27 µg/m^3
- $PM_{2.5}$ Annual, 3-year average 8.8 µg/m^3

Measured concentrations of $PM_{2.5}$ and NO_2 at the continuous monitoring station will be reviewed monthly to evaluate potential effects of Project construction on air quality. If individual 1-hour NO_2 or 24-hour $PM_{2.5}$ concentrations are measured at concentrations greater than the CAAQS (i.e., the absolute numeric value), measured concentrations will be investigated to confirm whether measurement error exists; determine if the Project is substantially contributing to the measured concentrations; whether measured concentrations are likely associated with other potential sources; and whether there is a trend in increasing NO_2 or $PM_{2.5}$ concentrations. At the end of each year of construction, NO_2 and $PM_{2.5}$ concentration measurements will be analyzed to determine trends in pollutant concentration relative to the CAAQS. If measured NO_2 or $PM_{2.5}$ concentrations are trending towards a potential exceedance of the CAAQS, Alberta Transportation will investigate to determine possible causes of elevated NO_2 or $PM_{2.5}$ concentrations and determine the appropriate adaptive mitigation as necessary.

7.2 POST-FLOOD OPERATIONS

7.2.1 TSP and $PM_{2.5}$ Monitoring

The Application Case (post-flood operations) has the highest concentrations of TSP and $PM_{2.5}$ associated with windblown silt occurring on and near the east PDA boundary. If a flood occurs that results in substantial deposition of sediment within the reservoir, once water is released and sediment begins to dry, ambient monitoring may be deployed to monitor potential effects associated with windblown sediment. Whether it is necessary to employ monitoring will be determined in consultation with stakeholders and regulatory agencies and will depend on the quantity, location and moisture of deposited sediment, time of year and whether mitigation to limit erosion has been applied.

If monitoring is required, monitoring for TSP and $PM_{2.5}$ at a location near the east PDA boundary would facilitate the timely application of additional mitigation measures for fugitive dust if excessive TSP or $PM_{2.5}$ levels be measured. Anticipated parameters to monitor fugitive dust from post-flood operations are:

- TSP, continuous
- $PM_{2.5}$, continuous
- meteorology for wind speed, wind direction, temperature and other variables

These data will be utilized to assist in determining the need for, or effectiveness of, mitigative actions following a flood where there is substantial sediment deposited into the off-stream reservoir.

While $PM_{2.5}$ is the substance of concern with respect to human health, TSP is a necessary accompaniment. $PM_{2.5}$ is mostly fine and ultra-fine material (less than 1 micron in aerodynamic diameter). Fugitive dust is mostly coarse material (greater that 10 microns in aerodynamic diameter). The ratio of $PM_{2.5}$/TSP is a good diagnostic indicator of whether if the source of $PM_{2.5}$ is fugitive dust (i.e., windblown sediment) or combustion-related (e.g., internal combustion exhaust, forest fire smoke). Measuring both allows staff to determine if the post-flood operations is indeed the source of $PM_{2.5}$ being measured, and if so, that mitigation is targeting the appropriate activity.

Triggers for $PM_{2.5}$ and TSP are based on the AAAQO:

- $PM_{2.5}$ 1-hour, first highest 80 μg/m^3
- $PM_{2.5}$ 24-hour, first highest 29 μg/m^3
- TSP 24-hour, first highest 100 μg/m^3

8.0 ADAPTIVE MANAGEMENT

Applying adaptive management in the context of this Plan involves a review of the effectiveness of the program to maintain the quality of the air and, by extension, protect potentially sensitive receptors (e.g., human, wildlife, vegetation, soils or waterbodies). Adaptation involves changing assumptions plus management and mitigations in response to new or different information obtained through monitoring.

Assumptions about the effects of various construction and other activities on air quality will be tested, as will be a series of actions based on triggers designed to achieve a desired outcome. Monitoring data will be reviewed to determine if management actions, mitigations, and trigger levels are appropriate. A minimum of one year of data is required to account for seasonal changes in prevailing wind direction and dispersion meteorology.

Alberta Transportation will update this AQMP as the Project progresses to keep it current. Keeping it up to date will be the responsibility of the Alberta Transportation Environment Manager or their designate. A scheduled review will be undertaken at least annually. The ambient monitoring and visual inspection programs will also be reviewed if it is determined the current methods are not effective in indicating or predicting the occurrences of air quality events. This AQMP will be updated to reflect any improvements that are identified.

Should any deficiencies be found during the scheduled reviews, an updated AQMP will be issued and outdated copies will be collected for archive.

9.0 REFERENCES

AEP (Alberta Environment and Parks). 2016. Air Monitoring Directive. Available from http://aep.alberta.ca/air/legislation/air-monitoring-directive/

CCME (Canadian Council of Ministers of the Environment). 2012. Guidance Document on Achievement Determination Canadian Ambient Air Quality Standards for Fine Particulate Matter and Ozone, Canadian Council of Ministers of the Environment, 2019. PN 1483, ISBN 978-1-896997-91-9 PDF

CCME. 2019. Guidance Document on Air Zone Management, Canadian Council of Ministers of the Environment, 2019. PN 1593, ISBN 978-1-77202-050-2 PDFCheminfo 2005. Cheminfo Services Inc. 2005. Best Practices for the Reduction of Air Emissions from Construction and Demolition