Fish and Fish Habitat – Springbank Off-Stream Reservoir Project

Prepared for:

The SR1 Concerned Landowner Group

Prepared by:

Allan Locke, P.Biol., RPBio

February 2021

Table of Contents

Executive Summary

Alberta Transportation is planning to build an off-stream reservoir project on the Elbow River to prevent or reduce flooding in the City of Calgary. The project will consist of a diversion structure on the Elbow River, a diversion canal, a reservoir, and a water return system back to the Elbow River. Understanding how aquatic ecosystems function, let alone modeling how the various aquatic components will respond to the proposed project, and then managing them for intended outcomes necessarily incurs a relatively high degree of uncertainty. The level of effort conducted by the Proponent adequately addresses much of the inherent uncertainty in understanding the impact to fish and fish habitat. This report provides a summary of a technical review of the scientific and technical data, assumptions, and methods used by the Proponent in their assessment to evaluate impacts to fish and fish habitat. Recommendations for further analysis and investigation of alternative designs are presented for consideration to reduce the impact to fish and fish habitat.

1.0 Introduction

Alberta Transportation (the Proponent) is proposing to develop the Springbank Off-Stream Reservoir Project (SR1; the Project) located approximately 15 kilometres west of Calgary, Alberta. The Project will be situated in a floodplain on the north side of the Elbow River. During high flow periods, when flows in the Elbow River exceed 160 cubic metres per second (cms), flows in excess of 160 cms up to approximately 600 cms will be diverted and stored in the reservoir before being released back into the Elbow River. The purpose of the Project is to prevent and reduce flood damage to downstream public infrastructure and private property.

The Project triggers a federal Canadian Environmental Assessment under the *Canadian Environmental Assessment Act* (Government of Canada 2012) and a provincial Alberta Environmental Impact Assessment under the *Environmental Protection and Enhancement Act* (Province of Alberta 2014). In order to comply with the legislation, and in recognition the Project will affect fish and fish habitat in the Elbow River, the Proponent reviewed relevant information and carried out several assessments to evaluate the potential for impact on the fisheries.

On behalf of the SR1 Concerned Landowner Group (the SCLG), the Proponent's Environmental Impact Assessment reports and subsequent Supplementary Information reports related to fish and fish habitat were reviewed. From this review it was determined the Proponent describes in sufficient detail the methods and analyses undertaken to assess the impact to fish and fish habitat.

For the fish and fish habitat components, the reports:

- described the existing and available information that was used to address spatial and temporal coverage,
- described the use of data and models, and
- suggested steps forward following the completion and acceptance of the reports.

The work undertaken as outlined in the Proponent's EIA reports is essential to understand complex aquatic ecological systems and to manage uncertainty in context of a unique water management project. Overall, the level of effort conducted for this Project adequately addresses much of the inherent uncertainty in the field of aquatic ecology. The reports also appropriately acknowledge the uncertainty typical for these types of studies.

2.0 Fish and Fish Habitat

2.1 Background

In 2016 the Proponent assessed fish and fish habitat by conducting a desktop review of historic fish and fish habitat data of the Elbow River and tributaries within the Local Assessment Area (LAA) using the Alberta Environment and Parks' (AEP) online Fisheries and Wildlife Management Information System (FWMIS) database. Additionally, relevant fish and fish habitat studies that have been carried out in the Elbow River basin and elsewhere were also reviewed. The Proponent has also collected site-specific fish and fish habitat data within the LAA and Project Development Area (PDA).

In 2018, an Aquatic Ecology Technical Data Report was prepared by the Proponent in support of an Environmental Impact Assessment for the Project. The spatial domain that was investigated is defined as the Local Assessment Area which is based on the Project area boundaries, drainage basin characteristics, and aquatic resources in the Elbow River and tributaries that may be affected by the Project (see Figure 2-1; Stantec 2018a). This consists of the section of the Elbow River from Elbow Falls at the west edge of the Project area downstream to the inlet of the Glenmore Reservoir.

As stated by Stantec (2018a), the objectives of the fish and fish habitat assessment were to:

- *Document the fish community in the LAA*
- *Characterize the biophysical and water quality conditions of 12 reaches of the Elbow River and two unnamed tributaries to the Elbow River; and*
- *Determine fish habitat in 12 reaches of the Elbow River and two unnamed tributaries to the Elbow River.*

Subsequent to this work, the Proponent collected additional field data providing more site-specific fish and fish habitat data. They state for example, a spawning survey *"…for brook trout and brown trout was completed during late November and early December 2019, over approximately 25 km of continuous habitat on Elbow River (i.e., from approximately 2 km upstream of the diversion inlet to the downstream extent of Elbow Springs Golf Course)"* During the fall 2019 spawning survey, 118 brown trout redds were identified (Alberta Transportation 2020a).

In addition to the above work, the Proponent also determined the status of all known fish species in the LAA through a search of Species at Risk databases, including:

- *Species at Risk Public Registry*
- *Committee on the Status of Endangered Wildlife in Canada (COSEWIC)*
- *General Status of Alberta Wild Species*

Species listed under the Alberta *Wildlife Act* (Province of Alberta 2017) and the federal *Species at Risk Act* (Government of Canada 2019) are afforded legislative protection. At the time of the search, of the 19 documented fish species found in the LAA, there are two species of management concern, bull trout (*Salvelinus confluentus*) and westslope cutthroat trout (*Oncorhynchus clarkii lewisi*). Both bull trout and westslope cutthroat trout are listed as *Threatened* under the Wildlife Act (Alberta), and *Threatened* under *COSEWIC*.

With respect to westslope cutthroat trout, the Proponent states that it, *"…is unlikely that there are pure westslope cutthroat trout within the LAA downstream of Bragg Creek…because the closest known population of genetically pure westslope cutthroat trout is in Prairie Creek (i.e., approximately 25km upstream of the LAA) and critical habitat extends into the Elbow River at the confluence. Another population of pure westslope cutthroat trout exists in Silvester Creek, a tributary of the Elbow River that is upstream of the Prairie Creek confluence"* (Stantec 2018a). Given all the evidence presented this is a reasonable assumption.

Bull trout are found throughout the Elbow River from the Elbow Falls downstream to the Glenmore Reservoir. The Proponent noted that, *"Bull trout are not expected to spawn in the portion of the Elbow River that is in the PDA or downstream of the PDA; however, they may migrate upstream through the PDA to upstream spawning locations and downstream after spawning, but this is not confirmed*" (Alberta Transportation 2019a). Work done by Popowich and Eisler (2008) shows the closer to Elbow Falls, the more bull trout spawning redds. Popowich and Paul (2006) show known spawning habitat in the area of Elbow Falls and show bull trout in the fall of 2004 being downstream of the PDA. The report also shows that bull trout are found throughout the year in the Elbow River from Elbow Falls downstream of the PDA with the majority of radio-tracked fish being upstream of the PDA. Reasons for bull trout selecting the area near the Elbow Falls for spawning is likely due to upwelling of groundwater and smaller sized gravel.

There are 19 species of resident fish in the Elbow River between Elbow Falls and the Glenmore Reservoir. As stated by the Proponent, *"Resident fish can move freely in Elbow River in the LAA and upstream to Elbow Falls, a distance of approximately 60 km. Barriers to fish movement do not exist within Elbow River between the falls and the downstream extent of the LAA at Glenmore Reservoir; therefore, resident fish species can potentially be found anywhere within this reach"* (Alberta Transportation 2020a). Of note, bull trout, a species listed as *Threatened* under the provincial Wildlife Act and federal Species at Risk Act, uses this reach to complete all aspects of its life history.

The EIA report, and specifically the request for Supplemental Information Reports are thorough and address required fish, fish habitat and aquatic ecosystem technical data collection and analysis for projects of this nature.

3.0 Project Impacts to Fish and Fish Habitat

This review of the Proponent's assessment on potential impacts of the Project to fish and fish habitat was done by separating the information into the following categories:

- Fish Passage at the Diversion Structure
- Fish Entrainment into the Diversion Canal
- Fish Rescue, and
- Return of Water back into the Elbow River

3.1 Fish Passage at the Diversion Structure

There are no barriers to fish movement within the Elbow River between the Elbow River Falls and the inlet to Glenmore Reservoir. The Proponent recognizes that all fish species known to inhabit this reach of the Elbow River can potentially be found anywhere in the LAA. Fish passage was therefore modelled for all fish species and all life stages. Passage was demonstrated with the Project in place during non-flood and post-flood operations for all species and sizes (including non-sportfish) for conditions where passage is possible under existing (baseline) conditions. (Alberta Transportation 2020b).

They carried out a detailed assessment to produce a preliminary design to ensure the passage of all fish from low flows up to the 1 in 3 day delay for the 1:10 year flood event (Alberta Transportation 2019b). They provided the basis for velocities and depths that fish can pass a structure during the 1:10 flow, without a 3 day delay. They also modelled the 3Q10 minimum flow that should provide velocities and depths that are suitable under extreme low flow situations (Stantec 2018a).

The Proponent's fish passage criteria considered the burst and sustained swimming speeds of several fish species of different sizes and life stages (Katopodis and Gervais 2016). As noted by the Proponent, the database presented by Katopodis and Gervais (2016) is the most detailed current fish swimming speed information available to inform fish passage design. In addition to the original approach to modeling fish passage, the Proponent used *A Swim Performance Online Tool* published by DiRocco and Gervais (2020), which prompts species-specific inputs that generate a graphical interpretation of the dataset provided in Katopodis and Gervais (2016). This approach generated the same results as the original modelling approach (Alberta Transportation 2020a).

The Proponent used the average body thickness of fish to derive the minimum design depth selection. A multiplier of 1.5 was then applied to the average body thickness to select the minimum design depth. It is noted the multiplier of 1.5, used in the State of Maine (Maine Department of Transportation (2004), will add a reasonable degree of caution.

Based on their analysis, the Proponent is proposing to design a series of three rock v-weirs downstream of the service spillway to stabilize the existing thalweg and limit step heights to a maximum of 20 cm (Figure 3 and Attachment IR26-1B in; Alberta Transportation 2019c). The weirs will be an extension of Class 2 riprap vanes that will tie into an existing gravel bar and maintain the existing river geometry under normal flow conditions. The structure will be lined with a cobble apron to protect it against erosion and undermining. It is expected that plunge pools will form that will serve as a refuge for migrating fish. The overall intent of the Proponent is to create a design that is hydraulically similar to the existing geometry and profile of the river with the same velocity and depth characteristics as the river upstream and downstream of the diversion structure (Alberta Transportation 2019c).

The proposed structures are effective at providing passage for fish and are far superior to a classic fishway. Overall, the evidence presented by the Proponent demonstrates that fish will be able to move past the structure under all flows conditions up to the 1 in 3 day delay for the 1:10 year flood event.

While the analysis presented is very thorough, it is recommended it would be beneficial to demonstrate the diversion structure is not the limiting factor to fish passage during low flows. While is it appropriate to use the 1 in 3 day delay for the 1:10 year flood for high flows, it is not clear if this criterion applies to fish passage at lows flows. The 3Q10 criterion was used in recognition that should a migration of spawning fish during the spring freshet encounter high flows, they could be delayed for three days below a dam. The criterion was originally used to design Denil and vertical-slot type fish ladders and then culvert bridges (Alberta Transportation and Utilities and Forestry, Lands and Wildlife 1992). For low flows, it should be demonstrated the design of the structure is such that it does not become the critical reach that blocks the movement of all fish of all sizes. Using the 2-D model, it can be determined where the natural critical reach is located in terms of depth and velocities. The final design of the structure should be such that it can be demonstrated the structure itself does not become the critical reach. As was done with the original analysis, using the greatest depth of the largest fish, and applying the same 1.5 multiplier, the 2-D model can be used to show the depths and velocities at the proposed structure do not exceed those of the existing natural critical reach.

3.2 Fish Entrainment into the Diversion Canal

The very nature of the Project means that fish will become entrained. This is the case for any water management structure that diverts water from a river. The Proponent correctly states that fish, and any of their life stages present, would encounter the diversion structure. The Proponent proposes that if 80% of the flow is being diverted, this could result in the entrainment of 80% of the fish that are upstream and near the diversion structure or being swept downstream during flooding (Stantec 2018b). This is a reasonable assumption based on the premise there is a linear relationship between diversion rates into the diversion structure and fish being swept into the diversion channel (Alberta Transportation 2019a). It is necessary to use an assumption given the general lack of science showing the relationship between diversion rates and numbers of fish entrained. The Proponent also states that adult fish can largely deal with high stream flow events and withstand downstream displacement. However, smaller fish are more susceptible to downstream displacement and therefore more smaller fish will be swept into the diversion structure. This is a reasonable statement. As stated by the

Proponent, determination of numbers of fish that will be entrained under any given flow event is very difficult to determine.

The Proponent provided estimates of fish entrainment based on the findings of Post et al. (2006) and fish population estimates in the Elbow River (Alberta Transportation 2020b). For the study done in 2003 on the Bow River at the Bow River Irrigation District (BRID) total entrainment was estimated at 3,996 rainbow trout (*Oncorhynchus mykiss*), 664 brown trout (*Salmo trutta*), and 2,352 mountain whitefish (*Prosopium williamsoni*). Fish larger than 150 mm fork length made up 42.0% of the total number of entrained rainbow trout, 17.0% of entrained brown trout, and 0.5% of entrained mountain whitefish. This represented 1.1, 0.8, and 0.3% of the total mortality observed in these Bow River populations Post et al. (2006).

Based on the work of Post et al. (2006) the Proponent used an entrainment factor of 1% to determine the total number of fish that would be lost from the system (Alberta Transportation 2020b). Using a range of adults in the Elbow River between 4,185 and 5,860, and a total population (including adult, juvenile, fry) that may range from 139,495 and 1,172,000, the number of entrained individuals was calculated to be 42 to 59 adults and 1,395 to 11,720 sub-adults. The information was then combined with a range of 40 to 60% expected mortality rate to determine the mortality. This estimate should be viewed as a conservative, meaning low, estimate of fish entrainment and therefore mortality.

While the work of Post et al. (2006) is the closest example of fish loss to the Project location, caution must be used in applying their information directly. The estimates for percentage loss of adult fish cannot be applied directly to other populations in other rivers and particularly for reaches of smaller length. The estimates of observed natural and fishing mortality are for a population in a specific reach of the Bow River at the observed densities in the river. If a population of interest was distributed over a smaller reach at the same density/km, then the loss of fish would be higher. Also, 2003 appeared to be a low entrainment year for rainbow trout which was 7 - 8 fold higher in 2002 and 2001 according to Trout Unlimited rescue data (Personal Communication, Dr. John Post, Professor, University of Calgary, February 22, 2021).

It is also known that it is a challenge to estimate the loss of fish to irrigation canals in the Bow River and to determine with great precision the numbers of fish that are entrained. For example, in a study conducted in the BRID irrigation canal, an attempt was made to use small mesh nets. However, they proved to be not usable due to floating debris. The second attempt to collect fish was to place chicken-wire fences at bridge abutments. This technique also proved to be problematic as complete seals could not be achieved. Many fish were observed floating in the canal and tangled in aquatic macrophytes. Particularly, numerous young-of-the-year mountain whitefish were observed floating and were too small to be collected in the counting fences, making it very challenging to estimate the total number of fish that were entrained in the irrigation canal (Environmental Management Associates 1983).

Also, in terms of flow, the diversion for the Project is unlike any of the diversions for irrigation headworks in terms of magnitude and duration. It is therefore reasonable to assume there will be differences in entrainment rates. The proportion of the Elbow River flow that is predicted to be diverted during a flood could be for a duration of less than four days. The Proponent suggests the proportion of resident Elbow River fish population entrained during a flooding event will be considerably less than that reported in Post et al. (2006), where the diversion and fish entrainment occurs over several months (Alberta Transportation 2020c). While this is possible, it is also possible there may be more fish entrained in terms of percentage. Given all the uncertainty, it is recommended a similar calculation be done using the Proponent's original estimate of a loss of 80% to better frame the range of possible outcomes.

In addition to the uncertainty in determining entrainment rates, it is equally challenging to conduct fish population estimates in medium sized rivers such as the Elbow River. Several sets of sampling gear will be required to sample the different habitat types, e.g., deep pools, pools, deep runs, runs and riffles. Float or raft electrofishers are required for deep and swift-water habitat while backpack shockers are more suitable in areas that are wadable. In order to fully understand and estimate the impacts of the Project, an assessment of all life stages of fish needs to occur. The Proponent reports that fry, juvenile and adult bull trout relative abundance values collected in the summer of 2020 were low relative to previous values. It is always a challenge when conducting this type of study and as the Proponent states, "*It is unknown if these low capture rates reflect a long-term trend, a temporary fluctuation in the population, or the result of sampling bias"* (Alberta Transportation 2020b). Given these challenges, caution must be exercised when combining the uncertainty of relative abundance and population modeling and multiplying it by the uncertainty of determining entrainment rates.

The Proponent states that, "*…it is expected that fish mortality due to entrainment in the reservoir will not result in a significant adverse effect to fish populations…",* (Alberta Transportation 2020a). This statement should be viewed with caution given the inherent uncertainty of doing these estimates. The estimated population of bull trout in the lower Elbow River being is in the range of 50-250 individuals (Alberta Sustainable Resource Development 2012), and potential impacts to a relatively low bull trout population could be well above the "no significant adverse effect". It is possible there could be "significant adverse impact".

In view of the foregoing, it is recommended the Proponent be prepared to do all that can be reasonably done to keep impact to fish low. It is recommended that effort be put towards doing all that is possible to exclude fish from entering the diversion canal. For instance, during operations just prior to opening the gates and during the time the gates are open, investigate whether using a sound device will move fish away from the structure. This will require looking at similar operations globally and the Proponent should be prepared to conduct research. All possible solutions should be investigated. For annual maintenance, it is recommended the final design of the system include a stop-log facility to isolate the gates so fish can be rescued and put back into the river before the gates are opened and water goes down the canal.

For those times where the flows that are diverted are relatively small, consider installing a fish return system in the canal. It would be portable system in that it would be installed for those flows where it would be efficient to use, and then removed. A fish return system would not be practical at the upper range of design flows for the canal. There are examples of fish return systems in Alberta that are owned and operated by the Government of Alberta.

The last solution is to develop a fish rescue plan which is discussed in the next section.

3.3 Fish Rescue

The operation of the structure will mean fish will be entrained and therefore the fish will need to be rescued and moved back to the Elbow River. As discussed in the previous section, estimating the number of fish that will be entrained during any operational event is very difficult to determine given the uncertainty in entrainment rate and estimating the number of fish in the Elbow River. Given this uncertainty, it is prudent to develop a robust and detailed fish rescue plan. The plan must consider the challenges in trying to capture fish in a reservoir. Also, the Proponent should conduct research into incorporating structural and operational aspects into the final design of the reservoir and outlet structure to assist in fish rescue.

The Proponent has suggested that, *"…water flows in the canal will be gradually reduced and the reservoir slowly drained to facilitate the movement of fish from the reservoir, back to the Elbow River with the receding water. The outlet will be designed and operated in a manner that allows fish egress out of the reservoir, downstream into the outlet channel. Drainage areas within the reservoir will be graded to reduce stranding of fish during release of stored flood water from the reservoir"* (Stantec 2018b). These suggestions are a good step in moving towards a final design to assist in fish rescue.

The Proponent has stated that, *"…Monitoring will be undertaken in the reservoir appropriate for conditions; e.g., use of a drone to identify isolated pools, by crews in shallow draft boats (e.g., airboats, light rafts with oars and jet motor, kayaks), or by crews on foot if the depth and substrate conditions are safe to wade in"* and *"… the low-level outlet canal will also be surveyed to identify isolated pools where fish might be stranded. Monitoring will be undertaken at a frequency that allows for successful fish rescue based on environmental conditions, including ambient air temperature and the rate of the receding water level"* (Stantec 2018c). The Proponent later states that, *"AEP will develop a fish monitoring program to identify isolated pools and other locations where fish may be stranded as water levels decrease in unnamed creek and reservoir. A draft plan is provided in the response to IR302, Appendix 302-1. The fish rescue plan will include the use of teams of fisheries biologists led by qualified aquatic environmental specialists that will be on hand to capture fish as water levels decrease and safely them to Elbow River. Indigenous groups have offered to participate and assist in the fish rescue efforts"* (Alberta Transportation 2019a). Again, this is a good step in developing a detailed fish rescue plan.

The Proponent also outlines the human resources that will be available and activities that will be undertaken for a fish rescue:

- *Monitoring for fish rescue activities will include the following:*

- *During release of water from the off-stream reservoir, isolated pools will be identified and the potential for fish to become stranded will be assessed.*

- *Monitoring in and around the outlet structure will observe if and how fish congregate around the outlet and if conditions permit their movement out of the reservoir. Visual monitoring will also include assessing for potential harm or mortality of fish caused by movement through the outlet.*

- *Water quality in the off-stream reservoir will be monitored using hand held meters to assess water temperature and dissolved oxygen to inform fish capture and handling methods. If conditions in the reservoir become unfavorable (i.e., low oxygen and elevated temperatures), additional fish rescue crews and equipment will be mobilized.*

- *When the water has been fully drained, the unnamed creek will also be surveyed to identify isolated pools where fish might be stranded.*

- *Fish will be handled according to conditions set out in the Fish Research License.*

- *Monitoring will be undertaken at a frequency that allows for successful fish rescue based on environmental conditions, including ambient air temperature and the rate of the receding water level.*

- *Shoreline surveys in Elbow River immediately downstream of the unnamed creek confluence with the Elbow River will be completed periodically to assess if potentially translocated fish show signs of stress or mortality. Adjustments in returning fish to Elbow River will be made, as needed, to mitigate stress to fish (e.g., increase acclimation time).* (Alberta Transportation 2019a)

This is a reasonable plan outline.

It is noted in developing the preliminary fish rescue plan, the Proponent reviewed fish rescues from four other locations as examples of fish rescue efforts that will help inform a fish rescue plan for the Project:

• Little Bow Reservoir (Alberta)

• Lac de Gras (Northwest Territories)

• Third Portage Lake (Nunavut), and

• King Richard Creek Fish (British Columbia) (Alberta Transportation 2020a)

The degree to which fish mortality will occur in the reservoir is not known. The Proponent has suggested, "*…stranding in the reservoir would be expected to cause mortality of fish that did not swim out of the reservoir during post-flood draining; however, this level residual effects for fish mortality was not predicted to not be significant"* (Alberta Transportation 2021). While this may be the case, given the uncertainty around estimating the entrainment of fish, the number of fish in the Elbow River, and the water quality conditions that may possibly develop in the reservoir, mortality could be higher than suggested.

Developing a fish rescue plan for a reservoir as unique as the proposed Project will be extremely challenging. Electrofishing will potentially prove to not be effective. Similarly, seining a relatively large water body will be extremely difficult. It is therefore recommended the Proponent continue to develop a detailed fish rescue plan in collaboration with Provincial and Federal fishery managers and scientists. Additionally, the Proponent should undertake research to determine if there are structural possibilities that can be incorporated into the design of the reservoir and outlet structure to aid in fish rescue operations.

3.4 Release of Water Back to the Elbow River

Once the flood levels in the Elbow River recede, flood water stored in the reservoir will be released back to the Elbow River. Releasing water back into the Elbow River poses potential threats to fish and fish habitat. Suspended sediment, temperature and dissolved oxygen are constituents that must be addressed to ensure there is no harm to fish and fish habitat when reservoir water is released. The Proponent has conducted modeling to demonstrate the degree to which suspended sediment, temperature, dissolved oxygen and other water quality constituents would impact the Elbow River as a result of releasing water from the reservoir. The benchmark used for evaluating the water quality constituents was the Canadian Council of Ministers of the Environment (CCME) surface water quality guidelines found on their web site (Canadian Council of Ministers of the Environment 2018).

The original water release scenarios evaluated for the EIA are known as the "late" release (Alberta Transportation 2018a, 2018b, 2018c, 2018d, 2018e, 2018f, 2018g). Subsequent to these scenarios, the Proponent provided modeling results for releasing water from the reservoir earlier, relative to the "late" release timing described in the EIA (Alberta Environment 2020a, 2020b, 2020d, 2020e). The "early" release modeling was done to explore the possibility of determining if this would improve the quality of the water being released.

Additionally, structural changes to the outlet structure were also made since the original EIA was filed in a similar attempt to improve the quality of the water being released (Alberta Environment 2020a). The Proponent reports, "*These changes have led to a positive change for hydrology, water quality and aquatic ecology. 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"* (Alberta Environment 2020e).

Much was learned from modeling both late and early release scenarios. As noted by the Proponent, there are pros and cons for both the late and early water release scenarios with respect to turbidity, dissolved oxygen, temperature, and other water quality parameters (Alberta Environment 2020a) in regards to meeting CCME guidelines. For example, "*For the 1:10 year flood, early release results in short-term exceedances of water quality guidelines in Elbow River. No exceedances in Elbow River are predicted for late release*" (Alberta Environment 2020a), and "*…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"* (Alberta Environment 2020d).

In a general sense, it intuitively seems it would be better to release water back to the Elbow River as early as possible. The modeling carried out by the Proponent suggests an earlier release time will result in reduced sediment deposition within the reservoir, therefore greater levels of suspended sediment would be released to the Elbow River. However, an earlier release would coincide with greater concentrations of suspended sediment in the Elbow River. Of note is the challenge with meeting CCME sediment guidelines during the last week to several days the reservoir is emptied. The Proponent proposes a reasonable solution would be during the last few days, the discharge can be controlled by reducing the flow rate and, the use of physical sediment barriers (Alberta Environment 2019a). Dissolved oxygen is predicted to decrease over time the longer water is held in the reservoir. For a small flood and large flood event combined with the late release, dissolved oxygen in the Elbow River will decrease over the last few days when the reservoir is emptied. With respect to temperature, the modeling shows that depending on the size of the flood and length of time water is in the reservoir, return flows could cause the temperature in the Elbow River to increase or decrease. Modeling has shown there are changes to water quality parameters in the reservoir, and therefore Elbow River, depending on the size of flood event and the timing of the release of water, particularly during the last few days.

Surface water quality in the Elbow River will be affected by both the filling and draining of the reservoir. The amount of time the water is held in the reservoir will affect sediment, temperature, and dissolved oxygen levels. Given the inherent complexity of the Project as it relates to fish and fish habitat, evaluating late and early release scenarios is prudent. Based on the modeling that has been carried out there still remains the potential for impact to fish and fish habitat. It is recommended modeling be continued to examine all possible flow release scenarios to strive for the best possible design for the Project to reduce impact to fish and fish habitat.

Similar to the suggestion provided by the Proponent to reduce sediment through operation of the low-level gate, having the means to withdrawal water from anywhere in the water column should be investigated. Having a multi-port tower, or similar device, means the release of water can be controlled to take water at one or several locations in the water column at any one time depending on the temperature, dissolved oxygen and sediment levels. This way, water of varying quality can be blended. Similarly, the Proponent should continue evaluating the design of the reservoir and outlet gate to enhance the settling of sediment and the capture of fish.

With the single purpose of the structure being to mitigate flooding, there is not much that could be done with respect to mitigating the change in the rate of the diversion flow. However, for the release of water, the potential effects to fish habitat resulting from changes to the frequency, duration, or magnitude of flows can be mitigated. The late and early release scenarios have shown there are differences with respect to impact to fish and fish habitat which will ultimately lead to trade-offs. The range of possible release scenarios to be evaluated should be expanded beyond a late and early scenario based on concepts of Environmental Flow science. In order to protect the aquatic ecosystem, meaning fish, fish habitat, aquatic invertebrates, water quality, temperature, channel morphology, etc., generally accepted environmental flow guidance should be considered. The "best" case scenario would be to determine if a release that results in no more than a 10% increase of the instantaneous flow in the Elbow River could be achieved. This criterion is considered to have a low probability of detectable impacts to aquatic ecosystems (Department of Fisheries and Oceans 2013) and has been described as providing a high level of ecological protection (Richter et al. 2012). Should this level of flow alteration be determined to not be practical, then continue modeling using a 20% criterion. This criterion is considered to provide a moderate level of ecological protection (Richter et al. 2012). If needed, modeling successive less protective Environmental Flow criterion can continue until such time it is met for a reasonable amount of time. At this point consideration can be given to focus in on those times when the Environmental Flow criterion is not met. Perhaps one Environmental Flow criterion can be used for those times when flows are above bankfull, and another Environmental Flow criterion can be used when flows are below bankfull. Given the potential for impact, and knowing there will be trade-offs amongst water quality parameters, evaluating as wide a range of possible flow release scenarios is warranted.

Given the inherent complexity of this unique project, the uncertainty in possible outcomes, and having to make trade-offs amongst water quality parameters, it is recommended a wide range of flow scenarios be evaluated. These scenarios would build on the late and early scenarios that have already been evaluated. Once all reasonable alternative flow release scenarios have been evaluated, a matrix for all expected flood events, e.g., 1:10, 1:100, and all flow release scenarios can be constructed. It will then be possible to evaluate trade-offs of impact to water quality parameters, and physical changes to the floodplain and the river through a structured decision-making process. When the best possible scenario is determined, then the way to achieve this flow release scenario should then be factored into the final design of the reservoir, dam, and outlet control structure.

3.0 Baseline Data and Monitoring

3.1 Pre-Project Baseline Data

Beginning immediately and before the final design is completed, pre-project baseline fish presence and fish population data should be collected. There currently does not exist any quantitative baseline data for this reach of the Elbow River. It is well known that assessing fish populations in medium sized rivers such as the Elbow River means a variety of sampling gear will be required to collect data. In order to fully understand and estimate the impacts of this project, an assessment of all life stages needs to occur. Conducting fish population estimates is difficult and requires a concerted effort. It is recommended the Proponent work with the fishery managers and scientists in the Provincial and Federal governments to develop a baseline data collection program.

Similarly, the Surface Water Monitoring Plan should continue. It should also be determined if there are ways the Plan should be modified to reduce uncertainty and improve model calibration and validation. This is particularly important for sedimentation.

3.2 Post-Project Monitoring

Given the uncertainty due to the uniqueness of the proposed structure, the possible frequency and magnitude in flood conditions that may occur, the effectiveness of the mitigation measures should be monitored to demonstrate there are no significant adverse effects. With respect to fish passage, the diversion structure should be monitored to demonstrate it is working as intended. This should include measuring flows, depths and velocities, as well as demonstrating that fish are free to move through the structure for any non-flood event flow, and any flow throughout the year.

As discussed previously, rescuing fish from the reservoir will be very difficult even if ideal conditions exist. Monitoring fish stranding should be conducted for the time there is water in the reservoir. Once water recedes in the outlet channel, monitoring should be conducted to ensure fish have not become trapped and can exit to the Elbow River. For all fish monitoring, human safety is of the upmost importance and a thorough and comprehensive safety plan should be developed.

Given the Project will be permitted by the Provincial and Federal Governments, it is assumed a detailed monitoring program for fish and fish habitat will be developed in collaboration with the Provincial and Federal fishery managers and scientists.

4.0 Summary

Alberta Transportation is proposing to build infrastructure on the Elbow River west of the City of Calgary to prevent and reduce flood damage to downstream public infrastructure and private property. The Project has the potential to impact fish and fish habitat. As such, the Proponent reviewed relevant literature and undertook a number of studies to address impact to fish and fish habitat. The Proponent developed preliminary designs for the diversion structure, the reservoir, and the outlet structure. Given feedback received from the Provincial and Federal Regulators, changes were made to the original EIA designs. On behalf of the SR1 Concerned Landowner Group, this report presented a summary of the Proponent's Environmental Impact Assessment reports and subsequent Supplementary Information reports related to fish and fish habitat. From the review it was determined the Proponent describes in sufficient detail the methods and analyses undertaken to assess the impact to fish and fish habitat.

Given the information, it is likely the Project will not cause significant adverse effects on fish and fish habitat. However, with respect to bull trout, given the uncertainty regarding the lack of precise life stage presence, population data, and any unique life history characteristics in this reach of the Elbow River, the uncertainty associated with determining entrainment, and the efficacy of rescuing of fish, it is possible the impact could be greater than is stated by the Proponent. Depending upon the frequency of the operation of the structure, the potential impact could be significant, particularly if two flood events occur within a 10-year period. The number of bull trout in this reach of the Elbow River is relatively small compared to, for example, the Bow River. If a high percentage of fish from a relatively small population is lost from the system, this presents a significant adverse risk.

With respect to going forward, baseline data needs to be collected now to reduce uncertainty and inform the final design for the diversion structure, the reservoir and the outlet structure. This should be done in consultation with the Provincial and Federal fishery managers and scientists. It is certain offsetting measures for the Project to compensate for the loss of fish and fish habitat will occur. Every effort possible should be done to ensure those measures are applied to this reach of the Elbow River.

5.0 Closure

The mitigation recommendations presented in this report were prepared for the exclusive use of the SR1 Concerned Landowner Group. Any use which a third party makes of this report or any reliance on, or decisions to be based on this report, are the responsibility of such third parties. 547426 Alberta Corp. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

6.0 References

Alberta Sustainable Resource Development. 2012. Bull Trout Conservation Management Plan 2012-2017. Alberta Sustainable Resource Development. Species at Risk Conservation Management Plan No. 8. Edmonton, AB, 90 pp.

Alberta Transportation. 2018a. Springbank Off-stream Reservoir Project - Environmental Impact Assessment – Volume 1: Project Description – Prepared by Stantec, March 2018.

Alberta Transportation. 2018b. Springbank Off-stream Reservoir Project - Environmental Impact Assessment – Volume 2: Assessment Approach – Prepared by Stantec, March 2018.

Alberta Transportation. 2018c. Springbank Off-stream Reservoir Project - Environmental Impact Assessment – Volume 3A: Effects Assessment (Construction and Dry Operations) – Prepared by Stantec, March 2018.

Alberta Transportation. 2018d. Springbank Off-stream Reservoir Project - Environmental Impact Assessment – Volume 3B: Effects Assessment (Flood and Post-Flood Operations) Assessment of Potential Effects on Water Quality – Prepared by Stantec, March 2018.

Alberta Transportation. 2018e. Springbank Off-stream Reservoir Project - Environmental Impact Assessment – Volume 3B: Effects Assessment (Flood and Post-Flood Operations) Assessment of Potential Effects on Aquatic Ecology – Prepared by Stantec, March 2018.

Alberta Transportation. 2018f. Springbank Off-stream Reservoir Project - Environmental Impact Assessment – Volume 4: Appendices, Appendix K - Surface Water Quality Report – Prepared by Stantec, March 2018.

Alberta Transportation. 2018g. Springbank Off-stream Reservoir Project - Environmental Impact Assessment – Volume 4: Appendices, Appendix M – Aquatic Ecology – Attachment 8A Fish Passage Analysis - Prepared by Stantec, March 2018.

Alberta Transportation. 2019a. Response to NRCB and AEP Supplemental Information Request 1 - July 28, 2018. Prepared by Stantec, May 2019.

Alberta Transportation. 2019b. Response to CEAA Supplemental Information Request Package 3 - August 31, 2018. Prepared by Stantec, May 2019.

Alberta Transportation. 2019c. Response to CEAA Supplemental Information Request Package 3 – Appendix IR26-1 SR1 Fish Passage Design - August 31, 2018. Prepared by Stantec, May 2019.

Alberta Transportation. 2020a. Response to NRCB and AEP Supplemental Information Request 2 - November 18, 2019. Prepared by Stantec, June 2020.

Alberta Transportation. 2020b. Response to AEP Supplemental Information Request 3 - November 4, 2020. Prepared by Stantec, December 2020.

Alberta Transportation. 2020c. Response to NECB and AEP Supplemental Information Request 2 - November 18, 2019. Prepared by Stantec, April 2020.

Alberta Transportation. 2020d. Response to Impact Assessment Agency of Canada Information Request Package 4 – Technical Review Round 2, March 23, 2020. Prepared by Stantec, June 2020.

Alberta Transportation. 2020e. Springbank Off-stream Reservoir Project. Changes to EIA Conclusions. Prepared by Stantec, June 2020.

Alberta Transportation. 2021. Alberta Transportation Feedback on Draft Potential Conditions.

Alberta Transportation and Utilities and Forestry, Lands and Wildlife. 1992. Fish Habitat Protection Guidelines for Stream Crossings. Alberta Energy/Forestry, Lands and Wildlife. Revised February 1992. Pub. No.: T/263. ISBN: 0-86499-883-X. Edmonton, Alberta. 45 pp

Canadian Council of Ministers of the Environment. 2018. Canadian Environmental Quality Guidelines website. http://ceqg-rcqe.ccme.ca/en/index.html

Department of Fisheries and Oceans. 2013. Framework for Assessing the Ecological Flow Requirements to Support Fisheries in Canada. Fisheries and Oceans Canada. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2013/017.

Di Rocco, R. and R. Gervais. 2020. SPOT: Swim Performance Online Tools. Available from http://www.fishprotectiontools.ca/

Fernet, D.A. 1983. The Effects of Magnacide H Treatment on the Fish Fauna of the Carseland-Bow Canal. Prepared by Environmental Management Associates for Alberta Environment, Planning Division.

Government of Canada. 2012. Canadian Environmental Assessment Act. S.C. 2012, c 19, s. 52 Current to March 28, 2016. Last amended on December, 2014. Department of Justice. Ottawa, Ontario. 70 pp.

Government of Canada. 2019. Species at Risk Act, S.C. 2002, c. 29. Current to August 28, 2019. Department of Justice. Ottawa, Ontario. 106 pp.

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

Maine Department of Transportation Environmental Office. 2004. Fish Passage Policy and Design Guide. Available at: https://www.fs.fed.us/biology/nsaec/fishxing/fplibrary/MDOT_2004_Fish_Passage_Policy_and_Design_Guide.pdf

Popowich, R. and A. Paul. 2006. Seasonal movement patterns and habitat selection of bull trout (*Salvelinus confluentus*) in fluvial environments.

Popowich, R. and G. Eisler. 2008. Fluvial Bull Trout Redd Surveys on the Elbow, Sheep and Highwood Rivers, Alberta. Prepared for: Trout Unlimited Canada. Prepared by: Applied Aquatic Research Ltd.

Post, J., B.van Poorten, T. Rhodes, P. Askey, and A. Paul. 2006. Fish entrainment into irrigation canals: an analytical approach and application to the Bow River, Alberta, Canada. North American Journal of Fisheries Management. 26:875-887

Province of Alberta. 2014. Environmental Protection and Enhancement Act. Revised Statutes of Alberta 2000 Chapter E-12. 158 pp.

Province of Alberta. 2017. Alberta Wildlife Act. Wildlife Regulation 143/1997. With amendments up to and including Alberta Regulation 93/2017. 320 pp.

Richter, B., Davis, M., Apse, C., and C. Konrad. 2012. A presumptive standard for environmental flow protection. River Research and Applications 28: 1312-1321.

Stantec. 2018a. Springbank Off-Stream Reservoir Project – Environmental Impact Assessment. Volume 4: Appendices, Appendix M. Aquatic Ecology. Attachment 8A Fish Passage Analysis and Technical Data Report. March 2018. Prepared for Alberta Transportation.

Stantec. 2018b. Springbank Off-Stream Reservoir Project – Environmental Impact Assessment. Volume 3B: Effects Assessment (Flood and Post-Flood Operations). Prepared for Alberta Transportation March 2018.

Stantec. 2018c. Springbank Off-Stream Reservoir Project – Environmental Impact Assessment. Volume 3C: Effects Assessment (Cumulative Effects, Follow-up and Monitoring). Prepared for Alberta Transportation March 2018.