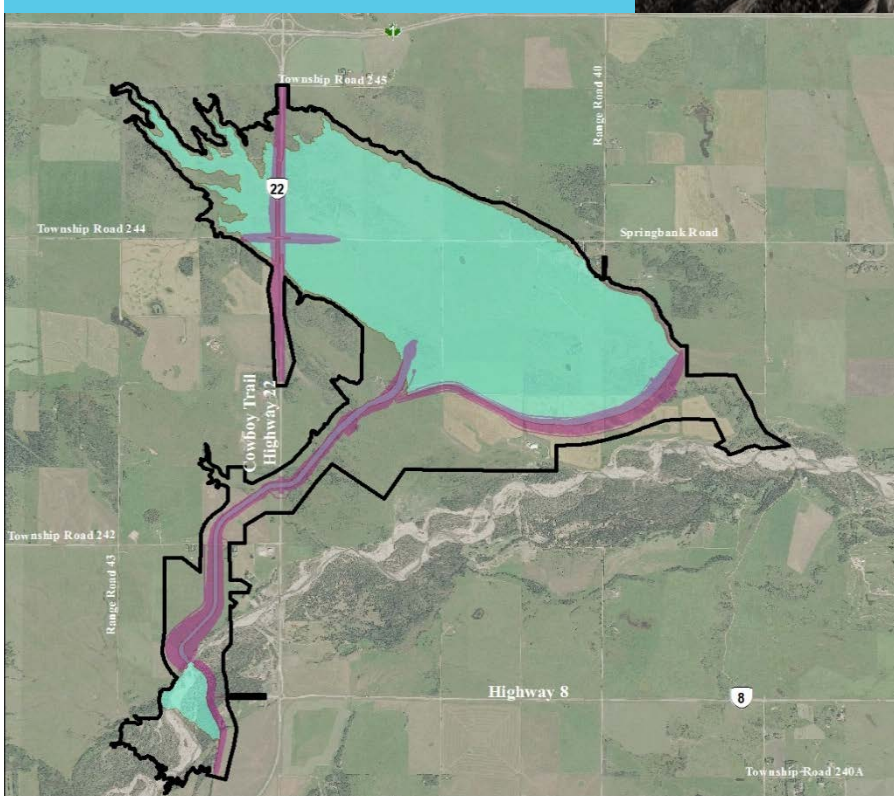
Alberta Transportation Springbank Off-stream Reservoir Project



Response to AEP Supplemental Information Request 3 dated November 4, 2020

December 2020

Alberta Transportation

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1 ACRONYMS

The following acronyms are used in this Supplemental Information Request.

AEP	Alberta Environment and Parks
BSP	Biologically Sensitive Period
EIA	Environmental Impact Assessment
FWMS	Fisheries and Wildlife Management Information System
IR	Information Request
LAA	local assessment area
NRCB	Natural Resources Conservation Board
TDR	technical data report
TOR	Terms of Reference

2 GENERAL

2.1 HYDROGEOLOGY

Question 1

Supplemental Information Request 2, SIR 55, Page 268 - 270

Alberta Transportation states:

c. As stated in the response to a., there is confidence in the conductivity values used for the initial conditions in the numerical model and the calibrated hydraulic conductivity values. However, the model sensitivity analysis presented in the TDR Update, Attachment E does examine the hypothetical effect of increasing the permeability of both the till and bedrock layers within the model. The hydraulic conductivity values for these units were increased by a factor of 1,000 (well beyond the expected range of natural variability of these geologic materials). The sensitivity analysis results suggest that the model simulations are most affected by parameterization of hydraulic conductivity values, and the higher conductivity values lead to further propagation of effects and, in turn, a larger area of effects. However, even when increasing the hydraulic conductivity values of the low conductivity units, the modelled effects remain within the LAA and north of Elbow River.

The above sensitivity analysis used different boundary conditions compared with the Supplemental Information Request 2, SIR 47 and 48. In the TDR Update, Attachment E - the boundary conditions along the diversion channel were wrong according to the statements in Supplemental Information Request 2, SIR 48; and the boundary conditions on top of the reservoir area didn't apply the loading head. As a result the sensitivity analysis results need to be updated.

a. Using the models explained in Figure 47-2, 47-3 and 48-1, update the conductivities so they are similar to those in the TDR Update, Attachment E. Complete the sensitivity analysis.

b. Provide maps similar Figure 47-2, 47-3 and 48-1 for a hydraulic conductivity of 10^{-5}.

c. Analyze the difference of the drawdown cone along the diversion channel. Explain the findings.

d. What percentage of the seepage has changed to the diversion channel?

e. Analyze the difference of the potential artesian area to the east and south-east of the off-stream dam. Explain the results.

f. Does the potential impacted area remain within the LAA? Explain.

g. What is the contingency monitoring and mitigation plan for a hydraulic conductivity of 10-5 should it occur? Explain.

Response

a. The model sensitivity Scenario 1 presented in the Hydrogeology Technical Data Report (TDR) Update (see Alberta Transportation's response to Round 1 Alberta Environment and Parks [AEP] information request [IR] 42, Appendix IR42-1), Attachment E considered an increase in hydraulic conductivity by a factor of 1,000 in the low conductivity till and bedrock layers. The same sensitivity scenario has been rerun for the purpose of this response using the updated version of the numerical model shown in Round 2 AEP Question 47 and Question 48, which includes the application of the conservative loading effect whereby the hydraulic head pressure in the reservoir has been applied directly to the bedrock layer.

   The results of increasing the conductivity by a factor of 1,000 and applying the conservative loading effect are presented in Figure 1-1. Figure 1-1 is an updated version of Figure E.1-1 (presented in Attachment E of the TDR Update), and it depicts the net change in head between PPX1 (the design flood with the Project) and EEX1 (the design flood without the Project).

   The updated sensitivity scenario results in increased lateral extent of the hydraulic head change around the reservoir. Hydraulic head increases are observed up to 800 m from the reservoir in the northeast and southwest directions. Increases are also observed up to 800 m to the southeast toward Elbow River. These updated sensitivity scenario effects are limited to the local assessment area (LAA) and do not extend beyond the edge of the fluvial deposits or beyond Elbow River.

   The model simulations for this sensitivity analysis show that the model is sensitive to the application of the conservative loading effect. However, the modelled effects remain within the LAA and north of Elbow River.

   Note that this simulation is meant as a theoretical exercise (i.e., increasing the hydraulic conductivity by a factor of 1,000 in the low conductivity till and bedrock layers is well above values derived from the field measurements) to explore the model sensitivity; it is not considered to be representative of potential subsurface conditions, based on the hydrostratigraphic framework for the Project.

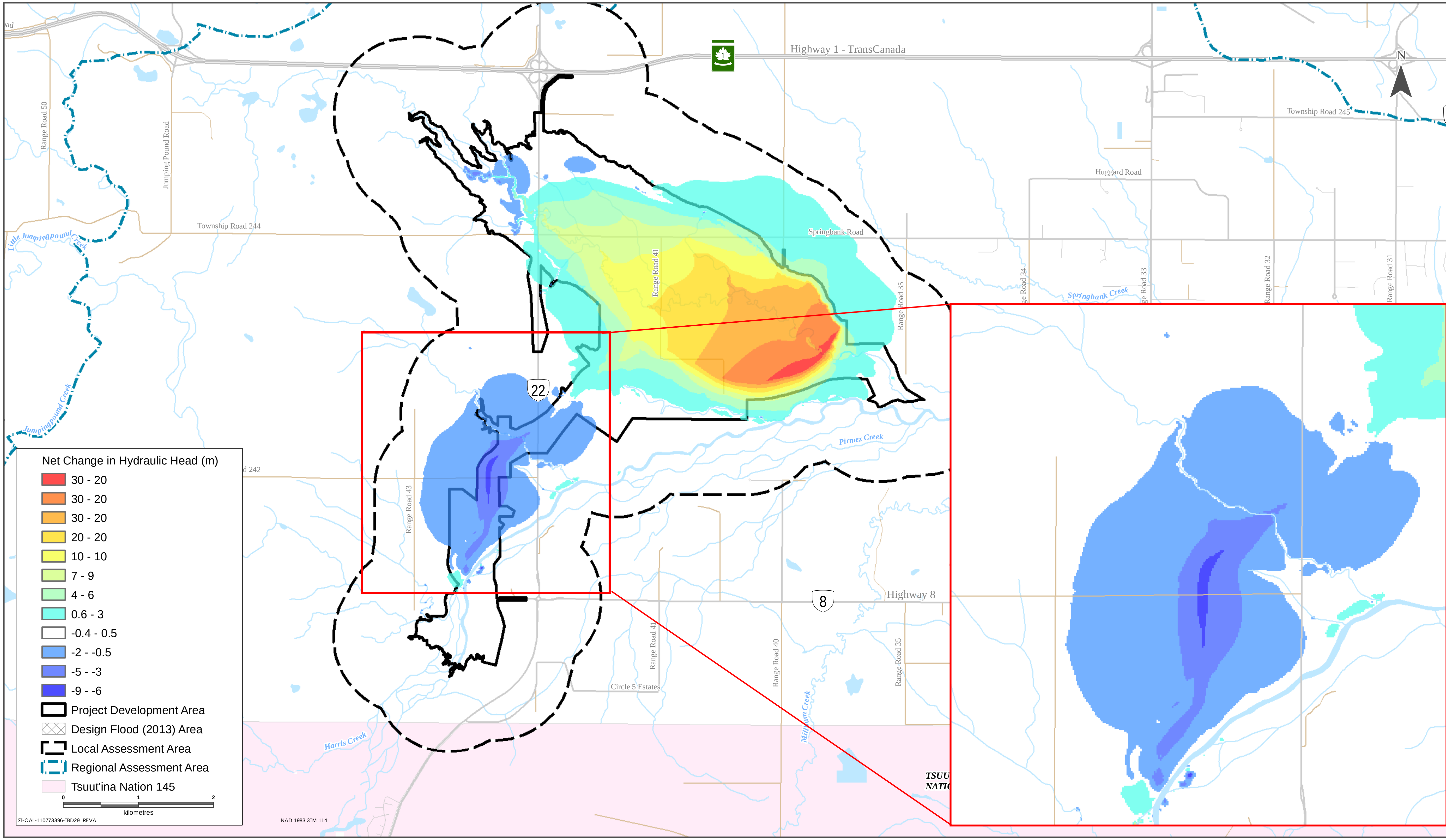
b. Updated versions of Round 2 AEP Question 47, Figures 47-2 and 47-3 are attached as Figures 1-2 and 1-3 and an updated version of Round 2 AEP Question 48, Figure 48-1 is attached as Figure 1-4.

   Figures 1-2 and 1-3 use the latest iteration of the model with the corrected nodes along the diversion channel and the conservative loading heads applied for the PPX1 simulation (the design flood scenario with the Project). This simulation incorporates an increase in the hydraulic conductivity by a factor of 10, for example, from 10^{-6} to 10^{-5} m/s for the upper bedrock, as requested in this IR. As was the case in the response to Round 2 AEP Question 47, the model was also run in steady state mode to represent the most conservative scenario. Under this scenario, water levels within the reservoir and diversion channel are maintained at their maximum elevations indefinitely (i.e., water is diverted into the Project, but it is never released and is continuously replenished), which is not representative of Project operations. These updated figures are discussed in e.

   Figure 1-4 is an updated version of Round 2 AEP Question 48, Figure 48-1 with the higher hydraulic conductivity (for example, from 10^{-6} to 10^{-5} m/s for the upper bedrock) applied to illustrate the sensitivity of the drawdown around the diversion channel in response to changes in hydraulic conductivity. The updated figure is discussed in the responses to c and d.

c. Figure 1-4 presents the sensitivity analysis with the hydraulic conductivity values increased by a factor of 10 as requested in this IR (for example, from 10^{-6} to 10^{-5} m/s for the upper bedrock), to examine the potential differences in the magnitude and extent of drawdown around the channel in the PPX0 scenario (dry diversion channel with average non-flood flow conditions in Elbow River). The steady-state simulation is also used to evaluate the sensitivity of the seepage rate into the diversion channel to changes in hydraulic conductivity.

   Figure 1-5 presents a comparison of the drawdown areas yielded by simulations using the original hydraulic conductivity values, and the sensitivity analysis run with the hydraulic conductivity values increased by a factor of 10. The increased hydraulic conductivity results in a lower maximum drawdown and reduced areal extent of drawdown greater than 1 m. The original simulation presented in Round 2 AEP Question 48, Figure 48-1 indicated a drawdown of up to 9 m immediately adjacent to the diversion channel and a drawdown of up to 1 m extending up to approximately 2.3 km from the diversion channel. By contrast, for this scenario, the drawdown adjacent to the channel is approximately 4 m and a drawdown of up to1 m is observed up to 700 m from the diversion channel.



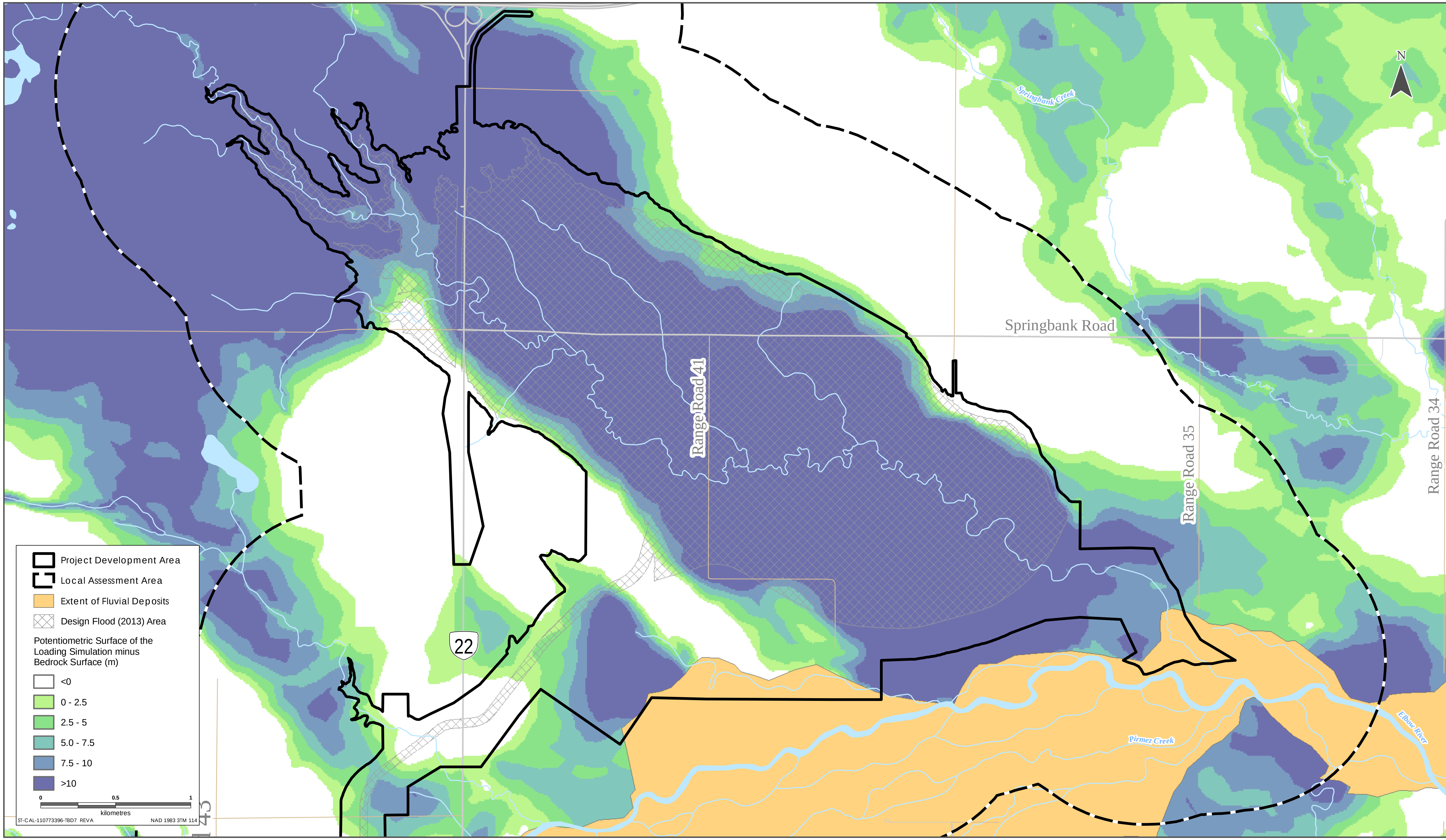
Sources: Base Data - Government of Alberta, Government of Canada. Thematic Data - Stantec Ltd.

Simulated Net Change in Head for the PPX1/EEX1 Sensitivity Scenario 1 at Timestep 650 with Conservative Loading Applied (revised from Round 1 AEP, IR42, Appendix 42-1, Figure E1.1)

Figure 1-1

Stantec

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT



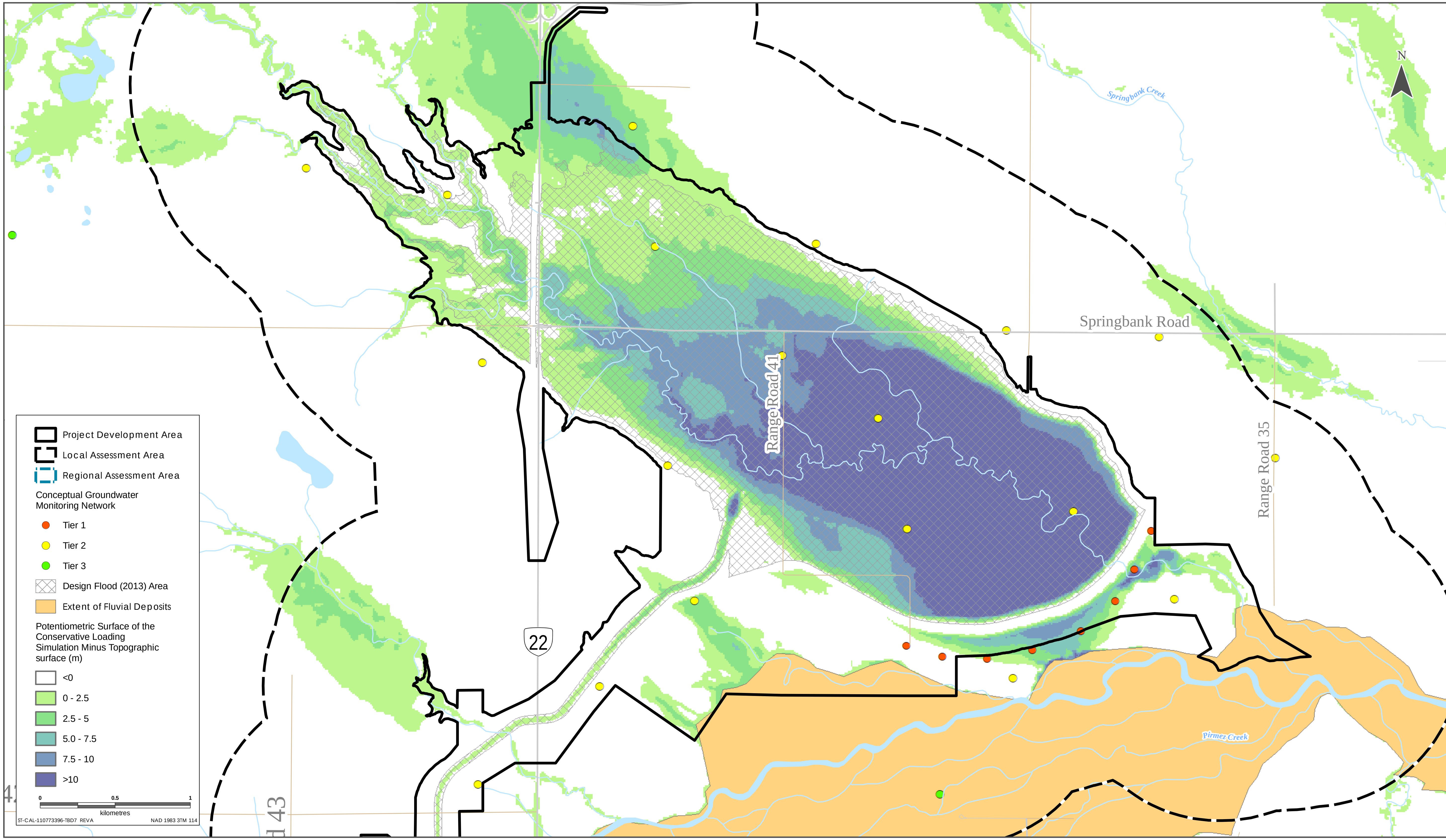
Sources: Base Data - Government of Alberta, Government of Canada. Thematic Data - Stantec Ltd.

Potentiometric Surface of the Conservative Loading Simulation using Conservative Hydraulic Conductivity (x10) minus Bedrock Surface showing Confined Bedrock Aquifer Areas (revised from Round 2 AEP IR 47, Figure 47-2)

Stantec

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT

Figure 1-2



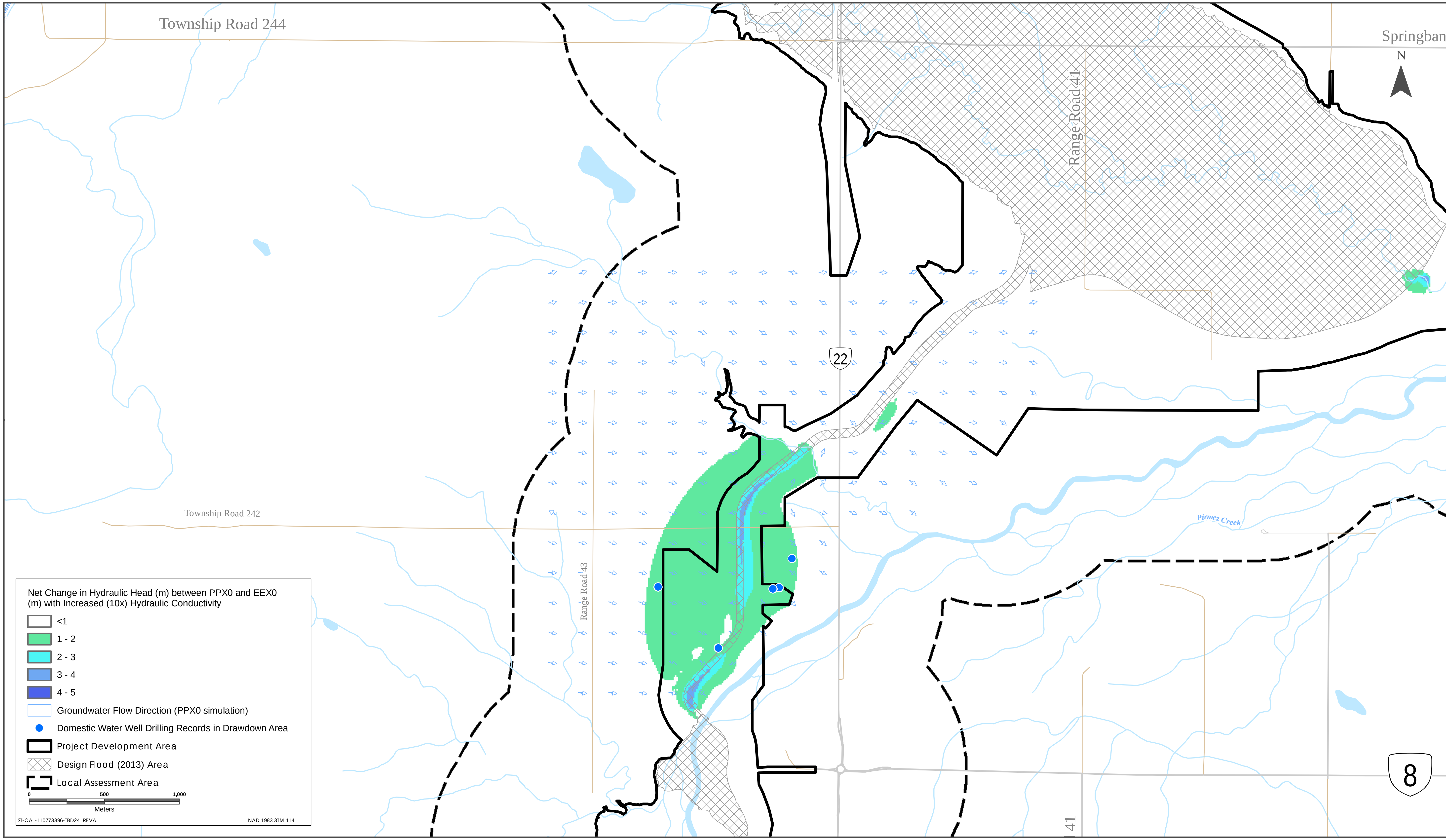
Sources: Base Data- Government of Alberta, Government of Canada. Thematic Data - Stantec Ltd.

Potentiometric Surface of the Conservative Loading Simulation and Conservative (x10) Hydraulic Conductivity minus Topographic Surface (revised from Round 2 AEP IR47, Figure 47-3)

Figure 1-3

Stantec

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT



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

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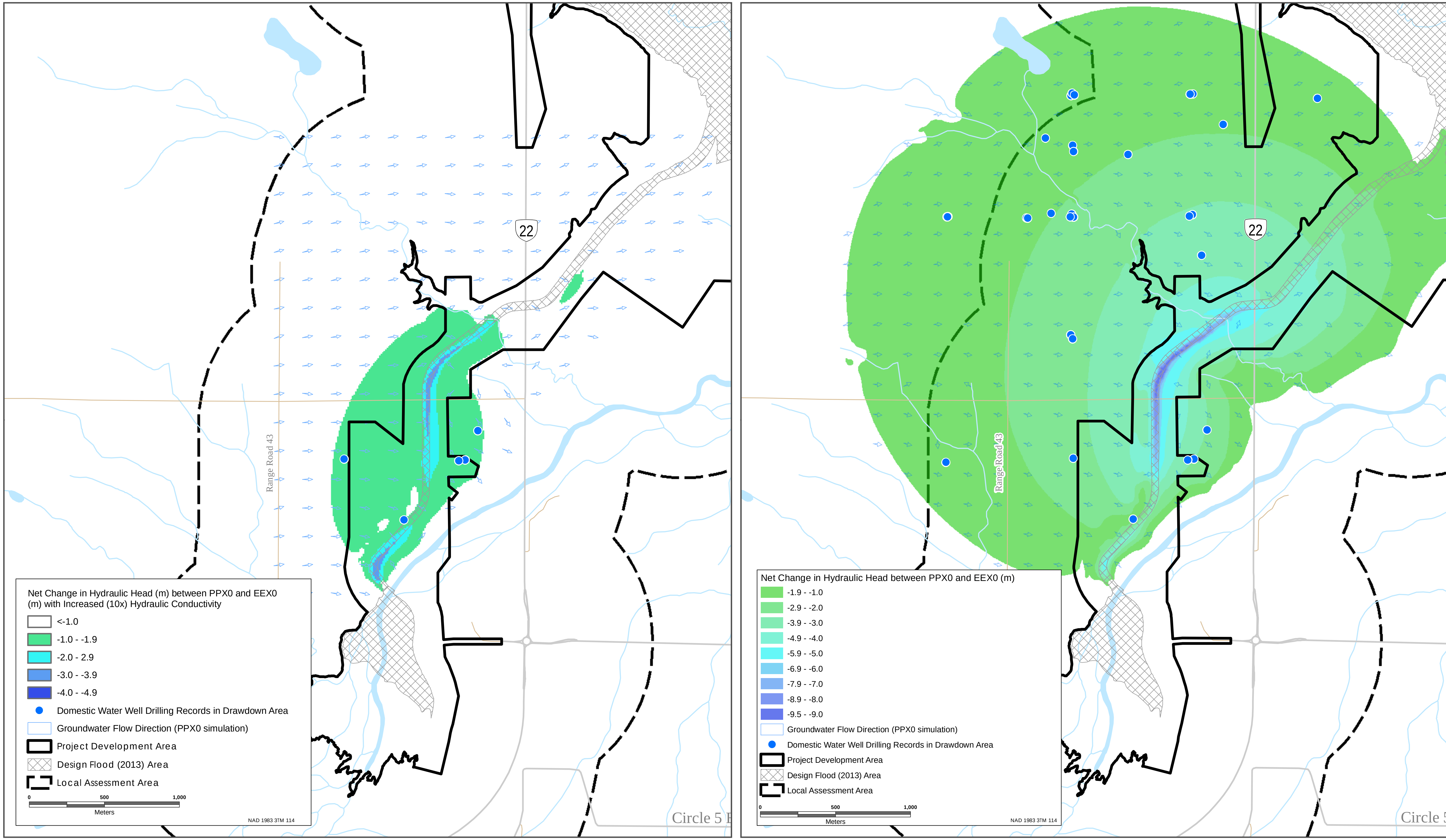
ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT

Simulated Net Change in Head for the PPX0/EEX0 Scenario with Increased (10x) Hydraulic Conductivity (revised from Round 2 AEP IR48, Figure 48-1)

Figure 1-4



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

Simulated Net Change in Head for the PPX0/EEX0 Scenario with Increased (10x) Hydraulic Conductivity
Compared to Original (1x) Hydraulic Conductivity

Figure 1-5

Within the semi-confined conditions of the upper bedrock, the increased hydraulic conductivity results in a smaller cone of depression because the maximum drawdown is reduced and the area required to re-equilibrate fluxes is decreased. The reduction of the magnitude and areal extent of the drawdown reflects in changes to both of the simulations (pre-Project and post-Project) that are used to derive the map of drawdowns. Increasing the hydraulic conductivity values in the upper bedrock results in decreased groundwater elevations for the pre-Project simulation (EEX0) in the area near the diversion channel. A dampened response to dewatering is also noted in the post-Project simulation (PPX0), where the drawdown in the area of influence is 'shallower' than in the previous simulations using the original K values. The combination of decreased heads in the pre-Project simulation with shallower drawdown response in the post-Project simulation result in a drawdown area that is lower in magnitude and smaller in areal extent.

Therefore, steady-state drawdown for the increased hydraulic conductivity scenario remains within the LAA. The domestic wells that could be potentially affected by the drawdown under this scenario are presented in Figure 1-4. However, it is anticipated that wells in this area of the PDA would be decommissioned prior to the dry operation phase of the Project, if baseline and construction phase monitoring of this area confirms that water levels are decreasing to the point where domestic well operation is adversely affected.

d. The previous estimate of the groundwater seepage rate into the channel was 0.026 m^3/s, based on the net flux at nodes within the diversion channel that were extracted from the PPX0 simulation (dry diversion channel with non-flood average flow conditions in Elbow River). This scenario and the increased hydraulic conductivity scenario were rerun using a cloud computing platform, rather than the previous desktop platform. As a result, the model yielded a different result, 0.0038 m^3/s, compared to the previous 0.026 m^3/s for the original hydraulic conductivity scenario. The differences in the results are attributed to differences in the model code version (which was recently updated to address issues with running the model in a cloud computing environment), which resulted in a slightly changed convergence solution for this steady state simulation. As part of the quality assurance process, the external model developer (DHI Group) reviewed the previous modelling and current modelling output files and confirmed these differences are attributed to changes to the SAMG matrix solver subroutine, which can result in slight changes in the convergence solution.

   Using the same model code version as the rerun, and after increasing only the hydraulic conductivity values by a factor of 10, the estimated groundwater seepage rate is 0.021 m^3/s into the diversion channel. This is an increase of 0.0172 m^3/s (relative percent increase of approximately 139%) relative to the estimate derived from the original hydraulic conductivity value (0.0038 m^3/s).

Despite this change in seepage rate (increase of 0.0172 m^3/s) resulting from an increase in the hydraulic conductivity by 10 times, the change in groundwater discharge into Elbow River would not be perceptible in comparison to the mean monthly flows in Elbow River of 3 m^3/s to 4 m^3/s during winter months when flow is the lowest. Further, a portion of the groundwater that is intercepted in the dry diversion channel will eventually return to Elbow River after transiting through the reservoir area and outlet channel and down the unnamed creek.

e. Figures 1-2 and 1-3 present the hydraulic head in bedrock layer 4 of the model for this sensitivity scenario subtracted from the top of bedrock elevation and subtracted from the topographic elevation, respectively.

   Figure 1-2, compared to Round 2 AEP Question 47, Figure 47-2, shows that the model simulation results are very similar when the hydraulic conductivity is increased by a factor of 10. The areas under confined conditions for the two scenarios remains relatively unchanged between the two.

   Figure 1-3, compared to Round 2 AEP Question 47, Figure 47-3, shows an increase in magnitude and area of potential artesian conditions to the southeast of the reservoir toward Elbow River. Other areas of apparent potential artesian conditions are also observed in areas farther from the PDA; however, these areas of artesian conditions are a result of the increased hydraulic head across the model domain and are not attributable to effects from the Project (i.e., with the change in hydraulic conductivity values, increased heads are noted across the model domain in both the pre-Project and post-Project simulations). Figure 1-3 indicates that increasing the hydraulic conductivity does not materially affect the areas of potential artesian conditions and that the effects remain, as before, within the LAA and north of Elbow River

f. Yes, the potential impacted area for artesian effects shown in Figure 1-3 remain within the LAA and north of the Elbow River as indicated in e.

g. Based on the modelled simulation with increased hydraulic conductivity, the current Draft Groundwater Monitoring Plan presented in response to Round 1 Natural Resources Conservation Board (NRCB) IR46, Appendix IR46-1 is appropriately robust and flexible to address the potential effects of flood operations with the increased hydraulic conductivity. Proposed monitoring well locations are situated near areas where artesian conditions may be expected (e.g., southeast of the dam and reservoir area), such that they will be able to detect changes in water levels.

   Through examination of water level changes across the monitoring network during and following flood operations, AEP will confirm the potential areal propagation of pressure effects and will be able to determine whether additional monitoring or mitigation measures need to be implemented outside the LAA. The current distribution of the proposed monitoring network includes areas where increased artesian conditions may occur, even with the increased hydraulic conductivity values.

Based on the results of this simulation, the existing mitigation measures are appropriate because they will enable monitoring of effects in the areas of potential artesian conditions, even in a scenario with increased hydraulic conductivity of the upper bedrock. The Groundwater Monitoring Plan will also identify whether implementation of further mitigation measures is required. Mitigation measures for increased pressures and potential artesian conditions arising from flood operations include:

- Mitigation for potential artesian flowing conditions include turning on well pumps to lower water levels or shutting in the well at the wellhead to control flows to surface.
- Effects related to groundwater discharges to ground surface would be mitigated by controlling the flows through proper conveyance (ditches or piping) and managing resulting water quality issues through implementation of erosion and sediment controls.
- Mitigation for potential basement flooding caused by rising shallow groundwater levels include constructing subsurface drains (e.g., weeping tile systems, interceptor trenches) to collect and control shallow groundwater.

2.2 AQUATICS

Question 2

Supplemental Information Request 2, SIR 68 and SIR 75, Page 329 and 363

Alberta Transportation states in SIR 68 and SIR 75 that field work will to be conducted from July to September 15, 2020 to obtain fish population data. Alberta Transportation also states that the population assessment will be provided to the NRCB and AEP once complete.

a. As required provide the fish population assessment and update SIR 68 and SIR 75 as required to reflect the new information.

Response

a. The results of the fish population assessment are presented in Appendix 2-1 and are discussed in Section 1.0.

   Round 2 AEP Question 68 and Question 75 have been reviewed in consideration of the results discussed in Appendix 2-1.

   Alberta Transportation's response to Round 2 AEP Question 68 presented the following:

   - The response to a. included a reference to desktop-based quantitative population estimates that are provided in Alberta Transportation's response to Round 2 NRCB Question 19. A commitment was made to further characterize fish species composition and abundance of Elbow River fish populations through a field program in summer 2020, which are presented in Appendix 2-1 and further discussed in Section 1.0 in this response. Relevant references are also provided to Alberta Transportation's response to Round 2 NRCB Question 19 where applicable, for completeness.

   Alberta Transportation's response to Round 2 AEP Question 75 presented the following:

   - The response to a. presents a discussion on the determination of significance for fish mortality. The significance for fish mortality does not change because fish mortality is not expected to occur to an extent that results in fish populations that are unable to recover. This is further described in Section 2.2.1 in this response.
   - The response to b. expands on the desktop-based population assessment by providing an estimate of fish mortality in the off-stream reservoir. This estimate has been updated to reflect the revised population estimates from 2020 field data and is presented in Section 2.1 of this response.

- The response to c. contained a reference to the Draft Fish Rescue and Fish Health Monitoring Plan (Round 2 NRCB IR31, Appendix 31-1) and design mitigation for the Project. The monitoring and mitigations discussed remain the same because they are designed based on the attributes of the reservoir; they do not change because updated population estimates do not modify the mitigation and monitoring measures.
- The response to d. contained a reference to the Draft Fish Rescue and Fish Health Monitoring Plan (Round 2 NRCB IR31, Appendix 31-1) and discussion of monitoring commitments. That discussion remains the same because the rescue and fish health plan are based on the attributes of the reservoir; they do not change because updated population estimates do not modify the rescue and fish health plan.

1.0 UPDATED AQUATIC BASELINE INFORMATION

Baseline assessment requirements for the Project are to provide an assessment of species composition, distribution and movement, abundance, habitat use, habitat quality, and life history parameters of fish populations that reside within the LAA, as indicated in the Terms of Reference (TOR). These baseline assessment elements have been documented in the Environmental Impact Assessment (EIA) and subsequent IRs: Volume 3A Section 8; Volume 3B Section 8; Volume 4, Appendix M; response to Round 2 NRCB Question 19; and response to Round 2 AEP Question 68.

The population study conducted in summer 2020 further expands on the following baseline assessment elements from the EIA:

- species composition
- distribution and movement
- abundance

Updates that pertain to the filed baseline information in the EIA and IRs are discussed in the following subsections.

1.1 Species Composition

Round 2 NRCB Question 19 requested information regarding species composition in the LAA; Alberta Transportation's response relied on information presented in the EIA. This information was referenced in response to Round 2 NRCB Question 68. The EIA identifies 19 species of fish that are known to occur in the Elbow River watershed, based on historical data from the Fisheries and Wildlife Management Information System (FWMIS) for years 1978 to 2015, and inventory sampling that was conducted in fall 2016 for the EIA (Volume 4, Appendix M).

Field data obtained from the summer 2020 field program included data for captures and observations of 16 of the 19 species identified in the EIA. It is possible that the remaining three species not captured are present in low numbers (i.e., known to occur in the watershed but limited presence within the local assessment area, which lowers the probability of capture). The information in the EIA as it relates to species composition is still relevant, and the assessment based on the 2020 fieldwork supports, and is consistent with, the original assessment.

1.2 Fish Species Distribution and Movement

Alberta Transportation's response to NRCB Round 2 Question 19 also provided information on fish species distribution and movement (resident fish can move freely in between Elbow Falls and Glenmore Reservoir).

Barriers to fish movement do not exist within Elbow River between the falls and the inlet to Glenmore Reservoir. Fish passage was modelled for all fish species and all life stages and fish in Alberta Transportation's response to Round 2 NRCB Question 21. Passage was demonstrated with 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. Fish species identified in the fish population assessment can potentially be found anywhere in the LAA.

Fieldwork to survey resident fish populations was completed between August 3 and 13, 2020, which is during the biologically sensitive period 2 (BSP; BSP-2 extends from June 16 to September 25) for fish species in Elbow River. Alberta Transportation's response to Round 2 NRCB Question 19 considered fish distribution during each BSP (Table 1-1, updated from the response to Round 2 NRCB Question 19). The information was used to show the proximity of fish species to the Project at different times of the year. The EIA and Round 2 NRCB Question 19 also included a discussion on fish distribution using FWMIS (AEP 2020) data for each BSP. A brief summary of fish distribution by BSP is presented as follows, with an update to BSP-2 that corresponds to the results from the summer 2020 field data.

Data from August 2020 fieldwork related to fish distribution in Elbow River was generally consistent with information presented in the EIA for BSP-2 (June 16 to September 25), with the following exceptions:

- Bull trout were not captured or observed downstream of the Project during BSP-2. Specifically, the distribution of bull trout records during summer 2020 were as follows:
  - two (2) juvenile bull trout were captured in an area between the proposed diversion structure and the low-level outlet locations
  - three (3) juvenile bull trout were captured in Redwood Meadows
  - 188 bull trout (juvenile and adult) observations or captures were recorded between Elbow Falls and Bragg Creek
- Brown trout were captured farther upstream in Elbow River than previously recorded.

Table 1-1 Fish Distribution and Movement of the Elbow River Fish Community at Biologically Significant Periods (Updated from Alberta Transportation's Response to Round 2 NRCB Question 19)

	BSP 1 April 2 to June 15[1]	BSP 2 June 16 to Sept 25[1]	Update to BSP 2 June 16 to Sept 25[2]	BSP 3 Sept 26 to Dec 1[1]	BSP 4 Dec 2 to April 1[1]
Bull trout	From Elbow Falls to the Project area	Distributed throughout the river from Elbow Falls to Discovery Ridge area	Distributed from Elbow Falls to the Project area	In the upper reaches of the river below Elbow Falls	No records
Brown trout	Distributed from near Redwood Meadows to Glenmore Reservoir	Distributed throughout the river except the upper 10 km below the falls	Distributed throughout the river	Distributed throughout the river	One record near Sarcee Bridge
Cutthroat trout	One record just upstream of Glenmore Reservoir	No records	From Elbow Falls to the confluence with Ranger Creek	No records	No records
Cutthroat trout-rainbow trout cross breed	No records	No records	No records	No records	No records
Mountain whitefish	Distributed from near Redwood Meadows to Glenmore Reservoir	Distributed throughout the river except the upper 10 km below the falls	Distributed throughout the river except the upper 8 km below Elbow falls	Distributed throughout the river except the lower reach (approximately 15 km) before Glenmore Reservoir	No records
Brook trout	Distributed from near Redwood Meadows to Glenmore Reservoir	Distributed throughout the river from the falls to Glenmore Reservoir	Distributed throughout the river from the falls to Glenmore Reservoir	Distributed throughout the river	No records

Table 1-1 Fish Distribution and Movement of the Elbow River Fish Community at Biologically Significant Periods (Updated from Alberta Transportation's Response to Round 2 NRCB Question 19)

	BSP 1 April 2 to June 15[1]	BSP 2 June 16 to Sept 25[1]	Update to BSP 2 June 16 to Sept 25[2]	BSP 3 Sept 26 to Dec 1[1]	BSP 4 Dec 2 to April 1[1]
Rainbow trout	Distributed from near Redwood Meadows to Glenmore Reservoir	Distributed throughout the river except the upper 10 km below the falls and the lower reach immediately above Glenmore Reservoir	Distributed from 8 km downstream of Elbow Falls to the Project area	Distributed sporadically throughout the river	No records
Northern pike	No records	Immediately above Glenmore Reservoir	None captured	No records	No records
Burbot	In the Project area	Distributed sporadically between near Redwood Meadows to Glenmore Reservoir	Found between downstream of the Project area and upstream of Discovery Ridge	Distributed sporadically from downstream of the Project site to Glenmore Reservoir	No records

NOTES:

1 Information presented in Alberta Transportation's responses to Round 2 NRCB Question 19, based on FWMIS (AEP 2020)

2 Information based on fieldwork completed in August 2020

1.3 Abundance

Relative abundance (i.e., percentages of each fish species) and absolute abundance (i.e., population size) are estimated in Alberta Transportation's response to Round 2 NRCB Question 19, which was used to inform responses to Round 2 NRCB Question 28 and Round 2 AEP Question 68. Relative abundance is estimated in the EIA (Volume 3B, Section 8.2.2.4) by extrapolating from FWMIS data. Absolute population estimates were derived from data obtained during redd surveys conducted in fall 2019 for brook trout and fall 2019 for brown trout, as well as published redd survey data for bull trout (Popowich and Eisler 2008). Population estimates for other resident species were inferred from the brook trout, brown trout, and bull trout estimates, and based on their relative abundances.

Relative abundance, and fish population abundances are presented in Table 1-2, which includes values presented in response to Round 2 NRCB Question 19 and updated values calculated from 2020 field program results. Alberta Transportation's response to NRCB Question 19 included an estimate of adult populations; this estimate is expanded in the current response to include total population.

Relative abundance values from summer 2020 fieldwork generally align with the values presented in the EIA (Volume 3B, Section 8.2.2.4), with the following difference:

- Large numbers of longnose dace (a forage fish) were captured during the August 2020 fieldwork. Relative abundance for this species was considerably higher in 2020 compared to what was documented in the EIA and in response to Round 2 NRCB Question 19. The implication of this change is that the relative abundances for all other species are proportionately lower in the 2020 results compared to the relative abundances reported in the EIA.
- Brook trout and brown trout are abundant in Elbow River; this is reflected in summer 2020 data as well as in the EIA and response to Round 2 IRs.
- Mountain whitefish and bull trout capture rates were low in summer 2020 fieldwork compared to the abundance values presented in response to Round 2 IRs.

1.4 Baseline Data Discussion

Fish species observations in 2020 included 16 of the 19 species that are known to occur in Elbow River and are aligned with the fish species composition in the EIA (Volume 4, Appendix M, Section 3.1.2, Table 3-1). For the remaining three species, results obtained from summer 2020 related to fish species composition do not change the information related to species composition that is provided in the EIA (Volume 4, Appendix M, Section 3.1.2, Table 3-1) and in Alberta Transportation's response to Round 2 NRCB Question 19; information does not change because the species that have been identified to occur in Elbow River align with known occurrences within the LAA.

Bull trout distribution in BSP-2 (June 16 to September 25) during summer 2020 was predominantly within the upper reaches of Elbow River. Of the 193 total observations, 188 bull trout were recorded between Elbow Falls and Bragg Creek. Three (3) juvenile bull trout were captured in Redwood Meadows, and two (2) bull trout were captured near the Project. No bull trout were recorded downstream of the Project. This distribution presents a change from the response to Round 2 NRCB Question 19, wherein bull trout historical records during BSP-2 included bull trout occurrences between Elbow Falls and the inlet to Glenmore Reservoir.

The absence of bull trout downstream of the Project during the summer 2020 field program could indicate that bull trout movement upstream began in early August and were not present downstream of the Project area when surveyed. It could also indicate that bull trout presence downstream of the Project is limited; only a small group of bull trout have been historically identified in the downstream reaches (Popowich and Paul 2006).

Bull trout relative abundance values from summer 2020 fieldwork were low relative to the values presented in the EIA and Round 2 NRCB Question 19. Field data obtained in 2020 suggest that the adult bull trout population in the LAA is 8 to 11 individuals, and total population (fry, juvenile, adult) in the LAA is 266 to 2,200 individuals. This estimate is lower relative to the abundance presented in response to Round 2 NRCB Question 19, and historical data (Sawatzky 2016). 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.

Table 1-2 Estimates of Relative Abundance and Population Size for Elbow River (adapted from Alberta Transportation's response to Round 2 NRCB Question 19 with New Information from August 2020 Fieldwork)

Common Name	Species	Relative Abundance (percent)[1]	Relative Abundance (percent)[2]	Calculated Relative Abundance[3]	Calculated Relative Abundance[4]	Predicted Adult Population Abundance[5]	Predicted Adult Population Abundance[6]	Predicted Total Population Abundance (Adults, Juvenile, Fry)[7]
longnose sucker	*Catostomus*	2.4	3.05	2.4	3.05	67-94	128-179	4,266 – 35,800
mountain sucker	*Catostomus platyrhynchus*	4	0.16	--	0.16	--	7-9	233 – 1,800
white sucker	*Catostomus commersonii*	0.3	1.84	0.3	1.84	8-12	77-108	2,566 – 21,600
fathead minnow	*Pimephales promelas*	--	--	--	--	--	--	--
lake chub	*Couesius plumbeus*	0.1	0.08	0.1	0.08	3-4	3-5	100 – 1,000
longnose dace	*Rhinichthys cataractae*	7	46.66	7	46.66	195-273	1,955 – 2,738	65,166 – 547,600
pearl dace	*Margariscus margarita*	--	--	--	--	--	--	--
spottail shiner	*Notropis hudsonius*	--	--	--	--	--	--	--
northern pike	*Esox lucius*	--	--	--	--	--	--	--
burbot	*Lota lota*	0.8	0.16	0.8	0.16	11-31	7-9	233 – 1,800
brook stickleback	*Culaea inconstans*	0.1	0.29	0.1	0.29	3-4	12-17	400 – 3,400
yellow perch	*Perca flavescens*	--	--	--	--	--	--	--
trout-perch	*Percopsis omiscomaycus*	--	--	--	--	--	--	--
brook trout	*Salvelinus fontinalis*	16.1	3.5	49	33.69	1,412-1,977	1,412-1,977	47,066 – 395,400
brown trout	*Salmo trutta*	42.8	33.88	16.1	11.26	472-661	472-661	15,733 – 132,200
bull trout	*Salvelinus confluentus*	10.5	7.77	4.2	0.20	64-95	8-11	266 – 2,200
Mountain whitefish	*Prosopium williamsoni*	17.5	1.67	17.5	1.67	487-683	70-98	2,333 – 19,600
rainbow trout	*Oncorhynchus mykiss*	2.4	0.71	2.4	0.71	67-94	30-42	1,000 – 8,400
westslope cutthroat trout	*Oncorhynchus clarkii lewisi*	0.1	0.1	0.1	0.1	3-4	4-6	133 – 1,200
Total							**4,185 – 5,860**	**139,495 – 1,172,000**

NOTES:

-- Dashes indicate fish species known to occur in the Elbow River watershed but were not captured during the field program.

1 Relative abundance values as presented in the EIA Volume 3B Section 8.2.2.4 and in response to Round 2 NRCB Question 19.

2 Relative abundance values are calculated from 2020 fish population surveys.

3 Relative abundances are adjusted for brown trout, bull trout, and brook trout redd survey data obtained in 2019 (Round 2 AEP Question 69, Appendix 69-2 and Appendix 69-3) to estimate adult pairs. All other relative abundance values rely on abundance values presented in the EIA, Volume 3B, Section 8.2.2.4 and in response to Round 2 NRCB Question 19.

4 Relative abundances are adjusted for brown trout, bull trout, and brook trout redd survey data obtained in 2019 (Round 2 AEP Question 69, Appendix 69-2 and Appendix 69-3) to estimate adult pairs. All other relative abundance values rely on the proportion of fish identified from the summer 2020 fieldwork.

5 Population abundance is estimated from the calculated relative abundance values (note c) and extrapolated from redd survey data for adult population sizes.

6 Population abundance is estimated from the calculated relative abundance values (note d) and extrapolated redd survey data for adult population sizes.

2.0 FISH MORTALITY

2.1 Fish Mortality Estimates

The updated fish mortality estimate is based on the following assumptions:

- Approximately 1% of the total population of Elbow River fish species (between Elbow Falls and the inlet into Glenmore Reservoir) may become entrained in the off-stream reservoir during flood operations. The entrainment percentage used to calculate fish mortality is the same as the rate provided in Alberta Transportation's response to Round 2 AEP Question 74. This entrainment percentage does not change because it is based on the most current and relevant literature available for fish entrainment that might be experienced during flood operations of the Project.
- Fish entrainment percentage assumes the volume of water that is diverted into the off-stream reservoir is the amount of related to a design flood.
- The number of adult fish in Elbow River may range between 4,185 and 5,860. The total population (including adult, juvenile, fry) may range from 139,495 and 1,172,000. The assumptions made to calculate these estimates are described in Appendix 2-1.
- The primary cause for fish mortality in the off-stream reservoir is expected to be the duration and exposure to suspended sediments (Round 2 AEP Question 75). The highest predicted mortality rate to fish associated with the Project is 40% to 60% for juvenile salmonids during the design flood early release scenario, based on the highest predicted SEV scores (as discussed in the response to Round 2 NRCB Question 32). The expected mortality of fish that are entrained in the reservoir is presented (Round 2 AEP Question 75) as follows, and does not change for the current estimate because the mortality percentages are not based on population estimates:
  - Mortality of 20% to 40% could occur for juvenile and adult salmonids that become entrained in the reservoir during a 1:100 year flood for both early and late release, as well as 20% to 40% mortality among juvenile and adult salmonids during late release for a design flood. This assumption is based on information presented in Alberta Transportation's response to Round 2 NRCB Question 32.
  - Mortality of 20% to 40% for adult salmonids and 40% to 60% for juvenile salmonids could occur following entrainment during the design flood, early release, as indicated in the response to Round 2 NRCB IR 32. This assumption is based on information presented in Alberta Transportation's response to Round 2 NRCB Question 32.

2.1.1 Entrainment Estimates

2.1.1.1 Adult fish entrainment

Adult fish entrainment is calculated as 1% entrainment (assumption stated above in Section 2.1) for the predicted adult population abundance (Table 1-2).

- Population range = 4,185 to 5,860 individuals
- 1% entrainment (population x 0.01) = 42 to 59 individuals

2.1.1.2 Total fish entrainment

Total fish population entrainment (i.e., fry, juvenile, adults in LAA) is calculated as 1% entrainment (assumption stated above in Section 2.1) for the predicted total population (Table 1-2).

- Population range = 139,495 to 1,172,000 individuals
- 1% entrainment (population x 0.01) = 1,395 to 11,720 individuals

2.1.2 Mortality Estimates

2.1.2.1 Adult fish mortality

Adult fish mortality is calculated as 40% to 60% (assumption stated above in Section 2.1) of the estimated adult fish that are entrained in the reservoir (Section 2.1.1.1).

- Mortality 40% to 60% of adult fish entrained = 17 to 24 individuals

2.1.2.2 Total fish mortality

Total fish mortality is calculated as 40% to 60% (assumption stated above in Section 2.1) of the total fish that are entrained in the reservoir (Section 2.1.1.2).

- Mortality of 40% to 60% of fish entrained = 558 to 4,688 individuals

Mortality estimates are based on potential effects of exposure to suspended sediments in the off-stream reservoir. Additional risks to fish survival are injury, predation, exposure to increased temperature, and stranding. These estimates do not account for fish rescues in the reservoir, which may increase the chance of survival. Fish mortality estimates may be higher or lower than presented here; however, fish mortality is not expected to exceed 1% of the total Elbow River fish population that may be entrained during flood operations.

2.2 Discussion of Effects to Fish Populations

Bull trout presence and abundance in Elbow River downstream of Bragg Creek is low, as demonstrated in fish distribution data obtained through summer 2020 fieldwork, FWMIS records included in Round 2 NRCB Question 19, FWMIS data included in EIA (Volume 3B, Section 8.2.2.4), and historical data (Popowich and Paul 2006).

During a year in which the Project is operational for flood mitigation, diversion into the reservoir could coincide with BSP-1 or BSP-2. Sportfish that may become entrained in the reservoir during flood operations will be predominantly brown trout and brook trout, based on current fish species distribution and population abundance data. Bull trout occurrences are predominantly limited to the upper reaches of Elbow River, and bull trout entrainment in the reservoir during flood operations is expected to be low.

Reservoir water would be drawn down at a time that coincides with BSP-2, which coincides with bull trout migration and spawning in the upper reaches of Elbow River. Fish species distribution data obtained in 2020 also coincides with BSP-2, and the data are reflective of the species distribution expected during reservoir water drawdown and release. Alberta Transportation's response to Round 2 NRCB Question 19 indicated that bull trout may be present in the downstream reaches of Elbow River during BSP-2, and reservoir water release could coincide with bull trout movement from areas downstream of the reservoir to the upper reaches of Elbow River. This potential impact is based on historical records of bull trout near the inlet to Glenmore Reservoir (Popowich and Paul 2006). More recent information obtained from summer 2020 during BSP-2 indicates that bull trout presence in the downstream reaches is rare. Bull trout mortality as a result of reservoir water release is not expected.

Reservoir water drawdown and release during BSP-2 also coincides with rainbow trout and cutthroat trout hybrid fry incubation and rearing periods. Reservoir water release will likely impact fry incubation and rearing cohorts downstream of the Project. This loss aligns with the loss that would be expected during a natural flood event (i.e., as occurs without the Project). The duration of water release might extend the effects of a flood relative to a natural flood; however, such timing will still encompass the same general life history stages of fish (e.g., rainbow trout rearing).

2.2.1 Significance of Fish Mortality

Residual serious harm to fish due to fish mortality occurs when fishery productivity or sustainability is adversely affected and where recovery to baseline levels is uncertain (EIA Volume 3B, Section 8.3). Residual effects on fish mortality are expected to be not significant.

Residual effects on fish as a result of fish mortality are not significant because the portion of the fish that population entrained in the reservoir is low relative to the overall populations in Elbow River. In addition, the likelihood that bull trout are present in the reservoir during flood operations, or downstream of the reservoir during flood water release, is low. Bull trout mortality as a result of flood operations is expected to be not significant because of low occurrence near the Project and downstream of the Project.

Sportfish species that are expected to be entrained in the reservoir during flood operations, or present downstream of the reservoir during water release, are predominantly brown trout and brook trout, as indicated through the fish population assessment (Appendix 2-1) and previous studies (Round 2 AEP IR19, EIA Volume 3B Section 8.2.2.4). Rainbow trout and cutthroat trout (hybrids) may also be affected during flood operations. Population abundances for these species have not been identified to be of management concern. The risks of fish mortality are not expected to threaten the long-term sustainability or productivity of fish populations in Elbow River.

Mitigation to reduce the risk of fish mortality is presented in the response to Round 2 AEP Question 75. Mitigation includes engineering design details to reduce the risk of injury or stranding and updated operational parameters to reduce the duration of reservoir water retention (Round 2 NRCB Introduction, Changes to the Project). Mitigation measures also include the Draft Fish Rescue and Fish Health Monitoring Plan (Round 2 NRCB Question 31, Appendix 31-1). The residual effects conclusion also considers that Fisheries and Oceans Canada (DFO) will require Alberta Transportation to offset any harmful alteration, disruption and destruction of fish habitat (Section 35 of the *Fisheries Act*) for construction and operation of the Project, and the unavoidable loss of fish (Section 34 of the *Fisheries Act*) during flood operations.

It is important to note that any authorizations issued related to Section 34.4 would be based on fish mortality estimates and not the determination of "not significant" discussed above. The fish mortality estimate provided here will be used to support a discussion of fish mortality under Section 34.4 of the *Fisheries Act* authorization for the Project.

DFO may require post-flood fish monitoring as part of an authorization for the Project. Post-flood monitoring would confirm whether the estimates of fish mortality are representative, underestimated, or overestimated. If post-flood monitoring indicates fish mortality estimates are underestimated, DFO could request additional offsetting be conducted to account for differences.

REFERENCES

AEP (Alberta Environment and Parks). 2020. Fish and Wildlife Management Information System (FWMIS) Internet Mapping Tool. Available at: https://www.alberta.ca/access-fwmis-data.aspx.

Popowich, R., and G. Eisler. 2008. Fluvial Bull Trout Redd Surveys on t Elbow, Sheep and Highwood Rivers, Alberta. Submitted to Trout Unlimited, Canada, Calgary AB. 16pp + Appendices.

Popowich, R., and A. Paul. 2006. Seasonal Movement Patterns and habitat Selection of Bull Trout (Salvelinus confluentus) in Fluvial Environments. 122p.

Sawatzky, C. 2016. Information in support of a recovery potential assessment of Bull Trout (Salvenius confluentus) (Saskatchewan – Nelson rivers populations) in Alberta. DFO Can. Sci. Advis. Sec. Res. Doc. 2016/113. V +190 p.

2.3 VEGETATION

Question 3

Supplemental Information Request 2, Question 87, Response b. Page 398
Appendix 87-1 Draft guiding principles and direction for future land use

Alberta Transportation states *Some grazing through permit is being considered for the reservoir and, based on input from Indigenous groups, Alberta Transportation is evaluating opportunities for short-term use of culturally important grazing species such as bison and elk*.

a. **If the proposed project is approved and administration of the lands as stated in Appendix 87-1 falls under the responsibility of Alberta Environment and Parks, is Alberta Transportation aware section 1 (l) of the Public Lands Act makes no provision for the placement of elk on grazing dispositions as this section of the legislation states "livestock" means horses, sheep, cattle and, to the extent permitted by the regulations, bison? If Alberta Transportation is aware of this clause what plan is in place to address placement of elk on grazing dispositions which complies with applicable legislation? If Alberta Transportation was not aware of this legislation how does this knowledge change the plan for the placement of elk on grazing dispositions?**

b. **Other than the naturally occurring elk resident within the area has Alberta Transportation made any other commitments related to the short-term use of the subject lands by elk? Explain.**

c. **Is Alberta Transportation aware grazing of bison on lands administered under the Public Lands Act requires special permission under the terms outlined in Sections 72 through 76 of the Public Land Administration Regulation? Explain.**

d. **Is Alberta Transportation aware bison typically require a more restrictive degree of fencing when compared to other classes of livestock? In addition, is Alberta Transportation aware such fencing may also require periodic placement of wildlife friendly crossing structures to permit the movement of wildlife across the landscape? Explain.**

e. **If bison grazing is carried out on the site has Alberta Transportation developed a fencing plan for the subject area which adequately contains this species, while at the same time permitting movement of wildlife across the landscape? Explain.**

f. **Has Alberta Transportation made any commitments related to the short-term use of the subject lands by bison which will be the responsibility of Alberta Environment and Parks if the proposed project receives approval? Explain all commitments which have been made.**

Response

a. Alberta Transportation is aware that Section (1) of the Alberta *Public Lands Act* states "livestock" means horses, sheep, cattle and, to the extent permitted by the regulations, bison. As such, Alberta Transportation understands that elk are not considered livestock, as defined in Section (1) of the *Public Lands Act* and a grazing permit cannot be issued for domestic elk under the *Public Lands Act*. Alberta Transportation also recognizes placement of elk within the off-stream reservoir for the purposes of grazing and vegetation management does not align with other existing legislation, including the Domestic Cervid Regulation and the Alberta *Livestock Industry Diversification Act,* which recognizes elk primarily for agricultural purposes (i.e., domestic cervid farms). Alberta Transportation acknowledges that using elk to support temporary grazing activities within the off-stream reservoir during dry operations is a unique consideration.

   Alberta Transportation's plan to address the placement of elk is to engage in discussions with Indigenous groups and AEP, as well as other stakeholders, as necessary to consider this option.

b. Alberta Transportation has made no commitments to Indigenous groups or other stakeholders related to the short-term use of elk in the off-stream reservoir. Alberta Transportation heard an interest from certain Indigenous groups to use elk for grazing in the reservoir and commits to consider this feedback as Project planning continues.

c. Alberta Transportation is aware the grazing of bison on lands administered under the *Public Lands Act* requires special permission under the terms outlined in Sections 72 through 76 of the Public Land Administration Regulation, which includes Section (72) approval to graze, Section (73) restricted locations, Section (74) cancellation of dispositions, Section (75) prohibitions, and Section (76) testing for disease on all bison and marking.

d. Alberta Transportation is aware of the Operating Standards for Alberta's Public Land Grazing Dispositions (GOA 2019), which states the grazing disposition holder must adequately fence the disposition to confine livestock pursuant to the Public Lands Administration Regulation 53(3), *Stray Animals Act* 37(1), and Forest Reserves Regulation 15(1) (GOA 2019). In addition, Alberta Transportation is aware that bison fencing may require periodic placement of wildlife crossing structures to facilitate wildlife movement across the landscape.

e. For clarification, AEP will be responsible for implementing the final land use plan (LUP), which will be developed in consultation with AEP and Indigenous groups. Therefore, if bison are used to graze vegetation within the off-stream reservoir during dry operations, AEP will be responsible for a disposition management plan that will identify an appropriate fence design to adequately confine bison and, where appropriate, also provide for wildlife movement across the landscape (e.g., wildlife crossing structures) following guidance provided in

Fencing Guidelines for Bison on Alberta Public Lands with Wildlife and Access in Mind (Gates 2006).

f. Alberta Transportation has made no commitments to Indigenous groups or other stakeholders related to the short-term use of bison within the off-stream reservoir. As referred above, Indigenous groups expressed an interest in using bison for grazing in the reservoir. Alberta Transportation will continue to engage Indigenous groups on the components of the LUP and reflect these considerations in Project planning.

REFERENCES

Gates, C. C. 2006. Fencing guidelines for bison on Alberta public lands with wildlife and access in mind. Faculty of Environmental Design, University of Calgary, Calgary, Alberta, Canada. 8 p. Available at: https://www.canadianbison.ca/application/files/7214/8778/3208/Fencing_guidelines_for_Bison_on_Alberta_Public_Land.pdf

GOA (Government of Alberta). 2019. Operating Standards for Alberta's Public Land Grazing Dispositions. Available at: https://www.alberta.ca/assets/documents/ep-grazing-disposition-standards-fact-sheet-2019.pdf

APPENDIX 2-1 FISH POPULATION ASSESSMENT

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT
RESPONSE TO AEP SUPPLEMENTAL INFORMATION REQUEST
DATED NOVEMBER 4, 2020

Appendix 2-1 Fish Population Assessment
December 2020

SPRINGBANK OFF-STREAM RESERVOIR PROJECT
Fish Population Assessment

Prepared for:
Alberta Transportation

Prepared by:
Stantec Consulting Ltd.

December 2020

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Abbreviations

AEP	Alberta Environment and Parks
BKTR	brook trout
BLTR	bull trout
BNTR	brown trout
BRST	brook stickleback
BURB	burbot
CPUE	catch per unit effort
CTTR	cutthroat trout
DFO	Fisheries and Oceans Canada
EIA	environmental impact assessment
FWMIS	Fisheries and Wildlife Management Information System
IR	information request
LKCH	lake chub
LNSC	longnose sucker
MNSC	mountain sucker
MNWH	mountain whitefish
RAP	restricted activity period
RNTR	rainbow trout
the Project	Springbank Off-stream Reservoir
WHSC	white sucker
UNKN	unknown

1.0 INTRODUCTION

This fish population study for Elbow River resident fish complements aquatic baseline studies in the Environmental Impact Assessment (EIA) for the Springbank Off-stream Reservoir (Project). The objective of this study is to characterize and assess the resident fish community for its species composition, distribution, demographics, relative abundance, and population abundance. The study domain is the portion of Elbow River between Elbow Falls and the inlet into Glenmore Reservoir.

The information presented here expands on previous baseline studies that were completed for the EIA in 2018 (Volume 4, Appendix M) and habitat mapping and spawning studies that were completed in 2019, in response to Round 2 Alberta Environment and Parks (AEP) Question 68.

The fisheries information collected in this study will also inform the *Fisheries Act* Application to be submitted to Fisheries and Oceans Canada (DFO).

1.1 BACKGROUND AND STUDY OBJECTIVES

The Round 2 Natural Resources Conservation Board (NRCB) Questions that related to fisheries asked for more Elbow River fisheries data to support a more detailed assessment of the potential changes to the fisheries population caused by the effects of Project construction and operations (primarily flood operations) on the resident fish community.

During an in-person meeting with AEP biologists, and subsequent phone calls to discuss study design, AEP stated that 10 to 12 sampling segments within the Elbow River sampling domain (i.e., Elbow River between Elbow Falls and inlet to Glenmore Reservoir) would be suitable for the fisheries impact assessment in the study domain (Christensen, pers. comm., November 7, 2019).

Preliminary estimates of baseline fisheries population based on provincial records (with some data limitations) were provided in response to Round 2 NRCB Question 19, Question 28 and Round 2 AEP Question 68. In addition, fish movement and distribution information presented in response to Round 2 NRCB Question 19 relied on provincial records of bull trout populations.

Data from the province to support the fish population estimates in Elbow River are limited (AEP 2020; Fisheries and Wildlife Management Information System (FWMIS) data between 1978 and 2015). Most of the available data were generated during local fish surveys without the intent of providing a quantitative population assessment. These survey results provided a desktop-based evaluation of relative abundance, fish species distribution, and population abundance in Elbow River, as demonstrated in the EIA Volume 3B Section 8.2.2.4 and in response to the Round 2 NRCB and AEP Questions, in which Alberta Transportation committed to collect additional baseline fisheries data prior to construction so as to fulfill pre-construction baseline survey requirements and strengthen the information on fish populations in the study domain. This study is in fulfillment of that commitment by Alberta Transportation.

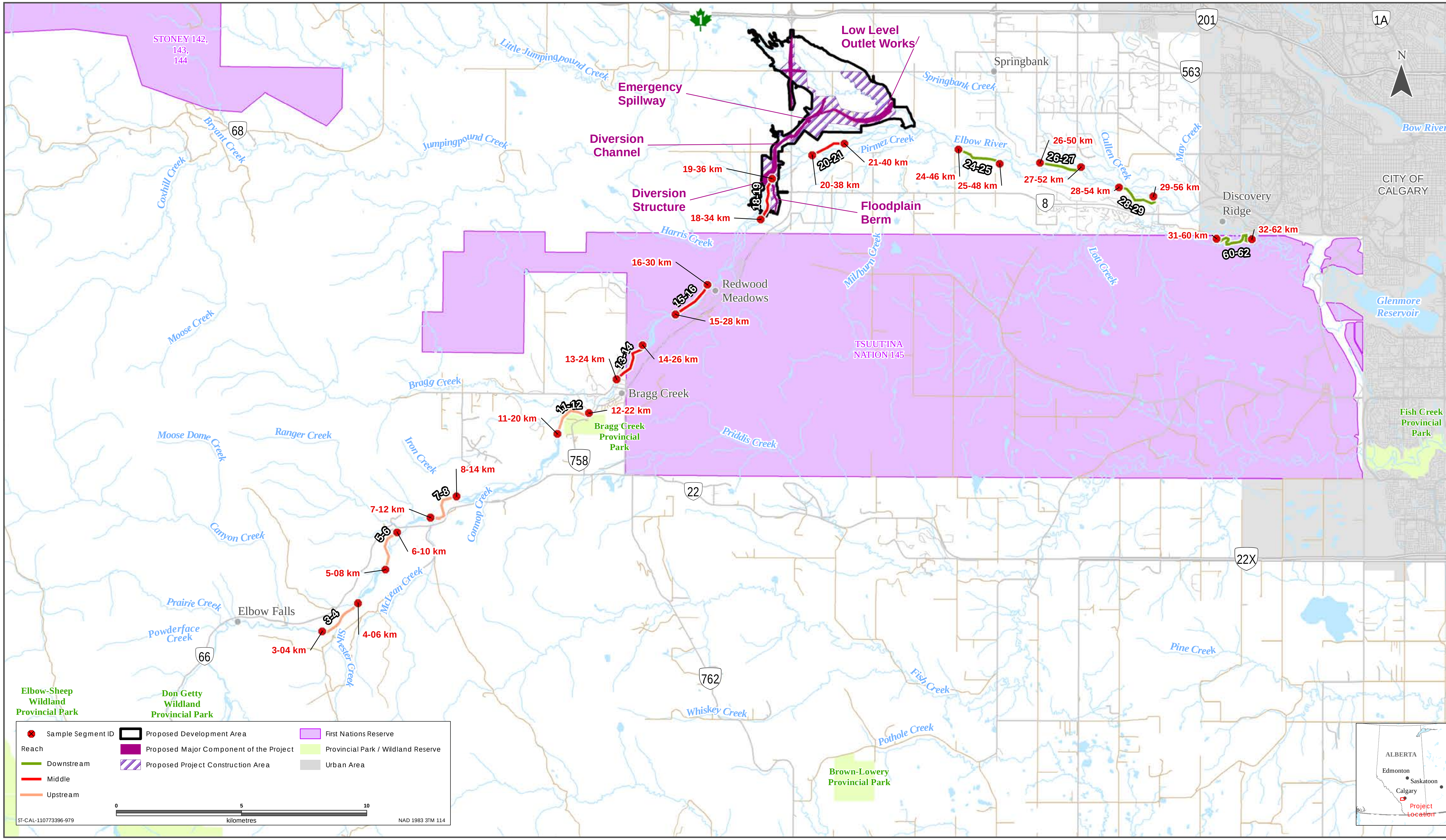
2.0 STUDY SETTING

The Elbow River study domain (Figure 2-1) is approximately a 70 km instream distance and is situated between Elbow Falls (NAD 83 515717 E 5632930 N) and the inlet to Glenmore Reservoir (NAD 83 559865 E 5646947 N). Elbow Falls is located in the Rocky Mountain foothills in Don Getty Wildland Provincial Park, approximately 40 km southwest of Bragg Creek. The river flows east from the falls through the following areas (from upstream to downstream):

- a portion of Don Getty Wildland Provincial Park
- the Hamlet of Bragg Creek
- Tsuut'ina Nation Reserve within Redwood Meadows
- agricultural lands and along the Springbank and Discovery Ridge communities
- the northeast corner of the Tsuut'ina Nation (west of the City of Calgary)
- into Calgary

Elbow River is generally characterized by erosional habitat with gravel/cobble substrates and riffle-pool-run channel unit sequences. The river flows through a constrained valley, downstream of Elbow Falls. Cobble and gravel bed substrates, bedrock outcrops and steep valley walls are common. This area is forested with little development. Downstream of Bragg Creek, the river gradient lessens, and the valley opens into an area dominated by agriculture, including areas for pasture and grazing. Riverbed substrates through this area are largely comprised of cobble and gravels with finer sediments in depositional areas. The river gradient is lowest at the farthest downstream sampling segments near Glenmore Reservoir; bedload sediment is smaller than upstream but still erosional in nature. Sediment deposition has developed a delta where the river enters Glenmore Reservoir.

Elbow River habitat supports resident native salmonid species (bull trout [*Salvelinus confluentus*] and mountain whitefish [*Prosopium williamsoni*]) and non-native species (rainbow trout [*Oncorhynchus mykiss*], brown trout [*Salmo trutta*], and brook trout [*Salvelinus fontinalis*]). Westslope cutthroat trout (*Oncorhynchus clarkii*) are resident in upstream tributaries. Other resident species include burbot (*Lota lota*), sucker sp. (*Catastomus* sp.) and small forage species (*Cyprinidae*).



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

Stantec

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT

Fish Population Study area in the Elbow River between Elbow Falls and Glenmore Reservoir

Figure 2-1

Mean monthly flows for Elbow River at Bragg Creek are as follows (standard deviation in brackets):

- June – 25.8 m^3/s (13.1)
- July – 15.4 m^3/s (7.4)
- August – 9.4 m^3/s (3.5)

Mean monthly flows for Elbow River at Sarcee Bridge in Calgary are as follows (standard deviation in brackets):

- June – 29.5 m^3/s (19.4)
- July – 15.5 m^3/s (7.2)
- August – 9.7 m^3/s (3.8)

Elbow River through the study domain is a Class C watercourse according to the Calgary Water Management Area map (ESRD 2012) with restricted activity periods (RAP) as follows:

- Elbow Falls to Bragg Creek – September 1 to August 15
- Bragg Creek to Glenmore Reservoir – May 1 to July 15 and September 16 to April 15

During the RAP, instream activities require additional mitigation measures to protect sensitive fish life stages.

2.1 ELBOW RIVER FISH POPULATIONS

Existing fish and fish habitat information from Elbow River and its tributaries was compiled using the FWMIS database in April 2020 (AEP 2020). The FWMIS data are presented in Table 2-1 and summarizes the presence and status of 19 fish species within Elbow River and its tributaries, including key fish species: brook trout (*Salvelinus fontinalis*), brown trout (*Salmo trutta*), bull trout (*Salvelinus confluentus*), burbot (*Lota lota*), cutthroat trout (*Oncorhynchus clarkii*), mountain whitefish (*Prosopium williamsoni*), rainbow trout (*Oncorhynchus mykiss*), white sucker (*Catostomus commersonii*), longnose sucker (*Catostomus catostomus*), and mountain sucker (*Catostomus platyrhynchus*) (Table 2-1). Elbow River provides high quality spawning, rearing, feeding and overwintering fish habitat throughout the study domain.

Table 2-1 Documented Fish Species in Elbow River and its Tributaries[1]

Species Information				Legislated Protection		Scientific Review or Recommendation	
Family[1]	Common Name[1]	Scientific Name[1]	Species Code	*SARA*[2] (Federal)	*Wildlife Act*[3] (Provincial)	COSEWIC[4] (Federal)	General Status[5] (Provincial)
Catostomidae (suckers)	longnose sucker	*Catostomus catostomus*	LNSC	No status	Not listed	Not assessed	*secure*
	mountain sucker (Saskatchewan River populations)	*Catostomus platyrhynchus*	MNSC	No status	Not listed	Not at risk	*secure*
	white sucker	*Catostomus commersonii*	WHSC	No status	Not listed	Not assessed	*secure*
Cyprinidae (carps and minnows)	fathead minnow	*Pimephales promelas*	FTMN	No status	Not listed	Not assessed	*secure*
	lake chub	*Couesius plumbeus*	LKCH	No status	Not listed	Not assessed	*secure*
	longnose dace	*Rhinichthys cataractae*	LNDC	No status	Not listed	Not assessed	*secure*
	pearl dace	*Margariscus margarita*	PRDC	No status	Not listed	Not assessed	*undetermined*
	spottail shiner	*Notropis hudsonius*	SPSH	No status	Not listed	Not assessed	*secure*
Esocidae (pikes and mudminnows)	northern pike*	*Esox lucius*	NRPK	No status	Not listed	Not assessed	*secure*
Gadidae (cods)	burbot*	*Lota*	BURB	No status	Not listed	Not assessed	*secure*
Gasterosteidae (sticklebacks)	brook stickleback	*Culaea inconstans*	BRST	No status	Not listed	Not assessed	*secure*
Percidae (perches and darters)	yellow perch*	*Perca flavescens*	YLPR	No status	Not listed	Not assessed	*secure*
Percopsidae (trout-perches)	trout-perch	*Percopsis omiscomaycus*	TRPR	No status	Not listed	Not assessed	*secure*

Table 2-1 Documented Fish Species in Elbow River and its Tributaries[1]

Species Information				Legislated Protection		Scientific Review or Recommendation	
Family[1]	**Common Name[1]**	**Scientific Name[1]**	**Species Code**	***SARA*[2] (Federal)**	***Wildlife Act*[3] (Provincial)**	**COSEWIC[4] (Federal)**	**General Status[5] (Provincial)**
Salmonidae (trout, char, salmon and whitefish)	brook trout*	*Salvelinus fontinalis*	BKTR	No status	Not listed	Not assessed	*exotic/alien*
	brown trout*	*Salmo trutta*	BNTR	No status	Not listed	Not assessed	*exotic/alien*
	bull trout* (Saskatchewan - Nelson Rivers populations)	*Salvelinus confluentus*	BLTR	Threatened	Threatened	Threatened	*at risk*
	mountain whitefish*	*Prosopium williamsoni*	MNWH	No status	Not listed	Not assessed	*secure*
	rainbow trout*	*Oncorhynchus mykiss*	RNTR	No status	Not listed	Not assessed	*secure*
	westslope cutthroat trout*	*Oncorhynchus clarkii lewisi*	WSCT	Threatened	Threatened	Threatened	*at risk*

NOTES:
[1] Common and Scientific Names of Fishes from the United States, Canada, and Mexico (Page et al. 2013)
[2] *Species at Risk Act* (SARA 2002) (GoC 2020)
[3] *Wildlife Act* – Wildlife Regulation (1997)
[4] Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (COSEWIC 2019)
[5] General Status of Alberta Wild Species (AEP 2017a)
* Denotes sportfish species

2.1.1 Bull Trout

The Elbow River bull trout population is considered part of the Saskatchewan-Nelson Rivers population (COSEWIC 2012) and is listed as *threatened* under Schedule 1 of the *Species at Risk Act* (SARA; GoC 2020). Bull trout has a provincial status of *at risk* in AEP (2017a) and is listed as *threatened* in the Alberta *Wildlife Act* (ESRD 2014).

Habitat degradation and reduced habitat connectivity through fragmentation pose threats to this population (COSEWIC 2012). The introduction of non-native species, such as eastern brook trout, has increased competition for food and spawning resources. Bull trout are also vulnerable to hybridization with introduced brook trout in areas where both species occur (COSEWIC 2012). Activities from oil and gas development, forestry, mining, transportation infrastructure and hydroelectric projects affect habitat by increasing siltation and water temperatures and decreasing stream flow volumes. Overfishing may also be a threat because bull trout are easily catchable and, therefore, susceptible to catch and release mortality in many areas that are accessible to anglers (COSEWIC 2012). Due to their vulnerability, AEP has implemented a zero-possession limit on bull trout throughout the province and instated a mandatory catch and release program.

Bull trout are a cold-water species that prefer water temperatures at or below 15˚C. Bull trout exhibit fluvial and adfluvial life history strategies and reside in larger rivers or lakes and then migrate to suitable habitat to spawn. Stream resident forms reside in smaller streams where they spawn and rear. Bull trout spawn between mid-August and early October in gravel and cobble areas with low levels of fine sediments. Bull trout are known to be more selective than brown trout and brook trout with regards to spawning habitat (Baxter and McPhail 1999; Fitzsimmons 2008; Raleigh et al. 1986) and have been previously identified to spawn in the upper reaches of Elbow River between Paddy's Flat and Elbow Falls (Popowich and Eisler 2008). Groundwater upwelling is commonly associated with spawning habitat selection (Baxter and McPhail 1999; Roberge et al. 2002), and it is likely that winter conditions in the upper reaches of Elbow River (between Paddy's Flat and Elbow Falls) are more favorable for bull trout egg incubation relative to the downstream reaches of Elbow River. Bull trout fry move to shallow, slower water with interstitial cover, moving to deeper water as they age.

2.1.2 Mountain Whitefish

Mountain whitefish are a native sport fish species and their typically high abundance supports the ecosystem in Elbow River. Mountain whitefish are found throughout Elbow River, and they are susceptible to disturbance. Primarily a benthic feeder, mountain whitefish feed on a variety of aquatic invertebrates that inhabit well oxygenated waters (Scott and Crossman 1998).

Mountain whitefish broadcast spawn over gravel and cobble substrates at moderate gradients (R.L. & L. Environmental Services Ltd. 1996; Nelson and Paetz 1992). They prefer shallow, depositional gravel areas interspaced by deep runs and pools or just downstream of cobble areas along armoured or depositional banks. Spawning occurs from September to early November (Nelson and Paetz 1992). Schools of mountain whitefish will congregate around mid-September and migrate to spawning locations when water temperatures are between 2°C and 6°C. Because mountain whitefish do not clean redds to deposit eggs (Scott and Crossman 1998), their spawning sites may be more susceptible to sediment deposition. This species moves in schools from pool to pool during migration and feeding (AEP 2017b). After emerging in March, young mountain whitefish will rear in shallow backwaters and side channels and near large woody debris cover in shallow areas (R.L. & L. Environmental Services Ltd. 1996).

2.1.3 Cutthroat Trout

Westslope cutthroat trout (*Oncorhynchus clarkii lewisi*) is protected under Schedule 1 of SARA and listed as *threatened* (GoC 2020), listed as *threatened* under the Alberta *Wildlife Act*, and *at risk* under Alberta's General Status of Wild Species 2015 (AEP 2017a). Westslope cutthroat trout are generally found in cold, high elevation waters with well connected, structurally diverse habitats that maintain relatively consistent water flows. Genetically pure (non-hybridized with rainbow trout) Westslope cutthroat trout stocks are not expected to be present in Elbow River, downstream of Bragg Creek, given the presence of introduced rainbow trout and the low-gradient habitat that is more suitable for rainbow trout and brown trout.

Westslope cutthroat trout are known to reside in the small headwater streams that are tributaries to upper Elbow River: Silvester Creek, Prairie Creek, and Quirk Creek.

Cutthroat trout spawn from April to June (Scott and Crossman 1998) in riffles that have gravel substrates and in depths generally less than 1 m. Females will dig a redd and cover the eggs with gravel after fertilization in water temperatures around 6°C up to around 10°C. The eggs will hatch between July and August, depending on temperatures. Fry require riffles with larger stone as cover when they hatch, moving to slower backwaters where there is cover from woody debris, boulders, or overhanging vegetation. Juveniles will remain close to cover provided by substrates, woody debris, or vegetation in riffles, runs, and pools. They will move to pools and, sometimes, burrow in interstitial spaces in gravel to overwinter. Juveniles will eat aquatic invertebrates and terrestrial insects, with adults switching to larger prey such as small fish when they are available. Adults require larger pools where there is cover to overwinter relative to juveniles.

2.1.4 Brown Trout

Brown trout are one of the most desired sport fish in Elbow River and are an introduced species not federally or provincially listed.

Brown trout are opportunistic drift feeders that prefer a variety of aquatic invertebrates, molluscs, fishes, and frogs (Scott and Crossman 1998). They typically prefer a moderate flow of water, with plenty of cover for ambushing prey. They are more resilient than native trout species and can flourish in warmer water temperatures than bull trout or cutthroat trout (Scott and Crossman 1998).

Brown trout likely spawn in the lower portion of the study domain, between Highway 22 and Glenmore Reservoir. Brown trout are known to spawn over gravels when water temperatures fall below 6 °C to 8°C, typically between October and December (Scott and Crossman 1998). Spawning brown trout can be large and require deep pools in October. Females will dig a redd and cover the eggs with gravel after fertilization; the eggs hatch between March and late April (Scott and Crossman 1998). Preferred spawning substrate size range from 0.3 cm to 10 cm, with water depths less than 0.5 m (Raleigh et al. 1986).

After emerging, the fry will seek cover habitats (e.g., large woody debris and undercut banks) in slower water and generally shallower than 0.15 m (Raleigh et al. 1986). They feed on plankton and aquatic invertebrates until the fry are large enough to successfully ambush fishes and larger prey types. Juveniles move to deeper water. Adult brown trout prefer water close to escape cover, such as overhanging vegetation, large woody debris, and undercut banks.

2.1.5 Brook Trout

Brook trout were introduced in Alberta over 80 years ago. Despite being considered an "invasive" species, because of their competition with native bull and cutthroat trout, they are a desired sport fish. Brook trout are found in Elbow River and its tributaries. They are opportunistic feeders that prefer a variety of aquatic invertebrates and fishes (Scott and Crossman 1998).

Brook trout spawn in early fall, normally in smaller tributaries on gravel substrates. In smaller streams, brook trout dig redds over sources of groundwater upwellings. Rearing young of year and juvenile brook trout prefer extensive overhead cover and woody debris in shallow areas (Roberge et al. 2002).

2.1.6 Rainbow Trout

Rainbow trout in the Elbow River watershed are an introduced species and are not federally or provincially listed.

Female rainbow trout select adequate substrate to dig depressions in the substrate for redds. Therefore, channel gradient, water velocity, and substrate size are important for spawning. Ideal spawning substrate typically ranges from clean, coarse sand to large gravel that the female can excavate (size range from 0.04 mm to 100 mm) (Nelson and Paetz 1992). Other factors that are important for salmonid spawning include stream morphology and water quality. Clear flowing streams with minimal siltation are optimal for spawning because eggs are sensitive to perturbations and siltation.

Fry prefer shallower, slower water than adults, with preferred depths less than 15 cm. Fry will disperse immediately after emergence into slow water and cover (roots, boulders, logjams, riffles, undercuts) where they prefer, for example, pool margins and interstitial spaces between rocks. Cover is important for rearing rainbow trout, including shallow rocky substrate, margins of river, and the absence of larger trout. Fine materials are known to reduce the value of riffles for fry. Juveniles start to prefer water velocities around 10 cm/s to 12 cm/s, but also up to velocities of 22 cm/s if rough substrate is present for cover. Juvenile rainbow trout will overwinter in shallow margins, near woody debris.

Adult rainbow trout velocity preferences are around 0.2 m/s to 0.3 m/s, with variable depths and normally in less than 1 m, except in winter. Adults prefer instream cover from boulders and large woody debris. Pools are important to trout as a refuge from adverse conditions during the winter.

2.1.7 Burbot

Burbot are a native piscivore that primarily reside in relatively larger and slower bodies of water. Burbot are a coolwater, freshwater member of the cod family that generally prefer deep lakes and deep, slow-moving rivers (Scott and Crossman 1998). Burbot are known to prefer cold, turbid water in deep channels. Because of their eel-like shape and swimming style, burbot have poor swimming abilities, but are known to migrate distances over 50 km to spawning sites (McPhail and Paragamian 2000).

In rivers, spawning habitat for burbot normally occurs in mid-winter in deep, low velocity areas over gravel, sand, or silt that occur in main and side channels behind depositional bars. The semi-buoyant eggs are broadcast into mid-water and drift downstream before settling into interstitial spaces on the substrate. Freshly hatched burbot are pelagic and drift downstream in the river, eventually moving towards the shoreline when their swimming ability improves. Rearing habitats (nearshore daytime cover) are associated with cover such as large and coarse substrates, undercuts, woody debris, and vegetation mats (Langhorne et al. 2001). As they grow into adults, they move into deeper and colder water. Adults are piscivorous and voracious feeders, actively hunting in deep areas and ambushing prey along the bed. When water temperatures drop in late fall, adult burbot are known to move towards the shoreline to feed (McPhail and Paragamian 2000).

2.1.8 Longnose Sucker

Longnose sucker broadcast spawn in riffle, run, transitions into pool habitat sections of rivers. They spawn in colder temperatures closer to ice-off in early spring and as late as June. Longnose suckers will spawn over coarse substrates, while white suckers will spawn over coarse and fine substrates, including sand and silt (Langhorne et al. 2001).

The young typically move into nearshore areas of lakes later in the summer and use large, coarse substrates and submergent and emergent vegetation as cover. They will use areas of debris and vegetation in nearshore areas as they age into the fall (Langhorne et al. 2001).

Longnose sucker are benthic feeders, ingesting plankton when young and plants, detritus, and benthic invertebrates as adults (Scott and Crossman 1998). Rearing habitat is located in areas with aquatic vegetation, woody debris, or boulder cover. Adults are rare where wetted width is less than 10 m, but they are almost always present where wetted widths are greater than 15 m (Meyer et al. 2009). Adults overwinter in deep pools.

2.1.9 White Sucker

White sucker is a broadcast species that spawns between May and June within shallow, gravel-bottom sections of streams (Scott and Crossman 1998). White suckers spawn in spring over coarse and fine substrates (including sand and silt) when water temperatures reach approximately 10°C (Scott and Crossman 1998; Langhorne et al. 2001).

Juvenile white sucker typically move into areas of lower velocity (such as backwaters) later in the summer and use large, coarse substrates and submergent and emergent vegetation as cover. As they develop, juvenile white sucker will also move into shoreline areas with debris and vegetation (Langhorne et al. 2001). White sucker is a benthic feeder, ingesting plankton when young. As adults, they ingest plants, detritus, and benthic invertebrates (Scott and Crossman 1998). Rearing habitat is located in areas with aquatic vegetation, woody debris, or boulder cover. Adults overwinter in deep pools.

2.1.10 Forage Fish

Forage fish species are defined by DFO as a species that is below the top of an aquatic food chain, is an important source of food for at least some predators, and experience high predation mortality. In riverine ecosystems, they are important for transferring energy from lower trophic levels up the food chain to the higher levels.

Because many higher trophic feeders (piscivores)—such as bull trout, rainbow trout and northern pike—require a forge fish prey base, it is assumed that the presence of picsivorous fish indicates suitable habitats for forage fish. Generally, they are more adaptable to a larger range of environmental conditions and less sensitive to perturbations in water quality, such as temperature and turbidity. Forage fish in Elbow River include species in the Cyprinidae (minnows), Gasterosteidae (stickleback), and Percopsidae (trout-perch) families.

3.0 METHODS

This section describes the approach used in developing the study design, field procedures, and data analyses to undertake the fish population study.

3.1 FISH POPULATION SURVEY DESIGN

The study design for Elbow River population study was developed with guidance provided by AEP fisheries biologists (through conversations with AEP for the Project; GOA 2018).

The objective of the fish population study is to characterize the resident fish community of Elbow River and assess the relative size and demographics of each resident population. The field population sampling study design assumed the following:

- The fish population study targeted all resident fish species in the community.
- Elbow River study domain is approximately 70 km (channel kilometres) between Elbow Falls and the inlet to Glenmore Reservoir.
- Fish have the widest distribution within the river in August, when the field sampling was completed (i.e., period when fish distributions are least likely to be clustered), as discussed in the "Medium and Large River Sampling Protocol" guidance document provided by AEP (GOA 2018).
- Large-bodied fish (including resident salmonid species) have their widest distribution through the Elbow River during the summer, as suggested by historical fisheries data for Elbow River (AEP 2020).

3.1.1 Sampling Segments

Sampling segments in Elbow River were selected using a spatially balanced hierarchical approach to account for the design assumptions listed above.

The study domain is approximately 70 km long and is divided into potential 35 sampling segments (each 2 km in length). The sampling design was arranged hierarchically by dividing the domain into three reaches of similar length; this would ensure a spatially balanced study design to address the possibility of differential assortment of resident populations of one or more species; this will take into consideration the possibility of one species being clustered in one section of the river:

- Reach 1 (upstream reach, between Elbow Falls and Bragg Creek), 11 potential sampling segments.

- Reach 2 (middle reach, between Bragg Creek and the downstream extent of SR1), 12 potential sampling segments.
- Reach 3 (downstream reach, between the downstream extent of the Project infrastructure and inlet to Glenmore Reservoir), 12 potential sampling segments.

From these 35 potential sampling segments within the study domain, a total of 12 sampling segments were carried forward for fish sampling inventories. In discussion with AEP biologists (Christensen, pers. comm., November 7, 2019), it was indicated that 10 to12 study segments would be adequate to give suitable representation of the study domain of Elbow River. The level of sampling effort undertaken would provide reasonable coverage and results to evaluate a sample population that reflects the natural population. To reach an overall sampling density of 12 sampling segments throughout the 70 km study domain, the following considerations were given to segment selection:

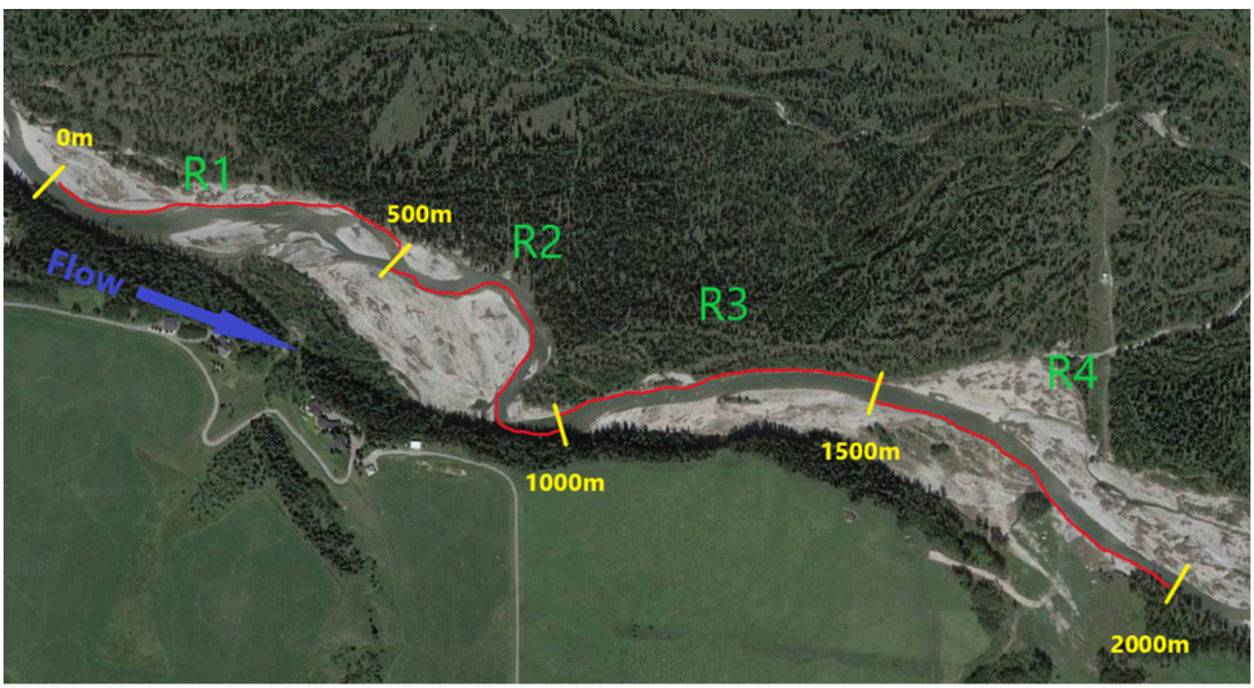
- Each potential sampling segment was given a number identifier 1 through 35 and five segments were randomly selected within each reach (i.e., upper, middle lower reach) using a random number generator in Microsoft Excel. The five reaches comprise of:
  - Four sampling segments were randomly selected in each reach (i.e., four segments in the upstream reach, four segments in the middle reach, and four segments in the downstream reach).
  - One additional sampling segment (i.e., the ‘alternative segment’) was selected in each reach as an alternate sampling segment in the event one of the four original sampling segments had to be discarded (e.g., due to site safety concerns, landowner access issues).
- Each sampling segment throughout the study domain had an equal probability of inclusion at the outset of segment selection; once selection started, where two adjacent segments were selected, a decision was made to adjust one of the selected segments so as to:
  - Prevent any resident population from being under- or over-represented.
  - Reduce bias associated with the “edge effect” (effects of fish movement or escape at the edge of the sampling segment) on sampling results was the same among all segments.
  - Reduce the possibility of fish residing at the boundary edge of two segments being captured and counted twice.
- Where randomly selected segments included adjacent segments, one of the segments was replaced by the subsequent segment so no two adjacent segments remained.
- Of the two adjacent segments, the one closest to another selected segment or at the edge of a reach remained and the other segment was adjusted in distance.
- Where two adjacent segments were in separate reaches, the segment in the downstream reach was adjusted in distance.

The location of the sampling segments is presented in Table 3-1 and Figure 3-1. Segments are listed in order from the farthest upstream segment (Segment 3-4), near Elbow Falls, to the farthest downstream segment (Segment 60-62), near Glenmore Reservoir.

Table 3-1 Location of Fish Sampling Segments

Sampling Segment ID	Date Sampled	Location (Lat./Long.)
3-4	Aug. 4, 2020	50.86948/-114.7191
5-6	Aug. 5, 2020	50.89444/-114.6914
7-8	Aug. 3, 2020	50.90894/-114.6630
11-12	Aug. 6, 2020	50.94135/-114.5935
13-14	Aug. 7, 2020	50.96237/-114.5566
15-16	Aug. 11, 2020	50.98434/-114.5218
18-19	Aug. 2, 2020	51.02180/-114.4785
20-21	Aug. 1, 2020	51.03840/-114.4465
24-25	Aug. 10, 2020	51.03705/-114.3601
26-27	Aug. 8, 2020	51.03239/-114.3133
28-29	Aug. 9, 2020	51.02290/-114.2691
60-62	Aug. 13, 2020	51.00648/-114.2144

Figure 3-1 Example Study Site Arrangement.



NOTE: Four study sites are arranged within each sampling segment. Two crews work downstream to upstream.

Each of the 12 sampling segments was subdivided into four sample sites to establish consistency across crew electrofishing coverage during fieldwork. Each segment was delineated on maps with marked GPS waypoints (i.e., NAD 83) such that field crews consistently covered the same areas during fishing efforts. Each segment was comprised four sequential and adjacent 500 m sampling sites (i.e., electrofishing sites). The sampling sites were defined (from upstream to downstream):

- R1: 1 m to 500 m
- R2: 501 m to 1000 m
- R3: 1001 m to 1500 m
- R4: 1501 m to 2000 m

Two crews sampled each of the 12 segments. Within each segment, the first crew sampled R1 and R2 (1 m to 1,000 m) and the second crew sampled R3 and R4 (1,001 m to 2,000 m). Both crews began at their downstream sampling reach (i.e., crew one began at R2 and crew two began at R4) and were in communication over radio to avoid overlap. Crews sampled for 500 m and then processed fish (i.e., measured fork or total length, identified to species, and photographed individuals) and released them downstream of where they were caught. Crews then fished the remaining 500 m reach, continuing to work from downstream to upstream. Once the upstream end was reached, crews measured fish and released them back into Elbow River.

Each crew consisted of two backpack electrofisher teams with one or two netters per backpack. One backpack electrofisher targeted deeper habitat (e.g., deep run, deep pools) while the second backpack electrofisher targeted shallower habitat (e.g., shallow run, riffles, shallow scour pools). Crews crossed the river as needed in order to wade safely and keep the backpack electrofisher out of water.

3.1.2 Survey Timing

The fish population assessment was conducted from August 3 to August 13, 2020. The windows are according to the provincial summer window and fall RAP.

The fish sampling effort was conducted by 10 fisheries biologists working simultaneously at multiple sites to complete the survey efficiently. The objective was to complete the sampling before fall spawning fish species began their migration to areas of the river where spawning occurs.

3.1.3 Electrofishing Operations

Backpack electrofisher units were used at all sites. A single pass electrofishing sample effort was conducted in each site within each segment. A tote barge with a mounted electrofishing unit was initially proposed during equipment communication with AEP; however, a tote barge could not be used due to low flows encountered during the sampling program.

The equipment set-up was conducted by qualified biologists that were experienced in using the electrofishing units. The system was tested for functionality to confirm that all components were grounded and the safety/kill switches were operational.

3.1.3.1 Data Entry

Prior to the start of electrofishing and at the beginning of each sampling site, the following relevant site data were collected:

- date, Segment ID and Site Label (e.g., R1, R2), GPS coordinates (NAD 83)
- crew member names
- site access data
- time of sampling
- air and water temperatures
- water conductivity
- water stage and turbidity
- wetted and rooted widths
- electrofishing unit type
- relevant site observations

The following information was recorded:

- each fish captured was identified as to species, life stage (fry, juvenile or adult), their fork or total length measured, and each individual was photographed
- for fish that were observed, but not captured, if species or life stage could not be identified, they were recorded as unknown
- electrofishing settings
- electrofishing effort (seconds)
- GPS coordinates at the end of each sampling segment

Information was recorded to distinguish for which site each fish was captured within which sampling segment.

3.1.3.2 Electrofishing operations

Electrofishing activities and fish handling were done safely and consistent with the Alberta Fisheries Management Division Electrofishing Policy Respecting Injuries to Fish (GOA 2012), and the conditions of the Fish Research License (20-0210 RL) and SARA permit (20-HCAA-00359).

Captured fish were released back into the 500 m long sampling site from where they were captured, once the site had been sampled.

Fish were monitored for signs of stress through the following measures:

- Electrofisher settings were set according to site water conditions and Alberta Fisheries Management Division Electrofishing Policy Respecting Injuries to Fish (GOA 2012) and conditions placed on provincial Fish Research License permits.
- Conductivity and temperature were monitored in Elbow River and electrofisher settings were adjusted, as needed, to maintain safe and effective operations for fish.
- The electrofishing unit was set to the lowest settings that were effective to capture fish so as to reduce harm to fish.
- Even though the minimum settings to capture fish were utilized, visual observations were routinely made of all captured fish to confirm that 1) there were no electrofishing burns, 2) swimming stability was normal (maintaining position in the water and not floating on side), and 3) stress behavior, such as ventilation rate, was normal and indicative of low stress.
- If any of the above indicators of harm to fish or stressors were observed, the electrofishing unit settings were adjusted to negate any harmful effects.
- Water temperature and dissolved oxygen were routinely monitored in the fish holding containers (i.e., coolers), and adjustments were made, as needed (e.g., replacing water, removing or replacing ice packs, adding aerators).
- Fish that appeared unable to maintain their position in the water were held within the river flow to ventilate the fish before release.

3.1.3.3 Cleaning and Decontamination

Whirling disease has been detected in many watersheds in southern Alberta. Equipment was cleaned and disinfected to reduce the spread of *Myxobolus cerebralis*, the parasite that causes the disease. The Alberta Government has developed standard decontamination protocols for watercraft and equipment (GOA 2017). This protocol was implemented and adhered to throughout the field program.

3.2 BULL TROUT REDD SURVEYS

Fall redd surveys were done for brown trout, brook trout and bull trout; the information is used to determine relative abundance and population size estimates.

3.2.1 Survey Timing

Redd surveys conducted in fall 2019 were documented with results and presented in response to Round 2 AEP Question 69 (Appendix 69-2 and Appendix 69-3).

Bull trout redd surveys were conducted between October 23 and 25, 2019 for the study area of Elbow River between Elbow Falls and Gooseberry Campground. Four bull trout redds were identified. Observations in 2019 were low compared to an estimate of 32 redds in 2006, noted by Popowich and Eisler (2008) between Elbow Falls and Paddy's Flat. No significant spikes in discharge occurred between August 2019 and October 2019 to suggest that degradation occurred; however, some uncertainty existed within these results based on survey timing.

Recognizing the annual variance in habitat conditions, use and spawning activity, an additional bull trout redd survey was conducted in fall 2020. Spot checks were conducted on September 21, 25, and 26, 2020 within the study area, specifically targeting areas were groundwater upwelling was previously observed (Round 2 AEP Question 69, Appendix 69-2) to record temperature and inspect for redds. No redds were identified during the spot checks; therefore, the crew paused efforts and initiated redd surveys of the entire extent of Elbow River between Elbow Falls and Gooseberry Campground between October 1 and 6, 2020. Due to low occurrence of redds during the spot checks, the crew also assessed a portion of Elbow River upstream of Elbow Falls on October 1, 2020 in areas where groundwater upwelling was observed.

3.2.2 Study Area

The study area in fall 2019 and fall 2020 consisted of main stem and side channel habitat on Elbow River between Elbow falls and Gooseberry Campground. The length of Elbow River from Elbow Falls to Gooseberry Campground was walked to visually inspect relevant habitats. This river reach was chosen to replicate previous spawning survey work completed on Elbow River (Popowich 2005; Popowich and Eisler 2008).

3.2.3 Field Observations

Spawning surveys were completed by a crew of two aquatic specialists who traversed the channel(s) in an upstream to downstream direction (when possible). Field staff wore polarized glasses to improve visibility through the water. Confirmed and suspected redds were counted, photographed, and georeferenced. Observations for each redd were completed within Stantec's Electronic Aquatic Utility tool (EAU) where the following information was collected:

- a generic point was used to identify redd location and photos were taken
- each generic point given a unique redd ID
- redd class designation:
  - definite, pit and tail spill recognizable with clean substrate
  - probable, pit and tail spill recognizable with dirty substrate
  - possible, pit and tail spill not recognizable
- denoted if fish observed on redd
- denoted if fish appears to be communal or individual redd (shape)
- stream-bed water depth (immediately upstream of pot)
- velocity and substrate composition

3.3 DATA ANALYSIS

3.3.1 Quality Control

Prior to the analysis of fish sampling data, a review of all field data were conducted. Apparent outliers were verified for accuracy and corrected, based on field notes. Outliers that could not be verified or corrected were removed from the data set.

3.3.2 Relative Abundance

Relative abundance was calculated through catch per unit effort (CPUE) for fish species and life stages in Elbow River. CPUE is a relative abundance index that provides an indirect measure of the number of fish in a given area (i.e., Elbow River study domain, sampling segment) that is commonly used by fisheries managers to assess population trends (Pope et al. 2010; Hunt 2020). Relative abundance can provide indication of population size, trophic interactions, competition, and limiting habitats within a system.

Calculation of CPUE, by Fish Species

CPUE, by fish species, was calculated for each segment by dividing the total number of each fish species captured or observed by the total number of electrofishing seconds accumulated and multiplying by 100.

Example: 90 Bull Trout captured or observed within 10,868 seconds of electrofishing effort

$$\text{CPUE} = (90/10{,}868) \times 100$$

$$= 0.8281$$

Calculation of CPUE, by Life Stage

CPUE, by life stage, was calculated using the same approach as CPUE, by fish species, but done for each life stage (fry, juvenile and adult) of each fish species. The total number of fish captured and observed for each life stage of each fish species was divided by the total number of electrofishing seconds of effort multiplied by 100. Fish that were observed but not captured and could not be identified to life stage were recorded as unknown and a CPUE calculated for this category.

Example: 90 juvenile Bull Trout captured or observed within 10,868 seconds of electrofishing effort

$$\text{CPUE} = (90/10{,}868) \times 100$$

$$= 0.8281$$

Calculation of Error Bars

For each life stage, the CPUE was calculated for each species at each sampled site. This data were plotted in bar graphs showing the CPUE for each species at each sampled site and grouped by life stage. The standard deviation was calculated based on the overall population of each species across all sites for each life stage. The standard deviation for each species was used to represent the error bars in both the positive and negative direction for each life stage on the bar graphs. Due to the nature of the data, error bars less than zero are not shown (e.g., Figure 4-30) because a negative CPUE is not possible. In some instances, a particular species' life stage was only captured at one site (e.g., adult rainbow trout only captured at Segment 13-14). In this case, there are no error bars shown because there are no other individuals of that species within that life stage to compare to.

3.3.3 Population Abundance

Relative abundance, through calculation of CPUE, can reflect population abundance when employed for closed-capture field studies (Pope et al. 2010), such as the use of block nets to keep fish within a segment. In the absence of closed-capture field studies, such as the field methods described here, CPUE can still provide indication of population abundance. The reliability of population abundance through relative abundance values can be refined with several years' worth of standardized data within the study domain and a refined understanding of fish species distribution.

Data obtained through relative abundance and redd surveys was extrapolated to estimate adult population abundance. Redd surveys provide a useful indication of the number of adult fish in a population. For example, bull trout are iteroparous (COSEWIC 2012), meaning that mature adults generally spawn every season. Johnston et al. (2007) reported adult female bull trout abundance in Smith-Dorrien Creek, Alberta, was approximately the same as the spawning redd counts. Considering male and female pairs, if every female spawned, the ratio of adult fish to the number of spawning redds would be 2:1 (if the number of females and males were approximately the same).

There may be some variation to the assumption that every adult spawns per season. Some literature suggests that adults will be inactive for a year and miss a spawning period. Al-Chokhachy et al. (2005) reported the mean number of adult bull trout spawners per redd in eastern Oregon streams was 2.68 (upper and lower bounds of 1.2 and 4.3). Dunham et al. (2001) reported the ratio of adult bull trout population size to redd count varied between 2.6 and 2.8 (i.e., a ratio above 2.0 indicates not all bull trout have spawned). As such, the population size estimates for bull trout includes the assumption that additional bull trout may be present in Elbow River but not actively spawning. Similar ratios for adult pairs were assumed for brook trout and brown trout redd survey data obtained from 2019 (presented in Round 2 AEP Question 69, Appendix 69-3). A factor of 2.0 to 2.8 was applied to redd survey values for estimating the adult population range. Adult population range for other fish species in Elbow River was extrapolated from relative abundance data in a manner that is consistent with the proportions of bull trout, brown trout, and brook trout population ranges.

Estimates of fry and juveniles were extrapolated from the adult population size through assumptions of apparent survival. Avila (2016) reported survival indexes of rainbow trout fry in the wild, and their results suggest that a considerable number of fry do not survive beyond one year. If a similar apparent survival is applied to Elbow River (using the assumption that variance between species and distribution is negligible), 100 juvenile salmonids would survive to one year from groups of fry that range from 3,333 to 20,000.

An example estimate of total population from an adult population range is as follows:

Adult rainbow trout population range = 40-60

Apparent survival = divide population size by 0.03 (lower range factor) to 0.005 (higher range factor) to estimate range of total fish

- *Lower range of total population = 1,333 to 8,000*
- *Higher range of total population = 2,000 to 12,000*

Estimated population range: 1,333 to 12,000 rainbow trout (includes fry, juvenile, adult)

4.0 RESULTS

4.1 RELATIVE ABUNDANCE RESULTS

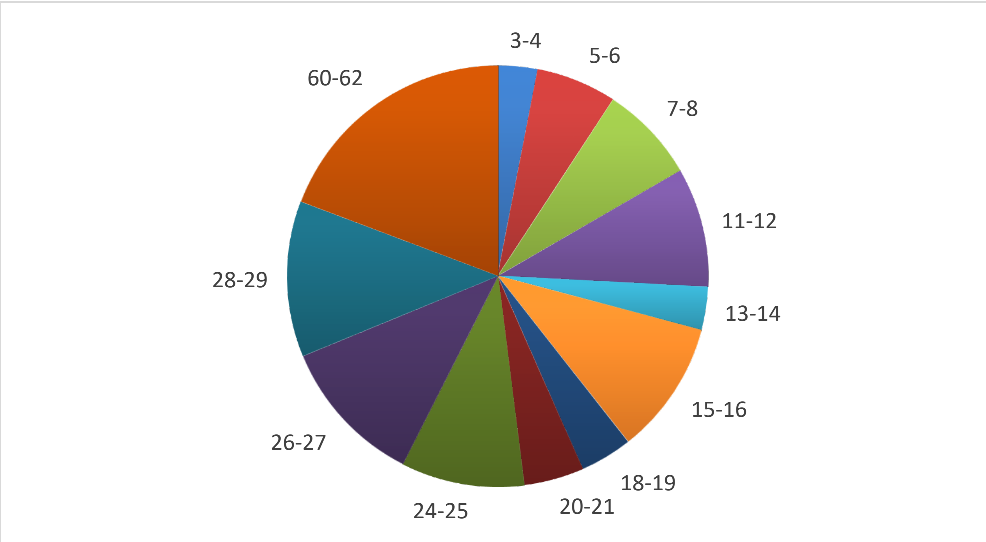
4.1.1 Combined Results

The total electrofishing effort was 109,788 seconds for all segments combined. A total of 1,726 fish were captured and 1,767 observed (i.e., fish were not captured during electrofishing sampling but observed in water by crews wading) for a total of 3,493 fish from the 12 sampling segments (Table 4-1 and Figure 4-1). The total fish captured comprised 16 species. CPUE was lowest at the farthest upstream segment (3-4) and highest at the farthest downstream segment (60-62). CPUE was variable throughout the study domain, ranging from 1.17 to 7.45, with a mean CPUE of 3.23.

Table 4-1 CPUE, by Segment, for Fish Captured and Observed

Segment ID	Electrofishing Time (s)	Number of Fish Captured	Number of Fish Observed	Fish Sum (Captured + Observed)	CPUE (#fish/100s)
3-4	7925	59	34	93	1.17
5-6	10452	150	99	249	2.38
7-8	10008	83	206	289	2.89
11-12	10868	197	189	386	3.55
13-14	9940	84	43	127	1.28
15-16	12080	284	196	480	3.97
18-19	9534	100	48	148	1.55
20-21	7537	94	40	134	1.78
24-25	7557	158	119	277	3.67
26-27	7559	176	155	331	4.38
28-29	8419	198	192	390	4.63
60-62	7909	143	446	589	7.45
TOTAL	**109788**	**1726**	**1767**	**3493**	**3.18**

Figure 4-1 CPUE, by Segment, for Fish Captured and Observed



Longnose dace were the most abundant fish species across all segments (Tables 4-2 and 4-3 and Figures 4-2 and 4-3). This species typically spawns multiple times each season, resulting in their high abundance (Roberts and Grossman 2001). The majority of longnose dace captured were adults.

Salmonids were the most abundant fish in the study domain of all fish captured and identified. Brown trout were the most abundant fish species; however, a relatively large number of unidentified Salmonids were observed but not captured. Brown trout and unidentified Salmonids had the highest relative abundance values, respectively, followed by bull trout, brook trout, and cutthroat trout (Table 4-2).

Table 4-2 CPUE, by Fish Species, for Fish Captured and Observed in all Segments Combined

Species	Total Number of Individuals	CPUE (#fish/100s)
LNSC	73	0.066
MNSC	4	0.004
WHSC	44	0.040
Catostomidae	171	0.156
LKCH	2	0.002
LNDC	1117	1.017
BURB	4	0.004

Table 4-2 CPUE, by Fish Species, for Fish Captured and Observed in all Segments Combined

Species	Total Number of Individuals	CPUE (#fish/100s)
BRST	7	0.006
BKTR	84	0.077
BNTR	811	0.739
BLTR	186	0.169
CTTR	5	0.005
MNWH	40	0.036
RNTR	17	0.015
Salmonidae	922	0.840
Unknown	2	0.002

Figure 4-2 CPUE, by Fish Species, for Fish Captured and Observed in all Segments Combined

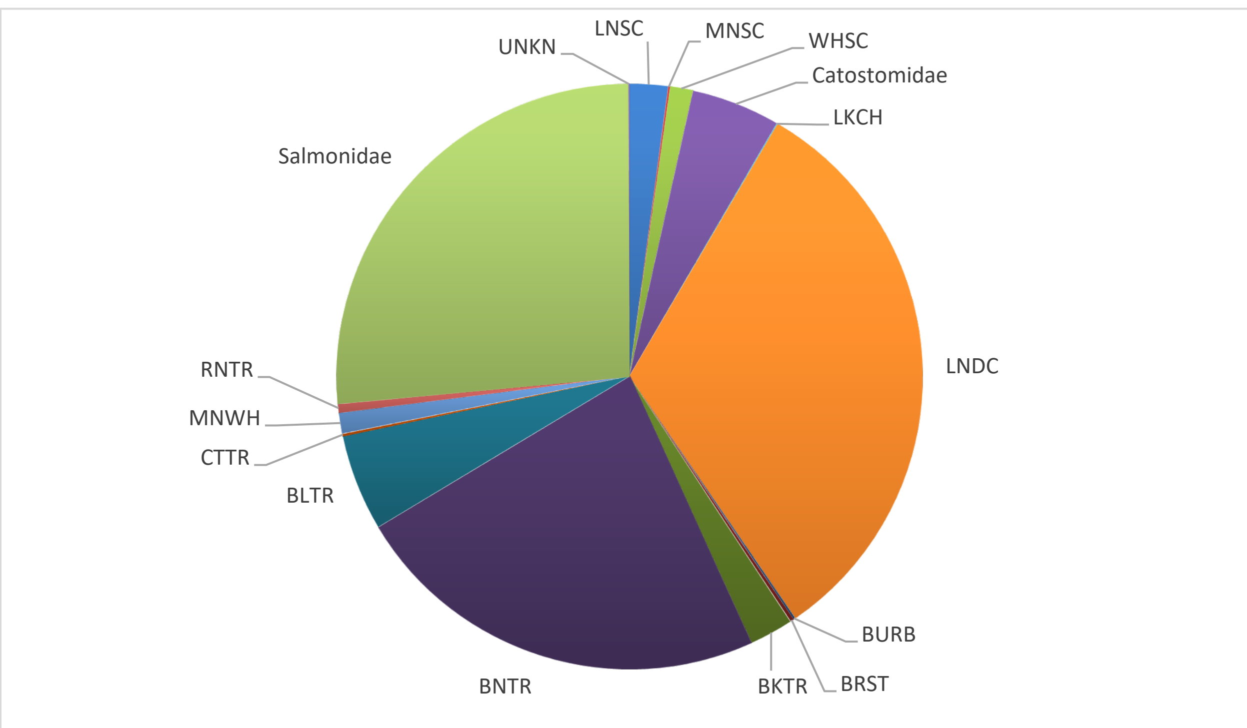
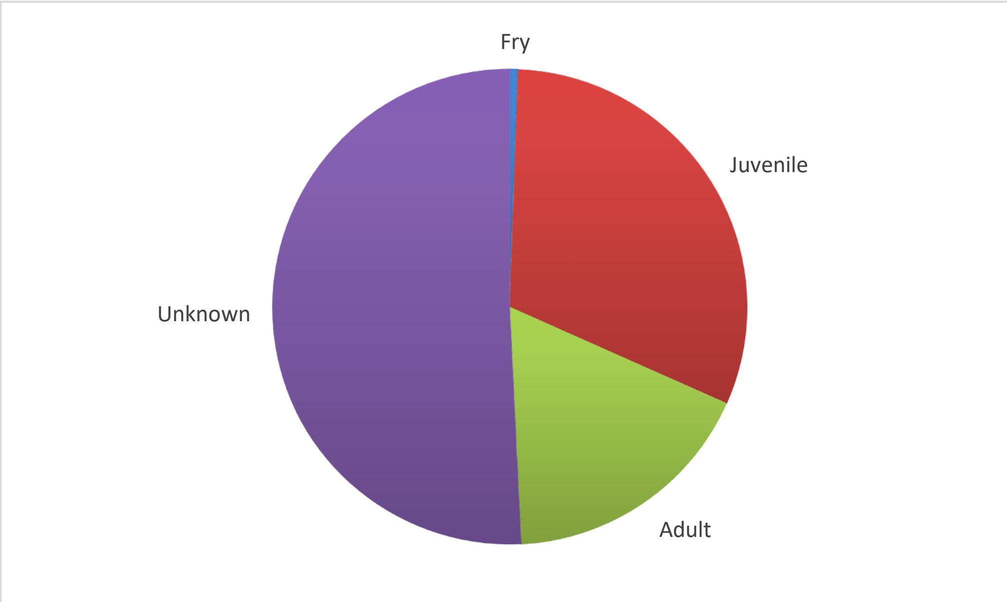


Table 4-3 CPUE, by Fish Species and by Life Stage, for Fish Captured and Observed in all Segments Combined

Species	Number of Fry	Number of Juveniles	Number of Adults	Number of Unknown Life Stage
LNSC	0	46	0	27
MNSC	4	0	0	0
WHSC	4	28	1	5
Catostomidae	0	0	0	171
LKCH	0	2	0	0
LNDC	1	19	486	611
BURB	0	4	0	0
BRST	0	5	2	0
BKTR	0	14	69	0
BNTR	0	732	48	31
BLTR	9	176	1	0
CTTR	1	4	0	0
MNWH	0	37	3	0
RNTR	0	15	2	0
Salmonidae	0	0	0	922
UNKN	1	0	0	1
TOTAL	**20**	**1082**	**612**	**1768**
CPUE (#fish/100s)	**0.02**	**0.99**	**0.56**	**1.61**

Figure 4-3 CPUE, by Life Stage, for Fish Captured and Observed in all Segments Combined



4.1.2 Sampling Segment Results

4.1.2.1 Segment 3-4

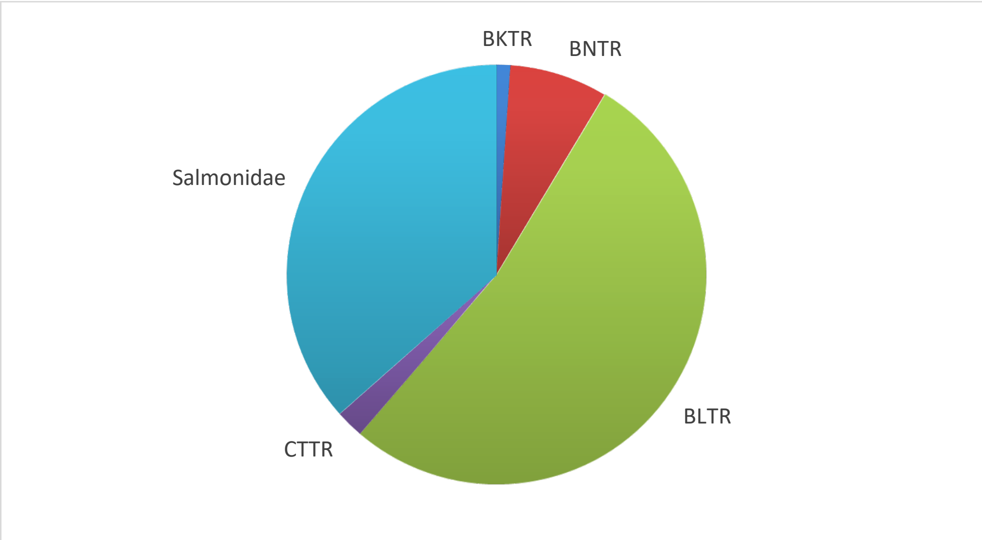
A total of 59 fish were captured and 34 fish observed (not captured) within Segment 3-4 (Table 4-4 and Figure 4-4). Fish captured and identified were four Salmonid species. Bull trout were the most abundant fish species; however, a relatively large number of unidentified Salmonids were observed (not captured). The relative abundance of the other species identified was considerably lower than that for bull trout.

Table 4-4 CPUE, by Fish Species, for Fish Captured and Observed in Segment 3-4

Species	Number Captured	Number Observed	Total Fish	CPUE (#fish/100s)
BKTR	1	0	1	0.013
BNTR	7	0	7	0.088
BLTR	49	0	49	0.618
CTTR	2	0	2	0.025
Salmonidae	0	34	34	0.429
TOTAL[1]	**59**	**34**	**93**	**1.174**

NOTE:
[1] CPUE calculations are based on 7,925 seconds of electrofishing effort. Each CPUE calculation has been rounded to 3 decimal places.

Figure 4-4 CPUE, by Fish Species, for Fish Captured and Observed in Segment 3-4



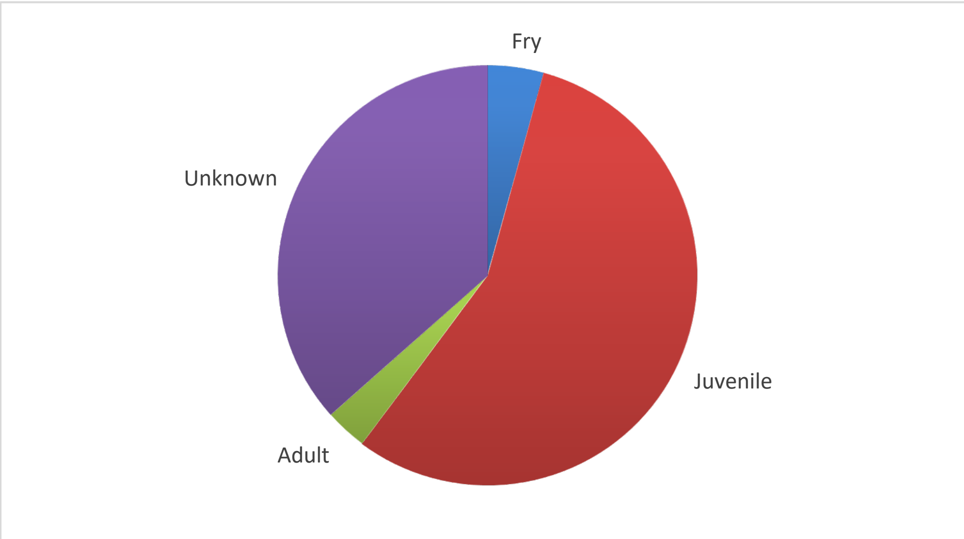
Juvenile bull trout were the most abundant fish species life stage followed by juvenile brown trout (Tables 4-5 and Figure 4-5). A relatively larger number of Salmonids observed (not captured) could not be identified as to life stage.

Table 4-5 CPUE, by Fish Species and by Life Stage, for Fish Captured and Observed in Segment 3-4

	CAPTURED			OBSERVED	CPUE (#fish/100s)			
Species	Fry	Juvenile	Adult	Unknown	Fry	Juvenile	Adult	Unknown
BKTR	0	0	1	0	0	0	0.013	0
BNTR	0	6	1	0	0	0.076	0.013	0
BLTR	4	44	1	0	0.050	0.555	0.013	0
CTTR	0	2	0	0	0	0.025	0	0
Salmonidae	0	0	0	34	0	0	0	0.429
TOTAL[1]	**4**	**52**	**3**	**34**	**0.050**	**0.656**	**0.038**	**0.429**

NOTE:
[1] CPUE calculations for life stages are based on 7,925 seconds of electrofishing effort. Each CPUE calculation has been rounded to 3 decimal places.

Figure 4-5 CPUE, by Life Stage, for Fish Captured and Observed in Segment 3-4



4.1.2.2 Segment 5-6

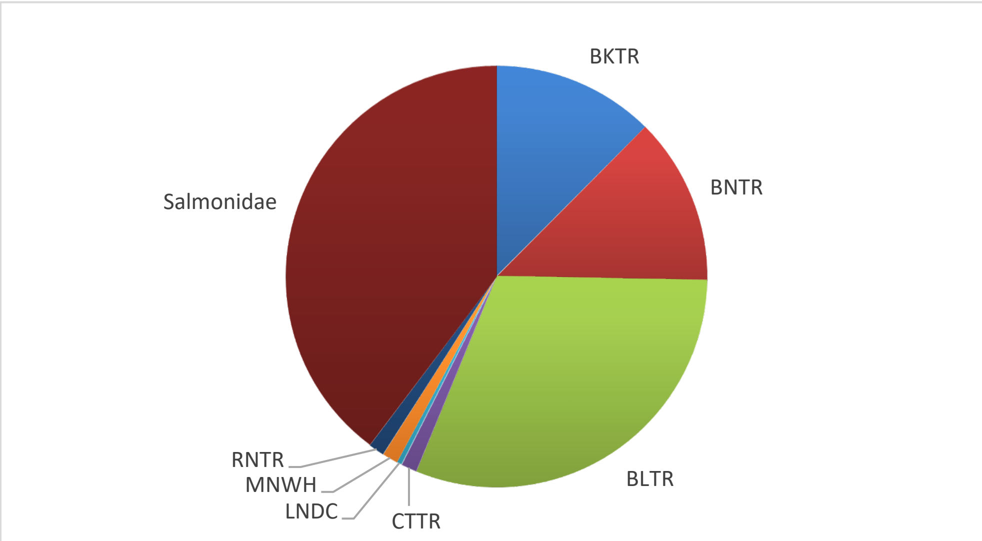
A total of 150 fish were captured and 99 observed (not captured) within Segment 5-6 (Table 4-6 and Figure 4-6). Fish captured and identified were six salmonid species. Bull trout were the most abundant fish species captured; however, a relatively large number of unidentified Salmonids were observed (not captured). The relative abundance of the other species identified in the segment were considerably lower than that for bull trout.

Table 4-6 CPUE, by Fish Species, for Fish Captured and Observed in Segment 5-6

Species	Number Captured	Number Observed	Total Fish	CPUE (#fish/100s)
BKTR	31	0	31	0.297
BNTR	32	0	32	0.306
BLTR	77	0	77	0.737
CTTR	3	0	3	0.029
LNDC	1	0	1	0.010
MNWH	3	0	3	0.029
RNTR	3	0	3	0.029
Salmonidae	0	99	99	0.947
TOTAL[1]	**150**	**99**	**249**	**2.382**

NOTE:
[1] CPUE calculations are based on 10,452 seconds of electrofishing effort. Each CPUE calculation has been rounded to 3 decimal places.

Figure 4-6 CPUE, by Fish Species, for Fish Captured and Observed in Segment 5-6



Juvenile bull trout were the most abundant fish species life stage captured, followed by juvenile brown trout and adult brook trout (Table 4-7 and Figure 4-7). A relatively larger number of salmonids observed (not captured) could not be identified as to life stage.

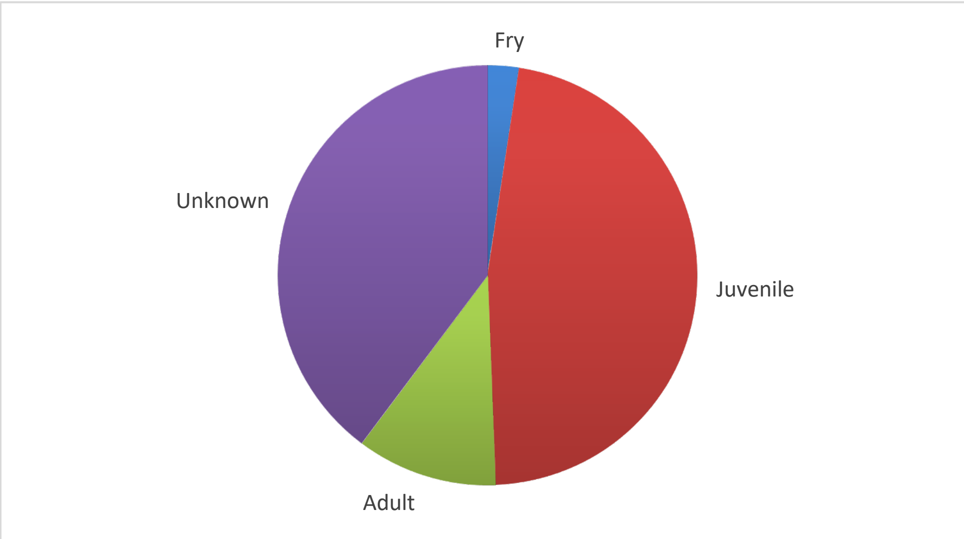
Table 4-7 CPUE, by Fish Species and by Life Stage, for Fish Captured and Observed in Segment 5-6

	CAPTURED			OBSERVED	CPUE (#fish/100s)			
Species	**Fry**	**Juvenile**	**Adult**	**Unknown**	**Fry**	**Juvenile**	**Adult**	**Unknown**
BKTR	0	6	25	0	0	0.057	0.239	0
BNTR	0	31	1	0	0	0.297	0.010	0
BLTR	5	72	0	0	0.048	0.689	0	0
CTTR	1	2	0	0	0.010	0.019	0.0	0
LNDC	0	0	1	0	0	0	0.010	0
MNWH	0	3	0	0	0	0.029	0	0
RNTR	0	3	0	0	0	0.029	0	0
Salmonidae	0	0	0	99	0	0	0	0.947
TOTAL[1]	**6**	**117**	**27**	**99**	**0.057**	**1.119**	**0.258**	**0.947**

NOTE:

[1] CPUE calculations for life stages are based on 10,452 seconds of electrofishing effort. Each CPUE calculation has been rounded to 3 decimal places.

Figure 4-7 CPUE, by Life Stage, for Fish Captured and Observed in Segment 5-6



4.1.2.3 Segment 7-8

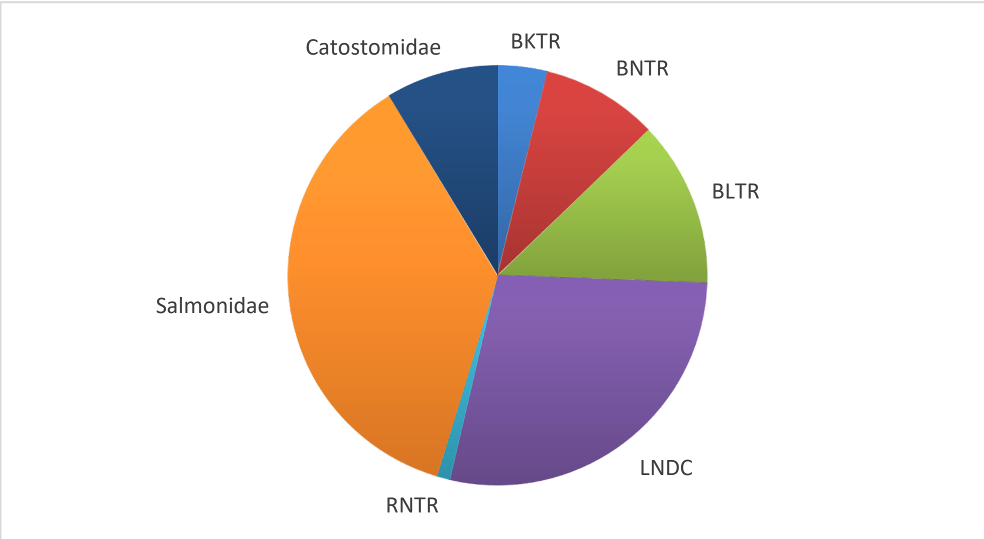
A total of 83 fish were captured and 206 observed (not captured) within Segment 7-8 (Table 4-8 and Figure 4-8). Fish captured and identified were four salmonid species. Bull trout were the most abundant fish species; however, a relatively large number of unidentified Salmonids were observed (not captured). Except for brown trout, the relative abundance of the other species identified in the segment was considerably lower than that for bull trout.

Table 4-8 CPUE, by Fish Species, for Fish Captured and Observed in Segment 7-8

Species	Number Captured	Number Observed	Total Fish	CPUE (#fish/100s)
BKTR	11	0	11	0.110
BNTR	26	0	26	0.260
BLTR	37	0	37	0.370
LNDC	6	75	81	0.809
RNTR	3	0	3	0.030
Salmonidae	0	106	106	1.059
Catostomidae	0	25	25	0.250
TOTAL[1]	**83**	**206**	**289**	**2.888**

NOTE:
[1] CPUE calculations are based on 10,008 seconds of electrofishing effort. Each CPUE calculation has been rounded to 3 decimal places

Figure 4-8 CPUE, by Fish Species, for Fish Captured and Observed in Segment 7-8



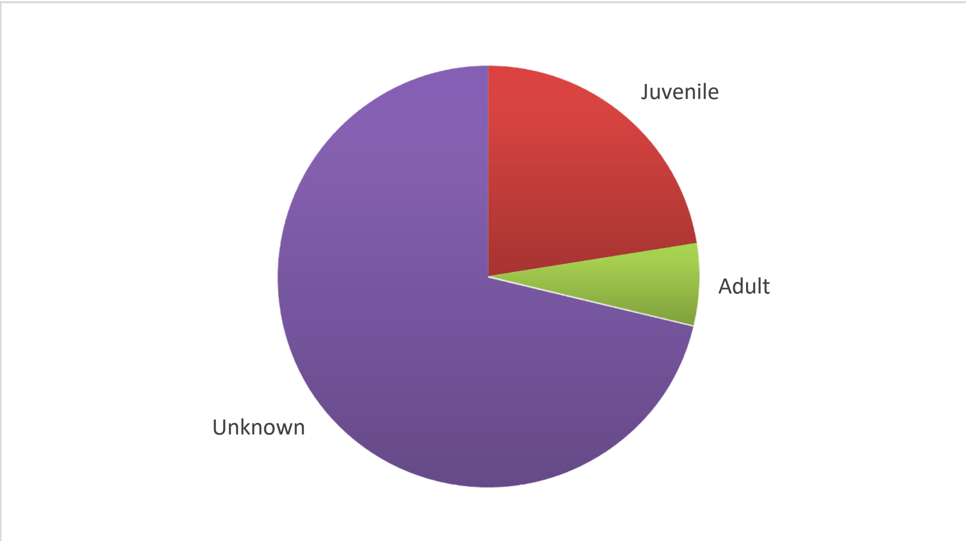
Juvenile bull trout were the most abundant fish species life stage followed by juvenile brown trout and adult brook trout (Table 4-9 and Figure 4-9). A relatively larger number of Salmonids and smaller number of Catostomids observed, but not captured, could not be identified to life stage.

Table 4-9 CPUE, by Fish Species and by Life Stage, for Fish Captured and Observed in Segment 7-8

	CAPTURED			OBSERVED	CPUE (#fish/100s)			
Species	Fry	Juvenile	Adult	Unknown	Fry	Juvenile	Adult	Unknown
BKTR	0	0	11	0	0	0	0.110	0
BNTR	0	25	1	0	0	0.250	0.010	0
BLTR	0	37	0	0	0	0.370	0	0
LNDC	0	0	6	75	0	0	0.060	0.749
RNTR	0	3	0	0	0	0.030	0	0
Salmonidae	0	0	0	106	0	0	0	1.059
Catostomidae	0	0	0	25	0	0	0	0.250
TOTAL[1]	**0**	**65**	**18**	**206**	**0**	**0.649**	**0.180**	**2.058**

NOTE:
[1] CPUE calculations for life stages are based on 10,008 seconds of electrofishing effort. Each CPUE calculation has been rounded to 3 decimal places.

Figure 4-9 CPUE, by Life Stage, for Fish Captured and Observed in Segment 7-8



4.1.2.4 Segment 11-12

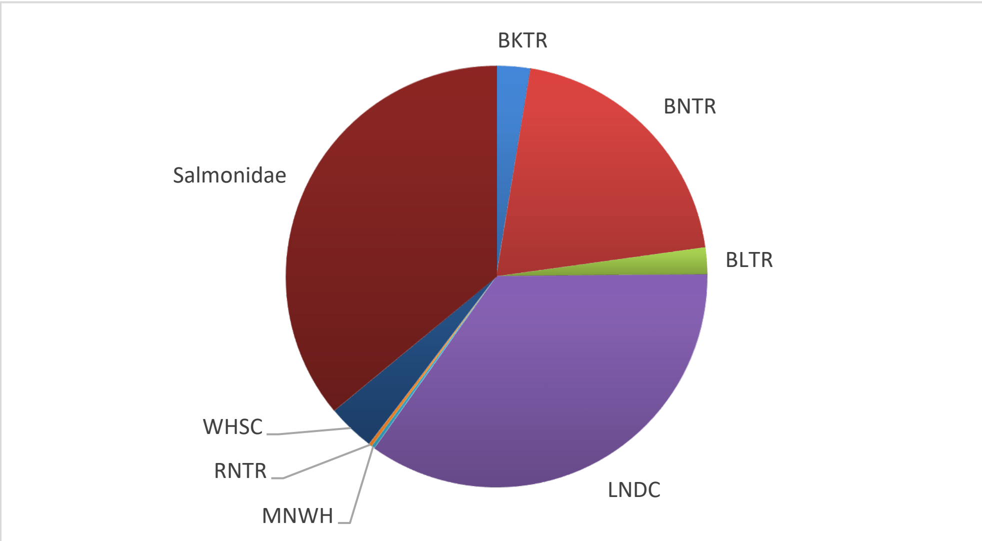
A total of 197 fish were captured and 189 observed but not captured, within Segment 11-12 (Table 4-10 and Figure 4-10). Fish captured and identified were five Salmonid. Brown trout were the most abundant sportfish species; however, a relatively large number of unidentified Salmonids were observed (not captured). The relative abundance of the other species identified in the segment was considerably lower than that for brown trout.

Table 4-10 CPUE, by Fish Species, for Fish Captured and Observed in Segment 11-12

Species	Number Captured	Number Observed	Total Fish	CPUE (#fish/100s)
BKTR	10	0	10	0.092
BNTR	78	0	78	0.718
BLTR	8	0	8	0.074
LNDC	90	45	135	1.242
MNWH	1	0	1	0.009
RNTR	1	0	1	0.009
WHSC	9	5	14	0.129
Salmonidae	0	139	139	1.279
TOTAL[1]	**197**	**189**	**386**	**3.552**

NOTE:
[1] CPUE calculations are based on 10,868 seconds of electrofishing effort. Each CPUE calculation has been rounded to 3 decimal places.

Figure 4-10 CPUE, by Fish Species, for Fish Captured and Observed in Segment 11-12



Juvenile brown trout were the most abundant fish species life stage followed by juvenile bull trout and adult brook trout and juvenile white sucker (Tables 4-11 and Figure 4-11). A relatively larger number of Salmonids observed (not captured) could not be identified as to life stage.

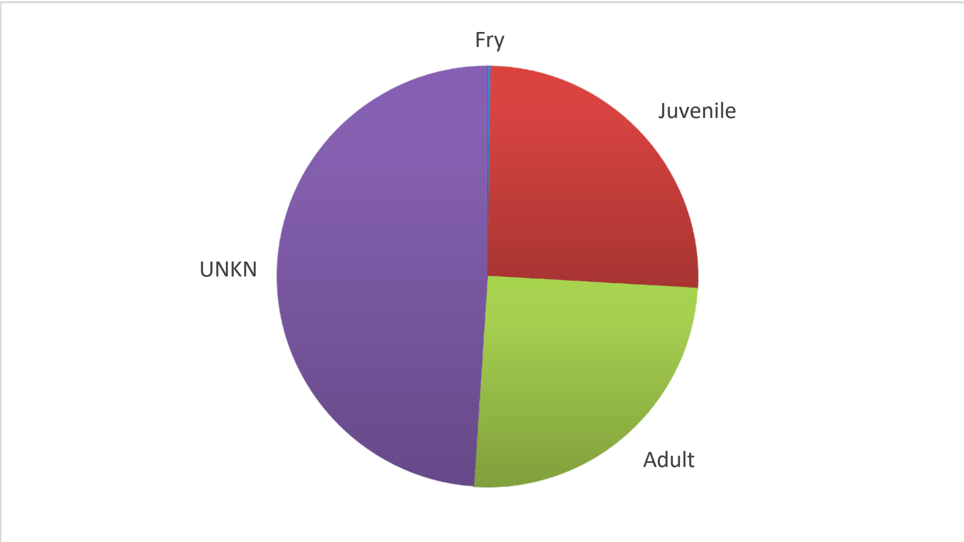
Table 4-11 CPUE, by Fish Species and by Life Stage, for Fish Captured and Observed in Segment 11-12

Species	CAPTURED			OBSERVED	CPUE (#fish/100s)			
	Fry	Juvenile	Adult	Unknown	Fry	Juvenile	Adult	Unknown
BKTR	0	2	8	0	0	0.018	0.074	0
BNTR	0	74	4	0	0	0.681	0.037	0
BLTR	0	8	0	0	0	0.074	0	0
LNDC	0	6	84	45	0	0.055	0.773	0.414
MNWH	0	1	0	0	0	0.009	0	0
RNTR	0	1	0	0	0	0.009	0	0
WHSC	1	7	1	5	0.009	0.064	0.009	0.046
Salmonidae	0	0	0	139	0	0	0	1.279
TOTAL[1]	**1**	**99**	**97**	**189**	**0.009**	**0.911**	**0.893**	**1.739**

NOTE:

[1] CPUE calculations for life stages are based on 10,868 seconds of electrofishing effort. Each CPUE calculation has been rounded to 3 decimal places.

Figure 4-11 CPUE, by Life Stage, for Fish Captured or Observed in Segment 11-12



4.1.2.5 Segment 13-14

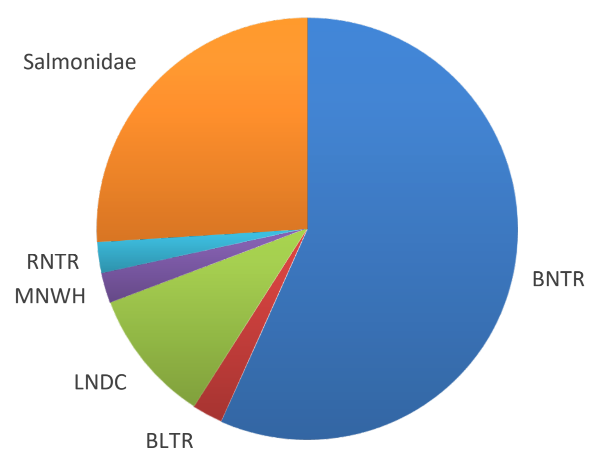
A total of 84 fish were captured and 43 observed but not captured, within Segment 13-14 (Table 4-12 and Figure 4-12). Fish captured and identified were four salmonid species. Brown trout were the most abundant fish species; however, a relatively large number of unidentified Salmonids were observed (not captured). The relative abundance of the other species identified in the segment was considerably lower than that for brown trout.

Table 4-12 CPUE, by Fish Species, for Fish Captured and Observed in Segment 13-14

Species	Number Captured	Number Observed	Total Fish	CPUE (#fish/100s)
BNTR	72	0	72	0.724
BLTR	3	0	3	0.030
LNDC	3	10	13	0.131
MNWH	3	0	3	0.030
RNTR	3	0	3	0.030
Salmonidae	0	33	33	0.332
TOTAL[1]	**84**	**43**	**127**	**1.278**

NOTE:
[1] CPUE calculations are based on 9,940 seconds of electrofishing effort. Each CPUE calculation has been rounded to 3 decimal places.

Figure 4-12 CPUE, by Fish Species, for Fish Captured and Observed in Segment 13-14



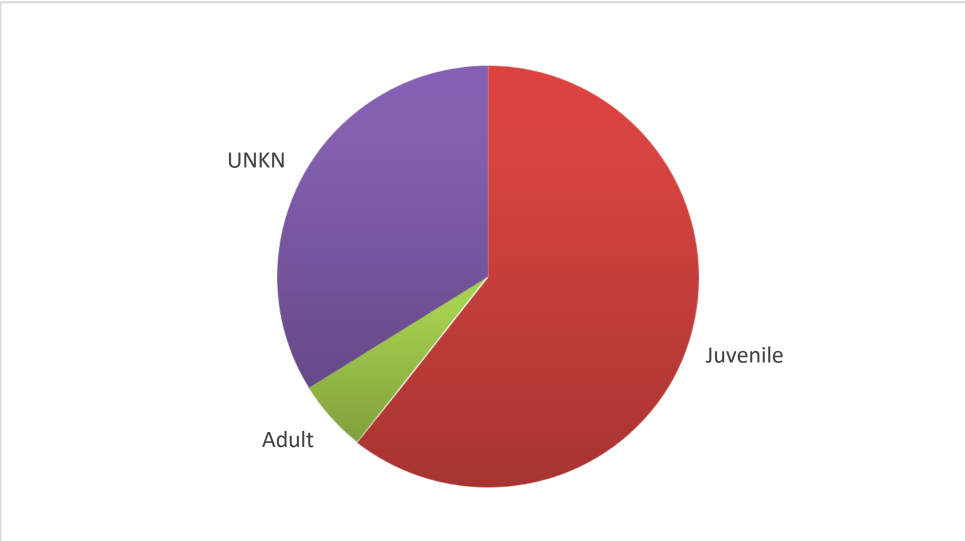
Juvenile brown trout were the most abundant fish species life stage (Tables 4-13 and Figure 4-13). A relatively larger number of Salmonids observed (not captured) could not be identified to life stage.

Table 4-13 CPUE, by Fish Species and by Life Stage, for Fish Captured and Observed in Segment 13-14

	CAPTURED			OBSERVED	CPUE (#fish/100s)			
Species	**Fry**	**Juvenile**	**Adult**	**Unknown**	**Fry**	**Juvenile**	**Adult**	**Unknown**
BNTR	0	71	1	0	0	0.714	0.010	0
BLTR	0	3	0	0	0	0.030	0	0
LNDC	0	0	3	10	0	0	0.030	0.101
MNWH	0	2	1	0	0	0.020	0.010	0
RNTR	0	1	2	0	0	0.010	0.020	0
Salmonidae	0	0	0	33	0	0	0	0.332
TOTAL[1]	**0**	**77**	**7**	**43**	**0**	**0.775**	**0.070**	**0.433**

NOTE:
[1] CPUE calculations for life stages are based on 9,940 seconds of electrofishing effort. Each CPUE calculation has been rounded to 3 decimal places.

Figure 4-13 CPUE, by Life Stage, for Fish Captured and Observed in Segment 13-14



4.1.2.6 Segment 15-16

A total of 284 fish were captured and 196 observed (not captured) within Segment 15-16 (Table 4-14 and Figure 4-14). Fish captured and identified were four salmonid species. Brown trout were the most abundant fish species; however, a relatively large number of unidentified Salmonids were observed (not captured). The relative abundance of the other species identified in the segment was considerably lower than that for brown trout.

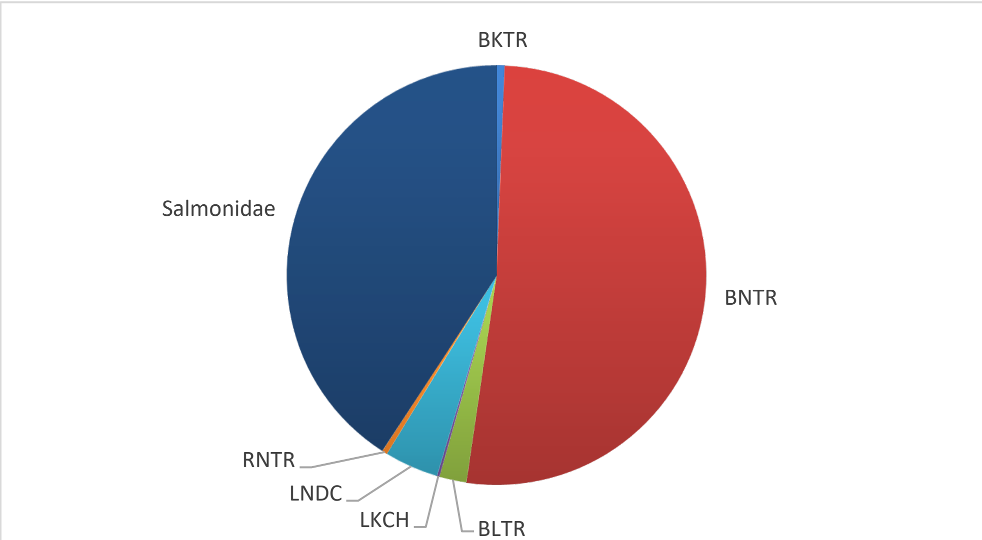
Table 4-14 CPUE, by Fish Species, for Fish Captured and Observed in Segment 15-16

Species	Number Captured	Number Observed	Total Fish	CPUE (#fish/100s)
BKTR	3	0	3	0.025
BNTR	248	0	248	2.053
BLTR	10	0	10	0.083
LKCH	1	0	1	0.008
LNDC	20	0	20	0.166
RNTR	2	0	2	0.017
Salmonidae	0	196	196	1.623
TOTAL[1]	**284**	**196**	**480**	**3.974**

NOTE:

[1] CPUE calculations are based on 12,080 seconds of electrofishing effort. Each CPUE calculation has been rounded to 3 decimal places.

Figure 4-14 CPUE, by Fish Species, for Fish Captured and Observed in Segment 15-16



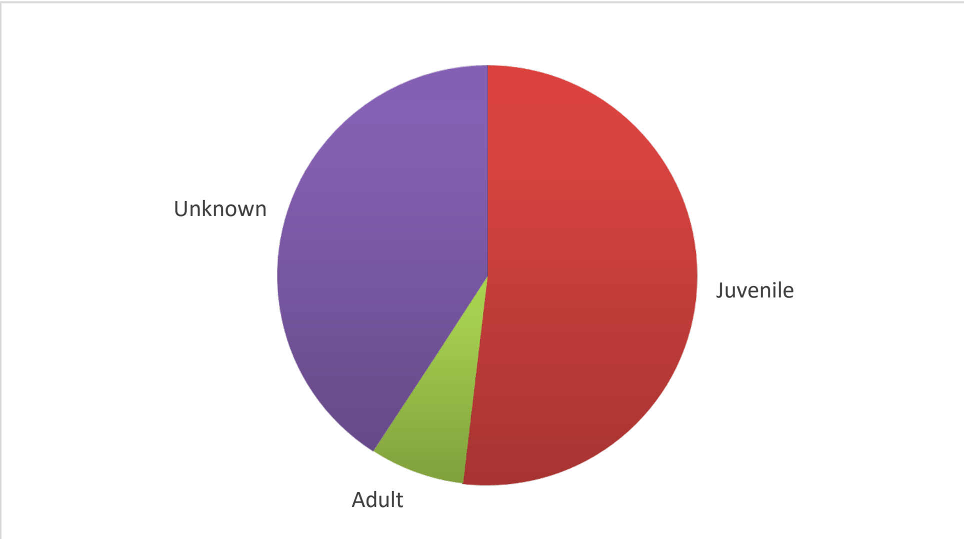
Juvenile brown trout were the most abundant fish species life stage followed by adult brown trout and juvenile bull trout (Table 4-15 and Figure 4-15). A relatively larger number of Salmonids observed (not captured) could not be identified to life stage.

Table 4-15 CPUE, by Fish Species and by Life Stage, for Fish Captured and Observed in Segment 15-16

Species	CAPTURED			OBSERVED	CPUE (#fish/100s)			
	Fry	Juvenile	Adult	Unknown	Fry	Juvenile	Adult	Unknown
BKTR	0	0	3	0	0	0	0.025	0
BNTR	0	235	13	0	0	1.945	0.108	0
BLTR	0	10	0	0	0	0.083	0	0
LKCH	0	1	0	0	0	0.008	0	0
LNDC	0	1	19	0	0	0.008	0.157	0
RNTR	0	2	0	0	0	0.017	0	0
Salmonidae	0	0	0	196	0	0	0	1.623
TOTAL[1]	**0**	**249**	**35**	**196**	**0**	**2.061**	**0.290**	**1.623**

NOTE:
[1] CPUE calculations for life stages are based on 12,080 seconds of electrofishing effort. Each CPUE calculation has been rounded to 3 decimal places.

Figure 4-15 CPUE, by Life Stage, for Fish Captured and Observed in Segment 15-16



4.1.2.7 Segment 18-19

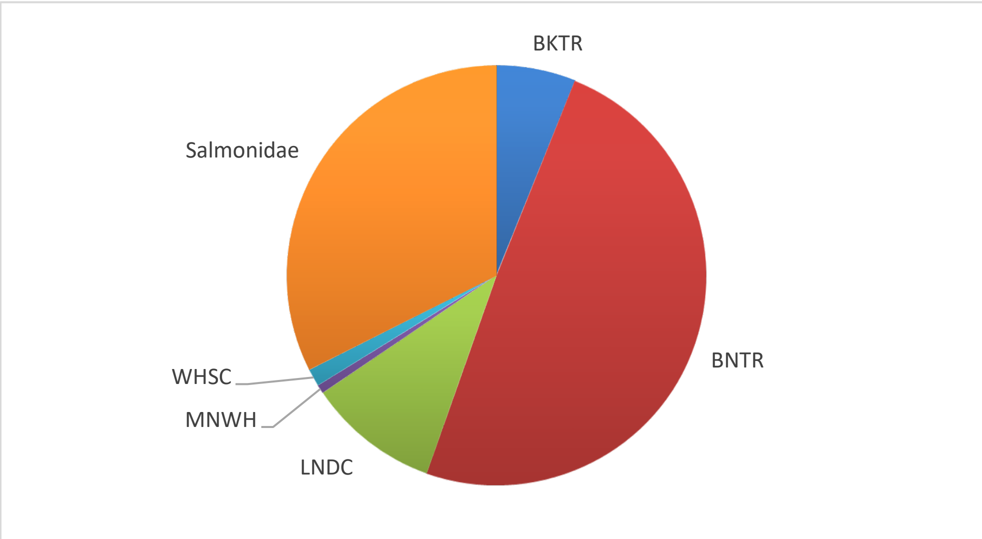
A total of 100 fish were captured and 48 observed but not captured, within Segment 18-19 (Table 4-16 and Figure 4-16). Fish captured and identified were three salmonid species. Brown trout were the most abundant fish species; however, a relatively large number of unidentified Salmonids were observed (not captured). The relative abundance of the other species identified in the segment was considerably lower than that for brown trout.

Table 4-16 CPUE, by Fish Species, for Fish Captured and Observed in Segment 18-19

Species	Number Captured	Number Observed	Total Fish	CPUE (#fish/100s)
BKTR	9	0	9	0.094
BNTR	73	0	73	0.766
LNDC	15	0	15	0.157
MNWH	1	0	1	0.010
WHSC	2	0	2	0.021
Salmonidae	0	48	48	0.503
TOTAL[1]	**100**	**48**	**148**	**1.552**

NOTE:
[1] CPUE calculations are based on 9,534 seconds of electrofishing effort. Each CPUE calculation has been rounded to 3 decimal places

Figure 4-16 CPUE, by Fish Species, for Fish Captured and Observed in Segment 18-19



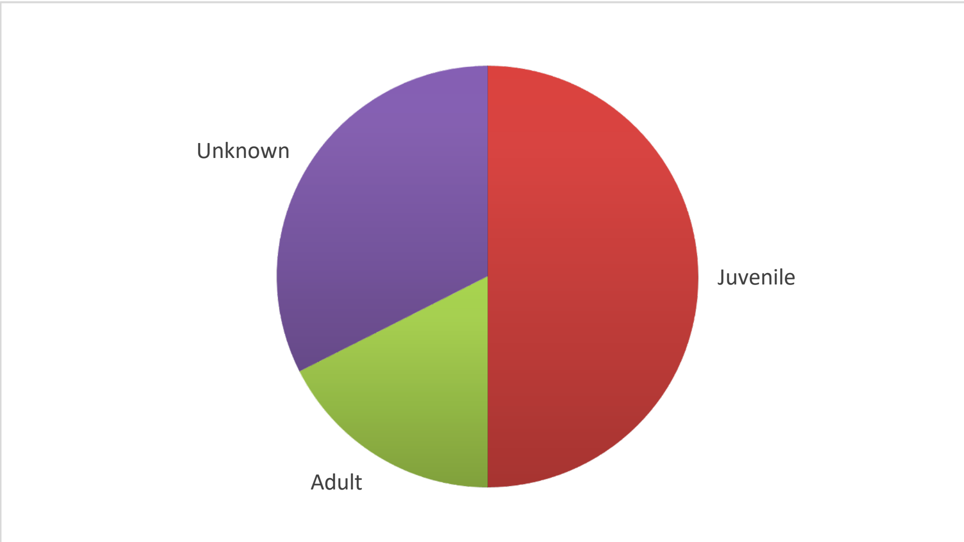
Juvenile brown trout were the most abundant fish species life stage followed by adult life stage brook trout and brown trout (Table 4-17 and Figure 4-17). A relatively larger number of Salmonids observed (not captured) could not be identified as to life stage.

Table 4-17 CPUE, by Fish Species and by Life Stage, for Fish Captured and Observed in Segment 18-19

	CAPTURED			OBSERVED	CPUE			
Species	**Fry**	**Juvenile**	**Adult**	**Unknown**	**Fry**	**Juvenile**	**Adult**	**Unknown**
BKTR	0	1	8	0	0	0.010	0.084	0
BNTR	0	69	4	0	0	0.724	0.042	0
LNDC	0	1	14	0	0	0.010	0.147	0
MNWH	0	1	0	0	0	0.010	0	0
WHSC	0	2	0	0	0	0.021	0	0
Salmonidae	0	0	0	48	0	0	0	0.503
TOTAL[1]	**0**	**74**	**26**	**48**	**0**	**0.776**	**0.273**	**0.503**

NOTE:
[1] CPUE calculations for life stages are based on 9,534 seconds of electrofishing effort. Each CPUE calculation has been rounded to 3 decimal places.

Figure 4-17 CPUE, by Life Stage, for Fish Captured and Observed in Segment 18-19



4.1.2.8 Segment 20-21

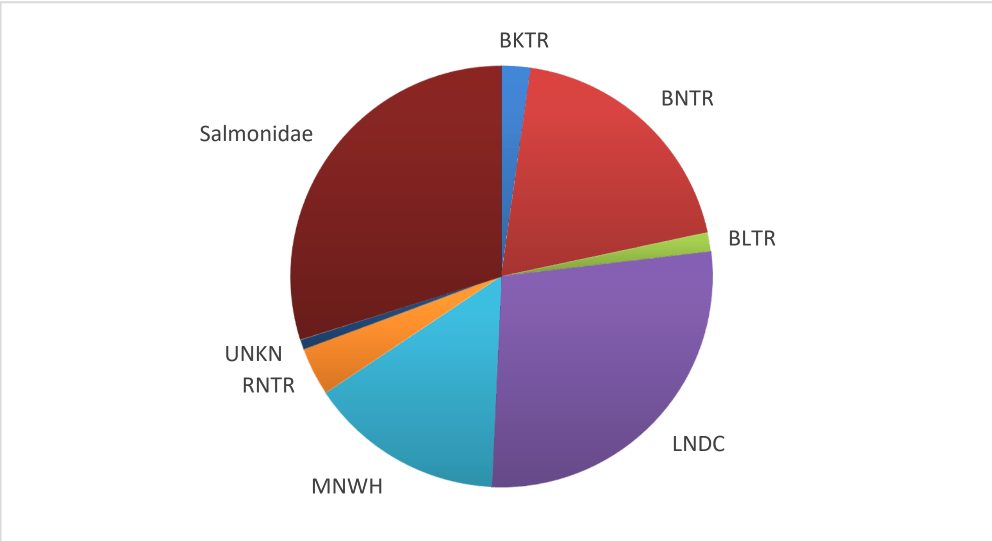
A total of 94 fish were captured and 40 observed but not captured, within Segment 20-21 (Table 4-18 and Figure 4-18). Fish captured and identified were five salmonid species. Brown trout were the most abundant sportfish species; however, a relatively large number of unidentified Salmonids were observed but not captured. Except for mountain whitefish, the relative abundance of the other species identified in the segment was considerably lower than that for brown trout.

Table 4-18 CPUE, by Fish Species, for Fish Captured and Observed in Segment 20-21

Species	Number Captured	Number Observed	Total Fish	CPUE (#fish/100s)
BKTR	3	0	3	0.040
BNTR	26	0	26	0.345
BLTR	2	0	2	0.027
LNDC	37	0	37	0.491
MNWH	20	0	20	0.265
RNTR	5	0	5	0.066
Unknown	1	0	1	0.013
Salmonidae	0	40	40	0.531
TOTAL[1]	**94**	**40**	**134**	**1.778**

NOTE:
[1] CPUE calculations are based on 7,537 seconds of electrofishing effort. Each CPUE calculation has been rounded to 3 decimal places.

Figure 4-18 CPUE, by Fish Species, for Fish Captured and Observed in Segment 20-21



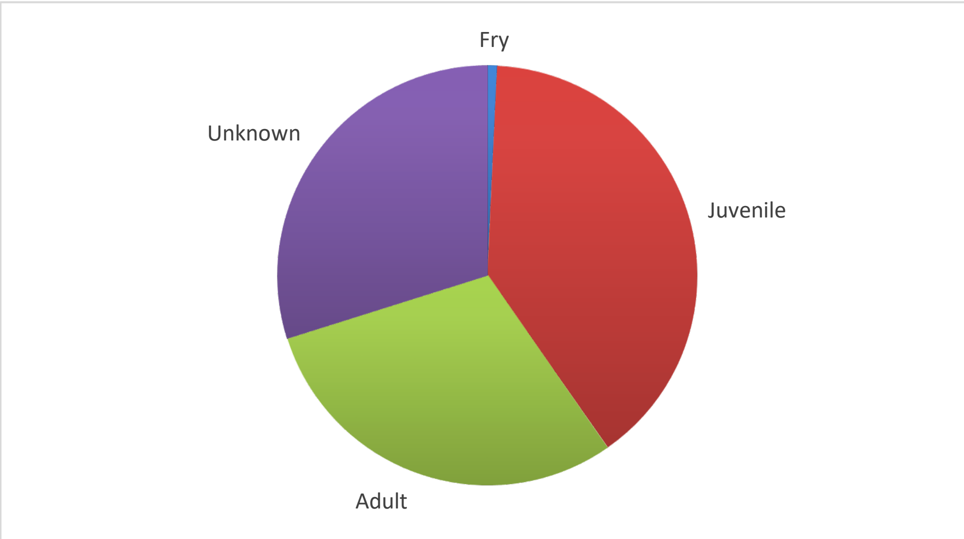
Juvenile brown trout and mountain whitefish were the most abundant fish species life stage (Tables 4-19 and Figure 4-19). A relatively larger number of Salmonids observed (not captured) could not be identified to life stage.

Table 4-19 CPUE, by Fish Species and by Life Stage, for Fish Captured and Observed in Segment 20-21

	CAPTURED			OBSERVED	CPUE (#fish/100s)			
Species	**Fry**	**Juvenile**	**Adult**	**Unknown**	**Fry**	**Juvenile**	**Adult**	**Unknown**
BKTR	0	0	3	0	0	0	0.040	0
BNTR	0	26	0	0	0	0.3455	0	0
BLTR	0	2	0	0	0	0.027	0	0
LNDC	0	0	37	0	0	0	0.491	0
MNWH	0	20	0	0	0	0.265	0	0
RNTR	0	5	0	0	0	0.066	0	0
UNKN	1	0	0	0	0.013	0	0	0
Salmonidae	0	0	0	40	0	0	0	0.531
TOTAL[1]	**1**	**53**	**40**	**40**	**0.013**	**0.703**	**0.531**	**0.531**

NOTE:
[1] CPUE calculations for life stages are based on 7,537 seconds of electrofishing effort. Each CPUE calculation has been rounded to 3 decimal places.

Figure 4-19 CPUE, by Life Stage, for Fish Captured and Observed in Segment 20-21



4.1.2.9 Segment 24-25

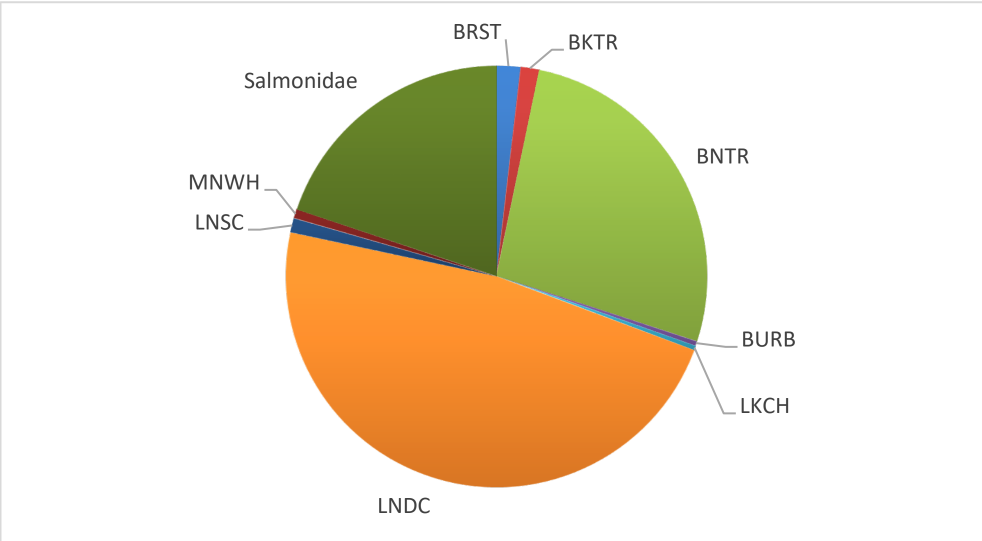
A total of 158 fish were captured and 119 observed but not captured, within Segment 24-25 (Table 4-20 and Figure 4-20). Fish captured and identified were three salmonid species. Brown trout were the most abundant sportfish species; however, a relatively large number of unidentified Salmonids were observed but not captured. The relative abundance of the other species identified in the segment was considerably lower than that for brown trout.

Table 4-20 CPUE, by Fish Species, for Fish Captured and Observed in Segment 24-25

Species	Number Captured	Number Observed	Total Fish	CPUE (#fish/100s)
BRST	5	0	5	0.066
BKTR	4	0	4	0.053
BNTR	74	0	74	0.979
BURB	1	0	1	0.013
LKCH	1	0	1	0.013
LNDC	68	64	132	1.747
LNSC	3	0	3	0.040
MNWH	2	0	2	0.026
Salmonidae	0	55	55	0.728
TOTAL[1]	**158**	**119**	**277**	**3.665**

NOTE:
[1] CPUE calculations are based on 7,557 seconds of electrofishing effort. Each CPUE calculation has been rounded to 3 decimal places.

Figure 4-20 CPUE, by Fish Species, for Fish Captured and Observed in Segment 24-25



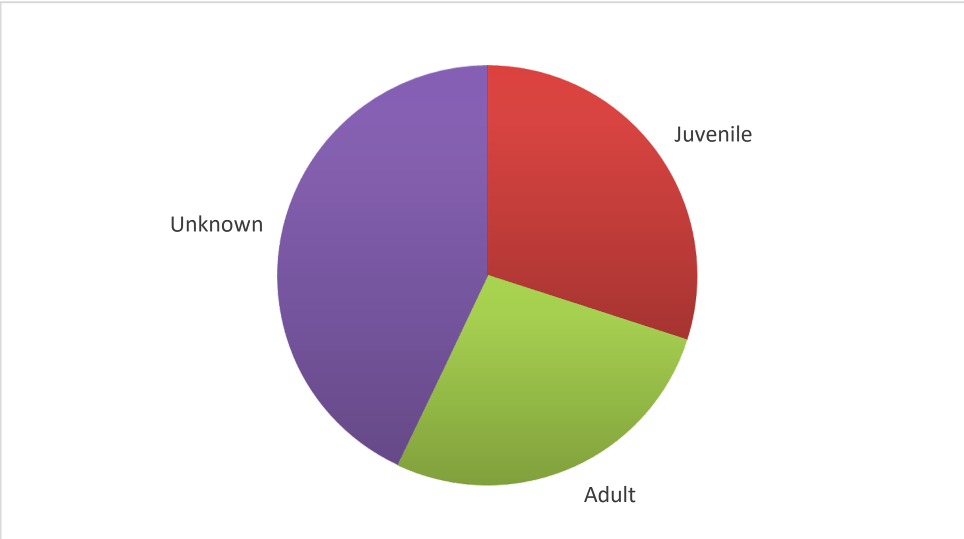
Juvenile brown trout were the most abundant fish species life stage (Table 4-21 and Figure 4-21). A relatively larger number of Salmonids observed (not captured) could not be identified to life stage

Table 4-21 CPUE, by Fish Species and by Life Stage, for Fish Captured and Observed in Segment 24-25

	CAPTURED			OBSERVED	CPUE (#fish/100s)			
Species	**Fry**	**Juvenile**	**Adult**	**Unknown**	**Fry**	**Juvenile**	**Adult**	**Unknown**
BRST	0	4	1	0	0	0.053	0.013	0
BKTR	0	2	2	0	0	0.026	0.026	0
BNTR	0	70	4	0	0	0.926	0.053	0
BURB	0	1	0	0	0	0.013	0	0
LKCH	0	1	0	0	0	0.013	0	0
LNDC	0	1	67	64	0	0.013	0.887	0.847
LNSC	0	3	0	0	0	0.040	0	0
MNWH	0	1	1	0	0	0.013	0.013	0
Salmonidae	0	0	0	55	0	0	0	0.728
TOTAL	**0**	**83**	**75**	**119**	**0**	**1.098**	**0.992**	**1.575**

NOTE:
[1] CPUE calculations for life stages are based on 7,557 seconds of electrofishing effort. Each CPUE calculation has been rounded to 3 decimal places.

Figure 4-21 CPUE, by Life Stage, for Fish Captured and Observed in Segment 24-25



4.1.2.10 Segment 26-27

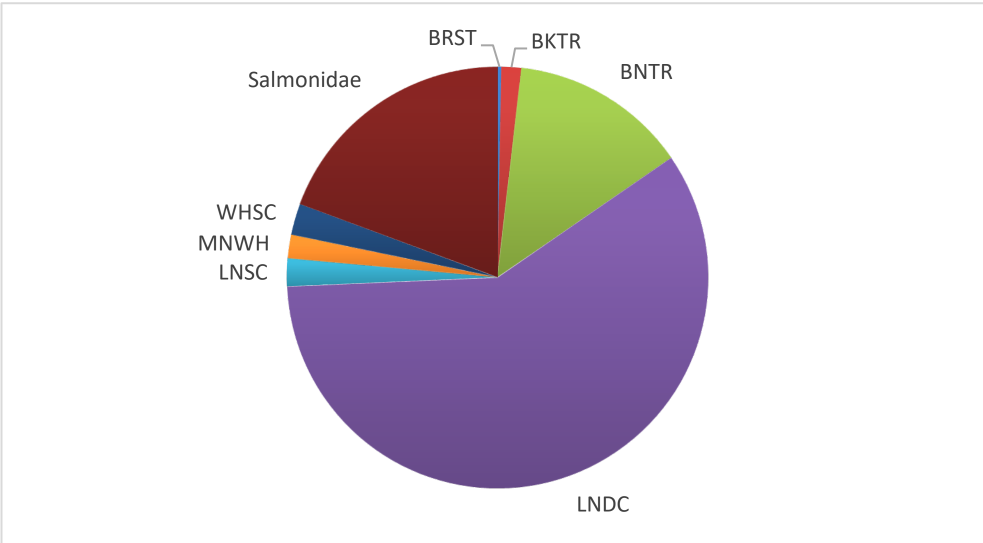
A total of 176 fish were captured and 155 observed but not captured, within Segment 26-27 (Table 4-22 and Figure 4-22). Fish captured and identified were three salmonid species. Brown trout were the most abundant sportfish species; however, a relatively large number of unidentified Salmonids were observed but not captured. The relative abundance of the other species identified in the segment was considerably lower than that for brown trout.

Table 4-22 CPUE, by Fish Species, for Fish Captured and Observed in Segment 26-27

Species	Number Captured	Number Observed	Total Fish	CPUE (#fish/100s)
BRST	1	0	1	0.013
BKTR	5	0	5	0.066
BNTR	45	0	45	0.595
LNDC	104	91	195	2.580
LNSC	7	0	7	0.093
MNWH	6	0	6	0.079
WHSC	8	0	8	0.106
Salmonidae	0	64	64	0.847
TOTAL[1]	**176**	**155**	**331**	**4.379**

NOTE:
[1] CPUE calculations are based on 7,559 seconds of electrofishing effort. Each CPUE calculation has been rounded to 3 decimal places.

Figure 4-22 CPUE, by Fish Species, for Fish Captured and Observed in Segment 26-27



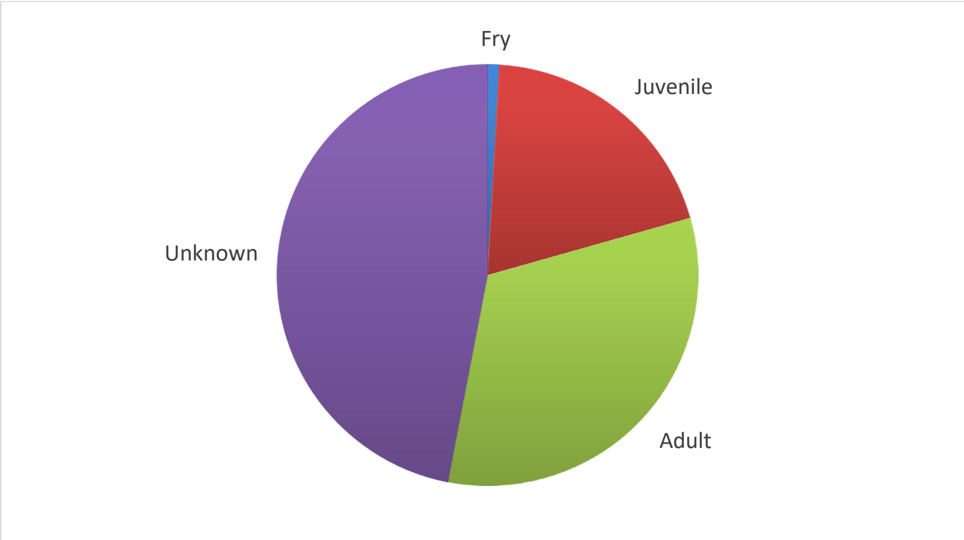
Adult longnose dace were the most abundant fish species life stage followed by juvenile life stage brown trout (Table 4-23 and Figure 4-23). A relatively larger number of Salmonidae observed (not captured) could not be identified to life stage.

Table 4-23 CPUE, by Fish Species and by Life Stage, for Fish Captured and Observed in Segment 26-27

Species	CAPTURED			OBSERVED	CPUE (#fish/100s)			
	Fry	Juvenile	Adult	Unknown	Fry	Juvenile	Adult	Unknown
BRST	0	1	0	0	0	0.013	0	0
BKTR	0	1	3	0	0	0.013	0.040	0
BNTR	0	40	5	0	0	0.529	0.066	0
LNDC	1	5	98	91	0.013	0.066	1.296	1.204
LNSC	0	7	0	0	0	0.093	0	0
MNWH	0	5	1	0	0	0.066	0.013	0
WHSC	2	6	0	0	0.026	0.079	0	0
Salmonidae	0	0	0	64	0	0	0	0.847
TOTAL[1]	**3**	**65**	**107**	**155**	**0.040**	**0.860**	**1.416**	**2.051**

NOTE:
[1] CPUE calculations for life stages are based on 7,559 seconds of electrofishing effort. Each CPUE calculation has been rounded to 3 decimal places.

Figure 4-23 CPUE, by Life Stage, for Fish Captured and Observed in Segment 26-27



4.1.2.11 Segment 28-29

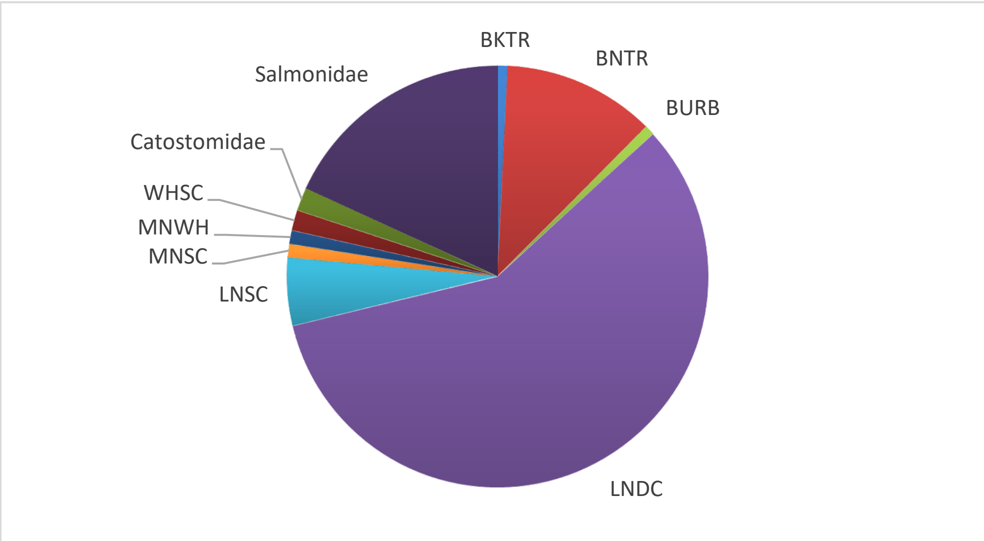
A total of 194 fish were captured and 192 observed but not captured, within Segment 28-29 (Table 4-24 and Figure 4-24). Fish captured and identified were three Salmonid species. Brown trout were the most abundant sportfish species; however, a relatively large number of unidentified Salmonids were observed but not captured. Except for longnose sucker, the relative abundance of the other species identified was considerably lower than that for brown trout.

Table 4-24 CPUE, by Fish Species, for Fish Captured and Observed in Segment 28-29

Species	Number Captured	Number Observed	Total Fish	CPUE (#fish/100s)
BKTR	3	0	3	0.036
BNTR	45	0	45	0.535
BURB	3	0	3	0.036
LNDC	109	115	224	2.661
LNSC	20	0	20	0.238
MNSC	4	0	4	0.048
MNWH	4	0	4	0.048
WHSC	6	0	6	0.071
Catostomidae	0	7	7	0.083
Salmonidae	0	70	70	0.831
TOTAL[1]	**194**	**192**	**386**	**4.585**

NOTE:
[1] CPUE calculations are based on 8,419 seconds of electrofishing effort. Each CPUE calculation has been rounded to 3 decimal places.

Figure 4-24 CPUE, by Fish Species, for Fish Captured and Observed in Segment 28-29



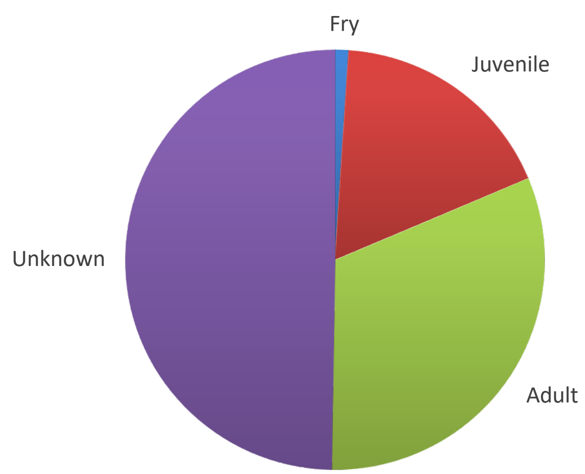
Adult longnose dace were the most abundant fish species life stage, followed by juvenile brown trout and juvenile longnose sucker (Table 4-25 and Figure 4-25). A relatively larger number of Salmonidae observed, but not captured, could not be identified to life stage.

Table 4-25 CPUE, by Fish Species and by Life Stage, for Fish Captured and Observed in Segment 28-29

Species	CAPTURED			OBSERVED	CPUE (#fish/100s)			
	Fry	Juvenile	Adult	Unknown	Fry	Juvenile	Adult	Unknown
BKTR	0	0	3	0	0	0	0.036	0
BNTR	0	36	9	0	0	0.428	0.107	0
BURB	0	3	0	0	0	0.036	0	0
LNDC	0	0	109	115	0	0	1.295	1.366
LNSC	0	20	0	0	0	0.238	0	0
MNSC	4	0	0	0	0.048	0	0	0
MNWH	0	4	0	0	0	0.048	0	0
WHSC	0	5	1	0	0	0.059	0.012	0
Catostomidae	0	0	0	7	0	0	0	0.083
Salmonidae	0	0	0	70	0	0	0	0.831
TOTAL[1]	**4**	**68**	**122**	**192**	**0.048**	**0.808**	**1.449**	**2.281**

NOTE:
[1] CPUE calculations for life stages are based on 8,419 seconds of electrofishing effort. Each CPUE calculation has been rounded to 3 decimal places.

Figure 4-25 CPUE, by Life Stage, for Fish Captured and Observed in Segment 28-29



4.1.2.12 Segment 60-62

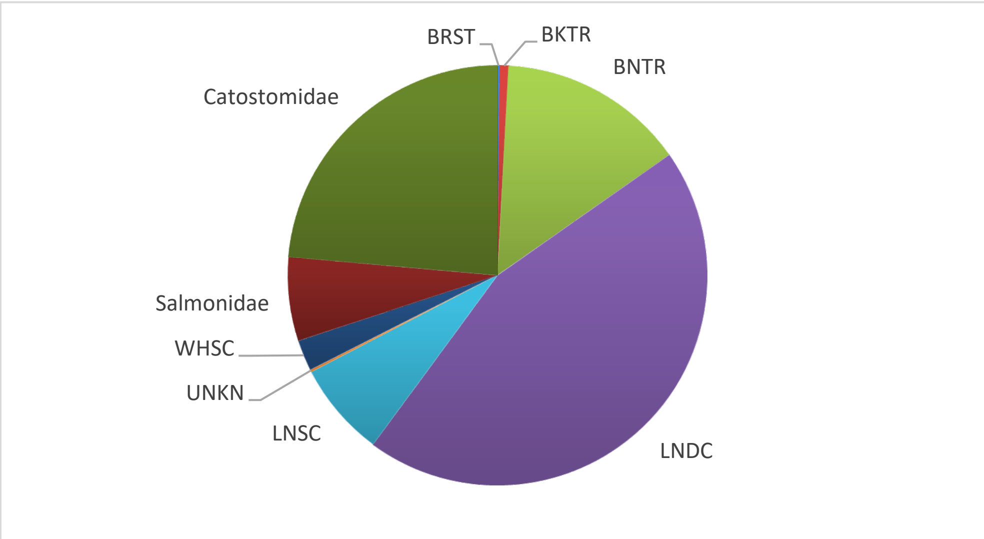
A total of 143 fish were captured and 446 observed but not captured, within Segment 60-62 (Table 4-26 and Figure 4-26). Fish captured and identified were two Salmonid species. Brown trout were the most abundant sportfish species; however, a relatively large number of unidentified Salmonids and Catostomids were observed but not captured. Except for longnose sucker and white sucker, the relative abundance of the other species was considerably lower than that for brown trout.

Table 4-26 CPUE, by Fish Species, for Fish Captured and Observed in Segment 60-62

Species	Number Captured	Number Observed	Total Fish	CPUE (#fish/100s)
BRST	1		1	0.013
BKTR	4		4	0.051
BNTR	54	31	85	1.075
LNDC	53	211	264	3.338
LNSC	16	27	43	0.544
UNKN	1		1	0.013
WHSC	14		14	0.177
Salmonidae		38	38	0.480
Catostomidae		139	139	1.757
TOTAL[1]	**143**	**446**	**589**	**7.447**

NOTE:
[1] CPUE calculations are based on 7,909 seconds of electrofishing effort. Each CPUE calculation has been rounded to 3 decimal places.

Figure 4-26 CPUE, by Fish Species, for Fish Captured and Observed in Segment 60-62



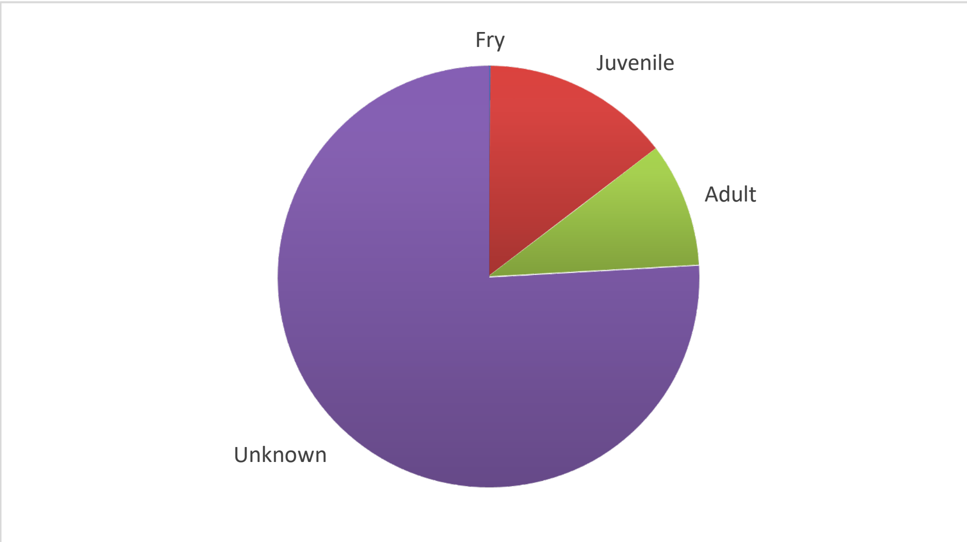
Juvenile brown trout were the most abundant fish species life stage followed by adult longnose dace and juvenile longnose sucker and white sucker (Table 4-27 and Figure 4-27). A relatively larger number of Salmonids and Catostomids observed (not captured) could not be identified to life stage.

Table 4-27 CPUE, by Fish Species and by Life Stage, for Fish Captured and Observed in Segment 60-62

	CAPTURED			OBSERVED	CPUE (#fish/100s)			
Species	**Fry**	**Juvenile**	**Adult**	**Unknown**	**Fry**	**Juvenile**	**Adult**	**Unknown**
BRST	0	0	1	0	0	0	0.013	0
BKTR	0	2	2	0	0	0.025	0.025	0
BNTR	0	49	5	31	0	0.620	0.063	0.392
LNDC	0	5	48	211	0	0.063	0.607	2.668
LNSC	0	16	0	27	0	0.202	0	0.341
UNKN	0	0	0	1	0	0	0	0.013
WHSC	1	13	0	0	0.013	0.164	0	0
Salmonidae	0	0	0	38	0	0	0	0.480
Catostomidae	0	0	0	139	0	0	0	1.757
TOTAL[1]	**1**	**85**	**56**	**447**	**0.013**	**1.075**	**0.708**	**5.652**

NOTE:
[1] CPUE calculations for life stages are based on 7,909 seconds of electrofishing effort. Each CPUE calculation has been rounded to 3 decimal places.

Figure 4-27 CPUE, by Life Stage, for Fish Captured and Observed in Segment 60-62



4.2 FISH SPECIES DISTRIBUTION RESULTS

Fish species distribution has been recorded through the presentation of relative abundance by segment (Section 4.1.2). Relative abundance, for each segment, is calculated by the mean percent CPUE of the electrofishing sampling events at each of the four sites within each sampling segment.

4.2.1 Fish Species Distribution by Location

Fish species distribution in Elbow River reflects the change in channel size, substrates, and gradient as the river habitats change from steep, higher elevation, and erosional channels to lower elevation depositional channels (EIA, Volume 3A, Section 8.2.2.4). To provide a summary of fish species distribution based on the three distinct habitat zones in the study domain, fish species are sorted into three river reaches based on areas of gradient change: 1) between the downstream extent of the Project and the inlet to Glenmore Reservoir (lower reach), 2) between the downstream extent of the Project and Bragg Creek (middle reach), and 3) between Bragg Creek and Elbow Falls (upper reach). Relative distribution of fish species in Elbow River in each of the three reaches is presented in Figure 4-28.

Salmonids are the most abundant sportfish species caught in the three reaches, with brown trout being the most abundant Salmonid in the lower reach and middle reach, and bull trout being the most abundant in the upper reach (Figure 4-29). Brook trout and rainbow trout are found consistently throughout the three river reaches.

Figure 4-28 Relative Distribution of Sport Fish Species, by Segment, in Elbow River

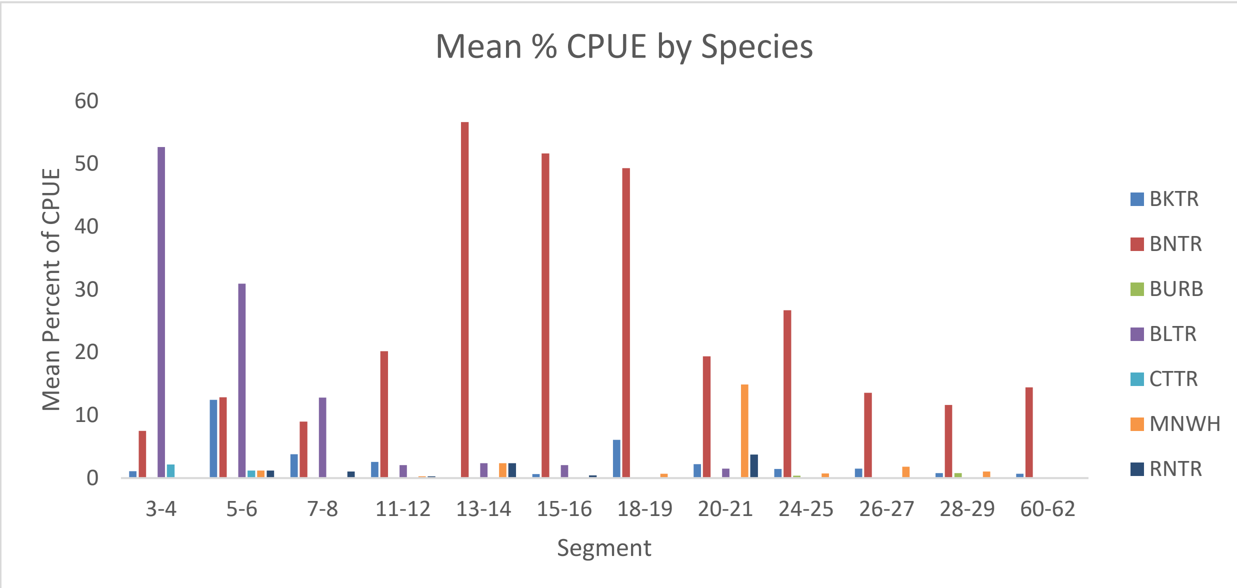
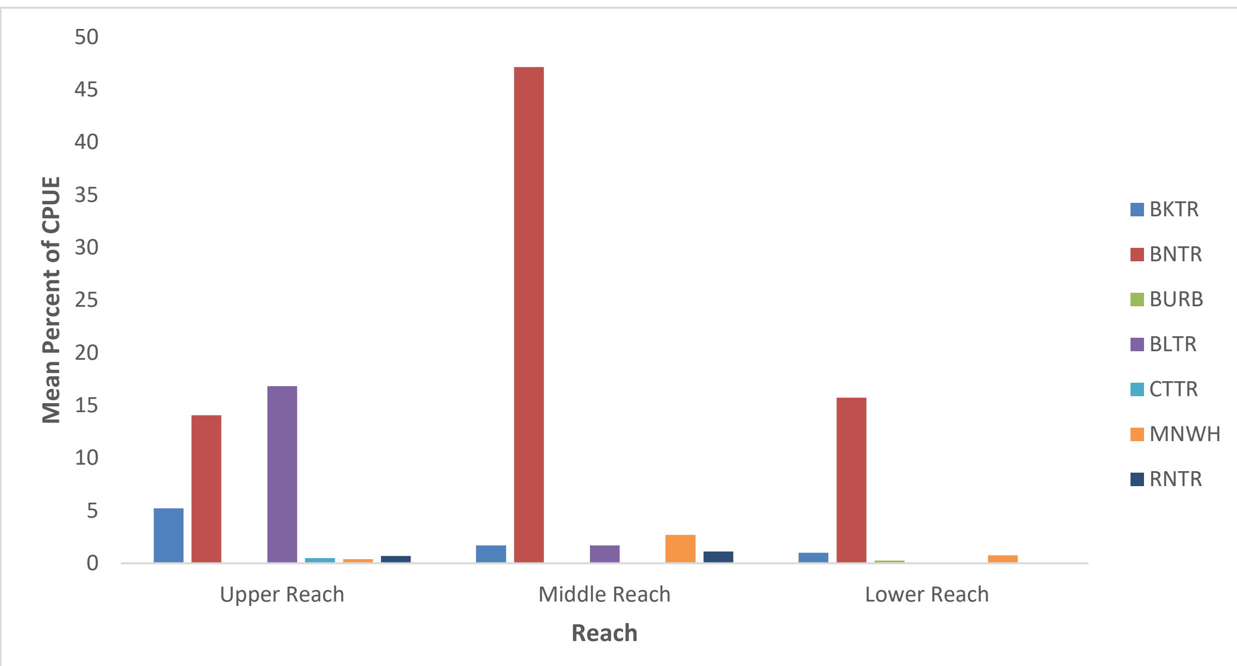


Figure 4-29 Relative Distribution of Sport Fish Species in Elbow River, by River Reach



A review of the fish species captured in each segment and the calculated CPUE identifies changes and trends in the fish assemblages and the relative abundance of individual fish species throughout the 70 km study domain. The data identifies the following trends in fish assemblages in the study domain of the Elbow River:

- Bull trout are the dominant fish species upstream of Bragg Creek (Segment 3-4 downstream to Segment 7-8).
- Brown trout was the most abundant fish species in segments 11-12, 13-14, 15-16, and 18-19.
- Bull trout abundance decreases from Segment 15-16 downstream to Segment 20-21.
- Bull trout were not captured downstream of Segment 20-21.
- Cutthroat trout were only captured at Segment 3-4 and Segment 5-6.
- Catostomid (sucker) species were not captured upstream of Segment 18-19.
- Rainbow trout were not captured downstream of Segment 20-21.
- Brown trout are present throughout study domain, but they are more abundant than any other Salmonid species at Segment 11-12 downstream to Segment 60-62.
- Brook trout are present, but in limited abundance, throughout study domain.
- Mountain whitefish are present, but in limited abundance, throughout study domain.
- Longnose dace (i.e., forage fish) are present throughout the study domain.
- Lake chub (i.e., forage fish) were only captured at Segment 24-25 but are likely present elsewhere in Elbow River.
- Brook stickleback (i.e., forage fish) were only captured at Segment 26-27 and Segment 60-62, but they are likely present throughout the lower sections of Elbow River near Glenmore Reservoir.

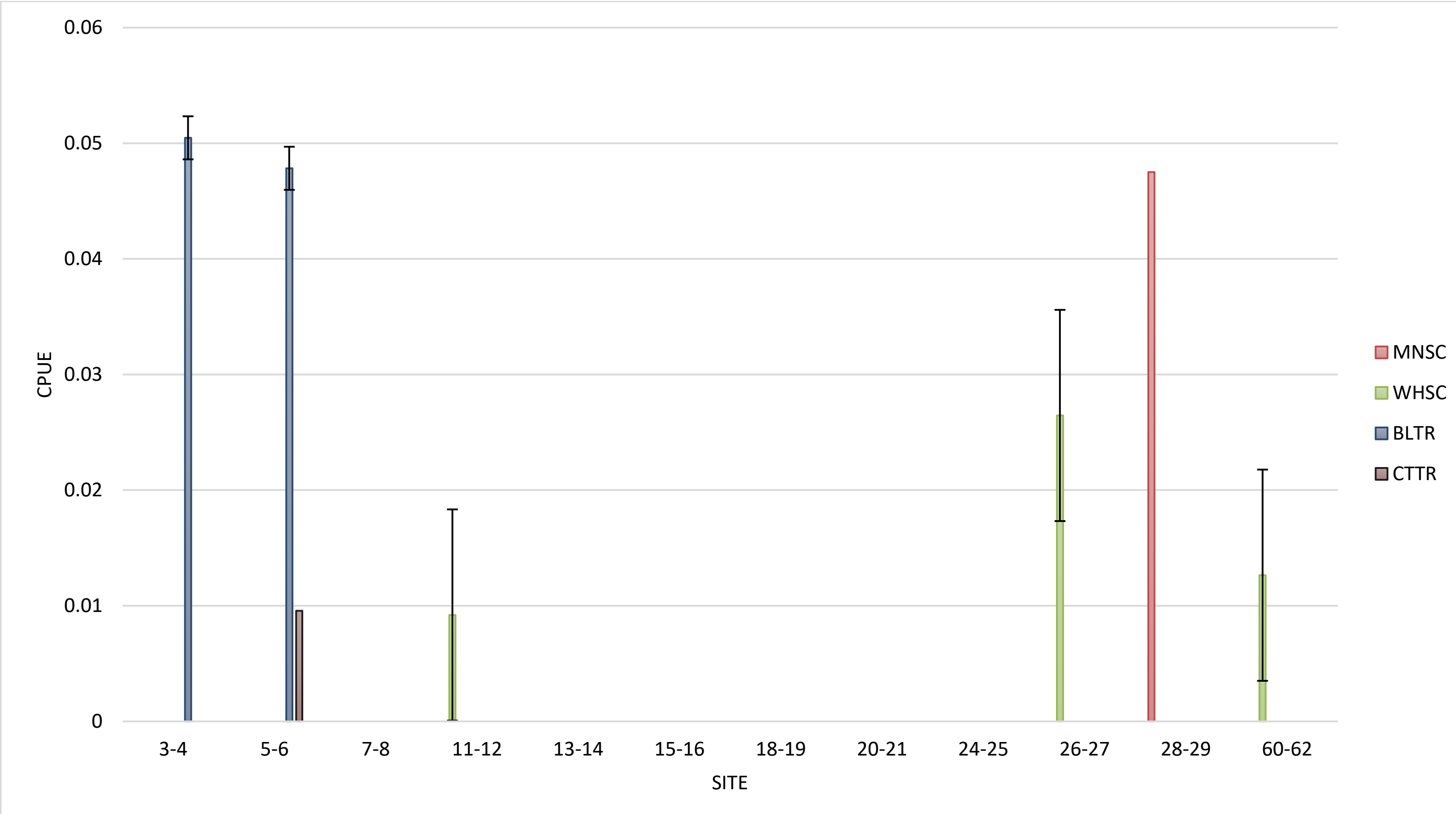
4.2.2 Fish Species Distribution, by Life Stage

The relative abundance fish, by life stage, is based on the mean percent of the CPUE for resident species (Figures 4-30 to 4-32).

4.2.2.1 Fry Life Stage

Of the fry life stage fish species captured, bull trout followed by cutthroat trout and white sucker fry life stage were the most abundant fish species at the farthest upstream segments (Figure 4-32). Of the fry life stage captured, mountain sucker followed by white sucker were the most abundant fish species at the farthest downstream segments. Longnose dace was the only other fish species of fry life stage captured and no fry life stage were captured from the middle segments.

Figure 4-30 Relative Distribution of Sport Fish Species for Fry Life Stage, by Segment



NOTE: no standard error bar available for mountain whitefish or mountain sucker because there was only one capture for each species.

4.2.2.2 Juvenile Life Stage

A total of 10 sport fish and Catostomidae species of juvenile life stage were captured in the study domain. Of the juvenile life stage fish captured, brown trout were the most abundant throughout the study domain and were captured in all segments (Figure 4-31). Of the juvenile life stage fish captured, bull trout were the most abundant fish species at the farthest upstream segments and brown trout in the middle and lower reaches. The relative abundance for all other species was substantially lower (captured or observed).

4.2.2.3 Adult Life Stage

A total of 10 sportfish and Catostomidae species of adult life stage were captured in the study domain. Of the adult life stage sport fish species, brook trout were the most abundant followed closely in abundance by adult life stage brown trout (Figure 4-32). The relative abundance for all other species was substantially lower (captured or observed).

4.2.2.4 Summary of Fish Species Assemblages, by Life Stage

Bull trout fry life stage were the most abundant sport fish species in the study domain but captured in the farthest upstream segments only. Brown trout were the most abundant juvenile life stage throughout the study domain and were captured in all segments. Brown trout juvenile life stage was highest in the middle to downstream segments. Brook trout adult life stage followed closely by brown adult trout life stage were the most abundant fish species with their highest abundance in the middle and downstream segments.

Spawning surveys were conducted in 2019 and 2020 from Elbow Falls downstream to Gooseberry Campground and from Redwood Meadows downstream to Discovery Ridge. In 2019, four bull trout redds were identified in the upstream section of the survey. In the downstream section of the survey, 353 brook trout, 115 brown trout and one bull trout redds were identified.

Figure 4-31 Relative Distribution of Sport Fish Species for Juvenile Life Stage, by Segment

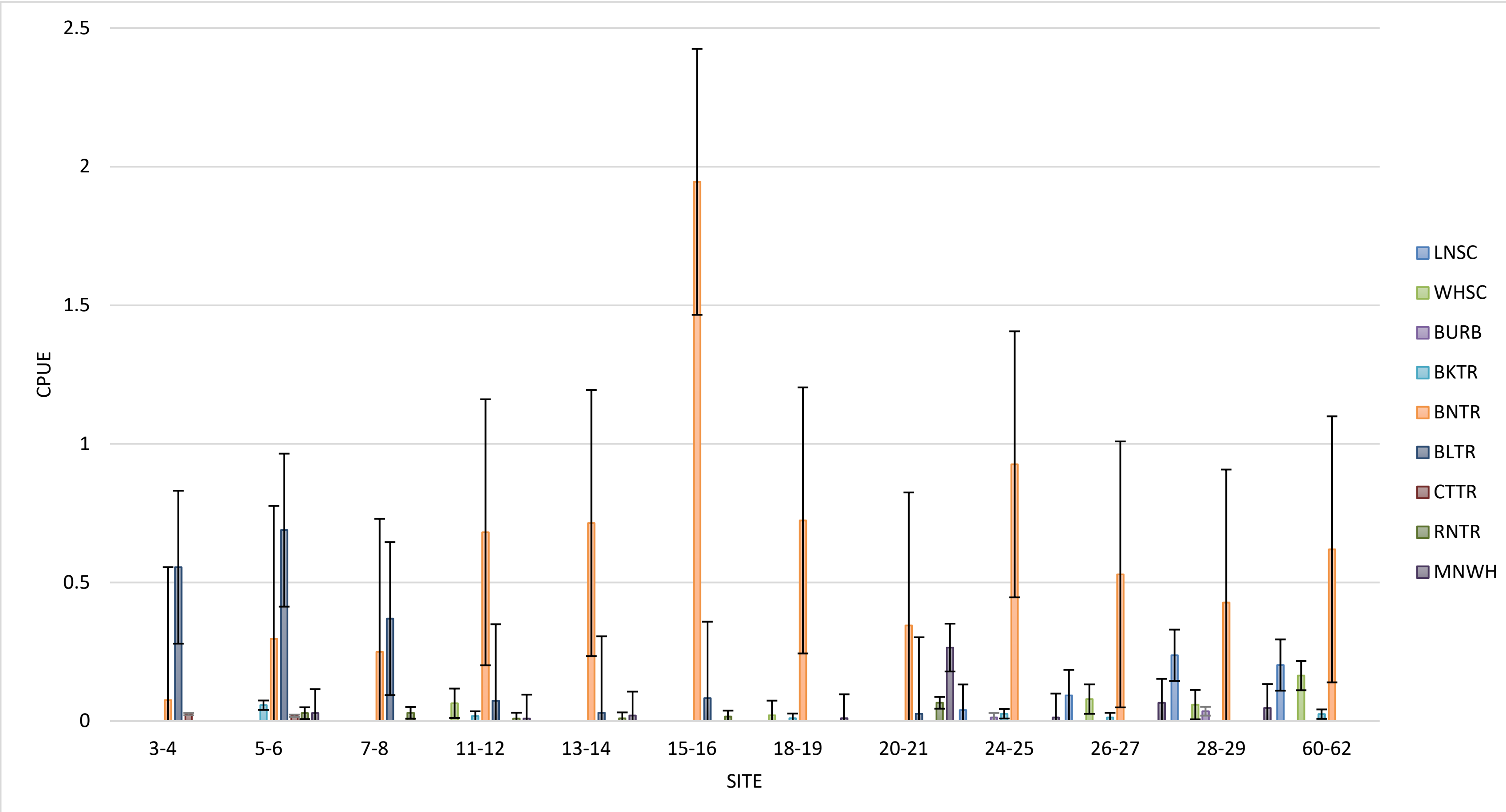
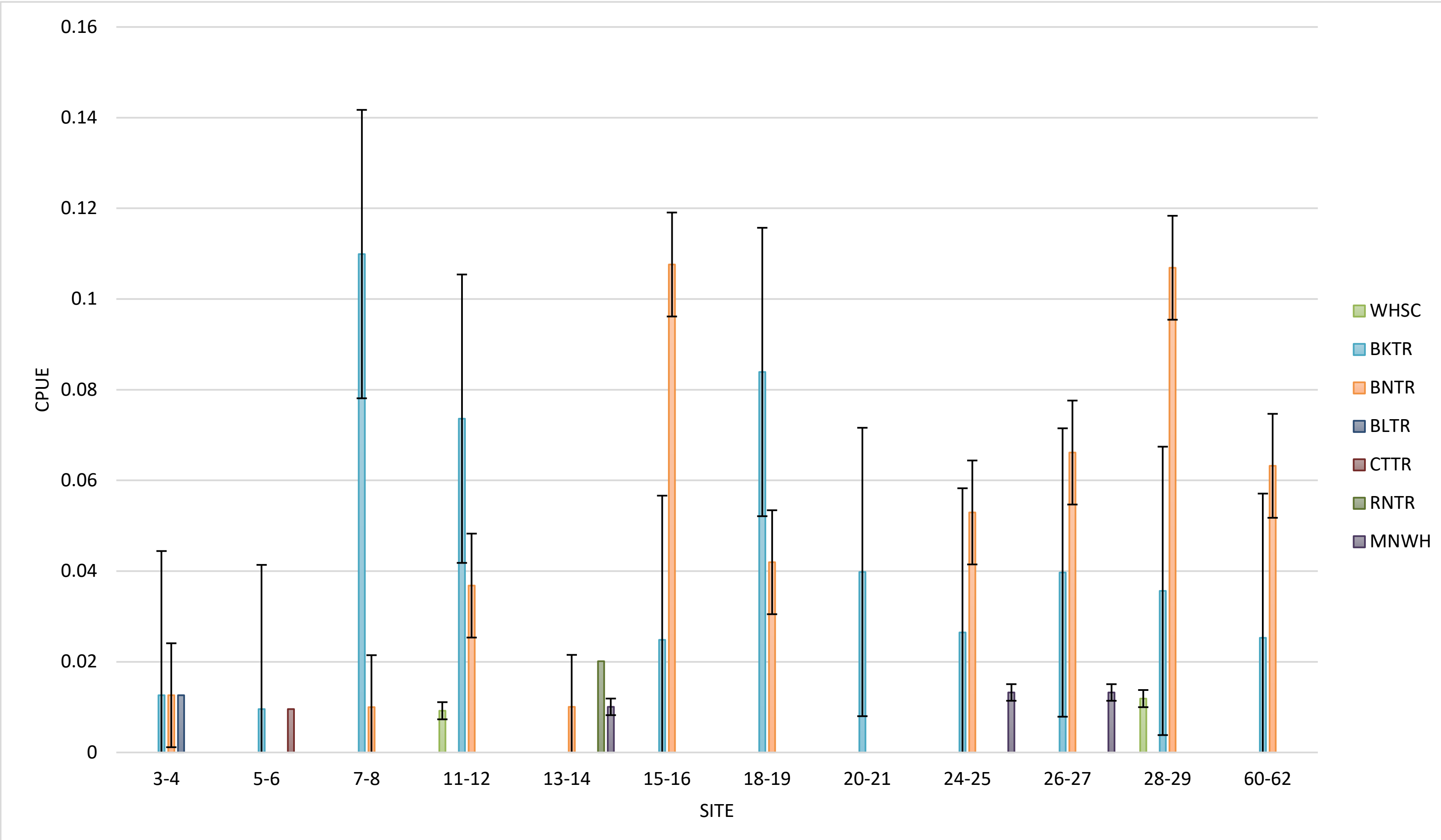


Figure 4-32 Relative Distribution of Sport Fish Species for Adult Life Stage, by Segment



4.3 BULL TROUT REDD SURVEYS

Results of the 2019 bull trout spawning survey is presented in Round 2 AEP Question 69, Appendix 69-2; it is summarized here for inclusion in the estimate of population abundance.

4.3.1 Fall 2019 Redd Survey

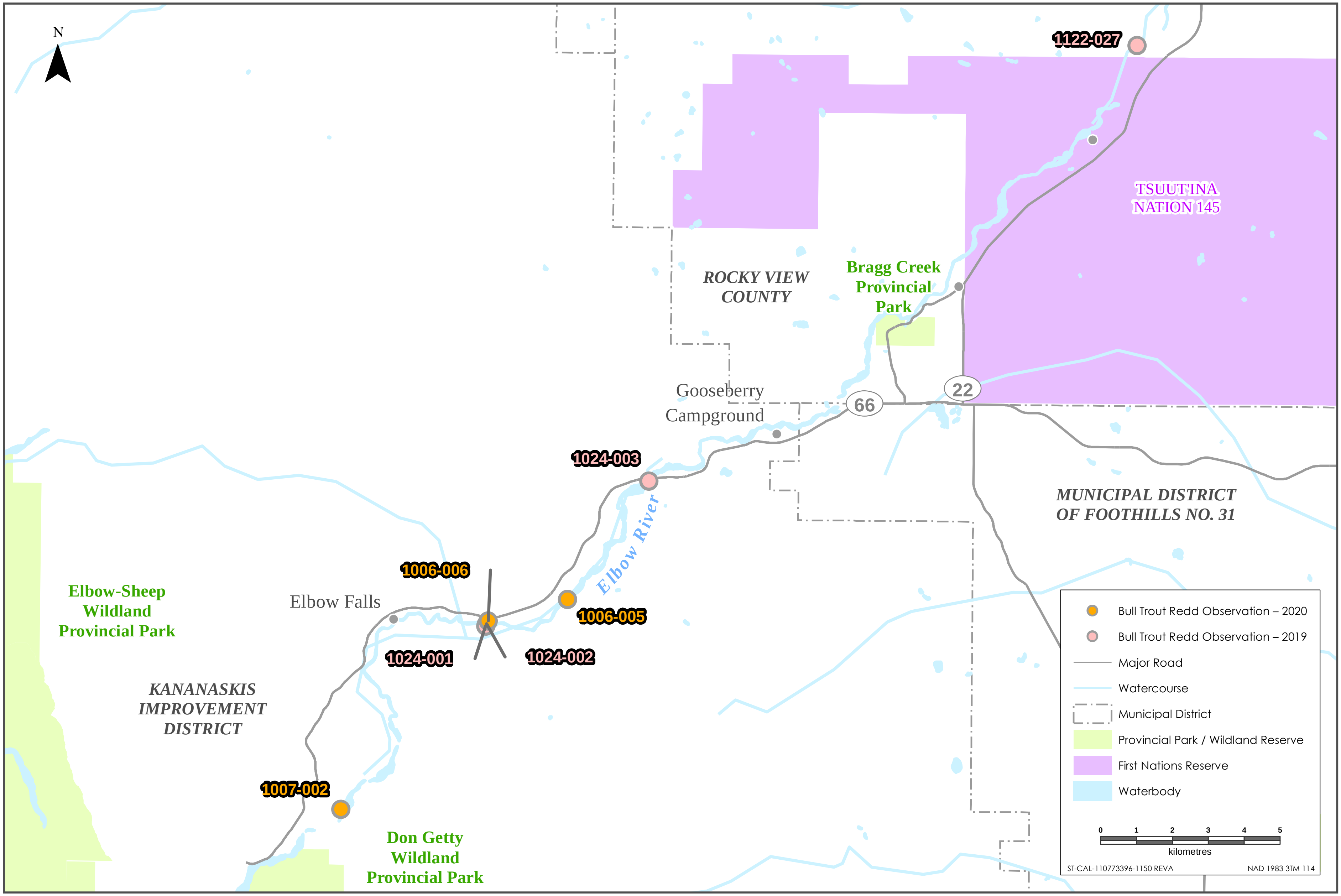
One probable, and three possible bull trout redds were identified during the 2019 bull trout redd survey (Table 4-28, Figure 4-33). No definite redds were observed. The four redds were identified within the main channel of Elbow River. The probable redd had a discernable pit and tail with a mix of clean and dirty substrate. The three possible redds included a visible depression, but no recognizable tail spill. All four locations containing potential redds were identified within a variety of microhabitat types, including a slow glide located in a side channel, a lateral gravel bar, and tail end of pools formed by bedrock. Redds observed were also associated with contributions of cover for spawning adults and emerging juveniles in the form of instream woody debris, bedrock cliffs, or overhead woody debris. Table 4-28 summarizes the bull trout redd survey observations in 2019 and 2020, and locations are presented in Figure 4-33.

Table 4-28 Summary Information for Potential Redds within the Study Domain

Survey Year	Site ID #	Class designation	Species
Fall 2019	RD1	Probable	Bull Trout
	RD2	Possible	Bull trout
	RD3	Possible	Bull trout
	RD4	Possible	Bull trout
Fall 2020	RD5	Probable	Bull trout
	RD6	Probable	Bull trout
	RD7	Possible	Bull trout

4.3.2 Fall 2020 Redd Survey

Site reconnaissance was conducted on September 21, 25, and 26 to measure temperature and complete spot checks for redds in areas where redds were historically found (Popowich and Eisler 2008; Round 2 AEP IR69, Appendix 69-2). Temperature ranged from 7.5°C to 8.5°C between Elbow Falls and Gooseberry Campground on September 21, 2020; and 6.3°C to 8.2°C on September 25 and 26, 2020. Temperature was within the range that has been historically noted to correspond with spawning activity (Popowich and Eisler 2008). No redds were observed during these visits.



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

Springbank Offstream Reservoir Bull Trout Redd Survey
Fall 2020

Stantec

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESEVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT

Figure 4-33

Bull trout redd surveys were completed between October 1 and 6, 2020 for the extent of Elbow River between Elbow Falls and Gooseberry Campground. Additional survey effort was undertaken upstream of Elbow Falls (i.e., outside of the LAA of the aquatics assessment and the current study domain). This effort was undertaken for comparison with low occurrence of redds within the surveyed area.

Two bull trout redds and one possible bull trout redd were identified during the spawning survey (Table 4-28). Of the two redds identified, one was located approximately 400 m downstream of the confluence with Canyon Creek (i.e., upstream of Elbow Falls, outside of the LAA and the study domain), and one was located near the confluence with McLean Creek. One possible bull trout redd was identified in a small side channel to Elbow River near Paddy's Flat. Several brook trout were actively spawning at the time of the survey (sized between 150-250 mm) and were observed on top of redds (and paired up in most cases) in the side channels near Gooseberry Campground and Allen Bill Day Use area. Bull trout typically spawn earlier than brook trout (Nelson and Paetz 1992); therefore, evidence of brook trout spawning likely indicates that the timing for bull trout surveys was appropriate for locating bull trout redds.

4.4 POPULATION ABUNDANCE

Adult population abundance was estimated from redd counts in 2019; due to the slight decrease in bull trout redd survey estimates in 2020 (i.e., 4 redds identified in 2019; whereas 3 redds identified in 2020), the redd survey estimate from 2019 was carried forward to estimate the adult population range. Redd counts and corresponding adult population ranges are presented in Table 4-29.

Table 4-29 Population Abundance of Adult Brook Trout, Brown Trout, and Bull Trout Populations in Elbow River Study Area, Based on Redd Counts

Species	Estimated Redd Count	Predicted Adult Population Range[1, 4]
Brook trout	706[2]	1,412 – 1,977
Brown trout	236[2]	472 - 661
Bull trout	4[3]	8 - 11

NOTES:

[1] Adult population abundance is estimated by multiplying redd values by a factor of 2.0 to 2.8 to account for seasonal variability in spawning activity (as discussed in Section 3.3.2)

[2] Redd count estimated from fall 2019 spawning survey

[3] Estimates were based on fall 2019 bull trout redd survey data (estimated 4 redds) ; a slightly higher count than 2020 (3 redds)

[4] Adult fish population ranges are carried forward for estimating total study domain population abundances in Table 4-30

Adult population ranges for other fish species in Elbow River was extrapolated by considering their relative abundance compared to that of brook trout, brown trout, and bull trout.

Total population ranges (including fry and juveniles) were extrapolated from relative abundance data and estimates of adult population ranges in Table 4-29. Total populations are presented in Table 4-30.

Table 4-30 Relative Abundance and Predicted Population Abundance of Fish Communities between Elbow Falls and inlet of Glenmore Reservoir

Common Name	Species	Relative Abundance (percent)[1]	Calculated Relative Abundance for Adult Estimates [2]	Predicted Adult Population Abundance [3]	Predicted Total Population Abundance (Adults, Juvenile, Fry) [4]
longnose sucker	*Catostomus*	3.05	3.05	128-179	4,266 – 35,800
mountain sucker	*Catostomus platyrhynchus*	0.16	0.16	7-9	233 – 1,800
white sucker	*Catostomus commersonii*	1.84	1.84	77-108	2,566 – 21,600
fathead minnow	*Pimephales promelas*	--	--	--	--
lake chub	*Couesius plumbeus*	0.08	0.08	3-5	100 – 1,000
longnose dace	*Rhinichthys cataractae*	46.66	46.66	1,955 – 2,738	65,166 – 547,600
pearl dace	*Margariscus margarita*	--	--	--	--
spottail shiner	*Notropis hudsonius*	--	--	--	--
northern pike	*Esox lucius*	--	--	--	--
burbot	*Lota lota*	0.16	0.16	7-9	233 – 1,800
Brook stickleback	*Culaea inconstans*	0.29	0.29	12-17	400 – 3,400
yellow perch	*Perca flavescens*	--	--	--	--
trout-perch	*Percopsis omiscomaycus*	--	--	--	--
brook trout	*Salvelinus fontinalis*	3.5	33.69	1,412-1,977	47,066 – 395,400
brown trout	*Salmo trutta*	33.88	11.26	472-661	15,733 – 132,200
bull trout	*Salvelinus confluentus*	7.77	0.20	8-11	266 – 2,200
mountain whitefish	*Prosopium williamsoni*	1.67	1.67	70-98	2,333 – 19,600

Table 4-30 Relative Abundance and Predicted Population Abundance of Fish Communities between Elbow Falls and inlet of Glenmore Reservoir

Common Name	Species	Relative Abundance (percent)[1]	Calculated Relative Abundance for Adult Estimates [2]	Predicted Adult Population Abundance [3]	Predicted Total Population Abundance (Adults, Juvenile, Fry) [4]
rainbow trout	*Oncorhynchus mykiss*	0.71	0.71	30-42	1,000 – 8,400
westslope cutthroat trout	*Oncorhynchus clarkii lewisi*	0.1	0.1	4-6	133 – 1,200
Subtotals / Ranges		**100%**	**100%**	**4,185 – 5,860**	**139,495 – 1,172,000**

NOTES:

-relative abundance estimates above have been rounded to 2 decimal places digit and totals may not add to 100%

-- Dashes indicate fish species known to occur in the Elbow River watershed but were not captured during the field program

[1] Relative abundance is estimated through fish capture results conducted in August 2020. Proportions exclude fish captures or observations that could not be identified as to species (e.g., general 'Salmonid' observations not included)

[2] Relative abundances were adjusted for brown trout, bull trout, and brook trout from the redd survey data to estimate adult pairs. All other relative abundance values rely on the proportion of fish identified through summer 2020 fieldwork

[3] Population abundance is estimated from the calculated relative abundance values (note b) and extrapolated redd survey data for adult population sizes

[4] Total population ranges are based on apparent survival of fry up to 1 year and assumes that juvenile fish survive to adulthood

5.0 ASSUMPTIONS AND UNCERTAINTY

Estimates of relative abundance and population abundance provide useful indication of population size and structure for fisheries management decisions. Precise calculations of population size are very difficult to complete in a wild population without the use of invasive, closed-capture techniques. Despite these limitations, population abundance was estimated by applying practical assumptions; these assumptions introduce uncertainty that is discussed in the following subsections.

5.1 FIELD PROGRAM DESIGN

Hydraulics of Elbow River in the study domain varied between high flows in confined areas to low water levels in braided sections of river; these characteristics presented diverse challenges for fishing access. Crews attempted tote barge electrofishing at the beginning of the program but were limited by access, and river flows presented electrical concerns with the operating unit. Tote barge electrofishing was proposed as the original sampling method during preliminary discussions with AEP. Backpack electrofisher units were used at all sites for the fish sampling program (approved as an alternative method in the fishing permits) and were considered the best available equipment to accommodate the river flows and variable river topography. The following considerations could have influenced the collected fish population data:

- Backpack electrofishing could have resulted in some bias in the data for small bodied or juvenile species. Backpack electrofishers are inefficient at sampling deep pools and runs where adult fish typically reside. User variance (i.e., operator's ability to wade) can further limit sampling in deeper pools where adults reside. Furthermore, adult fish will exhibit avoidance behaviour when the operator approaches, and fish can escape without capture.
- The schedule for fieldwork was primarily driven by the window of opportunity to conduct fieldwork during a time of year that avoids sensitive timing windows of fish species. Duration of fishing effort per segment was consequently limited by this window of opportunity to conduct fieldwork.
- Depletion fishing, or closed-capture fishing, was not completed for this study. In the absence of the ability to undertake depletion fishing, AEP's medium and large river sampling protocol was recommended by AEP to obtain pre-construction baseline surveys of Elbow River fish populations, and to support quantitative estimates of fish species in Elbow River, as requested in Round 2 NRCB Question 19 and Question 28. This protocol considers the limitations that are present with medium and large river studies, including fishing effectiveness in open systems, study duration, and fish species sensitivity. This sampling protocol provides a useful approach to study relative abundance of fish populations that can be replicated for multi-year fish inventories of medium to large study domains (i.e., several kilometres of river length). The field methods described in this protocol can be used to derive CPUE.

5.2 DATA INTERPRETATION

- Seasonal fish species distribution could influence relative abundance by location. Timing of fieldwork corresponds to BSP-2 (June 1 to September 26); this window corresponds to bull trout migration. Therefore, data aligned with expected bull trout distribution during the summer and fall and may not be representative of bull trout distribution during winter and spring.
- Fish species assemblages could influence relative abundance data (Rose and Kulka 1999). Segment selection was randomized in the study design, under the assumption that fish species are evenly distributed within Elbow River. The extent of fish species assemblage or clustering in the study domain is unknown; however, it is likely that some species were clustered to specific habitats.
- Population abundance values for brook, brown, and bull trout relied on redd survey data. Redd surveys can provide good indication of adult population size. Population abundance estimates of other species relied on relative abundance data because redd surveys are limited to species where egg identification is practical (e.g., mountain whitefish are broadcast spawners and identification requires kick nets that can disturb egg health).
- Bull trout redd observations in 2019 and 2020 were low relative to historical data (Popowich and Eisler 2008; Sawatzky 2016). Annual variation is expected in the data; however, it is unclear whether the survey results reported here indicate a decline in bull trout abundance or lowered abundance that is attributable to annual variation. Timing of the survey was considered appropriate for bull trout spawning for the following reasons:
  - Previous studies indicate that bull trout typically complete spawning in the study section by September 26 (Popowich and Eisler 2008). Bull trout were likely to have spawned at the time that surveys were conducted in 2019 and 2020.
  - Brook trout spawning activity typically begins after bull trout spawning (Nelson and Paetz 1992), and brook trout spawning activity was observed at the time of the 2020 bull trout spawning survey.
  - Water temperatures during both surveys (2019 and 2020) aligned with the temperature ranges that are expected for bull trout spawning.
  - Flow in Elbow River was stable between August 1 and October of 2019 and 2020, and no significant spikes in river flows occurred during that time that may have disturbed or mobilized bed sediments. It is not likely that sediment transport in the river altered the condition of the redds such that they would not be observable at the time of the survey.

- Relative abundance values were used to extrapolate population abundance for various age classes. Relying solely on adult relative abundance would limit the sample sizes that were available for calculations. These calculations could be refined through future studies, should larger sample sizes be available.
- Statistical power is limited for the results presented in this study because 1) one season of fish population data were collected and 2) two years of bull trout redd survey data were included. This limitation was acknowledged by AEP (Christensen, pers. comm. November 7, 2019) during discussions of study design. Annual variation in fish population abundance is probable. Power analyses can be calculated if multiple years of data are available in the future, which may refine the information presented in this study regarding fish species assemblages, distribution, relative abundance, and population abundance.

6.0 CONCLUSIONS

This population study supports the previous data reporting and analyses (EIA, Round 1 IRs and Round 2 IRs) undertaken to characterize the fish community and assess fish species composition, distribution, relative abundance and population abundance within the LAA. The information presented in this report fulfills pre-construction survey requirements of the Elbow River fish community and will inform the *Fisheries Act* Application for Authorization.

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