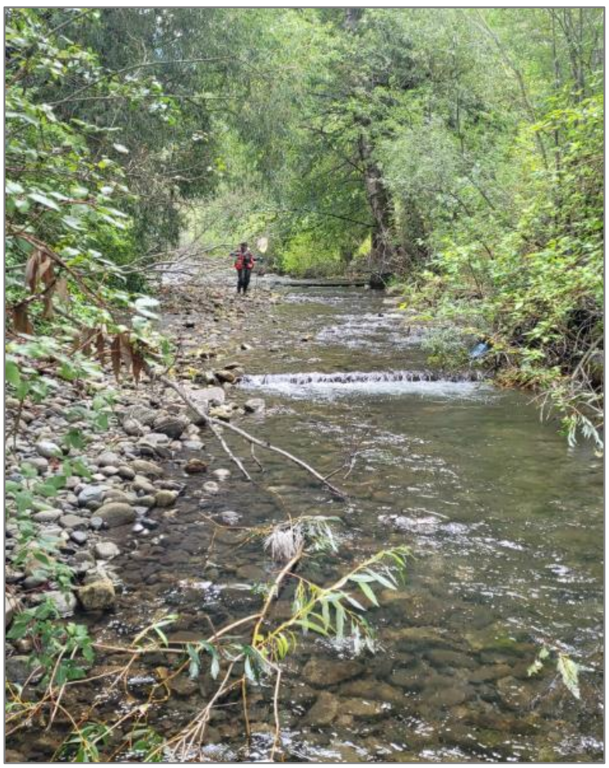
Cottonwood Creek
Fish Habitat Assessment - Level 1



Prepared for:
Living Lakes Canada
330 Baker Street
Nelson, BC, V1L 4H5

December 16, 2024

Prepared by:
Masse Environmental Consultants
812 Vernon Street
Nelson, BC, V1L 4G4

Project Number 2024-1153

TABLE OF CONTENTS

Table of Contents i

List of Figures ii

List of Photos ii

List of Tables iv

List of Appendices iv

1 Introduction 1

2 Background 1

2.1 Fish Habitat Overview 1

2.2 Existing Fisheries Information 2

3 Methods 3

3.1 Desktop Review 3

3.2 Field Studies 5

3.3 Data Analyses 5

4 Results 6

4.1 Fish Sampling 6

4.2 Section Description and Habitat Condition 7

4.2.1 R1-S1: Creek Mouth to Lakeside Drive Bridge 7

4.2.2 R1-S2: Lakeside Drive Bridge to CPR Lands 9

4.2.3 R2-S1: CPKC Lands to Baker Street Bridge 11

4.2.4 R2-S2: Baker Street Bridge to Cottonwood Falls 12

4.2.5 R3-S1: Highway 6 to Cottonwood Drive 14

4.2.6 R3-S2: Cottonwood Drive to Kline Road 16

4.2.7 R3-S2.1: Kline Road to Schesnuk Creek 18

4.2.8 R4-S1: Schesnuk Creek to Selous Creek 20

4.2.9 R4-S2: Upper Cottonwood Creek 21

4.3 Fish Habitat Ratings 23

5 Discussion 27

5.1 Fish Populations 27

5.2 Impacts to Fish Habitat 28

5.2.1 Sedimentation 28

5.2.2 Obstacles / Barriers to Fish Migration 29

5.2.3 Loss of Instream and Riparian Habitat Complexity 30

6 Recommendations for Restoration Strategies and Further Assessments 31
6.1 Restoring Habitat-Forming Processes in Disturbed Aquatic Habitat 31
6.1.1 Sill Log Area in R1-S2 32
6.1.2 R1-S1 33
6.1.3 Riffle Habitat in R3-S2.1 34
6.2 Improving Passage at Obstacles/Barriers 34
6.2.1 Concrete Flume in CPKC Lands 34
6.2.2 Constructed Dam/ Concrete Platform in R3-S1 36
6.2.3 Kline Road Culvert 36
6.2.4 Highway 6 Culvert 37
6.3 Working with Private Landowners to Restore and Protect Riparian Habitat 38
7 Further Studies 40
8 Closure 41
9 References 42

List of Figures

Figure 1. Length frequency distribution of Rainbow Trout captured in Cottonwood Creek. 7

List of Photos

Photo 1. Looking down R1-S1 1 to Kootenay Lake. Area affected by lake levels. 8
Photo 2. Upstream view of the upper portion of R1-S1, with riprap on the south bank. 8
Photo 3. Embedded cobble and gravel substrate. 9
Photo 4. Swamp-like habitat on the south bank. 9
Photo 5. Representative photo of the lower portion of R1-S2, with an installed sill log. Facing upstream. 10
Photo 6. Representative photo of the upper portion of R1-S2, where the creek flows through a vacant lot. 10
Photo 7. Plunge pool at the upstream end of R1-S2 formed at the outlet of a concrete flume. 10
Photo 8. Representative photo of substrates within R1-S2. 10
Photo 9. Representative photo of the flume running through CPKC lands (facing upstream). 12
Photo 10. Representative photo of flume under Baker Street bridge, with steel baffles on bottom. 12
Photo 11. Example of a small pool formed where the concrete bottom of the flume had worn away 12
Photo 12. Obstacle to fish passage at flume outlet. 12

Photo 13. Riprap armouring on both sides of channel, just upstream of Baker Street Bridge. 13
Photo 14. Concrete wall on east bank of the creek within R2-S2... 13
Photo 15. Cascades and pools just below Cottonwood Falls... 14
Photo 16. Substrates embedded with sand just downstream of a storm outfall...................................... 14
Photo 17. Lower section of R3-S1, running through undeveloped park area. Hwy 6 park and ride can be seen at the top of bank.. 15
Photo 18. Residential lawns on the west bank of the creek. Photo taken facing upstream. 15
Photo 19. Section of eroded bank just below Hwy 6 Park and Ride... 16
Photo 20. Small falls created by a constructed dam/platform at the upstream end of Site 5.................. 16
Photo 21. Upstream view of a section of R3-S2, with the road shoulder of Hwy 6 located at top of bank. Patch of Japanese knotweed is circled. 17
Photo 22. Riparian vegetation removal and relic riprap armouring on the east bank of R3-S2. 17
Photo 23. Section of eroded bank below a shed and driveway on residential property. 17
Photo 24. Example of small pool cover... 17
Photo 25. Residential property with channel armouring on east bank of Cottonwood Creek (facing upstream). 19
Photo 26. Example of a section of creek with relatively undeveloped riparian area within Section R3-S2.1 (facing upstream)... 19
Photo 27. Embedded gravel and cobble substrate.. 19
Photo 28. Upstream view of culvert outlet under Kline Road.. 19
Photo 29. Culvert under Hwy 6.. 20
Photo 30. Constructed dam next to a residential property forming a fish barrier during low flow conditions. 20
Photo 31. Representative photo of R4-S1. 21
Photo 32. Gravel bar with suitable spawning substrate that would be submerged in spring. 21
Photo 33. Representative photo of Site 9 (facing upstream). 22
Photo 34. Upstream view of Site 10, with Rail Trail bed on east bank... 22
Photo 35. Representative photo of Site 11 (facing upstream). 23
Photo 36. Section of swamp habitat just downstream of Highway 6 crossing at Cottonwood Lake......... 23
Photo 37. Accumulated sands and gravels at the base of the rail trail bed in Site 10. 23
Photo 38. Salvaging Rainbow Trout fry from a dewatered section of Site 11... 23
Photo 39. Site proposed for restoration in R1-S2.. 33
Photo 40. Site proposed for restoration in R1-S2.. 33
Photo 41. Swamp area on southwest bank of R1-S2 proposed for restoration.. 33
Photo 42. Site proposed for restoration in R3-S2.1... 34
Photo 43. Concrete flume proposed to be replaced or enhanced. 35

Photo 44. Drop at flume outlet. 35
Photo 45. Constructed dam/platform proposed to be replaced with a weir. 36
Photo 46. Proposed location for weir leading up to Kline Road culvert. 37
Photo 47. Kline Road culvert outlet. 37
Photo 48. Proposed location for weir leading up to Highway 6 culvert. 37
Photo 49. Highway 6 culvert. 37
Photo 50. Example of an apparently recently constructed building located at the top of bank of Cottonwood Creek. 38
Photo 51. Example of debris and sheds on creek bank. 39
Photo 52. Comparison of cover provided by a narrow strip of shrubs (photo right) vs. a non-vegetated bank (photo left) 39

List of Tables

Table 1. Summary of fish captured / observed during sampling efforts. 6
Table 2. Summary of habitat units present within Site 1 (R1-S1). 8
Table 3. Summary of habitat units present within Site 2 (R1-S2). 10
Table 4. Summary of habitat units present within Site 3 (R2-S1). 11
Table 5. Summary of habitat units present within Site 4 (R2-S2). 13
Table 6. Summary of habitat units present within Site 5 (R3-S1). 15
Table 7. Summary of habitat units present within Site 6 (R3-S2). 17
Table 8. Summary of habitat units present within Site 7 (R3-S2.1). 19
Table 9. Summary of habitat units present within Site 8 (R4-S1). 21
Table 10. Summary of habitat units present within R4-S2. 22
Table 11. Diagnostics of salmonid habitat (Anonymous 1993 from Slaney 1996) 24
Table 12. Habitat parameters for sites sampled on Cottonwood Creek 25

List of Appendices

Appendix 1. Map of Reaches, Sections, and Sampling Sites
Appendix 2. FHAP and Fish Sampling Data
Appendix 3. Recommended Restoration Sites

1 INTRODUCTION

Cottonwood Creek is an ~ 11 km long stream that flows from its headwaters upstream of Cottonwood Lake to the West Arm of Kootenay Lake, passing through the City of Nelson in its downstream reaches. The Cottonwood Creek watershed has been heavily impacted by anthropogenic development over the last 100 years, including road and rail development, mining, forestry, hydropower, and urban development including residential, industrial, and commercial land use.

There has been a long-standing interest by local non-profit and community groups in restoring impacted areas of Cottonwood Creek, including efforts by BC Fish and Wildlife and the Nelson Rod and Gun Club in the 1990s to improve spawning habitat in the lower reaches through the installation of spawning platforms. More recently, Living Lakes Canada (LLC) has been conducting monitoring programs within the watershed, and is hoping to undertake further restoration activities. As part of their efforts, LLC commissioned a study (Thomson 2024) which gathered known data and identified key threats regarding the aquatic health of the watershed, as well as identified steps to address data gaps requiring further attention. This study recognized that current knowledge of fish habitat and distribution within Cottonwood Creek is based on information collected from relatively sporadic sampling and using a variety of methods. A formal fish habitat assessment following provincial standards was recommended.

Masse Environmental Consultants Ltd. (Masse) was retained by LLC to conduct a Level 1 Field Assessment of Cottonwood Creek under the provincial Fish Habitat Assessment Procedures (FHAP; Johnston and Slaney 1996). The FHAP was designed to assist local groups to develop fish habitat rehabilitation and restoration projects at the watershed scale. Specifically, our Level 1 Field Assessment was designed to collect field data to:

1) identify areas of impact on biophysical fish habitat,
2) identify and prioritize restoration options, and
3) Identify the need for further field assessments.

2 BACKGROUND

2.1 Fish Habitat Overview

From its headwaters near the Apex cross country ski area to its mouth at the West Arm of Kootenay Lake, Cottonwood Creek drains an overall watershed of ~64 km^2. Cottonwood Lake is located at the headwaters of Cottonwood Creek (~11 km from the mouth), and is an ~ 6 ha lake with a mean depth of 7.3 m. Three main tributaries flow into Cottonwood Creek: Giveout Creek (~3.5 km from mouth), Selous Creek (~6.2 km from mouth), and Gold Creek (~8.5 km from mouth). Several other smaller tributaries also drain into the creek along its course. Fish distribution within Cottonwood Creek is defined by the Cottonwood Falls that is located ~930 m from the mouth and is the upstream migration limit for adfluvial fish in Kootenay Lake (i.e., fish that migrate between lake and stream habitat). The falls are ~ 10 m high, and immediately upstream the creek passes through a steep series of culvert, flume and canyon under Highway 3A.

Cottonwood Creek has been largely affected by development within the overall watershed, including impacts from forestry, mining, transportation, energy, commercial, residential and industrial land use. History and characteristics of the Cottonwood Creek watershed are provided in Thomson (2024). Within the City of Nelson Boundaries, Cottonwood Creek has been subject to a long history of channel manipulation. The general floodplain area has been infilled, and sections of the creek have been straightened, channelized, and restricted. Land use around the creek includes light and heavy industrial land use, as well as urban areas. In middle sections of the creek (i.e., between Cottonwood Falls and Selous Creek), the creek has been highly impacted by the presence of Highway 6, and residential and commercial property developments. The creek has been restricted by channel armouring along much of its length in this section, and riparian areas are often highly developed. Two known fish barriers are present within this section; the culvert under Kline Road is considered a barrier to fish passage, and another under Highway 6 is considered an obstacle (Silvatech 2014). In the upper sections of the creek between Selous Creek and Cottonwood Lake, the Creek is generally in a more natural state than lower reaches. This area remains subject to active forestry activity, and the creek often runs adjacent to Highway 6 and the historic rail bed that now makes up the Rail Trail. Thomson (2024) recognized several key threats to the health of Cottonwood Creek and its watershed, including sediment loading (from both natural sources as well as road abrasives used in the City of Nelson and along Highway 6), water quality impacts from upstream mine tailings and contaminated groundwater in the lower watershed associated with Canadian Pacific Kansas City lands (CPKC, formerly CP Rail), fish migration barriers, floodplain encroachments, and climate change.

2.2 Existing Fisheries Information

Fish species documented in Cottonwood Creek below Cottonwood Falls include Rainbow Trout (*Oncorhynchus mykiss*), Kokanee (*O. nerka*), Bull Trout (*Salvelinus confluentus*), Mountain Whitefish (*Prosopium williamsoni*), Longnose Dace (*Rhynichthys cataractae*), and Slimy Sculpin (*Cottus cognatus*) (Habitat Wizard 2024). Provincial records (Habitat Wizard 2024) also indicate Cutthroat Trout (*O. clarkii lewisi*) eggs were sporadically stocked in Gold Creek in the 1930s-1940s, however there have been no recent observations of this species to indicate that there is an established population here. Presumably, other fish species within the lake could also use areas of the creek near the mouth. In the 1940s, several Rainbow Trout rearing ponds were constructed by the Nelson District Rod and Gun Club just downstream of the falls, and a hatchery was later built and run by the province in this area until the mid 1960s (Province of BC 1965, cited in Thomson 2024). Both Rainbow Trout and Kokanee from the hatchery were stocked into the lower creek during its operations (FIDQ 2024). The lower section of the creek was historically used by spawning Kokanee in the fall, however this run has not been observed for several decades. The Nelson District Rod and Gun Club and BC Fish and Wildlife collaborated on a restoration project downstream of the CPKC lands in 1990, with focus on spawning habitat for Kokanee. Sill logs and spawning gravels were installed in the creek to create spawning platforms, and riparian planting was undertaken. Kokanee have not been documented using these features, suspected to be due to the infilling and sedimentation of the substrate.

Fish species upstream of the Cottonwood Falls are limited to resident Rainbow Trout and Redside Shiner (*Richardsonius balteatus)*, the latter of which is only found in Cottonwood Lake. The lake has been stocked with Rainbow Trout since the 1930s, and occasionally with Kokanee and Eastern Brook Trout (*Salvelinus fontinalis)* prior to the 1960s (FIDQ 2024). Since 2005, only triploid Rainbow Trout have been stocked in the lake, which are unable to breed with the natural population. Fish stocked in recent years range between ~230 – 700 g (FIDQ 2024). Rainbow Trout are spring spawners.

3 METHODS

3.1 Desktop Review

A desktop review was undertaken to gather existing information and provide framework for the Level 1 field assessment. The following information was consulted as part of the desktop review:

- Consultant and student reports (i.e., Smit 2014, Thomson 2009, Thomson 2024, and Silvatech 2014);
- Provincial records of fish and fish habitat sampling (Habitat Wizard 2024);
- Provincial fish stocking records (FIDQ 2024) and communications with hatchery staff;
- Current and historical aerial imagery (Google Earth, RDCK 2024);
- City of Nelson storm sewer system details and hydrological reports; and
- Local naturalist websites and newspaper articles.

Based on discussions with LLC and data collected during the desktop review, the four reaches that were previously identified by Thomson (2024) were further divided into sections, and representative sites were sampled throughout. Creek sections are referred to in this report as “Rx-Sx” to indicate which reach and section of the creek (Reachx-Sectionx). Sample sites are referred to in this report sequentially from downstream to upstream (i.e., 1 to 11). Reaches, sections, and sites are shown in Appendix 1, and summarized below:

Reach 1 extends from the mouth of the creek to the downstream end of the CPKC lands. This reach was further divided into 2 sections:

- R1-S1: This section includes the length of the creek from the mouth of the creek to Lakeside Drive bridge. **Site 1 covered the entire 209 m of R1-S1.**
- R1-S2: This section includes the area between Lakeside Drive bridge to the downstream end of the CPKC lands. **Site 2 covered the 152 m of R1-S2.**

Reach 2 extends from the downstream end of CPKC lands to Cottonwood Falls. This reach was further divided into 2 sections.

- R2-S1: The section includes the area of the concrete flume within CPKC lands up to Baker Street Bridge. **Site 3 covered the entire 194 m of R2-S1.**
- R2-S2: This section includes the area between Baker Street Bridge to Cottonwood falls. **Site 4 covered the entire 360 m of R2-S2.**

Reach 3 extends from Cottonwood Falls to Schesnuk Creek. This reach was further divided into three sections.

- R3-S1: This section includes the area between the Highway6/3A intersection culvert and Cottonwood Drive, which has been influenced by residential development and road infrastructure. **Site 5 covered the 639 m length of creek between the Highway6/3A intersection culvert and Lower Perrier Drive.**
- R3-S2: The section includes the area between Cottonwood Drive and Kline Road, which has been influenced by both residential and commercial development. **Site 6 covered the entire 615 m of R3-S2.**
- R3-S2.1: This section (from Kline Road to Schesnuk Creek) was separated as its own section following field date collection due to the presence of lower-gradient habitat compared to downstream. **Site 7 covered the 330 m length of the creek between Kline Road and the Highway 6 culvert.**

Reach 4 extends from Schesnuk Creek to Cottonwood Lake. This reach was split into 2 sections based on habitat characteristics observed at 4 sites sampled; the latter three sites were lumped as one representative section for habitat analyses (R4-S2).

- R4-S1: The section includes the area between Schesnuk and Selous Creek confluences, which is relatively undisturbed. **Site 8 covered a 160 m length of creek just upstream of Schesnuk Creek.**
- R4-S2: This section includes the area between Selous Creek and Cottonwood Lake. Three sites were sampled within this section, all within areas of relatively intact riparian habitat:
    - **Site 9 covered a 185 m section of creek ~800 m upstream of the Selous Creek confluence.**
    - **Site 10 covered a 155 m section of creek just upstream of the Gold Creek confluence.**
    - **Site 11 covered a 150 m section of creek between Highway 6 and Cottonwood.**

3.2 Field Studies

The fish habitat assessment was completed on August 27, 28, and 29 by Renae Mackas (RPBio.) and Sylvie Masse (RPBio.) of Masse, and Kai Smith (Env. Tech.) of LLC. Field sampling was undertaken under conditions representative of summer low flows (average discharge near mouth ranging from 0.26 – 0.32 m^3/sec, City of Nelson 2024). Weather leading up to and during the survey was generally dry, with rain experienced in the area on August 24, and showers on August 27.

Data collection was taken following the Level 1 Fish Habitat Assessment Procedures (Johnston & Slaney 1996). The FHAP methods are designed to collect specific habitat data by the following specific "habitat units" within streams:

- Riffles: Areas of turbulent, fast-flowing water, with gradients of 4% or less.
- Glides: Areas of fast-flowing, non-turbulent water.
- Pools: Areas of (relatively) slower, deeper water with a concave bottom profile, finer sediments, and a water surface gradient near 0%. Note that per FHAP, pools need to meet a certain size criterion to be considered a habitat unit. In areas where pools were present, but did not meet the size criteria, these areas were recorded as "pool-type" instream cover.
- Cascades: Steep, stepped "rifles" of bedrock or emergent cobble or boulders in channels with gradients greater than 4%.
- Other: includes features that do not fit into the above category, including culverted sections.

Length along reaches was recorded using a hip chain, and data was collected on the field sheets provided within the FHAP methods. Representative photos were taken of sites, and of any notable features observed during the assessment were georeferenced and photographed.

Supplemental fish sampling was also completed on September 3 and 5, to assess fish abundance within representative sections of the creek that had been previously assessed. Open site, single pass electrofishing was conducted over 50 m long sections of riffle habitat within sections sampled. All fish captured were identified to species, weighed, and measured (fork length). After recovering in clean water, fish were returned to the site. Fish that were observed but not captured during electrofishing were also counted, and their size estimated.

3.3 Data Analyses

All collected data were entered into Excel (Appendix 2), and a series of QA/QC exercises were completed. Data collected were then used to evaluate habitat conditions by comparing habitat features with diagnostic values, per FHAP methodology. Ideally, FHAP should evaluate habitat condition of a disturbed stream against regional standards collected from undisturbed watersheds in the same area. Where local regional standards are not available, which is common and was the case for this assessment, data are compared against the generic diagnostics outlined in Anonymous 1993 (from Johnston & Slaney 1996). We also compared habitat characteristics from highly disturbed and lesser disturbed areas that were sampled.

Fish capture data was used to generate length-frequency distribution histogram, and to calculate the condition of fish captured. The degree of well-being of a fish can be calculated using the condition factor, also known as length-weight factor, with the following formula:

$$K=100{,}000\ W/L^3$$

Where: W= the weight of the fish in grams

L= the standard length of the fish in millimeters

4 RESULTS

4.1 Fish Sampling

Electrofishing was completed at 6 sample sites (Table 1). A total of 201 fish were captured/observed during sampling, with 3 of these being Longnose Dace, and the rest being Rainbow Trout. Rainbow Trout ranged in size from 38 to 194 mm, representing all life stages. The maximum weight of fish captured was 63.5 g, which indicates that all Rainbow Trout captured were native fish as stocked fish in Cottonwood Lake range between 230 – 700 g (FIDQ 2024). The length-frequency distribution histogram of measured Rainbow Trout (Figure 1) suggest that there are at least 4 age classes within the population, representing years 0+ (<60 mm), 1+ (60 - 105 mm) , 2+ (105 – 135 mm) and 3+ (≥135 mm). Year 1 (0+) fish were captured in all sites electrofished except for R3-S2. The average condition of Rainbow Trout captured was 1.09. The condition factor is influenced by age of fish, sex, season, and stream productivity. Undernourished/thin fish usually have a condition factor of less than 1 and adequately fed or fat fish have a condition factor greater than 1.

Table 1. Summary of fish captured / observed during sampling efforts.

Area sampled	Spp[1]/ # Fish	Fish Length Ave. / Range (mm)	Density (Fish/m^2)	Average Condition Factor for RB
R1-S1 – Sill Log Area	LNC-3, RB-23	81 / 30-140	0.05	1.09
R2-S1 – Concrete flume	RB-26	103 / 50-194	0.08	1.12
R2-S2 – U/S of Baker St Bridge	RB-33	110 / 39-181	0.13	1.14
R3-S1 – U/S of Perrier Rd Bridge	RB- 54	113 / 46-174	0.26	1.13
R3-S2 – U/S of Cottonwood Dr. Bridge	RB-32	115 / 82-180	0.08	1.05
R4-S2 – Forested, relatively undisturbed habitat	RB-33	90 / 39-170	0.12	1.07

Note: [1]LNC = Longnose Dace, RB = Rainbow Trout

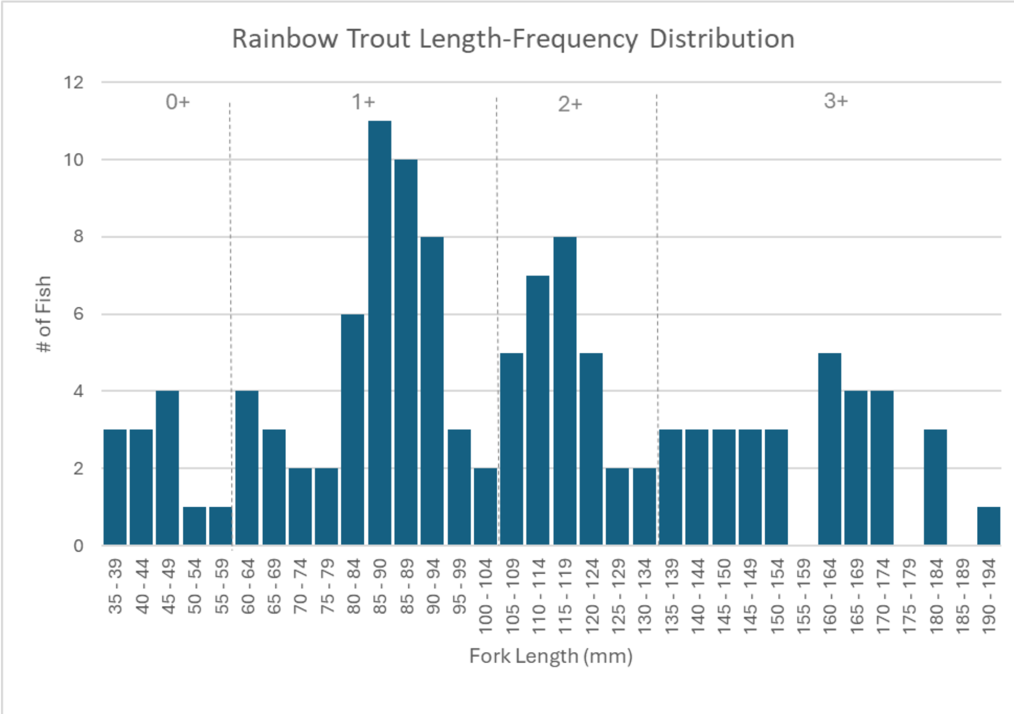


Figure 1. Length frequency distribution of Rainbow Trout captured in Cottonwood Creek.

4.2 Section Description and Habitat Condition

4.2.1 R1-S1: Creek Mouth to Lakeside Drive Bridge

Site 1 was 209 m long, covering the entire length of the section from the mouth of the creek up to Lakeside Drive bridge. Within this section, the creek flows between the airport runway to the north, and Lakeside Drive and industrial areas to the south (Photo 1 and Photo 2). Areas of the channel banks have been armoured with riprap. Five municipal storm system outfalls discharge into the creek in this section.

The stream channel had an average gradient of 1.0% and was made up of glide and riffle habitat (Table 2). Bankfull widths ranged from 8.2 – 16.6 m, and wetted width at the time of the survey was between 5.3 - 13.9 m. The average bankfull and wetted widths were 13.2 m and 10.3 m, respectively. Streambed substrates were predominantly cobbles and gravel, with some sand. Gravel and cobble substrate was highly embedded with sand and fine materials (Photo 3).

Riparian vegetation consisted of narrow strips (max. ~12 m) of large shrubs (predominantly willows (*Salix* sp.) and red-osier dogwood (*Cornus sericea*)) on both sides of the creek. Most areas that have been lined with riprap are now at least partially grown over with vegetation (see Photo 2). Canopy closure is low due to the width of the channel and lack of large trees. A large non-vegetated mid-channel bar was present at the time of the survey. During high water levels in the lake, the lower part of this section becomes backwatered, likely influencing streambed substrates through annual cycles of sediment deposition. A small area of swamp-like habitat (~70 m long x 3 m wide) is also located on the south side of the channel about 75 m upstream of the mouth (Photo 4). This area was dominated by alder (*Alnus sp*.), willow, and reed canary grass (*Phalaris arundinacea*), and may be wetted during highwater levels, but did not have any scoured channel. A small beaver lodge was noted on the north bank ~ 165 m upstream from the mouth, and evidence of recent beaver activity (chewed shrubs) was also noted.

This section of creek is accessible to fish from the lake, and is likely used by smaller fish year-round, and potentially larger fish during periods of higher water. This section generally lacks habitat complexity, and cover is sparse, consisting mainly of overhanging vegetation along the creek margins and occasional boulders. Only 2 pieces of functional large woody debris (LWD) were present. Rearing habitat quality for larger fish is limited due to the lack of deep pools. Spawning potential by salmonids is currently low due to the high amount of sedimentation present, leading to lack of suitable interstitial spaces for eggs to develop. We did not conduct electrofishing of this section as part of our field studies, however previous sampling efforts have documented Rainbow Trout, Longnose Dace, and Slimy Sculpin (Habitat Wizard, 2024).

Table 2. Summary of habitat units present within Site 1 (R1-S1).

Site	Length (m)	Ave. Channel Width (m)	Ave. Wetted Depth (m)	Ave. Gradient (%)	Area (% of Bankfull)					LWD
					Riffle	Glide	Cascade	Pool	Other	
1	209	13.2	0.25	1.0	30	70	0	0	0	2

Photo 1. Looking down R1-S1 1 to Kootenay Lake. Area affected by lake levels.

Photo 2. Upstream view of the upper portion of R1-S1, with riprap on the south bank.

Photo 3. Embedded cobble and gravel substrate.

Photo 4. Swamp-like habitat on the south bank.

4.2.2 R1-S2: Lakeside Drive Bridge to CPR Lands

Site 2 covered the entire 152 m of the section extending from Lakeside Drive to the downstream end of the industrial lands owned by CPKC. The creek flows though industrial areas at the downstream end of this section (Photo 5), and an empty lot at the upstream end (Photo 6). This section includes the restoration area where sill logs were previously installed (in the 1990s), and where riparian planting was undertaken. There are no municipal storm outfalls within this section.

The stream channel had an average gradient of 2.5 %, and habitat consisted mostly of riffles with a short section of glide habitat (Table 3). A large pool was also present at the upstream end, just below the concrete flume on CPKC land (Photo 7). Bankfull widths ranged from 7.7 – 17.1 m, and wetted widths ranged from 4.3 – 9.2 m. Streambed substrates were predominantly cobbles, with some pockets of gravels below the sill logs, and interspersed boulders (Photo 8). Riparian vegetation consisted of young mixed forest at the lower end of the section, and tall shrubs along the empty lot (see Photo 5 and Photo 6). Canopy closure ranged from 1 – 40%.

Like R1-S1, this section of creek is accessible to fish from the lake and is likely used for rearing year-round. Our sampling efforts in this section captured Rainbow Trout and Longnose Dace. Previous sampling by Smit (2014) documented the presence of one adult Bull Trout during the fall season (i.e., the spawning period for this species). Instream cover was more prevalent than R1-S1, but still generally sparse, consisting mainly of overhanging vegetation, and occasional boulders. Small plunge pools were also present below most of the sill logs, though these were partially infilled and were not deep enough to provide overwintering habitat. Small cobbles and pockets of gravel below the sill logs provide potential spawning habitat for salmonids, though these areas are generally quite embedded. The plunge pool at the upstream end provides excellent rearing/overwintering habitat. We observed several fish in this plunge pool during the habitat assessment, including an ~30 cm long salmonid. Although we were not able to electrofish the plunge pool, we suspect that the large salmonid observed during our assessment may have been an adult Bull Trout.

Table 3. Summary of habitat units present within Site 2 (R1-S2).

Site	Length (m)	Ave. Channel Width (m)	Ave. Wetted Depth (m)	Ave. Gradient (%)	Area (% of Bankfull)					LWD
					Riffle	Glide	Cascade	Pool	Other	
2	152	13.4	0.35	2.5	93	4	0	3	0	5

Photo 5. Representative photo of the lower portion of R1-S2, with an installed sill log. Facing upstream.

Photo 6. Representative photo of the upper portion of R1-S2, where the creek flows through a vacant lot.

Photo 7. Plunge pool at the upstream end of R1-S2 formed at the outlet of a concrete flume.

Photo 8. Representative photo of substrates within R1-S2.

4.2.3 R2-S1: CPKC Lands to Baker Street Bridge

Site 3 covered the entire 194 m long concrete flume constructed through the CPKC-owned lands and under the Baker Street bridge (Photo 9 and Photo 10). There is one municipal storm outfall that discharges into the west side of the flume just downstream of the Baker Street bridge.

Habitat within this section was essentially all riffle-like habitat formed by the flume, which has an average gradient of 3.0% (Table 4). Small areas of pool habitat (i.e., less than 3% of the overall flume area) were present in sections where the bottom of the flume had degraded, and the concrete had worn away (Photo 11). The bankfull width (i.e., width of the flume) was 6.4 m, and most of the flume was wetted with 15 cm water depth at the time of the assessment. Substrates were essentially all concrete, except for some areas where the concrete had broken away into cobble-sized blocks. Riparian vegetation over most of the section was minimal (essentially bare ground with some grass and weeds in the CPKC Yard), with some young deciduous forest just downstream of the Baker Street bridge.

The drop at the outlet of the flume presents an obstacle to upstream fish migration, particularly for smaller fish and during low flow conditions (Photo 12). Smit (2014) suggested that the flume itself is likely only passable during freshet conditions (i.e., when water is high enough to permit upstream migration), and that water velocities and lack of areas to rest within the flume likely restrict upstream travel to larger fish during a short period during freshet. Habitat within the flume is considered poor due to shallow water depths and lack of complexity, except for the small pool areas mentioned above. Our sampling documented Rainbow Trout within this site, nearly all of which were captured in these pools. No natural LWD was present, though the portion of the flume under the Baker Street bridge had steel baffles which functioned as LWD (Photo 10).

Table 4. Summary of habitat units present within Site 3 (R2-S1).

Site	Length (m)	Ave. Channel Width (m)	Ave. Wetted Depth (m)	Ave. Gradient (%)	Area (% of Bankfull)					LWD
					Riffle	Glide	Cascade	Pool	Other	
3	194	6.4	0.15	3.0	0	0	0	2	98	4

Photo 9. Representative photo of the flume running through CPKC lands (facing upstream).

Photo 10. Representative photo of flume under Baker Street bridge, with steel baffles on bottom.

Photo 11. Example of a small pool formed where the concrete bottom of the flume had worn away.

Photo 12. Obstacle to fish passage at flume outlet.

4.2.4 R2-S2: Baker Street Bridge to Cottonwood Falls

Site 4 covered the entire 360 m of the section between Baker Street bridge and Cottonwood Falls. Here, the creek flows through a mix of residential and commercial properties, and less-developed areas in Cottonwood Falls Park. Throughout most of its length, the creek has been confined by concrete walls and/or riprap armouring (Photo 13 and Photo 14). Additionally, eight municipal storm outfalls drain into the creek in this area.

The stream channel had an average gradient of 4.0%, and habitat was mostly a mix of riffles and glides, with a section of steeper (9%) cascade habitat just below the falls (Photo 15), and a small pool at the base of the falls (Table 5). Bankfull widths ranged from 3.5 – 11.3 m, and wetted widths were between 3.5 - 8.0 m at the time of the assessment. Substrates were predominantly cobbles, with boulders becoming more prevalent in the steeper section near the falls. There were pockets of sand and gravels along the stream margins, particularly in areas downstream of three larger storm outfalls (at Baker Street Bridge and Carbonate Street, Photo 16). Where present, riparian vegetation consisted of narrow strips of young mixed and deciduous forest. Canopy closure cover was generally less than 20%.

Cottonwood Falls, which is ~10 m in height, is a complete barrier to upstream fish movement. Our sampling and previous studies have captured Rainbow Trout within this section. Interestingly, several small Rainbow Trout fry (~40 mm) were observed in the pool at the base of the falls. It is unlikely that fry would be able to migrate up the cascade section leading up to the falls, so it is suspected that fish were washed downstream from habitat upstream of the falls. Rearing habitat is considered moderate, as instream cover is limited, and deep pools are scarce. Spawning habitat is considered poor, as suitable substrates are not available. Cover is mostly limited to boulders (i.e., riprap along banks) and overhanging vegetation. Some small pools were present within the steeper sections leading up to the falls. Only 1 piece of functional LWD was present. Fish use is likely limited to rearing and potentially overwintering by Rainbow Trout.

Table 5. Summary of habitat units present within Site 4 (R2-S2).

Site	Length (m)	Ave. Channel Width (m)	Ave. Wetted Depth (m)	Ave. Gradient (%)	Area (% of Bankfull)					LWD
					Riffle	Glide	Cascade	Pool	Other	
4	360	7.7	0.35	4.0	67	5	26	2	0	1

Photo 13. Riprap armouring on both sides of channel, just upstream of Baker Street Bridge.

Photo 14. Concrete wall on east bank of the creek within R2-S2.

Photo 15. Cascades and pools just below Cottonwood Falls.

Photo 16. Substrates embedded with sand just downstream of a storm outfall.

4.2.5 R3-S1: Highway 6 to Cottonwood Drive

Site 5 was a 639 m section extending from the dual box culvert inlet at the Highway 6 interchange to ~ 115 m upstream of Perrier Road. Highway 6 runs immediately adjacent to the east bank of the creek along this section (Photo 17). The west bank is a mix of undeveloped park space at the lower end and low-density residential properties off Perrier Road (Photo 18). Several sections of the creek (particularly in the residential area) have been confined with either riprap armouring or concrete walls. At least 9 municipal storm outfalls drain into the creek within this section, as well as several storm drainages from Highway 6.

The stream channel had an average gradient of 2.4%. The predominant habitat unit was riffles, though areas of cascades, glides, and pool habitat were also present (Table 6). Bankfull widths ranged from 4.8 - 12.6 m, and wetted widths ranged from 2.7 - 9.9 m at the time of the survey. Substrates were predominantly cobbles and boulders, with trace amounts of gravel along the stream margins. Riparian vegetation in the park space at the northern end of this section was relatively intact, with a mix of young mixed and deciduous forest (Photo 17). Further south in the residential areas, riparian vegetation on the west bank was often limited to lawn areas with only grass and shrub cover (Photo 18). Riparian vegetation along the east bank (Highway 6 road shoulder) was typically limited to only a few meters of vegetation, and less than 40% canopy closure. Disturbance indicators such as eroded bank (Photo 19) and LWD parallel to the stream banks indicated that high water flows during freshet conditions may cause channel disturbance.

This section of creek is not accessible to fish from downstream due to the barrier associated with Cottonwood Falls and the culvert/flume that passes under Highway 6, and Rainbow Trout within this section are part of a resident population that occupies the creek upstream of Cottonwood Falls. We did not sample this section for fish, though Rainbow Trout were captured here during sampling in 2001

(Habitat Wizard, 2024). A constructed dam/platform created from concrete sandbags ~ 110 m upstream of Perrier Road creates a small set of falls (~ 0.9 m high; Photo 20). At the top of the falls, only ~ 10 cm of water was flowing over an ~3 m long section of concrete. The combination of the falls and shallow water at the top creates a barrier to fish passage during low flow conditions, and potentially during higher flows for smaller fish. This section of creek provides moderate quality rearing and overwintering habitat for resident Rainbow Trout. A moderate amount of cover was provided by overhanging vegetation, boulders, and pools. Boulders also provide good cover and refuge habitat for fish during high water flows. Twenty-two pieces of functional LWD were present. Spawning potential is poor, given the general lack of suitable spawning substrate.

Table 6. Summary of habitat units present within Site 5 (R3-S1).

Site	Length (m)	Ave. Channel Width (m)	Ave. Wetted Depth (m)	Ave. Gradient (%)	Area (% of Bankfull)					LWD
					Riffle	Glide	Cascade	Pool	Other	
R3-S1	639	8.3	0.30	2.5	70	9	10	9	2	22

Photo 17. Lower section of R3-S1, running through undeveloped park area. Hwy 6 park and ride can be seen at the top of bank.

Photo 18. Residential lawns on the west bank of the creek. Photo taken facing upstream.

Photo 19. Section of eroded bank just below Hwy 6 Park and Ride.

Photo 20. Small falls created by a constructed dam/platform at the upstream end of Site 5.

4.2.6 R3-S2: Cottonwood Drive to Kline Road

Site 6 covered the entire 615 m of this section of creek between Cottonwood Drive and Kline Road. Giveout Creek flows into Cottonwood Creek at the upstream end of this section. Highway 6 is located on the east bank of Cottonwood Creek along the entire length, with the road shoulder at the top of bank in several areas (Photo 21). Properties on the west bank are a mix of low- to moderate- density areas, and many sections of the streambank have been highly modified by channel armouring and removal of riparian vegetation (Photo 22).

This area was markedly steeper than downstream sections, with an average gradient of 9.0%. Correspondingly, most of the habitat was cascades, with a trace amount of pool habitat units (i.e., 2% of the overall bankfull habitat). Flows were generally quite fast, and several sections of eroded bank and one LWD jam was noted in this section (Photo 23). Bankfull widths ranged from 4.3 – 11.0 m, and wetted widths ranged from 4.6 – 7.9 m at the time of the assessment. Substrates were predominantly boulders and cobbles, with trace amounts of gravel in stream margins. Riparian cover was generally minimal (usually less than 20% canopy closure), generally limited to narrow strips of young mixed forest and shrubs along the top of bank. One area of invasive Japanese knotweed (*Reynoutria japonica)* was noted on the Highway 6 road shoulder ~150 m downstream of upper Perrier Road/Highway 6 intersection (Photo 21).

No barriers to fish movement were noted within this section. Instream cover was moderate to abundant, provided mostly by boulders and small pools formed in steeper sections (Photo 24). Sixteen pieces of functional LWD were present. Our sampling efforts captured Rainbow Trout within this section; this species has also been documented in Giveout Creek by previous studies (Habitat Wizard, 2024). Good quality rearing habitat is available for larger fish, which can use boulder shelter for cover. The relatively steep gradient and fast flows are not as suitable for smaller fish; no 0+ fish were captured in this section. Small pools present did not provide optimal overwintering habitat, however the combination of a deep snow pack and high water velocities may prevent the water from freezing and provide overwintering opportunities. Spawning potential is low, given the lack of suitable gravel substrate.

Table 7. Summary of habitat units present within Site 6 (R3-S2).

Site	Length (m)	Ave. Channel Width (m)	Ave. Wetted Depth (m)	Ave. Gradient (%)	Area (% of Bankfull)					LWD
					Riffle	Glide	Cascade	Pool	Other	
6	615	8.2	0.35	9.0	0	0	98	2	0	16

Photo 21. Upstream view of a section of R3-S2, with the road shoulder of Hwy 6 located at top of bank. Patch of Japanese knotweed is circled.

Photo 22. Riparian vegetation removal and relic riprap armouring on the east bank of R3-S2.

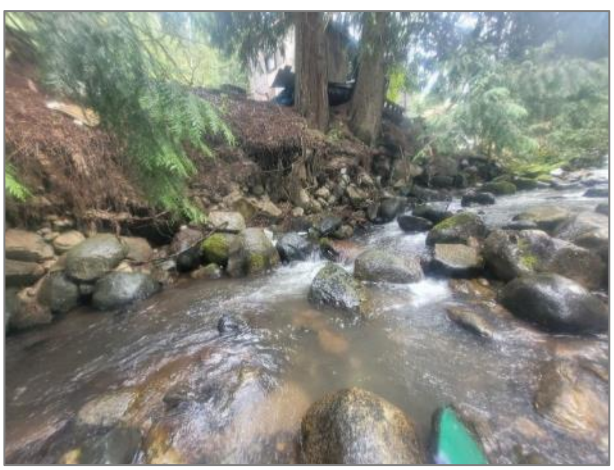


Photo 23. Section of eroded bank below a shed and driveway on residential property.

Photo 24. Example of small pool cover.

4.2.7 R3-S2.1: Kline Road to Schesnuk Creek

Site 7 (330 m long, from Kline Road to the culverted crossing of Highway 6), was originally assessed as part of Site 6 in R3-S2, but was split into its own site (and R3-S2.1 as its own section) based on differing habitat characteristics. This section starts at the culvert under Kline Road and extends up to Schesnuk Creek. Within this section, the creek runs through a mix of residential and commercial properties on both sides and is generally further from the highway than R3-S2. Much of this section has lawns or parking lots extending to the top of bank (Photo 25), with the exception of a few properties that have a relatively undisturbed riparian area (Photo 26). Armoured banks are common, including riprap and concrete walls.

This area was less steep than R3-S2, with an average gradient of 1.0%. Most of the habitat was comprised of riffles, with trace amounts of glides and pools. Bankfull widths ranged from 3.6 to 9.7 m, and wetted widths were between 2.1 - 8.5 m at the time of the survey. Cobbles made up most of the substrate types, with boulders as subdominant substrate. Small patches of suitable spawning gravels were present within this section on channel margins, however much of the substrate was quite embedded (Photo 27). In areas of dense development, riparian vegetation and cover was generally limited to narrow strips of shrubs along the top of bank, though some patches of intact mixed forest were also present Canopy closure ranged from less than 20% to 70-90%. There was a large patch of Japanese knotweed in the location of a private bridge near the Cool Waters RV Park.

The culverts at the upstream and downstream ends restrict upstream fish migration during low flow conditions, and likely to smaller fish under all flow conditions. The corrugated steel pipe culvert under Kline Road is 24 m long, with a gradient of 2%, and is not embedded. This was assessed as a barrier by Silvatech (2014). At the time of our survey, there was approximately 10 cm of water in the culvert, and a 0.15 m drop from the culvert outlet to the plunge pool (Photo 28). The culvert under Highway 6 is a 50 m long concrete box culvert, with a gradient of 3.5%. The culvert was not embedded, and only had about 5 cm of water flowing through it at the time of the survey (Photo 29). Additionally, a trash rack at the upstream end of this culvert collects debris that may further impede fish passage through the feature. This feature was considered an obstacle to fish passage (i.e., passable under some conditions) by Silvatech (2014). Additionally, we noted several small constructed "weirs" next to residential properties in this section where property owners had apparently stacked natural substrates to create a dammed pool next to their property. Some of these were constructed across the entire stream channel (Photo 30) and were considered potential barriers to upstream fish movement during low flow conditions.

We did not sample this section for fish, but this area is used by the Rainbow Trout resident population. Good rearing habitat is available, as flows are relatively slow and moderate cover is present in the form of boulders, overhanging vegetation, and pools. No LWD were present within this section. Patches of suitably-sized substrate for spawning are present, however spawning potential is currently limited due to sedimentation levels.

Table 8. Summary of habitat units present within Site 7 (R3-S2.1).

Site	Length (m)	Ave. Channel Width (m)	Ave. Wetted Depth (m)	Ave. Gradient (%)	Area (% of Bankfull)					LWD
					Riffle	Glide	Cascade	Pool	Other	
7	330	7.2	0.35	1.0	87	5	0	4	4	0

Photo 25. Residential property with channel armouring on east bank of Cottonwood Creek (facing upstream).

Photo 26. Example of a section of creek with relatively undeveloped riparian area within Section R3-S2.1 (facing upstream).

Photo 27. Embedded gravel and cobble substrate.

Photo 28. Upstream view of culvert outlet under Kline Road.

Photo 29. Culvert under Hwy 6.

Photo 30. Constructed dam next to a residential property forming a fish barrier during low flow conditions.

4.2.8 R4-S1: Schesnuk Creek to Selous Creek

Habitat in this section was assessed over a 160 m site (Site 8), just downstream of the outlet of Selous Creek. In this site, the creek runs through a relatively intact section of mature forest with natural channel banks between Highway 6 to the west and an area cleared for residential properties on the east (Photo 31).

The stream channel had an average gradient of 4.5%. Cascades and riffles were the dominant habitat units, with trace amounts of glide and pool habitat present. Bankfull widths ranged from 1.4 to 7.2 m, and wetted widths were between 1.0 - 5.1 m at the time of the survey. The predominant substrates were cobbles and boulders, though gravel bars were occasionally present in flatter sections (Photo 32), providing areas of clean, non-embedded spawning gravel. Riparian vegetation consisted of a mix of young and mature coniferous and mixed forest. In general, canopy closure was between 20 and 70%, except for areas where residential properties and the highway shoulder approached the creek.

Boulders, large woody debris, and undercut banks provided a moderate amount of cover, along with occasional small pools. Large woody debris was abundant in this site compared to downstream sites. The cover present provides moderate rearing habitat for juvenile Rainbow Trout. The pools present provide moderate overwintering habitat, though these features were generally not very deep. Spawning is possible in some of the flatter sections where gravel patches were present. No barriers to fish movement were noted during the survey. We did not sample this site for fish, several juvenile Rainbow Trout were observed while doing the habitat assessment.

Table 9. Summary of habitat units present within Site 8 (R4-S1).

Site	Length (m)	Ave. Channel Width (m)	Ave. Wetted Depth (m)	Ave. Gradient (%)	Area (% of Bankfull)					LWD
					Riffle	Glide	Cascade	Pool	Other	
8	160	6.2	0.20	4.5	40	4	55	1	0	28

Photo 31. Representative photo of R4-S1.

Photo 32. Gravel bar with suitable spawning substrate that would be submerged in spring.

4.2.9 R4-S2: Upper Cottonwood Creek

A total of 490 m of creek was assessed over three sites in upper Cottonwood Creek (between Selous Creek and Cottonwood Lake):

- Site 9: A 185 m section of creek ~800 m upstream of the Selous Creek confluence (Photo 33).
- Site 10: A 155 m section of creek just upstream of the Gold Creek confluence (Photo 34).
- Site 11: A 150 m section of creek between Highway 6 and Cottonwood Lake (Photo 35).

All three of these sites had similar stream characteristics and provided similar habitat, and for the purpose of this assessment were combined. In these areas, the creek ran through patches of relatively intact riparian forest with abundant large woody debris, and was often straddled by linear development (Highway 6 and Cottonwood Lake Park Road, the Rail Trail, and a powerline corridor). In several areas, road/rail embankments confined the channel banks, but otherwise the channel was in a relatively natural state.

The creek channel in R4-S2 was generally flatter and narrower than downstream sections. The average gradient was 2.0%. Riffle habitat was prevalent, with occasional sections of glides and sparce pools. A small section of wetland habitat was also present just downstream of the Highway 6 crossing (Photo 36).

Bankfull width ranged from 3.0 to 9.7 m, and wetted width was between 1.0 - 5.9 m at the time of the survey. Substrate was dominated by cobbles and gravels with several areas of sand and fine substrates. Several areas were noted where the Rail Trail and road embankment were sloughing into the creek channel and appeared to be the source of much of the sand and some of the gravel substrates (Photo 37). Riparian vegetation was a mix of mature coniferous forest and shrubs. Canopy closure was generally high (i.e., 40 – 70%), with the exception of areas of lower shrub cover.

This section of creek provides areas of excellent rearing habitat for juvenile Rainbow Trout, which were captured during sampling in Site 9. Abundant cover is available, particularly in the form of large and small woody debris, as well as overhanging vegetation. Several deep pools are present and suitable for overwintering. Spawning potential is also high due to the abundance of gravel substrates. No barriers to fish passage were present in the areas surveyed, though Site 11 was largely dewatered when we visited the site to conduct electrofishing on September 5. This had resulted in the formation of several isolated pools that had stranded Rainbow Trout fry (Photo 38). During an informal later visit to the site on October 14, the stream channel was still dewatered.

Table 10. Summary of habitat units present within R4-S2.

Sites	Length (m)	Ave. Channel Width (m)	Ave. Wetted Depth (m)	Ave. Gradient (%)	Area (% of Bankfull)					LWD
					Riffle	Glide	Cascade	Pool	Other	
9,10,11	490	5.1	0.15	2.0	79	15	0	3	3	175

Photo 33. Representative photo of Site 9 (facing upstream).

Photo 34. Upstream view of Site 10, with Rail Trail bed on east bank.

Photo 35. Representative photo of Site 11 (facing upstream).

Photo 36. Section of swamp habitat just downstream of Highway 6 crossing at Cottonwood Lake.

Photo 37. Accumulated sands and gravels at the base of the rail trail bed in Site 10.

Photo 38. Salvaging Rainbow Trout fry from a dewatered section of Site 11.

4.3 Fish Habitat Ratings

Data collected was used to calculate habitat parameters to be compared against generic diagnostics of salmonid habitat (Table 11). In general, most sections sampled rated “low” for most habitat parameters when compared against the generic diagnostics. This is shown in Table 12, and discussed in more detail below.

Table 11. Diagnostics of salmonid habitat (Anonymous 1993 from Slaney 1996)

Habitat Parameter	Gradient or Wb Class	Use	Quality		
			Poor	Fair	Good
Percent pool (by wetted area)	<2 %, < 15 m wide	Summer/winter rearing habitat	< 40 %	50-55 %	> 55 %
	2-5 %, < 15 m wide		< 30 %	30-40 %	> 40 %
	>5 %, < 15 m wide		< 20 %	20-30 %	> 30 %
Pool frequency (channel width spacing between pools)	all	Summer/winter rearing habitat	> 4 channel widths per pool	2-4 channel widths per pool	< 2 channel widths per pool
LWD pieces per bankfull channel width	all	Summer/winter rearing habitat	< 1	1-2	> 2
% Wood cover in pools	all	Summer/winter rearing habitat	most pools in low category (0 - 5%)	most pools in moderate category (6 - 20%)	most pools in high category (> 20%)
% Boulder cover in riffles / cascades	all	Summer/winter rearing habitat	< 10 %	10 - 30 %	> 30 %
Off-channel habitat	<3 %, all widths	Winter / spring rearing habitat	few or no backwaters, no off-channel ponds	some backwaters	backwaters with cover and ponds and other low energy off-channel areas
Substrate	all	Winter / spawning habitat	interstices filled: sand or small gravel subdominant in cobble or boulder dominant	interstices reduced: sand subdominant in some units with cobble or boulder dominant	interstices clear: sand or small gravel rarely subdominant in any habitat unit
Gravel quantity / quality	all	Spawning and incubation	absent or little / sand is dominant substrate at some sites	few / sand is subdominant substrate at some sites	frequent / sand is never dominant or subdominant substrate
Access to spawning areas	all	Adult migration	access blocked by low water, culvert, falls, temperature		no blockages

Note: [1]Diagnostics from Anonymous 1993 only consider boulder cover in riffles, but we have also included cascades given the prevalence of this habitat unit

Table 12. Habitat parameters for sites sampled on Cottonwood Creek

	Sites Sampled								
Habitat Parameter	**R1-S1**	**R1-S2**	**R2-S1**	**R2-S2**	**R3-S1**	**R3-S2**	**R3-S2.1**	**R4-S1**	**R4-S2**
Percent pool habitat units (by wetted area)	0% (Poor)	6% (Poor)	0% (Poor)	3% (Poor)	8% (Poor)	2% (Poor)	4% (Poor)	5% (Poor)	3% (Poor)
Percent pool cover (by wetted area)	0% (Poor)	7% (Poor)	5% (Poor)	3% (Poor)	2% (Poor)	5% (Poor)	5% (Poor)	4% (Poor)	6% (Poor)
Pool frequency (channel width spacing between pools)	n/a	11 (Poor)	30 (Poor)	46 (Poor)	19 (Poor)	37 (Poor)	23 (Poor)	25 (Poor)	32 (Poor)
LWD pieces per bankfull channel width	0.1 (Poor)	0.4 (Poor)	0.1 (Poor)	0 (Poor)	0.3 (Poor)	0.3 (Poor)	0 (Poor)	1.1 (Fair)	1.8 (Fair)
% Wood cover in pools	n/a	0% (Poor)	0% (Poor)	0% (Poor)	~3% (Poor)	0% (Poor)	~2% (Poor)	0% (Poor)	~10% (Fair)
% Boulder cover in riffles / cascades	2 % (Poor)	0 % (Poor)	n/a	7 % (Poor)	6 % (Poor)	12 % (Fair)	2 % (Poor)	6 % (Poor)	1 % (Poor)
Off-channel habitat	Little / Poor Access (Fair)	None (Poor)	None (Poor)	None (Poor)	Little / Poor Access (Fair)	None (Poor)	None (Poor)	Little (Fair)	Little (Fair)
Substrate	Poor	Poor	Poor	Fair	Fair	Fair	Fair	Fair - Good	Good
Gravel quantity / quality	Poor	Poor	Poor	Poor	Poor	Poor	Fair	Fair	Good
Access to spawning areas	Good*	Good*	Poor	Poor	Poor	Fair	Fair	Good	Good

Percent pool cover and pool frequency: Relatively few pools are present within all sites sampled on Cottonwood Creek, with pool frequency ranging between 11 – 46 channel width spacing between each pool and rated as *poor* for all sites (target for good is > 4). Overall, percent pool habitat (i.e., pool habitat units) ranged from 0% - 8%, also rating as *poor*. Total pool cover (i.e., including smaller pools) was similarly low. Sites further downstream in more disturbed areas scored similarly to the upper less disturbed sites. Deep pools in lower, steeper reaches were generally limited to plunge pools below features like culverts, flumes, etc., and were often associated with fish barriers. While some smaller pools also existed, these were often relatively shallow and of low to moderate value for overwintering fish and large fish.

Large woody debris and wood cover in pools: LWD was notably more abundant in upper sites than in lower sites. R4-S1 and R4-S2 both received a *fair* rating (ranging 1.1 to 1.8 pieces of functional LWD per bankfull width). In contrast, lower and mid- sections of the creek were rated as *poor*, ranging from 0 – 0.1 pieces per bankfull width. These areas, which were more developed, typically had less mature riparian vegetation, leading to less natural recruitment of LWD into the stream. Additionally, steeper gradients in the mid-sections are less likely to retain LWD due to faster water flows. Where LWD was present in these areas, the LWD pieces were usually parallel to the stream bank, indicative of disturbance and that LWD is mobilized during high flows in these areas.

Boulder cover in riffles and cascades: Boulder cover within riffles ranged from 0% to 12% across the sites sampled. R3-S2 received a *fair* rating, with all other sites receiving a *poor* rating. In the more developed areas of lower and mid-sections, boulder cover was mostly attributed to riprap armouring along channel banks rather than from natural substrates. Boulders were more prevalent in steeper sections where substrates were coarser and were less common in the upper sections of the creek because these areas were typically low gradient.

Off-channel habitat: Off-channel habitat was notably absent from most of the creek. These features typically provide refuge and shelter habitat during high flow events. Exceptions were two areas of swamp-like habitat adjacent to the channel, and secondary channels. A small area of swamp-like habitat was present on the east bank of R1-S1, which likely becomes wetted during higher water periods and backwatering from the lake. However, this area lacked a defined channel and is likely of minimal value to rearing fish. A larger swamp complex was present at the upper end of R4-S3 near the Highway 6 crossing, which provides excellent cover for fish. Sites R2-S1, R4-S1, and R4-S2 all had short sections of secondary side channels. Though these areas were small, they provided excellent rearing habitat for fish.

Substrates: Substrates were evaluated based on the extent of infill in interstitial spaces. R1-S1, R1-S2, and R2-S2 received *poor* ratings due to significant sedimentation levels. Fines and sand commonly filled natural cobble and gravel substrates, particularly downstream of municipal storm outfalls. In R2-S1 and Reach 3, boulder substrates were more prevalent. Although some sedimentation was noted, sufficient interstitial spaces remained available for fish shelter, leading to a *fair* rating for these areas.

Upper sites were rated as *good* for substrates. While some sediment input was observed from sloughing road and rail trail banks, most natural substrates remained relatively clean, with interstitial spaces generally clear.

Spawning gravels quantity / quality: Few areas of suitable spawning gravels were present within reaches 1 to 3 of Cottonwood Creek. Though R1-S1 and R1-S2 had abundant gravels present, these areas were mostly infilled with sand and fines such that they were not suitable for spawning. Reach 2 (from the flume on CPKC lands to Cottonwood Falls) and most of Reach 3 had little to no gravel present. These sections all received a *poor* rating. One exception was R3-S2.1, which had a long section of low gradient riffle habitat with areas of suitable spawning gravel present. This site was rated as *fair*. R4-S1 was also rated as *fair* due to the presence of gravel bars. R4-S2 had abundant gravel substrates, and was rated as *good.*

Access to spawning areas: Access to spawning areas was rated based on whether access to potential spawning areas is blocked by low water levels, culverts, etc. Access in R1-S1 and R1-S2 was considered *good*, though it is noted that the current infilled condition of substrates limits the spawning habitat value. Access in Reach 2 and R3-S1 were rated as *poor* for access due to the presence of obstacles/barriers between these sections and high-quality spawning habitat. R3-S2 and R3-S2.1 were rated as *fair,* due to the uninterrupted connection to riffle habitat with gravel substrate in R3-S2.1. Fish in these sections are likely restricted in their movement upstream of the Highway 6 culvert. No barriers or obstacles were observed in R4-S1 and R4-S2, and abundant spawning gravels were observed, so these sites were rated as *good*. Note that our assessment did not cover all of Cottonwood Creek within Reaches 3 and 4, and additional obstacles blocking spawning migration may be present.

5 Discussion

5.1 Fish Populations

Several species have potential to use the lower reaches of Cottonwood Creek below the falls, including adfluvial Kokanee and Bull Trout. Although they have not used the creek for spawning in many years, Kokanee may have the potential to return if suitable habitat conditions are restored. Ensuring that spawning areas are optimized for their needs could facilitate the re-establishment of a Kokanee run in this system. Additionally, Bull Trout have been spotted sporadically below the concrete flume on CPKC lands, and they may benefit from ongoing restoration efforts aimed at enhancing spawning habitat and access to potential rearing habitat between the flume and Cottonwood Falls.

Upstream of the falls, a resident population of Rainbow Trout is present. The condition of fish captured during our sampling suggest that these fish are generally healthy. Fry (0+) fish were captured in all sections sampled, except for the relatively steep R3-S2. Some of the lower areas sampled within Reach 3 (i.e., between Cottonwood Falls and Selous Creek) did not have what was considered to be suitable spawning habitat, which suggests that fry are likely moving downstream from upstream spawning areas.

The highest densities of Rainbow Trout were captured in section R3-S1, a section considered to provide moderate rearing habitat. Relatively high densities that were also captured in section R2-S1 were somewhat unexpected, given the lack of habitat complexity associated with the existing concrete flume. Nevertheless, the fact that essentially all fish captured were caught in the pools present that were created by failing concrete further highlights the importance of these habitat features. In contrast, the upstream "undisturbed" reaches yielded relatively low densities of Rainbow Trout, comparable or lower than some of the more developed areas.

5.2 Impacts to Fish Habitat

Based on our assessment, the major constraints to biophysical fish habitat within Cottonwood Creek appear to fall into 3 main categories (in no particular order): 1) sedimentation, 2) general loss of instream and riparian habitat complexity due to armouring of stream channels and development along channel banks, and 3) disruption of fish migration patterns due to the presence of obstacles and barriers.

5.2.1 Sedimentation

Sedimentation of substrates with fine materials (i.e., silts and sand) can negatively impact fish populations by directly altering habitat structure. Infilling of interstitial spaces can lead to the reduction or loss of suitable spawning gravels, and the infill of pool habitat used for rearing. Additionally, fish themselves may be affected by reduced water quality, and smothering of eggs/larvae and benthic food sources.

Thomson (2009) concluded that sedimentation in Cottonwood Creek is due to 3 main sources: the City of Nelson storm system, road abrasive (i.e., sand) input into the creek during plowing of snow on Highway 6, and natural input into the creek from landslides and tributary streams.

The City of Nelson has conducted recent upgrades to the municipal storm system, including installation of Vortech sediment retention devices in 3 catchment areas above the falls in 2009, and the recent installation of 2 smaller Contech sediment retention devices below the falls in Cottonwood Park in 2023 (C. MacKinnon, pers. comm). While these improvements will undoubtedly help reduce sediment loading into the lower reaches of the creek, it is crucial that these structures be regularly maintained to ensure that they function properly. Per communications with City of Nelson staff, we understand that stormceptors are cleaned with a hydrovac bi-annually by the City. Our assessment noted areas of abundant sand downstream of storm outfalls below Cottonwood Park; it is not clear if this sand is from prior to 2023, or from after when the 2 devices were installed in the park.

Our assessment also observed areas of moderate levels of sedimentation upstream of City boundaries. In some cases, these could be attributed to point sources such as eroding road and trail embankment next to the stream channel or storm runoff from Highway 6. In other cases, especially in larger areas of widespread sedimentation (such as the flatter sections of R3-S2.1), it was not possible to identify an accurate source.

It is important to recognize that while excessive sedimentation can harm fish habitat, sediment input from natural (and in some cases unnatural) sources can also contribute to the recruitment of valuable larger sediment such as gravel substrates. During our assessment of R4-S3 and R4-S4, we noted that gravel input from the Rail Trail and road embankments created patches of suitable spawning gravels. While it is important to manage excessive sediment input into the creek, smaller point sources of larger substrates (i.e., gravel) may not necessarily be negative.

5.2.2 Obstacles / Barriers to Fish Migration

Four main obstacles to fish migration were noted during our survey (see below). Additionally, some of the dammed pools presumably built by property owners in Reach 3 present temporary obstacles to fish passage which may interrupt movement of the resident Rainbow Trout population(s) in this area.

1. **The concrete flume that passes through the CPKC lands**: The drop at the outlet of the flume presents an obstacle to upstream fish migration, particularly for smaller fish and during low flow conditions. Although a prior assessment by Smit (2014) indicated that the flume itself may act as a barrier, our assessment noted the presence of several small pools in degraded areas along the flume's base. These pools could assist passage of fish that make it into the flume by providing shelter and resting spots. However, high flow rates in the spring still likely hinder upstream movement. Thus, while the flume may not completely block migration, it certainly acts as an obstacle at the least.
2. **Constructed dam/ concrete platform in R3-S1**: The combination of an ~0.9 m drop and shallow water levels at the top of the falls pose an obstacle to upstream migration, particularly during low flows and for smaller fish. It was not obvious in the field why this structure was originally built.

3. **Kline Road culvert:** The combination of the non-embedded culvert, shallow water depths, and drop at the culvert outlet impede fish passage. This was assessed as a barrier by Silvatech (2014).
4. **Highway 6 culvert:** A combination of culvert length, gradient, and shallow water depths in this feature may impede fish passage. This feature was considered an obstacle (i.e., impassable during low flow conditions but may be passable during higher flows) to fish passage by Silvatech (2014).

Cottonwood Falls is the upstream limit of adfluvial fish in Cottonwood Creek, though these fish are also limited by the presence of the concrete flume on CPKC lands. While there is no suitable spawning habitat located between the flume and the falls, this section provides potential rearing habitat that could be used by species recorded in the lower reaches, including juvenile Bull Trout, Rainbow Trout, Dace, and Sculpin.

All other obstacles are upstream of the falls where a resident Rainbow Trout population is located. While these fish do not migrate in and out of Kootenay Lake, they can still be negatively impacted by obstacles due to restricted movement to spawning and shelter habitat, genetic isolation, and increased risks to population stability (i.e., due to detrimental impacts to isolated areas).

5.2.3 Loss of Instream and Riparian Habitat Complexity

Large portions of the creek channel and stream banks have undergone significant modifications along much of the lower and mid-reaches of Cottonwood Creek, and the cumulative effects of these modifications have a substantial impact on fish habitat in these areas. Notable developments that contribute to a loss of habitat complexity include:

- **Channel Armoring**: The installation of concrete walls and riprap restricts channel widths, increases flow velocities through a narrower stream channel, and results in the loss of riparian vegetation.
- **Vegetation Clearance**: Removing vegetation above the top of bank reduces shelter, and diminishes the input of food and nutrients into the stream. Additionally, reduced shading can lead to increased water temperatures.
- **Stream Bank Disturbance**: Disturbances to the stream banks lead to a decline in riparian vegetation and increase the erosion of bank materials.
- **Invasive Species**: The introduction of invasive vegetation can adversely affect the health of aquatic habitat through displacement of native vegetation, reduced habitat complexity, and altered nutrient input. Japanese knotweed, which was noted in two locations, is considered a particularly harmful invasive species as it can reduce access to water for wildlife and potentially increase erosion of streambanks due to the displacement of natural root systems (MoF, N.D.).

6 Recommendations for Restoration Strategies and Further Assessments

The restoration strategies proposed are focused on high-level strategies:

- Restoring habitat-forming processes in areas of disturbed aquatic habitat (with a focus on higher quality habitat), through the placement of instream structures.
- Improving passage at current obstacles and barriers to fish movement.
- Working with private landowners to restore and protect riparian habitat.

Ongoing work to address sedimentation within the creek is also recommended, though work to be done is generally outside of the scope of a “shovel-ready” project for restoration by LLC. It is recommended that LLC continue to work and engage with both the City of Nelson and the Ministry of Transportation and Infrastructure to address sediment input into the creek.

6.1 Restoring Habitat-Forming Processes in Disturbed Aquatic Habitat

There are several techniques for restoring habitat-forming processes in instream fish habitat, including the installation of drop structures, placement of boulders and large wood debris (LWD), roughening channel substrates, and constructing riffle habitats. Additionally, cleaning existing spawning gravels and adding new gravels can enhance spawning habitat quality. These strategies can be implemented individually or in combination to increase habitat complexity. Collectively, these strategies help restore more natural flow patterns, facilitate the natural sorting of substrates, create areas of natural scour, and provide essential cover for fish.

Placement of instream structures such as boulders and LWD is a common restoration strategy in urban streams, but can be complicated by the state of surrounding land. LWD typically needs to be secured to the bank, which can be challenging in areas with high flow regimes or where channel banks have been armoured. Cables to secure the logs were commonly used as an anchoring method in the past, however general practices are moving away from the use of cables due to risks to fish and general safety associated with them breaking (Cramer 2012). In the case of Cottonwood Creek, LWD placement is typically only suitable in lower gradient areas with natural stream banks. In general, the cleaning or placement of gravels is only appropriate when the upstream source of sedimentation can be identified and managed over the long term.

The following areas have been identified as candidates for restoration (see Appendix 3):

6.1.1 Sill Log Area in R1-S2

This area was previously restored in 1990 with the installation of spawning platforms for Kokanee salmon. Kokanee were not observed to use the restored habitat, which is likely due to the continued sedimentation of the substrates. With recent improvements to the City of Nelson's stormwater infrastructure, a renewed opportunity may be present to restore this habitat more effectively. Although, sufficient reduction of sedimentation would be necessary and would have to be assessed.

The potential restoration site, which is ~ 84 m in length is a strong candidate for restoration due to its relatively intact riparian vegetation, which provides essential cover and contributes to water quality (Photo 39). Additionally, its accessibility to adfluvial fish enhances its potential as a viable rearing and spawning area. The adjacent land is owned by the City of Nelson, which facilitates access and further management and conservation efforts.

To rehabilitate this habitat, restoration measures should focus on adding instream structures that improve habitat complexity and promote natural scouring and cleaning of substrate. This could include the placement of boulder clusters and LWD to create a more defined thalweg and create microhabitats that support various fish life stages. Boulders of varying sizes should be placed throughout the riffle section and arranged in clusters to create pockets of slower water and areas of turbulence. LWD or rock sills can be placed extending into the channel to create areas of slowed water flow and trap sediment, and to create scoured pools downstream. Retaining and enhancing suitable spawning gravels could also improve the habitat value of this area. Strategies could involve cleaning existing substrate, introducing new substrate materials, and/or ensuring that flow patterns are conducive to natural sorting, cleaning, and distribution of gravel substrates. Any introduction of spawning habitat in the lower reaches should be mindful of sedimentation concerns as previously documented, and restoration design should take sedimentation into account. Further studies are recommended to confirm that newly installed gravels would not be at risk of failing due to sedimentation. Additional riparian planting can also be undertaken on the banks or any created channel bars to further improve riparian habitat quality. Any plantings should include beaver protection given the beaver activity noted downstream during our assessment.

Photo 39. Site proposed for restoration in R1-S2.

6.1.2 R1-S1

The area from the stream mouth to Lakeside Drive Bridge (Photo 40) could also benefit from restoring natural habitat complexity. While this area is also accessible to adfluvial fish, it is considered to be slightly lower on the priority list than R1-S2 as there is less existing riparian vegetation, and backwatering of this area during higher flows may inhibit the use by spawners. Nevertheless, this area can be improved for rearing and through installation of boulders and LWD as described above to create areas of refuge habitat and create a meandering thalweg. The mid-stream gravel bar could potentially be built up and revegetated with shrubs. As with R1-S2, any plantings should include beaver protection. It may also be possible to create a small side channel in the area of the swamp-like habitat (Photo 41) on the southwest bank to provide additional refuge habitat during higher flows.

Photo 40. Site proposed for restoration in R1-S2

Photo 41. Swamp area on southwest bank of R1-S2 proposed for restoration.

6.1.3 Riffle Habitat in R3-S2.1

One additional area that stands out as a potential candidate for restoring instream habitat is an approximately 150-meter long section of riffle habitat within R3-S2.1, located just north of the Cool Waters RV Park (Photo 42). The upstream-most 30 meters of this habitat unit is characterized by mature riparian forest, featuring natural stream banks and providing relatively good rearing habitat value.

While areas of gravel substrate are present, they have been somewhat infilled with sediment. To enhance the habitat, we recommend creating a meandering thalweg through the channel to promote more natural flow dynamics and increase natural scour, which can help form pools that provide cover for fish. Scarification of the streambed substrates could be considered to temporarily improve spawning potential. However, this should only be done once the upstream sources of sediment are better understood and can be effectively managed to prevent future sedimentation issues.

Photo 42. Site proposed for restoration in R3-S2.1.

6.2 Improving Passage at Obstacles/Barriers

Four main habitat features were identified in this assessment for improvements related to fish passage: the concrete flume on CPKC lands, a constructed dam/platform within R3-S1, and the two culverted crossings at Kline Road and Highway 6. In many cases, full replacement of stream crossings is challenging due to cost and land ownership constraints. Based on our assessment, we recommend improving passage at these structures prioritized as below:

6.2.1 Concrete Flume in CPKC Lands

Removing the concrete flume presents an opportunity to enhance habitat connectivity for adfluvial species within the lower portion of Cottonwood Creek up to Cottonwood Falls. Suitable spawning habitat is not available upstream of the flume, however restoring fish passage would provide access to additional rearing and potential overwintering habitat within the creek.

Ideally, the entire flume would be replaced with a more natural stream channel (Photo 43), and riparian planting with native vegetation completed to increase riparian cover. However, this option is complicated by land ownership issues and soil contamination in the surrounding area. If this restoration option is pursued, the new stream channel must include measures to protect against erosion and manage high flow events. Incorporating vegetated riprap is recommended to meet these measures, as well as enhancing riparian habitat.

If full replacement of the flume is not feasible, raising water levels at the outlet could mitigate the drop and reduce its barrier effect (Photo 44). Constructing a series of rock weirs leading up to the outlet can help elevate water levels effectively, and may backwater the outlet during lower flow levels. Ideally, the plunge pool habitat should be retained, as several fish were observed utilizing this pool. Concrete baffles could also be installed within the flume to enhance flow roughness and create areas of slower-moving water where fish can rest. However, these baffles should be considered temporary measures to dissipate flow energy until a more permanent solution is developed (WDFW 2003). If being considered, the installation of baffles should include a hydrological study to ensure that it would not impede the function of the flume. Adding baffles reduces hydraulic capacity, which often becomes a limit to flood capacity. The tendency for baffles to catch woody debris can also lead to reduced flow capacity. Increased riparian vegetation would also improve the habitat by providing more shade, nutrient input, and cover.

Photo 43. Concrete flume proposed to be replaced or enhanced.

Photo 44. Drop at flume outlet.

6.2.2 Constructed Dam/ Concrete Platform in R3-S1

This feature is identified as a priority for removal, as it is not associated with a stream crossing and would likely be relatively easy to remove (Photo 45). This feature should be removed and replaced with a series of rock weirs in the channel that provide fish passage over the elevation change. To the extent possible, weir installation should be done to incorporate deep pool habitat leading up to the feature.

Photo 45. Constructed dam/platform proposed to be replaced with a weir.

6.2.3 Kline Road Culvert

This feature currently presents a barrier to fish movement (Silvatech 2014) and prevents fish passage to higher quality rearing and potential spawning habitat upstream in R3-S2.1. Although full replacement with an open-bottom structure would be ideal, it may not be necessary. A rock weir can be constructed below the outlet to create backwater conditions at the culvert outlet, and baffles could be installed in the culvert to improve passage through the feature (Photo 46 and Photo 47). The weir should be constructed to maintain a stable water depth, ensuring that it does not obstruct flow, but allows for a gradual elevation change leading up to the culvert outlet.

Photo 46. Proposed location for weir leading up to Kline Road culvert.

Photo 47. Kline Road culvert outlet.

6.2.4 Highway 6 Culvert

Similar to the Kline Road culvert, full replacement of this feature with a more fish-friendly structure would be ideal, but this is complicated by costs and logistics associated with replacing a highway crossing. Full replacement may not be necessary. Construction of a weir or installation of baffles within the culvert are potential options to improve passage through the culvert (Photo 48 and Photo 49).

Photo 48. Proposed location for weir leading up to Highway 6 culvert.

Photo 49. Highway 6 culvert.

6.3 Working with Private Landowners to Restore and Protect Riparian Habitat

Both the Regional District of Central Kootenay (Area E) and the City of Nelson afford protection to riparian areas on private land under the RDCK Waterfront Development Permit (WDP) area, and the City's Natural Environment and Hazardous Lands Development Permit Area. Under the RDCK Area E Official Community Plan (OCP, Bylaw No. 2260), and the Nelson OCP (Bylaw No. 3247) riparian areas of Cottonwood Creek are within the development permit area, which is defined as 15 m either from of the high-water mark, or top of ravine bank. Development in these areas require assessment by a Qualified Environmental Practitioner in accordance with the provincial *Riparian Areas Regulation*, and typically cannot proceed unless there is evidence that a lesser setback will not negatively impact the function of the stream or riparian area.

It is evident from this assessment that streamside development has negatively impacted both the instream and riparian habitat function of Cottonwood Creek in several areas. In many instances, these developments appear to have been completed prior to the establishment of development permit areas, and have been grandfathered in under the current OCPs. Nevertheless, some instances of recent development along top of bank were noted during our assessment, for which we could not find records of recently issued development permits (e.g., Photo 50). In order to avoid further cumulative impacts to Cottonwood Creek, it is crucial that these bylaws are properly enforced. Wherever possible, permitting for future redevelopment in riparian areas should encourage property owners to move development further from the top of bank and restore riparian areas.

Photo 50. Example of an apparently recently constructed building located at the top of bank of Cottonwood Creek.

Additionally, property owners should be encouraged, wherever possible, to take steps to restore and maintain riparian habitat on their properties and protect habitat values in the creek. Based on conditions observed during our assessment, the following measures are recommended:

- **Restoration of riparian areas including replanting of riparian buffers, removal of debris and restoration of unused areas**. Several of the commercial and private properties along the creek (more particularly along sections R3-S1, R3-S2, and R3-S2.1) had minimal to no riparian vegetation, with lawns occasionally extending all the way up to the stream bank. Additionally, some properties had old debris and secondary structures (e.g. sheds, trailers) very close to top of bank that appeared to perhaps no longer be in use (Photo 51). Where possible, and where property owners are willing, we recommend removing some of these structures and debris, and replanting along the creek to a targeted *minimum* 3-5 m setback on the creek. Even a narrow strip of shrubs (e.g., willow or dogwood) along top of bank usually results in a notable increase in shade and cover (Photo 52).

Photo 51. Example of debris and sheds on creek bank.

Photo 52. Comparison of cover provided by a narrow strip of shrubs (photo right) vs. a non-vegetated bank (photo left)

- **Limit access to the creek to one specific location**. Property owners should be encouraged to limit their access points to the creek to one specific, low-impact location on their property.
- **Replace concrete walls and bare riprap with vegetated riprap.** If bank erosion protection structures along property edges require removal/updating, the use of vegetated riprap should be strongly encouraged. These projects should require approval under the provincial *Water Sustainability Act*, and the use of vegetated riprap is becoming an increasingly common condition stipulated for such projects.

- **Removal of invasive vegetation:** Three patches of Japanese knotweed were noted along the banks of R3-S2 and R3-S2.1 during our assessment (two on private property and one on the Highway 6 road shoulder), and additional patches may be present in areas that were not surveyed. In accordance with the provincial *Weed Control Act*, control of noxious weeds and invasive plants on private property is the responsibility of the landowner. It is recommended that these patches be properly treated and removed to minimize the risk of further spread. Control of knotweed can be challenging, as it can reproduce through small fragments. Chemical control is often the most effective, but needs to be completed by a certified pesticide applicator that is familiar with the requirements for chemical treatment around waterbodies..
- **Encourage property owners not to construct instream features that impede fish movement:** Several instances were noted in R3-S2 and R3-S2.1 where property owners had constructed small dams to create pooled areas next to their property. We recommend that these structures be removed (or at least adjusted so that fish are able to pass under low flow conditions).

A list of recommended improvements noted during our assessment is provided in Appendix 3. Implementing these will be highly dependent on property owner buy-in and willingness. A combination of broader landowner education programs, as well as directly approaching owners of specific properties will likely be required.

7 FURTHER STUDIES

Several of the proposed restoration strategies involve placement or removal of structures into a stream that is subject to a varied hydrological regime and high flows during freshet conditions. Given its proximity to privately-owned properties and important infrastructure, it is important to carefully examine any hydrological impacts of proposed activities to ensure that they do not pose any risk to adjacent properties and infrastructure. Such an assessment is outside the scope of this report, and should be completed by a Qualified Engineer.

Further assessments of the current potential for sedimentation in lower Cottonwood Creek should be undertaken to evaluate the effectiveness of the sediment receptors that have recently been added to the municipal storm system. Prior to any efforts to restore spawning habitat in this area, we recommend further studies to confirm that newly installed gravels would not be at risk of failing due to sedimentation.

Notably, our survey did not include all sections of the creek in Reach 3. If restoration projects are being pursued in this section, we recommend that this entire reach be examined in order to best prioritize potential restoration options. A detailed Level 1 FHAP is likely not required, but at a minimum, the sections that were not surveyed should be walked to determine if any additional areas of major impact are present (e.g., barriers, highly disturbed habitat) that may skew prioritization.

Additionally, we recommend that further thought be put into addressing the occasional dewatering in R4-S4. During the sampling event on September 5, portions of the channel were dewatered, resulting in several fry being stranded in isolated pools. A subsequent visit in mid-October revealed that the channel remained dewatered. While this area offers significant spawning habitat, the rearing potential is severely compromised if fry are frequently stranded. To address this issue, we suggest monitoring this area during low-flow conditions in the coming years to assess whether dewatering occurs regularly. If it does, we advise discussing potential strategies to maintain a wetted channel with a hydrological engineer.

Level 2 FHAPs will be required to further refine any of the habitat prescriptions identified by this assessment. During the Level 2 Assessments, a qualified biologist should visit the sites of interest along with an engineering professional to collect detailed measurements and inspections to develop site-specific restoration plans and budgets.

8 CLOSURE

We trust the information provided in this report meets your current requirements. If you have any questions or require any further information do not hesitate to contact the undersigned.

Renae Mackas, RPBio.

Sylvie Masse, RPBio.

9 REFERENCES

Anonymous. 1993. Fish habitat. pp. F1-F36. In Standard methodology for conducting watershed analysis. Version 2.0. Washington Forest Practices Board, Washington State Department of Natural Resources, Olympia. Cited in Johnston and Slaney 1996.

City of Nelson, Prepared by: Kootenay Environmental Innovation. 2024. Preliminary Discharge and Temperature (2023-04-21 to 2024-10-24) Cottonwood [Resource]. Columbia Basin Water Hub. Available at: https://doi.org/10.48511/8z8y-2t31

Cramer, Michelle L. (managing editor). 2012. Stream Habitat Restoration Guidelines. Copublished by the Washington Departments of Fish and Wildlife, Natural Resources, Transportation and Ecology, Washington State Recreation and Conservation Office, Puget Sound Partnership, and the U.S. Fish and Wildlife Service. Olympia, Washington. Available at: https://wdfw.wa.gov/sites/default/files/publications/01374/wdfw01374.pdf

[FIDQ] Fisheries Inventory Data Queries. 2024. Province of BC. Available at: https://a100.gov.bc.ca/pub/fidq/viewWatershedDictionary.do

Habitat Wizard. 2024. iMap web application. Victoria, BC. Available at: https://maps.gov.bc.ca/ess/hm/habwiz/

Johnston, N.T. and P. A. Slaney. 1996. Fish Habitat Assessment Procedures (FHAP). Watershed Restoration Technical Circular No. 8. Revised April 1996.

MacKinnon, C. City of Nelson Engineering. 2024. Personal communication. Email. September 6, 2024.

[MOF] Ministry of Forests. No Date. Victoria Lake – Invasive Knotweed Treatment FAQ. Available at https://www2.gov.bc.ca/assets/gov/environment/plants-animals-and-ecosystems/invasive-species/pest-management/victoria_lake_knotweed_faq.pdf

Province of BC, 1965. Report of the Department of Recreation and Conservation 1964. Volume 2 pg. 24. Available at http://resolve.library.ubc.ca/cgi-bin/catsearch?bid=1198198. Cited in Thomson 2024

[RDCK] Regional District of Central Kootenay. 2024. RDCK Public Web Map. Available at https://gis.rdck.bc.ca/portal/apps/webappviewer/index.html?id=e15a66aba317469481f584a71350f2ad

Silvatech 2014. Kootenay Fish Habitat Confirmation Assessment PD14TFE006. Prepared for BCTS, Nelson, BC.

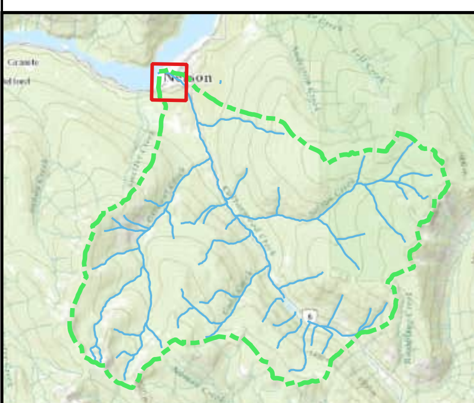
Smit, L. 2014. The impacts of urbanisation on fish and fish habitat in lower Cottonwood Creek in Nelson, BC. Student report prepared for Selkirk College, Castlegar BC.

Thomson, A. 2009. Sedimentation in lower reaches of Cottonwood Creek, Nelson BC. Consultants report prepared for the Nelson District Rod and Gun Club.

Thomson, A.R., 2024. Cottonwood Creek Water and Aquatic Resources Assessment. Consultant's report prepared for Living Lakes Canada. 63 pp. including Appendices.

[WDFW] Washington Department of Fish and Wildlife. 2003. Design of Road Culverts for Fish passage. Available at https://wdfw.wa.gov/sites/default/files/publications/00049/wdfw00049.pdf

APPENDIX 1. MAP OF REACHES, SECTIONS, AND SAMPLING SITES



Cottonwood Creek FHAP - Appendix 1A

Sampled Sites

- Site 1
- Site 2
- Site 3
- Site 4
- Streams (Not Sampled)

Reach Breaks

Fish Obstacles/Barriers

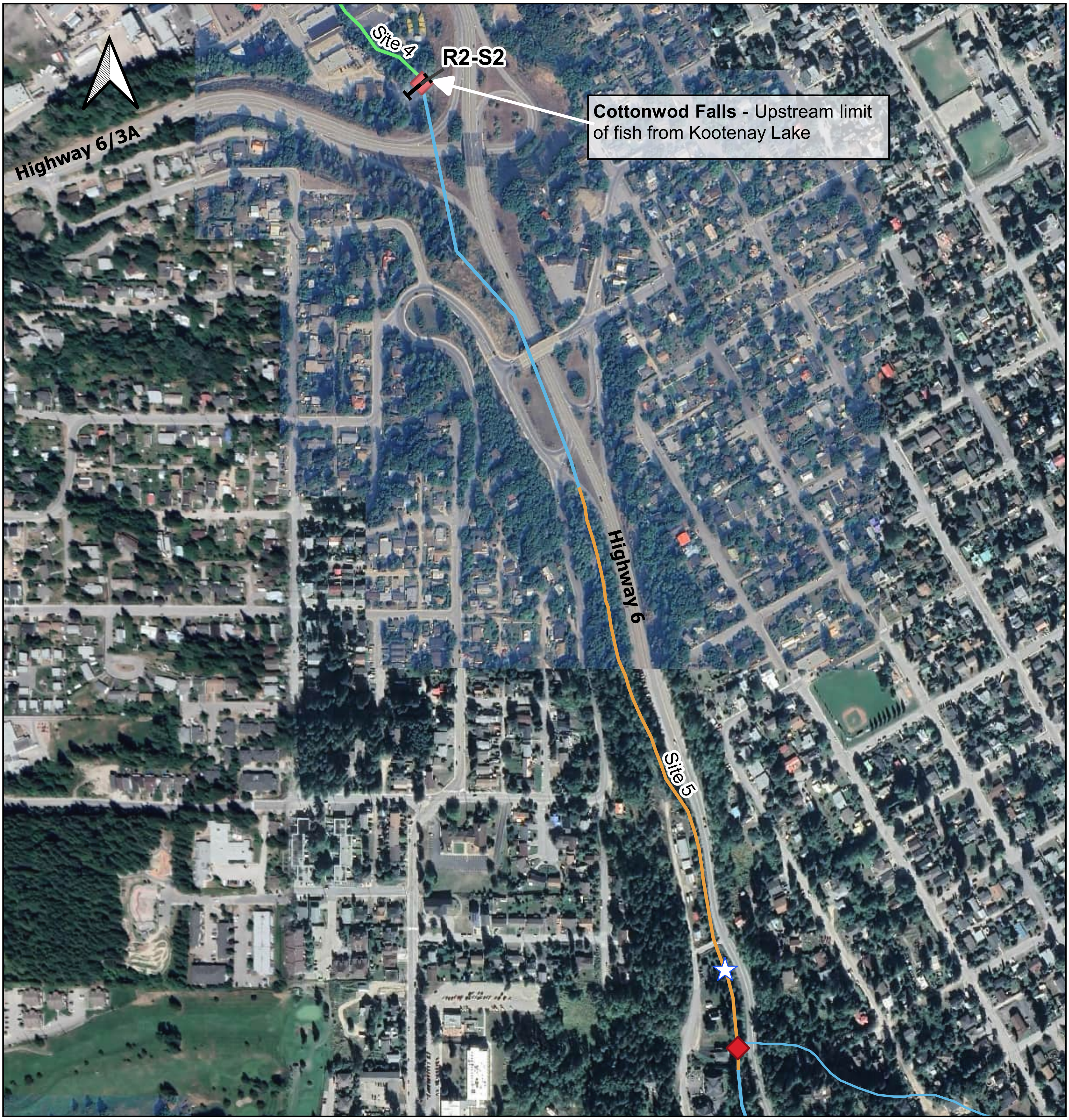
Electrofishing Sampling Location

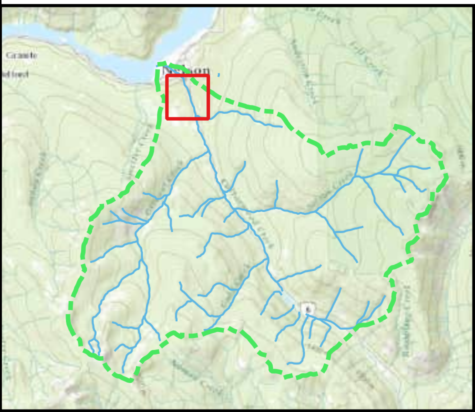
Cottonwood Creek Watershed (Base Map)

0 100 200 m

MASSE ENVIRONMENTAL

Map Date: 2024-12-05
Projection: NAD83 / UTM zone 11N
Project #: 2024-1153
Main Map Scale: 1:5,000
Overview Map Scale: 1:250,000





Cottonwood Creek FHAP - Appendix 1B

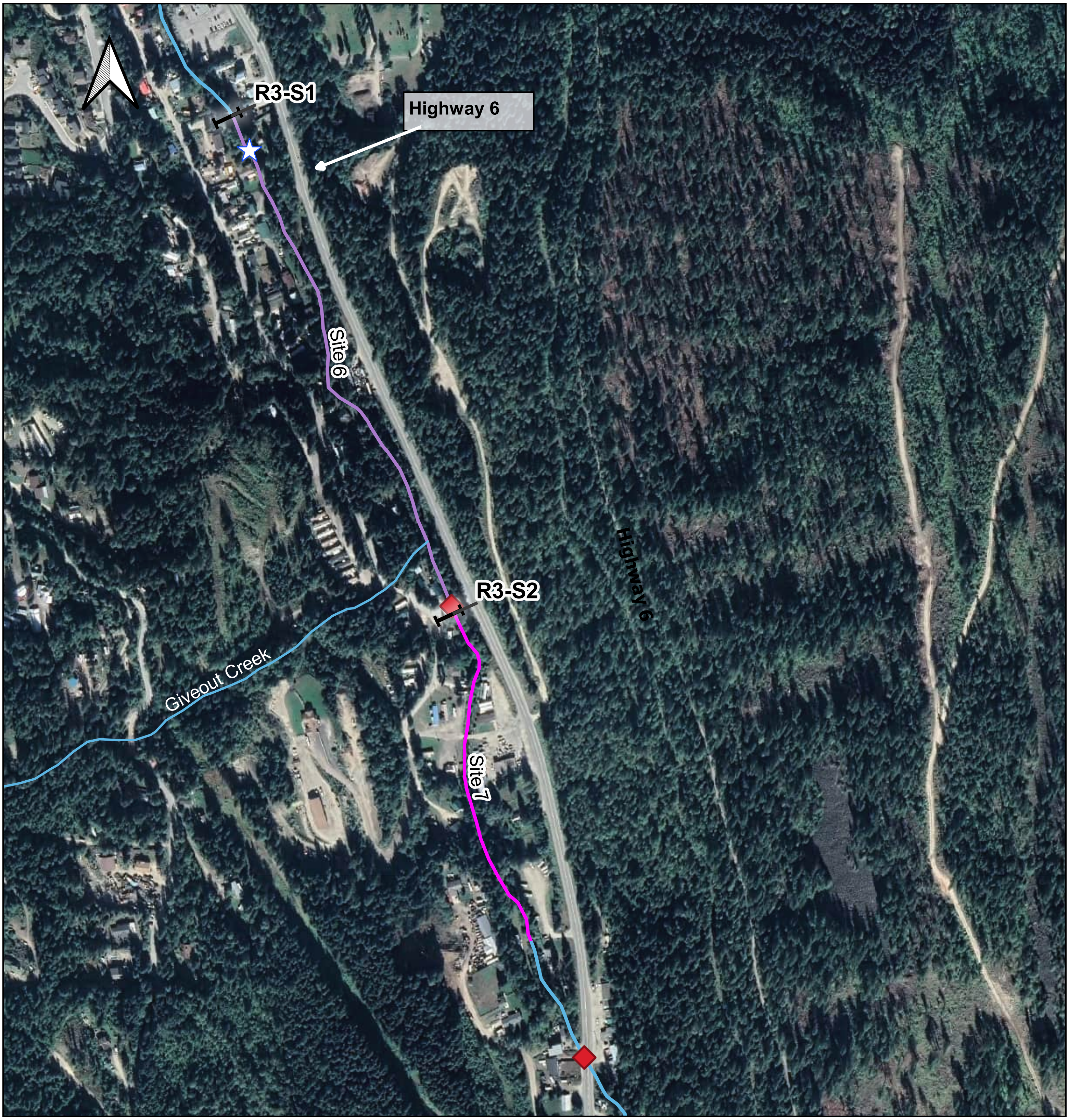
Sampled Sites

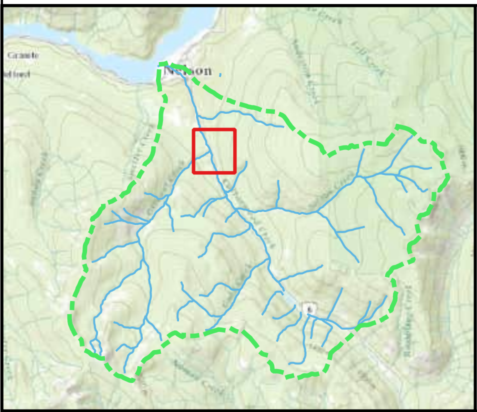
- Site 4
- Site 5
- Streams (Not Sampled)
- Reach Breaks
- Fish Obstacles/Barriers
- Electrofishing Sampling Location
- Cottonwood Creek Watershed (Base Map)

0 100 200 m

MASSE ENVIRONMENTAL

Map Date: 2024-12-05
Projection: NAD83 / UTM zone 11N
Project #: 2024-1153
Main Map Scale: 1:6,000
Overview Map Scale: 1:250,000





Cottonwood Creek FHAP - Appendix 1C

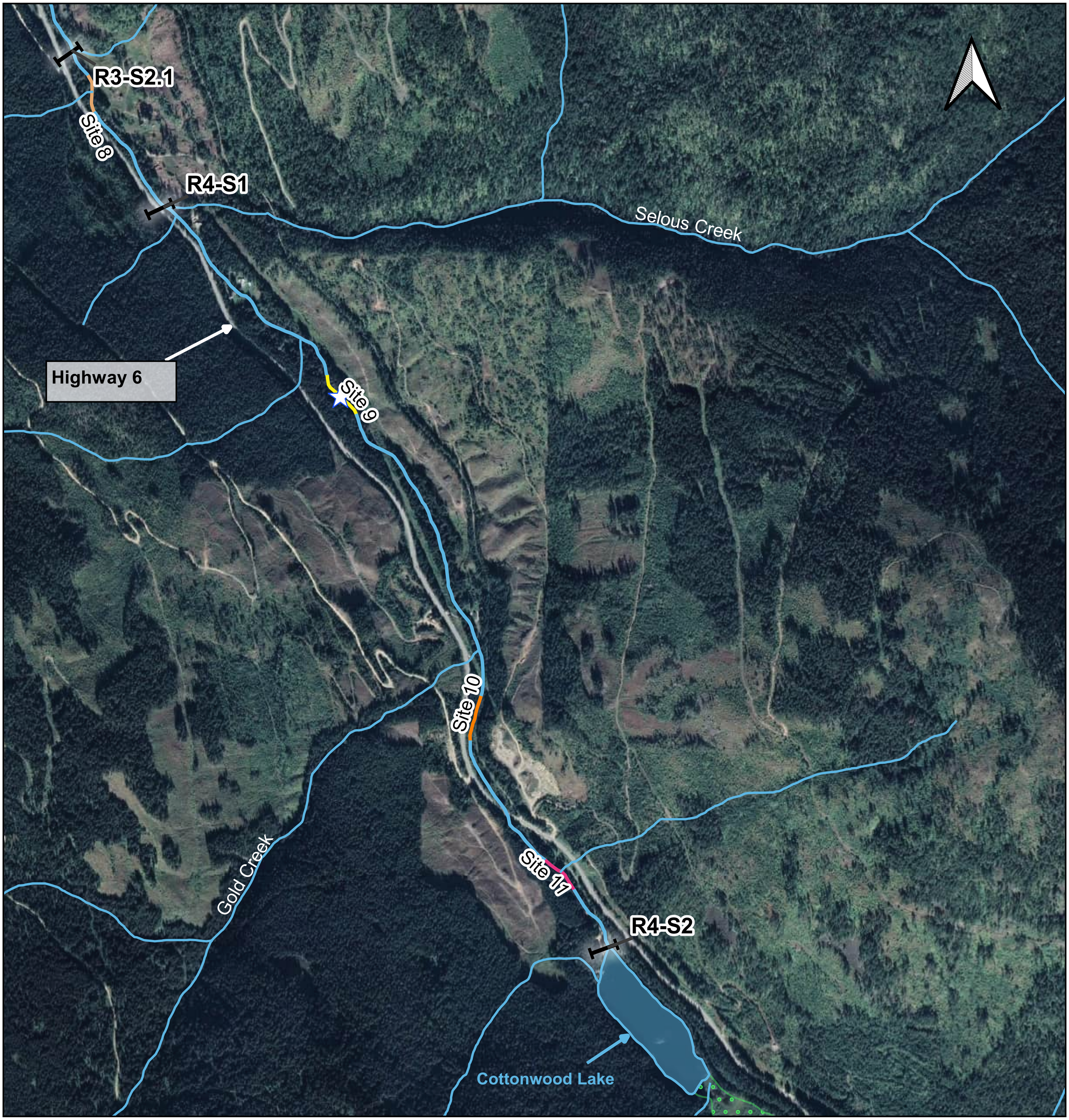
Sampled Sites

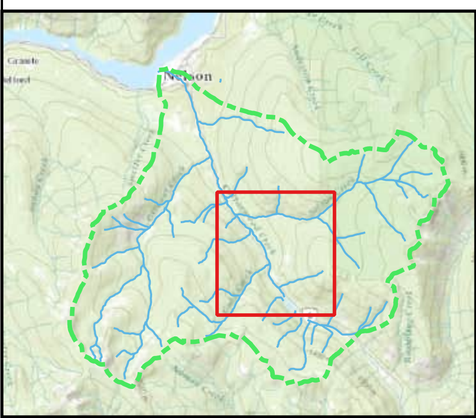
- Site 6
- Site 7
- Streams (Not Sampled)
- Reach Breaks
- Fish Obstacles/Barriers
- Electrofishing Sampling Location
- Cottonwood Creek Watershed (Base Map)

0 100 200 m

MASSE ENVIRONMENTAL

Map Date: 2024-12-05
Projection: NAD83 / UTM zone 11N
Project #: 2024-1153
Main Map Scale: 1:6,000
Overview Map Scale: 1:250,000





Cottonwood Creek FHAP - Appendix 1D

Sampled Sites

- Site 8
- Site 9
- Site 10
- Site 11
- Streams (Not Sampled)
- Reach Breaks
- Fish Obstacles/Barriers
- Electrofishing Sampling Location
- Wetlands
- Cottonwood Creek Watershed (Base Map)

0 300 600 m

MASSE ENVIRONMENTAL

Map Date: 2024-12-06
Projection: NAD83 / UTM zone 11N
Project #: 2024-1153
Main Map Scale: 1:17,000
Overview Map Scale: 1:250,000

APPENDIX 2. FHAP AND FISH SAMPLING DATA

Site	Reach-Section	Habitat Unit	Distance (m)	Habitat Type	Habitat Cat	Length (m)	Gradient (%)	Bankful Depth (m)	Ave. Wetted Depth (m)2	Bankful Width (m)	Wetted Width (m)	Pool Residual Depth (m)	Dominant Substrate	Subdominant Substrate	Spawning Gravel	LWD - total	Func. LWD (10-20 cm)	Func. LWD (20-50 cm)	Func. LWD (>50 cm)	Cover Type	%Cover1	Cover Type2	%Cover2
1	1-1	73	0	G	1	61.2	0.5	0.80	0.35	16.4	13.9		S	C	N	2	0	0	0	OV	2	B	2
1	1-1	74	61.2	R	1	16.7	2	0.80	0.10	16.6	10		C	G	A*	1	0	0	0	B	2	NA	5
1	1-1	75	77.9	G	1	30.5	1	1.25	0.45	16.2	9.8		C	S	N	2	0	0	0	OV	10	B	5
1	1-1	76	108.4	R	1	40.8	2	0.85	0.15	11.3	10.5		C	NA	T	2	0	1	0	OV	20	B	2
1	1-1	77	149.2	G	1	36.7	1	0.90	0.25	8.7	7.1		C	G	A*	1	1	0	0	OV	15	B	5
1	1-1	78	185.9	R	1	9.9	2	0.90	0.25	8.7	7.1		C	NA	A*	0	0	0	0	OV	15	B	5
1	1-1	79	195.8	G	1	12.9	1	1.10	0.30	8.2	5.3		B	S	N	0	0	0	0	OV	2	NA	0
2	1-2	80	208.7	R	1	27.3	3	1.20	0.20	7.8	4.3		C	B	N	0	0	0	0	OV	5	NA	0
2	1-2	81	236	R	1	83.9	2.5	0.60	0.20	17.1	9.3		C	G	L	8	0	4	0	OV	5	DP	2
2	1-2	82	319.9	R	1	15.4	2.5	1.30	0.30	11.3	6.4		C	G	L	2	0	0	0	OV	10	NA	0
2	1-2	83	335.3	G	1	9.3	1	1.20	0.40	9.0	5.5		C	S	N	0	0	0	0	OV	15	B	10
2	1-2	84	344.6	R	1	8.2	2.5	1.20	0.40	9.0	5.5		C	B	N	2	0	1	0	OV	15	B	10
2	1-2	85	352.8	P	1	7.4	0	1.20	0.60	7.7	8.7	0.80	C	S	N	0	0	0	0	DP	95	C	5
3	2-1	86	360.2	O	1	120.4	2	1.20	0.10	6.4	6.4		R	C	N	0	0	0	0	DP	5	NA	0
3	2-1	87	480.6	O	1	71.0	5	1.20	0.10	6.4	6.4		R	C	N	6	4	0	0	DP	5	NA	0
3	2-1	87.1	531.6	P	3	3.0	5	1.20	0.70	6.4	1.2	1.1	R	C	N	0	0	0	0	DP	80	NA	0
4	2-2	88	551.6	R	1	55.8	4	1.15	0.25	7.5	5.1		C	B	T	3	1	0	0	B	10	NA	0
4	2-2	89	607.4	G	1	29.7	1	1.40	0.30	3.5	3.5		C	S	T	0	0	0	0	B	5	NA	0
4	2-2	90	637.1	R	1	91.9	4	1.20	0.25	7.6	4.9		C	B	N	0	0	0	0	B	5	OV	2
4	2-2	91	729	R	1	54.1	3.5	1.20	0.25	7.4	5		C	B	N	0	0	0	0	B	2	OV	2
4	2-2	92	783.1	G	1	8.7	1.5	1.00	0.35	4.9	4.3		C	S	N	0	0	0	0	OV	2	NA	0
4	2-2	93	791.8	R	1	45.1	4	0.85	0.25	7.6	4.1		C	S	N	0	0	0	0	B	5	OV	2
4	2-2	94	836.9	C	1	44.7	6	0.70	0.25	11.3	7.4		C	B	N	1	0	0	0	B	10	DP	2
4	2-2	95	881.6	C	1	23.7	9	0.60	0.35	9.5	7.8		B	C	N	0	0	0	0	B	10	DP	5
4	2-2	96	905.3	P	1	6.0	0.5	0.80	0.75	8.0	8	0.95	B	C	N	0	0	0	0	DP	100	NA	0
5	3-1	25	0	O	1	11.0	6	0.65	0.25	12.2	9.9		R	NA	N	1	1	0	0	B	10	NA	0
5	3-1	26	11	P	1	2.2	1	0.85	0.25	9.2	5.3	0.35	S	B	N	0	0	0	0	DP	40	B	10
5	3-1	27	13.2	C	1	22.3	6	0.65	0.25	12.2	9.9		B	C	T	0	0	0	0	B	10	NA	0
5	3-1	28	35.5	C	1	5.9	6	0.65	0.25	12.2	9.9		R	NA	N	0	0	0	0	NA	0	NA	0
5	3-1	29	41.4	G	1	15.2	1	0.90	0.30	6.6	5		C	G	T	2	0	0	0	B	10	U	5
5	3-1	30	41.4	R	2	43.3	2	0.60	0.05	4.8	2.7		S	C	T	0	0	0	0	NA	0	NA	0
5	3-1	31	57.6	R	1	43.3	3	0.75	0.25	11.4	4.9		B	C	N	0	1	0	0	NA	15	NA	0
5	3-1	32	83.7	C	1	11.6	7	0.90	0.40	10.7	7.8		B	C	N	0	0	0	0	DP	5	B	10
5	3-1	33	95.3	R	1	23.7	2	0.65	0.25	7.8	4.4		B	C	T	1	0	1	0	B	10	OV	5
5	3-1	34	119	C	1	6.6	7	0.55	0.15	10.5	6.3		B	NA	N	1	0	1	0	DP	20	B	10
5	3-1	35	125.6	P	1	39.9	2	0.55	0.15	10.5	6.3		C	B	T	9	2	4	0	OV	15	B	5
5	3-1	36	165.5	G	1	16.8	1	0.55	0.20	12.1	9.6		C	B	T	4	3	1	0	B	5	OV	5
5	3-1	37	182.3	R	1	68.7	2	0.60	0.20	12.6	6.8		C	B	T	10	2	1	0	B	10	OV	5
5	3-1	38	251	R	1	98.6	2	0.60	0.35	6.5	5.4		C	B	T	4	0	0	0	OV	25	B	5
5	3-1	39	349.6	R	1	40.4	2	0.90	0.25	7.0	5		C	B	N	2	1	0	0	B	5	NA	0
5	3-1	40	390	G	1	8.0	1	0.85	0.35	6.2	4.6		C	B	N	0	0	0	0	B	5	NA	0
5	3-1	41	398	R	1	37.0	2	0.80	0.25	5.8	4.6		C	B	N	2	0	0	0	OV	10	B	5
5	3-1	42	435	G	1	7.0	1	1.00	0.30	6.3	4.2		C	B	N	0	0	0	0	OV	20	B	5
5	3-1	43	442	R	1	70.0	2.5	1.00	0.30	6.3	4.2		C	B	T	2	1	0	0	OV	20	B	5
5	3-1	44	512	G	1	9.5	1	0.70	0.25	6.1	4.1		B	C	T	0	0	0	0	DP	15	OV	10
5	3-1	45	521.5	R	1	53.3	2	0.85	0.25	7.3	5.7		C	B	T	1	1	0	0	OV	15	B	5
5	3-1	46	574.8	P	1	4.7	0	0.85	0.55	9.9	7.3	0.80	C	B	T	0	1	1	0	DP	90	LWD	5
6	3-2	49	0	C	1	50.0	6	0.90	0.25	10.2	7.9		B	C	N	0	0	0	0	B	10	DP	5
6	3-2	50	50	C	1	87.9	10.5	1.00	0.30	9.2	7.1		B	C	N	1	0	0	0	B	10	DP	5
6	3-2	51	137.9	C	1	15.4	6	1.10	0.30	4.3	6.2		B	C	T	0	0	0	0	B	10	C	5
6	3-2	52	153.3	C	1	35.0	9	0.90	0.25	6.1	4.7		B	C	T	2	0	0	0	B	15	DP	5
6	3-2	53	188.3	C	1	11.7	5	0.90	0.25	6.1	4.7		C	B	T	0	0	0	0	DP	10	C	5
6	3-2	54	200	C	1	38.3	8	1.10	0.35	8.5	6.2		B	C	N	1	0	1	0	B	20	DP	5
6	3-2	55	238.3	C	1	56.3	9.5	1.05	0.30	7.8	6.6		B	C	T	2	0	2	0	B	15	OV	5
6	3-2	56	294.6	C	1	64.7	11.5	0.90	0.20	11.0	6.3		B	C	T	6	0	0	0	B	15	DP	10
6	3-2	57	359.3	C	1	36.5	13	0.70	0.35	6.4	5.4		B	C	N	5	1	2	0	B	10	B	5
6	3-2	58	395.8	C	1	30.1	8	0.70	0.35	6.4	5.4		B	C	T	1	1	0	0	OV	20	B	5
6	3-2	59	425.9	P	1	4.9	0	1.20	0.55	7.6	7.1	0.55	C	B	T	1	1	0	0	DP	90	B	5
6	3-2	60	430.8	C	1	108.2	9	0.85	0.30	8.0	4.6		B	C	T	2	0	0	0	B	10	NA	0
6	3-2	61	539	P	1	6.0	1	1.25	0.65	7.3	6.2	0.65	C	B	T	0	0	0	0	DP	95	NA	0
6	3-2	62	545	C	1	15.0	7	0.85	0.30	8.0	4.6		B	C	N	11	0	0	0	B	15	NA	0
6	3-2	63	560	C	1	55.0	7	0.80	0.25	7.4	5.1		C	B	T	10	2	6	0	B	15	SWD	10
7	3-2.1	64	615	P	1	8.7	0	1.60	1.20	9.7	8.5	1.15	B	G	A	2	0	0	0	DP	100	NA	0
7	3-2.1	65	623.7	O	1	24.0	2	0.35	0.10	3.6	2.1		R	NA	N	0	0	0	0	NA	0	NA	0
7	3-2.1	97	0	R	1	26.8	1	0.65	0.25	8.6	4.4		C	B	L	0	0	0	0	B	5	OV	5
7	3-2.1	98	26.8	G	1	7.8	0.5	0.60	0.20	8.4	6.4		C	B	L	0	0	0	0	B	5	OV	5
7	3-2.1	99	34.6	P	1	2.6	0	0.65	0.35	7.2	6	0.60	C	B	N	0	0	0	0	DP	70	B	10
7	3-2.1	(100) 10	37.2	R	1	84.8	1	0.60	0.20	6.7	4.3		C	B	L	0	0	0	0	OV	10	B	2
7	3-2.1	(101)11	122	R	1	31.1	1	0.80	0.30	5.6	4.2		C	B	L	0	0	0	0	OV	25	NA	0

Site	Reach-Section	Habitat Unit	Distance (m)	Habitat Type	Habitat Cat	Length (m)	Gradient (%)	Bankful Depth (m)	Ave. Wetted Depth (m)2	Bankful Width (m)	Wetted Width (m)	Pool Residual Depth (m)	Dominant Substrate	Subdominant Substrate	Spawning Gravel	LWD - total	Func. LWD (10-20 cm)	Func. LWD (20-50 cm)	Func. LWD (>50 cm)	Cover Type	%Cover1	Cover Type2	%Cover2
7	3-2.1	(102)12	153.1	R	1	110.1	1	0.70	0.20	8.4	6.9		C	B	L	1	0	0	0	OV	5	B	2
7	3-2.1	(103)13	263.2	R	1	26.9	2.5	0.60	0.20	6.8	4.6		C	B	N	2	0	0	0	OV	15	B	2
7	3-2.1	(104)14	290.1	G	1	6.8	1	0.75	0.25	6.6	4.6		C	B	L	0	0	0	0	OV	15	B	0
8	4-1	301	0	P	1	3.2	0	0.80	0.35	6.0	6	0.40	B	C	N	0	0	0	0	DP	70	B	5
8	4-1	302	3.2	R	1	24.0	4	0.70	0.20	6.8	4.3		C	B	L	0	0	0	0	B	15	DP	10
8	4-1	303	27.2	C	1	64.2	7	0.65	0.20	7.2	4.3		C	B	L	4	0	5	1	B	5	NA	0
8	4-1	304	74.5	R	2	5.4	3.5	0.30	0.10	1.4	1		C	S	N	2	0	2	0	B	5	NA	0
8	4-1	305	74.5	P	2	5.0	0	0.45	0.25	2.5	2.5	0.40	S	G	L	5	1	3	1	DP	10	B	5
8	4-1	306	92	G	1	8.1	0.5	0.40	0.30	4.8	2.9		C	B	L	4	0	4	0	B	60	C	10
8	4-1	307	100.1	R	1	9.9	2.5	0.60	0.20	4.2	4.6		B	C	L	2	0	2	0	C	10	B	2
8	4-1	308	110	C	1	12.2	5	0.80	0.20	5.7	5.1		B	C	N	9	0	4	0	SWD	20	B	5
8	4-1	309	122.2	R	1	6.6	1.5	0.70	0.25	7.0	4.6		B	C	L	7	1	2	0	C	5	B	5
8	4-1	310	128.8	R	1	21.2	3	1.20	0.25	5.9	4		B	C	N	3	0	2	0	C	5	B	5
9	4-2	201	0	R	1	49.3	4	0.70	0.10	5.8	2.9		C	G	A	15	6	1	5	DP	10	C	10
9	4-2	202	49.3	G	2	5.5	0.5	0.45	0.10	6.7	1.5		C	G	L	5	0	2	1	LWD	20	NA	0
9	4-2	203	54.8	R	2	14.3	2	0.45	0.10	6.7	1.5		C	G	L	11	1	3	4	LWD	60	OV	20
9	4-2	204	69.1	G	2	13.6	0.5	0.45	0.10	4.6	1.7		C	S	L	9	2	6	1	LWD	25	DP	10
9	4-2	205	0	R	1	28.1	4	0.50	0.15	6.7	4.2		C	G	A	12	1	3	4	LWD	25	OV	40
9	4-2	206	28.1	G	1	6.8	1	0.45	0.20	5.3	3.4		C	G	A	2	1	0	0	OV	10	SWD	5
9	4-2	207	34.9	R	1	17.2	2	0.40	0.10	6.2	5.3		C	G	A	5	2	3	0	OV	5	LWD	5
9	4-2	208	52.1	P	1	4.2	0.5	0.60	0.35	4.9	3	0.60	C	G	A	2	0	0	0	DP	70	C	10
9	4-2	209	56.3	R	1	17.1	2	0.60	0.15	4.4	4.3		C	G	A	10	3	0	1	C	15	OV	10
9	4-2	210	73.4	P	1	3.1	0.5	0.80	0.35	8.5	5.9	0.60	S	G	A	2	0	0	1	DP	80	LWD	10
9	4-2	211	76.5	R	1	25.0	2	0.50	0.20	8.4	4.6		C	G	A	23	2	7	7	LWD	15	DP	10
10	4-2	301	0	R	1	55.0	2.5	0.45	0.10	3.5	2.6		C	B	A	9	2	0	0	SWD	10	B	5
10	4-2	302	55	G	1	7.4	0.5	0.50	0.15	3.0	2.1		G	C	A	4	0	4	0	DP	30	SWD	10
10	4-2	303	62.4	R	1	12.2	1.5	0.45	0.05	4.1	1.4		G	S	A	7	3	3	1	LWD	20	SWD	10
10	4-2	304	74.6	G	1	6.0	1	0.50	0.15	4.2	2.3		G	S	A	4	2	1	0	LWD	10	B	2
10	4-2	305	80.6	R	1	43.0	1.5	0.45	0.10	4.4	2.5		C	S	N	10	1	3	3	SWD	15	OV	5
10	4-2	306	123.6	G	1	6.9	0.5	0.60	0.25	3.0	2.3		C	S	N	2	0	1	0	OV	20	IV	10
10	4-2	307	130.5	R	1	7.9	1.5	0.60	0.25	3.0	2.3		C	S	N	0	0	0	0	OV	35	IV	10
10	4-2	308	138.4	O	1	16.7	0.5	0.40	0.15	5.3	2.6		S	S	N	3	1	2	0	OV	75	SWD	5
11	4-2	309	0	G	1	12.6	0.5	0.40	0.10	4.3	2.4		G	S	A	6	1	5	0	LWD	25	DP	10
11	4-2	310	12.6	R	1	6.0	1.5	0.50	0.05	5.5	1.8		G	S	A	8	3	3	2	LWD	15	NA	0
11	4-2	311	18.6	G	1	5.5	0.5	0.55	0.20	5.5	1.8		G	S	A	6	0	3	2	LWD	30	DP	10
11	4-2	312	24.1	R	1	20.3	1.5	0.50	0.15	6.5	2		G	S	A	15	1	12	2	LWD	30	DP	10
11	4-2	313	44.4	G	1	8.7	0.5	0.50	0.10	3.9	1.5		S	C	L	4	0	2	1	LWD	10	OV	10
11	4-2	314	53.1	R	1	21.8	2	0.50	0.10	9.7	2.7		G	S	A	23	7	9	3	LWD	20	DP	5
11	4-2	315	74.9	G	1	5.2	1	0.55	0.15	4.3	2.3		G	C	A	2	1	1	0	OV	15	NA	0
11	4-2	316	80.1	R	1	20.4	2	0.55	0.15	3.5	1		C	G	A	3	1	2	0	LWD	10	DP	10
11	4-2	317	100.5	P	1	4.4	0	0.75	0.35	4.2	2.9	0.40	C	S	N	2	0	1	0	DP	95	C	15
11	4-2	318	104.9	R	1	36.5	1.5	0.40	0.25	3.1	2.1		G	C	A	14	4	7	2	OV	55	LWD	20
11	4-2	319	141.4	G	1	8.8	0.5	0.40	0.05	3.9	2.3		G	C	A	10	3	2	1	OV	55	LWD	20

Site	Reach-Section	Habitat Unit	Distance (m)	Off Channel Type	Off Channel Access	Off Channel Length	Disturbance 1	Disturbance 2	Riparian Type	Riparian Structure	Canopy Closure	Barriers	Comments
1	1-1	73	0						S	SHR	1		substrate is cobble infilled with sand
1	1-1	74	61.2						S	SHR	1		gravel abundant, but very infilled; non-vegetated bar within channel;
1	1-1	75	77.9	W	P	27			S	SHR	1		beaver activity (chewed trees); willow/alder swamp on RB- ~ 2.8 m wide
1	1-1	76	108.4	W	P	27			S	SHR	1		willow/alder swamp on RB- ~ 2.8 m wide
1	1-1	77	149.2						S	SHR	1		gravel abundant, but very infilled; lots of garbage in channel; culvert outlet at 163.6 m; small backwatered channel present
1	1-1	78	185.9						S	SHR	1		gravel abundant, but very infilled;
1	1-1	79	195.8						S	SHR	1		Lakeside Drive bridge
2	1-2	80	208.7						M	PS	1		old pipe crossing just usptream of bridge
2	1-2	81	236						M	Y	1		pockets of gravel below sill logs; riffle habitat created by sill logs;small pools present below logs
2	1-2	82	319.9						S	INIT	1		
2	1-2	83	335.3						S	INIT	1		
2	1-2	84	344.6						S	INIT	1		
2	1-2	85	352.8						S	INIT	1		~25 cm salmonid seen in plunge pool plus several smaller
3	2-1	86	360.2						N/S	INIT	1	flume itself possible upstream barrier	flume
3	2-1	87	480.6						D	YF	3	flume itself possible upstream barrier	upper portion of flume (slightl steeper with steel baffles); steel baffles functioning as LWD
3	2-1	87.1	531.6						D	YF	3		small pool formed in the floor of the flume
4	2-2	88	551.6				EB		D	YF	1		pockets of gravel in stream margins; boulder cover is from riprap along banks
4	2-2	89	607.4				EB		S	INIT	1		pockets of gravel in stream margins; boulder cover is from riprap along banks
4	2-2	90	637.1				EB		D	YF	1		habitat unit starts under pedestrian bridge
4	2-2	91	729				EB		N/S	INIT	1		concrete walls on both sides
4	2-2	92	783.1				EB		S	INIT	3		
4	2-2	93	791.8				EB		N/D	PS	1		left bank is concrete wall, right bank is natural; storm outfall with lots of sand below (see below)
4	2-2	94	836.9				EB		M	YF	1		both banks "natural" ; boulder cover is from riprap along banks
4	2-2	95	881.6				EB		M	YF	1		boulder cover is from riprap along banks
4	2-2	96	905.3				EB		M	YF	1	falls at top	3 fry seen in pool (~40 mm long). Suspect washed down falls
5	3-1	25	0						0	YF	2	flume under the highway	top of concrete flume
5	3-1	26	11						M	YF	2		small pool at top of flume
5	3-1	27	13.2						M	YF	2	grizzly at upstream end	grizzly at upstream end, one small RB spotted
5	3-1	28	35.5						M	YF	2	grizzly	concrete base for grizzly
5	3-1	29	41.4				EB	BC	D	YF	2		piled debris on right bank
5	3-1	30	41.4						D	YF	2		secondary channel, fed by roadside culvert, likely connected with primary channel during high flows
5	3-1	31	57.6						D	YF	2		
5	3-1	32	83.7						D	YF	2		pool ~ .60 m deep, but didn't meet hab. Unit criteria
5	3-1	33	95.3						M	YF	3		
5	3-1	34	119						M	YF	2		small pool at d/s end
5	3-1	35	125.6						M	YF	2		material dumped onto RB from Park and Ride
5	3-1	36	165.5						D	YF	3		loss of riparian vegetation associated with walking path on LB
5	3-1	37	182.3				PD	MB	M	YF	1		juvenile RB spotted
5	3-1	38	251				JM		M	YF	2		a few small pools, confined by riprap on both sides
5	3-1	39	349.6						D	YF	2		channel less confined than unit d/s, houses on banks
5	3-1	40	390				EB		S	SHR	1		riprap on banks
5	3-1	41	398				EB		D	YF	1		fence on LB, riprap on banks
5	3-1	42	435						D	YF	1		bridge/OBC at 487.7 m
5	3-1	43	442						D	YF	1		
5	3-1	44	512						M/N	YF	1		no vegetation right bank, pools present
5	3-1	45	521.5						G	INIT	1		vegetation only present on RB after 556 m
5	3-1	46	574.8						S	SHR	1	falls created by concrete, 0.90 m drop to water. Concrete is 4.0 m long	concrete and sandbags
6	3-2	49	0						M	YF	2		narrow strip of riparian vegetation
6	3-2	50	50						M	YF	2		RB is constructed
6	3-2	51	137.9				EB		M	YF	2		ESC control, LB riprap
6	3-2	52	153.3						M	YF	2		
6	3-2	53	188.3						M	YF	1		undercut banks under bridge abutment
6	3-2	54	200						M	YF	1		
6	3-2	55	238.3				EB		C	YF	1		
6	3-2	56	294.6				JM		M	YF	1		pool at downtream end
6	3-2	57	359.3				EB		M	YF	1		close to road
6	3-2	58	395.8						M/N	MF/SHR	1		
6	3-2	59	425.9						M/N	MF/SHR	1		pool at base of plunge, 1 large RB spotted
6	3-2	60	430.8						M/N	YF	1		invasive vegetation (k notweed) on RB, road CV, one large RB spotted
6	3-2	61	539						M/S	YF/SHR	1		just downstream of convluence with Giveout Creek
6	3-2	62	545						M/S	YF/SHR	1		Giveout Creek confluence at 560 m
6	3-2	63	560				JM		M	YF	3		trees fallen across creek from LB, cobble and SWD caught in tree turnks
7	3-2.1	64	615						M	YF	2	culvert at upstream end	plunge pool at culvert outlet
7	3-2.1	65	623.7						M	YF	2	culvert itself likely unpassable by fish	CSP culvert, 3.6 m wide by 24 m long. Not embetted. 15 cm drop from culvert inlet to water at time of survey
7	3-2.1	97	0						M	YF	2	constructed weir at u/s end	weir is 45 cm drop to water below, with only 20 cm depth in channel below weir
7	3-2.1	98	26.8						M	YF	2	constructed weirs at u/s and d/s ends	
7	3-2.1	99	34.6						S	INIT	3		rocks have been piled within stream channel in areas
7	3-2.1	(100) 10	37.2						G/S	INIT	1		alternating lawns and thin strip of riparian vegetation
7	3-2.1	(101)11	122				EB		S	INIT	2		wood log on RB

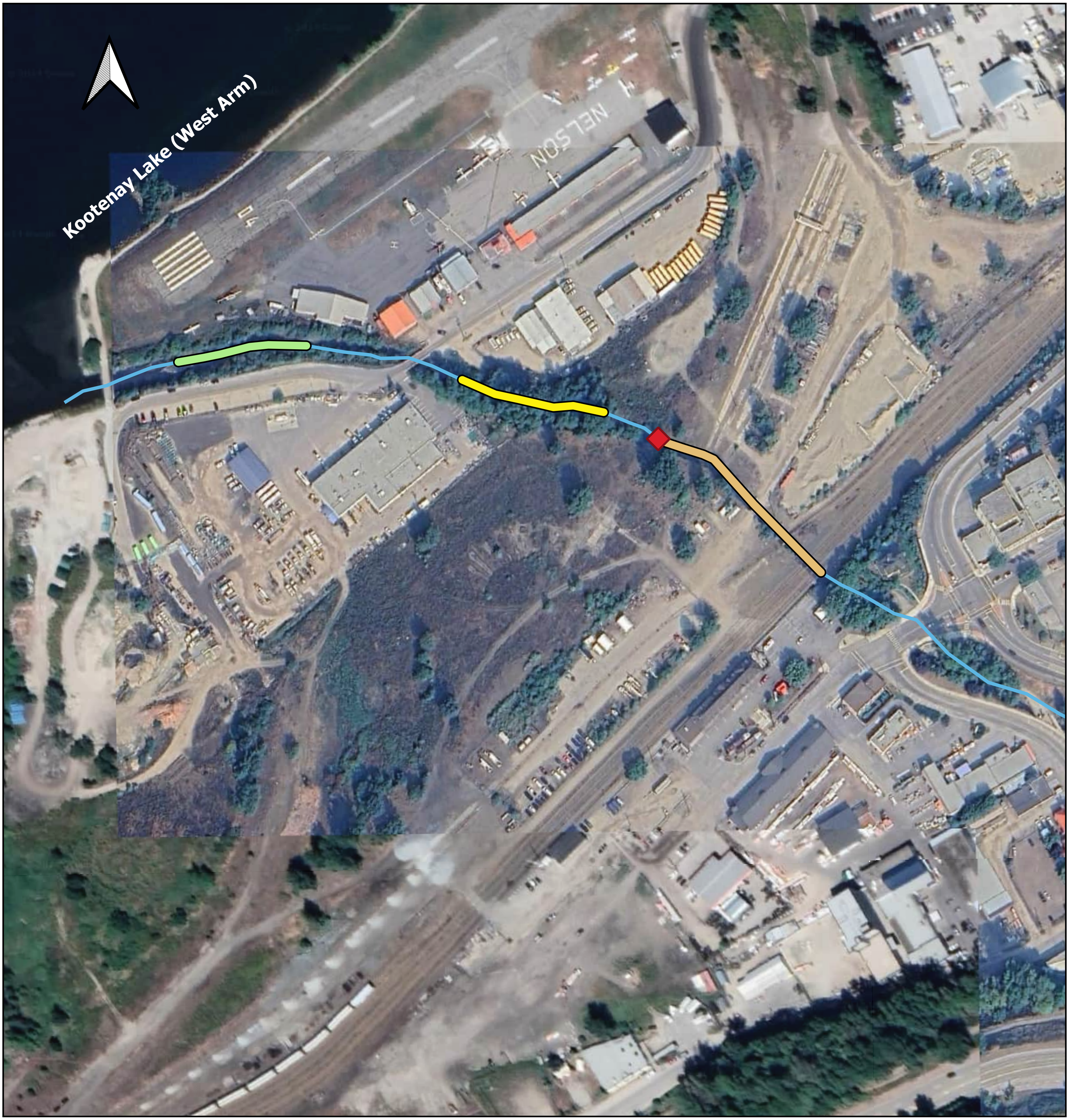
Site	Reach-Section	Habitat Unit	Distance (m)	Off Channel Type	Off Channel Access	Off Channel Length	Disturbance 1	Disturbance 2	Riparian Type	Riparian Structure	Canopy Closure	Barriers	Comments
7	3-2.1	(102)12	153.1						M	YF/MF	4		nice fish habitat, could benefit from pools and additional cover (potential restoration option?)
7	3-2.1	(103)13	263.2						M	YF	1	constructed weir (passable on one side)	invasive vegetation (japanese knotweed on RB)
7	3-2.1	(104)14	290.1						S	INIT	1	constructed weir (passable on one side)	
8	4-1	301	0						S/M	MF	2		okay rearing habitat, though not a lot of slow moving water or cover. Substrate is quite large
8	4-1	302	3.2						M	MF	1		okay rearing habitat, though not a lot of slow moving water or cover. Substrate is quite large
8	4-1	303	27.2				WG		C/M	MF/YF	2		okay rearing habitat, though not a lot of slow moving water or cover. Substrate is quite large
8	4-1	304	74.5				WG		C/M	MF/YF	2		side cahnnel, good rearing habitat
8	4-1	305	74.5						C/M	MF/YF	2		pool in side channel
8	4-1	306	92						C/M	MF	3		pool-like habitat, relatively fast flow; highway is within 20 m riparian area, norrow strip of rip veg on RB, next to cutblock
8	4-1	307	100.1				JM		C/M	MF	3		okay rearing habitat, though not a lot of slow moving water or cover. Substrate is quite large
8	4-1	308	110				JM		C/M	MF	3		okay rearing habitat, though not a lot of slow moving water or cover. Substrate is quite large
8	4-1	309	122.2				EB (hwy)		M	MF	3		eroding bank along highway LB,
8	4-1	310	128.8				EB (hwy)		M	YF	1		eroding bank along highway LB
9	4-2	201	0						C	MF	3		nice habitat (rearing small fish)
9	4-2	202	49.3						S/C	MF	3		side channel
9	4-2	203	54.8						S/C	MF	3		side channel
9	4-2	204	69.1				JM		S/C	MF	3	debris jam may be obstacle under low flows	side channel ; juvenile fish present
9	4-2	205	0				JM		S/C	MF	3	debris jam may be obstacle under low flows	
9	4-2	206	28.1						C	MF	1		
9	4-2	207	34.9						C	MF	2		nice habitat! Fish spotted (juvenile)
9	4-2	208	52.1						S/C	MF	1		
9	4-2	209	56.3						S/C	MF	1		
9	4-2	210	73.4						C	MF	3		nice habitat!
9	4-2	211	76.5						C/D	MF	2		excellent rearing habitat; Old road crossing?; within 30 m of cutblock on LB
10	4-2	301	0				EB		C/S	MF/SHR	3		RB (Fry) observed; gravel/sand input appears to at least in part be from the rail trail eroding
10	4-2	302	55				EB		C/S	MF/SHR	4		RB (Fry) observed; gravel/sand input appears to at least in part be from the rail trail eroding
10	4-2	303	62.4				EB		C/S	MF/SHR	3		gravel/sand input appears to at least in part be from the rail trail eroding
10	4-2	304	74.6				EB		C/S	MF/SHR	3		gravel/sand input appears to at least in part be from the rail trail eroding
10	4-2	305	80.6				EB	JM	C/S	MF/SHR	3	debris jam may be obstacle under low flows	gravel/sand input appears to at least in part be from the rail trail eroding
10	4-2	306	123.6				EB		C/S	MF/SHR	3		lots of instream vegetation (moss); gravel/sand input appears to at least in part be from the rail trail eroding
10	4-2	307	130.5				EB		S	INIT	2		lots of instream vegetation (moss); gravel/sand input appears to at least in part be from the rail trail eroding
10	4-2	308	138.4	W	N	16.7	EB		C	MF/SHR	2		1 RB (fry) observed, stream runs through alder/dogwood swamp habitat up to the hwy curve
11	4-2	309	0						C	MF/SHR	2		
11	4-2	310	12.6						C	MF	3		creek confined btwn road and hwy
11	4-2	311	18.6						C	MF	3		juv. Fish in pool;
11	4-2	312	24.1				JM		S/C	MF	3		creek confined btwn road and hwy
11	4-2	313	44.4				JM		S/C	MF	2		creek confined btwn road and hwy
11	4-2	314	53.1				SWD	MC	C	MF	3		creek confined btwn road and hwy
11	4-2	315	74.9						S/C	SHR/MF	3		creek confined btwn road and hwy
11	4-2	316	80.1						S/C	SHR/MF	3		creek confined btwn road and hwy
11	4-2	317	100.5						M	MF	3		fish in pool; creek confined between road and highway;
11	4-2	318	104.9						S/C	MF	2		creek confined btwn road and hwy
11	4-2	319	141.4						S/C	MF	2		creek confined btwn road and hwy

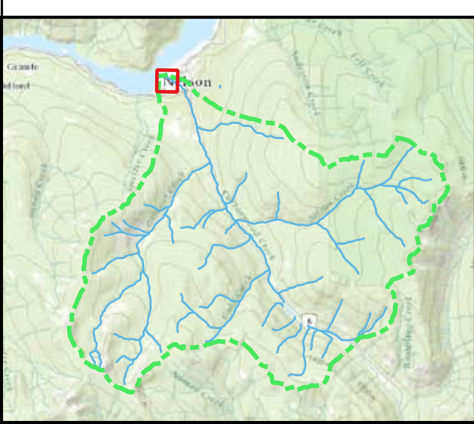
Site	Caught vs. Observed	Species	#	Weight (g)	Length (mm)	Condition
Site 2 (R1-S2)	Caught	RB	1	0.5	38	0.91
Site 2 (R1-S2)	Caught	RB	1	0.7	41	1.02
Site 2 (R1-S2)	Caught	RB	1	0.8	43	1.01
Site 2 (R1-S2)	Caught	RB	1	1.8	54	1.14
Site 2 (R1-S2)	Caught	RB	1	5.5	76	1.25
Site 2 (R1-S2)	Caught	RB	1	5.9	78	1.24
Site 2 (R1-S2)	Caught	LNC	1	5.8	79	1.18
Site 2 (R1-S2)	Caught	LNC	1	5.9	82	1.07
Site 2 (R1-S2)	Caught	LNC	1	7.7	87	1.17
Site 2 (R1-S2)	Caught	RB	1	8.5	92	1.09
Site 2 (R1-S2)	Caught	RB	1	8.3	95	0.97
Site 2 (R1-S2)	Caught	RB	1	10.1	97	1.11
Site 2 (R1-S2)	Caught	RB	1	14.4	114	0.97
Site 2 (R1-S2)	Caught	RB	1	15.9	115	1.05
Site 2 (R1-S2)	Caught	RB	1	36.2	140	1.32
Site 2 (R1-S2)	Observed	RB	3	-	40	N/A
Site 2 (R1-S2)	Observed	RB	5	-	120	N/A
Site 3 (R2-S1)	Caught	RB	1	-	194	N/A
Site 3 (R2-S1)	Caught	RB	1	1.7	52	1.21
Site 3 (R2-S1)	Caught	RB	1	2.1	60	0.97
Site 3 (R2-S1)	Caught	RB	1	3	60	1.39
Site 3 (R2-S1)	Caught	RB	1	3.2	65	1.17
Site 3 (R2-S1)	Caught	RB	1	3.6	69	1.10
Site 3 (R2-S1)	Caught	RB	1	13.6	104	1.21
Site 3 (R2-S1)	Caught	RB	1	12.3	110	0.92
Site 3 (R2-S1)	Caught	RB	1	18.4	115	1.21
Site 3 (R2-S1)	Caught	RB	1	24.8	134	1.03
Site 3 (R2-S1)	Caught	RB	1	34.5	152	0.98
Site 3 (R2-S1)	Caught	RB	1	46.2	160	1.13
Site 3 (R2-S1)	Observed	RB	2	-	50	N/A
Site 3 (R2-S1)	Observed	RB	5	-	100	N/A
Site 3 (R2-S1)	Observed	RB	7	-	120	N/A
Site 4 (R2-S2)	Caught	RB	1	0.8	39	1.35
Site 4 (R2-S2)	Caught	RB	1	2.3	57	1.24
Site 4 (R2-S2)	Caught	RB	1	2.1	60	0.97
Site 4 (R2-S2)	Caught	RB	1	7.4	82	1.34
Site 4 (R2-S2)	Caught	RB	1	6.5	85	1.06
Site 4 (R2-S2)	Caught	RB	1	8	89	1.13
Site 4 (R2-S2)	Caught	RB	1	11.5	100	1.15
Site 4 (R2-S2)	Caught	RB	1	11.5	105	0.99
Site 4 (R2-S2)	Caught	RB	1	-	108	N/A
Site 4 (R2-S2)	Caught	RB	1	19.3	120	1.12
Site 4 (R2-S2)	Caught	RB	1	-	125	N/A
Site 4 (R2-S2)	Caught	RB	1	33.5	145	1.10
Site 4 (R2-S2)	Caught	RB	1	-	152	N/A
Site 4 (R2-S2)	Caught	RB	1	43.6	160	1.06
Site 4 (R2-S2)	Caught	RB	1	46.2	161	1.11
Site 4 (R2-S2)	Caught	RB	1	-	170	N/A
Site 4 (R2-S2)	Caught	RB	1	-	181	N/A
Site 4 (R2-S2)	Observed	RB	3	-	50	N/A
Site 4 (R2-S2)	Observed	RB	6	-	100	N/A
Site 4 (R2-S2)	Observed	RB	7	-	120	N/A
Site 5 (R3-S1)	Caught	RB	1	0.9	46	0.92
Site 5 (R3-S1)	Caught	RB	1	-	73	N/A
Site 5 (R3-S1)	Caught	RB	1	8.2	81	1.54
Site 5 (R3-S1)	Caught	RB	1	7.6	85	1.24
Site 5 (R3-S1)	Caught	RB	1	8.3	85	1.35
Site 5 (R3-S1)	Caught	RB	1	-	87	N/A
Site 5 (R3-S1)	Caught	RB	1	10.2	90	1.40
Site 5 (R3-S1)	Caught	RB	1	-	92	N/A
Site 5 (R3-S1)	Caught	RB	1	-	92	N/A
Site 5 (R3-S1)	Caught	RB	1	-	94	N/A
Site 5 (R3-S1)	Caught	RB	1	11.1	108	0.88
Site 5 (R3-S1)	Caught	RB	1	16	109	1.24
Site 5 (R3-S1)	Caught	RB	1	-	110	N/A
Site 5 (R3-S1)	Caught	RB	1	12.2	112	0.87
Site 5 (R3-S1)	Caught	RB	1	16.4	115	1.08

Site	Caught vs. Observed	Species	#	Weight (g)	Length (mm)	Condition
Site 5 (R3-S1)	Caught	RB	1	17.1	118	1.04
Site 5 (R3-S1)	Caught	RB	1	17.8	121	1.00
Site 5 (R3-S1)	Caught	RB	1	17.5	122	0.96
Site 5 (R3-S1)	Caught	RB	1	-	123	N/A
Site 5 (R3-S1)	Caught	RB	1	21.5	124	1.13
Site 5 (R3-S1)	Caught	RB	1	21.9	125	1.12
Site 5 (R3-S1)	Caught	RB	1	26	135	1.06
Site 5 (R3-S1)	Caught	RB	1	28.5	135	1.16
Site 5 (R3-S1)	Caught	RB	1	30.7	140	1.12
Site 5 (R3-S1)	Caught	RB	1	-	161	N/A
Site 5 (R3-S1)	Caught	RB	1	-	165	N/A
Site 5 (R3-S1)	Caught	RB	1	56.4	169	1.17
Site 5 (R3-S1)	Caught	RB	1	61.3	169	1.27
Site 5 (R3-S1)	Caught	RB	1	-	174	N/A
Site 5 (R3-S1)	Observed	RB	4	-	50	N/A
Site 5 (R3-S1)	Observed	RB	14	-	100	N/A
Site 5 (R3-S1)	Observed	RB	7	-	120	N/A
Site 6 (R3-S2)	Caught	RB	1	5.8	82	1.05
Site 6 (R3-S2)	Caught	RB	1	6.3	83	1.10
Site 6 (R3-S2)	Caught	RB	1	5.9	85	0.96
Site 6 (R3-S2)	Caught	RB	1	6.4	85	1.04
Site 6 (R3-S2)	Caught	RB	1	6.5	85	1.06
Site 6 (R3-S2)	Caught	RB	1	7.5	86	1.18
Site 6 (R3-S2)	Caught	RB	1	7.5	87	1.14
Site 6 (R3-S2)	Caught	RB	1	8	89	1.13
Site 6 (R3-S2)	Caught	RB	1	7.2	90	0.99
Site 6 (R3-S2)	Caught	RB	1	8.3	90	1.14
Site 6 (R3-S2)	Caught	RB	1	6.9	92	0.89
Site 6 (R3-S2)	Caught	RB	1	12.9	95	1.50
Site 6 (R3-S2)	Caught	RB	1	12	105	1.04
Site 6 (R3-S2)	Caught	RB	1	13.2	110	0.99
Site 6 (R3-S2)	Caught	RB	1	16.9	114	1.14
Site 6 (R3-S2)	Caught	RB	1	18	115	1.18
Site 6 (R3-S2)	Caught	RB	1	12.3	117	0.77
Site 6 (R3-S2)	Caught	RB	1	27.1	140	0.99
Site 6 (R3-S2)	Caught	RB	1	26.3	145	0.86
Site 6 (R3-S2)	Caught	RB	1	30.2	145	0.99
Site 6 (R3-S2)	Caught	RB	1	34.1	150	1.01
Site 6 (R3-S2)	Caught	RB	1	34.1	160	0.83
Site 6 (R3-S2)	Caught	RB	1	53.5	170	1.09
Site 6 (R3-S2)	Caught	RB	1	62.4	180	1.07
Site 6 (R3-S2)	Caught	RB	1	63.5	180	1.09
Site 6 (R3-S2)	Observed	RB	3	-	100	N/A
Site 6 (R3-S2)	Observed	RB	4	-	120	N/A
Site 9 (R4-S2)	Caught	RB	1	0.6	39	1.01
Site 9 (R4-S2)	Caught	RB	1	0.8	40	1.25
Site 9 (R4-S2)	Caught	RB	1	1.2	47	1.16
Site 9 (R4-S2)	Caught	RB	1	-	47	N/A
Site 9 (R4-S2)	Caught	RB	1	1.2	48	1.09
Site 9 (R4-S2)	Caught	RB	1	2.5	60	1.16
Site 9 (R4-S2)	Caught	RB	1	4	69	1.22
Site 9 (R4-S2)	Caught	RB	1	4.1	74	1.01
Site 9 (R4-S2)	Caught	RB	1	4.8	76	1.09
Site 9 (R4-S2)	Caught	RB	1	5.5	82	1.00
Site 9 (R4-S2)	Caught	RB	1	5.5	82	1.00
Site 9 (R4-S2)	Caught	RB	1	15.9	114	1.07
Site 9 (R4-S2)	Caught	RB	1	15	115	0.99
Site 9 (R4-S2)	Caught	RB	1	16.5	118	1.00
Site 9 (R4-S2)	Caught	RB	1	23.7	130	1.08
Site 9 (R4-S2)	Caught	RB	1	26.6	139	0.99
Site 9 (R4-S2)	Caught	RB	1	48.3	165	1.08
Site 9 (R4-S2)	Caught	RB	1	-	170	N/A
Site 9 (R4-S2)	Observed	RB	3	-	50	N/A
Site 9 (R4-S2)	Observed	RB	6	-	100	N/A
Site 9 (R4-S2)	Observed	RB	6	-	120	N/A

APPENDIX 3. RECOMMENDED RESTORATION SITES

Restoration Site	Location (UTM - Zone 11U)
Sill Log Area in R1-S2 - proposed restoration area	~478000m E, 5482084m N to 478064m E 5482067m N
R1-S1 - proposed restoration area	~477833m E, 5482094m N to 477920m E, 5482106m N
Riffle Habitat in R3-S2.1 proposed restoration area	~479369m E, 5479261m N to 479405m E, 5479157m N
Concrete Flume on CPKC lands	478124m E, 5482045m N to 478214m N 5481961 m E
Barrier - constructed dam / concrete platform recommended for removal	478926m E, 5480587m N
Kline Road Culvert - recommend replacement or weir/baffles	479348m E, 5479487m N
Highway 6 Culvert - recommend replacement or weir/baffles	479495m E, 5478976m N
Small rock dam to be removed	479374m E, 5479428m N
Small rock dam to be removed	479431m E, 5479111m N
Small rock dam to be removed	479415m E, 5479148m N
Planting to increase riparian buffer on east bank	479367m E, 5479399m N
Planting to increase riparian buffer on east bank	479362m E, 5479349m N
Planting to increase riparian buffer on west bank	479357m E, 5479322m N
Planting to increase riparian buffer on west bank	478896m E, 5480720m N
Planting to increase riparian buffer on west bank	478925m E, 5480598m N
Planting above riprap on east bank and on west bank to improve riparian cover	479120m E, 5479989m N
Planting to increase riparian buffer on west bank	478921m E, 5480645m N
Planting to increase riparian buffer on west bank	479182m E, 5479865m N
Seed and plant east bank along Park and Ride to mitigate eroding bank	478790m E, 5481032m N
Planting to increase riparian buffer on west bank below fence	478886m E, 5480782m N
Planting to increase riparian buffer on west bank	478871m E, 5480854m N
Potential site for restoration on east bank? Old trailer on bench appeared to not be in use?	479348m E, 5479474m N
Remove debris from east bank, planting to increase riparian buffer.	479230m E, 5479722m N
Remove debris (and shed if not used?) on east bank. Address eroding bank.	479196m E, 5479798m N
Invasives removal - Knotweed on east bank (~60 m2)	479434m E, 5479103m N
Invasives Removal - Knotweed on highway bank (~10m2)	479294m E, 5479622m N
Invasives Removal - Knotweed on east bank (~10m2)	479415m E, 5479153m N





Cottonwood Creek Restoration - Appendix 3A

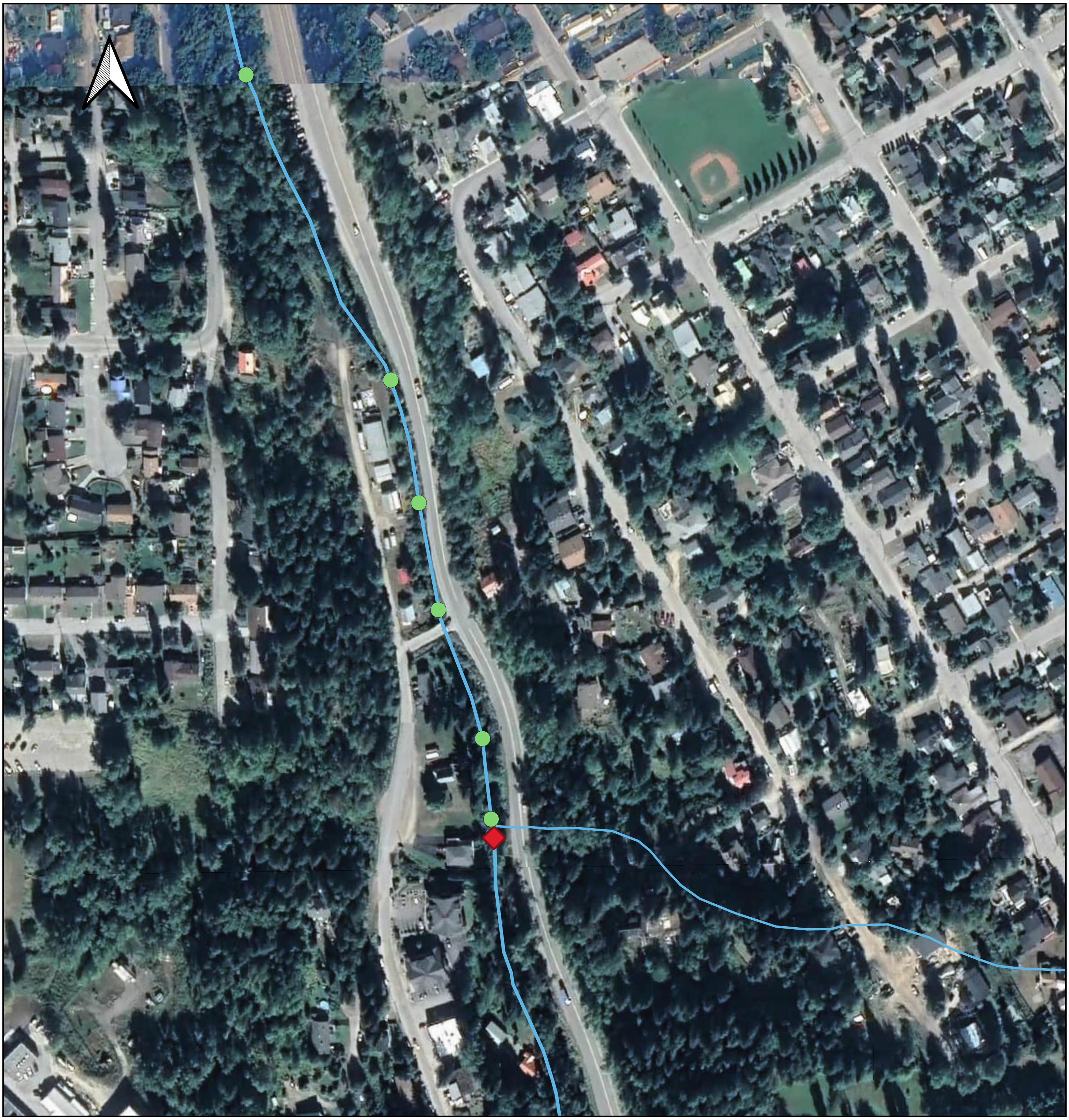
Proposed Restoration Sites

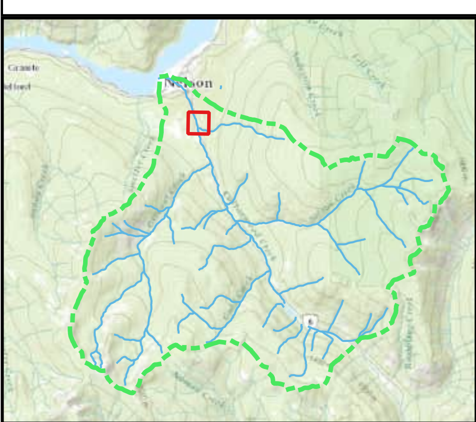
- R1-S1- Restoration
- Sill Log Area in R1-S2 - Restoration
- Concrete Flume in CPKC Lands - Removal / Enhancements
- Barrier Removal

0 100 200 m

MASSE ENVIRONMENTAL

Map Date: 2024-12-05
Projection: NAD83 / UTM zone 11N
Project #: 2024-1153
Main Map Scale: 1:3,000





Cottonwood Creek Restoration - Appendix 3B

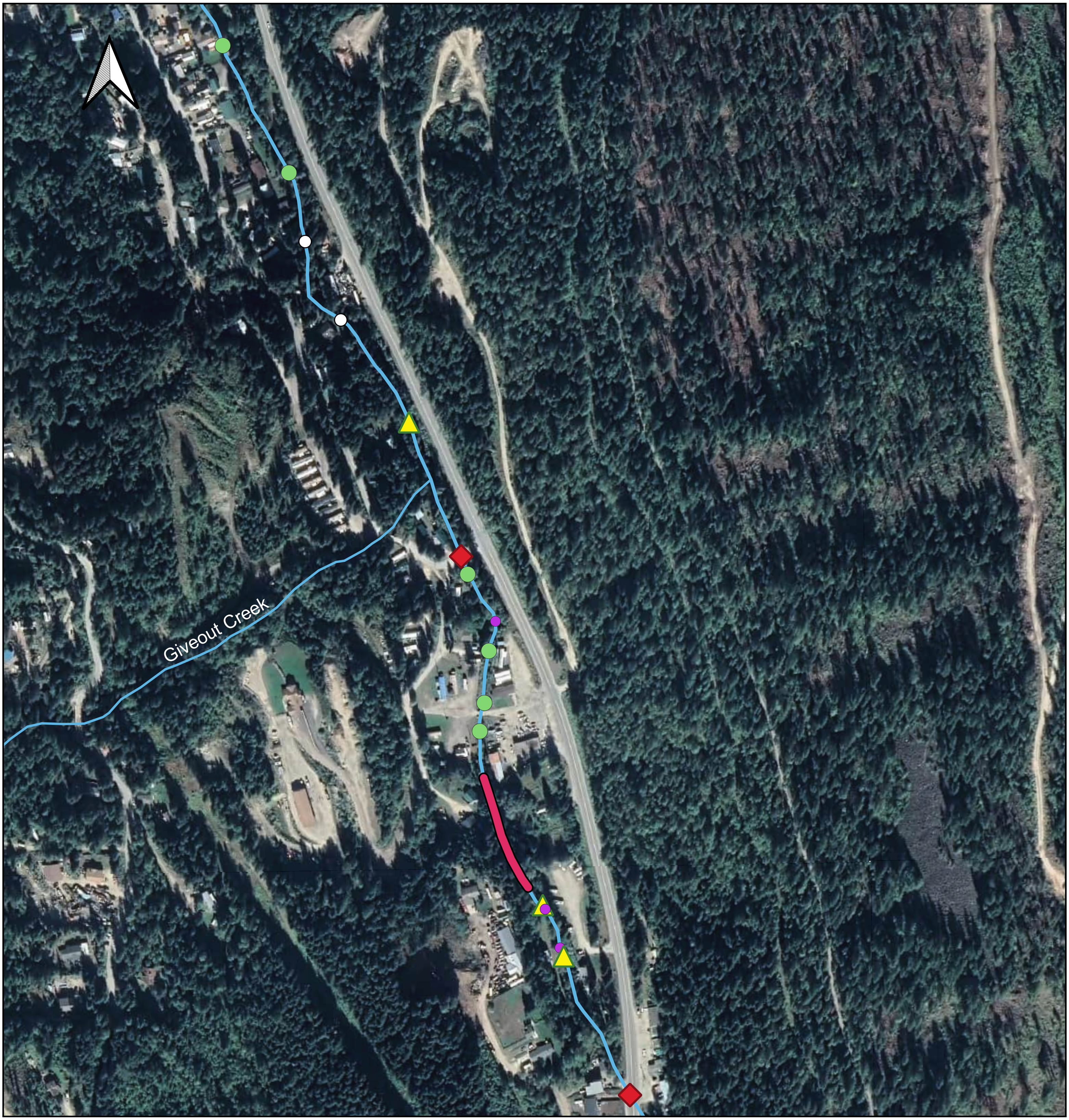
Proposed Restoration Sites

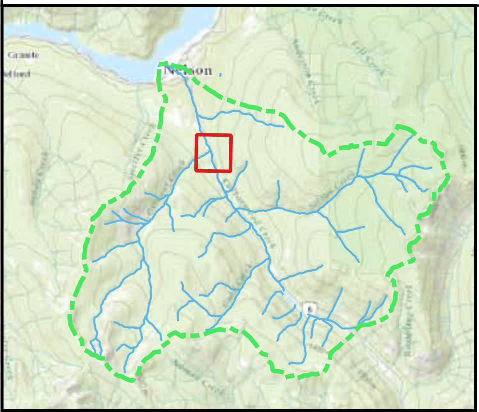
- Barrier Removal
- Riparian Planting

0 100 200 m

MASSE ENVIRONMENTAL

Map Date: 2024-12-05
Projection: NAD83 / UTM zone 11N
Project #: 2024-1153
Main Map Scale: 1:3,000





Cottonwood Creek Restoration- Appendix 3C

Proposed Restoration Sites

- Riffle Habitat in R3-S2.1 - Restoration
- Barrier Removal
- Instream Structure
- Debris Removal / Planting
- Invasive Vegetation Removal
- Riparian Planting

0 200 400 m

MASSE ENVIRONMENTAL

Map Date: 2024-12-05
Projection: NAD83 / UTM zone 11N
Project #: 2024-1153
Main Map Scale: 1:5,000