

Elk River Watershed Group Fish Passage Restoration Planning

Prepared for Canadian Wildlife Federation

Prepared by Al Irvine, B.Sc., R.P.Bio.

New Graph Environment

2020-12-22 DRaft

Table of Contents

List of Tables	v
List of Figures	vii
Executive Summary	ix
1 Introduction	1
2 Background	3
3 Methods	5
4 Results	15
5 Conclusion	21
Appendix - Crossing 50155	23
Appendix - Crossing 50159	33
Appendix - Crossing 50185	41
Appendix - Crossing 62423	53
Appendix - Crossings 62425 and 62426	61
Appendix - Crossing 62516	73
Appendix - Crossings 197533 and 197559	81
Appendix - Crossing 197555	97
Appendix - Phase 1 Fish Passage Assessment Data and Photos	107
References	235

List of Tables

List of Figures

5.1 Fish densities (fish/100m ²) for PSCIS crossing 50155.	29
5.2 Typical habitat downstream of PSCIS crossing 50155.	30
5.3 Typical habitat upstream of PSCIS crossing 50155.	31
5.4 Typical habitat downstream of PSCIS crossing 50159.	38
5.5 Typical habitat upstream of PSCIS crossing 50159.	39
5.6 Fish densities (fish/100m ²) for PSCIS crossing 50185.	48
5.7 Typical habitat downstream of PSCIS crossing 50185.	49
5.8 Typical habitat upstream of PSCIS crossing 50185.	50
5.9 Westslope cutthroat trout captured upstream of PSCIS crossing 50185.	51
5.10 Typical habitat downstream of PSCIS crossing 62423.	58
5.11 Typical habitat upstream of PSCIS crossing 62423.	59
5.12 Typical habitat downstream of PSCIS crossing 62425.	69
5.13 Typical habitat upstream of PSCIS crossing 62425 and downstream of PSCIS crossing 62426.	70
5.14 Grave Creek redirection out of historic channel located upstream of PSCIS crossing 62426.	71
5.15 Typical habitat downstream of PSCIS crossing 62516.	78
5.16 Typical habitat upstream of PSCIS crossing 62516.	79
5.17 Gravels suitable for spawning upstream of PSCIS crossing 62516.	80
5.18 Typical habitat downstream of PSCIS crossing 197533.	90
5.19 Typical habitat upstream of PSCIS crossing 197533 and downstream of PSCIS crossing 197533.	91
5.20 Westslope cutthroat trout in outlet pool downstream of PSCIS crossing 197559.	92
5.21 Subsurface flow area upstream of PSCIS crossing 197559.	93
5.22 Typical habitat above dewatered area upstream of PSCIS crossing 197533.	
5.23 Habitat within electrofishing site upstream of PSCIS crossing 197533.	9594
5.24 Typical habitat downstream of PSCIS crossing 197555.	103
5.25 Typical habitat upstream of PSCIS crossing 197555.	104
5.26 Bull trout captured downstream of PSCIS crossing 197555.	105

Executive Summary

1 Introduction

New Graph Environment and Nupqu Limited Partnership were retained by the Canadian Wildlife Federation in the fall of 2020 to plan and conduct fish passage assessments and habitat confirmation assessments at road-stream crossings within the Elk River watershed group. Although planning for assessments was conducted for both the Elk River watershed upstream of the Elko Dam near Elko, BC and the Flathead River, assessments focused on the Elk River and tributaries upstream of the Elko Dam.

The health and viability of freshwater fish populations can depend on access to tributary and off channel areas which provide refuge during high flows, opportunities for foraging, overwintering habitat, spawning habitat and summer rearing habitat (Bramblett et al. 2002; Swales and Levings 1989). Culverts can present barriers to fish migration due to increased water velocity, turbulence, a vertical drop at the culvert outlet and/or maintenance issues (Slaney, Zaldokas, and Watershed Restoration Program (B.C.) 1997). Reconnection of fragmented habitats is a management action that can generate some of the highest ecological returns on economic investments relative to other habitat restoration techniques (Saldi-Caromile et al. 2004).

2 Background

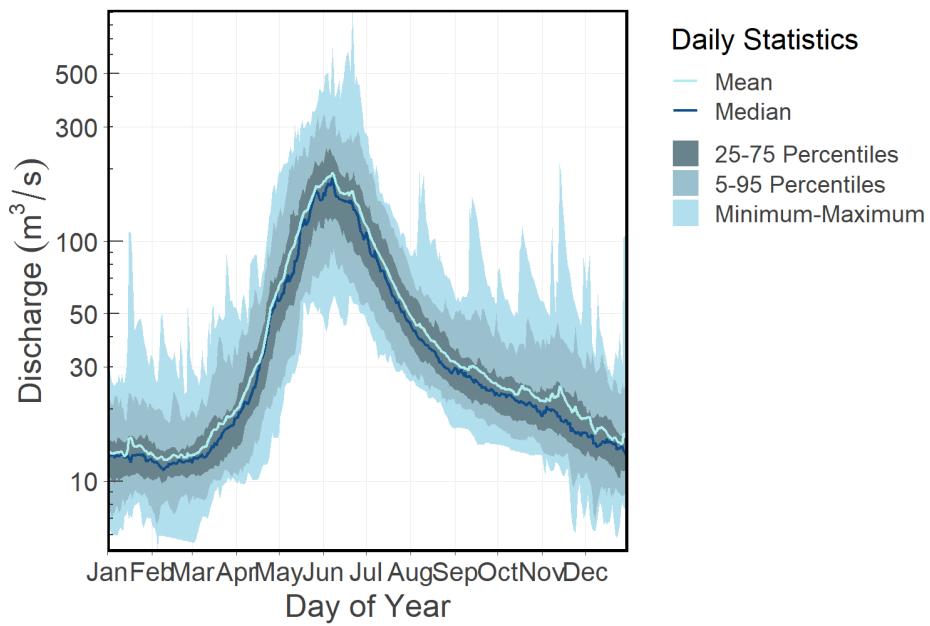
As a result of high-level direction from the provincial government, a Fish Passage Strategic Approach protocol has been developed for British Columbia to ensure that the greatest opportunities for restoration of fish passage are pursued. A Fish Passage Technical Working Group has been formed to coordinate the protocol and data is continuously amalgamated within the Provincial Steam Crossing Inventory System (PSCIS). The strategic approach protocol involves a four-phase process as described in Fish Passage Technical Working Group (2014) :

- Phase 1: Fish Passage Assessment – Fish stream crossings within watersheds with high fish values are assessed to determine barrier status of structures and document a general assessment of adjacent habitat quality and quantity.
- Phase 2: Habitat Confirmation – Assessments of crossings prioritized for follow up in Phase 1 studies are conducted to confirm quality and quantity of habitat upstream and down as well as to scope for other potential nearby barriers that could affect the practicality of remediation.
- Phase 3: Design – Site plans and designs are drawn for priority crossings where high value fish habitat has been confirmed.
- Phase 4: Remediation – Reconnection of isolated habitats through replacement, rehabilitation or removal of prioritized crossing structure barriers.

The scope of 2020/2021 project activities reported on in this document includes planning for and implementation of the first two phases of fish passage assessment in the Elk River watershed upstream of the Elko Dam.

2.1 Project Location

The project was focused within the upper Elk River watershed upstream of the Elko Dam located at Elko, BC.



2.2 Fisheries

3 Methods

Workflows for the project can be classified into four categories: planning, fish passage assessments, habitat confirmation assessments and reporting.

3.1 Planning

To identify priorities for crossing structure rehabilitation, background literature, fisheries information, PSCIS, Fish Habitat Model outputs modified from Norris and Mount (2016) and bcfishpass (Norris 2020) outputs were reviewed. The Fish Habitat Model was developed by the BC Ministry of Environment to provide estimates of the amount of fish habitat potentially accessible to fish upstream of crossing locations. The model calculates the average gradient of BC Freshwater Atlas [stream network lines](#) at minimum 100m long intervals starting from the downstream end of the streamline segment and working upstream. The network lines are broken into max gradient categories with new segments created when the average gradient of the stream lines exceeds user provided gradient thresholds.

Norris (2020) recently created bcfishpass which are sql and python based shell script libraries that “generate a simple model of aquatic habitat connectivity by identifying natural barriers to fish passage (plus hydro dams that are not feasible to remediate) and classifying all streams not upstream of these barriers as ‘potentially accessible’. On potentially accessible streams,” bcfishpass scripts “identify known barriers and additional anthropogenic features (primarily road/railway stream crossings, i.e. culverts) that are potentially barriers. To prioritize these features for assessment or remediation,” the scripts “report on how much modelled potentially accessible aquatic habitat the barriers may obstruct. The model can be refined with known fish observations. Depending on the modelling scenario, all aquatic habitat downstream of a given fish observation can be classified as ‘observed accessible’, overriding any downstream barriers.”

Following delineation of “non-fish habitat” with the Fish Habitat Model, the average gradient of each stream segment within habitat classified as below the 22% threshold was calculated and summed using bcfishpass to quantify upstream habitat potentially available for westslope cutthroat trout and facilitate

stream line symbology based on stream morphology. bcfishpass summed average gradients within seven categories (0 - 3%, 3 - 5%, 5 - 8%, 8 - 15%, 15 - 22%, 22 - 30% and >30%) with these outputs further amalgamated to summarize and symbolize potential upstream habitat in four categories: riffle/cascade (0 - 5%), step-pool (5 - 15%), step-pool very steep (15-20%) and extremely steep (20 - 30%) (Table 3.1). For each crossing location, the linear length of stream habitat upstream of crossings and <20% was summarized by average gradient and the area of lake and wetland habitat upstream was collated and reviewed to give an indication of the potential quantity and quality of habitat potentially gained should fish passage be restored.

Table 3.1: Stream gradient categories (threshold and average) and associated channel type.

Gradient	Channel Type
0 - 5%	Riffle and cascade pool
5 - 15%	Step pool
15 - 20%	Step pool - very steep
20 - 30%	Step pool - extremely steep (bull trout only)
>30%	Non fish habitat

To prepare for Phase 1 and 2 assessments in the study area, past fish passage assessment reports for the Elk River watershed group were first reviewed to identify crossing structures not yet assessed or previously ranked as priorities for rehabilitation in VAST Resource Solutions Inc. (2013) and Grainger (2011). To determine which of those crossings had not yet been assessed with Phase 2 assessments we cross-referenced these reports with only Phase 2 report completed in the study area (Massee Environmental Consultants Ltd. 2015) and reviewed outputs from the Fish Habitat Model and bcfishpass. Outputs for modelled and PSCIS crossings that met the following criteria underwent a detailed review to facilitate prioritization for Phase 1 - Fish Passage and/or Phase 2 - Habitat Confirmations.

- Stream crossing barriers and potential barriers on streams with confirmed fish presence upstream of the structure.
- Stream crossing barriers and potential barriers on streams documented as $\geq 2.0\text{m}$ wide with linear lengths of modeled upstream habitat $<22\%$ gradient for $\geq 1\text{km}$.
- Stream crossing barriers and potential barriers located on streams classified as 3rd order or higher.
- Stream crossing barriers and potential barriers located on streams with $>5\text{ ha}$ of modeled wetland and/or lake habitat upstream of the structure.
- Stream crossing barriers and potential barriers on streams with habitat value rated as “medium” or “high” in past fish passage assessment data.

3.2 Fish Passage Assessments

In the field, crossings prioritized for follow-up were first assessed for fish passage following the procedures outlined in “Field Assessment for Determining Fish Passage Status of Closed Bottomed Structures” (MoE 2011). Crossings surveyed included closed bottom structures (CBS), open bottom structures (OBS) and crossings considered “other” (i.e. fords). Six digit numerical crossing identifiers were generated by bcfishpass for each of the crossings modelled. Crossings identified in the field that had no corresponding GIS generated ID were given unique identifiers beginning with the date in YYYYMMDD format appended with an identifier between 1 and 10 (ex. 2020091601). Photos were taken at surveyed crossings and when possible included images of the road, crossing inlet, crossing outlet, crossing barrel, channel downstream and channel upstream of the crossing and any other relevant features. Additionally, the following information was recorded for all surveyed crossings: date of inspection, crossing reference, crew member initials, Universal Transverse Mercator (UTM) coordinates, stream name, road name and kilometer, road tenure information, crossing type, crossing subtype, culvert diameter or span for OBS, culvert length or width for OBS. A more detailed “full assessment” was completed for all closed bottom structures and included the following parameters: presence/absence of continuous culvert embedment (yes/no), average depth of embedment, whether or not the culvert bed resembled the native stream bed, presence of and percentage backwatering, fill depth, outlet drop, outlet pool depth, inlet drop, culvert slope, average downstream channel width, stream slope, presence/absence of beaver activity, presence/absence of fish at time of survey,

type of valley fill, and a habitat value rating. Habitat value ratings were based on channel morphology, flow characteristics (perennial, intermittent, ephemeral), fish migration patterns, the presence/absence of deep pools, un-embedded boulders, substrate, woody debris, undercut banks, aquatic vegetation and overhanging riparian vegetation (Table 3.2). For crossings determined to be potential barriers or barriers based on the data (see [Barrier Scoring \(page 8\)](#)), a culvert fix and recommended diameter/span was proposed.

All field data collected including photos were uploaded to the Provincial Stream Crossing Inventory System (PSCIS).

Table 3.2: Habitat value criteria (Fish Passage Technical Working Group, 2011).

Habitat Value	Fish Habitat Criteria
High	The presence of high value spawning or rearing habitat (e.g., locations with abundance of suitably sized gravels, deep pools, undercut banks, or stable debris) which are critical to the fish population.
Medium	Important migration corridor. Presence of suitable spawning habitat. Habitat with moderate rearing potential for the fish species present.
Low	No suitable spawning habitat, and habitat with low rearing potential (e.g., locations without deep pools, undercut banks, or stable debris, and with little or no suitably sized spawning gravels for the fish species present).

3.3 Barrier Scoring

Fish passage potential was determined for each stream crossing identified as a closed bottom structure on fish bearing and potentially fish bearing stream reaches. The combined scores from five criteria: depth and degree to which the

structure is embedded, outlet drop, stream width ratio, culvert slope, and culvert length were used to screen whether each culvert was a likely barrier to some fish species and life stages (Table 3.3, Table 3.4). These criteria were developed based on data obtained from various studies and reflect an estimation for the passage of a juvenile salmon or small resident rainbow trout (Clarkin et al. 2005 ; Bell 1991; Thompson 2013).

Table 3.3: Fish Barrier Scoring (MoE 2011).

Risk	Embedded	Value	Outlet Drop (cm)		SWR	Value	Slope (%)
LOW	>30cm or >20% of diameter and continuous	0	<15	0	<1.0	0	<1
MOD	<30cm or 20% of diameter but continuous	5	15-30	5	1.0- 1.3	3	1-3
HIGH	No embedding or discontinuous	10	>30	10	>1.3	6	>3

Table 3.4: Fish Barrier Scoring Results (MoE 2011).

Cumulative Score	Result
0-14	passable
15-19	potential barrier
>20	barrier

3.4 Habitat Confirmation Assessments

Following fish passage assessments, habitat confirmations were completed in accordance with procedures outlined in the document “A Checklist for Fish Habitat Confirmation Prior to the Rehabilitation of a Stream Crossing” (Fish Passage Technical Working Group 2011). The main objective of the field surveys was to document upstream habitat quantity and quality and to determine if any other obstructions exist above or below the crossing. Habitat value was assessed based on channel morphology, flow characteristics (perennial, intermittent, ephemeral), the presence/absence of deep pools, un-embedded boulders, substrate, woody debris, undercut banks, aquatic vegetation and overhanging riparian vegetation. Criteria used to rank habitat value was based on guidelines in Fish Passage Technical Working Group (2011) and summarized in Table ??.

During habitat confirmations, to standardize data collected and facilitate submission of the data to provincial databases, information was collated on [“Site Cards”](#). Habitat characteristics recorded included channel widths, wetted widths, residual pool depths, gradients, bankfull depths, stage, temperature, conductivity, pH, cover by type, substrate and channel morphology (among others). When possible, the crew surveyed downstream of the crossing to the point where fish presence had been previously confirmed and upstream to a minimum distance of 600m. Any potential obstacles to fish passage were inventoried with photos, physical descriptions and locations recorded on site cards. Surveyed routes were recorded with time-signatures on handheld GPS units.

Fish sampling was conducted at a subset of sites when biological data was considered to add significant value to the physical habitat assessment information. When possible, electrofishing was utilized within discrete site units both upstream and downstream of the subject crossing with electrofisher settings, water quality parameters (i.e. conductivity, temperature and pH), start location, length of site and wetted widths (average of a minimum of three) recorded. For each fish captured, fork length and species was recorded, with results included within the fish data submission spreadsheet. Fish information and habitat data will be submitted to the province under scientific fish collection permit CB20-611971.

##Reporting

This pdf report and an online [interactive report](#) were generated with bookdown (Xie 2016) from Rmarkdown (Allaire et al. 2020) documents processing raw data available at the [New Graph Environment Github Site](#). In addition to numerous spatial layers sourced through the BC Data Catalogue, data inputs for this project can be sourced [here](#) and include:

- [Fish Data Submission Spreadsheet Template - V 2.0, January 20, 2020](#)
- [pscis_assessment_template_v24.xls](#)
- [Fish Habitat Model/bcfishpass](#) outputs.
- [Excel spreadsheet detailing priority](#) level assigned for each of the crossings surveyed with Phase 2 assessments as well as details on the length of the surveys conducted and a conservative estimate of habitat suitable for fish species located upstream of the crossing.
- [GPS tracks](#) from field surveys.
- [Photos and photo metadata.](#)

3.4.1 Cost Benefit Analysis

A cost benefit analysis was conducted for each crossing determined to be a barrier based on an estimate of cost associated with remediation or replacement of the crossing with a structure that facilitates fish passage and the amount of potential habitat that would be made available by remediating fish passage at the site (habitat gain index).

3.4.2 Habitat Gain Index

The habitat gain index is the quantity of modelled habitat upstream of the subject crossing and represents an estimate of habitat gained with remediation of fish passage at the crossing. For this project, a gradient threshold between accessible and non-accessible habitat was set at 20% (for a minimum length of 100m) intended to represent the maximum gradient of which westslope cutthroat trout are likely to be able to migrate upstream. For Phase 1 assessments a “net” value of habitat quantity output from bcfishpass was used to estimate the amount of habitat upstream of each crossing less than 20% gradient before either a falls of height >5m - as recorded in MoE (2020c), a road-stream crossing recorded in PSCIS as a barrier, or a modelled unassessed crossing. For Phase 2 assessments, the amount of potential habitat upstream of each crossing was estimated by measuring the amount of mainstem and stream segments > 1st order upstream of the crossing using the measure tool within QGIS (QGIS Development Team 2009).

Potential options to remediate fish passage were selected from MoE (2011) and included:

- * Removal (RM) - Complete removal of the structure and deactivation of the road.
- * Open Bottom Structure (OBS) - Replacement of the culvert with a bridge or other open bottom structure. For this project we considered bridges as the only viable option for OBS type based on consultation with FLNR road crossing engineering experts. It should be noted however, that box culverts could be considered a viable and economical option as they have been observed as successfully facilitating fish passage on the west coast of the province (Betty Rebellato, Canadian Wildlife Federation - Project Biologist). * Streambed

Simulation (SS) - Replacement of the structure with a streambed simulation design culvert. Often achieved by embedding the culvert by 40% or more. Based on consultation with FLNR engineering experts, we considered crossings on streams with a channel width of <2m and a stream gradient of <8% as candidates for replacement with streambed simulations. * Additional Substrate Material (EM) - Add additional substrate to the culvert and/or downstream weir to embed culvert and reduce overall velocity/turbulence. This option was considered only when outlet drop = 0, culvert slope <1.0% and stream width ratio < 1.0. * Backwater (BW) - Backwatering of the structure to reduce velocity and turbulence. This option was considered only when outlet drop < 0.3m, culvert slope <2.0%, stream width ratio < 1.2 and stream profiling indicates it would be effective..

Cost estimates for structure replacement with bridges and embedded culverts were generated based on the channel width, slope of the culvert, depth of fill, road class and road surface type. Road details were sourced from FLNRORD (2020b) and FLNRORD (2020a) through bcfishpass. Interviews with Phil MacDonald, Engineering Specialist FLNR - Kootenay, Steve Page, Area Engineer - FLNR - Northern Engineering Group and Matt Hawkins - MoTi - Design Supervisor for Highway Design and Survey - Nelson were utilized to help refine estimates. Base costs for installation of bridges on forest service roads and permit roads with surfaces specified as rough and loose was estimated at \$12500/linear m and assumed that the road could be closed during construction. For streams with channel widths <2m embedded culverts were reported as an effective solution with total installation costs estimated at \$25k/crossing (pers. comm. Phil MacDonald, Steve Page). A multiplier table was generated to estimate incremental cost increases due to the type of road with costs estimated for structure replacement on paved surfaces, railways and arterial/highways costing up to 20 times more than forest service roads due to expenses associated with design/engineering requirements, traffic control and paving. The cost multiplier table (Table 3.5) used for cost estimates in this study is a "rough first draft", should be considered very approximate and refined for future projects.

Table 3.5:

Class	Surface	Class Multiplier	Surface Multiplier	Bridge \$K/m	Streambed Simulation \$K
Forest Service Road	Loose	1	1	12.5	25
Local	Loose	1	1	12.5	25
Road Permit	Loose	1	1	12.5	25
Unclassified	Loose	1	1	12.5	25
Unclassified	Rough	1	1	12.5	25
Collector	Paved	1	2	25.0	50
Local	Paved	1	2	25.0	50
Rail	Rail	5	2	125.0	250
Arterial	Paved	10	2	250.0	500
Highway	Paved	10	2	250.0	500

4 Results

4.1 Phase 1

A total of XXX assessments were conducted between xxx and xxxxxxxxxxxx. Site details and photos are presented in

The analysis phase is summarized in Table ?? [test][test]

Table 4.1: Modelled upstream habitat estimate and cost benefit for Phase 1 assessments.

PSCIS ID	Stream	Road	Stream Width (m)	Priority	Fix	Cost Est (\$K)	Habitat Upstream (m)	Cost Benefit (m / \$K)
197525	Tributary to Elk River	Spur from Elk River FSR	1.00	low	RM	NA	940	NA
197529	Littlemoor Creek	Lower Elk Valley Road	1.00	low	SS-CBS	500	145	0.3
197537	North Littlemoor Creek	Highway 43	1.60	mod	SS-CBS	500	533	1.1
197559	Brule Creek	Highway 43	6.10	high	OBS	3050	763	0.3
197559	Brule Creek	Highway 43	6.10	high	OBS	3050	763	0.3
197559	Brule Creek	Highway 43	6.10	high	OBS	3050	763	0.3
197559	Brule Creek	Highway 43	6.10	high	OBS	3050	763	0.3

4.2 Phase 2

Raw results are included in digital format as [Attachment 2](#) and summarized in Tables [4.2 - 4.5](#)

Table 4.2: Overview of habitat confirmation sites.

Site	Stream	Road	Tenure	UTM (11U)	Fish Species	Habitat		
						Gain (km)	Value	Priority
50155	Tributary to Lizard Creek	Island Lake Lodge Road	MoTi recreation	635113 5484261	EB, WCT	1.8	Medium	moderate
50159	Tributary to Lizard Creek	Island Lake Lodge Road	MoTi recreation	633320 5484601	NA	0.3	Medium	high
50185	Tributary to Morrisey Creek	River Rd	FLNR 5466	645683 5469025	EB, WCT	4.5	High	moderate
62423	Harriet Lake Creek	Grave Creek FSR	Unknown	660508 5524239	NA	2.4	Low	low
62425	Grave Creek	Spur	Canfor R08362	661486 5524426	NA	0.2	Medium	moderate
62426	Grave Creek	Spur	Canfor R08362	661611 5524460	NA	1.8	Medium	moderate
62516	Tributary to Lizard	Island Lake	MoTi recreation	636123 5484087	NA	0.5	Medium	moderate

PSCIS	ID	Em
50159	No	

Table 4.3: Summary of Phase 2 fish passage reassessments.

PSCIS ID	Embedded	Outlet Drop (m)	Diameter		Slope (%)	Length (m)	Score	Result
			(m)	SWR				
50155	No	0.22	0.9	2.5	2.6	11	26	Barrier

50185	No	0.00	2.2	2.0	3.4	17	29	Barrier
62423	No	0.18	0.9	1.6	0.5	12	21	Barrier
62425	No	0.47	1.2	3.1	7.5	12	36	Barrier
62426	No	0.25	1.2	2.9	5.0	12	31	Barrier
62516	No	0.49	1.2	2.1	5.0	11	36	Barrier
197533	No	0.70	3.3	2.2	4.0	20	39	Barrier
197555	No	1.48	1.5	2.3	3.5	49	42	Barrier
197559	Yes	0.00	2.5	2.4	2.5	35	22	Barrier

Table 4.4: Cost benefit analysis for Phase 2 assessments.

pscis_crossing_id	stream_name	road_name	downstream_channel_width_meters
50155	Tributary to Lizard Creek	Island Lake Lodge Road	2.25
50159	Tributary to Lizard Creek	Island Lake Lodge Road	2.45
50185	Tributary to Morrisey Creek	River Rd	4.30
62423	Harriet Lake Creek	Grave Creek FSR	1.44
62425	Grave Creek	Spur	3.70
62426	Grave Creek	Spur	3.50
62516	Tributary to Lizard Creek	Island Lake Lodge Road	2.47
62516	Tributary to Lizard Creek	Island Lake Lodge Road	2.47
197533	Brule Creek	Busato Rd	7.10
197533	Brule Creek	Busato Rd	7.10

Table 4.5: Summary of Phase 2 habitat confirmation details.

Site	Length Surveyed (m)	Channel Width (m)	Wetted Width (m)	Pool Depth (m)	Gradient (%)	Total Cover	Habitat Value

5 Conclusion

Appendix - Crossing 50155

Island Lake Lodge Road - Tributary to Lizard Creek

Site Location

Crossing 50155 is located on a tributary to Lizard Creek, approximately 75m upstream from the confluence with Lizard Creek. The stream is located approximately 100m east of the location where it is mapped on the freshwater atlas stream layer. Island Lake Lodge Road is an extension of Mt.Fernie Park Road with access to Highway 3 located within Fernie city limits. The area is a popular recreational destination for hikers and mountain bikers. Island Lake Lodge is a year round tourist destination providing accommodations, guided hiking and backcountry catskiing for clients.

Background

At the crossing location, the stream is 2nd order with a watershed area upstream of the road of approximately 1.8km². The elevation of the watershed ranges from a maximum of 1945m to 1080m at the culvert. One 12m long bridge (PSCIS 197543) is located upstream of the subject crossing approximately 575m on the Lazy Lizard bike trail and another 7m long bridge structure is located downstream also on a recreational trail. A search of provincial records yielded no fisheries information for the stream (MoE 2020d). Downstream, Lizard Creek supports westslope cutthroat trout, bull trout, mountain whitefish, brook trout, longnose sucker and longnose dace (MoE 2020b).

PSCIS stream crossing 50155 was ranked as a high priority for follow up with habitat confirmation due to the large size of the stream relative to other tributary streams in the watershed, the previously rated high value habitat and because it was prioritized for follow up by VAST Resource Solutions Inc. (2013). The habitat confirmation was completed on September 22, 2020. A map of the watershed including areas surveyed is provided in Attachment 1 – Map [082G.113](#).

Stream Characteristics at Crossing

At the time of the survey, the un-embedded and non-backwatered 0.9m diameter crossing was considered a barrier to upstream fish passage with a pipe length of 11m, a culvert slope of 2.6%, a stream width ratio of 2.5 an outlet drop of 0.22m (Table [5.1](#)). Water temperature was 9°C, pH was 7.7 and conductivity was 480uS/cm.

Stream Characteristics Downstream

The stream was surveyed downstream from the culvert for 100m to Lizard Creek. Overall, total cover amount was rated as moderate with undercut banks dominant. Cover was also present as small woody debris, large woody debris, and overhanging vegetation (Table [5.6](#), Figure [5.2](#)). The average channel width was 2.2m, the average wetted width was 1.9m and the average gradient was 4.3%. Habitat value was rated as medium with good potential for fry/juvenile salmonid rearing but a lack of deep pools for adult overwintering and rearing.

Stream Characteristics Upstream

The stream was surveyed upstream from the culvert for 700m. Overall, total cover amount was rated as abundant with deep pools dominant. Cover was also present as small woody debris, large woody debris, boulders, undercut banks, and overhanging vegetation (Table [5.6](#), Figure [5.3](#)). The average channel width was 2.2m, the average wetted width was 1.6m and the average gradient was 10.5%. There were frequent areas of gravels suitable for resident westslope cutthroat trout spawning. Frequent pools to 40cm deep were present and associated with small and large woody debris. Habitat value was rated as high for fry and juvenile westslope cutthroat rearing.

Fish Sampling

To assess potential impacts of the culvert on fish densities in the stream we electrofished upstream and downstream of the crossing. Three sites were

sampled upstream and one site was sampled downstream. A total of 42 westslope cutthroat trout and 4 eastern brook trout were captured upstream with 28 westslope cutthroat trout and 2 eastern brook trout captured downstream. Raw results are included in digital format as [Attachment 2](#) and summarized in Tables [5.3 - 5.4](#) and Figure [5.1](#).

Structure Remediation and Cost Estimate

Structure replacement with an open bottomed culvert is recommended to provide unconstrained access to the habitat located upstream of PSCIS crossing 50155. The cost for work is estimated at \$125000 for a cost benefit of \$8700/linear m and \$9700/m².

Conclusion

There is an estimated 1.8km of mainstem habitat upstream of crossing 50155 with habitat in the areas surveyed upstream of the crossing rated as high value for fry and juvenile salmonid rearing. Although potentially attributable to the lower gradient habitat downstream and the proximity to the Lizard Creek mainstem, fish sampling results indicated that the crossing is potentially negatively impacting habitat capacity upstream of the crossing as higher densities of westslope cutthroat trout were captured downstream of the crossing than above. The road may be part of the Island Lake Recreational tenure or solely the responsibility of the Ministry of Forests, Lands, Natural Resource Operations & Rural Development. The crossing was ranked as a moderate priority for proceeding to design for replacement with an open bottomed structure.

Table 5.1: Summary of fish passage reassessment for PSCIS crossing 50155.

Location and Stream Data		Crossing Characteristics	
Date	2020-09-22	Crossing Sub Type	Round Culvert
PSCIS ID	50155	Diameter (m)	0.9

External ID	NA	Length (m)	11
Crew	KP, AI	Embedded	No
UTM Zone	11	Depth Embedded (m)	NA
Easting	635113	Resemble Channel	No
Northing	5484261	Backwatered	No
Stream	Tributary to Lizard Creek	Percent Backwatered	NA
Road	Island Lake Lodge Road	Fill Depth (m)	0.3
Road Tenure	MoTi recreation	Outlet Drop (m)	0.22
Channel Width (m)	2.25	Outlet Pool Depth (m)	0.45
Stream Slope (%)	4.3	Inlet Drop	Yes
Beaver Activity	No	Slope (%)	2.6
Habitat Value	Medium	Valley Fill	Deep Fill
Photos:			



Table 5.2: Summary of habitat details for PSCIS crossing 50155.

Location	Length Surveyed
----------	-----------------

		Channel (m)	Wetted Width (m)	Pool Depth (m)	Gradient (%)	Total Cover	Habitat Value
Upstream	700		2.2	1.6	0.3	10.5	abundant high
Downstream	100		2.2	1.9	.	4.3	moderate medium

Table 5.3: Electrofishing sites for PSCIS crossing 50155.

Site	Location	Width (m)	Length (m)	Area (m ²)	Effort (s)	Effort (s/m ²)
19	Downstream	1.7	40	68	200	2.9
18	Upstream	1.6	25	40	117	2.9
33	Upstream	1.6	13	21	61	2.9
34	Upstream	1.6	45	72	154	2.1

Table 5.4: Westslope cutthroat trout densities (fish/100m²) for PSCIS crossing 50155.

Site	Location	Fry	Parr	Adult	Juvenile
19	Downstream	35.3	4.4	1.5	.
18	Upstream	15	12.5	.	.
33	Upstream	23.8	9.5	.	9.5

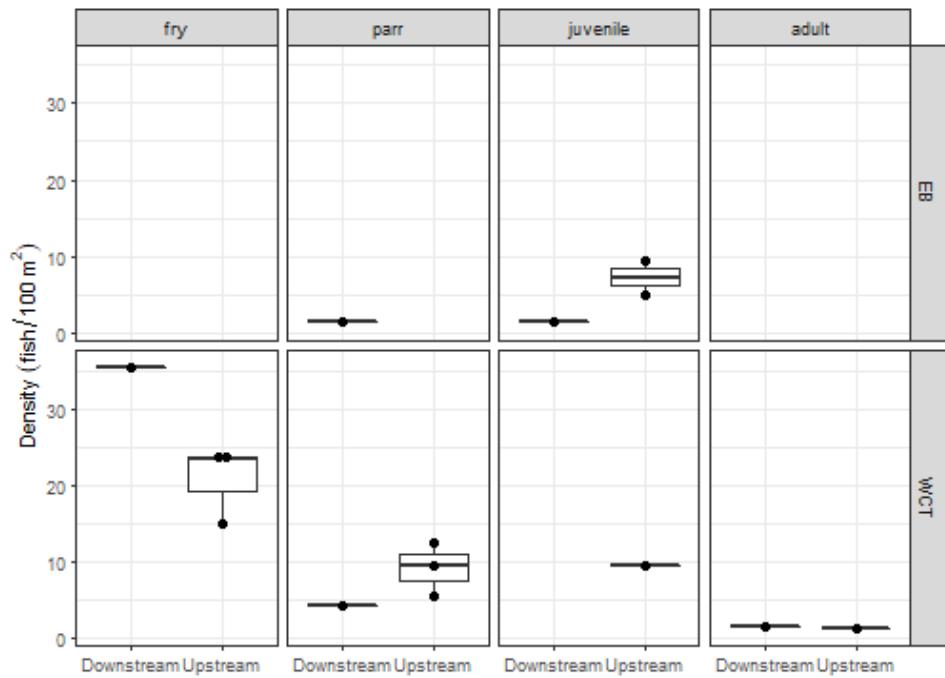


Figure 5.1: Fish densities (fish/100m²) for PSCIS crossing 50155.



Figure 5.2: Typical habitat downstream of PSCIS crossing 50155.



Figure 5.3: Typical habitat upstream of PSCIS crossing 50155.

Appendix - Crossing 50159

Island Lake Lodge Road - Tributary to Lizard Creek

Site Location

Crossing 50159 is located on a tributary to Lizard Creek, approximately 150m upstream from the confluence with Lizard Creek. This crossing has also been recorded in PSCIS as crossing 62510. Island Lake Lodge Road is an extension of Mt.Fernie Park Road which is accessed from Highway 3 within Fernie city limits. The area is a popular recreational destination for hikers and mountain bikers. Island Lake Lodge is located at 1400m of elevation near Island Lake and is a year round tourist destination providing accommodations, guided hiking and backcountry catskiing for clients. The subject stream is not mapped in the freshwater atlas stream layer and may have been diverted as part of a micro-hydro facility for Island Lake Lodge. A small building that could be a generating station was observed on aerial imagery approximately 1500m upstream of the road.

Background

At the crossing location, the stream had good flow and is located within an area of old growth cedar adjacent to a recreation trail. At the time of the survey the stream was the highest volume tributary to Lizard Creek located on the east side of the valley. No fisheries information was available for the stream (MoE 2020d), however, Lizard Creek supports westslope cutthroat trout, bull trout, mountain whitefish, brook trout, longnose sucker and longnose dace (MoE 2020b).

PSCIS stream crossing 50159 was ranked as a high priority for follow up with habitat confirmation due to the relatively large size of the stream recorded in PSCIS (channel width = 3.5m) relative to other tributary streams in the Lizard Creek watershed and because it was rated as containing high value habitat by VAST Resource Solutions Inc. (2013) and Grainger (2011). The habitat confirmation was completed on September 22, 2020. A map of the watershed including areas surveyed is provided in Attachment 1 – Map [082G.113](#).

Stream Characteristics at Crossing

At the time of the survey, the un-embedded and non-backwatered 0.8m diameter crossing was considered a barrier to upstream fish passage with a pipe length of 12m, a culvert slope of 8%, a stream width ratio of 3.1 and an outlet drop of 1.6m (Table [5.5](#)). Water temperature was 10°C, pH was 7.6 and conductivity was 729uS/cm.

Stream Characteristics Downstream

The stream was surveyed downstream from the culvert for 150m to Lizard Creek. Overall, total cover amount was rated as moderate with large woody debris dominant. Cover was also present as small woody debris, deep pools, and overhanging vegetation (Table [5.2](#), Figure [5.2](#)). The average channel width was 2.5m, the average wetted width was 2.3m and the average gradient was 8.8%. The dominant substrate was gravels with cobbles subdominant. Some small pools and steps of 0.2 - 0.6m in height were present throughout the area surveyed. Large woody debris steps ranging from 0.4 - 0.8m high were spaced sporadically throughout area surveyed. The stream contained relatively flatter sections from 3 - 8% and steeper sections of 15 - 18% for first 350m above culvert (UTM: 11 U 632810 5484842) where the stream becomes too steep for upstream salmonid passage (35%). Habitat value was rated as moderate for salmonid fry/juvenile rearing and high value habitat for spawning.

Stream Characteristics Upstream

The stream was surveyed upstream from the culvert for 400m. Overall, total cover amount was rated as moderate with undercut banks dominant. Cover was also present as small woody debris, large woody debris, and deep pools (Table [5.2](#), Figure [5.3](#)). The average channel width was 3m, the average wetted width was 2.6m and the average gradient was 11.2%. There were frequent areas of gravels suitable for resident westslope cutthroat trout spawning. Frequent pools to 40cm deep were present and associated with small and large woody debris. Habitat value was rated as high for fry and juvenile westslope cutthroat rearing.

Structure Remediation and Cost Estimate

Structure replacement with a bridge is recommended to provide access to the habitat located upstream of PSCIS crossing 50159. The cost for the work is estimated at \$125000 for a cost benefit of \$0/linear m and \$0/m².

Conclusion

There is 0.3km of mainstem habitat upstream of crossing 50159 with habitat in the areas surveyed upstream of the crossing rated as high value for fry and juvenile salmonid rearing. The road may be part of the Island Lake Recreational tenure or solely the responsibility of the Ministry of Forests, Lands, Natural Resource Operations & Rural Development. The crossing was ranked as a high priority for proceeding to design for replacement with an open bottomed structure.

Table 5.5: Summary of fish passage reassessment for PSCIS crossing 50159.

Location and Stream Data		Crossing Characteristics	
Date	2020-09-22	Crossing Sub Type	Round Culvert
PSCIS ID	50159	Diameter (m)	0.8
External ID	NA	Length (m)	12
Crew	KP, AI	Embedded	No

UTM Zone	11	Depth Embedded (m)	NA
Easting	633320	Resemble Channel	No
Northing	5484601	Backwatered	No
Stream	Tributary to Lizard Creek	Percent Backwatered	NA
Road	Island Lake Lodge Road	Fill Depth (m)	1
Road Tenure	MoTi recreation	Outlet Drop (m)	1.6
Channel Width (m)	2.45	Outlet Pool Depth (m)	0
Stream Slope (%)	9	Inlet Drop	Yes
Beaver Activity	No	Slope (%)	8
Habitat Value	Medium	Valley Fill	Deep Fill
Photos:			



Table 5.6: Summary of habitat details for PSCIS crossing 50159.

Location	Length Surveyed
----------	-----------------

		Channel Width (m)	Wetted Width (m)	Pool Depth (m)	Gradient (%)	Total Cover	Habitat Value
Upstream	400			3.0 2.6	0.4	11.2	moderate high
Downstream	150			2.5 2.3	0.2	8.8	moderate high



Figure 5.4: Typical habitat downstream of PSCIS crossing 50159.



Figure 5.5: Typical habitat upstream of PSCIS crossing 50159.

Appendix - Crossing 50185

River Rd - Tributary to Morrissey Creek

Site Location

Crossing 50185 is located on a tributary to Morrissey Creek, approximately 255m upstream from the confluence with Morrissey Creek. The crossing is located on River Road just south of Morrissey approximately 15km south of Fernie. The road is accessed off of Lodgepole FSR via the Morrissey Bridge over the Elk River adjacent to Highway 3. River Road is a gravel forest tenure road (forest file id 5466 with active log hauling at the time of the survey).

Background

At the crossing location, the stream is 4th order with a watershed area upstream of the road of approximately 12km². The elevation of the watershed ranges from a maximum of 2000 to 970m at the culvert. Upstream of the crossing, there are no anthropogenic barriers on the mainstem however PSCIS crossing 50181 (also recorded as PSCIS 103033) is documented as a barrier located on a significantly sized tributary entering the stream from the north-east approximately 2.8km upstream of River Road. A wetland type area is mapped at the top of the watershed (area NAha). No fisheries information was available for the stream (MoE 2020d) however westslope cutthroat trout, bull trout, mountain whitefish, brook trout, longnose sucker and longnose dace have been recorded downstream in Morrissey Creek (MoE 2020b).

PSCIS stream crossing 50185 was ranked as a high priority for follow up with habitat confirmation due to the large size of the stream relative to other tributary streams in the watershed, the previously rated moderate value habitat as rated by VAST Resource Solutions Inc. (2013). The habitat confirmation was completed on September 21, 2020. A map of the watershed including areas surveyed is provided in Attachment 1 – Map [082G.108](#).

Stream Characteristics at Crossing

At the time of the survey, the un-embedded and non-backwatered 2.2m diameter crossing was considered a barrier to upstream fish passage with a pipe length of 17m, a culvert slope of 3.4%, a stream width ratio of 2 and an outlet drop of 0m (Table [5.7](#)). Water temperature was 9°C, pH was 7.6 and conductivity was 378uS/cm. It appeared as though fish passage restoration works had taken place at the site historically as there were what appeared to be boulder riffle structures installed downstream of the crossing. The structures appeared to be effective at reducing the outlet drop size but had created a rock drop (0.4m) and were not resulting in backwatering of the culvert.

Stream Characteristics Downstream

The stream was surveyed downstream from the culvert for 255m to the confluence with Morrissey Creek. The mouth of the stream is located approximately 500m upstream from the confluence of Morrissey Creek and the Elk River. Overall, total cover amount was rated as moderate with small woody debris dominant. Cover was also present as large woody debris, undercut banks, deep pools, and overhanging vegetation (Table [5.8](#), Figure [5.7](#)). The average channel width was 4.3m, the average wetted width was 2.7m and the average gradient was 4.2%. The dominant substrate was cobbles with gravels subdominant. There were frequent pools formed by small and large woody debris ranging from 0.3 - 0.75m in depth (average residual depth = 0.4m). Pockets of small gravels suitable for resident salmonid spawning were also present. Habitat value was rated as high with good potential for fry/juvenile salmonid rearing.

Stream Characteristics Upstream

The stream was surveyed upstream from the culvert for 740m. Overall, total cover amount was rated as moderate with small woody debris dominant. Cover was also present as large woody debris, undercut banks, deep pools, and overhanging vegetation (Table [5.8](#), Figure [5.8](#)). The average channel width was 4m, the average wetted width was 2.8m and the average gradient was 6.2%. The dominant substrate was cobbles with gravels subdominant. The stream had good

flows with fry observed throughout the area surveyed. Pools to 0.6m deep (average residual depth =0.4m) were present with pockets of gravel suitable for spawning throughout. Infrequent large woody debris jams to 0.5m high were also observed. There were frequent areas of gravels suitable for resident westslope cutthroat trout spawning. Habitat value was rated as high for fry and juvenile westslope cutthroat trout rearing.

Fish Sampling

To assess potential impacts of the culvert on fish densities in the stream electrofishing was conducted upstream and downstream of the crossing. Four sites were sampled upstream and five sites were sampled downstream. A total of 29 westslope cutthroat trout and 22 eastern brook trout were captured upstream with 26 westslope cutthroat trout and 3 eastern brook trout captured downstream (Figure 5.9). Raw results are included in digital format as [Attachment 2](#) and summarized in Tables [5.9 - 5.10](#) and Figure [5.6](#).

Structure Remediation and Cost Estimate

Structure replacement with an open bottomed structure is recommended to provide access to the habitat located upstream of PSCIS crossing 50185. The cost of the work is estimated at \$125000 for a cost benefit of \$14400/linear m and \$30900/m².

Conclusion

There is an estimated 4.5km of mainstem habitat upstream of crossing 50185 with habitat in the areas surveyed upstream of the crossing rated as high value for fry and juvenile salmonid rearing. Fish sampling results indicated that densities of westslope cutthroat trout fry and parr were similiar upstream and downstream of the crossing with a general trend of higher densities below the crossing for both life stages. River Road is under tenure of the Ministry of Forests, Lands, Natural Resource Operations & Rural Development. The crossing was ranked as a moderate priority for proceeding to design for replacement with an open bottomed structure.

Table 5.7: Summary of fish passage reassessment for PSCIS crossing 50185.

Location and Stream Data	.	Crossing Characteristics	-
Date	2020-09-21	Crossing Sub Type	Round Culvert
PSCIS ID	50185	Diameter (m)	2.2
External ID	NA	Length (m)	17
Crew	KP, AI	Embedded	No
UTM Zone	11	Depth Embedded (m)	NA
Easting	645683	Resemble Channel	No
Northing	5469025	Backwatered	No
Stream	Tributary to Morrisey Creek	Percent Backwatered	NA
Road	River Rd	Fill Depth (m)	1.4
Road Tenure	FLNR 5466	Outlet Drop (m)	0
Channel Width (m)	4.3	Outlet Pool Depth (m)	0
Stream Slope (%)	4.3	Inlet Drop	No
Beaver Activity	No	Slope (%)	3.4
Habitat Value	High	Valley Fill	Deep Fill
Photos:			



Table 5.8: Summary of habitat details for PSCIS crossing 50185.

Location	Length Surveyed
----------	-----------------

		Channel Width (m)	Wetted Width (m)	Pool Depth (m)	Gradient (%)	Total Cover	Habitat Value
	Upstream	740		4.0 2.8	0.4	6.2	moderate high
	Downstream	255		4.3 2.7	0.4	4.2	moderate high

Table 5.9: Electrofishing sites for PSCIS crossing 50185.

Site	Location	Width (m)	Length (m)	Area (m ²)	Effort (s)	Effort (s/m ²)
24	Downstream	2.70	40	108	361	3.3
25	Downstream	2.25	7	16	70	4.4
26	Downstream	2.60	3	8	36	4.5
27	Downstream	2.60	3	8	57	7.1
28	Downstream	3.10	7	22	170	7.7
29	Upstream	2.90	40	116	361	3.1
30	Upstream	2.67	13	35	123	3.5
31	Upstream	2.80	13	36	63	1.8
32	Upstream	4.47	18	80	223	2.8

Table 5.10: Westslope cutthroat trout densities (fish/100m²) for PSCIS crossing 50185.

Site	Location	Fry	Parr	Juvenile
24	Downstream	0.9	2.8	•
25				

26	Downstream	12.5	37.5	.
27	Downstream	.	25	12.5
28	Downstream	50	4.5	.
29	Upstream	4.3	0.9	.
30	Upstream	.	5.7	.
31	Upstream	2.8	.	.
32	Upstream	22.5	2.5	.

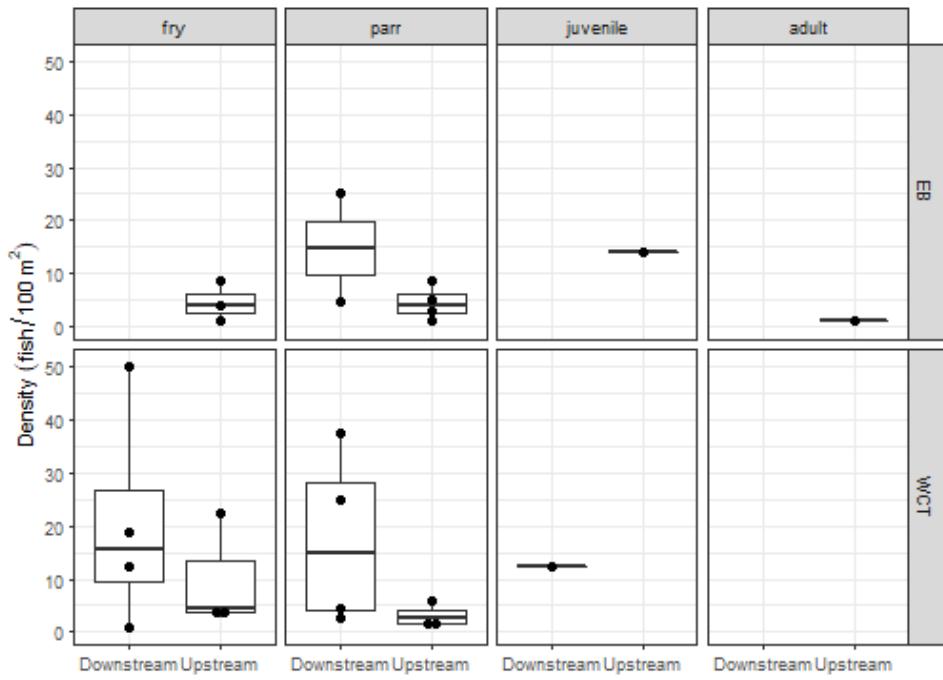


Figure 5.6: Fish densities (fish/100m²) for PSCIS crossing 50185.



Figure 5.7: Typical habitat downstream of PSCIS crossing 50185.



Figure 5.8: Typical habitat upstream of PSCIS crossing 50185.



Figure 5.9: Westslope cutthroat trout captured upstream of PSCIS crossing 50185.

Appendix - Crossing 62423

Grave Creek FSR - Harriet Lake Creek

Site Location

Crossing 62423 is located on Harriet Lake Creek, approximately 30m upstream from the confluence with Grave Creek and accessed from Grave Creek Forest Service Road. Although the freshwater atlas stream layer mapping incorrectly indicates the subject stream is the mainstem of Grave Creek it is actually a small drainage that joins Harriet Lake Creek which flows primarily from the 6ha Harriet Lake located to the north at an elevation of 2100m approximately 4km upstream of the crossing.

Background

Harriet Lake was stocked with “wild” westslope cutthroat trout five times between 1985 and 2002 (MoE 2020a). Downstream, Grave Creek is known to contain westslope cutthroat trout, rainbow trout and bull trout (MoE 2020b). Two habitat confirmation assessments were conducted downstream on the mainstem of Grave Creek in 2014 at PSCIS crossings 62421 and 62422 (Masse Environmental Consultants Ltd. 2015). Although Heather Lamson - MoE Fisheries Biologist recommended the culverts not be removed to prevent potential hybridization of westslope cutthroat trout with stocked rainbow trout downstream (Masse Environmental Consultants Ltd. 2015), both structures had been replaced with bridges at the time of the surveys. Designs and remediations of these crossings were not recorded in PSCIS. Reassessments of these crossings were conducted by our team in 2020 and results will be loaded to PSCIS. In the field, Lotic Environmental Ltd. field teams were observed conducting two-pass closed site electrofishing in Grave Creek as part of a westslope cutthroat trout population assessment and aquatic monitoring program. Data from the program is uploaded to the Fisheries Information Summary System annually and is made available through the BC Data Catalog (MoE 2020b, 2020d).

Although the modelling of potential habitat upstream of this crossing was considered not accurate due to the incorrect mapping of Grave Creek, during field work planning, PSCIS stream crossing 62423 was ranked as a high priority for follow up with habitat confirmation due to the large size of the modelled stream network upstream (20km) and because it was located on a stream with habitat rated as moderate value by VAST Resource Solutions Inc. (2013). A bridge (PSCIS 62413) is located approximately 1km upstream of the crossing. The habitat confirmation was completed on September 20, 2020. A map of the watershed including areas surveyed is provided in Attachment 1 – Map [082G.124](#).

Stream Characteristics at Crossing

At the time of the survey, the un-embedded and non-backwatered 0.9m diameter crossing was considered a barrier to upstream fish passage with a pipe length of 12m, a culvert slope of 0.5%, a stream width ratio of 1.6 and an outlet drop of 0.18m (Table [5.11](#)). The stream was dry at the crossing location at the time of the survey.

Stream Characteristics Downstream

The stream was surveyed downstream from the culvert for 30m to Grave Creek. Overall, total cover amount was rated as moderate with overhanging vegetation dominant. Cover was also present as small woody debris and boulders (Table [5.12](#), Figure [5.11](#)). The average channel width was 1.3m, and the average gradient was 4%. The dominant substrate was cobbles with boulders subdominant. Habitat value was rated as low value due to a lack of flow.

Stream Characteristics Upstream

The stream was surveyed upstream from the culvert in the general location of the mapped Grave Creek streamline for 725m. As Harriet Lake Creek was the primary source of flow for the area and enters the surveyed tributary 150m upstream of the crossing location, flows were very minimal and substrate was

primarily fines above its confluence. There was however, a visible channel in this location with a ford (PSCIS 197563) located approximately 600m upstream of PSCSIS 62423. Overall, total cover amount was rated as moderate with undercut banks dominant. Cover was also present as small woody debris, large woody debris, and boulders (Table 5.12, Figure 5.10). The average channel width was 1.2m, the average wetted width was 0.8m and the average gradient was 4.4%. Harriet Lake Creek gradients modelled at 19% just upstream of the bridge located 1km upstream and too steep for upstream westslope cutthroat passage (>20%) at 2.2km. Habitat value was rated as medium for fry and juvenile westslope cutthroat rearing in Harriet Creek and low in the unnamed tributary mapped as Grave Creek due to a lack of flow.

Location and

Date

Structure Remediation and Cost Estimate

Structure replacement with an embedded culvert is recommended to provide access to the habitat located upstream of PSCIS crossing 62423. The cost for the work is estimated at \$25000 for a cost benefit of \$63100/linear m and \$45500/m².

Conclusion

There is 2.4km of mainstem habitat upstream of crossing 62423 with habitat in the areas surveyed upstream of the crossing rated as medium value. Although the provincial forest tenure road layer does not include Grave Creek FSR, it is likely that it is a tenure road under the responsibility of the Ministry of Forests, Lands, Natural Resource Operations and Rural Development. The crossing was ranked as a low priority for proceeding to design for replacement with an open bottomed structure.

Table 5.11: Summary of fish passage reassessment for PSCIS crossing 62423.

Location and Stream Data	Crossing Characteristics	-
--------------------------	--------------------------	---

PSCIS ID	62423	Diameter (m)	0.9
External ID	NA	Length (m)	12
Crew	KP, AI	Embedded	No
UTM Zone	11	Depth Embedded (m)	NA
Easting	660508	Resemble Channel	No
Northing	5524239	Backwatered	No
Stream	Harriet Lake Creek	Percent Backwatered	NA
Road	Grave Creek FSR	Fill Depth (m)	0.3
Road Tenure	Unknown	Outlet Drop (m)	0.18
Channel Width (m)	1.44	Outlet Pool Depth (m)	0.6
Stream Slope (%)	4	Inlet Drop	Yes
Beaver Activity	No	Slope (%)	0.5
Habitat Value	Low	Valley Fill	Deep Fill

Photos:



Table 5.12: Summary of habitat details for PSCIS crossing 62423.

Location	Length Surveyed
----------	-----------------

		Pool			Gradient (%)	Total Cover (%)	Habitat Value
(m)	Channel Width (m)	Wetted Width (m)	Depth (m)				
Downstream	30		1.3	.	.	4.0	moderate low
Upstream	725	1.2	0.8	0.2	4.4	moderate	medium



Figure 5.10: Typical habitat downstream of PSCIS crossing 62423.



Figure 5.11: Typical habitat upstream of PSCIS crossing 62423.

Appendix - Crossings 62425 and 62426

Spur - Grave Creek

Site Location

PSCIS crossings 62425 and 62426 are located on Grave Creek, approximately 75m and 185m upstream from where Grave Creek splits into two channels with the majority of flow originating from the other channel flowing from the south. Of note, the confluence of Grave Creek and the other channel is located approximately 175m to the west of where the confluence is mapped - likely due to a channel redirection approximately 375m upstream that appears to have occurred due to a large woody debris jam. Three PSCIS crossings (62427, 62428 and 62429) and one un-assessed modelled crossing (modelled ID 4601159) are located upstream of 62426 however, there are very minimal quantities of potential habitat upstream of their locations. Although mapped within the digital road atlas it is suspected that the road on which both culverts are located is a forest tenure road (Canfor Forest Products Ltd. tenure) as it is located immediately adjacent to another forest tenure road and within an area utilized for forestry.

Background

Grave Creek is known to contain westslope cutthroat trout, rainbow trout and bull trout downstream of the subject culverts and westslope cutthroat trout above (MoE 2020b). Two habitat confirmation assessments were conducted downstream on the mainstem of Grave Creek in 2014 at PSCIS crossings 62421 and 62422 (Massee Environmental Consultants Ltd. 2015). Although Heather Lamson - MoE Fisheries Biologist recommended the culverts not be removed to prevent potential hybridization of westslope cutthroat trout with stocked rainbow trout downstream (Massee Environmental Consultants Ltd. 2015), both structures had been replaced with bridges at the time of the surveys. Designs and remediations of these crossings were not recorded in PSCIS. Reassessments of these crossings were conducted by our team in 2020 and results will be loaded to PSCIS. In the field, Lotic Environmental Ltd. field teams were observed conducting two-pass closed site electrofishing in Grave Creek as part of a westslope cutthroat trout population assessment and aquatic monitoring

program. Data from the program is uploaded to the Fisheries Information Summary System annually and is made available through the BC Data Catalog (MoE 2020b, 2020d).

PSCIS stream crossings 62425 and 62426 were ranked as moderate priorities for follow up with habitat confirmation due to the relatively large size of the stream network upstream (3.5km) and because they contained habitat rated as moderate value by VAST Resource Solutions Inc. (2013). The habitat confirmation was completed on September 20, 2020. A map of the watershed including areas surveyed is provided in Attachment 1 – Map [082G.124](#).

Stream Characteristics at Crossing

At the time of the survey, both culverts were un-embedded, non-backwatered and considered barriers to upstream fish passage. PSCIS crossing 62425 was 1.2m in diameter with a pipe length of 12m, a culvert slope of 7.5%, a stream width ratio of 3.1 and an outlet drop of 0.47m (Table [5.13](#)). PSCIS crossing 62426 was 1.2m in diameter with a pipe length of 12m, a culvert slope of 5%, a stream width ratio of 2.9 and an outlet drop of 0.25m (Table [5.14](#)). Water temperature was 8° C, pH was 7.8 and conductivity was 370uS/cm.

Stream Characteristics Downstream of 62425

The stream was surveyed downstream from the culvert for 75m to where the stream joins the flow entering the valley from the south. Overall, total cover amount was rated as moderate with deep pools dominant. Cover was also present as small woody debris, large woody debris, boulders, undercut banks, and overhanging vegetation (Table [5.15](#), Figure [5.12](#)). The average channel width was 3.7m, the average wetted width was 1.8m and the average gradient was 7.5%. The dominant substrate was cobbles with boulders subdominant. Downstream of the crossing there were frequent sections of gravels suitable for salmonid spawning and no barriers or obstacles to fish passage. Habitat was rated as high value for fry/juvenile salmonid rearing.

Stream Characteristics Upstream of 62425 and Downstream of 62426

The stream was surveyed upstream from 62425 for 170m to 62426. Overall, total cover amount was rated as moderate with deep pools dominant. Cover was also present as large woody debris and boulders (Table 5.15, Figure 5.13). The average channel width was 3.5m, the average wetted width was 2.1m and the average gradient was 5%. There were abundant gravels suitable for resident westslope cutthroat trout spawning throughout (Figure 5.14). Some debris jam steps to 0.8m in height were observed and there were approximately 15 westslope cutthroat trout (approximately 170mm long) in the outlet pool for crossing 62426. Habitat value was rated as high for fry/juvenile salmonid rearing.

Stream Characteristics Upstream of 62426

The stream was surveyed upstream from 62426 for 650m. Overall, total cover amount was rated as moderate with deep pools dominant. Cover was also present as boulders (Table 5.15, Figure 5.13). The average channel width was 3.5m, the average wetted width was 1.6m and the average gradient was 11.9%. This stream channel showed evidence of recent disturbance with eroding banks, multiple channels and aggraded sections throughout. Steps (0.6 - 0.9m in height) due to large woody debris debris jams were frequent throughout surveyed area and at a point approximately 200 m upstream of the road-stream crossing to the top end of the area surveyed, cover was limited to sporadic pools up to 0.3m deep. As mentioned previously, the historic channel was abandoned at 175m upstream of 62426 (UTM: 11 U 661748 5524558, Figure 5.14) with no flow observed within its banks. One of the tributaries that enters Grave Creek approximately 250m upstream of 62426 was accessed off of an adjacent spur road with a rapid assessment conducted 250m upstream from the confluence with Grave Creek (UTM: 11U 662083 5524708). The average channel width at this location was 1.9m and the average gradient was 9%. Immediately upstream, the gradient in this tributary was 20% representing grades not likely passable for westslope cutthroat trout migrating upstream. Overall, habitat value upstream of 62426 within the mainstem of Grave Creek was rated as medium with moderate rearing potential for fry/juvenile westslope cutthroat trout.

Structure Remediation and Cost Estimate

Replacing PSCIS crossings 62425 and 62426 with bridges is recommended to provide access to the habitat located upstream. The costs are estimated at \$125000 and \$125000 respectively for a combined cost benefit of \$17600/linear m and \$32000/m².

Conclusion

There is 0.2km of habitat upstream of crossing 62425 with habitat rated as high value for fry and juvenile salmonid rearing and another 1.8km upstream of 62426 rated as high. Although mapped within the digital road atlas it is suspected that the road on which both culverts are located is a forest tenure road (Canfor Forest Products Ltd. permit) as it is located immediately adjacent to another forest tenure road under permit to Canfor and within an area utilized for forestry. If this is the case, the underlying responsibility for the road belongs to the Ministry of Forests, Lands, Natural Resource Operations and Rural Development with Canfor responsible for maintenance and upgrades. The crossing was ranked as moderate priority for proceeding to design for replacement.

Table 5.13: Summary of fish passage reassessment for PSCIS crossing 62425.

Location and Stream Data		Crossing Characteristics	
Date	2020-09-20	Crossing Sub Type	Round Culvert
PSCIS ID	62425	Diameter (m)	1.2
External ID	NA	Length (m)	12
Crew	KP, AI	Embedded	No
UTM Zone	11	Depth Embedded (m)	NA
Easting	661486	Resemble Channel	No
Northing	5524426	Backwatered	No

Stream	Grave Creek	Percent Backwatered	NA
Road	Spur	Fill Depth (m)	1
Road Tenure	Canfor R08362	Outlet Drop (m)	0.47
Channel Width (m)	3.7	Outlet Pool Depth (m)	0.38
Stream Slope (%)	7.5	Inlet Drop	Yes
Beaver Activity	No	Slope (%)	7.5
Habitat Value	Medium	Valley Fill	Deep Fill

Photos:



Table 5.14: Summary of fish passage reassessment for PSCIS crossing 62426.

Location and Stream Data		Crossing Characteristics	
Date	2020-09-20	Crossing Sub Type	Round Culvert
PSCIS ID	62426	Diameter (m)	1.2
External ID	NA	Length (m)	12
Crew	KP, AI	Embedded	No
UTM Zone	11	Depth Embedded (m)	NA
Easting	661611	Resemble Channel	No
Northing	5524460	Backwatered	No
Stream	Grave Creek	Percent Backwatered	NA
Road	Spur	Fill Depth (m)	1
Road Tenure	Canfor R08362	Outlet Drop (m)	0.25
Channel Width (m)	3.5	Outlet Pool Depth (m)	0.65
Stream Slope (%)	6	Inlet Drop	Yes
Beaver Activity	No	Slope (%)	5
Habitat Value	Medium	Valley Fill	Deep Fill
Photos:			



Table 5.15: Summary of habitat details for PSCIS crossings 62425 and 62426.

Site	Location	Length Surveyed (m)	Channel Width (m)	Wetted Width (m)	Pool Depth (m)	Gradient (%)	Total Cover	Habitat Value
62425	Upstream	170	3.5	2.1	0.3	5.0	moderate	high
62425	Downstream	75	3.7	1.8	0.3	7.5	moderate	high
62426	Upstream	650	3.9	1.6	0.4	11.9	moderate	medium



Figure 5.12: Typical habitat downstream of PSCIS crossing 62425.



Figure 5.13: Typical habitat upstream of PSCIS crossing 62425 and downstream of PSCIS crossing 62426.



Figure 5.14: Grave Creek redirection out of historic channel located upstream of PSCIS crossing 62426.

Appendix - Crossing 62516

Island Lake Lodge Road - Tributary to Lizard Creek

Site Location

Crossing 62516 is located on a tributary to Lizard Creek, approximately 630m upstream from the confluence with Lizard Creek. This culvert has also been recorded in PSCIS as crossing 50153. The stream has been diverted from its historic channel and runs adjacent to a historic road to Lizard Creek approximately 500 downstream of the location of the confluence in the freshwater atlas. Island Lake Lodge Road is an extension of Mt.Fernie Park Road which is accessed from Highway 3 within Fernie city limits. The Mt.Fernie Provincial Park is a popular recreational destination for hikers, sightseers and mountain bikers. Island Lake Lodge is located at 1400m of elevation near Island Lake and is a year round tourist destination providing accommodations, guided hiking and backcountry catskiing.

Background

At the crossing location, the stream had good flow and is located within an area of old growth cedar adjacent to a recreation trail. At the time of the survey the stream was the highest volume tributary to Lizard Creek located on the east side of the valley. No fisheries information was available for the stream (MoE 2020d). Downstream however, Lizard Creek supports westslope cutthroat trout, bull trout, mountain whitefish, brook trout, longnose sucker and longnose dace (MoE 2020b).

PSCIS stream crossing 62516 was ranked as a high priority for follow up with habitat confirmation due to the relatively large size of the stream recorded in PSCIS (channel width = 3.5m) relative to other tributary streams in the Lizard Creek watershed and because it was rated as containing high value habitat by VAST Resource Solutions Inc. (2013) and Grainger (2011). There is a bridge (PSCIS 197566) located on the Lazy Lizard recreation trail approximatley 350m upstream of the crossing and an unassessed modelled crossing (modelled ID 4600929) approximately 950m upstream. Downstream approximately 400m there

is a foot bridge (PSCIS 197544) on a recreational hiking/biking trail. The habitat confirmation was completed on September 23, 2020. A map of the watershed including areas surveyed is provided in Attachment 1 – Map [082G.113](#).

Stream Characteristics at Crossing

The culvert located at PSCIS 62516 appeared to have been replaced in 2020 with fresh rock and road fill present. At the time of the survey, the un-embedded and non-backwatered 1.2m diameter crossing was considered a barrier to upstream fish passage with a pipe length of 11m, a culvert slope of 5%, a stream width ratio of 2.1 and an outlet drop of 0.49m (Table [5.16](#)). Water temperature was 9° C, pH was 7.9 and conductivity was 333uS/cm.

Stream Characteristics Downstream

The stream was surveyed downstream from the culvert for 630m to Lizard Creek. Overall, total cover amount was rated as moderate with deep pools dominant. Cover was also present as small woody debris, large woody debris, undercut banks, and overhanging vegetation (Table [5.17](#), Figure [5.15](#)). The average channel width was 2.5m, the average wetted width was 1.4m and the average gradient was 2.7%. The dominant substrate was gravels with cobbles subdominant. Adjacent to the historic road, on the right bank of stream, there was very limited shrub and tree riparian vegetation. Downstream of the crossing there were frequent sections of gravels suitable for salmonid spawning and no barriers or obstacles to fish passage. Habitat was rated as high value for fry/juvenile salmonid rearing.

Stream Characteristics Upstream

The stream was surveyed upstream from the culvert for 730m. Overall, total cover amount was rated as moderate with undercut banks dominant. Cover was also present as small woody debris, large woody debris, deep pools, and overhanging vegetation (Table [5.17](#), Figure [5.15](#)). The average channel width was 2m, the average wetted width was 1.3m and the average gradient was 7.6%. There were abundant gravels suitable for resident westslope cutthroat trout

spawning throughout (Figure 5.15). Fry were observed within the area surveyed to 540m upstream of the culvert where gradients increased to >20% for a distance of approximately 15m. Although no sampling was conducted, no fish were observed above this high gradient section. Habitat value was rated as high for fry/juvenile salmonid rearing.

Structure Remediation and Cost Estimate

Structure replacement with an open bottomed structure is recommended to provide access to the habitat located upstream of PSCIS crossing 62516. The cost of the work is estimated at \$125000 for a cost benefit of \$5000/linear m and \$6100/m².

Conclusion

There is 0.5km of mainstem habitat upstream of crossing 62516 with habitat rated as high value for fry and juvenile salmonid rearing. The road may be part of the Island Lake Recreational tenure or solely the responsibility of the Ministry of Forests, Lands, Natural Resource Operations & Rural Development. The crossing was ranked as a moderate priority for proceeding to design for replacement.

Table 5.16: Summary of fish passage reassessment for PSCIS crossing 62516.

Location and Stream Data		Crossing Characteristics	
Date	2020-09-23	Crossing Sub Type	Round Culvert
PSCIS ID	62516	Diameter (m)	1.2
External ID	NA	Length (m)	11
Crew	KP, AI	Embedded	No

UTM Zone	11	Depth Embedded (m)	NA
Easting	636123	Resemble Channel	No
Northing	5484087	Backwatered	No
Stream	Tributary to Lizard Creek	Percent Backwatered	NA
Road	Island Lake Lodge Road	Fill Depth (m)	1.3
Road Tenure	MoTi recreation	Outlet Drop (m)	0.49
Channel Width (m)	2.47	Outlet Pool Depth (m)	0.8
Stream Slope (%)	2.67	Inlet Drop	No
Beaver Activity	No	Slope (%)	5
Habitat Value	Medium	Valley Fill	Deep Fill
Photos:			



Table 5.17: Summary of habitat details for PSCIS crossing 62516.

Location	Length Surveyed
----------	-----------------

		Channel Width (m)	Wetted Width (m)	Pool Depth (m)	Gradient (%)	Total Cover	Habitat Value
Upstream	730			2.0 1.3	0.3	7.6	moderate high
Downstream	630			2.5 1.4	0.4	2.7	moderate high



Figure 5.15: Typical habitat downstream of PSCIS crossing 62516.



Figure 5.16: Typical habitat upstream of PSCIS crossing 62516.

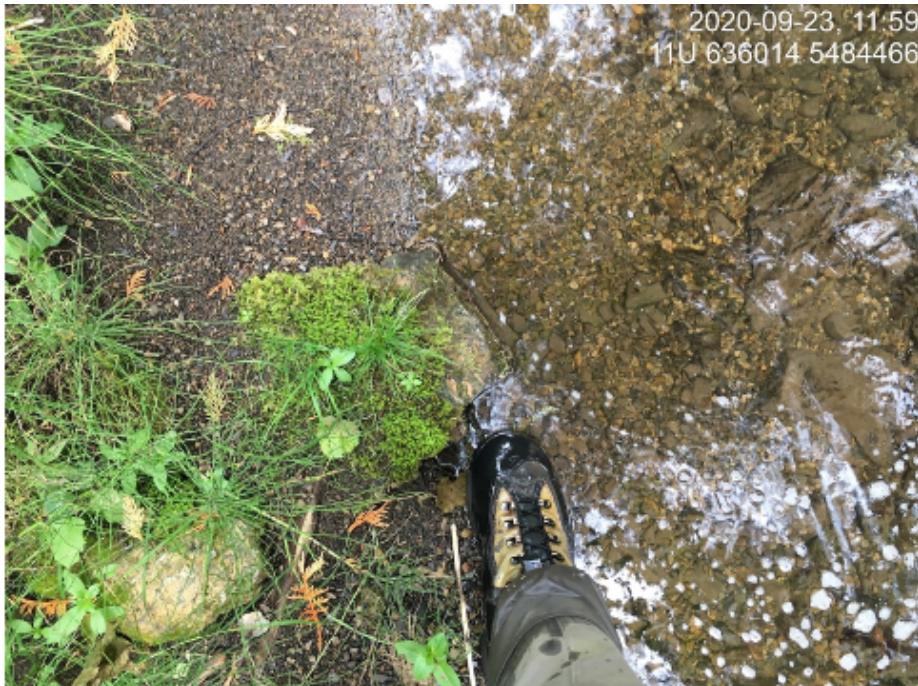


Figure 5.17: Gravels suitable for spawning upstream of PSCIS crossing 62516.

Appendix - Crossings 197533 and 197559

Busato Rd and Highway 43 - Brule Creek

Site Location

PSCIS crossings 197533 and 197559 are located north of Sparwood, BC on Brule Creek, approximately 600m and 725m upstream from the Elk River. During 2020 surveys, two fords (PSCIS 197535 and 197536) were documented 700m and 2km upstream of crossing 197559 respectively. Although several un-assessed crossings are modelled upstream of PSCIS 197536 (ford), review of aerial imagery indicates that the sole crossing upstream on the mainstem of Brule Creek is a bridge (modelled crossing 24706664) and the remaining upstream crossings are on small and/or very steep tributaries and unlikely to be blocking access to significant amounts of important habitat. Both Busato Road and Highway 43 are the responsibility of the Ministry of Transportation and Infrastructure.

Background

At the crossing locations, Brule Creek is a 5th order stream with a watershed area upstream of the highway of approximately 87km². The elevation of the watershed ranges from a maximum of 2800 to 1200m at PSCIS crossing 197533. Brule Creek is known to contain westslope cutthroat trout, rainbow trout and bull trout downstream of the subject culverts and westslope cutthroat trout and rainbow trout above (MoE 2020b). On the south side of the upper watershed, at an elevation of 2000m is Josephine Lake (A.K.A. Big Lake) which is 5ha in area. A biophysical inventory in 1983 indicated the lake contained no fish however, it was stocked with westslope cutthroat trout from 1983 - 2000 (MoE 2020b; "Fish Inventories Data Queries" 2020).

PSCIS stream crossings 197533 and 197559 were ranked as high priorities for follow up with habitat confirmation due to the large size of the stream network upstream (37km) and because Brule Creek is a 5th order stream. The habitat confirmation was completed on September 17, 2020. A map of the watershed including areas surveyed is provided in Attachment 1 – Map [082G.123](#).

Stream Characteristics at Crossing

At the time of the survey, both culverts were un-embedded, non-backwatered and considered barriers to upstream fish passage. PSCIS crossing 197533 was 3.3m in diameter with a pipe length of 20m, a culvert slope of 4%, a stream width ratio of 2.2 and an outlet drop of 0.7m (Table [5.18](#)). PSCIS crossing 197559 was 2.5m in diameter with a pipe length of 35m, a culvert slope of 2.5%, a stream width ratio of 2.4 and an outlet drop of 0m (Table [5.19](#)). Water temperature was 6°C, pH was 7.5 and conductivity was 337uS/cm.

Stream Characteristics Downstream of 197533

The stream was surveyed downstream from the culvert for 400m. Overall, total cover amount was rated as moderate with small woody debris dominant. Cover was also present as large woody debris and overhanging vegetation (Table [5.20](#), Figure [5.18](#)). The average channel width was 7.4m, the average wetted width was 4.1m and the average gradient was 1.9%. The dominant substrate was cobbles with boulders subdominant. In the area surveyed, the stream channel appeared to be anthropogenically channelized and straightened with influence of adjacent livestock grazing/access negatively impacting stream banks due to loss of riparian vegetation and erosion. Habitat was rated as medium as it was considered an important migration corridor with moderate value habitat for fry/juvenile salmonid rearing.

Stream Characteristics Upstream of 197533 and Downstream of 197559

The stream was surveyed upstream from 197533 for 125m to 197559. Overall, total cover amount was rated as moderate with dominant. Cover was also present as (Table [5.20](#), Figure [5.19](#)). The average channel width was 5.5m, the average wetted width was 3.8m and the average gradient was 1.5%. There was a large pool at the outlet of crossing 197559 containing approximately nine westslope cutthroat trout with lengths of five of the fish estimated at 200mm and four at 300mm (Figure [5.20](#)). The outlet pool was depth was >1m with gravels

suitable for spawning at the tailout. Habitat value was rated as high for resident and fluvial salmonid rearing and spawning.

Stream Characteristics Upstream of 197559

The stream was surveyed immediately upstream from 197559 for 1200m and then another 600m beginning at the ford (PSCIS 197536) 2km upstream for a total of 1600m. The channel was dewatered immediately upstream of Highway 43 with intermittent pools only to a distance approximately 670 m upstream. Upstream of the dewatered area, stream flows increased with increasing upstream distance. Overall, total cover amount was rated as moderate with deep pools dominant. Cover was also present as boulders and undercut banks (Table 5.20, Figure 5.19). The average channel width was 5.5m, the average wetted width was 2.3m and the average gradient was 3.5%. Overall, habitat upstream of 197559 was rated as high value habitat present suitable for resident and fluvial salmonid rearing and spawning.

Fish Sampling

To assess potential impacts of the culvert on fisheries values in the stream, electrofishing was conducted upstream of the crossing. Sampling was not conducted downstream of crossing 197559 as bull trout presence was suspected and it was determined that spawners and/or eggs may have been present. One site was sampled upstream with no fish captured (Figure 5.9). Raw results are included in digital format as [Attachment 2](#) and summarized in Table 5.21.

Structure Remediation and Cost Estimate

As properties on Busato Road could be accessed from either side of the road, removal of PSCIS 197533 could be explored as an option for providing access to the 125m of habitat located upstream and below PSCIS 197533. However, to facilitate an estimate of “worst case scenario”, costs for replacement of both crossing 197533 and 197533 with bridges are estimated at \$178000 and

\$3050000 respectively. The combined cost benefit of replacements are estimated at \$1000/linear m and \$3400/m².

Conclusion

There is 0.1km of habitat upstream of crossing 197559 and another 23km upstream of 197559 rated as high value for resident and fluvial salmonid rearing/spawning. The lack of fish captured upstream of the crossing is not an indication of a lack of fish presence but may be indicative of low population densities and/or restricted access due to downstream culverts and dewatering. Although an interim ranking for remediation at the crossings was assessed as high priority to proceeding to designs for both crossings, follow up to determine the extent of dewatering during higher flow periods is recommended. Although unconfirmed at the time of reporting, the 670m section of stream located immediately upstream of Highway 43 that was flowing subsurface at the time of the survey, very likely flows above ground during high and peak flows when adult westslope cutthroat trout display a general pattern of upstream movement to spawning areas (Schweigert et al. 2017).

Table 5.18: Summary of fish passage reassessment for PSCIS crossing 197533.

Location and Stream Data		Crossing Characteristics	
Date	2020-09-17	Crossing Sub Type	Oval Culvert
PSCIS ID	197533	Diameter (m)	3.3
External ID	NA	Length (m)	20
Crew	AI, KP	Embedded	No
UTM Zone	11	Depth Embedded (m)	NA
Easting	651626	Resemble Channel	No
Northing	5528888	Backwatered	No

Stream	Brule Creek	Percent Backwatered	NA
Road	Busato Rd	Fill Depth (m)	1
Road Tenure	MoTi local	Outlet Drop (m)	0.7
Channel Width (m)	7.1	Outlet Pool Depth (m)	1.5
Stream Slope (%)	2	Inlet Drop	Yes
Beaver Activity	No	Slope (%)	4
Habitat Value	High	Valley Fill	Deep Fill
Photos:			



Table 5.19: Summary of fish passage reassessment for PSCIS crossing 197559.

Location and Stream Data		Crossing Characteristics	
Date	2020-09-17	Crossing Sub Type	Round Culvert
PSCIS ID	197559	Diameter (m)	2.5
External ID	NA	Length (m)	35
Crew	KP, AI	Embedded	Yes
UTM Zone	11	Depth Embedded (m)	0.05
Easting	651516	Resemble Channel	Yes
Northing	5528829	Backwatered	No
Stream	Brule Creek	Percent Backwatered	NA
Road	Highway 43	Fill Depth (m)	3
Road Tenure	MoTi highway	Outlet Drop (m)	0
Channel Width (m)	6.1	Outlet Pool Depth (m)	1.7
Stream Slope (%)	1.5	Inlet Drop	No
Beaver Activity	No	Slope (%)	2.5
Habitat Value	Medium	Valley Fill	Deep Fill
Photos:			



Table 5.20: Summary of habitat details for PSCIS crossings 197533 and 197559.

Site	Location	Length Surveyed (m)	Channel Width (m)	Wetted Width (m)	Pool Depth (m)	Gradient (%)	Total Cover	Habitat Value
197533	Upstream	125	5.5	3.8	.	1.5	moderate	high
197533	Downstream	400	7.4	4.1	.	1.9	moderate	medium
197559	Upstream	1600	7.7	2.3	0.6	3.5	moderate	high

Table 5.21: Electrofishing site upstream of PSCIS crossing 197559.

Site	Location	Width (m)	Length (m)	Area (m ²)	Effort (s)	Effort (s/m ²)
6	Upstream	5.1	200	1020	233	0.2



Figure 5.18: Typical habitat downstream of PSCIS crossing 197533.



Figure 5.19: Typical habitat upstream of PSCIS crossing 197533 and downstream of PSCIS crossing 197533.

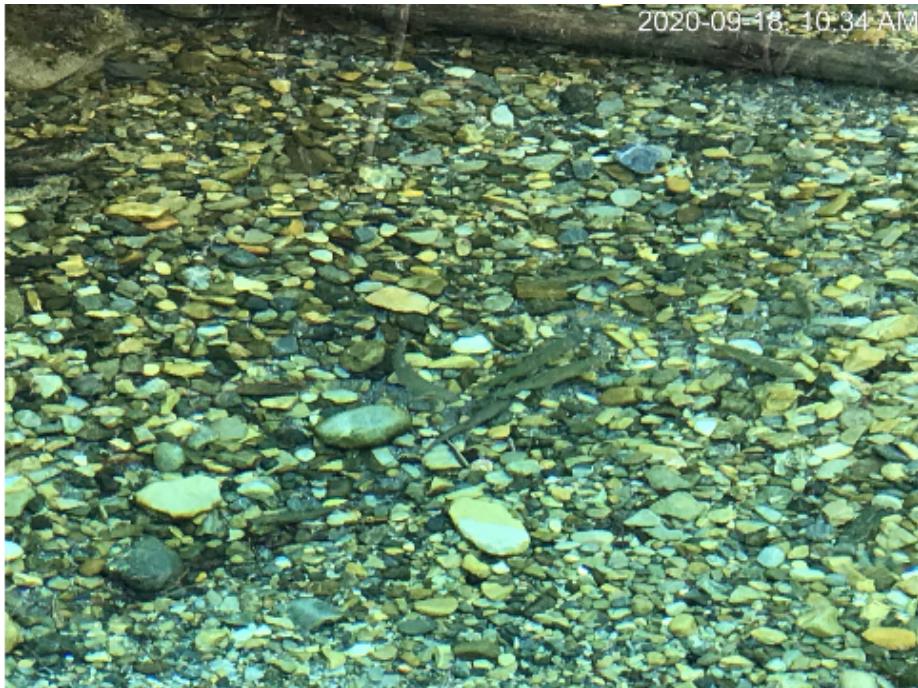


Figure 5.20: Westslope cutthroat trout in outlet pool downstream of PSCIS crossing 197559.



Figure 5.21: Subsurface flow area upstream of PSCIS crossing 197559.

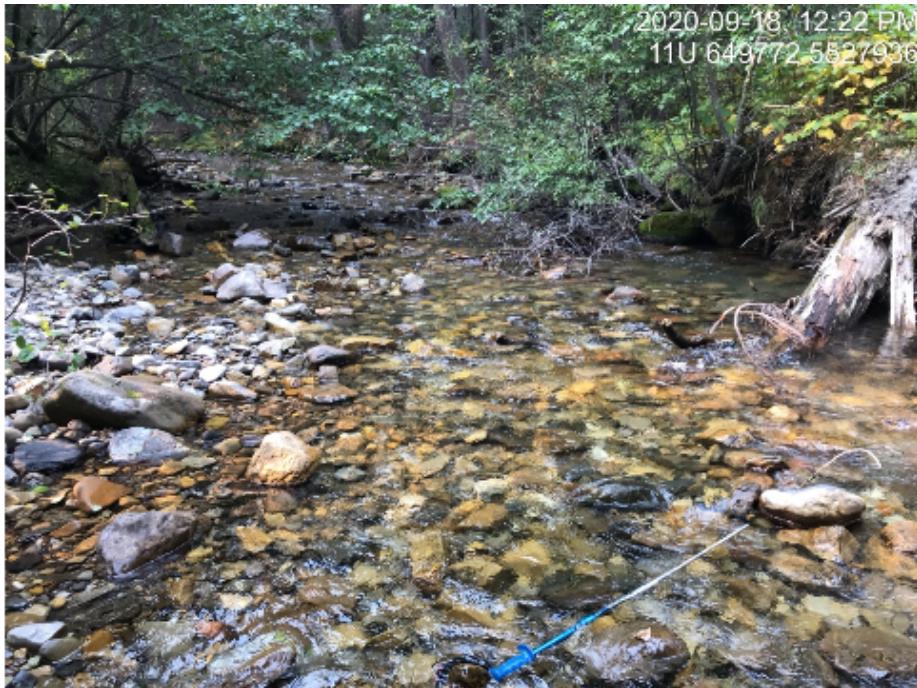


Figure 5.22: Typical habitat above dewatered area upstream of PSCIS crossing 197533.



Figure 5.23: Habitat within electrofishing site upstream of PSCIS crossing 197533.

Appendix - Crossing 197555

Elk River FSR - Tributary to Elk River

Site Location

Crossing 197555 is located on a tributary to Elk River, approximately 900m upstream from the confluence with the Elk River. The crossing is located on the Elk River FSR approximately 10km north of Elkford, BC. The Elk River FSR is a gravel forest tenure road (forest file id 0103 with active log hauling at the time of the survey).

Background

At the crossing location, the stream is 4th order with a watershed area upstream of the road of approximately 17km². The elevation of the watershed ranges from a maximum of 2900 to 1400m at the culvert. Upstream of the crossing, there are no anthropogenic barriers on the mainstem. Although there are two modelled crossings on small tributaries that enter the stream approximately 1.5km upstream of the road, machinery operators encountered onsite indicated that they had been removed during road deactivation. No fisheries information was available for the stream (MoE 2020d) however westslope cutthroat trout, bull trout, mountain whitefish, brook trout, longnose sucker and longnose dace (among other species) have been recorded downstream in the Elk River (MoE 2020b).

PSCIS stream crossing 197555 was ranked as a high priority for follow up with habitat confirmation due to the large amount of habitat modelled upstream of the crossing. The habitat confirmation was completed on September 16, 2020. A map of the watershed including areas surveyed is provided in Attachment 1 – Map [082J.103](#).

Stream Characteristics at Crossing

At the time of the survey, the un-embedded and non-backwatered 1.5m diameter crossing was considered a barrier to upstream fish passage with a pipe length of 49m, a culvert slope of 3.5%, a stream width ratio of 2.3 and an outlet drop of 1.48m (Table [5.22](#)). Water temperature was 6°C, pH was 7.2 and conductivity was 378uS/cm.

Stream Characteristics Downstream

The stream was surveyed downstream from the culvert for 700m. Overall, total cover amount was rated as moderate with deep pools dominant. Cover was also present as small woody debris, large woody debris, boulders, and overhanging vegetation (Table [5.23](#), Figure [5.24](#)). The average channel width was 4.4m, the average wetted width was 3.1m and the average gradient was 3.6%. The dominant substrate was cobbles with gravels subdominant. There were frequent pools formed by small and large woody debris ranging from 0.3 - 0.75m in depth (average residual depth = 0.4m). Frequent pockets of gravels suitably sized for resident and fluvial salmonid spawning were also present. Habitat value was rated as high with good potential for fry/juvenile salmonid rearing.

Stream Characteristics Upstream

The stream was surveyed upstream from the culvert for 675m. Overall, total cover amount was rated as abundant with boulders as the dominant type. Cover was also present as small woody debris, large woody debris, undercut banks, deep pools, and overhanging vegetation (Table [5.23](#), Figure [5.25](#)). The average channel width was 5.9m, the average wetted width was 3.8m and the average gradient was 5.9%. The dominant substrate was cobbles with boulders subdominant. The stream had good flows with fry observed throughout the area surveyed. Pools to 0.6m deep (average residual depth = 0.4m) were present with pockets of gravel suitable for spawning throughout. Infrequent large woody debris jams to 0.5m high were also observed. Pockets of gravel suitable for resident and fluvial salmonid spawning were present throughout the area

surveyed. Habitat value was rated as high for fry and juvenile westslope cutthroat trout and bull trout rearing.

Fish Sampling

To assess potential impacts of the culvert on fish communities in the stream, electrofishing was conducted upstream and downstream of the crossing. One 150m site was sampled upstream and one 315m site was sampled downstream. One bull trout was captured downstream and no fish were captured upstream (Figure 5.26). Raw results are included in digital format as [Attachment 2](#) and summarized in Table [5.24](#).

Structure Remediation and Cost Estimate

Structure replacement with an open bottomed culvert is recommended to provide access to the habitat located upstream of PSCIS crossing 197555. Due to the large amount of fill on the road (8) the size of a replacement bridge was estimated at 25m. The cost for work is estimated at \$312000 for a cost benefit of \$21900/linear m and \$38400/m².

Conclusion

There is an estimated 6km of mainstem habitat upstream of crossing 197555 with habitat in the areas surveyed upstream of the crossing rated as high value for fry and juvenile salmonid rearing. However, fish sampling results indicate that westslope cutthroat trout are not currently utilizing the stream and densities of bull trout are very low. This could be the result of the cold water conditions due to the positioning of the watershed at high elevation in the generally cold Rocky Mountain setting. Elk River FSR is a forest tenure licensee road of the Ministry of Forests, Lands, Natural Resource Operations & Rural Development. The crossing was ranked as a moderate priority for proceeding to design for replacement with an open bottomed structure.

Table 5.22: Summary of fish passage reassessment for PSCIS crossing 197555.

Location and Stream Data		Crossing Characteristics	
Date	2020-09-16	Crossing Sub Type	Round Culvert
PSCIS ID	197555	Diameter (m)	1.5
External ID	NA	Length (m)	49
Crew	KP, AI	Embedded	No
UTM Zone	11	Depth Embedded (m)	NA
Easting	646735	Resemble Channel	No
Northing	5554534	Backwatered	No
Stream	Tributary to Elk River	Percent Backwatered	NA
Road	Elk River FSR	Fill Depth (m)	8
Road Tenure	FLNR 0103	Outlet Drop (m)	1.48
Channel Width (m)	3.5	Outlet Pool Depth (m)	1.3
Stream Slope (%)	1.5	Inlet Drop	Yes
Beaver Activity	No	Slope (%)	3.5
Habitat Value	High	Valley Fill	Deep Fill
Photos:			



Table 5.23: Summary of habitat details for PSCIS crossing 197555.

Location	Length Surveyed
----------	-----------------

		Channel Width (m)	Wetted Width (m)	Pool Depth (m)	Gradient (%)	Total Cover	Habitat Value
	Upstream	675		5.9 3.8	0.4	5.9	abundant high
	Downstream	700		4.4 3.1	0.4	3.6	moderate high

Table 5.24: Electrofishing sites for PSCIS crossing 197555.

Site	Location	Width (m)	Length (m)	Area (m ²)	Effort (s)	Effort (s/m ²)
4	Downstream	3.1	315	976	550	0.6
3	Upstream	3.8	150	570	177	0.3



Figure 5.24: Typical habitat downstream of PSCIS crossing 197555.



Figure 5.25: Typical habitat upstream of PSCIS crossing 197555.



Figure 5.26: Bull trout captured downstream of PSCIS crossing 197555.

Appendix - Phase 1 Fish Passage Assessment Data and Photos

Location and Stream Data		Crossing Characteristics	
Date	2020-09-23	Crossing Sub Type	Round Culvert
PSCIS ID	NA	Diameter (m)	0.65
External ID	4600008	Length (m)	11
Crew	AI, KP	Embedded	Yes
UTM Zone	11	Depth Embedded (m)	0.1
Easting	640268	Resemble Channel	Yes
Northing	5481377	Backwatered	No
Stream	Tributary to Elk River	Percent Backwatered	NA
Road	Robinson Road	Fill Depth (m)	1.2
Road Tenure	MoTi local	Outlet Drop (m)	0
Channel Width (m)	1.2	Outlet Pool Depth (m)	0
Stream Slope (%)	0.5	Inlet Drop	No
Beaver Activity	No	Slope (%)	0.5
Habitat Value	Low	Valley Fill	Deep Fill

Photos: 4600008



Comments: Dry mostly vegetated channel. Not likely fish habitat.

Location and Stream Data		Crossing Characteristics –	
Date	2020-09-24	Crossing Sub Type	Round Culvert
PSCIS ID	NA	Diameter (m)	0.6
External ID	4600026	Length (m)	22
Crew	AI, MF, DN	Embedded	No
UTM Zone	11	Depth Embedded (m)	NA
Easting	642911	Resemble Channel	No
Northing	5490630	Backwatered	No
Stream	Tributary to Elk River	Percent Backwatered	NA
Road	Dicken Rd	Fill Depth (m)	2
Road Tenure	MoTi collector	Outlet Drop (m)	1.3
Channel Width (m)	2.2	Outlet Pool Depth (m)	0.3
Stream Slope (%)	3	Inlet Drop	No
Beaver Activity	No	Slope (%)	1.5
Habitat Value	Low	Valley Fill	Deep Fill

Photos: 4600026



Comments: Stream dry at time of survey. Children's fort in upstream channel indicating that flows are likely very minimal year round.

Location and Stream Data		Crossing Characteristics	
Date	2020-09-24	Crossing Sub Type	Round Culvert
PSCIS ID	NA	Diameter (m)	0.95
External ID	4600028	Length (m)	14
Crew	AI, MF, DN	Embedded	No
UTM Zone	11	Depth Embedded (m)	NA
Easting	642559	Resemble Channel	No
Northing	5490377	Backwatered	No
Stream	Bean Creek	Percent Backwatered	NA
Road	Dicken Rd	Fill Depth (m)	1.2
Road Tenure	MoTi collector	Outlet Drop (m)	0.57
Channel Width (m)	2	Outlet Pool Depth (m)	0.22
Stream Slope (%)	5	Inlet Drop	No
Beaver Activity	No	Slope (%)	5.5
Habitat Value	High	Valley Fill	Deep Fill

Photos: 4600028



Comments: Multiple fish observed in outlet pool (~190mm). Some gravels suitable for spawning located upstream.

Location and Stream Data		Crossing Characteristics	
Date	2020-09-17	Crossing Sub Type	Round Culvert
PSCIS ID	NA	Diameter (m)	0.75
External ID	4600037	Length (m)	6
Crew	AI, KP	Embedded	Yes
UTM Zone	11	Depth Embedded (m)	0.1
Easting	651867	Resemble Channel	Yes
Northing	5522741	Backwatered	No
Stream	Dalzell Creek	Percent Backwatered	NA
Road	Driveway	Fill Depth (m)	0.3
Road Tenure	private	Outlet Drop (m)	0
Channel Width (m)	2.5	Outlet Pool Depth (m)	0
Stream Slope (%)	1.5	Inlet Drop	No
Beaver Activity	No	Slope (%)	2
Habitat Value	Medium	Valley Fill	Deep Fill

Photos: 4600037



Comments: Embedded culvert on private driveway. EB known upstream. Culvert does not appear likely to be significantly impacting upstream fish passage for juvenile or adult WCT at time of survey.

Location and Stream Data		Crossing Characteristics	
Date	2020-09-17	Crossing Sub Type	Round Culvert
PSCIS ID	NA	Diameter (m)	0.75
External ID	4600038	Length (m)	12
Crew	AI, KP	Embedded	Yes
UTM Zone	11	Depth Embedded (m)	0.18
Easting	651917	Resemble Channel	Yes
Northing	5522888	Backwatered	No
Stream	Dalzell Creek	Percent Backwatered	NA
Road	Driveway	Fill Depth (m)	0.3
Road Tenure	private	Outlet Drop (m)	0
Channel Width (m)	1.2	Outlet Pool Depth (m)	0
Stream Slope (%)	1.5	Inlet Drop	Yes
Beaver Activity	No	Slope (%)	2
Habitat Value	Medium	Valley Fill	Deep Fill

Photos: 4600038



Comments: Culvert collapsing in the middle. Private residence driveway. Wetland type habitat upstream. Culvert does not appear likely to be significantly impacting upstream fish passage for juvenile or adult WCT at time of survey.

Location and Stream Data	.	Crossing Characteristics	-
Date	2020-09-17	Crossing Sub Type	Round Culvert
PSCIS ID	NA	Diameter (m)	0.45
External ID	4600039	Length (m)	16
Crew	KP, AI	Embedded	Yes
UTM Zone	11	Depth Embedded (m)	0.07
Easting	651833	Resemble Channel	Yes
Northing	5522544	Backwatered	No
Stream	Dalzell Creek	Percent Backwatered	NA
Road	Lower Elk Valley Road	Fill Depth (m)	1
Road Tenure	MoTi arterial	Outlet Drop (m)	0
Channel Width (m)	3.8	Outlet Pool Depth (m)	0.07
Stream Slope (%)	1	Inlet Drop	No
Beaver Activity	No	Slope (%)	3.5
Habitat Value	Medium	Valley Fill	Deep Fill

Photos: 4600039



Comments: Three barrels (.45m each). Two of the three have water flowing through them. Upstream and downstream channel widens out, slow flow through vegetated channel. Highly manipulated banks. Deep fine substrate on both sides of crossing. Upstream resembles a wetland. Crossing does not appear likely to be significantly impacting upstream fish passage for juvenile or adult WCT at time of survey.

Location and Stream Data		Crossing Characteristics	
Date	2020-09-17	Crossing Sub Type	Round Culvert
PSCIS ID	NA	Diameter (m)	0.9
External ID	4600040	Length (m)	22
Crew	AI, KP	Embedded	Yes
UTM Zone	11	Depth Embedded (m)	0.3
Easting	652004	Resemble Channel	Yes
Northing	5522330	Backwatered	No
Stream	Dalzell Creek	Percent Backwatered	NA
Road	Airport Road	Fill Depth (m)	0.5
Road Tenure	MoTi local	Outlet Drop (m)	0
Channel Width (m)	5	Outlet Pool Depth (m)	0
Stream Slope (%)	0	Inlet Drop	No
Beaver Activity	No	Slope (%)	2.5
Habitat Value	Medium	Valley Fill	Deep Fill

Photos: 4600040



Comments: Fenced private land upstream and downstream. Wetland area downstream. Culvert does not appear likely to be significantly impacting upstream fish passage for juvenile or adult WCT at time of survey.

Location and Stream Data		Crossing Characteristics	
Date	2020-09-17	Crossing Sub Type	Round Culvert
PSCIS ID	NA	Diameter (m)	3.2
External ID	4600069	Length (m)	18
Crew	AI, KP	Embedded	No
UTM Zone	11	Depth Embedded (m)	NA
Easting	650144	Resemble Channel	No
Northing	5532055	Backwatered	No
Stream	Weigart Creek	Percent Backwatered	NA
Road	Highway 43	Fill Depth (m)	1.3
Road Tenure	MoTi highway	Outlet Drop (m)	0.15
Channel Width (m)	4.3	Outlet Pool Depth (m)	0.6
Stream Slope (%)	2	Inlet Drop	Yes
Beaver Activity	No	Slope (%)	3.4
Habitat Value	High	Valley Fill	Deep Fill

Photos: 4600069



Comments: Large stream with good flow. Flows currently mostly through south culvert which has slightly higher outlet drop. Similar elevation outlets so added together for width. Lazer level used for culvert slope. Cobble/boulder substrate. Boulder cover.

Location and Stream Data		Crossing Characteristics	
Date	2020-09-17	Crossing Sub Type	Round Culvert
PSCIS ID	NA	Diameter (m)	2.5
External ID	4600070	Length (m)	35
Crew	KP, AI	Embedded	Yes
UTM Zone	11	Depth Embedded (m)	0.05
Easting	651516	Resemble Channel	Yes
Northing	5528829	Backwatered	No
Stream	Brule Creek	Percent Backwatered	NA
Road	Highway 43	Fill Depth (m)	3
Road Tenure	MoTi highway	Outlet Drop (m)	0
Channel Width (m)	6.1	Outlet Pool Depth (m)	1.7
Stream Slope (%)	1.5	Inlet Drop	No
Beaver Activity	No	Slope (%)	2.5
Habitat Value	Medium	Valley Fill	Deep Fill

Photos: 4600070



Comments: Dewatered upstream of highway for 600m. Deep pool present downstream fed subsurface from northside of culvert. Approximately 9 WCT in outlet pool. Four fish ~300mm and 5 fish ~200 mm. High confidence that the larger fish were WCT as easy to recognize spotted backs from bank.

Location and Stream Data		Crossing Characteristics –	
Date	2020-09-23	Crossing Sub Type	Round Culvert
PSCIS ID	NA	Diameter (m)	0.75
External ID	4600077	Length (m)	20
Crew	AI, KP	Embedded	Yes
UTM Zone	11	Depth Embedded (m)	0.1
Easting	639864	Resemble Channel	Yes
Northing	5483627	Backwatered	No
Stream	Tributary to Elk River	Percent Backwatered	NA
Road	Mt Mclean Road	Fill Depth (m)	4
Road Tenure	Fernie local	Outlet Drop (m)	0
Channel Width (m)	2.7	Outlet Pool Depth (m)	0
Stream Slope (%)	0.5	Inlet Drop	No
Beaver Activity	No	Slope (%)	0.5
Habitat Value	Low	Valley Fill	Deep Fill

Photos: 4600077

Comments: Dry channel. Culvert is embedded.

Location and Stream Data		Crossing Characteristics	
Date	2020-09-23	Crossing Sub Type	Round Culvert
PSCIS ID	NA	Diameter (m)	1.1
External ID	4600080	Length (m)	43
Crew	KP, AI	Embedded	No
UTM Zone	11	Depth Embedded (m)	NA
Easting	640568	Resemble Channel	No
Northing	5481516	Backwatered	No
Stream	Tributary to Elk River	Percent Backwatered	NA
Road	Cokato Road	Fill Depth (m)	2
Road Tenure	MoTi local	Outlet Drop (m)	0
Channel Width (m)	2.1	Outlet Pool Depth (m)	0
Stream Slope (%)	3.5	Inlet Drop	No
Beaver Activity	No	Slope (%)	4
Habitat Value	Low	Valley Fill	Deep Fill

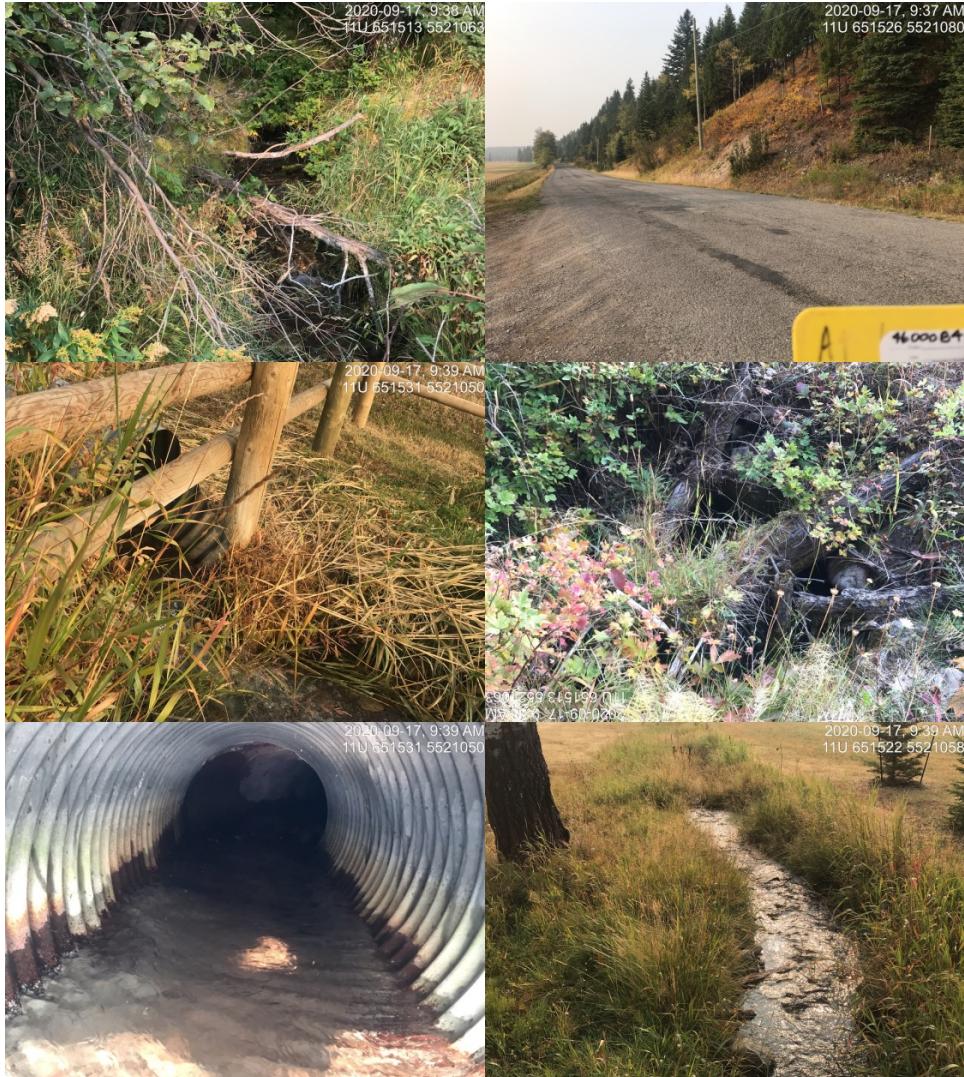
Photos: 4600080



Comments: 2 barrels, 0.90 and 1.1m. Debris rack on inlet. Stream dry at time of survey.

Location and Stream Data	.	Crossing Characteristics	-
Date	2020-09-17	Crossing Sub Type	Round Culvert
PSCIS ID	NA	Diameter (m)	0.6
External ID	4600084	Length (m)	22
Crew	AI, KP	Embedded	No
UTM Zone	11	Depth Embedded (m)	NA
Easting	651532	Resemble Channel	No
Northing	5521052	Backwatered	No
Stream	Littlemoor Creek	Percent Backwatered	NA
Road	Lower Elk Valley Road	Fill Depth (m)	0.8
Road Tenure	MoTi arterial	Outlet Drop (m)	0.2
Channel Width (m)	1	Outlet Pool Depth (m)	0.15
Stream Slope (%)	0.5	Inlet Drop	No
Beaver Activity	No	Slope (%)	3
Habitat Value	Low	Valley Fill	Deep Fill

Photos: 4600084



Comments: Flows through fenced private land upstream and downstream. Inlet has quite a bit of debris on it. Upstream is much steeper than downstream with gradient estimated at 12%. Small stream with good flow.

Location and Stream Data	.	Crossing Characteristics	-
Date	2020-09-17	Crossing Sub Type	Round Culvert
PSCIS ID	NA	Diameter (m)	0.45
External ID	4600090	Length (m)	18
Crew	KP, AI	Embedded	No
UTM Zone	11	Depth Embedded (m)	NA
Easting	651814	Resemble Channel	No
Northing	5519652	Backwatered	No
Stream	Tributary to Elk River	Percent Backwatered	NA
Road	Lower Elk Valley Road	Fill Depth (m)	1
Road Tenure	MoTi arterial	Outlet Drop (m)	0
Channel Width (m)	0	Outlet Pool Depth (m)	0
Stream Slope (%)	0	Inlet Drop	No
Beaver Activity	No	Slope (%)	1.5
Habitat Value	Low	Valley Fill	Deep Fill

Photos: 4600090



Comments: No visible channel. Not likely fish habitat. Agricultural area.

Location and Stream Data	.	Crossing Characteristics	-
Date	2020-09-17	Crossing Sub Type	Round Culvert
PSCIS ID	NA	Diameter (m)	0.8
External ID	4600092	Length (m)	18
Crew	KP, AI	Embedded	No
UTM Zone	11	Depth Embedded (m)	NA
Easting	651701	Resemble Channel	No
Northing	5521881	Backwatered	No
Stream	North Littlemoor Creek	Percent Backwatered	NA
Road	Lower Elk Valley Road	Fill Depth (m)	0.6
Road Tenure	MoTi arterial	Outlet Drop (m)	0
Channel Width (m)	1.5	Outlet Pool Depth (m)	0
Stream Slope (%)	2.5	Inlet Drop	No
Beaver Activity	No	Slope (%)	3
Habitat Value	Low	Valley Fill	Deep Fill

Photos: 4600092



Comments: Stream slope estimated due to fenced private land.

Location and Stream Data		Crossing Characteristics	
Date	2020-09-23	Crossing Sub Type	Round Culvert
PSCIS ID	NA	Diameter (m)	0.5
External ID	4600102	Length (m)	16
Crew	AI, Kp	Embedded	No
UTM Zone	11	Depth Embedded (m)	NA
Easting	640306	Resemble Channel	No
Northing	5481672	Backwatered	No
Stream	Tributary to Elk River	Percent Backwatered	NA
Road	McGiverin Road	Fill Depth (m)	1
Road Tenure	MoTi local	Outlet Drop (m)	0
Channel Width (m)	0.5	Outlet Pool Depth (m)	0
Stream Slope (%)	0	Inlet Drop	No
Beaver Activity	No	Slope (%)	1
Habitat Value	Low	Valley Fill	Deep Fill

Photos: 4600102



Comments: Vegetated channel. Not likely fish habitat.

Location and Stream Data		Crossing Characteristics –	
Date	2020-09-23	Crossing Sub Type	Round Culvert
PSCIS ID	NA	Diameter (m)	1.2
External ID	4600130	Length (m)	22
Crew	KP, AI	Embedded	No
UTM Zone	11	Depth Embedded (m)	NA
Easting	640037	Resemble Channel	No
Northing	5483655	Backwatered	Yes
Stream	Tributary to Elk River	Percent Backwatered	20
Road	Cokato Road	Fill Depth (m)	8
Road Tenure	Fernie collector	Outlet Drop (m)	0
Channel Width (m)	0.65	Outlet Pool Depth (m)	0
Stream Slope (%)	9	Inlet Drop	Yes
Beaver Activity	No	Slope (%)	9
Habitat Value	Low	Valley Fill	Deep Fill

Photos: 4600130



Comments: Very low flow at time of survey and 0.5m inlet drop from debris. Very steep culvert, possibly 2 sections with further upstream section being much steeper.

Location and Stream Data		Crossing Characteristics –	
Date	2020-09-24	Crossing Sub Type	Round Culvert
PSCIS ID	NA	Diameter (m)	0.9
External ID	4600134	Length (m)	48
Crew	KP, AI	Embedded	No
UTM Zone	11	Depth Embedded (m)	NA
Easting	638639	Resemble Channel	No
Northing	5480681	Backwatered	No
Stream	Tributary to Elk River	Percent Backwatered	NA
Road	Fernie ski hill	Fill Depth (m)	3
Road Tenure	unclassified	Outlet Drop (m)	0.09
Channel Width (m)	1.4	Outlet Pool Depth (m)	0.22
Stream Slope (%)	5	Inlet Drop	No
Beaver Activity	No	Slope (%)	9
Habitat Value	Low	Valley Fill	Deep Fill

Photos: 4600134



Comments: Debris guard on inlet. Unable to see through the culvert to other end. Highly manipulated banks, drains large parking area and ski hill. Steep with placed rocks (rip rap) in spots upstream. Stream goes under large turn around, paved area. Culvert likely >1 piece with slight angle. Armoured banks downstream, lots of sediment (sand) form pavement and parking area.

Location and Stream Data		Crossing Characteristics	
Date	2020-09-18	Crossing Sub Type	Round Culvert
PSCIS ID	NA	Diameter (m)	0.9
External ID	4600140	Length (m)	22
Crew	KP, AI	Embedded	No
UTM Zone	11	Depth Embedded (m)	NA
Easting	651110	Resemble Channel	No
Northing	5515356	Backwatered	No
Stream	Whiting Creek	Percent Backwatered	NA
Road	Highway 43	Fill Depth (m)	3
Road Tenure	MoTi arterial	Outlet Drop (m)	0.18
Channel Width (m)	0.6	Outlet Pool Depth (m)	0
Stream Slope (%)	2	Inlet Drop	No
Beaver Activity	No	Slope (%)	1.5
Habitat Value	Low	Valley Fill	Deep Fill

Photos: 4600140



Comments: No access up or downstream due to fenced private land. Stream slope estimated.
Water pipe intake at the outlet.

Location and Stream Data		Crossing Characteristics	
Date	2020-09-24	Crossing Sub Type	Pipe Arch
PSCIS ID	NA	Diameter (m)	4
External ID	4600157	Length (m)	44
Crew	AI, MF, DN	Embedded	NA
UTM Zone	11	Depth Embedded (m)	NA
Easting	643565	Resemble Channel	NA
Northing	5490325	Backwatered	NA
Stream	Hartley Creek	Percent Backwatered	NA
Road	Highway 3	Fill Depth (m)	NA
Road Tenure	MoTi highway	Outlet Drop (m)	NA
Channel Width (m)	NA	Outlet Pool Depth (m)	NA
Stream Slope (%)	NA	Inlet Drop	NA
Beaver Activity	No	Slope (%)	NA
Habitat Value	NA	Valley Fill	NA

Photos: 4600157



Comments: This crossing is very full of debris and has been recently dredges. Less than 30cm freeboard from top of aggraded gravels at inlet and top of pipe arch. Newly installed overflow pipe (0.55 diameter) on left bank.

Location and Stream Data		Crossing Characteristics	
Date	2020-09-24	Crossing Sub Type	Round Culvert
PSCIS ID	NA	Diameter (m)	1.8
External ID	4600158	Length (m)	30
Crew	AI, MF, DN	Embedded	No
UTM Zone	11	Depth Embedded (m)	NA
Easting	642739	Resemble Channel	No
Northing	5489444	Backwatered	No
Stream	Bean Creek	Percent Backwatered	NA
Road	Highway 3	Fill Depth (m)	1.5
Road Tenure	MoTi highway	Outlet Drop (m)	0.17
Channel Width (m)	3.2	Outlet Pool Depth (m)	0.24
Stream Slope (%)	0.5	Inlet Drop	No
Beaver Activity	No	Slope (%)	1
Habitat Value	Medium	Valley Fill	Deep Fill

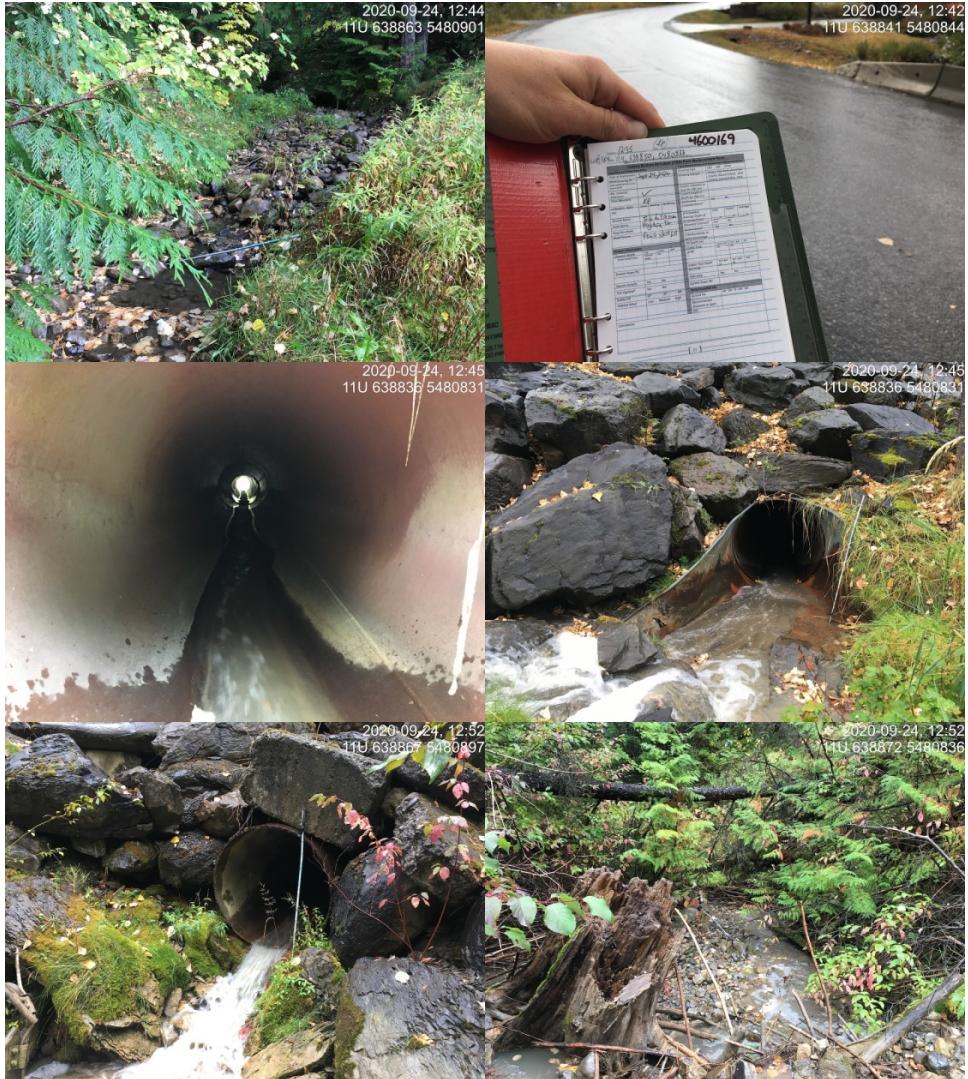
Photos: 4600158



Comments: Fish observed at upstream crossing on Bean Rd. Grate on inlet may prevent passage off adult fish. Fill depth estimated from photos.

Location and Stream Data	.	Crossing Characteristics	-
Date	2020-09-24	Crossing Sub Type	Round Culvert
PSCIS ID	NA	Diameter (m)	1
External ID	4600169	Length (m)	36
Crew	KP, AI	Embedded	No
UTM Zone	11	Depth Embedded (m)	NA
Easting	638850	Resemble Channel	No
Northing	5480833	Backwatered	No
Stream	Tributary to Elk River	Percent Backwatered	NA
Road	Highline Drive (Fernie ski hill)	Fill Depth (m)	6
Road Tenure	MoTi local	Outlet Drop (m)	0.2
Channel Width (m)	2.3	Outlet Pool Depth (m)	0.25
Stream Slope (%)	11.5	Inlet Drop	No
Beaver Activity	No	Slope (%)	13
Habitat Value	Medium	Valley Fill	Deep Fill

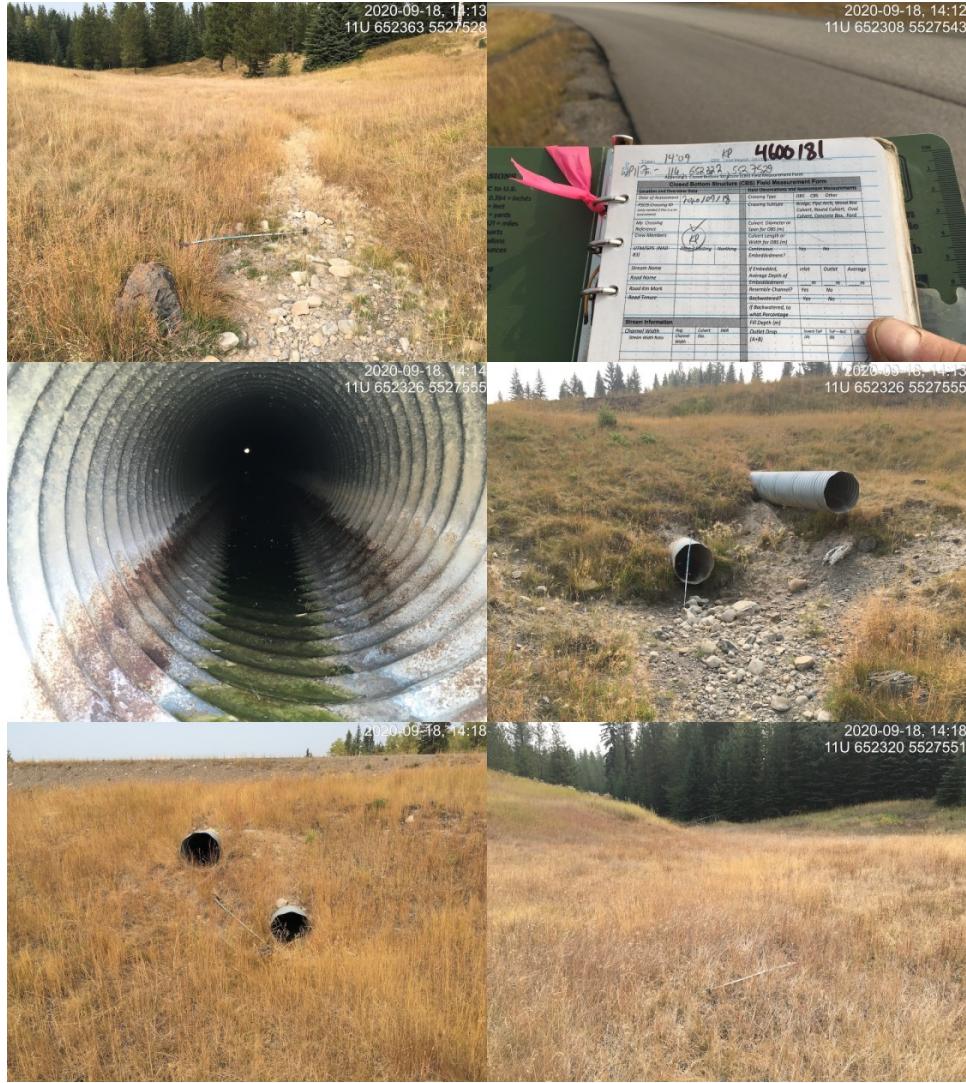
Photos: 4600169



Comments: Very recent heavy rains, 2 side channels for ski hill drainage infrastructure giving significant flow contributions just upstream of crossing, one of which is especially turbid (from large parking lot). Culvert not baffled, very steep. A lot of fill on paved access to condos. Old metal collar of culvert ripped off and in outlet pool.

Location and Stream Data		Crossing Characteristics –	
Date	2020-09-18	Crossing Sub Type	Round Culvert
PSCIS ID	NA	Diameter (m)	0.6
External ID	4600181	Length (m)	73
Crew	KP, AI	Embedded	No
UTM Zone	11	Depth Embedded (m)	NA
Easting	652322	Resemble Channel	No
Northing	5527529	Backwatered	No
Stream	Tributary to Elk River	Percent Backwatered	NA
Road	Line creek mine road	Fill Depth (m)	3.5
Road Tenure	MoTi local	Outlet Drop (m)	0
Channel Width (m)	0.5	Outlet Pool Depth (m)	0
Stream Slope (%)	2	Inlet Drop	No
Beaver Activity	No	Slope (%)	2
Habitat Value	Low	Valley Fill	Deep Fill

Photos: 4600181



Comments: Dry at time of survey, no channel present, area vegetated grassland. Two culverts, 0.60m in diameter. Top culvert 0.5m higher than the lower.

Location and Stream Data		Crossing Characteristics	
Date	2020-09-17	Crossing Sub Type	Oval Culvert
PSCIS ID	NA	Diameter (m)	3.3
External ID	4600183	Length (m)	20
Crew	AI, KP	Embedded	No
UTM Zone	11	Depth Embedded (m)	NA
Easting	651626	Resemble Channel	No
Northing	5528888	Backwatered	No
Stream	Brule Creek	Percent Backwatered	NA
Road	Busato Road	Fill Depth (m)	1
Road Tenure	MoTi local	Outlet Drop (m)	0.7
Channel Width (m)	7.1	Outlet Pool Depth (m)	1.5
Stream Slope (%)	2	Inlet Drop	Yes
Beaver Activity	No	Slope (%)	4
Habitat Value	High	Valley Fill	Deep Fill

Photos: 4600183



Comments: Large stream with good flow at this crossing. Culvert inlet is damaged and there is a large outlet drop. Upstream of highway the stream is subsurface for ~600m.

Location and Stream Data	.	Crossing Characteristics	-
Date	2020-09-18	Crossing Sub Type	Round Culvert
PSCIS ID	NA	Diameter (m)	0.6
External ID	4600184	Length (m)	30
Crew	AI, KP	Embedded	No
UTM Zone	11	Depth Embedded (m)	NA
Easting	650954	Resemble Channel	No
Northing	5522199	Backwatered	No
Stream	North Littlemoor Creek	Percent Backwatered	NA
Road	Highway 43	Fill Depth (m)	4
Road Tenure	MoTi highway	Outlet Drop (m)	0.65
Channel Width (m)	1.6	Outlet Pool Depth (m)	0.55
Stream Slope (%)	5	Inlet Drop	No
Beaver Activity	No	Slope (%)	8
Habitat Value	Medium	Valley Fill	Deep Fill

Photos: 4600184



Comments: Small stream with good flow, EB known upstream. Fenced private land upstream and downstream. Stream measurements estimated due to fenced private land. Large outlet drop.

Location and Stream Data		Crossing Characteristics	
Date	2020-09-18	Crossing Sub Type	Round Culvert
PSCIS ID	NA	Diameter (m)	0.9
External ID	4600185	Length (m)	40
Crew	AI, KP	Embedded	No
UTM Zone	11	Depth Embedded (m)	NA
Easting	651002	Resemble Channel	No
Northing	5521022	Backwatered	No
Stream	Littlemoor Creek	Percent Backwatered	NA
Road	Highway 43	Fill Depth (m)	5
Road Tenure	MoTi highway	Outlet Drop (m)	0.3
Channel Width (m)	1.2	Outlet Pool Depth (m)	0.55
Stream Slope (%)	3.5	Inlet Drop	Yes
Beaver Activity	No	Slope (%)	5
Habitat Value	Medium	Valley Fill	Deep Fill

Photos: 4600185



Comments: Culvert has extension with corner, small stream with good flow. WCT and EB documented upstream. Gravels present suitable for WCT and EB spawning.

Location and Stream Data		Crossing Characteristics	
Date	2020-09-18	Crossing Sub Type	Round Culvert
PSCIS ID	NA	Diameter (m)	0.8
External ID	4600186	Length (m)	22
Crew	KP, AI	Embedded	No
UTM Zone	11	Depth Embedded (m)	NA
Easting	651051	Resemble Channel	No
Northing	5519343	Backwatered	No
Stream	Hollow Creek	Percent Backwatered	NA
Road	Highway 43	Fill Depth (m)	0.8
Road Tenure	MoTi highway	Outlet Drop (m)	0.46
Channel Width (m)	1.1	Outlet Pool Depth (m)	0.36
Stream Slope (%)	2	Inlet Drop	No
Beaver Activity	No	Slope (%)	4
Habitat Value	Low	Valley Fill	Deep Fill

Photos: 4600186



Comments: No access up or downstream due to fenced private land. Stream slope estimated.

Location and Stream Data		Crossing Characteristics –	
Date	2020-09-23	Crossing Sub Type	Round Culvert
PSCIS ID	NA	Diameter (m)	1.2
External ID	4600316	Length (m)	12
Crew	KP, AI	Embedded	No
UTM Zone	11	Depth Embedded (m)	NA
Easting	641167	Resemble Channel	No
Northing	5479429	Backwatered	No
Stream	Tributary to Elk River	Percent Backwatered	NA
Road	Cokato Road	Fill Depth (m)	0.5
Road Tenure	MoTi local	Outlet Drop (m)	0
Channel Width (m)	4.1	Outlet Pool Depth (m)	0
Stream Slope (%)	4	Inlet Drop	No
Beaver Activity	No	Slope (%)	2.5
Habitat Value	Low	Valley Fill	Deep Fill

Photos: 4600316



Comments: Stream dry at time of survey. Three barrels, 1.2m in diameter. All three very similar elevation, all perched .2-.50m above substrate.

Location and Stream Data	.	Crossing Characteristics	-
Date	2020-09-17	Crossing Sub Type	Round Culvert
PSCIS ID	NA	Diameter (m)	0.6
External ID	4600329	Length (m)	12
Crew	AI, KP	Embedded	No
UTM Zone	11	Depth Embedded (m)	NA
Easting	652325	Resemble Channel	Yes
Northing	5515789	Backwatered	No
Stream	Tributary to Whiting Creek	Percent Backwatered	NA
Road	Lower Elk Valley Road	Fill Depth (m)	1
Road Tenure	MoTi arterial	Outlet Drop (m)	0
Channel Width (m)	0.5	Outlet Pool Depth (m)	0
Stream Slope (%)	0	Inlet Drop	No
Beaver Activity	No	Slope (%)	1
Habitat Value	Low	Valley Fill	Deep Fill

Photos: 4600329



Comments: Whiting creek appeared to not be present through agricultural field downstream. This appeared to be only channel present for Whiting crossing this road although the main Whiting channel is present upstream. Dry, heavily vegetated channel downstream. Defined channel upstream but seems unlikely to be fish bearing.

Location and Stream Data		Crossing Characteristics –	
Date	2020-09-24	Crossing Sub Type	Round Culvert
PSCIS ID	NA	Diameter (m)	1.2
External ID	4600332	Length (m)	25
Crew	AI, KP	Embedded	No
UTM Zone	11	Depth Embedded (m)	NA
Easting	639511	Resemble Channel	No
Northing	5481114	Backwatered	No
Stream	Tributary to Elk River	Percent Backwatered	NA
Road	Highway 3	Fill Depth (m)	2.3
Road Tenure	MoTi highway	Outlet Drop (m)	0
Channel Width (m)	3.3	Outlet Pool Depth (m)	0.5
Stream Slope (%)	4	Inlet Drop	Yes
Beaver Activity	No	Slope (%)	1.5
Habitat Value	Medium	Valley Fill	Deep Fill

Photos: 4600332



Comments: Fry observed at outlet pool. Inlet of active pipe mostly plugged with debris. Overflow pipe is 0.8m outlet drop with fry/juveniles stranded in outlet pool. Flows out of Fernie Ski Hill Road development area.

Location and Stream Data		Crossing Characteristics	
Date	2020-09-18	Crossing Sub Type	Oval Culvert
PSCIS ID	NA	Diameter (m)	2.6
External ID	4600367	Length (m)	20
Crew	AI, KP	Embedded	No
UTM Zone	11	Depth Embedded (m)	NA
Easting	643534	Resemble Channel	No
Northing	5490723	Backwatered	No
Stream	Hartley Creek	Percent Backwatered	NA
Road	Dicken Road	Fill Depth (m)	0.4
Road Tenure	MoTi collector	Outlet Drop (m)	0.4
Channel Width (m)	3.5	Outlet Pool Depth (m)	0.8
Stream Slope (%)	1	Inlet Drop	No
Beaver Activity	No	Slope (%)	2
Habitat Value	High	Valley Fill	Deep Fill

Photos: 4600367



Comments: Laser level used for culvert slope. WCT spawning system. See Management Plan for the Westslope Cutthroat Trout (*Oncorhynchus clarkii lewisi*) in British Columbia 2014
<http://a100.gov.bc.ca/pub/eirs/finishDownloadDocument.do?subdocumentId=9781>

Location and Stream Data		Crossing Characteristics	
Date	2020-09-20	Crossing Sub Type	Ford
PSCIS ID	NA	Diameter (m)	NA
External ID	4601129	Length (m)	NA
Crew	KP, AI	Embedded	NA
UTM Zone	11	Depth Embedded (m)	NA
Easting	661062	Resemble Channel	NA
Northing	5524446	Backwatered	NA
Stream	Grave Creek	Percent Backwatered	NA
Road	NA	Fill Depth (m)	NA
Road Tenure	unclassified	Outlet Drop (m)	NA
Channel Width (m)	NA	Outlet Pool Depth (m)	NA
Stream Slope (%)	NA	Inlet Drop	NA
Beaver Activity	No	Slope (%)	NA
Habitat Value	NA	Valley Fill	NA

Photos: 4601129



Comments: Deactivated road. Ford.

Location and Stream Data		Crossing Characteristics	
Date	2020-09-18	Crossing Sub Type	Ford
PSCIS ID	NA	Diameter (m)	NA
External ID	4601205	Length (m)	NA
Crew	AI, KP	Embedded	NA
UTM Zone	11	Depth Embedded (m)	NA
Easting	650917	Resemble Channel	NA
Northing	5528513	Backwatered	NA
Stream	Brule Creek	Percent Backwatered	NA
Road	Private	Fill Depth (m)	NA
Road Tenure	private	Outlet Drop (m)	NA
Channel Width (m)	NA	Outlet Pool Depth (m)	NA
Stream Slope (%)	NA	Inlet Drop	NA
Beaver Activity	No	Slope (%)	NA
Habitat Value	NA	Valley Fill	NA

Photos: 4601205



Comments: Pulled crossing, no issues, is now a ford.

Location and Stream Data		Crossing Characteristics	
Date	2020-09-24	Crossing Sub Type	Round Culvert
PSCIS ID	NA	Diameter (m)	0.9
External ID	4601556	Length (m)	14
Crew	KP, AI	Embedded	No
UTM Zone	11	Depth Embedded (m)	NA
Easting	638522	Resemble Channel	No
Northing	5480616	Backwatered	No
Stream	Tributary to Elk River	Percent Backwatered	NA
Road	Fernie ski hill	Fill Depth (m)	1.2
Road Tenure	unclassified	Outlet Drop (m)	0
Channel Width (m)	1.3	Outlet Pool Depth (m)	0.2
Stream Slope (%)	8	Inlet Drop	Yes
Beaver Activity	No	Slope (%)	9
Habitat Value	Low	Valley Fill	Deep Fill

Photos: 4601556



NO IMAGE AVAILABLE

Comments: Stream gradient immediately upstream of crossing is near 20%. Crossing is last of a series within close proximity to each other. The crossing downstream of this one is near 100m long. Likely more crossings upstream on ski hill infrastructure and access roads. Recent heavy rains.

Location and Stream Data		Crossing Characteristics –	
Date	2020-09-23	Crossing Sub Type	Round Culvert
PSCIS ID	NA	Diameter (m)	1.5
External ID	4601594	Length (m)	22
Crew	KP, AI	Embedded	No
UTM Zone	11	Depth Embedded (m)	NA
Easting	641090	Resemble Channel	No
Northing	5479392	Backwatered	No
Stream	Tributary to Elk River	Percent Backwatered	NA
Road	Railway	Fill Depth (m)	2
Road Tenure	Canadian Pacific	Outlet Drop (m)	0
Channel Width (m)	2.7	Outlet Pool Depth (m)	0
Stream Slope (%)	2.5	Inlet Drop	No
Beaver Activity	No	Slope (%)	1.5
Habitat Value	Low	Valley Fill	Deep Fill

Photos: 4601594



Comments: Stream dry at time of survey. 2 barrels (0.80 and 1.5m in diameter), similar heights but 1.5m slightly lower. Smaller barrel inlet damaged.

Location and Stream Data		Crossing Characteristics	
Date	2020-09-24	Crossing Sub Type	Round Culvert
PSCIS ID	NA	Diameter (m)	1.2
External ID	4601639	Length (m)	99
Crew	KP, AI	Embedded	No
UTM Zone	11	Depth Embedded (m)	NA
Easting	638630	Resemble Channel	No
Northing	5480655	Backwatered	No
Stream	Tributary to Elk River	Percent Backwatered	NA
Road	Fernie ski hill	Fill Depth (m)	2.5
Road Tenure	unclassified	Outlet Drop (m)	0.73
Channel Width (m)	1.5	Outlet Pool Depth (m)	0.65
Stream Slope (%)	6	Inlet Drop	Yes
Beaver Activity	No	Slope (%)	11
Habitat Value	Low	Valley Fill	Deep Fill

Photos: 4601639



Comments: Huge crossing through the ski hill parking lot and lodge area. Large outlet drop and pool, extremely long culvert (close to 100m) tied in with other drainage infrastructure at the base of the Fernie ski hill. Inlet drop about .15m.

Location and Stream Data	.	Crossing Characteristics	-
Date	2020-09-20	Crossing Sub Type	Round Culvert
PSCIS ID	NA	Diameter (m)	0.9
External ID	4602270	Length (m)	14
Crew	KP, AI	Embedded	No
UTM Zone	11	Depth Embedded (m)	NA
Easting	655441	Resemble Channel	No
Northing	5524175	Backwatered	No
Stream	Tributary to Grave Creek	Percent Backwatered	NA
Road	NA	Fill Depth (m)	2
Road Tenure	unclassified	Outlet Drop (m)	0
Channel Width (m)	1.5	Outlet Pool Depth (m)	0
Stream Slope (%)	3	Inlet Drop	Yes
Beaver Activity	No	Slope (%)	4
Habitat Value	Low	Valley Fill	Deep Fill

Photos: 4602270



Comments: Inlet clogged with debris 3/4 of way up. Upstream area is wetland/pond.

Location and Stream Data		Crossing Characteristics	
Date	2020-09-18	Crossing Sub Type	Ford
PSCIS ID	NA	Diameter (m)	NA
External ID	4602276	Length (m)	NA
Crew	AI	Embedded	NA
UTM Zone	11	Depth Embedded (m)	NA
Easting	649758	Resemble Channel	NA
Northing	5527935	Backwatered	NA
Stream	Brule Creek	Percent Backwatered	NA
Road	Spur	Fill Depth (m)	NA
Road Tenure	unclassified	Outlet Drop (m)	NA
Channel Width (m)	NA	Outlet Pool Depth (m)	NA
Stream Slope (%)	NA	Inlet Drop	NA
Beaver Activity	No	Slope (%)	NA
Habitat Value	NA	Valley Fill	NA

Photos: 4602276



Comments: Deactivated. Ford. no issues.

Location and Stream Data		Crossing Characteristics	
Date	2020-09-24	Crossing Sub Type	Round Culvert
PSCIS ID	NA	Diameter (m)	1.2
External ID	4602349	Length (m)	10
Crew	KP, AI	Embedded	No
UTM Zone	11	Depth Embedded (m)	NA
Easting	638525	Resemble Channel	No
Northing	5481496	Backwatered	Yes
Stream	Tributary to Elk River	Percent Backwatered	20
Road	Fernie Nordic Trail	Fill Depth (m)	1.5
Road Tenure	unclassified	Outlet Drop (m)	0
Channel Width (m)	2	Outlet Pool Depth (m)	2
Stream Slope (%)	7	Inlet Drop	No
Beaver Activity	No	Slope (%)	3.5
Habitat Value	Medium	Valley Fill	Deep Fill

Photos: 4602349



Comments: Outlet pool appears dredged, very deep, approximately 2m and 7-8m long. Nice stream, good flow.

Location and Stream Data		Crossing Characteristics	
Date	2020-09-20	Crossing Sub Type	Round Culvert
PSCIS ID	NA	Diameter (m)	0.6
External ID	4602533	Length (m)	8
Crew	KP, AI	Embedded	No
UTM Zone	11	Depth Embedded (m)	NA
Easting	661172	Resemble Channel	No
Northing	5524451	Backwatered	No
Stream	Grave Creek	Percent Backwatered	NA
Road	NA	Fill Depth (m)	0.35
Road Tenure	unclassified	Outlet Drop (m)	0
Channel Width (m)	0.1	Outlet Pool Depth (m)	0
Stream Slope (%)	1	Inlet Drop	No
Beaver Activity	No	Slope (%)	4
Habitat Value	Low	Valley Fill	Deep Fill

Photos: 4602533



Comments: Stream dry at time of survey, channel not visible for about 40 downstream. Water and channel appear about 65m downstream of crossing. Upstream side of crossing inlet not visible, covered by road fill or deep organic debris. Channel upstream non-existent and dry. This system (labelled as Grave creek on the map) must be a side channel or remnant channel.

Location and Stream Data		Crossing Characteristics	
Date	2020-09-23	Crossing Sub Type	Round Culvert
PSCIS ID	NA	Diameter (m)	0.6
External ID	4603265	Length (m)	13
Crew	AI, KP	Embedded	No
UTM Zone	11	Depth Embedded (m)	NA
Easting	640287	Resemble Channel	No
Northing	5481650	Backwatered	No
Stream	Tributary to Elk River	Percent Backwatered	NA
Road	Railway	Fill Depth (m)	3
Road Tenure	Canadian Pacific	Outlet Drop (m)	0
Channel Width (m)	0.5	Outlet Pool Depth (m)	0
Stream Slope (%)	0	Inlet Drop	No
Beaver Activity	No	Slope (%)	0.5
Habitat Value	Low	Valley Fill	Deep Fill

Photos: 4603265



Comments: Dry vegetated channel. Not likely fish habitat.

Location and Stream Data		Crossing Characteristics	
Date	2020-09-23	Crossing Sub Type	Round Culvert
PSCIS ID	NA	Diameter (m)	1.2
External ID	4603291	Length (m)	13
Crew	KP, AI	Embedded	No
UTM Zone	11	Depth Embedded (m)	NA
Easting	640891	Resemble Channel	No
Northing	5480517	Backwatered	No
Stream	Cokato Creek	Percent Backwatered	NA
Road	Cokato Road	Fill Depth (m)	0.5
Road Tenure	MoTi local	Outlet Drop (m)	0
Channel Width (m)	4.5	Outlet Pool Depth (m)	0
Stream Slope (%)	4	Inlet Drop	No
Beaver Activity	No	Slope (%)	4
Habitat Value	Low	Valley Fill	Deep Fill

Photos: 4603291



Comments: 3 large barrels (all 1.2m), very perched 0.7-1.3m above substrate. Stream dry at time of survey. Debris rack on upstream side of culvert. Note there is a slope change at the inlet of structure, much steeper short section possibly from damage.

Location and Stream Data		Crossing Characteristics –	
Date	2020-09-18	Crossing Sub Type	Round Culvert
PSCIS ID	NA	Diameter (m)	0.8
External ID	4604198	Length (m)	9
Crew	AI, KP	Embedded	No
UTM Zone	11	Depth Embedded (m)	NA
Easting	647819	Resemble Channel	No
Northing	5498551	Backwatered	No
Stream	Tributary to Elk River	Percent Backwatered	NA
Road	Hadner FSR	Fill Depth (m)	1
Road Tenure	FLNR 6946	Outlet Drop (m)	0.6
Channel Width (m)	2.9	Outlet Pool Depth (m)	0.3
Stream Slope (%)	19	Inlet Drop	Yes
Beaver Activity	No	Slope (%)	6
Habitat Value	Medium	Valley Fill	Deep Fill

Photos: 4604198



Comments: Steep stream with good flow. FISS sample site 2593 near crossing location. Suspect too steep to be fish bearing.

Location and Stream Data		Crossing Characteristics –	
Date	2020-09-24	Crossing Sub Type	Round Culvert
PSCIS ID	NA	Diameter (m)	0.9
External ID	4604455	Length (m)	16
Crew	KP, AI	Embedded	No
UTM Zone	11	Depth Embedded (m)	NA
Easting	638669	Resemble Channel	No
Northing	5480601	Backwatered	No
Stream	Tributary to Elk River	Percent Backwatered	NA
Road	Fernie ski hill	Fill Depth (m)	2
Road Tenure	unclassified	Outlet Drop (m)	0.15
Channel Width (m)	1.5	Outlet Pool Depth (m)	0.2
Stream Slope (%)	9	Inlet Drop	Yes
Beaver Activity	No	Slope (%)	7
Habitat Value	Low	Valley Fill	Deep Fill

Photos: 4604455



Comments: Inlet drop about .40m, significant and looks like increased barrier. Crossing is Fernie ski hill gravel road. Currently high and turbid due to heavy rain.

Location and Stream Data		Crossing Characteristics	
Date	2020-09-16	Crossing Sub Type	Pipe Arch
PSCIS ID	NA	Diameter (m)	2.5
External ID	4605636	Length (m)	14
Crew	KP, AI	Embedded	NA
UTM Zone	11	Depth Embedded (m)	NA
Easting	644148	Resemble Channel	NA
Northing	5564425	Backwatered	NA
Stream	Tributary to Elk River	Percent Backwatered	NA
Road	Elk River FSR	Fill Depth (m)	NA
Road Tenure	FLNR 0103	Outlet Drop (m)	NA
Channel Width (m)	NA	Outlet Pool Depth (m)	NA
Stream Slope (%)	NA	Inlet Drop	NA
Beaver Activity	No	Slope (%)	NA
Habitat Value	NA	Valley Fill	NA

Photos: 4605636



Comments: Appears passable.

Location and Stream Data		Crossing Characteristics	
Date	2020-09-16	Crossing Sub Type	Round Culvert
PSCIS ID	NA	Diameter (m)	0.9
External ID	4605649	Length (m)	17
Crew	KP, AI	Embedded	No
UTM Zone	11	Depth Embedded (m)	NA
Easting	645873	Resemble Channel	No
Northing	5556758	Backwatered	Yes
Stream	Tributary to Elk River	Percent Backwatered	100
Road	Elk River FSR	Fill Depth (m)	1.5
Road Tenure	FLNR 0103	Outlet Drop (m)	0
Channel Width (m)	1	Outlet Pool Depth (m)	0.6
Stream Slope (%)	2.5	Inlet Drop	No
Beaver Activity	No	Slope (%)	0.5
Habitat Value	Medium	Valley Fill	Deep Fill

Photos: 4605649



NO IMAGE AVAILABLE

Comments: Low, slow flow. Culvert completely backwatered.

Location and Stream Data		Crossing Characteristics –	
Date	2020-09-16	Crossing Sub Type	Round Culvert
PSCIS ID	NA	Diameter (m)	0.9
External ID	4605653	Length (m)	11
Crew	AI, KP	Embedded	No
UTM Zone	11	Depth Embedded (m)	NA
Easting	644666	Resemble Channel	No
Northing	5564940	Backwatered	No
Stream	Tributary to Elk River	Percent Backwatered	NA
Road	Elk River FSR	Fill Depth (m)	0.4
Road Tenure	FLNR 0103	Outlet Drop (m)	0
Channel Width (m)	2.5	Outlet Pool Depth (m)	0.2
Stream Slope (%)	2	Inlet Drop	No
Beaver Activity	No	Slope (%)	3.2
Habitat Value	Medium	Valley Fill	Deep Fill

Photos: 4605653



Comments: Good habitat, habitat assessment (FHAP) conducted in 2016 (Masse Environmental Consultants Ltd.) for proposed coal mine EA (Bingay). Electrofished U/S and D/S, see provincial records and data submission file at <http://a100.gov.bc.ca/pub/acat/public/viewReport.do?reportId=52717>. Culvert does not appear to be barrier to any species at any life stage at time of survey. Could be barrier to small fish at high flows. EB and WCT recorded upstream.

Location and Stream Data		Crossing Characteristics –	
Date	2020-09-16	Crossing Sub Type	Round Culvert
PSCIS ID	NA	Diameter (m)	0.6
External ID	4605675	Length (m)	10
Crew	AI, KP	Embedded	No
UTM Zone	11	Depth Embedded (m)	NA
Easting	645225	Resemble Channel	No
Northing	5567096	Backwatered	No
Stream	Tributary to Elk River	Percent Backwatered	NA
Road	Elk River FSR	Fill Depth (m)	0.5
Road Tenure	NA	Outlet Drop (m)	0
Channel Width (m)	2	Outlet Pool Depth (m)	0.05
Stream Slope (%)	0.5	Inlet Drop	No
Beaver Activity	No	Slope (%)	2.5
Habitat Value	Medium	Valley Fill	Deep Fill

Photos: 4605675



Comments: Culvert slope estimate. Stream dredged upstream to remove sediments. Flows are slow through culvert and unlikely barrier for fry/parr for much of year. Crossing 4606244 is on deactivated spur upstream so very likely a ford, about 300m upstream same thing for 4604099.

Location and Stream Data		Crossing Characteristics	
Date	2020-09-16	Crossing Sub Type	Round Culvert
PSCIS ID	NA	Diameter (m)	1.5
External ID	4605697	Length (m)	2
Crew	AI, KP	Embedded	No
UTM Zone	11	Depth Embedded (m)	NA
Easting	648722	Resemble Channel	No
Northing	5548198	Backwatered	No
Stream	Crossing Creek	Percent Backwatered	NA
Road	Elk River FSR	Fill Depth (m)	1
Road Tenure	FLNR 0103	Outlet Drop (m)	0
Channel Width (m)	2.5	Outlet Pool Depth (m)	0
Stream Slope (%)	3.5	Inlet Drop	No
Beaver Activity	No	Slope (%)	5
Habitat Value	Low	Valley Fill	Deep Fill

Photos: 4605697



Comments: Dry channel at time of survey, channel transitions to grass flats about 60 meters downstream.

Location and Stream Data		Crossing Characteristics	
Date	2020-09-16	Crossing Sub Type	Round Culvert
PSCIS ID	NA	Diameter (m)	0.35
External ID	4605705	Length (m)	15
Crew	AI, KP	Embedded	No
UTM Zone	11	Depth Embedded (m)	NA
Easting	643733	Resemble Channel	No
Northing	5560586	Backwatered	No
Stream	Tributary to Elk River	Percent Backwatered	NA
Road	Elk River FSR	Fill Depth (m)	1.2
Road Tenure	Unknown	Outlet Drop (m)	2.15
Channel Width (m)	1	Outlet Pool Depth (m)	0.4
Stream Slope (%)	0.5	Inlet Drop	No
Beaver Activity	No	Slope (%)	2.5
Habitat Value	Low	Valley Fill	Deep Fill

Photos: 4605705



Comments: Stream not located where mapped. Unlikely fish bearing. Flows into forest floor downstream of culvert.

Location and Stream Data		Crossing Characteristics –	
Date	2020-09-16	Crossing Sub Type	Round Culvert
PSCIS ID	NA	Diameter (m)	0.6
External ID	4605707	Length (m)	11
Crew	KP, AI	Embedded	No
UTM Zone	11	Depth Embedded (m)	NA
Easting	643981	Resemble Channel	No
Northing	5561132	Backwatered	No
Stream	Tributary to Elk River	Percent Backwatered	NA
Road	Elk River FSR	Fill Depth (m)	0.4
Road Tenure	FLNR 0103	Outlet Drop (m)	0
Channel Width (m)	2.3	Outlet Pool Depth (m)	0
Stream Slope (%)	1	Inlet Drop	No
Beaver Activity	No	Slope (%)	1.5
Habitat Value	Low	Valley Fill	Deep Fill

Photos: 4605707



Comments: Stream dry at time of survey. Vegetated channel, loaded with sediment. Inlet of culvert damaged, partly bent. Inlet and outlet area dredged. Not likely fish habitat.

Location and Stream Data	.	Crossing Characteristics	-
Date	2020-09-16	Crossing Sub Type	Round Culvert
PSCIS ID	NA	Diameter (m)	0.6
External ID	4605708	Length (m)	10
Crew	AI, KP	Embedded	Yes
UTM Zone	11	Depth Embedded (m)	0.1
Easting	643611	Resemble Channel	Yes
Northing	5559835	Backwatered	No
Stream	Tributary to Lowe Creek	Percent Backwatered	NA
Road	Elk River FSR	Fill Depth (m)	0.5
Road Tenure	FLNR 0103	Outlet Drop (m)	0
Channel Width (m)	1.1	Outlet Pool Depth (m)	0
Stream Slope (%)	3.5	Inlet Drop	No
Beaver Activity	No	Slope (%)	1.5
Habitat Value	Low	Valley Fill	Deep Fill

Photos: 4605708



Comments: Channelized downstream due to dredging for about 30m. Small stream, substrate primarily fines but some gravel present.

Location and Stream Data		Crossing Characteristics –	
Date	2020-09-16	Crossing Sub Type	Round Culvert
PSCIS ID	NA	Diameter (m)	1.5
External ID	4605732	Length (m)	49
Crew	KP, AI	Embedded	No
UTM Zone	11	Depth Embedded (m)	NA
Easting	646735	Resemble Channel	No
Northing	5554534	Backwatered	No
Stream	Tributary to Elk River	Percent Backwatered	NA
Road	Elk River FSR	Fill Depth (m)	8
Road Tenure	FLNR 0103	Outlet Drop (m)	1.48
Channel Width (m)	3.5	Outlet Pool Depth (m)	1.3
Stream Slope (%)	1.5	Inlet Drop	Yes
Beaver Activity	No	Slope (%)	3.5
Habitat Value	High	Valley Fill	Deep Fill

Photos: 4605732



Comments: Large perched culvert. High value habitat. Habitat confirmation and sampling conducted.

Location and Stream Data		Crossing Characteristics –	
Date	2020-09-16	Crossing Sub Type	Round Culvert
PSCIS ID	NA	Diameter (m)	1.2
External ID	4605733	Length (m)	10
Crew	AI, KP	Embedded	No
UTM Zone	11	Depth Embedded (m)	NA
Easting	647191	Resemble Channel	No
Northing	5552693	Backwatered	No
Stream	Tributary to Elk River	Percent Backwatered	NA
Road	Elk River FSR	Fill Depth (m)	1
Road Tenure	FLNR 0103	Outlet Drop (m)	0.3
Channel Width (m)	3.1	Outlet Pool Depth (m)	0.6
Stream Slope (%)	2	Inlet Drop	No
Beaver Activity	No	Slope (%)	1
Habitat Value	Low	Valley Fill	Deep Fill

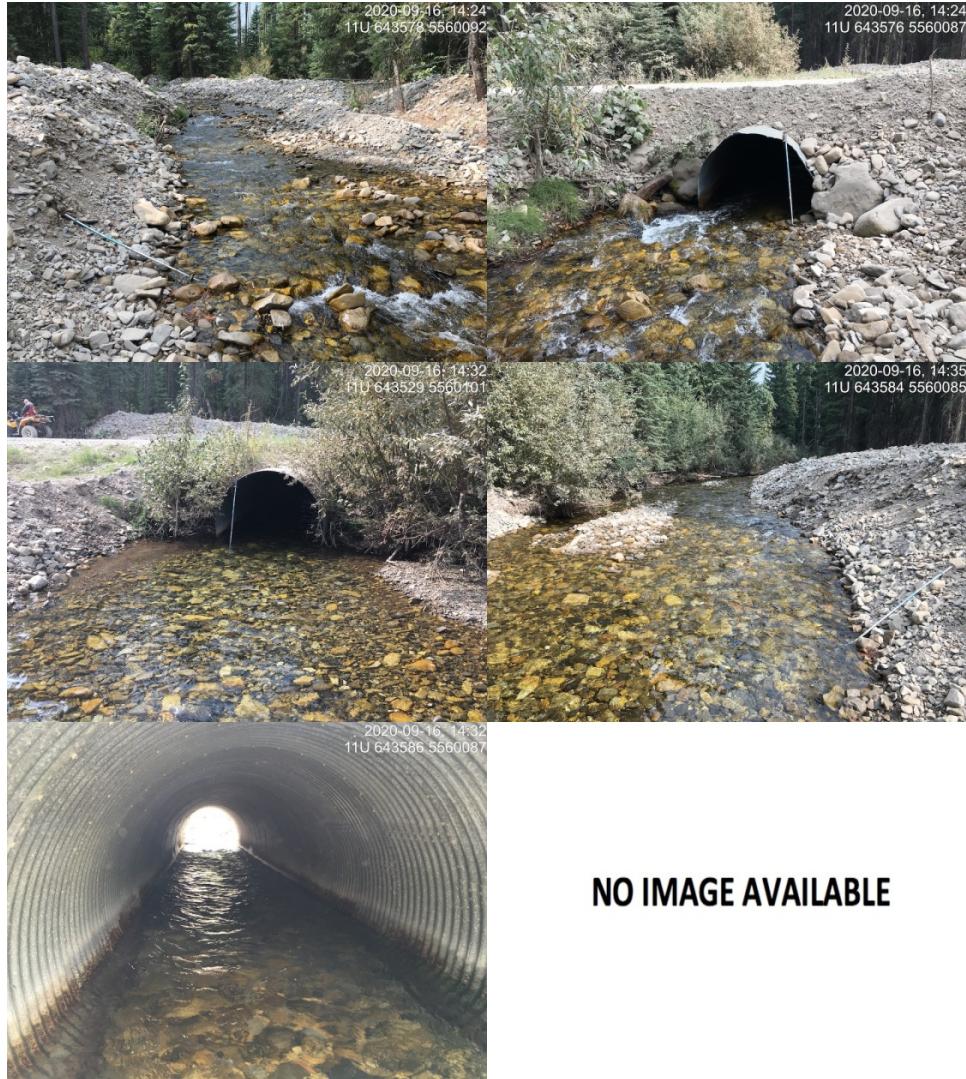
Photos: 4605733



Comments: Freshly dredged. Dry. Dredging may extend well down channel. See photo from about 130m downstream.

Location and Stream Data		Crossing Characteristics	
Date	2020-09-16	Crossing Sub Type	Round Culvert
PSCIS ID	NA	Diameter (m)	1.5
External ID	4605742	Length (m)	15
Crew	KP, AI	Embedded	Yes
UTM Zone	11	Depth Embedded (m)	0.12
Easting	643578	Resemble Channel	Yes
Northing	5560087	Backwatered	No
Stream	Lowe Creek	Percent Backwatered	NA
Road	Elk River FSR	Fill Depth (m)	0.3
Road Tenure	FLNR 0103	Outlet Drop (m)	0
Channel Width (m)	2.5	Outlet Pool Depth (m)	0.2
Stream Slope (%)	3.5	Inlet Drop	No
Beaver Activity	No	Slope (%)	1.5
Habitat Value	High	Valley Fill	Deep Fill

Photos: 4605742



NO IMAGE AVAILABLE

Comments: Upstream past dredging natural channel 2.5m wide. Downstream below dredging extremely braided, original channel difficult to track. Channel widths >10m at times with substrate on top of banks and in bases of trees. Channel dredged upstream and downstream approximately 75m on each. Habitat assessment (FHAP) conducted in 2016 (Masse Environmental Consultants Ltd.) for proposed coal mine EA (Bingay). Electrofished D/S, see provincial records and data submission file at <http://a100.gov.bc.ca/pub/acat/public/viewReport.do?reportId=52717>.

Location and Stream Data	.	Crossing Characteristics	-
Date	2020-09-16	Crossing Sub Type	Round Culvert
PSCIS ID	NA	Diameter (m)	0.4
External ID	4606669	Length (m)	10
Crew	AI, KP	Embedded	No
UTM Zone	11	Depth Embedded (m)	NA
Easting	646462	Resemble Channel	No
Northing	5554360	Backwatered	No
Stream	Tributary to Elk River	Percent Backwatered	NA
Road	Spur from Elk River FSR	Fill Depth (m)	1
Road Tenure	Canfor R08473	Outlet Drop (m)	0
Channel Width (m)	1	Outlet Pool Depth (m)	0
Stream Slope (%)	0.5	Inlet Drop	No
Beaver Activity	No	Slope (%)	2
Habitat Value	Low	Valley Fill	Deep Fill

Photos: 4606669



Comments: Plan in place to deactivate entire network here (personal communication with local machinery operator). Dry, vegetated channel. Likely non-fish bearing.

Location and Stream Data		Crossing Characteristics	
Date	2020-09-23	Crossing Sub Type	Concrete Box
PSCIS ID	NA	Diameter (m)	1.2
External ID	4606807	Length (m)	9
Crew	KP, AI	Embedded	Yes
UTM Zone	11	Depth Embedded (m)	0.09
Easting	639952	Resemble Channel	No
Northing	5483636	Backwatered	No
Stream	Tributary to Elk River	Percent Backwatered	NA
Road	Railway	Fill Depth (m)	6
Road Tenure	Canadian Pacific	Outlet Drop (m)	0
Channel Width (m)	1.5	Outlet Pool Depth (m)	0
Stream Slope (%)	30	Inlet Drop	No
Beaver Activity	No	Slope (%)	1.5
Habitat Value	Low	Valley Fill	Deep Fill

Photos: 4606807



Comments: Concrete arch, >30% downstream of culvert for 10m likely from railway fill. Dry downstream with stagnant pools upstream.

Location and Stream Data	.	Crossing Characteristics	-
Date	2020-09-16	Crossing Sub Type	Round Culvert
PSCIS ID	NA	Diameter (m)	0.4
External ID	4606835	Length (m)	10
Crew	AI, KP	Embedded	No
UTM Zone	11	Depth Embedded (m)	NA
Easting	644829	Resemble Channel	No
Northing	5559116	Backwatered	No
Stream	Tributary to Elk River	Percent Backwatered	NA
Road	Spur from Elk River FSR	Fill Depth (m)	1
Road Tenure	Canfor R08370	Outlet Drop (m)	0.3
Channel Width (m)	1	Outlet Pool Depth (m)	0
Stream Slope (%)	3	Inlet Drop	No
Beaver Activity	No	Slope (%)	2.5
Habitat Value	Low	Valley Fill	Deep Fill

Photos: 4606835



Comments: Road is deactivated downstream so no crossings below (4607172, 4606929). Dry vegetated channel. Not likely fish bearing at this location.

Location and Stream Data		Crossing Characteristics	
Date	2020-09-18	Crossing Sub Type	Bridge
PSCIS ID	NA	Diameter (m)	4
External ID	4607023	Length (m)	18
Crew	AI, KP	Embedded	NA
UTM Zone	11	Depth Embedded (m)	NA
Easting	648041	Resemble Channel	NA
Northing	5499983	Backwatered	NA
Stream	McCool Creek	Percent Backwatered	NA
Road	NA	Fill Depth (m)	NA
Road Tenure	Canfor R08477	Outlet Drop (m)	NA
Channel Width (m)	NA	Outlet Pool Depth (m)	NA
Stream Slope (%)	NA	Inlet Drop	NA
Beaver Activity	No	Slope (%)	NA
Habitat Value	NA	Valley Fill	NA

Photos: 4607023



NO IMAGE AVAILABLE



Comments: Bridge.

Location and Stream Data		Crossing Characteristics	
Date	2020-09-18	Crossing Sub Type	Bridge
PSCIS ID	NA	Diameter (m)	4
External ID	2020091801	Length (m)	18
Crew	AI, KP	Embedded	NA
UTM Zone	11	Depth Embedded (m)	NA
Easting	648381	Resemble Channel	NA
Northing	5499536	Backwatered	NA
Stream	McCool Creek	Percent Backwatered	NA
Road	Hadner FSR	Fill Depth (m)	NA
Road Tenure	FLNR 6946	Outlet Drop (m)	NA
Channel Width (m)	NA	Outlet Pool Depth (m)	NA
Stream Slope (%)	NA	Inlet Drop	NA
Beaver Activity	No	Slope (%)	NA
Habitat Value	NA	Valley Fill	NA

Photos: 2020091801



Comments: Bridge.

Location and Stream Data		Crossing Characteristics	
Date	2020-09-22	Crossing Sub Type	Bridge
PSCIS ID	NA	Diameter (m)	1.2
External ID	2020092201	Length (m)	12
Crew	AI, KP	Embedded	NA
UTM Zone	11	Depth Embedded (m)	NA
Easting	634969	Resemble Channel	NA
Northing	5484828	Backwatered	NA
Stream	Tributary to Lizard Creek	Percent Backwatered	NA
Road	Lazy Lizard Lower	Fill Depth (m)	NA
Road Tenure	Unknown	Outlet Drop (m)	NA
Channel Width (m)	NA	Outlet Pool Depth (m)	NA
Stream Slope (%)	NA	Inlet Drop	NA
Beaver Activity	No	Slope (%)	NA
Habitat Value	NA	Valley Fill	NA

Photos: 2020092201



Comments: Bike trail.

Location and Stream Data		Crossing Characteristics	
Date	2020-09-23	Crossing Sub Type	Bridge
PSCIS ID	NA	Diameter (m)	1.2
External ID	2020092301	Length (m)	8
Crew	AI, KP	Embedded	NA
UTM Zone	11	Depth Embedded (m)	NA
Easting	636474	Resemble Channel	NA
Northing	5483873	Backwatered	NA
Stream	Tributary to Lizard Creek	Percent Backwatered	NA
Road	Trail	Fill Depth (m)	NA
Road Tenure	Unknown	Outlet Drop (m)	NA
Channel Width (m)	NA	Outlet Pool Depth (m)	NA
Stream Slope (%)	NA	Inlet Drop	NA
Beaver Activity	No	Slope (%)	NA
Habitat Value	NA	Valley Fill	NA

Photos: 2020092301



NO IMAGE AVAILABLE

Comments: Trail. Stream has been diverted to beside the road.

Location and Stream Data		Crossing Characteristics –	
Date	2020-09-23	Crossing Sub Type	Round Culvert
PSCIS ID	NA	Diameter (m)	0.6
External ID	2020092302	Length (m)	14
Crew	AI, KP	Embedded	Yes
UTM Zone	11	Depth Embedded (m)	0.03
Easting	640218	Resemble Channel	Yes
Northing	5481065	Backwatered	No
Stream	Tributary to Elk River	Percent Backwatered	NA
Road	Hill Road	Fill Depth (m)	1.2
Road Tenure	Unknown	Outlet Drop (m)	0
Channel Width (m)	1.5	Outlet Pool Depth (m)	0
Stream Slope (%)	0	Inlet Drop	No
Beaver Activity	No	Slope (%)	0.5
Habitat Value	Low	Valley Fill	Deep Fill

Photos: 2020092302



Comments: Dry vegetated channel. Not likely fish habitat.

Location and Stream Data		Crossing Characteristics	
Date	2020-09-23	Crossing Sub Type	Round Culvert
PSCIS ID	NA	Diameter (m)	0.6
External ID	2020092303	Length (m)	15
Crew	AI, KP	Embedded	No
UTM Zone	11	Depth Embedded (m)	NA
Easting	640227	Resemble Channel	No
Northing	5481028	Backwatered	No
Stream	Tributary to Elk River	Percent Backwatered	NA
Road	Driveway	Fill Depth (m)	1
Road Tenure	Unknown	Outlet Drop (m)	0
Channel Width (m)	1.5	Outlet Pool Depth (m)	0
Stream Slope (%)	2	Inlet Drop	No
Beaver Activity	No	Slope (%)	0.5
Habitat Value	Low	Valley Fill	Deep Fill

Photos: 2020092303



Comments: Dry, mostly vegetated channel. Not likely fish habitat. Two pipes, one buried by fill. Inlet elevated resulting in small area of wetland vegetation upstream.

Location and Stream Data		Crossing Characteristics	
Date	2020-09-23	Crossing Sub Type	Bridge
PSCIS ID	NA	Diameter (m)	1.2
External ID	2020092310	Length (m)	14
Crew	KP, AI	Embedded	NA
UTM Zone	11	Depth Embedded (m)	NA
Easting	636029	Resemble Channel	NA
Northing	5484419	Backwatered	NA
Stream	Tributary to Lizard Creek	Percent Backwatered	NA
Road	Lazy Lizard Lower	Fill Depth (m)	NA
Road Tenure	Unknown	Outlet Drop (m)	NA
Channel Width (m)	NA	Outlet Pool Depth (m)	NA
Stream Slope (%)	NA	Inlet Drop	NA
Beaver Activity	No	Slope (%)	NA
Habitat Value	NA	Valley Fill	NA

Photos: 2020092310



Comments: Nice wooden pedestrian/bike bridge for recreational use.

References

- Allaire, JJ, Yihui Xie, Jonathan McPherson, Javier Luraschi, Kevin Ushey, Aron Atkins, Hadley Wickham, Joe Cheng, Winston Chang, and Richard Iannone. 2020. *Rmarkdown: Dynamic Documents for R*. <https://github.com/rstudio/rmarkdown>.
- Bell, M. C. 1991. "Fisheries Handbook of Engineering Requirements and Biological Criteria." https://www.fs.fed.us/biology/nsaec/fishxing/fplibary/Bell_1991_Fisheries_handbook_of_engineering_requirements.pdf.
- Bramblett, Robert, Mason Bryant, Brenda Wright, and Robert White. 2002. "Seasonal Use of Small Tributary and Main-Stem Habitats by Juvenile Steelhead, Coho Salmon, and Dolly Varden in a Southeastern Alaska Drainage Basin." *Transactions of the American Fisheries Society* 131: 498–506. [https://doi.org/10.1577/1548-8659\(2002\)131<0498:SUOSTA>2.0.CO;2](https://doi.org/10.1577/1548-8659(2002)131<0498:SUOSTA>2.0.CO;2).
- Clarkin, K, A Connor, M Furniss, B Gubernick, M Love, K Moynan, and S WilsonMusser. 2005. "National Inventory and Assessment Procedure for Identifying Barriers to Aquatic Organism Passage at Road-Stream Crossings." United States Department of Agriculture, Forest Service, National Technology and Development Program. <https://www.fs.fed.us/biology/nsaec/fishxing/publications/PDFs/NIAP.pdf>.
- "Fish Inventories Data Queries." 2020. Ministry of Environment and Climate Change Strategy - Knowledge Management. 2020. <http://a100.gov.bc.ca/pub/fidq/welcome.do>.
- Fish Passage Technical Working Group. 2011. "A Checklist for Fish Habitat Confirmation Prior to the Rehabilitation Fo a Stream Crossing." <https://www2.gov.bc.ca/assets/gov/environment/natural-resource-stewardship/land-based-investment/forests-for-tomorrow/checklist-for-fish-habitat-confirmation-201112.pdf>.
- . 2014. "Fish Passage Strategic Approach: Protocol for Prioritizing Sites for Fish Passage Remediation." <https://www2.gov.bc.ca/assets/gov/environment/plants-animals-and-ecosystems/fish-fish-habitat/fish-passage/strategic20approach20july202014.pdf>.

- FLNRORD. 2020a. "Digital Road Atlas (DRA) - Master Partially-Attributed Roads - Data Catalogue." 2020. <https://catalogue.data.gov.bc.ca/dataset/digital-road-atlas-dra-master-partially-attributed-roads>.
- . 2020b. "Forest Tenure Road Section Lines - Data Catalogue." 2020. <https://catalogue.data.gov.bc.ca/dataset/forest-tenure-road-section-lines>.
- Grainger, Karen L. 2011. "2011 Fish Passage Culvert Assessments Within the Rocky Mountain Resource District."
- Masse Environmental Consultants Ltd. 2015. "Fish Habitat Confirmation Assessments â€“ East Kootenay Area Project PD15TFE010."
- MoE. 2011. "Field Assessment for Determining Fish Passage Status of Closed Bottom Structures." BC Ministry of Environment (MoE). <https://www2.gov.bc.ca/assets/gov/environment/natural-resource-stewardship/land-based-investment/forests-for-tomorrow/field-assessment-for-determining-fish-passage-status-of-cbs.pdf>.
- . 2020a. "Fish Inventories Data Queries." Ministry of Environment and Climate Change Strategy - Knowledge Management. 2020. <http://a100.gov.bc.ca/pub/fidq/searchSingleWaterbody.do>.
- . 2020b. "Known BC Fish Observations and BC Fish Distributions." Ministry of Environment and Climate Change Strategy - Knowledge Management. 2020. <https://catalogue.data.gov.bc.ca/dataset/known-bc-fish-observations-and-bc-fish-distributions>.
- . 2020c. "Provincial Obstacles to Fish Passage - Data Catalogue." Ministry of Environment and Climate Change Strategy - Knowledge Management. 2020. <https://catalogue.data.gov.bc.ca/dataset/provincial-obstacles-to-fish-passage>.
- . 2020d. "Stream Inventory Sample Sites." Ministry of Environment and Climate Change Strategy - Knowledge Management. 2020. <https://catalogue.data.gov.bc.ca/dataset/stream-inventory-sample-sites>.
- Norris, Simon. 2020. *Bcfishpass*. Hillcrest Geographics. <https://github.com/smnorris/bcfishpass>.

- Norris, Simon, and Craig Mount. 2016. "Fish Passage GIS Analysis Version 2.2 – Methodology and Output Data Specifications." <https://data.skeenosalmon.info/dataset/bc-fish-passage-program>.
- QGIS Development Team. 2009. *QGIS Geographic Information System*. Open Source Geospatial Foundation. <http://qgis.osgeo.org>.
- Saldi-Caromile, K, K Bates, P Skidmore, J Barenti, and D Pineo. 2004. "Stream Habitat Restoration Guidelines: Final Draft." <https://wdfw.wa.gov/sites/default/files/publications/00043/wdfw00043.pdf>.
- Schweigert, J. F, John Robert Post, Canada, Environment, Iimate Change Canada, Canadian Wildlife Service, and Committee on the Status of Endangered Wildlife in Canada. 2017. *COSEWIC Assessment and Status Report on the Westslope Cutthroat Trout, Oncorhynchus Clarkii Lewisi, Saskatchewan-Nelson River Populations, Pacific Populations, in Canada*. Ottawa: Environment and Climate Change Canada. http://publications.gc.ca/collections/collection_2017/eccc/CW69-14-506-2017-eng.pdf.
- Slaney, P. A, Daiva O Zaldokas, and Watershed Restoration Program (B.C.). 1997. *Fish Habitat Rehabilitation Procedures*. Vancouver, B.C.: Watershed Restoration Program. https://www.for.gov.bc.ca/hfd/library/FFIP/Slaney_PA1997_A.pdf.
- Swales, Stephen, and C. Leving. 1989. "Role of Off-Channel Ponds in the Life Cycle of Coho Salmon (Oncorhynchus Kisutch) and Other Juvenile Salmonids in the Coldwater River, British Columbia." *Canadian Journal of Fisheries and Aquatic Sciences - CAN J FISHERIES AQUAT SCI* 46: 232–42. <https://doi.org/10.1139/f89-032>.
- Thompson, Richard. 2013. "Assessing Fish Passage at Culverts – the Method, Its Metrics and Preliminary Findings from over 4,000 Assessments." https://www2.gov.bc.ca/assets/gov/environment/plants-animals-and-ecosystems/fish-fish-habitat/fish-passage/assessing_fish_passage_at_culverts.pdf.
- VAST Resource Solutions Inc. 2013. "2012 Fish Passage Assessments in BCTS Kootenay Business Area (PD13TFE006)."

http://a100.gov.bc.ca/appsdata/acat/documents/r43047/PD13TFE006_VAST_FinalReport_1405379598103_53

- Xie, Yihui. 2016. *Bookdown: Authoring Books and Technical Documents with R Markdown*. Boca Raton, Florida: Chapman; Hall/CRC.
<https://github.com/rstudio/bookdown>.

