Fish Habitat Assessments for Fish Passage Restoration in the Kootenay Business Area

Project Number PD13TFE005

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1.0 EXECUTIVE SUMMARY

In 2011, a fish passage assessment study conducted within the Kootenay Business Area and Rocky Mountain Resource District identified 19 faulty stream crossings that require restoration work (Grainger, 2012). In August and September 2012, VAST Resource Solutions (VAST) conducted a habitat confirmation study at these 19 locations. Objectives were to validate findings from the 2011 study, assess fish habitat, and evaluate the habitat gain potential upstream of the faulty crossings. This study followed the provincial standards described in "Field Assessment for Determining Fish Passage Status of CBS" (BC MOE, 2011) and "Checklist for Fish Habitat Confirmation" (FPTWG, 2011).

Stream crossings were located in 4 watershed groups: Bull River (BULL), Columbia River (COLR), Elk River (ELKR), and Kootenay River (KOTR). Two provincially blue-listed fish species, Westslope Cutthroat Trout (WCT) and Bull Trout (BT), occur in these watersheds. Other common species include Rainbow Trout (RT), Mountain Whitefish (MW), and Eastern Brook Trout (EB).

Species inventory data, fish habitat value, barrier scoring, and amount of potential habitat gained upstream of faulty crossings were analyzed to produce a ranked list of sites for priority of restoration efforts that would achieve greatest benefit. A total of 6 crossings were identified as high priority for restoration work, while 6 crossings were identified as medium priority and 7 crossings were identified as low priority.

This project was funded by the Forest Investment Account Land Based Investment Program (Projects # PD13TFE005).

2.0 SCOPE OF WORK

The objective of the fish habitat confirmation study was to conduct a qualitative and quantitative assessment of potential gains from habitat restoration work at selected stream crossings. A total of 19 culverts were identified by Grainger (2012) as barriers on known fish-bearing streams with high habitat value. These 19 culverts were further assessed by Vast to validate 2012 culvert assessments, assess the quality of fish habitat and quantify the potential habitat gained by removal/replacement of culverts. Species inventory data, fish habitat value, barrier scoring, and amount of potential habitat gained upstream of faulty crossings were analyzed to produce a ranked list of sites for priority of restoration efforts that would achieve greatest benefit.

3.0 STUDY AREA

The study stream crossings were located throughout the East Kootenay Region in the Elk River, Kootenay River, and Columbia River watersheds. Biogeoclimatic zones in the region range from Ponderosa Pine at low elevations to Englemann Spruce Subalpine Fir at higher elevations. Maps of the study area are presented in Figure 1 and Appendix 1-Figures 1-7. The locations of the assessed crossings are summarized in Table 1.

Figure 1: General map of the study area

Table 1: Summary of locations of assessed stream crossings. Watershed Group codes are denoted as follows: BULL = Bull River, COLR = Columbia River, ELKR = Elk River, and KOTR = Kootenay River.

PSCIS ID	Crossing Reference	Watershed Group	UTM Zone	Easting	Northing	Stream Name	Road Name
-	Linklater05	BULL	11	626673	5435053	Meadow Creek	Meadow Creek Road
-	Linklater16	BULL	11	619606	5430077	Linklater Creek	Linklater Creek Road
50558	Linklater21	BULL	11	624330	5435210	Purcell Creek	Linklater Creek Road
-	Plumbob04	BULL	11	619415	5461376	Plumbob Creek	Teepee
50590	Dunbar01	COLR	11	544555	5626078	Outlet Creek	Cartwright
50604	Frances03	COLR	11	544186	5623066	Frances Creek	Frances Creek
51111	Flathead06	ELKR	11	681763	5448438	Unnamed tributary to Flathead River	Flathead
51122	Flathead15	ELKR	11	681666	5443573	Beryl Creek	Flathead-Border
51174	Howell04	ELKR	11	668173	5456331	Howell Creek	Howell
50453	Cedrus01	KOTR	11	598618	5582200	Cedrus Creek	Kootenay
50548	EFork13	KOTR	11	635530	5555837	East White River	East Fork White River
50549	EFork14	KOTR	11	624689	5560064	Koos Creek	East Fork White River
50557	EFork22	KOTR	11	625761	5560258	Barr Creek	East Fork White River
50558	EFork23	KOTR	11	630240	5559087	Stork Creek	East Fork White River
50560	EFork25	KOTR	11	635522	5556288	East White River	Bull River
50417	White18	KOTR	11	608391	5562508	Ptarmigan Creek	White-Ptarmigan
50418	White19	KOTR	11	606664	5562011	Ptarmigan Creek	White-Ptarmigan
-	White20	KOTR	11	606052	5561979	Ptarmigan Creek	White-Ptarmigan
50437	White28	KOTR	11	601719	5579195	unnamed tributary to White River	White Rock

4.0 METHODS

4.1 Pre-field planning

The first phase of the fish assessment procedure involved planning and preparation to ensure that assessment efforts were focused where fisheries values are the highest in priority watersheds. The extent of the study area and the allocated budget was determined by BCTS through review of assessments conducted by Grainger (2012). The 19 sites selected for the review were assessed by Vast to validate culvert assessments, determine the quality of fish habitat, and to quantify potential fish habitat gain from future restoration efforts and recommendations.

Field investigations were preceded by a review of historical fish distribution and known fish barrier data for the selected watersheds. Information was gathered from the provincial Fisheries Information System (FISS), Habitat Wizard, and iMapBC.

All historical fisheries information was plotted on field maps for each selected watershed (see maps in Appendix 1 Figures 1-7).

4.2 Data Collection

4.2.1 Culvert Assessment

Culvert assessments were completed following the BC MOE and MFLNRO protocols (BC MOE, 2011; FPTWG, 2011) to confirm the fish passage status of each structure and provide recommendations on future culvert replacement/repair work. The information collected using these protocols fall into five broad categories: i) location and overview information; ii) field observations and assessment measurements; iii) stream information; iv) barrier scoring data; and v) recommendations.

A series of parameters, including outlet drop, culvert slope, culvert diameter, and channel width (collected under the field observations and stream information categories), were quantified to assess fish passage. These parameters were used in a fish barrier scoring system to determine the likelihood that the assessed culvert is a barrier to safe fish passage.

4.2.2 Fish Habitat Assessment

Fish habitat upstream and downstream of crossings was assessed based on standard methods described in the "Checklist for Fish Habitat Confirmation Prior to the Rehabilitation of a Stream Crossing" (FPTWG, 2011) and in "Reconnaissance (1:20 000) Fish and Fish Habitat Inventory Standards and Procedures" (BC MOE, 2001). All field observations were photo documented.

The overall habitat quality upstream and downstream of crossings was assessed based on availability of rearing, foraging, spawning, and overwintering habitat. Observers recorded instream habitat types, bed materials, water quality (i.e., water temperature, conductivity, pH, turbidity), cover, stream gradient, water velocity, and presence of fish and invertebrates. The presence of provincially listed and migratory fish species (i.e., WCT and BT) in each watershed was also taken into consideration in assessments of fish habitat quality.

Depending on habitat characteristics and quality, observers walked along the stream for up to 7 km upstream and downstream to identify potential barriers. Photos were taken of barriers and habitat features useful for restoration work consideration. Where historical records indicated the presence of a barrier on a stream (e.g., dam, cascade, log jam, other stream crossing), the location of the barrier was also visited to confirm the persistence of the barrier and assess fish passage.

All fish habitat assessments were conducted by two experienced fish biologists.

4.3 Data Analysis

The following criteria, presented in order of importance, were taken into consideration to prioritize sites for restoration work:

1. Presence of listed species (i.e., BT or WCT) and quality of habitat for these species (migration corridor, spawning site, juvenile rearing habitat)
2. Overall habitat quality
3. Presence of other barriers to fish passage
4. Potential habitat gain (km) based on GIS measurements
5. Cost estimate of restoration work based on fill depth, site accessibility, replacement structure, and potential channel restoration work.

5.0 RESULTS AND RECOMMENDATIONS

The assessments conducted at the 19 sites identified 6 stream crossings as high priority sites for restoration work, 6 as medium priority sites, and 7 as low priority sites. All pictures taken during the assessments are provided in Appendix II.

Table 2 provides a summary of culvert parameters as recorded on the Closed Bottom Structure (CBS) Field Measurement Form (BC MOE, 2011). A ranked list of crossings for priority restoration work based on criteria described in section 4.3 is presented in Table 3. Detailed habitat assessments are summarized in section 5.1 and 5.2.

Table 2: Summary of culvert parameters recorded in the Closed Bottom Structure (CBS) Field Measurement Form (BC MOE, 2011). Valley Fill codes are denoted as 'DF' = Deep Fill, 'SH' = Shallow Fill.

PSCIS ID	Crossing Reference	Diameter (m)	Length/ Width (m)	Cont. Embed-dedment?	Outlet Drop (m)	Outlet Pool Depth	Inlet Drop?	Culvert Slope (%)	Fill Depth (m)	D/S Channel Width (m)	Stream Slope	Beaver Activity?	Fish Obs?	Valley Fill	Habitat Value	Stream Width Ratio
50548	EFork13	1.35	9.90	No	0.40	0.95	No	3.0	0.45	6.76	3.80	No	Yes	DF	High	5.007
50560	EFork25	1.45	12.00	No	0.05	0.62	Yes	2.0	0.65	4.07	3.30	No	Yes	DF	High	2.807
50557	EFork22	1.20	9.50	No	0.39	0.30	Yes	2.0	0.25	3.75	6.80	No	Yes	DF	High	3.074
	Plumbob04	1.62	11.88	No	0.61	0.37	No	2.5	0.40	4.67	1.50	Yes	Yes	DF	Medium	2.883
50558	Linklater21	1.25	14.10	No	0.56	0.86	Yes	1.0	1.50	2.84	4.50	No	Yes	DF	High	1.136
50590	Dunbar01	0.90	9.46	No	0.00	0.33	Yes	8.5	0.40	6.16	3.00	No	Yes	DF	High	6.844
50604	Frances03	0.90	6.17	No	0.31	0.04	No	4.0	0.20	7.34	2.00	No	No	DF	Medium	8.165
50558	EFork23	2.60	12.10	No	0.75	1.15	No	3.5	0.45	5.76	7.67	No	No	DF	Medium	2.215
	Linklater16	1.55	18.00	No	0.00	0.56	Yes	3.0	1.30	3.40	14.00	No	Yes	DF	Medium	2.194
50453	Cedrus01	3.40	30.59	No	0.85	0.64	No	6.0	4.00	4.00	5.50	No	Yes	DF	Medium	1.176
51111	Flathead06	0.90	33.00	No	1.90	0.95	No	2.4	9.99	2.59	4.25	Yes	No	DF	Medium	2.878
51122	Flathead15	0.60	12.20	No	0.30	0.80	No	1.5	0.70	3.60	2.00	Yes	Yes	DF	Medium	6.000
50437	White28	1.60	20.00	No	1.40	0.50	Yes	6.0	2.20	4.85	7.00	No	No	DF	Low	3.031
51174	Howell04	2.00	12.00	No	0.55	1.40	Yes	3.0	1.13	3.96	3.00	No	No	SF	Low	1.980
	Linklater05	1.10	7.50	No	0.30	0.24	No	1.0	0.50	3.46	1.00	Yes	Yes	DF	Low	3.145
50549	EFork14	1.35	9.00	Yes	0.08	0.15	No	2.4	1.60	2.32	8.13	No	Yes	DF	Low	1.719
50417	White18	2.15	24.25	No	0.00	0.80	Yes	7.5	1.18	2.50	13.00	No	No	DF	Low	6.047
50418	White19	0.93	18.09	No	0.00	0.80	No	5.0	0.80	3.10	9.50	No	No	DF	Low	10.215
50419	White20	2.1	14.12	No	0.45	0.6	Yes	5	1.04	2.80	8.00	No	No	DF	Low	3.810

Table 3: Ranked list of priority sites for restoration work

PSCIS ID	My Crossing Reference	Culvert Assessment (Barrier Score)	Listed species occurring in watershed	Significance of instream habitat for listed species	Overall Fish Habitat Value	Other permanent barriers on stream?	Habitat Gain Potential (km)	Cost estimate of restoration work	PRIORITY
50548	EFork13	Barrier (36)	WCT, BT	Critical	High	None	8	High	HIGH
50560	EFork25	Barrier (21)	WCT, BT	Critical	High	None	8	High	HIGH
50557	EFork22	Barrier (31)	WCT, BT	Important / Critical	High	Some persistent debris	8.5	Low	HIGH
-	Plumbob04	Barrier (31)	WCT, BT	Important / Critical	High	Beaver dams	27	Moderate	HIGH
50558	Linklater21	Barrier (28)	WCT, BT	Important	High	No	7.6	Low	HIGH
50590	Dunbar01	Barrier (26)	WCT	Important	High	Some persistent debris	2	High	HIGH
50604	Frances03	Barrier (36)	WCT	Important	Medium	Beaver dams	5	Low	MEDIUM
50558	EFork23	Barrier (36)	WCT, BT	Important	Medium	Cascades (~0.5m)	9.2	Low	MEDIUM
-	Linklater16	Barrier (29)	WCT, BT	Important	Medium	Cascades (~1m)	6	Moderate	MEDIUM
50453	Cedrus01	Barrier (39)	WCT, BT	Important	Medium	Some persistent debris	13	High	MEDIUM
51111	Flathead06	Barrier (37)	WCT, BT	Important	Medium	Cascades (~1m)	9.5	High	MEDIUM
51122	Flathead15	Barrier (31)	WCT, BT	Important / Marginal	Medium	Beaver dams	11.1	Low	MEDIUM
50437	White28	Barrier (39)	WCT, BT	Marginal	Low	Cascades (~1.2m)	6.1	High	LOW
51174	Howell04	Barrier (36)	WCT, BT	Marginal	Low	Cascades (~2m)	12.8	High	LOW
-	Linklater05	Barrier (26)	WCT, BT	Marginal	Low	Beaver dams	17	Low	LOW
50549	EFork14	Potential (16)	WCT, BT	Marginal	Low	Some persistent debris	3.8	Low	LOW
50417	White18	Barrier (23)	WCT	Marginal	Low	Persistent debris	6.5	Low	LOW
50418	White19	Barrier (23)	WCT	Marginal	Low	Ephemeral section	6.5	Low	LOW
50419	White20	Barrier (30)	WCT	Marginal	Low	Ephemeral section	5.8	Low	LOW

5.1 High Priority Sites

5.1.1 EFork 25 and EFork 13 (PSCIS ID 50548 and 50560)

Habitat:
Stream crossings EFork 25 and EFork 13 are located on the East White River, one of the three branches of the White River, which originates in Height of The Rockies Provincial Park. The White River is 65 km long and flows into the Kootenay River east of Canal Flats, BC. It is a highly productive stream that hosts a diverse fish community. In particular, the three forks of the White River offer critical spawning habitat to local BT populations, a blue-listed species (the status of BT is currently under review by COSEWIC as an addition to the Species at Risk list). Angling on the White River watershed is subject to Classified Waters Regulation.

Upstream Habitat: EFork 25 and EFork 13 are located approximately 700 and 200 m, respectively, downstream of Munroe Lake, the headwater of the East White River. The lake hosts a stocked population of WCT and offers excellent rearing, feeding, and overwintering habitat. This habitat is not available to East White River fish due to faulty culverts at EFork 25 and EFork 13. No barrier was found between the crossings and Munroe Lake. At both locations, the original stream channel morphology directly upstream of the crossings has been altered resulting in large impounded areas, approximately 40 m wide and 70 m long. A number of adult and juvenile WCT were observed foraging in these impoundments.

Downstream Habitat: Instream habitat in the vicinity of the two culverts is a combination of slow riffles and runs with good fish cover provided by rocky substrate, large woody debris, and some undercut banks. The dominant substrate type is cobble (D_{90}=15 cm) and provides good salmonid spawning habitat.

Approximately 7 stream kilometers were assessed downstream of Munroe Lake. No permanent barrier was found. A beaver dam reported approximately 6 km downstream of EFork25 is no longer a barrier to fish migration.

At the time of the survey, numerous adult BT were observed spawning along the 5 km stretch of the East White River directly downstream of EFork 25. Although Munroe Lake does not offer good spawning habitat for this species, rearing and overwintering habitat would highly benefit juvenile BT should the access to the lake be restored.

Culvert Assessment:
EFork 13 (Appendix I – Fig.4; Appendix II) is a closed bottom structure approximately 9.90 m in length, 1.35 m in diameter, with a fill depth of 0.45 m. The culvert is not embedded and the outlet is perched at 0.25 m above the current water level (outlet drop = 0.40 m) creating a barrier to juvenile and some adult fish species. Boulders added near the outlet suggest that backwatering of the structure was attempted but was not successful.

EFork 25 (Appendix I – Fig.4; Appendix II) is a closed bottom structure of 12.00 m in length and 1.45 m in diameter with a fill depth of 0.45 m at the inlet and 0.85 m at the outlet. Although the outlet is not perched, this culvert is not properly embedded, which results in a velocity barrier for juvenile fish. Boulders added near the outlet suggest that backwatering of the structure was attempted but was not successful.

Recommendations:
Culverts at EFork13 and EFork25 should be replaced by bridge structures. Based on the downstream channel width measured at both sites, we estimate that the span of the two structures should be at least

9.00 m. Alternatively, low profile arch structures could be used given the relatively low stream gradient. Following replacement of the culvert, some stream restoration work should be conducted upstream of the structures where impoundments have altered the original instream habitat.

5.1.2 EFork 22 (PSCIS ID: 50557)

Habitat:
The culvert is located on Barr Creek, approximately 100 m upstream of the confluence with the East White River. There is no barrier downstream of the culvert. Numerous mature BT were observed on the East White River mainstem in the vicinity of the Barr Creek confluence.

Upstream Habitat: Approximately, 2 km of stream were surveyed upstream of the crossing. Numerous deep pools offer good rearing and overwintering habitat. The substrate, dominated by small cobble, offers fair to good spawning habitat for salmonids. Substrate and water temperature measured at the time of the survey were suitable for BT spawning. Small cascades created by woody debris are located immediately upstream of the crossing but do not represent permanent barriers to fish passage. A more significant cascade (height approx. 90 cm) was observed 350 m upstream of the crossing but is not a permanent barrier. Adult and juvenile WCT were observed throughout the stream.

Downstream Habitat: The short downstream section before the confluence with the East White River offers similar instream habitat as upstream. No barrier was observed.

Culvert Assessment:
The crossing consists of two 1.20 m culverts that are not embedded creating a velocity barrier. One of the culverts also has a 0.39 m outlet drop, further hindering fish passage. The fill depth is only 0.25 m, which should facilitate restoration work.

Recommendations:
Due to a stream gradient greater than 5%, a bridge should be considered to replace the current culverts. Based on the measured channel width, we estimate that the structure span should be at least 6.00 m.

5.1.3 Plumbob04 (PSCIS ID: -)

Habitat:
The crossing is located on Plumbob Creek, which flows into Koocanusa Reservoir. Known fish species occurring in the creek include BT, WCT, and EB. Adult BT were recorded in the stream in 1977 and again in 1990 but juveniles of this species were never found in the watershed.

Upstream Habitat: The instream habitat upstream of the crossing is composed of shallow riffle-run successions with few deep pools. Cover is provided by undercut banks, overhanging vegetation, and large woody debris. Substrate is dominated by gravel and cobble with some sand present. Overall, Plumbob Creek offers fair rearing and spawning habitat but overwintering habitat is poor. Adult and juvenile WCT were spotted throughout the watershed. Approximately 7km of stream were surveyed. A number of persistent beaver dams were observed 2.6 km upstream of the crossing. Significant beaver activity in the area may affect the effectiveness of restoration work.

Downstream Habitat: A series of small cascades have been reported 100 m from the confluence with Kookanusa Reservoir but are not barriers to fish. Approximately 500 m of stream were assessed downstream of the crossing. Habitat was similar to upstream reaches.

Culvert Assessment:
The structure consists of a 1.60 m diameter round culvert. It is not embedded and the outlet is perched at 0.61 m, creating an impassable barrier. The crossing is located on Teepee Road, a major logging road.

Recommendations:
Although it is not clear whether Plumbob Creek provides spawning habitat to Koocanusa BT, the Plumbob04 stream crossing should be replaced in order to restore fish access to the upper reach of the creek. A low profile arch structure would likely be more suitable than a bridge at this location as it will not restrict the effective width of the road. Based on the measured channel width, the diameter of the structure should be at least 5.00 m.

5.1.4 Linklater21 (PSCIS ID: 50558)

Habitat:
The crossing is located on Purcell Creek, a tributary to Linklater Creek, which flows into Koocanusa Reservoir and is a known BT spawning stream.

Upstream Habitat: Approximately 1.2 km of stream were assessed upstream of the culvert. Instream habitat is composed of a riffle-pool system with suitable spawning substrate and excellent cover provided by undercut banks, overhanging vegetation, and woody debris. The stream is highly suitable for spawning and rearing of salmonids, including BT. However, overwintering habitat is poor due to the lack of deep pools. Salmonid fry were observed in pool habitat. Persistent debris created a small cascade 200 m upstream of the crossing but it is not a permanent barrier. Other small cascades created by persistent debris were observed but no permanent barrier was found on the stream.

Downstream Habitat: Downstream habitat was similar to the upstream section. Salmonid fry were observed in pool habitat. A bridge crossing is located where Meadow Creek Road crosses Purcell Creek (km 45.9). No barrier was observed.

Culvert Assessment:
The crossing consists in two 1.25 m culverts with a 0.56 m outlet drop. The crossing is impassable to fish. The fill depth is 1.50 m and can be easily excavated.

Recommendations:
Due to the relatively low stream gradient, an arch or pipe arch structure may be suitable at this location. The small impoundment observed directly upstream of the crossing indicates that the current structure is undersized. The diameter/span of the replacement structure should be greater than 2.50 m.

5.1.5 Dunbar01 (PSCIS ID: 50590)

Habitat:
The crossing is located on Outlet Creek, which connects Big Fish Lake to Dunbar Creek. Known fish species occurring in the watershed include WCT, RT, and EB.

Upstream Habitat: Approximately 1.5 km of stream were assessed upstream of the crossing. Instream habitat in Outlet Creek offers excellent rearing and spawning opportunities for salmonids. The channel comprises low gradient riffle-runs with excellent spawning substrate. Cover is provided by some deep pools, woody debris and over-hanging vegetation. Abundant periphyton and aquatic insects indicate a high level of productivity. Adult and juvenile salmonids were observed throughout.

Big Fish Lake is located approximately 1.5 km upstream of the crossing and provides excellent foraging and overwintering habitat. The lake was stocked with WCT between 1938 and 1990 and with triploid RT in 2009 and 2010.

A large impounded area is located immediately upstream of the faulty crossing resulting in significant alterations of the original channel.

Downstream Habitat: Downstream habitat was similar to the upstream section. Near the confluence with Dunbar Creek (approx. 500 m downstream of crossing), Outlet Creek enters an extensive wetland complex with important beaver activity.

Culvert Assessment:
The crossing consists of two 0.90 m round culverts. The two structures are heavily deteriorated. Water seeps under one of the structures through the road fill. The culverts are not embedded, creating a velocity barrier to upstream fish movement. The large impoundment upstream of the crossing and evidence of scouring on the road indicate that the structure is significantly under-sized.

Recommendations:
We recommend that the current structures be replaced by a bridge crossing. Based on the measured channel width of 6.16 m, we estimate that the span of the bridge should be at least 8.00 m. Although the habitat gain potential is only 2 km at this location, restoring fish access to Big Fish Lake would represent a significant gain of foraging, rearing, and overwintering habitat for the Dunbar Creek Watershed fish community.

5.2 Medium and Low Priority Sites

5.2.1 Frances03 (PSCIS ID: 50604)

Habitat:
The crossing is located on an unnamed stream that connects Frances Creek and Leadqueen Lake.

Upstream Habitat: The substrate is dominated by sand and gravel. Significant cover for fish is provided by abundant large woody debris and overhanging vegetation. There are no barriers along the stream until the confluence with Frances Creek, located approximately 300 m downstream from the culvert. Overwintering habitat is poor (pool depth=0.5 m). Some good rearing habitat is available upstream of the crossing. Spawning habitat is low to fair due to the presence of fine sediments. Juvenile cyprinids were observed throughout the stream. Approximately 300 m upstream, the riparian vegetation opens to a meadow. The outlet of Leadqueen Lake is obstructed by an old beaver dam. The lake is shallow and was stocked with WCT between 1938 and 1988. The habitat is suitable for cyprinids but only marginally suitable for salmonids. The lake offers some overwintering opportunity but upstream access is limited by the beaver dam.

Downstream Habitat: Downstream habitat is similar to the upstream section although substrate has a higher cobble component. No barrier was found between the crossing and the nearby confluence with Frances Creek.

Culvert:
The culvert is not embedded and slightly perched (0.31 m) creating a barrier to juvenile and some adult fish.

Recommendation:
This site was given a medium priority due to the limited availability of habitat upstream. However, the stream provides important (not critical) rearing habitat for Frances Creek fish and Leadqueen Lake may provide overwintering habitat. Replacement with 1.5 m simulated substrate culvert is recommended.

5.2.2 EFork23 (PSCIS ID: 50558)

Habitat:
The crossing is located on Stork Creek, 200 m upstream of the confluence with the East Fork White River. The East Fork White River has a high gradient with white water occurring at the confluence. However, it becomes braided with low gradient immediately upstream of the confluence with Stork Creek, offering prime spawning habitat for BT.

Upstream Habitat: Approximately 3.5 km of stream were surveyed upstream of the crossing. The instream habitat is characterized by a step-pool channel morphology and an average stream gradient of 8% with the substrate dominated by boulders. A number of small cascades (0.50 m height) were observed but were not permanent barriers to fish. The undefined channel and abundant large woody debris observed upstream of the crossing indicated some recent disturbance in the watershed. In fact, the riparian area has been heavily damaged by cable logging across the creek near the road crossing on Stork Creek, which caused abundant debris to enter the creek. The stream offers some spawning habitat but rearing and overwintering habitat quality upstream of the crossing are fair to poor due to the scarcity of deep pools and the high water velocity. No fish were observed upstream of the crossing.

Downstream Habitat: The short downstream section offers similar habitat as the upstream. No barrier was found.

Culvert:
Culvert is perched (0.75 m) and impassable.

Recommendation:
We recommend that this site be assigned a medium replacement priority. Although instream habitat availability is limited, the site is in close proximity to an important BT migration corridor and may be used by this species. The current structure should be replaced by a bridge crossing due to the relatively high stream gradient with a span of at least 8.00 m.

5.2.3 Linklater16 (PSCIS ID: -)

Habitat:
This reach of Linklater Creek has a high gradient stream with numerous cascades, large boulders, and overhanging vegetation.

Upstream Habitat: The overwintering habitat is fair to poor due to the scarcity of deep pools (maximum pool depth=0.45 m). Good WCT habitat is available, particularly upstream of the culvert where adult and juveniles were observed. The substrate material is too large for BT spawning. Abundant periphyton and invertebrates were observed, indicating good productivity. A 0.9 m cascade with bedrock was observed 20 m upstream of the crossing.

Downstream Habitat: The downstream section has a higher stream gradient than upstream. A 1 m high cascade is located approximately 50 m downstream of the culvert.

Culvert:
The crossing is located at relatively high elevation near the headwaters of Linklater Creek. The culvert is not embedded, creating a velocity barrier.

Recommendation:
The instream habitat upstream of the crossing is important to the local WCT population yet not critical. Due to the presence of cascades and bedrock, we recommend assigning a medium replacement priority to this crossing. The current culvert should be replaced by a bridge structure (with a span > 6.00 m)

5.2.4 Cedrus01 (PSCIS ID: 50453)

Habitat:
The crossing is located on Cedrus Creek, an Upper Kootenay River tributary.

Upstream Habitat: Approximately 2.5 km of stream were assessed. The substrate is highly embedded and compacted due to the high clay content. Falls (height=1.2 m) created by persistent debris were found 200 m upstream of the culvert. Overall fish habitat quality is good; good overwintering habitat (deep pools with depths of approximately 1.0 m); spawning habitat quality is fair (the presence of WCT fry indicate that the species successfully spawn here); rearing habitat is good with a complex mix of habitat types. The proximity of the Kootenay River to the stream adds to the value of rearing habitat. Adult and fry WCT were observed throughout stream.

Downstream Habitat: The downstream section provides similar habitat as the upstream. Approximately 400 m of stream were assessed. No barrier was found.

Culvert:
The pipe arch culvert is perched (0.85 m) and is a definite barrier to fish. The anticipated replacement costs are high due to the very deep fill on top of the culvert.

Recommendation:
The upstream section offers important habitat to WCT but is not critical. The high fill depth above the culvert and the presence of an upstream barrier would limit the cost-effectiveness of restoration work. Replacement with an arch structure (with a span of at least 5.00 m) is recommended.

5.2.5 Flathead06 (PSCIS ID: 51111)

Habitat:
The crossing is located on a small unnamed tributary to the Flathead River.

Upstream Habitat: The stream has a moderate gradient with a cobble and boulder substrate and a thick riparian zone. The upstream section is characterized by cascade-pool habitats with numerous cascades (height=0.6-1.00 m) created by persistent debris. A small lake is located in the head water but could not be reached during the assessment. Reconnection with the mainstem could create habitat for mainstem juvenile fish. Overwintering, rearing, and spawning habitat are fair. Excellent habitat is offered for WCT but no fish were observed.

Downstream Habitat: Stream gradient on the downstream section is lower than upstream. The section was assessed from the culvert to the confluence with the Flathead River. No barrier was found.

Culvert:
The confluence is located approximately 200 m downstream of the crossing. The culvert is perched (1.9 m) and the fill depth is extremely high (approximately 10.0 m).

Recommendations:
Due to the extreme fill depth of the culvert, we suggest that the site be assigned a medium priority for restoration. However, the upstream habitat is suitable for WCT and may also be used by Flathead River BT. Replacement with an open bottom arch (with a span of at least 4.00 m) is recommended.

5.2.6 Flathead15 (PSCIS ID: 51122)

Habitat:
The crossing is located on Beryl Creek, a tributary of the Flathead River. Beryl Lake is located approximately 500 m upstream of the crossing.

Upstream Habitat: The upstream habitat is characterized by low gradient with abundant fine sediment and large woody debris. There is significant beaver activity throughout the area. A beaver dam is located 50 m upstream of the culvert. The upstream habitat is impounded with high fine sediment and macrophytes (*Myriophyllum*). Adult EB were observed in the beaver impoundment. The upstream habitat is a network of shallow channels and beaver ponds. Beryl Lake is shallow with limited overwintering habitat available. Overall habitat quality for salmonids is low due to poor overwintering habitat, negligible spawning opportunities, and only fair rearing habitat.

Downstream Habitat: The downstream section offers similar habitat as upstream with low stream gradient and large beaver impoundments.

Culvert:
The crossing consists of two round culverts. The left downstream culvert is not embedded but is not an impassable barrier due to its low gradient. The right downstream culvert is perched approximately 0.30 m.

Recommendation:
We recommend assigning a low-medium replacement priority to this crossing. Although the stream provides some rearing habitat and is connected to the Flathead River, the lack of overwintering or spawning habitat, and the high level of beaver activity in the area would significantly limit the effectiveness of the restoration work. Replacement with an arch structure is recommended (greater than 5.00 m).

5.2.7 White28 (PSCIS ID: 50437)

Habitat:
The crossing is located on an unnamed tributary of the White River, approximately 1.5 km upstream of its confluence.

Upstream Habitat: Numerous cascades and pools were observed along the stream. Overall fish habitat quality is low to fair due to poor spawning habitat and the presence of multiple barriers. Overwintering habitat is fair due to numerous deep pools (average pool depth = 0.40 m). No fish were observed.

Downstream Habitat: Numerous cascades were observed downstream of the crossing with a maximum height of 1.20 m. Similar to the upstream section, the substrate has a high clay content, resulting in high embeddedness and compaction.

Culvert:
The outlet is perched at 1.40 m, creating an impassable barrier.

Recommendations:
Due to the high fill depth and marginal fish habitat quality, we suggest assigning a low replacement priority to this stream crossing. Replacement with a bridge structure (with span of at least 6.00 m) is recommended.

5.2.8 Howell04 (PSCIS ID: 51174)

Habitat:
The crossing is located on Howell Creek, a tributary to the Elk River.

Upstream Habitat: The substrate is dominated by bedrock and numerous small cascades (approximately 0.7-1.0 m high) were observed. The stream washes out the road at approximately 1.93 km upstream from the culvert. A 2.00 m high waterfall (>20% gradient) was also located at the washout area. The upstream slope increases significantly as the stream transitions from bedrock-riffle-pool (long riffle, shallow pool stretches) to step-pool (with shallow pools) and cascade-pool areas. Overwintering habitat is fair to poor. Spawning habitat is poor due to the presence of bedrock. Rearing habitat is fair. No fish were observed.

Dowsntream Habitat: Approximately 500 m of stream were assessed downstream of the crossing. Numerous bedrock cascades (0.7 to 1.0 m high) were noted and no fish were observed. The presence of waterfalls beyond the assessed section is very likely.

Culvert:
The culvert is perched (0.55 m) and has a fill depth of greater than 1.00 m. The site is made up of shallow fill with large expanses of bedrock.

Recommendation:
A low priority should be given to the replacement of this crossing due the presence of bedrock, which would impede embeddedment of the new structure. Multiple impassable barriers were also observed. Replacement with a bridge structure (with a span of at least 5.00 m) is recommended.

5.2.9 Linklater05 (PSCIS ID: -)

Habitat:
The crossing is located on Meadow Creek, a tributary to Linklater Creek. The channel has a low stream gradient and the substrate is dominated by organic material and silt. The crossing is located in a large wetland complex. Important beaver activity is present both upstream and downstream.

Upstream Habitat: Approximately 4 km of stream were assessed upstream of the crossing. Upstream fish habitat is only marginally suitable for native salmonid species. The water temperature at the time of the survey was 17.5 °C. Overwintering and spawning habitat is negligible. Rearing habitat is poor for WCT but is suitable for EB and cyprinids.

Downstream Habitat: A beaver dam was observed immediately upstream of the confluence with Linklater Creek. The rest of the downstream section offers similar habitat as upstream characterized by low gradient and fine sediments.

Culvert:
The double culverts do not appear to be an impassable fish barrier – the culverts are not embedded but passage is possible due to the low velocity in the culverts. Scour on the road surface indicates that the structures are undersized and cannot accommodate spring high flows.

Recommendation:
Due to the low fish habitat quality for native salmonid species, the replacement of this stream crossing structure should be treated as a low priority. A substrate simulation culvert with a span of at least 5.00 m would be a suitable replacement at this site.

5.2.10 EFork14 (PSCIS ID: 50549)

Habitat:
The crossing is located on Koos Creek, a small tributary to the East White River. The overall fish habitat quality on Koos Creek is poor.

Upstream Habitat: The crossing is located at a reach break where stream gradient increases from 2% to 12%. The substrate is dominated by fine sediments. Abundant large woody debris is present. Overwintering and spawning habitat are poor due to the lack of deep pools and suitable substrate. However, WCT fry were observed in the upper reaches suggesting that the species manages to spawn in the creek. The water has high conductivity (370 μS) due to the high amount of organic matter. The riparian area was heavily impacted by logging.

Downstream Habitat: The downstream habitat has low stream gradient with a high fine sediment component. This reach only offers poor to fair rearing habitat. There is no barrier between the culvert and the confluence with the East White River.

Culvert:
The culvert is only partly embedded but is not a significant barrier to fish since it has low velocity. The road fill material was observed to be spilling over the culvert and is slowly covering the outlet.

Recommendation:
Due to the low fish habitat quality, the assigned priority for replacement of this culvert should be low. A bridge would be a suitable replacement structure (with a span of at least 4.00 m) due to the high stream gradient at this crossing location.

5.2.11 White18, White19, and White20 (PSCIS ID: 50417, 50418, 50419)

Habitat:
The three crossings are located on Ptarmigan Creek, a small tributary to White River. Ptarmigan Lake is the headwaters of the creek and the lake was stocked with WCT until 1986.

Upstream Habitat: The creek is relatively steep with many barriers (up to 1 m high) that likely impede upstream fish movement. The substrate is dominated by cobbles with a significant fine sediment component. Few pools are available. An extremely large amount of persistent debris caused by avalanche and wildfire at km 38 fills up the creek channel for approximately 400 m. Further upstream, the stream becomes ephemeral and the creek channel was dry. The riparian area is heavily impacted by logging.

Dowsntream Habitat: Downstream of White18, instream habitat is similar to the upstream section with high stream gradient and numerous cascades and persistent debris likely impeding fish passage. No fish were observed. Approximately 750 m of stream were assessed downstream of White18.

Culverts:
The stream channel at the two further upstream crossings was dry. The three culverts are not properly embedded likely resulting in velocity barriers to juvenile fish.

Recommendation:
Restoration work on this creek is low priority due to the particularly poor fish habitat quality. Replacement by open bottom arch structures (with spans of at least 4.00 m) is recommended.

6.0 CONCLUSIONS

Table 4 summarizes recommendations for culvert replacement or repair of the 19 faulty culverts assessed in the BCTS Kootenay Business Area as part of project PD13TFE005.

Table 4: Summary of prioritization of site restoration work and recommended replacement structures. Sites are listed in order of decreasing priority.

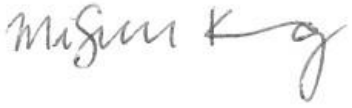
PSCIS ID	My Crossing Reference	PRIORITY	Recommendation	Proposed Span / Diameter
50548	EFork13	HIGH	Bridge	>9m
50560	EFork25	HIGH	Bridge	>9m
50557	EFork22	HIGH	Bridge	>6m
-	Plumbob04	HIGH	Low profile arch	5 m
50558	Linklater21	HIGH	Low profile arch	2.5 m
50590	Dunbar01	HIGH	Bridge	8 m
50604	Frances03	MEDIUM	Simulated Substrate	1.5 m
50558	EFork23	MEDIUM	Bridge	>8 m
-	Linklater16	MEDIUM	Bridge	>6m
50453	Cedrus01	MEDIUM	Arch	5 m
51111	Flathead06	MEDIUM	Arch	4 m
51122	Flathead15	MEDIUM	Low profile arch	5 m
50437	White28	LOW	Bridge	6 m
51174	Howell04	LOW	Bridge	>5m
-	Linklater05	LOW	Simulated Substrate	2.5 m (x2); total = 5.0 m
50549	EFork14	LOW	Bridge	>4 m
50417	White18	LOW	Arch	>4 m
50418	White19	LOW	Arch	>4 m
50419	White20	LOW	Arch	>4 m

7.0 CLOSURE

This report has been prepared in accordance with generally accepted biology practices in British Columbia. Vast trusts that this report satisfies the requirements of BCTS and the FPTWG. Should BCTS or FPTWG have any comments, please contact us at your convenience.

Yours truly,

Prepared By:



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REFERENCES

BC Fisheries and Fisheries and Oceans Canada. Fisheries Information Summary System (FISS). Available from: http://a100.gov.bc.ca/pub/fidq/main.do;jsessionid=cdb2ed5343122f3e0456b2c4cfc28ad8cadf1e621192bb66dfe9675e2361d11c.e3uMah8KbhmLe34Lc3yOc3aLc3f0n6jAmljGr5XDqQLvpAe

BC Fisheries Information Services Branch. 2001. Reconnaissance (1:20 000) Fish and Fish Habitat Inventory Standards and Procedures. Version 2.0. Available from: http://archive.ilmb.gov.bc.ca/risc/pubs/aquatic/recon/recce2c.pdf

BC Ministry of Environment. 2011. Field Assessment for Determining Fish Passage Status of Closed Bottom Structures. 4 th Edition, August 2011. Available from: www.for.gov.bc.ca/ftp/hcp/external/publish/web/fia/Field-Assessment-for-Determining-Fish-Passage-Status-of-CBS.pdf

BC Ministry of Environment. 2011. Provincial Stream Crossing Inventory System (PSCIS) User Guide, July 2011. Available from: www.for.gov.bc.ca/ftp/hcp/external/publish/web/fia/PSCIS-User-Guide.pdf

BC Ministry of Environment. Habitat Wizard. Available from: www.env.gov.bc.ca/habwiz/

BC Ministry of Environment. Ecocat. Available from: www.env.gov.bc.ca/ecocat/

Fish Passage Technical Working Group, BC Ministry of Forests, Lands, and Natural Resource Operations. 2011. A Checklist for Fish Habitat Confirmation Prior to the Rehabilitation of a Stream Crossing. December 2011. Available from: http://www.for.gov.bc.ca/ftp/HCP/external/!publish/Web/FIA/Checklist-for-fish-habitat-confirmation-201112.pdf

Government of British Columbia. 2012. iMapBC. Available from: webmaps.gov.bc.ca/imfx/imf.jsp?site=imapbc

Grainger, KL. 2012. 2011 Fish Passage Culvert Assessments within the Rocky Mountain Resource District. Prepared for Ministry of Forests, Lands and Natural Resource Operations, BC Timber Sales, Kootenay Business Area.

APPENDIX I: FIELD MAPS

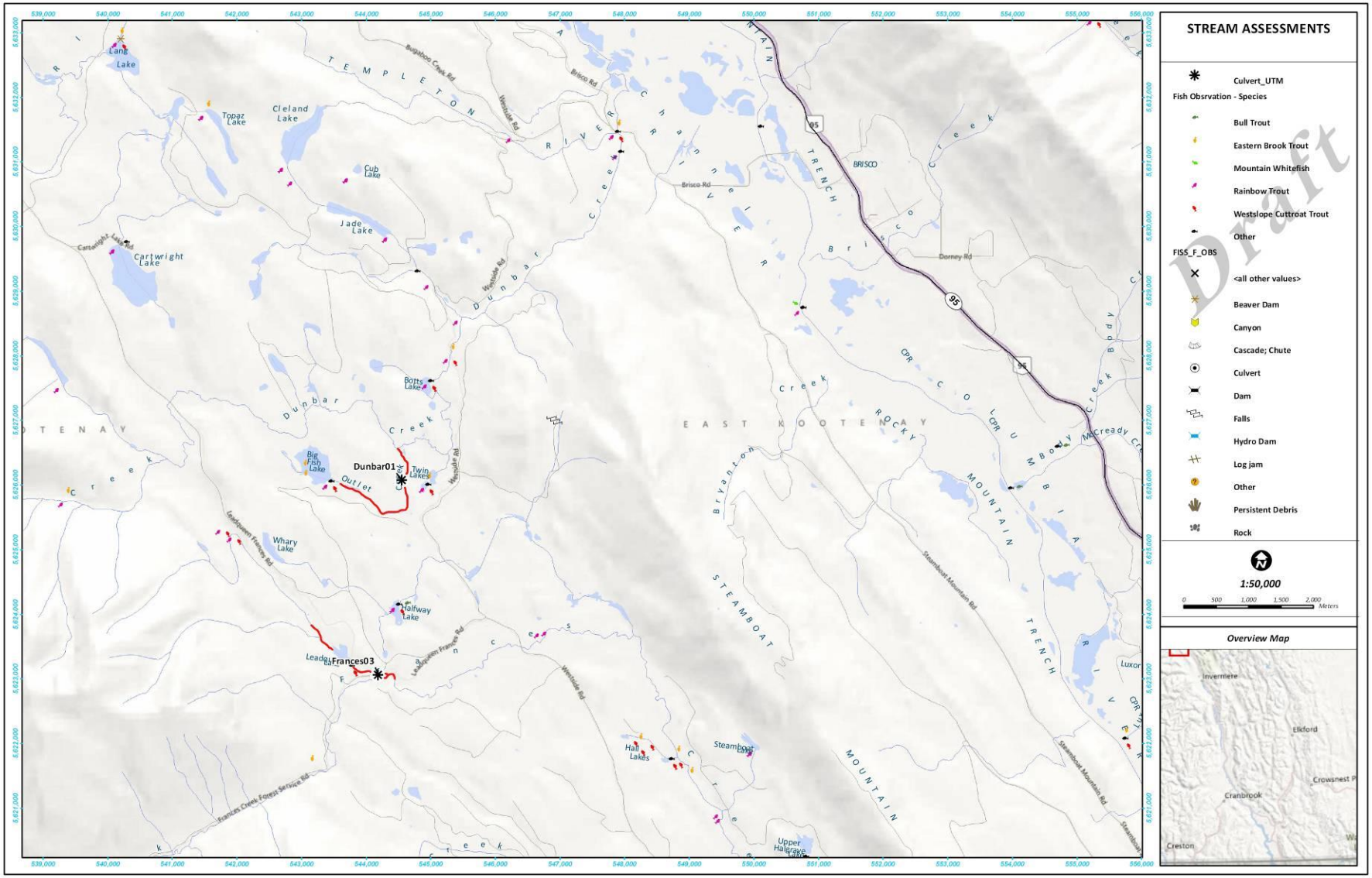


Figure 1: Study area of Dunbar01 and Frances 03. Red lines indicate lengths of stream assessed.

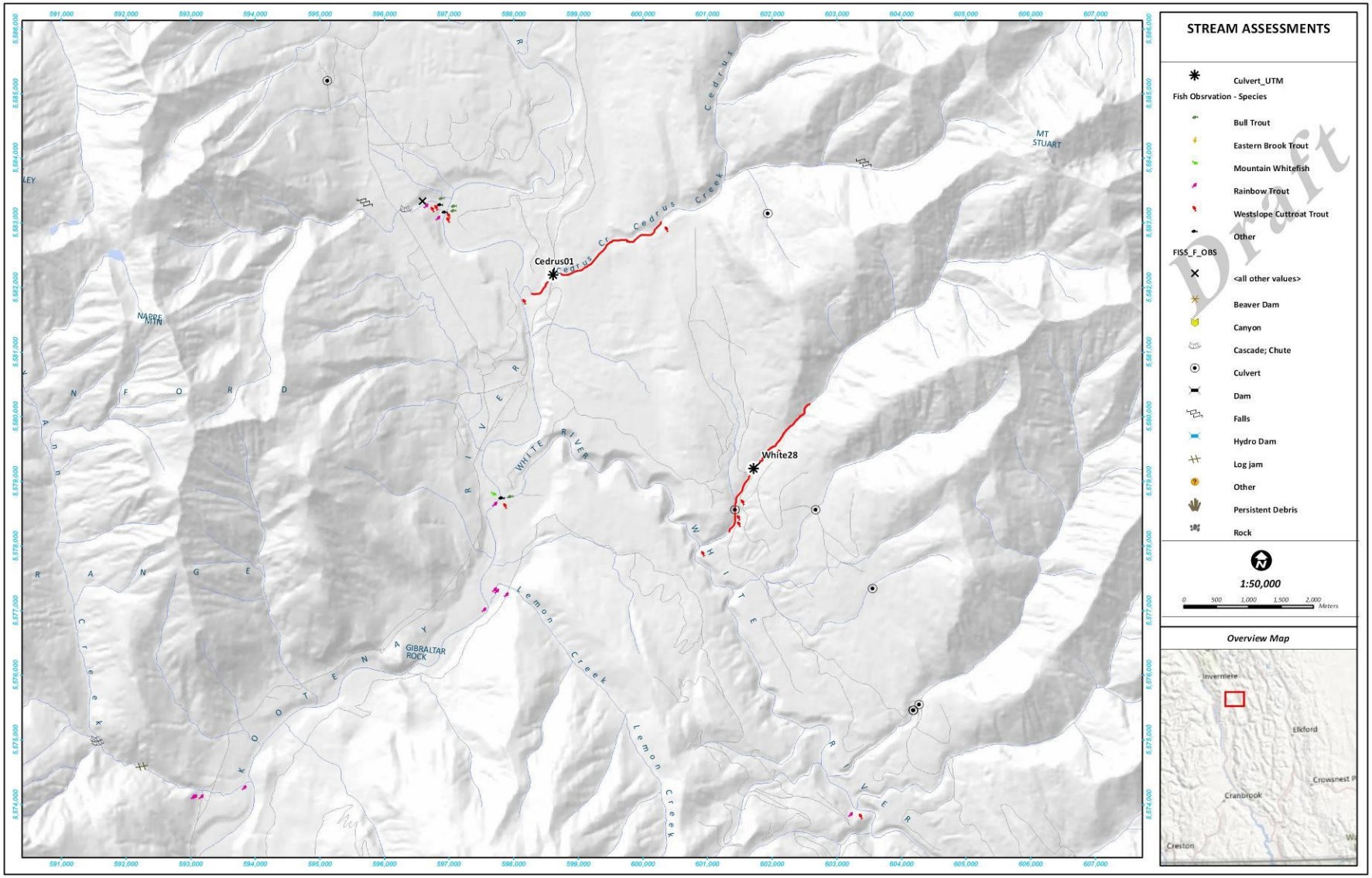


Figure 2: Study area of Cedrus01 and White28. Red lines indicate lengths of stream assessed.

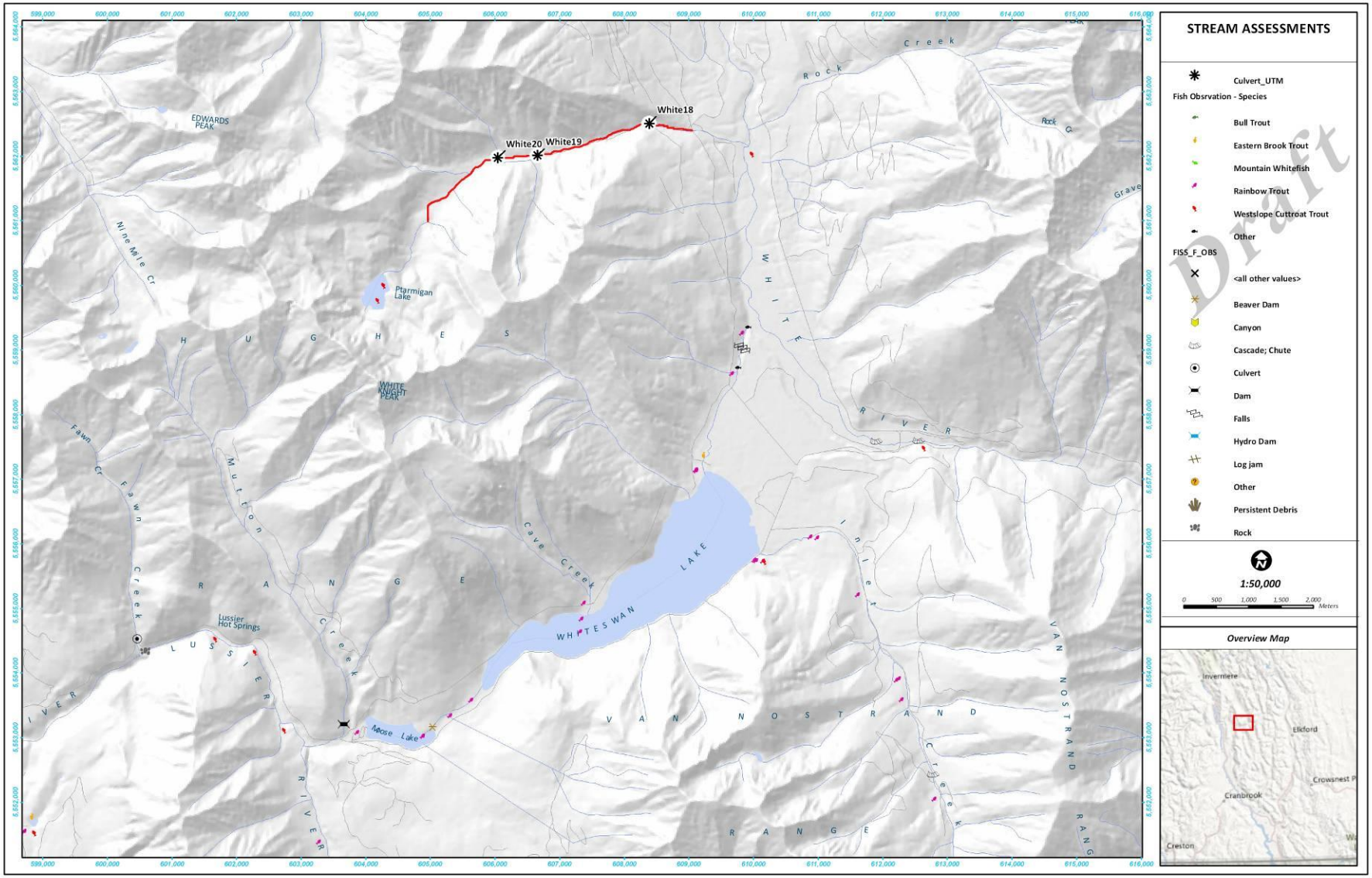


Figure 3: Study area of White18, White19, and White20. Red lines indicate lengths of stream assessed.

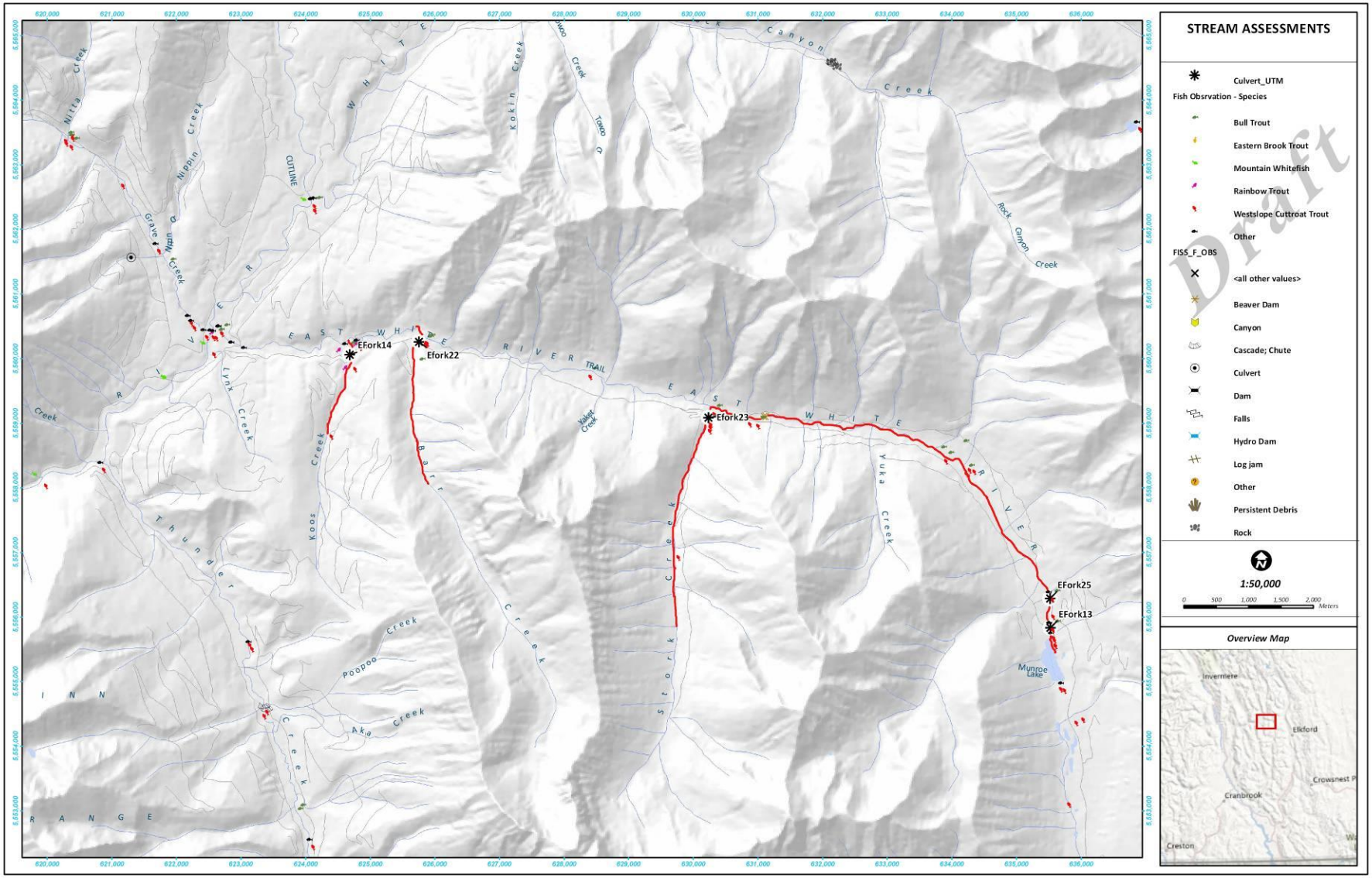


Figure 4: Study area of EFork13, EFork14, EFork22, EFork23, and EFork25. Red lines indicate lengths of stream assessed.

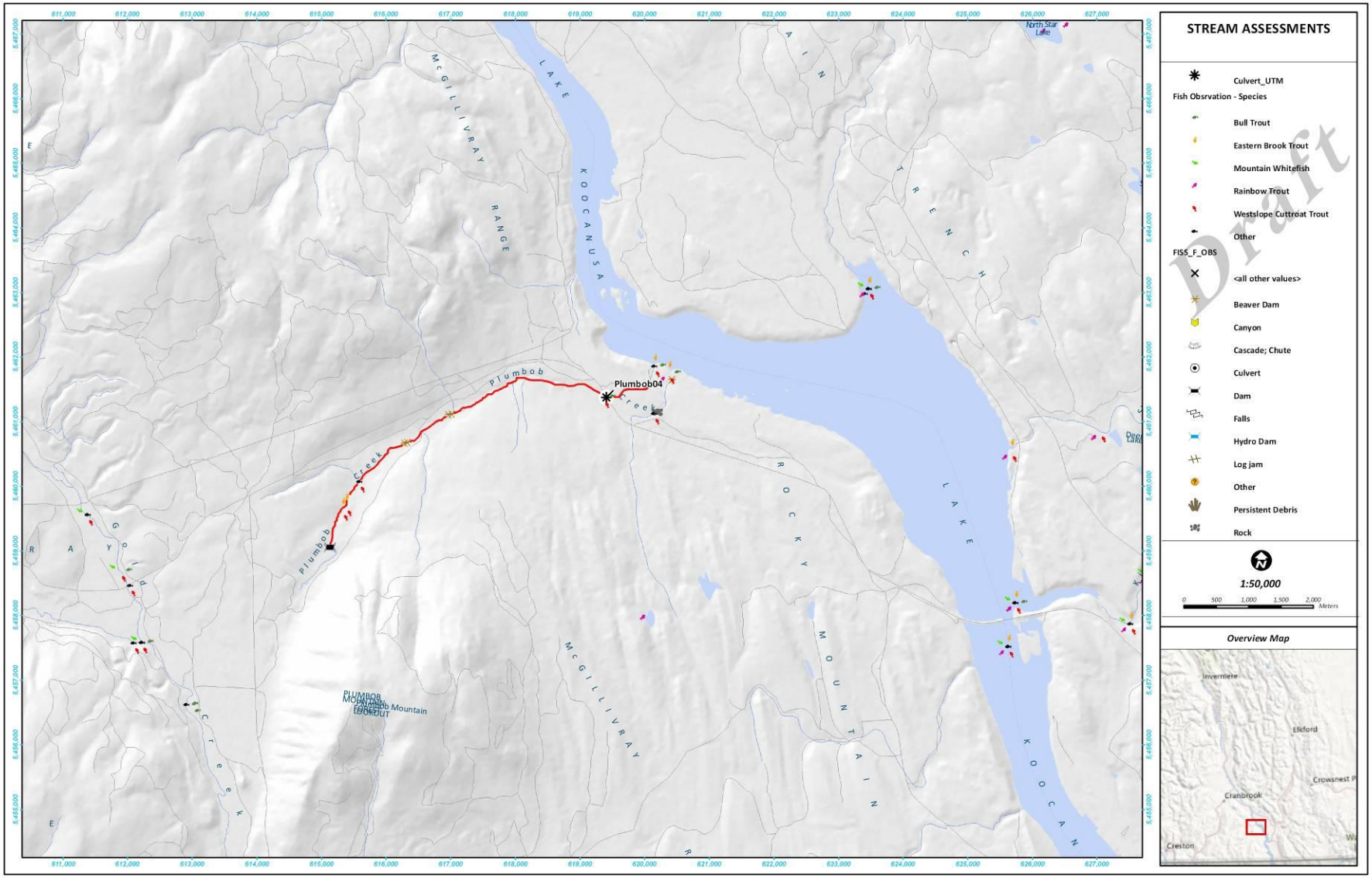


Figure 5: Study area of Plumbob04. Red lines indicate lengths of stream assessed.

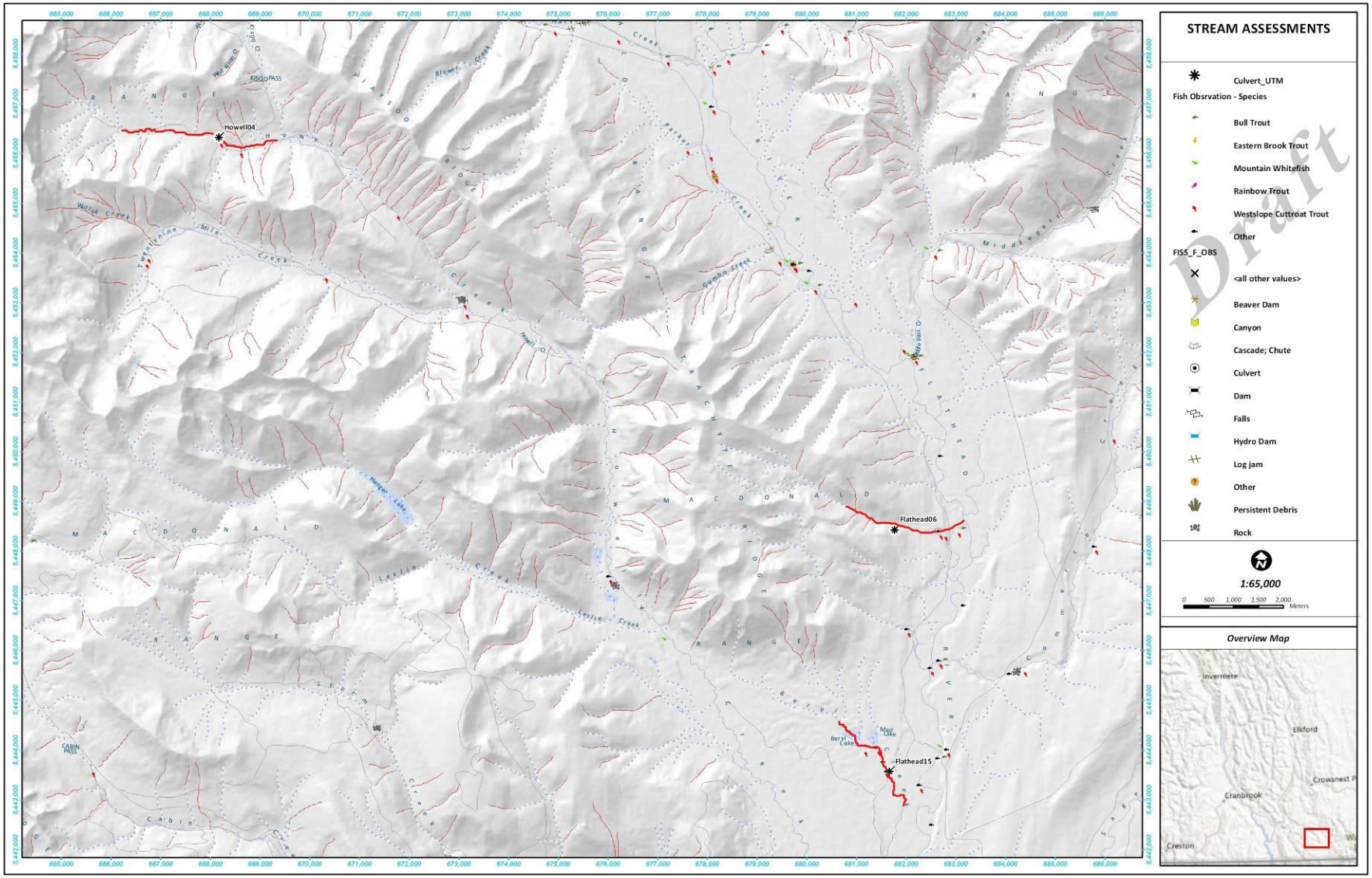


Figure 6: Study area of Howell04, Flathead06, and Flathead15. Red lines indicate lengths of stream assessed.

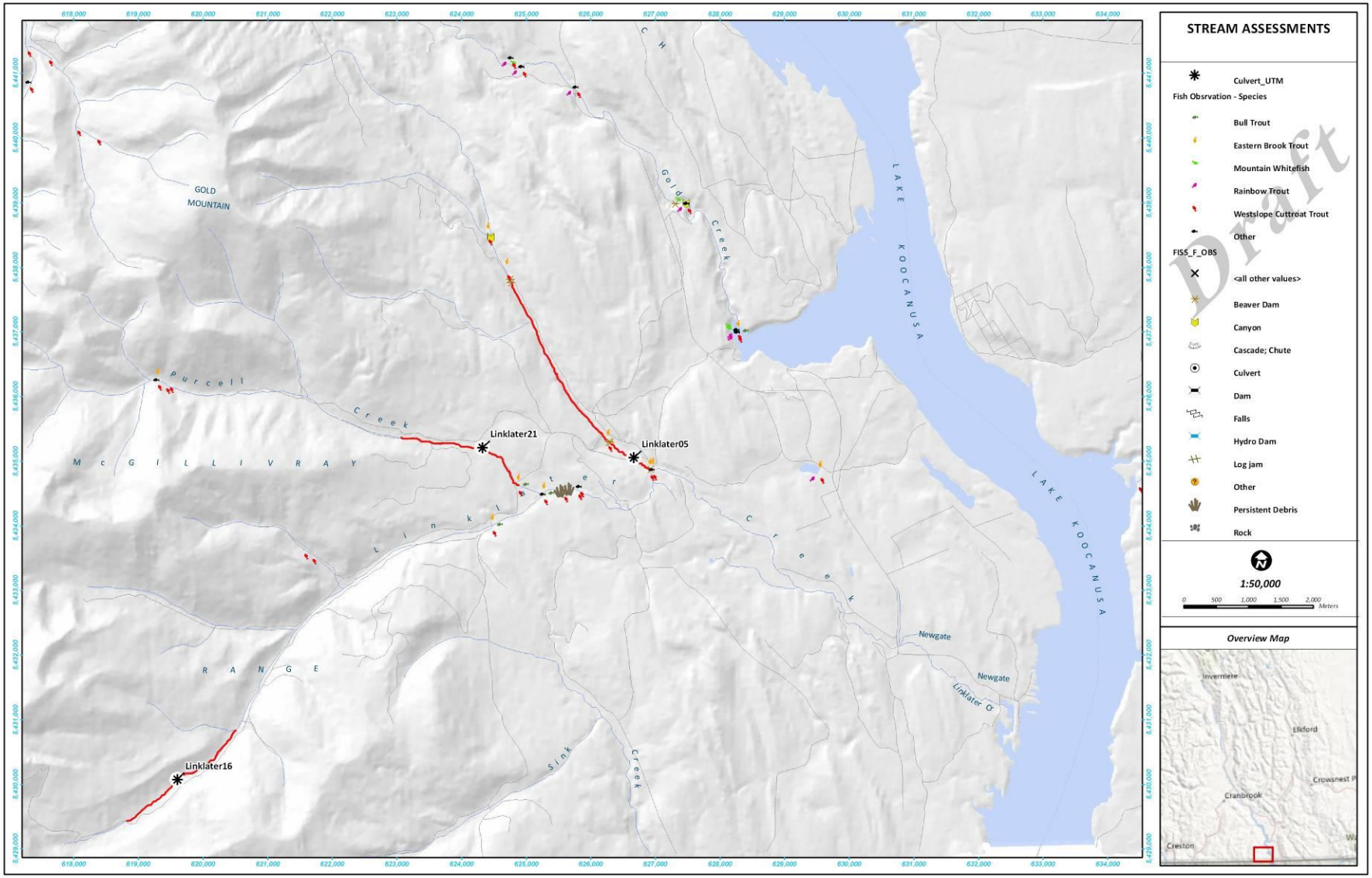


Figure 7: Study area of Linklater05, Linklater16, and Linklater21. Red lines indicate lengths of stream assessed.

APPENDIX II: PHOTOS OF CULVERTS

Photos of EFork13 (PSCIS Crossing ID 50548)


Upstream view from culvert


Inlet of culvert.


Culvert barrel at outlet.


Outlet of culvert.


Outlet.


Downstream view from culvert.

Photos of EFork25 (PSCIS Crossing ID 50560)


Upstream view from culvert


Inlet of culvert.


Culvert barrel at outlet.


Outlet of culvert.


Outlet.


Downstream view from culvert.

Photos of EFork22 (PSCIS Crossing ID 50557)


Upstream of culvert


Upstream view from culvert.


Inlet of culvert.


Outlet of culvert. Note that right downstream culvert is perched.


Downstream view from culvert. Pooling at outlet.


Downstream of culvert.

Photos of Plumbob04 (PSCIS Crossing ID -)


Upstream of culvert


Inlet of culvert.


Culvert barrel at inlet.


Outlet of culvert.


Downstream of culvert.


Permanent beaver dam upstream of culvert.

Photos of Linklater21 (PSCIS Crossing ID 50558)


Upstream of culvert


Inlet of culvert.


Inlet.


Outlet of culvert. Note that culverts are perched.


Downstream view from culvert.


Downstream of culvert.

Photos of Dunbar01 (PSCIS Crossing ID 50590)


Upstream of culvert


Upstream view from culvert.


Inlet of culvert.


Barrel of right downstream culvert.


Downstream view from culvert.


Downstream of culvert.

Photos of Frances03 (PSCIS Crossing ID 50604)


Upstream of inlet.


Inlet of culvert.

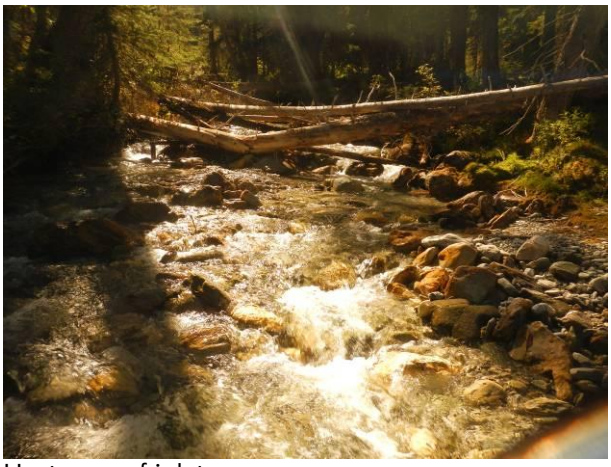

Outlet of culvert.


Downstream of outlet.


Downstream of culvert.


Permanent beaver dam and resulting impoundment.

Photos of EFork23 (PSCIS Crossing ID 50558)


Upstream of inlet.


Inlet of culvert.

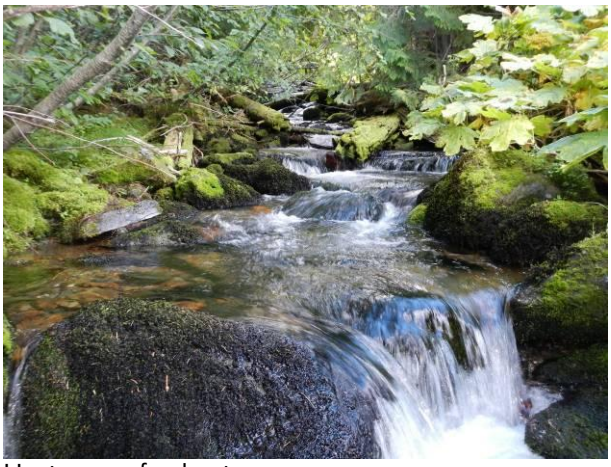

Outlet of perched culvert.


Downstream from outlet.


Channel is highly disturbed upstream of culvert with abundant large woody debris. Disturbance was caused by upstream cable logging.


Cable logging across creek near upstream road crossing at Stork Creek.

Photos of Linklater16 (PSCIS Crossing ID -)


Upstream of culvert.


Upstream view from inlet.


Outlet and barrel of culvert.


Downstream view from outlet.


Downstream of culvert.


Cascade (1.3 m high) upstream of culvert. Numerous cascades are present along the stream.

Photos of Cedrus01 (PSCIS Crossing ID 50453)


Upstream of culvert.


Upstream view from inlet.


Inlet and barrel of culvert.


Perched culvert barrel at outlet.


Downstream view from outlet.


Downstream of culvert.

Photos of Flathead06 (PSCIS Crossing ID 51111)


Upstream of culvert.


Perched culvert outlet.


Outlet of culvert.


Road fill is approximately 10.00 m deep.


Downstream view from outlet.


Downstream of culvert.

Photos of Flathead15 (PSCIS Crossing ID 51122)

Upstream of inlet.

Outlet of right downstream culvert. This culvert is perched but the left downstream culvert is not perched.

Outlet of culverts.

Downstream of culvert.

Numerous beaver dams were observed, which might limit the effectiveness of restoration work.

Beryl Lake is a shallow lake with limited overwintering habitat.

Photos of White28 (PSCIS Crossing ID 50437)


Upstream of culvert.


Upstream view from inlet.


Inlet of culvert.


Perched culvert barrel at outlet.


Downstream view from outlet.


Barrier to fish passage (1.20 m high) created by persistent debris downstream of culvert.

Photos of Howell04 (PSCIS Crossing ID 51174)

Upstream of inlet.

Inlet of culvert. Note high depth of road fill (>1.00 m).

Perched culvert at outlet.

Downstream of outlet.

The stream washes out the road at approximately 1.93 km upstream from culvert. A 2.00 m high waterfall (>20% gradient) was also located at the washout area.

Bedrock cascades 100 m upstream of culvert.

Photos of Linklater05 (PSCIS Crossing ID -)

Inlet of culverts. Scour on the road surface indicates that the culverts are undersized and cannot accommodate spring high flows.

Barrel of left downstream culvert at outlet.

Outlet of culverts. The culverts are not embedded but they are not barriers to fish due to the low water velocity.

Organic material and silt substrate downstream of culvert.

Downstream from culvert.

Confluence with Linklater Creek.

Photos of EFork14 (PSCIS Crossing ID 50549)

Upstream of culvert. Abundant large woody debris and sediment are present in the stream.

Culvert is partially embedded at the inlet.

Outlet of culverts. Road fill is spilling over the culvert and covering the outlet.

Downstream view from outlet.

Downstream from culvert.

WCT fry observed upstream of culvert.

Photos of White18 (PSCIS Crossing ID 50417)


Upstream of inlet.


Inlet of culvert with inlet drop (0.70 m).


Outlet of culvert.


Downstream view from outlet.


Waterfalls and large woody debris upstream of culvert.


Persistent large woody debris at km 38.

Photos of White19 and White20 (PSCIS Crossing ID 50418 and 50419)


Upstream of inlet of White19.


Culvert barrel at outlet of White19. Backwatering was attempted.


Downstream of outlet of White19.


Upstream of inlet of White 20.


Culvert barrel at outlet of White20.


Downstream of outlet of White20.