*3772/WP2513*

# CHEAKAMUS RIVER RESIDENT FISH ABUNDANCE MONITORING PROGRAM

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*Submitted to:*
**Cheakamus Ecosystem Restoration Technical Committee**

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# 1.0 Introduction

This document summarizes a proposed Resident Fish Abundance Monitoring Program (RAMP) for the anadromous portion of the Cheakamus River. The objective of the monitoring program is to describe the post spill abundance of resident juvenile and adult fish in the Cheakamus River in order to measure recovery, and determine if or when population levels reach pre-spill abundance levels or densities reach a state of equilibrium (e.g. are no longer increasing). A literature review conducted during development of the Cheakamus Ecosystem Recovery Plan (CERP), 2006 (Triton 2006) identified that historical surveys in the Cheakamus River have focused on species of cultural and commercial importance (e.g. anadromous salmon and trout). Information on the abundance of other species (e.g. sculpins and lamprey) was collected during these surveys, however habitat utilized by these species was not necessarily targeted and therefore the information from these surveys may not reflect actual levels of pre-spill abundance. The RAMP will collect post spill abundance information on all species of fish captured in the sampling areas. Monitoring sites will be established to encompass a variety of fish habitats utilized by species identified as being impacted by the spill. This document outlines the proposed monitoring program in the anadromous reach, describes site selection criteria and recommended fish sampling techniques.

# 2.0 Background

The Cheakamus River is a major tributary of the Squamish watershed, draining a 1070 $km^2$ area of the Coastal Mountain range in south-western BC (NHC, 2000) (Figure 1). The flow regime of the Lower Cheakamus River is regulated by the Daisy Lake dam and reservoir, which diverts a portion of the annual discharge to the Cheakamus Powerhouse in the Squamish valley. Diversion volumes and power production vary with both climate and regulation (Marmorek and Parnell, 2002). The traditional territory of the Squamish Nation encompasses the entire Cheakamus watershed, and the Squamish Nation members have traditionally relied on the river and the watershed for cultural practices and food as well as transportation (Marmorek and Parnell, 2002).

Downstream of Daisy Lake dam the Cheakamus River flows 24 km before entering the Squamish River at Baynes Island near the community of Brackendale. The Cheakamus River supports a variety of anadromous and resident fish species. Anadromous fish access is limited by a series of impassable falls (between Reach 9 and 10) located approximately 17 km upstream from the confluence with the Squamish River. In August 2005 a sodium hydroxide spill, approximately 2 km upstream of the anadromous barrier, affected anadromous and resident species present in the river at the time of the spill (McCubbing *et. al*. 2006). Resident species upstream of the spill were not affected. Resident fish in the river upstream of the impassable barrier and downstream of the spill (Reach 10) were affected to an unknown degree.

# 3.0 Survey Methodology

The RAMP has been developed based on information identified from a review of aerial photographs, existing fish and fish habitat survey reports (e.g. Van Dishoeck, 2000, 2002a and 2002b, Sneep, 2001), literature on species habitat preferences, field reconnaissance surveys and local knowledge from people familiar with the Cheakamus River watershed. The information review was used to identify a preliminary list of sites to be sampled in the anadromous reach encompassing a variety of fish habitat types. Site selection was further refined based on observations and results during fish sampling surveys conducted in the Cheakamus River during May and Sept 2006 (Triton unpublished data.)

A four person sampling crew will conduct fish sampling surveys. The four-person crew will be required to transport and deploy sampling gear in a timely and effective manner and provide logistical support to collect biological information on captured fish. The proposed RAMP will include surveys in the following time frames:

- March /April, to evaluate overwintering habitat use, and assess juvenile distribution prior to the typical period of spring outmigration;
- September / October, to assess juvenile distribution after the summer growing period and monitor seasonal growth rates.

These time periods have also been selected based on suitable river conditions for effective sampling and on available historic sampling information, which could provide time series data sets for comparison of relative abundance and densities.

## *3.1 Target Species*

During the literature review conducted in preparation of the CERP, 2006 (Triton 2006) species abundance information gaps were identified for several fish species in the Cheakamus River. These species have a variety of life history cycles including anadromous and non anadromous, or a combination of these two forms. The species identified as having information gaps will be the primary species targeted for abundance monitoring by the RAMP and include:

Prickly sculpin (Cottus asper);
Coastrange sculpin (Cottus aleuticus);
Pacific lamprey (Lampetra tridentata);
Western brook lamprey (Lampetra richardsoni);
Cutthroat trout (Oncorhynchus clarkii);
Char (Dolly Varden and bull trout) (Salvelinus sp.); and,
Threespine stickleback (Gasterosteus aculeatus); and,

In addition to species with limited historical information or information gaps, rainbow and steelhead trout (Oncorhynchus mykiss) will also be targeted by the RAMP due to their long residency period in the Cheakamus River. Replication of historic sites targeted at this species will also allow for comparison to historical information for rainbow trout and anecdotal information on other species from these sampling locations.

Other anadromous species present in the Cheakamus River will also be captured during the RAMP, and information for these species will be recorded and reported. Other species to be captured and enumerated during the RAMP will likely include:

- Chinook salmon (*Oncorhynchus tshawytscha*);
- Pink salmon (*Oncorhynchus gorbuscha*);
- Coho salmon (*Oncorhynchus kisutch*); and,
- Chum salmon (*Oncorhynchus keta*).

## *3.2 Sampling Techniques*

In order to effectively sample a variety of habitat types and assess fish species presence the proposed fish-sampling plan will include a combination of the following sampling techniques:

- Minnow trapping;
- Electrofishing (closed and open); and,
- Seining.

Snorkeling was also considered as part of the sampling plan, but was discounted due to the size and habitat preferences of target species, difficulties in replicating observer efficiency and likelihood of variable visibility conditions between surveys. The use of snorkeling as a potential tool to monitor abundance of some species life stages will continue to be evaluated and some selective snorkel surveys may be conducted in an effort to further evaluate this sampling methodology or identify habitat preferences of target species.

Table 1 summarizes the species of fish targeted by the RAMP and the effective sampling techniques for various species and life history stages. Capture efficiency will also be affected by seasonal timing of each survey, and specific gear selection and settings. (e.g. newly emerged young of the year (YoY) can be expected to pass through standard mesh size used in minnow traps (6mm), and higher frequencies are required to electrofish for smaller size classes). The use of sampling gear effective for capturing smaller size classes of fish will effect the ability to capture larger more mobile life history stages (i.e. smaller mesh sizes for seining, and minnow trapping), and may effect survival rates (i.e. higher frequencies during electrofishing can harm larger fish). Decisions about gear selection will be based on maximizing survival of fish captured with the secondary consideration of maximizing fish capture for the targeted size range.

**Table 1. Summary of species, and life history stages targeted by various sampling techniques, RAMP**

| Target species | Life history stage | Minnow trapping | electrofishing | Seining |
|---|---|---|---|---|
| Cottid | YoY | | x | x |
| | juvenile | x | x | x |
| | adult | x | x | x |
| Lamprey | YoY | | x | |
| | ammocoete | | x | |
| | adult | | x | |

| | | | | |
|---|---|---|---|---|
| Cutthroat | YoY | x | x | x |
| | juvenile | x | x | x |
| | adult | | x | x |
| Char | YoY | x | x | x |
| | juvenile | x | x | x |
| | adult | | x | x |
| Three-spine stickleback | YoY | | x | x |
| | juvenile | x | x | x |
| | adult | x | x | x |
| Rainbow | YoY | x | x | x |
| | juvenile | x | x | x |
| | adult | | x | x |

### 3.2.1 Minnow Trapping

Minnow traps will be set during each sampling survey. Sampling sites will be selected to encompass a variety of hydraulic units and will be approximately 500 m in length. Minnow traps will be baited with salmon roe and will be set at a density of approximately 10 traps per 100 m in each sampling area, totaling approximately 50 traps per 500 m sampling site. Each minnow trap will be baited with approximately 5 g of salmon roe and set overnight. Trap locations will be marked in the field and geo-referenced using hand held geographic positioning (GPS) units. Other data recorded at each trapping location will include:

- Hydraulic unit type (riffle, pool, glide),;
- Trap depth;
- Proximity of nearby cover features; and,
- Cover type.

Five minnow trapping areas encompassing a variety of habitat types will be established in the Cheakamus River study area. Each minnow trapping area will be approximately 500 meters in length. The general locations of minnow trapping areas are described in Appendix 1 and shown in Figure 2.

### 3.2.2 Electrofishing

Electrofishing will be conducted during each sampling survey. Sampling sites will be selected to represent various habitat types and will include a combination of open and closed sites. Closed pass sites will be used in lower velocity, shallow sites which are relatively easy to access and isolate. Open pass electrofishing will typically be used in more difficult to access areas and areas of high velocity and large substrate that cannot be effectively isolated. The use of open pass electrofishing sites will also allow for sampling a greater number of sites over a given time period as considerable time is required to set-up an effective site isolation for closed pass electrofishing. Typically a four person crew can only sample two closed pass sites per day, whereas four open sites can typically be sampled per day allowing for an increased ability to sample additional types of habitat in a wider variety of locations within the same time frame.

Open and closed electrofishing sites will be sampled by triple pass removal to maximize opportunities for identifying species composition and fish densities in surveyed areas. Each electrofishing site will be measured to the nearest meter, and geo-referenced for replication on future surveys. In situ water quality information including water temperature, pH and conductivity will also be collected along with a detailed site description and upstream and downstream facing photographs of each site. Typical information collected at each electrofishing site will include:

- Date, time and crew members present;
- Location (river km and UTM);
- Site dimensions and characteristics (length, width, depth, and velocity);
- Hydraulic type (riffle, pool glide etc.);
- Water quality (pH, temperature, and conductivity, turbidity (clarity in cm));
- Model electrofisher used, effort per pass (seconds) and electrofisher settings;
- Substrate composition (%);
- $D_{90}$ and $D_{max}$; and,
- Cover types present and percent of area within each sampling site;

At each electrofishing site an area of approximately 100$m^2$ will be sampled. Site dimensions and total area sampled may vary based on site accessibility and field conditions as well as final location of any isolation nets. In areas where the nets fit across the width of the stream or channel, the nets will be placed at the upstream and downstream end of the site. Mainstem sites will be isolated by deploying nets from the margin around selected habitat units, and will be anchored in place with rebar and local substrate to create an effective isolation seal.

Based on monitoring sites established in 2006 it is proposed approximately 12 open and 12 closed pass electrofshing sites will be sampled during each survey. The general locations of proposed electrofishing sites are described in Appendix 1 and shown in Figure 2.

### 3.2.3 Seining

Seining will be conducted during each sampling survey. Sampling sites will be selected that are effectively sampled by beach or pole seine conducted by wading. Each seine site will be measured to the nearest meter, and geo-referenced. During each survey the total wetted area of each site seined will also be estimated based on length and width of the area seined.

Sampling efforts and field observations during September 2006 indicated substrate size, depth, visibility, and fish utilization of backwaters sites may limit the utility of seining as an effective fish abundance monitoring tool. Sites that could be effectively sampled by seining were difficult to locate and few fish were captured during seining trials at accessible locations. The use of seining as a suitable techniques for sampling resident species in the Cheakamus River will continue to be assessed in conjunction with other sampling efforts as time and site conditions permit. Future sampling surveys will also asses the seasonal effectiveness for capturing young of the year (YoY) juveniles in an effort to identify suitable monitoring sites or areas that can be effectively sampled by seining.

### *3.3 Site Selection and Target Habitats*

Where feasible and appropriate to capture targeted species, sampling sites will include replication of sites sampled during previous surveys in order to provide a baseline for comparison of species abundance and trends. Many of the target species such as cutthroat, char and sculpin will utilize similar habitats to at least some degree and therefore may be captured using a variety of sampling methods (e.g. minnow trapping, seining, and electrofishing). Lamprey and stickleback may also use similar habitat however they typically have habitat preferences that vary considerably from the other species. Stickleback can be captured using all of the above mentioned sampling techniques, but lamprey have a specific habitat preference for sandy or silty soft bottom habitats, and rearing strategy (i.e. burrowing into soft sediments) which typically does not expose them to capture by minnow trapping or seining. Therefore, species-specific monitoring sites will be required for these two species, and electrofishing will be the primary method of abundance monitoring for lamprey.

The majority of sample sites will encompass the most abundant habitat types in the Cheakamus River, which is mainstem habitat composed of cobble and boulder substrate with a variety of velocity gradients. Based on experience from previous sampling in the Cheakamus River (Van Dishoeck, 2000, 2002a and 2002b, Sneep, 2001, Triton 2006, unpublished data), juveniles of all the target species can be captured in this type of habitat by electrofishing, and all of the target species except lamprey can be captured by minnow trapping. Seine sites will target areas of smaller substrate and lower velocities such as gravel bars or back-channels, and would typically target YoY juveniles (fry).

Based on results of sampling efforts in 2006 a series of monitoring sites have been established that will form the basis of future surveys (Appendix 1, Figure 2). These sites have been selected to represent a variety of habitat types utilized by target species. Some examples of the habitats types and species, targeted by these sites include:

- Cobble and boulder substrates (mainstem and side channel) (target - cottids, cutthroat and char, but all or most species may be captured depending on site-specific habitat characteristics and velocities);
- Low velocity back channels (target - threespine stickleback, and YoY);
- Areas of sediment deposition, or accumulation (target - lamprey); and,
- Tributaries or restoration channels (target - all or most species).

Habitat conditions may vary over time as a result of instream conditions such as seasonal water levels, and morphological changes. In addition, field observations, and sampling results will provide an ongoing increase in knowledge of species habitat preferences and densities, and therefore some flexibility will be required to identify and sample habitats used by target species, as well as track species distribution (e.g. greater sampling emphasis may be placed on sites in the lower river to track distribution of species suspected to be colonizing under utilized habitats from the Squamish River during the early stages of recovery). The need to adjust site locations or sample additional habitat or alternate locations to better understand the distribution and abundance of target species will be assed both in the field and during analysis of data from field surveys.

### *3.4 Biological Data Collection*

Captured fish will be identified to species and enumerated by size classes. Some species of fish in the Cheakamus River are difficult to differentiate (e.g. char, cottids and lamprey) and it may be necessary to collect voucher specimens for more detailed examination in order to confirm speciation. In addition, it may be desirable to collect some species for examination of stomach contents to determine preferred seasonal prey items. Collection of voucher specimens will be considered and discussed with regulatory agencies and the Cheakamus Ecosystem Restoration Technical Committee (CERTC), and if deemed beneficial collection of voucher specimens will be conducted in accordance with permits or approvals issued by responsible government agencies. Inadvertent mortalities will be recorded and may also be retained for voucher specimens.

A minimum of 10% of each species of fish captured by each methodology and from each sampling location will be anaesthetized, and measured for length (to the nearest mm) and weight (to the nearest 0.01gm). In order to develop length frequency relationships for estimating species age classes the sampling crew will endeavor to measure all resident fish species (i.e. rainbow trout, cottids, lamprey, and threespine stickleback) to the nearest mm. Time constraints and logistics of anesthetizing and measuring large numbers of fish may limit the ability to measure all fish captured and daily field specific modifications to proposed biological data collection protocols are expected. Anaesthetized fish will be allowed to fully recover, before being released back into the river near the vicinity of capture.

## 4.0 Other Information

In order to describe general habitat characteristics and features of each sampling location Resource Information Standards Committee (RISC) site cards will be used to collect reach level information on each sampling area (MSRM 2004).

Habitat data will also be collected at each sampling site and recorded on individual site cards developed specifically for the project to ensure consistency of data collection as described in section 3.5 Electrofishing.

## 5.0 Reporting

### *5.1 Fish Sampling Data*

Fish sampling data will be compiled and presented in tabular or graphical format as appropriate. Some examples of comparative data analysis that may be undertaken and discussed for each species include:

Densities of fish in each sampling site (Electrofishing) (expressed as fish per unit (FPU) or fish per 100m2);
Catch Per Unit Effort (CPUE) (per second of electrofishing, and per set for minnow trapping);
Percent species composition for each sampling methodology and habitat unit type;
Minimum, maximum and average fork length (mm) by species, age class, and sampling method;

Minimum, maximum and average weight (gm) by species, age class, and sampling method; and,
Minimum, maximum and average condition factor (Ricker 1975) (calculated for salmonid species).

### *5.2 Data Compilation and Analysis*

At the end of each field season a summary report will be prepared documenting the study objectives, methods and results. Discussion of the results will be presented including a summary of fish densities by species and location and comparing observed densities to available historic information for the Cheakamus River (Van Dishoeck, 2000, 2002a and 2002b, and Sneep, 2001) for each species. As the available data set increases over time comparisons will be also made to the observed trend in species abundance and densities within the Cheakamus River over the course of the recovery period.

Where available calculated densities and comparison to historic information will form the basis for measuring species recovery. Where historic density information is not available or lacking, it is expected density trends and determination of equilibrium densities during sampling surveys (e.g. when observed densities are no longer increasing) will form the basis for measuring recovery. At this time species-specific density targets have not been established and will be developed as the program progresses based on analysis of results, comparison to historic data, and ongoing discussions with the CERTC.

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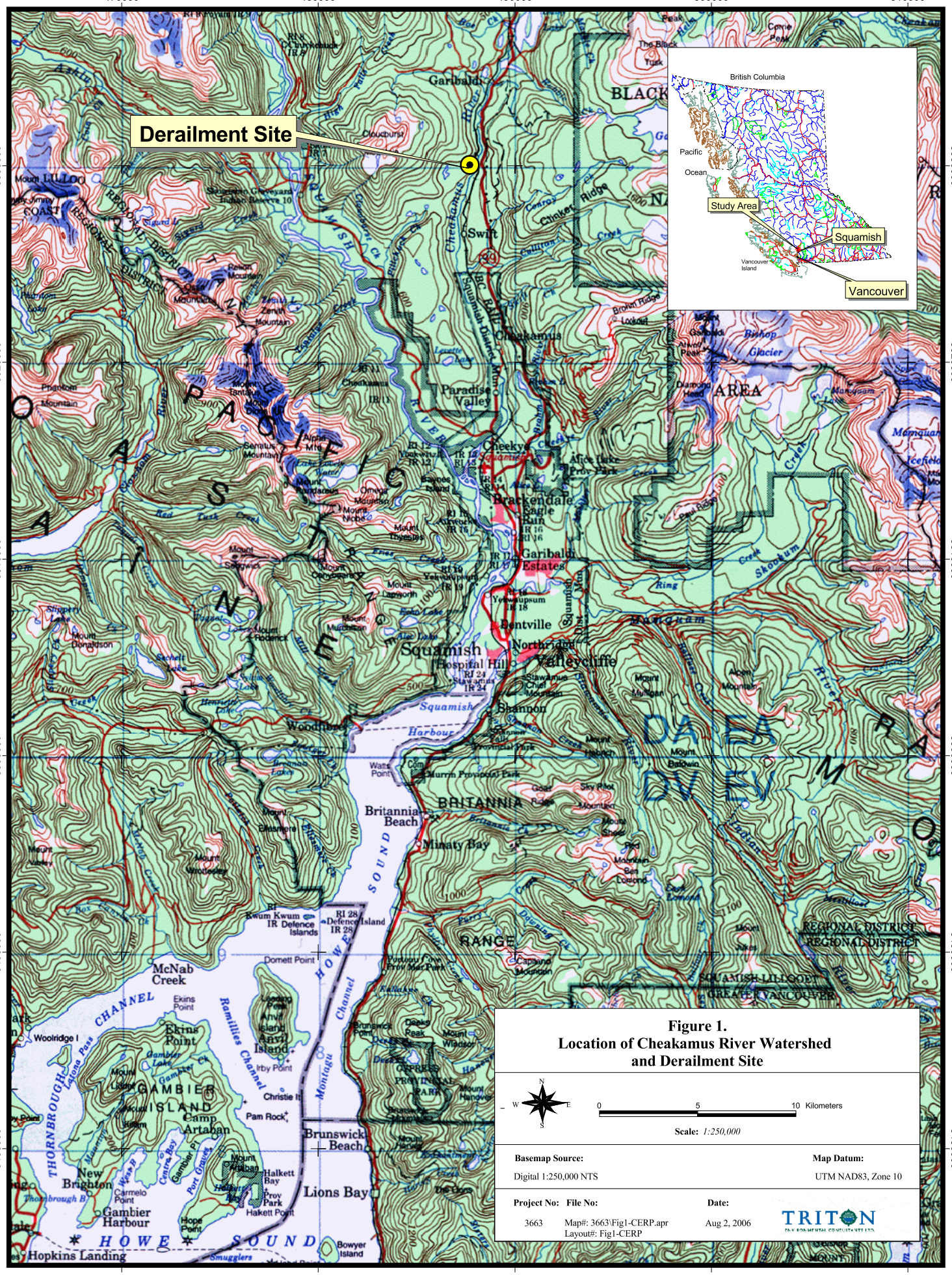
Derailment Site
British Columbia
Pacific
Ocean
Study Area
Squamish
Vancouver
Vancouver Island
470000
480000
490000
500000
510000
5530000
5520000
5510000
5500000
5490000
5480000
Garibaldi
Cheakamus
Paradise Valley
Brackendale
Garibaldi Estates
Squamish
Hospital Hill
Valleycliffe
Brannon
Woodfibre
Britannia Beach
Minaty Bay
Howe Sound
Defence Island
McNab Creek
Ekins Point
Anvil Island
GAMBIER ISLAND
Camp Artaban
New Brighton
Gambier Harbour
Hopkins Landing
Brunswick Beach
Lions Bay
Bowyer Island
Thornbrough Channel
Ramillies Channel
Montagu Channel
Howe Sound
Figure 1.
Location of Cheakamus River Watershed
and Derailment Site
N
W
E
S
0
5
10 Kilometers
Scale: 1:250,000
Basemap Source:
Digital 1:250,000 NTS
Map Datum:
UTM NAD83, Zone 10
Project No: 3663
File No: Map#: 3663\Fig1-CERP.apr
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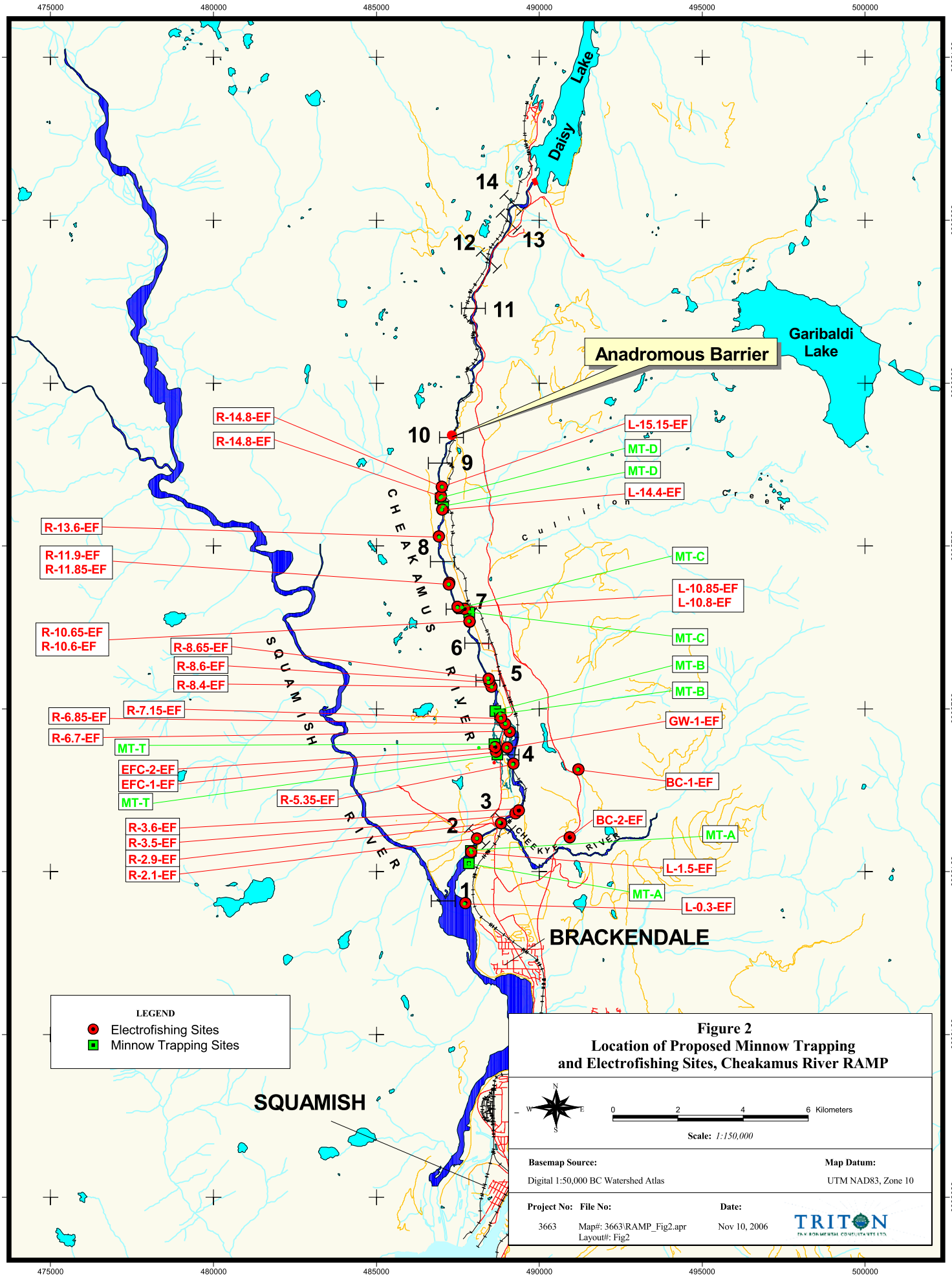
475000
480000
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500000
5540000
5535000
5530000
5525000
5520000
5515000
5510000
5505000
Daisy Lake
Garibaldi Lake
Anadromous Barrier
14
12
13
11
10
9
8
7
6
5
4
3
2
1
R-14.8-EF
R-14.8-EF
L-15.15-EF
MT-D
MT-D
L-14.4-EF
R-13.6-EF
R-11.9-EF
R-11.85-EF
MT-C
L-10.85-EF
L-10.8-EF
R-10.65-EF
R-10.6-EF
MT-C
R-8.65-EF
R-8.6-EF
R-8.4-EF
MT-B
MT-B
R-7.15-EF
R-6.85-EF
R-6.7-EF
GW-1-EF
MT-T
EFC-2-EF
EFC-1-EF
MT-T
BC-1-EF
R-5.35-EF
BC-2-EF
R-3.6-EF
R-3.5-EF
R-2.9-EF
R-2.1-EF
MT-A
L-1.5-EF
MT-A
L-0.3-EF
CHEAKAMUS RIVER
SQUAMISH RIVER
Culliton Creek
CHEEKYE RIVER
BRACKENDALE
SQUAMISH
LEGEND
Electrofishing Sites
Minnow Trapping Sites
Figure 2
Location of Proposed Minnow Trapping
and Electrofishing Sites, Cheakamus River RAMP
N
W
E
S
0
2
4
6 Kilometers
Scale: 1:150,000
Basemap Source:
Digital 1:50,000 BC Watershed Atlas
Map Datum:
UTM NAD83, Zone 10
Project No:
3663
File No:
Map#: 3663\RAMP_Fig2.apr
Layout#: Fig2
Date:
Nov 10, 2006
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**Appendix 1. Location of proposed minnow trapping and electrofishing sites, Cheakamus River RAMP**

| Location | Easting | Northing | River Km | Margin | Reach | Method | Site Name |
|---|---|---|---|---|---|---|---|
| **MINNOW TRAPPING AREAS** | | | | | | | |
| Cheakamus River | 487892 | 5515630 | 1.1 to 1.6 | left | 1 | MT #1 | MT-A |
| Cheakamus River | 487829 | 5515244 | 1.1 to 1.6 | left | 1 | MT #50 | MT-A |
| Cheakamus River | 488636 | 5519916 | 7.1 to 7.45 | right | 4 | MT #1 | MT-B |
| Cheakamus River | 488785 | 5519817 | 7.1 to 7.45 | right | 4 | MT #50 | MT-B |
| Cheakamus River | 487840 | 5522944 | 10.4 to 1.8 | left | 6 | MT #1 | MT-C |
| Cheakamus River | 487604 | 5523076 | 10.4 to 1.8 | left | 6 | MT #50 | MT-C |
| Cheakamus River | 486965 | 5526450 | 14.4 to 14.8 | left | 8 | MT #1 | MT-D |
| Cheakamus River | 487043 | 5526175 | 14.4 to 14.8 | left | 8 | MT #50 | MT-D |
| Emerald Forest Creek | 488704 | 5518590 | n/a | n/a | n/a | MT #1 | MT-T |
| Emerald Forest Creek | 488610 | 5518900 | n/a | n/a | n/a | MT #50 | MT-T |
| **ELECTROFISHING SITES** | | | | | | | |
| Emerald Forest Creek | 488665 | 5518673 | 0+065 to 0+095 | | n/a | EF | EFC-1-EF |
| Emerald Forest Creek | 488634 | 5518809 | 0+175 to 0+195 | | n/a | EF | EFC-2-EF |
| Gorbuscha West | 489005 | 5518800 | 0+060 to 0+070 | left | n/a | EF | GW-1-EF |
| Cheakamus River | 487719 | 5514021 | 0.3 | left | 1 | EF | L-0.3-EF |
| Cheakamus River | 487905 | 5515598 | 1.5 | left | 1 | EF | L-1.5-EF |
| Cheakamus River | 488082 | 5516003 | 2.1 | right | 2 | EF | R-2.1-EF |
| Cheakamus River | 488811 | 5516475 | 2.9 | right | 2 | EF | R-2.9-EF |
| Cheakamus River | 489268 | 5516786 | 3.5 | right | 3 | EF | R-3.5-EF |
| Cheakamus River | 489364 | 5516873 | 3.6 | right | 2 | EF | R-3.6-EF |
| Cheakamus River | 489195 | 5518300 | 5.35 | right | 3 | EF | R-5.35-EF |
| Cheakamus River | 489090 | 5519280 | 6.7 | right | 4 | EF | R-6.7-EF |
| Cheakamus River | 488941 | 5519519 | 6.85 | left | 4 | EF | R-6.85-EF |
| Cheakamus River | 488813 | 5519717 | 7.15 | right | 4 | EF | R_7.15-EF |
| Cheakamus River | 488523 | 5520669 | 8.4 | right | 5 | EF | R-8.4-EF |
| Cheakamus River | 488456 | 5520826 | 8.6 | left | 5 | EF | R-8.6-EF |
| Cheakamus River | 488433 | 5520908 | 8.65 | right | 5 | EF | R-8.65-EF |
| Cheakamus River | 487700 | 5523056 | 10.8 | left | 6 | EF | L-10.8-EF |
| Cheakamus River | 487854 | 5522657 | 10.6 | right | 6 | EF | R-10.6-EF |
| Cheakamus River | 487847 | 5522679 | 10.65 | right | 6 | EF | R-10.65-EF |
| Cheakamus River | 487507 | 5523077 | 10.8 | left | 6 | EF | L-10.8-EF |
| Cheakamus River | 487484 | 5523126 | 10.85 | left | 6 | EF | L-10.85-EF |
| Cheakamus River | 487235 | 5523858 | 11.85 | right | 7 | EF | R11.85EF |
| Cheakamus River | 487210 | 5523805 | 11.9 | right | 7 | EF | R-11.9-EF |
| Cheakamus River | 486910 | 5525275 | 13.6 | right | 8 | EF | R-13.6-EF |
| Cheakamus River | 487010 | 5526110 | 14.4 | left | 8 | EF | L-14.4-EF |
| Cheakamus River | 486969 | 5526510 | 14.8 | right | 8 | EF | R-14.8-EF |
| Cheakamus River | 487000 | 5526800 | 15.15 | left | 8 | EF | L-15.15-EF |
| Brohm Creek | 491199 | 5518123 | FSR Bridge | | | EF | BC-1-EF |
| Brohm Creek | 490928 | 5516048 | | | | EF | BC-2-EF |