BC hydro

FOR GENERATIONS

Report Title: *Peace River Fish and Aquatics Investigations - Peace River and Tributary Summer Fish Distribution, Habitat Assessment and Radio Telemetry Studies 2005*
Project: Peace River Site C Hydro Project
Prepared By: Amec Earth & Environmental and LGL Limited
Prepared for: BC Hydro

NOTE TO READER:

This is a report on a study commissioned toward the development of engineering, environmental and technical work conducted to further define the potential Site C project.

For environmental studies, the focus is on the development of an environmental and socio-economic baseline around the area of the potential Site C Project. Baseline studies are generally a survey of existing conditions within a project study area.

This report and other information may be used for future planning work or an environmental assessment or regulatory applications related to the potential Site C Project.

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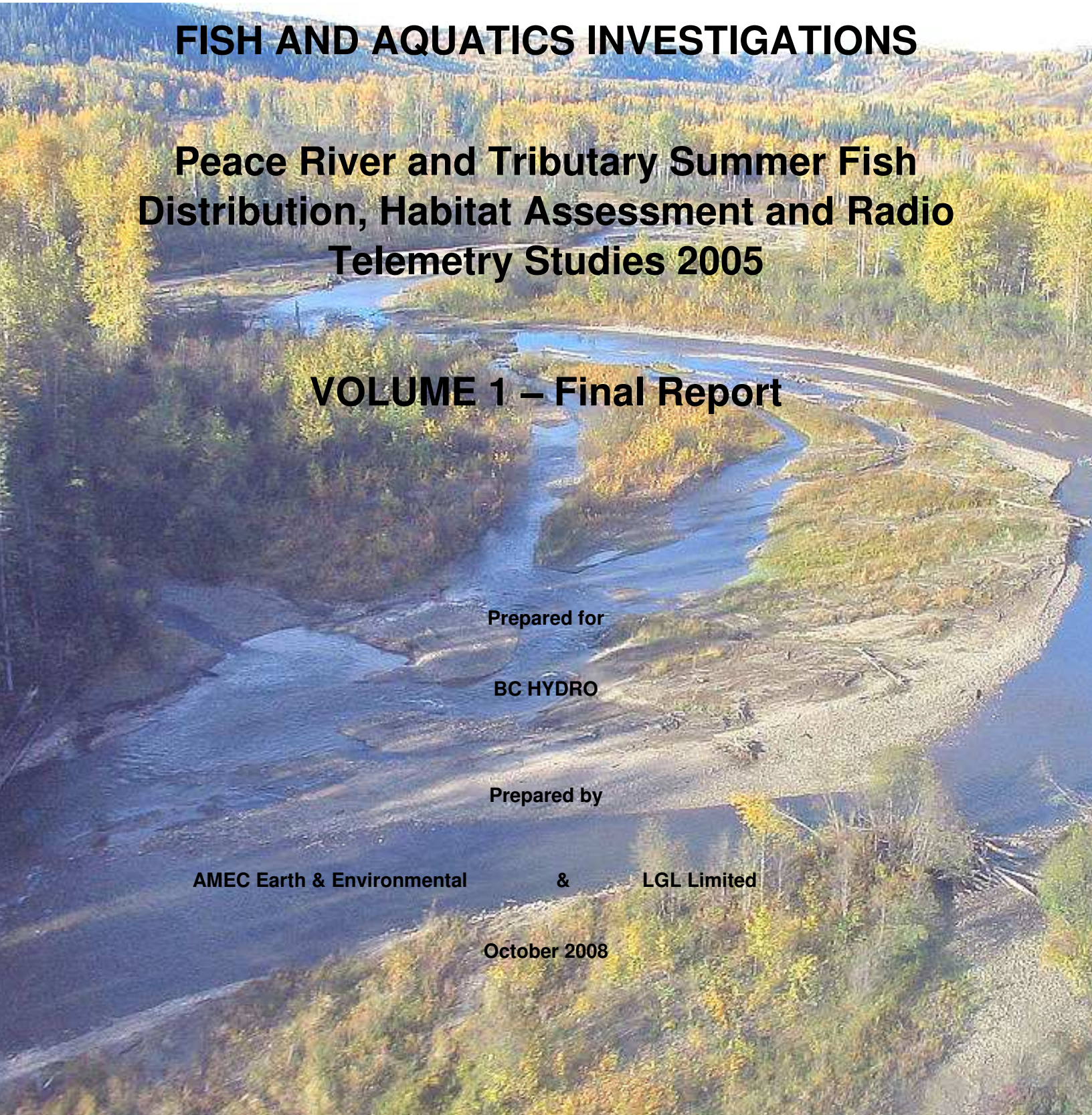
PEACE RIVER
FISH AND AQUATICS INVESTIGATIONS



Peace River and Tributary Summer Fish Distribution, Habitat Assessment and Radio Telemetry Studies 2005

VOLUME 1 – Final Report

Prepared for

BC HYDRO

Prepared by

AMEC Earth & Environmental **&** **LGL Limited**

October 2008

Executive Summary

BC Hydro has been investigating the potential for furthering hydro-power development downstream of their two existing facilities in the headwaters of the Peace River by building a Site C dam in the vicinity of Fort St. John. Several fisheries and aquatic studies have been conducted over the years to assess the potential environmental effects of the dam. In BC Hydro's recent review of the available existing environmental information, it was concluded that further fish and habitat investigations are needed to provide a more current and better understanding of the river's resources and potential impacts of the proposed development. In response to this decision, BC Hydro commissioned AMEC Earth & Environmental, jointly with LGL Limited and Mainstream Aquatics Limited, to undertake specific environmental studies on the upper Peace River system. Two field programs were planned. The first, conducted during August-September, 2005, examined fish habitat, collected fish biological data, radio-tagged fish for telemetry study, and installed thermographs at specific sites. The second field program is scheduled for February-March 2006 and will service the thermographs, track the fish that were radio-tagged in September 2005, and install fixed-station telemetry receivers at specific sites. The main findings of the 2005 field program are:

- In the mainstem and most of the tributaries, runs made up the greatest proportion of instream habitat, but the habitat was frequently of minimal value for fish due to the beds compacted with fines and lack of cover;
- All of the tributaries had moderate proportions of pool habitat, with some sites having considerable cover. However, with the exception of the Halfway and Moberly rivers, the flows in the tributaries were either too low (Red and Wilder creeks) or marginal (Cache, Farrell and Lynx creeks) to provide holding habitat for fish in pools;
- Off-channel habitats were common in some tributaries (e.g., Moberly River), but in the smaller streams these usually had little flow and were heavily silted;
- During base flows, the instream habitat conditions were not appreciably better in the lower than in the upper reaches in any of the tributaries;
- Several of the tributaries had sufficient quantities of good quality gravel and some of the smaller ones (e.g., Cache, Farrell, Lynx) may have greater potential for fish spawning at higher flows;
- There were no barriers to fish passage in any of the tributaries and none of the tributaries possessed specifically critical habitat (e.g., spawning, rearing) for fish in the segment below the Site C reservoir maximum normal operating level;
- In the mainstem, a total of 2,139 fish was sampled comprising 19 species (10 sportfish species) with the catch dominated by mountain whitefish (72%). Arctic grayling, rainbow trout, walleye and kokanee constituted 5%, 4%, 3% and 2% of the catch, respectively. Other sportfish, including bull trout, burbot, goldeye and northern pike were rare (<1% of catch);
- In the tributaries, a total of 882 fish was captured comprising 12 species (5 sportfish) with the catch dominated (94%) by non-sportfish (daces, suckers and others). Mountain

whitefish and rainbow trout were the most common sportfish, whereas others (e.g., bull trout, Arctic grayling) were rare;

- In the Peace River, between the Peace Canyon dam and the Beatton River, 58 walleye, 39 Arctic grayling and 29 rainbow trout were tagged for 2006 movement study; and,
- Nine telemetry stations were roughed in. Electronics will be installed in these shells during early spring, 2006, and fish movements will be monitored.

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1.0 INTRODUCTION

1.1 Background

BC Hydro operates two major hydro facilities on the upper Peace River in British Columbia, and has for some time been investigating the potential for further hydro-power development downstream at Site C in the vicinity of Fort St. John (see BCH 1990). A reservoir would inundate the river upstream almost to the foot of the existing Peace Canyon Dam (a distance of 83 km), and would alter the physical habitat and water quality and temperature in both the mainstem and lower reaches of several tributaries, and potentially disrupt natural fish migrations.

Over the years, BC Hydro has commissioned a number of fisheries and aquatic studies to assess the potential environmental effects of a Site C dam. Among the major studies done to date, there have been several works completed by R.L.&L. (1991a, 1991b, 1992 and 2001) and others (e.g., ARL 1991a, 1991b), as well as an ongoing fish indexing program for the upper Peace River system (P&E Environmental Consultants 2002, 2003; Mainstream Aquatics 2004). These studies provide considerable information on the habitats and fish populations of various sectors of the upper Peace River system. However, in BC Hydro's recent review of the available existing environmental information, it was concluded that further fish and habitat investigations were needed to provide a current understanding of the river's resources and potential impacts of the proposed Site C dam. Habitat quantification is the initial phase of receiving a Section 35(2) Authorization under the Fisheries Act. Appropriate levels of quantification are necessary to avoid delays in the process and to support development of any mitigation and compensation plans.

The tributaries of the Peace River may provide nursery areas for fish populations in the mainstem. A better understanding of the fish utilization of tributaries potentially inundated by the proposed reservoir is required, as well as assessments of potential fish passage problems, and of the habitat above and below the inundation zone.

The quantification and current utilization of habitat for target fish species within the identified study area will be a critical step in the impact assessment if the proposed Site C dam progresses to the regulatory process. R.L.&L. (1991a) demonstrated that bull trout released in the Peace River moved into the Halfway River and tributaries for spawning purposes. Movement up to 200 km from the Halfway River-Peace River confluence to the Christina Falls on the Graham River has been documented (R.L.&L. 1991a). Adult mountain whitefish move downstream to the lower Halfway mainstem during the late autumn to over-winter (R.L. & L. 1991a). However, young-of-the-year (YOY) and yearling mountain whitefish are assumed to over-winter in upstream

reaches of the Halfway and Graham river watersheds. Existing regional inventory and radio-telemetry data (MELP 1999) suggests that Arctic grayling spawning and rearing occurs in the lower portion of the Halfway River (DES 2002).

In order to gain a better understanding of fish habitat and fish populations, BC Hydro commissioned AMEC Earth & Environmental, jointly with LGL Limited and Mainstream Aquatics Limited, to undertake specific studies on the Peace River and its tributaries upstream of the proposed Site C dam in fall 2005.

The scope of the work in the present study was to conduct detailed habitat and fish surveys in the tributaries that would be affected by the Site C dam, and to initiate radio tracking of the migrations/movements of several sport fish species within the mainstem, and between the mainstem and tributaries. From existing information it appears that some of the sport fish species move through the Site C area to various locations in the Peace River and its tributaries at given times of the year to complete their life cycles. These life history movements require further documentation for assessment of potential impacts of the Site C dam.

The following sections outline the major component of the study conducted from August 2005 to March 31, 2006. The work began with detailed planning from August 9 through 24, 2005. BC Hydro approved the plan, and the program was started as outlined in the following sections.

Our 2005 field program was conducted from August 25 to September 30, 2005. During this field program we examined fish habitat, collected fish biological data, tagged fish for telemetry, and established thermographs within the tributaries. This report summarizes the results of our fall 2005 investigations.

1.2 Study Area

The study area lies in northeast British Columbia and includes both the mainstem of the Peace River and its tributaries, extending from the Peace Canyon Dam downstream to Kiskatenaw Creek, including the proposed Site C dam location (Figure 1).

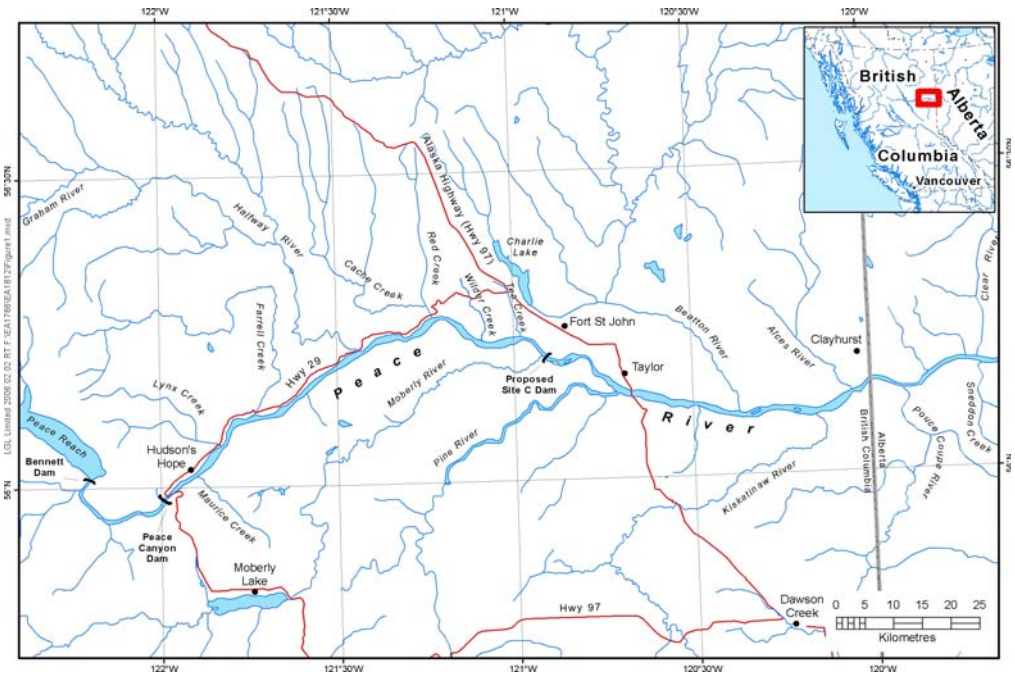

Figure 1: Peace River study area and proposed Site C Dam location.

1.2.1 Physical Setting

Within the study area, the Peace River flows through a gently meandering valley a few kilometres wide and a couple hundred metres deep situated in an area of relatively flat to slightly rolling terrain. The base rock of this area consists of fairly soft horizontally bedded shale, which has been eroded to a depth of some 60 m to form a wide, flat-bottomed valley (BCH 1990). The valley floor is overlain with a layer of alluvium some 10 m thick through which the meandering river channel traverses. The less steep valley slopes and terraces were wooded. The mainstem consisted predominantly of a single, wide channel, with gentle gradients, cobble substrates and fairly homogeneous character of flow. The drop in river elevation between the Peace Canyon Dam and Site C was approximately 64 m over a distance of 83 km, giving rise to a gradient of 0.07%.

In several tributaries, the lower segments were quite deeply incised sluggish-flowing channels, with eroded banks and considerable silt deposits. Beyond the lower segments, silt deposits were less excessive in some streams and gravel quality was improved.

1.2.2 Fish Resources

Twenty one species of fish have been recorded for the whole of the Peace River, with 20 species found in the upper half of the river (above the Smoky River confluence in Alberta) and 10 species in the downstream half (R.L.&L., 1991a). The upper Peace River system supports a fairly diverse mix of fishes, comprising populations of both sport fish (salmonids, whitefish, pike,

burbot) and non-sportfish (minnows, suckers, sculpin), with several of these listed in British Columbia as species at risk or of special concern (BC Conservation Data Centre 2005). R.L.&L. (1991a) recorded a total of 12 sportfish species for the Site C study area. The more common species captured were mountain whitefish, lake whitefish, Arctic grayling, rainbow trout and walleye, and the less common being bull trout, kokanee, northern pike, burbot and goldeye.

The species which were the primary focus in the present study were walleye, Arctic grayling, rainbow trout (spring spawners), and mountain whitefish and bull trout (autumn spawners).

1.3 Study Approach

The approach to this study involves two field programs, with the first one conducted during August-September, 2005, and the second one to be undertaken in February-March 2006. The 2006 field program will be reported in a future document. The specific tasks in the 2005 program were as follows:

August - September 2005

- Conduct a helicopter reconnaissance of the tributaries at the outset of the study;
- Install water temperature loggers at strategic locations along the mainstem;
- Conduct detailed FHAP surveys (WRP 1994; Johnston and Slaney 1996) in selected reaches of the tributaries to quantify and assess the habitat that currently exists in these waterways for fish; the habitat survey in the mainstem of the Peace River was of a more general nature as the character of the river was fairly homogeneous within the study area;
- Assess and describe the distribution of fish in the tributaries;
- Map the available habitat and fish captures in the tributaries using GIS platform;
- Install fixed-station radio telemetry receiver boxes at strategic locations along the mainstem and tributaries for the purpose of monitoring the movements of radio-tagged fish in 2006; and
- Collect, radio-tag and release a sufficient number of adult walleye, Arctic grayling and rainbow trout in the mainstem of the Peace River within the general vicinity of the proposed Site C dam for determination of their movements prior to spawning in the spring. The tags in these fish are pre-programmed to become activated in February 2006.

2.0 METHODS

2.1 Flows and Water Temperatures

2.1.1 Mainstem

Information on flows for the period between August 15 and September 30, 2005 was obtained from Water Survey of Canada (WSC, EC 2005). Information was collected at hydrometric stations in the Peace (at Hudson Hope), Halfway and Moberly rivers. The data were used to document timing and the extent of the flow fluctuations during the study period. For each day during the sampling period, average, minimum and maximum discharge was determined for the previous 10 year period (1995 to 2004) to put 2005 discharge into context.

2.1.2 Tributaries

Tidbit® temperature loggers were placed in Farrell, Lynx, and Maurice creeks in pools that were not influenced by waters of the Peace River mainstem.

In Cache, Moberly and Wilder Creeks, Tidbit® temperature loggers were installed and the flow velocities were measured with a flow meter.

In the Halfway River, a temperature logger was deployed at the WSC Station.

Data loggers are projected to be downloaded in March 2006. Data will be presented and discussed in a future report.

2.2 Habitat Quantification

Habitat surveys in both the mainstem and tributaries were carried out during a period of low flows between August and September 2005. Habitat assessment in the Peace River mainstem was based primarily on observation and measurements conducted from a boat. In the tributaries, detailed habitat surveys and fish sampling were undertaken on foot in and above the potential zone of impact. These assessments were conducted to determine if the habitat that would be lost in the zone inundated by the proposed Site C Dam reservoir is of critical importance for survival of the local fish populations.

2.2.1 Mainstem

Habitat investigations in the mainstem extended from the existing Peace Canyon Dam downstream of the proposed Site C dam to within the vicinity of the Pine River confluence. The fall 2005 field program was designed to update 1989 habitat unit mapping (ARL 1991a) and includes depth sounding. Existing BC Hydro aerial photography, taken at specific flows provided baseline maps. A Lowrance LMS-480DF GPS/Sounder unit deployed from a 6 m jet boat was used to collect depth information throughout the channel in the reaches between Peace Canyon dam and the Pine River confluence. ArcGIS 9.0 with the Spatial Analyst extension was used to convert the depth

records to isobaths (contours). The objective was to characterize primary habitat features in the mainstem.

Bathymetric surveys were conducted during 12 periods from September 16 to 18. Information on flows was obtained from the Hudson Hope Hydrometric Station and the Taylor Hydrometric Station and the distance range downstream was tracked for the given time of the survey periods. The Peace River discharge at Peace Canyon Dam is reduced daily during periods of low power demand. Soundings were taken during flows of approximately 1200-1500 m^3/s.

2.2.2 Tributaries

2.2.2.1 Habitat Assessment Methodology

In the tributaries, detailed physical habitat surveys were carried out in the reaches within and upstream of the potential zone of inundation of the Moberly, Wilder, Red, Cache, Halfway, Farrell, Lynx and Maurice systems. The survey distance upstream in the tributaries was taken as approximately twice the maximum normal operating level of the proposed reservoir, in all but Cache Creek (Table 1), to allow an instream habitat assessment both within and beyond the inundated reaches. The maximum normal operating water level of 461.8 m for the proposed reservoir (BCH 1990) was taken as the 460 m contour on TRIM 1:20,000 maps to approximate the extent of inundation in each of the tributaries. The FHAP survey distances covered in each of the tributaries are shown in Table 1 below. Habitat data collected within and beyond the zone of inundation were processed separately for each of the tributaries for comparative purposes.

Table 1: Location, length and FHAP survey distance of Peace River tributaries potentially inundated by Site C dam.

Tributary	Watershed area (km^2)	Distance upstream from Site C Dam (km)	Length of tributary inundated by Site C reservoir (km)	Survey distance
Moberly River	1833	2.5	10	20
Wilder Creek	100	14	2.5	5
Cache Creek	899	25	8	9.5
Red Creek	238	28.5	1.5	1.5
Halfway River	9402	41	14	28
Farrell Creek	620	63	2.5	5
Lynx Creek	307	73	0.8	1.6
Maurice Creek	266	79	0.3	0.6

Note: Red Creek is a tributary of Cache Creek with its confluence 3.5 km upstream from the mouth of Cache Creek.

With the exception of the Halfway River, which was too deep for wading in most areas and was therefore surveyed from a boat, habitat surveys in the other tributaries were conducted on foot, involving two crews. There were two people per crew, usually working in separate tributaries concurrently. The methodology used to conduct detailed habitat assessment in the tributaries followed the procedures described in British Columbia's Watershed Restoration Technical Circular No. 8 (WRP 1994; Johnston and Slaney 1996). The procedure involved progressively working in an upstream direction within the study area of each tributary, identifying individual habitat types, and measuring and recording specific information within each habitat area. The waypoints of the downstream and upstream boundaries of each habitat type (pool, riffle, run, other) were determined with the use of a Garmin 12 GPS unit. Within each habitat type, various physical attributes were measured and recorded on standardized data sheets. The information recorded included habitat type, wetted channel width, bankfull width and height, channel gradient (%), mean water depth (based on three measurements), maximum water depth in pools, substrate composition (% fines, gravels, cobbles, boulders, bedrock), compactness of substrate, % woody debris, % overhead cover, off-channel habitat (type, access) and riparian vegetation (type, stage). More detailed information of these and other habitat attributes not mentioned above is given in the Appendix A.

Digital photographs were taken of each habitat type surveyed and any of its significant features, with the location, date and direction of view recorded for each photograph.

2.2.2.2 Data Analysis and Interpretation

In the office, the data were entered into an *Access* database, checked for errors/omissions and corrected, and then analyzed by tributary for the results of various biophysical parameters. The results provided information on the quantity and quality of habitat available for fish which was used in assessing the importance of these reaches for fish populations in this part of the Peace River system. A summary of the diagnostic values of the condition of the existing habitat available for fish was prepared for each tributary based on specific bio-standards for the following parameters.

Percent Pools and Pool Frequency

Ratings for the percentage of pool habitat and pool frequency (spacing between pools) were assigned for each reach. A *poor* rating was given if the percentage of pool habitat was <30%, a *fair* rating if 30-40%, and a *good* rating if >40%. Similarly, ratings for pool frequency were as follows: *poor*, if the number of bankfull widths per pool was >10; *fair*, if 6-10; and *good*, if <6.

Holding Pools

Johnston and Slaney (1996) use the simplistic definition of pools greater than 1 m in depth to be 'good' holding habitat for adult fish, with no regard for

inclusion of cover. In the present study, the criterion used to define holding pools suitable for adult fish was that used by LGL Limited (2005), which incorporates both the maximum water depth and presence of cover (e.g., large woody debris (LWD), boulder, undercut bank, overhanging vegetation) within pools. By their criterion, a deep pool suitable for adult fish is one in which maximum pool depth multiplied by the % cover is ≥30.

The diagnostic value used to assess the adequacy of holding pools for adult fish within a reach in the present study was the total number of deep pools per 1000 m of stream. The ratings applied were *poor* if the number of deep pools was < 1, *fair* if the number of deep pools was between 1 and 2, and *good* if the number of deep pools was >2.

The percentage of cover attributable to large woody debris (LWD) in pools was rated as *poor* if it constituted <6%, *fair* if 6-20%, and *good* if >20% of the pool area.

Riffles

Riffles are usually short segments of relatively shallow and fast-flowing water, with their channels characterized by steep gradients and coarse, loose substrates, with very little fines present. They are the main food-producing sites in streams and rivers, and often support diverse and abundant communities of periphyton (slippery growth of diatoms and algae on the substrates) and benthic invertebrates, with the latter contributing to drifting food organisms for fish in pools. Large boulders provide important cover for the larger fish in riffles, whereas the smaller fish tend to use the cover available beneath and between the cobbles. The diagnostic for percent boulder cover in riffles was rated as *poor* if boulders constituted <10% of the area, *fair* if 10-30%, and *good* if >30%.

Runs (=Glides)

In habitat terminology, the meaning of runs and glides is generally considered to be synonymous, with the ‘glide’ designation commonly used among hydrologists and biologists in North America (e.g., Johnston and Slaney 1996). In keeping with previous fisheries reports prepared for BC Hydro on the Peace River project (e.g., R.L.&L 2001, and others), the term ‘run’ rather than ‘glide’ is used throughout this report. Runs are fairly homogeneous areas consisting of intermediate water depths and velocities and substrate sizes to those found in pools and riffles, with a smooth to minor turbulence on the surface. They usually occur downstream of pools, with the beds of their channels not loose, but rather quite compacted and embedded with fines. They are not well endowed with cover, and consequently are not preferred habitat by fish, although can be of significance in patches if cover is available. Computation of the diagnostics for runs was not included in the data analysis. For information on physical characteristics of runs refer to the Appendix A.

Gravel Quantity for Spawning

The quantity of gravel available for spawning was visually assessed. Gravel quantity (i.e., habitat area available for fish spawning) was calculated as 100% of the stream wetted area with available gravels (2-64 mm), plus 20% of the wetted area with available cobbles (64-256 mm), multiplied by the wetted area of the given habitat type. Gravel quantity was rated as *low* if the available habitat for spawning was <10% of the total wetted area, *medium* if 10-25%, and *high* if >25%.

Gravel Quality for Spawning

The quality of spawning gravels was also assessed visually. The quality of the available gravel for spawning was rated as good, *fair* or *poor* depending on the degree of compactness and embeddedness (% fines). Loose and clean substrates (≤15% fines) providing excellent habitat for spawning were rated as *good*, moderately compacted and embedded substrates (<25% fines) were rated as *fair*, and heavily compacted and embedded substrates (>25% fines) were rated as *poor*.

Off-channel Habitat

Off-channel habitat was rated as *good* if there was more than one off-channel area present (of any type), *fair* if there was only one off-channel, and *poor* if there was no off-channel. This diagnostic, as defined by Johnston and Slaney (1996), does not include the length or area of the off-channel habitat, although for it to be included in the analysis it had to be considered as an important habitat (based primarily on its extent and access) for fish in the field survey.

2.3 Fish Sampling

2.3.1 Mainstem

Fish utilization of the various available habitats was assessed for each target fish species present within the study area. For fish sampling in the mainstem, the study area was divided into eight sections so that differences in species composition and biological parameters could be identified between reaches and compared with data recorded in previous studies (Figure 2). The eight mainstem sampling sections are defined as:

- the base of the Peace Canyon Dam to the mouth of Farrell Creek;
- the mouth of Farrell Creek to the mouth of the Halfway River;
- the mouth of the Halfway River to the mouth of Cache Creek;
- the mouth of Cache Creek to the mouth of the Moberly River;
- the mouth of Moberly River to the mouth of the Pine River;
- the mouth of Pine River to the mouth of the Beatton River;

- the mouth of Beatton River to the mouth of the Kiskatenaw River; and
- the mouth of the Kiskatenaw River to the Alberta border.

To avoid conflicts with ongoing sampling programs of other studies, sections 1a, 3, and 5a were not sampled in the present survey (Figure 2).

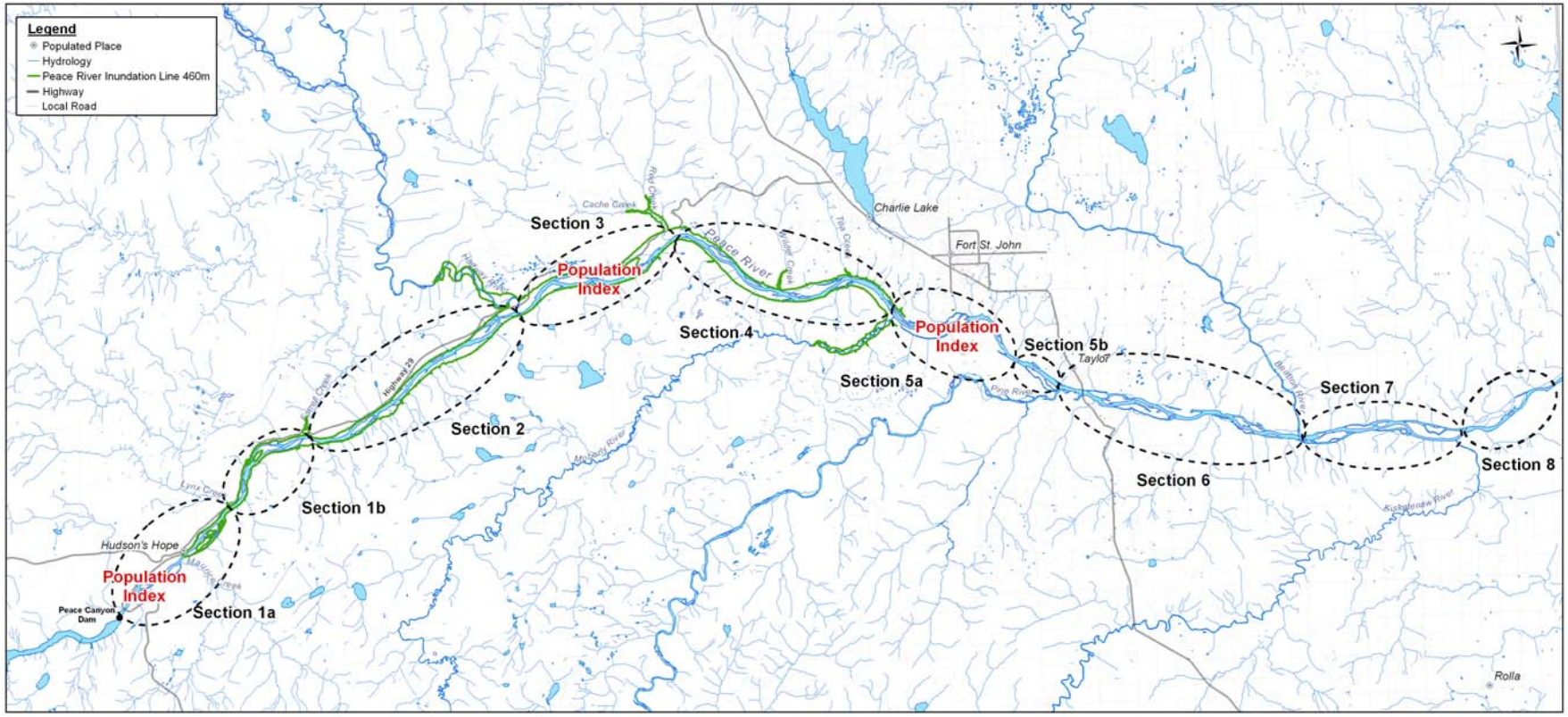

Figure 2: Peace River fish sampling sections.

During fall 2005, fish populations in the Peace River mainstem were sampled using a Smith-Root boat shocker. This technique is best for capturing fish in water depths of up to two meters. To facilitate comparisons, the boat operation and sampling protocol approximated the methods of Mainstream Aquatics (2004).

A 6-m boat equipped with a 235 HP outboard-jet motor, a double-boom anode system and GPP 5.0 electrofishing system, was used for this purpose. Amperage output ranged from 3.0 to 4.0 amperes (A) at a frequency of 60 Hz direct current. Voltage ranged from 770 to 1080 V. The sampling procedure involved drifting downstream (at motor idle) along the channel margins in water depths <2 m while outputting pulsed DC electricity. Two crew members positioned on a netting platform at the bow of the boat netted immobilized fish, while a third navigated. Captured fish were immediately placed in a 400 liter (L) onboard live well. The sampling included observations of fish made while collecting fish for radio telemetry tagging (see Section 2.4).

Capture efforts focused on areas of fish aggregation noted by P&E (2003) and Mainstream Aquatics (2004). Electrofishing was conducted in sections varying in length from 1,000 to 2,500 m. The length of time for each pass averaged 31 minutes and ranged from 4.5 to 65.8 minutes, depending on the site characteristics (boat shocking log is presented in Appendix B, Table B1). To avoid recapture of previously collected fish, processing and release occurred near the upstream end of each section. Location, effort, catch numbers, species, and size data were recorded. Fish were measured to the nearest mm and weighed to the nearest gram

Because there are ongoing marking and tagging programs in the Williston reservoir and on the Peace River, care was taken to ensure that all captured fish were examined for marks or tags, and that records were kept and distributed to the relevant groups.

All raw data were entered into Excel® spreadsheets for data storage. Quality control measures included visual inspection of the data immediately upon entry, random inspections of samples of data by a second party, and basic summary statistics to identify data entry errors.

Species compositions in the various study sections were compiled using Excel® software. Standard life history summaries were generated including length-frequency distributions using Excel® software. Catch-per-unit-effort (CPUE) was calculated based on the number of fish captured divided by the sampling effort expended using a particular technique. For boat electrofishing, both length (m) and time (s) were recorded during sampling. To facilitate comparisons with previous studies, time was used to calculate CPUE, and expressed as fish/hour. Small fish habitat utilization was assessed by comparing the CPUE with the reach (i.e. above of below the zone of inundation) for the tributaries.

2.3.2 Tributaries

With the exception of the Halfway River which was sampled with the use of a boat-mounted electroshocker in all but the side channels (that were sampled with a backpack model), fish sampling in the tributaries was carried out with the use of Smith-Root backpack electroshockers (both battery- and generator-powered models were used), with sampling progressing in an upstream direction by habitat type in selected reaches at the time that the habitat surveys were done. Typically, the one-pass sampling procedure was used and the distance covered in each pass was about 100 or 200 m. For both the single and multiple pass sampling sites, the captured fish were anesthetized in a clove oil solution, identified to species and measured (fork length except total for sculpin and burbot, mm). Wet weights were taken from a subsample of the fish caught. The data were recorded and the fish released.

2.4 Radio Telemetry

2.4.1 Radio Transmitters

Pulse-coded microprocessor transmitters fabricated by Lotek Engineering Inc. were used. Two transmitter sizes were used depending on the size of the fish. For the smaller fish (<400 mm fork length), the tags used were model MCFT-3FM, which were 11 mm in diameter, 59 mm in length, and weighed 10 g in air (4.6 g in water). For the larger fish (>400 mm fork length), the tags were model MCFT-3A, which were 16 mm in diameter, 46 mm long, and weighed 16 g in air (6.7 g in water). Both tag sizes had a 400 mm long antenna (150 MHz, 3-element Yagi) and a 3-v battery to transmit the signal. At a transmission rate of one pulse every 5 s (set at the time of manufacture), the estimated operational life was 560 and 761 days for the small and large tags, respectively. The tags were estimated to lose 2% of their useable life per week between the time of manufacture and deployment.

2.4.2 Fixed-station Receiver Sites

In all, nine fixed-station receiver sites were established at strategic locations to monitor the movements of radio-tagged fish in the Peace River and several tributaries. A waterproof metal enclosure to house the receiver, switcher and battery was installed 1-2 m above ground at each site.

Five of the fixed-station receiver sites were located at the confluences of the Peace River and the following tributaries: Beatton River, Pine River, Moberly River, Farrell Creek and Lynx Creek. Two receiver stations were installed along the Peace River mainstem. One was just downstream of the Halfway River confluence, and the other was approximately two hundred metres downstream of the Peace Canyon Dam. Two receiver stations were sited on the Halfway River, one at approximately 2 km upstream of the confluence

with the Peace River, and the other about 60 km upstream from the Peace River at the confluence with the Graham River.

Both the reception and directionality of each fixed-station receiver site was thoroughly tested using the following telemetry equipment and components:

two or more directional antennae (four-element "Yagi") were secured to the trunk of a tree and orientated to provide signal detections from the directions that fish were likely to be moving;

a peripheral switching unit (to switch between antennae);

a Lotek model SRX-400 receiver that was programmable for frequencies ranging from 148.000-152.000 MHz;

a 12-v deep cycle battery; and

high-grade (specialty) co-axial cable from the antennae to the switching unit (attached to port connectors in the enclosure).

Antennae arrangements for the receiver stations varied with location on the river. Receiver stations that were sited along the mainstem of the river (i.e., not at the confluence of a tributary) were equipped with two antennae (one to detect signals originating from upstream locations and the other to detect signals from downstream locations). Receiver stations that were situated at the confluence of a tributary and the mainstem, had three antennae installed (one to detect signals originating from upstream mainstem locations, the second to detect signals from the tributary, and the third to detect signals from downstream mainstem locations).

The testing procedure involved two people with hand-held radios and use of an inflatable boat at the deeper water sites. From a position in the middle of the mainstem, a live radio tag (same as those implanted in the fish) attached to a weight was lowered to a depth of 5-10 m. With the other person positioned at the receiver station and in communication with the hand-held radios, the signal reception and strength of a radio tag were determined at different locations and depths in the river. Typically, testing started from 500-700 m upstream of the receiver station and continued downstream for approximately the same distance below the station.

Upon completion of testing at each site, only the receiver housing and antennae arrangement were left intact; all other equipment was removed and will be re-installed when tracking is initiated in 2006.

2.4.3 Fish Collecting, Tagging and Releasing

The fish used in the radio telemetry study were collected from the mainstem with a Smith-Root electrofishing machine operated from a jet boat. The captured fish were held onboard in large plastic containers filled with fresh river water. Usually several fish were collected before tagging started. One walleye, which had a Floy tag in its dorsal area from a previous tagging

operation, died in the holding container, and four others bled excessively from the incision and so were not tagged; one subsequently died, and the remaining three were stitched-up, held until fully recovered, then released. The numbers of fish that were successfully tagged and released in autumn 2005 amounted to 58 walleye (WP), 39 Arctic grayling (GR) and 29 rainbow trout (RB). These fish tagging results are presented in Appendix B2. The locations of the fish release sites along the mainstem of the Peace River are shown in Figure 3.

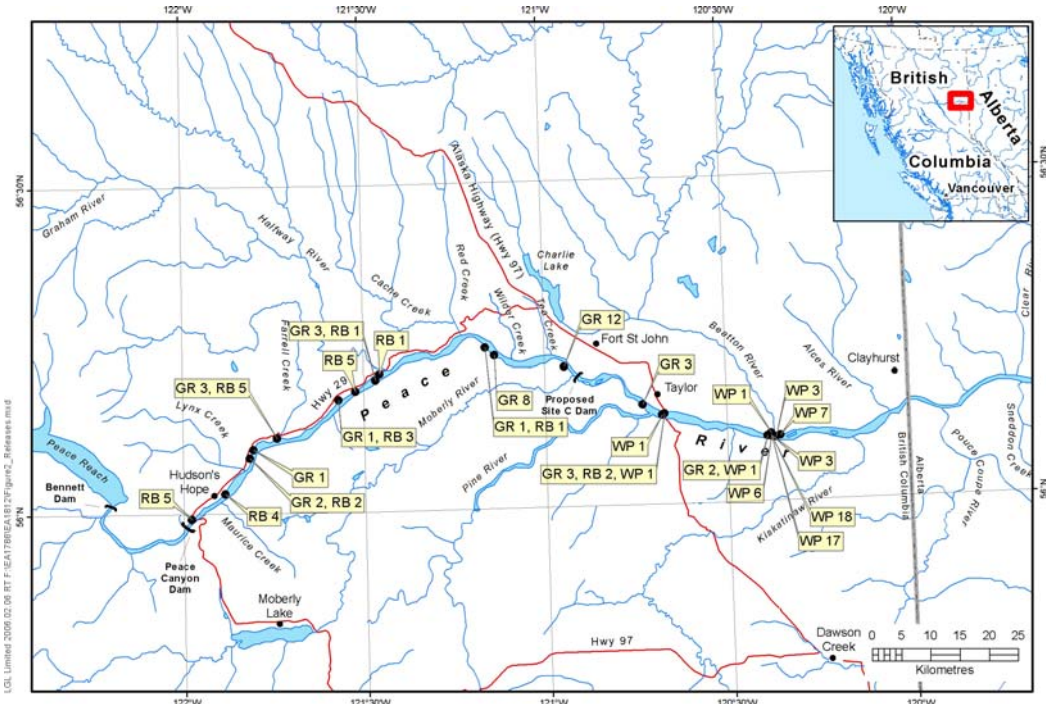

Figure 3: Release locations for fish radio-tagged in the Peace River.

A minimum of 15 minutes was allowed for the fish to recover from capture before proceeding with surgically implanting a radio tag in the peritoneal cavity of a fish. The following tagging procedure was used.

An individual fish was taken from the holding container and placed in an anesthetic bath of clove oil for about 3 min, or until it lost equilibrium. The fork length and wet weight of the fish were recorded, and the tag size used was based on the length of the fish. The anesthetized fish was placed ventral side up on a small table soaked with a diluted solution of Stress Coat (Aquarium Pharmaceuticals Inc., Chalfont, PA) to minimize scale loss and help maintain the exterior mucous covering. The tag and dissecting instruments were soaked in Hibitane germicide solution before use. The gills were continuously flushed with the anesthetic solution and the eyes were covered with a moistened paper towel.

To implant the transmitter in a fish, an incision approximately 15 mm long was made 3 mm away from and parallel to the mid-ventral line, starting about 3 mm forward of the pelvic girdle. The incision was just deep enough to penetrate the peritoneum. To provide an outlet in the body wall of the fish for the antenna to exit, a sheathed catheter was inserted in the incision, with the pointed end positioned 5-10 mm off-center from the mid-ventral line and posterior to the origin of the pelvic fins (Adams et al., 1998). Pulling the sheath back slightly onto the catheter shaft exposed the pointed end, and pressure was then applied until both the catheter and sheath pierced the skin of the fish. The catheter was then withdrawn from the incision, leaving the sheath in position through which to guide the transmitter antenna through the body wall of the fish.

The magnet deactivating the transmitter was removed and the signal emitted from the transmitter was tested just prior to being soaked in the germicide solution. Upon removal of the magnet, the signal was emitted for approximately one minute to test if the tag was working, after which it stopped and remained dormant for 20 wks until it automatically reactivated. The transmitter number was then recorded and tag implantation was begun by first threading the antenna through the catheter sheath. Both the antenna and sheath were then gently pulled posteriorly, while the transmitter was being inserted into the body cavity. The position of the transmitter in the fish was adjusted by gently pulling on the antenna until the transmitter was horizontal and directly under the incision. An intraperitoneal antibiotic, Liquimycin, was pipetted (50 μl) into the incision to prevent infection. The incision was closed with three or four interrupted, absorbable sutures, evenly spaced along the length of the incision. The antenna was attached to the side of the fish with a single suture in the caudal peduncle about 5-6 mm posteriorly to the antenna exit site. A small amount of a cyanoadhesive compound (Nexaband) was applied to the incision and antenna exit site to secure the sutures in place. Any excess adhesive was wiped off with Q-tips. About one minute prior to completion of surgery, the flow of anesthetic solution to the gills of the fish was replaced with fresh river water to start the fish's recovery.

The tag implanting procedure (including the time it took for the fish to become anesthetized initially) usually took 6-7 min to complete. Upon completion of tag implantation, each fish was held in a large plastic container with fresh river water for several minutes to ensure that it was in a healthy state before released. The surgical equipment was disinfected with the diluted germicidal solution after each fish.

2.4.4 Monitoring Fish Movements

The radio tags implanted in the fish were pre-programmed by the manufacturer to become activated 20 weeks (±1 hour) after the tags were implanted in the fish. The last batch of fish in the Peace River study was

tagged on 29 September 2005, which means that the tags in this batch of fish will not become activated until 15 February 2006. To initiate the fish tracking program, an aerial survey was conducted of the Peace River mainstem and tributaries in February 2006. A radio receiver was placed on board the aircraft to determine the locations of the tagged fish. Additional aerial tracking is to be undertaken in late March 2006. Results for 2006 telemetry component will be included in a future report.

3.0 RESULTS

3.1 Mainstem

3.1.1 Flows and Water Temperature

Flow data during the sampling period of August 15 through September 30 was obtained for each year between 1995 through 2005 from Water Survey of Canada (EC 2005).

The 2005 Peace River mainstem flows for each day during the sample period were compared with the previous 10-year average, maximum, and minimum flows in Appendix B, Table B3. Peak daily flows in 2005 ranged from 582 to 1,445 m^3/s, averaging 1,103 m^3/s. The 10-year maximum daily flows ranged from 1,340 to 3,010 m^3/s, averaging 1,783 m^3/s. Minimum daily flows over the previous 10 years averaged 419 m^3/s, and ranged from 346 to 731 m^3/s.

The 2005 flows were within the range of previous observations and averaged 13% higher than the 10-year average (961 m^3/s) for each day, but were lower on 14 of the 47 days in the sample period (Figure 4). From September 4 through 22, the 2005 flows were mainly lower than the 10 year average, and on September 11 approached the 10 minimum flow (Figure 4).

Hydro power operations upstream of the study area resulted in large diurnal fluctuations in flows in the mainstem during 2005 (Figure 5). For example, during a one week period from September 19 through 26, 2005, flows ranged from 332 to1,920 m^3/s (Figure 5), with flows lowest between midnight and 7:00 a.m. Data inputs are presented in Appendix B, Table B4.

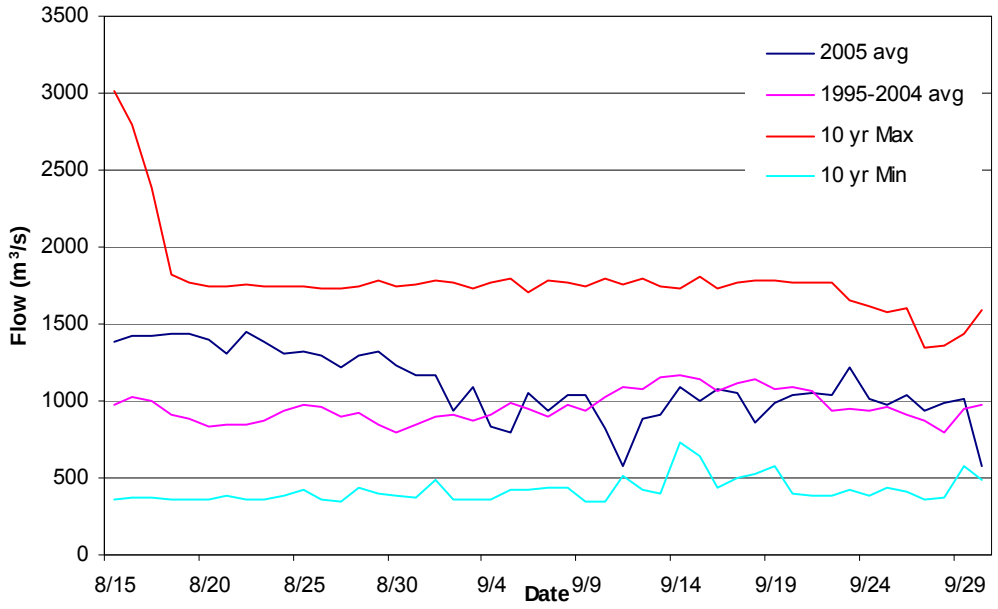

Figure 4: ***Daily flow (m^3/s) in Peace River (at Hudson Hope) between August 15, 2005 and September 30, 2005 and 1995-2004 maxima, minima, and average.***

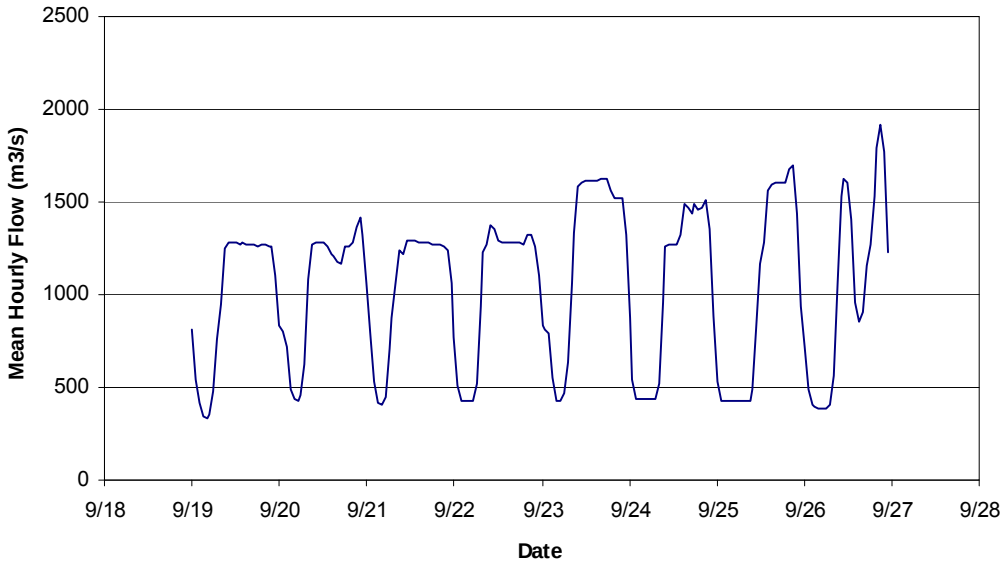

Figure 5: ***Hourly average flow (m^3/s) between September 19, 2005 and September 26, 2005.***

At the Moberly River station (WSC 07FA008), peak daily flows in 2005 ranged from 3.2 to 5.4 m^3/s, averaging 4.1 m^3/s. The 2005 flows were much lower than the 10-year average (7.6 m^3/s), averaging 87% lower for the study period (Figure 6). The 10-year maximum daily flows ranged from 9.3 to 50.7 m^3/s, averaging 25.3 m^3/s. Minimum daily flows over the previous 10 years averaged 1.4 m^3/s, and ranged from 0.6 to 2.5 m^3/s. The 2005 flows were the fourth lowest since 1995. Comparison data of the Moberly River 2005 discharge with the previous 10-year average discharge are presented in Appendix B Table B5.

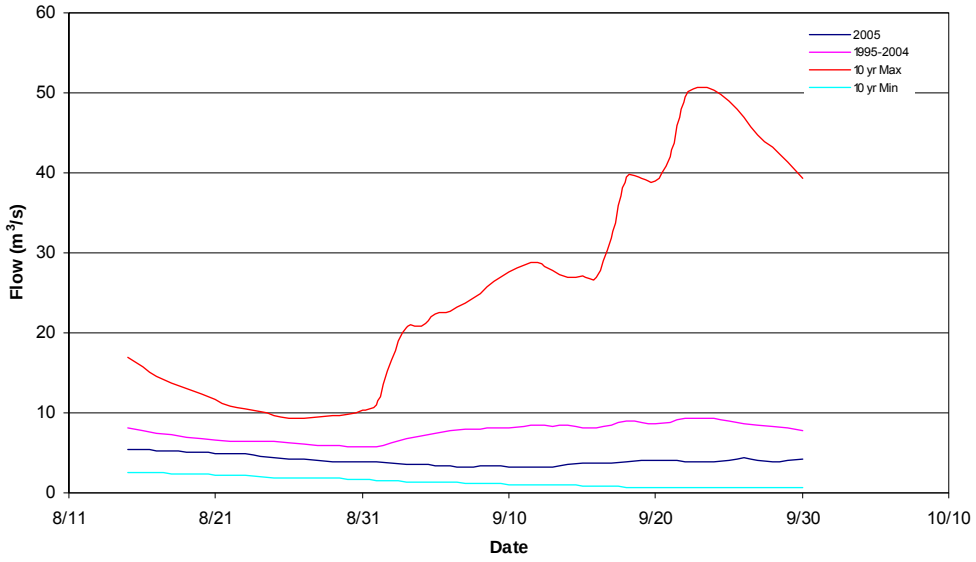

Figure 6: ***Mean daily flows (m^3/s) of Moberly River (WSC 07FA008) between August 15 and September 30, 2005 and 1995-2004 maxima, minima, and average.***

The 10 year maximum daily flows at the Halfway River station (WSC 07FA006) ranged from 100 to 385 m^3/s, averaging 208 m^3/s. Minimum daily flows over the previous 10 years averaged 26 m^3/s, and ranged from 18 to 39 m^3/s. This is nearly a 10 fold difference and demonstrates high fluctuations between years. Peak daily flows in 2005 ranged from 48 to 104 m^3/s, averaging 67 m^3/s. The 2005 flows averaged 14% lower than the 10-year average (76 m^3/s) for each day, and showed decreasing tread in flows compared to the 10-year mean throughout the sample period (Figure 7). The Halfway River 2005 flows for each day during the sample period were compared with the previous 10-year average flow in Appendix B, Table B6.

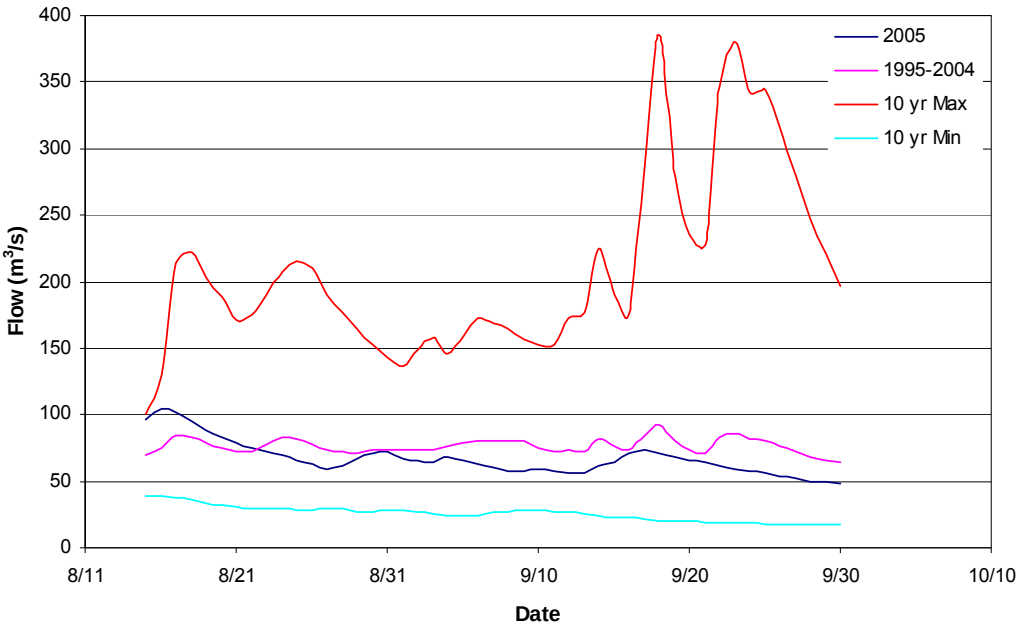

Figure 7: ***Mean daily flow (m^3/s) of Lower Halfway River (WSC 07FA006) between August 15, 2005 and September 30, 2005 and 1995-2004 maximums, minimums, and average.***

3.1.2 Channel Characteristics

Bathymetry data mapped from soundings are presented in Appendix B8 and Table 2 below.

Table 2: ***Peace River depths by habitat unit type between Peace Canyon Dam and Pine River confluence***

Habitat Type	Number of Habitat Units	Area (km^2)	Average of Maximum Depths (m)
Glide	132	20.23	4.0
Riffle	70	2.89	3.0
Pool	26	0.65	2.7
Bar	10	0.31	2.3
Debris Accumulation	1	0.02	1.5

Both depth measurement points and interpolated contours were used to determine maximum depth in each Habitat Unit. Depth measurements were collected along most of the Peace River project area. The coverage was extensive but not exhaustive and some areas were not sounded. For example, in some instances, Habitat Units were measured for depth along a

small portion of the total unit. Therefore, depth values for these units may not be as representative of the whole.

The five deepest river segments in the study area are shown in Figure 8, with the maximum depths observed in the reach immediately downstream of Peace Canyon dam.

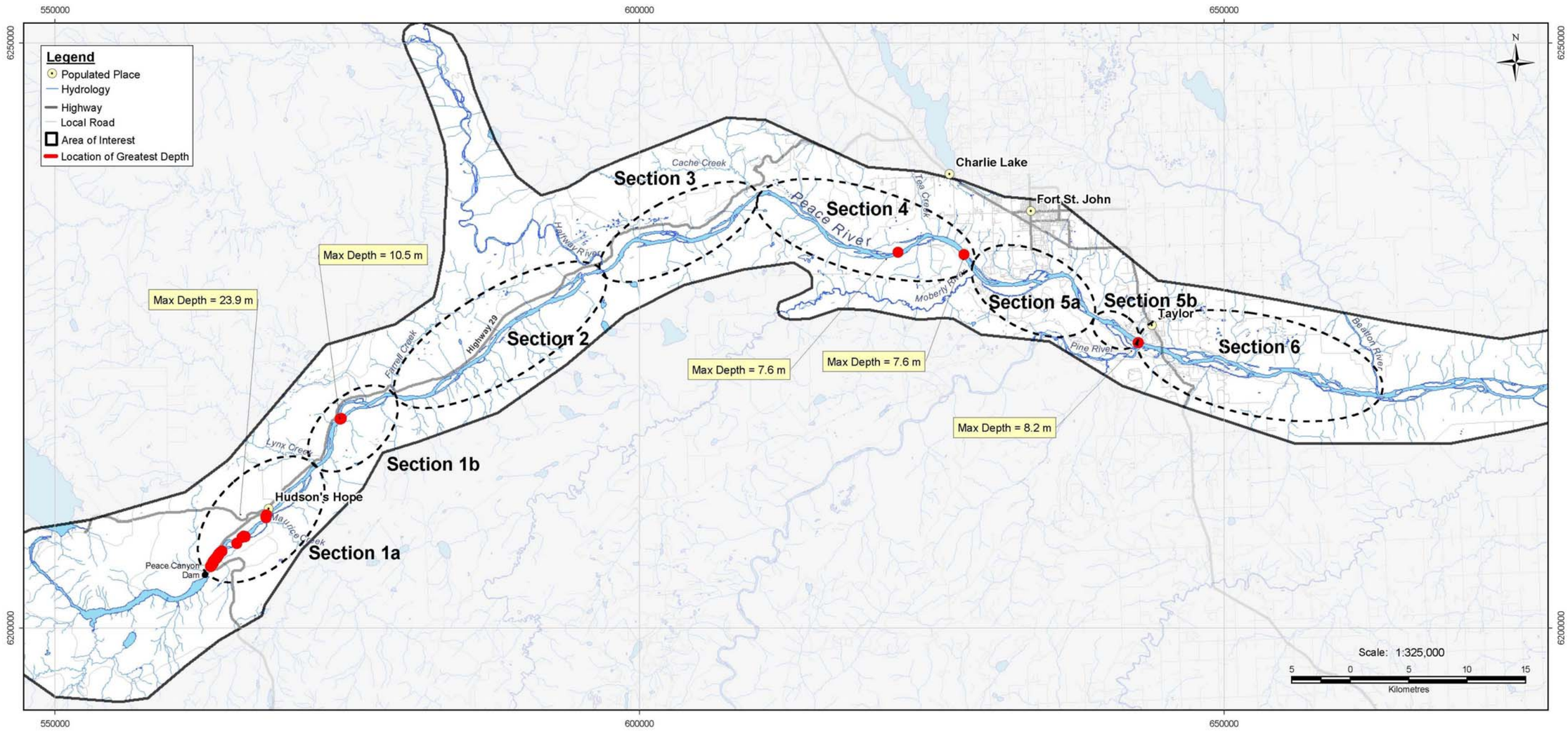

Figure 8: Five deepest locations measured along the Peace River

3.1.3 Fish Populations

A total of 2,139 fish was captured or observed during the fish sampling in the 2005 late summer study of the Peace River mainstem (Appendix C, Table C1). A list of common and scientific names of fish observed in the mainstem in 2005 is presented in Table 3. Fish captured or observed represented 19 species, which included 10 sportfish, 4 minnows, 3 suckers, 1 sculpin, and 1 other.

Table 3: Fish species recorded in the Peace River mainstem, 2005

Category	Common Name	Scientific Name
Sportfish	Arctic grayling	*Thymallus arcticus*
	Bull trout	*Salvelinus confluentus*
	Burbot	*Lota lota*
	Goldeye	*Hiodon alosoides*
	Kokanee	*Oncorhynchus nerka*
	Lake trout	*Salvelinus namaycush*
	Mountain whitefish	*Prosopium williamsoni*
	Northern pike	*Esox lucius*
	Rainbow trout	*Oncorhynchus mykiss*
	Walleye	*Stizostedion vitreum vitreum*
Minnows	Longnose dace	*Rhinichthys cataractae*
	Northern pikeminnow	*Ptychocheilus oregonensis*
	Redside shiner	*Richardsonius balteatus*
	Spottail shiner	*Notropis hudsonius*
Suckers	Largescale sucker	*Catostomus macrocheilus*
	Longnose sucker	*Catostomus catostomus*
	White sucker	*Catostomus commersonii*
Sculpin	Slimy sculpin	*Cottus cognatus*
Other	Trout-perch	*Percopsis omiscomaycus*

Species composition by section is shown in Table 4. Mountain whitefish was the most common and ubiquitous species collected (72%), and this was the only sportfish to represent a major percentage of the overall catch. Arctic grayling, rainbow trout, walleye, and kokanee represented 5%, 4%, 3%, and 2% respectfully. All other sportfish, including bull trout, burbot, goldeye and northern pike were rarely observed (<1% of catch).

Longnose suckers were the second most numerically abundant fish observed (8%), with the remaining two sucker species (largescale sucker and white sucker) being less common. Minnows, sculpin, and trout-perch represented less than 2% of the total.

The percentage of sportfish in the samples appeared to decline from upstream (98.2%) to downstream (35.7%). Inversely, the percentage of suckers rose from 1.6% in section 1 to 64% in sections 7 and 8.

Sampling during 2005 provided information to compare with previous studies in the Peace River and filled some geographic gaps compared to the work done in 1999, 2000 (R.L.&L. 2001), and 2003 (Mainstream Aquatics 2004). For example, the 2005 sampling in sections 5 and 6 were not sampled in the previous three years of studies, and section 7 was not covered in the 2003 study. This is important as walleye made up nearly 17% (59 fish) of the catch in section 6 and there was very little showing in the other sections in 2005 or previous years. For example, only nine walleye were recorded in the 1999/2000 studies by R.L.&L.

Catch per unit effort (CPUE) as the number of fish captured per hour of shocking is presented in Table 5. CPUE for all species averaged nearly 64 fish, with a range from 22 (Section 7/8) to 107 (Section 2). The CPUE for mountain whitefish in the mainstem was 46 fish per hour shocked (Table 5). Mountain whitefish CPUE ranged from 5 in Sections 7/8 to 86 in Section 2. CPUE for Arctic grayling was highest (9 fish/hour) in Section 4. Rainbow trout were most abundant (>5 fish/hour) in sections 1a and 2. Walleye were absent from most sections but they were abundant (7 fish/hour) in section 5b near the mouth of the Beatton River. Bull trout had relatively low abundance in all sections of the Peace River (<1 fish/hour).

Table 4: Species composition for Peace River, by section, 2005.

Group	Species	Section 1b		Section 2		Section 4		Section 5b		Section 6		Section 7/8		Total Mainstem	
		n	%	n	%	n	%	n	%	n	%	n	%	n	%
Sportfish	Arctic grayling	13	1.9	9	1.6	35	11.4	19	8.8	29	8.3	-	-	105	4.9
	Bull trout	7	1.0	4	0.7	1	0.3	-	-	-	-	1	3.6	13	0.6
	Burbot	-	-	-	-	-	-	-	-	4	1.1	-	-	4	0.2
	Goldeye	-	-	-	-	-	-	-	-	1	0.3	-	-	1	0.0
	Kokanee	46	6.7	-	-	-	-	-	-	-	-	-	-	46	2.2
	Lake trout	1	0.1	-	-	-	-	-	-	-	-	-	-	1	0.0
	Mountain whitefish	554	81.2	449	80.6	242	79.1	136	63.0	160	45.7	7	25.0	1,548	72.4
	Northern pike	1	0.1	1	0.2	-	-	-	-	4	1.1	-	-	6	0.3
	Rainbow trout	48	7.0	28	5.0	4	1.3	7	3.2	2	0.6	-	-	89	4.2
	Walleye	-	-	-	-	-	-	2	0.9	59	16.9	2	7.1	63	2.9
	Subtotal	**670**	**98.2**	**491**	**88.2**	**282**	**92.2**	**164**	**75.9**	**254**	**72.6**	**10**	**35.7**	**1,871**	**87.5**
Minnows	Longnose dace	-	-	-	-	-	-	1	0.5	-	-	-	-	1	0.0
	Northern pikeminnow	-	-	6	1.1	2	0.7	-	-	2	0.6	-	-	10	0.5
	Redside shiner	-	-	3	0.5	-	-	1	0.5	6	1.7	-	-	10	0.5
	Spottail shiner	1	0.1	1	0.2	-	-	-	-	-	-	-	-	2	0.1
	Unidentified minnow	-	-	-	-	-	-	-	-	1	0.3	-	-	1	0.0
	Subtotal	**1**	**0.1**	**10**	**1.8**	**2**	**0.7**	**2**	**0.9**	**9**	**2.6**	**-**	**-**	**24**	**1.1**
Suckers	Largescale sucker	6	0.9	23	4.1	4	1.3	2	0.9	5	1.4	2	7.1	42	2.0
	Longnose sucker	5	0.7	26	4.7	18	5.9	39	18.1	75	21.4	16	57.1	179	8.4
	White sucker	-	-	7	1.3	-	-	3	1.4	-	-	-	-	10	0.5
	Subtotal	**11**	**1.6**	**56**	**10.1**	**22**	**7.2**	**44**	**20.4**	**80**	**22.9**	**18**	**64.3**	**231**	**10.8**
Sculpin	Slimy sculpin	-	-	-	-	-	-	3	1.4	-	-	-	-	3	0.1
	Subtotal	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**1.4**	**-**	**-**	**-**	**-**	**3**	**0.1**
Other	Trout-perch	-	-	-	-	-	-	3	1.4	2	0.6	-	-	5	0.2
	Subtotal	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**1.4**	**7**	**2.0**	**-**	**-**	**10**	**0.5**
Total		**682**		**557**		**306**		**216**		**350**		**28**		**2,139**	

Table 5: Catch-per-unit-effort (CPUE) for Peace River, by species, 2005

Section	Hours shocked	CPUE*					
		All Species	Arctic grayling	Bull trout	Mountain whitefish	Rainbow trout	Walleye
1b	10	71.5	1.4	0.7	57.7	5.0	-
2	5	107.2	1.7	0.8	86.3	5.4	-
4	4	81.0	9.2	0.3	63.7	1.1	-
5b	5	40.6	3.6	-	25.7	1.3	0.4
6	8	41.7	3.5	-	19.0	0.2	7.0
7/8	1	22.4	-	0.8	5.4	-	1.5
Combined	34	63.9	3.1	0.4	46.2	2.7	1.9

**Note: ***Catch-per-unit-effort (CPUE) equals the number of fish captured per hour shocked.

3.1.3.1 Arctic Grayling

During 2005, 105 Arctic grayling were captured and lengths were recorded for 70. Length data by section are presented in Table 6 and length-frequency for all sections combined is shown in Figure 9. Arctic grayling averaged 255 mm and ranged in length from 25 mm to 375 mm. Based on the length-frequency figure, modal length classes occur at 225, 300 and 375 mm.

Fish measured in 1990 (R.L.&L. 1991a) ranged from 110 to 460 mm fork length. In 1999, 23 Arctic grayling were measured, and these ranged in fork length from 20 to 390 mm (R.L.&L. 2001). In 1990, 440 fish were measured, the strongest mode was at 210 mm, with minor modes around 290 mm, 330 mm, 370 mm, and a showing of young-of-the-year fish at 120 mm (R.L.&L. 1991a).

Table 6: Fork length (mm) for Arctic grayling in the Peace River by section, 2005

		Fork length (mm)		
Section	**n**	**Mean**	**Min**	**Max**
1b	7	317	259	371
2	6	241	83	361
4	29	265	25	375
5	16	236	121	352
6	12	225	98	314
7/8	0			
Combined	70	255	25	375

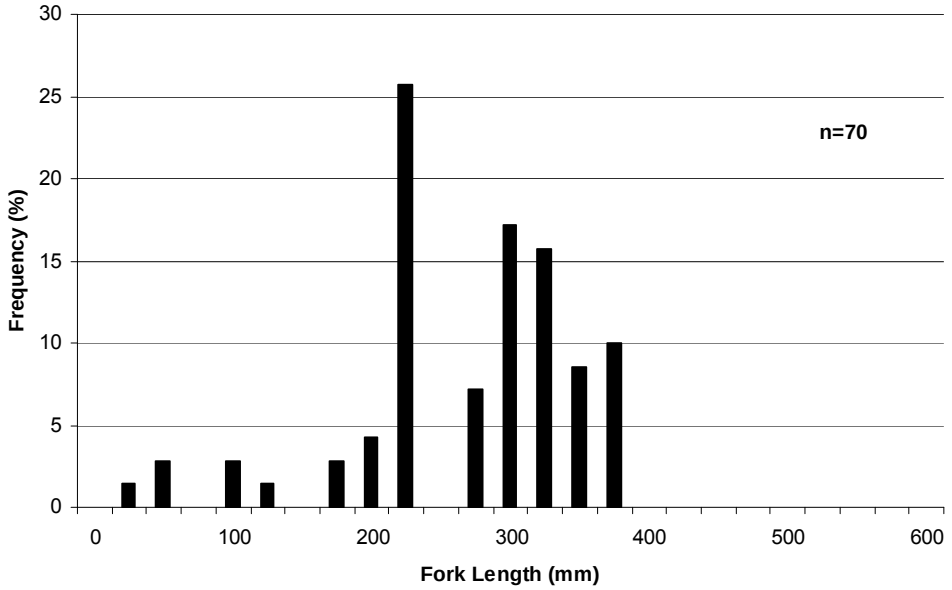

Figure 9: Length-frequency distribution of Arctic grayling captured in all sections of the Peace River, September 2005.

3.1.3.2 Bull Trout

Most of the bull trout (11 of 13) were captured in sections 1b and 2 in the 2005 study. The fish ranged in fork length from 214 to 1600 mm, averaging 500 mm. R.L. & L. (2001) measured 60 fish during 1999 that ranged from 203 to 867 mm fork length.

3.1.3.3 Mountain Whitefish

Within Section 1 of the Peace River, 554 mountain whitefish were collected during 2005. Lengths were taken from 542. These fish ranged in length from 20 mm to 556 mm fork length, averaging 278 mm. The length-frequency histogram (Figure 10) shows a multimodal distribution of fork lengths with the strongest peak around 320 mm and the second around 220 mm.

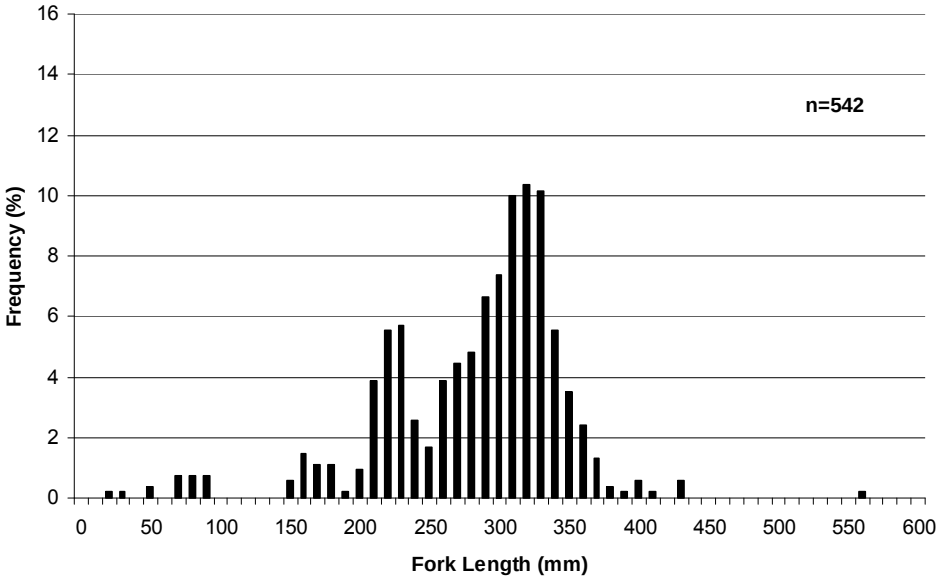

Figure 10: Length-frequency distribution of mountain whitefish captured in Section 1 of the Peace River, September 2005

Of the 446 mountain whitefish measured in Section 2, the range in length was 50 to 593 mm, averaging 254 mm (Figure 11). These data show four distinctive modes. The strongest was around 170 mm, the next around 310 mm, followed closely by a mode around 220 mm, with a showing around 90 mm.

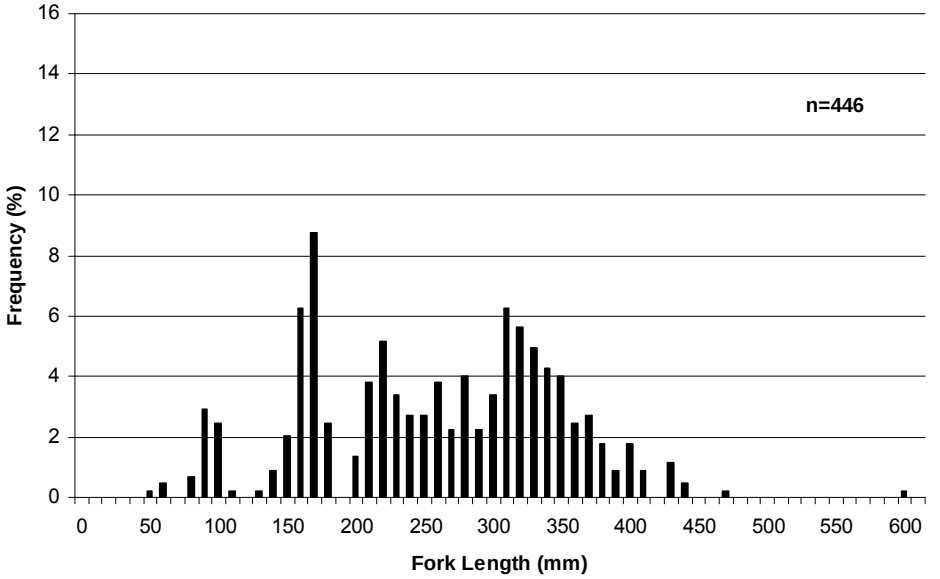

Figure 11: Length-frequency distribution of mountain whitefish captured in Section 2 of the Peace River, September 2005

Within Section 4, length data was collected for 238 mountain whitefish. These fish ranged in length from 25 mm to 500 mm fork length, averaging 271 mm. The length-frequency histogram (Figure 12) shows a multimodal distribution quite similar to that of Section 2. The strongest mode was around 160 mm and the next around 310 mm.

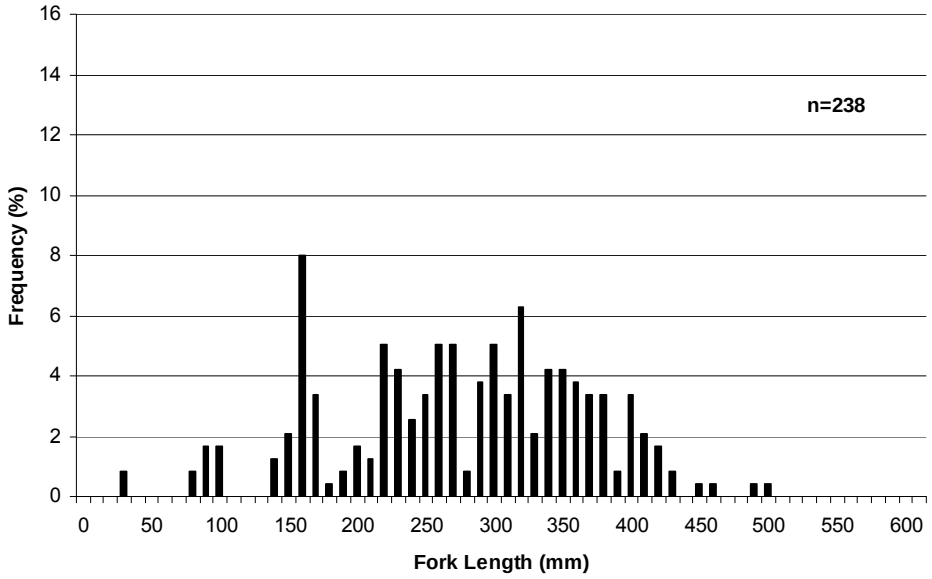

Figure 12: Length-frequency distribution of mountain whitefish captured in Section 4 of the Peace River, September 2005

A total of 135 mountain whitefish were measured in Section 5b. The range in length was 35 to 440 mm, averaging 230 mm (Figure 13). These data showed a strong mode at 160 with less distinctive modes around 80 to 90 and around 370 to 380 mm.

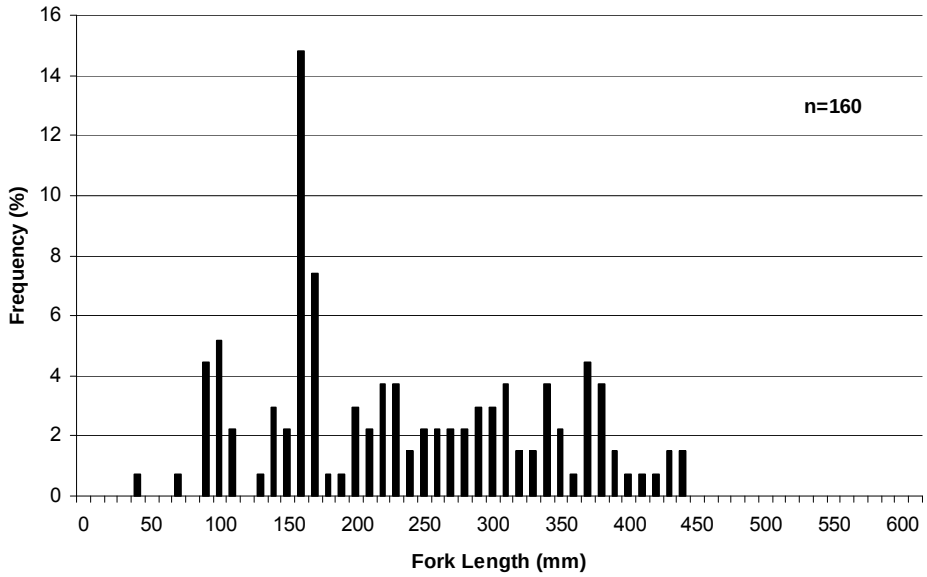

Figure 13: Length-frequency distribution of mountain whitefish captured in Section 5b of the Peace River, September 2005

Of the 160 mountain whitefish measured in Section 6, the range in length was 25 to 490 mm, averaging 254 mm (Figure 14). These data show a multimodal distribution. The strongest mode was around 100 mm, the next around 170 mm and 330 mm.

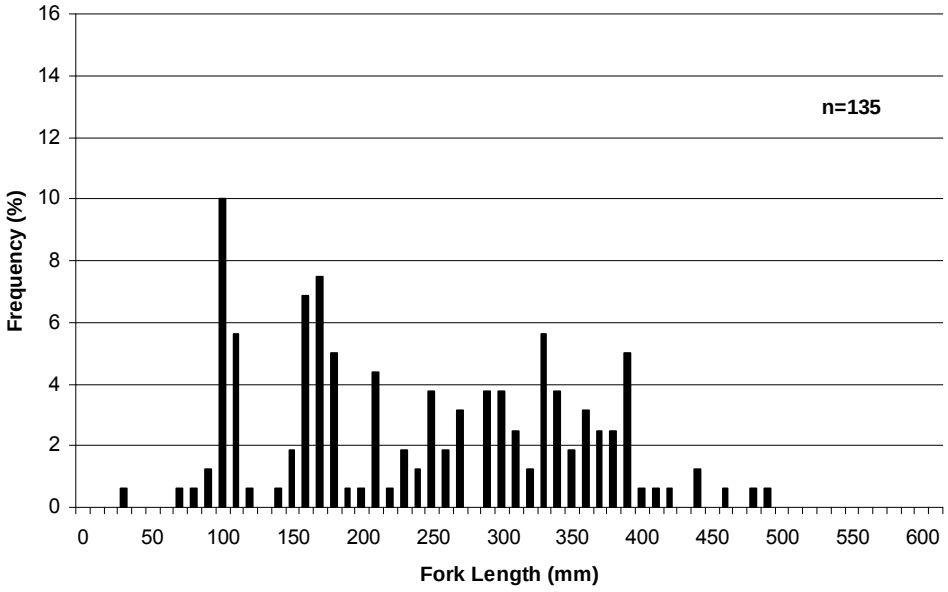

Figure 14: Length-frequency distribution of mountain whitefish captured in Section 6 of the Peace River, September 2005

A small amount of sampling was conducted in Sections 7 and 8. Lengths were recorded for seven fish in Section 7. Lengths ranged from 243 to 451 mm, with an average of 318 mm.

The combined length frequency data for all sections for mountain whitefish (n=1528) sampled during 2005 are presented in Figure 15. The data exhibited at least four, possibly five modes, at 100, 160, 220, possibly at 260, then at 320 mm, which was the highest. Based on the age-length relationship developed for Peace River whitefish sampled in the mainstem by Mainstem Aquatics (2004), these modes correspond to young-of-the-year, one year, two year, three year, and mixture of mainly four and five year old fish.

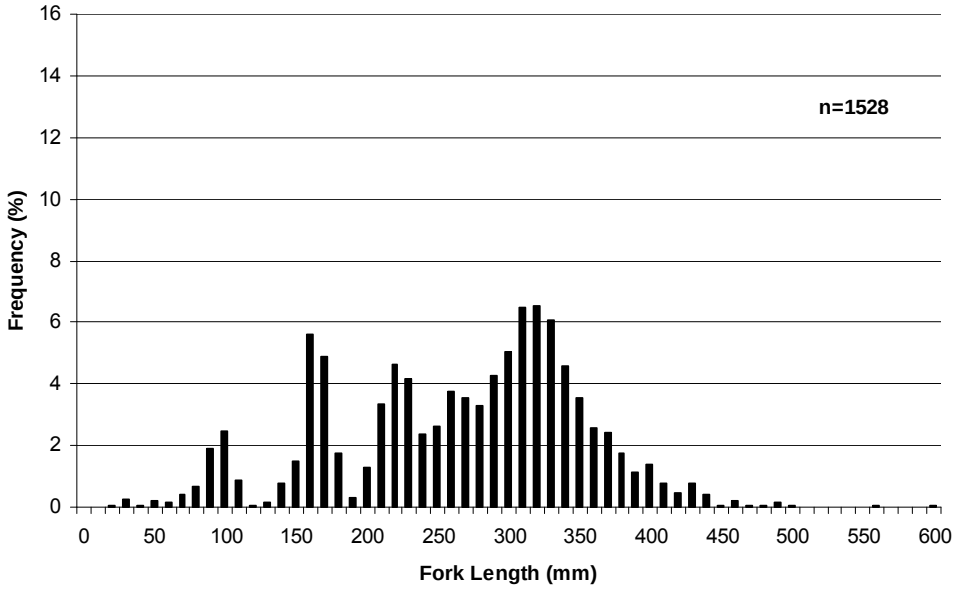

Figure 15: Length-frequency distribution of mountain whitefish captured in all sections of the Peace River, September 2005

A summary of mountain whitefish fork length data, by section, is presented in Table 7. In general, the size of mountain whitefish declines from Section 1 to Section 7/8. This pattern was also observed for mountain whitefish in 2003 by Mainstream Aquatics (2004).

Table 7: Fork length (mm) for mountain whitefish in the Peace River by section, 2005

Section	n	Fork Length (mm)		
		Mean	Min	Max
1b	554	278	20	556
2	446	254	50	593
4	238	271	25	500
5b	135	238	35	436
6	160	254	25	490
7/8	7	318	243	451
Combined	1528	262	20	593

3.1.3.4 Rainbow Trout

Most of the rainbow trout measured were in Sections 1b and 2 of the Peace River. Table 8 presents fork length data for each section and Figure 16 displays the length-frequency for all sections combined. In September 2005, lengths ranged from 44 to 630 mm and averaged 279 mm for the 62 rainbow trout measured in the Peace River. In 1990, a total of 107 rainbow trout were measured that averaged 275 and ranged from 150 to 730 mm fork length (R.L.&L. 1991a).

Table 8: Fork length (mm) for rainbow trout in the Peace River by section, 2005

Section	n	Fork Length (mm)		
		Mean	Min	Max
1b	32	260	44	450
2	18	263	84	396
4	3	305	209	396
5b	7	432	147	630
6	2	142	114	169
7/8	0			
Combined	62	279	44	630

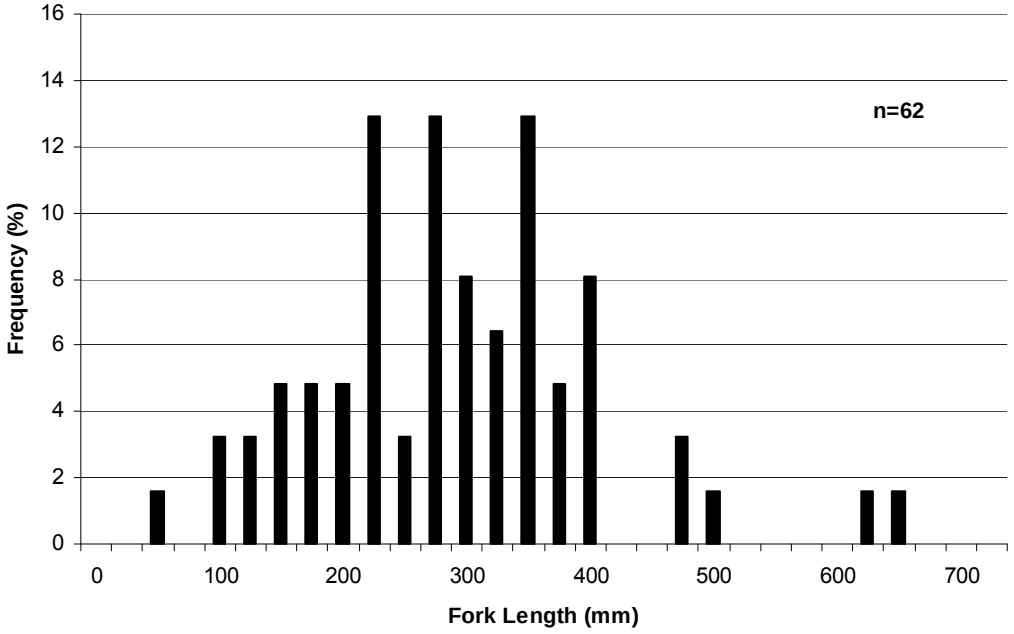

Figure 16: Length-frequency distribution of rainbow trout captured in all sections of the Peace River, September 2005

3.1.3.5 Walleye

During 2005, most walleye (94%) were only found in Section 6 near the mouth of the Beatton River. Lengths for all walleye measured ranged from 275 to 574 mm, averaging 413. The length-frequency for the 57 walleye measured in Section 6 is presented in Figure 17. A length mode was observed at 450 mm. Walleye were not assessed in any previous studies because of low numbers recorded.

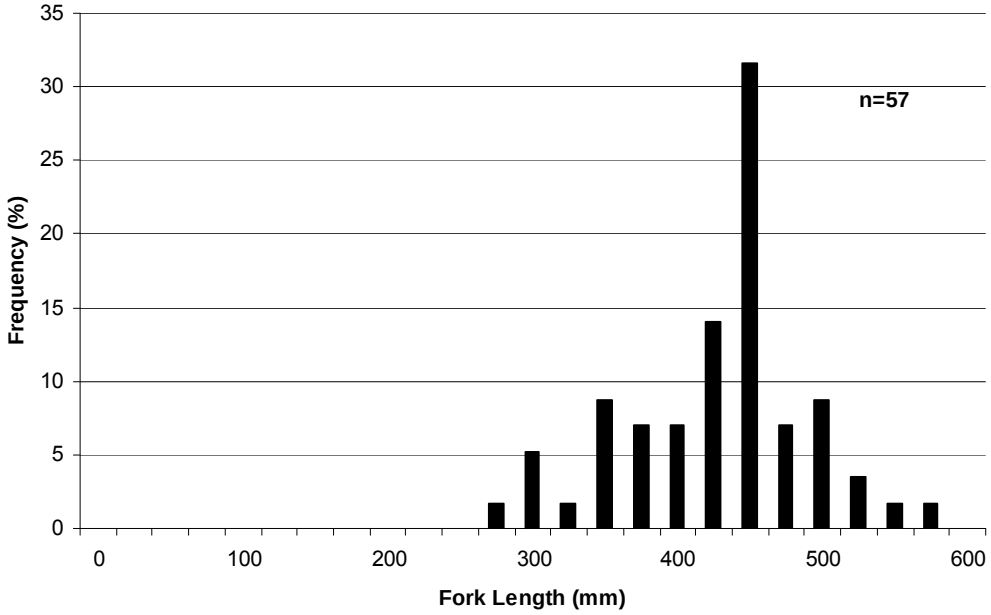

Figure 17**: **Length-frequency distribution of walleye captured in Section 6 of the Peace River, September 2005

3.1.3.6 Other Sportfish

Lake trout and kokanee were only captured in Section 1. Only one lake trout was captured and this fish measured 540 mm. Forty-six kokanee were measured and their lengths ranged from 56 to 664 mm, averaging 151 mm.

Three burbot were measured in Section 6 and their lengths were 374, 413, and 449 mm. The only goldeye capture in the Peace River mainstem in 2005 was also captured in Section 6 and measured 390 mm.

Northern pike were rare and only five were measured from Sections 1, 2 and 6. The northern pike ranged in length from 438 mm to 898 mm and averaged 672 mm.

3.1.3.7 Non-Sportfish

Nine non-sportfish species were captured in the Peace River mainstem in September 2005. Average, minimum and maximum lengths are shown in Table 9.

Table 9: ***Fork length (mm) for non-sportfish in all sections of the Peace River, 2005***

Species	n	Fork Length (mm)*		
		Mean	Min	Max
Longnose sucker	174	341	86	528
Largescale sucker	42	386	116	540
White sucker	9	148	72	330
Longnose dace	1	74	74	74
Northern pikeminnow	9	279	135	471
Redside shiner	10	79	63	95
Spottail shiner	2	43	41	45
Slimy sculpin	3	79	71	84
Trout-perch	4	73	61	79

Note: *Total length for sculpin

Longnose suckers were the most common non-sportfish species captured. Within the mainstem of the Peace River, 174 longnose sucker were measured during 2005. The highest percent frequency was in section 7/8 (57%), but most numbers (75) were observed in section 6.

Longnose suckers ranged in length from 86 mm to 528 mm and averaged 341 mm. Table 10 presents longnose sucker length data by section and Figure 18 shows the length-frequency. The length-frequency shows a multi-modal distribution of fork lengths with the strongest peaks at 370 and 410 mm with other distinct modes at 140 mm and 250 mm.

Table 10: ***Fork length (mm) for longnose sucker in the Peace River by section, 2005***

Section	n	Fork Length (mm)		
		Mean	Min	Max
1b	5	284	133	418
2	26	212	108	493
4	18	415	118	528
5b	37	338	86	522
6	72	371	204	472
7/8	16	356	228	486
Combined	174	341	86	528

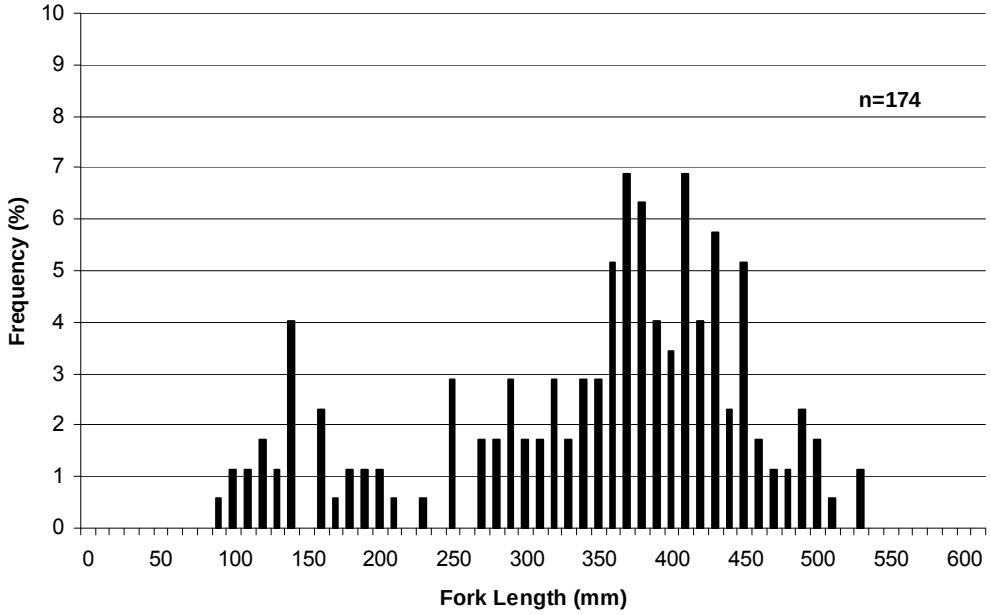

Figure 18**: **Length-frequency distribution of longnose sucker captured in all sections of the Peace River, September 2005

3.1.4 Rare and Endangered Species

There are no fish species in the study area that have been listed as extirpated, endangered or threatened by the Committee On the Status of Endangered Species In Canada (COSEWIC).

A few Peace River fish species are listed as either red (extirpated, endangered, or threatened within BC) or blue (at risk or of special concern) by the British Columbia Conservation Data Centre. Spottail shiner are red-listed in British Columbia. Arctic grayling are not listed in the lower Peace River, but the Williston Lake population is red-listed provincially. Bull trout, goldeye, and pearl dace are present in the study area and blue-listed in British Columbia (BC Conservation Data Centre 2005).

3.2 Tributaries

3.2.1 Instream Habitat Assessment

The instream habitat assessment is presented separately for the habitat above and below the potential zone of inundation for tributaries upstream of the proposed Site C dam. For each of the tributaries, the area within the footprint of the proposed Site C dam is referred to as the lower reach, and the area upstream of the proposed footprint as the upper reach throughout the report.

For comparative purposes, the basic physical characteristics of the lower and upper reaches of the tributaries are summarized in Table 11. For most of the tributaries, the summary of these characteristics is reasonably similar between the two reaches. That is, the wetted channel widths, bankfull widths and heights, channel gradients and water depths did not differ greatly over the lengths of stream surveyed.

The stream for which the data summary differs most between reaches is Maurice Creek, which was considerably wider and deeper in the lower than in the upper reach, probably largely because of influence from flows in the mainstem. There is only 300 m that would be flooded by the Site C dam and some sections of this area are already influenced by Peace Canyon dam flows.

There were no marked differences in substrate composition between reaches for most of the tributaries, the exceptions being that Cache and Maurice creeks had greater proportions of fines in the lower reach, and boulders were more common in the lower reach of both Lynx and Maurice. The upper reach of Maurice Creek had considerable bedrock (18.6%), whereas none was recorded in the lower reach.

Table 11: Summary of habitat variables by tributary, 2005.

		Tributary							
Reach	**Variable**	**Moberly River**	**Wilder Creek**	**Cache Creek**	**Red Creek**	**Halfway River**	**Farrell Creek**	**Lynx Creek**	**Maurice Creek**
Lower	Wetted width (m)	18.6	2.2	7.2	3.8	75.2	11.4	6.3	15
	Bankfull width (m)	37.3	8.9	21	9.2	118.5	26.1	11	24
	Bankfull height (m)	1.3	0.6	0.6	0.5	1.7	1.8	0.4	0.9
	Gradient (%)	0.8	0.9	1	0.9	1	1.1	2	0.5
	Mean Water depth (m)	0.4	0.3	0.2	0.2	1.7	0.3	0.4	0.5
	Maximum Pool depth (m)	1.2	0.5	0.8	0.5	1.5	0.9	0.7	1.3
	Discharge (m^3/s)	2.1	0.001	-	-	-	0.2	0.1	0.1
					Substrate Composition (%)				
	- fines	20.2	57.3	19.8	20.7	7.8	13.4	46.7	27.5
	- gravels	35	28	56.1	58.3	44.1	37.6	10	17.5
	- cobbles	42.2	11.9	21.9	16.2	42.4	32.6	16.7	22.5
	- boulders	2.6	1.8	2	2.5	4.5	7	26.7	32.5
	- bedrock	-	1	0.2	0.1	1.4	9.5	-	-
Upper	Wetted width (m)	19.7	2.1	-	7.3	55.9	10.9	6.3	8.3

Reach	Variable	Tributary							
		Moberly River	Wilder Creek	Cache Creek	Red Creek	Halfway River	Farrell Creek	Lynx Creek	Maurice Creek
	Bankfull width (m)	38.5	10.7	-	17.8	119.9	29.1	11.7	17
	Bankfull height (m)	0.8	0.5	-	0.5	1.7	1.5	0.5	0.7
	Gradient (%)	0.7	1	-	1	1.1	1	0.9	0.5
	Mean Water depth (m)	0.5	0.1	-	0.2	0.9	0.3	0.5	0.2
	Maximum Pool depth (m)	1.1	-	-	0.6	1.9	0.7	0.6	0.6
		Substrate Composition (%)							
	- fines	21.2	58.3	-	3.2	4.7	12.5	45.4	19.3
	- gravels	30.6	22	-	79.5	38.2	47.5	19.3	21.4
	- cobbles	38.2	19.5	-	12.1	50.6	29	26	37.1
	- boulders	6.8	0.2	-	3.5	3	1.8	6.6	3.6
	- bedrock	-	-	-	0.2	2.4	2.3	2.8	18.6

The proportion of the different habitat types (based on length of stream) present in the lower and upper reaches of each of the tributaries is summarized (Table 12) to give an appreciation of the habitat composition of these streams. Runs constituted a high proportion of the habitat in both the lower (71%) and upper (58%) reaches of the Halfway River. In the Moberly River, runs comprised 45% in the lower reach and 34% in the upper reach. In the other tributaries, excluding Red Creek, the proportion of run habitat ranged from 12 to 34%. With the exception of Cache Creek which had a high proportion of pool habitat in both reaches (46 to 52%), the amount of pool habitat in the other tributaries was moderate. All of the tributaries, except the Halfway River, had a reasonable amount (>30%) of riffle habitat.

There were no barriers to fish passage (e.g., impassable waterfall, chute, cascade, or other) along the length of stream surveyed in any of the tributaries.

The riparian vegetation bordering these streams consisted mainly of a mix of poplar, birch, willows, conifers, shrubs, sedges, and grasses (see Appendix A for vegetation data).

Photos are presented in the sections below to display typical habitat in the lower and upper reach. Unless noted otherwise in the captions, all photos were taken looking upstream. With the exception of some of the smaller streams for which the survey length was quite short and few photographs were taken (e.g., Wilder, Red, Maurice), the photographs for the tributaries

are presented in the order of riffle, pool, run and others (e.g., off-channel, if present).

Table 12: ***Percent of habitat type (based on stream length) in the lower and upper reach by tributary, fall 2005.***

		Percent by Tributary							
Reach	**Habitat**	**Moberly River**	**Wilder Creek**	**Cache Creek**	**Red Creek**	**Halfway River**	**Farrell Creek**	**Lynx Creek**	**Maurice Creek**
Lower	Riffle	32.3	59.2	30.2	38.9	9.2	51.9	90.3	70.2
	Pool	13.1	10.2	52.2	22.6	20.1	35.9	9.7	29.8
	Run	44.8	20.4	16.6	32.6	70.7	12.1	-	-
	Other	9	10.1	-	5.9	-	-	-	-
Upper	Riffle	39.7	70.5	30.3	-	20.7	49.9	59.2	40.6
	Pool	17.3	-	46.1	-	21.2	34	23.4	25.3
	Run	33.6	29.5	19.2	-	58.2	15	14.6	34.1
	Other	8.4	-	4.4	-	-	-	2.8	-

3.2.1.1 Moberly River

The Moberly River is a moderate size, low gradient, meandering, cobble-bedded river with a fairly broad flood plain comprising gravel bars (many of them vegetated) and various tertiary channels typically at meanders. It drains a watershed of 1832 km^2 (Table 1) and enters the Peace River just upstream of the proposed Site C location. Moberly Lake, comprising an area of 28.5 km^2, lies 121 km above the Peace River confluence (Figure 1).

Owing to its low gradient and proximity to the proposed dam, about 10 km of this river would be inundated. From the mouth upstream, approximately 20 km of the river was surveyed to assess instream habitat. Photographs portraying features of the different habitat types, including off-channels, in both the lower and upper reaches are shown in Plates 1-8.

Plate 1: ***Lower Moberly River, riffle with gravel bar between***

Plate 2: ***Lower Moberly River, deep pool with virtually no bank cover.***

Plate 3: ***Lower Moberly River, fast-flowing run, with minimal cover for fish.***

Plate 4: ***Lower Moberly River, side channel with some good bank cover.***

Plate 5: ***Upper Moberly River, wide and shallow, cobble/bouldery riffle.***

Plate 6: ***Upper Moberly River, deep pool with plenty of log cover along bank.***

Plate 7: ***Upper Moberly River, run with small patches of wood cover along bank.***

Plate 8: ***Upper Moberly River, side channel with an abundance of log cover.***

The Moberly River was surveyed during 9 to 14 September when the flows were appreciably lower relative to that of the average flows for the period 1995-2004 (see Figure 6). The summary of the instream habitat variables for the lower and upper reaches of the Moberly River indicates that the habitat was fairly homogenous along the length of the river surveyed (Table 11). Moreover, any habitat differences observed were mostly minor between the lower and upper reaches. For both reaches, the proportion of pool habitat and pool frequency were rated as *poor*, comprising 14% and 18% pool habitat, and 14.4% and 10.2% pool frequency, respectively (Table 13). Similarly, there was no difference in the quality of holding pools for fish, with the pools in both reaches rated as *poor*. Likewise, the overall proportions of wood and overhead cover in pools were rated as *poor* in both reaches, although some pools had ample log cover along the banks (see Plate 6). On the other hand, riffles overall had more boulder cover in the upper than in the lower reach (examples, Plates 1 and 5). Both reaches had ample gravel for spawning, but neither was of good quality due to considerable compaction with fines. Some good quality off-channel habitat with adequate wood cover was present in both reaches (examples, Plates 4 and 8).

Table 13: Habitat condition in upper and lower reach by Peace River tributary, fall 2005.

Reach	Tributary	% Pools[1]		Pool Frequency[2]		Holding Pools[3]		% Wood in Pools[4]		% Boulder in Riffles[5]		% Overhead Cover[6]		Gravel Quantity (%)[7]		Gravel Quality[8]		Off-channel Habitat[9]	
		Value	Rating	Value	Rating	Value	Rating	Value	Rating	Value	Rating	Value	Rating	Value	Rating	Value	Rating	Value	Rating
Lower	Moberly	14	Poor	14.4	Poor	0.2	Poor	3.8	Poor	3.4	Poor	7.3	Poor	41	Good	20	Fair	15	Good
	Wilder	16	Poor	31.8	Poor	0.2	Poor	21.9	Good	3.2	Poor	33.6	Good	19	Fair	57	Poor	—	n/a
	Red	26	Poor	14.3	Poor	—	n/a	8.1	Fair	3.7	Poor	17.8	Fair	61	Good	21	Fair	3	Good
	Cache	58	Good	4.5	Good	0.1	Poor	6.3	Fair	2.5	Poor	14	Fair	55	Good	20	Fair	4	Good
	Halfway	14	Poor	12.4	Poor	—	n/a	0.3	Poor	2.3	Poor	7.9	Poor	53	Good	8	Good	1	Fair
	Farrell	45	Good	6.2	Fair	—	n/a	0.2	Poor	10.7	Fair	11.2	Fair	40	Good	13	Good	1	Fair
	Lynx	8	Poor	36.5	Poor	—	n/a	1.6	Poor	37.5	Good	13.6	Fair	18	Fair	47	Poor	—	n/a
	Maurice	68	Good	15.1	Poor	2.8	Good	0.1	Poor	35	Good	34.1	Good	21	Fair	28	Poor	—	n/a
Upper	Moberly	18	Poor	10.2	Poor	0.1	Poor	2.6	Poor	10.1	Fair	6.8	Poor	39	Good	21	Fair	18	Good
	Wilder	—	n/a	—	Poor	—	n/a	—	n/a	0.4	Poor	—	n/a	33	Good	58	Poor	—	n/a
	Red	42	Good	4.7	Good	—	n/a	8.6	Fair	4.1	Poor	23.9	Good	79	Good	3	Good	—	n/a
	Cache	15	Poor	14	Poor	—	n/a	1.8	Poor	2.4	Poor	9.7	Poor	53	Good	5	Good	10	Good
	Halfway	33	Fair	4.6	Good	0.3	Poor	5.6	Fair	2.5	Poor	17.1	Fair	55	Good	13	Good	5	Good
	Farrell	28	Poor	11.7	Poor	1.1	Fair	5.2	Fair	10.4	Fair	15.6	Fair	21	Fair	45	Poor	1	Fair
	Lynx	20	Poor	6.4	Fair	—	n/a	1.7	Poor	7.3	Poor	2.2	Poor	29	Good	19	Fair	—	n/a
	Maurice	18	Poor	10.2	Poor	0.1	Poor	2.6	Poor	10.1	Fair	6.8	Poor	39	Good	21	Fair	18	Good

Note: [1] Value is percent pools (%P = total pool area / total wetted area). Poor < 30%, Fair <= 40%, Good > 40% (for gradients 2-5%); [2] Value is number of bankfull widths per pool (PF = mean bankfull width / total number of pools). Good < 6, Fair <= 10, Poor > 10.; [3] Value is the number of pools per 1000 m for which the product of the maximum depth times the total overhead cover is >= 30. Poor < 1, Fair <= 2, Good > 2.; [4] Value is the mean percent wood cover in pools. Poor < 6%, Fair <= 20%, Good > 20%.; [5] Value is the percent boulder cover in riffles. Poor < 10%, Fair <= 30%, Good > 30%.; [6] Value is the percent overhead cover in pools. Poor < 10%, Fair < 20%, Good > 20%.; [7] Value is percent spawning area (%Quantity = spawning area / total wetted area). Poor < 10%, Fair <= 25%, Good > 25%.; [8] Value is the percent of substrate in <2 mm category (fines). Poor > 25%, Fair >15% and uncompacted, Good < =15% and uncompacted.; and, [9] Value is the number of off-channel habitats. Poor < 1, Fair <= 2, Good > 2.

3.2.1.2 Wilder Creek

Wilder Creek is a small stream, with a heavily aggraded channel, minimal surface flow and no useful habitat for fish at the time of this survey (Plates 9 and 10). A meaningful comparison of the habitat diagnostics between reaches is not possible as there were no pools in the upper reach. Pools in the lower reach had a high proportion (34%) of overhead cover (Table 13). Although some substrate suitable for spawning was present, spawning is not likely to be of importance for autumn-spawning fish in this stream due to inadequate flows. However, it may be of some importance for spring-spawning fish when flows are higher. There was no off-channel habitat associated with this stream.

Plate 9: ***Lower Wilder Creek, an aggraded channel, minimal surface flow and no wood cover.***

Plate 10: ***Upper Wilder Creek, sediment wedges, some woody cover, eroded banks.***

3.2.1.3 Cache Creek

A considerable length (~8 km) of Cache Creek would be inundated with development of the proposed Site C reservoir. The character of the habitat in the lower and upper reaches of this small stream is depicted in Plates 11-16. Generally, the habitat was reasonably similar between reaches, with riffles lacking in boulder cover and the runs constituting extensive lengths of stream with silted beds and virtually no cover for fish. Proportionally, there was a good amount of pool habitat in both reaches, although the pools generally were somewhat shallow. Thus, as holding habitat for fish, the pools were of poor quality in the lower reach, and none qualified as a holding pool in the upper reach. These pools, however, had moderate amounts of woody debris and other forms of cover, and at higher flows they may provide some useful holding habitat. Ample gravel for spawning existed in both reaches, with the quality being better in the upper than in the lower reach. Some good off-channel habitat existed in the lower reach, but none was present in the upper reach.

Plate 11: ***Lower Cache Creek, shallow, aggraded riffle with cobble substrate.***

Plate 12: ***Lower Cache Creek, pool with silted bed and some wood cover.***

Plate 13: ***Lower Cache Creek, extensive, barren run with heavily silted bed.***

Plate 14: ***Upper Cache Creek, shallow riffle with partially embedded substrate.***

Plate 15: ***Upper Cache Creek, pool with an abundance of wood cover.***

Plate 16: ***Upper Cache Creek, shallow run, silted bed, no cover.***

3.2.1.4 Red Creek

Approximately 1.5 km of Red Creek (a tributary to Cache Creek) would be flooded by the reservoir. This small stream had excessive iron deposits (see Plates 17 and 18) and is not likely to be of any importance to fish in terms of providing suitable habitat for rearing and/or spawning. In addition to the iron deposits, the habitat was of poor quality in most respects (Table 13).

Plate 17: ***Lower Red Creek, pool with excessive iron deposits, minimal cover.***

Plate 18: ***Upper Red Creek, poor water quality, some wood cover, unstable banks.***

3.2.1.5 Halfway River

The Halfway River is a large river with a watershed of 9,402 km^2 that extends well into the Rocky Mountains. It was characterized by fairly fast-flowing conditions throughout the length (~ 28 km) of stream surveyed (see Plates 19-26). Fast-flowing conditions prevailed in all habitat types, with riffles comprising broad areas of moderate water depths, while pools generally were quite deep with some cover, and runs typically consisted of extensive lengths of stream of relatively deep water with virtually no suitable cover for fish. At the time of survey (10-14 September, 2005), the Halfway River discharge was slightly lower than the average flow during the period 1995-2004 (see Figure 7).

The summary of the diagnostics for the Halfway River indicates that the physical habitat was very similar between the lower and upper reaches, with the differences in the values of the diagnostics between reaches being minor and the ratings for each variable being the same for both reaches (Table 13). In both reaches, the proportion and frequency of occurrence of pools were rated as *poor*, and none qualified as suitable holding habitat for fish. Also, the proportions of wood and overhead cover in pools were rated as *poor* in both reaches. However, there was ample gravel of good quality for spawning in both reaches, but the flow was probably too fast for fish in most places. Off-channel habitats with some cover existed in both reaches. Off channel

habitat was far more plentiful in the upper reach, but it had considerable silt deposits.

Plate 19: ***Lower Halfway River, fast-flowing riffle with minimal instream cover***

Plate 20: ***Lower Halfway River, deep pool along cliff face, no cover.***

Plate 21: ***Lower Halfway River, extensive, fast-flowing, deep, barren run.***

Plate 22: ***Lower Halfway River off-channel with minimal flow, excessive silt deposits***

Plate 23: ***Upper Halfway River (downstream view), riffle with a backwater on the right.***

Plate 24: ***Upper Halfway River, deep, fast-flowing pool with major wood cover.***

Plate 25: ***Upper Halfway River (downstream view), large run flowing against steep bank.***

Plate 26: ***Upper Halfway River, an off-channel pool with silted bed and some wood cover.***

3.2.1.6 Farrell Creek

Farrell Creek is a small stream situated towards the upstream end of the proposed Site C reservoir. Approximately 2.5 km of this stream would be inundated. The character of the section of stream surveyed is portrayed in Plates 27-33. Overall, it consisted of a gently sloping gravel/cobble bed, with riffles comprising approximately 50% of the total habitat (Table 12). Runs were far less common (14% of the total habitat) and consisted mainly of rather extensive, shallow sections of stream with little effective cover for fish. The diagnostics of habitat condition were reasonably similar between reaches (Table 13), with the amount of pool habitat ranging between *fair* and *good*, but lacking in sufficient water depth and cover to serve as suitable holding areas for larger fish. This stream had a fairly high proportion of riffle habitat,

but with a considerably greater amount of boulder cover in the lower reach. There was ample gravel of good quality for spawning in both reaches, which may have greater potential as such at higher flows. Off-channel habitats were present mostly in the upper reach, some with adequate wood cover, but heavily aggraded and with insufficient flow. At higher flows these may intermittently provide some useful habitat for fish.

Plate 27: ***Lower Farrell Creek, bouldery riffle along cliff face.***

Plate 28: ***Lower Farrell Creek, pool with some boulder and log cover.***

Plate 29: ***Lower Farrell Creek, shallow, barren run.***

Plate 30: ***Upper Farrell Creek, cobble/bouldery riffle.***

Plate 31: ***Upper Farrell Creek, pool with considerable bank cover.***

Plate 32: ***Upper Farrell Creek, shallow run with some wood cover along bank.***

Plate 33: ***Upper Farrell Creek, an aggraded off-channel with little surface flow, but ample cover.***

3.2.1.7 Lynx Creek

Lynx Creek would only be inundated 0.8 km by the proposed Site C dam because it would be located near the upstream end of the proposed Site C reservoir. Lynx Creek is a small stream, characterized by moderate gradients (average 2%), reasonable habitat in riffles, but with considerable silt deposits in pools and runs during base flow conditions (Plates 34-39). The proportion and frequency of pool habitat in either reach were minor, and the little that was there (particularly in the lower reach) was not highly rated as holding habitat for fish due to insufficient water depth and wood cover (Table 13). Gravel quantity for spawning was rated as *fair* in both reaches, but generally it was of *poor* quality because of excessive fines. A series of beaver dams in the upper reach created some pool habitat (Plate 40), but probably was a barrier to fish movements during low flows.

Plate 34: ***Lower Lynx Creek, cobble/bouldery riffle, moderately embedded with fines.***

Plate 35: ***Lower Lynx Creek, shallow, silted pool with some wood cover.***

Plate 36: ***Lower Lynx Creek, a shallow run with silted bed, no useful cover.***

Plate 37: ***Upper Lynx Creek, a moderately steep, bouldery riffle, partially embedded with fines.***

Plate 38: ***Upper Lynx Creek, deep pool bordered by steep cliffs with no cover.***

Plate 39: ***Upper Lynx Creek, shallow run, silted bed, no useful cover.***

Plate 40: ***Upper Lynx Creek, series of beaver dams creating small pool habitat.***

3.2.1.8 Maurice Creek

With only about 0.3 km of stream being flooded, the potential effects of the Site C reservoir on habitat in Maurice Creek would be minor (Table 1; Plates 41 and 42). In general, the habitat in the lower reach of this small stream was of better quality than that in the upper reach, probably largely due to flow influences from the mainstem of the Peace River. In addition, riffles in the lower reach had more boulder cover than did those in the upper reach.

Plate 41: ***Maurice Creek, fairly deep pool against cliff face with no cover.***

Plate 42: ***Maurice Creek, riffle with fairly loose cobble/boulder substrates, not embedded.***

3.2.2 Fish Distribution

Electrofishing surveys were conducted in eight tributaries of the Peace River from September 1st to 15th, 2005. All fish capture data is available in Appendix C2. In addition, maps displaying the distribution of habitat along the tributaries and locations of fish captures are available at the end of this report (Maps 1-13).

The abundance and relative proportion of fish captured per site is presented in Table 14. In total, 963 fish were captured, representing 15 species and one unidentified minnow species. This unidentified species was originally identified in the field as a pearl dace hybrid. However, based on later examination of field photos, it appears that these fish are likely lake chub. Given that a voucher sample was not available for positive identification, they are only referred to as unidentified minnow species throughout this report. The unidentified species was the most common species captured (30% of catch) as a result of high catch rates in Cache Creek and the Moberly River.

Mountain whitefish was the most common sportfish and contributed 8% to the total catch. Rainbow trout only contributed 5% to the total catch but they were very common in Maurice Creek (28% of catch in that site). Other sportfish captured included Arctic grayling (0.1%), bull trout (0.7%), and burbot (0.1%).

For the non-sportfish, longnose suckers and longnose dace were the most common and ubiquitous species with 13% and 15% of the catch, respectively. Slimy sculpin were the most abundant species captured in Maurice Creek and made up 53% of the catch at that site.

For the first pass of electrofishing for each site in each tributary, catch-per-unit-effort (CPUE) has been calculated and these data are presented in Table 15. Cache Creek had the highest overall CPUE while Wilder Creek had the lowest.

Table 14: Number and relative abundance of fish captured in Peace River tributaries, fall 2005.

		Tributary																	
		Moberly Creek		Wilder Creek		Cache Creek		Red Creek		Halfway River		Farrell Creek		Lynx Creek		Maurice Creek		All Sites	
Group	Species	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Sportfish	Arctic grayling		0		0		0		0		0		0		0	1	0.9	1	0.1
	Bull trout		0		0		0		0	5	3.7		0	2	1.3		0	7	0.7
	Burbot	1	0.5		0		0		0		0		0		0		0	1	0.1
	Mountain whitefish	16	8.4		0		0		0	27	20.0	2	4.1	31	20.5	5	4.3	81	8.4
	Rainbow trout	2	1.0		0		0		0	3	2.2		0	10	6.6	33	28.4	48	5.0
Suckers	Largescale sucker	9	4.7		0		0		0	9	6.7		0	5	3.3		0	23	2.4
	Longnose sucker	40	20.9		0	33	11.0	3	15.8	34	25.2	7	14.3	11	7.3	1	0.9	129	13.4
	White sucker	29	15.2		0		0		0	9	6.7		0	1	0.7	1	0.9	40	4.2
Minnows	Flathead chub		0		0		0		0	7	5.2		0		0		0	7	0.7
	Lake chub		0		0		0		0	1	0.7		0		0		0	1	0.1
	Longnose dace	15	7.9	2	100	31	10.3		0	1	0.7	26	53.1	61	40.4	4	3.4	140	14.5
	Northern pikeminnow	1	0.5		0	1	0.3		0	7	5.2		0	26	17.2		0	35	3.6
	Redside shiner	13	6.8		0	38	12.7		0	29	21.5	1	2.0	1	0.7		0	82	8.5
	Unidentified minnow	62	32.5		0	197	65.7	16	84.2	3	2.2	8	16.3	2	1.3		0	288	29.9
Sculpin	Prickly sculpin		0		0		0		0		0		0		0	9	7.8	9	0.9
	Slimy sculpin	3	1.6		0		0		0		0	2	4.1		0	61	52.6	66	6.9
Unknown			0		0		0		0		0	3	6.1	1	0.7	1	0.9	5	0.5
Total		191		2		300		19		135		49		151		116		963	

Table 15: Catch-per-unit-effort for fish captured in Peace River tributaries, fall 2005.

		Tributary																	
		Moberly Creek		Wilder Creek		Cache Creek		Red Creek		Halfway River[1]		Farrell Creek		Lynx Creek		Maurice Creek		All Sites	
Group	Species	n	CPUE* 100s[2]	n	CPUE* 100s	n	CPUE* 100s	n	CPUE* 100s	n	CPUE* 100s	n	CPUE* 100s	n	CPUE* 100s	n	CPUE* 100s	n	CPUE* 100s
Sportfish	Arctic grayling		0.0		0.0		0.0		0.0		0.0		0.0		0.0	1	0.1	1	0.0
	Bull trout		0.0		0.0		0.0		0.0	5	0.1		0.0		0.0		0.0	5	0.0
	Burbot	1	0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	1	0.0
	Mountain whitefish	16	0.4		0.0		0.0		0.0	27	0.3	2	0.1	22	0.6	1	0.1	68	0.3
	Rainbow trout	2	0.0		0.0		0.0		0.0	3	0.0		0.0	9	0.2	18	0.9	32	0.2
Suckers	Largescale sucker	9	0.2		0.0		0.0		0.0	9	0.1		0.0	3	0.1		0.0	21	0.1
	Longnose sucker	40	0.9		0.0	24	1.3	3	0.6	34	0.4	7	0.3	7	0.2		0.0	115	0.6
	White sucker	29	0.7		0.0		0.0		0.0	9	0.1		0.0	1	0.0	1	0.1	40	0.2
Minnows	Flathead chub		0.0		0.0		0.0		0.0	7	0.1		0.0		0.0		0.0	7	0.0
	Lake chub		0.0		0.0		0.0		0.0	1	0.0		0.0		0.0		0.0	1	0.0
	Longnose dace	15	0.3	1	0.1	25	1.4		0.0	1	0.0	23	0.9	42	1.1	3	0.2	110	0.5
	Northern pikeminnow	1	0.0		0.0		0.0		0.0	7	0.1		0.0	12	0.3		0.0	20	0.1
	Redside shiner	13	0.3		0.0	26	1.4		0.0	29	0.3	1	0.0	1	0.0		0.0	70	0.3
	Unidentified minnow	62	1.4		0.0	134	7.5	16	3.5	3	0.0	8	0.3	1	0.0		0.0	224	1.1
Sculpin	Prickly sculpin		0.0		0.0		0.0		0.0		0.0		0.0		0.0	8	0.4	8	0.0
	Slimy sculpin	3	0.1		0.0		0.0		0.0		0.0	2	0.1		0.0	25	1.3	30	0.1
	Unknown		0.0		0.0		0.0		0.0		0.0	3	0.1	1	0.0	1	0.1	5	0.0
Total		191	4.3	1	0.1	209	11.6	19	4.1	135	1.4	46	1.7	99	2.5	58	3.0	758	3.7
Total electrofishing seconds[3]		4425		877		1796		462		9646		2634		3956		1948		20442	

Note: [1]Most of the sampling in Halfway River was conducted by boat electrofishing, while backpack electrofishing was conducted at all other sites; [2]Catch-per-unit-effort (CPUE) is the number of fish captured in the first pass divided by the elapsed time spent electrofishing – values have been multiplied by 100 to give CPUE for 100 seconds of electrofishing; [3]Total electrofishing effort is the sum of the time spent electrofishing in the first pass at multiple sites.

3.2.2.1 Moberly River

Owing to the complexity of habitat and large extent (20 km) of the habitat surveys, backpack electrofishing in the Moberly River was limited to off-channel sites of good quality and adequate size in the lower reach. Four sites were sampled in the lower reach on September 15, 2005. A total of 10 species of fish (plus an unidentified minnow) was recorded for the Moberly River (Table 14; Maps 1-3), which is similar to that recorded for the Halfway River. The overall catch-per-unit-effort (4.3 fish/100 seconds) for the Moberly River was the second highest of all the tributaries sampled (Table 15).

Mountain whitefish was the most common sportfish present (8% of the catch) in the Moberly River sampling sites. Burbot and rainbow trout were the only other sportfish captured and these fish were rare (<1% of catch). The most common non-sportfish species captured included longnose dace (8%), longnose suckers (21%) white suckers (15%), and an unidentified minnow (33%).

As sampling was restricted to off-channel sites in the lower reach, fish habitat associations and comparisons between reaches are not possible for this river.

3.2.2.2 Wilder Creek

One site was sampled in the lower reach of Wilder Creek on September 5, 2005. Two longnose dace were captured in Wilder Creek (Table 14; Map 4). Wilder Creek had the lowest catch-per-unit-effort of all the Peace River tributaries sampled (0.1 fish/100 seconds; Table 15).

3.2.2.3 Cache Creek

Two sites were sampled in the lower reach and one in the upper reach of Cache Creek on September 5 and 6, 2005. Due to low flows and excessive silt deposits, this stream had relatively poor quality habitat available for fish at the time of the survey.

No sportfish were captured in Cache Creek. The species captured included longnose dace (10%), redside shiner (13%), longnose sucker (11%), northern pikeminnow (0.3%) and an unidentified minnow (66%; Table 14; Map 5).

Of all the Peace River tributaries sampled, Cache Creek had the highest CPUE (Table 15). All the species captured were found in both the upper and lower reach (Table 16). However, the upper reach of Cache Creek had a higher CPUE than the lower reach.

Table 16: Catch-per-unit-effort for fish captured in Cache Creek by reach, fall 2005

Species	Lower reach		Upper reach	
	n	CPUE*100s	n	CPUE*100s
Longnose suckers	16	1.0	8	3.3
Longnose dace	24	1.5	1	0.4
Redside shiner	23	1.5	3	1.2
Unidentified minnow	104	6.7	30	12.4
All species	167	10.7	42	17.4
Effort (s)	1555		241	
# of Sites	2		1	

Note: Catch-per-unit-effort (CPUE) is the number of fish captured in the first pass divided by the elapsed time spent electrofishing; CPUE values have been multiplied by 100 to give CPUE for 100 seconds of electrofishing;

3.2.2.4 Red Creek

One site was sampled in the lower reach of Red Creek on September 7, 2005. A total of 19 fish were captured including 3 longnose suckers and 16 unidentified minnows (Table 14).

3.2.2.5 Halfway River

Seven locations in the Halfway River were sampled on September 11th, 13th and 14th by boat and backpack electrofishing. At two of the five sample stations fish were captured with backpack electroshockers in side channels, while the rest were captured by boat shocking, primarily in the mainstem. Three sample sites were located below the zone of inundation and four above (Maps 6-10).

Eleven species of fish (plus one unidentified minnow) were captured in the Halfway River which had the highest diversity of all the Peace River tributaries sampled in 2005 (Table 14). Fish species composition was relatively evenly distributed between minnows (36%), suckers (39%) and sportfish (26%).

Three sportfish species were captured in the upper and lower reaches of the Halfway River (Table 17). Mountain whitefish were the most common sportfish captured comprising 20% of the total catch. More mountain whitefish were captured in the upper reach than the lower reach. Bull trout and rainbow trout were relatively rare in both reaches (Table 17).

Longnose, largescale and white suckers were all captured in the Halfway River. Largescale and longnose suckers were more common in the upper reach while more white suckers were collected in the lower reach (Table 17).

Six species of minnows were collected in the Halfway River including flathead chub, lake chub, longnose dace, northern pikeminnow, redside shiner and

unidentified cyprinid species. More minnows of all species were captured in the upper reach than the lower reach (Table 17).

The flow in this river was relatively fast, with very few fish of any species found in riffles, other than mountain whitefish and redside shiners, and an occasional juvenile bull trout. Small numbers of bull trout and rainbow trout were recorded in pools and runs. Mountain whitefish were widely distributed in the river, occurring in all habitat types, although proportionally they were more common in runs. Of the non-sportfish species, both longnose and white suckers and redside shiners occurred mainly in runs, whereas the largescale sucker was primarily an inhabitant of pools. Small numbers of the northern pikeminnow were captured in pools and runs, and the flathead chub was sparsely scattered in all habitats of the main channel. Relatively few species of fish were found in off-channels, with the list consisting of small numbers of longnose sucker and longnose dace.

Table 17: Catch-per-unit-effort for fish captured in Halfway River by reach, fall 2005

	Lower reach		Upper reach	
Species	**n**	**CPUE*100s**	**n**	**CPUE*100s**
Bull trout	1	0.0	4	0.1
Mountain whitefish	2	0.1	25	0.4
Rainbow trout	1	0.0	2	0.0
Largescale sucker		0.0	9	0.1
Longnose sucker	3	0.1	31	0.5
White sucker	7	0.2	2	0.0
Flathead chub	2	0.1	5	0.1
Lake chub		0.0	1	0.0
Longnose dace		0.0	1	0.0
Northern pikeminnow		0.0	7	0.1
Redside shiner	8	0.2	21	0.3
Unidentified minnow		0.0	3	0.0
All species	24	0.7	111	1.8
Effort (s)	3386		6262	
# of sites (1 backpack/reach)	2		5	

Note: Most of the sampling in Halfway River was conducted by boat electrofishing, while backpack electrofishing was conducted at all other sites; Catch-per-unit-effort (CPUE) is the number of fish captured in the first pass divided by the elapsed time spent electrofishing; CPUE values have been multiplied by 100 to give CPUE for 100 seconds of electrofishing; Total electrofishing effort is the sum of the time spent electrofishing in the first pass at multiple sites.

3.2.2.6 Farrell Creek

Three sites in Farrell Creek were sampled by backpack electrofishing on September 4th and 6th, 2005. Five species were captured in Farrell Creek, as well as 2 unknown species (Table 14; Map 11).

Mountain whitefish (4% of catch) were the only sportfish captured and this species was only captured in the lower reach (Table 18). Redside shiner was also only captured in the lower reach while slimy sculpin were only captured in the upper reach. Longnose suckers and longnose dace were captured in both reaches but were more abundant in the upper reach.

Table 18: Catch-per-unit-effort for fish captured in Farrell Creek by reach, fall 2005

	Lower reach		Upper reach	
Species	**n**	**CPUE*100s**	**n**	**CPUE*100s**
Mountain whitefish	2	0.1		0
Longnose sucker	5	0.2	2	1
Longnose dace	20	0.8	3	1.5
Redside shiner	1	0.0		0
Unidentified minnow	1	0.0	7	3.5
Slimy sculpin		0.0	2	1
Unknown	3	0.1		0
All species	32	1.2	14	7
Effort (s)	2634		200	
# of sites	2		1	

Note: Catch-per-unit-effort (CPUE) is the number of fish captured in the first pass divided by the elapsed time spent electrofishing; CPUE values have been multiplied by 100 to give CPUE for 100 seconds of electrofishing;

3.2.2.7 Lynx Creek

Lynx Creek was sampled on September 2nd, 3rd and 7th, 2005. Two sites per reach were sampled. Nine identified and 2 unknown species were captured in Lynx Creek (Table 14; Map 12). Longnose dace (40%), mountain whitefish (21%) and northern pikeminnow (17%) were the most abundant species in Lynx Creek

Mountain whitefish and rainbow trout were the only sportfish species captured and both species were only captured in the lower reach (Table 19). Longnose, largescale and white suckers were also only captured in the lower reach of Lynx Creek. Longnose dace and northern pikeminnow were captured in both the upper and lower reaches, while redside shiners were only captured in the lower reach.

Table 19: Catch-per-unit-effort for fish captured in Lynx Creek by reach, fall 2005

Species	Lower reach		Upper reach	
	n	CPUE*100s	n	CPUE*100s
Mountain whitefish	22	0.8		0.0
Rainbow trout	9	0.3		0.0
Largescale sucker	3	0.1		0.0
Longnose sucker	7	0.3		0.0
White sucker	1	0.0		0.0
Longnose dace	22	0.8	20	1.6
Northern pikeminnow	11	0.4	1	0.1
Redside shiner	1	0.0		0.0
Unidentified minnow	1	0.0		0.0
Unknown	1	0.0		0.0
All species	78	2.9	21	1.7
Effort (s)	2729		1227	
# of sites	2		2	

Note: Catch-per-unit-effort (CPUE) is the number of fish captured in the first pass divided by the elapsed time spent electrofishing; CPUE values have been multiplied by 100 to give CPUE for 100 seconds of electrofishing;

3.2.2.8 Maurice Creek

On September 1st, 2005, two sites were sampled in the lower reach of Maurice Creek. Eight species were captured including Arctic grayling (1%), mountain whitefish (4%) and rainbow trout (28%), longnose sucker (1%), white sucker (1%), longnose dace (3%), prickly sculpin (8%) and slimy sculpin (53%; Table 14; Map 13).

Rainbow trout in Maurice Creek made up the highest proportion of sportfish captured in any of the tributaries sampled (Table 14). Sculpin species, that were rare in most tributaries, contributed about 60% to the catch in Maurice Creek.

Fish sampling in Maurice Creek was limited to riffle habitat in the lower reach since inundation by the Site C development would be minor (~ 0.3 km upstream from the confluence). Accordingly, no discussion of fish habitat associations is available for this stream.

3.2.3 Fish Population Characteristics

3.2.3.1 Moberly River

A total of 191 fish was captured in Moberly River. Mean, minimum, and maximum lengths, by species, is shown in Table 20.

The sportfish captured in the Moberly River consisted of mainly mountain whitefish and one burbot (208 mm). The length of mountain whitefish in the Moberly River ranged from 66 to 174 mm and averaged 91 mm. Longnose suckers were the most common species captured in the Moberly River. The average length of longnose sucker was 61 mm, and length ranged from 25 to 90 mm with one fish at 137 mm.

Table 20: Mean, minimum and maximum fork length (mm) for fish captured in Moberly River, fall 2005.

		Fork Length (mm)			
Group	**Species**	**n**	**Mean**	**Min**	**Max**
Sportfish	Burbot	1	208		
	Mountain whitefish	16	91	66	174
	Rainbow trout	2	85	77	92
Suckers	Largescale sucker	9	76	61	98
	Longnose sucker	40	61	25	137
	White sucker	29	68	29	266
Minnows	Longnose dace	15	40	18	94
	Northern pikeminnow	1	101		
	Redside shiner	13	78	51	108
	Unidentified minnow	62	59	31	93
Sculpin	Slimy sculpin	3	66	41	90

3.2.3.2 Wilder Creek

Two longnose dace were captured in Wilder Creek below the line of inundation. The fork length of these longnose dace were 40 and 44 mm.

3.2.3.3 Cache Creek

A total of 300 fish was captured in Cache Creek. Mean, minimum, and maximum lengths, by species, are shown in Table 21.

No sportfish were sampled in this stream. Fish in this creek were dominated by minnows (89%) and longnose suckers were also common (11%). Longnose dace length averaged 30 mm and ranged from 21 to 99 mm. Redside shiner measured 27 mm, on average, and ranged from 19 to 38 mm. The average length of longnose suckers was 69 mm, and length ranged from 26 to 161 mm.

Table 21: Mean, minimum and maximum fork length (mm) for fish captured in Cache Creek, fall 2005.

Group	Species	Fork Length (mm)			
		n	Mean	Min	Max
Suckers	Longnose sucker	28	69	26	161
Minnows	Longnose dace	30	30	21	99
	Northern pikeminnow	1	111		
	Redside shiner	33	27	19	38
	Unidentified minnow	129	60	23	140

3.2.3.4 Red Creek

A total of 19 fish were captured in Red Creek. Fork lengths for the three longnose suckers measured were 33, 46, and 50 mm. The 16 unidentified minnow species captured averaged 39 mm fork length and ranged from 25 to 75 mm.

3.2.3.5 Halfway River

The species composition was relatively evenly distributed between minnows, suckers, and sportfish. Longnose sucker was the most numerous species followed closely by redside shiner and mountain whitefish. Mean, minimum, and maximum lengths for all species captured in Halfway River are shown in Table 22.

The average length of longnose sucker was 196 mm, and length ranged from 49 to 398 mm. The redside shiner measured 88 mm, on average, and lengths ranged from 47 to 150 mm. The average length of mountain whitefish was 227 mm, and length ranged from 53 to 356 mm. In general, fish in this tributary were larger than in the other tributaries probably because of the greater size of this river.

Table 22: Mean, minimum and maximum fork length (mm) for fish captured in Halfway River, fall 2005.

Group	Species	Fork Length (mm)			
		n	Mean	Min	Max
Sportfish	Bull trout	5	313	220	388
	Mountain whitefish	26	227	53	356
	Rainbow trout	3	272	211	367
Suckers	Largescale sucker	9	240	164	409
	Longnose sucker	34	196	49	398
	White sucker	9	106	29	378
Minnows	Flathead chub	7	151	72	238
	Lake chub	1	62		
	Longnose dace	1	39		

Group	Species	Fork Length (mm)			
		n	Mean	Min	Max
	Northern pikeminnow	7	239	188	318
	Redside shiner	29	88	47	150

3.2.3.6 Farrell Creek

A total of 49 fish were captured in Farrell Creek. Mean, minimum, and maximum lengths for all species are shown in Table 23.

Fish in this creek were dominated by minnows (71%), with longnose dace being the most common species. Longnose dace averaged 44 mm and ranged in length from 12 to 72 mm. The two mountain whitefish captured were the only sportfish observed in Farrell Creek. These mountain whitefish measured 62 and 79 mm in length.

Table 23: Mean, minimum and maximum fork length (mm) for fish captured in Farrell Creek, fall 2005.

Group	Species	Fork Length (mm)			
		n	Mean	Min	Max
Sportfish	Mountain whitefish	2	71	62	79
Suckers	Longnose sucker	7	59	32	88
Minnows	Longnose dace	26	44	12	72
	Redside shiner	1	80		
Sculpin	Slimy sculpin	2	62	57	66

3.2.3.7 Lynx Creek

A total of 51 fish were observed in Lynx Creek. Mean, minimum, and maximum lengths for all species captured are shown in Table 24.

Fish in this creek were dominated by minnows (60%), with longnose dace (40%) being the most common species. Longnose dace measured 124 mm on average and ranged in length from 19 to 243 mm

Mountain whitefish were all young-of-the-year, averaging 59 mm and ranging from 37 to 85 mm. The average length of rainbow trout was 153 mm and ranged from 53 to 228 mm. Also, two bull trout were captured in Lynx Creek and these fish measured 208 and 214 mm.

Table 24: Mean, minimum and maximum fork length (mm) for fish captured in Lynx Creek, fall 2005.

Group	Species	Fork Length (mm)			
		n	Mean	Min	Max
Sportfish	Bull trout	2	211	208	214
	Mountain whitefish	31	59	37	85
	Rainbow trout	10	153	53	228
Suckers	Largescale sucker	5	199	159	221
	Longnose sucker	11	150	28	225
	White sucker	1	36		
Minnows	Longnose dace	61	124	19	243
	Northern pikeminnow	26	203	83	260
	Redside shiner	1	42		

3.2.3.8 Maurice Creek

A total of 116 fish were observed in Maurice Creek. Mean, minimum, and maximum lengths, by species, are shown in Table 25.

Fish in this creek were dominated by sculpin (60%), with slimy sculpin being the most common species. The average length of slimy sculpin was 71 mm and ranged from 31 to 134 mm.

Sportfish comprised 34% of the catch and most were rainbow trout. The average length of rainbow trout was 112 mm, and length ranged from 45 to 195 mm. Five mountain whitefish were captured ranging from 70 to 90 mm. The only arctic grayling captured in 2005 measured 58 mm.

Table 25: Mean, minimum and maximum fork length (mm) for fish captured in Maurice Creek, fall 2005.

Group	Species	Fork Length (mm)			
		n	Mean	Min	Max
Sportfish	Arctic grayling	1	58		
	Mountain whitefish	5	77	70	90
	Rainbow trout	33	112	45	195
Suckers	Longnose sucker	1	116		
	White sucker	1	70		
Minnows	Longnose dace	4	101	90	115
Sculpin	Prickly sculpin	9	75	55	125
	Slimy sculpin	61	71	31	134

4.0 DISCUSSION

4.1 Flows and Water Temperature

Discharge in the tributaries was below average during the field surveys but within the range of flows observed over the previous decade. Water temperature data will not be available until the temperature loggers are downloaded in spring 2006.

4.2 Assessment of Habitat

Water depths in the sampled sections of the Peace River were relatively consistent with maximum depths in the range of 3-4 m. Depths of over 7 m were recorded in the five deepest locations. The maximum depth recorded was 23.9 m at a location upstream of Maurice Creek.

The biophysical surveys conducted in the tributaries provide a substantial body of information for characterization and assessment of habitat in these waterways during the late summer-autumn period of base flow conditions. With the exception of the Halfway and Moberly Rivers, the flows during that period were low in all of the tributaries, with the most extreme conditions existing in Wilder, Red and Cache creeks. In all but one of these smaller tributaries, maximum pool depth was less than 1 m. Not surprisingly, due to low flows and insufficient water depths, these tributaries, in general, provided poor holding pools for larger fish, even though, some of them had reasonable amounts of woody debris and other forms of cover. Among the tributaries surveyed, the lower reach of Maurice Creek was the only one with a *good* rating for holding pools, whereas in the others, holding pools were either rated as *fair* or *poor*, or were non-existent (e.g., Red and Lynx creeks).

From a comparison of the longitudinal plots of habitat types along the length of the tributaries surveyed, it is evident that habitat diversity was greatest in the Moberly River, lowest in the Halfway River, and intermediate in the others. The Moberly, with its gentle gradient and broad floodplain, consisted of a diversified mix of main channel, tertiary channel and off-channel habitats interspersed with islands and gravel bars, particularly at meanders. Similar habitat diversity in the lower reaches of the river was noted by ARL (1991a). In contrast, the Halfway River was characterized by a predominance of long sections of fast-flowing runs with a minimum of instream cover for fish. Of the smaller tributaries, the habitat composition was quite variable, with Wilder Creek consisting mainly of riffles and runs, Cache Creek was dominated by pools, Farrell Creek comprised a mix of all three primary habitat types, whereas both Lynx and Maurice creeks were dominated by bouldery riffles.

Both the quantity and quality of gravel were reasonable in all of the tributaries, and in some (Red and Cache creeks and Halfway River) the area suitable for fish spawning exceeded 50% of the wetted stream area. The

area of gravel suitable for spawning was least in the lower reaches of Wilder, Lynx and Maurice creeks, but even these scored a *fair* rating. The proportion of fines (<2 mm diameter) in the gravels was least in Cache and Red creeks and Halfway River. In all, but the Halfway River, which had a high proportion of fast-flowing water, the potential for fish spawning is likely to improve at slightly higher flows than those recorded during this survey.

With minor exceptions, there were no major differences in the diagnostics of habitat condition between the lower and upper reaches in any of the tributaries. The more obvious differences were that Cache, Farrell and Maurice creeks had a greater proportion of pool habitat in the lower reach, Wilder, Farrell, Lynx and Maurice creeks had more bouldery riffle areas in the lower reach, and gravel quality due to the presence of fines was poorer in the lower reaches of Cache, Farrell and Lynx creeks and the Halfway River.

There were no barriers to fish movements/migrations along the length of the streams surveyed in any of the tributaries. However, further upstream several impassable waterfalls exist in Maurice Creek, with the first and last one located approximately 3 km and 8 km, respectively, from the river mouth (ARL 1991a). No critical habitats (e.g., spawning, rearing) were identified. Critical habitats are defined as those that are required for survival of a particular species or life stage of fish. With the exception of the Halfway and Moberly rivers, these tributaries are seasonally unstable environments characterized by low flows during the late summer to autumn period and freezing during winter. Exceedingly low flows were recorded by Slaney et al. (1991) in the smaller tributaries during biophysical surveys conducted in September 1989, with, for example, the flow in Cache Creek estimated at 0.01 m^3/s. At best, these smaller tributaries may be of some importance for spring spawning and early rearing fish (e.g., rainbow trout, Arctic grayling).

4.3 Fish Distribution and Habitat Associations

Some information on fish habitat associations in the Peace River system is available from R.L.&L. (1991a, 1991b) which align to some extent with the findings of the present study. Briefly, they reported that:

- Rainbow trout were found mostly in deep pools; young-of-the-year fish were not found in the mainstem and presumably occupy the tributaries (in the present study, juvenile rainbow trout were reasonably common in lower Maurice Creek near the confluence with the Peace River mainstem);
- Walleye tended to occur near the confluences of major tributaries;
- Arctic grayling were mostly found in runs with cobble substrates;
- Mountain whitefish were mainly in deep runs and riffles, with cobble/gravel substrates. The species did not commonly occur in pools, nor in areas with fine substrates;

- Bull trout tended to occupy deep-water habitat such as pools and runs in the Halfway River.

In the present study, most of the rainbow trout in the Peace River mainstem were found in sections 1 and 2 and consisted of larger fish (average fork length 257 mm). In the tributaries, rainbow trout comprised mainly juveniles, averaging 112 mm FL and 153 mm FL in Maurice and Lynx creeks, respectively. The presence of larger rainbow trout in the Peace River mainstem and juvenile fish in the tributaries parallels previous studies findings regarding the distribution of rainbow trout by age group.

Based on locations of walleye observations in the present study, the conclusion of R.L.&L. (1991a) regarding walleye distribution is supported, at least in relation to their presence at the mouth of the Beatton River.

Only one Arctic grayling, a juvenile 58 mm in length, was found in the tributaries in the present study (Maurice Creek), while 105 were observed in the mainstem. Likewise, very few mountain whitefish were found in the tributaries compared with those captured in the mainstem.

In the present study, five bull trout were observed in the Halfway River and 13 were observed in the mainstem. Only two were sampled in the tributaries (Lynx Creek), suggesting that bull trout prefer the “big river” environment.

4.4 Fish Movement

4.4.1 Within the Mainstem

Seasonal movements of fish within the mainstem are as yet poorly understood. From the limited information that exists for some of the sportfish species, there appears to be considerable variation in the extent of movement between species. R.L.&L. (1991a) noted that Arctic grayling, mountain whitefish, rainbow trout and northern pike remain largely sedentary in the mainstem, but move seasonally to spawn. Others, such as walleye and bull trout may undertake extensive mainstem migrations. For example, a tagged bull trout was recorded to travel about 500 km in the Halfway River watershed (AMEC 2006). Burrows et al. (2000) reported an annual range of movement of up to 275 km for adult bull trout in the upper Peace River system. Such extensive movements are associated with spawning, feeding and overwintering migrations of these fish.

4.4.2 Between the Mainstem and Tributaries

Little is known of the seasonal migrations/movements of fish between the mainstem and tributaries. R.L.&L. (1991a) mentioned that rainbow trout moved upstream in Maurice Creek during spring, and mountain whitefish moved into spawning areas in the Halfway River in autumn. Burrows et al. (2000) found that the movements of radio-tagged bull trout (length range 349-885 mm) in the upper Peace River system varied considerably between

individuals. Some fish remained relatively sedentary either in the Peace River mainstem or Halfway River until the second year of tracking, presumably feeding and overwintering in the same locale. In contrast, other fish moved upstream in both years of tracking. Some bull trout were reported to return to tributaries of the Halfway River in which they had been recorded previously, whereas others spent considerable time in streams in which they had not been recorded in the previous year. Burrows et al. (2000) noted that bull trout will negotiate low flow conditions in some streams during autumn, presumably for spawning purposes. In several small streams, bull trout would have negotiated riffle areas with water depths less than their body depths during upstream and downstream migrations to their preferred sites.

4.5 Fish Populations

4.5.1 Within the Mainstem

4.5.1.1 Mountain Whitefish

In the current study, relative abundance for mountain whitefish in the overall mainstem, as represented by catch-per-unit-effort (CPUE), was 46 fish per hour shocked. Data from 1989 and 1999 (R.L.&L., 2001) were compared by reaches equivalent to the current study's sections (Table 27). From the Peace Canyon Dam to the Halfway River, and between the Halfway River and the Pine River the density of mountain whitefish appears to have declined to less than half of that observed for the mainstem in the previous studies. Between the Pine River and the Alberta Border, CPUE was similar in 1989 and 2005 but was twice as high in 1999. These results suggest there may be a lot of variability in the abundance of mountain whitefish between years.

Table 26: CPUE for fish species captured in the Peace River, 1989, 1999 and 2005

	Catch-per-unit-effort (fish/hour) by Peace River section								
	PC Dam to Halfway River[1]			Halfway River to Pine River[2]			Pine River to Alberta Border[3]		
Species	**1989**	**1999**	**2005**	**1989**	**1999**	**2005**	**1989**	**1999**	**2005**
Arctic grayling	2.5	0.5	1.5	8	2.4	5.9	0.5	1.3	3
Bull trout	0.5	5.5	0.7	0.5	4.5	0.1	0.2	1.9	0.1
Mountain whitefish	142	181	67.8	87	180	41.5	16	35	17.2
Rainbow trout	4.4	2.8	5.1	1.3	1.9	1.2	1.5	2	0.2
Walleye	0	0	0	0.6	0	0.2	12.5	1.3	6.3

Notes: [1] Sections 1 and 2 in 2005; [2] Sections 4 and 5 in 2005;[3] Sections 6, 7, and 8 in 2005; CPUEs are estimated from Figure 3-19 in RL&L 2001

Length data from 1989, 1999 (R.L.&L., 2001) and 2003 (Mainstem Aquatics Ltd., 2004), were compared with the 2005 mainstem data for this species.

The 2005 data show a similar pattern to 1999, but is skewed towards larger fork lengths because the 2005 data did not include spring or fall data. Fish sampled in the summer of 1989 using boat electrofishing did not exhibit a similar length distribution. The 1989 data showed more of a bell curve with a peak at 290 mm. As noted by R.L.& L. (2001), the absence of smaller fish during 1989 was due to sampling bias in the capture technique.

During the 2003 study, fish in the zone analogous to the 2005 Sections 1 and 2 exhibited a condensed, bi-modal distribution with peaks at 260 mm and 320 mm. Fish <175 mm fork length and >360 mm were largely absent, suggesting a dominance of three to five year old fish (Mainstem 2004). Mountain whitefish in the zone analogous to the 2005 Sections 3 and 4 showed a broader, multi-modal range of lengths with peaks around 160 mm, 210 mm, 300 mm, and 340 mm. The Mainstem (2004) study also reported similar results for data collected the previous year, and concluded there were spatial differences between the two zones in population size and age structure.

In the current study, nearly 10% of the fish in Section 4 were > 370 mm while only 4% from Sections 1 and 2 combined were > 370 mm. Section 1 (Figure 10), especially had very few (4%) <175 mm fork length and a bi-modal distribution. Data from Sections 5 and 6 (not sampled in the Mainstem (2004) study) also exhibited a broad size range with both younger and older fish, suggesting the trend seen in Section 4 continued downstream (for example, see Figure 14).

4.5.1.2 Rainbow Trout

In the current study, overall CPUE for rainbow trout in the mainstem was 3 fish per hour shocked. Data from 1989, and 1999 (R.L.&L. 2001) were compared by reaches equivalent to the current study's sections (Table 26). From the Peace Canyon Dam to the Halfway River, and between the Halfway River and the Pine River, abundance was comparable for all study years, generally declining from upstream to downstream. In that portion of the mainstem from the Pine River to the Alberta Border, CPUE in 2005 was about 10% of 1989 and 1999 values.

Rainbow trout were not assessed in the 2003 study by Mainstream Aquatics (2004), although 113 fish were observed. In 1999, R.L.&L. (2001) measured 32 fish that ranged from 70 to 458 mm fork length and averaged 285 mm. In 1990, the 107 rainbow trout measured averaged 275 mm and ranged from 110 to 470 mm fork length (R.L.&L. 1991b). The 1990 sample also contained a broad range with an apparent mode at 270 mm. When these results were compared to the 2005 study data, the results observed in 2005 were very similar with 60 fish ranging from 50 to 620 mm, averaging 283 mm fork length.

4.5.1.3 Bull Trout

The CPUE for bull trout in the mainstem was very low at 0.4 fish per hour shocked during the current study. The relative abundance of bull trout was similar in the sections in which they were captured. Data from 1989, and 1999 (R.L.&L., 2001) were compared by reaches equivalent to the 2005 study's sections (Table 26). CPUE in 1999 was 10 times that of the other two study years. This trend was similar to that observed for mountain whitefish. While CPUE in the upper reach was about the same between 1989 and 2005, the CPUE values for 2005 were less than half of those observed in 1989 in the lower two reaches. In the 2003 study by Mainstream Aquatics (2004), 72 were observed in the sample zone analogous to the 2005 sections 1 and 2, and 102 were captured in the zone analogous to the 2005 sections 3 and 4 (compared to 11 fish captured in sections 1 and 2 and one fish captured in section 4, respectively, in 2005).

In 2005, length averaged 500 mm and ranged from 214 to 1600 mm for the 13 bull trout measured. Most fish sampled during the 1990 study were between 200 and 450 mm fork length (n=118; R.L&L. 1991b), while fish captured in 1999 ranged from 203 to 867 mm (n=60; R.L. & L. 2001).

4.5.1.4 Arctic Grayling

In the current study, the CPUE of Arctic grayling in the overall mainstem was 3.1 fish per hour shocked. Data from 1989 and 1999 (R.L.& L. 2001) were compared by reaches equivalent to the current study's sections (Table 26). In all reaches, CPUE during the 1999 study was less than half that of the current year, just the inverse of the trend that was observed for mountain whitefish and bull trout. In the reach from Halfway River to the Pine River, CPUEs were similar in 1989 and the current study, but from the Pine River to the Alberta border, the 2005 CPUE was six times (3.0 fish/hour) that of the 1989. CPUEs were highest in the Halfway to Pine River section. This distribution of Arctic grayling catch was quite similar to that in the Mainstream Aquatics study (2004). Most fish (124 of 142) were captured in the reaches equivalent to Section 4, which also had the highest tally (third of the fish) in 2005.

Section 1 fish averaged larger in size than Section 4 in 2005. This trend was also seen in the 2002-2004 period reported in the Mainstream Aquatics study (2004).

4.5.1.5 Walleye

CPUE for walleye from the current study in the total mainstem study area was 1.9 fish per hour shocked. Data from 1989 and 1999 (R.L.&L. 2001) were compared to the reaches in the current study (Table 26). From the Peace Canyon Dam to the Halfway River, no fish were captured in any of the studies, and few fish were captured between the Halfway River and the Pine River. Nearly all fish were captured in that portion of the mainstem from the

Pine River to the Alberta Border, CPUE was quite variable between years: 12.5 in 1989, 1.3 in 1999, compared with 6.3 in 2005. R.L.&L. (2001) reported nine walleye observed in 1999, all from the reaches near the Beatton River. R.L.&L. (1991a) reported 39 walleye with distribution all the way to Lynx Creek. Only four walleye were captured in the Mainstream Aquatics study (2004), between the mouths of Cache Creek and Moberly River. Walleye are highly migratory and known to move downstream in the late fall, which is when the R.L.&L. study was conducted.

In the current study, 61 walleye fork lengths ranged from 270 to 670 mm, averaging 417 mm. R.L.&L. (2001) reported walleye, with fork lengths ranging from 230 to 475 mm.

4.5.1.6 Longnose sucker

In 2005, longnose suckers (n=174) averaged 341 mm in length and ranged from 86 to 528 mm. The strongest modal length classes were seen at 370 and 410 mm. Fish measured in 1990 (R.L.&L., 1991b) ranged from 160 to 510 mm fork length an exhibited a bell shaped histogram peaking at 390 mm. In 1999, 349 longnose sucker were measured (R.L.&L., 2001), and these ranged in fork length from 20 to 500 mm and showed a sharp mode at 30 mm representing young-of-the-year (YOY) in that sampling. The remaining larger fish showed a length frequency similar to that reported for 1990 and 2005, suggesting that sampling gear used in 1999 was more effective for YOY. The smaller lengths were indicative of those fish captured by beach seine in 1999. The 1989 (R.L.&L. 1991a) and 2005 data showed fork lengths between 350 and 450 dominating, and these fish were captured by boat electrofishing. Beach seine sampling was not used in 1989 and 2005 which explains why less YOY were captured.

4.5.2 Within the Tributaries

4.5.2.1 Sportfish

Sportfish species made up 14% (138 of 963) of the fish sampled in the tributaries, and most of these were mountain whitefish (8%) and rainbow trout (5%). No kokanee, northern pike, lake trout, or walleye were captured.

During the 2005 study, lengths of 16 mountain whitefish in the Moberly River ranged from 66 to 174 mm and averaged 91 mm. In the fall of 1989, 86 mountain whitefish were measured (ARL 1991a) that averaged 173 mm and ranged from 35 to 360 mm fork length. Additional sampling is required to assess the annual variability in the size and numbers of mountain whitefish in the Moberly River.

Although no mountain whitefish were observed in Lynx Creek in the fall of 1989, they were seen (ARL 1991a) during June that year and also in September and October 1974 (RRCS 1979) when large numbers of juveniles of this species were recorded. ARL (1991a) theorized lack of fish in the fall

may be related to water temperature (or reduced stream flows) and proposed that the fish may leave before the temperature drops below 4ºC.

Most of the 48 rainbow trout captured in tributaries were seen in Maurice (69%) and Lynx (21%) creeks. The average length of rainbow trout was 112 mm in 2005 (n=33), but averaged only 77 mm (n=64) in 1989. Comparable numbers of rainbow trout and fork length statistics were observed for fish caught in Lynx Creek during the current study and in 1989 (ARL 1991a), but the average length trend of larger fish in 2005, as seen in Maurice Creek, was also observed in Lynx Creek (153 mm vs. 124 mm).

ARL (1991a) sampled fish with beach seines and electro-shocking during fall of 1989 in Moberly Creek. They took 25 northern pike and 31 Arctic grayling, while none were observed in 2005. One Arctic grayling was observed in 2005 in Maurice Creek, while four were seen in 1989. Only seven bull trout were observed in the tributaries during the current study, five in the Halfway River and two in Lynx Creek.

4.5.2.2 Non-Sportfish

Minnow species dominated the catch in the tributaries and species composition varied between the 2005 and the 1989 surveys. An unidentified minnow species was the most common species captured (30% of catch) as a result of high catch rates in Cache Creek and the Moberly River. This unidentified species was originally identified in the field as a pearl dace hybrid. However, based on later examination of field photos, it appears that these fish are likely lake chub. Given that a voucher sample was not available for positive identification, they are only referred to as unidentified minnow species throughout this report. Longnose dace was also an abundant species in 2005. They were captured in all sites, except Red Creek, and represented 15% of the total catch.

In 1989, ARL (1991a) observed 47 pearl dace in Lynx Creek. ARL (1991a) did not report any longnose dace in the tributaries, except in Lynx Creek, as the 1989 catch was dominated by redside shiner. This latter species comprised 9% of the non-sportfish observed in 2005.

Sucker species made up 20% of the total catch, with longnose sucker being the most common species. Largescale and white suckers were uncommon or absent in all tributaries except Moberly and Halfway rivers. The average length of longnose sucker in Moberly River was 61 mm, and length ranged from 25 to 137 mm (Table 20), while in 1989, the average length of this species was larger at 100 mm, and ranged from 19 to 375 mm (ARL 1991a).

Sculpin made up 27% of the catch in 1989, compared to 2% in 2005. However, sculpin species made up most of the catch (64%) at Maurice Creek. Prickly sculpin were only found in Maurice Creek, as were 53 of the 58 slimy sculpin seen in tributaries during the current study.

In 1989, only a few minnows (peamouth) were captured (ARL 1991a) in Wilder Creek, apparently due to low flows. Similarly, only two longnose dace were captured during the current study.

In general, 2005 length statistics for non-sportfish species in the tributaries were comparable to data from 1989.

5.0 CONCLUSIONS

For the mainstem, it is concluded that:

- During early autumn, most of the adult sportfish species resided in the Peace River mainstem rather than in the tributaries.
- Catch per unit effort in the reaches of the Peace River mainstem below the confluence of the Moberly River was less than half of that of the catch in the reaches above the Moberly River.
- The percentage of sportfish caught in the total catch declined from upstream (98%) to downstream (36%) as the percentage of suckers rose from 2% to 64%.
- Analysis of mountain whitefish length frequency data confirmed previous findings that there were spatial differences in population size and age structure in the Peace River mainstem above and below the confluence of the Halfway River, which continued to the Alberta boarder.
- Arctic grayling were most abundant in the reaches between Halfway and Moberly Rivers, although larger fish tend to be upstream of Halfway River, and this was consistent with previous studies.
- Walleye appeared to be most abundant in Section 6 during the 2005 summer sampling period, but historic data suggests a wider distribution depending on time of year sampled.
- From comparisons of fish species composition and catch data of previous years with those of the present study, the numbers of sportfish, especially Arctic grayling, bull trout, and northern pike in both the mainstem and tributaries, have declined.
- In the mainstem and most of the tributaries, runs made up the greatest proportion of instream habitat, but the habitat. Runs were frequently of minimal value for fish due to lack of cover and compacted substrate.

From the biophysical findings in the tributaries, it is concluded that:

- All the tributaries had moderate proportions of pool habitat, with some sites having considerable cover. However, with the exception of Halfway and Moberly rivers, the flows in the tributaries were either too low (Red and Wilder Creeks) or too marginal (Cache, Farrell and Lynx creeks) to provide holding habitat for fish in all seasons.

- The habitat ratings for all tributaries, except the Halfway River, would probably improve at higher flows.
- The habitat attributes were similar in the lower and upper reaches of most of the tributaries, with the exceptions that gravel quality was better in the upper reaches in all but the Moberly River and Wilder Creek, and riffles in the lower reaches of Maurice, Lynx, Farrell and Wilder creeks had more boulder cover than did riffles in the other tributaries.
- There were no barriers to fish passage in any of the tributaries and none of the tributaries possessed specifically critical habitat (e.g. for spawning, rearing, overwintering etc.) for fish below the zone of inundation.
- Minnow species dominated in the tributaries and species composition varied between 2005 and 1989 surveys.
- Sportfish in all the tributaries comprised less than 10% of the catch, except in Halfway River, Lynx Creek and Maurice Creek.
- Mountain whitefish was the most common and ubiquitous sportfish but rainbow trout were relatively abundant in Lynx and Maurice creeks

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7.0 CLOSURE

Recommendations presented herein are based on an evaluation of the findings of the fish and aquatic investigations described. If conditions other than those reported are noted during subsequent phases of the study, AMEC should be notified and be given the opportunity to review and revise the current recommendations, if necessary.

This report has been prepared for the exclusive use of BC Hydro for specific application to the area within this report. Any use which a third party makes of this report, or any reliance on or decisions made based on it, are the responsibility of such third parties. AMEC accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report. It has been prepared in accordance with generally accepted practices. No other warranty, expressed or implied, is made.

AMEC appreciates the opportunity to assist BC Hydro with this project. If you have any questions, or require further assistance, please do not hesitate to contact the undersigned.

Respectfully Submitted,

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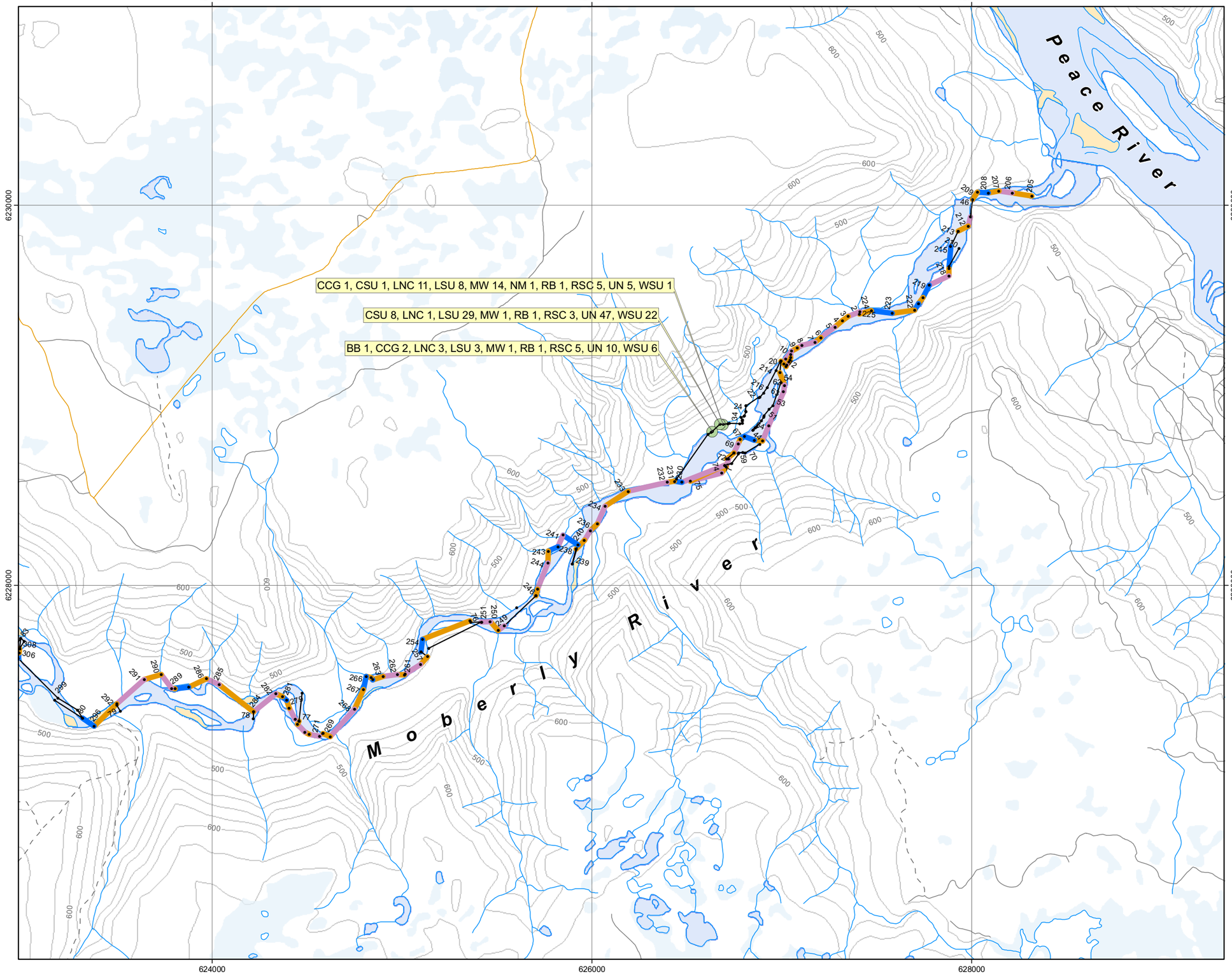

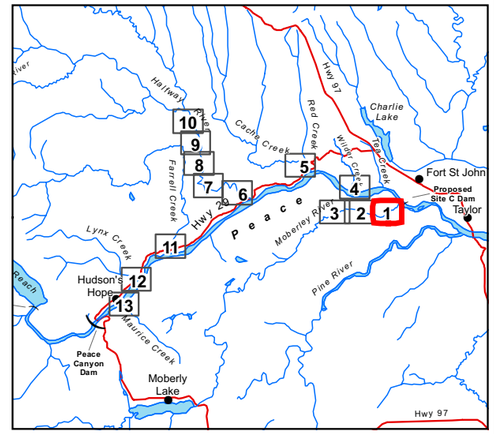

Habitat Type

Other | Run | Pool | Riffle

- Waypoints
- Fish Sample
- Site C Highwater

DRAFT

S P E C I E S

BB	Burbot	LSU	Longnose Sucker
BT	Bull Trout	MW	Mountain Whitefish
CAS	Prickly Sculpin	NM	Northern Pikeminnow
CCG	Slimy Sculpin	RB	Rainbow Trout
CSU	Largescale Sucker	RSC	Redside Shiner
FHC	Flathead Chub	UK	Unknown
GR	Arctic Grayling	UN	Unidentified Cyprinid
LKC	Lake Chub	WSU	White Sucker
LNC	Longnose Dace		

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0 500 1000 1500

Metres

Reference BC TRIM, scale 1:20000.

CLIENT: BC hydro

PROJECT: Peace River Site C Investigations

Peace River Fish and Habitat Associations 2005

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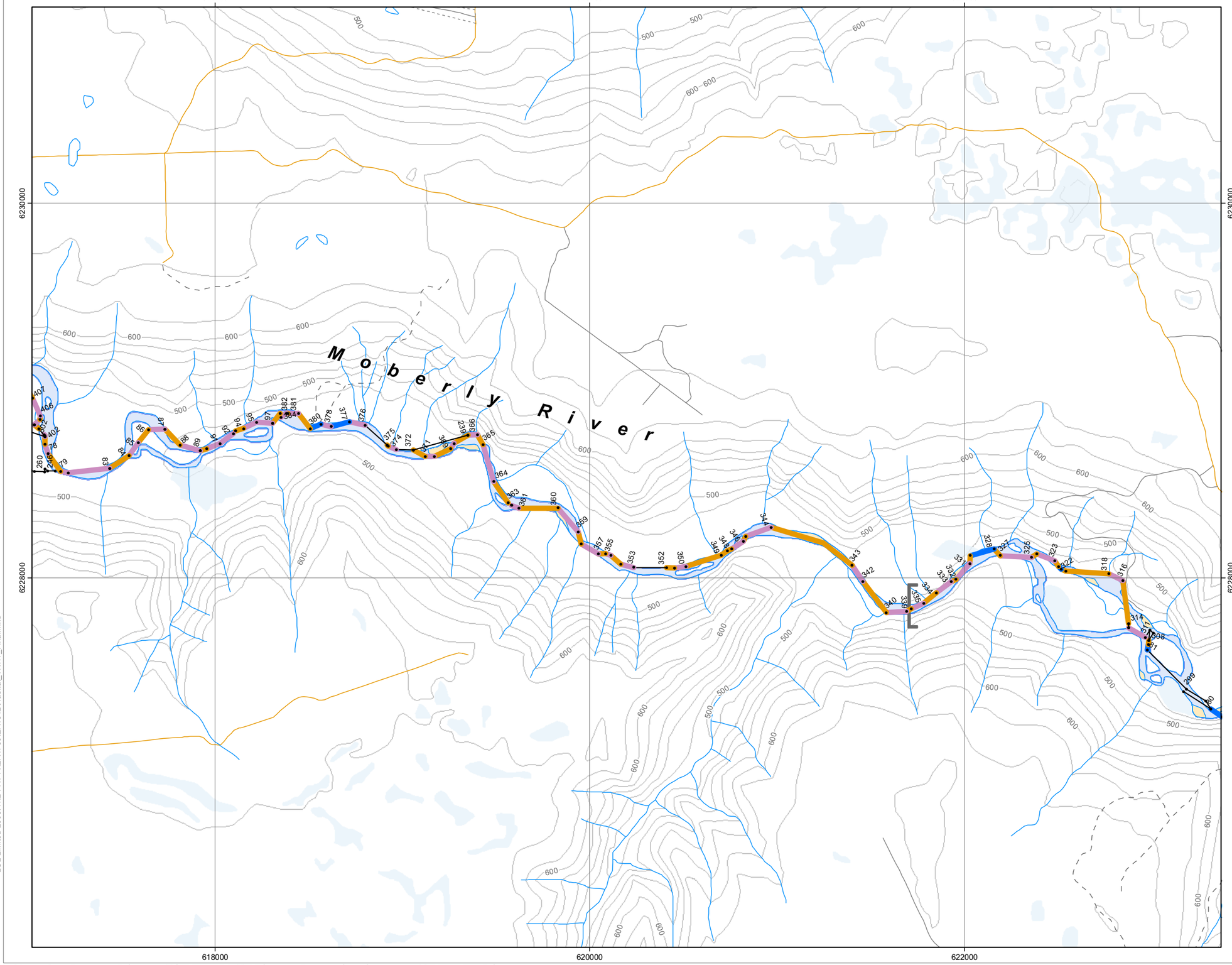

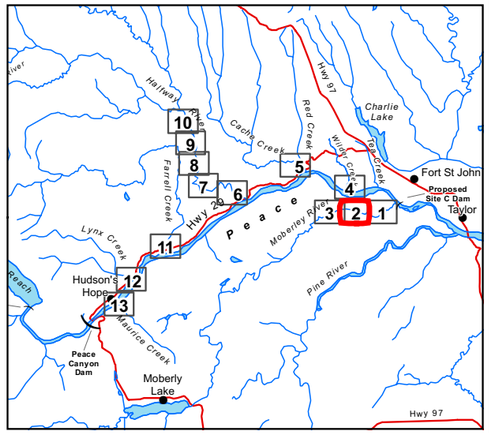

Habitat Type

Other | Run | Pool | Riffle

- Waypoints
- Fish Sample
- Site C Highwater

DRAFT

S P E C I E S

BB	Burbot	LSU	Longnose Sucker
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LNC	Longnose Dace		

1:20000

0 500 1000 1500

Metres

Reference BC TRIM, scale 1:20000.

CLIENT: BC hydro

PROJECT: Peace River Site C Investigations

Peace River Fish and Habitat Associations 2005

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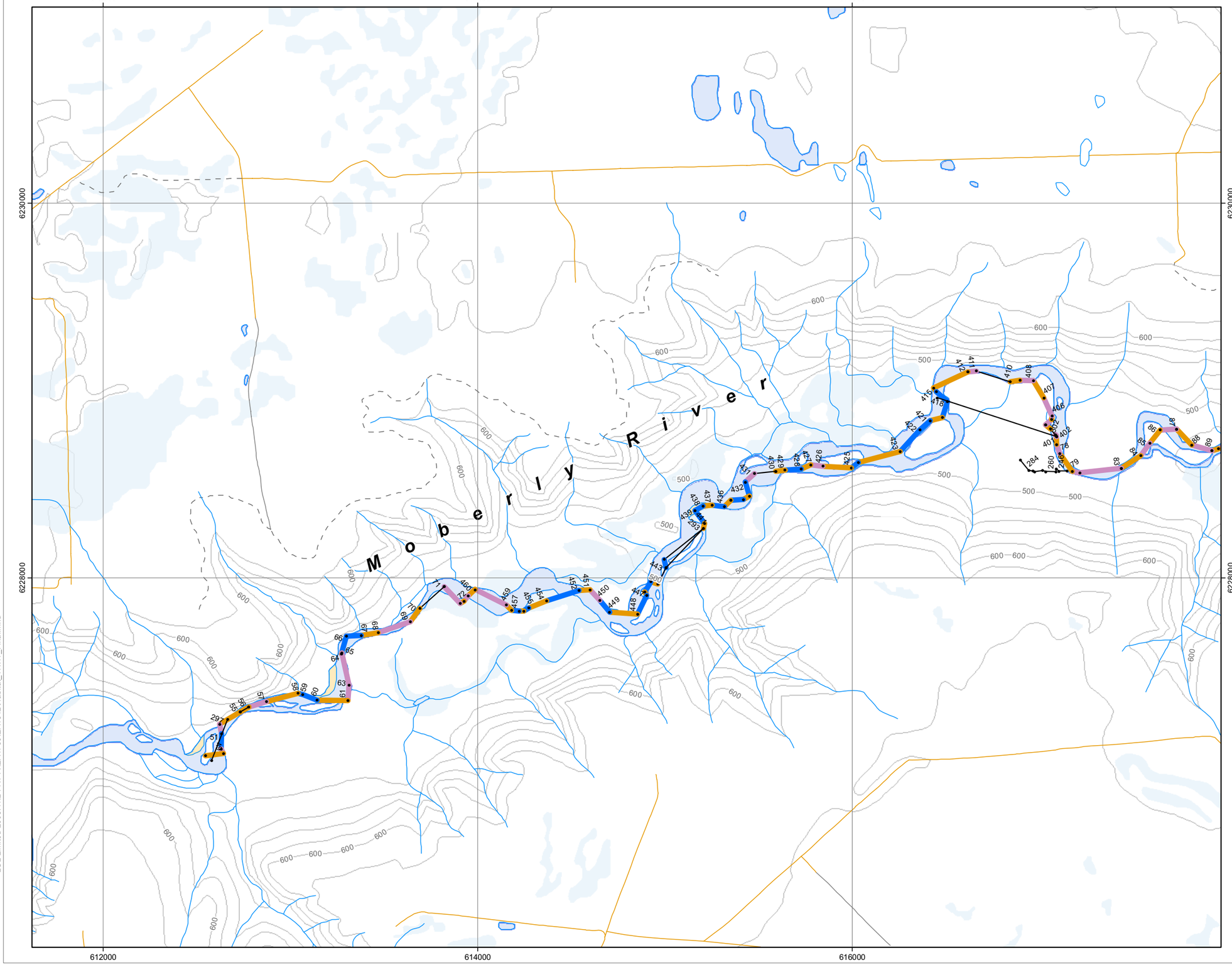
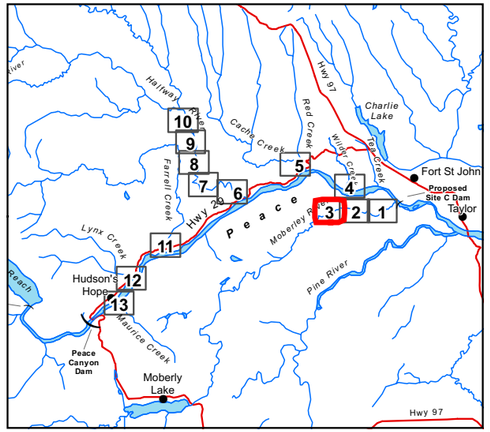




Habitat Type

Other Run Pool Riffle

- Waypoints
- Fish Sample
- [Site C Highwater

DRAFT

S P E C I E S

BB	Burbot	LSU	Longnose Sucker
BT	Bull Trout	MW	Mountain Whitefish
CAS	Prickly Sculpin	NM	Northern Pikeminnow
CCG	Slimy Sculpin	RB	Rainbow Trout
CSU	Largescale Sucker	RSC	Redside Shiner
FHC	Flathead Chub	UK	Unknown
GR	Arctic Grayling	UN	Unidentified Cyprinid
LKC	Lake Chub	WSU	White Sucker
LNC	Longnose Dace		

1:20000

0 500 1000 1500

Metres

Reference BC TRIM, scale 1:20000.

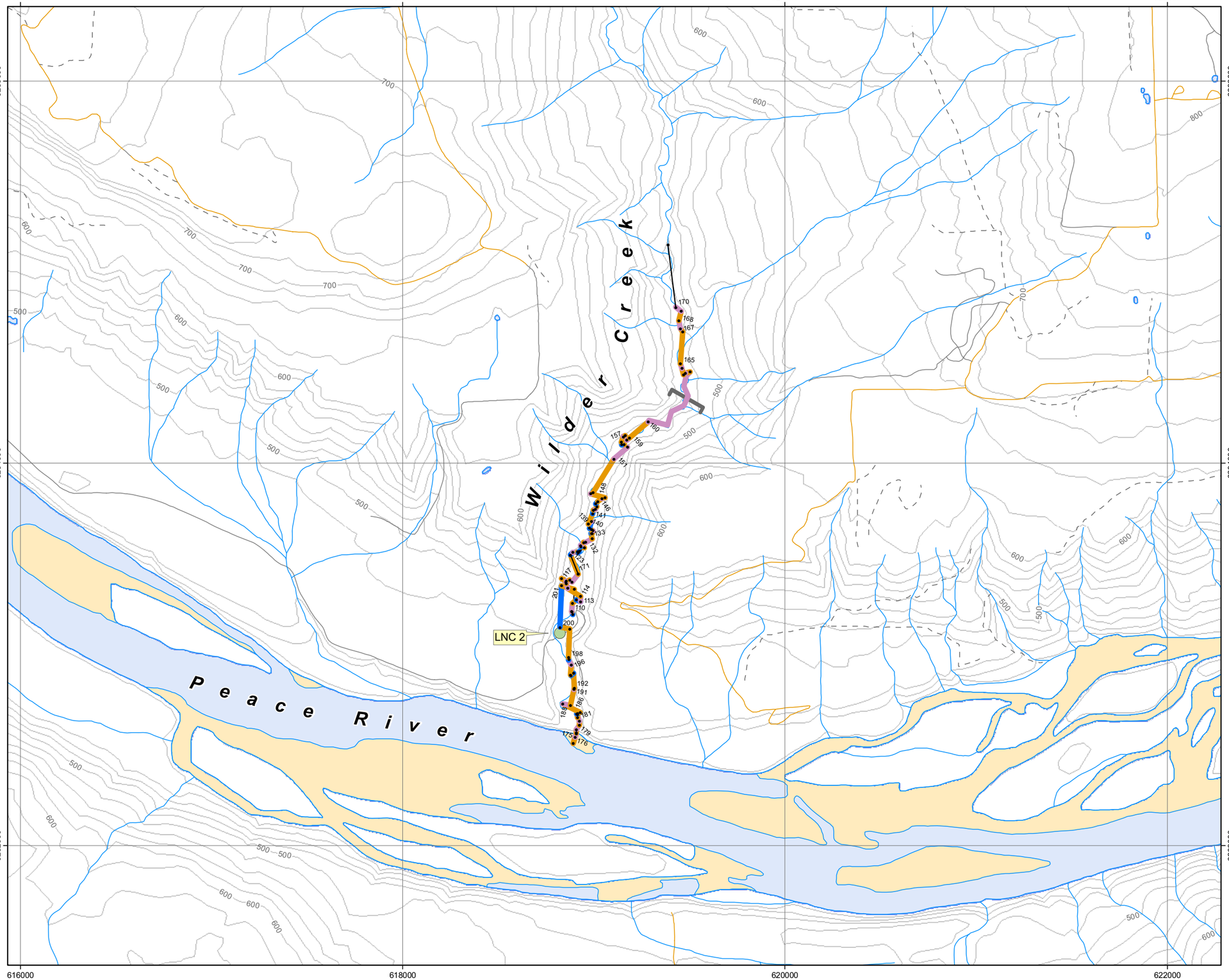
CLIENT: BC hydro

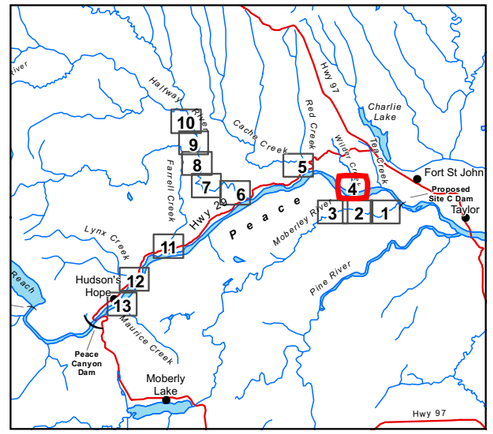
PROJECT: Peace River Site C Investigations

Peace River Fish and Habitat Associations 2005

DATE: March 17, 2006	ANALYST: CRT	**MAP 3 - Moberly River**
JOB No: EA1812	QA/QC: ---	PDF FILE: FishHabitat_MapX.pdf
GIS FILE: Habitat_17x11_Final.mxd		LGL LIMITED environmental research associates
PROJECTION: UTM Zone 10	DATUM: NAD83	

LGL Limited 2008.11.24 RT F:\EA1786\EA1812\Habitat_17x11_Final.mxd





Habitat Type

Other | Run | Pool | Riffle

- Waypoints
- Fish Sample
- Site C Highwater

DRAFT

S P E C I E S

BB	Burbot	LSU	Longnose Sucker
BT	Bull Trout	MW	Mountain Whitefish
CAS	Prickly Sculpin	NM	Northern Pikeminnow
CCG	Slimy Sculpin	RB	Rainbow Trout
CSU	Largescale Sucker	RSC	Redside Shiner
FHC	Flathead Chub	UK	Unknown
GR	Arctic Grayling	UN	Unidentified Cyprinid
LKC	Lake Chub	WSU	White Sucker
LNC	Longnose Dace		

1:20000

0 500 1000 1500

Metres

Reference BC TRIM, scale 1:20000.

CLIENT: BC hydro

PROJECT: Peace River Site C Investigations

Peace River Fish and Habitat Associations 2005

DATE: March 17, 2006	ANALYST: CRT	**MAP 4 - Wilder Creek**
JOB No: EA1812	QA/QC: ---	PDF FILE: FishHabitat_MapX.pdf
GIS FILE: Habitat_17x11_Final.mxd		
PROJECTION: UTM Zone 10	DATUM: NAD83	LGL LIMITED environmental research associates

LGL Limited 2008.11.24 RT F:\EA1786\EA1812\Habitat_17x11_Final.mxd

606000
608000
610000
6240000
6238000

Red Creek

Cache Creek

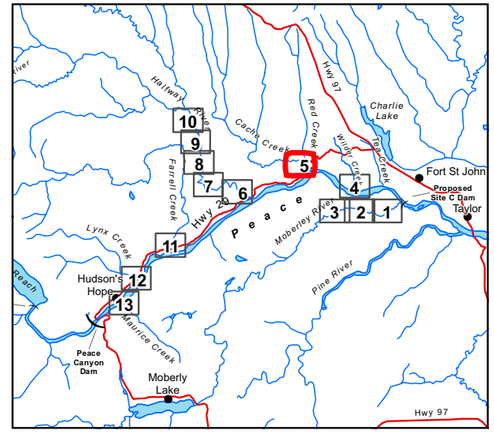
Peace River

LNC 24, LSU 2, RSC 3, UN 34

LSU 3, UN 16

LNC 1, LSU 8, RSC 3, UN 30

LNC 6, LSU 23, NM 1, RSC 33, UN 133



Habitat Type

Other
Run
Pool
Riffle

- Waypoints
- Fish Sample
- Site C Highwater

DRAFT

S P E C I E S

BB	Burbot	LSU	Longnose Sucker
BT	Bull Trout	MW	Mountain Whitefish
CAS	Prickly Sculpin	NM	Northern Pikeminnow
CCG	Slimy Sculpin	RB	Rainbow Trout
CSU	Largescale Sucker	RSC	Redside Shiner
FHC	Flathead Chub	UK	Unknown
GR	Arctic Grayling	UN	Unidentified Cyprinid
LKC	Lake Chub	WSU	White Sucker
LNC	Longnose Dace		

1:20000

0 500 1000 1500

Metres

Reference BC TRIM, scale 1:20000.

CLIENT: BC hydro

PROJECT: Peace River Site C Investigations

Peace River Fish and Habitat Associations 2005

DATE: March 17, 2006	ANALYST: CRT	**MAP 5 - Cache/Red Creek**
JOB No: EA1812	QA/QC: ---	PDF FILE: FishHabitat_MapX.pdf
GIS FILE: Habitat_17x11_Final.mxd		
PROJECTION: UTM Zone 10	DATUM: NAD83	LGL LIMITED environmental research associates

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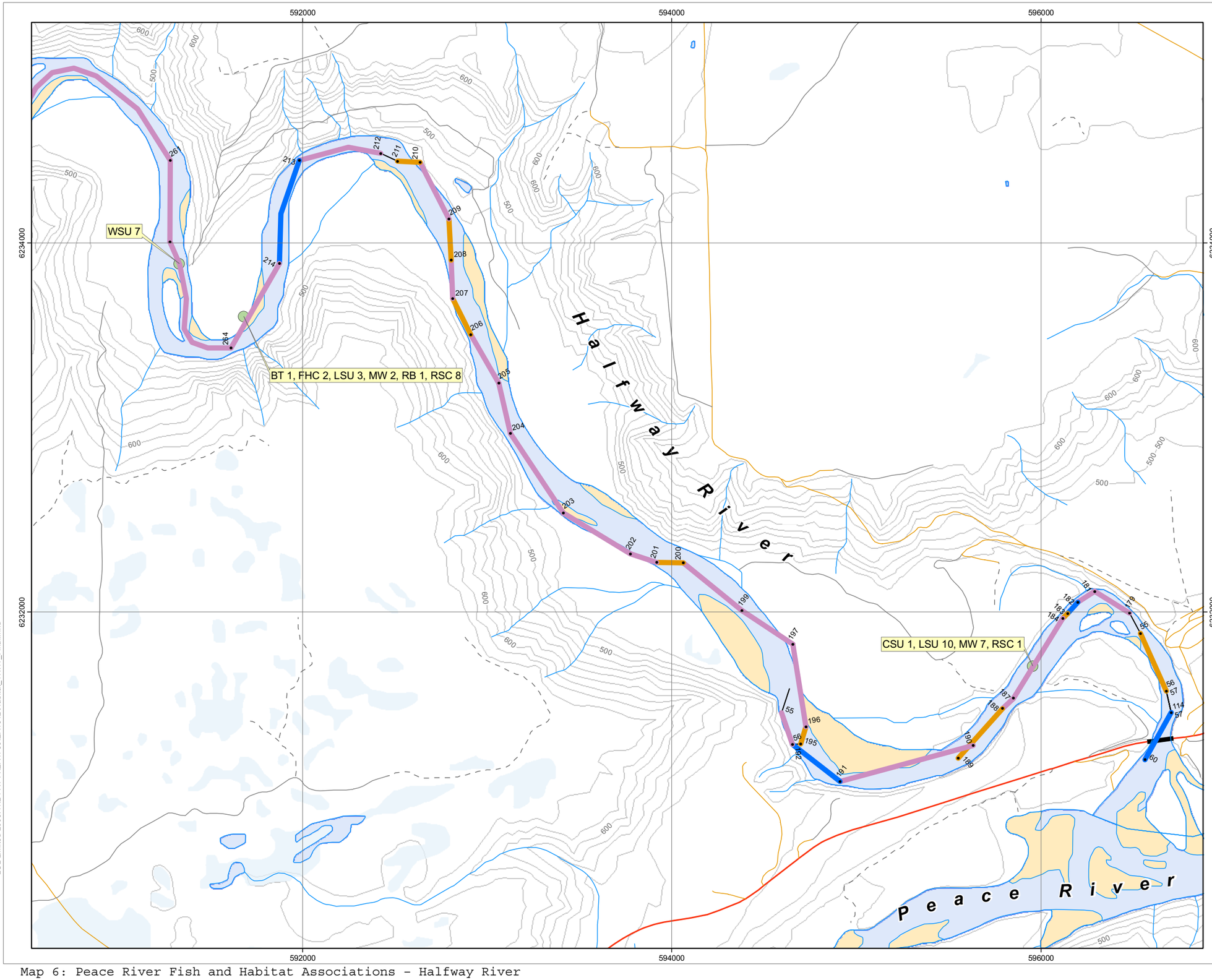
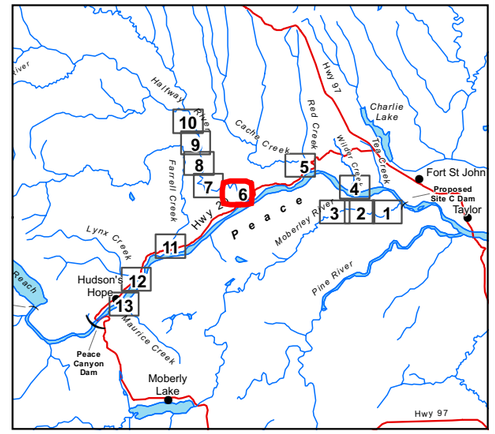




Habitat Type

Other | Run | Pool | Riffle

- Waypoints
- Fish Sample
- [Site C Highwater

DRAFT

S P E C I E S

BB	Burbot	LSU	Longnose Sucker
BT	Bull Trout	MW	Mountain Whitefish
CAS	Prickly Sculpin	NM	Northern Pikeminnow
CCG	Slimy Sculpin	RB	Rainbow Trout
CSU	Largescale Sucker	RSC	Redside Shiner
FHC	Flathead Chub	UK	Unknown
GR	Arctic Grayling	UN	Unidentified Cyprinid
LKC	Lake Chub	WSU	White Sucker
LNC	Longnose Dace		

1:20000

0 500 1000 1500

Metres

Reference BC TRIM, scale 1:20000.

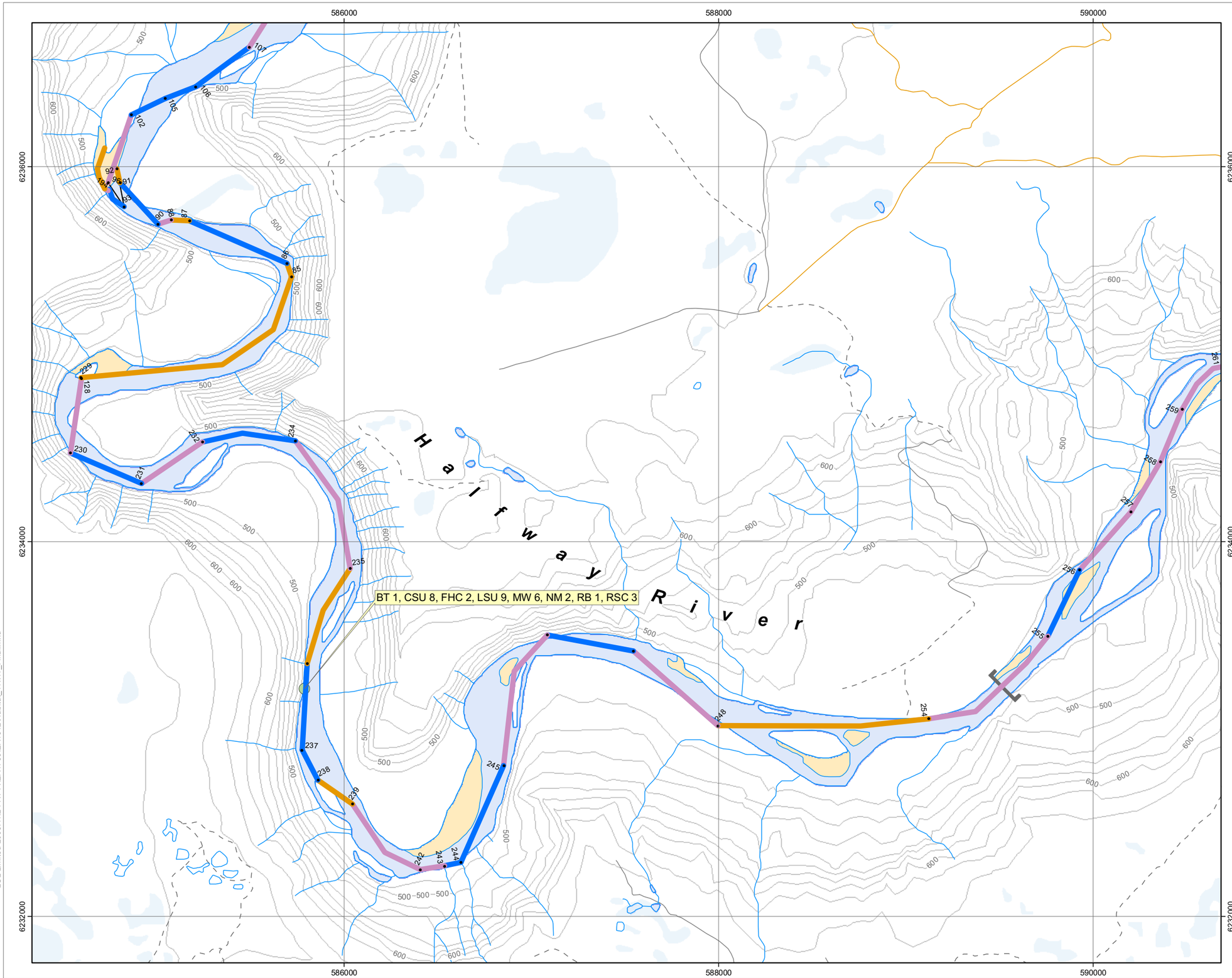
CLIENT: BC hydro

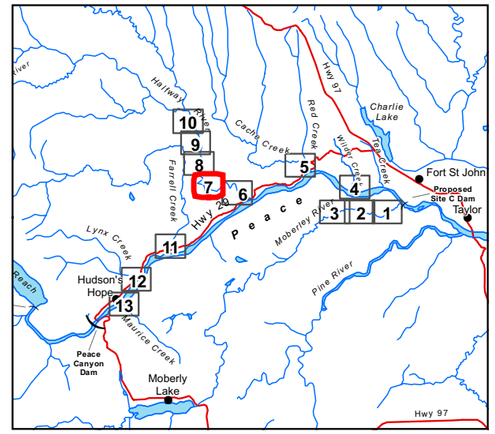
PROJECT: Peace River Site C Investigations

Peace River Fish and Habitat Associations 2005

DATE: March 17, 2006	ANALYST: CRT	**MAP 6 - Halfway River**
JOB No: EA1812	QA/QC: ---	PDF FILE: FishHabitat_MapX.pdf
GIS FILE: Habitat_17x11_Final.mxd		
PROJECTION: UTM Zone 10	DATUM: NAD83	LGL LIMITED environmental research associates

LGL Limited 2008.11.24 RT F:\EA1786\EA1812\Habitat_17x11_Final.mxd





Habitat Type

Other | Run | Pool | Riffle

- Waypoints
- Fish Sample
- Site C Highwater

DRAFT

S P E C I E S

BB	Burbot	LSU	Longnose Sucker
BT	Bull Trout	MW	Mountain Whitefish
CAS	Prickly Sculpin	NM	Northern Pikeminnow
CCG	Slimy Sculpin	RB	Rainbow Trout
CSU	Largescale Sucker	RSC	Redside Shiner
FHC	Flathead Chub	UK	Unknown
GR	Arctic Grayling	UN	Unidentified Cyprinid
LKC	Lake Chub	WSU	White Sucker
LNC	Longnose Dace		

1:20000

0 500 1000 1500

Metres

Reference BC TRIM, scale 1:20000.

CLIENT: BC hydro

PROJECT: Peace River Site C Investigations

Peace River Fish and Habitat Associations 2005

DATE: March 17, 2006	ANALYST: CRT	**MAP 7 - Halfway River**
JOB No: EA1812	QA/QC: ---	PDF FILE: FishHabitat_MapX.pdf
GIS FILE: Habitat_17x11_Final.mxd		
PROJECTION: UTM Zone 10	DATUM: NAD83	LGL LIMITED environmental research associates

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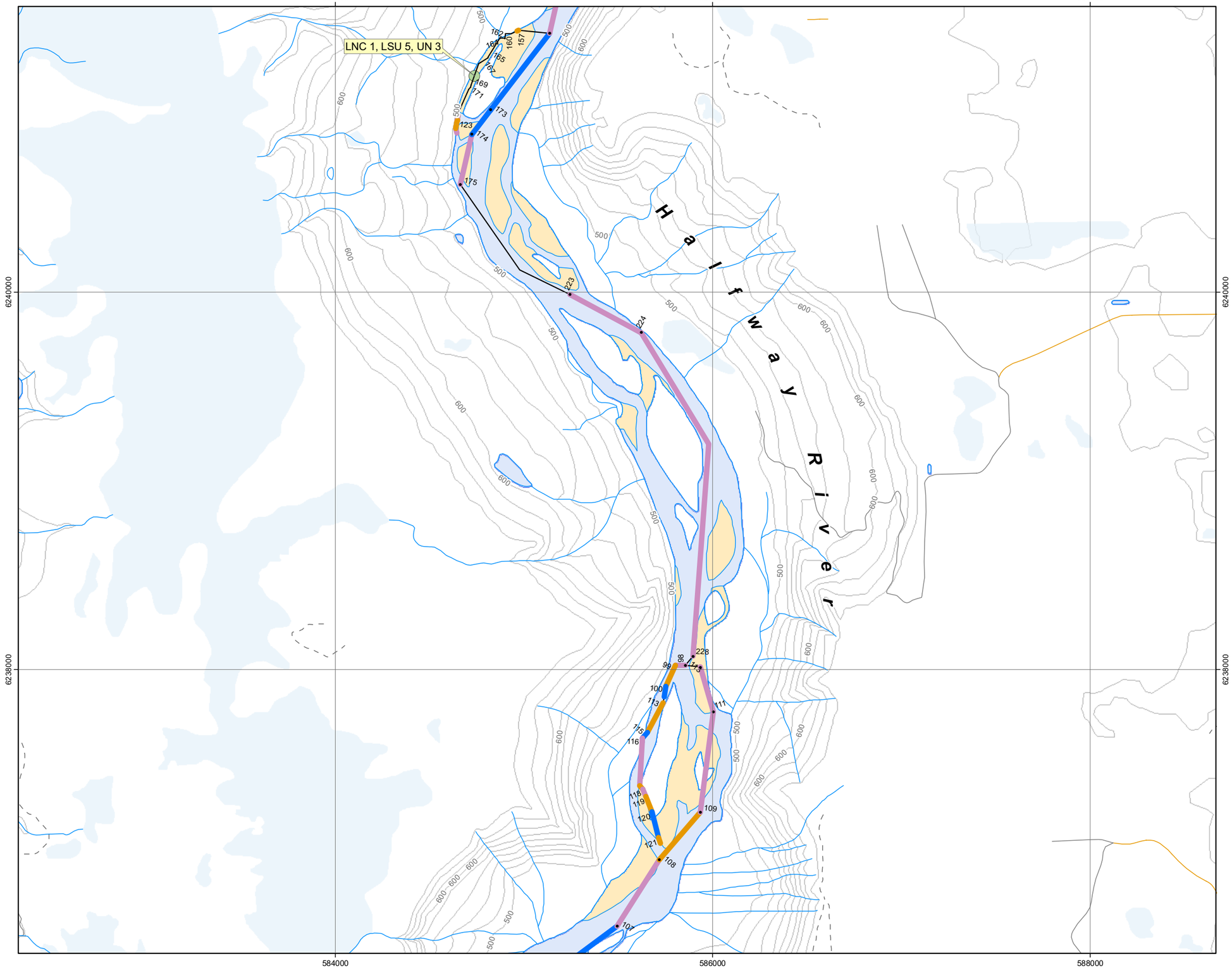
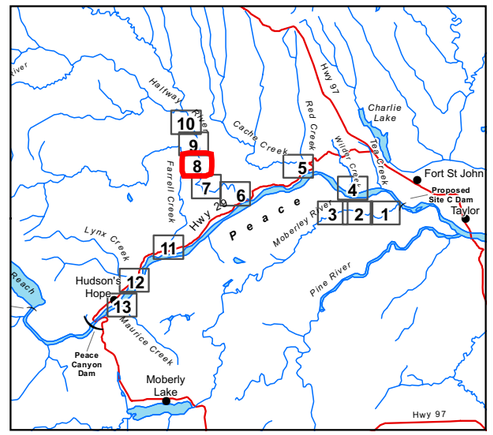




Habitat Type

Other | Run | Pool | Riffle

- Waypoints
- Fish Sample
- [Site C Highwater

DRAFT

S P E C I E S

BB	Burbot	LSU	Longnose Sucker
BT	Bull Trout	MW	Mountain Whitefish
CAS	Prickly Sculpin	NM	Northern Pikeminnow
CCG	Slimy Sculpin	RB	Rainbow Trout
CSU	Largescale Sucker	RSC	Redside Shiner
FHC	Flathead Chub	UK	Unknown
GR	Arctic Grayling	UN	Unidentified Cyprinid
LKC	Lake Chub	WSU	White Sucker
LNC	Longnose Dace		

1:20000

0 500 1000 1500

Metres

Reference BC TRIM, scale 1:20000.

CLIENT: BC hydro

PROJECT: Peace River Site C Investigations

Peace River Fish and Habitat Associations 2005

DATE: March 17, 2006	ANALYST: CRT	**MAP 8 - Halfway River**
JOB No: EA1812	QA/QC: ---	PDF FILE: FishHabitat_MapX.pdf
GIS FILE: Habitat_17x11_Final.mxd		
PROJECTION: UTM Zone 10	DATUM: NAD83	LGL LIMITED environmental research associates

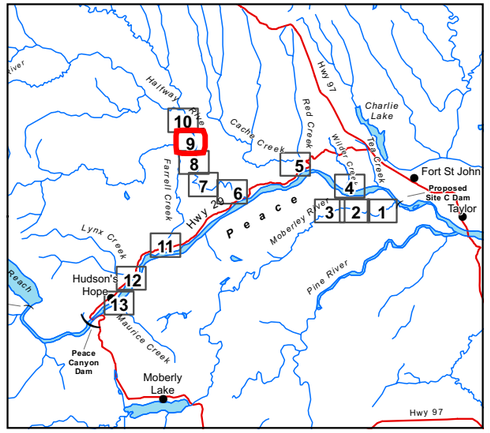
LGL Limited 2008.11.24 RT F:\EA1786\EA1812\Habitat_17x11_Final.mxd

582000
584000
586000
6246000
6244000
6242000

Halfway River

BT 2, LKC 1, LSU 4, MW 3, NM 5, RB 1, RSC 8

LNC 1, LSU 5, UN 3



Habitat Type

Other
Run
Pool
Riffle

- Waypoints
- Fish Sample
- Site C Highwater

DRAFT

S P E C I E S

BB	Burbot	LSU	Longnose Sucker
BT	Bull Trout	MW	Mountain Whitefish
CAS	Prickly Sculpin	NM	Northern Pikeminnow
CCG	Slimy Sculpin	RB	Rainbow Trout
CSU	Largescale Sucker	RSC	Redside Shiner
FHC	Flathead Chub	UK	Unknown
GR	Arctic Grayling	UN	Unidentified Cyprinid
LKC	Lake Chub	WSU	White Sucker
LNC	Longnose Dace		

1:20000

0 500 1000 1500

Metres

Reference BC TRIM, scale 1:20000.

CLIENT: BC hydro

PROJECT: Peace River Site C Investigations

Peace River Fish and Habitat Associations 2005

DATE: March 17, 2006	ANALYST: CRT	**MAP 9 - Halfway River**
JOB No: EA1812	QA/QC: ---	PDF FILE: FishHabitat_MapX.pdf
GIS FILE: Habitat_17x11_Final.mxd		
PROJECTION: UTM Zone 10	DATUM: NAD83	LGL LIMITED environmental research associates

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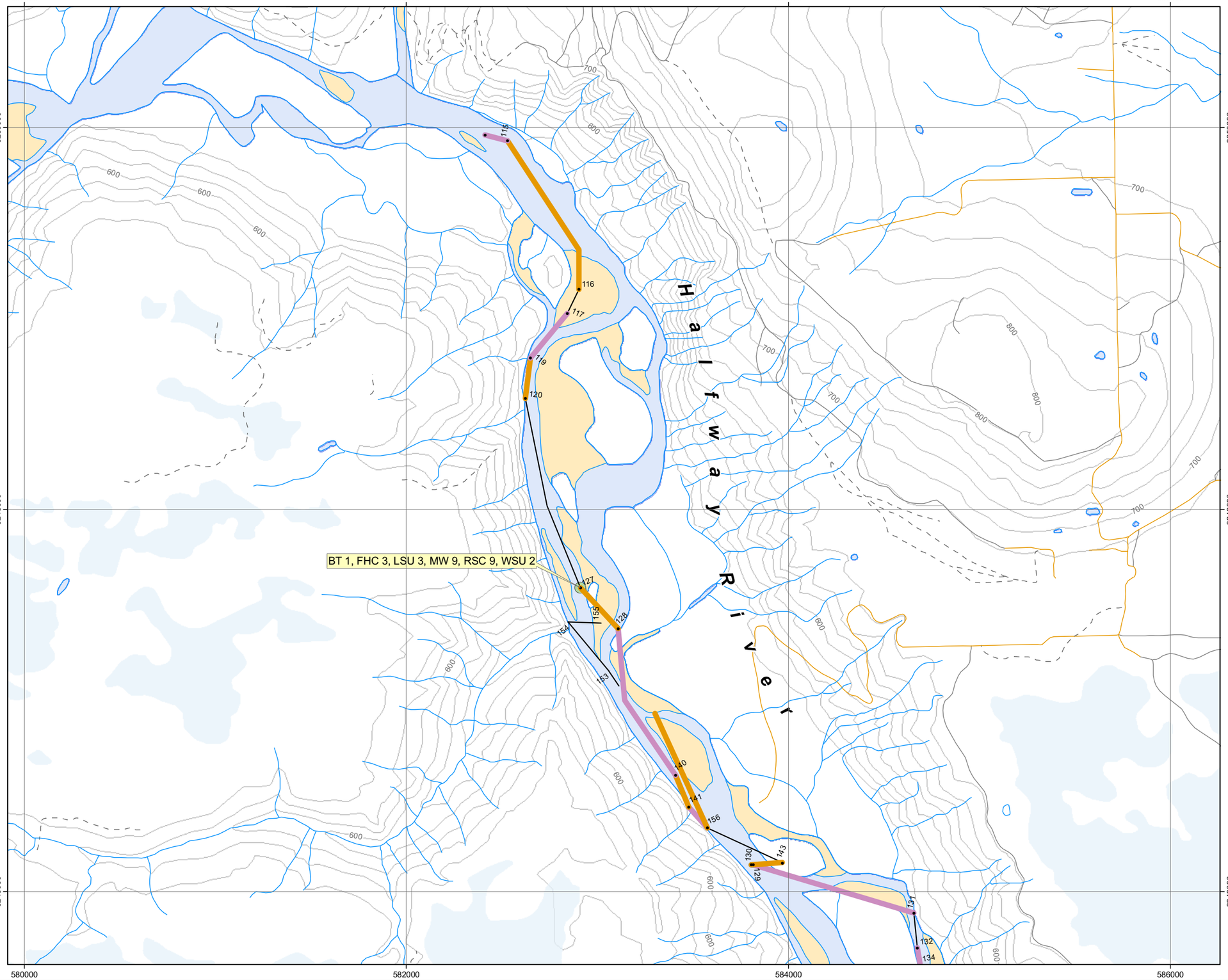

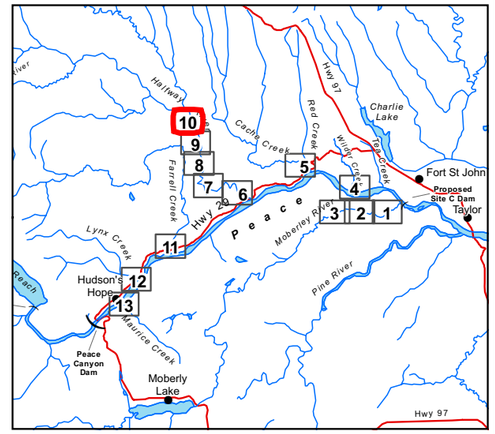

Habitat Type

Other | Run | Pool | Riffle

- Waypoints
- Fish Sample
- Site C Highwater

DRAFT

S P E C I E S

BB	Burbot	LSU	Longnose Sucker
BT	Bull Trout	MW	Mountain Whitefish
CAS	Prickly Sculpin	NM	Northern Pikeminnow
CCG	Slimy Sculpin	RB	Rainbow Trout
CSU	Largescale Sucker	RSC	Redside Shiner
FHC	Flathead Chub	UK	Unknown
GR	Arctic Grayling	UN	Unidentified Cyprinid
LKC	Lake Chub	WSU	White Sucker
LNC	Longnose Dace		

1:20000

0 500 1000 1500

Metres

Reference BC TRIM, scale 1:20000.

CLIENT: BC hydro

PROJECT: Peace River Site C Investigations

Peace River Fish and Habitat Associations 2005

DATE: March 17, 2006	ANALYST: CRT	**MAP 10 - Halfway River**
JOB No: EA1812	QA/QC: ---	PDF FILE: FishHabitat_MapX.pdf
GIS FILE: Habitat_17x11_Final.mxd		LGL LIMITED environmental research associates
PROJECTION: UTM Zone 10	DATUM: NAD83	

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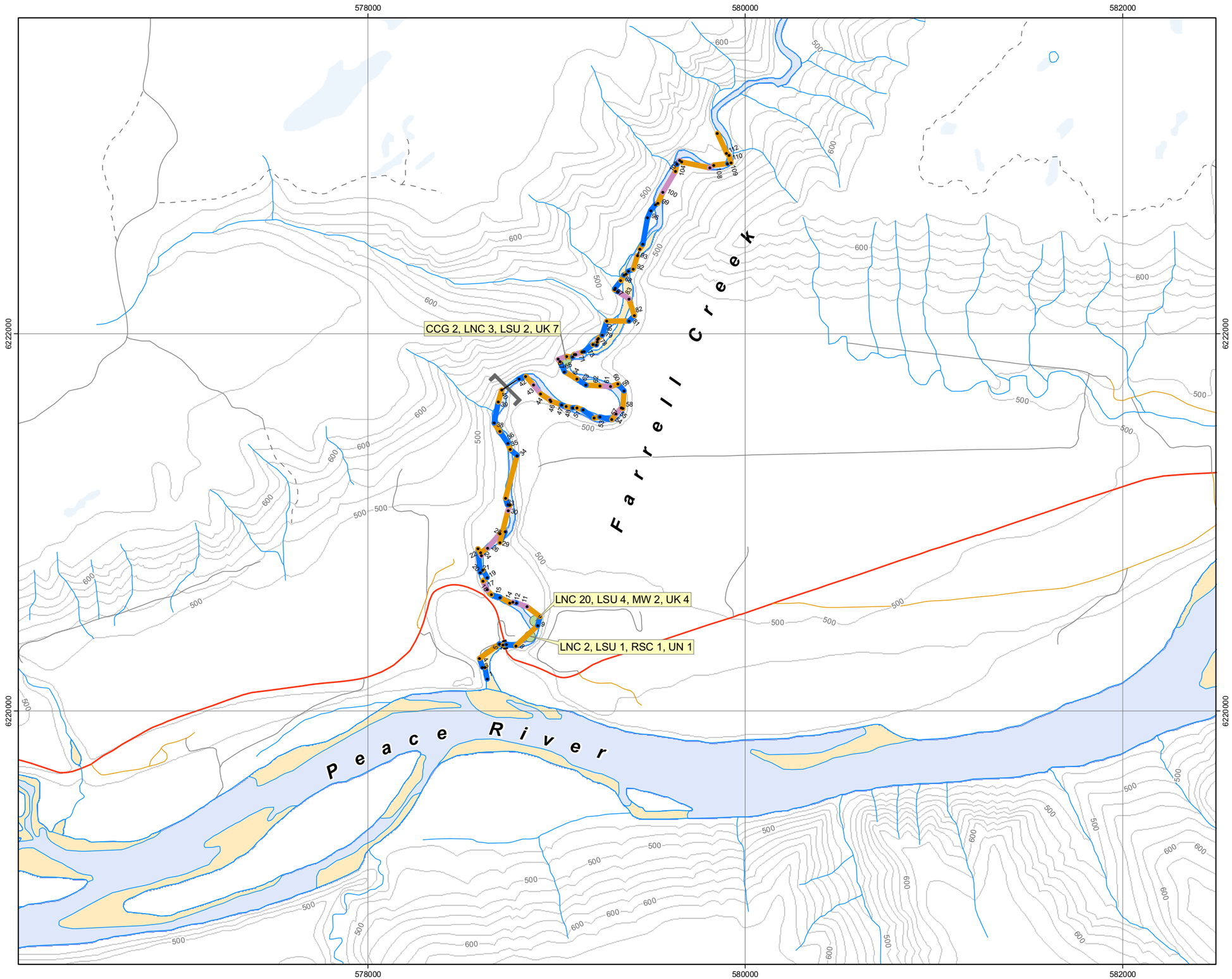
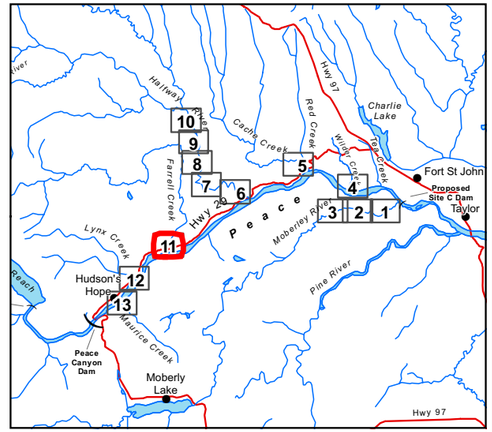




Habitat Type

Other | Run | Pool | Riffle

- Waypoints
- Fish Sample
- [Site C Highwater

DRAFT

S P E C I E S

BB	Burbot	LSU	Longnose Sucker
BT	Bull Trout	MW	Mountain Whitefish
CAS	Prickly Sculpin	NM	Northern Pikeminnow
CCG	Slimy Sculpin	RB	Rainbow Trout
CSU	Largescale Sucker	RSC	Redside Shiner
FHC	Flathead Chub	UK	Unknown
GR	Arctic Grayling	UN	Unidentified Cyprinid
LKC	Lake Chub	WSU	White Sucker
LNC	Longnose Dace		

1:20000

0 500 1000 1500

Metres

Reference BC TRIM, scale 1:20000.

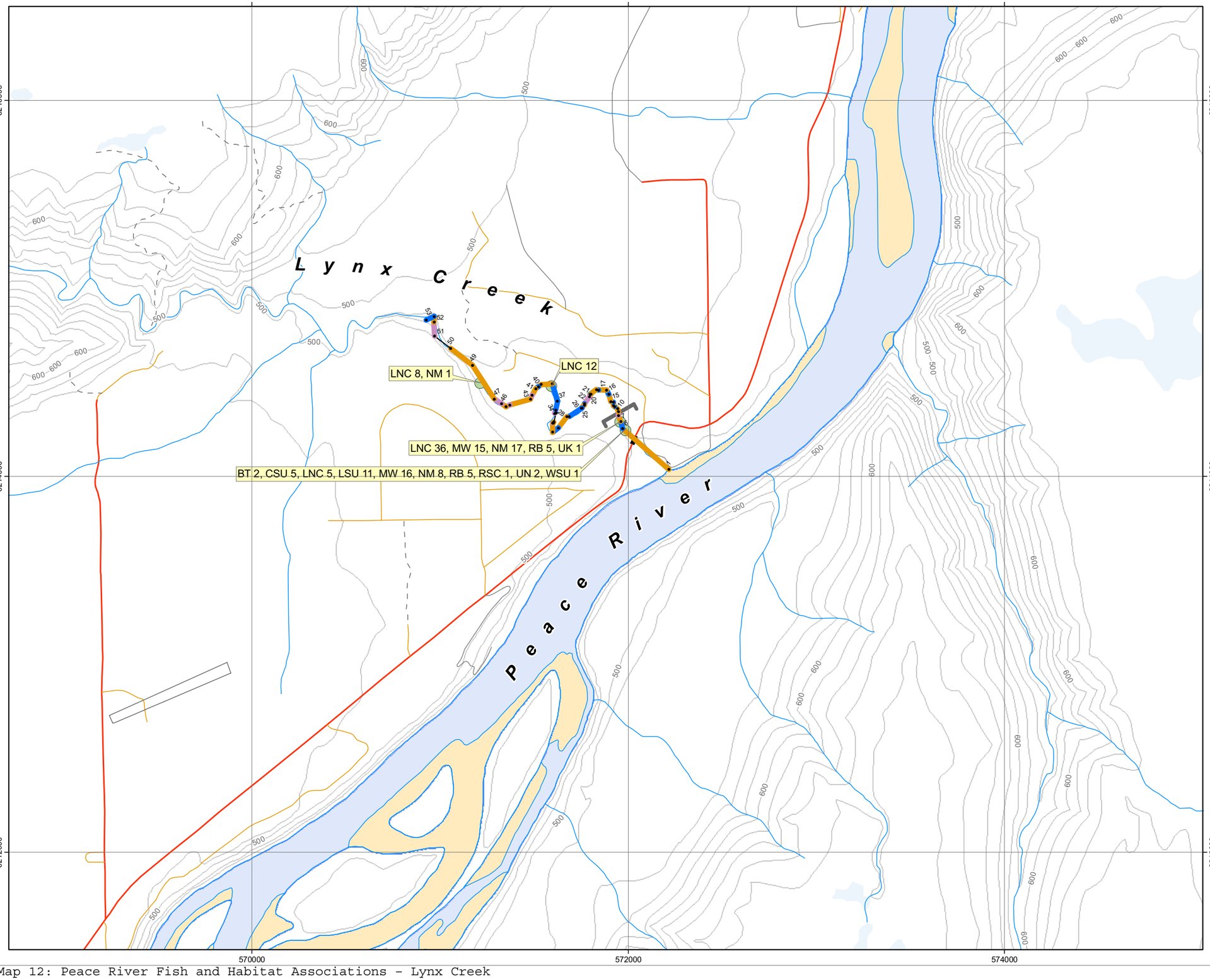
CLIENT: BC hydro

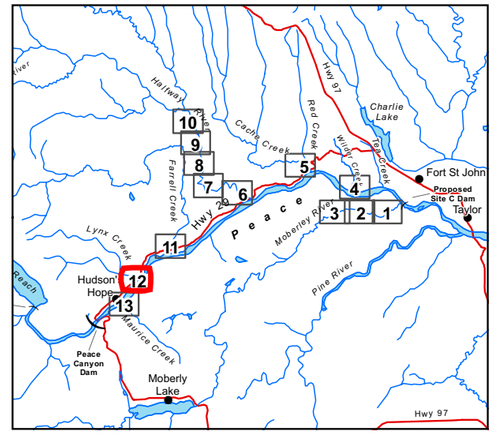
PROJECT: Peace River Site C Investigations

Peace River Fish and Habitat Associations 2005

DATE: March 17, 2006	ANALYST: CRT	**MAP 11 - Farrell Creek**
JOB No: EA1812	QA/QC: ---	PDF FILE: FishHabitat_MapX.pdf
GIS FILE: Habitat_17x11_Final.mxd		
PROJECTION: UTM Zone 10	DATUM: NAD83	LGL LIMITED environmental research associates

LGL Limited 2008.11.24 RT F:\EA1786\EA1812\Habitat_17x11_Final.mxd





Habitat Type

Other | Run | Pool | Riffle

- Waypoints
- Fish Sample
- Site C Highwater

DRAFT

S P E C I E S

BB	Burbot	LSU	Longnose Sucker
BT	Bull Trout	MW	Mountain Whitefish
CAS	Prickly Sculpin	NM	Northern Pikeminnow
CCG	Slimy Sculpin	RB	Rainbow Trout
CSU	Largescale Sucker	RSC	Redside Shiner
FHC	Flathead Chub	UK	Unknown
GR	Arctic Grayling	UN	Unidentified Cyprinid
LKC	Lake Chub	WSU	White Sucker
LNC	Longnose Dace		

1:20000

0 500 1000 1500

Metres

Reference BC TRIM, scale 1:20000.

CLIENT: BC hydro

PROJECT: Peace River Site C Investigations

Peace River Fish and Habitat Associations 2005

DATE: March 17, 2006	ANALYST: CRT	**MAP 12 - Lynx Creek**
JOB No: EA1812	QA/QC: ---	PDF FILE: FishHabitat_MapX.pdf
GIS FILE: Habitat_17x11_Final.mxd		
PROJECTION: UTM Zone 10	DATUM: NAD83	LGL LIMITED environmental research associates

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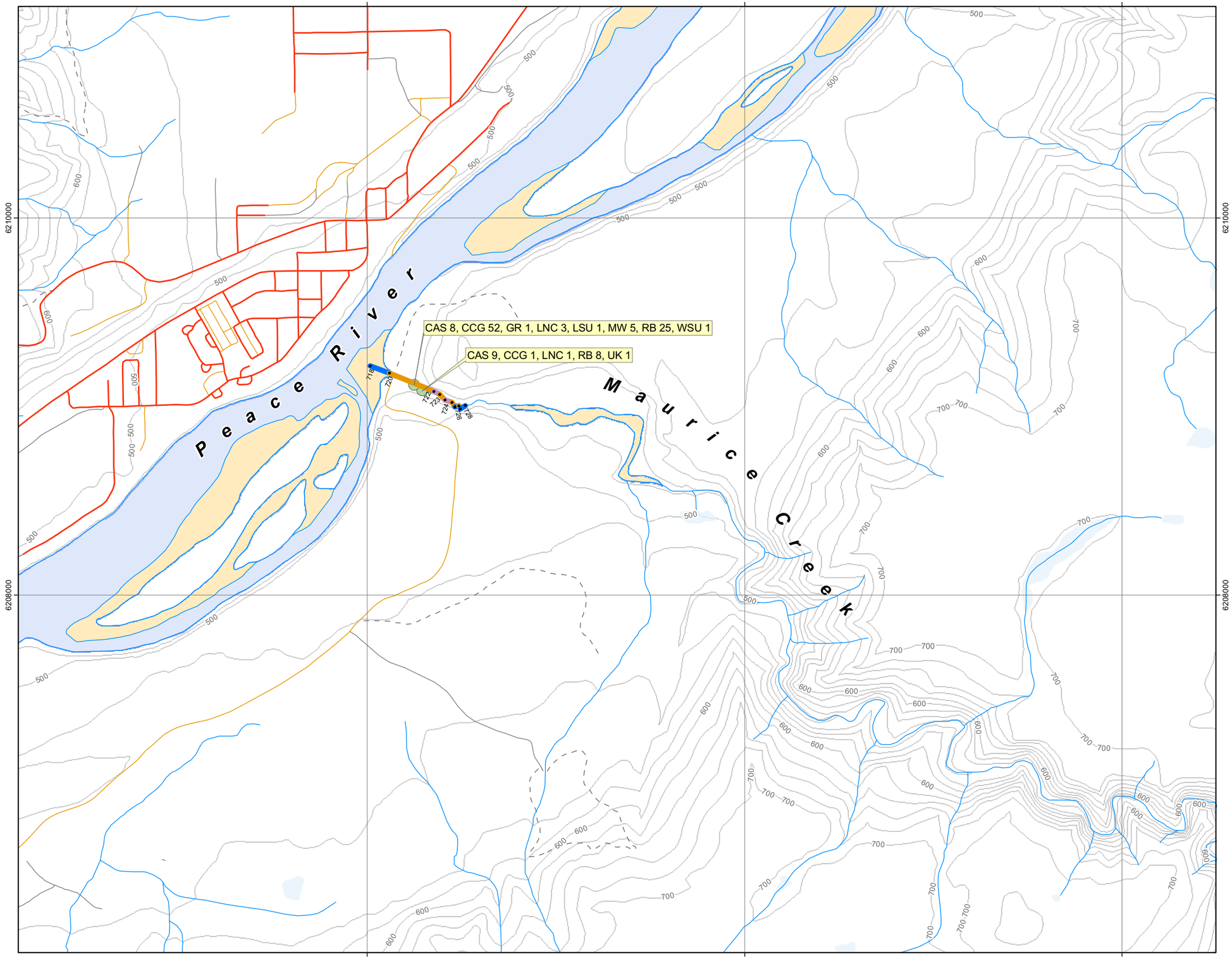

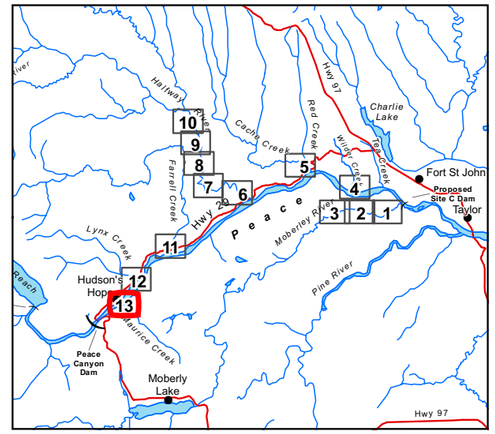

Habitat Type

Other | Run | Pool | Riffle

- Waypoints
- Fish Sample
- Site C Highwater

DRAFT

S P E C I E S

BB	Burbot	LSU	Longnose Sucker
BT	Bull Trout	MW	Mountain Whitefish
CAS	Prickly Sculpin	NM	Northern Pikeminnow
CCG	Slimy Sculpin	RB	Rainbow Trout
CSU	Largescale Sucker	RSC	Redside Shiner
FHC	Flathead Chub	UK	Unknown
GR	Arctic Grayling	UN	Unidentified Cyprinid
LKC	Lake Chub	WSU	White Sucker
LNC	Longnose Dace		

1:20000

0 500 1000 1500

Metres

Reference BC TRIM, scale 1:20000.

CLIENT: BC hydro

PROJECT: Peace River Site C Investigations

Peace River Fish and Habitat Associations 2005

DATE: March 17, 2006	ANALYST: CRT	**MAP 13 - Maurice Creek**
JOB No: EA1812	QA/QC: ---	PDF FILE: FishHabitat_MapX.pdf
GIS FILE: Habitat_17x11_Final.mxd		
PROJECTION: UTM Zone 10	DATUM: NAD83	LGL LIMITED environmental research associates

LGL Limited 2008.11.24 RT F:\EA1786\EA1812\Habitat_17x11_Final.mxd