Campbell River Project Water Use Plan

Heber, Quinsam and Salmon River Smolt and Spawner Abundance Assessments

Implementation Year 1

Reference: JHTMON-8

Year 1 Annual Monitoring Report

Study Period: March 1, 2014 to April 30, 2015

Laich-Kwil-Tach Environmental Assessment Ltd. Partnership and Ecofish Research Ltd.

April 16, 2015

JHTMON-8: Salmon River and Quinsam River Smolt and Spawner Abundance Assessments

Year 1 Annual Monitoring Report

BC Hydro Water License Requirements
6911 Southpoint Drive, 11th Floor
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EXECUTIVE SUMMARY

Water Use Plans (WUPs) were developed for all of BC Hydro's hydroelectric facilities through a consultative process and there is expected to be monitoring to address outstanding management questions in the years following the implementation of a WUP. As the Campbell River Water Use Plan process reached completion, a number of uncertainties remained with respect to the effects of BC Hydro operations on aquatic resources. The JHTMON-8 monitoring program focuses on the Salmon and Quinsam rivers which both have high fisheries values and include diversion infrastructure that diverts a portion of natural flow elsewhere in the Campbell River watershed for hydroelectric power generation.

The study aims to address the following three management questions:

1. What are the primary factors that limit fish abundance in the Campbell River System and how are these factors influenced by BC Hydro operations?
2. Have WUP-based operations changed the influence of these primary factors on fish abundance, allowing carrying capacity to increase?
3. If the expected gains in fish abundance have not been fully realized, what factors if any are masking the response and are they influenced by BC Hydro operations?

These questions will be addressed by testing six null hypotheses that seek to test whether juvenile fish abundance varies between years (H_01) and, if so, whether abundance is related to the following drivers: habitat availability (H_02), water quality (H_03), floods (H_04), food abundance (H_05), and the abundance of returning adult fish (H_06). Species of primary interest are Coho Salmon (*Oncorhynchus kisutch*) and Steelhead (*Oncorhynchus mykiss*), although the study involves compiling adult escapement data for a wider range of anadromous salmonid species for both rivers, as well as collecting abundance data for both juvenile and adult life stages for a range of species in the Quinsam River (at the salmon counting fence).

The table below summarizes the field sampling programs scheduled to be undertaken annually as part of JHTMON-8.

Table 1. Summary of field sampling programs undertaken for JHTMON-8.

River	Sampling program	Lead organization[1]	Method	Timing
Salmon	Adult Steelhead survey	BCCF	Snorkel surveys	March – April
	Juvenile Steelhead abundance	LKT	Closed site multi-pass electrofishing	September
	Juvenile Coho abundance	DFO (Year 1 only)	Closed site multi-pass netting	October
	Salmon escapement surveys	DFO	Various	September – November
	Water quality sampling	LKT	*In situ* and laboratory analysis	May – October
	Invertebrate sampling	LKT	Drift sampling	May – October
Quinsam	Quinsam River Hatchery juvenile downstream migration (various species)	DFO	Fish fence	March – June
	Salmon escapement surveys	DFO	Various	September – November
	Water quality sampling	LKT	*In situ* and laboratory analysis	May – November
	Invertebrate sampling	LKT	Drift sampling	May – October

[1]BCCF, British Columbia Conservation Foundation; LKT, Laich-Kwil-Tach Environmental Assessment Ltd. Partnership; DFO, Fisheries and Oceans Canada

All sampling programs were successfully completed in Year 1 (2014). Methods and results are summarized for all programs in this report, although programs led by other parties (BCCF or DFO) are only briefly summarized and the reader is directed to full reports in appendices.

JHTMON-8 is at an early stage; however, fish abundance data so far support rejection of H_01 for at least some species; i.e., fish abundance measured in Year 1 exhibits inter-annual variability relative to historic data, in cases where historical comparisons were made. In the Salmon River, the adult Steelhead count in the standard index reach ('Lower Index'; count = 29) was one of the lowest on record (annual monitoring since 1998), and 3.7 times lower than the historic mean count. The overall mean count (standardized for depth and velocity) of juvenile Steelhead (49 fry per 100 m^2) was slightly lower than the historic annual mean (annual monitoring since 1998), and less than the target set by provincial biologists of 60 fry per 100 m^2. Variability in juvenile Steelhead abundance was considerable between sites, and this was also the case for juvenile Coho Salmon, for which estimated biomass varied between ~7.0 and 0 g/m^2 at the six sites sampled. Historic juvenile Coho Salmon abundance data for the Salmon River have not been compiled by DFO at this time. Similarly, Year 1 juvenile fish abundance measured at the counting fence on the Quinsam River has yet to be compared with historic data although adult salmon escapement estimates (1950s until 2013) show marked inter-annual fluctuations on both rivers. Most notably, Pink Salmon escapement in 2013 was a near-record high on the Salmon River (~45,000) and a record high on the Quinsam River (~1.03 million).

Water quality data were collected throughout the growing season at a single index site on the Salmon and Quinsam rivers. The results so far show that both rivers are oligotrophic with water quality parameters generally in the optimum ranges for salmonid growth. Exceptions to this were high summer water temperatures in both rivers, but most notably in the Quinsam River where the monthly-mean water temperature in August was 19.8 °C at the index site. Also, one relatively low dissolved oxygen measurement was made in the Salmon River during September when average concentration (8.80 mg/L) did not meet the provincial guideline for the protection of buried embryo/alevin (instantaneous minimum of 9 mg/L).

Invertebrate drift was sampled throughout the growing season at a single index site on both rivers. Invertebrate drift was sampled approximately monthly from May through October, with the exception of June when sampling was undertaken weekly. Invertebrate biomass was generally highest on both rivers during the spring and early summer, before declining later in the growing season. Seasonal trends were less apparent for diversity and richness. The invertebrate communities (in terms of biomass) were dominated by mayflies, caddisflies, and true flies on both rivers.

The management questions have not been addressed at this stage, although we outline proposed analytical methods that should be used when further data are collected. Recommendations to improve JHTMON-8 data collection and analyses are also provided.

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1. INTRODUCTION

1.1. Background to Water Use Planning

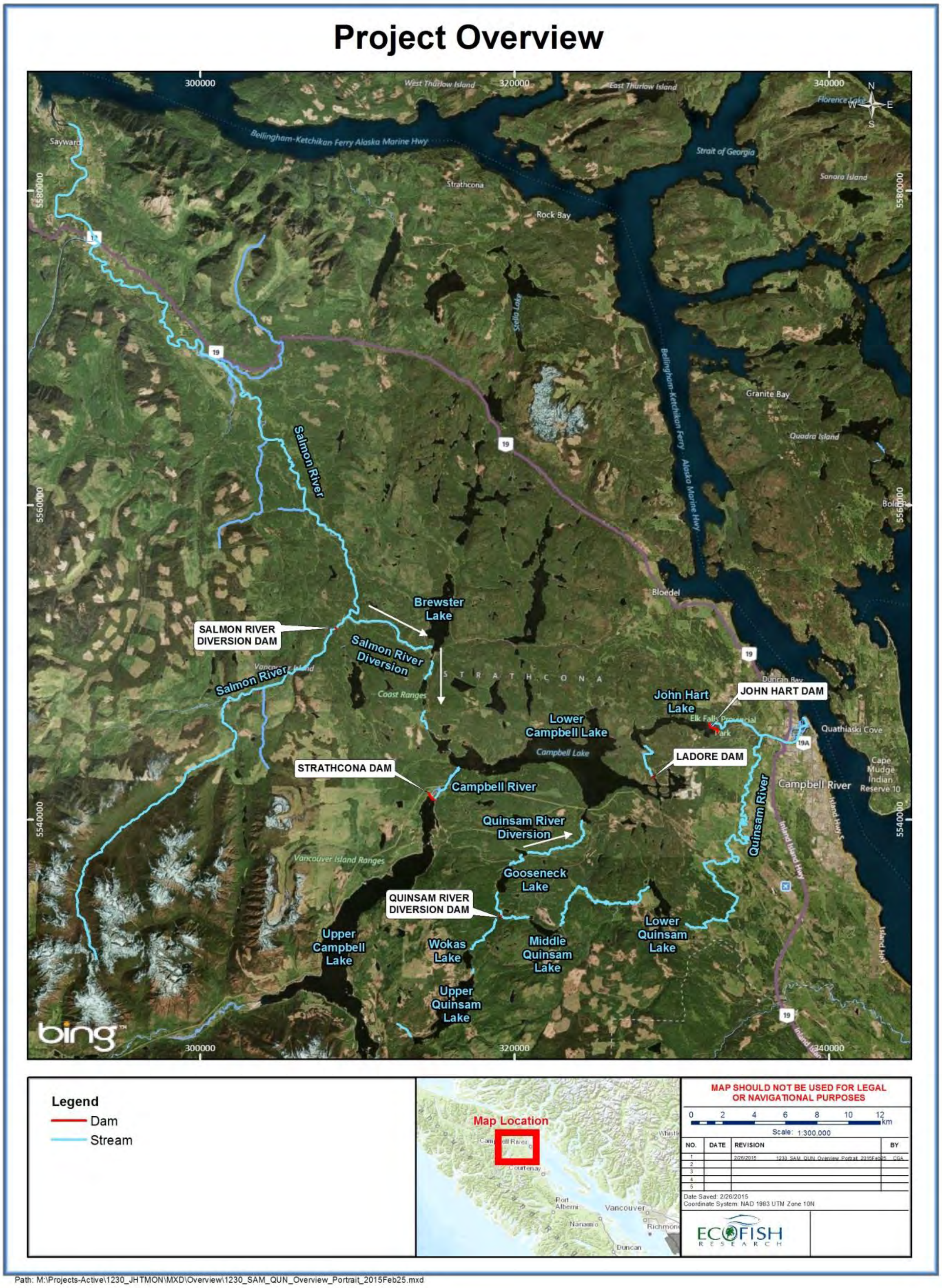
Water use planning exemplifies sustainable work in practice at BC Hydro. The goal is to provide a balance between the competing uses of water that include fish and wildlife, recreation, and power generation. Water Use Plans (WUPs) were developed for all of BC Hydro's hydroelectric facilities through a consultative process involving local stakeholders, government agencies and First Nations. The framework for water use planning requires that a WUP be reviewed on a periodic basis and there is expected to be monitoring to address outstanding management questions in the years following the implementation of a WUP.

As the Campbell River Water Use Plan process reached completion, a number of uncertainties remained with respect to the effects of BC Hydro operations on aquatic resources. A key question throughout the WUP process was "what limits fish abundance?" For example, are fish abundance and biomass limited by available habitat, food, environmental perturbations or ecological interactions? Answering this question is an important step to better understanding how human activities in the watershed affect fisheries, and to effectively manage water uses to protect and enhance aquatic resources. To address this uncertainty, monitoring programs were designed to assess whether fish benefits are being realized under the WUP operating regime and to evaluate whether limits to fish production could be improved by modifying operations in the future. The *Salmon River and Quinsam River Smolt and Spawner Abundance Assessments* (JHTMON-8) comprise one of the monitoring studies that are part of wider monitoring of the Campbell River WUP. JHTMON-8 focuses on monitoring fish populations and environmental factors that may influence fish abundance in the Salmon and Quinsam rivers; this will help to better understand the potential biological effects of BC Hydro operations.

1.2. BC Hydro Infrastructure, Operations and the Monitoring Context

Both the Salmon and Quinsam rivers are located to the west of the city of Campbell River on the east coast of Vancouver Island, British Columbia. Both the Salmon River and the Quinsam River diversion dams divert a portion of water from the river mainstems to generate hydroelectricity downstream at Ladore and John Hart generation stations (Map 1). Details of the diversion infrastructure and operations are provided in the Campbell River System WUP (BC Hydro 2012).

Map 1. Overview of the Salmon River and Quinsam River watersheds.



1.2.1. The Salmon River and Diversion

The Salmon River flows from headwaters in Strathcona Provincial Park in a general northwards direction to the ocean at Sayward. Major tributaries include Grilse Creek, the Memekay River and the White River, all of which drain the western side of the Salmon River watershed. The area of the watershed is approximately 1,300 km^2 and mean annual discharge (MAD) near the mouth is 63 m^3/s (Burt 2010). The Salmon River has high fisheries values and the river supports a range of salmonid and non-salmonid fish species, including those that are both anadromous and resident (Burt 2010). The Salmon River supports all five species of Pacific salmon (*Oncorhynchus* spp.) as well as both resident and anadromous Rainbow Trout (*Oncorhynchus mykiss*), Cutthroat Trout (*Oncorhynchus clarkii*) and Dolly Varden (*Salvelinus malama*). Lamprey (*Lampetra* spp.) and Sculpin (*Cottus* spp.) species are also present.

The Salmon River Diversion infrastructure was initially constructed in 1958. The diversion dam is a 69 m long rock-filled timber crib dam that diverts water into the Campbell River watershed. Water is diverted from the mainstem of the Salmon River via an intake channel, through a radial gate and into a concrete-lined canal that conveys water to Brewster Lake, which is upstream of Lower Campbell Lake Reservoir. Non-diverted water is returned to the mainstem downstream, either via the main spillway, an undersluice, a trimming weir, or the fishway.

Blasting was undertaken in 1975 and 1976 to remove a rock obstruction in a canyon at river km 38 that formed both a velocity and vertical obstruction to fish migrating upstream (Ptolemy *et al.* 1977 cited in Burt 2010). Subsequent surveys showed that juvenile Steelhead were present upstream of the canyon where they were previously absent.

A fish (smolt) screen was installed in 1986 to prevent out-migrating smolts from being diverted into the Campbell River watershed. The fishway was installed in 1992 to aid upstream passage of fish past the diversion dam. There have been issues with the performance of both the fish screen and the fish way (Burt 2010), and a project is currently underway to upgrade the Salmon River Diversion to improve upstream fish passage, downstream juvenile mitigation, and the flow control/debris management at the dam. The diversion canal is scheduled to be fully operational in 2017 or 2018, with improved upstream fish passage structures fully operational prior to that (Cecic, pers. comm. 2014).

A total of 493.39 million m^3 is licensed to be diverted annually, and the 7.8 km diversion canal has a maximum design discharge capacity of 45 m^3/s. The Campbell River System WUP stipulates maximum down ramping rates for the Salmon River and the Diversion Canal (Table 2), maximum diversion flows to enhance fish screen efficiency (Table 3), and minimum flows that must be maintained in the Salmon River downstream of the diversion dam when sufficient flows are naturally available (4.0 m^3/s).

Table 2. Salmon River maximum permitted down ramping rates (BC Hydro 2012).

Stream	Salmon River discharge (m^3/s)	Salmon River maximum down ramping rate ($m^3/s/h$)
Salmon River	< 8.0	1.0
	8.0 to 10.0	2.0
	>10.0	10.0
Salmon River Diversion	0 to 43.0	10.0

Table 3. Salmon River maximum permitted diversion flows (BC Hydro 2012).

Date	Maximum diversion (m^3/s)	Fish screen operation
Jan 1 to Mar 31	43	N/A
Apr 1 to Dec 31	15	On

Nutrient enrichment for salmonid enhancement has occurred in the Salmon River watershed since 1989 (Pellett 2011). Fertilization locations, methodology and application rates have varied throughout this period, as the project changed from an experimental study to an operational-scale program that is designed to improve habitat suitability (food abundance), primarily for winter run Steelhead and Coho Salmon. Monitoring has primarily focused on Grilse Creek (upstream of the diversion dam), which is the only site to have received continuous nutrient application throughout 1989-2010[1].

1.2.2. The Quinsam River and Diversion

The Quinsam River is the only major tributary of the lower Campbell River, entering the Campbell River approximately 3.5 km upstream of the mouth. The Quinsam flows through a series of lakes and has a mainstem length of 45 km (excluding lakes), a watershed area of 283 km^2, and a mean annual discharge near the mouth of 8.5 m^3/s. The river has high fisheries values, supporting the same assemblage of native salmonid species that is found in the Salmon River (Burt 2003). The Quinsam River Hatchery was constructed in 1957 and is located 3.3 km upstream from the confluence with the Campbell River. The hatchery has been active in the watershed, augmenting populations of Chinook Salmon, Pink Salmon, Coho Salmon, Cutthroat Trout and Steelhead (DFO

[1] Locations that have received intermittent applications are: i) mainstem Salmon R. at Rock Creek; ii) mainstem Salmon R. at Menzies Mainline Bridge; iii) mainstem Salmon R. at Memekay Mainline Bridge; iv) upper Salmon R. near Jessie Creek; v) Bigtree Creek; vi) Kay Creek; vii) Memekay R. (two sites) viii) Cooper Creek (Pellett 2011).

2009). Smolt and fry life stages that are ready for downstream migration to the ocean are released from the hatchery during the spring. In addition, juvenile Coho Salmon, Steelhead and (less frequently) Chinook Salmon have been outplanted to the upper watershed since 1978 to promote adult returns upstream of the hatchery (Burt 2003).

The Quinsam River Diversion comprises a small concrete gravity storage dam, a concrete gravity diversion dam, a concrete flume and the natural waterways that convey water to Lower Campbell Lake Reservoir. Non-diverted water is conveyed to the Quinsam River via an undersluice gate or the free crest weir. The dams were both constructed in 1957.

A total of 100 million m^3 is licensed to be diverted annually and the design capacity of the Quinsam River Diversion is 8.50 m^3/s. As for the Salmon River Diversion Dam, the WUP stipulates maximum down ramping rates (Table 4) and minimum flows (when naturally available) in the Quinsam River downstream of the diversion dam (Table 5).

Table 4. Quinsam River maximum permitted down ramping rates (BC Hydro 2012).

Stream	Discharge (m^3/s)	Maximum down ramping rate ($m^3/s/h$)
Quinsam River	> 4.0	8.5
	≤ 4.0	1.0
Quinsam Diversion	> 2.0	N/A
	≤ 2.0	1.0

Table 5. Minimum permitted discharge in the Quinsam River (BC Hydro 2012).

Date	Minimum discharge in Quinsam River (m^3/s)
Jan 1 to Apr 30	2.0
May 1 to Oct 31	1.0
Nov 1 to Dec 31	0.6

1.3. Management Questions and Hypotheses

The JHTMON-8 monitoring program aims to address the following three management questions:

1. What are the primary factors that limit fish abundance in the Campbell River System and how are these factors influenced by BC Hydro operations?
2. Have WUP-based operations changed the influence of these primary factors on fish abundance, allowing carrying capacity to increase?
3. If the expected gains in fish abundance have not been fully realized, what factors if any are masking the response and are they influenced by BC Hydro operations?

In addressing the questions, the monitoring program is designed to test the following five null hypotheses separately for both the Salmon and Quinsam rivers:

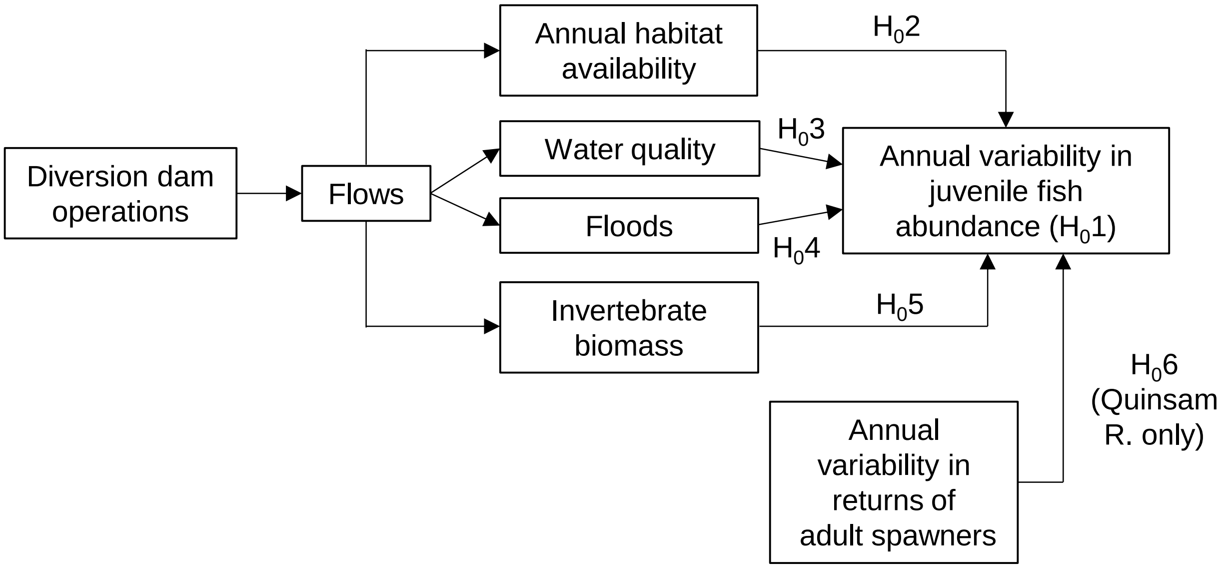
> $H_0$1: Annual population abundance does not vary with time (i.e., years) over the course of the Monitor.
>
> $H_0$2: Annual population abundance is not correlated with annual habitat availability as measured by Weighted Usable Area (WUA).
>
> $H_0$3: Annual population abundance is not correlated with water quality.
>
> $H_0$4: Annual population abundance is not correlated with the occurrence of flood events.
>
> $H_0$5: Annual population abundance is not correlated with food availability as measured by aquatic invertebrate sampling.

There is one additional null hypothesis to be tested for the Quinsam River System where adult escapement and smolt abundance data are collected separately for a wide range of species:

- $H_0$6: Annual smolt abundance is not correlated with the number of adult returns.

The basis of JHTMON-8 is outlined conceptually in Figure 1. The monitoring program is designed to first establish whether there is among-year variability in fish abundance ($H_0$1). The program is then designed to collect data to examine whether inter-annual variability in fish abundance is related to important environmental factors that could be influenced by BC Hydro operations, specifically: Weighted Usable Area of habitat ($H_0$2); water quality ($H_0$3); an accumulated flood risk index during the spawning and incubation periods ($H_0$4), or; invertebrate abundance (food availability; $H_0$5). The study will also investigate whether annual variability in juvenile fish abundance is affected by annual variability in salmon spawner escapement ($H_0$6) – a factor that is influenced by marine survival and not by diversion dam operations. At present, it has been proposed to test $H_0$6 using data only for the Quinsam River (LKT 2014) because data collected at the Quinsam River Hatchery salmon counting fence are expected to have high precision and accuracy, whereas the methods employed to measure fish abundance on the Salmon River will have a higher level of error and may not provide data that are suitable to formally test $H_0$6.

Figure 1. Effect-pathway diagram showing the context of the six hypotheses that the JHTMON-8 monitoring program sets out to address.



1.4. Scope of the JHTMON-8 Study

1.4.1. Overview

The JHTMON-8 study has been designed to build upon monitoring that is already occurring in the Quinsam and Salmon watersheds. This allows the study to integrate established work programs and provides an opportunity to incorporate historic data into the analyses. Table 6 summarizes the field sampling programs that were undertaken during Year 1 of JHTMON-8, and are set to continue annually for a total of ten years.

Table 6. Summary of field sampling programs undertaken for JHTMON-8.

River	Sampling program	Lead organization[1]	Method	Timing
Salmon	Adult Steelhead survey	BCCF	Snorkel surveys	March – April
	Juvenile Steelhead abundance	LKT	Closed site multi-pass electrofishing	September
	Juvenile Coho abundance	DFO (Year 1 only)	Closed site multi-pass netting	October
	Salmon escapement surveys	DFO	Various	September – November
	Water quality sampling	LKT	*In situ* and laboratory analysis	May – October
	Invertebrate sampling	LKT	Drift sampling	May – October
Quinsam	Quinsam River Hatchery juvenile downstream migration (various species)	DFO	Fish fence	March – June
	Salmon escapement surveys	DFO	Various	September – November
	Water quality sampling	LKT	*In situ* and laboratory analysis	May – November
	Invertebrate sampling	LKT	Drift sampling	May – October

[1]BCCF, British Columbia Conservation Foundation; LKT, Laich-Kwil-Tach Environmental Assessment Ltd. Partnership; DFO, Fisheries and Oceans Canada

The species of primary interest on the Salmon River are anadromous Rainbow Trout (Steelhead) and Coho Salmon; surveys to enumerate juvenile Coho Salmon and both juvenile and adult Steelhead provide the majority of the fisheries data for the Salmon River for JHTMON-8. Fisheries data for the Quinsam River are primarily obtained via operation of a fish fence at Quinsam River Hatchery to enumerate downstream juvenile migration of a range of species. Species of primary interest in the Quinsam River include Chinook Salmon, Coho Salmon and Steelhead, while data for Pink Salmon smolt outmigration are also considered. In addition to these data, escapement data for a range of Pacific salmon species obtained by Fisheries and Oceans Canada (DFO) during routine monitoring are also considered for both rivers as part of JHTMON-8.

Methods and results from all field sampling programs are presented in this report although, in some cases where data collection has been led by another party, we direct the reader to other reports for detailed descriptions of methods and supplementary information. Further information about the scope and objectives of specific sampling programs are provided below.

1.4.2. Fish Population Assessments

Accurate and precise measures of fish abundance are core requirements of JHTMON-8. It is necessary to employ a range of scientifically robust methods with sufficient effort to adequately quantify abundances of the numerous species that are of primary interest for the program (see Section 1.4). The fish sampling program was therefore designed to ensure that the error associated with fish sampling methods is sufficiently small that any between-year variability in fish abundance can be detected.

The fish abundance data will first be used to test $H_0 1$: '*annual population abundance does not vary with time (i.e., years) over the course of the Monitor*' (Section 1.3). Analysis will be undertaken towards the end of the ten-year monitor to examine whether there are statistically significant variations in fish abundance between years. This analysis will consider the two rivers and individual species separately. Where possible, suitable historic data will be incorporated into the analyses to extend the datasets and provide context to any variability observed during the monitor.

Furthermore, the program was designed to enumerate both adult and juvenile life stages to allow relationships between the numbers of adult spawning fish and juvenile recruitment to be examined. This enables testing of $H_0 6$: *'annual smolt abundance is not correlated with the number of adult returns'* which will help to tease apart the extent to which any variations in abundance reflect either variations in adult returns (dependent on marine conditions and harvest) or variations in juvenile survival (dependent on freshwater conditions). This hypothesis is proposed to only be formally tested for the Quinsam River where operation of the salmon counting fence is expected to provide the precise and accurate data that are necessary. Consideration will, however, also be given to deriving spawner-recruitment relationships using the Salmon River data to improve understanding of the extent to which any variability in fish abundance may be caused by environmental factors that could potentially be influenced by BC Hydro operations, and factors that are independent of this (see Abell *et al*. 2014 for further details). Testing $H_0 6$ will involve comparing the productivity of naturally spawned Coho and Chinook salmon with the productivity of out-planting colonization programs that out-plant juvenile fish (adipose fin clipped) to areas in the upper Quinsam River watershed (e.g., Lower Quinsam Lake). Such analyses will therefore verify whether such areas are fully 'seeded'.

Based on initial consideration of historic data for the Salmon River (Abell *et al.* 2014), we anticipate that significant variability in annual population abundance will be detected (i.e., the null hypothesis will be rejected) for at least some of the species and life stages that are monitored. It will therefore be necessary to use these data to test four of the five remaining hypotheses to determine whether there are any relationships between the observed variability in fish abundance, and variations in key environmental factors, namely: habitat ($H_0$2), water quality ($H_0$3), floods ($H_0$4) and food availability ($H_0$5).

1.4.3. Water Quality

Healthy fish populations require water quality to be within a confined range. This range of suitable conditions varies depending on the individual parameter, fish species and life stage. The objective of the JHTMON-8 water quality monitoring is to measure biologically important water quality parameters to provide data to test $H_0$3: '*annual population abundance is not correlated with water quality*' (Section 1.3). Analysis will later be undertaken towards the end of the ten-year monitor to examine whether there is a relationship between fish abundance and water quality. If a relationship is detected (i.e., the null hypothesis is rejected), then further work would be required to examine whether water use activities in the watershed affect water quality and, if so, how this may impact fish communities, both positively and negatively.

Thus, a key objective of this aspect of the study is that water quality data are collected that suitably reflect variability of water quality in time and space, and are representative of the conditions experienced by fish communities. A single mainstem index site was selected on each river that was assumed to be representative of water quality in the wider watershed. At each site, both in situ measurements and grab samples for laboratory analysis were collected approximately monthly during the growing season. Water and air temperature was also measured near-continuously during the growing season at each site using duplicate sensors.

1.4.4. Invertebrate Drift

Invertebrates typically form the bulk of the diet of both juvenile and resident adult salmonids in rivers (Quinn 2005). Invertebrate populations can vary due to a range of factors and therefore variability in the abundance and biomass of invertebrates can be an important factor that limits the growth of salmonids in rivers. The objective of the JHTMON-8 invertebrate sampling is to provide data to test $H_0$5: "*annual population abundance is not correlated with food availability as measured by aquatic invertebrate sampling*" (Section 1.3). Analysis will later be undertaken towards the end of the ten-year monitor to examine whether there are any relationships between fish abundance and food availability, as inferred from invertebrate sampling. If a relationship is detected (i.e., the null hypothesis is rejected), then further work would be required to examine whether water use activities in the watershed affect invertebrate communities and, if so, how this may impact fish communities, both positively and negatively.

A key objective is therefore to collect invertebrate data that reflect variability of watershed invertebrate communities in time and space, and are therefore representative of the food available to fish communities. A single mainstem index site was selected on each river that was assumed to be representative of the invertebrate communities present in the wider watershed. Invertebrate drift biomass was measured as a proxy for food availability, although invertebrate community composition was also studied to provide information on food quality. Drift sampling was undertaken during the growing season when salmonid juveniles have the greatest potential for growth. Sampling was conducted multiple times throughout the year, with heightened sampling effort during one month to support analysis of how invertebrate drift varies over time.

1.4.5. Salmon River Desktop Review

Ecofish completed a desktop review to examine the nature and extent of historical data that were available for the Salmon River watershed (Abell *et al*. 2014). The objectives were:

1. To identify opportunities to use existing or proposed future (e.g., from other monitors) datasets to optimize the study design for JHTMON-8.
2. To critically examine the extent to which five JHTMON-8 hypotheses are testable using current and proposed future data to inform expectations about the extent of knowledge that could be gained from the monitor.

The desktop review resulted in a number of recommendations and opportunities for improvements to the monitor. These recommendations and opportunities were separated into those that are related to actions that should be undertaken within the scope of the current JHTMON-8 monitor, and those that are outside of the current scope yet are desirable to consider. The review also outlined a methodology to test the JHTMON-8 hypotheses in combination to provide integrated understanding, as well as presenting a proposed timeline for data analysis tasks.

Recommendations from the desktop study are presented in Appendix A of this report and discussed briefly in Section 5.1.

2. METHODS

2.1. Fish Population Assessments

2.1.1. Salmon River Adult Steelhead Survey

Annual spring snorkel surveys have been conducted as part of Steelhead stock production monitoring on the Salmon River since 1998. These have been undertaken by British Columbia Conservation Foundation (BCCF) and Ministry of Environment (MoE) staff. Surveys of an index reach ('Lower Index') is the primary stock assessment method, with surveys typically undertaken during the second week of March. Additional surveys of two reaches further upstream have also been undertaken in April during most of the years since 2000. These surveys provide valuable information to inform the JHTMON-8 study, and they will be analyzed alongside juvenile Steelhead data (see Section 2.1.2) at a later stage to examine spawner-recruitment relationships.

This work was led by BCCF in 2014, with technical support provided by LKT. Detailed descriptions of methods and field observations are provided in the snorkel survey reports prepared individually for each of the three reaches by BCCF. These reports are presented in Appendix A and only a brief summary of the methods is presented here.

The Lower Index reach was surveyed in March 2014, approximately one week later than historic surveys. Two additional index reaches further upstream (Rock Creek and Upper Index) were surveyed in April 2014. The Rock Creek reach is upstream of the Salmon River Diversion Dam, whereas both the Upper and Lower index reaches are downstream of the diversion. Both the Upper and Lower reaches are sub-divided into upper and lower sections. Sampling dates and descriptions of the reaches are presented in Table 7; locations that designate the limits of each reach are labelled on Map 3.

Each reach was snorkelled during a single day by two experienced technicians. Surveys were conducted in a downstream direction with particularly steep and potentially dangerous sections bypassed on foot. Surveyors counted the number of adult Steelhead, in addition to the following information where visible:

- Sex
- Fish condition factor (1, bright; 2, pre-spawn; 3, mid-spawn; 4, post spawn)
- Presence of tags
- Presence of adult resident trout

Table 7. Adult Steelhead snorkel survey reach details. Reaches are listed in an upstream to downstream direction; see Map 3 for locations of reach limits.

Reach	Section	Length (km)	Date sampled	Upstream limit	Downstream limit
Rock Creek	-	6.2	Apr-14	Rock Creek Mainline Bridge	Salmon River Diversion Dam
Upper Index	Upper	5.9	Apr-14	Salmon River Diversion Dam	Memekay Mainline Bridge
	Lower	5.6	Apr-14	Memekay Mainline Bridge	Norberg Creek confluenece
Lower Index	Upper	7.2	Mar-24	Hydrometric Station 08HD007 (near Kay Creek confluence)	Bigtree Creek confluence
	Lower	4.3	Mar-24	Bigtree Creek confluence	Pallans (Hern Road)

2.1.2. Salmon River Juvenile Steelhead Abundance

2.1.2.1. Field Methods

Juvenile Steelhead[2] were sampled with multi-pass removal electrofishing at five sites upstream and five sites downstream of the Salmon River Diversion (Table 8; Map 3). Site locations matched those sampled by BCCF in previous years, with minor adjustments made to the positions of stop nets to account for changes in stream morphology. The main criteria used to select sampling locations were:

- Water depth (maximum 1.0 m, average 0.1 to 0.4 m)
- Water velocity (maximum 1.0 m/s, average 0.1 to 0.5 m/s)
- Cover and substrate (non-embedded boulder, cobble, and/or gravel)
- Area of site (target 100 m^2)
- Proximity to previous sampling location (as close as possible)

Table 8. Details of juvenile Steelhead sampling sites in the Salmon River.

Location	Site	Historic Site #	Historic Site Name/Description	Site Ref. (km)	Date	Mesohabitat	UTM Zone	UTM Easting	UTM Northing
Below Diversion	SAM-EF01	1	Pallans (23.94 km)	23.94	5-Sep-14	Riffle	10 U	297922	5570705
	SAM-EF02	2	WSC Station (Kay Creek)	35.44	4-Sep-14	Riffle	10 U	304030	5564241
	SAM-EF03	3	Memekay Mainline Bridge	52.60	4-Sep-14	Riffle	10 U	309310	5556475
	SAM-EF04	4	Smolt Screen	58.02	4-Sep-14	Glide	10 U	309036	5552478
	SAM-EF05	7	Washout, old bridge 5km u/s diversion	27.93	4-Sep-14	Riffle	10 U	304267	5548471
Above Diversion	SAM-EF06	5	Washout 500 m u/s of Grilse confluence	67.73	3-Sep-14	Riffle	10 U	301417	5546997
	SAM-EF07	6	Memekay River (lower bridge)	69.25	5-Sep-14	Riffle	10 U	302056	5566097
	SAM-EF08	8	Grilse Ck (100 m u/s of lower bridge)	70.77	3-Sep-14	Riffle	10 U	300741	5547323
	SAM-EF09	9	Grilse Ck (300 m d/s of upper bridge)	74.27	3-Sep-14	Riffle	10 U	297133	5546961
	SAM-EF10	10	Grilse Ck (500 m d/s of upper bridge)	75.91	3-Sep-14	Riffle	10 U	296773	5546524

Fish were captured using closed-site multi-pass removal electrofishing methods in accordance with guidelines (Lewis *et al.* 2004; Hatfield *et al.* 2007). Sites were enclosed using stop nets (15.2 m long × 1.2 m deep, mesh size = 3.2 mm). Each pass consisted of two full circuits of the enclosure, and two to three passes were conducted at each site. Data recorded included:

- Sampling effort (seconds) expended during each pass
- The number, species, length (+/- 1 mm) and mass (+/- 0.01 g) of each fish caught per pass
- Wetted width (three or four measurements) and site length

[2] For consistency with the historical sampling program, we use the term 'juvenile Steelhead' to refer to juvenile (fry and parr) Rainbow Trout. We acknowledge that this may include resident and anadromous individuals.

- Physical stream characteristics (cover types, substrate size, habitat type, stream gradient, compaction, sand in substrate, and roughness)

After electrofishing was complete, hydraulic habitat variables were measured along a transect placed across the width of the sampling site. A minimum of ten wetted stations spaced a minimum of 0.25 m apart were placed along each transect. The following was measured at each station: distance from wetted edge, water depth, water velocity, and available cover. The net locations were recorded on a diagram if transects did not go across the entire width of the stream. If a single transect was not long enough to accommodate 10 wetted stations, an additional transect was completed at the site.

Water temperature and conductivity were measured using in situ meters calibrated prior to sampling. Photographs from standardized locations were also taken at each sampling site. Scales were collected from a sub-sample of each size class.

2.1.2.2. Data Analysis

Individual Fish Data

For juvenile Steelhead, we defined age class structure and described length-weight relationships, Fulton's condition factor (K), and length at age. Fulton's condition factor (K) was calculated for all captured fish as:

$$K = \text{weight} * \text{length}^{-3} * 100{,}000$$

where weight was recorded in g and length in mm. Scale samples were examined under a dissecting microscope to age individual fish: representative scales were photographed and apparent annuli were noted on a digital image. Fish age was determined by two independent observers using a double blind methodology. The data produced by each observer were then compared to identify any discrepancies. Where discrepancies occurred, they were discussed and final age determination was based on professional judgement of the senior biologist.

Fish were separated into age classes for fish abundance and biomass analysis. To define discrete age class size bins (size classes), the length-frequency histograms for fish captured during electrofishing were reviewed along with all of the length at age data from the scale analysis. Based on these data, discrete fork length ranges were defined for each of the following age classes: fry (0+), parr (1+), parr (2+) and adult (≥3+), although no adult fish were captured during sampling in 2014. These discrete fork length ranges allow all fish to be assigned an age class based on fork length for population analysis. This needs to be conducted annually as size ranges of age classes may differ from year to year. Summary statistics of fish length, weight, and Fulton's condition factor are presented for these age classes for both the upstream and diversion reaches.

Population Analysis

Total abundance and biomass were calculated for Steelhead fry (0+) using removal depletion algorithms in MicroFish V3.0 (Van Deventer 2006). Fish abundance and biomass by age class at individual sites were then standardized to fish per 100 m^2.

Abundance and biomass estimates were also adjusted to account for differences in habitat suitability of each sampling site. The habitat suitability of each electrofishing site was determined using the transect data for each sampling enclosure and habitat suitability indices (HSI) for Steelhead fry (0+) from BC Water Use Planning (WUP) projects (curves dated February 2001 provided by R. Ptolemy, MoE). Habitat suitability is expressed as a usability percentage, which is calculated by computing the weighted usable width (WUW) of each transect within the sampling enclosures, and dividing by the wetted width of the transect. The transect usability at each site was then used to adjust the fish density estimates. Results are expressed in terms of fish per unit area (FPU: fish/100 m^2), and are reported as both non-adjusted (FPU_{obs}) and usability-adjusted estimates (FPU_{adj}), and as non-adjusted and adjusted biomass per unit area (BPU_{obs} and BPU_{adj}: g/100 m^2). Abundance and biomass densities are presented for individual sites and as averages for upstream and downstream of the diversion reaches.

Results were compared with historical data collected at the same sites by BCCF.

2.1.3. Salmon River Juvenile Coho Salmon Abundance

The abundance of juvenile Coho Salmon has been measured in the Salmon River during the fall by DFO since 2008. This work is being integrated into the JHTMON-8 study to support continued collection of abundance data for a species of primary interest in the study. Continuation of this established monitoring program means that historic data collected between 2008 and 2014 can be used to increase the time span considered during analysis. This work was led by DFO in 2014, with technical support provided by LKT. A detailed work statement prepared by the DFO lead scientist is included in the 2014 report (Anderson 2014), which is presented in Appendix C; a brief summary of the methods is presented here.

Sampling was conducted on September 29 and 30. Six sites were sampled: three upstream of the diversion and three downstream (see Map 3). Sites were selected that were representative of the Coho Salmon habitat generally present. Sites were typically ~ 30 m long and comprised habitat units with slow moving water such as pools.

Sites were isolated using barrier nets placed at the upstream and downstream ends to form full enclosures that included the full width of the channel. Multi-pass beach and pole seine netting was then used to remove fish (Figure 2). Three to six passes were undertaken with the objective of observing declining catches to permit estimation of capture efficiency to allow estimation of total fish abundance. Fish caught were retained until sampling was complete. Length (mm), mass (g) and species ID were recorded for all fish. Scale analysis was completed for a sub-sample of Coho Salmon to establish size-age relationships. Juvenile Coho Salmon abundance was estimated at each site using a capture efficiency model.

Figure 2. Beach seine sampling of juvenile Coho Salmon at the Grilse Creek mainstem site. Reproduced from Anderson (2014; Appendix C).

2.1.4. Salmon and Quinsam River Salmon Escapement

Annual salmon spawner escapement counts have been undertaken on the Salmon and Quinsam rivers since the 1950s by DFO and its predecessors. While these data are collected as part of wider salmon stock assessment work, they provide an important source of data to support the JHTMON-8 study. The results of fall 2013 surveys were obtained from DFO's New Salmon Escapement Database (nuSEDS) to provide data that can be used during a later stage of this ten-year program to examine relationships between numbers of adult spawning fish and outmigrating juvenile fish enumerated in 2014. Methods used in the 2013 surveys are summarized in Table 9 and Table 10 for the Salmon and Quinsam rivers respectively, based on information provided in the nuSEDS database (DFO 2013). Surveys of individual species conducted by DFO conform to one of six types, ranging from Type-1 (most rigorous, almost every fish counted individually) to Type-6 (least rigorous, determination of presence/absence only). The survey types used for the 2013 counts are reported in the two tables of methods, with further general details about survey types provided in Table 11.

Table 9. Methods used during 2013 salmon spawner escapement counts on the Salmon River (DFO 2013). See Table 11 for descriptions of survey types.

	Salmon species				
	Chinook	**Chum**	**Coho**	**Pink**	**Sockeye**
Survey type	3	4	3	3	3
Number of surveys	10	Unk	12	10	Unk
Survey methods	Snorkel surveys, overflights (n=4)	Unk	Unk	Unk	Unk
Date of first inspection	July-05	Unk	July-12	July-12	Unk
Date of last inspection	October-11	Unk	November-14	October-11	Unk
Estimation method	Area under the curve	Peak live + dead	Area under the curve	Area under the curve	Peak live + dead

Table 10. Methods used during 2013 salmon spawner escapement counts on the Quinsam River (DFO 2013). See Table 11 for descriptions of survey types.

	Salmon species				
	Chinook	**Chum**	**Coho**	**Pink**	**Sockeye**
Survey type	2	3	2	2	3
Number of surveys	11	Unk	Unk	Unk	Unk
Survey methods	Unk	Unk	Unk	Bank walks, creel survey	Unk
Date of first inspection	August-02	August-02	August-02	August-02	August-02
Date of last inspection	November-30	December-05	December-15	November-30	December-01
Estimation method	Mark & recapture (Petersen)	Fixed site census	Fixed site census	Fixed site census	Fixed site census

Table 11. Summary of definitions of salmon spawner escapement 'survey types' reported in Table 9 and Table 10 (DFO 2013).

Type	Abundance estimate type	Resolution	Analytical methods	Reliability (within stock comparisons)	Units	Accuracy	Precision
2	True	High resolution survey method(s): high effort (5 or more trips), standard methods (e.g. equal effort surveys executed by walk, swim, overflight, etc.)	Simple to complex multi-step, but always rigorous	Reliable resolution of between year differences >25% (in absolute units)	Absolute abundance	Actual or assigned estimate and high	Actual estimate, high to moderate
3	Relative	Medium resolution survey method(s): high effort (5 or more trips), standard methods (e.g. mark-recapture, serial counts for area under curve, etc.)	Simple to complex multi-step, but always rigorous	Reliable resolution of between year differences >25% (in absolute units)	Relative abundance linked to method	Assigned range and medium to high	Assigned estimate, medium to high
4	Relative	Medium resolution survey method(s): low to moderate effort (1-4 trips), known survey method	Simple analysis by known methods	Reliable resolution of between year differences >200% (in relative units)	Relative abundance linked to method	Unknown assumed fairly constant	Unknown assumed fairly constant

2.1.5. Quinsam River Salmon Counting Fence Operation to Enumerate Downstream Juvenile Migration

Technical staff provided by LKT worked under the instruction of DFO hatchery staff to enumerate fish at the Quinsam River Hatchery counting fence. DFO fisheries scientists prepared a report that describes the methods in detail and presents analysis of the results (Ewart and Kerr 2014). This report is presented in Appendix D, hence only a brief summary of the methods is presented here.

Fish were caught using inclined plane traps that catch a proportion of the salmonid fry and smolts that migrate downstream through the fence (Figure 3). Sampling was undertaken from March 18 until June 13, with traps deployed continuously during this period. The proportion of the width of the river that was 'fished' varied depending on fish abundance, with a smaller number of traps (three) used during March and April when Pink Salmon fry were out-migrating and highly abundant. Mark recapture techniques were used to measure catch efficiency for individual species. These values were then used to extrapolate the numbers of fish caught in the traps to estimate total outmigration of each species for every day that the traps were operated.

Figure 3. View downstream towards the salmon counting fence. Reproduced from Ewart and Kerr 2014 (Appendix D).

2.2. Water Quality

2.2.1. Water Chemistry

2.2.1.1. Salmon River and Quinsam River Water Chemistry Monitoring

One water quality site was established in the Salmon River (SAM-WQ; Map 3) and in the Quinsam River (QUN-WQ; Map 4). Both sites were selected based on the guidelines of the British Columbia Field Sampling Manual (Clarke 2003) and the Ambient Fresh Water and Effluent Sampling Manual (RISC 2003).

The Salmon River site (SAM-WQ) was located downstream of the Salmon River Diversion, in a run immediately downstream of a braided section of the river with sandy banks. Representative photos of SAM-WQ are provided in Figure 4 and in Appendix H. The SAM-WQ coordinates, site elevations, and sample dates (in situ and laboratory samples) are provided in Table 12.

The Quinsam River site (SAM-WQ) is located upstream of the confluence with the Iron River, and downstream of the Quinsam Coal Mine and the Salmon carcass nutrient enhancement site. Representative photos of QUN-WQ are provided in Figure 5 and in Appendix H. The QUN-WQ coordinates, site elevations, and sample dates (in situ and laboratory samples) are provided in Table 12.

Table 12. Water quality index site details and sampling dates.

Waterbody	Site Name	UTM Coordinates (Zone 10)		Elevation	Sampling Dates
		Easting	Northing	(m)	(2014)
Salmon River	SAM-WQ	309308	5556385	172	21-May; 17-Jun.; 23-Jul; 18-Aug.; 23-Sep.; 03-Nov.
Quinsam River	QUN-WQ	327433	5534757	193	23-May; 18-Jun.; 22-Jul; 19-Aug.; 24-Sep.; 04-Nov.

Figure 4. Looking downstream to SAM-WQ on September 23, 2014.

Figure 5. Looking upstream to QUN-WQ on September 24, 2014.

Water quality was monitored six times at each site on an approximate monthly basis during May through November, 2014. No sampling was conducted during October due to high flow conditions. Standard methods were employed to measure and collect water chemistry data. Sample collection and analyses were completed according to procedures set out in the Guidelines for Designing and Implementing a Water Quality Monitoring Program in British Columbia (RISC 1998). Water chemistry parameters were chosen based on provincial standards (Lewis *et al.* 2004). The parameters sampled are presented in Table 13 (in situ) and Table 14 (laboratory). Laboratory method detection limits (MDL) occasionally differ (Table 14) due to matrix effects in the sample, or variations in laboratory analytical instruments.

Table 13. Water quality parameters measured in situ and meters used for measurement.

Parameter	Unit	Meter
General Water Quality		
Water Temperature	°C	YSI Pro Plus and P4 Tracker
pH	pH units	YSI Pro Plus
Specific Conductivity	μS/cm	YSI Pro Plus
Dissolved Gases		
Dissolved Oxygen	mg/L	YSI Pro Plus
Dissolved Oxygen	% Saturation	YSI Pro Plus
Total Gas Pressure	mm Hg	P4 Tracker
Barometric Pressure	mm Hg	P4 Tracker
Total Gas Pressure	%	P4 Tracker
Δ Pressure	mm Hg	P4 Tracker

Table 14. Parameters analyzed in the laboratory by ALS Environmental and corresponding units and method detection limit (MDL).

Parameter	Unit	MDL
General Water Quality		
Specific conductivity	µS/cm	2
pH	pH	0.1
Total suspended solids	mg/L	1
Turbidity	NTU	0.1
Alkalinity, Total (as $CaCO_3$)	mg/L	2
Nutrients		
Ammonia, Total (as N)	mg/L	0.005
Nitrate (as N)	mg/L	0.005
Nitrite (as N)	mg/L	0.001
Orthophosphate-dissolved (as P)	mg/L	0.001
Total phosphorus	mg/L	0.002

2.2.1.2. Quality Assurance/Quality Control

In situ water quality meters were maintained and operated following manufacturer recommendations. Maintenance included calibration, cleaning, periodic replacement of components, and proper storage. Triplicate in situ readings were recorded from each meter at each site on each sampling date unless otherwise noted.

For samples collected for laboratory analysis, sampling procedures and assignment of detection limits were determined following the guidelines of the British Columbia Field Sampling Manual (Clarke 2003) and the Ambient Fresh Water and Effluent Sampling Manual (RISC 1998). Duplicate samples were collected on each sampling date at each site, in addition to both a trip blank and a field blank. Thus more than 50% of the samples collected during sampling were quality assurance/quality control (QA/QC) samples. This exceeds guideline recommendations; the BC field sampling manual recommends that 20 to 30% of samples consist of QA/QC samples, while the RISC manual recommends a minimum of 10% of samples.

Samples for laboratory analysis were collected in clean 1 L plastic bottles provided by a certified laboratory. Samples were packaged in clean coolers that were filled with ice packs and couriered to ALS Environmental in Burnaby within 24 to 48 hours of collection. Standard Chain of Custody procedure was strictly adhered to. ALS Environmental performed in house quality control checks including analysis of replicate aliquots, measurement of standard reference materials, and method blanks. A summary of the quality assurance/quality control (QA/QC) qualifiers and comments from laboratory analysis is provided in Appendix F and Appendix G.

It is a common occurrence in Vancouver Island streams to have concentrations of a number of parameters (notably nutrients) that are less than, or near, the MDL. When this occurs, there are a number of different possible methods that can be used to analyze these values. In this report, any values that were less than the MDL were assigned the actual MDL values and averaged with the results of the other replicates. In these cases the average is also less than the average reported.

2.2.1.3. Comparison with Guidelines for the Protection of Aquatic Life

Water quality guidelines for the protection of aquatic life and typical ranges of water quality parameters in British Columbia waters that were considered for this report are provided in Appendix E. Any results for water chemistry parameters that approached or exceeded guidelines for the protection of aquatic life or ranges typical for British Columbia are noted in Section 3.2.

For many of the water quality parameters measured in this study, there are provincial water quality guidelines for the protection of aquatic life. For total phosphorus, there are no provincial guidelines; however, there are federal guidelines (CCME 2004). For the remaining parameters without provincial guidelines (i.e., orthophosphate, alkalinity, and specific conductivity) there are no federal guidelines either.

2.2.2.Water and Air Temperature

2.2.2.1. Salmon River and Quinsam River Temperature Monitoring

Baseline water temperature was monitored near-continuously at the water quality index site on both rivers between May 2014 and November 2014. Air temperature was also measured to collect further information about environmental conditions at the sites, and these measurements provide data that could be used to model water temperatures elsewhere in the watershed if later required.

Water temperature was recorded at intervals of 15 minutes using self-contained Tidbit v2 loggers made by Onset (MA, USA). The loggers are accurate to 0.2°C and have a resolution of 0.02°C. For most of the record duration, water temperature at each of the monitoring stations was concurrently logged by duplicate Tidbit loggers installed on separate anchors. This redundancy ensured availability of data in case one of the loggers malfunctioned or was lost. This was the case at SAM-WQ where one of the Tidbit loggers was lost during high flows in late October and the data were not retrieved.

Air temperature was also collected using one HOBO Air Temperature U23 Data Logger at each river. The temperature loggers recorded air temperature at a regular interval of 15 minutes. The loggers were placed on trees that were close (< 100 m) to the site. Temperature measurements were made at station SAM-WQ during the period May, 21 to November, 03; measurements were made at station QUN-WQ during the period May, 23 to November, 04.

2.2.2.2. Data Analysis

Water temperature data were analyzed as follows. First, outliers were identified and removed. This was done for each Tidbit logger by comparing temperature data from the duplicate station loggers and the loggers at the other stations. For example, occasional drops in water level that exposed the temperature loggers to the air were considered as outliers and removed from the dataset. Second, the records from duplicate loggers (when available) were averaged and records from different download dates were combined into a single time-series for each monitoring station. The time series for all stations were then interpolated to a regular interval of 15 minutes, starting at the full hour.

For data presentation, plots were generated from the 15-min temperature and air data. Statistical metrics summarized in Table 15, were chosen based on the water temperature guidelines for the protection of freshwater aquatic life (Oliver and Fidler 2001; Table 16).

Plots were generated of the hourly rates of change in water temperature. Analysis of the water temperature data involved computing the following summary statistics: mean, minimum, and maximum water temperatures for each month of the record, hourly rate of change of temperature, and days with mean daily temperature >18°C, >20°C , and <1°C. However, given that only spring and summer data were available, the number of days with temperatures less than 1°C could not be computed.

Similarly, the number of degree days in the growing season was not computed in Year 1 due to a lack of temperature data for the start and end dates of the growing season. These statistics were based on the data collected at, or interpolated to, intervals of 15 min.

Table 15. Statistical parameters calculated during analysis of water and air temperature data.

Parameter	Description	Method of Calculation
Monthly water- and air- temperature statistics	Average, minimum, and maximum temperatures on monthly basis	Calculated from temperatures observed at or interpolated to 15-min intervals.
Rate of change in water temperature	Change in water temperature over hourly intervals.	Calculated from temperatures observed at or interpolated to 15-min intervals. The hourly rate of change was set to the difference between temperature data points that are separated by one hour and was assigned to the average time for these data points.
Length of growing season	Start date, end date, and duration of growing season.	Estimated according to Coleman and Fausch (2007) who define the start of the growing season as the beginning of the first week when average stream temperature exceeds and remains above 5°C, and define the end of the season to be the last day of the first week when average stream temperature drops below 4°C.
Accumulated thermal units in growing season	Degree days in growing season.	Daily average water temperatures are summed over the length of the growing season; i.e., from the start date of the growing season to the end date of the growing season.
Number of days with extreme daily-mean temperature	Total number of days with daily-mean water temperature >20°C , >18°C , and <1°C	Calculated from daily-mean temperatures.

Table 16. Water temperature guidelines for the protection of freshwater aquatic life (Oliver and Fidler 2001).

Category	Guideline
All Streams	the rate of temperature change in natural water bodies not to exceed 1°C/hr
	temperature metrics to be described by the mean weekly maximum temperature (MWMxT)
Streams with Known Fish Presence	mean weekly maximum water temperatures should not exceed ±1°C beyond the optimum temperature range for each life history phase of the most sensitive salmonid species present
Streams with Bull Trout or Dolly Varden	maximum daily temperatures should not exceed 15°C
	maximum spawning temperature should not exceed 10°C
	preferred incubation temperatures should range from 2- 6°C
	±1°C change from natural condition[1]
Streams with Unknown Fish Presence	salmonid rearing temperatures not to exceed MWMxT of 18°C
	maximum daily temperature not to exceed 19°C
	maximum temperature for salmonid incubation from June until August not to exceed 12°C

[1] provided natural conditions are within these guidelines, if they are not, natural conditions should not be altered (Deniseger, pers. comm 2009).

2.3. Invertebrate Drift

2.3.1. Sample Collection

One invertebrate drift sampling site was established on the Salmon River and on the Quinsam River, both located close (<150 m) to the water quality index sites (Map 3 and Map 4). Representative photos of the Quinsam River and Salmon River invertebrate drift sites are provided in Figure 6 and Figure 7, respectively. Sites were located in the tail-out of a riffle, upstream of any obvious source of debris that could clog the nets or areas that receive frequent sediment disturbance. Invertebrate sampling was conducted on an approximately monthly basis from May to November, with weekly sampling conducted during June. In total, sampling occurred on nine dates on each river, and no sampling was conducted during October as flows were too high at the end of the month when the work was scheduled. Table 17 presents details of the sampling dates and times.

Invertebrate drift sampling followed methods recommended in Hatfield *et al.* (2007) and Lewis *et al.* (2013). Upon arrival at site, local areas with velocities of 0.2 to 0.4 m/s were identified with a model 2100 Swoffer meter with a 7.5 cm propeller and a 1.4 m top-set rod. This range of velocities is ideal for sampling invertebrate drift as velocities are slow enough to prevent clogging of the nets. Due to flow conditions at the time of sampling, it was not always possible to deploy the nets in areas with velocities of 0.2 m/s to 0.4 m/s (as per Hatfield *et al.* 2007), and nets often sampled higher water velocities.

Five drift nets were deployed simultaneously across the channel. The mouth of each drift net was positioned perpendicular to the direction of stream flow, and nets were spaced apart to ensure that each individual net did not obstruct flow into an adjacent net. The drift net mouth dimensions were 0.3 × 0.3 m and the nets (250 μm mesh) extended 1 m behind the mouth. Nets were anchored such that there was no sediment disturbance upstream of the net before and during deployment. All nets were deployed so that the top edge of the net was above the water surface so that both invertebrate drift in the water column and on the water surface could be sampled.

At the start of sampling, measurements were made of water depth in each net and the water velocity at the midpoint of the water column that was being sampled by each net. These measurements were repeated hourly to permit calculation of the volume of water sampled with each net. Any large debris (e.g., leaves) that had entered the nets was periodically removed from the nets (after it had been washed of any invertebrates which were returned to the nets). Nets were deployed for four to five hours on each sample date (Table 17). Once the nets were removed, the contents of each net were transferred into a sample jar (500 mL plastic jars with screw top lids) and samples were preserved in the field with a 10% solution of formalin (formalin = 37-40% formaldehyde).

Table 17. Invertebrate drift sample site locations, sample timing, and sampling duration.

Stream	Site	Sample Date	UTM Coordinate (Zone 10)		Start Time[1]	Finish Time[2]	Sampling Duration[3,4]
			Easting	Northing			
Salmon River	SAM-IV	21-May-14	309,304	5,556,468	8:17	13:14	4:57
		03-Jun-04	309,304	5,556,468	6:35	10:50	4:15
		11-Jun-14	309,304	5,556,468	6:45	10:54	4:08
		17-Jun-14	309,304	5,556,468	6:45	10:50	4:05
		26-Jun-14	309,304	5,556,468	6:45	10:51	4:06
		23-Jul-14	309,304	5,556,468	6:36	10:49	4:13
		18-Aug-14	309,304	5,556,468	6:38	10:52	4:14
		23-Sep-14	309,304	5,556,468	8:15	12:26	4:11
		03-Nov-14	309,304	5,556,468	8:15	12:15	4:00
Quinsam River	QUN-IV	23-May-14	327,361	5,534,796	6:43	11:45	5:02
		04-Jun-04	327,361	5,534,796	6:36	10:45	4:09
		12-Jun-14	327,361	5,534,796	6:42	10:50	4:08
		18-Jun-14	327,361	5,534,796	6:45	10:48	4:03
		27-Jun-14	327,361	5,534,796	6:38	10:50	4:12
		22-Jul-14	327,361	5,534,796	6:56	11:15	4:19
		19-Aug-14	327,361	5,534,796	6:45	10:50	4:05
		24-Sep-14	327,361	5,534,796	8:09	12:19	4:10
		04-Nov-14	327,361	5,534,796	8:18	12:19	4:01

[1] Indicates when the first net was set.

[2] Indicates when the last net was removed

[3] Indicates the time duration between the first and last net retrieved.

[4] For data analysis, start and finish times for individual nets were used to calculate the volume of water filtered for each net.

Figure 6. View upstream towards SAM-IV, September 23, 2014.

Figure 7. View upstream towards QUN-IV, June 04, 2014.

2.3.2. Laboratory Processing

Samples were sent to Ms. Dolecki of Invertebrates Unlimited in Vancouver, BC for processing. Ms. Dolecki is a taxonomist with Level II (genus) certification for Group 2 (Ephemeroptera, Plecoptera, and Trichoptera (EPT)) and for Chironomidae from the North American Benthological Society.

The drift samples were first processed by removing the formalin (pouring it through a 250 μm sieve), followed by immediate picking of the very large and rare taxa. Samples were split into subsamples if the number of invertebrates was over 1,000. The invertebrates were enumerated using a Leica stereo-microscope with 6 to 8 × magnification, with additional examination of crucial body parts undertaken at higher magnifications (up to 400 ×) using an Olympus inverted microscope where necessary. Individuals from all samples were identified to the highest taxonomic resolution possible and it was noted whether a taxon was aquatic, semi-aquatic, or terrestrial. Life stages were also recorded.

Digitizing software (Zoobbiom v. 1.3; Hopcroft 1991) was used to measure the length and biomass (mg dry weight) of a sub-sample of individuals, with the average biomass of individuals in each taxon calculated. For abundant taxa, up to 25 randomly chosen individuals per taxon were digitized to address the variability in size structure of the group. For the rare taxa, all individuals in the taxon were measured. The damaged or partial specimens were excluded from the measurements. For pupae and emerging Chironomidae, up to 50 individuals were measured.

To provide QA/QC, all the samples were re-picked a second time to calculate the accuracy of picking. This assured that > 90% accuracy was attained, and the accuracy of the methods employed is expected to be over 95%.

2.3.3. Data Analysis

Parameters were chosen and calculated as per Lewis *et al.* (2013), and all taxa (aquatic, semi-aquatic, and terrestrial) were considered. Density (# of individuals) and biomass (mg dry weight) of each sample (i.e., net) were expressed as units per m^3 of water, where volume is the amount of water that was filtered through a single net during a set. Volume filtered by each net was calculated as follows:

- Time period durations (seconds) were calculated for each depth (m) and velocity (m/s) measurement;
    - The duration attributed to the first measurement was from the time the nets were set until halfway between the first and second measurements;
    - The second duration was from halfway between the first and second measurements until halfway between the second and third measurements. This was repeated up to the last measurements;
    - The duration used for the last measurement was from halfway between the second to last and the last measurements associated with net retrieval.

- Average flow (m^3/s) was calculated for each net and time period by multiplying the depth (m) the width of the net (0.3 m) and by the velocity (m/s). This was then multiplied by the time attributed to that measurement. The volumes associated with individual time periods were added together to obtain the total volume filtered by a net over the entire sampling duration.

Family richness (i.e., the number of families present) was calculated for each sample. Simpson's diversity (1-λ, Simpson 1949) was calculated from family level density data to provide a measure that reflects both richness and the relative distribution or 'evenness' of invertebrate communities. The Canadian Ecological Flow Index (CEFI) was calculated using family level data for aquatic taxa following Armanini *et al.* (2011). As per the direction of David Armanini (Armanini, pers. comm. 2013), there is no need to exclude taxa that are present in <5% of the samples from the CEFI calculation. Relative abundances of taxa in each net were calculated considering only aquatic taxa, and only aquatic taxa used to develop the CEFI index were considered when calculating the index. The mean, standard deviation, and coefficient of variation were calculated for each of these parameters at each site on each sample date. The top 5 families contributing to biomass at each site on each date were also identified.

PRIMER (Plymouth Routines in Multivariate Ecological Research) version 6 software was used to generate a Bray-Curtis similarity matrix for samples collected from each study stream. The similarity matrix was generated from square-root-transformed density data for aquatic, semi-aquatic, and terrestrial taxa at the highest taxonomic resolution available for each taxon. The square root transformation down-weights the effect of the most abundant taxa, allowing for a better representation of the invertebrate community as a whole, rather than having similarity measures dominated by only the most abundant taxa. The similarity matrix was generated by considering each net as a sample. The similarity coefficient was calculated for all possible pairs of nets with respect to the taxonomic composition and abundance of different taxa at all sites on both sample dates. Density data from all five nets at each site on each date were also averaged, and these averaged data were considered as samples for the calculation of the similarity matrix.

The resulting Bray-Curtis similarity matrices were then examined using cluster analysis dendrograms in PRIMER to detect similarities among samples. The clustering method used is a hierarchical clustering with group-average linking. The method takes a Bray-Curtis similarity matrix as a starting point and successively fuses the samples into groups, and the groups into larger clusters. The method starts with the highest mutual similarities, and then gradually lowers the similarity level at which groups are formed. The significance level for clustering was set at 5% using the SIMPROF tool in PRIMER (1000 permutations were used to calculate the mean similarity profile and 999 to generate the null distribution of the departure statistic). Further discussion of the cluster analysis can be found in Clarke and Warwick (2001) and Clarke and Gorley (2006).

The Bray-Curtis similarity matrices were also examined using non-metric, multi-dimensional scaling (MDS) ordination plots in PRIMER to detect trends in similarity among samples. MDS uses an algorithm that successively refines the positions of the points (samples) until they satisfy, as closely as possible, the dissimilarity between samples (Clarke and Warwick 2001). This algorithm was repeated 1,000 times for each similarity matrix (i.e., with density from each net as a sample and with average density from each site on each date as samples). The result is a two-dimensional ordination plot in which points that are close together represent samples that are very similar in community composition with respect to the taxa present and their abundances. Conversely, points that are far apart represent samples with a very different community composition. Further discussion of the MDS analysis can be found in Clarke and Warwick (2001) and Clarke and Gorley (2006).

3. RESULTS

3.1. Fish Population Assessments

3.1.1. Salmon River Adult Steelhead Survey

Only a brief summary of the results is presented here; detailed results and field notes from the adult Steelhead surveys are provided in the BCCF snorkel survey reports presented in Appendix B.

Adult Steelhead counts for 2014 surveys are summarized in Table 18. Fish density was highest in the Upper Index reach (4.4 fish/km) where fish were approximately evenly distributed between the upper and lower sections.

Table 18 Adult Steelhead snorkel survey data for the Salmon River. See Table 7 and Map 3 for reach details.

Reach	Section	Count	Reach density (fish/km)
Rock Creek	-	13	2.1
Upper Index	Upper	26	4.4
	Lower	25	
Lower Index	Upper	30	3.4
	Lower	9	

The 2014 counts were lower than counts made in the last four years for each of the index reaches (Figure 8 to Figure 10). The Upper Index count (51) was the lowest of the nine surveys that have been undertaken since 2008 (Figure 9). The Lower Index count (29) was more than five times lower than the count for either of the previous two years, and 3.7 times lower than the mean count for the dataset (146; Figure 10). Further analysis of historical data, including counts for individual reach sections, is provided in Appendix B.

Figure 8. Historic and 2014 adult Steelhead counts for the Rock Creek index reach, Salmon River. '0' denotes a nil count; other blank values indicate that no survey was conducted. Data provided by BCCF; see Appendix B for further details.

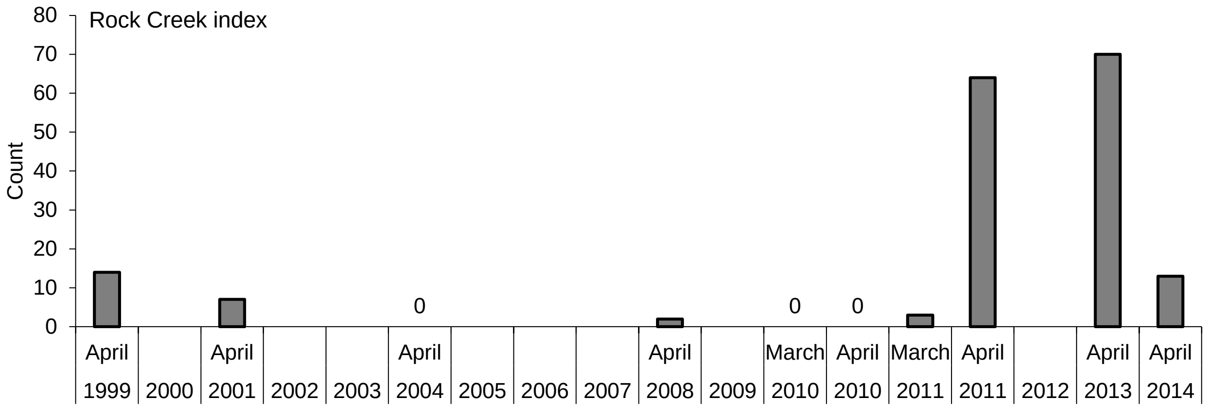


Figure 9. Historic and 2014 adult Steelhead counts for the Upper Index reach, Salmon River. Data provided by BCCF; see Appendix B for further details.

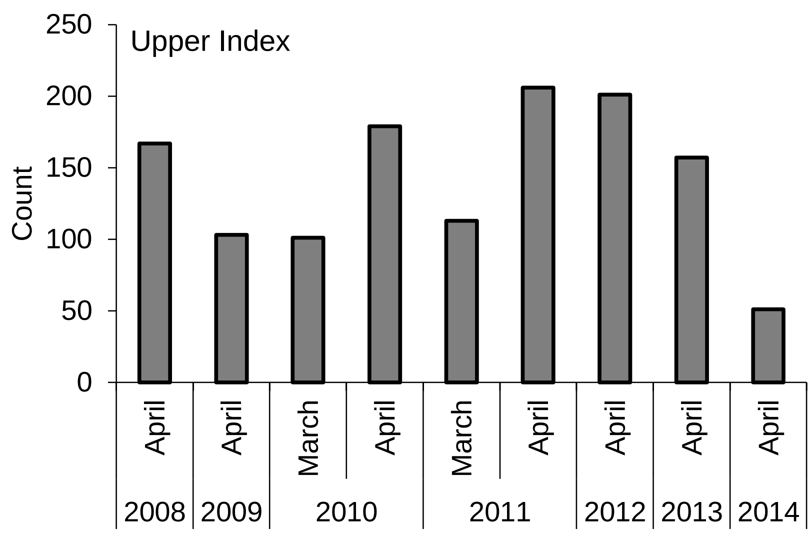
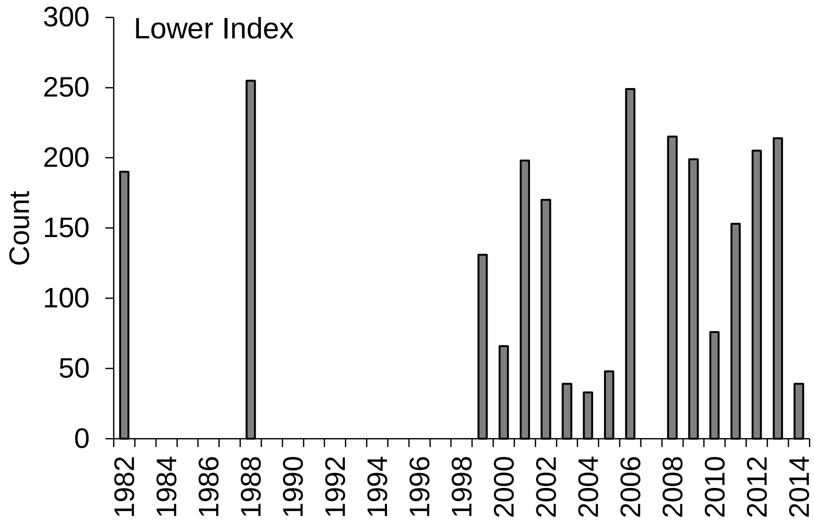


Figure 10. Historic and 2014 adult Steelhead counts for the Lower Index reach, Salmon River. Absence of bars for some years indicates that no survey was conducted. Data provided by BCCF; see Appendix B for further details.



3.1.2. Salmon River Juvenile Steelhead Abundance

3.1.2.1. Habitat

Habitat characteristics for the ten juvenile Steelhead sampling sites are shown in Table 19. Individual sites ranged from 64.1 m^2 to 145.6 m^2. Gradient varied among sites between 0.8% and 1.5%; water temperature during sampling varied between 10°C and 18°C (Table 19). Cobble was the dominant substrate type (20% to 70%), followed by large gravel (10% to 70%) and boulder (0% to 50%). Cobble and boulder were the dominant and subdominant cover types at all sites, except for SAM-EF01, which only had cobble cover.

Table 19. Habitat characteristics for juvenile Steelhead sampling sites in the Salmon River watershed.

Location	Site	Mesohabitat	Site Length (m)	Site Width (m)	Site Area (m^2)	Gradient (%)	Water Temp. (°C)	Cover Type[1]		Substrate Composition (%)[2]					
								D	SD	BR	BO	CO	LG	SG	F
Below Diversion	SAM-EF01	Riffle	17.5	8.3	145.6	1.0	15.6	CO	N	0	0	20	70	5	5
	SAM-EF02	Riffle	18.3	6.1	110.8	-	18.0	CO	BO	0	10	70	10	5	5
	SAM-EF03	Riffle	13.6	6.0	81.7	1.5	15.0	BO	CO	0	50	40	10	0	0
	SAM-EF04	Glide	11.6	5.6	64.1	0.8	14.7	CO	BO	0	20	35	15	15	15
	SAM-EF07	Riffle	18.1	5.5	98.7	1.0	13.0	CO	BO	0	25	50	15	10	0
Above Diversion	SAM-EF05	Riffle	12.0	7.6	90.2	1.0	12.7	CO	BO	0	5	60	25	8	2
	SAM-EF06	Riffle	16.6	5.7	94.8	1.0	17.0	BO	CO	0	10	70	20	0	0
	SAM-EF08	Riffle	15.6	6.0	93.6	1.0	13.0	CO	BO	0	10	45	35	10	0
	SAM-EF09	Riffle	16.2	5.2	83.2	1.5	15.1	BO	CO	2	8	45	20	25	0
	SAM-EF10	Riffle	14.7	5.3	78.1	1.5	10.4	CO	BO	2	20	38	20	20	0

[1] SWD = Small Woody Debris, LWD = Large Woody Debris, B = Boulders, LC = Large Cobble, SC = Small Cobble, U = Undercut Banks, DP = Deep Pools, OV = Overhanging Vegetation, VB = Velocity Breaks, IV = Instream Vegetation, N = None.
[2] BR = Bedrock, BO = Boulder, LC = Large Cobble , SC = Small Cobble, LG = Large Gravel, SG = Small Gravel, F = Fines.
"-" Dashes indicate were data was not collected.

3.1.2.2. Catch Summary

Electrofishing effort varied from 1,836 seconds to 2,471 seconds, with three passes completed at eight sites, and two passes completed at two sites (Table 20). A total of 564 juvenile Steelhead were captured; 295 fish were captured in sites downstream of the diversion and 269 fish were captured upstream of the diversion. The average catch per site was 59 fish downstream of the diversion, and 54 upstream of the diversion.

Table 20. Sampling effort and catch summaries for juvenile Steelhead sites sampled in the Salmon River watershed.

Location	Site	Date	Total Electrofishing Effort (sec)				Electrofishing Catch (# of RB)[1]			
			Pass 1	Pass 2	Pass 3	Total	Pass 1	Pass 2	Pass 3	Total
Below Diversion	SAM-EF01	5-Sep-14	1,060	792	520	2,372	97	74	12	183
	SAM-EF02	4-Sep-14	840	550	446	1,836	17	6	2	25
	SAM-EF03	4-Sep-14	760	730	540	2,030	34	10	3	47
	SAM-EF04	4-Sep-14	960	752	588	2,300	16	5	1	22
	SAM-EF07	5-Sep-14	1,015	922	534	2,471	15	3	0	18
	Below Diversion Total					**11,009**				**295**
	Below Diversion Average					**2,202**				**59**
Above Diversion	SAM-EF05	4-Sep-14	1,307	1,106	-	2,413	69	10	-	79
	SAM-EF06	3-Sep-14	850	650	598	2,098	7	3	1	11
	SAM-EF08	3-Sep-14	1,104	796	646	2,546	63	10	2	75
	SAM-EF09	3-Sep-14	1,347	1,031	-	2,378	66	17	-	83
	SAM-EF10	3-Sep-14	852	818	719	2,389	16	5	0	21
	Above Diversion Total					**11,824**				**269**
	Above Diversion Average					**2,365**				**54**
Combined Total						**22,833**				**564**
Combined Average						**2,283**				**56**

"-" Dashes indicate that a 3rd pass was not completed.
[1] RB - Rainbow Trout.

3.1.2.3. Juvenile Steelhead Length-Weight Relationships

Juvenile Steelhead fork length ranged from 42 to 147 mm below the diversion, and 35 to 156 mm above the diversion. The length-frequency distribution is presented in Figure 11. The distribution shows a clear peak between 30 and 80 mm, and a less distinct peak between 90 and 110 mm. The low frequency of larger fish greater than 90 mm reflects sampling effort focus on age 0+ fry.

Scale samples were analyzed for 18 juvenile fish at the Ecofish laboratory in Campbell River, BC. The results of the length at age relationship are presented in Figure 12. Based on a review of this aging data, and length-frequency histograms, discrete fork length ranges were defined for each age class and year (Table 21). Steelhead juveniles between 35 and 83 mm were defined as fry (0+), those measuring between 84 and 122 mm were defined to be aged 1+ and fish measuring between 137 and 156 mm were considered age 2+ (Table 21). No fish caught were between 122 and 136 mm; therefore, we did not include that size range in the age assignment table.

Figure 11. Length frequency histogram of juvenile Steelhead captured in the Salmon River watershed, September 2014.

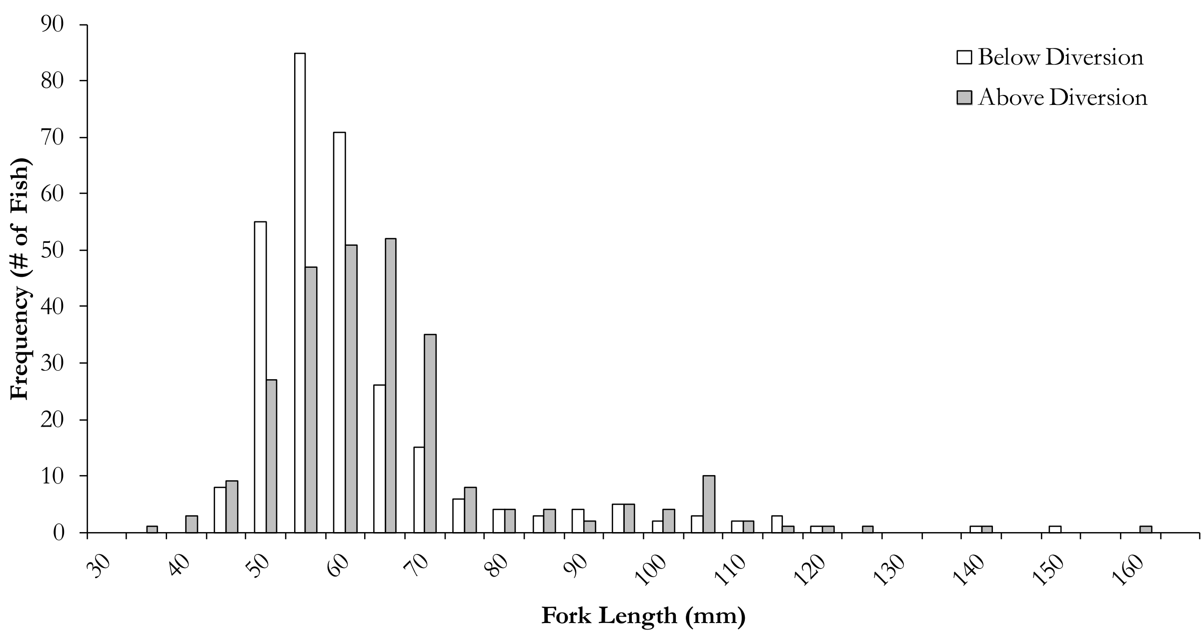


Figure 12. Length at age of juvenile Steelhead captured in the Salmon River watershed, September 2014.

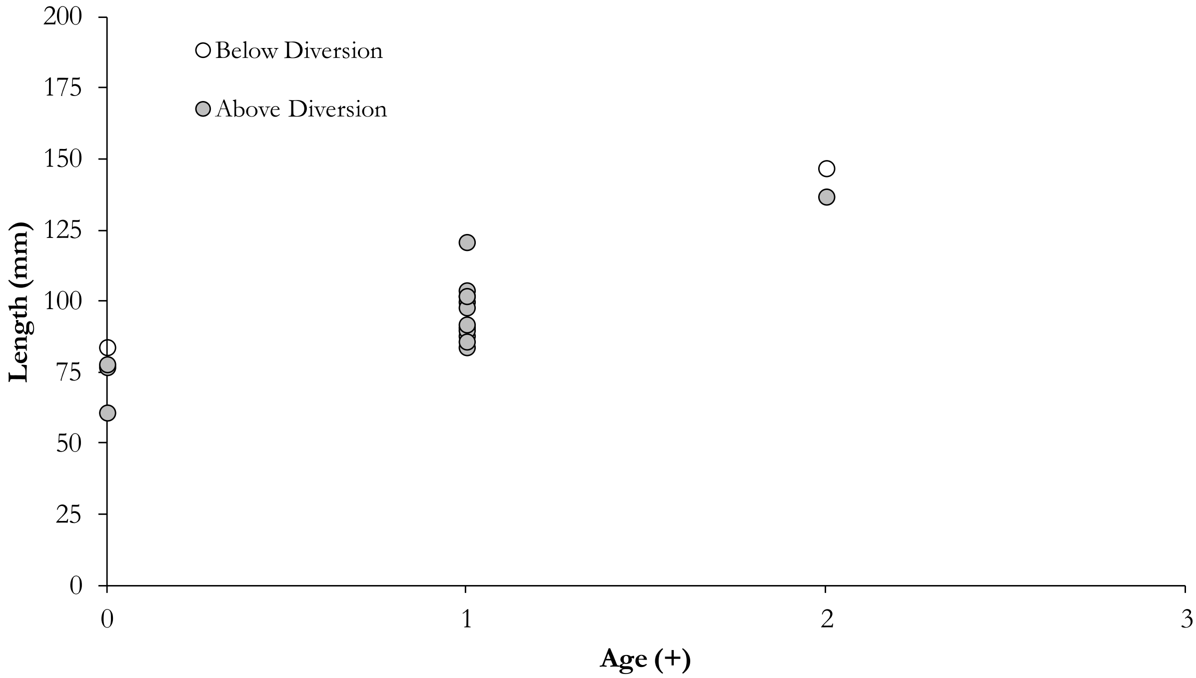


Table 21. Fork length range used to assign age classes for population analysis of juvenile Steelhead captured in the Salmon River watershed, September 2014.

Age Class	Fork Length Range (mm)
Fry 0+	35-83
Parr (1+)	84-121
Parr (2+)	137-156

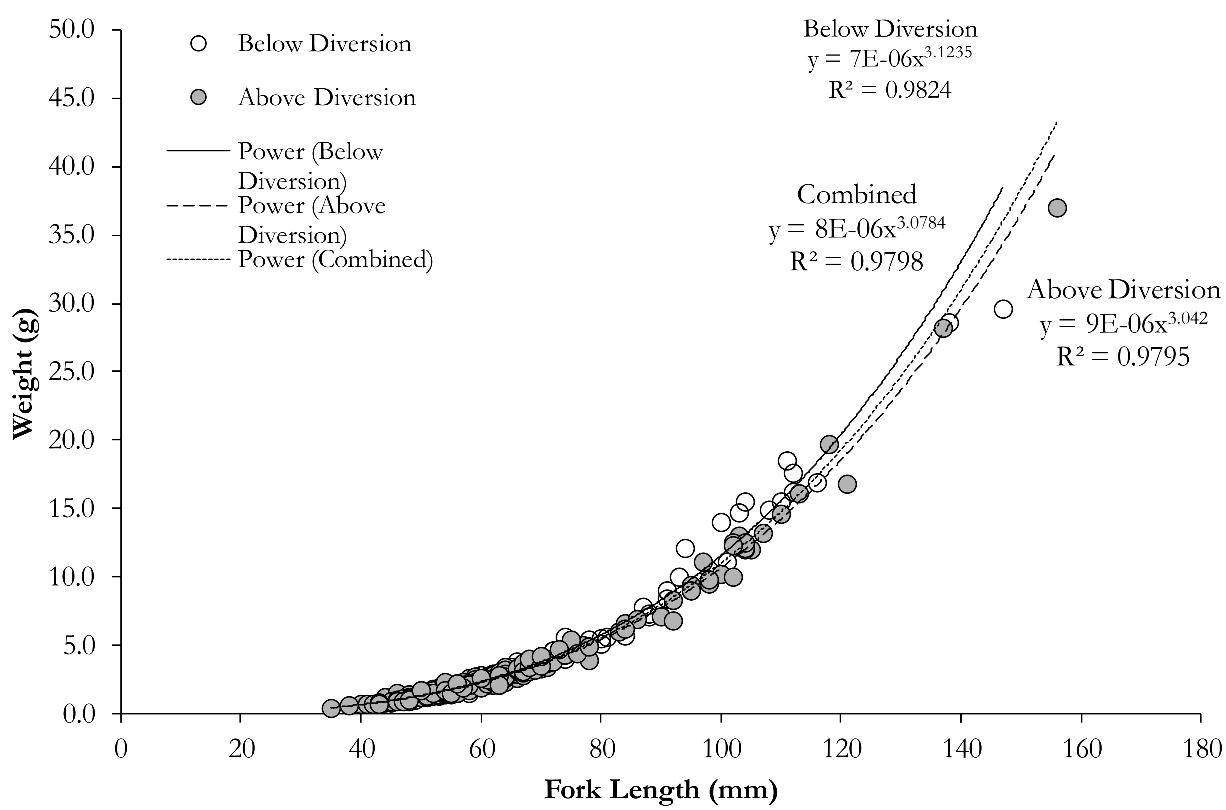
Fork length was measured for all 564 juvenile Steelhead captured in 2014, and weight was also measured for 409 fish (Table 22). Length-weight relationships for the 409 fish are shown in Figure 13. The relationship among these variables is well described by a power function that indicates that fork length accounts for 98% of the variance in juvenile Steelhead weight. These relationships were used to provide an estimated weight for fish that were not weighed in the field; this allowed an estimate of total biomass of fish within sampled sites.

Table 22 provides the fork length, weight and condition of juvenile Steelhead. Overall, the average condition was similar among age classes and years, and averaged 1.1 above the diversion, and 1.0 below the diversion; these values are considered poor to fair for this species (Barnham and Baxter 1998).

Table 22. Summary of fork length, weight and condition of juvenile Steelhead captured during electrofishing at 10 sites in the Salmon River watershed in 2014.

Location	Age Class	Fork Length (mm)				Weight (g)				Condition Factor (K)			
		n	Average	Min	Max	n	Average	Min	Max	n	Average	Min	Max
Below Diversion	0+	271	56	42	81	117	2.3	0.7	5.6	117	1.1	0.8	1.4
	1+	22	98	84	116	22	11.6	5.7	18.5	22	1.2	1.0	1.5
	2+	2	143	138	147	2	29.1	28.6	29.6	2	1.0	0.9	1.1
	Combined Total	295	60	42	147	141	4.2	0.7	29.6	141	1.1	0.8	1.5
Above Diversion	0+	238	59	35	83	237	2.2	0.4	6.0	237	1.0	0.8	1.5
	1+	29	100	84	121	29	11.0	6.2	19.7	29	1.1	0.9	1.2
	2+	2	147	137	156	2	32.6	28.2	37.0	2	1.0	1.0	1.1
	Combined Total	269	64	35	156	268	3.4	0.4	37.0	268	1.0	0.8	1.5

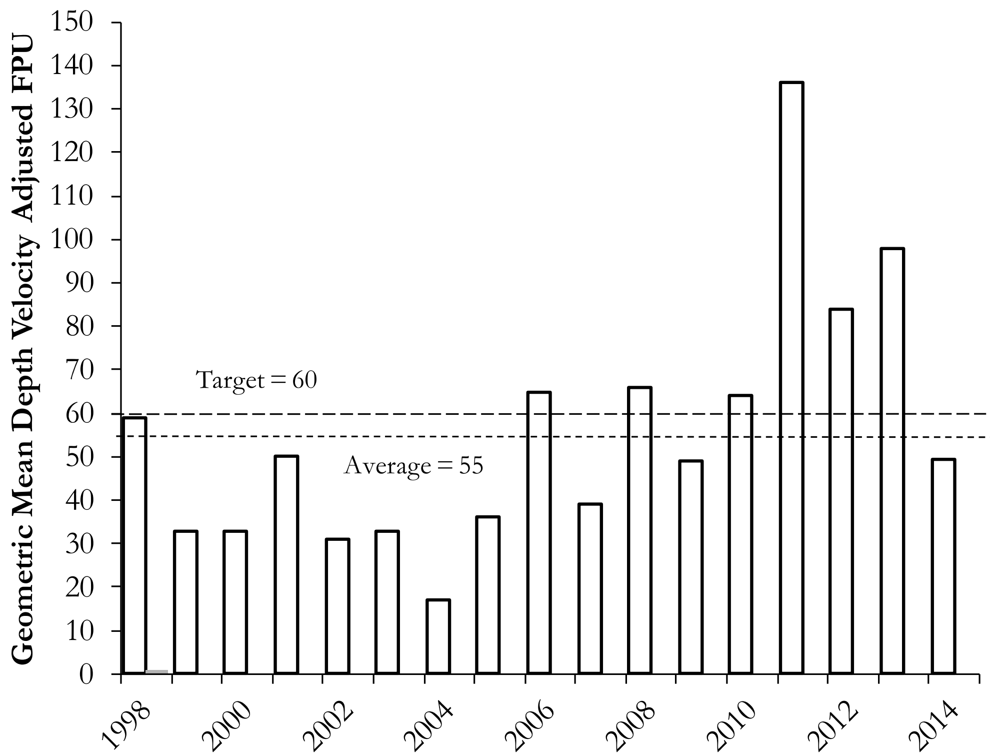
Figure 13. Length-weight regressions for 409 juvenile Steelhead captured sampled in the Salmon River watershed, September 2014.



3.1.2.4. Fish Abundance

The geometric mean depth-velocity-adjusted-abundance in 2014 was 49 fry per 100 m^2 (fry per unit/FPU), which is below the target of 60 FPU set by provincial biologists. The target of 60 FPU was based on the predicted juvenile Rainbow Trout/Steelhead capacity of 162 g/100 m^2 (Lill 2002) and assumes a mean fry weight of 2.7 g (Pellett 2014). The average abundance across all years is 55 FPU; just slightly below the 60 FPU target (Figure 14).

Figure 14. Geometric mean depth/velocity adjusted abundance of Steelhead fry sampled in the Salmon River watershed in 1998-2014.



*2011 data represents sites upstream of the diversion only.

The density of Steelhead fry in the Salmon River and tributaries was variable among sites in 2014 (Figure 15). Nevertheless, the average depth/velocity adjusted fry abundance was similar at sites above the diversion (77.6 FPU) and downstream of the diversion (77.4 FPU) (Table 23). The geometric mean FPU for all sites combined in 2014 is 49 (Figure 14), which is much lower than average of 77.5 FPU observed above and below the diversion (Table 23). The geometric mean formula indicates the central tendency and reduces the effect of particularly high or low values on the calculated mean.

In 2013, the average densities above and below the diversion were also very similar (i.e., 95.8 FPU above the diversion, and 102.3 FPU below the diversion) (Pellet 2014). The results indicate that adult Steelhead successfully spawned throughout the watershed including areas upstream of the diversion dam in 2013 and 2014.

Figure 15. Depth/velocity adjusted Steelhead fry abundance (fish per unit area; FPU) sampled at each site in the Salmon River watershed in 2014.

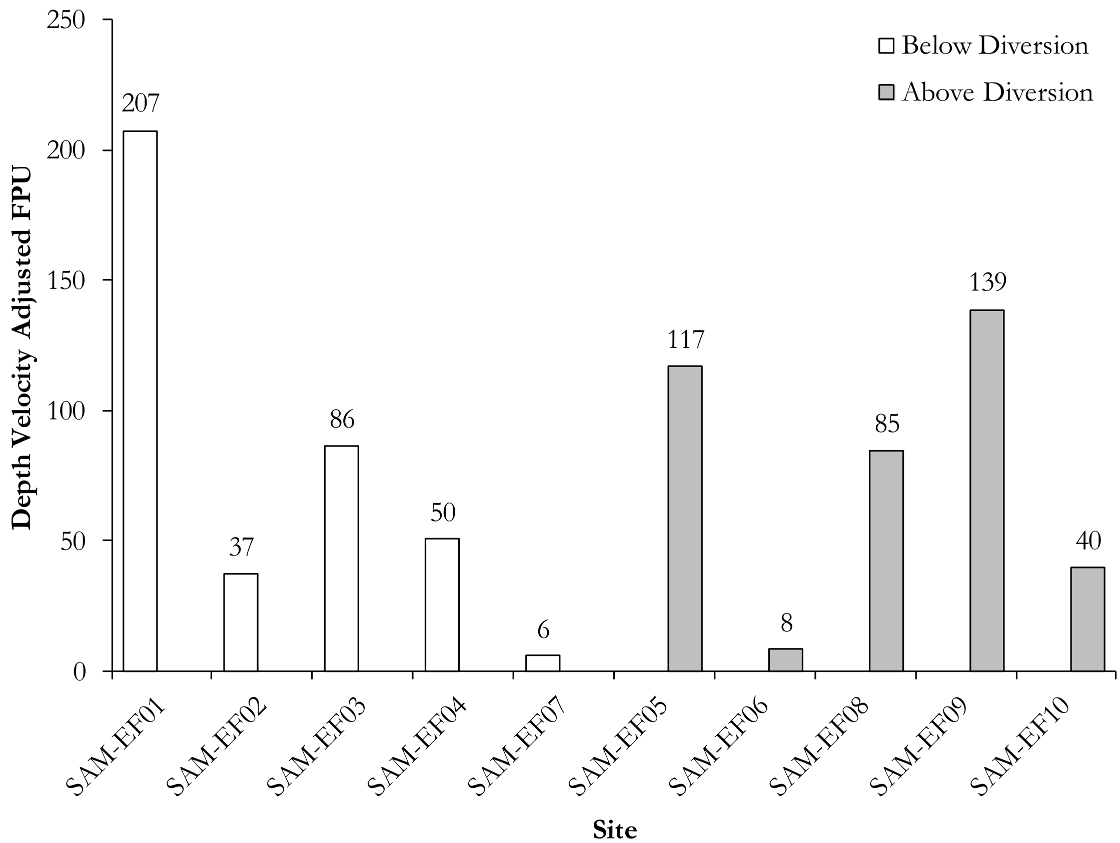


Table 23. Steelhead fry abundance and biomass results from electrofishing sites located upstream and downstream of the Salmon River Diversion, September 2014.

Location	Site	Usability (%)	Observed Densities[1,2]		Adjusted Densities[3,4]		Maximum Densities[5,6]	
			FPU_{obs} (#/100 m^2)	BPU_{obs} (g/100 m^2)	FPU_{adj} (#/100 m^2)	BPU_{adj} (g/100 m^2)	FPU_{max} (#/100 m^2)	BPU_{max} (g/100 m^2)
Below Diversion	SAM-EF01	67%	138.7	212.6	207.4	317.8	147	224.5
	SAM-EF02	61%	22.6	52.9	37.3	87.3	96	224.5
	SAM-EF03	52%	45.3	115.0	86.3	219.2	88	224.5
	SAM-EF04	65%	32.8	83.3	50.5	128.3	88	224.5
	SAM-EF07	89%	5.1	24.6	5.7	27.5	46	224.5
	Mean	**67%**	**48.9**	**97.7**	**77.4**	**156.0**	**93.0**	
Above Diversion	SAM-EF05	68%	79.8	212.8	116.7	311.3	84	224.5
	SAM-EF06	77%	6.3	19.2	8.2	24.8	74	224.5
	SAM-EF08	83%	70.5	131.0	84.6	157.1	121	224.5
	SAM-EF09	69%	96.2	206.1	138.8	297.3	105	224.5
	SAM-EF10	61%	24.3	30.6	39.7	49.9	178	224.5
	Mean	**72%**	**55.4**	**119.9**	**77.6**	**168.1**	**112.5**	

1 FPU_{obs} = Observed fish per unit (100 m^2) based on population estimates computed using MicroFish V3.0

2 BPU_{obs} = Biomass of fish per unit (100 m^2) based on population estimates computed using MicroFish V3.0

3 FPU_{adj} = FPU_{obs}/Usability (%)

4 BPU_{adj} = BPU_{obs}/Usability (%)

5 FPU_{max} = Theoretical Maximum Biomass/Mean Weight (g) of the Age Class (by site)

6. BPU_{max} = Theoretical Maximum Biomass = (Alkalinity^0.6)*35

The geometric mean fish density above and below the diversion has been variable since 2006, with an apparent increase in fry abundance in sites upstream of the diversion in 2011-2013 (Figure 16). Between 2006 and 2010, relative abundance was greater downstream of the diversion. In 2014, fry density was similar between sites above and below the diversion, and was more consistent with results collected between 1998 and 2006.

Figure 16. Geometric mean depth velocity adjusted juvenile Steelhead fish per unit area (FPU) from sampling sites above and below the Salmon River Diversion between 1998-2014.

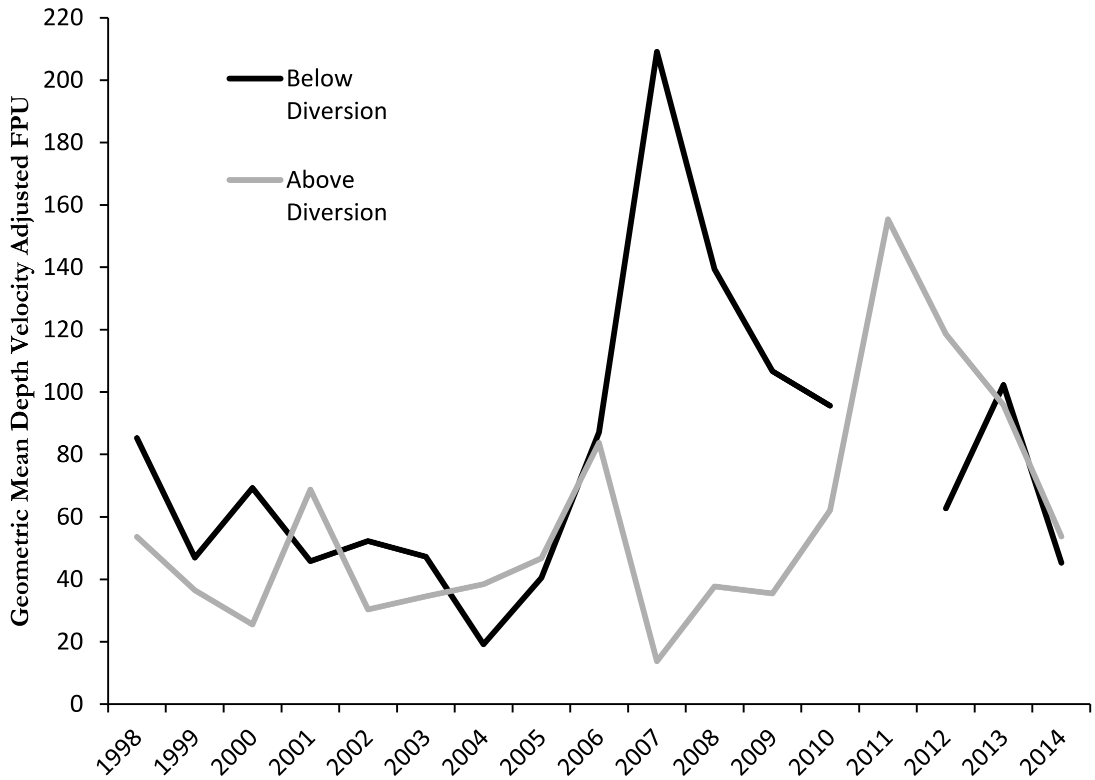
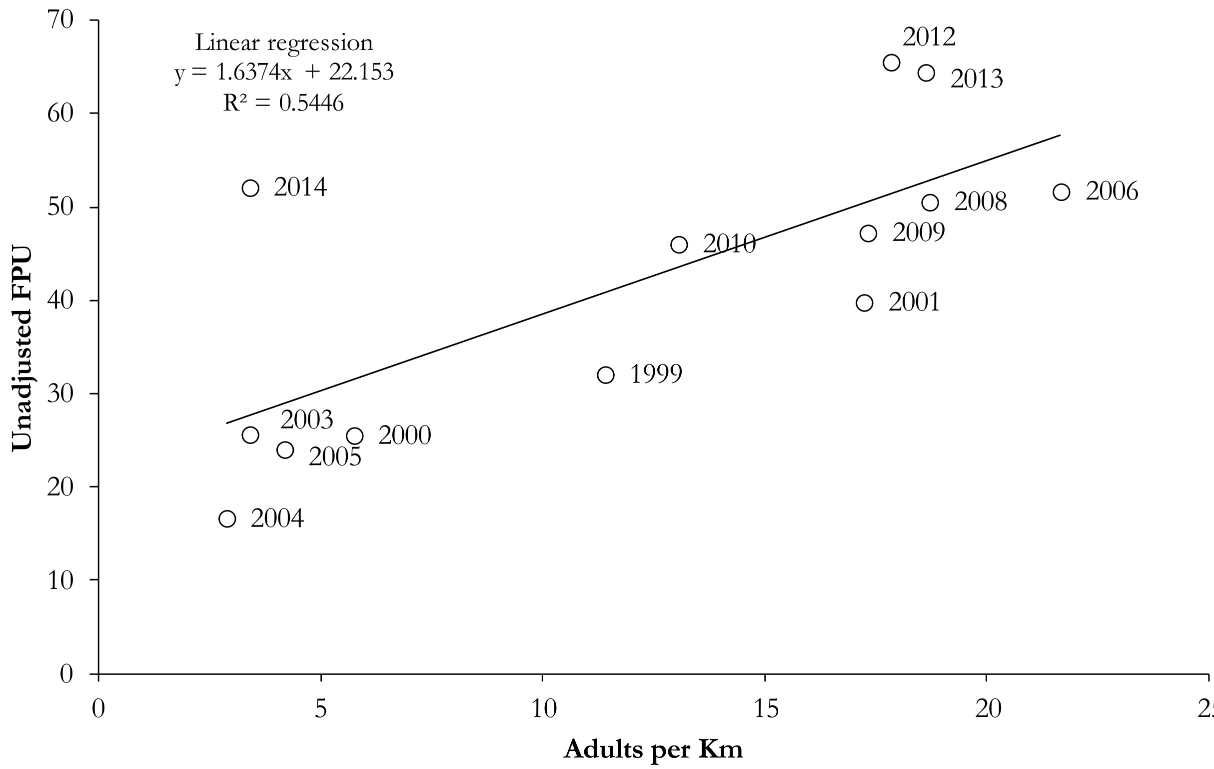


Figure 17 shows the average unadjusted densities of Steelhead fry compared with the peak adult Steelhead count from the 11.5 km lower index section on the Salmon River (Kay Creek to Pallan). The 2014 value is somewhat of an outlier on the historical relationship, indicating high Steelhead fry density from the (low) adult returns. The reasons for this pattern are not known, but could indicate particularly good incubation conditions in 2014, or a relatively high proportion of large (i.e., fecund) adult females resulting in a high number of eggs per spawner.

Figure 17. RB/ST FPU (non-depth velocity adjusted) vs. peak adult steelhead per km.



3.1.3. Salmon River Juvenile Coho Salmon Abundance

Juvenile Coho Salmon were caught at five of the six sites sampled (Table 24). The majority of the fry caught had hatched in 2014; on average 85% of fry caught at the five sites were age 0+ (range = 72 to 94%). No age 2+ fry were caught.

Table 24. Juvenile Coho Salmon abundance data.

Site	# Passes	Area (m^2)	Area > 10 cm deep (m^2)	Water T (°C)	# of fry caught	Estimated # of fry	# age 0+ fry	# age 1+ fry	# age 2+ fry
BTCkFlCh	4	128.3	124.2	11.5	51	52	39	12	0
Mari	4	111.1	94.8	11.9	52	65	49	3	0
Pater	6	57.7	49.1	12.6	75	76	69	6	0
G02	4	170.5	161.0	12.4	248	285	228	20	0
Gmain	5	78.8	74.8	12.9	182	198	131	51	0
Crowned	3	166.0	131.9	10.7	0	0	0	0	0

Age 0+ accounted for the largest proportion total biomass of Coho Salmon at four of the sites, with age 1+ fish making the dominant contribution to total biomass only at Gmain (Figure 18). Estimated total biomass (i.e., modelled biomass based on catch data and estimated capture efficiency) was greatest at Gmain (Figure 19).

Figure 18. Measured Juvenile Coho Salmon biomass by age class.

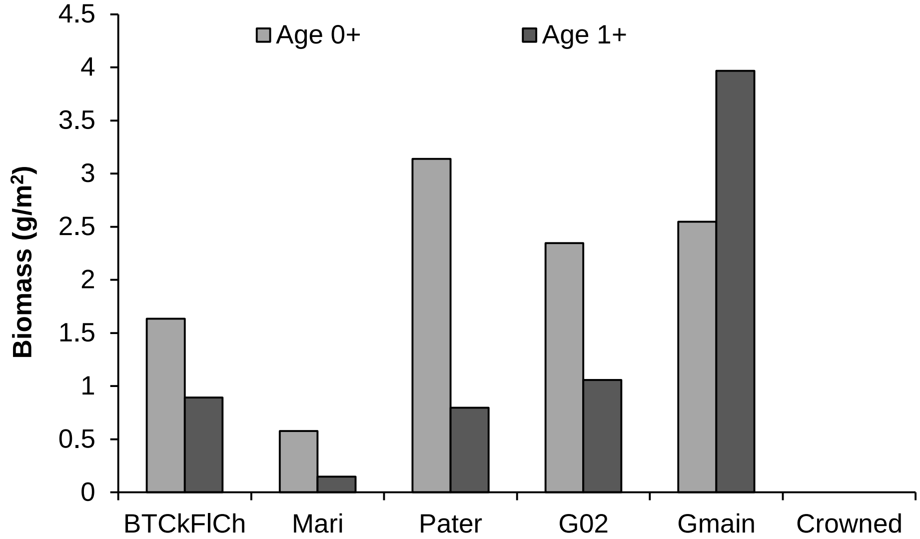
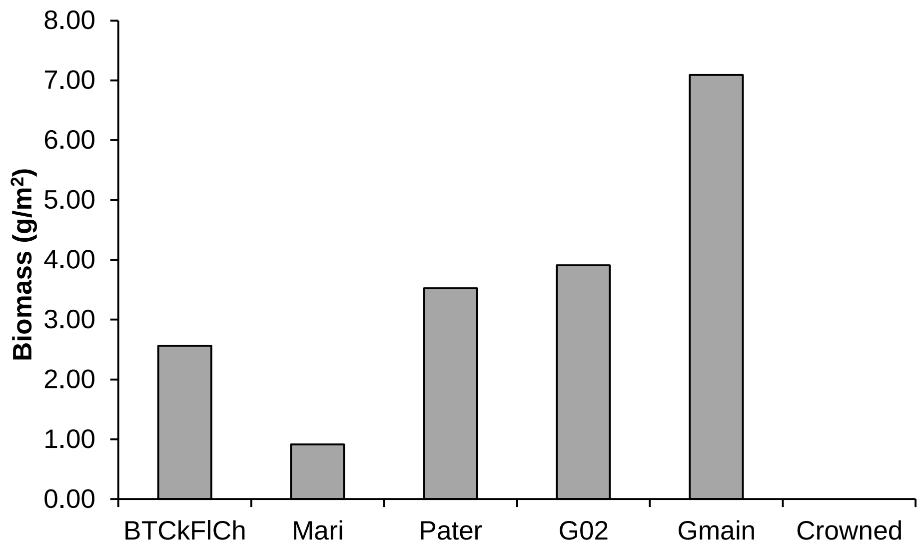


Figure 19. Total estimated Juvenile Coho Salmon biomass, based on catch data and capture efficiency estimates.



There was no evidence for a systematic difference in biomass between sites that were upstream and downstream of the diversion dam.

3.1.4.Salmon and Quinsam River Salmon Escapement

Salmon escapement data for 2013 for the Salmon and Quinsam rivers are presented in Table 25. Summary statistics for the period of record are also provided in this table to provide points of reference. Figure 20 and Figure 21 present salmon escapement data for the periods of record for the Salmon River and Quinsam River respectively.

Table 25. Salmon escapement data for the Salmon and Quinsam rivers (DFO 2013).

River	Statistic	Chinook	Chum	Coho	Pink	Sockeye
Salmon	2013 count	407	1	3,502	44,820	4
	Mean (1953-2013)	875	969	3,364	30,443	32
	Median(1953-2013)	722	400	2,000	7,500	1
	10th percentile (1953-2013)	126	0	310	1,260	0
	90th percentile (1953-2013)	1,500	3,500	7,500	76,946	100
	Percent of years sampled (1953-2013)[1]	100	95	98	100	56
Quinsam	2013 count	3,356	151	14,952	1,030,767	8
	Mean (1957-2013)	4,113	515	12,418	103,163	57
	Median(1957-2013)	3,356	325	9,310	27,000	25
	10th percentile (1957-2013)	25	82	1,500	1,275	6
	90th percentile (1957-2013)	10,348	1,500	33,442	287,496	143
	Percent of years sampled (1957-2013)[1]	79	95	98	98	74

1. Note that this is approximate; uncertainty in data recording means that a count of zero is not always distinguished from a record of 'not measured'.

Figure 20. Salmon escapement for the Salmon River (1953-2013; DFO 2013).

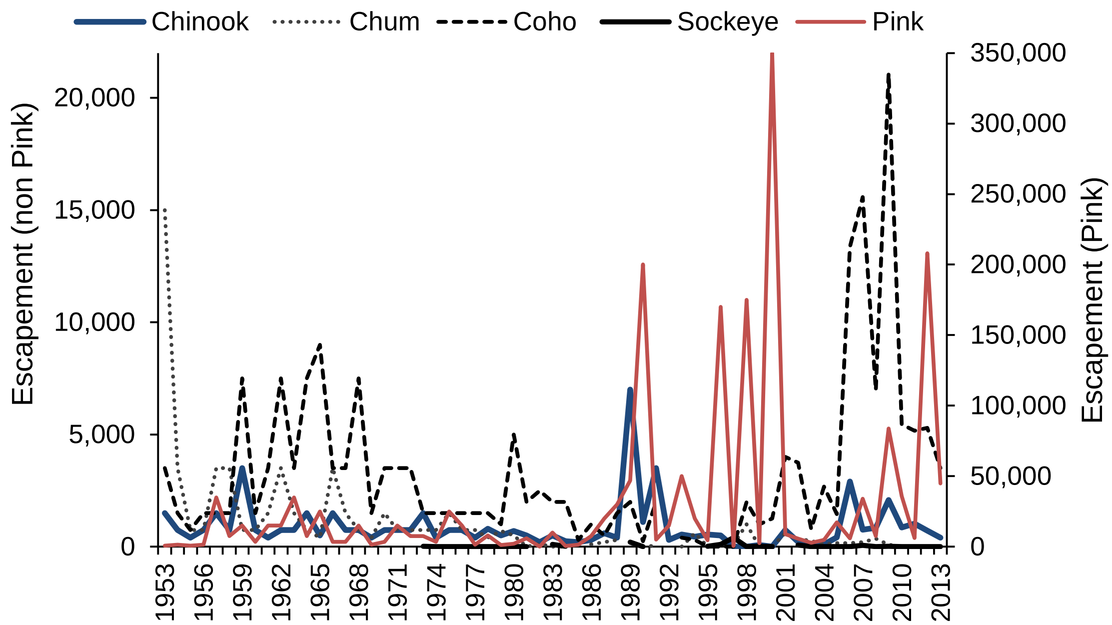
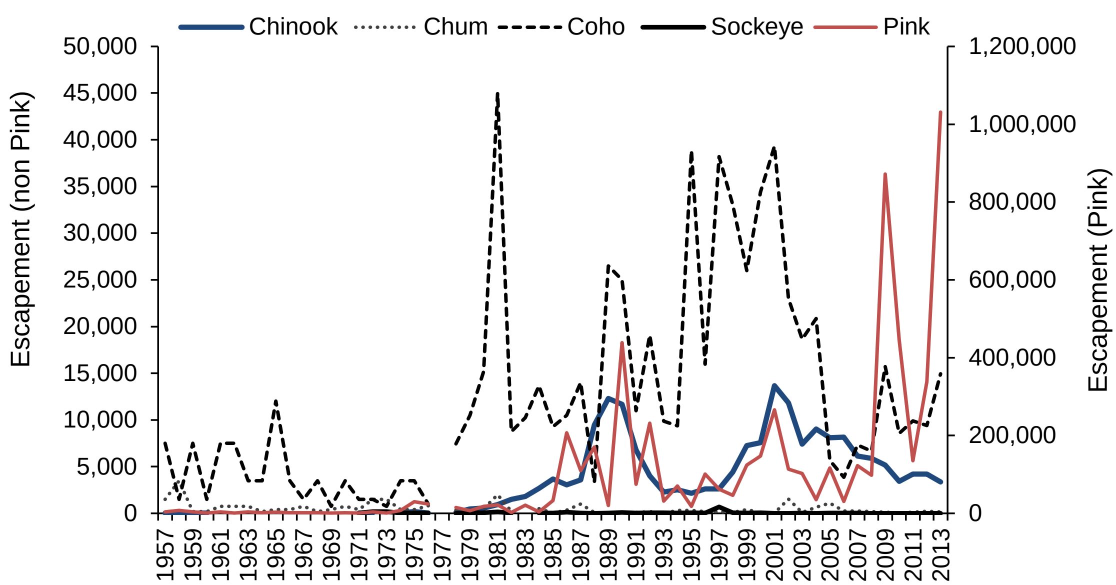


Figure 21. Salmon escapement for the Quinsam River (1957-2013; DFO 2013).



Pink, Coho and Chinook salmon were the dominant returning species in 2013, with Chum and Sockeye salmon comprising a very small minority (< 0.02%) of the total escapement for each river (Table 25), consistent with historical data (Figure 20 and Figure 21). 2013 was notable for high returns of Pink Salmon, particularly in the Quinsam River where Pink Salmon escapement (1,030,767) was the highest on record. Coho Salmon escapement was relatively high in 2013, and the historical mean and median counts were exceeded on both rivers. Chinook Salmon escapement (407) was relatively low in the Salmon River where it was approximately half of the historical mean (875) and only just over half of the historic median count. Chinook Salmon escapement on the Quinsam River was equal to the median value.

3.1.5. Quinsam River Salmon Counting Fence Operation to Enumerate Downstream Juvenile Migration

Conditions for the trapping operation were optimal throughout the sampling period, yielding high quality downstream migration data. The data collected at the salmon counting fence are summarized in Table 26. Further details are provided in the separate report prepared by DFO fisheries biologists (Ewart and Kerr 2014; Appendix D).

Table 26. Summary of downstream migration data collected at the Quinsam River Hatchery salmon counting fence, March 18 to June 16, 2014 (Ewart and Kerr 2014; Appendix D).

Species	Stage	Total estimated migration	Peak migration	Migration period	Comments
Colonized Coho (by length)	Smolt	36,339	13-May	Apr 27 - Jun 10	
Wild Coho	Smolt	21,564	16-May	May 7 - Jun 9	
2 year old Coho	Smolt	55	10-May	May 10 - May 30	Only 5 individuals trapped
Coho	Fry	230,490	27-May	Mar 19 - Jun 10	
Steelhead (wild)	Smolt	6,930	20-May	Apr 24 - Jun 3	
Steelhead	Fingerling	55	2-Jun	Mar 13 - Jun 5	
Steelhead	Kelts	1	14-Apr	14 Apr - June 4	Catch efficiency unknown; no extrapolation
Cutthroat	Fingerling	33	2-Jun	Apr 22 - Jun 6	
Cutthroat	Smolt	616	2-Jun	May 1 - Jun 4	
Trout Fry	Fry	176	2-Jun	May 11 - June 16	
Chinook	Fry	18,819	28-May	Apr 28 - Jun 10	
Chum	Fry	2,094	2-May	Mar 19 - Jun 9	
Sockeye	Fry	2,471	28-Mar	Mar 19 - Apr 14	
Pink	Fry	22,000,259	18-Apr	Mar 4 - Jun6	
Dolly Varden	Smolt	33	16-May	May 7 - 16	Only 3 individuals trapped
Lamprey (2 species)	All	5,255	23-May	Mar 25 - Jun 10	
Sculpin	All	3,850	3-Jun	Mar 19 - Jun 10	

3.2. Water Quality

3.2.1. Water Chemistry

3.2.1.1. Salmon River

The in situ and lab water chemistry results for the Salmon River at SAM-WQ are summarized in Table 27 (general parameters measured in situ), Table 28 (dissolved gases), Table 29 (general parameters measured at ALS labs), and Table 30 (low level nutrients measured at ALS labs).

The following water quality parameter concentration ranges were measured over the course of the monthly sampling during Year 1 in the Salmon River. Only those values that exceed the provincial or federal guidelines for the protection of aquatic life, or are not within the normal ranges of BC rivers, are discussed in additional detail (see Appendix E for applicable guidelines and typical ranges).

Alkalinity

Alkalinity (as $CaCO_3$) measured at ALS labs ranged from 12.3 mg/L (May 2014) to 23.9 mg/L (September, 2014; Table 27). Alkalinity concentrations less than 10 mg/L in streams indicate sensitivity to acidic inputs, or poor buffering capacity. Alkalinity in the range of 10 mg/L to 20 mg/L indicates that the watercourse is moderately sensitive to acidic inputs, whereas values greater than 20 mg/L suggest a low sensitivity (Nagpal *et al.* 2006). Thus, the Salmon River exhibits predominantly moderate sensitivity to acidic inputs during the growing season.

Specific Conductivity and Total Dissolved Solids

In-situ specific conductivity (conductivity normalized to 25°C) ranged from 28.2 µS/cm (May sampling) to 54.7 µS/cm (September sampling) (Table 27). Similarly, lab values for specific conductivity ranged from 27.2 µS/cm to 56.3 µS/cm, with the lowest value occurring in May, and the highest in August. Coastal British Columbia streams generally have a specific conductivity of ~100 µS/cm (RISC 1998).

Total dissolved solids measured in the lab for the Salmon River ranged from 32 mg/L (May sampling) to 53 mg/L (November sampling) (Table 29).

pH

pH values measured in the laboratory ranged from 7.38 to 7.79, whereas in-situ pH ranged from 6.85 to 7.21 (Table 27 and Table 29 respectively). Natural fresh waters have a pH range from 4 to 10; British Columbia lakes tend to have a pH ≥ 7.0, and coastal streams commonly have pH values of 5.5 to 6.5 (RISC 1998).

Turbidity and Total Suspended Solids (TSS)

Turbidity in the Salmon River at SAM-WQ was low, indicating high water clarity (values ranged from 0.22 NTU to 0.92 NTU) (Table 27). Similarly, low TSS concentrations were measured throughout the sampling period, with concentrations that were predominantly non-detectable (<1.0

mg/L) (Table 29). One major exception was the August, 18, 2014 sampling date: one duplicate had a concentration of <1.0 mg/L while the other had a concentration of 8.1 mg/L. Field and trip blanks were <1.0 mg/L indicating that contamination was unlikely during the sampling, however, since this spike in TSS was not observed in the turbidity results, it is likely to be an anomalous result that reflects contamination or error during laboratory analysis. In British Columbia, natural values of turbidity and TSS concentrations vary extensively, and show daily/seasonal variation (Singleton 2001).

Dissolved Oxygen

Dissolved oxygen concentrations in the Salmon River were high over the course of the monthly monitoring, with the exception of the September 23, 2014 sampling when average concentration was 8.80 mg/L, corresponding to 88.2% saturation. This concentration does not meet the more conservative provincial guideline (DO instantaneous minimum of 9 mg/L) for the protection of buried embryo/alevin (Table 28) (MOE 1997a and MOE 1997b, Appendix E. In British Columbia, surface waters generally exhibit dissolved oxygen concentrations greater than 10 mg/L, and are close to equilibrium with the atmosphere (i.e., ~ 100%; RISC 1998).

Total Gas Pressure

Total Gas Pressure may be reported in mm Hg, as percent saturation, or as ΔP (total gas pressure in mm Hg minus barometric pressure in mm Hg). ΔP is the most conducive measure for making comparisons among sites and to Provincial guidelines, as it does not require adjustments for site elevation (Fidler and Miller 1994). In 2014, in the Salmon River ΔP ranged from -11 mm Hg to 13 mm Hg (Table 28). In British Columbia, dissolved gas supersaturation may occur in natural waters with ΔP values as high as 50 mm Hg to 80 mm Hg (Fidler and Miller 1994).

Nitrogen

Ammonia concentrations in the Salmon River at SAMWQ were less than the MDL of 5.0 μg N/L. (Table 30). Ammonia is usually present at low concentrations (<100 μg N/L) in waters not affected by wastewater discharges (Nordin and Pommen 1986).

Nitrite concentrations were below MDL of 1.0 μg N/L for all the monthly sampling dates (Table 30). Nitrite is an unstable intermediate ion which serves as an indicator of recent contamination from sewage and/or agricultural runoff; levels are typically <1.0 μg N/L (RISC 1998).

Nitrate concentrations ranged from 8.5 μg N/L to 71.6 μg N/L over the course of the sampling, with the highest concentrations measured in the September 2014 (71.6 μg N/L), followed by August 2014 (27.6 μg N/L) and November 2014 (26.1 μg/L; Table 30). In oligotrophic lakes and streams, nitrate concentrations are usually lower than 100 μg N/L (Nordin and Pommen 1986).

Phosphorus

Orthophosphate was below the detection limit of 1.0 μg P/L or very close to the detection limit in all cases (Table 30). Very low orthophosphate concentrations are expected as it is a readily biologically available form of phosphorus and would be quickly taken up in nutrient limited streams. Coastal British Columbia streams typically have orthophosphate concentrations <1.0 μg P/L (Slaney and Ward 1993; Ashley and Slaney 1997).

Total phosphorus concentrations over the Year 1 sampling period were low ranging from <2.0 μg P/L to 5.6 μg P/L, with the higher concentrations occurring in May and August (Table 30).

Table 27. Salmon River (SAM-WQ) general water quality parameters measured in-situ during Year 1, 2014.

Date	Specific Conductivity µS/cm				pH pH units				Air Temperature °C				Water Temperature °C			
	Avg[1]	Min	Max	SD	Avg[1]	Min	Max	SD	Avg[1]	Min	Max	SD	Avg[1]	Min	Max	SD
21-May	28.2	28.2	28.2	0.0	6.91	6.91	6.91	0.00	-	-	-	-	9.1	9.1	9.1	0.0
17-Jun	37.1	37.1	37.1	0.0	7.21	7.17	7.23	0.03	12	12	12	0	12.2	12.1	12.2	0.1
23-Jul	46.7	46.7	46.7	0.0	7.03	7.03	7.03	0.00	14	14	14	0	15.5	15.5	15.5	0.0
18-Aug	54.1	54.1	54.1	0.0	7.14	7.12	7.16	0.02	16	16	16	0	17.2	17.2	17.2	0.0
23-Sep	54.7	54.7	54.8	0.1	7.22	7.21	7.23	0.01	17	17	17	0	14.6	14.6	14.6	0.0
03-Nov	35.5	35.5	35.6	0.1	6.85	6.83	6.87	0.02	8	-	-	-	8.2	8.2	8.2	0.0

[1] Average of three replicates (n=3) on each date unless otherwise indicated.

Table 28. Salmon River (SAM-WQ) dissolved gases measured in-situ during Year 1, 2014.

Date	Dissolved Oxygen %				Dissolved Oxygen mg/L				Barometric Pressure mm Hg				TGP mm Hg				TGP %				ΔP mm Hg			
	Avg[1]	Min	Max	SD	Avg[1]	Min	Max	SD	Avg[1]	Min	Max	SD	Avg[1]	Min	Max	SD	Avg[1]	Min	Max	SD	Avg[1]	Min	Max	SD
21-May	102.6	102.6	102.6	0.0	11.68	11.67	11.68	0.01	748	748	748	0	761	761	761	0	102	102	102	0	13	13	13	0
17-Jun	99.3	99.1	99.7	0.3	10.73	10.68	10.76	0.04	749	749	749	0	758	755	761	3	101	101	102	1	9	6	12	3
23-Jul	101.8	101.8	101.9	0.1	10.20	10.20	10.20	0.00	747	747	747	0	755	755	755	0	101	101	101	0	8	8	8	0
18-Aug	98.9	98.0	100.6	1.4	9.56	9.43	9.73	0.15	750	750	750	0	761	757	764	4	101	101	102	1	11	7	14	4
23-Sep	88.2	87.1	88.8	0.9	8.80	8.71	8.86	0.08	760	760	760	0	749	748	751	2	98	98	99	1	-11	-12	-9	2
03-Nov	95.7	95.1	96.5	0.7	11.08	11.02	11.18	0.09	763	762	763	1	763	761	764	2	100	100	100	0	0	-2	1	2

[1] Average of three replicates (n=3) on each date unless otherwise indicated.

Blue Shading indicates that the more conservative provincial guideline (DO instantaneous minimum of 9 mg/L) for the protection of buried embryo/alevin has not been achieved. Note that the guideline for life stages other than buried embryo/alevin is not exceeded (DO instantaneous minimum of 5 mg/L).

Table 29. Salmon River (SAM-WQ) general water quality parameters measured at ALS labs during Year 1, 2014.

Date	Site	Alkalinity, Total (as $CaCO_3$) mg/L				Specific Conductivity (lab) µS/cm				Total Dissolved Solids mg/L				Total Suspended Solids mg/L				Turbidity NTU				pH pH units			
		Avg[1]	Min	Max	SD	Avg[1]	Min	Max	SD	Avg[1]	Min	Max	SD	Avg[1]	Min	Max	SD	Avg[1]	Min	Max	SD	Avg[1]	Min	Max	SD
21-May	SAM-WQ	12.3	12.2	12.3	0.1	27.2	27.0	27.3	0.2	32	31	32	1	<1.0	<1.0	<1.0	0.0	0.30	0.22	0.38	0.11	7.38	7.35	7.40	0.04
	SAM-field blank	<2.0	-	-	-	<2.0	-	-	-	<10	-	-	-	<1.0	-	-	-	<0.10	-	-	-	5.60	-	-	-
	SAM-travel blank	<2.0	-	-	-	<2.0	-	-	-	<10	-	-	-	<1.0	-	-	-	<0.10	-	-	-	5.54	-	-	-
17-Jun	SAM-WQ	17.6	17.3	17.8	0.4	40.5	37.5	43.5	4.2	33	31	34	2	<1.0	<1.0	<1.0	0.0	0.22	0.17	0.26	0.06	7.57	7.55	7.59	0.03
	SAM-field blank	<2.0	-	-	-	<2.0	-	-	-	<10	-	-	-	<1.0	-	-	-	<0.10	-	-	-	5.44	-	-	-
	SAM-travel blank	<2.0	-	-	-	<2.0	-	-	-	<10	-	-	-	<1.0	-	-	-	<0.10	-	-	-	5.48	-	-	-
23-Jul	SAM-WQ	21.0	20.7	21.2	0.4	46.5	46.4	46.6	0.1	38	38	38	0	<1.0	<1.0	<1.0	0.0	0.92	0.71	1.12	0.29	7.58	7.53	7.62	0.06
	SAM-field blank	<2.0	-	-	-	<2.0	-	-	-	<10	-	-	-	<1.0	-	-	-	<0.10	-	-	-	5.50	-	-	-
	SAM-travel blank	<2.0	-	-	-	<2.0	-	-	-	<10	-	-	-	<1.0	-	-	-	<0.10	-	-	-	5.47	-	-	-
18-Aug	SAM-WQ	23.8	23.6	23.9	0.2	56.3	55.3	57.3	1.4	49	43	55	8	<4.6	<1.0	8.1	5.0	0.22	0.20	0.23	0.02	7.79	7.76	7.82	0.04
	SAM-field blank	<2.0	-	-	-	<2.0	-	-	-	<10	-	-	-	<1.0	-	-	-	<0.10	-	-	-	6.50	-	-	-
	SAM-travel blank	<2.0	-	-	-	<2.0	-	-	-	<10	-	-	-	<1.0	-	-	-	<0.10	-	-	-	6.05	-	-	-
23-Sep	SAM-WQ	23.9	23.8	23.9	0.1	53.1	52.8	53.4	0.4	46	41	51	7	<1.0	<1.0	<1.0	0.0	0.26	0.23	0.28	0.04	7.65	7.48	7.82	0.24
	SAM-field blank	<2.0	-	-	-	<2.0	-	-	-	<10	-	-	-	<1.0	-	-	-	<0.10	-	-	-	5.28	-	-	-
	SAM-travel blank	<2.0	-	-	-	<2.0	-	-	-	<10	-	-	-	<1.0	-	-	-	<0.10	-	-	-	6.03	-	-	-
03-Nov	SAM-WQ	16.6	16.5	16.6	0.1	37.2	36.7	37.7	0.7	53	37	69	23	<1.0	<1.0	<1.0	0.0	0.33	0.32	0.34	0.01	7.61	7.56	7.65	0.06
	SAM-field blank	<2.0	-	-	-	<2.0	-	-	-	<10	-	-	-	<1.0	-	-	-	<0.10	-	-	-	5.75	-	-	-
	SAM-travel blank	<2.0	-	-	-	<2.0	-	-	-	<10	-	-	-	<1.0	-	-	-	<0.10	-	-	-	5.73	-	-	-

[1] Average of two duplicates (n=2) on each date unless otherwise indicated. For field and travel blanks n=1.

Parameters that have a concentration below the detection limit are assumed to have a concentration equal to the detection limit for calculation purposes.

Table 30. Salmon River (SAM-WQ) low level nutrients measured at ALS labs during Year 1, 2014.

Date	Site	Ammonia, Total (as N) µg/L				Nitrate (as N) µg/L				Nitrite (as N) µg/L				Dissolved Orthophosphate (as P) µg/L				Total Phosphorus (P) µg/L			
		Avg[1]	Min	Max	SD	Avg[1]	Min	Max	SD	Avg[1]	Min	Max	SD	Avg[1]	Min	Max	SD	Avg[1]	Min	Max	SD
21-May	SAM-WQ	<5.0	<5.0	<5.0	0.0	8.8	8.4	9.1	0.5	<1.0	<1.0	<1.0	0.0	<1.0	<1.0	<1.0	0.0	3.2	3.1	3.2	0.1
	SAM-field blank	<5.0	-	-	-	<5.0	-	-	-	<1.0	-	-	-	<1.0	-	-	-	<2.0	-	-	-
	SAM-travel blank	<5.0	-	-	-	<5.0	-	-	-	<1.0	-	-	-	<1.0	-	-	-	<2.0	-	-	-
17-Jun	SAM-WQ	<5.0	<5.0	<5.0	0.0	15.5	15.2	15.7	0.4	<1.0	<1.0	<1.0	0.0	<1.0	<1.0	<1.0	0.0	<2.1	<2.0	2.1	0.1
	SAM-field blank	<5.0	-	-	-	<5.0	-	-	-	<1.0	-	-	-	<1.0	-	-	-	<2.0	-	-	-
	SAM-travel blank	60.8	-	-	-	<5.0	-	-	-	<1.0	-	-	-	<1.0	-	-	-	<2.0	-	-	-
23-Jul	SAM-WQ	<5.0	<5.0	<5.0	0.0	8.5	8.5	8.5	0.0	<1.0	<1.0	<1.0	0.0	<1.0	<1.0	<1.0	0.0	2.4	2.2	2.5	0.2
	SAM-field blank	<5.0	-	-	-	<5.0	-	-	-	<1.0	-	-	-	<1.0	-	-	-	<2.0	-	-	-
	SAM-travel blank	50.2	-	-	-	<5.0	-	-	-	<1.0	-	-	-	<1.0	-	-	-	<2.0	-	-	-
18-Aug	SAM-WQ	5.8	5.5	6.0	0.4	27.6	27.4	27.7	0.2	<1.0	<1.0	<1.0	0.0	<1.1	<1.0	1.1	0.1	<3.8	<2.0	5.6	2.5
	SAM-field blank	<5.0	-	-	-	<5.0	-	-	-	<1.0	-	-	-	<1.0	-	-	-	<2.0	-	-	-
	SAM-travel blank	88.5	-	-	-	<5.0	-	-	-	<1.0	-	-	-	<1.0	-	-	-	<2.0	-	-	-
23-Sep	SAM-WQ	<5.0	<5.0	<5.0	0.0	71.6	70.8	72.4	1.1	<1.0	<1.0	<1.0	0.0	<1.0	<1.0	<1.0	0.0	<2.3	<2.0	2.5	0.4
	SAM-field blank	<5.0	-	-	-	<5.0	-	-	-	<1.0	-	-	-	<1.0	-	-	-	<2.0	-	-	-
	SAM-travel blank	81.6	-	-	-	<5.0	-	-	-	<1.0	-	-	-	<1.0	-	-	-	<2.0	-	-	-
03-Nov	SAM-WQ	<5.0	<5.0	<5.0	0.0	26.1	25.6	26.5	0.6	<1.0	<1.0	<1.0	0.0	<1.0	<1.0	<1.0	0.0	<2.0	<2.0	<2.0	0.0
	SAM-field blank	<5.0	-	-	-	<5.0	-	-	-	<1.0	-	-	-	<1.0	-	-	-	<2.0	-	-	-
	SAM-travel blank	87.7	-	-	-	<5.0	-	-	-	<1.0	-	-	-	<1.0	-	-	-	<2.0	-	-	-

[1] Average of two duplicates (n=2) on each date unless otherwise indicated. For field and travel blanks n=1.

Parameters that have a concentration below the detection limit are assumed to have a concentration equal to the detection limit for calculation purposes.

3.2.1.1. Quinsam River

The in-situ and lab water chemistry results for the Quinsam River at QUN-WQ are summarized in Table 31 (general parameters measured in-situ), Table 32 (dissolved gases measured in-situ), Table 33 (general parameters measured at ALS labs), and Table 34 (low level nutrients measured at ALS labs).

The following water quality parameter concentration ranges were measured over the course of the monthly sampling during Year 1 in the Quinsam River. Only those values that exceed the provincial or federal guidelines for the protection of aquatic life, or are not within the normal ranges of BC rivers, are discussed in additional detail (see Appendix E for applicable guidelines and typical ranges).

Alkalinity

Alkalinity (as $CaCO_3$) measured at ALS labs ranged from 23.5 mg/L (Nov 2014) to 42.4 mg/L (July, 2014; Table 31). Alkalinity concentrations were in all cases greater than 20 mg/L suggesting that the Quinsam River has a low sensitivity to acidic inputs (Nagpal *et al.* 2006).

Specific Conductivity and Total Dissolved Solids

In-situ specific conductivity (conductivity normalized to 25°C) ranged from 69.4 µS/cm (Nov sampling) to 152.4 µS/cm (August sampling) (Table 31). Similarly, lab values for specific conductivity ranged from 70.7 µS/cm (November sampling) to 166 µS/cm (August sampling). Coastal British Columbia streams generally have a specific conductivity of ~100 µS/cm (RISC 1998). The highest specific conductivity values in the Quinsam River were measured in June, July and August and were above 100 µS/cm.

Total dissolved solids measured in the lab for the Quinsam River ranged from 53 mg/L to 105 mg/L (July sampling) (Table 29).

pH

pH values measured in the laboratory ranged from 7.52 to 8.05 while in-situ pH ranged from 7.01 to 7.58 (Table 33 and Table 31, respectively). Natural fresh waters have a pH range from 4 to 10, British Columbia lakes tend to have a pH ≥ 7.0, and coastal streams commonly have pH values of 5.5 to 6.5 (RISC 1998).

Turbidity and Total Suspended Solids (TSS)

Turbidity in the Quinsam River at QUN-WQ was low, indicating high water clarity (values ranged from 0.40 NTU to 0.93 NTU) (Table 33). Similarly, low TSS concentrations were measured during the monthly Year 1 sampling period with non-detectable (<1.0 mg/L) concentrations in all cases.

Dissolved Oxygen

Dissolved oxygen concentrations and % saturation in the Quinsam River were relatively high over the course of the monthly monitoring; however, during the June, August and September sampling, the average DO concentration did not meet the more conservative provincial guideline (DO instantaneous minimum of 9 mg/L) for the protection of buried embryos/alevins (Table 32) (MOE 1997a and MOE 1997b, Appendix E). In British Columbia, surface waters generally exhibit DO concentrations greater than 10 mg/L, and are close to equilibrium with the atmosphere (i.e., ~100%; RISC 1998).

Total Gas Pressure

Total Gas Pressure may be reported in mm Hg, as percent saturation, or as ΔP (total gas pressure in mm Hg minus barometric pressure in mm Hg). In 2014, in the Quinsam River ΔP ranged from -14 mm Hg to 7 mm Hg (Table 32). In British Columbia, dissolved gas supersaturation may occur in natural waters with ΔP values as high as 50 mm Hg to 80 mm Hg (Fidler and Miller 1994).

Nitrogen

Ammonia concentrations in the Quinsam River at SAM-WQ were less than, or close to, the detection limit of 5.0 µg N/L (Table 32). Ammonia is usually present at low concentrations (<100 µg N/L) in waters not affected by waste discharges (Nordin and Pommen 1986).

Nitrite concentrations were below the detection limit of 1.0 µg N/L for all the monthly sampling dates (Table 30). Nitrite is an unstable intermediate ion serving as an indicator of recent contamination from sewage and/or agricultural runoff; levels are typically <1.0 µg N/L (RISC 1998).

Nitrate concentrations ranged from 13.5 µg N/L to 31.9 µg N/L over the course of the sampling with the highest concentrations measured in the June and July (30.1 µg N/L and 31.9 µg N/L respectively) (Table 34). In oligotrophic lakes and streams, nitrate concentrations are usually lower than 100 µg N/L (Nordin and Pommen 1986).

Phosphorus

Orthophosphate was below the detection limit of 1.0 µg P/L or very close to the detection limit in all cases (Table 34). Very low orthophosphate concentrations are expected as it is a readily biologically available form of phosphorus and would be quickly taken up in nutrient limited streams. Coastal British Columbia streams typically have orthophosphate concentrations <1.0 µg P/L (Slaney and Ward 1993; Ashley and Slaney 1997).

Total phosphorus concentrations over the Year 1 sampling period were low ranging from 2.6 µg P/L to 5.0 µg P/L (Table 34).

Table 31. Quinsam River (QUN-WQ) general water quality parameters measured in-situ during Year 1, 2014.

Date	Specific Conductivity µS/cm				pH pH units				Air Temperature °C				Water Temperature °C			
	Avg[1]	Min	Max	SD	Avg[1]	Min	Max	SD	Avg[1]	Min	Max	SD	Avg[1]	Min	Max	SD
23-May	95.6	95.6	95.6	0.0	7.38	7.38	7.39	0.01	-	-	-	-	12.8	12.8	12.8	0.0
18-Jun	143.1	143.1	143.1	0.0	7.58	7.57	7.58	0.01	14	14	14	0	17.1	17.1	17.1	0.0
22-Jul	148.1	148.1	148.1	0.0	7.36	7.36	7.36	0.00	16	16	16	0	17.7	17.7	17.7	0.0
19-Aug	152.3	152.2	152.4	0.1	7.38	7.36	7.43	0.04	19	19	19	0	20.2	20.2	20.2	0.0
24-Sep	109.9	109.9	109.9	0.0	7.30	7.23	7.36	0.07	14	14	14	0	16.1	16.1	16.1	0.0
04-Nov	69.4	69.4	69.4	0.0	7.01	7.01	7.02	0.01	7	7	7	0	9.6	9.6	9.6	0.0

[1] Average of three replicates (n=3) on each date unless otherwise indicated.

Table 32. Quinsam River (QUN-WQ) dissolved gases measured in-situ during Year 1, 2014.

Date	Dissolved Oxygen %				Dissolved Oxygen mg/L				Barometric Pressure mm Hg				TGP mm Hg				TGP %				ΔP mm Hg			
	Avg[1]	Min	Max	SD	Avg[1]	Min	Max	SD	Avg[1]	Min	Max	SD	Avg[1]	Min	Max	SD	Avg[1]	Min	Max	SD	Avg[1]	Min	Max	SD
23-May	101.8	101.4	102.6	0.7	10.74	10.69	10.82	0.07	744	743	745	1	744	744	745	1	100	100	100	0	0	0	1	1
18-Jun	91.3	90.9	91.9	0.5	8.84	8.80	8.87	0.04	748	748	749	1	755	753	757	2	101	101	101	0	7	5	8	2
22-Jul	95.8	95.8	95.9	0.1	9.13	9.12	9.13	0.01	747	747	748	1	753	753	753	0	101	101	101	0	6	5	6	1
19-Aug	77.9	77.7	78.3	0.3	7.01	6.99	7.03	0.02	745	744	745	1	735	735	735	0	99	99	99	0	-10	-10	-9	1
24-Sep	91.7	90.1	92.7	1.4	8.78	8.53	8.91	0.21	753	752	753	1	739	739	740	1	98	98	98	0	-13	-14	-13	1
04-Nov	88.5	88.4	88.5	0.1	9.95	9.94	9.96	0.01	761	761	762	1	755	755	755	0	99	99	99	0	-6	-7	-6	1

[1] Average of three replicates (n=3) on each date unless otherwise indicated.

Blue Shading indicates that the more conservative provincial guideline (DO instantaneous minimum of 9 mg/L) for the protection of buried embryo/alevin has not been achieved. Note that the guideline for life stages other than buried embryo/alevin is not exceeded (DO instantaneous minimum of 5 mg/L).

Table 33. Quinsam River (QUN-WQ) general water quality parameters measured at ALS labs during Year 1, 2014.

Date	Site	Alkalinity (as CaCO3) mg/L				Specific Conductivity µS/cm				Total Dissolved Solids mg/L				Total Suspended Solids mg/L				Turbidity NTU				pH (lab) pH units			
		Avg[1]	Min	Max	SD	Avg[1]	Min	Max	SD	Avg[1]	Min	Max	SD	Avg[1]	Min	Max	SD	Avg[1]	Min	Max	SD	Avg[1]	Min	Max	SD
23-May	QUN-WQ	31.7	31.5	31.8	0.2	94.8	94.1	95.4	0.9	69	68	70	1	<1.0	<1.0	<1.0	0.0	0.59	0.52	0.65	0.09	7.77	7.77	7.77	0.00
	QUN-field blank	<2.0	-	-	-	<2.0	-	-	-	<10	-	-	-	<1.0	-	-	-	<0.10	-	-	-	5.60	-	-	-
	QUN-trip blank	<2.0	-	-	-	<2.0	-	-	-	<10	-	-	-	<1.0	-	-	-	<0.10	-	-	-	5.64	-	-	-
18-Jun	QUN-WQ	41.0	40.8	41.1	0.2	139.5	139.0	140.0	0.7	96	96	96	0	<1.0	<1.0	<1.0	0.0	0.42	0.40	0.44	0.03	7.87	7.87	7.87	0.00
	QUN-field blank	<2.0	-	-	-	<2.0	-	-	-	<10	-	-	-	<1.0	-	-	-	<0.10	-	-	-	5.47	-	-	-
	QUN-trip blank	<2.0	-	-	-	<2.0	-	-	-	<10	-	-	-	<1.0	-	-	-	<0.10	-	-	-	5.45	-	-	-
22-Jul	QUN-WQ	42.4	42.4	42.4	0.0	140.0	139.0	141.0	1.4	103	101	105	3	<1.0	<1.0	<1.0	0.0	0.46	0.44	0.47	0.02	7.73	7.65	7.81	0.11
	QUN-field blank	<2.0	-	-	-	<2.0	-	-	-	<10	-	-	-	<1.0	-	-	-	<0.10	-	-	-	5.69	-	-	-
	QUN-trip blank	<2.0	-	-	-	<2.0	-	-	-	<10	-	-	-	<1.0	-	-	-	<0.10	-	-	-	5.76	-	-	-
19-Aug	QUN-WQ	42.1	41.9	42.3	0.3	156.0	146.0	166.0	14.1	96	95	96	1	<1.0	<1.0	<1.0	0.0	0.70	0.47	0.93	0.33	7.81	7.57	8.05	0.34
	QUN-field blank	<2.0	-	-	-	<2.0	-	-	-	<10	-	-	-	<1.0	-	-	-	<0.10	-	-	-	5.91	-	-	-
	QUN-trip blank	<2.0	-	-	-	<2.0	-	-	-	<10	-	-	-	<1.0	-	-	-	<0.10	-	-	-	6.17	-	-	-
24-Sep	QUN-WQ	35.0	35.0	35.0	0.0	109.0	109.0	109.0	0.0	71	67	74	5	<1.0	<1.0	<1.0	0.0	0.56	0.50	0.62	0.08	7.55	7.52	7.58	0.04
	QUN-field blank	<2.0	-	-	-	<2.0	-	-	-	<10	-	-	-	<1.0	-	-	-	<0.10	-	-	-	5.45	-	-	-
	QUN-trip blank	<2.0	-	-	-	<2.0	-	-	-	<10	-	-	-	<1.0	-	-	-	<0.10	-	-	-	5.41	-	-	-
04-Nov	QUN-WQ	23.7	23.5	23.8	0.2	71.3	70.7	71.8	0.8	59	53	64	8	<1.0	<1.0	<1.0	0.0	0.74	0.71	0.77	0.04	7.61	7.59	7.63	0.03
	QUN-field blank	<2.0	-	-	-	<2.0	-	-	-	<10	-	-	-	<1.0	-	-	-	<0.10	-	-	-	5.70	-	-	-
	QUN-trip blank	<2.0	-	-	-	<2.0	-	-	-	<10	-	-	-	<1.0	-	-	-	<0.10	-	-	-	5.75	-	-	-

[1] Average of two duplicates (n=2) on each date unless otherwise indicated. For field and travel blanks n=1.

Parameters that have a concentration below the detection limit are assumed to have a concentration equal to the detection limit for calculation purposes.

Table 34. Quinsam River (QUN-WQ) low level nutrients measured at ALS labs during Year 1, 2014.

Date	Site	Ammonia, Total (as N) µg/L				Nitrate (as N) µg/L				Nitrite (as N) µg/L				Dissolved Orthophosphate (as P) µg/L				Total Phosphorus (P) µg/L			
		Avg[1]	Min	Max	SD	Avg[1]	Min	Max	SD	Avg[1]	Min	Max	SD	Avg[1]	Min	Max	SD	Avg[1]	Min	Max	SD
23-May	QUN-WQ	<5.0	<5.0	<5.0	0.0	13.8	13.5	14.0	0.4	<1.0	<1.0	<1.0	0.0	<1.0	<1.0	<1.0	0.0	3.9	3.8	3.9	0.1
	QUN-field blank	<5.0	-	-	-	<5.0	-	-	-	<1.0	-	-	-	<1.0	-	-	-	<2.0	-	-	-
	QUN-trip blank	<5.0	-	-	-	<5.0	-	-	-	<1.0	-	-	-	<1.0	-	-	-	<2.0	-	-	-
18-Jun	QUN-WQ	<5.0	<5.0	<5.0	0.0	29.7	29.2	30.1	0.6	<1.0	<1.0	<1.0	0.0	<1.0	<1.0	<1.0	0.0	2.8	2.7	2.9	0.1
	QUN-field blank	<5.0	-	-	-	<5.0	-	-	-	<1.0	-	-	-	<1.0	-	-	-	<2.0	-	-	-
	QUN-trip blank	<5.0	-	-	-	<5.0	-	-	-	<1.0	-	-	-	<1.0	-	-	-	<2.0	-	-	-
22-Jul	QUN-WQ	<5.0	<5.0	<5.0	0.0	31.6	31.3	31.9	0.4	<1.0	<1.0	<1.0	0.0	<1.0	<1.0	<1.0	0.0	2.9	2.6	3.2	0.4
	QUN-field blank	<5.0	-	-	-	<5.0	-	-	-	<1.0	-	-	-	<1.0	-	-	-	<2.0	-	-	-
	QUN-trip blank	27.1	-	-	-	<5.0	-	-	-	<1.0	-	-	-	<1.0	-	-	-	<2.0	-	-	-
19-Aug	QUN-WQ	<5.2	<5.0	5.3	0.2	17.1	17.0	17.1	0.1	<1.0	<1.0	<1.0	0.0	<1.0	<1.0	<1.0	0.0	4.8	4.6	5.0	0.3
	QUN-field blank	<5.0	-	-	-	<5.0	-	-	-	<1.0	-	-	-	<1.0	-	-	-	<2.0	-	-	-
	QUN-trip blank	38.7	-	-	-	<5.0	-	-	-	<1.0	-	-	-	<1.0	-	-	-	<2.0	-	-	-
24-Sep	QUN-WQ	<5.0	<5.0	<5.0	0.0	21.2	20.7	21.6	0.6	<1.0	<1.0	<1.0	0.0	<1.0	<1.0	<1.0	0.0	4.3	3.9	4.6	0.5
	QUN-field blank	<5.0	-	-	-	<5.0	-	-	-	<1.0	-	-	-	<1.0	-	-	-	<2.0	-	-	-
	QUN-trip blank	55.1	-	-	-	<5.0	-	-	-	<1.0	-	-	-	<1.0	-	-	-	<2.0	-	-	-
04-Nov	QUN-WQ	5.1	5.1	5.1	0.0	24.6	24.0	25.1	0.8	<1.0	<1.0	<1.0	0.0	<1.0	<1.0	<1.0	0.0	3.7	2.9	4.4	1.1
	QUN-field blank	<5.0	-	-	-	<5.0	-	-	-	<1.0	-	-	-	<1.0	-	-	-	<2.0	-	-	-
	QUN-trip blank	99.5	-	-	-	<5.0	-	-	-	<1.0	-	-	-	<1.0	-	-	-	<2.0	-	-	-

[1] Average of two duplicates (n=2) on each date unless otherwise indicated. For field and travel blanks n=1.

Parameters that have a concentration below the detection limit are assumed to have a concentration equal to the detection limit for calculation purposes.

3.2.2. Water and Air Temperature Monitoring

3.2.2.1. Salmon River

Baseline water temperature data were examined to characterize the thermal regime of the Salmon River at SAM-WQ. The water temperature measurements are depicted in Figure 22 and the mean, minimum, and maximum water temperatures for each month of the record are summarized in Table 35.

The highest monthly-mean temperature of 18.7°C occurred in August, 2014. During the monitoring period the coolest temperature measurement was 10.2°C in June, and the warmest temperature measurement was 23.3°C measured in August (Table 35).

Figure 22. Water temperature in the Salmon River (SAM-WQ) from May to October, 2014.

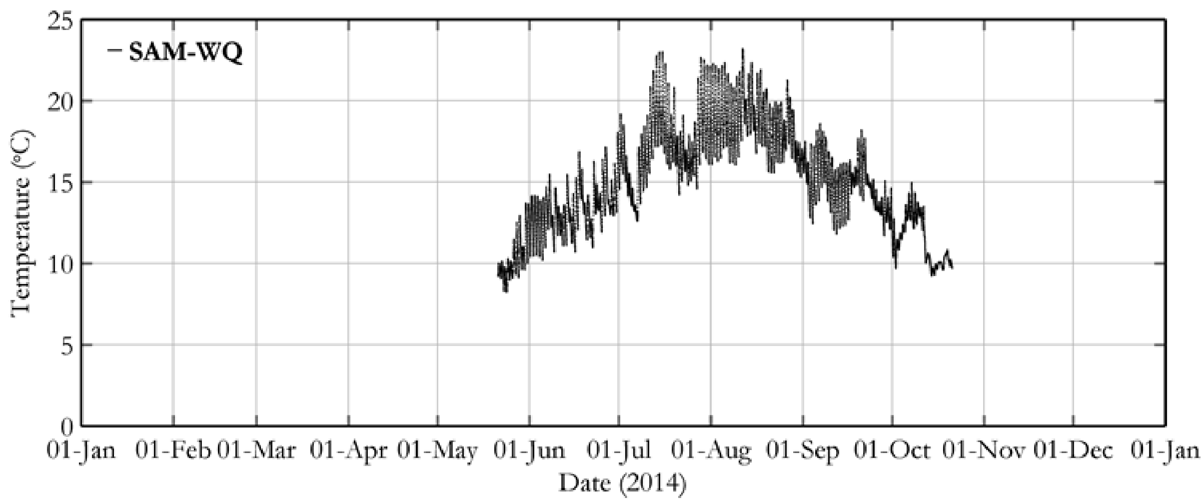


Table 35. Monthly water temperature statistics at SAM-WQ in the Salmon River.

Year	Month	SAM-WQ			
		Avg	Min	Max	SD
2014	May	-	-	-	-
	Jun	13.3	10.2	18.0	1.4
	Jul	17.2	12.6	23.0	2.3
	Aug	18.7	15.3	23.2	1.7
	Sep	14.9	11.7	18.6	1.5
	Oct	-	-	-	-

Months with less than three weeks of data were not included.

The water temperature records for the Salmon River indicate occurrences of warm water temperatures. Over the period of record (152 days), there were 35 days (23%) with daily-mean temperatures above 18°C (maximum guideline mean weekly temperature for salmonid rearing; Table 16), as well as five occurrences of daily mean temperature above 20°C (Table 36).

Large, rapid temperature changes can affect fish growth and survival (Oliver and Fidler 2001), thus rates of change in water temperature at SAM-WQ were examined and are summarized in Table 37 and presented in Figure 23. The hourly rates of temperature change were between -0.4°C/hr and +0.8°C/hr for at least 90% of the time (based on the 5th and 95th percentiles), and were between -0.4°C/hr and +1.0°C/hr for at least 98% of the time (based on the 1st and 99th percentiles).

The maximum positive rate of water temperature change varied from 0.8°C/hr to 1.3°C/hr and the negative rate of water temperature change varied from -0.4°C/hr to -0.8°C/hr. The majority of rates of hourly temperature change were within ± 1°C/hr (Table 37). Based on our experience on other streams in British Columbia, it is normal for a small percentage of data points to have hourly rates of water temperature change that exceed ±1°C, and when water temperature decreases faster than 1°C/hr it is usually associated with a rainfall event.

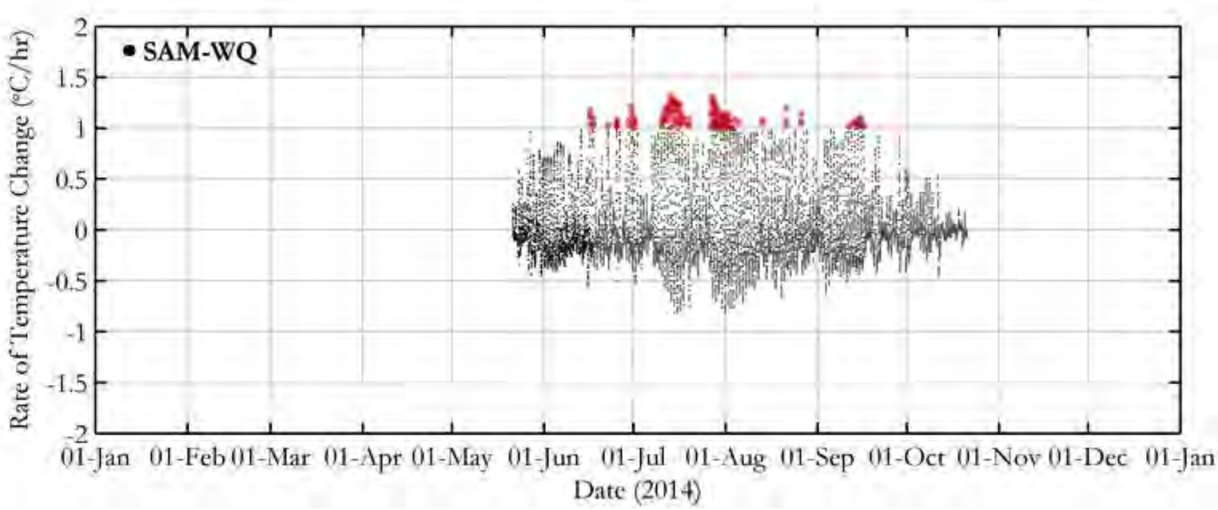
Table 36. Summary of the number of days with mean daily water temperatures >18°C and >20°C in the Salmon River at SAM-WQ.

Site	Year	Record Length (days)	Days T_{water}> 20°C	Days T_{water}> 18°C
SAM-WQ	2014	152	2 (13%)	35 (23%)

Table 37. Statistics for the hourly rates of change in water temperature at SAM-WQ in the Salmon River. Shown is the frequency of rates of change exceeding a magnitude of 1°C/hr.

Start Date of record	End Date of record	Number of Datapoints	Occurrence of rates >1°C/hr		Max -ve	Percentile				Max +ve
			Number	% of record		1th	5th	95th	99th	
21-May-2014	21-Oct-2014	14,679	163	1.1	-0.8	-0.6	-0.4	0.8	1.0	1.3

Figure 23. Rate of change in hourly water temperature in the Salmon River (SAM-WQ) from May to October, 2014.



Air temperature data are summarized in Table 38. The lowest air temperature measured during the monitoring period was 4.5°C measured in September, while the highest air temperature was 31.5°C in August. The maximum monthly mean air temperature (17.8°C) was in August, 2014.

Table 38. Monthly air temperature statistics at SAM-WQ in the Salmon River

Year	Month	SAM-AT			
		Avg	Min	Max	SD
2014	May	-	-	-	-
	Jun	13.7	7.0	22.7	3.3
	Jul	16.9	8.1	29.7	4.3
	Aug	17.8	9.2	31.5	4.3
	Sep	13.7	4.5	25.7	4.1
	Oct	9.9	1.2	16.3	2.8
	Nov	-	-	-	-

Months with less than three weeks of data were not included.

3.2.2.2. Quinsam River

Water temperature data were examined to characterize the thermal regime of the Quinsam River at QUN-WQ for the monitoring period. The water temperature records are depicted Figure 24 and the mean, minimum, and maximum water temperatures for each month of the record are summarized in Table 39.

Figure 24. Water temperature in the Quinsam River (QUN-WQ) from May to November, 2014.

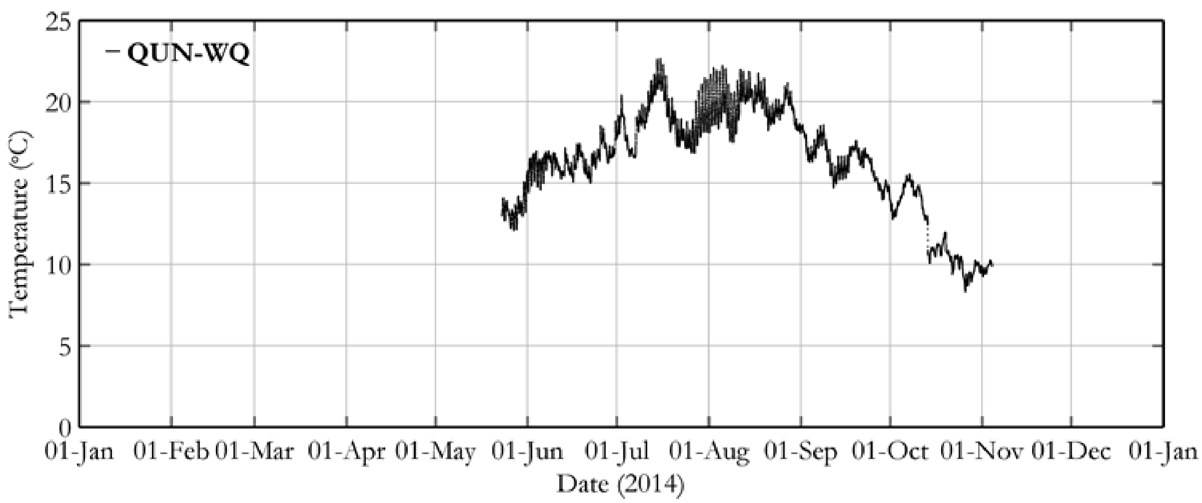


Table 39. Monthly water temperature statistics at QUN-WQ in the Quinsam River.

Year	Month	QUN-WQ Avg	Min	Max	SD
2014	May	-	-	-	-
	Jun	16.3	14.4	18.8	0.7
	Jul	18.9	16.5	22.7	1.4
	Aug	19.8	17.5	22.2	1.0
	Sep	16.3	13.9	18.6	1.1
	Oct	11.8	8.3	15.5	2.1
	Nov	-	-	-	-

Months with less than three weeks of data were not included.

The highest monthly-mean water temperature of 19.8°C occurred in August, 2014. During the monitoring period the coolest temperature recorded was 8.3°C measured in October and the warmest temperature was 22.7°C measured in July (Table 39).

The water temperature records for the Quinsam River indicate occurrences of extremely warm water temperatures. Over the period of record (164 days), there were 54 days (33%) with daily-mean temperatures above 21°C, as well as 21 (13%) occurrences of daily mean temperature above 20°C (Table 40).

Large, rapid temperature changes can affect fish growth and survival (Oliver and Fidler 2001), thus rates of change in water temperature at QUN-WQ were examined and are summarized Table 41 and presented in Figure 25. The hourly rates of temperature change at the monitoring stations were between -0.2°C/hr and +0.3°C/hr for at least 90% of the time (based on the 5th and 95th percentiles) and were between -0.4°C/hr and +0.5°C/hr for at least 98% of the time (based on the 1st and 99th percentiles).

The maximum positive rate of water temperature change varied from 0.3°C/hr to 0.9°C/hr, and the negative rate of water temperature change varied from -0.2°C/hr to -1.3°C/hr. The majority of rates of hourly temperature change were within ± 1°C/hr (Table 41).

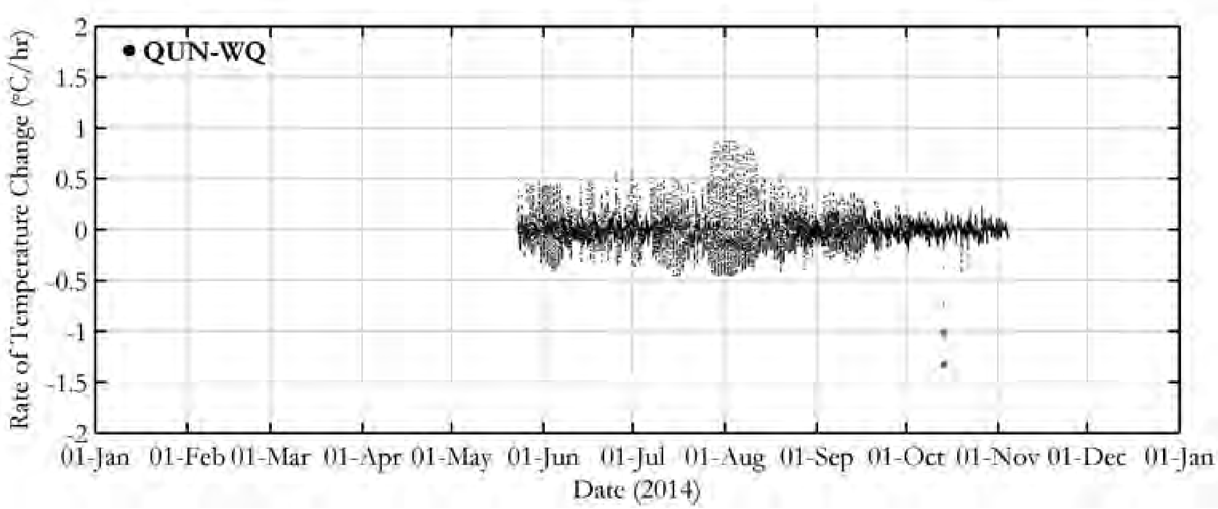
Table 40. Summary of the number of days with mean daily water temperatures >18°C and >20°C in the Quinsam River at QUN-WQ.

Site	Year	Record Length (days)	Days T_{water}> 20°C	Days T_{water}> 18°C
QUN-WQ	2014	164	21 (13%)	54 (33%)

Table 41. Statistics for the hourly rates of change in water temperature at QUN-WQ in the Quinsam River. Shown is the frequency of rates of change exceeding a magnitude of 1°C/hr.

Start Date of record	End Date of record	Number of Datapoints	Occurrence of rates >1°C/hr		Max -ve	Percentile				Max +ve
			Number	% of record		1th	5th	95th	99th	
23-May-2014	4-Nov-2014	15,839	4	0.0	-1.3	-0.4	-0.2	0.3	0.5	0.9

Figure 25. Rate of change in hourly water temperature in the Quinsam River (QUN-WQ) from May to November, 2014.



Air temperature data are summarized in Table 42. The maximum monthly mean air temperature (17.8°C) was in August, 2014. The lowest air temperature measured during the monitoring period was -7.0°C measured in November, while the highest air temperature of 31.5°C occurred in July.

Table 42. Monthly air temperature statistics at QUN-WQ in the Quinsam River

Year	Month	QUN-AT			
		Avg	Min	Max	SD
2014	May	-	-	-	-
	Jun	14.3	5.3	23.4	3.6
	Jul	17.8	8.8	31.5	4.6
	Aug	18.6	9.4	30.0	4.4
	Sep	14.1	5.1	26.3	4.1
	Oct	10.1	1.6	17.9	2.8
	Nov	3.1	-7.0	12.1	4.5

Months with less than three weeks of data were not included.

3.3. Invertebrate Drift

3.3.1. Salmon River Invertebrate Drift

The mean invertebrate drift density (individuals/m^3), biomass (mg/m^3), Simpson's family-level diversity index (1-λ), richness (# families), and CEFI index at each site on each sample date are provided in Table 43, along with the standard deviations and coefficients of variation. The means and standard deviations for each of these parameters are plotted in Figure 26, Figure 27, Figure 28, Figure 29, and Figure 30 respectively. In all cases other than the CEFI index (where only aquatic taxa are considered), the results are for all taxa (aquatic, semi-aquatic, and terrestrial). Numbers provided in the text below are mean ± standard deviation.

3.3.1.1. Density

The invertebrate drift density in Salmon River was variable across sampling dates, increasing from spring through mid-summer, and then declining into late summer and fall (Figure 26). Mean density values were lowest during spring (0.72 ± 0.29 individuals/m^3 on June 11, 2014 and 0.85 ± 0.26 individuals/m^3 on May 21, 2014) and fall (0.89 ± 0.21 individuals/m^3 on November 4, 2014) sampling, and peaked in mid-summer (3.11 ± 1.43 individuals/m^3 on August 18, 2014) (Table 43 and Figure 26). Density values remained relatively constant during the weekly sampling period in June, ranging from 0.72 ± 0.29 individuals/m^3 to 1.10 ± 0.37 individuals/m^3 (Table 43 and Figure 26). Density values were also highly variable across samples collected on the same sample date, with the coefficient of variation ranging from 16.20% to 46.04% (Table 43).

3.3.1.2. Biomass

The invertebrate drift biomass in Salmon River was also highly variable across sampling dates (Figure 27), with greater biomass generally being observed in spring compared to summer and fall. Mean biomass values peaked in spring, with a value of 0.12 ± 0.03 mg/m^3 on June 3, 2014 (Table 43 and Figure 27). The lowest biomass occurred during sampling on September 23, 2014, where an average biomass value of 0.04 ± 0.01 mg/m^3 was observed (Table 43 and Figure 27). Similar to density, biomass values were also highly variable across samples collected on the same sample date, with the coefficient of variation ranging from 23.50% to 113.95% (Table 43).

3.3.1.3. Simpson's Family Level Diversity (1- λ)

Mean Simpson's family level diversity values were highest in the spring (0.90 ± 0.019 on June 3, 2014) and fall (0.90 ± 0.008 on September 23, 2014), and lowest in the summer (0.75 ± 0.039 on August 18, 2014) (Table 43 and Figure 28). Diversity values appear to follow an inverse trend when compared to density (see Figure 26 and Figure 28), suggesting that the high density values observed in summer are a result of high invertebrate populations for a subset of taxa, rather than an overall increase in invertebrate population size across all species. Compared to density and biomass, diversity values showed relatively low variability across samples collected on the same sample date, with coefficient of variation values ranging from 0.85% to 5.12% (Table 43).

3.3.1.4. Richness (# of Families)

Similar to diversity results, mean family richness values were highest in the spring (41.8±5.8 families on May 21, 2014) and fall (42.4 ± 5.6 families on November 3, 2014), and lowest in the summer (20.8 ± 3.7 families on July 23, 2014) (Table 43 and Figure 29). Compared to density and biomass, richness values showed relatively low variability across samples collected on the same sample date, with the coefficient of variation ranging from 7.4% to 45.3% (Table 43).

3.3.1.5. Canadian Ecological Flow Index

Mean CEFI results show no apparent seasonal trend (Figure 30). The highest mean CEFI value of 0.37 was observed on two dates in the spring (May 21, 2014 and June 17, 2014) and on November 3, 2014 (Table 43 and Figure 30). On the remaining sample dates, the CEFI index ranged from 0.33 to 0.34 (Table 43 and Figure 30). Compared to all other parameters, CEFI showed the lowest variability between samples collected on the same sample date, with the coefficient of variation ranging from 1.52% to 3.91% (Table 43).

Table 43. Salmon River invertebrate drift mean density (individuals/m^3), biomass (mg/m^3), Simpson's diversity index (1-λ, family level), richness (# of families) and CEFI index.

	All Taxa (Aquatic, Semi-Aquatic, and Terrestrial)														
Sample Date	Density (#/m^3)			Biomass (mg/m^3)			Simspon's Diversity Index (1-λ)			Richness (# of Families)			CEFI Index†		
	Mean	S.D.	C.V.	Mean	S.D.	C.V.	Mean	S.D.	C.V.	Mean	S.D.	C.V.	Mean	S.D.	C.V.
21-May-2014	0.85	0.26	30.06	0.11	0.033	31.09	0.86	0.019	2.22	41.8	5.8	13.9	0.37	0.0069	1.86
03-Jun-2014	0.92	0.24	25.77	0.12	0.034	29.09	0.90	0.019	2.16	41.6	8.8	21.2	0.34	0.010	2.80
11-Jun-2014	0.72	0.29	40.33	0.037	0.010	27.14	0.89	0.020	2.24	25.4	4.3	17.1	0.34	0.0075	2.19
17-Jun-2014	1.10	0.37	34.00	0.062	0.031	49.98	0.84	0.015	1.76	28.6	7.0	24.6	0.37	0.0084	2.28
26-Jun-2014	0.86	0.33	38.49	0.10	0.115	113.95	0.87	0.031	3.63	27.2	12.3	45.3	0.35	0.010	2.91
23-Jul-2014	1.48	0.52	35.28	0.056	0.025	45.09	0.82	0.034	4.13	20.8	3.7	17.8	0.33	0.013	3.91
18-Aug-2014	3.11	1.43	46.04	0.066	0.028	41.65	0.75	0.039	5.12	22.4	4.3	19.4	0.34	0.0066	1.92
23-Sep-2014	1.28	0.21	16.20	0.036	0.0085	23.50	0.90	0.008	0.85	22.2	1.6	7.4	0.34	0.0052	1.52
03-Nov-2014	0.89	0.21	23.50	0.063	0.012	18.80	0.89	0.029	3.27	42.4	5.6	13.2	0.37	0.011	2.97

† Calculation considers only aquatic taxa

Figure 26. Salmon River mean invertebrate drift density (individuals/m³) ± SD.

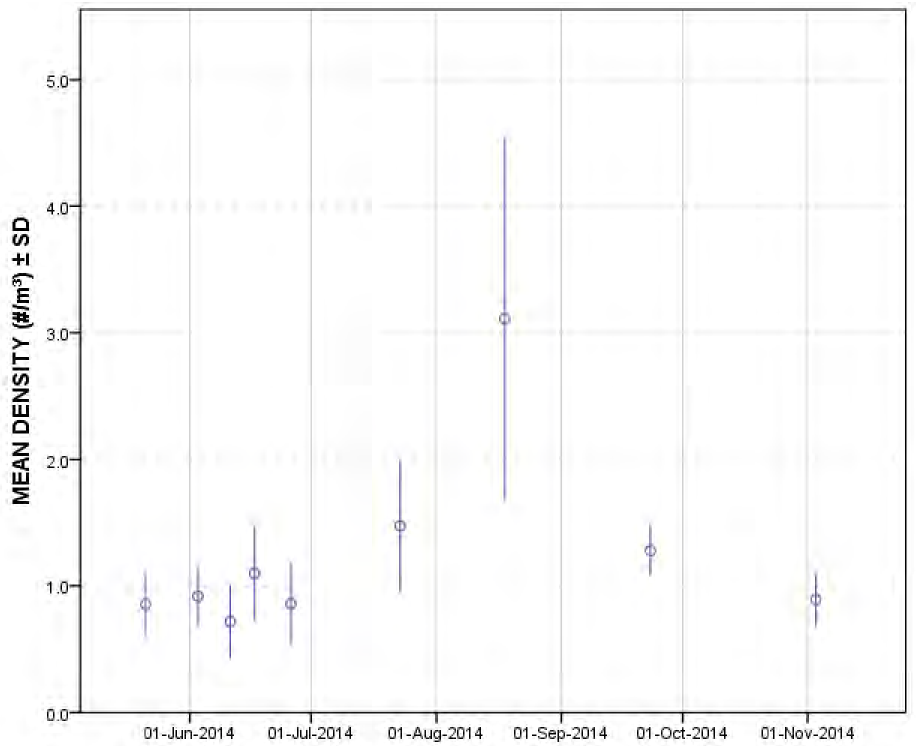


Figure 27. Salmon River mean invertebrate drift biomass (mg/m³) ± SD.

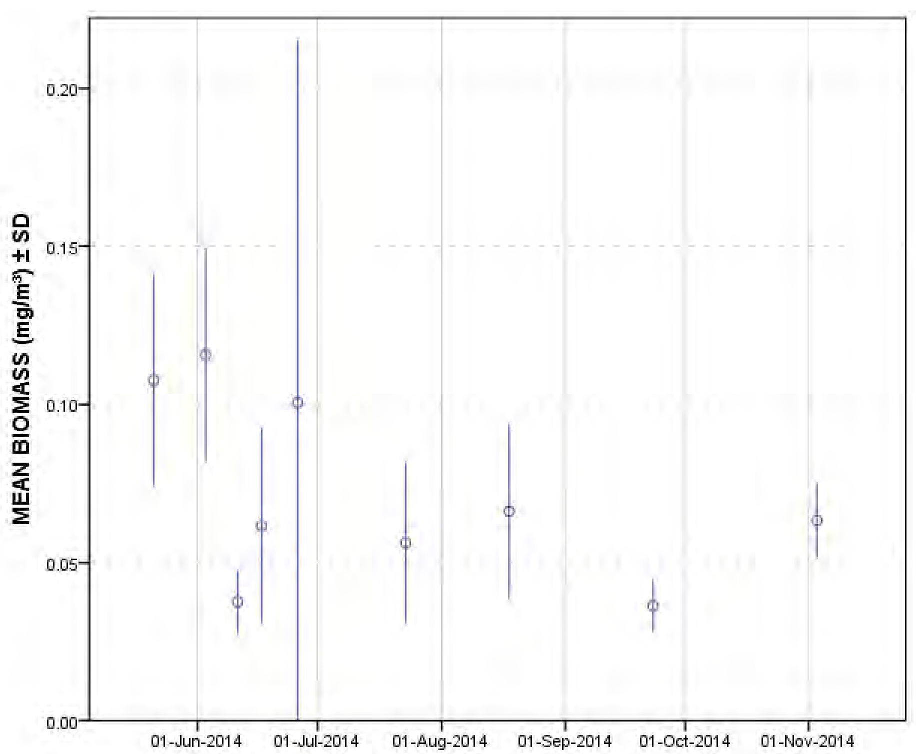


Figure 28. Salmon River mean family level Simpson's diversity index (1- λ) ± SD.

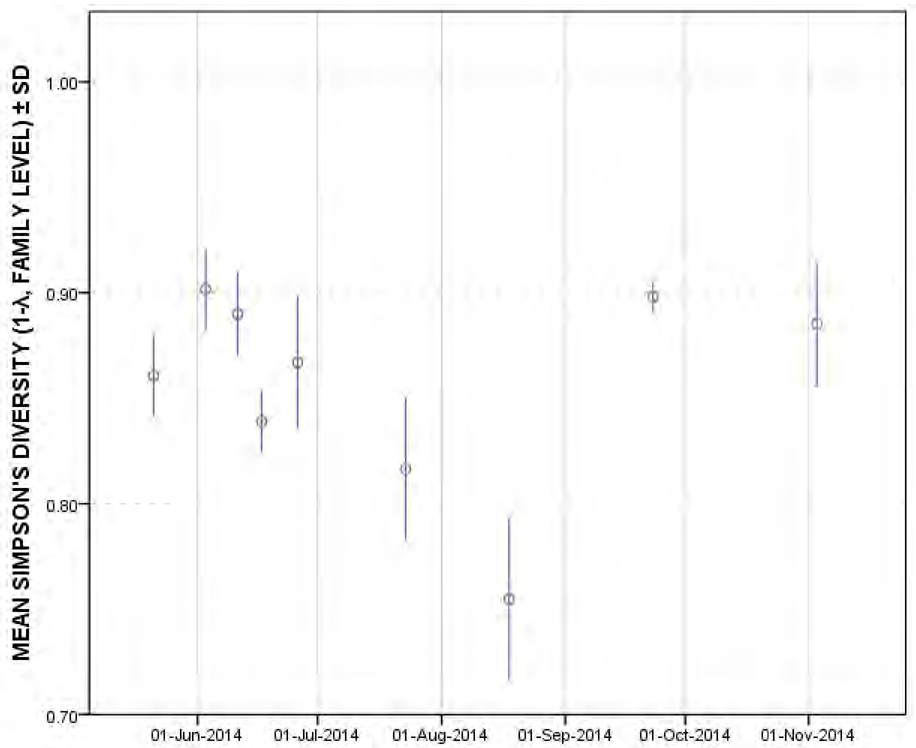


Figure 29. Salmon River mean family richness (# of families) ± SD.

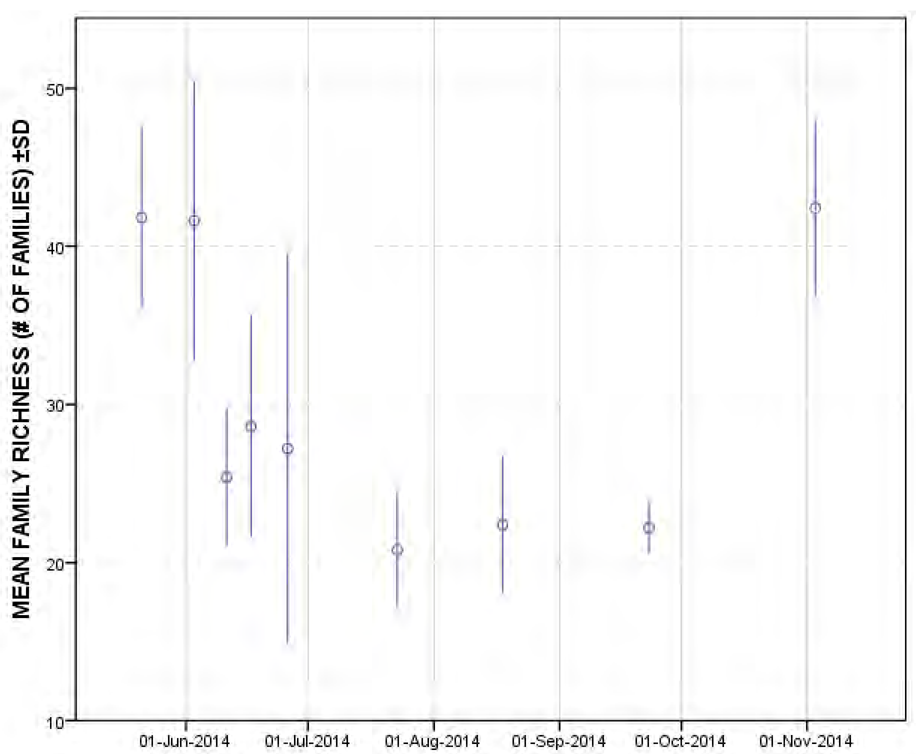
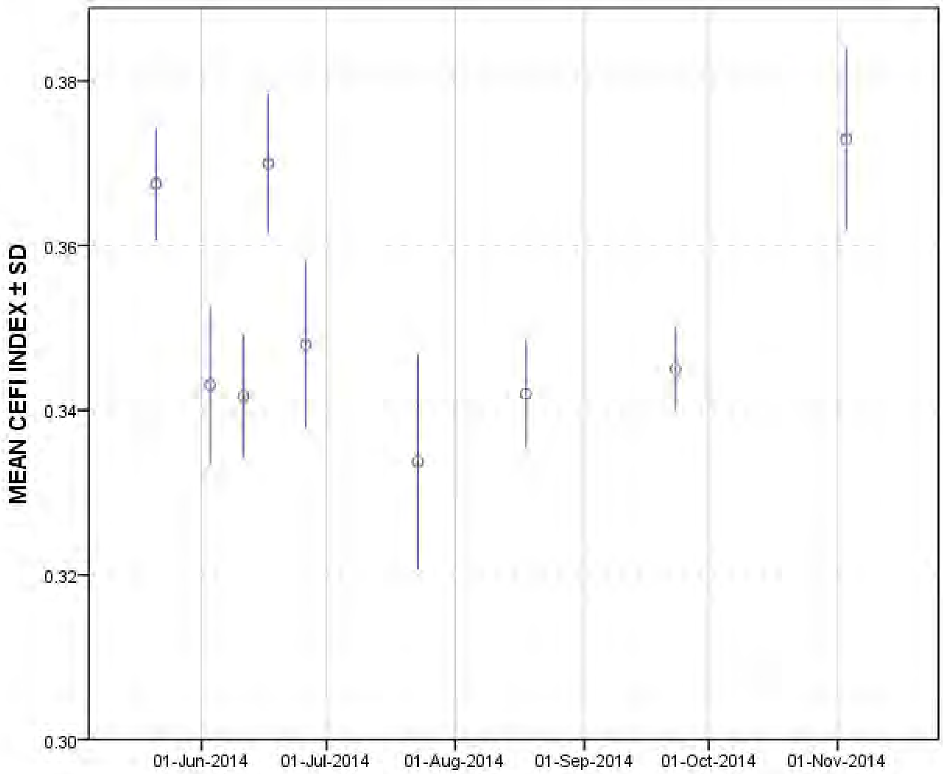


Figure 30. Salmon River mean CEFI index ± SD.



3.3.1.6. Top Five Families Contributing to Biomass

A summary of the top five families contributing to biomass in the invertebrate drift community on each sample date is provided in Table 44. Note that in some instances (e.g., Ephemeroptera), a taxonomic level higher than family is provided, as this was the lowest taxonomic resolution available in such cases. The invertebrate community was dominated (in terms of biomass) by mayflies (Baetidae, Heptageniidae, Ephemeroptera, and Ephemerellidae), caddisflies (Limnephilidae, Lepidostomatidae, Polycentropodidae, Rhyacophilidae, and Hydropsychidae), and true flies (Chironomidae, Simuliidae, Empididae, and Dixidae). Mites (Hygrobatidae, Torrenticolidae, and Sperchontidae), Beetles (Carabidae and Gyrinidae), sawflies (Tenthredinidae) and stoneflies (Chloroperlidae) were also occasionally within the top five families during sampling.

Considering all samples, Baetidae (mayflies) were among the top contributors to biomass on 7 of the 9 sample dates, and were the top contributor on two of these dates (with contributions of 28.3% and 19.5%). Baetidae was the second top contributor to biomass on three of the 9 sample dates, with contributions ranging from 10.6% to 14.4%.

Heptageniidae (mayflies) appeared in the top five contributors to biomass on 4 of the 9 sample dates, and were the top contributor in three dates (contributions ranging from 14.0% to 17.3%).

Chironomidae was a top five contributors to biomass on five on the 9 sample dates. It was the top contributor to biomass in two dates (contributions of 19.4% and 13.0%).

Tenthredinidae (Sawflies) were the top contributor to biomass on June 26, 2014, contributing 30.0% of the total biomass. Tenthredinidae was not a top five contributor to biomass on any other sample date.

Caddisflies (primarily Lepidostomatidae and Limnephilidae) were among the top five contributors to biomass on all samples dates in the spring and fall, but were not among the top five contributors to biomass during summer sampling dates.

Table 44. Salmon River top five families contributing to invertebrate drift biomass.

21-May-2014		3-Jun-2014		11-Jun-2014		17-Jun-2014		26-Jun-2014	
Family	% of Total Biomass	Family	% of Total Biomass	Family	% of Total Biomass	Family	% of Total Biomass	Family	% of Total Biomass
Heptageniidae	15.5	Limnephilidae	18.9	Baetidae	19.5	Heptageniidae	14.0	Tenthredinidae	30.0
Lepidostomatidae	12.8	Lepidostomatidae	13.7	Limnephilidae	14.4	Baetidae	10.6	Ephemeroptera	9.6
Baetidae	12.2	Heptageniidae	9.5	Chironomidae	9.3	Lepidostomatidae	9.0	Gyrinidae	6.2
Limnephilidae	11.6	Baetidae	8.7	Torrenticolidae	5.5	Ephemeroptera	8.6	Empididae	5.2
Ephemerellidae	8.3	Ephemeroptera	7.7	Polycentropodidae	5.2	Carabidae	7.8	Ephemerellidae	5.0

23-Jul-2014		18-Aug-2014		23-Sep-2014		3-Nov-2014	
Family	% of Total Biomass	Family	% of Total Biomass	Family	% of Total Biomass	Family	% of Total Biomass
Baetidae	28.3	Chironomidae	19.4	Chironomidae	13.0	Heptageniidae	17.3
Chironomidae	15.7	Baetidae	14.4	Sperchontidae	9.0	Baetidae	14.1
Ephemeroptera	10.0	Simuliidae	10.4	Rhyacophilidae	9.0	Lepidostomatidae	6.1
Hygrobatidae	9.3	Ameletidae	9.8	Dixidae	8.4	Chironomidae	6.0
Torrenticolidae	9.0	Chloroperlidae	9.4	Ephemerellidae	7.5	Hydropsychidae	3.9

Mayflies	Stoneflies	Caddisflies	True Flies	Mites	Beetles	Sawflies

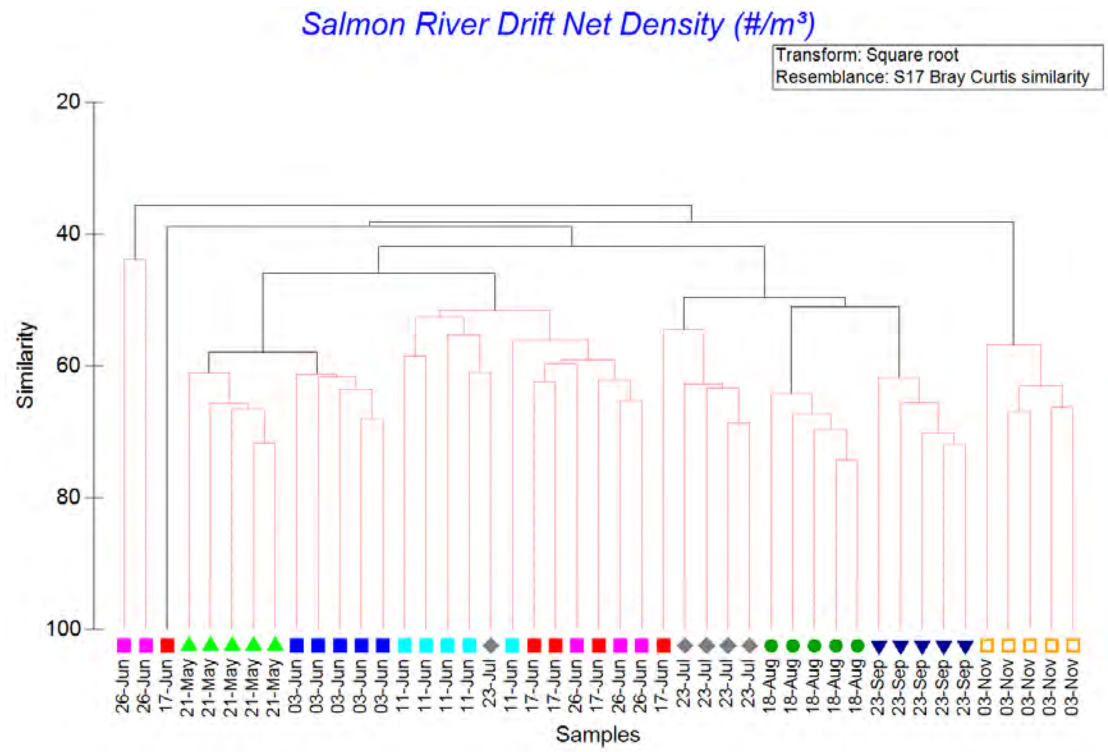
3.3.1.7. Multivariate Analysis

The results of the cluster analysis performed on the Bray-Curtis similarity matrices (generated from density data) is provided in the dendrograms in Figure 31; data from the highest available taxonomic resolution were analyzed using density data from each replicate on each date (Figure 31a) and using mean density on each sample date (Figure 31b). Black lines indicate branching of groups with a dissimilar community composition at a 5% significance level (SIMPROF test); red lines denote groups that are not significantly different in their community composition at a 5% significance level (Simprof test). The analyses indicate that there is a seasonal trend in community composition. Samples collected in late fall (November 3, 2014) have the least similar invertebrate drift community composition compared to the other sample dates. June 11, 17, & 26, 2014 samples are not significantly different from each other in terms of the invertebrate community composition. Samples collected on May 21, 2014 and June 3, 2014 show similar community compositions, as do samples collected on July 23, 2014 and August 18, 2014 and September 23, 2014.

The multi-dimensional scaling (MDS) on the Bray Curtis similarity matrices (generated from density data at the highest taxonomic resolution available in the dataset) is shown in an ordination plot in Figure 32, where points that are close together represent samples that are very similar in community composition and points that are far apart correspond to samples with very different community composition. MDS plots were generated using density data from each replicate on each sample date (Figure 32a) and using mean density on each sample date (Figure 32b). The MDS generated from individual replicates has a stress value of 0.17 and the MDS generated from the mean density data at each site on each data has a stress value of 0.04. Stress values ≤0.1 correspond to a good ordination with no real prospect of a misleading interpretation with respect to differences in community composition among samples (Clarke and Warwick 2001). Stress values between 0.1 and 0.2 provide a useful 2-dimensional MDS representation as long as there is agreement in groupings between dendrograms (i.e. Figure 31a) and the MDS plot (i.e. Figure 32a) (Clark and Warwick 2001). The similarities displayed in Figure 32a are those from Figure 31a and suggest that the representation of the invertebrate community in the MDS plot is accurate (i.e., the differences in the community composition are greatest among seasons). This is supported by the similar result using the average density data on each date where the stress value was <0.1 (Figure 32b).

Figure 31. **Salmon River cluster analysis results on the Bray-Curtis similarity matrix, a) by sample, and b) by date.**

a)



b)

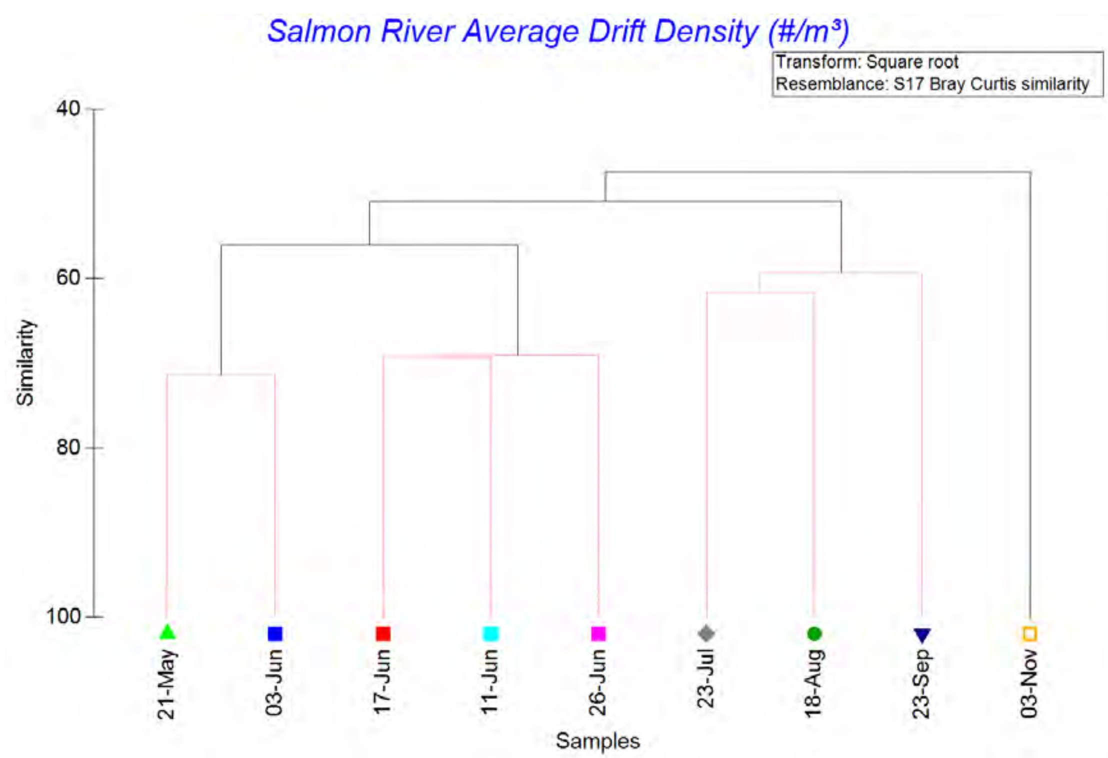
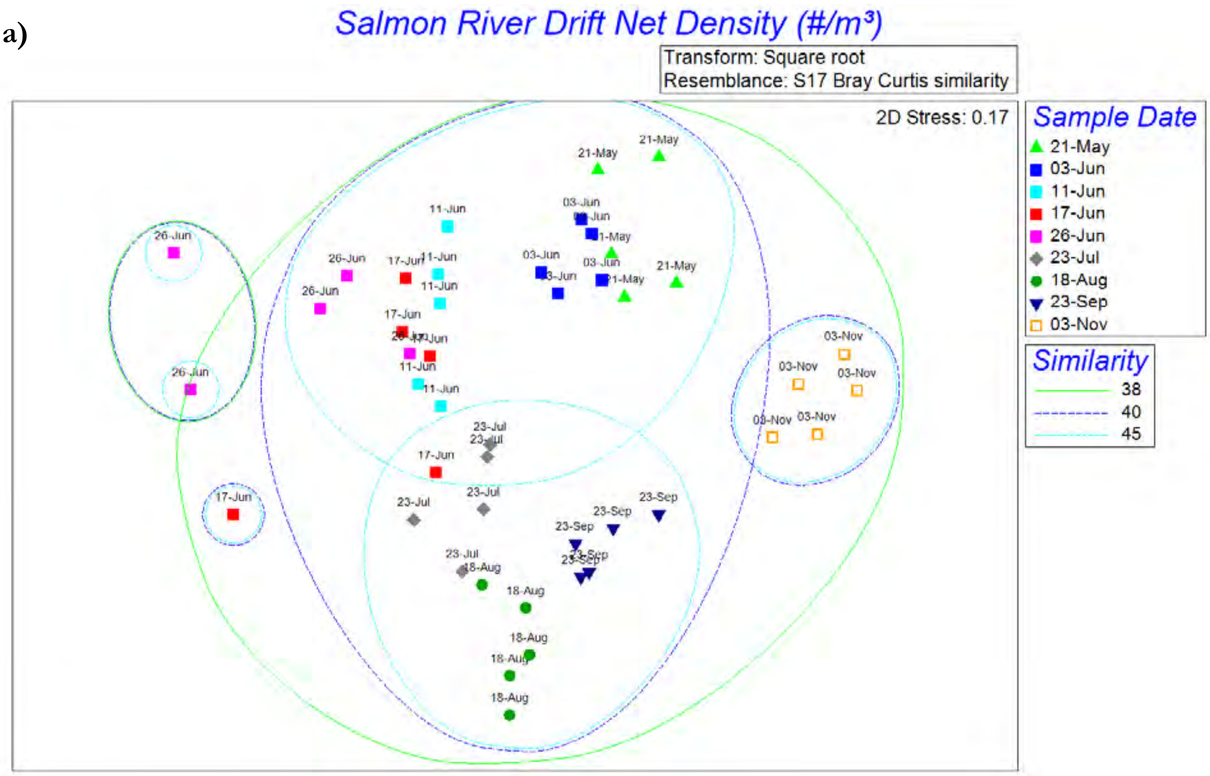
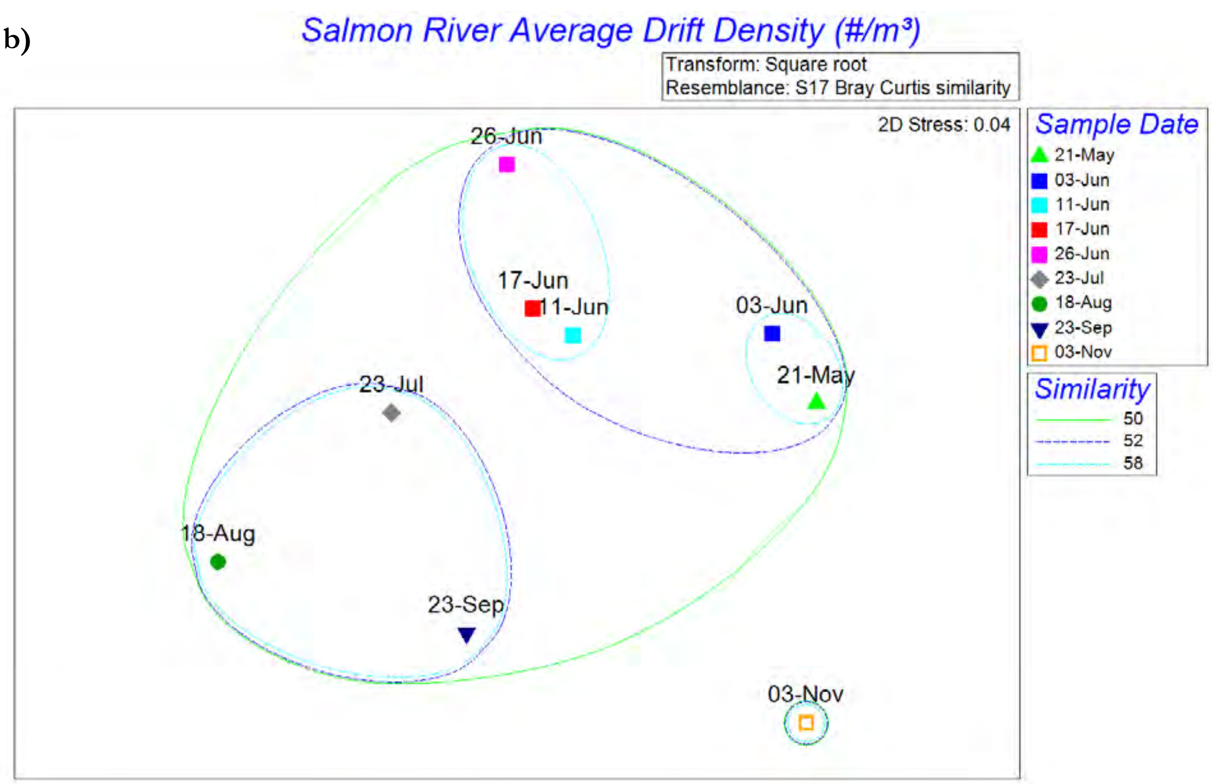


Figure 32. Salmon River non-metric, MDS ordination plot, a) by sample, b) by date.

a)



b)



3.3.2. Quinsam River Invertebrate Drift

The mean invertebrate drift density (individuals/m^3), biomass (mg/m^3), Simpson's family-level diversity index (1-λ), richness (# families), and CEFI index at each site on each sample date are provided in Table 45, along with the standard deviations and coefficients of variation. The means and standard deviations for each of these parameters are plotted in Figure 33, Figure 34, Figure 35, Figure 36, and Figure 37 respectively. In all cases other than the CEFI index (where only aquatic taxa are considered), the results are for all taxa (aquatic, semi-aquatic, and terrestrial). Numbers provided in the text below are mean ± standard deviation.

3.3.2.1. Density

The invertebrate drift density in Quinsam River was highly variable across sampling dates, increasing from spring through mid-summer, and then declining into late summer and fall (Figure 33). Mean density values were lowest during early spring (0.96 ± 0.12 individuals/m^3 on May 23, 2014) and fall (0.65 ± 0.22 individuals/m^3 on November 4, 2014) sampling, and peaked in mid-summer (6.88 ± 3.26 individuals/m^3 on August 19, 2014) (Table 45 and Figure 33). Density values remained relatively constant during weekly sampling in June, ranging from 2.47 ± 0.45 individuals/m^3 to 3.12 ± 0.64 individuals/m^3 (Table 45 and Figure 33). Density values were also highly variable across samples collected on the same sample date, with the coefficient of variation ranging from 8.06% to 47.47% (Table 45).

3.3.2.2. Biomass

The invertebrate drift biomass in the Quinsam River was also highly variable across sampling dates (Figure 34), being highest in the spring and decreasing through summer and fall. Mean biomass values peaked with a value of 0.36 ± 0.065 mg/m^3 on June 4, 2014 (Table 45 and Figure 34). The lowest biomass occurred during sampling on November 4, 2014, with an average biomass value of 0.065 ± 0.022 mg/m^3 (Table 45 and Figure 34). Similar to density, biomass values were also highly variable across samples collected on the same sample date, with the coefficient of variation ranging from 14.07% to 35.64% (Table 45).

3.3.2.3. Simpson's Family Level Diversity (1- λ)

Mean Simpson's family level diversity values were highest in the spring (0.84 ± 0.019 on May 23, 2014) and fall (0.91 ± 0.034 on November 4, 2014), and lowest in the summer (0.68 ± 0.141 on August 19, 2014) (Table 45 and Figure 35). Diversity values appear to follow an inverse trend when compared to the pattern in density (see Figure 33 and Figure 35), suggesting that the high density values observed in summer are a result of high invertebrate populations for a subset of taxa, rather than an overall increase in invertebrate population size across all species. Compared to density and biomass, diversity values showed relatively low variability across samples collected on the same sample date, with coefficient of variation values ranging from 2.20% to 20.73% (Table 45).

3.3.2.4. Richness (# of Families)

Mean family richness results show no apparent seasonal trend, although there was notably higher richness in November compared to May through September (Figure 36). Mean richness ranged from 30.2 ± 6.6 families on June 18, 2014 to 44.2 ± 7.8 families on November 4, 2014 (Table 45 and Figure 36). Compared to density and biomass, richness values showed relatively low variability across samples collected on the same sample date, with the coefficient of variation ranging from 4.1% to 21.9% (Table 45).

3.3.2.5. Canadian Ecological Flow Index

Mean CEFI values show a generally declining trend from spring through to fall (Figure 37). The highest mean CEFI value of 0.37 ± 0.011 was observed on May 23, 2014, while the lowest mean CEFI value of 0.32 ± 0.011 was observed on September 24, 2014 (Table 45 and Figure 37). Compared to all other parameters, CEFI showed the lowest variability between samples collected on the same sample date, with the coefficient of variation ranging from 0.64% to 4.50% (Table 45).

Table 45. Quinsam River invertebrate drift mean density (individuals/m^3), biomass (mg/m^3), Simpson's diversity index (1-λ, family level), richness (# of families) and CEFI index.

All Taxa (Aquatic, Semi-Aquatic, and Terrestrial)															
Sample Date	Density (#/m^3)			Biomass (mg/m^3)			Simspon's Diversity Index (1-λ)			Richness (# of Families)			CEFI Index†		
	Mean	S.D.	C.V.	Mean	S.D.	C.V.	Mean	S.D.	C.V.	Mean	S.D.	C.V.	Mean	S.D.	C.V.
23-May-2014	0.96	0.12	12.52	0.20	0.041	21.16	0.84	0.019	2.20	37.8	4.0	10.5	0.37	0.011	2.83
04-Jun-2014	2.74	0.22	8.06	0.36	0.057	15.97	0.78	0.028	3.58	33.0	4.7	14.2	0.36	0.016	4.50
12-Jun-2014	2.58	0.30	11.72	0.21	0.065	31.35	0.74	0.035	4.79	32.6	4.2	12.8	0.36	0.0085	2.36
18-Jun-2014	3.12	0.64	20.61	0.17	0.063	36.87	0.76	0.022	2.83	30.2	6.6	21.9	0.36	0.0059	1.62
27-Jun-2014	2.47	0.45	18.36	0.14	0.046	33.23	0.80	0.028	3.55	33.6	5.2	15.4	0.35	0.0073	2.09
22-Jul-2014	4.19	0.73	17.47	0.14	0.019	14.07	0.81	0.022	2.77	30.6	5.6	18.3	0.36	0.0023	0.64
19-Aug-2014	6.88	3.26	47.47	0.16	0.025	15.66	0.68	0.14	20.73	36.6	3.6	10.0	0.35	0.0064	1.85
24-Sep-2014	2.36	0.85	35.86	0.087	0.031	35.64	0.80	0.069	8.57	32.6	1.3	4.1	0.32	0.011	3.35
04-Nov-2014	0.65	0.22	33.38	0.065	0.022	33.45	0.91	0.034	3.76	44.2	7.8	17.7	0.33	0.0052	1.57

† Calculation considers only aquatic taxa

Figure 33. Quinsam River mean invertebrate drift density (individuals/m³) ± SD.

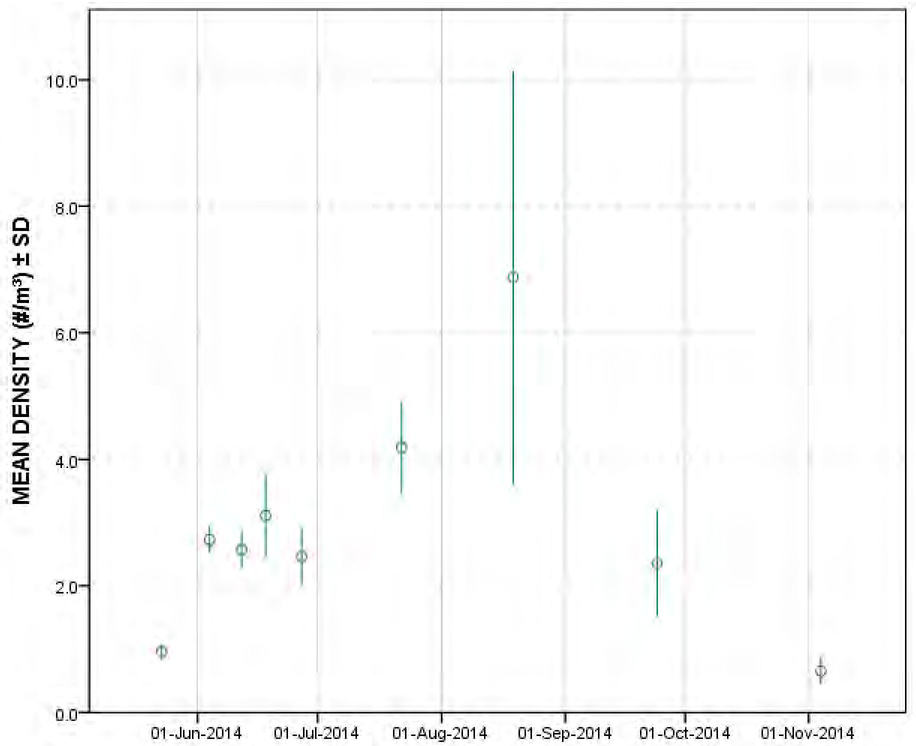


Figure 34. Quinsam River mean invertebrate drift biomass (mg/m³) ± SD.

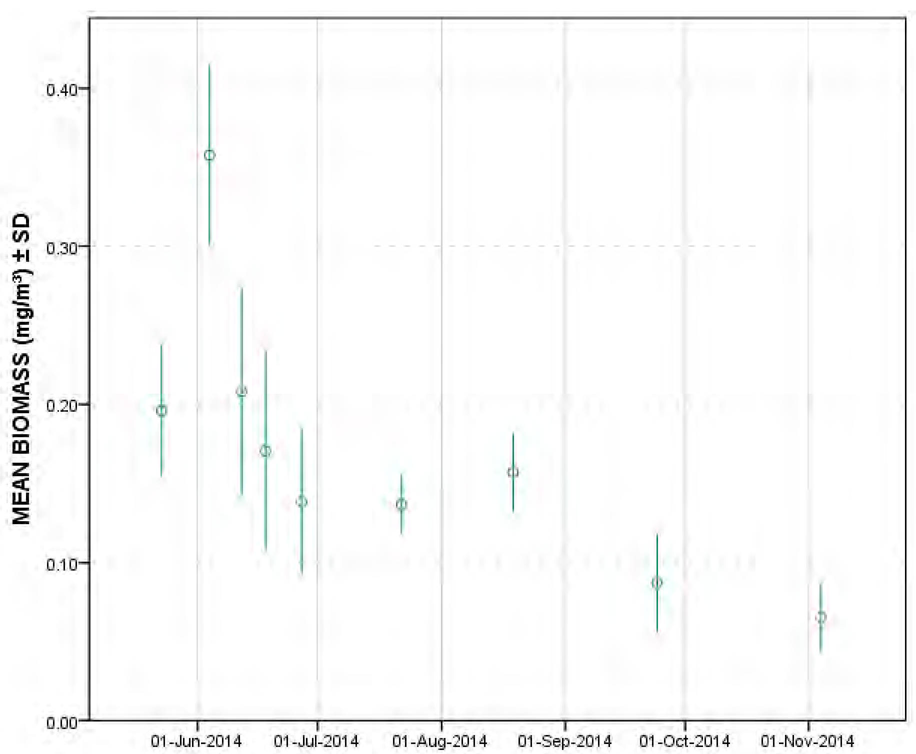


Figure 35. Quinsam River mean family level Simpson's diversity index (1- λ) ± SD.

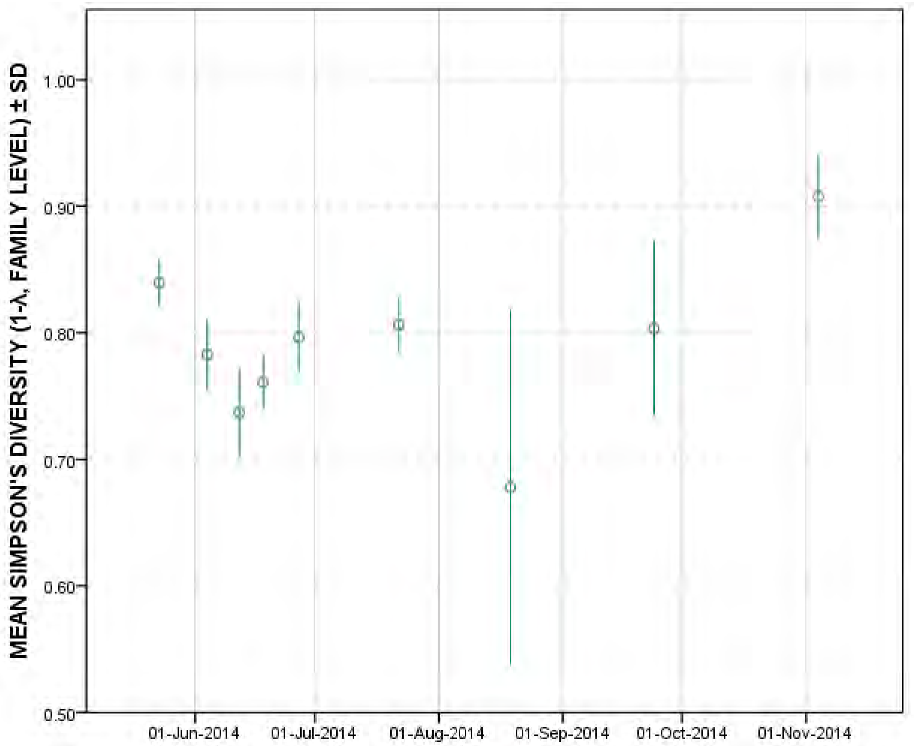


Figure 36. Quinsam River mean richness (# of families) ± SD.

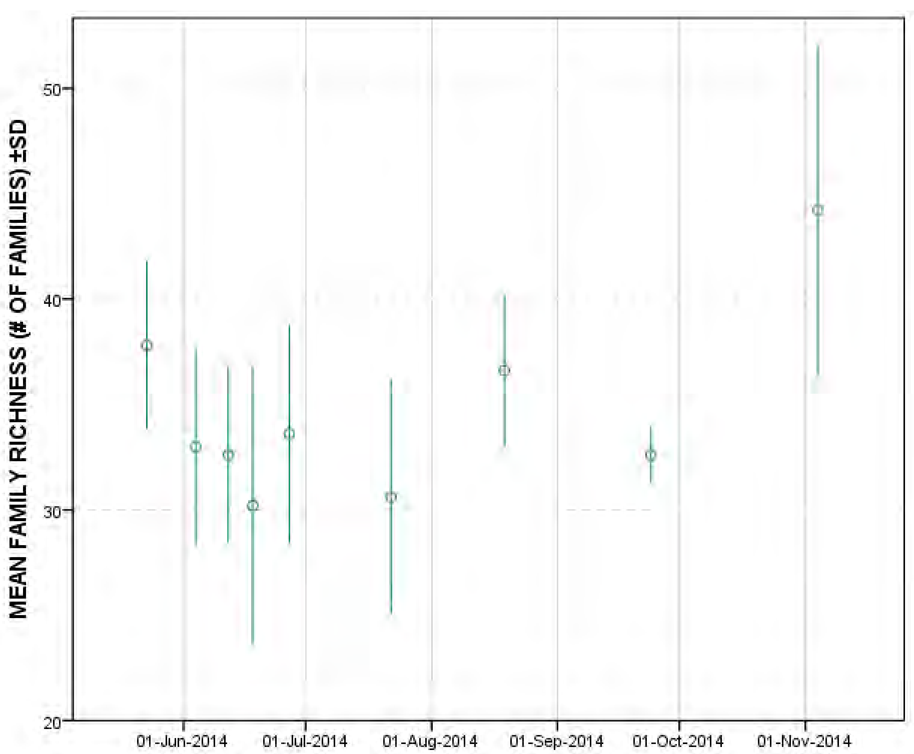
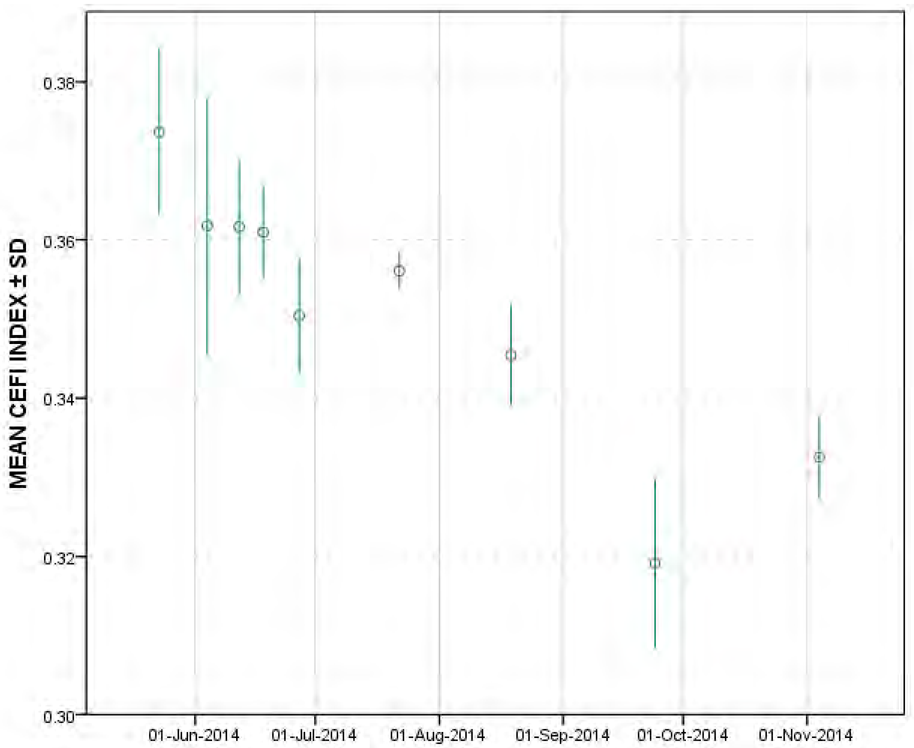


Figure 37. Quinsam River mean CEFI index ± SD.



3.3.2.6. Top Five Families Contributing to Biomass

A summary of the top five families contributing to biomass in the invertebrate drift community on each sample date is provided in Table 46. Note that in some instances (e.g., Ephemeroptera, Ostracoda, Megadrilacea), a taxonomic level higher than family is provided, as this was the lowest taxonomic resolution available in such cases. The invertebrate community was dominated (in terms of biomass) by mayflies (Baetidae, Ephemeroptera, and Ephemerellidae), caddisflies (Limnephilidae, Hydropsychidae, and Lepidostomatidae) and true flies (Chironomidae and Simuliidae). True bugs (Gerridae and Aphididae), Beetles (Carabidae and Chrysomelidae), Crustaceans (Ostracoda) and earthworms (Megadrilacea) were also occasionally within the top five families during sampling.

Considering all sample dates, Baetidae (mayflies) were the top contributor to biomass on 5 of the 9 sample dates, with the contribution ranging from 17.7% to 35.0% of the total biomass. On the four sample dates that Baetidae was not the top contributor to biomass, it was second top contributor on three sample dates, and was not one of the top five families in another case (November 4, 2014).

During spring and early summer, Limnephilidae (Caddisflies) were consistently among the top contributors to biomass. Limnephilidae was the top contributor on two of 9 samples dates, both occurring in during spring (May 23, 2014 and June 4, 2014), with contributions ranging from 28.5% to 31.6%. Limnephilidae was second top contributor on three of 9 sample dates (June 12, 18, and 27, 2014). Following these sample dates, Limnephilidae never appeared in the top five families.

Chironomidae (true flies) appeared in the top five families contributing to biomass on all 9 sample dates. Chironomidae was never the top contributor to biomass, and was the second top contributor on only one of the 9 sample dates. Considering all sample dates, Chironomidae contribution to total biomass ranged from 4.0% to 15.1%.

Table 46. Quinsam River top five families contributing to invertebrate drift biomass.

23-May-14		4-Jun-14		12-Jun-14		18-Jun-14		27-Jun-14	
Family	% of Total Biomass	Family	% of Total Biomass	Family	% of Total Biomass	Family	% of Total Biomass	Family	% of Total Biomass
Limnephilidae	31.6	Limnephilidae	28.5	Baetidae	20.8	Baetidae	20.4	Baetidae	17.7
Baetidae	16.7	Baetidae	17.6	Limnephilidae	18.0	Limnephilidae	11.6	Limnephilidae	13.6
Simuliidae	13.7	Gerridae	8.7	Ephemeroptera	13.2	Chironomidae	10.1	Chironomidae	11.7
Ephemeroptera	5.7	Chironomidae	7.5	Carabidae	9.8	Ephemeroptera	9.2	Chrysomelidae	8.0
Chironomidae	4.0	Ephemeroptera	6.9	Chironomidae	7.5	Aphididae	7.7	Simuliidae	5.5

22-Jul-14		19-Aug-14		24-Sep-14		4-Nov-14	
Family	% of Total Biomass	Family	% of Total Biomass	Family	% of Total Biomass	Family	% of Total Biomass
Baetidae	35.0	Baetidae	19.1	Hydropsychidae	15.0	Megadrilacea	16.2
Chironomidae	14.4	Simuliidae	18.4	Baetidae	12.9	Lepidostomatidae	7.9
Ostracoda	6.4	Chironomidae	15.1	Chironomidae	12.1	Chironomidae	5.9
Simuliidae	6.3	Ostracoda	6.3	Ostracoda	11.4	Ephemerellidae	4.1
Hydropsychidae	4.3	Hydropsychidae	4.8	Simuliidae	7.9	Hydropsychidae	4.0
Mayflies	Caddisflies	True Flies	Mites	Beetles	Crustacean	Earthworm	True Bugs

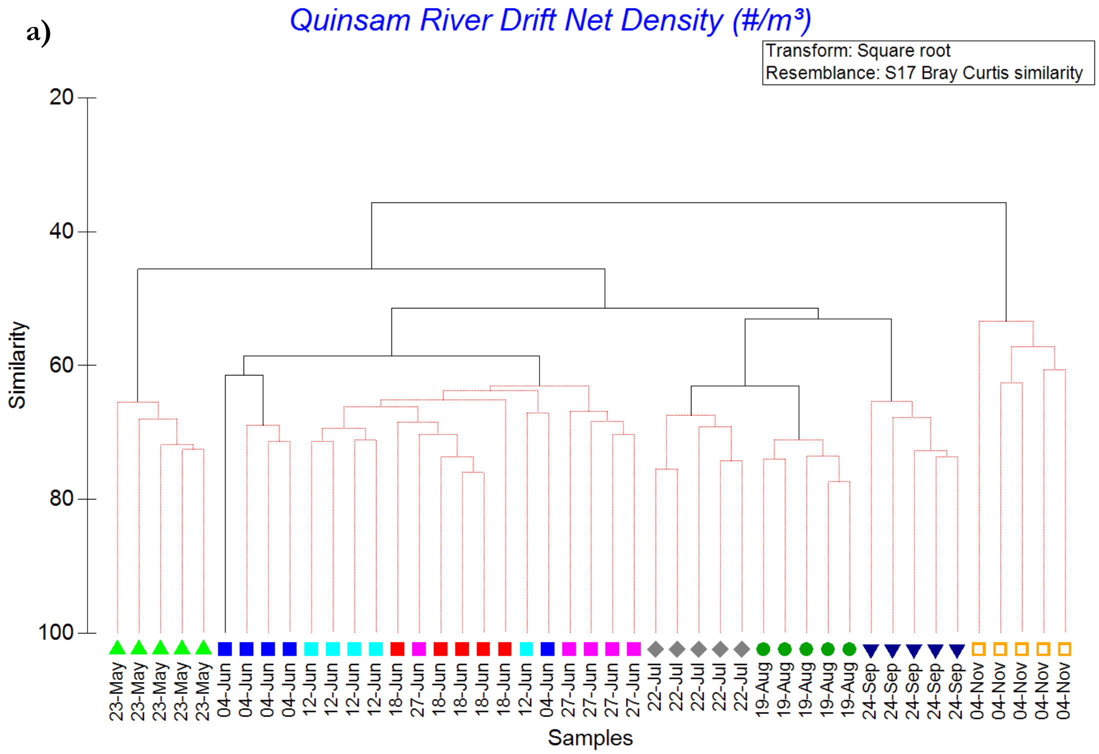
3.3.3. Multivariate Analysis

The results of the cluster analysis performed on the Bray-Curtis similarity matrices (generated from density data) is provided in the dendrograms in Figure 38; data from the highest available taxonomic resolution were analyzed using density data from each replicate on each date (Figure 38a) and using mean density on each sample date (Figure 38b). Black lines indicate branching of groups with a dissimilar community composition (taxa present and densities at which they are present) at a 5% significance level (SIMPROF test); red lines denote groups that are not significantly different in their community composition at a 5% significance level (SIMPROF test). The analyses indicate that there is a seasonal trend in the invertebrate drift community composition. Samples collected in late fall (November 4, 2014) have the least similar community composition compared to the other sample dates, followed by samples collected in early spring (May 23, 2014). June 12, 18, 27, 2014 samples are not significantly different from each other. Similarly, samples collected on July 22, 2014 and August 19, 2014 are not significantly different from each other when considering average drift density.

The multi-dimensional scaling (MDS) on the Bray Curtis similarity matrices (generated from density data at the highest taxonomic resolution available in the dataset) is shown in an ordination plot in Figure 39, where points that are close together represent samples that are very similar in community composition and points that are far apart correspond to samples with very different community composition. MDS plots were generated using density data from each replicate on each sample date (Figure 39a) and using mean density on each sample date (Figure 39b). The MDS generated from individual replicates has a stress value of 0.11 and the MDS generated from the mean density data at each site on each data has a stress value of 0.01. Stress values ≤ 0.1 correspond to a good ordination with no real prospect of a misleading interpretation with respect to differences in community composition among samples (Clarke and Warwick 2001). Stress values between 0.1 and 0.2 provide a useful 2-dimensional MDS representation as long as there is agreement in groupings between dendrograms (i.e., Figure 38a) and the MDS plot (i.e. Figure 39a) (Clark and Warwick 2001). The similarities displayed in Figure 39a are those from Figure 38a, and suggest that the representation of the invertebrate community in the MDS plot is accurate (i.e., the invertebrate drift community composition in terms of the taxa present and the densities at which they are present varies by season). This is supported by the similar result using the average density data on each date where the stress value was <0.1 (Figure 39b).

Figure 38. Quinsam River cluster analysis results on the Bray-Curtis similarity matrix, a) by sample, and b) by date.

a)



b)

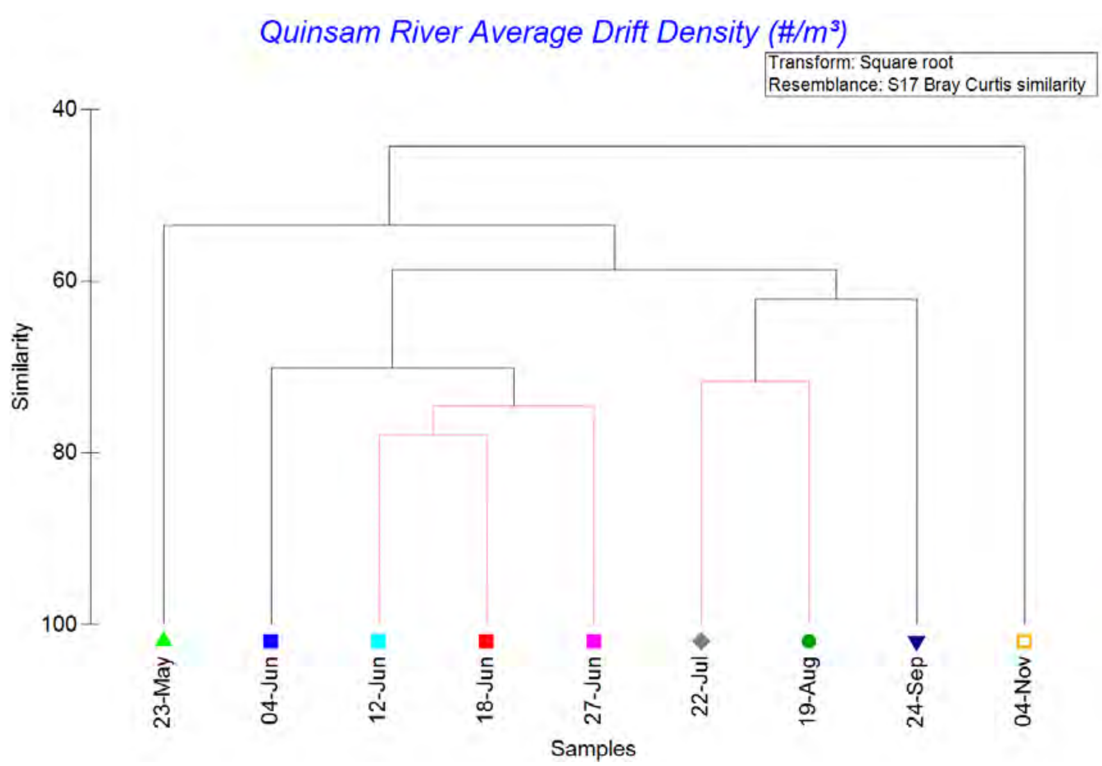
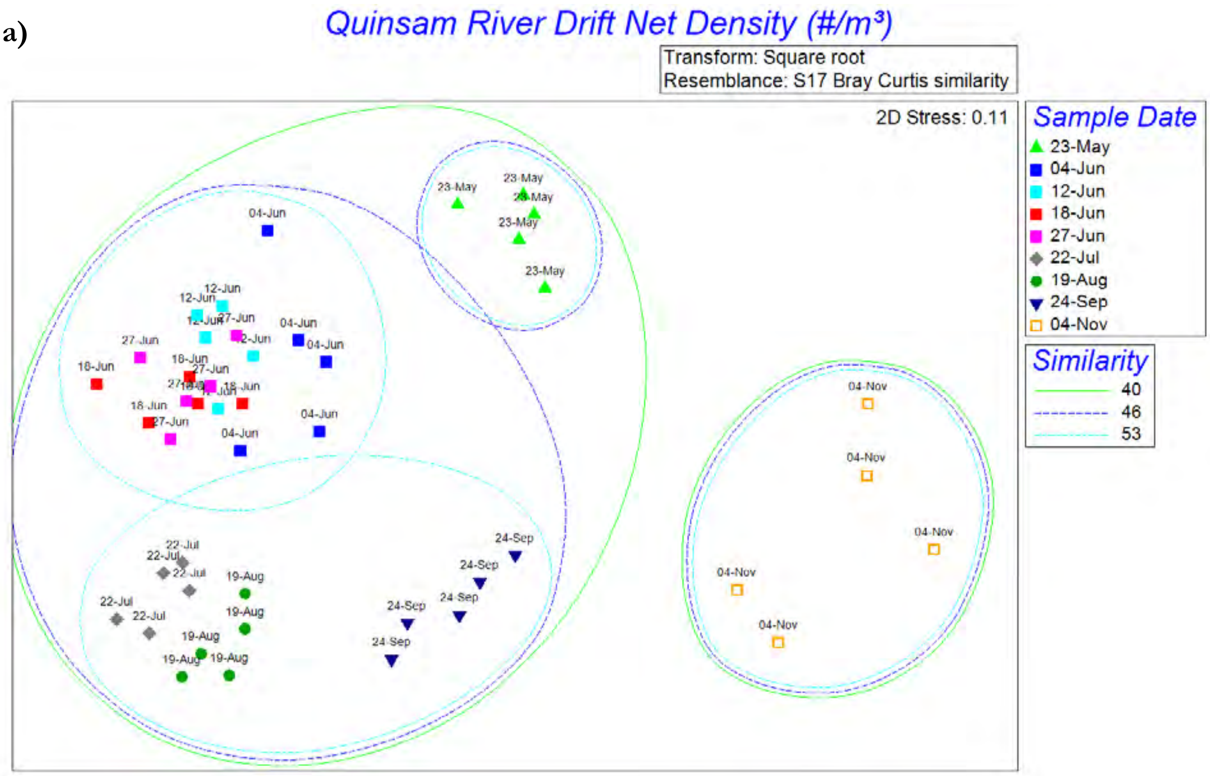
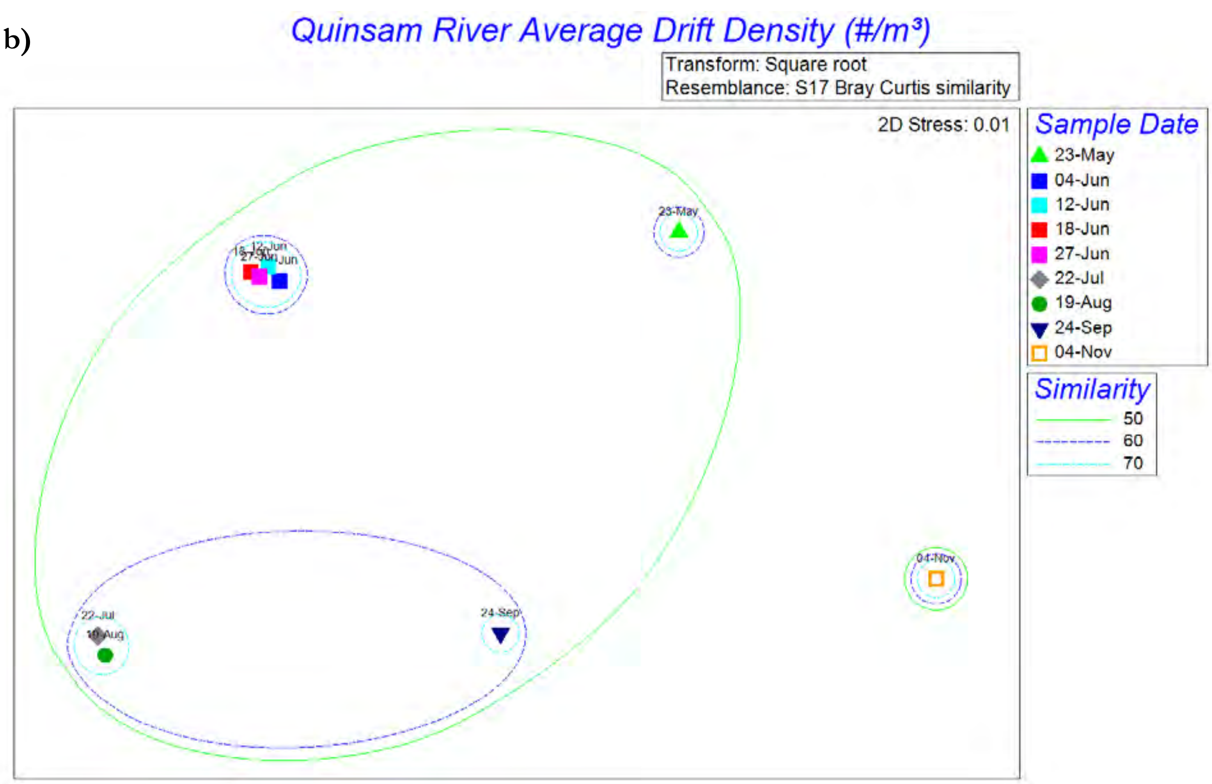


Figure 39. Quinsam River non-metric, MDS ordination plot, a) by sample, b) by date.

a)



b)



4. DISCUSSION AND CONCLUSIONS

Given that this is Year 1 of the ten year study, it is premature to address the management questions (Section 1.3) at this stage. Instead, a summary of the current status of each of the six hypotheses is provided below, including details of analyses that should be undertaken to formally test each hypothesis when data for more years are available. Such analysis should commence during approximately Year 8 of the study.

$H_0$1: Annual population abundance does not vary with time (i.e., years) over the course of the Monitor

Although this study is at an early stage, consideration of Year 1 results and historical data compiled so far shows considerable inter-annual variability in juvenile fish abundance – see standardized juvenile Steelhead abundance, 1998 to 2014 (Figure 14). Historical data have yet to be compiled for the Quinsam River salmon counting fence operations and the Salmon River juvenile Coho Salmon sampling.

Inter-annual variability in the data should first be examined to characterize the nature of between-year differences in abundance and to determine whether variations are statistically significant using appropriate methods such as analysis of variance (e.g., for juvenile Steelhead data). Data should then be assessed by fisheries biologists to determine whether inter-annual variability is biologically significant for each dataset. This will require consideration of various factors for individual life stages and species, including: historic abundance, estimates of carrying capacity, and any relevant conservation targets such as Steelhead population thresholds that denote Conservation Concern (Lil 2002). Results should be analyzed to try and derive robust spawner-recruitment relationships for priority species, based on abundance data for juveniles and the appropriate age class of adult returning fish (note that this will also test $H_0$6). Such relationships will permit juvenile abundance data to be normalized to reflect variability in the number of adult returns, thus helping to differentiate between inter-annual variability in abundance due to the local environmental conditions during spawning and rearing, versus abundance fluctuations associated with marine conditions. Such analysis will help to examine whether inter-annual variability in abundance is related to factors that can be influenced by BC Hydro operations, or whether variability is due to factors such as harvest and marine productivity that are unrelated to the freshwater environment. At this stage, however, it has yet to be determined whether satisfactory spawner-recruitment relationships can be derived for all species of interest. If reliable spawner-recruitment relationships cannot be developed, we plan to use uncorrected juvenile abundance data (i.e., not normalized for spawner abundance) as the dependent variable in analyses. However, we note that the potential influence of variability in escapement should still be considered qualitatively, as failure to do so can lead to misleading inferences about the role of environmental factors in driving population fluctuations (Walters and Ludwig 1981).

$H_0$2: Annual population abundance is not correlated with annual habitat availability as measured by Weighted Usable Area (WUA)

Weighted Usable Area (in m^2) provides an index of habitat availability that is calculated using relationships developed between flow and the area of different habitats (Lewis *et al.* 2004). The metric is weighted based on Habitat Suitability Index scores; these provide a relative measure (between 0 and 1) of the suitability of a particular habitat for the species and life stage of interest.

To test this hypothesis, it will be necessary to analyze fish abundance data collected during this study in concert with WUA determined as part of separate studies that involve deriving relationships between habitat and flow for sites on the Salmon and Quinsam rivers. Specifically, JHTMON-6 will involve deriving flow-habitat relationships for the Salmon River mainstem at 20 transects downstream of the diversion, whereas results of work already undertaken during the WUP process can be used to provide information about flow-habitat relationships in the Quinsam River mainstem downstream of the diversion (BC Hydro 2013).

Analysis to test this hypothesis should be undertaken separately for individual species and watersheds. Initially, analysis should focus on the ten-year period of the monitor. It will subsequently be valuable to also consider historic data, although this will depend on whether it is deemed appropriate to hindcast the flow-habitat relationship using historic flow data.

$H_0$3: Annual population abundance is not correlated with water quality

Year 1 water quality results show that measurements of some water quality parameters were, at times, outside of the preferred ranges for fish species present in the watersheds. Specifically, monthly mean water temperatures that exceeded the guideline temperature[3] for suitable salmonid rearing conditions (18°C; Table 16) were recorded on both rivers, while dissolved oxygen concentration less than the provincial guideline for the protection of buried embryo/alevin was recorded on one occasion in the Salmon River (albeit during the early fall when the risk to embryo/alevin is low).

When further data have been collected, this hypothesis can be formally tested using statistical methods such as correlation and regression to examine relationships between annual juvenile population abundance and individual water quality variables. Results from Year 1 indicate that water temperature is a particularly important variable to consider (see recommendation 8 below). The extent of spatial variability in water quality throughout the watersheds is not well known, and for water temperature in particular, there is potential for differences between fish sampling sites, e.g., due to localized groundwater upwelling or differences in shade conditions. Currently, the scope of JHTMON-8 includes water quality monitoring at only a single index site in each watershed, and it is assumed that water quality data are representative of wider conditions.

[3] Expressed as a mean weekly maximum temperature

$H_0$4: Annual population abundance is not correlated with the occurrence of flood events

Hydrologic data to test this hypothesis will be obtained from the Water Survey of Canada for the discharge gauges in both watersheds (see Map 3 and Map 4). Discharge data were therefore not specifically compiled for this report, although it is notable that significant flooding did occur in the Campbell River watershed during December 2015.

To test this hypothesis, it will be necessary to quantify a range of hydrologic indicators to characterize the nature and extent of flood events (e.g., see Table 47). Exploratory analysis methods such as correlation should be used to examine potential relationships between hydrologic indices and fish abundance. Further analysis (e.g., using regression methods) should be undertaken using a subset of any variables that are most closely correlated with fish abundance. Consideration should be given to the potential for threshold effects as a relationship may only be present within a certain environmental range, e.g. above a specific peak discharge.

Table 47. Characteristics of hydrologic variability quantified by Indicators of Hydrologic Alteration (Richter *et al.* 1996).

Characteristic	Example indicator
Magnitude	Maximum annual daily mean discharge
Timing	Date of annual maximum discharge
Duration	Annual mean duration of flood pulses
Frequency	# of flood pulses per year
Rate of change	Mean of absolute differences between daily mean discharge measurements

$H_0$5: Annual population abundance is not correlated with food availability as measured by aquatic invertebrate sampling

Invertebrate data comparable with the Year 1 data have not historically been collected in either watershed and therefore data for further years are required before relationships between aquatic invertebrate drift and fish abundance can be examined. Future analysis should focus on using metrics of invertebrate biomass and density as independent variables, although invertebrate community composition should also be considered as it relates to food quality. As with water quality, the study is currently premised on the assumption that invertebrate drift measured at a single index site is representative of conditions experienced by fish in the wider watershed.

$H_0$6: Annual smolt abundance is not correlated with the number of adult returns

No analysis has been undertaken to test this hypothesis at this stage; this hypothesis will be tested during the course of analysis to determine whether robust spawner-recruitment relationships can be derived (see discussion of $H_0$1 above). This analysis could commence approximately midway through the study (see Table 48) and should incorporate historical data to maximize the sample sizes available.

5. RECOMMENDATIONS

5.1. Recommendations from the Salmon River Desktop Review

The Salmon River Desktop Review (see Section 1.4.5) resulted in a number of recommendations to improve the study; these are presented in Appendix A. Recommendations include actions that could be undertaken within the current scope of the study, in addition to actions that would necessitate a scope extension. Although the review focused on the Salmon River, several of the recommendations are also relevant to the Quinsam River watershed.

All of the recommendations that relate to the current scope were either implemented in the course of Year 1 data analysis, or can be readily implemented in future years. Key recommendations that relate to work outside of the current scope are reiterated below in Section 5.2. In particular, this includes the recommendation that the spatial coverage of water quality monitoring should be extended; this was considered by BC Hydro to be particularly worthwhile during discussions about the desktop review.

The desktop review also outlined a series of ten data analysis tasks to be undertaken during the course of the study, with the expectation that it is feasible to undertake one task per year (Table 48). The order of the tasks approximately corresponds to the sequence in which they should be undertaken, although strict adherence to the chronology is not essential. Task 1 is to 'specify metrics of food abundance that can be used to test $H_0$5'. This task was identified because there may be advantages to monitoring proxy variables of food abundance that can be measured with less effort than invertebrate drift. Specifically, measurement of stream water nutrient or benthic chlorophyll *a* concentrations at multiple sites could provide information about food abundance at greater spatial resolution and similar effort, compared to measuring invertebrate drift at a single index site in each watershed.

Table 48. Data analysis tasks outlined in the Salmon River Desktop Review (Abell *et al.* 2014).

#	Task
1	Specify metrics of food abundance that can be used to test H_05
2	Collate historic water quality data
3	Collate historic discharge data and quantify a range of Indicators of Hydrologic Alteration (IHA)
4	Derive a protocol for derivation of recruitment–spawner relationships for both Coho and Steelhead at each site
5	Specify water quality metrics that can be used to test H_03
6	Apply discharge–habitat relationship derived during JHTMON–6 program to quantify historic variability in Weighted Usable Area (WUA) in the Salmon River
7	Synthesise a 'naturalized' discharge record that represents hydrological conditions in the absence of diversion operations. Quantify WUA and IHA for naturalized and regulated flows.
8	Undertake preliminary individual hypothesis testing
9	Extend preliminary hypothesis testing by testing hypotheses in combination
10	Update previous tasks and complete data analysis

We propose that monitoring of invertebrate drift continues throughout the remainder of the study. Quantification of invertebrate drift provides a more direct measure of food abundance than other methods. In addition, the use of standard invertebrate sampling methods based on provincial guidelines (Lewis *et al.* 2013) means that results can be directly compared with other watersheds to provide context. We propose that density (# of individuals) and biomass (mg dry weight), both standardized to the volume of water filtered (see Section 2.3.3), should be the primary independent variables used to test H_05, although community composition should also be considered to provide information about the quality of food available to fish.

5.2. Recommendations based on the Year 1 Results

Recommendations based on the Year 1 results are presented below for each program component. The recommendations are numbered to facilitate discussion and tracking, and have been summarized in Table 49.

5.2.1. Fish Population Assessments

1. Historical data should be compiled for the Quinsam River Salmon Counting Fence operations and the Salmon River juvenile Coho Salmon sampling to maximize the extent of data available to test H_01[4].

[4] Historical Coho Salmon abundance data (Salmon River) were requested from DFO who confirmed that they need to undertake further QA/QC before comparative analysis can be undertaken (Anderson, pers. comm. 2015).

5.2.2. Water Quality

The JHTMON-8 study has been designed to build upon historic monitoring, and there may be opportunities to integrate water quality data into the study that either has been, or continues to be, collected in the watersheds as part of other programs. Analysis of data from other monitoring programs is outside of the current JHTMON-8 scope; however, it could provide valuable information about:

i. How water quality varies spatially throughout the watersheds;

ii. Historical trends;

iii. Typical parameter ranges of the key water quality parameters; and

iv. Whether it would be useful to make changes to the current suite of water quality parameters that are measured.

Specifically, we recommend that:

2. Data (predominantly nutrient and benthic chlorophyll *a* concentrations) collected by BCCF as part of the ongoing nutrient enrichment monitoring program in the Salmon River watershed should be explicitly considered when testing $H_0$3. These data could also provide information to test $H_0$5 that relates to food abundance. BCCF were contacted as part of the Salmon River Desktop Review and they confirmed that there is no constraint to such data sharing, although some further time is needed to compile it (Pellett, pers. comm. 2014).
3. A brief desktop review should be undertaken for the Quinsam River watershed; the review should describe data sources and compile and summarize available water quality monitoring data. Historic water quality monitoring has occurred in this watershed by both Environment Canada and Quinsam Coal Ltd, and included parameters that are not in the current JHTMON-8 water quality monitoring scope, yet have potential to influence fish populations (e.g., metals; see Burt 2003).

We also make a number of recommendations related to increasing the spatial extent of water quality monitoring in each watershed – this was a key recommendation of the Salmon River Desktop Review (see Appendix A). These are outside of the current scope of the JHTMON-8 study although individual recommendations could be implemented in isolation and, potentially, for only a subset of the remaining years. These recommendations are listed below, with those deemed to have the best ratio of benefits to costs listed first.

4. Establish more sites to monitor water temperature near-continuously using in situ probes (e.g., a further three sites in each watershed). This reflects that temperature is a particularly important parameter that is likely to exhibit considerable spatial heterogeneity. Any further sites should be close to existing fish sampling sites (Salmon River) and also include different habitat types (e.g., spawning, rearing) to reflect the varying sensitivity to temperature between fish life history stages.

5. Add a single control site in the upper watershed of both rivers, upstream of the diversion infrastructure. For the Salmon River, this would provide water quality data that are more representative of conditions at individual juvenile fish sampling sites, many of which are upstream of the diversion (see Map 3).
6. Undertake water quality sampling at individual (although not necessarily all) fish sampling sites in the Salmon River watershed. This would be a considerable increase in sampling effort, but it would provide data that are likely to be more representative of the individual fish sampling sites (note that many of the juvenile fish sampling sites are located in tributaries that may be poorly represented by the current water quality index site in the mainstem; see Map 3). Depending on the scope of the BCCF nutrient enrichment monitoring program (see above), it may not be necessary to measure the full suite of parameters at additional sites, e.g., an additional monitoring site could be established in Grilse Creek but there may be no need to measure nutrient concentrations there due to overlap with the scope of nutrient enrichment monitoring. For example, addition of two further sites upstream of the diversion – one in Grilse Creek and one in the mainstem, downstream of Rock Creek (see Map 3) – would provide water quality data that are likely to be substantially more representative of the sites upstream of the diversion than the single current index site.

As the study proceeds, there may be opportunities to modify the suite of water quality parameters to ensure that the monitoring focuses on parameters that have the greatest potential to affect fish populations and, potentially, achieve budget efficiencies. Specifically:

7. Total gas pressure concentrations measured during Year 1 were well below the provincial guideline concentration (110%) for the protection of biota. This is consistent with historical measurements by BC Hydro (Bruce, pers. comm. 2015). Both of the diversions have low potential to cause elevated TGP concentrations and therefore this parameter could be removed from the suite that is measured.

Water and air temperature loggers in both watersheds are continuously logging data, although a full year of data was not yet available during Year 1 data analysis. Therefore:

8. Once a full year of data is available, we recommend that mean weekly maximum temperatures (MWMxT) are calculated for both watersheds, with the results analyzed in the context of the preferred temperature ranges for species of primary interest. This will allow us to determine the proportion of data that is above or below the optimal temperature range for key fish species, and the proportion of data that is in exceedance of the provincial guidelines for the fish species (specifically, MWMxT should not exceed ±1°C beyond the optimum temperature range for each life history phase of the most sensitive salmonid species present; Oliver and Fidler 2001). Temperature data for winter months would also help to examine whether water temperatures are within optimum ranges for incubation life stages of priority species.

5.2.3. Invertebrate Drift

9. The month that is sampled weekly should be rotated in Year 2 to July, with the remainder of the months sampled monthly. Such annual rotation will provide weekly data for every month of the growing season during at least one year during the duration of the study. This will support analysis of seasonal variability of invertebrate communities and help to quantify the variance associated with monthly data, i.e., provide information about the extent to which a sampling trip during a single month is representative of the month as a whole.
10. Given that invertebrate biomass is of primary consideration when considering food abundance, consideration should be given to removing large bodied individuals (e.g., earthworms) from individual samples when calculating standardized biomass in cases where it is likely that including such individuals will bias the results.

5.2.4. Summary of Year 1 Recommendations

Recommendations listed above are summarized below in Table 49.

Table 49. Recommendations to improve JHTMON-8 data collection and analyses.

Number	Environmental component	Recommendation
1	Fisheries	Historical data should be compiled for the Quinsam River Salmon Counting Fence operations and the Salmon River juvenile Coho Salmon sampling to maximize the extent of data available to test $H_0 1$.
2	Water quality	Data (predominantly nutrient and benthic chlorophyll *a* concentrations) collected by BCCF as part of the ongoing nutrient enrichment monitoring program in the Salmon River watershed should be explicitly considered when testing $H_0 3$. These data could also provide information to test $H_0 5$ that relates to food abundance.
3		A brief desktop review should be undertaken for the Quinsam River watershed; the review should describe data sources and compile and summarize available water quality monitoring data.
4		Increase the spatial resolution of water quality sampling - option 1: Establish more sites to monitor water temperature near-continuously using in situ probes (e.g., a further three sites in each watershed).
5		Increase the spatial resolution of water quality sampling - option 2: Add a single control site in the upper watershed of both rivers, upstream of the diversion infrastructure.
6		Increase the spatial resolution of water quality sampling - option 3: Also undertake water quality sampling at individual (although not necessarily all) fish sampling sites in the Salmon River watershed, e.g. add two further sites upstream of the diversion.
7		Modify the suite of water quality parameters by omitting TGP.
8		Use annual temperature records to analyze mean weekly maximum temperatures in the context of optimal ranges for individual species and life stages.
9	Invertebrate drift	The month that is sampled weekly should be rotated in Year 2 to July, with the remainder of the months sampled monthly.
10		Develop a method to avoid bias in biomass measurements due to large bodied individuals.

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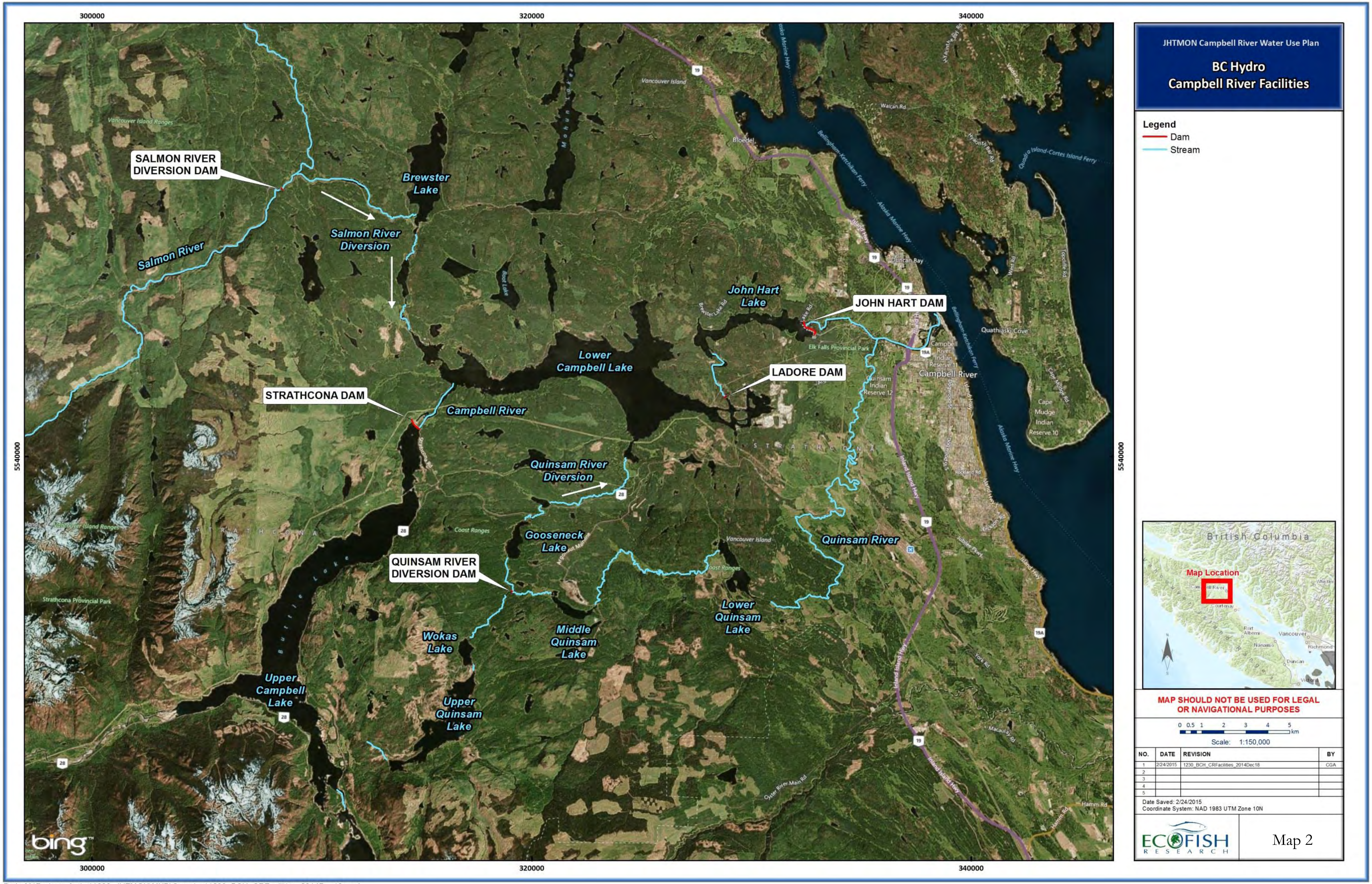
PROJECT MAPS



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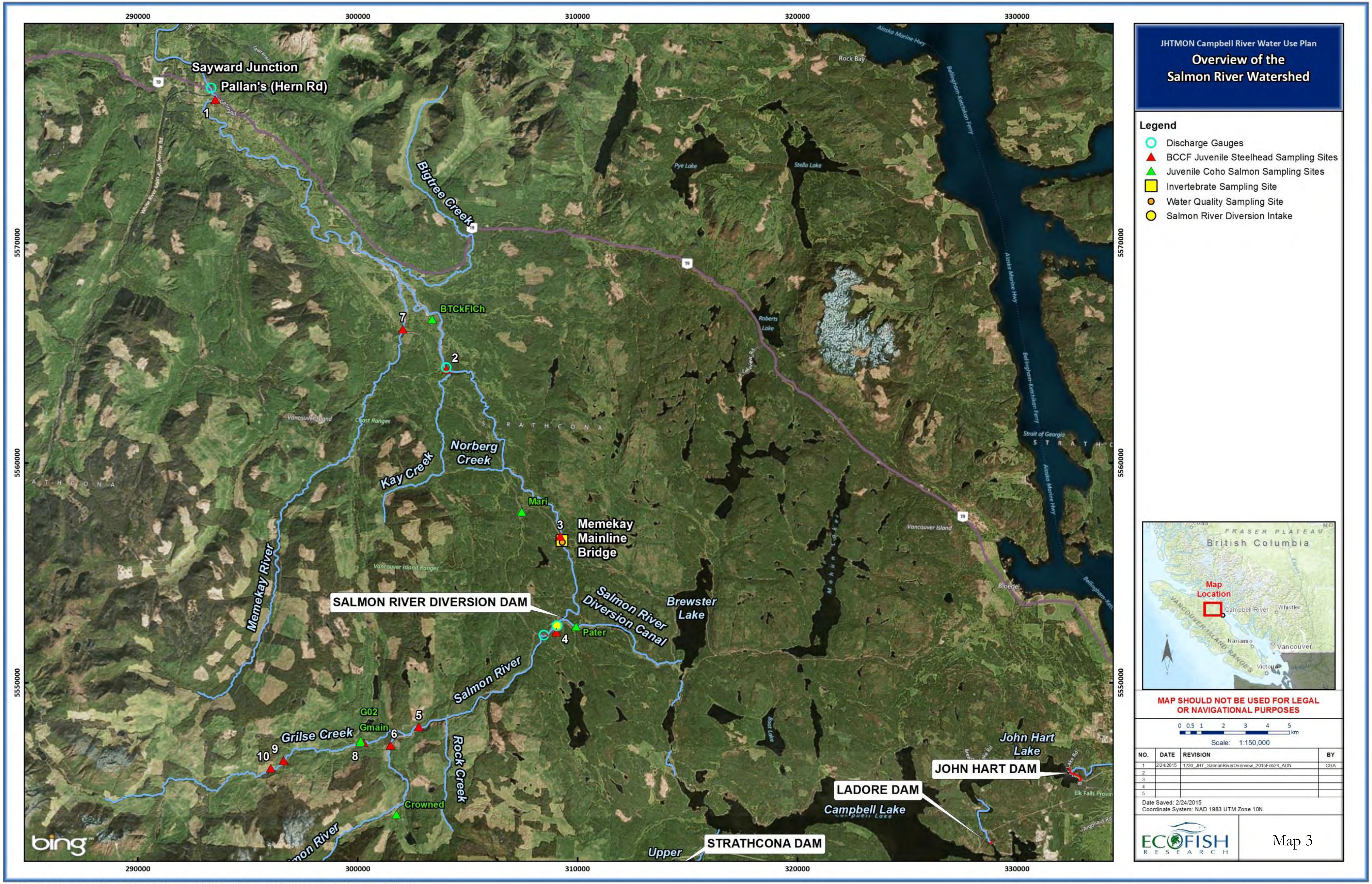

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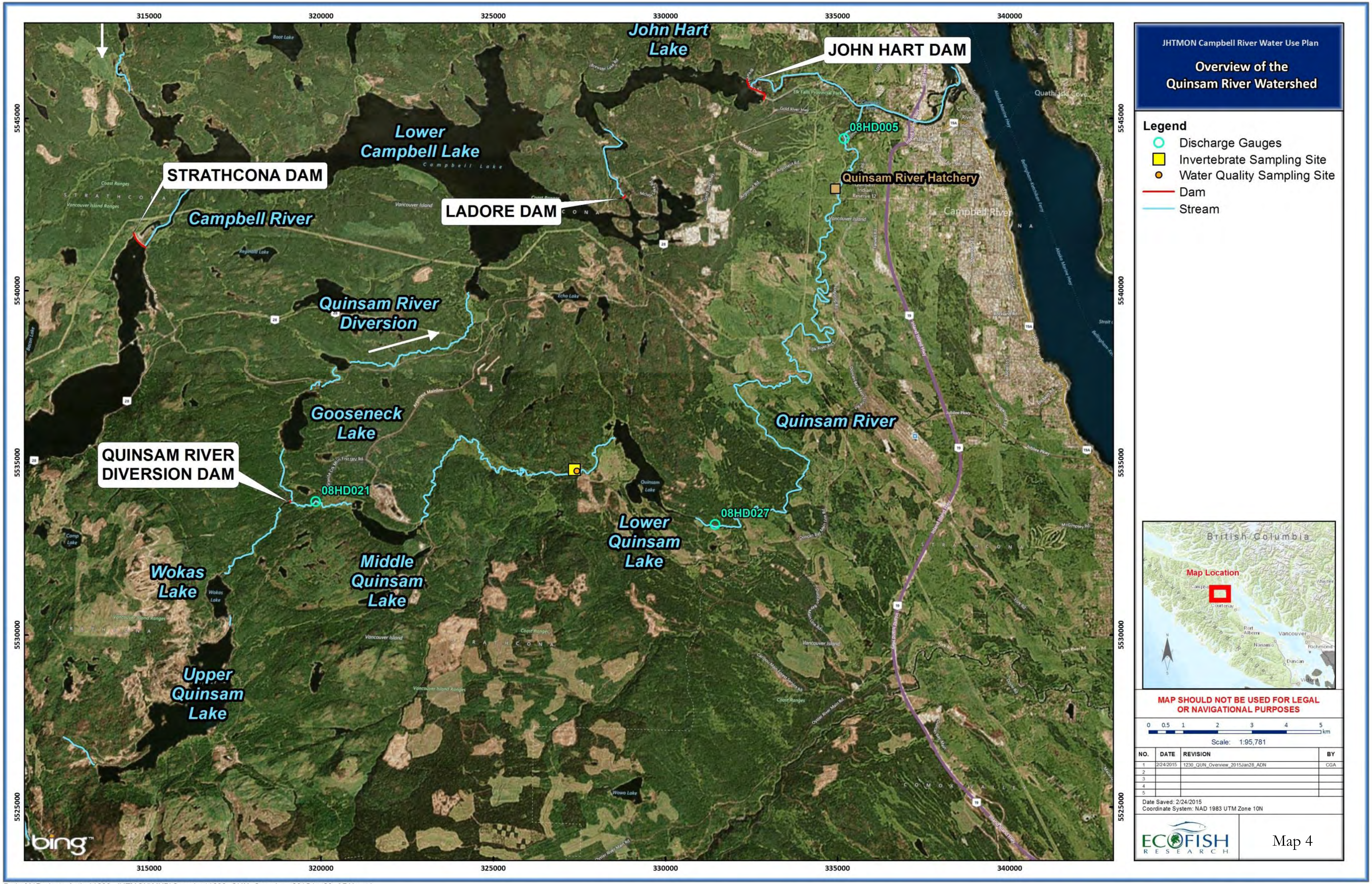

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APPENDICES

Appendix A. Recommendations from the Salmon River Desktop Review.

1. RECOMMENDATIONS

We have separated recommendations into those that relate to the current scope of the JHTMON-8 monitoring program, and those that relate to additional work that could potentially be undertaken as part of further projects.

1.1. Recommendations relating to the current JHTMON-8 scope

- Analysis of variability in fish abundance ($H_0$1) and the potential effects of environmental variables ($H_0$2 to $H_0$5) should incorporate historic data relating to juvenile and adult Steelhead and Coho populations. This analysis should consider any changes in association with variability in diversion dam operations (e.g., before and after the WUP implementation). Furthermore, a comparison of juvenile abundance between sites that are upstream and downstream of the diversion dam could help with understanding operational impacts, although we do not recommend that this is a core focus of the study due to problems with distinguishing variability that may be due to operations, from variability due to natural longitudinal gradients in environmental factors.

- Recruitment-spawner relationships should be derived for Steelhead and Coho to normalize for the effects of variability in salmonid escapement which are due to marine conditions and unaffected by BC Hydro's activities. Relationships should be examined for Steelhead using separate abundance data for reaches upstream and downstream of the diversion dam. This would help to isolate any effects that are due to altered discharge from those that are due to impeded upstream passage. In addition to testing hypotheses $H_0$2 to $H_0$5 individually, multivariate analysis of the combined potential effects of environmental factors on fish abundance (and condition) should be undertaken to identify any causal, cumulative or synergistic relationships.

- Length and mass data collected during fish sampling should be used to extend the analysis to separately examine the effects of environmental factors on fish body size, age and condition, in addition to abundance.

- Opportunities to collect water quality data opportunistically during fish sampling (e.g. temperature, pH, conductivity and dissolved oxygen concentration measured using an *in situ* probe) should be maximised. Data should be collated to permit analysis of how water quality at the fish sampling sites compares with water quality at the index site.

- A staged approach should be adopted during data analysis help to distribute work evenly throughout the program and provide opportunities to partially address management questions before the end of the monitor.

- There should be ongoing communication between parties involved with monitoring of the nutrient enrichment operations and those involved with the JHTMON-8 monitoring program. Historic and proposed future data regarding nutrient concentrations and periphyton biomass provide a very good opportunity to extend analysis of both $H_0 3$ (regarding water quality) and $H_0 5$ (regarding food availability). Where possible, synergies should be sought between the two projects that allow information collected during nutrient enrichment monitoring during the ten year JHTMON-8 monitoring program to be readily incorporated into existing analyses. A comprehensive analysis of historic data is outside of the JHTMON-8 scope, but it may be useful to undertake a separate combined review of both datasets at the end of the JHTMON-8 monitoring period.

1.2. Recommendations that relate to work outside of the current JHTMON-8 scope

- A review of the invertebrate data should be undertaken after Year 1 to consider whether the data for a single index site are sufficient to adequately test $H_0 5$, or whether it is preferable to measure invertebrates or alternative proxy variables (e.g., concentrations of nutrients and benthic chlorophyll *a*) at multiple sites. If a need for change is identified, there may be potential to adopt modifications that do not require additional resources, although increases to the overall sampling effort are not anticipated as part of the current JHTMON-8 program.
- It would be beneficial to extend the spatial coverage of water quality monitoring so that site-scale (rather than watershed-scale) analysis of water quality can be undertaken to test $H_0 3$. In particular, installing probes to continuously measure temperature at each fish sampling site would be beneficial.
- There is an opportunity to extend the work that will be undertaken to test $H_0 2$ (habitat availability) and $H_0 4$ (floods) to better understand how diversion operations affect environmental factors in the Salmon River watershed. Specifically, a range of discharge records could be synthesized that correspond to a range of different operational regimes, including a regime corresponding to no diversion. The current work that is proposed could then be readily extended to quantify habitat availability (WUA) and biologically important hydrologic metrics (IHA) for a range of different management options. Such work could be undertaken following amendment to the scope of JHTMON-6.
- It would be useful to develop flow-habitat relationships for the Salmon River upstream of the diversion to better quantify habitat availability at upstream fish sampling sites. This would improve the quality of the data available to test $H_0 2$.
- Analysis to test $H_0 1$ could also consider historic Chinook escapement data. Chinook Salmon is a high priority species for DFO in the watershed, although it is not a focus of the current scope of work.
- Consultation with DFO regarding separating adult counts for reaches upstream and downstream of the diversion dam could support assessment of upstream passage at the diversion dam.

Appendix B. Salmon River Adult Steelhead Snorkel Survey Reports Prepared by BCCF.

FILE NOTE

Date: March 25, 2014
File: 34560-20/SNORK
xf: 34560-27/Salmon

British Columbia Conservation Foundation

SNORKEL SURVEY REPORT
Salmon River

DATE:	March 24, 2014
WEATHER:	Light overcast
WATER TEMP:	3.4 °C, @ Kay Creek, 1030 hrs
DISCHARGE:	6.0 m^3/s above diversion, 40.3 m^3/s near Sayward (per WSC)
VISIBILITY:	Upper: 5-6 m effective, Secchi 10 m Lower: 5-6 m effective, Secchi 10 m
PERSONNEL:	Upper: K. Pellett, M. Dick Lower: S. Pollard, J. Craig
AREA:	Upper: Hydrometric Station 08HD007 (near Kay Creek confluence) to Bigtree Creek confluence (7.2 km) Lower: Bigtree Creek confluence to Pallans (4.3 km) Total Distance: 11.5 km

1. Fish Observed:

Adults

A total of 39 winter steelhead were observed (30 in the upper and 9 in the lower) for a density of 3.4 fish/km. Fish distribution favored upper reaches with 8 fish above Bigtree Mainline Bridge and 16 downstream to the Memekay River confluence. Only 15 fish were observed from the Memekay confluence to Pallans. The majority of fish were moderately coloured with equal proportions of bright and dark fish noted. A total of 14 males and 19 females were positively identified for and observed male to female ratio of 0.7:1.

Condition[1]	**1**	**2**	**3**	**4**	**5**
upper	6	13	7	0	4
lower	3	3	2	0	1
Total (%)	26%	48%	26%	0	N/A

Juveniles

A group of approximately 30 chinook fry was observed in a root wad upstream of the Memekay River confluence.

Trout

8 wild cutthroat trout were observed in the lower section (4 @ 25-35 cm, 5@ 35-45 cm). The number of cutthroat was significantly less than that observed in the last four years.

In addition, one rainbow trout @ 35 cm was noted in the upper survey.

[1] 1 (bright), 2 (moderately coloured), 3 (mid spawn), 4 (post spawn), 5 (unidentified)

2. Notes:

- The Bigtree side-channel appeared to be fully functional with sufficient flow. The intake was briefly inspected in-stream by surveyors and found to be clear of debris.
- Dangerous LWD jams were numerous and could not be inspected safely for fish in both sections.
- Transit time was approximately 3:00 for the upper section and 2:30 for the lower section.
- Occasional pieces of terminal tackle (flies, pink worms, floats) were documented in substrate and snagged on wood throughout both reaches.
- Two anglers were encountered on the upper survey approximately 300 m downstream of the Memekay confluence. One of the anglers was playing a steelhead as the surveyors swam by – this fish was not included in the swim count.
- The reach between Memekay and Bigtree confluences was very different as usual with braided and shallow areas throughout except for occasional peripheral LWD scour holes.
- No anglers were observed in the lower survey. Fishing tackle was noted several times on substrates/wood. Within the last km, large logs have again been chain-sawed to maintain a rafting route to Pallans. Two pick-ups were parked at Pallans.
- The lower index has several smaller changes but is close to channel conditions observed last year. More wood has accumulated in the key jams. One or two of the larger runs are exceptionally wide (i.e., >100m) and coverage drops significantly.
- Braiding and bifurcations are commonplace between Bigtree confluence and the top of the Farm Run. We suspect the Farm Run itself remains single thread. Starting just upstream of the Farm Run tailout, the river loses water to several right bank bifurcations into the forest over the next 400m. None are safe to survey – most are fast and dangerous with abundant sweepers and jams. By the end of the 180º left turn, the river loses >50% of its flow. Two of 9 steelhead adults were counted downstream of this point, in the original channel with 50% flow.
- This year's count of 39 is well below the long term average of 152 and 5 year average of 169. Refer to Figure 1 for further details on historic steelhead and cutthroat counts.

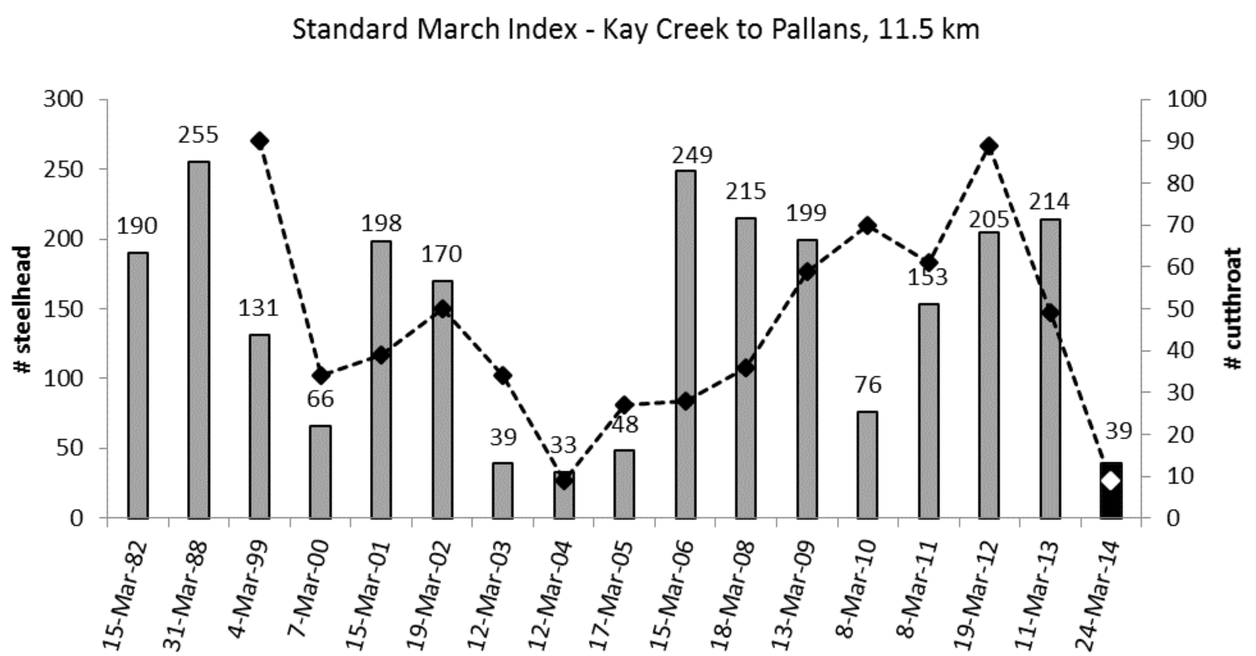

Figure 1. Winter steelhead (bars) and cutthroat (markers) snorkel observations in March for the Salmon River index section (Kay Creek to Pallans, 11.5 km), 1982-2014.

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Fisheries Biologist,
BC Conservation Foundation

cc: All Fisheries staff
Steelhead Crew
Eva Wichmann, BC Hydro
Ian Murphy, Ecofish Research Ltd.
Conservation Officer Service, Campbell River
S. Anderson, Fisheries Biologist, DFO, Campbell River
Kim Duncan, A-Tlegay Fisheries Society, Campbell River

FILE NOTE

Date: April 17, 2014
File: 34560-20/SNORK
xf: 34560-27/Salmon

SNORKEL SUPERVEY REPORT
Salmon River

DATE:	April 14, 2014
WEATHER:	Clear
WATER TEMP:	3.6 ºC @ 1200 hrs, diversion pool
DISCHARGE:	14.3 m^3/s above diversion (per WSC)
VISIBILITY:	6-8 m effective, Secchi –14.0 m lower
PERSONNEL:	Upper: S. Stenhouse, D. Price
	Lower: J. Craig, J. Duncan
AREA:	Upper: Diversion to Memekay ML Bridge (5.9 km)
	Lower: Memekay ML Bridge to Norberg Cr (5.6 km)
	Total Distance: 11.5 km

1. Fish Observed:

Adults

A total of 51 winter steelhead were observed (26 in the upper and 25 in the lower) for a density of 4.4 fish/km. The distribution of fish was generally spread out in singles or pairs, with 4 fish observed between the Salmon River Diversion and Menzies Mainline Bridge (550 m). Five fish were observed between Menzies Mainline and Patterson Creek. In the lower section, fish were evenly distributed with the largest group of 4 at Marilou Creek. Eight kelts were positively identified, and at least three full redds as well as several test redds noted. A total of 19 males and 23 females were positively identified for a male to female ratio of 0.83:1. The majority of steelhead were in mid spawn condition with few bright fish noted in both surveys. See table below for further details.

Condition[1]	1	2	3	4	n
% (upper)	0	46	23	8	20
% (lower)	0	55	45	0	22

Juveniles

No juveniles were noted in either survey.

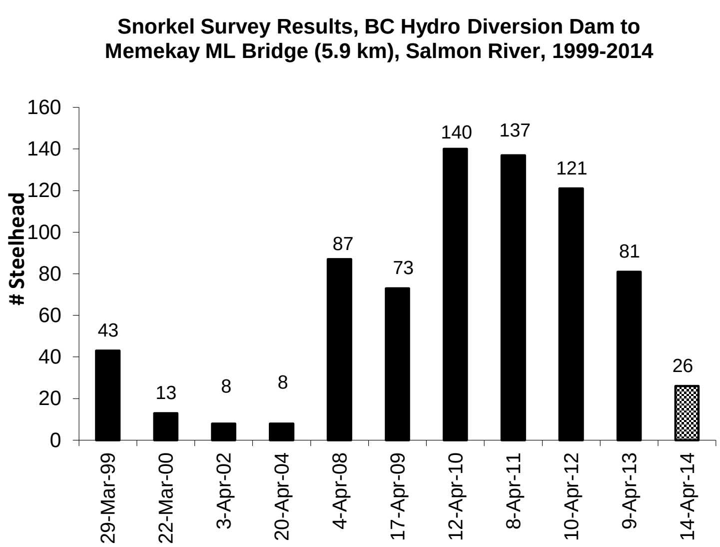
Trout

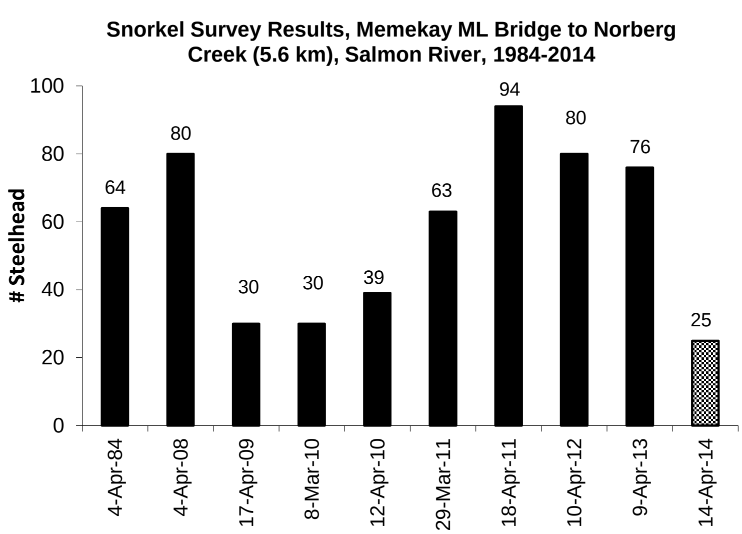
2 CT in lower section - 1 @ 25-35 cm, 1 @ 35-45 cm

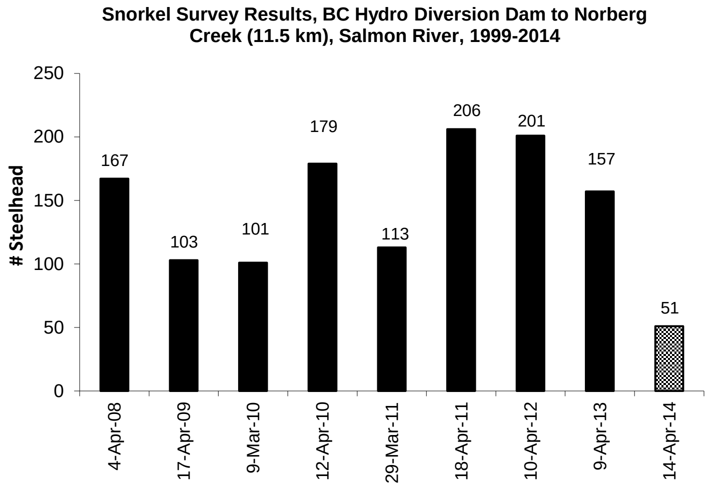
[1] 1 (bright), 2 (pre-spawn), 3(mid-spawn), 4 (post spawn), n (number of fish assessed for condition)

2. Notes:

- Flows were heavier than usual for this survey which meant coverage may have been reduced. Visibility was excellent which may have offset reduced efficiency.
- Many wide sections with abundant LWD cover were difficult to competently survey. Two sections (80-150 m in length) in particular where channel avulsions had occurred were steep white water – crew walked around for safety. Several dangerous sweepers were encountered throughout the section.
- Only 40% of mainstem flows reaches the traditional Marilou Creek confluence pool; the balance splits to a large right bank channel around a 150 m-long island.
- One of the newer avulsions has resulted in the mainstem moving east 140 m. As a result, Norberg Creek is difficult to notice entering the mainstem (the crew missed it entirely), likely mixing with small left bank braids amongst open gravel bars.
- 3 ST redds were noted in the lower section but no kelts were confirmed.
- The crew added more flagging to the takeout location at Norberg Creek (river side and road side).
- The crew completed the survey relatively quickly, in just under 2 hours.
- This year's count of 51 is down significantly from recent surveys where as many as 206 were enumerated in 2011. However, this correlates well with the lower index count of 39 on March 24, 2014. See attached charts for comparison to past surveys.







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Eva Wichmann - BC Hydro
Don McCubbing, Instream Fisheries Research
Conservation Officer Service, Campbell River
S. Anderson, Fisheries Biologist, DFO, Campbell River

FILE NOTE

Date: April 17, 2014
File: 34560-20/SNORK
xf: 34560-27/Salmon

British Columbia Conservation Foundation

SNORKEL SURVEY REPORT
Salmon River

DATE: April 14, 2014
WEATHER: Clear
WATER TEMP: 3.6 ºC @ 1200 hrs, (per WSC)
DISCHARGE: 14.3 m^3/s above diversion (per WSC)
VISIBILITY: 6-8 m effective, Secchi – 14 m
PERSONNEL: K. Pellett, H. Wright
AREA: Rock Creek to Diversion (6.2 km)

1. Fish Observed:

Adults

A total of 13 winter steelhead were observed over the 6.2 km section for a density of 2.1 fish/km. The distribution of fish was higher in the upper end of the survey. The largest group (3) was observed approximately 1/4 of the way through survey. Six redds and two actively spawning fish were noted. The male to female ratio for the upper survey was 0.63:1 (n=13). The majority of steelhead were in mid spawn condition with only a few brighter fish observed, see table below for further details.

Condition[1]	1	2	3	4	n
Count	0	3	9	0	12
%	0	25	75	0	

Juveniles

No juveniles were observed.

Trout

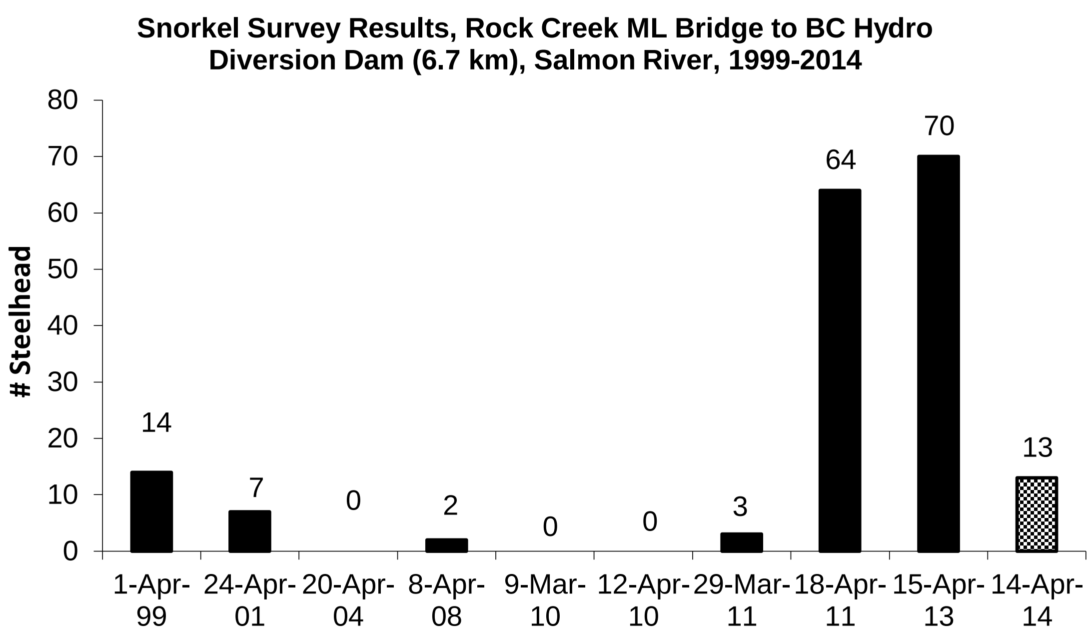
No were observed in this section.

2. Notes:

- The count of 13 fish in this section was below recent highs of 64 in 2011 and 70 in 2013. However, the March index count was down by a similar proportion so this result was not unexpected.
- The Diversion to Norberg Creek index was also swum on April 14 yielding a count of 51 adults over 11.5 km (4.4 fish/km)

[1] 1 (bright), 2 (pre-spawn), 3(mid-spawn), 4 (post spawn), n (number of fish assessed for condition)

- Passage conditions at the Diversion Dam were not investigated in 2014. The default setting of the undersluice gate has been changed from 6" (15 cm) to 14" (36 cm). This has likely influenced the range in mainstem flows which provide a reduced head through the fishway. This condition is known to improve passage at the site.
- The trimming weir was spilling water into Diversion Pool although the volume appeared to be less due to the new undersluice setting.
- Transport time through the reach was estimated at 2.0 hours; relatively fast due to higher flows.
- The road between the diversion dam and Rock Creek was free of snow and easily passable by vehicle. Small accumulations of snow were present on the sides of the road.
- 14.3 m^3/s is above the recommended flows for surveying this section of river. Highly experienced swimmers completed this survey with no incidents but several steep sections were bypassed on foot.
- Two steelhead were encountered over a redd in the lower reaches of the survey. It appears that spawning is a week or two earlier than in cooler years (2011-2012).
- No anglers or evidence of angling was observed on this closed section of river.
- No repeat spawners with external tags were observed from passage studies in 2011 and 2012.
- Refer to chart below for a summary of observations over multiple years.



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Appendix C. Salmon River Juvenile Coho Salmon Sampling Report Prepared by DFO.

Salmon River juvenile sampling 2014 Notes

S. Anderson

Objective – determine presence, population, size and density of juvenile coho in a variety of habitats both upstream and downstream of the Salmon River diversion dam.

Initiated in 2008, annually since scheduled for mid late September (first year was late August). To determine if there is a difference in the densities, or the quality of habitat – as expressed by numbers and size of fish in typical Coho habitats.

Set up 3 sites upstream and downstream of the diversion dam (started with 4 upstream, dropped one due to time constraints – (First Lake creek outlet to Grilse Crk), added one more downstream to give 3 up and down. We have only caught one Coho fry at Crowned Creek, most upstream of sites.

Procedure, protocols, measurements and data as per DFO Stock Assessment information. The skew and kurtosis stats on the spreadsheet summaries are not yet being used – the analysis wasn't completed, but the both are interesting to look at from just an observation perspective. Skew with the longer tail to the right can indicate smaller fish, with densities too high for limited productivity, a longer tail to the left can indicate less density dependency – the habitat can support the population. This is only relevant to the **0+ Coho fry** – and does not include the 1+ age classes or the trout biomass presence. Basic habitat parameters measured include wetted area within stop nets and wetted area greater than 10cm depth –considered to be the usable Coho fry habitat. Oxygen and temperature are also routinely measured. Populations estimates from the multipass removal are calculated from an old DOS program – an Excel update is soon available.

This year we had much lower catches in some sites – goal is to get minimum 100 coho fry. A very dry summer may have effected juvenile survival. Also at site G02 upstream of the SR diversion dam we noted a large number of coho fry with 'pop-eyes' exopthalamy –samples obtained the week after our survey were sent to DFO diagnostics lab – were identified as having a likely trematode –fluke parasite. Other testing –bacteriology and virology came back negative. Some of the parasites were behind the eyes, and also in the skeletal muscles. Stomachs of sampled fish were full; so prey detection was OK, however startle response was much reduced, so could mean some were blinded. Will try to get out in the Spring to sample – see if the fry have survived the winter. Surmised that there the intermediate host – likely a snail had huge infections and released to environment. Site conditions looked good when we were there, water levels and temperatures may have been affected by the very dry warm summer.

Scale smear samples were taken for Coho fry to determine the breakdown of 0+ to 1+ so the fry density calculations relying on only 0+ population are possible.

We look at the trends within sites, between sites as well as between years. Changes in the densities, sizes etc are relative to the sites annually.

DFO Stock Assessment staff have been conduction helicopter overflights intermittently with more intensive sampling over the past few years(BCHydro FWCP funded) to look at adult Salmon timing and distribution- with objective to look at numbers accessing above the diversion dam.

Sampling Dates: September 29-30, 2014

Sites: Crowned Creek, Grilse Creek, Grilse Creek Trib (G02), Paterson Creek, Marilou Creek and Big Tree Creek Mainline Flood channel (natural channel) fig 1.

Crew   A-Tlegay::Mike Dick, Dustin Price, Karl ?, Shane Pollard

EcoFish Leah Hull

DFO-Dan Babchuk, Lorne Frisson Shannon Anderson

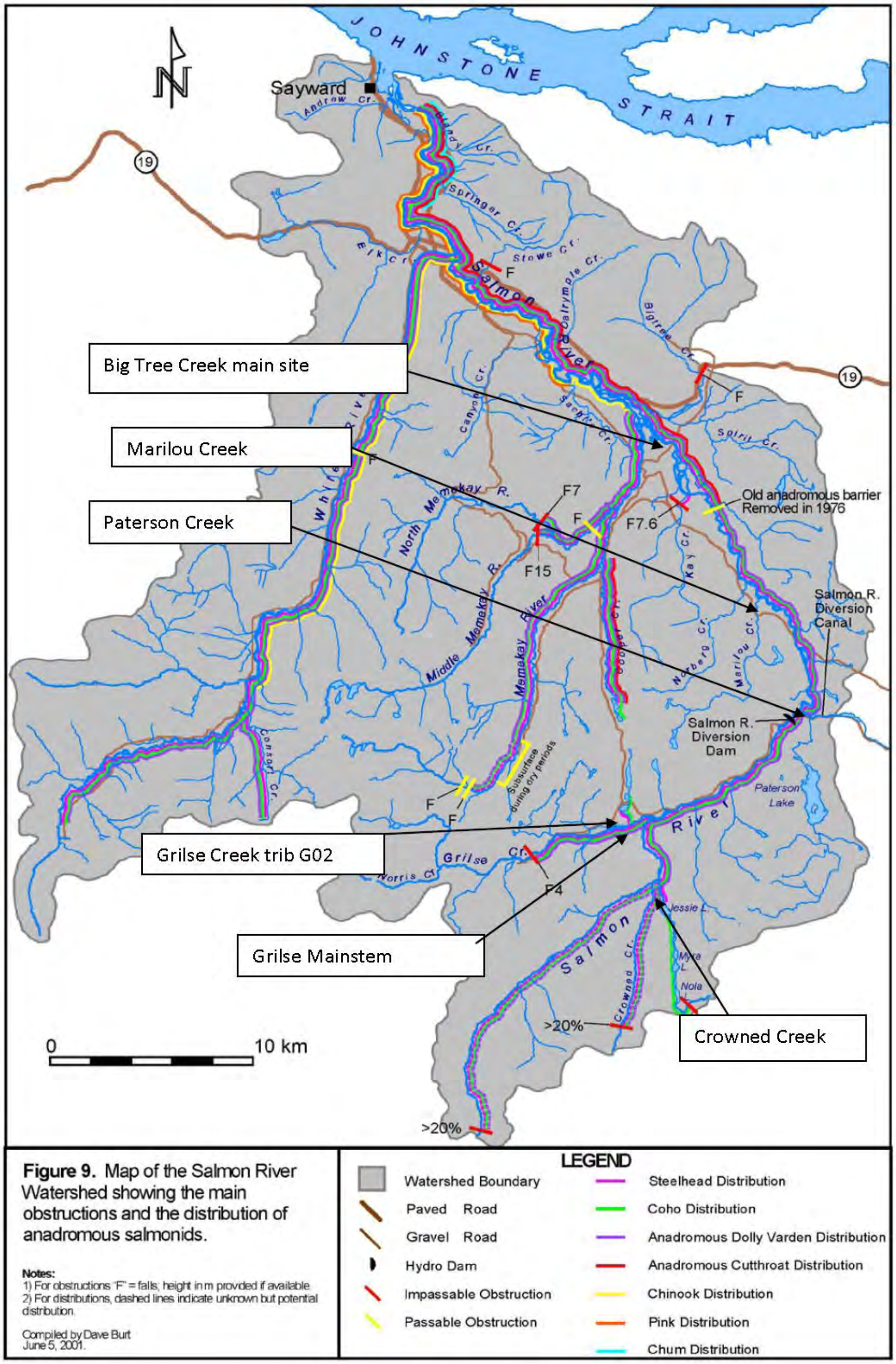
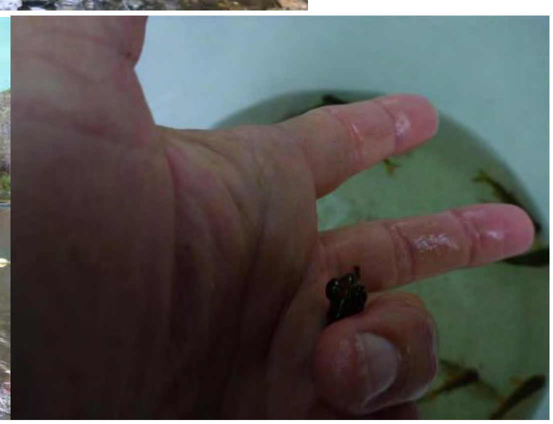


Figure 1. map of Salmon River – (from Burt 2002). Showing approximate area of juvenile sampling.

Crowned Creek –from bridge



Grilse Creek Trib

Grisle Creek mainstem- ish (small side channel)

Marilou Creek

Big Tree Creek Main Flood channel

Coho Fry Surveys

WORK STATEMENT

We are now assessing coho stocks throughout the coast and in the Skeena and Fraser watersheds by determining the density and size of the juveniles prior to overwintering. Densities are difficult to interpret since they are so dependent on the habitat of the sampling site. However, it is becoming apparent that the change in densities at the same site from one year to the next often reflects changes that have occurred in the number of parental spawners. We think the size of the fry may also tell us whether the stream is capable of supporting more than the observed number of fry, that is whether the spawning was sufficient to fully 'seed' the stream. The size attribute that does this is not the average size (which strongly depends on the density of the fry) but how the sizes are distributed. If you plot the number of coho of each size, eg. 50mm, 51mm, 52mm etc., you will get a length frequency distribution starting out with no really small fry, going to a peak number somewhere near the average size and declining down to no really large fry. Its the skewness that appears to be an important indicator: is the length interval between the smallest fry and the most common size smaller than between the most common size and the largest fry? If it is not significantly smaller, ie. if there is little skewness, there may be excess food and other resources for all and the stream may be under-seeded. Secondly, knowing the size of the fry allows us, in relativer terms at least, to estimate how well they will survive in the coming winter. That, in combination with the density estimate, tells us how the size of the smolt run next spring is likely to change.

SELECTING A STOCK AND SAMPLING SITE

Stock assessments by our Division are usually directed at wild (ie. not enhanced) stocks so this may be your first criterion. Second, the stock should be in a stream section (reach) that is small enough to allow a density estimate to be made, usually where it can be sealed off with barrier nets. Third, the habitat in the site should not have so much cover like deep water, extremely deep overhanging banks or thick woody debris that you are unlikely to capture most of the coho with the gear you have. However, it should be a site where you have some expectation that coho occupy. It would not be useful to pick a long riffle because few if any coho will be there. In short, pick coho habitat that you can sample. Most coho occupy pools and backwaters where the current is not strong, where there is at least 10cm depth and where they have some cover like large woody debris, overhanging banks, overhanging vegetation or aquatic vegetation. <u>Try not to pick the best coho habitat in the stream either - we want a reach that is representative of the coho habitat in the stream.</u>

The reach should normally be about 30m long but the upper and lower bounds will depend on factors such as:

- the expected catch (determined by looking for fry or trying a few pole seine scoops). A catch of 120 to 500 is ideal.
- locations of spots that can best be sealed with barrier nets. For example, avoid putting a barrier net in the middle of a pool - its usually difficult and its not a good idea to arbitrarily divide a habitat type occupied by coho.

Once the site has been selected it should not be changed later unless the reach has changed (eg. pools filled in) or you have found a another coho habitat site that you are able to sample much better. Do not expand or contract the reach at later samplings in response to the catch you expect and do not change a site to obtain better coho habitat (unless the old site is no longer coho habitat).

Record the site in enough detail so someone not familiar with the area can find it. Flag the upper and lower boundaries of the site and preferably mark it more permanently than that, e.g. tree paint.

GETTING A DENSITY ESTIMATE

A list is attached of the equipment and supplies you will need to obtain the estimate and sample the catch. The density estimate consists of getting estimates of the number of coho in the reach and of the area of water they occupy.

1. The Abundance Estimate

a) Seal the reach off using barrier nets. Avoid overhanging banks which are almost impossible to seal. Riffles are usually easy and it doesn't matter if you divide them since few coho will be there. Use ropes or sticks to keep the top of the net up and hold the bottom down with rocks or sticks. You will probably have to periodically clean these nets of leaves during the session.

b) Select the gear. Unless the reach is entirely accessible to beach or pole seining, you should use a shocker in conjunction with netting. Netting and shocking complement each other since they are more efficient with different sizes of fish (shocking is better for larger fish). However, shock in moderation by only shocking those areas that couldn't be reached by netting. Shocking may kill or drive fish into deep cover, artificially reducing catches in subsequent passes. Typically, we beach seine if possible and 'clean up' remaining areas like riffles and stream banks with pole seining and/or shocking or we pole seine and shock. We seldom use more than 120 seconds of shocker time in each pass.

c) Fish the reach with the selected gears. Record the amount of effort you expend: the number of beach seine sets and/or pole seine sweeps and the number of seconds of shocking. This is pass 1 of at least 3 and it is critical to expend the same effort each time, so balance the effort. Too little effort and the next catch may not be substantially less and another pass will have to be done. Too much effort is unnecessary and the very low catch you may get in pass 2 makes it less likely that the pass 3 catch will be smaller yet - which causes some analytical problems (this will become clearer below). We normally pace ourselve to get a catch in Pass 2 which is a quarter to a third of the Pass 1 catch and our Pass 3 catch is very small or zero. It is entirely dependent on the site and the number of coho but we almost never beach seine a pool more than once per pass and may make 10-20 pole seine sweeps in a 30m reach and perhaps shock for up to 300 seconds (seldom more than 120 sec, as note above).

If you are netting and shocking, do the netting first. Fish with the current when pole seining (more fish are caught if the water is muddy) and against the current when shocking (you need to see). You may have to wait for the water to clear before shocking. If so, process the netting catch while the water clears. If you can shock immediately, the third person can start processing the netting catch while the other two are shocking. Do not release any fish until all the passes are finished. Keep an eye on them in the buckets and change their water periodically. Do not keep large sculpins, trout or char in with the fry or fry will disappear.

d) <u>Repeat the same fishing at least twice more</u>. Arrange your sampling and other tasks so you give as much time as possible for the fish to settle down between passes. <u>Use the same effort in the second and third passes</u>. This is critical - guard against slackness in later passes. Your effort should not vary because of poor, even zero, catches. If the coho catch has not declined 'significantly', so the third pass catch is still more than 20% of the first pass catch or if one of the catches was higher than the previous one, you should do more than three passes. This is particularly true if the last catch is greater than its predecessor because no estimate is then possible with the data at hand. If you do not have time, it is acceptable to stop the session with a catch that is higher than its predecessor but only if the catch is very small (say less than 5).

Examples:

Catches				Comments
Pass 1	Pass 2	Pass 3	Pass 4	
155	43	6	Not needed	Good est.
155	95	28	"	Fairly good est.
155	95	53	21	Pass 4 gives a much better est.
155	176	47	15	The 3 pass estimate would have been poor.
155	43	47	15	No est. possible after 3 - need 4
49	0	2	?	No est. possible after 3 but with such low numbers it would be acceptable to stop at 3. [The analyst can later force an estimate by making the catch zero in an imaginary fourth pass.]
1	0	1	?	Probably wouldn't do a fourth

2. Estimating the Area of Habitat

Run a 50m surveyor's measuring tape between the lower and upper boundaries of the reach and tie it off. Use another tape, a 30m is sufficient, to measure the width of the stream at points along the first tape. Two widths are recorded at each point: the total stream width and the width of water which is greater than 10cm deep. The latter is measured because it is the most meaningful for coho since it excludes riffles and other shallows which they seldom inhabit. The 10 cm depth is usually estimated by seeing where the water comes to on the wader boot. The length on the upstream/downstream tape must be recorded with the two widths and a statement of the habitat type. Here is an example:

Length	Total Width	Width >10cm	Type
2.1(lower end)	3.1	2.7	P(bottom)

5.2	4.6	3.4	P
7.3	6.2	6.0	P
7.5	9.9	8.5	P
12.9	9.5	1.5	P(top)
15.1	3.7	2.1	G
18.0	3.3	0.9	R(bottom)
20.8	3.1	1.1	P(bottom)
24.1	5.8	5.2	P
26.9(up end)	1.4	0	P(top)

This describes a reach that is 24.8m long (26.9 minus 2.1) and consists, going upstream, of a pool, glide, riffle and pool. The lower pool is 10.8m long (12.9-2.1), the glide is 5.1m long (18-12.9), the riffle is 2.8m long and the upper pool is 6.1m long. Measure as many points as required to be able to draw a reasonable map: take widths where a habitat type (riffle, glide or pool) changes, where the amount of shallow water changes relative to deeper water, and where there are sudden width changes. The fourth measurement is an example of a rapid width change: by defining it exactly where it occurred, between 7.3 and 7.5m, a much more accurate area can be calculated than if the next measurement was at 12.9m. Sometimes side channels or isolated side pools are more easily measured separately by noting their length and a few widths or an estimated average width. If the side pools or channels are small, we may just estimate what percent of their area is >10cm deep.

Your results are interpreted better if the reach is photographed. Take as many photos as necessary to show all the major parts of each reach (usually 2 or 3). Note them on the data sheet (see below).

There may be a relationship between coho productivity and water temperature and conductivity. If you have a temperature/conductivity meter ensure that it is calibrated periodically and take a reading above each site (away from the water disturbances). Do not have the meter recording near an active electrofisher. If you do not have an electronic meter, please take a thermometer reading.

SAMPLING THE CATCH

1. The Data Sheet. An example data sheet is attached. Note that water level is usually a subjective assessment of whether the creek is high, low or normal for the time of sampling. Leave blank if you don't know. Under the top part there are three main columns which can be used in several ways. At least for Pass 1, we usually have one for netted coho, one for shocked coho and one for other species (showing catches by each gear in the same column). Use them any way you like but we suggest that you also keep the shocked catches separate from netted catches (combine pole and beach seine catches however). Enter at the top of the main column the pass number, the species or 'Spp' (coho, other, or all) and the effort or 'E' (see the legend at the bottom of the form). The first sub-column shows the fork lengths in mm. The tens digits are put in by you based on the size range of the catch. The second sub-column is used for tallies of the lengths (see below). And the third sub-column can be used for several things: recording other species if a separate main column is not used, recording scale book grid numbers for lengths at which scales have been sampled, or for weights. At the bottom of the form you should record: (1) where you took photos of the reach and in what direction (upstream, downstream, cross-stream); and (2) the number(s) of the scale book(s). The codes, 1 - 3, for the scale books are only used in the rare event that more than one book is used per session (see below).

2. Preparation. Prepare the anaesthetic bath and test one fish to see how quickly it is anaesthetized, 20 seconds is about right. We use about 3L in the bath. Fully label the scale book and prepare the data sheet.

3. Lengths. All salmon, trout and char must be measured. Coho in particular cannot be sub-sampled for lengths because the shape of their length frequency distribution is sensitive to errors in selecting a random sample of the total catch. Take each fork length (tip of nose to fork of tail) using the measuring boards and record on the data sheet as a tally mark in the appropriate row (see example). If three crew are available, we have two measuring and one recording with one of the measurers taking weights or scales when necessary.

4. Weights. If time permits, wet weights can be recorded in the second column. Blot the fish lightly with absorbent towels or sponges beforehand. We do not usually weigh the fish but when we do, we get a maximum of 3 weights per mm size class (ie. row).

5. Scale Samples. It is important to take scales for aging from any coho that could be yearlings. We do not normally take scales from coho under 70 mm fork length on the coast if it is after August. A typical sample will be about 5% of the total but this will vary. Start by selecting a minimum size which is giving something higher, say 10%, and adjust this size cutoff (usually upward) as the distribution of length tallies becomes apparent. If two size groups are developing as you measure, adjust the minimum scale sampling size to capture all the larger fish and especially the fish in the overlap length range between the two. All coho above the minimum size should have scales taken.

Fully label the scale book. Using a scalpel, scrape a sample from the side, just behind the dorsal fin and above the lateral line and, without turning the scalpel over, slide the scale smear onto the grid square in the scale book using a pencil. Spread the scales around the square using the pencil. Wipe clean the scalpel and pencil. Record the grid number in the appropriate mm size class row on the form. If you use more than one scale book, indicate which book the grid number is for, either by using the book codes, 1-3, associated on the bottom of the form with each book number, or by drawing a dividing line in each row where a grid number refers to a new book. We seldom need more than one book, however.

Kent Simpson
Stock Assessment Div.

(attach.)

EQUIPMENT AND SUPPLIES

Barrier nets (2-4) - maximum mesh size that will stop fry, usually about 5/16" stretch mesh
- about 10m x 1m
- we don't use floats (too bulky) and use light chain or leadline on the bottom

Rope, about 1/4" dia. - for tying barrier nets, etc.
Beach seine - 40ft x 6ft is a versatile size
Pole seine - 2 man type
Backpack electrofisher, with anode pole, cathode, batteries (2), and rubber gloves (3pr) - recommend a paddle type cathode (a rat-tail is not preferred) and a ring-type anode. Cover the ring with netting so fish can be scooped by the shocker person.
Charger for shocker batteries
Pole scoop - used by the shocker assistant to scoop fish. We use a kitchen sieve lashed to a light pole 5-6ft long.
Sieves (2) - kitchen sieves for scooping fish
Buckets (5) for holding fish - 3-5 gal with holes drilled about 4" from the top or with screen windows so water can be replenished.
Chest waders
Polaroid sunglasses - essential for shocking
Anesthetic tray - a plastic wash basin, about 18"x12"
Anesthetic
Measuring boards (2)
Scalpels (4 or more)
Scale books, preferably with a book number and grid numbers 1-50 (allow 1.5 per site)
Pencils
Data forms (allow 2 per site)
Clipboard, legal size
Weigh scale (optional), with batteries and tray
Towels or sponges for blotting fish being weighed
Camera with high speed (eg. ASA 400) film
Survey measuring tapes, 50m and 30m (one each)
Waterproof notebook, ring binder type, with waterproof pages
Tally counter
Packs (3) for barrier nets, beach seine and other gear
Container for sampling utensils. We use a Tupperware box that fits inside the plastic anesthetic tray when packed.
Thermometers (2-3), or
Conductivity/temperature meter
GPS unit

Appendix D. Quinsam River Juvenile Downstream Migration Report Prepared by DFO.

2014 QUINSAM RIVER JUVENILE DOWNSTREAM MIGRATION

BC Hydro Water Use Plan Monitoring Study #8

D.Ewart & S.Kerr,
Quinsam River Hatchery

July 10, 2014

INTRODUCTION

As part of the successful management of both the natural and hatchery stocks of salmonids in the Quinsam River, a downstream assessment program has been performed each spring from 1975 to 1992, and 1996 to 2002, (1993, 94, & 95 were not done because of budget cuts to the hatchery program).
In the spring of 2014, funding for the program was provided by BC Hydro as part of a 10 year monitoring study for the Water Use Plan. The study, (#8) will collect salmon spawner and juvenile data for the Quinsam River over a 10 year period and be used to determine impacts of the BC Hydro flow diversion upriver.
Approximately $16.0k was budgeted for full time labour to carry out the field work, (March to June), and $25.0k is budgeted for capital improvements to the hatchery assessment infrastructure on the counting fence. The program is being run by Laich-Kwil-Tach Environmental Assessments Limited Partnerships (LKT) for BC Hydro. A-Tlegay Fisheries Society and Ecofish Research Ltd. are supporting LKT to deliver this program. All administration and experienced technical labour is provided by the group, with DFO's Quinsam Hatchery staff allowing the use of the hatchery facilities to carry out the project and providing leadership of the program by experienced hatchery staff who supervise the field work and data collection.

This program enumerates salmonid fry and smolts migrating downstream from above the Quinsam River hatchery counting fence.
The juvenile trapping program began in late March and continued until mid June in order to cover the full migration range of all salmonid species in the Quinsam River

METHODS

Flow & Temperature

Temperatures are measured electronically at the Quinsam River Hatchery still well, and recorded daily on the hatchery monitor computer, (continuously, see Table 1)
Quinsam River level and discharge is measured remotely at the BC Hydro monitoring station "QSL" located in the upper river, (below Lower Quinsam Lake). This information is accessed on the BC Hydro web-site
http//www.bchydro.com/info/res_hydromet/data/qsl.txt., (see Table 2)

Fence Operation

The 30 m diversion fence on the Quinsam River is located approximately 300 m upstream of Quinsam Hatchery. Trapping set-up consists of the following:

1. Solid panels are placed into slots on the fence structure to raise the river level for trapping, and to maintain the Quinsam River intake for water supply to the hatchery.
2. Wolf traps (inclined plane traps) are placed into 3 fence panel openings spaced evenly across the fence, (openings 4, 10, & 16 moving from counting shack east across fence). Each wolf trap opening is 12 inches, and the trailing end of the trap leads to a catch trough. The catch trough directs fish to a floating live-box that is located immediately downstream of the counting shack.

3. 3 solid plywood panels are placed into openings 1 - 3 near counting shack to protect the live box, (which is located directly behind).
4. For Pink fry trapping, (mid - March to end of April), it is not necessary to "fish" the whole river, (because of the large number of fry potentially trapped). 3 traps are fished with the rest of the fence left open to spill water. For Coho & Steelhead smolt trapping, a larger portion of the river needs to be diverted through the traps. This is done by adding solid panels into all of the open panel sections.
   Note: 1 panel is left open during the day for adult Steelhead and trout passage upstream.
5. The traps were "fished"7 days per week over a 24 hour period and pulled in the mornings for cleaning and fry/smolt counting.
6. Trapping in 2014 began on March 18th and continued until June 13th.

Fry & Smolt Catch-Efficiency Tests

In 2009, John Taylor, (fisheries consultant and statistician), was hired to assist hatchery staff with establishing a mark re-capture plan for Pinks to improve the calculation of total population estimates, (see John Taylor's Report).
In general, his recommendations were to release an average of 4,000 – 4500 marked Pink fry per event. Also, the number of releases were increased to target once per week during the migration timing. In addition, with proper funding for this project, trapping and enumeration was carried out 7 days per week. In the past, funding had limited trapping activity to weekdays only with weekends not being covered and those days possible catch only estimated.

The mark re-capture method is based on dye-marking a known number of fry with Bismark Brown and then re-capturing these marked fish in the traps. Efficiency of the traps can then be calculated and the numbers used to estimate the total population migrating downriver.
A minimum of 4,000 fry were marked and released approximately 200 meters above the trapping fence, (releases performed 2 hours after sunset). A proportion of these marked fry were then caught and enumerated over the next 1 to 3 days.
In 2014, staff at the Quinsam hatchery constructed a timer activated release box that was set to release fish. The best results were obtained by placing the fry in the release box at 3:30 pm on the night of release and setting the timer for 2 hours after sunset 200 meters above the trapping fence.

Coho smolt catch efficiency is tested by clipping half of either the right or left ventral fin. As with the Pink fry, the marked fish are released above the fence and captured in the traps over the next several days. Note that numbers of smolts marked averaged around 350 per event and was a much smaller number than Pinks based on the lower abundance of smolts to use for marking purposes.
Initially, the same release box was tried for the coho smolt releases. However, on the first release it was determined that up to 40% of the fish did not leave the box by 8:00 am the next morning. In the days that followed, very few marked fish were recaptured at the fence traps which made the population expansion estimates biased and not considered to

be accurate, (because the clipped smolts stayed in the release area for a prolonged period and did not migrate like normal).
A different strategy was implemented for releasing marked Coho smolts, which was based on the methods used in previous years, (no release box). It involved releasing the fish directly into the river (approximately 300 meters above the trapping fence). This was done at 1530 hours and allowed the smolts to acclimate into the river flow rather than hold in a box on the river margin.
One release was done using this method and the results indicated that adequate numbers of marked smolts were recaptured the following days to provide solid data to calculate trapping efficiency and the catch co-efficient. The results also matched results from previous years.
This method has become the standard for all smolt mark-recovery releases.

For fry and smolt expanded population estimates, catch-efficiency was calculated by number of marked fish caught divided by total number marked (percentage catch). The catch co-efficient is then calculated
Example:
If re-capture is 5%, then 100/5 = 20. The catch co-efficient for that period would be 20, meaning that for every fish caught in the trap, there would be a multiplication factor of 20, (to account for the fish that escaped the traps). This catch-coefficient is used and averaged for the periods traps are fished. Factors such as river level will significantly affect the rate of catch at the traps, and for this reason, mark releases are targeted to match the weekly river conditions. Also, past records of similar conditions are used to check if there are any questionable catch efficiencies.

RESULTS

For a summary of all species enumerated, see Table 3.
The following are the results for the main species of interest.

Pink fry

Traps were operating on March 18th, and small numbers of fry were caught initially. Peak migration was on April 18th, and was over by May 9th
Total expanded number that migrated was estimated at **22,000,259 (based on mark recapture expanded estimate).** This number is the most recorded in the history of Quinsam Hatchery trapping operations, (since 1974), and is almost 5 times higher than 2006 migration which was estimated at 4.7 million fry.

An estimated 374,134 pairs of adult Pinks were counted upriver through the hatchery counting fence in September of 2013. This number had the potential of depositing 561 million eggs (based on a fecundity of 1,500 eggs per female).
The survival rate to fry from this egg deposition is then **estimated at 3.9%.**
This is lower than the last two previous years, (12%, 10%), but much higher than the 2009 Brood year (.28%) when very similar numbers of adults spawned in the same reach, (366,610 pairs). In 2009, the very low survival to fry migration was considered to be an

affect of over crowding on the spawning grounds, pre-spawn mortality, and a very unstable fall and winter incubation period that saw several large flood events that washed gravel away and caused high egg mortality.
In comparison, the 2013 return had similar high numbers of spawners in the same upper river habitat. However, the winter conditions in the Quinsam River were cool and very stable. Although adult spawner density is probably an important factor in the reduced survival to fry stage, the stable incubation conditions in the river mitigated the affect during the winter of 2013/14.

Coho Smolts
All Coho smolts migrated between April 27th and June 10th, with the peak being the 15th of May.

- Colonized Coho: During June of 2013, 33,912 Coho fry were adipose clipped and released with 136,072 unmarked fry into the upper Quinsam watershed. The release areas were accessed by truck, and were limited to the lakes. Coho that were trapped as smolts at the hatchery fence in 2014 were assessed for missing adipose fins, and measured for lengths. A "size grade" was determined to assess the numbers of wild to colonized smolts. Colonized Coho smolt migration was estimated **at 36,339**, which works out to a survival rate calculated at 21.4%. This is a standard survival rate that is similar to past years of Coho smolt assessments. Note that colonized Coho appeared to have started migration a week and a half earlier than the wild smolts, and the peaks reflected the same.
- Wild Coho: Estimate of **21,564** smolts migrated from natural production in the upper river. This was significantly better than the last year of trapping (2006), but is still much lower than the wild smolt migration of the 80's and 90's. This is most likely a reflection on the very poor adult Coho returns beginning in 2005 and continuing to 2012 brood year. In 2013 however, the recruitment to the upper river for spawners has increased significantly from previous years with a total escapement of 11,971 adults above the Quinsam River fence.

Coho Fry
The fry migration was **230,490**, which was very good and coincides with the large number of Coho adults returning to spawn in 2013. Estimates of survival are impossible to calculate because the fry abundance is only based on the fish that migrated down stream and not what the resident abundance is. It does indicate however, that egg to fry survival may have been better in 2013/2014 compared with fry counts from previous years. The same factors as for the Pinks would have contributed to the Coho survival.

Steelhead Smolts
All Steelhead smolts migrated between April 24th and June 3rd, with the peak being May 20th. Note that all Steelhead smolts migrating downstream in 2014 come from natural recruitment in the river, (no captive brood or hatchery programs).
Estimated migration is **6,930** smolts and is comparable with the previous 14 years when smolt assessments were done.

Note that Steelhead adult assessment is not carried out by the provincial agency responsible, so it is not possible to calculate an accurate survival rate from egg to smolt. However, if we use applicable biostandards for other salmonids, (for in-river survival 3% egg to smolt has been used as an average), and an adult female Steelhead fecundity of 4,000 e/f, we can back calculate to get a rough estimate of the potential number of adults that produced these smolts.

231,100 eggs produced 6930 smolts (at 3% survival).

231,100/4,000 = 58 females.

Assuming a 50/50 ratio of male to female, the total return may have been 116 adults in the 2012/13 brood years. This is a very low number compared to the 1980's, and is an indicator of very poor ocean survival and chronic low adult recruitment to the watershed. It may also be an indicator of a limit to the carrying capacity of the upper river which could be compounded by adult migration barriers below Lower Quinsam Lake, and low winter flows. This may have reduced the homing instinct of adults to return to the abundant habitat above Lower Quinsam Lake where Steelhead historically migrated and spent their rearing years. More work should be done to assess Steelhead recruitment to these upper river areas.

<u>Chinook</u>

Wild Chinook migrated between April 28th & June 16th, (the date the downstream trap was removed). The peak was May 28th. Note that all of these fry derived from natural spawners counted above the hatchery fence.

- Total Chinook migration was estimated at **18,819**. An estimated 247 female Chinook were counted above the hatchery fence in 2013 with an estimated fecundity of 6200, and the potential for 1,531,400 million egg deposition. This calculates to an egg to fry survival rate of 1.23%.

<u>Other species</u>

Refer to spreadsheet "Quinsam Downstream Migration" for a summary of the migration of other fish species.

DISCUSSION

The new partnership with the LKT, Quinsam Hatchery staff, and BC Hydro worked very well considering that it was the first year of the Water Use Plan Monitoring studies and the timeline to initiate was short. In general, the A'Tlegay Technicians, (Mike Dick and Shane Pollard) worked very well with the hatchery staff, and in particular, Shawn Kerr who was the lead hatchery technician supervising the project for DFO. Conditions for the trapping season were optimum throughout, (river flows and weather), and data collected was very good and recorded at a high standard. It would be desirable for the future continuing downstream projects to have the same A'Tlegay Technicians involved to make use of the experience and training that has gone into developing them in the procedures used for the Quinsam project.

During the summer of 2014, work will be done to renovate the trapping equipment on the counting fence to expend the capital funds committed to the project ($25k). This will include new traps, catch trough, winches, and associated equipment.

Table 1: Quinsam River Temperature

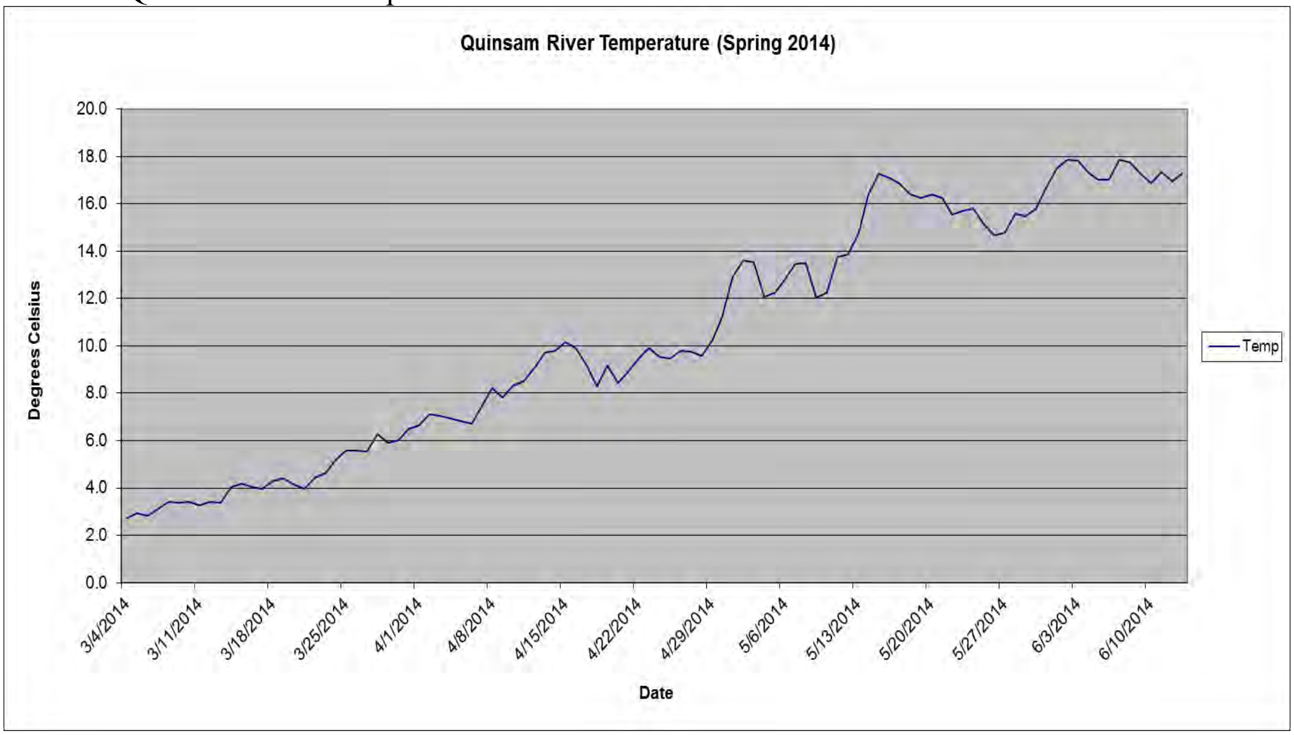


Table 2: Quinsam River Flow (QSL BC Hydro Station)

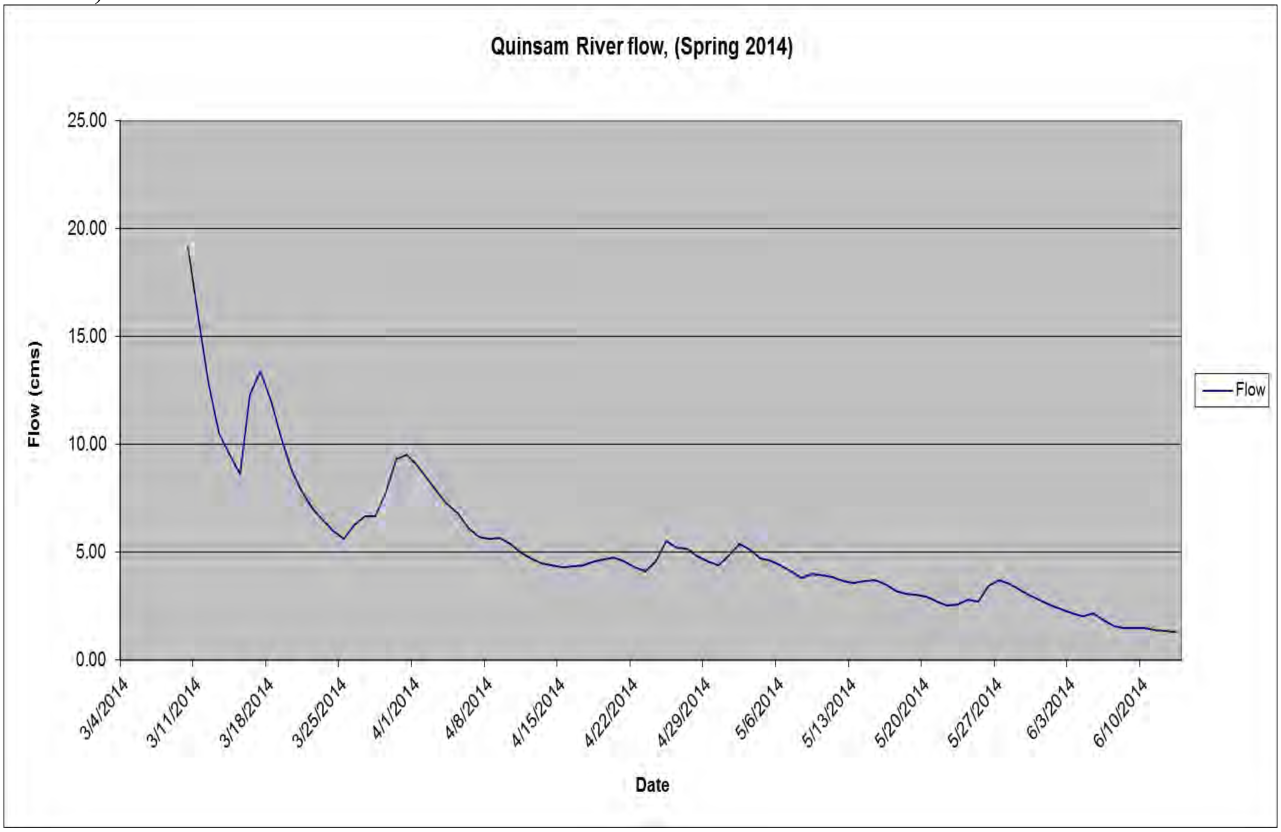


Table 3: Quinsam River Downstream, 2014 Summary

SPECIES	STAGE	TOTAL ESTIMATED MIGRATION	PEAK MIGRATION	MIGRATION PERIOD	ESTIMATED SURVIVAL	COMMENTS
Colonized Coho (by length)	Smolt	**36,339**	13-May-14	Apr 27 - Jun 10		Traps removed June 16
Wild Coho	Smolt	**21,564**	16-May-14	May 7 - Jun 9		Traps removed June 16
2 Year old Coho	Smolt	**55**	10-May-14	May 10 - May 30		Only trapped 5
Coho	Fry	**230,490**	27-May-14	Mar 19 - Jun 10		Traps removed June 16
Steelhead (Wild)	Smolt	**6,930**	20-May-14	Apr 24 - Jun 3		Traps removed June 16
Steelhead	Fingerling	**55**	2-Jun-14	Mar 13 - Jun 5		Traps removed June 16
Steelhead	Kelts	**1**	14-Apr-14	14 Apr - June 4		Only trapped 1, expansion unknown
Cutthroat	Fingerling	**33**	2-Jun-14	Apr 22 - Jun 6		Traps removed June 16
Cutthroat	Smolt	**616**	2-Jun-14	May 1 - Jun 4		Traps removed June 16
Trout Fry	Fry	**176**	2-Jun-14	May 11 - June 16		Traps removed June 16
Chinook	Fry	**18,819**	28-May-14	Apr 28 - Jun 10		Traps removed June 16
Chum	Fry	**2,094**	2-May-14	Mar 19 - Jun 9		Traps removed June 16
Sockeye	Fry	**2,471**	28-Mar-14	Mar 19 - Apr 14		Traps removed June 16
Pink	Fry	**22,000,259**	18-Apr-14	Mar 4-Jun6		Traps removed June 16
Dolly Varden	Smolt	**33**	16-May-14	May 7 - 16		Only trapped 3
Lamprey (2 species)	all	**5,255**	23-May-14	Mar 25 - Jun 10		Traps removed June 16
Sculpin	all	**3,850**	3-Jun-14	Mar 19 - Jun 10		Traps removed June 16
STARTED TRAPPING ON March 18/14:						

Quinsam Hatchery Counting Fence

Upstream view of fence

Catch Trough on downstream side

Live holding box

Live holding box


Counting trapped fry


Catch trough to holding box


Upstream view of wolf trap (1 of 3)


Downstream view of wolf trap

Appendix E. Water Quality Guidelines, Typical Parameter Values and Qualtiy Control Results Summary.

LIST OF TABLES

Table 1. Water quality guidelines for the protection of aquatic life in British Columbia for parameters with less complex guidelines.

Parameter	Unit	BC Guideline for the Protection of Aquatic Life[1]	Guideline Reference
Specific Conductivity	µS/cm	No provincial or federal guidelines	n/a
pH	pH units	When baseline values are between 6.5 and 9 there is no restriction on changes within this range (lethal effects observed below 4.5 and above 9.5)	McKean and Nagpal (1991)
Alkalinity	mg/L	No provincial or federal guidelines. However, waterbodies with <10 mg/L are highly sensitive to acidic inputs, 10 to 20 mg/L are moderatly sensitive to acidic inputs, > 20 mg/L have a low sensitivity to acidic inputs	n/a
Total Ammonia (N)	µg/L	Dependent on pH and temperature, too numerous to present, lowest maximum allowable concentration of 680 µg/L occurs at a pH of 9 and water temperature of 8ºC, lowest maximum average 30 day concentration of 102 µg/L occurs at a pH of 9 and water temperature of 20ºC	Nordin and Pommen (1986)
Nitrite (N)	µg/L	The lowest maximum allowable concentration occurs when chloride is ≤ 2 mg/L; instantaneous maximum allowable concentration is 60 µg/L and a maximum 30 day average of 20 µg/L is allowed when chloride is ≤ 2 mg/L	Nordin and Pommen (1986)
Nitrate (N)	µg/L	The 30 day average concentration to protect freshwater aquatic life is 3,000 µg/L[2] and the maximum concentration is 32,800 µg/L.	Meays (2009)
Orthophosphate	µg/L	No provincial or federal guidelines	n/a
Total Phosphate (P)	µg/L	Trigger ranges that would signify a change in the trophic classification: <4: ultra-oligotrophic, 4-10 oligotrophic, 10 -20 mesotrophic, 20-35 meso-eutrophic, 35-100 eutrophic, > 100 hyper-eutrophic	CCME (2004)

[1] Guideline for total phosphate is a federal guideline; provincial guidelines do not exist

[2] The 30-d average (chronic) concentration is based on 5 weekly samples collected within a 30-day period.

Table 2. Total suspended solids and turbidity guidelines for the protection of aquatic life in British Columbia.

Period	British Columbia[1] Suspended Sediment and Turbidity Guidelines for the Protection of Aquatic Life	
	Total Suspended Sediments (mg/L)	**Turbidity (NTU)**
Clear Flow Period (less than 25 mg/L or less than 8 NTU)	"Induced suspended sediment concentrations should not exceed background levels by more than 25 mg/L during any 24-hour period (hourly sampling preferred). For sediment inputs that last between 24 hours and 30 days (daily sampling preferred), the average suspended sediment concentration should not exceed background by more than 5 mg/L."	"Induced turbidity should not exceed background levels by more than 8 NTU during any 24-hour period (hourly sampling preferred). For sediment inputs that last between 24 hours and 30 days (daily sampling preferred) the mean turbidity should not exceed background by more than 2 NTU."
Turbid Flow Period (greater than or equal to 25 mg/L or greater than or equal to 8 NTU)	"Induced suspended sediment concentrations should not exceed background levels by more than 10 mg/L at any time when background levels are between 25 and 100 mg/L. When background exceeds 100 mg/L, suspended sediments should not be increased by more than 10% of the measured background level at any one time."	"Induced turbidity should not exceed background levels by more than 5 NTU at any time when background turbidity is between 8 and 50 NTU. When background exceeds 50 NTU, turbidity should not be increased by more than 10% of the measured background level at any one time."

[1] reproduced from Singleton (2001)

Table 3. Dissolved oxygen guidelines for the protection of aquatic life in British Columbia.

	BC Guidelines for the Protection of Aquatic Life[1]		
	Life Stages Other Than Buried Embryo/Alevin	**Buried Embryo/Alevin[2]**	**Buried Embryo/Alevin[2]**
Dissolved Oxygen Concentration	Water column mg/L O_2	Water column mg/L O_2	Interstitial Water mg/L O_2
Instantaneous minimum[3]	5	9	6
30-day mean[4]	8	11	8

[1] MOE (1997a) and MOE (1997b)

[2] For the buried embryo / alevin life stages these are in-stream concentrations from spawning to the point of yolk sac absorption or 30 days post-hatch for fish; the water column concentrations recommended to achieve interstitial dissolved oxygen values when the latter are unavailable. Interstitial oxygen measurements would supersede water column measurements in comparing to criteria.

[3] The instantaneous minimum level is to be maintained at all times.

[4] The mean is based on at least five approximately evenly spaced samples. If a diurnal cycle exists in the water body, measurements should be taken when oxygen levels are lowest (usually early morning).

Table 4. Total gas pressure guidelines for the protection of aquatic life in British Columbia.

Water Depth	Maximum Allowable ΔP (Total Gas Pressure - Barometric Pressure) for the Protection of Aquatic Life in BC[1]
> 1 m	76 mm Hg regardless of pO_2 levels
< 1 m	$\Delta P_{\text{initiation of swim bladder overinflation}} = 73.89 * \text{water depth (m)} + 0.15 * pO_2$ where pO_2 = 157 mm Hg (i.e., sea level normoxic condition) In its most conservative form (assuming water column depth = 0 m), the BC guideline for waters less than 1 m deep is that the maximum allowable ΔP should not exceed 24 mm Hg

[1] Fidler and Miller (1994)

Table 5. Typical values for water quality parameters in British Columbia waters.

Parameter	Unit	Typical Range in BC	Reference
Specific Conductivity	µS/cm	The typical value in coastal British Columbia streams is 100 µS/cm, while interior streams range up to 500 µS/cm	RISC (1998)
pH	pH units	Natural fresh waters have a pH range from 4 to 10, and lakes tend to have a pH ≥ 7.0.	RISC (1998)
Alkalinity	mg/L	Natural waters almost always have concentrations less than 500 mg/L, with waters in coastal BC typically ranging from 0 to 10 mg/L; waters in interior BC can have values greater than 100 mg/L	RISC (1998)
Total Suspended Solids	mg/L	In British Columbia natural concentrations of suspended solids vary extensively between waterbodies and between	Singleton (1985) in Caux *et al.* (1997)
Turbidity	NTU	In British Columbia natural concentrations of suspended solids vary extensively between waterbodies and between	Singleton (1985) in Caux *et al.* (1997)
Dissolved Oxygen	mg/L	In BC surface waters are generally well aerated and have DO concentrations greater than 10 mg/L	MOE (1997a)
Dissolved Oxygen	% saturatio n	In BC surface waters are generally well aerated and have DO concentrations close to equilibrium with the atmosphere (i.e., close to 100% saturation)	MOE (1997a)
ΔP (Total Gas Pressure - Barometric Pressure)	mm Hg	In British Columbia, dissolved gas supersaturation is a natural feature of many waters with ΔP commonly being between 50 – 80 mm Hg. (We often see values between -10	Fidler and Miller (1994)
Total Ammonia (N)	mg/L	<0.1 mg/L for waters not affected by waste discharges	Nordin and Pommen (1986)
Nitrite (N)	mg/L	Due to its unstable nature, nitrite concentrations are very low, typically present in surface waters at concentrations of <0.001 mg/L	RISC (1998)
Nitrate (N)	mg/L	In oligotrophic lakes and streams, nitrate concentrations are expected to be <0.1 mg/L, and most surface waters have <0.3 mg/L of nitrate.	Nordin and Pommen (1986)
Orthophosphate	mg/L	This form of phosphorus is the most readily available for uptake during photosynthesis. High levels can be associated with algae blooms.	RISC (1998)
Total Phosphate (P)	mg/L	Water bodies with total phosphorus concentrations between 0.004 and 0.01 mg/L are considered oligotrophic, 0.01-0.02 mg/L mesotrophic, 0.02-0.035 mg/L meso-eutrophic, and 0.035-0.10 mg/L is considered eutrophic.	CCME (2004)

Table 6. Hold time exceedances for water samples analyzed by ALS Environmental.

Description	Site	Sampling Date	Recommended Hold Time (days)	Actual Hold Time (days)
Anions and Nutrients				
Nitrite in Water by Ion Chromatography	QUN-WQ	19-Aug-2014 10:08:00	3	8
Nitrate in Water by Ion Chromatography	QUN-WQ	19-Aug-2014 10:08:00	3	8

All samples for all sites and sample dates exceeded the recommended hold time for pH of 0.25 hrs.

REFERENCES

Caux, P.-Y., D.R.J. Moore, and D. MacDonald. 1997. Ambient water quality guidelines (criteria) for turbidity, suspended and benthic sediments: technical appendix. Prepared for the British Columbia Ministry of Environment, Lands and Parks. Water Quality Branch, Environment and Resource Management Division, Victoria, BC. 82p. Available online at: http://www.env.gov.bc.ca/wat/wq/BCguidelines/turbidity/turbiditytech.pdf. Accessed on January 11, 2015.

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MOE (B.C. Ministry of Environment). 1997b. Ambient water quality criteria for dissolved oxygen: technical appendix. Prepared pursuant to Section 2(e) of the Environment Management Act, 1981. Signed by Don Fast, Assistant Deputy Minister, Environment and Lands HQ Division. Available online at: http://www.env.gov.bc.ca/wat/wq/BCguidelines/do/index.html. Accessed on January 11, 2015.

Nordin, R.N. and L.W. Pommen. 1986. Water quality criteria for nitrogen (nitrate, nitrite, and ammonia): technical appendix. Water Quality Unit, Water Management Branch, British Columbia Ministry of Environment and Parks. Victoria, BC. Available online at: http://www.env.gov.bc.ca/wat/wq/BCguidelines/nitrogen/nitrogentech.pdf. Accessed on January 11, 2015.

RISC (Resources Information Standards Committee). 1998. Guidelines for designing and implementing a water quality monitoring program in British Columbia. Prepared by the BC Ministry of Environment, Lands and Parks for the Resource Inventory Commission. Available online at: http://www.for.gov.bc.ca/hts/risc/pubs/aquatic/design/index.htm. Accessed on Accessed on January 22, 2015.

Singleton, H. 2001. Ambient water quality guidelines (criteria) for turbidity, suspended and benthic sediment: overview report. Water Quality Management Branch, Ministry of Environment and Parks (now called Ministry of Environment). Available online at: http://www.env.gov.bc.ca/wat/wq/BCguidelines/turbidity/turbidity.html. Accessed on January 11, 2015.

Appendix F. ALS Laboratory Water Quality Results and QA for the Salmon River, Year 1 Monitoring.

ECOFISH RESEARCH LTD
ATTN: Kevin Ganshorn
Suite F, 450 - 8th Street
Courtenay BC V9N 1N5

Date Received: 22-MAY-14
Report Date: 29-MAY-14 12:50 (MT)
Version: FINAL

Client Phone: 250-334-3042

Certificate of Analysis

Lab Work Order #: L1458857

Project P.O. #:	NOT SUBMITTED
Job Reference:	1230 JHT-MON8
C of C Numbers:	OL-1281
Legal Site Desc:	

Ariel Tang
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1458857-1	L1458857-2	L1458857-3	L1458857-4	
	Description	Water	Water	Water	Water	
	Sampled Date	21-MAY-14	21-MAY-14	21-MAY-14	21-MAY-14	
	Sampled Time	10:30	10:31	10:33	10:34	
	Client ID	SAM-WQ1A	SAM-WQ1B	SAM- FIELD BLANK	SAM- TRAVEL BLANK	
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	27.0	27.3	<2.0	<2.0	
	pH (pH)	7.40	7.35	5.60	5.54	
	Total Suspended Solids (mg/L)	<1.0	<1.0	<1.0	<1.0	
	Total Dissolved Solids (mg/L)	32	31	<10	<10	
	Turbidity (NTU)	0.22	0.38	<0.10	<0.10	
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	12.3	12.2	<2.0	<2.0	
	Ammonia, Total (as N) (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	
	Nitrate (as N) (mg/L)	0.0084	0.0091	<0.0050	<0.0050	
	Nitrite (as N) (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Orthophosphate-Dissolved (as P) (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Phosphorus (P)-Total (mg/L)	0.0032	0.0031	<0.0020	<0.0020	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Phosphorus (P)-Total	MS-B	L1458857-1, -2, -3, -4

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-COL-VA	Water	Alkalinity by Colourimetric (Automated)	EPA 310.2

This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.

ANIONS-NO2-IC-VA	Water	Nitrite in Water by Ion Chromatography	EPA 300.0

This analysis is carried out using procedures adapted from EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography". Nitrite is detected by UV absorbance.

ANIONS-NO3-IC-VA	Water	Nitrate in Water by Ion Chromatography	EPA 300.0

This analysis is carried out using procedures adapted from EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography". Nitrate is detected by UV absorbance.

EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

NH3-F-VA	Water	Ammonia in Water by Fluorescence	J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

P-T-COL-VA	Water	Total P in Water by Colour	APHA 4500-P Phosphorus

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Phosphorus is determined colourimetrically after persulphate digestion of the sample.

PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H "pH Value"

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PO4-DO-COL-VA	Water	Diss. Orthophosphate in Water by Colour	APHA 4500-P Phosphorus

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Dissolved Orthophosphate is determined colourimetrically on a sample that has been lab or field filtered through a 0.45 micron membrane filter.

TDS-VA	Water	Total Dissolved Solids by Gravimetric	APHA 2540 C - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

TSS-LOW-VA	Water	Total Suspended Solids by Grav. (1 mg/L)	APHA 2540 Gravimetric

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total suspended solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.

TURBIDITY-VA	Water	Turbidity by Meter	APHA 2130 "Turbidity"

This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.

TURBIDITY-VA	Water	Turbidity by Meter	APHA 2130 Turbidity

This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location

Reference Information

VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

OL-1281

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Client: ECOFISH RESEARCH LTD
Suite F, 450 - 8th Street
Courtenay BC V9N 1N5

Contact: Kevin Ganshorn

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-COL-VA	**Water**							
Batch R2845941								
WG1879527-2 CRM		**VA-ALKL-CONTROL**						
Alkalinity, Total (as CaCO3)			99.6		%		85-115	27-MAY-14
WG1879527-5 CRM		**VA-ALKM-CONTROL**						
Alkalinity, Total (as CaCO3)			99.0		%		85-115	27-MAY-14
WG1879527-6 DUP		**L1458857-4**						
Alkalinity, Total (as CaCO3)		<2.0	<2.0	RPD-NA	mg/L	N/A	20	27-MAY-14
WG1879527-1 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	27-MAY-14
WG1879527-4 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	27-MAY-14
ANIONS-NO2-IC-VA	**Water**							
Batch R2846776								
WG1877928-17 LCS								
Nitrite (as N)			100.4		%		90-110	23-MAY-14
WG1877928-2 LCS								
Nitrite (as N)			101.5		%		90-110	23-MAY-14
WG1877928-1 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	23-MAY-14
WG1877928-10 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	23-MAY-14
WG1877928-13 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	23-MAY-14
WG1877928-16 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	23-MAY-14
WG1877928-4 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	23-MAY-14
WG1877928-7 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	23-MAY-14
WG1877928-11 MS		**L1458967-2**						
Nitrite (as N)			99.5		%		75-125	23-MAY-14
WG1877928-14 MS		**L1459347-4**						
Nitrite (as N)			100.6		%		75-125	23-MAY-14
WG1877928-5 MS		**L1458854-5**						
Nitrite (as N)			101.3		%		75-125	23-MAY-14
WG1877928-8 MS		**L1458857-4**						
Nitrite (as N)			100.8		%		75-125	23-MAY-14
ANIONS-NO3-IC-VA	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ANIONS-NO3-IC-VA	**Water**							
Batch R2846776								
WG1877928-17 LCS								
Nitrate (as N)			100.7		%		90-110	23-MAY-14
WG1877928-2 LCS								
Nitrate (as N)			101.3		%		90-110	23-MAY-14
WG1877928-1 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	23-MAY-14
WG1877928-10 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	23-MAY-14
WG1877928-13 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	23-MAY-14
WG1877928-16 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	23-MAY-14
WG1877928-4 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	23-MAY-14
WG1877928-7 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	23-MAY-14
WG1877928-11 MS		**L1458967-2**						
Nitrate (as N)			101.1		%		75-125	23-MAY-14
WG1877928-14 MS		**L1459347-4**						
Nitrate (as N)			101.5		%		75-125	23-MAY-14
WG1877928-18 MS		**L1458277-8**						
Nitrate (as N)			101.4		%		75-125	23-MAY-14
WG1877928-5 MS		**L1458854-5**						
Nitrate (as N)			101.9		%		75-125	23-MAY-14
WG1877928-8 MS		**L1458857-4**						
Nitrate (as N)			101.9		%		75-125	23-MAY-14
EC-PCT-VA	**Water**							
Batch R2844232								
WG1877786-17 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			99.3		%		90-110	23-MAY-14
WG1877786-18 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			98.2		%		90-110	23-MAY-14
WG1877786-19 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			97.6		%		90-110	23-MAY-14
WG1877786-20 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			98.4		%		90-110	23-MAY-14
WG1877786-21 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			99.1		%		90-110	23-MAY-14
WG1877786-22 CRM		**VA-EC-PCT-CONTROL**						

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
EC-PCT-VA	**Water**							
Batch R2844232								
WG1877786-22 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			99.5		%		90-110	23-MAY-14
WG1877786-23 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			99.9		%		90-110	23-MAY-14
WG1877786-24 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			100.0		%		90-110	23-MAY-14
WG1877786-1 MB								
Conductivity			<2.0		uS/cm		2	23-MAY-14
WG1877786-2 MB								
Conductivity			<2.0		uS/cm		2	23-MAY-14
WG1877786-3 MB								
Conductivity			<2.0		uS/cm		2	23-MAY-14
WG1877786-4 MB								
Conductivity			<2.0		uS/cm		2	23-MAY-14
WG1877786-5 MB								
Conductivity			<2.0		uS/cm		2	23-MAY-14
WG1877786-6 MB								
Conductivity			<2.0		uS/cm		2	23-MAY-14
WG1877786-7 MB								
Conductivity			<2.0		uS/cm		2	23-MAY-14
WG1877786-8 MB								
Conductivity			<2.0		uS/cm		2	23-MAY-14
NH3-F-VA	**Water**							
Batch R2847307								
WG1880192-2 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			105.8		%		85-115	27-MAY-14
WG1880192-4 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			88.3		%		85-115	27-MAY-14
WG1880192-6 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			95.8		%		85-115	27-MAY-14
WG1880192-8 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			90.1		%		85-115	27-MAY-14
WG1880192-1 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	27-MAY-14
WG1880192-3 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	27-MAY-14
WG1880192-5 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	27-MAY-14
WG1880192-7 MB								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NH3-F-VA	**Water**							
Batch R2847307								
WG1880192-7 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	27-MAY-14
WG1880192-10 MS		**L1456844-1**						
Ammonia, Total (as N)			97.6		%		75-125	27-MAY-14
WG1880192-12 MS		**L1457185-1**						
Ammonia, Total (as N)			95.4		%		75-125	27-MAY-14
WG1880192-14 MS		**L1457232-3**						
Ammonia, Total (as N)			95.3		%		75-125	27-MAY-14
Batch R2847583								
WG1880769-10 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			99.2		%		85-115	28-MAY-14
WG1880769-2 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			95.0		%		85-115	28-MAY-14
WG1880769-4 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			102.4		%		85-115	28-MAY-14
WG1880769-6 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			103.0		%		85-115	28-MAY-14
WG1880769-8 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			105.2		%		85-115	28-MAY-14
WG1880769-1 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	28-MAY-14
WG1880769-3 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	28-MAY-14
WG1880769-5 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	28-MAY-14
WG1880769-7 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	28-MAY-14
WG1880769-9 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	28-MAY-14
WG1880769-12 MS		**L1455760-2**						
Ammonia, Total (as N)			98.7		%		75-125	28-MAY-14
WG1880769-14 MS		**L1455918-1**						
Ammonia, Total (as N)			96.4		%		75-125	28-MAY-14
WG1880769-16 MS		**L1457499-3**						
Ammonia, Total (as N)			84.4		%		75-125	28-MAY-14
WG1880769-18 MS		**L1457185-3**						
Ammonia, Total (as N)			98.4		%		75-125	28-MAY-14
P-T-COL-VA	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
P-T-COL-VA	**Water**							
Batch R2846818								
WG1878231-10 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			103.9		%		80-120	25-MAY-14
WG1878231-14 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			104.4		%		80-120	25-MAY-14
WG1878231-18 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			103.7		%		80-120	25-MAY-14
WG1878231-2 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			102.6		%		80-120	25-MAY-14
WG1878231-22 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			104.4		%		80-120	25-MAY-14
WG1878231-26 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			101.5		%		80-120	25-MAY-14
WG1878231-30 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			105.1		%		80-120	25-MAY-14
WG1878231-34 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			104.8		%		80-120	25-MAY-14
WG1878231-6 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			102.4		%		80-120	25-MAY-14
WG1878231-1 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	25-MAY-14
WG1878231-13 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	25-MAY-14
WG1878231-17 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	25-MAY-14
WG1878231-21 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	25-MAY-14
WG1878231-25 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	25-MAY-14
WG1878231-29 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	25-MAY-14
WG1878231-33 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	25-MAY-14
WG1878231-5 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	25-MAY-14
WG1878231-9 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	25-MAY-14
WG1878231-12 MS		**L1458001-6**						
Phosphorus (P)-Total			101.5		%		70-130	25-MAY-14
WG1878231-16 MS		**L1458185-5**						

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
P-T-COL-VA	**Water**							
Batch R2846818								
WG1878231-16 MS		**L1458185-5**						
Phosphorus (P)-Total			100.6		%		70-130	25-MAY-14
WG1878231-20 MS		**L1458703-5**						
Phosphorus (P)-Total			N/A	MS-B	%		-	25-MAY-14
WG1878231-24 MS		**L1458709-6**						
Phosphorus (P)-Total			101.1		%		70-130	25-MAY-14
WG1878231-28 MS		**L1458898-1**						
Phosphorus (P)-Total			102.2		%		70-130	25-MAY-14
WG1878231-4 MS		**L1457511-2**						
Phosphorus (P)-Total			109.1		%		70-130	25-MAY-14
WG1878231-8 MS		**L1457922-3**						
Phosphorus (P)-Total			112.1		%		70-130	25-MAY-14
PH-PCT-VA	**Water**							
Batch R2844232								
WG1877786-25 CRM		**VA-PH7-BUF**						
pH			7.02		pH		6.9-7.1	23-MAY-14
WG1877786-26 CRM		**VA-PH7-BUF**						
pH			7.02		pH		6.9-7.1	23-MAY-14
WG1877786-27 CRM		**VA-PH7-BUF**						
pH			7.00		pH		6.9-7.1	23-MAY-14
WG1877786-28 CRM		**VA-PH7-BUF**						
pH			7.00		pH		6.9-7.1	23-MAY-14
WG1877786-29 CRM		**VA-PH7-BUF**						
pH			7.02		pH		6.9-7.1	23-MAY-14
WG1877786-30 CRM		**VA-PH7-BUF**						
pH			7.02		pH		6.9-7.1	23-MAY-14
WG1877786-31 CRM		**VA-PH7-BUF**						
pH			7.01		pH		6.9-7.1	23-MAY-14
WG1877786-32 CRM		**VA-PH7-BUF**						
pH			7.02		pH		6.9-7.1	23-MAY-14
PO4-DO-COL-VA	**Water**							
Batch R2844507								
WG1877862-2 CRM		**VA-OPO4-CONTROL**						
Orthophosphate-Dissolved (as P)			104.9		%		80-120	23-MAY-14
WG1877862-8 CRM		**VA-OPO4-CONTROL**						
Orthophosphate-Dissolved (as P)			99.9		%		80-120	23-MAY-14
WG1877862-1 MB								
Orthophosphate-Dissolved (as P)			<0.0010		mg/L		0.001	23-MAY-14

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PO4-DO-COL-VA	**Water**							
Batch R2844507								
WG1877862-7 MB								
Orthophosphate-Dissolved (as P)			<0.0010		mg/L		0.001	23-MAY-14
WG1877862-4 MS		**L1457511-2**						
Orthophosphate-Dissolved (as P)			104.0		%		70-130	23-MAY-14
WG1877862-6 MS		**L1458882-8**						
Orthophosphate-Dissolved (as P)			104.6		%		70-130	23-MAY-14
TDS-VA	**Water**							
Batch R2844369								
WG1877535-2 LCS								
Total Dissolved Solids			104.2		%		85-115	22-MAY-14
WG1877535-5 LCS								
Total Dissolved Solids			103.5		%		85-115	22-MAY-14
WG1877535-1 MB								
Total Dissolved Solids			<10		mg/L		10	22-MAY-14
WG1877535-4 MB								
Total Dissolved Solids			<10		mg/L		10	22-MAY-14
TSS-LOW-VA	**Water**							
Batch R2846754								
WG1879368-2 LCS								
Total Suspended Solids			105.2		%		85-115	26-MAY-14
WG1879368-4 LCS								
Total Suspended Solids			107.9		%		85-115	26-MAY-14
WG1879368-6 LCS								
Total Suspended Solids			100.9		%		85-115	26-MAY-14
WG1879368-8 LCS								
Total Suspended Solids			111.5		%		85-115	26-MAY-14
WG1879368-1 MB								
Total Suspended Solids			<1.0		mg/L		1	26-MAY-14
WG1879368-3 MB								
Total Suspended Solids			<1.0		mg/L		1	26-MAY-14
WG1879368-5 MB								
Total Suspended Solids			<1.0		mg/L		1	26-MAY-14
WG1879368-7 MB								
Total Suspended Solids			<1.0		mg/L		1	26-MAY-14
TURBIDITY-VA	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TURBIDITY-VA	**Water**							
Batch R2843620								
WG1877693-11 CRM		**VA-FORM-40**						
Turbidity			100.0		%		85-115	22-MAY-14
WG1877693-14 CRM		**VA-FORM-40**						
Turbidity			99.3		%		85-115	22-MAY-14
WG1877693-2 CRM		**VA-FORM-40**						
Turbidity			98.8		%		85-115	22-MAY-14
WG1877693-5 CRM		**VA-FORM-40**						
Turbidity			98.5		%		85-115	22-MAY-14
WG1877693-8 CRM		**VA-FORM-40**						
Turbidity			100.0		%		85-115	22-MAY-14
WG1877693-15 DUP		**L1458857-1**						
Turbidity		0.22	0.22		NTU	1.4	15	22-MAY-14
WG1877693-1 MB								
Turbidity			<0.10		NTU		0.1	22-MAY-14
WG1877693-10 MB								
Turbidity			<0.10		NTU		0.1	22-MAY-14
WG1877693-13 MB								
Turbidity			<0.10		NTU		0.1	22-MAY-14
WG1877693-4 MB								
Turbidity			<0.10		NTU		0.1	22-MAY-14
WG1877693-7 MB								
Turbidity			<0.10		NTU		0.1	22-MAY-14

Quality Control Report

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
J	Duplicate results and limits are expressed in terms of absolute difference.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH by Meter (Automated)							
	1	21-MAY-14 10:30	23-MAY-14 23:00	0.25	60	hours	EHTR-FM
	2	21-MAY-14 10:31	23-MAY-14 23:00	0.25	60	hours	EHTR-FM
	3	21-MAY-14 10:33	23-MAY-14 23:00	0.25	60	hours	EHTR-FM
	4	21-MAY-14 10:34	23-MAY-14 23:00	0.25	60	hours	EHTR-FM

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L1458857 were received on 22-MAY-14 12:20.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

Short Holding Time

Rush Processing

ALS Environmental

Chain of Custody / Analytical Request Form

Canada Toll Free : 1 800 668 9878

www.alsglobal.com

COC #: OL-1281

Report To	
Company:	ECOFISH RESEARCH LTD
Contact:	Kevin Ganshorn
Address:	906- 595 Howe Street Vancouver, BC Canada, V6C2T5
Phone:	604-608-6180 Fax: 604-559-6180

Invoice To ☑Email ☐Mail	
Company:	ECOFISH RESEARCH LTD
Contact:	Accounts Payable
Address:	Suite F, 450 - 8th Street Courtenay, BC Canada, V9N 1N5
Email:	accountspayable@ecofishresearch.com
Phone:	250-334-3042

Lab Work Order # (lab use only): L1458857

Reporting	
Distribution:	☐Fax ☐Mail ☑Email
☑Criteria on Report (select from Guidelines below)	
Report Type:	☑Excel ☐Digital
Report Format:	CROSSTAB_ALSQC
Report Email(s):	kganshorn@ecofishresearch.com tkasubuchi@ecofishresearch.com pdinn@ecofishresearch.com
EDD Format:	
EDD Email(s):	

Project Info	
Job #:	1230 JHT-MON8
PO/AFE:	
LSD:	
Quote #:	
ALS Contact:	Ariel Tang
Sampler:	Kyle Milburn

Service Requested

- ◉ Regular (Standard Turnaround Times - Business Days) - R
- ○ Priority (3 Days) - surcharge will apply - P
- ○ Priority (2 Days) - surcharge will apply - P2
- ○ Emergency (1-2 day) – surcharge will apply - E
- ○ Same Day or Weekend Emergency - surcharge will apply - E2
- ○ Specify date required - X

Analysis Requests (Please indicate below Filtered, Preserved or both(F, P, F/P))

Sample #	Sample Identification (This will appear on the report)	Longitude	Latitude	Date	Time	Sample Type	Number of Containers	Alkalinity by Colourimetric (Automated)	Ammonia in Water by Fluorescence	Conductivity (Automated)	Diss. Orthophosphate in Water by Colour	Nitrate in Water by Ion Chromatography	Nitrite in Water by Ion Chromatography	Total Dissolved Solids by Gravimetric	Total P in Water by Colour	Total Suspended Solids by Grav. (1 mg/L)	Turbidity by Meter	pH by Meter (Automated)
	SAM-WQ1A			May21/14	10:30	Water	3	R	R	R	R	R	R	R	R	R	R	R
	SAM-WQ1B			May21/14	10:31	Water	3	R	R	R	R	R	R	R	R	R	R	R
	SAM-Field Blank			May21/14	10:33	Water	3	R	R	R	R	R	R	R	R	R	R	R
	SAM-Trip Blank			May21/14	10:34	Water	3	R	R	R	R	R	R	R	R	R	R	R

L1458857-COFC

Special Instructions/Comments

The questions below must be answered for water samples (check Yes or No)

Are any sample taken from a regulated DW system? ☐Yes ☐No

If yes, please use an authorized drinking water COC

Is the water sampled intended to be potable for human consumption? ☐Yes ☐No

Guidelines

British Columbia Approved and Working Water Quality Guidelines (JULY, 2013) - BCAWWQG - Freshwater Aquatic Life

SAMPLE CONDITION (lab use only)

☐Frozen ☐Cold ☐Ambient ☐Cooling Initiated

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by: Kyle Milburn	Date: May22	Time: 6:30	Received by: YL	Date: May22	Time: 12:20	Temperature: 5.1 °C	Verified by:	Date:	Time:	Observations: ☐Yes If Yes add SIF

ECOFISH RESEARCH LTD
ATTN: Kevin Ganshorn
Suite F, 450 - 8th Street
Courtenay BC V9N 1N5

Date Received: 18-JUN-14
Report Date: 26-JUN-14 15:46 (MT)
Version: FINAL

Client Phone: 250-334-3042

Certificate of Analysis

Lab Work Order #: L1473244

Project P.O. #: NOT SUBMITTED
Job Reference: 1230 JHT-MON8
C of C Numbers: OL-1305
Legal Site Desc:

Ariel Tang
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1473244-1	L1473244-2	L1473244-3	L1473244-4	
	Description	Water	Water	Water	Water	
	Sampled Date	17-JUN-14	17-JUN-14	17-JUN-14	17-JUN-14	
	Sampled Time	10:01	10:01	10:01	10:01	
	Client ID	SAM-WQ1A	SAM-WQ1B	SAM-FIELD BLANK	SAM-TRAVEL BLANK	
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	43.5	37.5	<2.0	<2.0	
	pH (pH)	7.59	7.55	5.44	5.48	
	Total Suspended Solids (mg/L)	<1.0	<1.0	<1.0	<1.0	
	Total Dissolved Solids (mg/L)	31	34	<10	<10	
	Turbidity (NTU)	0.17	0.26	<0.10	<0.10	
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	17.8	17.3	<2.0	<2.0	
	Ammonia, Total (as N) (mg/L)	<0.0050	<0.0050	<0.0050	0.0608 RRV	
	Nitrate (as N) (mg/L)	0.0157	0.0152	<0.0050	<0.0050	
	Nitrite (as N) (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Orthophosphate-Dissolved (as P) (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Phosphorus (P)-Total Dissolved (mg/L)	<0.0020	<0.0020	<0.0020	<0.0020	
	Phosphorus (P)-Total (mg/L)	<0.0020	0.0021	<0.0020	<0.0020	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Duplicate	Nitrite (as N)	DLM	L1473244-1, -2, -3, -4
Duplicate	Nitrate (as N)	DLM	L1473244-1, -2, -3, -4
Duplicate	Nitrite (as N)	DLM	L1473244-1, -2, -3, -4
Duplicate	Nitrate (as N)	DLM	L1473244-1, -2, -3, -4
Matrix Spike	Nitrate (as N)	MS-B	L1473244-1, -2, -3, -4
Matrix Spike	Phosphorus (P)-Total Dissolved	MS-B	L1473244-1, -2, -3, -4
Matrix Spike	Phosphorus (P)-Total	MS-B	L1473244-1, -2, -3, -4

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLM	Detection Limit Adjusted due to sample matrix effects.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
RRV	Reported Result Verified By Repeat Analysis

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-COL-VA	Water	Alkalinity by Colourimetric (Automated)	EPA 310.2

This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.

ANIONS-NO2-IC-VA	Water	Nitrite in Water by Ion Chromatography	EPA 300.0

This analysis is carried out using procedures adapted from EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography". Nitrite is detected by UV absorbance.

ANIONS-NO3-IC-VA	Water	Nitrate in Water by Ion Chromatography	EPA 300.0

This analysis is carried out using procedures adapted from EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography". Nitrate is detected by UV absorbance.

EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

NH3-F-VA	Water	Ammonia in Water by Fluorescence	J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

P-T-PRES-COL-VA	Water	Total P in Water by Colour	APHA 4500-P Phosphorus

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Phosphorus is determined colourimetrically after persulphate digestion of the sample.

P-TD-COL-VA	Water	Total Dissolved P in Water by Colour	APHA 4500-P Phosphorous

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Dissolved Phosphorus is determined colourimetrically after persulphate digestion of a sample that has been lab or field filtered through a 0.45 micron membrane filter.

PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H "pH Value"

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PO4-DO-COL-VA	Water	Diss. Orthophosphate in Water by Colour	APHA 4500-P Phosphorus

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Dissolved Orthophosphate is determined colourimetrically on a sample that has been lab or field filtered through a 0.45 micron membrane filter.

TDS-VA	Water	Total Dissolved Solids by Gravimetric	APHA 2540 C - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

TSS-LOW-VA	Water	Total Suspended Solids by Grav. (1 mg/L)	APHA 2540 Gravimetric

Reference Information

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total suspended solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.

TURBIDITY-VA	Water	Turbidity by Meter	APHA 2130 "Turbidity"

This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.

TURBIDITY-VA	Water	Turbidity by Meter	APHA 2130 Turbidity

This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

OL-1305

GLOSSARY OF REPORT TERMS
Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Client: ECOFISH RESEARCH LTD
Suite F, 450 - 8th Street
Courtenay BC V9N 1N5
Contact: Kevin Ganshorn

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-COL-VA	**Water**							
Batch R2871694								
WG1897610-2 CRM		**VA-ALKL-CONTROL**						
Alkalinity, Total (as CaCO3)			106.3		%		85-115	23-JUN-14
WG1897610-5 CRM		**VA-ALKM-CONTROL**						
Alkalinity, Total (as CaCO3)			106.0		%		85-115	23-JUN-14
WG1897610-8 CRM		**VA-ALKH-CONTROL**						
Alkalinity, Total (as CaCO3)			105.8		%		85-115	23-JUN-14
WG1897610-1 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	23-JUN-14
WG1897610-4 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	23-JUN-14
WG1897610-7 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	23-JUN-14
ANIONS-NO2-IC-VA	**Water**							
Batch R2869601								
WG1894907-18 LCS								
Nitrite (as N)			104.2		%		90-110	19-JUN-14
WG1894907-2 LCS								
Nitrite (as N)			104.3		%		90-110	19-JUN-14
WG1894907-1 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	19-JUN-14
WG1894907-10 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	19-JUN-14
WG1894907-13 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	19-JUN-14
WG1894907-16 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	19-JUN-14
WG1894907-4 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	19-JUN-14
WG1894907-7 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	19-JUN-14
WG1894907-11 MS		**L1473244-2**						
Nitrite (as N)			103.1		%		75-125	19-JUN-14
WG1894907-17 MS		**L1473642-1**						
Nitrite (as N)			96.0		%		75-125	19-JUN-14
WG1894907-5 MS		**L1472823-2**						
Nitrite (as N)			101.7		%		75-125	19-JUN-14
WG1894907-8 MS		**L1473010-5**						
Nitrite (as N)			100.5		%		75-125	19-JUN-14

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ANIONS-NO3-IC-VA	**Water**							
Batch R2869601								
WG1894907-18 LCS								
Nitrate (as N)			103.8		%		90-110	19-JUN-14
WG1894907-2 LCS								
Nitrate (as N)			103.3		%		90-110	19-JUN-14
WG1894907-1 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	19-JUN-14
WG1894907-10 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	19-JUN-14
WG1894907-13 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	19-JUN-14
WG1894907-16 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	19-JUN-14
WG1894907-4 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	19-JUN-14
WG1894907-7 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	19-JUN-14
WG1894907-11 MS		**L1473244-2**						
Nitrate (as N)			102.7		%		75-125	19-JUN-14
WG1894907-17 MS		**L1473642-1**						
Nitrate (as N)			96.0		%		75-125	19-JUN-14
WG1894907-5 MS		**L1472823-2**						
Nitrate (as N)			101.7		%		75-125	19-JUN-14
WG1894907-8 MS		**L1473010-5**						
Nitrate (as N)			N/A	MS-B	%		-	19-JUN-14
EC-PCT-VA	**Water**							
Batch R2869469								
WG1895323-17 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			99.3		%		90-110	20-JUN-14
WG1895323-18 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			97.8		%		90-110	21-JUN-14
WG1895323-19 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			98.6		%		90-110	21-JUN-14
WG1895323-20 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			99.6		%		90-110	21-JUN-14
WG1895323-21 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			99.4		%		90-110	21-JUN-14
WG1895323-22 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			99.7		%		90-110	21-JUN-14
WG1895323-23 CRM		**VA-EC-PCT-CONTROL**						

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
EC-PCT-VA	**Water**							
Batch R2869469								
WG1895323-23 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			100.6		%		90-110	21-JUN-14
WG1895323-24 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			100.8		%		90-110	21-JUN-14
WG1895323-1 MB								
Conductivity			<2.0		uS/cm		2	20-JUN-14
WG1895323-2 MB								
Conductivity			<2.0		uS/cm		2	21-JUN-14
WG1895323-3 MB								
Conductivity			<2.0		uS/cm		2	21-JUN-14
WG1895323-4 MB								
Conductivity			<2.0		uS/cm		2	21-JUN-14
WG1895323-5 MB								
Conductivity			<2.0		uS/cm		2	21-JUN-14
WG1895323-6 MB								
Conductivity			<2.0		uS/cm		2	21-JUN-14
WG1895323-7 MB								
Conductivity			<2.0		uS/cm		2	21-JUN-14
WG1895323-8 MB								
Conductivity			<2.0		uS/cm		2	21-JUN-14
NH3-F-VA	**Water**							
Batch R2872659								
WG1898276-2 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			97.5		%		85-115	24-JUN-14
WG1898276-4 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			94.1		%		85-115	24-JUN-14
WG1898276-6 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			93.5		%		85-115	24-JUN-14
WG1898276-8 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			98.6		%		85-115	24-JUN-14
WG1898276-1 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	24-JUN-14
WG1898276-3 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	24-JUN-14
WG1898276-5 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	24-JUN-14
WG1898276-7 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	24-JUN-14
WG1898276-10 MS		**L1473679-5**						

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NH3-F-VA	**Water**							
Batch R2872659								
WG1898276-10 MS		**L1473679-5**						
Ammonia, Total (as N)			86.8		%		75-125	24-JUN-14
WG1898276-12 MS		**L1473924-5**						
Ammonia, Total (as N)			102.0		%		75-125	24-JUN-14
Batch R2872948								
WG1899080-10 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			101.6		%		85-115	25-JUN-14
WG1899080-2 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			93.2		%		85-115	25-JUN-14
WG1899080-4 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			97.2		%		85-115	25-JUN-14
WG1899080-6 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			93.1		%		85-115	25-JUN-14
WG1899080-8 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			90.3		%		85-115	25-JUN-14
WG1899080-1 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	25-JUN-14
WG1899080-3 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	25-JUN-14
WG1899080-5 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	25-JUN-14
WG1899080-7 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	25-JUN-14
WG1899080-9 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	25-JUN-14
WG1899080-12 MS		**L1473174-13**						
Ammonia, Total (as N)			108.3		%		75-125	25-JUN-14
WG1899080-14 MS		**L1473183-7**						
Ammonia, Total (as N)			89.7		%		75-125	25-JUN-14
WG1899080-16 MS		**L1474093-1**						
Ammonia, Total (as N)			99.0		%		75-125	25-JUN-14
P-T-PRES-COL-VA	**Water**							
Batch R2871932								
WG1897757-10 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			100.1		%		80-120	24-JUN-14
WG1897757-14 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			98.7		%		80-120	24-JUN-14
WG1897757-18 CRM		**VA-ERA-PO4**						

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
P-T-PRES-COL-VA	**Water**							
Batch R2871932								
WG1897757-18 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			97.3		%		80-120	24-JUN-14
WG1897757-2 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			105.4		%		80-120	24-JUN-14
WG1897757-6 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			104.8		%		80-120	24-JUN-14
WG1897757-1 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	24-JUN-14
WG1897757-13 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	24-JUN-14
WG1897757-17 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	24-JUN-14
WG1897757-5 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	24-JUN-14
WG1897757-9 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	24-JUN-14
WG1897757-12 MS		**L1473174-12**						
Phosphorus (P)-Total			99.6		%		70-130	24-JUN-14
WG1897757-20 MS		**L1473265-5**						
Phosphorus (P)-Total			87.8		%		70-130	24-JUN-14
WG1897757-8 MS		**L1473924-14**						
Phosphorus (P)-Total			N/A	MS-B	%		-	24-JUN-14
P-TD-COL-VA	**Water**							
Batch R2871917								
WG1897754-10 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total Dissolved			102.2		%		80-120	24-JUN-14
WG1897754-14 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total Dissolved			95.6		%		80-120	24-JUN-14
WG1897754-2 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total Dissolved			103.6		%		80-120	24-JUN-14
WG1897754-6 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total Dissolved			106.4		%		80-120	24-JUN-14
WG1897754-1 MB								
Phosphorus (P)-Total Dissolved			<0.0020		mg/L		0.002	24-JUN-14
WG1897754-13 MB								
Phosphorus (P)-Total Dissolved			<0.0020		mg/L		0.002	24-JUN-14
WG1897754-5 MB								
Phosphorus (P)-Total Dissolved			<0.0020		mg/L		0.002	24-JUN-14
WG1897754-9 MB								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
P-TD-COL-VA	**Water**							
Batch R2871917								
WG1897754-9 MB								
Phosphorus (P)-Total Dissolved			<0.0020		mg/L		0.002	24-JUN-14
WG1897754-12 MS		**L1473174-12**						
Phosphorus (P)-Total Dissolved			98.3		%		70-130	24-JUN-14
WG1897754-16 MS		**L1473265-5**						
Phosphorus (P)-Total Dissolved			93.6		%		70-130	24-JUN-14
WG1897754-4 MS		**L1474822-1**						
Phosphorus (P)-Total Dissolved			N/A	MS-B	%		-	24-JUN-14
WG1897754-8 MS		**L1472720-2**						
Phosphorus (P)-Total Dissolved			96.2		%		70-130	24-JUN-14
PH-PCT-VA	**Water**							
Batch R2869469								
WG1895323-25 CRM		**VA-PH7-BUF**						
pH			6.99		pH		6.9-7.1	20-JUN-14
WG1895323-26 CRM		**VA-PH7-BUF**						
pH			6.95		pH		6.9-7.1	21-JUN-14
WG1895323-27 CRM		**VA-PH7-BUF**						
pH			6.94		pH		6.9-7.1	21-JUN-14
WG1895323-28 CRM		**VA-PH7-BUF**						
pH			6.92		pH		6.9-7.1	21-JUN-14
WG1895323-29 CRM		**VA-PH7-BUF**						
pH			6.92		pH		6.9-7.1	21-JUN-14
WG1895323-30 CRM		**VA-PH7-BUF**						
pH			6.92		pH		6.9-7.1	21-JUN-14
WG1895323-31 CRM		**VA-PH7-BUF**						
pH			6.94		pH		6.9-7.1	21-JUN-14
WG1895323-32 CRM		**VA-PH7-BUF**						
pH			6.92		pH		6.9-7.1	21-JUN-14
PO4-DO-COL-VA	**Water**							
Batch R2868791								
WG1895448-10 CRM		**VA-OPO4-CONTROL**						
Orthophosphate-Dissolved (as P)			99.0		%		80-120	19-JUN-14
WG1895448-14 CRM		**VA-OPO4-CONTROL**						
Orthophosphate-Dissolved (as P)			101.1		%		80-120	19-JUN-14
WG1895448-18 CRM		**VA-OPO4-CONTROL**						
Orthophosphate-Dissolved (as P)			94.0		%		80-120	19-JUN-14
WG1895448-2 CRM		**VA-OPO4-CONTROL**						
Orthophosphate-Dissolved (as P)			104.1		%		80-120	19-JUN-14

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PO4-DO-COL-VA	**Water**							
Batch R2868791								
WG1895448-22 CRM		**VA-OPO4-CONTROL**						
Orthophosphate-Dissolved (as P)			99.2		%		80-120	19-JUN-14
WG1895448-26 CRM		**VA-OPO4-CONTROL**						
Orthophosphate-Dissolved (as P)			97.8		%		80-120	19-JUN-14
WG1895448-6 CRM		**VA-OPO4-CONTROL**						
Orthophosphate-Dissolved (as P)			102.8		%		80-120	19-JUN-14
WG1895448-1 MB								
Orthophosphate-Dissolved (as P)			<0.0010		mg/L		0.001	19-JUN-14
WG1895448-13 MB								
Orthophosphate-Dissolved (as P)			<0.0010		mg/L		0.001	19-JUN-14
WG1895448-17 MB								
Orthophosphate-Dissolved (as P)			<0.0010		mg/L		0.001	19-JUN-14
WG1895448-21 MB								
Orthophosphate-Dissolved (as P)			<0.0010		mg/L		0.001	19-JUN-14
WG1895448-25 MB								
Orthophosphate-Dissolved (as P)			<0.0010		mg/L		0.001	19-JUN-14
WG1895448-5 MB								
Orthophosphate-Dissolved (as P)			<0.0010		mg/L		0.001	19-JUN-14
WG1895448-9 MB								
Orthophosphate-Dissolved (as P)			<0.0010		mg/L		0.001	19-JUN-14
WG1895448-12 MS		**L1473265-10**						
Orthophosphate-Dissolved (as P)			98.2		%		70-130	19-JUN-14
WG1895448-16 MS		**L1473526-1**						
Orthophosphate-Dissolved (as P)			101.2		%		70-130	19-JUN-14
WG1895448-20 MS		**L1473679-9**						
Orthophosphate-Dissolved (as P)			96.1		%		70-130	19-JUN-14
WG1895448-24 MS		**L1473924-16**						
Orthophosphate-Dissolved (as P)			99.7		%		70-130	19-JUN-14
WG1895448-4 MS		**L1472720-5**						
Orthophosphate-Dissolved (as P)			95.2		%		70-130	19-JUN-14
WG1895448-8 MS		**L1473174-8**						
Orthophosphate-Dissolved (as P)			93.3		%		70-130	19-JUN-14
TDS-VA	**Water**							
Batch R2872050								
WG1897227-11 LCS								
Total Dissolved Solids			103.3		%		85-115	23-JUN-14
WG1897227-2 LCS								
Total Dissolved Solids			102.7		%		85-115	23-JUN-14
WG1897227-5 LCS								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TDS-VA	**Water**							
Batch R2872050								
WG1897227-5 LCS								
Total Dissolved Solids			93.6		%		85-115	23-JUN-14
WG1897227-8 LCS								
Total Dissolved Solids			101.2		%		85-115	23-JUN-14
WG1897227-1 MB								
Total Dissolved Solids			<10		mg/L		10	23-JUN-14
WG1897227-10 MB								
Total Dissolved Solids			<10		mg/L		10	23-JUN-14
WG1897227-4 MB								
Total Dissolved Solids			<10		mg/L		10	23-JUN-14
WG1897227-7 MB								
Total Dissolved Solids			<10		mg/L		10	23-JUN-14
TSS-LOW-VA	**Water**							
Batch R2870907								
WG1896528-2 LCS								
Total Suspended Solids			93.9		%		85-115	20-JUN-14
WG1896528-4 LCS								
Total Suspended Solids			93.1		%		85-115	20-JUN-14
WG1896528-6 LCS								
Total Suspended Solids			97.5		%		85-115	20-JUN-14
WG1896528-8 LCS								
Total Suspended Solids			93.6		%		85-115	20-JUN-14
WG1896528-1 MB								
Total Suspended Solids			<1.0		mg/L		1	20-JUN-14
WG1896528-3 MB								
Total Suspended Solids			<1.0		mg/L		1	20-JUN-14
WG1896528-5 MB								
Total Suspended Solids			<1.0		mg/L		1	20-JUN-14
WG1896528-7 MB								
Total Suspended Solids			<1.0		mg/L		1	20-JUN-14
TURBIDITY-VA	**Water**							
Batch R2868776								
WG1895458-11 CRM		**VA-FORM-40**						
Turbidity			98.5		%		85-115	19-JUN-14
WG1895458-14 CRM		**VA-FORM-40**						
Turbidity			98.8		%		85-115	19-JUN-14
WG1895458-17 CRM		**VA-FORM-40**						
Turbidity			99.8		%		85-115	19-JUN-14

Quality Control Report

Test		Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TURBIDITY-VA		**Water**							
Batch	**R2868776**								
WG1895458-2	**CRM**		**VA-FORM-40**						
Turbidity				99.0		%		85-115	19-JUN-14
WG1895458-20	**CRM**		**VA-FORM-40**						
Turbidity				99.3		%		85-115	19-JUN-14
WG1895458-5	**CRM**		**VA-FORM-40**						
Turbidity				98.5		%		85-115	19-JUN-14
WG1895458-8	**CRM**		**VA-FORM-40**						
Turbidity				100.0		%		85-115	19-JUN-14
WG1895458-1	**MB**								
Turbidity				<0.10		NTU		0.1	19-JUN-14
WG1895458-10	**MB**								
Turbidity				<0.10		NTU		0.1	19-JUN-14
WG1895458-13	**MB**								
Turbidity				<0.10		NTU		0.1	19-JUN-14
WG1895458-16	**MB**								
Turbidity				<0.10		NTU		0.1	19-JUN-14
WG1895458-19	**MB**								
Turbidity				<0.10		NTU		0.1	19-JUN-14
WG1895458-4	**MB**								
Turbidity				<0.10		NTU		0.1	19-JUN-14
WG1895458-7	**MB**								
Turbidity				<0.10		NTU		0.1	19-JUN-14

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
DLM	Detection Limit Adjusted due to sample matrix effects.
J	Duplicate results and limits are expressed in terms of absolute difference.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH by Meter (Automated)							
	1	17-JUN-14 10:01	21-JUN-14 06:05	0.25	92	hours	EHTR-FM
	2	17-JUN-14 10:01	21-JUN-14 06:05	0.25	92	hours	EHTR-FM
	3	17-JUN-14 10:01	21-JUN-14 06:05	0.25	92	hours	EHTR-FM
	4	17-JUN-14 10:01	21-JUN-14 06:05	0.25	92	hours	EHTR-FM
Anions and Nutrients							
Total Dissolved P in Water by Colour							
	1	17-JUN-14 10:01	23-JUN-14 12:08	3	6	days	EHT
	2	17-JUN-14 10:01	23-JUN-14 12:08	3	6	days	EHT
	3	17-JUN-14 10:01	23-JUN-14 12:08	3	6	days	EHT
	4	17-JUN-14 10:01	23-JUN-14 12:08	3	6	days	EHT

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L1473244 were received on 18-JUN-14 16:00.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

Short Holding Time

Rush Processing

ALS Environm[ental]

of Custody / Analytical Request Form
Canada Toll Free : 1 800 668 9878
www.alsglobal.com

L1473244-COFC

COC #: OL-1305

Report To

Company: ECOFISH RESEARCH LTD
Contact: Kevin Ganshom
Address: 906 - 595 Howe Street
Vancouver, BC
Canada, V6C2T5
Phone: 604-608-6180 Fax: 604-559-6180

Invoice To ☑Email ☐Mail
Company: ECOFISH RESEARCH LTD
Contact: Accounts Payable
Address: Suite F, 450 - 8th Street
Courtenay, BC
Canada, V9N 1N5
Email: accountspayable@ecofishresearch.com
Phone: 250-334-3042

Lab Work Order # (lab use only): L1473244

Reporting

Distribution: ☐Fax ☐Mail ☑Email
☑Criteria on Report (select from Guidelines below)
Report Type: ☑Excel ☐Digital
Report Format: CROSSTAB_ALSQC
Report Email(s): kganshom@ecofishresearch.com
tkasubuchi@ecofishresearch.com
pdinn@ecofishresearch.com
EDD Format:
EDD Email(s):

Project Info
Job #: 1230 JHT-MON8
PO/AFE:
LSD:
Quote #:
ALS Contact: Ariel Tang
Sampler: Leah Hull

⦿ Regular (Standard Turnaround Times - Business Days) - R
○ Priority (3 Days) - surcharge will apply - P
○ Priority (2 Days) - surcharge will apply - P2
○ Emergency (1-2 day) – surcharge will apply - E
○ Same Day or Weekend Emergency - surcharge will apply - E2
○ Specify date required - X

Analysis Requests (Please indicate below Filtered, Preserved or both(F, P, F/P))

Sample #	Sample Identification (This will appear on the report)	Longitude	Latitude	Date	Time	Sample Type	Number of Containers	Alkalinity by Colourimetric (Automated)	Ammonia in Water by Fluorescence	Conductivity (Automated)	Diss. Orthophosphate in Water by Colour	Nitrate in Water by Ion Chromatography	Nitrite in Water by Ion Chromatography	Total Dissolved Solids by Gravimetric	Total P in Water by Colour	Total Suspended Solids by Grav. (1 mg/L)	Turbidity by Meter	pH by Meter (Automated)			
	SAM-WQ1A			17-June-2014	10:01	Water	3	R	R	R	R	R	R	R	R	R	R	R			
	SAM-WQ1B			"	10:01	Water	3	R	R	R	R	R	R	R	R	R	R	R			
	SAM- FIELD BLANK — unlabelled containers.			"	10:01	Water	3	R	R	R	R	R	R	R	R	R	R	R			
	SAM- TRAVEL BLANK			"	10:01	Water	3	R	R	R	R	R	R	R	R	R	R	R			
	~~SAM-WQ1?~~																				

Special Instructions/Comments

please note label changes.

The questions below must be answered for water samples (check Yes or No)

Are any sample taken from a regulated DW system? ☐Yes ☐No
If yes, please use an authorized drinking water COC
Is the water sampled intended to be potable for human consumption? ☐Yes ☐No

Guidelines

British Columbia Approved and Working Water Quality Guidelines (JULY, 2013) - BCAWWQG - Freshwater Aquatic Life

SAMPLE CONDITION (lab use only)
☐Frozen ☐Cold ☐Ambient ☐Cooling Initiated

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by: Leah Hull	Date: 18-June-2014	Time: ~~[illegible]~~ 12:30	Received by: Paige	Date: June 18	Time: 16:00	Temperature: 3.5 °C	Verified by:	Date:	Time:	Observations: ☐Yes If Yes add SIF

ECOFISH RESEARCH LTD
ATTN: Kevin Ganshorn
Suite F, 450 - 8th Street
Courtenay BC V9N 1N5

Date Received: 22-JUL-14
Report Date: 05-AUG-14 15:57 (MT)
Version: FINAL REV. 2

Client Phone: 250-334-3042

Certificate of Analysis

Lab Work Order #: L1490944

Project P.O. #: NOT SUBMITTED
Job Reference: 1230 JHT-MON8
C of C Numbers: OL-1313
Legal Site Desc:

Comments:

5-AUG-2014 Sampling date and time has been added to all samples in this submission as per client request.

Ariel Tang
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1490944-1	L1490944-2	L1490944-3	L1490944-4	
	Description	Water	Water	Water	Water	
	Sampled Date	22-JUL-14	22-JUL-14	22-JUL-14	22-JUL-14	
	Sampled Time	09:25	09:25	09:25	09:25	
	Client ID	QUN-WQ1A	QUN-WQ1B	QUN-TRIP BLANK	QUN-FILED BLANK	
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	139	141	<2.0	<2.0	
	pH (pH)	7.65	7.81	5.76	5.69	
	Total Suspended Solids (mg/L)	<1.0	<1.0	<1.0	<1.0	
	Total Dissolved Solids (mg/L)	105	101	<10	<10	
	Turbidity (NTU)	0.47	0.44	<0.10	<0.10	
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	42.4	42.4	<2.0	<2.0	
	Ammonia, Total (as N) (mg/L)	<0.0050	<0.0050	0.0271 RRV	<0.0050	
	Nitrate (as N) (mg/L)	0.0313	0.0319	<0.0050	<0.0050	
	Nitrite (as N) (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Orthophosphate-Dissolved (as P) (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Phosphorus (P)-Total (mg/L)	0.0026	0.0032	<0.0020	<0.0020	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Orthophosphate-Dissolved (as P)	MS-B	L1490944-1, -2, -3, -4
Matrix Spike	Orthophosphate-Dissolved (as P)	MS-B	L1490944-1, -2, -3, -4
Matrix Spike	Phosphorus (P)-Total	MS-B	L1490944-1, -2, -3, -4

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
RRV	Reported Result Verified By Repeat Analysis

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-COL-VA	Water	Alkalinity by Colourimetric (Automated)	EPA 310.2

This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.

ANIONS-NO2-IC-VA	Water	Nitrite in Water by Ion Chromatography	EPA 300.0

This analysis is carried out using procedures adapted from EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography". Nitrite is detected by UV absorbance.

ANIONS-NO3-IC-VA	Water	Nitrate in Water by Ion Chromatography	EPA 300.0

This analysis is carried out using procedures adapted from EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography". Nitrate is detected by UV absorbance.

EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

NH3-F-VA	Water	Ammonia in Water by Fluorescence	J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

P-T-PRES-COL-VA	Water	Total P in Water by Colour	APHA 4500-P Phosphorus

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Phosphorus is determined colourimetrically after persulphate digestion of the sample.

PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H "pH Value"

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PO4-DO-COL-VA	Water	Diss. Orthophosphate in Water by Colour	APHA 4500-P Phosphorus

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Dissolved Orthophosphate is determined colourimetrically on a sample that has been lab or field filtered through a 0.45 micron membrane filter.

TDS-VA	Water	Total Dissolved Solids by Gravimetric	APHA 2540 C - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

TSS-LOW-VA	Water	Total Suspended Solids by Grav. (1 mg/L)	APHA 2540 Gravimetric

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total suspended solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.

TURBIDITY-VA	Water	Turbidity by Meter	APHA 2130 "Turbidity"

This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.

TURBIDITY-VA	Water	Turbidity by Meter	APHA 2130 Turbidity

This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

Reference Information

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

OL-1313

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Client: ECOFISH RESEARCH LTD
Suite F, 450 - 8th Street
Courtenay BC V9N 1N5

Contact: Kevin Ganshorn

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-COL-VA	**Water**							
Batch R2897151								
WG1917795-2 CRM		**VA-ALKL-CONTROL**						
Alkalinity, Total (as CaCO3)			104.0		%		85-115	24-JUL-14
WG1917795-5 CRM		**VA-ALKM-CONTROL**						
Alkalinity, Total (as CaCO3)			103.0		%		85-115	24-JUL-14
WG1917795-8 CRM		**VA-ALKH-CONTROL**						
Alkalinity, Total (as CaCO3)			106.7		%		85-115	24-JUL-14
WG1917795-1 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	24-JUL-14
WG1917795-11 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	24-JUL-14
WG1917795-13 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	24-JUL-14
WG1917795-4 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	24-JUL-14
WG1917795-7 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	24-JUL-14
ANIONS-NO2-IC-VA	**Water**							
Batch R2896413								
WG1916479-15 LCS								
Nitrite (as N)			103.6		%		90-110	23-JUL-14
WG1916479-2 LCS								
Nitrite (as N)			102.7		%		90-110	23-JUL-14
WG1916479-1 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	23-JUL-14
WG1916479-10 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	23-JUL-14
WG1916479-13 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	23-JUL-14
WG1916479-4 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	23-JUL-14
WG1916479-7 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	23-JUL-14
WG1916479-14 MS		**L1490151-3**						
Nitrite (as N)			103.4		%		75-125	23-JUL-14
WG1916479-5 MS		**L1489843-1**						
Nitrite (as N)			102.1		%		75-125	23-JUL-14
ANIONS-NO3-IC-VA	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ANIONS-NO3-IC-VA	**Water**							
Batch R2896413								
WG1916479-15 LCS								
Nitrate (as N)			102.8		%		90-110	23-JUL-14
WG1916479-2 LCS								
Nitrate (as N)			102.1		%		90-110	23-JUL-14
WG1916479-1 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	23-JUL-14
WG1916479-10 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	23-JUL-14
WG1916479-13 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	23-JUL-14
WG1916479-4 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	23-JUL-14
WG1916479-7 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	23-JUL-14
WG1916479-14 MS		**L1490151-3**						
Nitrate (as N)			102.1		%		75-125	23-JUL-14
WG1916479-5 MS		**L1489843-1**						
Nitrate (as N)			101.5		%		75-125	23-JUL-14
WG1916479-8 MS		**L1490663-16**						
Nitrate (as N)			103.8		%		75-125	23-JUL-14
EC-PCT-VA	**Water**							
Batch R2896538								
WG1916878-17 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			98.2		%		90-110	24-JUL-14
WG1916878-18 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			96.7		%		90-110	24-JUL-14
WG1916878-19 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			96.9		%		90-110	24-JUL-14
WG1916878-20 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			97.9		%		90-110	24-JUL-14
WG1916878-21 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			97.3		%		90-110	24-JUL-14
WG1916878-22 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			97.7		%		90-110	24-JUL-14
WG1916878-23 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			98.2		%		90-110	24-JUL-14
WG1916878-24 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			97.9		%		90-110	24-JUL-14
WG1916878-1 MB								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
EC-PCT-VA	**Water**							
Batch R2896538								
WG1916878-1 MB								
Conductivity			<2.0		uS/cm		2	24-JUL-14
WG1916878-2 MB								
Conductivity			<2.0		uS/cm		2	24-JUL-14
WG1916878-3 MB								
Conductivity			<2.0		uS/cm		2	24-JUL-14
WG1916878-4 MB								
Conductivity			<2.0		uS/cm		2	24-JUL-14
WG1916878-5 MB								
Conductivity			<2.0		uS/cm		2	24-JUL-14
WG1916878-6 MB								
Conductivity			<2.0		uS/cm		2	24-JUL-14
WG1916878-7 MB								
Conductivity			<2.0		uS/cm		2	24-JUL-14
WG1916878-8 MB								
Conductivity			<2.0		uS/cm		2	24-JUL-14
NH3-F-VA	**Water**							
Batch R2896858								
WG1917189-10 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			105.9		%		85-115	24-JUL-14
WG1917189-2 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			110.3		%		85-115	24-JUL-14
WG1917189-4 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			103.0		%		85-115	24-JUL-14
WG1917189-6 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			108.9		%		85-115	24-JUL-14
WG1917189-8 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			96.9		%		85-115	24-JUL-14
WG1917189-11 DUP		**L1490944-1**						
Ammonia, Total (as N)		<0.0050	<0.0050	RPD-NA	mg/L	N/A	20	24-JUL-14
WG1917189-1 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	24-JUL-14
WG1917189-3 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	24-JUL-14
WG1917189-5 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	24-JUL-14
WG1917189-7 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	24-JUL-14
WG1917189-9 MB								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NH3-F-VA	**Water**							
Batch R2896858								
WG1917189-9 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	24-JUL-14
WG1917189-12 MS		**L1490944-1**						
Ammonia, Total (as N)			90.1		%		75-125	24-JUL-14
WG1917189-14 MS		**L1491468-1**						
Ammonia, Total (as N)			90.6		%		75-125	24-JUL-14
Batch R2898830								
WG1918693-2 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			102.1		%		85-115	25-JUL-14
WG1918693-4 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			111.3		%		85-115	25-JUL-14
WG1918693-1 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	25-JUL-14
WG1918693-3 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	25-JUL-14
WG1918693-6 MS		**L1489671-2**						
Ammonia, Total (as N)			109.8		%		75-125	25-JUL-14
P-T-PRES-COL-VA	**Water**							
Batch R2896476								
WG1916705-10 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			94.2		%		80-120	24-JUL-14
WG1916705-2 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			95.8		%		80-120	24-JUL-14
WG1916705-6 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			98.7		%		80-120	24-JUL-14
WG1916705-1 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	24-JUL-14
WG1916705-5 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	24-JUL-14
WG1916705-9 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	24-JUL-14
WG1916705-12 MS		**L1491009-8**						
Phosphorus (P)-Total			N/A	MS-B	%		-	24-JUL-14
WG1916705-4 MS		**L1490888-2**						
Phosphorus (P)-Total			100.8		%		70-130	24-JUL-14
WG1916705-8 MS		**L1491115-2**						
Phosphorus (P)-Total			99.6		%		70-130	24-JUL-14
PH-PCT-VA	**Water**							

Quality Control Report

Workorder: L1490944 Report Date: 05-AUG-14

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PH-PCT-VA	**Water**							
Batch R2896538								
WG1916878-25 CRM		**VA-PH7-BUF**						
pH			7.00		pH		6.9-7.1	24-JUL-14
WG1916878-26 CRM		**VA-PH7-BUF**						
pH			7.00		pH		6.9-7.1	24-JUL-14
WG1916878-27 CRM		**VA-PH7-BUF**						
pH			7.00		pH		6.9-7.1	24-JUL-14
WG1916878-28 CRM		**VA-PH7-BUF**						
pH			7.00		pH		6.9-7.1	24-JUL-14
WG1916878-29 CRM		**VA-PH7-BUF**						
pH			7.00		pH		6.9-7.1	24-JUL-14
WG1916878-30 CRM		**VA-PH7-BUF**						
pH			6.97		pH		6.9-7.1	24-JUL-14
WG1916878-31 CRM		**VA-PH7-BUF**						
pH			6.99		pH		6.9-7.1	24-JUL-14
WG1916878-32 CRM		**VA-PH7-BUF**						
pH			6.99		pH		6.9-7.1	24-JUL-14
PO4-DO-COL-VA	**Water**							
Batch R2895781								
WG1916707-11 CRM		**VA-OPO4-CONTROL**						
Orthophosphate-Dissolved (as P)			93.7		%		80-120	23-JUL-14
WG1916707-15 CRM		**VA-OPO4-CONTROL**						
Orthophosphate-Dissolved (as P)			95.9		%		80-120	23-JUL-14
WG1916707-2 CRM		**VA-OPO4-CONTROL**						
Orthophosphate-Dissolved (as P)			91.6		%		80-120	23-JUL-14
WG1916707-6 CRM		**VA-OPO4-CONTROL**						
Orthophosphate-Dissolved (as P)			95.3		%		80-120	23-JUL-14
WG1916707-1 MB								
Orthophosphate-Dissolved (as P)			<0.0010		mg/L		0.001	23-JUL-14
WG1916707-10 MB								
Orthophosphate-Dissolved (as P)			<0.0010		mg/L		0.001	23-JUL-14
WG1916707-14 MB								
Orthophosphate-Dissolved (as P)			<0.0010		mg/L		0.001	23-JUL-14
WG1916707-5 MB								
Orthophosphate-Dissolved (as P)			<0.0010		mg/L		0.001	23-JUL-14
WG1916707-12 MS		**L1491208-1**						
Orthophosphate-Dissolved (as P)			N/A	MS-B	%		-	23-JUL-14
WG1916707-4 MS		**L1490878-2**						
Orthophosphate-Dissolved (as P)			N/A	MS-B	%		-	23-JUL-14
WG1916707-8 MS		**L1489671-4**						

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PO4-DO-COL-VA	**Water**							
Batch R2895781								
WG1916707-8 MS		**L1489671-4**						
Orthophosphate-Dissolved (as P)			98.1		%		70-130	23-JUL-14
TDS-VA	**Water**							
Batch R2896719								
WG1917001-2 LCS								
Total Dissolved Solids			101.7		%		85-115	23-JUL-14
WG1917001-5 LCS								
Total Dissolved Solids			100.2		%		85-115	23-JUL-14
WG1917001-1 MB								
Total Dissolved Solids			<10		mg/L		10	23-JUL-14
WG1917001-4 MB								
Total Dissolved Solids			<10		mg/L		10	23-JUL-14
TSS-LOW-VA	**Water**							
Batch R2897699								
WG1918081-2 LCS								
Total Suspended Solids			90.5		%		85-115	24-JUL-14
WG1918081-4 LCS								
Total Suspended Solids			92.0		%		85-115	24-JUL-14
WG1918081-1 MB								
Total Suspended Solids			<1.0		mg/L		1	24-JUL-14
WG1918081-3 MB								
Total Suspended Solids			<1.0		mg/L		1	24-JUL-14
TURBIDITY-VA	**Water**							
Batch R2896862								
WG1917870-2 CRM		**VA-FORM-40**						
Turbidity			102.3		%		85-115	24-JUL-14
WG1917870-5 CRM		**VA-FORM-40**						
Turbidity			101.0		%		85-115	24-JUL-14
WG1917870-8 CRM		**VA-FORM-40**						
Turbidity			100.8		%		85-115	24-JUL-14
WG1917870-3 DUP		**L1490944-1**						
Turbidity		0.47	0.46		NTU	1.3	15	24-JUL-14
WG1917870-1 MB								
Turbidity			<0.10		NTU		0.1	24-JUL-14
WG1917870-4 MB								
Turbidity			<0.10		NTU		0.1	24-JUL-14
WG1917870-7 MB								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TURBIDITY-VA	**Water**							
Batch R2896862								
WG1917870-7 MB								
Turbidity			<0.10		NTU		0.1	24-JUL-14

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
J	Duplicate results and limits are expressed in terms of absolute difference.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH by Meter (Automated)							
	1	22-JUL-14 09:25	24-JUL-14 10:57	0.25	49	hours	EHTR-FM
	2	22-JUL-14 09:25	24-JUL-14 10:57	0.25	49	hours	EHTR-FM
	3	22-JUL-14 09:25	24-JUL-14 10:57	0.25	49	hours	EHTR-FM
	4	22-JUL-14 09:25	24-JUL-14 10:57	0.25	49	hours	EHTR-FM

Legend & Qualifier Definitions:

EHTR-FM: Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR: Exceeded ALS recommended hold time prior to sample receipt.
EHTL: Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT: Exceeded ALS recommended hold time prior to analysis.
Rec. HT: ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L1490944 were received on 22-JUL-14 19:10.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

Short Holding Time

Rush Processing

Chain of Custody / Analytical Request Form
Canada Toll Free : 1 800 668 9878
www.alsglobal.com

Report To

Company:	ECOFISH RESEARCH LTD
Contact:	Kevin Ganshorn
Address:	906 - 595 Howe Street Vancouver, BC Canada, V6C2T5
Phone:	604-608-6180
Fax:	604 559-6180

Invoice To ☑Email ☐Mail

Company:	ECOFISH RESEARCH LTD
Contact:	Accounts Payable
Address:	Suite F, 450 - 8th Street Courtenay, BC Canada, V9N 1N5
Email:	accountspayable@ecofishresearch.com
Phone:	250-334-3042

Lab Work Order # (lab use only)

Reporting

Distribution:	☐Fax ☐Mail ☑Email
☑Criteria on Report (select from Guidelines below)	
Report Type:	☑Excel ☐Digital
Report Format:	CROSSTAB_ALSQC
Report Email(s):	kganshorn@ecofishresearch.com tkasubuchi@ecofishresearch.com pdinn@ecofishresearch.com
EDD Format:	
EDD Email(s):	

Project Info

Job #:	1230 JHT-MON8
PO/AFE:	
LSD:	
Quote #:	
ALS Contact: Ariel Tang	Sampler:

Service Requested

- ◉ Regular (Standard Turnaround Times - Business Days) - R
- ○ Priority (3 Days) - surcharge will apply - P
- ○ Priority (2 Days) - surcharge will apply - P2
- ○ Emergency (1-2 day) – surcharge will apply - E
- ○ Same Day or Weekend Emergency - surcharge will apply - E2
- ○ Specify date required - X

Analysis Requests — Please indicate below Filtered, Preserved or both(F, P, F/P)

Sample #	Sample Identification (This will appear on the report)	Longitude	Latitude	Date	Time	Sample Type	Number of Containers	Alkalinity by Colourimetric (Automated)	Ammonia in Water by Fluorescence	Conductivity (Automated)	Diss. Orthophosphate in Water by Colour	Nitrate in Water by Ion Chromatography	Nitrite in Water by Ion Chromatography	Total Dissolved Solids by Gravimetric	Total P in Water by Colour	Total Suspended Solids by Grav. (1 mg/L)	Turbidity by Meter	pH by Meter (Automated)
	QUN-WQ1A					Water	3	R	R	R	R	R	R	R	R	R	R	R
	QUN-WQ1B					Water	3	R	R	R	R	R	R	R	R	R	R	R
	QUN-TRIP BLANK					Water	3	R	R	R	R	R	R	R	R	R	R	R
	QUN-FIELD BLANK					Water	3	R	R	R	R	R	R	R	R	R	R	R

L1490944-COFC

Special Instructions/Comments

The questions below must be answered for water samples (check Yes or No)

Are any sample taken from a regulated DW system? ☐Yes ☑No

If yes, please use an authorized drinking water COC

Is the water sampled intended to be potable for human consumption? ☐Yes ☑No

Guidelines

British Columbia Approved and Working Water Quality Guidelines (JULY, 2013) - BCAWWQG - Freshwater Aquatic Life

SAMPLE CONDITION (lab use only)

☐Frozen ☐Cold ☐Ambient ☐Cooling Initiated

SHIPMENT RELEASE (client use)			**SHIPMENT RECEPTION (lab use only)**				**SHIPMENT VERIFICATION (lab use only)**			
Released by: Kyle Milborn	Date: July 22/14	Time: 13:00	Received by: YC	Date: July 22	Time: 19:10	Temperature: 15.7°C	Verified by:	Date:	Time:	Observations: ☐Yes If Yes add SIF

Kyle M

ECOFISH RESEARCH LTD
ATTN: Kevin Ganshorn
Suite F, 450 - 8th Street
Courtenay BC V9N 1N5

Date Received: 18-AUG-14
Report Date: 26-AUG-14 16:05 (MT)
Version: FINAL

Client Phone: 250-334-3042

Certificate of Analysis

Lab Work Order #: L1504390

Project P.O. #: NOT SUBMITTED
Job Reference: 1230 JHT-MON8
C of C Numbers:
Legal Site Desc:

Ariel Tang
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1504390-1	L1504390-2	L1504390-3	L1504390-4	
	Description	Water	Water	Water	Water	
	Sampled Date	18-AUG-14	18-AUG-14	18-AUG-14	18-AUG-14	
	Sampled Time	09:30	09:30	09:30	09:30	
	Client ID	SAM-WQ1A	SAM-WQ1B	SAM-FIELD BLANK	SAM-TRAVEL BLANK	
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	57.3	55.3	<2.0	<2.0	
	pH (pH)	7.82	7.76	6.50	6.05	
	Total Suspended Solids (mg/L)	8.1	<1.0	<1.0	<1.0	
	Total Dissolved Solids (mg/L)	55	43	<10	<10	
	Turbidity (NTU)	0.23	0.20	<0.10	<0.10	
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	23.6	23.9	<2.0	<2.0	
	Ammonia, Total (as N) (mg/L)	0.0060	0.0055	<0.0050	0.0885 RRV	
	Nitrate (as N) (mg/L)	0.0274	0.0277	<0.0050	<0.0050	
	Nitrite (as N) (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Orthophosphate-Dissolved (as P) (mg/L)	0.0011	<0.0010	<0.0010	<0.0010	
	Phosphorus (P)-Total (mg/L)	0.0056	<0.0020	<0.0020	<0.0020	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Duplicate	Nitrite (as N)	DLM	L1504390-1, -2, -3, -4
Matrix Spike	Phosphorus (P)-Total	MS-B	L1504390-1

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLM	Detection Limit Adjusted due to sample matrix effects.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
RRV	Reported Result Verified By Repeat Analysis

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-COL-VA	Water	Alkalinity by Colourimetric (Automated)	EPA 310.2

This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.

ANIONS-NO2-IC-VA	Water	Nitrite in Water by Ion Chromatography	EPA 300.0

This analysis is carried out using procedures adapted from EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography". Nitrite is detected by UV absorbance.

ANIONS-NO3-IC-VA	Water	Nitrate in Water by Ion Chromatography	EPA 300.0

This analysis is carried out using procedures adapted from EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography". Nitrate is detected by UV absorbance.

EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

NH3-F-VA	Water	Ammonia in Water by Fluorescence	J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

P-T-PRES-COL-VA	Water	Total P in Water by Colour	APHA 4500-P Phosphorus

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Phosphorus is determined colourimetrically after persulphate digestion of the sample.

PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H "pH Value"

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PO4-DO-COL-VA	Water	Diss. Orthophosphate in Water by Colour	APHA 4500-P Phosphorus

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Dissolved Orthophosphate is determined colourimetrically on a sample that has been lab or field filtered through a 0.45 micron membrane filter.

TDS-VA	Water	Total Dissolved Solids by Gravimetric	APHA 2540 C - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

TSS-LOW-VA	Water	Total Suspended Solids by Grav. (1 mg/L)	APHA 2540 Gravimetric

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total suspended solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.

TURBIDITY-VA	Water	Turbidity by Meter	APHA 2130 "Turbidity"

This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.

TURBIDITY-VA	Water	Turbidity by Meter	APHA 2130 Turbidity

This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

Reference Information

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Client: ECOFISH RESEARCH LTD
Suite F, 450 - 8th Street
Courtenay BC V9N 1N5

Contact: Kevin Ganshorn

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-COL-VA	**Water**							
Batch R2923700								
WG1934396-2 CRM		**VA-ALKL-CONTROL**						
Alkalinity, Total (as CaCO3)			99.4		%		85-115	20-AUG-14
WG1934396-5 CRM		**VA-ALKM-CONTROL**						
Alkalinity, Total (as CaCO3)			98.4		%		85-115	20-AUG-14
WG1934396-8 CRM		**VA-ALKH-CONTROL**						
Alkalinity, Total (as CaCO3)			102.4		%		85-115	20-AUG-14
WG1934396-1 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	20-AUG-14
WG1934396-10 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	20-AUG-14
WG1934396-12 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	20-AUG-14
WG1934396-4 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	20-AUG-14
WG1934396-7 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	20-AUG-14
ANIONS-NO2-IC-VA	**Water**							
Batch R2927783								
WG1934503-18 LCS								
Nitrite (as N)			102.1		%		90-110	20-AUG-14
WG1934503-2 LCS								
Nitrite (as N)			101.3		%		90-110	20-AUG-14
WG1934503-1 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	20-AUG-14
WG1934503-10 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	20-AUG-14
WG1934503-13 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	20-AUG-14
WG1934503-16 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	20-AUG-14
WG1934503-4 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	20-AUG-14
WG1934503-7 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	20-AUG-14
WG1934503-14 MS		**L1504390-4**						
Nitrite (as N)			103.1		%		75-125	20-AUG-14
WG1934503-17 MS		**L1504432-1**						
Nitrite (as N)			103.1		%		75-125	20-AUG-14
WG1934503-5 MS		**L1503699-1**						

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ANIONS-NO2-IC-VA	**Water**							
Batch R2927783								
WG1934503-5 MS		**L1503699-1**						
Nitrite (as N)			104.9		%		75-125	20-AUG-14
WG1934503-8 MS		**L1503713-1**						
Nitrite (as N)			103.0		%		75-125	20-AUG-14
ANIONS-NO3-IC-VA	**Water**							
Batch R2927783								
WG1934503-18 LCS								
Nitrate (as N)			101.1		%		90-110	20-AUG-14
WG1934503-2 LCS								
Nitrate (as N)			100.6		%		90-110	20-AUG-14
WG1934503-1 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	20-AUG-14
WG1934503-10 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	20-AUG-14
WG1934503-13 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	20-AUG-14
WG1934503-16 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	20-AUG-14
WG1934503-4 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	20-AUG-14
WG1934503-7 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	20-AUG-14
WG1934503-14 MS		**L1504390-4**						
Nitrate (as N)			101.5		%		75-125	20-AUG-14
WG1934503-17 MS		**L1504432-1**						
Nitrate (as N)			101.7		%		75-125	20-AUG-14
WG1934503-5 MS		**L1503699-1**						
Nitrate (as N)			102.3		%		75-125	20-AUG-14
WG1934503-8 MS		**L1503713-1**						
Nitrate (as N)			101.6		%		75-125	20-AUG-14
EC-PCT-VA	**Water**							
Batch R2924990								
WG1934474-17 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			99.1		%		90-110	20-AUG-14
WG1934474-18 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			96.6		%		90-110	20-AUG-14
WG1934474-19 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			98.1		%		90-110	20-AUG-14

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
EC-PCT-VA	**Water**							
Batch R2924990								
WG1934474-20 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			97.7		%		90-110	20-AUG-14
WG1934474-21 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			97.8		%		90-110	20-AUG-14
WG1934474-22 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			98.2		%		90-110	20-AUG-14
WG1934474-23 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			97.8		%		90-110	20-AUG-14
WG1934474-24 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			98.2		%		90-110	20-AUG-14
WG1934474-36 DUP		**L1504390-4**						
Conductivity		<2.0	<2.0	RPD-NA	uS/cm	N/A	10	20-AUG-14
WG1934474-1 MB								
Conductivity			<2.0		uS/cm		2	20-AUG-14
WG1934474-2 MB								
Conductivity			<2.0		uS/cm		2	20-AUG-14
WG1934474-3 MB								
Conductivity			<2.0		uS/cm		2	20-AUG-14
WG1934474-4 MB								
Conductivity			<2.0		uS/cm		2	20-AUG-14
WG1934474-5 MB								
Conductivity			<2.0		uS/cm		2	20-AUG-14
WG1934474-6 MB								
Conductivity			<2.0		uS/cm		2	20-AUG-14
WG1934474-7 MB								
Conductivity			<2.0		uS/cm		2	20-AUG-14
WG1934474-8 MB								
Conductivity			<2.0		uS/cm		2	20-AUG-14
NH3-F-VA	**Water**							
Batch R2926566								
WG1935627-10 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			96.6		%		85-115	22-AUG-14
WG1935627-2 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			99.3		%		85-115	22-AUG-14
WG1935627-20 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			96.3		%		85-115	22-AUG-14
WG1935627-4 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			93.8		%		85-115	22-AUG-14
WG1935627-6 CRM		**VA-NH3-F**						

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NH3-F-VA	**Water**							
Batch R2926566								
WG1935627-6 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			90.6		%		85-115	22-AUG-14
WG1935627-8 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			103.6		%		85-115	22-AUG-14
WG1935627-11 DUP		**L1504390-2**						
Ammonia, Total (as N)		0.0055	0.0054		mg/L	2.6	20	22-AUG-14
WG1935627-1 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	22-AUG-14
WG1935627-19 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	22-AUG-14
WG1935627-3 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	22-AUG-14
WG1935627-5 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	22-AUG-14
WG1935627-7 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	22-AUG-14
WG1935627-9 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	22-AUG-14
WG1935627-12 MS		**L1504390-2**						
Ammonia, Total (as N)			99.7		%		75-125	22-AUG-14
WG1935627-14 MS		**L1504721-3**						
Ammonia, Total (as N)			104.3		%		75-125	22-AUG-14
WG1935627-16 MS		**L1497859-7**						
Ammonia, Total (as N)			97.4		%		75-125	22-AUG-14
WG1935627-18 MS		**L1506271-1**						
Ammonia, Total (as N)			89.8		%		75-125	22-AUG-14
Batch R2926609								
WG1936798-10 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			102.5		%		85-115	22-AUG-14
WG1936798-2 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			101.1		%		85-115	22-AUG-14
WG1936798-4 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			102.4		%		85-115	22-AUG-14
WG1936798-6 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			105.1		%		85-115	22-AUG-14
WG1936798-8 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			99.6		%		85-115	22-AUG-14
WG1936798-1 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	22-AUG-14

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NH3-F-VA	**Water**							
Batch R2926609								
WG1936798-3 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	22-AUG-14
WG1936798-5 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	22-AUG-14
WG1936798-7 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	22-AUG-14
WG1936798-9 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	22-AUG-14
WG1936798-12 MS		**L1506592-2**						
Ammonia, Total (as N)			107.3		%		75-125	22-AUG-14
WG1936798-14 MS		**L1505550-7**						
Ammonia, Total (as N)			103.1		%		75-125	22-AUG-14
WG1936798-16 MS		**L1504285-1**						
Ammonia, Total (as N)			99.8		%		75-125	22-AUG-14
WG1936798-18 MS		**L1497859-1**						
Ammonia, Total (as N)			110.4		%		75-125	22-AUG-14
P-T-PRES-COL-VA	**Water**							
Batch R2924307								
WG1934210-10 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			103.4		%		80-120	20-AUG-14
WG1934210-2 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			97.7		%		80-120	20-AUG-14
WG1934210-6 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			95.7		%		80-120	20-AUG-14
WG1934210-1 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	20-AUG-14
WG1934210-5 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	20-AUG-14
WG1934210-9 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	20-AUG-14
WG1934210-4 MS		**L1503822-2**						
Phosphorus (P)-Total			94.2		%		70-130	20-AUG-14
WG1934210-8 MS		**L1503822-22**						
Phosphorus (P)-Total			109.4		%		70-130	20-AUG-14
Batch R2925352								
WG1935260-10 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			90.8		%		80-120	21-AUG-14
WG1935260-2 CRM		**VA-ERA-PO4**						

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
P-T-PRES-COL-VA	**Water**							
Batch R2925352								
WG1935260-2 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			98.7		%		80-120	21-AUG-14
WG1935260-6 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			92.0		%		80-120	21-AUG-14
WG1935260-1 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	21-AUG-14
WG1935260-5 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	21-AUG-14
WG1935260-9 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	21-AUG-14
WG1935260-12 MS		**L1504293-2**						
Phosphorus (P)-Total			98.8		%		70-130	21-AUG-14
WG1935260-4 MS		**L1505202-4**						
Phosphorus (P)-Total			90.9		%		70-130	21-AUG-14
WG1935260-8 MS		**L1505330-8**						
Phosphorus (P)-Total			N/A	MS-B	%		-	21-AUG-14
PH-PCT-VA	**Water**							
Batch R2924990								
WG1934474-25 CRM		**VA-PH7-BUF**						
pH			7.01		pH		6.9-7.1	20-AUG-14
WG1934474-26 CRM		**VA-PH7-BUF**						
pH			6.99		pH		6.9-7.1	20-AUG-14
WG1934474-27 CRM		**VA-PH7-BUF**						
pH			6.97		pH		6.9-7.1	20-AUG-14
WG1934474-28 CRM		**VA-PH7-BUF**						
pH			6.97		pH		6.9-7.1	20-AUG-14
WG1934474-29 CRM		**VA-PH7-BUF**						
pH			6.96		pH		6.9-7.1	20-AUG-14
WG1934474-30 CRM		**VA-PH7-BUF**						
pH			6.99		pH		6.9-7.1	20-AUG-14
WG1934474-31 CRM		**VA-PH7-BUF**						
pH			6.95		pH		6.9-7.1	20-AUG-14
WG1934474-32 CRM		**VA-PH7-BUF**						
pH			6.94		pH		6.9-7.1	20-AUG-14
WG1934474-36 DUP		**L1504390-4**						
pH		6.05	5.86	J	pH	0.18	0.3	20-AUG-14
PO4-DO-COL-VA	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PO4-DO-COL-VA	**Water**							
Batch R2924516								
WG1935176-10 CRM		**VA-OPO4-CONTROL**						
Orthophosphate-Dissolved (as P)			87.6		%		80-120	20-AUG-14
WG1935176-15 CRM		**VA-OPO4-CONTROL**						
Orthophosphate-Dissolved (as P)			97.4		%		80-120	20-AUG-14
WG1935176-2 CRM		**VA-OPO4-CONTROL**						
Orthophosphate-Dissolved (as P)			102.1		%		80-120	20-AUG-14
WG1935176-6 CRM		**VA-OPO4-CONTROL**						
Orthophosphate-Dissolved (as P)			101.5		%		80-120	20-AUG-14
WG1935176-1 MB								
Orthophosphate-Dissolved (as P)			<0.0010		mg/L		0.001	20-AUG-14
WG1935176-14 MB								
Orthophosphate-Dissolved (as P)			<0.0010		mg/L		0.001	20-AUG-14
WG1935176-5 MB								
Orthophosphate-Dissolved (as P)			<0.0010		mg/L		0.001	20-AUG-14
WG1935176-9 MB								
Orthophosphate-Dissolved (as P)			<0.0010		mg/L		0.001	20-AUG-14
WG1935176-12 MS		**L1504997-5**						
Orthophosphate-Dissolved (as P)			96.8		%		70-130	20-AUG-14
WG1935176-4 MS		**L1505202-4**						
Orthophosphate-Dissolved (as P)			86.7		%		70-130	20-AUG-14
WG1935176-8 MS		**L1505010-1**						
Orthophosphate-Dissolved (as P)			104.1		%		70-130	20-AUG-14
TDS-VA	**Water**							
Batch R2925490								
WG1935251-2 LCS								
Total Dissolved Solids			99.1		%		85-115	21-AUG-14
WG1935251-5 LCS								
Total Dissolved Solids			99.1		%		85-115	21-AUG-14
WG1935251-1 MB								
Total Dissolved Solids			<10		mg/L		10	21-AUG-14
WG1935251-4 MB								
Total Dissolved Solids			<10		mg/L		10	21-AUG-14
TSS-LOW-VA	**Water**							
Batch R2924006								
WG1934242-2 LCS								
Total Suspended Solids			97.5		%		85-115	19-AUG-14
WG1934242-4 LCS								
Total Suspended Solids			108.7		%		85-115	19-AUG-14

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TSS-LOW-VA	**Water**							
Batch R2924006								
WG1934242-6 LCS								
Total Suspended Solids			104.6		%		85-115	19-AUG-14
WG1934242-8 LCS								
Total Suspended Solids			104.3		%		85-115	19-AUG-14
WG1934242-1 MB								
Total Suspended Solids			<1.0		mg/L		1	19-AUG-14
WG1934242-3 MB								
Total Suspended Solids			<1.0		mg/L		1	19-AUG-14
WG1934242-5 MB								
Total Suspended Solids			<1.0		mg/L		1	19-AUG-14
WG1934242-7 MB								
Total Suspended Solids			<1.0		mg/L		1	19-AUG-14
TURBIDITY-VA	**Water**							
Batch R2923540								
WG1934319-2 CRM		**VA-FORM-40**						
Turbidity			96.3		%		85-115	19-AUG-14
WG1934319-5 CRM		**VA-FORM-40**						
Turbidity			98.3		%		85-115	19-AUG-14
WG1934319-1 MB								
Turbidity			<0.10		NTU		0.1	19-AUG-14
WG1934319-4 MB								
Turbidity			<0.10		NTU		0.1	19-AUG-14
Batch R2923935								
WG1934699-2 CRM		**VA-FORM-40**						
Turbidity			99.8		%		85-115	20-AUG-14
WG1934699-1 MB								
Turbidity			<0.10		NTU		0.1	20-AUG-14

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
DLM	Detection Limit Adjusted due to sample matrix effects.
J	Duplicate results and limits are expressed in terms of absolute difference.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH by Meter (Automated)							
	1	18-AUG-14 09:30	20-AUG-14 23:00	0.25	61	hours	EHTR-FM
	2	18-AUG-14 09:30	20-AUG-14 23:00	0.25	61	hours	EHTR-FM
	3	18-AUG-14 09:30	20-AUG-14 23:00	0.25	61	hours	EHTR-FM
	4	18-AUG-14 09:30	20-AUG-14 23:00	0.25	61	hours	EHTR-FM

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L1504390 were received on 18-AUG-14 21:05.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

L1504390-COFC

Chain of Custody / Analytical Request Form
Canada Toll Free : 1 800 668 9878
www.alsglobal.com

COC #: OL-1307

Report To	
Company:	ECOFISH RESEARCH LTD
Contact:	Kevin Ganshorn
Address:	906 - 595 Howe Street Vancouver, BC Canada, V6C2T5
Phone:	604-608-6180
Fax:	604 559-6180

Invoice To	☑Email ☐Mail
Company:	ECOFISH RESEARCH LTD
Contact:	Accounts Payable
Address:	Suite F, 450 - 8th Street Courtenay, BC Canada, V9N 1N5
Email:	accountspayable@ecofishresearch.com
Phone:	250-334-3042

Lab Work Order # (lab use only)

Reporting	
Distribution:	☐Fax ☐Mail ☑Email
☑ Criteria on Report (select from Guidelines below)	
Report Type:	☑Excel ☐Digital
Report Format:	CROSSTAB_ALSQC
Report Email(s):	kganshorn@ecofishresearch.com tkasubuchi@ecofishresearch.com pdinn@ecofishresearch.com
EDD Format:	
EDD Email(s):	

Project Info	
Job #:	1230 JHT-MON8
PO/AFE:	
LSD:	
Quote #:	
ALS Contact: Ariel Tang	Sampler: Leah Hull

Service Requested

- ◉ Regular (Standard Turnaround Times - Business Days) - R
- ○ Priority (3 Days) - surcharge will apply - P
- ○ Priority (2 Days) - surcharge will apply - P2
- ○ Emergency (1-2 day) – surcharge will apply - E
- ○ Same Day or Weekend Emergency - surcharge will apply - E2
- ○ Specify date required - X

Analysis Requests

Please indicate below Filtered, Preserved or both(F, P, F/P)

Sample #	Sample Identification (This will appear on the report)	Longitude	Latitude	Date	Time	Sample Type	Number of Containers	Alkalinity by Colourimetric (Automated)	Ammonia in Water by Fluorescence	Conductivity (Automated)	Diss. Orthophosphate in Water by Colour	Nitrate in Water by Ion Chromatography	Nitrite in Water by Ion Chromatography	Total Dissolved Solids by Gravimetric	Total P in Water by Colour	Total Suspended Solids by Grav. (1 mg/L)	Turbidity by Meter	pH by Meter (Automated)			
	SAM-WQ1A			18-Aug-2014	9:30	Water	3	R	R	R	R	R	R	R	R	R	R	R			
	SAM-WQ1B					Water	3	R	R	R	R	R	R	R	R	R	R	R			
	SAM- FIELD BLANK					Water	3	R	R	R	R	R	R	R	R	R	R	R			
	SAM- TRAVEL BLANK					Water	3	R	R	R	R	R	R	R	R	R	R	R			

Special Instructions/Comments

The questions below must be answered for water samples (check Yes or No)

Are any sample taken from a regulated DW system? ☐Yes ☒No

If yes, please use an authorized drinking water COC

Is the water sampled intended to be potable for human consumption? ☐Yes ☒No

Guidelines

British Columbia Approved and Working Water Quality Guidelines (JULY, 2013) - BCAWWQG - Freshwater Aquatic Life

SAMPLE CONDITION (lab use only)

☐Frozen ☐Cold ☐Ambient ☐Cooling Initiated

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by: Leah Hull	Date: 18-Aug-2014	Time: 14:45	Received by:	Date: 18-Aug-14	Time: 21:05	Temperature: 7.0 °C	Verified by:	Date:	Time:	Observations: ☐Yes If Yes add SIF

ECOFISH RESEARCH LTD
ATTN: Kevin Ganshorn
Suite F, 450 - 8th Street
Courtenay BC V9N 1N5

Date Received: 24-SEP-14
Report Date: 01-OCT-14 17:48 (MT)
Version: FINAL

Client Phone: 250-334-3042

Certificate of Analysis

Lab Work Order #: L1522700

Project P.O. #: NOT SUBMITTED
Job Reference: 1230 JHT-MON8
C of C Numbers: OL-1308
Legal Site Desc:

Ariel Tang
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1522700-1	L1522700-2	L1522700-3	L1522700-4	
	Description	Water	Water	Water	Water	
	Sampled Date	23-SEP-14	23-SEP-14	23-SEP-14	23-SEP-14	
	Sampled Time	11:30	11:30	11:30	11:30	
	Client ID	SAM-WQA	SAM-WQB	SAM-FIELD BLANK	SAM-TRAVEL BLANK	
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	53.4	52.8	<2.0	<2.0	
	pH (pH)	7.82	7.48	5.28	6.03	
	Total Suspended Solids (mg/L)	<1.0	<1.0	<1.0	<1.0	
	Total Dissolved Solids (mg/L)	51	41	<10	<10	
	Turbidity (NTU)	0.28	0.23	<0.10	<0.10	
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	23.8	23.9	<2.0	<2.0	
	Ammonia, Total (as N) (mg/L)	<0.0050	<0.0050	<0.0050	0.0816 RRV	
	Nitrate (as N) (mg/L)	0.0708	0.0724	<0.0050	<0.0050	
	Nitrite (as N) (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Orthophosphate-Dissolved (as P) (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Phosphorus (P)-Total (mg/L)	0.0025	0.0020	<0.0020	<0.0020	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Duplicate	Nitrite (as N)	DLM	L1522700-1, -2, -3, -4
Matrix Spike	Ammonia, Total (as N)	MS-B	L1522700-4

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLM	Detection Limit Adjusted due to sample matrix effects.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
RRV	Reported Result Verified By Repeat Analysis

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-COL-VA	Water	Alkalinity by Colourimetric (Automated)	EPA 310.2

This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.

ANIONS-NO2-IC-VA	Water	Nitrite in Water by Ion Chromatography	EPA 300.0

This analysis is carried out using procedures adapted from EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography". Nitrite is detected by UV absorbance.

ANIONS-NO3-IC-VA	Water	Nitrate in Water by Ion Chromatography	EPA 300.0

This analysis is carried out using procedures adapted from EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography". Nitrate is detected by UV absorbance.

EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

NH3-F-VA	Water	Ammonia in Water by Fluorescence	J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

P-T-PRES-COL-VA	Water	Total P in Water by Colour	APHA 4500-P Phosphorus

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Phosphorus is determined colourimetrically after persulphate digestion of the sample.

PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H "pH Value"

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PO4-DO-COL-VA	Water	Diss. Orthophosphate in Water by Colour	APHA 4500-P Phosphorus

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Dissolved Orthophosphate is determined colourimetrically on a sample that has been lab or field filtered through a 0.45 micron membrane filter.

TDS-VA	Water	Total Dissolved Solids by Gravimetric	APHA 2540 C - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

TSS-LOW-VA	Water	Total Suspended Solids by Grav. (1 mg/L)	APHA 2540 Gravimetric

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total suspended solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.

TURBIDITY-VA	Water	Turbidity by Meter	APHA 2130 "Turbidity"

This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.

TURBIDITY-VA	Water	Turbidity by Meter	APHA 2130 Turbidity

This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

Reference Information

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

OL-1308

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Client: ECOFISH RESEARCH LTD
Suite F, 450 - 8th Street
Courtenay BC V9N 1N5

Contact: Kevin Ganshorn

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-COL-VA	**Water**							
Batch R2965468								
WG1962508-2 CRM		**VA-ALKL-CONTROL**						
Alkalinity, Total (as CaCO3)			101.8		%		85-115	30-SEP-14
WG1962508-5 CRM		**VA-ALKM-CONTROL**						
Alkalinity, Total (as CaCO3)			105.8		%		85-115	30-SEP-14
WG1962508-8 CRM		**VA-ALKH-CONTROL**						
Alkalinity, Total (as CaCO3)			101.6		%		85-115	30-SEP-14
WG1962508-27 DUP		**L1522700-4**						
Alkalinity, Total (as CaCO3)		<2.0	<2.0	RPD-NA	mg/L	N/A	20	30-SEP-14
WG1962508-1 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	30-SEP-14
WG1962508-10 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	30-SEP-14
WG1962508-12 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	30-SEP-14
WG1962508-14 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	30-SEP-14
WG1962508-16 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	30-SEP-14
WG1962508-18 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	30-SEP-14
WG1962508-20 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	30-SEP-14
WG1962508-22 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	30-SEP-14
WG1962508-24 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	30-SEP-14
WG1962508-26 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	30-SEP-14
WG1962508-4 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	30-SEP-14
WG1962508-7 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	30-SEP-14
ANIONS-NO2-IC-VA	**Water**							
Batch R2960627								
WG1958554-12 LCS								
Nitrite (as N)			101.9		%		90-110	24-SEP-14
WG1958554-2 LCS								
Nitrite (as N)			102.5		%		90-110	24-SEP-14
WG1958554-1 MB								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ANIONS-NO2-IC-VA	**Water**							
Batch R2960627								
WG1958554-1 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	24-SEP-14
WG1958554-10 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	24-SEP-14
WG1958554-4 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	24-SEP-14
WG1958554-7 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	24-SEP-14
WG1958554-11 MS		**L1522703-1**						
Nitrite (as N)			106.8		%		75-125	24-SEP-14
WG1958554-5 MS		**L1522676-3**						
Nitrite (as N)			102.2		%		75-125	24-SEP-14
WG1958554-8 MS		**L1522700-4**						
Nitrite (as N)			103.2		%		75-125	24-SEP-14
ANIONS-NO3-IC-VA	**Water**							
Batch R2960627								
WG1958554-12 LCS								
Nitrate (as N)			102.1		%		90-110	24-SEP-14
WG1958554-2 LCS								
Nitrate (as N)			101.9		%		90-110	24-SEP-14
WG1958554-1 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	24-SEP-14
WG1958554-10 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	24-SEP-14
WG1958554-4 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	24-SEP-14
WG1958554-7 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	24-SEP-14
WG1958554-11 MS		**L1522703-1**						
Nitrate (as N)			107.2		%		75-125	24-SEP-14
WG1958554-5 MS		**L1522676-3**						
Nitrate (as N)			102.2		%		75-125	24-SEP-14
WG1958554-8 MS		**L1522700-4**						
Nitrate (as N)			103.4		%		75-125	24-SEP-14
EC-PCT-VA	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
EC-PCT-VA	**Water**							
Batch R2963331								
WG1961714-17 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			98.6		%		90-110	29-SEP-14
WG1961714-18 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			97.3		%		90-110	29-SEP-14
WG1961714-19 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			97.6		%		90-110	29-SEP-14
WG1961714-20 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			98.0		%		90-110	29-SEP-14
WG1961714-21 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			98.3		%		90-110	29-SEP-14
WG1961714-22 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			98.1		%		90-110	29-SEP-14
WG1961714-23 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			98.2		%		90-110	29-SEP-14
WG1961714-24 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			99.0		%		90-110	29-SEP-14
WG1961714-1 MB								
Conductivity			<2.0		uS/cm		2	29-SEP-14
WG1961714-2 MB								
Conductivity			<2.0		uS/cm		2	29-SEP-14
WG1961714-3 MB								
Conductivity			<2.0		uS/cm		2	29-SEP-14
WG1961714-4 MB								
Conductivity			<2.0		uS/cm		2	29-SEP-14
WG1961714-5 MB								
Conductivity			<2.0		uS/cm		2	29-SEP-14
WG1961714-6 MB								
Conductivity			<2.0		uS/cm		2	29-SEP-14
WG1961714-7 MB								
Conductivity			<2.0		uS/cm		2	29-SEP-14
WG1961714-8 MB								
Conductivity			<2.0		uS/cm		2	29-SEP-14
NH3-F-VA	**Water**							
Batch R2964538								
WG1960971-2 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			105.1		%		85-115	29-SEP-14
WG1960971-4 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			97.9		%		85-115	29-SEP-14
WG1960971-6 CRM		**VA-NH3-F**						

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NH3-F-VA	**Water**							
Batch R2964538								
WG1960971-6 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			100.2		%		85-115	29-SEP-14
WG1960971-7 DUP		**L1522700-2**						
Ammonia, Total (as N)		<0.0050	<0.0050	RPD-NA	mg/L	N/A	20	29-SEP-14
WG1960971-1 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	29-SEP-14
WG1960971-3 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	29-SEP-14
WG1960971-5 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	29-SEP-14
WG1960971-10 MS		**L1521858-1**						
Ammonia, Total (as N)			94.0		%		75-125	29-SEP-14
WG1960971-12 MS		**L1522194-5**						
Ammonia, Total (as N)			96.8		%		75-125	29-SEP-14
WG1960971-8 MS		**L1522700-2**						
Ammonia, Total (as N)			100.9		%		75-125	29-SEP-14
Batch R2965329								
WG1962402-2 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			102.1		%		85-115	30-SEP-14
WG1962402-4 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			102.9		%		85-115	30-SEP-14
WG1962402-6 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			103.3		%		85-115	30-SEP-14
WG1962402-8 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			101.5		%		85-115	30-SEP-14
WG1962402-1 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	30-SEP-14
WG1962402-3 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	30-SEP-14
WG1962402-5 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	30-SEP-14
WG1962402-7 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	30-SEP-14
WG1962402-10 MS		**L1522485-5**						
Ammonia, Total (as N)			103.6		%		75-125	30-SEP-14
WG1962402-16 MS		**L1521218-11**						
Ammonia, Total (as N)			N/A	MS-B	%		-	30-SEP-14
P-T-PRES-COL-VA	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
P-T-PRES-COL-VA	**Water**							
Batch R2964128								
WG1960983-10 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			104.5		%		80-120	28-SEP-14
WG1960983-2 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			108.1		%		80-120	28-SEP-14
WG1960983-6 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			105.8		%		80-120	28-SEP-14
WG1960983-11 DUP		**L1522700-2**						
Phosphorus (P)-Total		0.0020	0.0027	J	mg/L	0.0007	0.004	28-SEP-14
WG1960983-1 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	28-SEP-14
WG1960983-5 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	28-SEP-14
WG1960983-9 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	28-SEP-14
WG1960983-12 MS		**L1522700-3**						
Phosphorus (P)-Total			101.1		%		70-130	28-SEP-14
WG1960983-4 MS		**L1523544-3**						
Phosphorus (P)-Total			99.2		%		70-130	28-SEP-14
WG1960983-8 MS		**L1522222-4**						
Phosphorus (P)-Total			106.6		%		70-130	28-SEP-14
PH-PCT-VA	**Water**							
Batch R2963331								
WG1961714-25 CRM		**VA-PH7-BUF**						
pH			7.01		pH		6.9-7.1	29-SEP-14
WG1961714-26 CRM		**VA-PH7-BUF**						
pH			7.01		pH		6.9-7.1	29-SEP-14
WG1961714-27 CRM		**VA-PH7-BUF**						
pH			6.99		pH		6.9-7.1	29-SEP-14
WG1961714-28 CRM		**VA-PH7-BUF**						
pH			6.98		pH		6.9-7.1	29-SEP-14
WG1961714-29 CRM		**VA-PH7-BUF**						
pH			6.96		pH		6.9-7.1	29-SEP-14
WG1961714-30 CRM		**VA-PH7-BUF**						
pH			6.97		pH		6.9-7.1	29-SEP-14
WG1961714-31 CRM		**VA-PH7-BUF**						
pH			6.97		pH		6.9-7.1	29-SEP-14
WG1961714-32 CRM		**VA-PH7-BUF**						
pH			6.96		pH		6.9-7.1	29-SEP-14

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PH-PCT-VA	**Water**							
Batch R2966964								
WG1963535-25 CRM		**VA-PH7-BUF**						
pH			7.04		pH		6.9-7.1	01-OCT-14
WG1963535-26 CRM		**VA-PH7-BUF**						
pH			7.04		pH		6.9-7.1	01-OCT-14
PO4-DO-COL-VA	**Water**							
Batch R2957981								
WG1958878-2 CRM		**VA-OPO4-CONTROL**						
Orthophosphate-Dissolved (as P)			85.7		%		80-120	25-SEP-14
WG1958878-6 CRM		**VA-OPO4-CONTROL**						
Orthophosphate-Dissolved (as P)			83.7		%		80-120	25-SEP-14
WG1958878-1 MB								
Orthophosphate-Dissolved (as P)			<0.0010		mg/L		0.001	25-SEP-14
WG1958878-5 MB								
Orthophosphate-Dissolved (as P)			<0.0010		mg/L		0.001	25-SEP-14
WG1958878-4 MS		**L1522194-2**						
Orthophosphate-Dissolved (as P)			92.4		%		70-130	25-SEP-14
WG1958878-8 MS		**L1522691-3**						
Orthophosphate-Dissolved (as P)			91.7		%		70-130	25-SEP-14
TDS-VA	**Water**							
Batch R2962739								
WG1960316-11 LCS								
Total Dissolved Solids			105.6		%		85-115	26-SEP-14
WG1960316-2 LCS								
Total Dissolved Solids			101.1		%		85-115	26-SEP-14
WG1960316-5 LCS								
Total Dissolved Solids			103.1		%		85-115	26-SEP-14
WG1960316-8 LCS								
Total Dissolved Solids			103.2		%		85-115	26-SEP-14
WG1960316-1 MB								
Total Dissolved Solids			<10		mg/L		10	26-SEP-14
WG1960316-10 MB								
Total Dissolved Solids			<10		mg/L		10	26-SEP-14
WG1960316-4 MB								
Total Dissolved Solids			<10		mg/L		10	26-SEP-14
WG1960316-7 MB								
Total Dissolved Solids			<10		mg/L		10	26-SEP-14
TSS-LOW-VA	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TSS-LOW-VA	**Water**							
Batch R2959697								
WG1958908-2 LCS								
Total Suspended Solids			96.9		%		85-115	25-SEP-14
WG1958908-4 LCS								
Total Suspended Solids			102.3		%		85-115	25-SEP-14
WG1958908-1 MB								
Total Suspended Solids			<1.0		mg/L		1	25-SEP-14
WG1958908-3 MB								
Total Suspended Solids			<1.0		mg/L		1	25-SEP-14
TURBIDITY-VA	**Water**							
Batch R2957953								
WG1958882-2 CRM		**VA-FORM-40**						
Turbidity			99.3		%		85-115	25-SEP-14
WG1958882-5 CRM		**VA-FORM-40**						
Turbidity			98.8		%		85-115	25-SEP-14
WG1958882-6 DUP		**L1522700-1**						
Turbidity		0.28	0.30		NTU	5.9	15	25-SEP-14
WG1958882-1 MB								
Turbidity			<0.10		NTU		0.1	25-SEP-14
WG1958882-4 MB								
Turbidity			<0.10		NTU		0.1	25-SEP-14

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
DLM	Detection Limit Adjusted due to sample matrix effects.
J	Duplicate results and limits are expressed in terms of absolute difference.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH by Meter (Automated)							
	1	23-SEP-14 11:30	29-SEP-14 23:00	0.25	156	hours	EHTR-FM
	2	23-SEP-14 11:30	29-SEP-14 23:00	0.25	156	hours	EHTR-FM
	3	23-SEP-14 11:30	01-OCT-14 13:34	0.25	194	hours	EHTR-FM
	4	23-SEP-14 11:30	29-SEP-14 23:00	0.25	156	hours	EHTR-FM

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L1522700 were received on 24-SEP-14 10:40.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

Short Holding Time

Rush Processing

L1522700-COFC

COC #: OL-1308

ALS Environ...

Report To

Company: ECOFISH RESEARCH LTD
Contact: Kevin Ganshorn
Address: 906 - 595 Howe Street
Vancouver, BC
Canada, V6C2t5
Phone: 604-608-6180 Fax: 604 559-6180

Invoice To ☑Email ☐Mail

Company: ECOFISH RESEARCH LTD
Contact: Accounts Payable
Address: Suite F, 450 - 8th Street
Courtenay, BC
Canada, V9N 1N5
Email: accountspayable@ecofishresearch.com
Phone: 250-334-3042

Lab Work Order # (lab use only): L1522700

Reporting

Distribution: ☐Fax ☐Mail ☑Email
☑Cirtieria on Report (select from Guidelines below)
Report Type: ☑Excel ☐Digital
Report Format: CROSSTAB_ALSQC
Report Email(s): kganshorn@ecofishresearch.com
tkasubuchi@ecofishresearch.com
pdinn@ecofishresearch.com
EDD Format:
EDD Email(s):

Project Info

Job #: 1230 JHT-MON8
PO/AFE:
LSD:
Quote #:

ALS Contact: Ariel Tang
Sampler: Leah Hull

Service Requested

◉ Regular (Standard Turnaround Times - Business Days) - R
○ Priority (3 Days) - surcharge will apply - P
○ Priority (2 Days) - surcharge will apply - P2
○ Emergency (1-2 day) – surcharge will apply - E
○ Same Day or Weekend Emergency - surcharge will apply - E2
○ Specify date required - X

Analysis Requests (Please indicate below Filtered, Preserved or both(F, P, F/P))

Sample #	Sample Identification (This will appear on the report)	Longitude	Latitude	Date	Time	Sample Type	Number of Containers	Alkalinity by Colourimetric (Automated)	Ammonia in Water by Fluorescence	Conductivity (Automated)	Diss. Orthophosphate in Water by Colour	Nitrate in Water by Ion Chromatography	Nitrite in Water by Ion Chromatography	Total Dissolved Solids by Gravimetric	Total P in Water by Colour	Total Suspended Solids by Grav. (1 mg/L)	Turbidity by Meter	pH by Meter (Automated)			
	~~SAM-WQ1A~~ SAM-WQA			23-Sept-2014	11:30	Water	3	R	R	R	R	R	R	R	R	R	R	R			
	~~SAM-WQ1B~~ SAM-WQB			↓	↓	Water	3	R	R	R	R	R	R	R	R	R	R	R			
	SAM- FIELD BLANK					Water	3	R	R	R	R	R	R	R	R	R	R	R			
	SAM- TRAVEL BLANK					Water	3	R	R	R	R	R	R	R	R	R	R	R			

Special Instructions/Comments

The questions below must be answered for water samples (check Yes or No)

Are any sample taken from a regulated DW system? ☐Yes ☒No
If yes, please use an authorized drinking water COC
Is the water sampled intended to be potable for human consumption? ☐Yes ☒No

Guidelines

British Columbia Approved and Working Water Quality Guidelines (JULY, 2013) - BCAWWQG - Freshwater Aquatic Life

SAMPLE CONDITION (lab use only)

☐Frozen ☐Cold ☐Ambient ☐Cooling Initiated

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date:	Time:	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations:
Leah Hull	23-Sept-2014	15:45	JN	Sept 24	10:40	6.5 °C				☐Yes If Yes add SIF

ECOFISH RESEARCH LTD
ATTN: Kevin Ganshorn
Suite F, 450 - 8th Street
Courtenay BC V9N 1N5

Date Received:	24-SEP-14
Report Date:	02-OCT-14 17:11 (MT)
Version:	FINAL

Client Phone: 250-334-3042

Certificate of Analysis

Lab Work Order #:	**L1523178**
Project P.O. #:	NOT SUBMITTED
Job Reference:	1230 JHT-MON8
C of C Numbers:	
Legal Site Desc:	

Ariel Tang
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1523178-1	L1523178-2	L1523178-3	L1523178-4	
	Description	Water	Water	Water	Water	
	Sampled Date	24-SEP-14	24-SEP-14	24-SEP-14	24-SEP-14	
	Sampled Time	11:20	11:20	11:20	11:20	
	Client ID	QUN-WQA	QUN-WQB	QUN-TRIP BLANK	QUN-FIELD BLANK	
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	109	109	<2.0	<2.0	
	pH (pH)	7.52	7.58	5.41	5.45	
	Total Suspended Solids (mg/L)	<1.0	<1.0	<1.0	<1.0	
	Total Dissolved Solids (mg/L)	67	74	<10	<10	
	Turbidity (NTU)	0.50	0.62	<0.10	<0.10	
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	35.0	35.0	<2.0	<2.0	
	Ammonia, Total (as N) (mg/L)	<0.0050	<0.0050	0.0551 RRV	<0.0050	
	Nitrate (as N) (mg/L)	0.0207	0.0216	<0.0050	<0.0050	
	Nitrite (as N) (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Orthophosphate-Dissolved (as P) (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Phosphorus (P)-Total (mg/L)	0.0039	0.0046	<0.0020	<0.0020	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Ammonia, Total (as N)	MS-B	L1523178-3

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
RRV	Reported Result Verified By Repeat Analysis

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-COL-VA	Water	Alkalinity by Colourimetric (Automated)	EPA 310.2

This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.

ANIONS-NO2-IC-VA	Water	Nitrite in Water by Ion Chromatography	EPA 300.0

This analysis is carried out using procedures adapted from EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography". Nitrite is detected by UV absorbance.

ANIONS-NO3-IC-VA	Water	Nitrate in Water by Ion Chromatography	EPA 300.0

This analysis is carried out using procedures adapted from EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography". Nitrate is detected by UV absorbance.

EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

NH3-F-VA	Water	Ammonia in Water by Fluorescence	J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

P-T-PRES-COL-VA	Water	Total P in Water by Colour	APHA 4500-P Phosphorus

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Phosphorus is determined colourimetrically after persulphate digestion of the sample.

PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H "pH Value"

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PO4-DO-COL-VA	Water	Diss. Orthophosphate in Water by Colour	APHA 4500-P Phosphorus

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Dissolved Orthophosphate is determined colourimetrically on a sample that has been lab or field filtered through a 0.45 micron membrane filter.

TDS-VA	Water	Total Dissolved Solids by Gravimetric	APHA 2540 C - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

TSS-LOW-VA	Water	Total Suspended Solids by Grav. (1 mg/L)	APHA 2540 Gravimetric

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total suspended solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.

TURBIDITY-VA	Water	Turbidity by Meter	APHA 2130 "Turbidity"

This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.

TURBIDITY-VA	Water	Turbidity by Meter	APHA 2130 Turbidity

This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code **Laboratory Location**

Reference Information

VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Client: ECOFISH RESEARCH LTD
Suite F, 450 - 8th Street
Courtenay BC V9N 1N5
Contact: Kevin Ganshorn

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-COL-VA	**Water**							
Batch R2967249								
WG1963665-2 CRM		**VA-ALKL-CONTROL**						
Alkalinity, Total (as CaCO3)			104.5		%		85-115	01-OCT-14
WG1963665-5 CRM		**VA-ALKM-CONTROL**						
Alkalinity, Total (as CaCO3)			104.1		%		85-115	01-OCT-14
WG1963665-8 CRM		**VA-ALKH-CONTROL**						
Alkalinity, Total (as CaCO3)			104.1		%		85-115	01-OCT-14
WG1963665-1 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	01-OCT-14
WG1963665-10 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	01-OCT-14
WG1963665-12 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	01-OCT-14
WG1963665-15 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	01-OCT-14
WG1963665-17 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	01-OCT-14
WG1963665-20 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	01-OCT-14
WG1963665-4 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	01-OCT-14
WG1963665-7 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	01-OCT-14
ANIONS-NO2-IC-VA	**Water**							
Batch R2962874								
WG1958988-12 LCS								
Nitrite (as N)			102.2		%		90-110	25-SEP-14
WG1958988-2 LCS								
Nitrite (as N)			102.7		%		90-110	25-SEP-14
WG1958988-1 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	25-SEP-14
WG1958988-10 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	25-SEP-14
WG1958988-4 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	25-SEP-14
WG1958988-7 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	25-SEP-14
WG1958988-11 MS		**L1523544-1**						
Nitrite (as N)			102.2		%		75-125	25-SEP-14
WG1958988-5 MS		**L1523347-7**						

Quality Control Report

Test		Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ANIONS-NO2-IC-VA		**Water**							
Batch	**R2962874**								
WG1958988-5	**MS**		**L1523347-7**						
Nitrite (as N)				104.0		%		75-125	25-SEP-14
WG1958988-8	**MS**		**L1523562-4**						
Nitrite (as N)				102.6		%		75-125	25-SEP-14
ANIONS-NO3-IC-VA		**Water**							
Batch	**R2962874**								
WG1958988-12	**LCS**								
Nitrate (as N)				101.5		%		90-110	25-SEP-14
WG1958988-2	**LCS**								
Nitrate (as N)				101.6		%		90-110	25-SEP-14
WG1958988-1	**MB**								
Nitrate (as N)				<0.0050		mg/L		0.005	25-SEP-14
WG1958988-10	**MB**								
Nitrate (as N)				<0.0050		mg/L		0.005	25-SEP-14
WG1958988-4	**MB**								
Nitrate (as N)				<0.0050		mg/L		0.005	25-SEP-14
WG1958988-7	**MB**								
Nitrate (as N)				<0.0050		mg/L		0.005	25-SEP-14
WG1958988-11	**MS**		**L1523544-1**						
Nitrate (as N)				101.6		%		75-125	25-SEP-14
WG1958988-5	**MS**		**L1523347-7**						
Nitrate (as N)				103.4		%		75-125	25-SEP-14
WG1958988-8	**MS**		**L1523562-4**						
Nitrate (as N)				102.2		%		75-125	25-SEP-14
EC-PCT-VA		**Water**							
Batch	**R2964914**								
WG1962520-17	**CRM**		**VA-EC-PCT-CONTROL**						
Conductivity				99.7		%		90-110	30-SEP-14
WG1962520-18	**CRM**		**VA-EC-PCT-CONTROL**						
Conductivity				98.1		%		90-110	30-SEP-14
WG1962520-19	**CRM**		**VA-EC-PCT-CONTROL**						
Conductivity				98.4		%		90-110	30-SEP-14
WG1962520-20	**CRM**		**VA-EC-PCT-CONTROL**						
Conductivity				100.0		%		90-110	30-SEP-14
WG1962520-21	**CRM**		**VA-EC-PCT-CONTROL**						
Conductivity				99.8		%		90-110	30-SEP-14
WG1962520-22	**CRM**		**VA-EC-PCT-CONTROL**						
Conductivity				100.8		%		90-110	30-SEP-14

ALS Environmental

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
EC-PCT-VA	**Water**							
Batch R2964914								
WG1962520-23 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			100.0		%		90-110	30-SEP-14
WG1962520-24 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			100.3		%		90-110	30-SEP-14
WG1962520-42 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			100.1		%		90-110	30-SEP-14
WG1962520-1 MB								
Conductivity			<2.0		uS/cm		2	30-SEP-14
WG1962520-2 MB								
Conductivity			<2.0		uS/cm		2	30-SEP-14
WG1962520-3 MB								
Conductivity			<2.0		uS/cm		2	30-SEP-14
WG1962520-4 MB								
Conductivity			<2.0		uS/cm		2	30-SEP-14
WG1962520-40 MB								
Conductivity			<2.0		uS/cm		2	30-SEP-14
WG1962520-5 MB								
Conductivity			<2.0		uS/cm		2	30-SEP-14
WG1962520-6 MB								
Conductivity			<2.0		uS/cm		2	30-SEP-14
WG1962520-7 MB								
Conductivity			<2.0		uS/cm		2	30-SEP-14
WG1962520-8 MB								
Conductivity			<2.0		uS/cm		2	30-SEP-14
NH3-F-VA	**Water**							
Batch R2963748								
WG1961185-2 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			97.0		%		85-115	29-SEP-14
WG1961185-4 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			96.8		%		85-115	29-SEP-14
WG1961185-6 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			96.3		%		85-115	29-SEP-14
WG1961185-8 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			97.0		%		85-115	29-SEP-14
WG1961185-13 DUP		**L1523178-1**						
Ammonia, Total (as N)		<0.0050	<0.0050	RPD-NA	mg/L	N/A	20	29-SEP-14
WG1961185-1 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	29-SEP-14
WG1961185-3 MB								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NH3-F-VA	**Water**							
Batch R2963748								
WG1961185-3 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	29-SEP-14
WG1961185-5 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	29-SEP-14
WG1961185-7 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	29-SEP-14
WG1961185-10 MS		**L1523335-1**						
Ammonia, Total (as N)			96.9		%		75-125	29-SEP-14
WG1961185-12 MS		**L1523335-4**						
Ammonia, Total (as N)			97.7		%		75-125	29-SEP-14
WG1961185-14 MS		**L1523178-1**						
Ammonia, Total (as N)			97.9		%		75-125	29-SEP-14
Batch R2963762								
WG1959947-2 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			101.8		%		85-115	29-SEP-14
WG1959947-4 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			107.9		%		85-115	29-SEP-14
WG1959947-6 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			102.2		%		85-115	29-SEP-14
WG1959947-1 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	29-SEP-14
WG1959947-3 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	29-SEP-14
WG1959947-5 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	29-SEP-14
WG1959947-12 MS		**L1520738-3**						
Ammonia, Total (as N)			N/A	MS-B	%		-	29-SEP-14
WG1959947-8 MS		**L1520952-1**						
Ammonia, Total (as N)			103.3		%		75-125	29-SEP-14
P-T-PRES-COL-VA	**Water**							
Batch R2964677								
WG1961319-10 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			108.8		%		80-120	29-SEP-14
WG1961319-2 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			89.1		%		80-120	29-SEP-14
WG1961319-6 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			106.0		%		80-120	29-SEP-14
WG1961319-1 MB								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
P-T-PRES-COL-VA	**Water**							
Batch R2964677								
WG1961319-1 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	29-SEP-14
WG1961319-5 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	29-SEP-14
WG1961319-9 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	29-SEP-14
WG1961319-12 MS		**L1523468-6**						
Phosphorus (P)-Total			107.0		%		70-130	29-SEP-14
WG1961319-4 MS		**L1521858-7**						
Phosphorus (P)-Total			90.9		%		70-130	29-SEP-14
WG1961319-8 MS		**L1523335-3**						
Phosphorus (P)-Total			100.4		%		70-130	29-SEP-14
PH-PCT-VA	**Water**							
Batch R2964914								
WG1962520-25 CRM		**VA-PH7-BUF**						
pH			7.01		pH		6.9-7.1	30-SEP-14
WG1962520-26 CRM		**VA-PH7-BUF**						
pH			7.02		pH		6.9-7.1	30-SEP-14
WG1962520-27 CRM		**VA-PH7-BUF**						
pH			7.03		pH		6.9-7.1	30-SEP-14
WG1962520-28 CRM		**VA-PH7-BUF**						
pH			7.02		pH		6.9-7.1	30-SEP-14
WG1962520-29 CRM		**VA-PH7-BUF**						
pH			7.02		pH		6.9-7.1	30-SEP-14
WG1962520-30 CRM		**VA-PH7-BUF**						
pH			7.01		pH		6.9-7.1	30-SEP-14
WG1962520-31 CRM		**VA-PH7-BUF**						
pH			7.02		pH		6.9-7.1	30-SEP-14
WG1962520-32 CRM		**VA-PH7-BUF**						
pH			7.03		pH		6.9-7.1	30-SEP-14
WG1962520-43 CRM		**VA-PH7-BUF**						
pH			7.03		pH		6.9-7.1	30-SEP-14
PO4-DO-COL-VA	**Water**							
Batch R2959859								
WG1959948-2 CRM		**VA-OPO4-CONTROL**						
Orthophosphate-Dissolved (as P)			91.7		%		80-120	25-SEP-14
WG1959948-6 CRM		**VA-OPO4-CONTROL**						
Orthophosphate-Dissolved (as P)			92.3		%		80-120	26-SEP-14

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PO4-DO-COL-VA	**Water**							
Batch R2959859								
WG1959948-1 MB								
Orthophosphate-Dissolved (as P)			<0.0010		mg/L		0.001	25-SEP-14
WG1959948-5 MB								
Orthophosphate-Dissolved (as P)			<0.0010		mg/L		0.001	26-SEP-14
WG1959948-4 MS		**L1523366-14**						
Orthophosphate-Dissolved (as P)			105.4		%		70-130	25-SEP-14
WG1959948-8 MS		**L1522914-2**						
Orthophosphate-Dissolved (as P)			93.3		%		70-130	26-SEP-14
TDS-VA	**Water**							
Batch R2964339								
WG1962450-2 LCS								
Total Dissolved Solids			100.1		%		85-115	29-SEP-14
WG1962450-1 MB								
Total Dissolved Solids			<10		mg/L		10	29-SEP-14
TSS-LOW-VA	**Water**							
Batch R2964397								
WG1962464-2 LCS								
Total Suspended Solids			86.9		%		85-115	30-SEP-14
WG1962464-4 LCS								
Total Suspended Solids			90.9		%		85-115	30-SEP-14
WG1962464-1 MB								
Total Suspended Solids			<1.0		mg/L		1	30-SEP-14
WG1962464-3 MB								
Total Suspended Solids			<1.0		mg/L		1	30-SEP-14
TURBIDITY-VA	**Water**							
Batch R2959809								
WG1959744-11 CRM		**VA-FORM-40**						
Turbidity			97.3		%		85-115	25-SEP-14
WG1959744-14 CRM		**VA-FORM-40**						
Turbidity			95.8		%		85-115	25-SEP-14
WG1959744-17 CRM		**VA-FORM-40**						
Turbidity			99.5		%		85-115	25-SEP-14
WG1959744-2 CRM		**VA-FORM-40**						
Turbidity			99.8		%		85-115	25-SEP-14
WG1959744-5 CRM		**VA-FORM-40**						
Turbidity			98.0		%		85-115	25-SEP-14
WG1959744-8 CRM		**VA-FORM-40**						
Turbidity			96.5		%		85-115	25-SEP-14

Quality Control Report

Test		Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TURBIDITY-VA		**Water**							
Batch	**R2959809**								
WG1959744-1	**MB**								
Turbidity				<0.10		NTU		0.1	25-SEP-14
WG1959744-10	**MB**								
Turbidity				<0.10		NTU		0.1	25-SEP-14
WG1959744-13	**MB**								
Turbidity				<0.10		NTU		0.1	25-SEP-14
WG1959744-16	**MB**								
Turbidity				<0.10		NTU		0.1	25-SEP-14
WG1959744-4	**MB**								
Turbidity				<0.10		NTU		0.1	25-SEP-14
WG1959744-7	**MB**								
Turbidity				<0.10		NTU		0.1	25-SEP-14

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
J	Duplicate results and limits are expressed in terms of absolute difference.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH by Meter (Automated)							
	1	24-SEP-14 11:20	30-SEP-14 23:00	0.25	156	hours	EHTR-FM
	2	24-SEP-14 11:20	30-SEP-14 23:00	0.25	156	hours	EHTR-FM
	3	24-SEP-14 11:20	30-SEP-14 23:00	0.25	156	hours	EHTR-FM
	4	24-SEP-14 11:20	30-SEP-14 23:00	0.25	156	hours	EHTR-FM

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L1523178 were received on 24-SEP-14 19:55.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

L1523178-COFC

ALS Environmental

Analytical Request Form
ee : 1 800 668 9878
......sglobal.com

COC #: OL-1315

Report To		Reporting		Service Requested
Company:	ECOFISH RESEARCH LTD	Distribution:	☐Fax ☐Mail ☑Email	⦿ Regular (Standard Turnaround Times - Business Days) - R
Contact:	Kevin Ganshorn	☑Criteria on Report (select from Guidelines below)		O Priority (3 Days) - surcharge will apply - P
Address:	906 - 595 Howe Street Vancouver, BC Canada, V6C2T5	Report Type:	☑Excel ☐Digital	O Priority (2 Days) - surcharge will apply - P2
		Report Format:	CROSSTAB_ALSQC	O Emergency (1-2 day) – surcharge will apply - E
		Report Email(s):	kganshorn@ecofishresearch.com tkasubuchi@ecofishresearch.com pdinn@ecofishresearch.com	O Same Day or Weekend Emergency - surcharge will apply - E2
Phone:	604-608-6180 Fax: 604 559-6180			O Specify date required - X
Invoice To	☑Email ☐Mail	EDD Format:		
Company:	ECOFISH RESEARCH LTD	EDD Email(s):		
Contact:	Accounts Payable			
Address:	Suite F, 450 - 8th Street Courtenay, BC Canada, V9N 1N5	Project Info		
		Job #:	1230 JHT-MON8	
		PO/AFE:		
Email:	accountspayable@ecofishresearch.com	LSD:		
Phone:	250-334-3042	Quote #:		
Lab Work Order # (lab use only)		ALS Contact: Ariel Tang	Sampler: Leah Hull	

Analysis Requests — Please indicate below Filtered, Preserved or both(F, P, F/P)

Sample #	Sample Identification (This will appear on the report)	Longitude	Latitude	Date	Time	Sample Type	Number of Containers	Alkalinity by Colourimetric (Automated)	Ammonia in Water by Fluorescence	Conductivity (Automated)	Diss. Orthophosphate in Water by Colour	Nitrate in Water by Ion Chromatography	Nitrite in Water by Ion Chromatography	Total Dissolved Solids by Gravimetric	Total P in Water by Colour	Total Suspended Solids by Grav. (1 mg/L)	Turbidity by Meter	pH by Meter (Automated)
	QUN-WQ1A			24-Sept-2014	11:20	Water	3	R	R	R	R	R	R	R	R	R	R	R
	QUN-WQ1B			↓	↓	Water	3	R	R	R	R	R	R	R	R	R	R	R
	QUN-TRIP BLANK			↓	↓	Water	3	R	R	R	R	R	R	R	R	R	R	R
	QUN-FIELD BLANK			↓	↓	Water	3	R	R	R	R	R	R	R	R	R	R	R

Short Holding Time

Rush Processing

The questions below must be answered for water samples (check Yes or No)

Are any sample taken from a regulated DW system? ☐Yes ☒No

If yes, please use an authorized drinking water COC

Is the water sampled intended to be potable for human consumption? ☐Yes ☒No

Guidelines

British Columbia Approved and Working Water Quality Guidelines (JULY, 2013) - BCAWWQG - Freshwater Aquatic Life

SAMPLE CONDITION (lab use only)

☐Frozen ☐Cold ☐Ambient ☐Cooling Initiated

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by: Leah Hull	Date: 24-Sept-2014	Time: 15:30	Received by: PAUL	Date: SEP 24	Time: 19:55	Temperature: 7 °C	Verified by:	Date:	Time:	Observations: ☐Yes If Yes add SIF

Appendix G. ALS Laboratory Water Quality Results and QA for the Quinsam River, Year 1 Monitoring.

ECOFISH RESEARCH LTD
ATTN: Kevin Ganshorn
Suite F, 450 - 8th Street
Courtenay BC V9N 1N5

Date Received: 24-MAY-14
Report Date: 02-JUN-14 15:53 (MT)
Version: FINAL

Client Phone: 250-334-3042

Certificate of Analysis

Lab Work Order #: L1459824

Project P.O. #: NOT SUBMITTED
Job Reference: 1230 JHT-MON8
C of C Numbers: OL-1282
Legal Site Desc:

Ariel Tang
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1459824-1	L1459824-2	L1459824-3	L1459824-4	
	Description	Water	Water	Water	Water	
	Sampled Date	23-MAY-14	23-MAY-14	23-MAY-14	23-MAY-14	
	Sampled Time	09:29	09:30		09:30	
	Client ID	QUN-WQ1A	QUN-WQ1B	QUN-TRIP BLANK	QUN-FIELD BLANK	
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	95.4	94.1	<2.0	<2.0	
	pH (pH)	7.77	7.77	5.64	5.60	
	Total Suspended Solids (mg/L)	<1.0	<1.0	<1.0	<1.0	
	Total Dissolved Solids (mg/L)	70	68	<10	<10	
	Turbidity (NTU)	0.65	0.52	<0.10	<0.10	
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	31.5	31.8	<2.0	<2.0	
	Ammonia, Total (as N) (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	
	Nitrate (as N) (mg/L)	0.0140	0.0135	<0.0050	<0.0050	
	Nitrite (as N) (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Orthophosphate-Dissolved (as P) (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Phosphorus (P)-Total (mg/L)	0.0038	0.0039	<0.0020	<0.0020	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Phosphorus (P)-Total	MS-B	L1459824-1, -2, -3, -4
Matrix Spike	Phosphorus (P)-Total	MS-B	L1459824-1, -2, -3, -4
Matrix Spike	Phosphorus (P)-Total	MS-B	L1459824-1, -2, -3, -4
Matrix Spike	Phosphorus (P)-Total	MS-B	L1459824-1, -2, -3, -4

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-COL-VA	Water	Alkalinity by Colourimetric (Automated)	EPA 310.2

This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.

ANIONS-NO2-IC-VA	Water	Nitrite in Water by Ion Chromatography	EPA 300.0

This analysis is carried out using procedures adapted from EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography". Nitrite is detected by UV absorbance.

ANIONS-NO3-IC-VA	Water	Nitrate in Water by Ion Chromatography	EPA 300.0

This analysis is carried out using procedures adapted from EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography". Nitrate is detected by UV absorbance.

EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

NH3-F-VA	Water	Ammonia in Water by Fluorescence	J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

P-T-COL-VA	Water	Total P in Water by Colour	APHA 4500-P Phosphorus

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Phosphorus is determined colourimetrically after persulphate digestion of the sample.

PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H "pH Value"

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PO4-DO-COL-VA	Water	Diss. Orthophosphate in Water by Colour	APHA 4500-P Phosphorus

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Dissolved Orthophosphate is determined colourimetrically on a sample that has been lab or field filtered through a 0.45 micron membrane filter.

TDS-VA	Water	Total Dissolved Solids by Gravimetric	APHA 2540 C - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

TSS-LOW-VA	Water	Total Suspended Solids by Grav. (1 mg/L)	APHA 2540 Gravimetric

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total suspended solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.

TURBIDITY-VA	Water	Turbidity by Meter	APHA 2130 "Turbidity"

This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.

TURBIDITY-VA	Water	Turbidity by Meter	APHA 2130 Turbidity

This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

Reference Information

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

OL-1282

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Client: ECOFISH RESEARCH LTD
Suite F, 450 - 8th Street
Courtenay BC V9N 1N5
Contact: Kevin Ganshorn

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-COL-VA	**Water**							
Batch R2847663								
WG1880264-2 CRM		**VA-ALKL-CONTROL**						
Alkalinity, Total (as CaCO3)			105.3		%		85-115	27-MAY-14
WG1880264-5 CRM		**VA-ALKM-CONTROL**						
Alkalinity, Total (as CaCO3)			105.5		%		85-115	27-MAY-14
WG1880264-8 CRM		**VA-ALKH-CONTROL**						
Alkalinity, Total (as CaCO3)			104.4		%		85-115	27-MAY-14
WG1880264-1 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	27-MAY-14
WG1880264-10 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	27-MAY-14
WG1880264-12 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	27-MAY-14
WG1880264-14 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	27-MAY-14
WG1880264-16 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	27-MAY-14
WG1880264-18 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	27-MAY-14
WG1880264-20 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	27-MAY-14
WG1880264-4 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	27-MAY-14
WG1880264-7 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	27-MAY-14
ANIONS-NO2-IC-VA	**Water**							
Batch R2845717								
WG1878528-9 DUP		**L1459824-1**						
Nitrite (as N)		<0.0010	<0.0010	RPD-NA	mg/L	N/A	20	24-MAY-14
WG1878528-15 LCS								
Nitrite (as N)			100.3		%		90-110	24-MAY-14
WG1878528-2 LCS								
Nitrite (as N)			100.8		%		90-110	24-MAY-14
WG1878528-1 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	24-MAY-14
WG1878528-10 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	24-MAY-14
WG1878528-13 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	24-MAY-14
WG1878528-4 MB								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ANIONS-NO2-IC-VA	**Water**							
Batch R2845717								
WG1878528-4 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	24-MAY-14
WG1878528-7 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	24-MAY-14
WG1878528-11 MS		**L1458592-1**						
Nitrite (as N)			93.7		%		75-125	24-MAY-14
WG1878528-14 MS		**L1459824-2**						
Nitrite (as N)			100.9		%		75-125	24-MAY-14
WG1878528-5 MS		**L1459574-4**						
Nitrite (as N)			95.5		%		75-125	24-MAY-14
ANIONS-NO3-IC-VA	**Water**							
Batch R2845717								
WG1878528-9 DUP		**L1459824-1**						
Nitrate (as N)		0.0140	0.0137		mg/L	2.2	20	24-MAY-14
WG1878528-15 LCS								
Nitrate (as N)			101.6		%		90-110	24-MAY-14
WG1878528-2 LCS								
Nitrate (as N)			101.3		%		90-110	24-MAY-14
WG1878528-1 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	24-MAY-14
WG1878528-10 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	24-MAY-14
WG1878528-13 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	24-MAY-14
WG1878528-4 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	24-MAY-14
WG1878528-7 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	24-MAY-14
WG1878528-11 MS		**L1458592-1**						
Nitrate (as N)			96.9		%		75-125	24-MAY-14
WG1878528-14 MS		**L1459824-2**						
Nitrate (as N)			102.7		%		75-125	24-MAY-14
WG1878528-5 MS		**L1459574-4**						
Nitrate (as N)			96.2		%		75-125	24-MAY-14
WG1878528-8 MS		**L1459778-8**						
Nitrate (as N)			102.1		%		75-125	24-MAY-14
EC-PCT-VA	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
EC-PCT-VA	**Water**							
Batch R2845655								
WG1878948-17 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			99.7		%		90-110	26-MAY-14
WG1878948-18 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			98.2		%		90-110	26-MAY-14
WG1878948-19 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			98.6		%		90-110	26-MAY-14
WG1878948-20 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			98.6		%		90-110	26-MAY-14
WG1878948-21 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			99.0		%		90-110	26-MAY-14
WG1878948-22 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			98.9		%		90-110	26-MAY-14
WG1878948-23 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			99.9		%		90-110	26-MAY-14
WG1878948-24 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			100.2		%		90-110	26-MAY-14
WG1878948-37 DUP		**L1459824-2**						
Conductivity		94.1	94.0		uS/cm	0.1	10	26-MAY-14
WG1878948-1 MB								
Conductivity			<2.0		uS/cm		2	26-MAY-14
WG1878948-2 MB								
Conductivity			<2.0		uS/cm		2	26-MAY-14
WG1878948-3 MB								
Conductivity			<2.0		uS/cm		2	26-MAY-14
WG1878948-4 MB								
Conductivity			<2.0		uS/cm		2	26-MAY-14
WG1878948-5 MB								
Conductivity			<2.0		uS/cm		2	26-MAY-14
WG1878948-6 MB								
Conductivity			<2.0		uS/cm		2	26-MAY-14
WG1878948-7 MB								
Conductivity			<2.0		uS/cm		2	26-MAY-14
WG1878948-8 MB								
Conductivity			<2.0		uS/cm		2	26-MAY-14
NH3-F-VA	**Water**							
Batch R2849673								
WG1882495-2 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			93.7		%		85-115	31-MAY-14
WG1882495-4 CRM		**VA-NH3-F**						

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NH3-F-VA	**Water**							
Batch R2849673								
WG1882495-4 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			98.2		%		85-115	31-MAY-14
WG1882495-6 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			105.7		%		85-115	31-MAY-14
WG1882495-8 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			108.2		%		85-115	31-MAY-14
WG1882495-1 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	31-MAY-14
WG1882495-3 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	31-MAY-14
WG1882495-5 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	31-MAY-14
WG1882495-7 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	31-MAY-14
WG1882495-10 MS		**L1459778-1**						
Ammonia, Total (as N)			101.5		%		75-125	31-MAY-14
P-T-COL-VA	**Water**							
Batch R2846839								
WG1878655-10 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			108.8		%		80-120	26-MAY-14
WG1878655-14 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			103.5		%		80-120	26-MAY-14
WG1878655-18 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			109.0		%		80-120	26-MAY-14
WG1878655-2 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			106.8		%		80-120	26-MAY-14
WG1878655-22 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			106.6		%		80-120	26-MAY-14
WG1878655-6 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			102.7		%		80-120	26-MAY-14
WG1878655-1 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	26-MAY-14
WG1878655-13 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	26-MAY-14
WG1878655-17 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	26-MAY-14
WG1878655-21 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	26-MAY-14
WG1878655-5 MB								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
P-T-COL-VA	**Water**							
Batch R2846839								
WG1878655-5 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	26-MAY-14
WG1878655-9 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	26-MAY-14
WG1878655-12 MS		**L1459474-2**						
Phosphorus (P)-Total			N/A	MS-B	%		-	26-MAY-14
WG1878655-16 MS		**L1459537-17**						
Phosphorus (P)-Total			N/A	MS-B	%		-	26-MAY-14
WG1878655-20 MS		**L1459567-15**						
Phosphorus (P)-Total			102.0		%		70-130	26-MAY-14
WG1878655-24 MS		**L1459571-14**						
Phosphorus (P)-Total			107.0		%		70-130	26-MAY-14
WG1878655-4 MS		**L1458340-2**						
Phosphorus (P)-Total			N/A	MS-B	%		-	26-MAY-14
WG1878655-8 MS		**L1459380-3**						
Phosphorus (P)-Total			N/A	MS-B	%		-	26-MAY-14
PH-PCT-VA	**Water**							
Batch R2845655								
WG1878948-25 CRM		**VA-PH7-BUF**						
pH			7.01		pH		6.9-7.1	26-MAY-14
WG1878948-26 CRM		**VA-PH7-BUF**						
pH			7.02		pH		6.9-7.1	26-MAY-14
WG1878948-27 CRM		**VA-PH7-BUF**						
pH			7.02		pH		6.9-7.1	26-MAY-14
WG1878948-28 CRM		**VA-PH7-BUF**						
pH			7.03		pH		6.9-7.1	26-MAY-14
WG1878948-29 CRM		**VA-PH7-BUF**						
pH			7.05		pH		6.9-7.1	26-MAY-14
WG1878948-30 CRM		**VA-PH7-BUF**						
pH			7.03		pH		6.9-7.1	26-MAY-14
WG1878948-31 CRM		**VA-PH7-BUF**						
pH			7.02		pH		6.9-7.1	26-MAY-14
WG1878948-32 CRM		**VA-PH7-BUF**						
pH			7.00		pH		6.9-7.1	26-MAY-14
WG1878948-37 DUP		**L1459824-2**						
pH		7.77	7.77	J	pH	0.00	0.3	26-MAY-14
PO4-DO-COL-VA	**Water**							

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PO4-DO-COL-VA	**Water**							
Batch R2846906								
WG1878690-2 CRM		**VA-OPO4-CONTROL**						
Orthophosphate-Dissolved (as P)			96.1		%		80-120	24-MAY-14
WG1878690-1 MB								
Orthophosphate-Dissolved (as P)			<0.0010		mg/L		0.001	24-MAY-14
WG1878690-4 MS		**L1459484-1**						
Orthophosphate-Dissolved (as P)			100.4		%		70-130	24-MAY-14
WG1878690-6 MS		**L1459713-5**						
Orthophosphate-Dissolved (as P)			102.7		%		70-130	24-MAY-14
WG1878690-8 MS		**L1459778-22**						
Orthophosphate-Dissolved (as P)			101.6		%		70-130	24-MAY-14
TDS-VA	**Water**							
Batch R2849138								
WG1881513-2 LCS								
Total Dissolved Solids			103.8		%		85-115	29-MAY-14
WG1881513-5 LCS								
Total Dissolved Solids			98.5		%		85-115	29-MAY-14
WG1881513-8 LCS								
Total Dissolved Solids			100.6		%		85-115	29-MAY-14
WG1881513-1 MB								
Total Dissolved Solids			<10		mg/L		10	29-MAY-14
WG1881513-4 MB								
Total Dissolved Solids			<10		mg/L		10	29-MAY-14
WG1881513-7 MB								
Total Dissolved Solids			<10		mg/L		10	29-MAY-14
TSS-LOW-VA	**Water**							
Batch R2846507								
WG1879521-2 LCS								
Total Suspended Solids			94.8		%		85-115	26-MAY-14
WG1879521-1 MB								
Total Suspended Solids			<1.0		mg/L		1	26-MAY-14
TURBIDITY-VA	**Water**							
Batch R2847145								
WG1878695-2 CRM		**VA-FORM-40**						
Turbidity			99.3		%		85-115	24-MAY-14
WG1878695-5 CRM		**VA-FORM-40**						
Turbidity			99.0		%		85-115	24-MAY-14
WG1878695-1 MB								
Turbidity			<0.10		NTU		0.1	24-MAY-14

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TURBIDITY-VA	**Water**							
Batch R2847145								
WG1878695-4 MB								
Turbidity			<0.10		NTU		0.1	24-MAY-14

Quality Control Report

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
J	Duplicate results and limits are expressed in terms of absolute difference.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH by Meter (Automated)							
	1	23-MAY-14 09:29	26-MAY-14 23:00	0.25	85	hours	EHTR-FM
	2	23-MAY-14 09:30	26-MAY-14 23:00	0.25	85	hours	EHTR-FM
	3	23-MAY-14	26-MAY-14 23:00	0.25	83	hours	EHTR-FM
	4	23-MAY-14 09:30	26-MAY-14 23:00	0.25	85	hours	EHTR-FM

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L1459824 were received on 24-MAY-14 08:50.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

ALS Environmental

Chain of Custody / Analytical Request Fo[rm]
Canada Toll Free : 1 800 668 9878
www.alsglobal.com

L1459824-COFC

COC # OL-1282

Report To		Reporting		Turnaround
Company:	ECOFISH RESEARCH LTD	Distribution:	☐Fax ☐Mail ☑Email	⊙ Regular (Standard Turnaround Times - Business Days) - R
Contact:	Kevin Ganshorn	☑ Criteria on Report (select from Guidelines below)		○ Priority (3 Days) - surcharge will apply - P
Address:	906- 595 Howe Street Vancouver, BC Canada, V6C2T5	Report Type:	☑Excel ☐Digital	○ Priority (2 Days) - surcharge will apply - P2
		Report Format:	CROSSTAB_ALSQC	○ Emergency (1-2 day) – surcharge will apply - E
		Report Email(s):	kganshorn@ecofishresearch.com tkasubuchi@ecofishresearch.com pdinn@ecofishresearch.com	○ Same Day or Weekend Emergency - surcharge will apply - E2
				○ Specify date required - X
Phone:	604-608-6180 Fax: 604-559-6180			

Invoice To ☑Email ☐Mail			
Company:	ECOFISH RESEARCH LTD	EDD Format:	
Contact:	Accounts Payable	EDD Email(s):	
Address:	Suite F, 450 - 8th Street Courtenay, BC Canada, V9N 1N5	**Project Info**	
		Job #:	1230 JHT-MON8
		PO/AFE:	
		LSD:	
Email:	accountspayable@ecofishresearch.com	Quote #:	
Phone:	250-334-3042		
Lab Work Order # (lab use only)		ALS Contact: Ariel Tang	Sampler:

Analysis Requests — Please indicate below Filtered, Preserved or both(F, P, F/P)

Sample #	Sample Identification (This will appear on the report)	Longitude	Latitude	Date	Time	Sample Type	Number of Containers	Alkalinity by Colourimetric (Automated)	Ammonia in Water by Fluorescence	Conductivity (Automated)	Diss. Orthophosphate in Water by Colour	Nitrate in Water by Ion Chromatography	Nitrite in Water by Ion Chromatography	Total Dissolved Solids by Gravimetric	Total P in Water by Colour	Total Suspended Solids by Grav. (1 mg/L)	Turbidity by Meter	pH by Meter (Automated)
	QUN-WQ1A			May 23/14	9:29	Water	3	R	R	R	R	R	R	R	R	R	R	R
	QUN-WQ1B			May 23/14	9:30	Water	3	R	R	R	R	R	R	R	R	R	R	R
	QUN-Trip Blank			May 23/14		Water	3	R	R	R	R	R	R	R	R	R	R	R
	QUN-Field Blank			May /14	9:30	Water	3	R	R	R	R	R	R	R	R	R	R	R

Short Holding Time

Rush Processing

Special Instructions/Comments

The questions below must be answered for water samples (check Yes or No)

Are any sample taken from a regulated DW system? ☐Yes ☐No

If yes, please use an authorized drinking water COC

Is the water sampled intended to be potable for human consumption? ☐Yes ☐No

Guidelines

British Columbia Approved and Working Water Quality Guidelines (JULY, 2013) - BCAWWQG - Freshwater Aquatic Life

SAMPLE CONDITION (lab use only)

☐Frozen ☐Cold ☐Ambient ☐Cooling Initiated

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date:	Time:	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: ☐Yes If Yes add SIF
Kyle Milburn	May 23	14:20	JK	May 24	8:50	11.9 °C				

ECOFISH RESEARCH LTD
ATTN: Kevin Ganshorn
Suite F, 450 - 8th Street
Courtenay BC V9N 1N5

Date Received: 19-JUN-14
Report Date: 27-JUN-14 10:57 (MT)
Version: FINAL

Client Phone: 250-334-3042

Certificate of Analysis

Lab Work Order #: L1474093

Project P.O. #: NOT SUBMITTED
Job Reference: 1230 JHT-MON8
C of C Numbers: OL-1312
Legal Site Desc:

Ariel Tang
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1474093-1	L1474093-2	L1474093-3	L1474093-4	
	Description	Water	Water	Water	Water	
	Sampled Date	18-JUN-14	18-JUN-14	18-JUN-14	18-JUN-14	
	Sampled Time	08:58	08:58	08:58	08:58	
	Client ID	QUN-WQ1A	QUN-WQ1B	QUN-TRIP BLANK	QUN-FIELD BLANK	
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	139	140	<2.0	<2.0	
	pH (pH)	7.87	7.87	5.45	5.47	
	Total Suspended Solids (mg/L)	<1.0	<1.0	<1.0	<1.0	
	Total Dissolved Solids (mg/L)	96	96	<10	<10	
	Turbidity (NTU)	0.40	0.44	<0.10	<0.10	
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	41.1	40.8	<2.0	<2.0	
	Ammonia, Total (as N) (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	
	Nitrate (as N) (mg/L)	0.0301	0.0292	<0.0050	<0.0050	
	Nitrite (as N) (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Orthophosphate-Dissolved (as P) (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Phosphorus (P)-Total (mg/L)	0.0027	0.0029	<0.0020	<0.0020	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Duplicate	Nitrite (as N)	DLM	L1474093-1, -2, -3, -4
Matrix Spike	Phosphorus (P)-Total	MS-B	L1474093-1, -2, -3, -4

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLM	Detection Limit Adjusted due to sample matrix effects.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-COL-VA	Water	Alkalinity by Colourimetric (Automated)	EPA 310.2

This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.

ANIONS-NO2-IC-VA	Water	Nitrite in Water by Ion Chromatography	EPA 300.0

This analysis is carried out using procedures adapted from EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography". Nitrite is detected by UV absorbance.

ANIONS-NO3-IC-VA	Water	Nitrate in Water by Ion Chromatography	EPA 300.0

This analysis is carried out using procedures adapted from EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography". Nitrate is detected by UV absorbance.

EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

NH3-F-VA	Water	Ammonia in Water by Fluorescence	J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

P-T-PRES-COL-VA	Water	Total P in Water by Colour	APHA 4500-P Phosphorus

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Phosphorus is determined colourimetrically after persulphate digestion of the sample.

PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H "pH Value"

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PO4-DO-COL-VA	Water	Diss. Orthophosphate in Water by Colour	APHA 4500-P Phosphorus

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Dissolved Orthophosphate is determined colourimetrically on a sample that has been lab or field filtered through a 0.45 micron membrane filter.

TDS-VA	Water	Total Dissolved Solids by Gravimetric	APHA 2540 C - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

TSS-LOW-VA	Water	Total Suspended Solids by Grav. (1 mg/L)	APHA 2540 Gravimetric

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total suspended solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.

TURBIDITY-VA	Water	Turbidity by Meter	APHA 2130 "Turbidity"

This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.

TURBIDITY-VA	Water	Turbidity by Meter	APHA 2130 Turbidity

This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Reference Information

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

OL-1312

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Client: ECOFISH RESEARCH LTD
Suite F, 450 - 8th Street
Courtenay BC V9N 1N5
Contact: Kevin Ganshorn

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-COL-VA	**Water**							
Batch R2872382								
WG1898019-2 CRM		**VA-ALKL-CONTROL**						
Alkalinity, Total (as CaCO3)			103.2		%		85-115	24-JUN-14
WG1898019-5 CRM		**VA-ALKM-CONTROL**						
Alkalinity, Total (as CaCO3)			105.0		%		85-115	24-JUN-14
WG1898019-8 CRM		**VA-ALKH-CONTROL**						
Alkalinity, Total (as CaCO3)			107.9		%		85-115	24-JUN-14
WG1898019-1 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	24-JUN-14
WG1898019-10 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	24-JUN-14
WG1898019-12 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	24-JUN-14
WG1898019-14 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	24-JUN-14
WG1898019-16 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	24-JUN-14
WG1898019-18 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	24-JUN-14
WG1898019-20 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	24-JUN-14
WG1898019-22 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	24-JUN-14
WG1898019-24 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	24-JUN-14
WG1898019-26 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	24-JUN-14
WG1898019-28 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	24-JUN-14
WG1898019-4 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	24-JUN-14
WG1898019-7 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	24-JUN-14
ANIONS-NO2-IC-VA	**Water**							
Batch R2871846								
WG1896548-2 LCS								
Nitrite (as N)			100.9		%		90-110	21-JUN-14
WG1896548-21 LCS								
Nitrite (as N)			99.3		%		90-110	21-JUN-14
WG1896548-1 MB								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ANIONS-NO2-IC-VA	**Water**							
Batch R2871846								
WG1896548-1 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	21-JUN-14
WG1896548-10 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	21-JUN-14
WG1896548-13 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	21-JUN-14
WG1896548-16 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	21-JUN-14
WG1896548-19 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	21-JUN-14
WG1896548-4 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	21-JUN-14
WG1896548-7 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	21-JUN-14
WG1896548-11 MS		**L1473854-7**						
Nitrite (as N)			99.2		%		75-125	21-JUN-14
WG1896548-14 MS		**L1473965-17**						
Nitrite (as N)			99.5		%		75-125	21-JUN-14
WG1896548-17 MS		**L1474093-4**						
Nitrite (as N)			99.5		%		75-125	21-JUN-14
WG1896548-20 MS		**L1474653-2**						
Nitrite (as N)			97.7		%		75-125	21-JUN-14
ANIONS-NO3-IC-VA	**Water**							
Batch R2871846								
WG1896548-2 LCS								
Nitrate (as N)			103.0		%		90-110	21-JUN-14
WG1896548-21 LCS								
Nitrate (as N)			102.3		%		90-110	21-JUN-14
WG1896548-1 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	21-JUN-14
WG1896548-10 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	21-JUN-14
WG1896548-13 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	21-JUN-14
WG1896548-16 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	21-JUN-14
WG1896548-19 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	21-JUN-14
WG1896548-4 MB								

ALS Environmental

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ANIONS-NO3-IC-VA	**Water**							
Batch R2871846								
WG1896548-4 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	21-JUN-14
WG1896548-7 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	21-JUN-14
WG1896548-11 MS		**L1473854-7**						
Nitrate (as N)			101.9		%		75-125	21-JUN-14
WG1896548-14 MS		**L1473965-17**						
Nitrate (as N)			102.1		%		75-125	21-JUN-14
WG1896548-17 MS		**L1474093-4**						
Nitrate (as N)			102.1		%		75-125	21-JUN-14
WG1896548-20 MS		**L1474653-2**						
Nitrate (as N)			95.4		%		75-125	21-JUN-14
EC-PCT-VA	**Water**							
Batch R2870916								
WG1897069-17 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			98.6		%		90-110	23-JUN-14
WG1897069-18 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			97.5		%		90-110	23-JUN-14
WG1897069-19 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			98.6		%		90-110	23-JUN-14
WG1897069-20 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			99.2		%		90-110	23-JUN-14
WG1897069-21 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			98.8		%		90-110	23-JUN-14
WG1897069-22 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			98.4		%		90-110	23-JUN-14
WG1897069-23 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			99.5		%		90-110	23-JUN-14
WG1897069-24 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			100.3		%		90-110	23-JUN-14
WG1897069-1 MB								
Conductivity			<2.0		uS/cm		2	23-JUN-14
WG1897069-2 MB								
Conductivity			<2.0		uS/cm		2	23-JUN-14
WG1897069-3 MB								
Conductivity			<2.0		uS/cm		2	23-JUN-14
WG1897069-4 MB								
Conductivity			<2.0		uS/cm		2	23-JUN-14
WG1897069-5 MB								

Quality Control Report

Test		Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
EC-PCT-VA		**Water**							
Batch	**R2870916**								
WG1897069-5	**MB**								
Conductivity				<2.0		uS/cm		2	23-JUN-14
WG1897069-6	**MB**								
Conductivity				<2.0		uS/cm		2	23-JUN-14
WG1897069-7	**MB**								
Conductivity				<2.0		uS/cm		2	23-JUN-14
WG1897069-8	**MB**								
Conductivity				<2.0		uS/cm		2	23-JUN-14
NH3-F-VA		**Water**							
Batch	**R2872948**								
WG1899080-10	**CRM**		**VA-NH3-F**						
Ammonia, Total (as N)				101.6		%		85-115	25-JUN-14
WG1899080-2	**CRM**		**VA-NH3-F**						
Ammonia, Total (as N)				93.2		%		85-115	25-JUN-14
WG1899080-4	**CRM**		**VA-NH3-F**						
Ammonia, Total (as N)				97.2		%		85-115	25-JUN-14
WG1899080-6	**CRM**		**VA-NH3-F**						
Ammonia, Total (as N)				93.1		%		85-115	25-JUN-14
WG1899080-8	**CRM**		**VA-NH3-F**						
Ammonia, Total (as N)				90.3		%		85-115	25-JUN-14
WG1899080-15	**DUP**		**L1474093-1**						
Ammonia, Total (as N)			<0.0050	<0.0050	RPD-NA	mg/L	N/A	20	25-JUN-14
WG1899080-1	**MB**								
Ammonia, Total (as N)				<0.0050		mg/L		0.005	25-JUN-14
WG1899080-3	**MB**								
Ammonia, Total (as N)				<0.0050		mg/L		0.005	25-JUN-14
WG1899080-5	**MB**								
Ammonia, Total (as N)				<0.0050		mg/L		0.005	25-JUN-14
WG1899080-7	**MB**								
Ammonia, Total (as N)				<0.0050		mg/L		0.005	25-JUN-14
WG1899080-9	**MB**								
Ammonia, Total (as N)				<0.0050		mg/L		0.005	25-JUN-14
WG1899080-12	**MS**		**L1473174-13**						
Ammonia, Total (as N)				108.3		%		75-125	25-JUN-14
WG1899080-14	**MS**		**L1473183-7**						
Ammonia, Total (as N)				89.7		%		75-125	25-JUN-14
WG1899080-16	**MS**		**L1474093-1**						
Ammonia, Total (as N)				99.0		%		75-125	25-JUN-14

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
P-T-PRES-COL-VA	**Water**							
Batch R2871932								
WG1897757-10 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			100.1		%		80-120	24-JUN-14
WG1897757-14 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			98.7		%		80-120	24-JUN-14
WG1897757-18 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			97.3		%		80-120	24-JUN-14
WG1897757-2 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			105.4		%		80-120	24-JUN-14
WG1897757-6 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			104.8		%		80-120	24-JUN-14
WG1897757-1 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	24-JUN-14
WG1897757-13 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	24-JUN-14
WG1897757-17 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	24-JUN-14
WG1897757-5 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	24-JUN-14
WG1897757-9 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	24-JUN-14
WG1897757-12 MS		**L1473174-12**						
Phosphorus (P)-Total			99.6		%		70-130	24-JUN-14
WG1897757-20 MS		**L1473265-5**						
Phosphorus (P)-Total			87.8		%		70-130	24-JUN-14
WG1897757-8 MS		**L1473924-14**						
Phosphorus (P)-Total			N/A	MS-B	%		-	24-JUN-14
PH-PCT-VA	**Water**							
Batch R2870916								
WG1897069-25 CRM		**VA-PH7-BUF**						
pH			6.98		pH		6.9-7.1	23-JUN-14
WG1897069-26 CRM		**VA-PH7-BUF**						
pH			6.97		pH		6.9-7.1	23-JUN-14
WG1897069-27 CRM		**VA-PH7-BUF**						
pH			6.98		pH		6.9-7.1	23-JUN-14
WG1897069-28 CRM		**VA-PH7-BUF**						
pH			6.98		pH		6.9-7.1	23-JUN-14
WG1897069-29 CRM		**VA-PH7-BUF**						
pH			6.98		pH		6.9-7.1	23-JUN-14
WG1897069-30 CRM		**VA-PH7-BUF**						

Environmental

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PH-PCT-VA	**Water**							
Batch R2870916								
WG1897069-30 CRM		**VA-PH7-BUF**						
pH			6.97		pH		6.9-7.1	23-JUN-14
WG1897069-31 CRM		**VA-PH7-BUF**						
pH			6.98		pH		6.9-7.1	23-JUN-14
WG1897069-32 CRM		**VA-PH7-BUF**						
pH			6.97		pH		6.9-7.1	23-JUN-14
PO4-DO-COL-VA	**Water**							
Batch R2869858								
WG1896369-12 CRM		**VA-OPO4-CONTROL**						
Orthophosphate-Dissolved (as P)			102.2		%		80-120	20-JUN-14
WG1896369-18 CRM		**VA-OPO4-CONTROL**						
Orthophosphate-Dissolved (as P)			103.9		%		80-120	20-JUN-14
WG1896369-2 CRM		**VA-OPO4-CONTROL**						
Orthophosphate-Dissolved (as P)			105.2		%		80-120	20-JUN-14
WG1896369-22 CRM		**VA-OPO4-CONTROL**						
Orthophosphate-Dissolved (as P)			90.8		%		80-120	20-JUN-14
WG1896369-8 CRM		**VA-OPO4-CONTROL**						
Orthophosphate-Dissolved (as P)			102.7		%		80-120	20-JUN-14
WG1896369-1 MB								
Orthophosphate-Dissolved (as P)			<0.0010		mg/L		0.001	20-JUN-14
WG1896369-11 MB								
Orthophosphate-Dissolved (as P)			<0.0010		mg/L		0.001	20-JUN-14
WG1896369-17 MB								
Orthophosphate-Dissolved (as P)			<0.0010		mg/L		0.001	20-JUN-14
WG1896369-21 MB								
Orthophosphate-Dissolved (as P)			<0.0010		mg/L		0.001	20-JUN-14
WG1896369-7 MB								
Orthophosphate-Dissolved (as P)			<0.0010		mg/L		0.001	20-JUN-14
WG1896369-10 MS		**L1473441-2**						
Orthophosphate-Dissolved (as P)			94.0		%		70-130	20-JUN-14
WG1896369-14 MS		**L1473827-9**						
Orthophosphate-Dissolved (as P)			92.6		%		70-130	20-JUN-14
WG1896369-16 MS		**L1473965-16**						
Orthophosphate-Dissolved (as P)			97.3		%		70-130	20-JUN-14
WG1896369-20 MS		**L1474322-5**						
Orthophosphate-Dissolved (as P)			95.9		%		70-130	20-JUN-14
WG1896369-4 MS		**L1473174-10**						
Orthophosphate-Dissolved (as P)			97.2		%		70-130	20-JUN-14
WG1896369-6 MS		**L1474083-4**						

ALS Environmental

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PO4-DO-COL-VA	**Water**							
Batch R2869858								
WG1896369-6 MS		**L1474083-4**						
Orthophosphate-Dissolved (as P)			96.4		%		70-130	20-JUN-14
TDS-VA	**Water**							
Batch R2872658								
WG1897963-11 LCS								
Total Dissolved Solids			101.3		%		85-115	24-JUN-14
WG1897963-2 LCS								
Total Dissolved Solids			101.9		%		85-115	24-JUN-14
WG1897963-5 LCS								
Total Dissolved Solids			101.9		%		85-115	24-JUN-14
WG1897963-8 LCS								
Total Dissolved Solids			100.9		%		85-115	24-JUN-14
WG1897963-1 MB								
Total Dissolved Solids			<10		mg/L		10	24-JUN-14
WG1897963-10 MB								
Total Dissolved Solids			<10		mg/L		10	24-JUN-14
WG1897963-4 MB								
Total Dissolved Solids			<10		mg/L		10	24-JUN-14
WG1897963-7 MB								
Total Dissolved Solids			<10		mg/L		10	24-JUN-14
TSS-LOW-VA	**Water**							
Batch R2871785								
WG1897880-2 LCS								
Total Suspended Solids			103.5		%		85-115	23-JUN-14
WG1897880-4 LCS								
Total Suspended Solids			103.3		%		85-115	23-JUN-14
WG1897880-1 MB								
Total Suspended Solids			<1.0		mg/L		1	23-JUN-14
WG1897880-3 MB								
Total Suspended Solids			<1.0		mg/L		1	23-JUN-14
TURBIDITY-VA	**Water**							
Batch R2869846								
WG1896434-11 CRM		**VA-FORM-40**						
Turbidity			99.5		%		85-115	20-JUN-14
WG1896434-2 CRM		**VA-FORM-40**						
Turbidity			98.5		%		85-115	20-JUN-14
WG1896434-5 CRM		**VA-FORM-40**						

Quality Control Report

Test		Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TURBIDITY-VA		**Water**							
Batch	**R2869846**								
WG1896434-5	**CRM**		**VA-FORM-40**						
Turbidity				100.0		%		85-115	20-JUN-14
WG1896434-8	**CRM**		**VA-FORM-40**						
Turbidity				98.8		%		85-115	20-JUN-14
WG1896434-1	**MB**								
Turbidity				<0.10		NTU		0.1	20-JUN-14
WG1896434-10	**MB**								
Turbidity				<0.10		NTU		0.1	20-JUN-14
WG1896434-4	**MB**								
Turbidity				<0.10		NTU		0.1	20-JUN-14
WG1896434-7	**MB**								
Turbidity				<0.10		NTU		0.1	20-JUN-14

Quality Control Report

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
DLM	Detection Limit Adjusted due to sample matrix effects.
J	Duplicate results and limits are expressed in terms of absolute difference.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH by Meter (Automated)							
	1	18-JUN-14 08:58	23-JUN-14 23:00	0.25	134	hours	EHTR-FM
	2	18-JUN-14 08:58	23-JUN-14 23:00	0.25	134	hours	EHTR-FM
	3	18-JUN-14 08:58	23-JUN-14 23:00	0.25	134	hours	EHTR-FM
	4	18-JUN-14 08:58	23-JUN-14 23:00	0.25	134	hours	EHTR-FM

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L1474093 were received on 19-JUN-14 18:55.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

L1474093-COFC

Chain of Custody / Analytical Request Form

Canada Toll Free : 1 800 668 9878

www.alsglobal.com

Report To

Company: ECOFISH RESEARCH LTD

Contact: Kevin Ganshorn

Address: Suite 906 - 595 Howe Street
Vancouver, BC
Canada, V6C2T5

Phone: 604-608-6180 | Fax: 604 559-6180

Invoice To ☑Email ☐Mail

Company: ECOFISH RESEARCH LTD

Contact: Accounts Payable

Address: Suite F, 450 - 8th Street
Courtenay, BC
Canada, V9N 1N5

Email: accountspayable@ecofishresearch.com

Phone: 250-334-3042

Lab Work Order # (lab use only)

Reporting

Distribution: ☐Fax ☐Mail ☑Email

☑Citeria on Report (select from Guidelines below)

Report Type: ☑Excel ☐Digital

Report Format: CROSSTAB_ALSQC

Report Email(s): kganshorn@ecofishresearch.com
tkasubuchi@ecofishresearch.com
pdinn@ecofishresearch.com

EDD Format:

EDD Email(s):

Project Info

Job #: 1230 JHT-MON8

PO/AFE:

LSD:

Quote #:

ALS Contact: Ariel Tang | Sampler: Leah Hull

Service Requested

◉ Regular (Standard Turnaround Times - Business Days) - R
○ Priority (3 Days) - surcharge will apply - P
○ Priority (2 Days) - surcharge will apply - P2
○ Emergency (1-2 day) – surcharge will apply - E
○ Same Day or Weekend Emergency - surcharge will apply - E2
○ Specify date required - X

Analysis Requests — Please indicate below Filtered, Preserved or both(F, P, F/P)

Sample #	Sample Identification (This will appear on the report)	Longitude	Latitude	Date	Time	Sample Type	Number of Containers	Alkalinity by Colourimetric (Automated)	Ammonia in Water by Fluorescence	Conductivity (Automated)	Diss. Orthophosphate in Water by Colour	Nitrate in Water by Ion Chromatography	Nitrite in Water by Ion Chromatography	Total Dissolved Solids by Gravimetric	Total P in Water by Colour	Total Suspended Solids by Grav. (1 mg/L)	Turbidity by Meter	pH by Meter (Automated)
1	QUN-WQ1A			18-June-2014	8:58	Water	3	R	R	R	R	R	R	R	R	R	R	R
1	QUN-WQ1B			18-June-2014	8:58	Water	3	R	R	R	R	R	R	R	R	R	R	R
1	QUN-TRIP BLANK			18-June-2014	8:58	Water	3	R	R	R	R	R	R	R	R	R	R	R
1	QUN-FIELD BLANK			18-June-2014	8:58	Water	3	R	R	R	R	R	R	R	R	R	R	R

Short Holding Time

Rush Processing

The questions below must be answered for water samples (check Yes or No)

Are any sample taken from a regulated DW system? ☐Yes ☐No

If yes, please use an authorized drinking water COC

Is the water sampled intended to be potable for human consumption? ☐Yes ☐No

Guidelines

British Columbia Approved and Working Water Quality Guidelines (JULY, 2013) - BCAWWQG - Freshwater Aquatic Life

SAMPLE CONDITION (lab use only)

☐Frozen ☐Cold ☐Ambient ☐Cooling Initiated

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by: Leah Hull	Date: 18-June 2014	Time: 12:00	Received by: [illegible signature]	Date: June 18	Time: 1855	Temperature: 7 °C	Verified by:	Date:	Time:	Observations: ☐Yes If Yes add SIF

ECOFISH RESEARCH LTD
ATTN: Kevin Ganshorn
Suite F, 450 - 8th Street
Courtenay BC V9N 1N5

Date Received: 22-JUL-14
Report Date: 05-AUG-14 15:57 (MT)
Version: FINAL REV. 2

Client Phone: 250-334-3042

Certificate of Analysis

Lab Work Order #: L1490944

Project P.O. #:	NOT SUBMITTED
Job Reference:	1230 JHT-MON8
C of C Numbers:	OL-1313
Legal Site Desc:	

Comments:

5-AUG-2014 Sampling date and time has been added to all samples in this submission as per client request.

Ariel Tang
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1490944-1	L1490944-2	L1490944-3	L1490944-4
	Description	Water	Water	Water	Water
	Sampled Date	22-JUL-14	22-JUL-14	22-JUL-14	22-JUL-14
	Sampled Time	09:25	09:25	09:25	09:25
	Client ID	QUN-WQ1A	QUN-WQ1B	QUN-TRIP BLANK	QUN-FILED BLANK
Grouping	**Analyte**				
WATER					
Physical Tests	Conductivity (uS/cm)	139	141	<2.0	<2.0
	pH (pH)	7.65	7.81	5.76	5.69
	Total Suspended Solids (mg/L)	<1.0	<1.0	<1.0	<1.0
	Total Dissolved Solids (mg/L)	105	101	<10	<10
	Turbidity (NTU)	0.47	0.44	<0.10	<0.10
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	42.4	42.4	<2.0	<2.0
	Ammonia, Total (as N) (mg/L)	<0.0050	<0.0050	0.0271 RRV	<0.0050
	Nitrate (as N) (mg/L)	0.0313	0.0319	<0.0050	<0.0050
	Nitrite (as N) (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010
	Orthophosphate-Dissolved (as P) (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010
	Phosphorus (P)-Total (mg/L)	0.0026	0.0032	<0.0020	<0.0020

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Orthophosphate-Dissolved (as P)	MS-B	L1490944-1, -2, -3, -4
Matrix Spike	Orthophosphate-Dissolved (as P)	MS-B	L1490944-1, -2, -3, -4
Matrix Spike	Phosphorus (P)-Total	MS-B	L1490944-1, -2, -3, -4

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
RRV	Reported Result Verified By Repeat Analysis

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-COL-VA	Water	Alkalinity by Colourimetric (Automated)	EPA 310.2

This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.

ANIONS-NO2-IC-VA	Water	Nitrite in Water by Ion Chromatography	EPA 300.0

This analysis is carried out using procedures adapted from EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography". Nitrite is detected by UV absorbance.

ANIONS-NO3-IC-VA	Water	Nitrate in Water by Ion Chromatography	EPA 300.0

This analysis is carried out using procedures adapted from EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography". Nitrate is detected by UV absorbance.

EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

NH3-F-VA	Water	Ammonia in Water by Fluorescence	J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

P-T-PRES-COL-VA	Water	Total P in Water by Colour	APHA 4500-P Phosphorus

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Phosphorus is determined colourimetrically after persulphate digestion of the sample.

PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H "pH Value"

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PO4-DO-COL-VA	Water	Diss. Orthophosphate in Water by Colour	APHA 4500-P Phosphorus

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Dissolved Orthophosphate is determined colourimetrically on a sample that has been lab or field filtered through a 0.45 micron membrane filter.

TDS-VA	Water	Total Dissolved Solids by Gravimetric	APHA 2540 C - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

TSS-LOW-VA	Water	Total Suspended Solids by Grav. (1 mg/L)	APHA 2540 Gravimetric

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total suspended solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.

TURBIDITY-VA	Water	Turbidity by Meter	APHA 2130 "Turbidity"

This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.

TURBIDITY-VA	Water	Turbidity by Meter	APHA 2130 Turbidity

This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

Reference Information

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

OL-1313

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Client: ECOFISH RESEARCH LTD
Suite F, 450 - 8th Street
Courtenay BC V9N 1N5

Contact: Kevin Ganshorn

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-COL-VA	**Water**							
Batch R2897151								
WG1917795-2 CRM		**VA-ALKL-CONTROL**						
Alkalinity, Total (as CaCO3)			104.0		%		85-115	24-JUL-14
WG1917795-5 CRM		**VA-ALKM-CONTROL**						
Alkalinity, Total (as CaCO3)			103.0		%		85-115	24-JUL-14
WG1917795-8 CRM		**VA-ALKH-CONTROL**						
Alkalinity, Total (as CaCO3)			106.7		%		85-115	24-JUL-14
WG1917795-1 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	24-JUL-14
WG1917795-11 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	24-JUL-14
WG1917795-13 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	24-JUL-14
WG1917795-4 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	24-JUL-14
WG1917795-7 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	24-JUL-14
ANIONS-NO2-IC-VA	**Water**							
Batch R2896413								
WG1916479-15 LCS								
Nitrite (as N)			103.6		%		90-110	23-JUL-14
WG1916479-2 LCS								
Nitrite (as N)			102.7		%		90-110	23-JUL-14
WG1916479-1 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	23-JUL-14
WG1916479-10 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	23-JUL-14
WG1916479-13 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	23-JUL-14
WG1916479-4 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	23-JUL-14
WG1916479-7 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	23-JUL-14
WG1916479-14 MS		**L1490151-3**						
Nitrite (as N)			103.4		%		75-125	23-JUL-14
WG1916479-5 MS		**L1489843-1**						
Nitrite (as N)			102.1		%		75-125	23-JUL-14
ANIONS-NO3-IC-VA	**Water**							

Quality Control Report

Test		Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ANIONS-NO3-IC-VA		**Water**							
Batch	**R2896413**								
WG1916479-15	**LCS**								
Nitrate (as N)				102.8		%		90-110	23-JUL-14
WG1916479-2	**LCS**								
Nitrate (as N)				102.1		%		90-110	23-JUL-14
WG1916479-1	**MB**								
Nitrate (as N)				<0.0050		mg/L		0.005	23-JUL-14
WG1916479-10	**MB**								
Nitrate (as N)				<0.0050		mg/L		0.005	23-JUL-14
WG1916479-13	**MB**								
Nitrate (as N)				<0.0050		mg/L		0.005	23-JUL-14
WG1916479-4	**MB**								
Nitrate (as N)				<0.0050		mg/L		0.005	23-JUL-14
WG1916479-7	**MB**								
Nitrate (as N)				<0.0050		mg/L		0.005	23-JUL-14
WG1916479-14	**MS**		**L1490151-3**						
Nitrate (as N)				102.1		%		75-125	23-JUL-14
WG1916479-5	**MS**		**L1489843-1**						
Nitrate (as N)				101.5		%		75-125	23-JUL-14
WG1916479-8	**MS**		**L1490663-16**						
Nitrate (as N)				103.8		%		75-125	23-JUL-14
EC-PCT-VA		**Water**							
Batch	**R2896538**								
WG1916878-17	**CRM**		**VA-EC-PCT-CONTROL**						
Conductivity				98.2		%		90-110	24-JUL-14
WG1916878-18	**CRM**		**VA-EC-PCT-CONTROL**						
Conductivity				96.7		%		90-110	24-JUL-14
WG1916878-19	**CRM**		**VA-EC-PCT-CONTROL**						
Conductivity				96.9		%		90-110	24-JUL-14
WG1916878-20	**CRM**		**VA-EC-PCT-CONTROL**						
Conductivity				97.9		%		90-110	24-JUL-14
WG1916878-21	**CRM**		**VA-EC-PCT-CONTROL**						
Conductivity				97.3		%		90-110	24-JUL-14
WG1916878-22	**CRM**		**VA-EC-PCT-CONTROL**						
Conductivity				97.7		%		90-110	24-JUL-14
WG1916878-23	**CRM**		**VA-EC-PCT-CONTROL**						
Conductivity				98.2		%		90-110	24-JUL-14
WG1916878-24	**CRM**		**VA-EC-PCT-CONTROL**						
Conductivity				97.9		%		90-110	24-JUL-14
WG1916878-1	**MB**								

Quality Control Report

Test		Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
EC-PCT-VA		**Water**							
Batch	**R2896538**								
WG1916878-1	**MB**								
Conductivity				<2.0		uS/cm		2	24-JUL-14
WG1916878-2	**MB**								
Conductivity				<2.0		uS/cm		2	24-JUL-14
WG1916878-3	**MB**								
Conductivity				<2.0		uS/cm		2	24-JUL-14
WG1916878-4	**MB**								
Conductivity				<2.0		uS/cm		2	24-JUL-14
WG1916878-5	**MB**								
Conductivity				<2.0		uS/cm		2	24-JUL-14
WG1916878-6	**MB**								
Conductivity				<2.0		uS/cm		2	24-JUL-14
WG1916878-7	**MB**								
Conductivity				<2.0		uS/cm		2	24-JUL-14
WG1916878-8	**MB**								
Conductivity				<2.0		uS/cm		2	24-JUL-14
NH3-F-VA		**Water**							
Batch	**R2896858**								
WG1917189-10	**CRM**		**VA-NH3-F**						
Ammonia, Total (as N)				105.9		%		85-115	24-JUL-14
WG1917189-2	**CRM**		**VA-NH3-F**						
Ammonia, Total (as N)				110.3		%		85-115	24-JUL-14
WG1917189-4	**CRM**		**VA-NH3-F**						
Ammonia, Total (as N)				103.0		%		85-115	24-JUL-14
WG1917189-6	**CRM**		**VA-NH3-F**						
Ammonia, Total (as N)				108.9		%		85-115	24-JUL-14
WG1917189-8	**CRM**		**VA-NH3-F**						
Ammonia, Total (as N)				96.9		%		85-115	24-JUL-14
WG1917189-11	**DUP**		**L1490944-1**						
Ammonia, Total (as N)			<0.0050	<0.0050	RPD-NA	mg/L	N/A	20	24-JUL-14
WG1917189-1	**MB**								
Ammonia, Total (as N)				<0.0050		mg/L		0.005	24-JUL-14
WG1917189-3	**MB**								
Ammonia, Total (as N)				<0.0050		mg/L		0.005	24-JUL-14
WG1917189-5	**MB**								
Ammonia, Total (as N)				<0.0050		mg/L		0.005	24-JUL-14
WG1917189-7	**MB**								
Ammonia, Total (as N)				<0.0050		mg/L		0.005	24-JUL-14
WG1917189-9	**MB**								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NH3-F-VA	**Water**							
Batch R2896858								
WG1917189-9 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	24-JUL-14
WG1917189-12 MS		**L1490944-1**						
Ammonia, Total (as N)			90.1		%		75-125	24-JUL-14
WG1917189-14 MS		**L1491468-1**						
Ammonia, Total (as N)			90.6		%		75-125	24-JUL-14
Batch R2898830								
WG1918693-2 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			102.1		%		85-115	25-JUL-14
WG1918693-4 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			111.3		%		85-115	25-JUL-14
WG1918693-1 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	25-JUL-14
WG1918693-3 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	25-JUL-14
WG1918693-6 MS		**L1489671-2**						
Ammonia, Total (as N)			109.8		%		75-125	25-JUL-14
P-T-PRES-COL-VA	**Water**							
Batch R2896476								
WG1916705-10 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			94.2		%		80-120	24-JUL-14
WG1916705-2 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			95.8		%		80-120	24-JUL-14
WG1916705-6 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			98.7		%		80-120	24-JUL-14
WG1916705-1 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	24-JUL-14
WG1916705-5 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	24-JUL-14
WG1916705-9 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	24-JUL-14
WG1916705-12 MS		**L1491009-8**						
Phosphorus (P)-Total			N/A	MS-B	%		-	24-JUL-14
WG1916705-4 MS		**L1490888-2**						
Phosphorus (P)-Total			100.8		%		70-130	24-JUL-14
WG1916705-8 MS		**L1491115-2**						
Phosphorus (P)-Total			99.6		%		70-130	24-JUL-14
PH-PCT-VA	**Water**							

ALS Environmental

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PH-PCT-VA	**Water**							
Batch R2896538								
WG1916878-25 CRM		**VA-PH7-BUF**						
pH			7.00		pH		6.9-7.1	24-JUL-14
WG1916878-26 CRM		**VA-PH7-BUF**						
pH			7.00		pH		6.9-7.1	24-JUL-14
WG1916878-27 CRM		**VA-PH7-BUF**						
pH			7.00		pH		6.9-7.1	24-JUL-14
WG1916878-28 CRM		**VA-PH7-BUF**						
pH			7.00		pH		6.9-7.1	24-JUL-14
WG1916878-29 CRM		**VA-PH7-BUF**						
pH			7.00		pH		6.9-7.1	24-JUL-14
WG1916878-30 CRM		**VA-PH7-BUF**						
pH			6.97		pH		6.9-7.1	24-JUL-14
WG1916878-31 CRM		**VA-PH7-BUF**						
pH			6.99		pH		6.9-7.1	24-JUL-14
WG1916878-32 CRM		**VA-PH7-BUF**						
pH			6.99		pH		6.9-7.1	24-JUL-14
PO4-DO-COL-VA	**Water**							
Batch R2895781								
WG1916707-11 CRM		**VA-OPO4-CONTROL**						
Orthophosphate-Dissolved (as P)			93.7		%		80-120	23-JUL-14
WG1916707-15 CRM		**VA-OPO4-CONTROL**						
Orthophosphate-Dissolved (as P)			95.9		%		80-120	23-JUL-14
WG1916707-2 CRM		**VA-OPO4-CONTROL**						
Orthophosphate-Dissolved (as P)			91.6		%		80-120	23-JUL-14
WG1916707-6 CRM		**VA-OPO4-CONTROL**						
Orthophosphate-Dissolved (as P)			95.3		%		80-120	23-JUL-14
WG1916707-1 MB								
Orthophosphate-Dissolved (as P)			<0.0010		mg/L		0.001	23-JUL-14
WG1916707-10 MB								
Orthophosphate-Dissolved (as P)			<0.0010		mg/L		0.001	23-JUL-14
WG1916707-14 MB								
Orthophosphate-Dissolved (as P)			<0.0010		mg/L		0.001	23-JUL-14
WG1916707-5 MB								
Orthophosphate-Dissolved (as P)			<0.0010		mg/L		0.001	23-JUL-14
WG1916707-12 MS		**L1491208-1**						
Orthophosphate-Dissolved (as P)			N/A	MS-B	%		-	23-JUL-14
WG1916707-4 MS		**L1490878-2**						
Orthophosphate-Dissolved (as P)			N/A	MS-B	%		-	23-JUL-14
WG1916707-8 MS		**L1489671-4**						

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PO4-DO-COL-VA	**Water**							
Batch R2895781								
WG1916707-8 MS		**L1489671-4**						
Orthophosphate-Dissolved (as P)			98.1		%		70-130	23-JUL-14
TDS-VA	**Water**							
Batch R2896719								
WG1917001-2 LCS								
Total Dissolved Solids			101.7		%		85-115	23-JUL-14
WG1917001-5 LCS								
Total Dissolved Solids			100.2		%		85-115	23-JUL-14
WG1917001-1 MB								
Total Dissolved Solids			<10		mg/L		10	23-JUL-14
WG1917001-4 MB								
Total Dissolved Solids			<10		mg/L		10	23-JUL-14
TSS-LOW-VA	**Water**							
Batch R2897699								
WG1918081-2 LCS								
Total Suspended Solids			90.5		%		85-115	24-JUL-14
WG1918081-4 LCS								
Total Suspended Solids			92.0		%		85-115	24-JUL-14
WG1918081-1 MB								
Total Suspended Solids			<1.0		mg/L		1	24-JUL-14
WG1918081-3 MB								
Total Suspended Solids			<1.0		mg/L		1	24-JUL-14
TURBIDITY-VA	**Water**							
Batch R2896862								
WG1917870-2 CRM		**VA-FORM-40**						
Turbidity			102.3		%		85-115	24-JUL-14
WG1917870-5 CRM		**VA-FORM-40**						
Turbidity			101.0		%		85-115	24-JUL-14
WG1917870-8 CRM		**VA-FORM-40**						
Turbidity			100.8		%		85-115	24-JUL-14
WG1917870-3 DUP		**L1490944-1**						
Turbidity		0.47	0.46		NTU	1.3	15	24-JUL-14
WG1917870-1 MB								
Turbidity			<0.10		NTU		0.1	24-JUL-14
WG1917870-4 MB								
Turbidity			<0.10		NTU		0.1	24-JUL-14
WG1917870-7 MB								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TURBIDITY-VA	**Water**							
Batch R2896862								
WG1917870-7 MB								
Turbidity			<0.10		NTU		0.1	24-JUL-14

Quality Control Report

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
J	Duplicate results and limits are expressed in terms of absolute difference.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH by Meter (Automated)							
	1	22-JUL-14 09:25	24-JUL-14 10:57	0.25	49	hours	EHTR-FM
	2	22-JUL-14 09:25	24-JUL-14 10:57	0.25	49	hours	EHTR-FM
	3	22-JUL-14 09:25	24-JUL-14 10:57	0.25	49	hours	EHTR-FM
	4	22-JUL-14 09:25	24-JUL-14 10:57	0.25	49	hours	EHTR-FM

Legend & Qualifier Definitions:

EHTR-FM: Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR: Exceeded ALS recommended hold time prior to sample receipt.
EHTL: Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT: Exceeded ALS recommended hold time prior to analysis.
Rec. HT: ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L1490944 were received on 22-JUL-14 19:10.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

Short Holding Time

Rush Processing

Chain of Custody / Analytical Request Form
Canada Toll Free : 1 800 668 9878
www.alsglobal.com

COC #: OL-1313

Report To

Company:	ECOFISH RESEARCH LTD
Contact:	Kevin Ganshorn
Address:	906 - 595 Howe Street Vancouver, BC Canada, V6C2T5
Phone:	604-608-6180
Fax:	604 559-6180

Invoice To ☑Email ☐Mail

Company:	ECOFISH RESEARCH LTD
Contact:	Accounts Payable
Address:	Suite F, 450 - 8th Street Courtenay, BC Canada, V9N 1N5
Email:	accountspayable@ecofishresearch.com
Phone:	250-334-3042

Lab Work Order # (lab use only)

Reporting

Distribution:	☐Fax ☐Mail ☑Email
☑Criteria on Report (select from Guidelines below)	
Report Type:	☑Excel ☐Digital
Report Format:	CROSSTAB_ALSQC
Report Email(s):	kganshorn@ecofishresearch.com tkasubuchi@ecofishresearch.com pdinn@ecofishresearch.com
EDD Format:	
EDD Email(s):	

Project Info

Job #:	1230 JHT-MON8
PO/AFE:	
LSD:	
Quote #:	
ALS Contact:	Ariel Tang
Sampler:	

Service Requested

- ◉ Regular (Standard Turnaround Times - Business Days) - R
- ○ Priority (3 Days) - surcharge will apply - P
- ○ Priority (2 Days) - surcharge will apply - P2
- ○ Emergency (1-2 day) – surcharge will apply - E
- ○ Same Day or Weekend Emergency - surcharge will apply - E2
- ○ Specify date required - X

Analysis Requests

Please indicate below Filtered, Preserved or both(F, P, F/P)

Sample #	Sample Identification (This will appear on the report)	Longitude	Latitude	Date	Time	Sample Type	Number of Containers	Alkalinity by Colourimetric (Automated)	Ammonia in Water by Fluorescence	Conductivity (Automated)	Diss. Orthophosphate in Water by Colour	Nitrate in Water by Ion Chromatography	Nitrite in Water by Ion Chromatography	Total Dissolved Solids by Gravimetric	Total P in Water by Colour	Total Suspended Solids by Grav. (1 mg/L)	Turbidity by Meter	pH by Meter (Automated)		
	QUN-WQ1A					Water	3	R	R	R	R	R	R	R	R	R	R	R		
	QUN-WQ1B					Water	3	R	R	R	R	R	R	R	R	R	R	R		
	QUN-TRIP BLANK					Water	3	R	R	R	R	R	R	R	R	R	R	R		
	QUN-FIELD BLANK					Water	3	R	R	R	R	R	R	R	R	R	R	R		

L1490944-COFC

Special Instructions/Comments

The questions below must be answered for water samples (check Yes or No)

Are any sample taken from a regulated DW system? ☐Yes ☑No

If yes, please use an authorized drinking water COC

Is the water sampled intended to be potable for human consumption? ☐Yes ☑No

Guidelines

British Columbia Approved and Working Water Quality Guidelines (JULY, 2013) - BCAWWQG - Freshwater Aquatic Life

SAMPLE CONDITION (lab use only)

☐Frozen ☐Cold ☐Ambient ☐Cooling Initiated

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by: Kyle Milborn	Date: July 22/14	Time: 13:00	Received by: YC	Date: July 22	Time: 19:10	Temperature: 15.7°C	Verified by:	Date:	Time:	Observations: ☐Yes If Yes add SIF

Kyle M

ECOFISH RESEARCH LTD
ATTN: Kevin Ganshorn
Suite F, 450 - 8th Street
Courtenay BC V9N 1N5

Date Received: 19-AUG-14
Report Date: 28-AUG-14 18:02 (MT)
Version: FINAL

Client Phone: 250-334-3042

Certificate of Analysis

Lab Work Order #: L1505119

Project P.O. #: NOT SUBMITTED
Job Reference: 1230 JHT-MON8
C of C Numbers: OL-1314
Legal Site Desc:

Ariel Tang
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1505119-1	L1505119-2	L1505119-3	L1505119-4
	Description	Water	Water	Water	Water
	Sampled Date	19-AUG-14	19-AUG-14	19-AUG-14	19-AUG-14
	Sampled Time	10:08	10:08	10:08	10:08
	Client ID	QUN-WQ1A	QUN-WQ1B	QUN-TRIP BLANK	QUN-FIELD BLANK
WATER					
Physical Tests	Conductivity (uS/cm)	146	166	<2.0	<2.0
	pH (pH)	7.57	8.05	6.17	5.91
	Total Suspended Solids (mg/L)	<1.0	<1.0	<1.0	<1.0
	Total Dissolved Solids (mg/L)	95	96	<10	<10
	Turbidity (NTU)	0.93	0.47	<0.10	<0.10
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	42.3	41.9	<2.0	<2.0
	Ammonia, Total (as N) (mg/L)	<0.0050	0.0053	0.0387 RRV	<0.0050
	Nitrate (as N) (mg/L)	0.0170	0.0171	<0.0050	<0.0050
	Nitrite (as N) (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010
	Orthophosphate-Dissolved (as P) (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010
	Phosphorus (P)-Total (mg/L)	0.0050	0.0046	<0.0020	<0.0020

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Phosphorus (P)-Total	MS-B	L1505119-1, -2, -3, -4

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
RRV	Reported Result Verified By Repeat Analysis

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-COL-VA	Water	Alkalinity by Colourimetric (Automated)	EPA 310.2

This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.

ANIONS-NO2-IC-VA	Water	Nitrite in Water by Ion Chromatography	EPA 300.0

This analysis is carried out using procedures adapted from EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography". Nitrite is detected by UV absorbance.

ANIONS-NO3-IC-VA	Water	Nitrate in Water by Ion Chromatography	EPA 300.0

This analysis is carried out using procedures adapted from EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography". Nitrate is detected by UV absorbance.

EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

NH3-F-VA	Water	Ammonia in Water by Fluorescence	J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

P-T-PRES-COL-VA	Water	Total P in Water by Colour	APHA 4500-P Phosphorus

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Phosphorus is determined colourimetrically after persulphate digestion of the sample.

PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H "pH Value"

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PO4-DO-COL-VA	Water	Diss. Orthophosphate in Water by Colour	APHA 4500-P Phosphorus

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Dissolved Orthophosphate is determined colourimetrically on a sample that has been lab or field filtered through a 0.45 micron membrane filter.

TDS-VA	Water	Total Dissolved Solids by Gravimetric	APHA 2540 C - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

TSS-LOW-VA	Water	Total Suspended Solids by Grav. (1 mg/L)	APHA 2540 Gravimetric

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total suspended solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.

TURBIDITY-VA	Water	Turbidity by Meter	APHA 2130 "Turbidity"

This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.

TURBIDITY-VA	Water	Turbidity by Meter	APHA 2130 Turbidity

This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code **Laboratory Location**

Reference Information

VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

OL-1314

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Client: ECOFISH RESEARCH LTD
Suite F, 450 - 8th Street
Courtenay BC V9N 1N5
Contact: Kevin Ganshorn

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-COL-VA	**Water**							
Batch R2925458								
WG1935606-2 CRM		**VA-ALKL-CONTROL**						
Alkalinity, Total (as CaCO3)			98.9		%		85-115	21-AUG-14
WG1935606-5 CRM		**VA-ALKM-CONTROL**						
Alkalinity, Total (as CaCO3)			103.5		%		85-115	21-AUG-14
WG1935606-8 CRM		**VA-ALKH-CONTROL**						
Alkalinity, Total (as CaCO3)			102.2		%		85-115	21-AUG-14
WG1935606-1 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	21-AUG-14
WG1935606-10 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	21-AUG-14
WG1935606-12 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	21-AUG-14
WG1935606-14 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	21-AUG-14
WG1935606-4 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	21-AUG-14
WG1935606-7 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	21-AUG-14
ANIONS-NO2-IC-VA	**Water**							
Batch R2926377								
WG1935361-2 LCS								
Nitrite (as N)			100.8		%		90-110	21-AUG-14
WG1935361-21 LCS								
Nitrite (as N)			100.5		%		90-110	21-AUG-14
WG1935361-1 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	21-AUG-14
WG1935361-10 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	21-AUG-14
WG1935361-13 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	21-AUG-14
WG1935361-16 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	21-AUG-14
WG1935361-19 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	21-AUG-14
WG1935361-4 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	21-AUG-14
WG1935361-7 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	21-AUG-14
WG1935361-11 MS		**L1502952-3**						

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ANIONS-NO2-IC-VA	**Water**							
Batch R2926377								
WG1935361-11 MS		**L1502952-3**						
Nitrite (as N)			101.4		%		75-125	21-AUG-14
WG1935361-17 MS		**L1504772-1**						
Nitrite (as N)			100.7		%		75-125	21-AUG-14
WG1935361-20 MS		**L1506263-3**						
Nitrite (as N)			99.4		%		75-125	21-AUG-14
WG1935361-8 MS		**L1505124-1**						
Nitrite (as N)			102.4		%		75-125	21-AUG-14
Batch R2932161								
WG1939303-17 LCS								
Nitrite (as N)			104.1		%		90-110	27-AUG-14
WG1939303-2 LCS								
Nitrite (as N)			104.5		%		90-110	27-AUG-14
WG1939303-1 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	27-AUG-14
WG1939303-15 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	27-AUG-14
WG1939303-4 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	27-AUG-14
WG1939303-7 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	27-AUG-14
WG1939303-5 MS		**L1508386-4**						
Nitrite (as N)			102.6		%		75-125	27-AUG-14
WG1939303-8 MS		**L1508599-6**						
Nitrite (as N)			103.7		%		75-125	27-AUG-14
ANIONS-NO3-IC-VA	**Water**							
Batch R2926377								
WG1935361-2 LCS								
Nitrate (as N)			100.4		%		90-110	21-AUG-14
WG1935361-21 LCS								
Nitrate (as N)			100.2		%		90-110	21-AUG-14
WG1935361-1 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	21-AUG-14
WG1935361-10 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	21-AUG-14
WG1935361-13 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	21-AUG-14
WG1935361-16 MB								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ANIONS-NO3-IC-VA	**Water**							
Batch R2926377								
WG1935361-16 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	21-AUG-14
WG1935361-19 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	21-AUG-14
WG1935361-4 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	21-AUG-14
WG1935361-7 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	21-AUG-14
WG1935361-11 MS		**L1502952-3**						
Nitrate (as N)			101.4		%		75-125	21-AUG-14
WG1935361-20 MS		**L1506263-3**						
Nitrate (as N)			99.6		%		75-125	21-AUG-14
WG1935361-8 MS		**L1505124-1**						
Nitrate (as N)			101.4		%		75-125	21-AUG-14
Batch R2932161								
WG1939303-17 LCS								
Nitrate (as N)			102.8		%		90-110	27-AUG-14
WG1939303-2 LCS								
Nitrate (as N)			102.9		%		90-110	27-AUG-14
WG1939303-1 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	27-AUG-14
WG1939303-15 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	27-AUG-14
WG1939303-4 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	27-AUG-14
WG1939303-7 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	27-AUG-14
WG1939303-5 MS		**L1508386-4**						
Nitrate (as N)			101.2		%		75-125	27-AUG-14
WG1939303-8 MS		**L1508599-6**						
Nitrate (as N)			102.1		%		75-125	27-AUG-14
EC-PCT-VA	**Water**							
Batch R2925250								
WG1935317-17 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			98.0		%		90-110	21-AUG-14
WG1935317-18 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			97.4		%		90-110	21-AUG-14
WG1935317-19 CRM		**VA-EC-PCT-CONTROL**						

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
EC-PCT-VA	**Water**							
Batch R2925250								
WG1935317-19 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			98.4		%		90-110	21-AUG-14
WG1935317-20 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			98.1		%		90-110	21-AUG-14
WG1935317-21 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			98.0		%		90-110	21-AUG-14
WG1935317-22 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			98.0		%		90-110	21-AUG-14
WG1935317-23 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			98.4		%		90-110	21-AUG-14
WG1935317-24 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			98.4		%		90-110	21-AUG-14
WG1935317-1 MB								
Conductivity			<2.0		uS/cm		2	21-AUG-14
WG1935317-2 MB								
Conductivity			<2.0		uS/cm		2	21-AUG-14
WG1935317-3 MB								
Conductivity			<2.0		uS/cm		2	21-AUG-14
WG1935317-4 MB								
Conductivity			<2.0		uS/cm		2	21-AUG-14
WG1935317-5 MB								
Conductivity			<2.0		uS/cm		2	21-AUG-14
WG1935317-6 MB								
Conductivity			<2.0		uS/cm		2	21-AUG-14
WG1935317-7 MB								
Conductivity			<2.0		uS/cm		2	21-AUG-14
WG1935317-8 MB								
Conductivity			<2.0		uS/cm		2	21-AUG-14
NH3-F-VA	**Water**							
Batch R2927928								
WG1935726-2 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			99.5		%		85-115	25-AUG-14
WG1935726-4 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			104.9		%		85-115	25-AUG-14
WG1935726-6 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			101.1		%		85-115	25-AUG-14
WG1935726-9 DUP		**L1505119-2**						
Ammonia, Total (as N)		0.0053	<0.0050	RPD-NA	mg/L	N/A	20	25-AUG-14
WG1935726-1 MB								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NH3-F-VA	**Water**							
Batch R2927928								
WG1935726-1 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	25-AUG-14
WG1935726-3 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	25-AUG-14
WG1935726-5 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	25-AUG-14
WG1935726-10 MS		**L1505119-2**						
Ammonia, Total (as N)			99.8		%		75-125	25-AUG-14
WG1935726-8 MS		**L1503272-1**						
Ammonia, Total (as N)			116.0		%		75-125	25-AUG-14
Batch R2928035								
WG1937812-2 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			102.3		%		85-115	25-AUG-14
WG1937812-4 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			103.6		%		85-115	25-AUG-14
WG1937812-6 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			103.8		%		85-115	25-AUG-14
WG1937812-8 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			101.9		%		85-115	25-AUG-14
WG1937812-1 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	25-AUG-14
WG1937812-3 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	25-AUG-14
WG1937812-5 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	25-AUG-14
WG1937812-7 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	25-AUG-14
WG1937812-10 MS		**L1507238-1**						
Ammonia, Total (as N)			100.5		%		75-125	25-AUG-14
WG1937812-12 MS		**L1507347-1**						
Ammonia, Total (as N)			102.0		%		75-125	25-AUG-14
WG1937812-14 MS		**L1505356-2**						
Ammonia, Total (as N)			103.9		%		75-125	25-AUG-14
P-T-PRES-COL-VA	**Water**							
Batch R2925352								
WG1935260-10 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			90.8		%		80-120	21-AUG-14
WG1935260-2 CRM		**VA-ERA-PO4**						

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
P-T-PRES-COL-VA	**Water**							
Batch R2925352								
WG1935260-2 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			98.7		%		80-120	21-AUG-14
WG1935260-6 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			92.0		%		80-120	21-AUG-14
WG1935260-1 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	21-AUG-14
WG1935260-5 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	21-AUG-14
WG1935260-9 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	21-AUG-14
WG1935260-12 MS		**L1504293-2**						
Phosphorus (P)-Total			98.8		%		70-130	21-AUG-14
WG1935260-4 MS		**L1505202-4**						
Phosphorus (P)-Total			90.9		%		70-130	21-AUG-14
WG1935260-8 MS		**L1505330-8**						
Phosphorus (P)-Total			N/A	MS-B	%		-	21-AUG-14
PH-PCT-VA	**Water**							
Batch R2925250								
WG1935317-25 CRM		**VA-PH7-BUF**						
pH			7.01		pH		6.9-7.1	21-AUG-14
WG1935317-26 CRM		**VA-PH7-BUF**						
pH			7.03		pH		6.9-7.1	21-AUG-14
WG1935317-27 CRM		**VA-PH7-BUF**						
pH			7.01		pH		6.9-7.1	21-AUG-14
WG1935317-28 CRM		**VA-PH7-BUF**						
pH			7.02		pH		6.9-7.1	21-AUG-14
WG1935317-29 CRM		**VA-PH7-BUF**						
pH			7.01		pH		6.9-7.1	21-AUG-14
WG1935317-30 CRM		**VA-PH7-BUF**						
pH			7.01		pH		6.9-7.1	21-AUG-14
WG1935317-31 CRM		**VA-PH7-BUF**						
pH			7.05		pH		6.9-7.1	21-AUG-14
WG1935317-32 CRM		**VA-PH7-BUF**						
pH			6.99		pH		6.9-7.1	21-AUG-14
PO4-DO-COL-VA	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PO4-DO-COL-VA	**Water**							
Batch R2924516								
WG1935176-10 CRM		**VA-OPO4-CONTROL**						
Orthophosphate-Dissolved (as P)			87.6		%		80-120	20-AUG-14
WG1935176-15 CRM		**VA-OPO4-CONTROL**						
Orthophosphate-Dissolved (as P)			97.4		%		80-120	20-AUG-14
WG1935176-2 CRM		**VA-OPO4-CONTROL**						
Orthophosphate-Dissolved (as P)			102.1		%		80-120	20-AUG-14
WG1935176-6 CRM		**VA-OPO4-CONTROL**						
Orthophosphate-Dissolved (as P)			101.5		%		80-120	20-AUG-14
WG1935176-1 MB								
Orthophosphate-Dissolved (as P)			<0.0010		mg/L		0.001	20-AUG-14
WG1935176-14 MB								
Orthophosphate-Dissolved (as P)			<0.0010		mg/L		0.001	20-AUG-14
WG1935176-5 MB								
Orthophosphate-Dissolved (as P)			<0.0010		mg/L		0.001	20-AUG-14
WG1935176-9 MB								
Orthophosphate-Dissolved (as P)			<0.0010		mg/L		0.001	20-AUG-14
WG1935176-12 MS		**L1504997-5**						
Orthophosphate-Dissolved (as P)			96.8		%		70-130	20-AUG-14
WG1935176-4 MS		**L1505202-4**						
Orthophosphate-Dissolved (as P)			86.7		%		70-130	20-AUG-14
WG1935176-8 MS		**L1505010-1**						
Orthophosphate-Dissolved (as P)			104.1		%		70-130	20-AUG-14
TDS-VA	**Water**							
Batch R2926486								
WG1936057-2 LCS								
Total Dissolved Solids			102.4		%		85-115	21-AUG-14
WG1936057-5 LCS								
Total Dissolved Solids			101.9		%		85-115	21-AUG-14
WG1936057-1 MB								
Total Dissolved Solids			<10		mg/L		10	21-AUG-14
WG1936057-4 MB								
Total Dissolved Solids			<10		mg/L		10	21-AUG-14
TSS-LOW-VA	**Water**							
Batch R2925175								
WG1935240-2 LCS								
Total Suspended Solids			94.3		%		85-115	20-AUG-14
WG1935240-4 LCS								
Total Suspended Solids			101.5		%		85-115	20-AUG-14

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TSS-LOW-VA	**Water**							
Batch R2925175								
WG1935240-6 LCS								
Total Suspended Solids			101.5		%		85-115	20-AUG-14
WG1935240-1 MB								
Total Suspended Solids			<1.0		mg/L		1	20-AUG-14
WG1935240-3 MB								
Total Suspended Solids			<1.0		mg/L		1	20-AUG-14
WG1935240-5 MB								
Total Suspended Solids			<1.0		mg/L		1	20-AUG-14
TURBIDITY-VA	**Water**							
Batch R2924424								
WG1935141-2 CRM		**VA-FORM-40**						
Turbidity			100.3		%		85-115	20-AUG-14
WG1935141-5 CRM		**VA-FORM-40**						
Turbidity			100.3		%		85-115	20-AUG-14
WG1935141-8 CRM		**VA-FORM-40**						
Turbidity			100.3		%		85-115	20-AUG-14
WG1935141-1 MB								
Turbidity			<0.10		NTU		0.1	20-AUG-14
WG1935141-4 MB								
Turbidity			<0.10		NTU		0.1	20-AUG-14
WG1935141-7 MB								
Turbidity			<0.10		NTU		0.1	20-AUG-14

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
J	Duplicate results and limits are expressed in terms of absolute difference.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH by Meter (Automated)							
	1	19-AUG-14 10:08	21-AUG-14 23:00	0.25	61	hours	EHTR-FM
	2	19-AUG-14 10:08	21-AUG-14 23:00	0.25	61	hours	EHTR-FM
	3	19-AUG-14 10:08	21-AUG-14 23:00	0.25	61	hours	EHTR-FM
	4	19-AUG-14 10:08	21-AUG-14 23:00	0.25	61	hours	EHTR-FM
Anions and Nutrients							
Nitrate in Water by Ion Chromatography							
	1	19-AUG-14 10:08	27-AUG-14 06:57	3	8	days	EHT
	2	19-AUG-14 10:08	27-AUG-14 06:57	3	8	days	EHT
	3	19-AUG-14 10:08	27-AUG-14 06:57	3	8	days	EHT
Nitrite in Water by Ion Chromatography							
	1	19-AUG-14 10:08	27-AUG-14 06:57	3	8	days	EHT
	2	19-AUG-14 10:08	27-AUG-14 06:57	3	8	days	EHT
	3	19-AUG-14 10:08	27-AUG-14 06:57	3	8	days	EHT

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L1505119 were received on 19-AUG-14 18:50.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

L1505119-COFC

COC #: OL-1314

Chain of Custody / Analytical Request Form
Canada Toll Free : 1 800 668 9878
www.alsglobal.com

Report To
Company: ECOFISH RESEARCH LTD
Contact: Kevin Ganshorn
Address: 906 - 595 Howe Street, Vancouver, BC, Canada, V6C2T5
Phone: 604-608-6180 | Fax: 604 559-6180

Invoice To ☑Email ☐Mail
Company: ECOFISH RESEARCH LTD
Contact: Accounts Payable
Address: Suite F, 450 - 8th Street, Courtenay, BC, Canada, V9N 1N5
Email: accountspayable@ecofishresearch.com
Phone: 250-334-3042

Lab Work Order # (lab use only)

Reporting
Distribution: ☐Fax ☐Mail ☑Email
☑ Criteria on Report (select from Guidelines below)
Report Type: ☑Excel ☐Digital
Report Format: CROSSTAB_ALSQC
Report Email(s): kganshorn@ecofishresearch.com, tkasubuchi@ecofishresearch.com, pdinn@ecofishresearch.com
EDD Format:
EDD Email(s):

Project Info
Job #: 1230 JHT-MON8
PO/AFE:
LSD:
Quote #:
ALS Contact: Ariel Tang | Sampler: Leah Hull

Service Requested
⦿ Regular (Standard Turnaround Times - Business Days) - R
○ Priority (3 Days) - surcharge will apply - P
○ Priority (2 Days) - surcharge will apply - P2
○ Emergency (1-2 day) – surcharge will apply - E
○ Same Day or Weekend Emergency - surcharge will apply - E2
○ Specify date required - X

Analysis Requests (Please indicate below Filtered, Preserved or both(F, P, F/P))

Sample #	Sample Identification (This will appear on the report)	Longitude	Latitude	Date	Time	Sample Type	Number of Containers	Alkalinity by Colourimetric (Automated)	Ammonia in Water by Fluorescence	Conductivity (Automated)	Diss. Orthophosphate in Water by Colour	Nitrate in Water by Ion Chromatography	Nitrite in Water by Ion Chromatography	Total Dissolved Solids by Gravimetric	Total P in Water by Colour	Total Suspended Solids by Grav. (1 mg/L)	Turbidity by Meter	pH by Meter (Automated)
	QUN-WQ1A			19-Aug-2014	10:08	Water	3	R	R	R	R	R	R	R	R	R	R	R
	QUN-WQ1B			↓	↓	Water	3	R	R	R	R	R	R	R	R	R	R	R
	QUN-TRIP BLANK			↓	↓	Water	3	R	R	R	R	R	R	R	R	R	R	R
	QUN-FIELD BLANK			↓	↓	Water	3	R	R	R	R	R	R	R	R	R	R	R

Short Holding Time

Rush Processing

Special Instr...

... must be answered for water samples (check Yes or No)
Are any sample taken from a regulated DW system? ☐Yes ☒No
If yes, please use an authorized drinking water COC
Is the water sampled intended to be potable for human consumption? ☐Yes ☒No

Guidelines
British Columbia Approved and Working Water Quality Guidelines (JULY, 2013) - BCAWWQG - Freshwater Aquatic Life

SAMPLE CONDITION (lab use only)
☐Frozen ☐Cold ☐Ambient ☐Cooling Initiated

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by: Leah Hull	Date: 19-Aug 2014	Time: 13:45	Received by: Bren	Date: Aug 19	Time: 1850	Temperature: 10 °C	Verified by:	Date:	Time:	Observations: ☐Yes If Yes add SIF

ECOFISH RESEARCH LTD
ATTN: Kevin Ganshorn
Suite F, 450 - 8th Street
Courtenay BC V9N 1N5

Date Received: 24-SEP-14
Report Date: 02-OCT-14 17:11 (MT)
Version: FINAL

Client Phone: 250-334-3042

Certificate of Analysis

Lab Work Order #: **L1523178**

Project P.O. #: NOT SUBMITTED
Job Reference: 1230 JHT-MON8
C of C Numbers:
Legal Site Desc:

Ariel Tang
Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1523178-1	L1523178-2	L1523178-3	L1523178-4	
	Description	Water	Water	Water	Water	
	Sampled Date	24-SEP-14	24-SEP-14	24-SEP-14	24-SEP-14	
	Sampled Time	11:20	11:20	11:20	11:20	
	Client ID	QUN-WQA	QUN-WQB	QUN-TRIP BLANK	QUN-FIELD BLANK	
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	109	109	<2.0	<2.0	
	pH (pH)	7.52	7.58	5.41	5.45	
	Total Suspended Solids (mg/L)	<1.0	<1.0	<1.0	<1.0	
	Total Dissolved Solids (mg/L)	67	74	<10	<10	
	Turbidity (NTU)	0.50	0.62	<0.10	<0.10	
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	35.0	35.0	<2.0	<2.0	
	Ammonia, Total (as N) (mg/L)	<0.0050	<0.0050	0.0551 RRV	<0.0050	
	Nitrate (as N) (mg/L)	0.0207	0.0216	<0.0050	<0.0050	
	Nitrite (as N) (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Orthophosphate-Dissolved (as P) (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Phosphorus (P)-Total (mg/L)	0.0039	0.0046	<0.0020	<0.0020	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Ammonia, Total (as N)	MS-B	L1523178-3

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
RRV	Reported Result Verified By Repeat Analysis

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-COL-VA	Water	Alkalinity by Colourimetric (Automated)	EPA 310.2

This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.

ANIONS-NO2-IC-VA	Water	Nitrite in Water by Ion Chromatography	EPA 300.0

This analysis is carried out using procedures adapted from EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography". Nitrite is detected by UV absorbance.

ANIONS-NO3-IC-VA	Water	Nitrate in Water by Ion Chromatography	EPA 300.0

This analysis is carried out using procedures adapted from EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography". Nitrate is detected by UV absorbance.

EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

NH3-F-VA	Water	Ammonia in Water by Fluorescence	J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

P-T-PRES-COL-VA	Water	Total P in Water by Colour	APHA 4500-P Phosphorus

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Phosphorus is determined colourimetrically after persulphate digestion of the sample.

PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H "pH Value"

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PO4-DO-COL-VA	Water	Diss. Orthophosphate in Water by Colour	APHA 4500-P Phosphorus

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Dissolved Orthophosphate is determined colourimetrically on a sample that has been lab or field filtered through a 0.45 micron membrane filter.

TDS-VA	Water	Total Dissolved Solids by Gravimetric	APHA 2540 C - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

TSS-LOW-VA	Water	Total Suspended Solids by Grav. (1 mg/L)	APHA 2540 Gravimetric

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total suspended solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.

TURBIDITY-VA	Water	Turbidity by Meter	APHA 2130 "Turbidity"

This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.

TURBIDITY-VA	Water	Turbidity by Meter	APHA 2130 Turbidity

This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code **Laboratory Location**

Reference Information

VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Client: ECOFISH RESEARCH LTD
Suite F, 450 - 8th Street
Courtenay BC V9N 1N5
Contact: Kevin Ganshorn

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-COL-VA	**Water**							
Batch R2967249								
WG1963665-2 CRM		**VA-ALKL-CONTROL**						
Alkalinity, Total (as CaCO3)			104.5		%		85-115	01-OCT-14
WG1963665-5 CRM		**VA-ALKM-CONTROL**						
Alkalinity, Total (as CaCO3)			104.1		%		85-115	01-OCT-14
WG1963665-8 CRM		**VA-ALKH-CONTROL**						
Alkalinity, Total (as CaCO3)			104.1		%		85-115	01-OCT-14
WG1963665-1 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	01-OCT-14
WG1963665-10 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	01-OCT-14
WG1963665-12 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	01-OCT-14
WG1963665-15 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	01-OCT-14
WG1963665-17 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	01-OCT-14
WG1963665-20 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	01-OCT-14
WG1963665-4 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	01-OCT-14
WG1963665-7 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	01-OCT-14
ANIONS-NO2-IC-VA	**Water**							
Batch R2962874								
WG1958988-12 LCS								
Nitrite (as N)			102.2		%		90-110	25-SEP-14
WG1958988-2 LCS								
Nitrite (as N)			102.7		%		90-110	25-SEP-14
WG1958988-1 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	25-SEP-14
WG1958988-10 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	25-SEP-14
WG1958988-4 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	25-SEP-14
WG1958988-7 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	25-SEP-14
WG1958988-11 MS		**L1523544-1**						
Nitrite (as N)			102.2		%		75-125	25-SEP-14
WG1958988-5 MS		**L1523347-7**						

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ANIONS-NO2-IC-VA	**Water**							
Batch R2962874								
WG1958988-5 MS		**L1523347-7**						
Nitrite (as N)			104.0		%		75-125	25-SEP-14
WG1958988-8 MS		**L1523562-4**						
Nitrite (as N)			102.6		%		75-125	25-SEP-14
ANIONS-NO3-IC-VA	**Water**							
Batch R2962874								
WG1958988-12 LCS								
Nitrate (as N)			101.5		%		90-110	25-SEP-14
WG1958988-2 LCS								
Nitrate (as N)			101.6		%		90-110	25-SEP-14
WG1958988-1 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	25-SEP-14
WG1958988-10 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	25-SEP-14
WG1958988-4 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	25-SEP-14
WG1958988-7 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	25-SEP-14
WG1958988-11 MS		**L1523544-1**						
Nitrate (as N)			101.6		%		75-125	25-SEP-14
WG1958988-5 MS		**L1523347-7**						
Nitrate (as N)			103.4		%		75-125	25-SEP-14
WG1958988-8 MS		**L1523562-4**						
Nitrate (as N)			102.2		%		75-125	25-SEP-14
EC-PCT-VA	**Water**							
Batch R2964914								
WG1962520-17 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			99.7		%		90-110	30-SEP-14
WG1962520-18 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			98.1		%		90-110	30-SEP-14
WG1962520-19 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			98.4		%		90-110	30-SEP-14
WG1962520-20 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			100.0		%		90-110	30-SEP-14
WG1962520-21 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			99.8		%		90-110	30-SEP-14
WG1962520-22 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			100.8		%		90-110	30-SEP-14

ALS Environmental

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
EC-PCT-VA	**Water**							
Batch R2964914								
WG1962520-23 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			100.0		%		90-110	30-SEP-14
WG1962520-24 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			100.3		%		90-110	30-SEP-14
WG1962520-42 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			100.1		%		90-110	30-SEP-14
WG1962520-1 MB								
Conductivity			<2.0		uS/cm		2	30-SEP-14
WG1962520-2 MB								
Conductivity			<2.0		uS/cm		2	30-SEP-14
WG1962520-3 MB								
Conductivity			<2.0		uS/cm		2	30-SEP-14
WG1962520-4 MB								
Conductivity			<2.0		uS/cm		2	30-SEP-14
WG1962520-40 MB								
Conductivity			<2.0		uS/cm		2	30-SEP-14
WG1962520-5 MB								
Conductivity			<2.0		uS/cm		2	30-SEP-14
WG1962520-6 MB								
Conductivity			<2.0		uS/cm		2	30-SEP-14
WG1962520-7 MB								
Conductivity			<2.0		uS/cm		2	30-SEP-14
WG1962520-8 MB								
Conductivity			<2.0		uS/cm		2	30-SEP-14
NH3-F-VA	**Water**							
Batch R2963748								
WG1961185-2 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			97.0		%		85-115	29-SEP-14
WG1961185-4 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			96.8		%		85-115	29-SEP-14
WG1961185-6 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			96.3		%		85-115	29-SEP-14
WG1961185-8 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			97.0		%		85-115	29-SEP-14
WG1961185-13 DUP		**L1523178-1**						
Ammonia, Total (as N)		<0.0050	<0.0050	RPD-NA	mg/L	N/A	20	29-SEP-14
WG1961185-1 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	29-SEP-14
WG1961185-3 MB								

ALS Environmental

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NH3-F-VA	**Water**							
Batch R2963748								
WG1961185-3 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	29-SEP-14
WG1961185-5 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	29-SEP-14
WG1961185-7 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	29-SEP-14
WG1961185-10 MS		**L1523335-1**						
Ammonia, Total (as N)			96.9		%		75-125	29-SEP-14
WG1961185-12 MS		**L1523335-4**						
Ammonia, Total (as N)			97.7		%		75-125	29-SEP-14
WG1961185-14 MS		**L1523178-1**						
Ammonia, Total (as N)			97.9		%		75-125	29-SEP-14
Batch R2963762								
WG1959947-2 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			101.8		%		85-115	29-SEP-14
WG1959947-4 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			107.9		%		85-115	29-SEP-14
WG1959947-6 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			102.2		%		85-115	29-SEP-14
WG1959947-1 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	29-SEP-14
WG1959947-3 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	29-SEP-14
WG1959947-5 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	29-SEP-14
WG1959947-12 MS		**L1520738-3**						
Ammonia, Total (as N)			N/A	MS-B	%		-	29-SEP-14
WG1959947-8 MS		**L1520952-1**						
Ammonia, Total (as N)			103.3		%		75-125	29-SEP-14
P-T-PRES-COL-VA	**Water**							
Batch R2964677								
WG1961319-10 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			108.8		%		80-120	29-SEP-14
WG1961319-2 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			89.1		%		80-120	29-SEP-14
WG1961319-6 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			106.0		%		80-120	29-SEP-14
WG1961319-1 MB								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
P-T-PRES-COL-VA	**Water**							
Batch R2964677								
WG1961319-1 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	29-SEP-14
WG1961319-5 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	29-SEP-14
WG1961319-9 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	29-SEP-14
WG1961319-12 MS		**L1523468-6**						
Phosphorus (P)-Total			107.0		%		70-130	29-SEP-14
WG1961319-4 MS		**L1521858-7**						
Phosphorus (P)-Total			90.9		%		70-130	29-SEP-14
WG1961319-8 MS		**L1523335-3**						
Phosphorus (P)-Total			100.4		%		70-130	29-SEP-14
PH-PCT-VA	**Water**							
Batch R2964914								
WG1962520-25 CRM		**VA-PH7-BUF**						
pH			7.01		pH		6.9-7.1	30-SEP-14
WG1962520-26 CRM		**VA-PH7-BUF**						
pH			7.02		pH		6.9-7.1	30-SEP-14
WG1962520-27 CRM		**VA-PH7-BUF**						
pH			7.03		pH		6.9-7.1	30-SEP-14
WG1962520-28 CRM		**VA-PH7-BUF**						
pH			7.02		pH		6.9-7.1	30-SEP-14
WG1962520-29 CRM		**VA-PH7-BUF**						
pH			7.02		pH		6.9-7.1	30-SEP-14
WG1962520-30 CRM		**VA-PH7-BUF**						
pH			7.01		pH		6.9-7.1	30-SEP-14
WG1962520-31 CRM		**VA-PH7-BUF**						
pH			7.02		pH		6.9-7.1	30-SEP-14
WG1962520-32 CRM		**VA-PH7-BUF**						
pH			7.03		pH		6.9-7.1	30-SEP-14
WG1962520-43 CRM		**VA-PH7-BUF**						
pH			7.03		pH		6.9-7.1	30-SEP-14
PO4-DO-COL-VA	**Water**							
Batch R2959859								
WG1959948-2 CRM		**VA-OPO4-CONTROL**						
Orthophosphate-Dissolved (as P)			91.7		%		80-120	25-SEP-14
WG1959948-6 CRM		**VA-OPO4-CONTROL**						
Orthophosphate-Dissolved (as P)			92.3		%		80-120	26-SEP-14

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PO4-DO-COL-VA	**Water**							
Batch R2959859								
WG1959948-1 MB								
Orthophosphate-Dissolved (as P)			<0.0010		mg/L		0.001	25-SEP-14
WG1959948-5 MB								
Orthophosphate-Dissolved (as P)			<0.0010		mg/L		0.001	26-SEP-14
WG1959948-4 MS		**L1523366-14**						
Orthophosphate-Dissolved (as P)			105.4		%		70-130	25-SEP-14
WG1959948-8 MS		**L1522914-2**						
Orthophosphate-Dissolved (as P)			93.3		%		70-130	26-SEP-14
TDS-VA	**Water**							
Batch R2964339								
WG1962450-2 LCS								
Total Dissolved Solids			100.1		%		85-115	29-SEP-14
WG1962450-1 MB								
Total Dissolved Solids			<10		mg/L		10	29-SEP-14
TSS-LOW-VA	**Water**							
Batch R2964397								
WG1962464-2 LCS								
Total Suspended Solids			86.9		%		85-115	30-SEP-14
WG1962464-4 LCS								
Total Suspended Solids			90.9		%		85-115	30-SEP-14
WG1962464-1 MB								
Total Suspended Solids			<1.0		mg/L		1	30-SEP-14
WG1962464-3 MB								
Total Suspended Solids			<1.0		mg/L		1	30-SEP-14
TURBIDITY-VA	**Water**							
Batch R2959809								
WG1959744-11 CRM		**VA-FORM-40**						
Turbidity			97.3		%		85-115	25-SEP-14
WG1959744-14 CRM		**VA-FORM-40**						
Turbidity			95.8		%		85-115	25-SEP-14
WG1959744-17 CRM		**VA-FORM-40**						
Turbidity			99.5		%		85-115	25-SEP-14
WG1959744-2 CRM		**VA-FORM-40**						
Turbidity			99.8		%		85-115	25-SEP-14
WG1959744-5 CRM		**VA-FORM-40**						
Turbidity			98.0		%		85-115	25-SEP-14
WG1959744-8 CRM		**VA-FORM-40**						
Turbidity			96.5		%		85-115	25-SEP-14

ALS Environmental

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TURBIDITY-VA	**Water**							
Batch R2959809								
WG1959744-1 MB								
Turbidity			<0.10		NTU		0.1	25-SEP-14
WG1959744-10 MB								
Turbidity			<0.10		NTU		0.1	25-SEP-14
WG1959744-13 MB								
Turbidity			<0.10		NTU		0.1	25-SEP-14
WG1959744-16 MB								
Turbidity			<0.10		NTU		0.1	25-SEP-14
WG1959744-4 MB								
Turbidity			<0.10		NTU		0.1	25-SEP-14
WG1959744-7 MB								
Turbidity			<0.10		NTU		0.1	25-SEP-14

Quality Control Report

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
J	Duplicate results and limits are expressed in terms of absolute difference.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH by Meter (Automated)							
	1	24-SEP-14 11:20	30-SEP-14 23:00	0.25	156	hours	EHTR-FM
	2	24-SEP-14 11:20	30-SEP-14 23:00	0.25	156	hours	EHTR-FM
	3	24-SEP-14 11:20	30-SEP-14 23:00	0.25	156	hours	EHTR-FM
	4	24-SEP-14 11:20	30-SEP-14 23:00	0.25	156	hours	EHTR-FM

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L1523178 were received on 24-SEP-14 19:55.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

L1523178-COFC

ALS Environmental

COC #: OL-1315

\nalytical Request Form
ee : 1 800 668 9878
.....sglobal.com

Report To		Reporting		Service Requested
Company:	ECOFISH RESEARCH LTD	Distribution:	☐Fax ☐Mail ☑Email	⦿ Regular (Standard Turnaround Times - Business Days) - R
Contact:	Kevin Ganshorn	☑ Criteria on Report (select from Guidelines below)		○ Priority (3 Days) - surcharge will apply - P
Address:	906 - 595 Howe Street Vancouver, BC Canada, V6C2T5	Report Type:	☑Excel ☐Digital	○ Priority (2 Days) - surcharge will apply - P2
		Report Format:	CROSSTAB_ALSQC	○ Emergency (1-2 day) – surcharge will apply - E
		Report Email(s):	kganshorn@ecofishresearch.com tkasubuchi@ecofishresearch.com pdinn@ecofishresearch.com	○ Same Day or Weekend Emergency - surcharge will apply - E2
				○ Specify date required - X
Phone:	604-608-6180 Fax: 604 559-6180			
Invoice To	☑Email ☐Mail	EDD Format:		
Company:	ECOFISH RESEARCH LTD	EDD Email(s):		
Contact:	Accounts Payable			
Address:	Suite F, 450 - 8th Street Courtenay, BC Canada, V9N 1N5	Project Info		
		Job #:	1230 JHT-MON8	
		PO/AFE:		
Email:	accountspayable@ecofishresearch.com	LSD:		
Phone:	250-334-3042	Quote #:		
Lab Work Order # (lab use only)		ALS Contact: Ariel Tang	Sampler: Leah Hull	

Analysis Requests — Please indicate below Filtered, Preserved or both(F, P, F/P)

Sample #	Sample Identification (This will appear on the report)	Longitude	Latitude	Date	Time	Sample Type	Number of Containers	Alkalinity by Colourimetric (Automated)	Ammonia in Water by Fluorescence	Conductivity (Automated)	Diss. Orthophosphate in Water by Colour	Nitrate in Water by Ion Chromatography	Nitrite in Water by Ion Chromatography	Total Dissolved Solids by Gravimetric	Total P in Water by Colour	Total Suspended Solids by Grav. (1 mg/L)	Turbidity by Meter	pH by Meter (Automated)			
	QUN-WQ1A			24-Sept-2014	11:20	Water	3	R	R	R	R	R	R	R	R	R	R	R			
	QUN-WQ1B			↓	↓	Water	3	R	R	R	R	R	R	R	R	R	R	R			
	QUN-TRIP BLANK					Water	3	R	R	R	R	R	R	R	R	R	R	R			
	QUN-FIELD BLANK					Water	3	R	R	R	R	R	R	R	R	R	R	R			

Short Holding Time

Rush Processing

The questions below must be answered for water samples (check Yes or No)

Are any sample taken from a regulated DW system? ☐Yes ☒No

If yes, please use an authorized drinking water COC

Is the water sampled intended to be potable for human consumption? ☐Yes ☒No

Guidelines

British Columbia Approved and Working Water Quality Guidelines (JULY, 2013) - BCAWWQG - Freshwater Aquatic Life

SAMPLE CONDITION (lab use only)

☐Frozen ☐Cold ☐Ambient ☐Cooling Initiated

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by: Leah Hull	Date: 24-Sept-2014	Time: 15:30	Received by: PAUL	Date: SEP 24	Time: 19:55	Temperature: 7 °C	Verified by:	Date:	Time:	Observations: ☐Yes If Yes add SIF

ECOFISH RESEARCH LTD
ATTN: Kevin Ganshorn
Suite 906 - 595 Howe Street
Vancouver BC V6C 2T5

Date Received: 05-NOV-14
Report Date: 13-NOV-14 11:36 (MT)
Version: FINAL

Client Phone: 604-608-6180

Certificate of Analysis

Lab Work Order #: L1543026

Project P.O. #:	NOT SUBMITTED
Job Reference:	1230 JHT-MON8
C of C Numbers:	OL-1316
Legal Site Desc:	

Ariel Tang
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1543026-1	L1543026-2	L1543026-3	L1543026-4	
	Description	WATER	WATER	WATER	WATER	
	Sampled Date	04-NOV-14	04-NOV-14	04-NOV-14	04-NOV-14	
	Sampled Time	11:05	11:05	11:05	11:05	
	Client ID	QUN-WQA	QUN-WQB	QUN-TRIP BLANK	QUN-FIELD BLANK	
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	71.8	70.7	<2.0	<2.0	
	pH (pH)	7.63	7.59	5.75	5.70	
	Total Suspended Solids (mg/L)	<1.0	<1.0	<1.0	<1.0	
	Total Dissolved Solids (mg/L)	64	53	<10	<10	
	Turbidity (NTU)	0.77	0.71	<0.10	<0.10	
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	23.5	23.8	<2.0	<2.0	
	Ammonia, Total (as N) (mg/L)	0.0051	0.0051	0.0995 RRV	<0.0050	
	Nitrate (as N) (mg/L)	0.0240	0.0251	<0.0050	<0.0050	
	Nitrite (as N) (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Orthophosphate-Dissolved (as P) (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Phosphorus (P)-Total (mg/L)	0.0029	0.0044	<0.0020	<0.0020	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Phosphorus (P)-Total	MS-B	L1543026-1, -2, -3, -4

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
RRV	Reported Result Verified By Repeat Analysis

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-COL-VA	Water	Alkalinity by Colourimetric (Automated)	EPA 310.2

This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.

ANIONS-NO2-IC-VA	Water	Nitrite in Water by Ion Chromatography	EPA 300.0

This analysis is carried out using procedures adapted from EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography". Nitrite is detected by UV absorbance.

ANIONS-NO3-IC-VA	Water	Nitrate in Water by Ion Chromatography	EPA 300.0

This analysis is carried out using procedures adapted from EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography". Nitrate is detected by UV absorbance.

EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

NH3-F-VA	Water	Ammonia in Water by Fluorescence	J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

P-T-PRES-COL-VA	Water	Total P in Water by Colour	APHA 4500-P Phosphorus

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Phosphorus is determined colourimetrically after persulphate digestion of the sample.

PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H "pH Value"

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PO4-DO-COL-VA	Water	Diss. Orthophosphate in Water by Colour	APHA 4500-P Phosphorus

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Dissolved Orthophosphate is determined colourimetrically on a sample that has been lab or field filtered through a 0.45 micron membrane filter.

TDS-VA	Water	Total Dissolved Solids by Gravimetric	APHA 2540 C - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

TSS-LOW-VA	Water	Total Suspended Solids by Grav. (1 mg/L)	APHA 2540 Gravimetric

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total suspended solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.

TURBIDITY-VA	Water	Turbidity by Meter	APHA 2130 "Turbidity"

This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.

TURBIDITY-VA	Water	Turbidity by Meter	APHA 2130 Turbidity

This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code **Laboratory Location**

Reference Information

VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

OL-1316

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Client: ECOFISH RESEARCH LTD
Suite 906 - 595 Howe Street
Vancouver BC V6C 2T5

Contact: Kevin Ganshorn

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-COL-VA	**Water**							
Batch R3057760								
WG1990991-2 CRM		**VA-ALKL-CONTROL**						
Alkalinity, Total (as CaCO3)			100.1		%		85-115	06-NOV-14
WG1990991-5 CRM		**VA-ALKM-CONTROL**						
Alkalinity, Total (as CaCO3)			103.0		%		85-115	06-NOV-14
WG1990991-8 CRM		**VA-ALKH-CONTROL**						
Alkalinity, Total (as CaCO3)			103.4		%		85-115	06-NOV-14
WG1990991-1 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	06-NOV-14
WG1990991-4 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	06-NOV-14
WG1990991-7 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	06-NOV-14
ANIONS-NO2-IC-VA	**Water**							
Batch R3055829								
WG1989240-3 DUP		**L1543026-1**						
Nitrite (as N)		<0.0010	<0.0010	RPD-NA	mg/L	N/A	20	05-NOV-14
WG1989240-6 DUP		**L1543026-4**						
Nitrite (as N)		<0.0010	<0.0010	RPD-NA	mg/L	N/A	20	05-NOV-14
WG1989240-2 LCS								
Nitrite (as N)			100.9		%		90-110	05-NOV-14
WG1989240-9 LCS								
Nitrite (as N)			101.1		%		90-110	05-NOV-14
WG1989240-1 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	05-NOV-14
WG1989240-4 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	05-NOV-14
WG1989240-7 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	05-NOV-14
WG1989240-5 MS		**L1543026-3**						
Nitrite (as N)			101.3		%		75-125	05-NOV-14
WG1989240-8 MS		**L1543026-4**						
Nitrite (as N)			99.5		%		75-125	05-NOV-14
ANIONS-NO3-IC-VA	**Water**							
Batch R3055829								
WG1989240-3 DUP		**L1543026-1**						
Nitrate (as N)		0.0240	0.0233		mg/L	3.3	20	05-NOV-14
WG1989240-6 DUP		**L1543026-4**						
Nitrate (as N)		<0.0050	<0.0050	RPD-NA	mg/L	N/A	20	05-NOV-14

Quality Control Report

Test		Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ANIONS-NO3-IC-VA		**Water**							
Batch	**R3055829**								
WG1989240-2	**LCS**								
Nitrate (as N)				101.4		%		90-110	05-NOV-14
WG1989240-9	**LCS**								
Nitrate (as N)				101.4		%		90-110	05-NOV-14
WG1989240-1	**MB**								
Nitrate (as N)				<0.0050		mg/L		0.005	05-NOV-14
WG1989240-4	**MB**								
Nitrate (as N)				<0.0050		mg/L		0.005	05-NOV-14
WG1989240-7	**MB**								
Nitrate (as N)				<0.0050		mg/L		0.005	05-NOV-14
WG1989240-5	**MS**		**L1543026-3**						
Nitrate (as N)				102.3		%		75-125	05-NOV-14
WG1989240-8	**MS**		**L1543026-4**						
Nitrate (as N)				99.8		%		75-125	05-NOV-14
EC-PCT-VA		**Water**							
Batch	**R3055708**								
WG1989770-17	**CRM**		**VA-EC-PCT-CONTROL**						
Conductivity				100.5		%		90-110	06-NOV-14
WG1989770-18	**CRM**		**VA-EC-PCT-CONTROL**						
Conductivity				98.8		%		90-110	06-NOV-14
WG1989770-19	**CRM**		**VA-EC-PCT-CONTROL**						
Conductivity				99.2		%		90-110	06-NOV-14
WG1989770-20	**CRM**		**VA-EC-PCT-CONTROL**						
Conductivity				99.9		%		90-110	06-NOV-14
WG1989770-21	**CRM**		**VA-EC-PCT-CONTROL**						
Conductivity				99.7		%		90-110	06-NOV-14
WG1989770-22	**CRM**		**VA-EC-PCT-CONTROL**						
Conductivity				100.1		%		90-110	06-NOV-14
WG1989770-23	**CRM**		**VA-EC-PCT-CONTROL**						
Conductivity				100.2		%		90-110	06-NOV-14
WG1989770-24	**CRM**		**VA-EC-PCT-CONTROL**						
Conductivity				100.7		%		90-110	06-NOV-14
WG1989770-1	**MB**								
Conductivity				<2.0		uS/cm		2	06-NOV-14
WG1989770-2	**MB**								
Conductivity				<2.0		uS/cm		2	06-NOV-14
WG1989770-3	**MB**								
Conductivity				<2.0		uS/cm		2	06-NOV-14
WG1989770-4	**MB**								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
EC-PCT-VA	**Water**							
Batch R3055708								
WG1989770-4 MB								
Conductivity			<2.0		uS/cm		2	06-NOV-14
WG1989770-5 MB								
Conductivity			<2.0		uS/cm		2	06-NOV-14
WG1989770-6 MB								
Conductivity			<2.0		uS/cm		2	06-NOV-14
WG1989770-7 MB								
Conductivity			<2.0		uS/cm		2	06-NOV-14
WG1989770-8 MB								
Conductivity			<2.0		uS/cm		2	06-NOV-14
NH3-F-VA	**Water**							
Batch R3066442								
WG1991003-2 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			107.8		%		85-115	10-NOV-14
WG1991003-4 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			107.3		%		85-115	10-NOV-14
WG1991003-6 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			108.8		%		85-115	10-NOV-14
WG1991003-7 DUP		**L1543026-1**						
Ammonia, Total (as N)		0.0051	0.0053		mg/L	5.2	20	10-NOV-14
WG1991003-1 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	10-NOV-14
WG1991003-3 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	10-NOV-14
WG1991003-5 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	10-NOV-14
WG1991003-8 MS		**L1543026-1**						
Ammonia, Total (as N)			102.9		%		75-125	10-NOV-14
Batch R3070505								
WG1993176-2 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			111.9		%		85-115	12-NOV-14
WG1993176-4 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			111.0		%		85-115	12-NOV-14
WG1993176-6 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			113.0		%		85-115	12-NOV-14
WG1993176-8 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			111.3		%		85-115	12-NOV-14
WG1993176-1 MB								

Quality Control Report

Workorder: L1543026 Report Date: 13-NOV-14

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NH3-F-VA	**Water**							
Batch R3070505								
WG1993176-1 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	12-NOV-14
WG1993176-3 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	12-NOV-14
WG1993176-5 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	12-NOV-14
WG1993176-7 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	12-NOV-14
P-T-PRES-COL-VA	**Water**							
Batch R3056678								
WG1990076-10 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			101.6		%		80-120	06-NOV-14
WG1990076-14 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			103.4		%		80-120	06-NOV-14
WG1990076-2 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			105.0		%		80-120	06-NOV-14
WG1990076-6 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			106.0		%		80-120	06-NOV-14
WG1990076-1 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	06-NOV-14
WG1990076-13 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	06-NOV-14
WG1990076-5 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	06-NOV-14
WG1990076-9 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	06-NOV-14
PH-PCT-VA	**Water**							
Batch R3055708								
WG1989770-25 CRM		**VA-PH7-BUF**						
pH			7.03		pH		6.9-7.1	06-NOV-14
WG1989770-26 CRM		**VA-PH7-BUF**						
pH			7.03		pH		6.9-7.1	06-NOV-14
WG1989770-27 CRM		**VA-PH7-BUF**						
pH			7.02		pH		6.9-7.1	06-NOV-14
WG1989770-28 CRM		**VA-PH7-BUF**						
pH			7.02		pH		6.9-7.1	06-NOV-14
WG1989770-29 CRM		**VA-PH7-BUF**						
pH			7.03		pH		6.9-7.1	06-NOV-14

ALS Environmental

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PH-PCT-VA	**Water**							
Batch R3055708								
WG1989770-30 CRM		**VA-PH7-BUF**						
pH			7.05		pH		6.9-7.1	06-NOV-14
WG1989770-31 CRM		**VA-PH7-BUF**						
pH			7.04		pH		6.9-7.1	06-NOV-14
WG1989770-32 CRM		**VA-PH7-BUF**						
pH			7.03		pH		6.9-7.1	06-NOV-14
PO4-DO-COL-VA	**Water**							
Batch R3054092								
WG1990054-2 CRM		**VA-OPO4-CONTROL**						
Orthophosphate-Dissolved (as P)			100.9		%		80-120	06-NOV-14
WG1990054-6 CRM		**VA-OPO4-CONTROL**						
Orthophosphate-Dissolved (as P)			95.1		%		80-120	06-NOV-14
WG1990054-7 DUP		**L1543026-1**						
Orthophosphate-Dissolved (as P)		<0.0010	<0.0010	RPD-NA	mg/L	N/A	20	06-NOV-14
WG1990054-1 MB								
Orthophosphate-Dissolved (as P)			<0.0010		mg/L		0.001	06-NOV-14
WG1990054-5 MB								
Orthophosphate-Dissolved (as P)			<0.0010		mg/L		0.001	06-NOV-14
WG1990054-8 MS		**L1543026-2**						
Orthophosphate-Dissolved (as P)			88.0		%		70-130	06-NOV-14
TDS-VA	**Water**							
Batch R3061408								
WG1991028-11 LCS								
Total Dissolved Solids			97.4		%		85-115	07-NOV-14
WG1991028-14 LCS								
Total Dissolved Solids			94.6		%		85-115	07-NOV-14
WG1991028-8 LCS								
Total Dissolved Solids			97.6		%		85-115	07-NOV-14
WG1991028-10 MB								
Total Dissolved Solids			<10		mg/L		10	07-NOV-14
WG1991028-13 MB								
Total Dissolved Solids			<10		mg/L		10	07-NOV-14
WG1991028-7 MB								
Total Dissolved Solids			<10		mg/L		10	07-NOV-14
TSS-LOW-VA	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TSS-LOW-VA	**Water**							
Batch R3058669								
WG1990702-2 LCS								
Total Suspended Solids			105.7		%		85-115	06-NOV-14
WG1990702-4 LCS								
Total Suspended Solids			94.5		%		85-115	06-NOV-14
WG1990702-1 MB								
Total Suspended Solids			<1.0		mg/L		1	06-NOV-14
WG1990702-3 MB								
Total Suspended Solids			<1.0		mg/L		1	06-NOV-14
TURBIDITY-VA	**Water**							
Batch R3054123								
WG1990144-2 CRM		**VA-FORM-40**						
Turbidity			99.3		%		85-115	06-NOV-14
WG1990144-5 CRM		**VA-FORM-40**						
Turbidity			99.3		%		85-115	06-NOV-14
WG1990144-8 CRM		**VA-FORM-40**						
Turbidity			100.3		%		85-115	06-NOV-14
WG1990144-1 MB								
Turbidity			<0.10		NTU		0.1	06-NOV-14
WG1990144-4 MB								
Turbidity			<0.10		NTU		0.1	06-NOV-14
WG1990144-7 MB								
Turbidity			<0.10		NTU		0.1	06-NOV-14

Quality Control Report

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
J	Duplicate results and limits are expressed in terms of absolute difference.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH by Meter (Automated)							
	1	04-NOV-14 11:05	06-NOV-14 23:00	0.25	60	hours	EHTR-FM
	2	04-NOV-14 11:05	06-NOV-14 23:00	0.25	60	hours	EHTR-FM
	3	04-NOV-14 11:05	06-NOV-14 23:00	0.25	60	hours	EHTR-FM
	4	04-NOV-14 11:05	06-NOV-14 23:00	0.25	60	hours	EHTR-FM

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L1543026 were received on 05-NOV-14 12:25.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

L1543026-COFC

Chain of Custody / Analytical Request Form
Canada Toll Free : 1 800 668 9878
www.alsglobal.com

COC #: OL-1316

Report To
Company: ECOFISH RESEARCH LTD
Contact: Kevin Ganshorn
Address: 906 - 595 Howe Street
Vancouver, BC
Canada, V6C2T5
Phone: 604-608-6180 Fax: 604 559-6180

Invoice To ☑Email ☐Mail
Company: ECOFISH RESEARCH LTD
Contact: Accounts Payable
Address: Suite F, 450 - 8th Street
Courtenay, BC
Canada, V9N 1N5
Email: accountspayable@ecofishresearch.com
Phone: 250-334-3042

Lab Work Order # (lab use only)

Reporting
Distribution: ☐Fax ☐Mail ☑Email
☑ Criteria on Report (select from Guidelines below)
Report Type: ☑Excel ☐Digital
Report Format: CROSSTAB_ALSQC
Report Email(s): kganshorn@ecofishresearch.com
tkasubuchi@ecofishresearch.com
pdinn@ecofishresearch.com
EDD Format:
EDD Email(s):

Project Info
Job #: 1230 JHT-MON8
PO/AFE:
LSD:
Quote #:
ALS Contact: Ariel Tang
Sampler: Leah Hull

Service Requested
⊙ Regular (Standard Turnaround Times - Business Days) - R
○ Priority (3 Days) - surcharge will apply - P
○ Priority (2 Days) - surcharge will apply - P2
○ Emergency (1-2 day) – surcharge will apply - E
○ Same Day or Weekend Emergency - surcharge will apply - E2
○ Specify date required - X

Analysis Requests

Please indicate below Filtered, Preserved or both (F, P, F/P)

Sample #	Sample Identification (This will appear on the report)	Longitude	Latitude	Date	Time	Sample Type	Number of Containers	Alkalinity by Colourimetric (Automated)	Ammonia in Water by Fluorescence	Conductivity (Automated)	Diss. Orthophosphate in Water by Colour	Nitrate in Water by Ion Chromatography	Nitrite in Water by Ion Chromatography	Total Dissolved Solids by Gravimetric	Total P in Water by Colour	Total Suspended Solids by Grav. (1 mg/L)	Turbidity by Meter	pH by Meter (Automated)
	QUN-~~WQ1A~~ – WQA			4-Nov-2014	11:05	Water	3	R	R	R	R	R	R	R	R	R	R	R
	QUN-~~WQ1B~~ – WQB					Water	3	R	R	R	R	R	R	R	R	R	R	R
	QUN-TRIP BLANK					Water	3	R	R	R	R	R	R	R	R	R	R	R
	QUN-FIELD BLANK					Water	3	R	R	R	R	R	R	R	R	R	R	R

Short Holding Time
Rush Processing

The questions below must be answered for water samples (check Yes or No)
Are any sample taken from a regulated DW system? ☐Yes ☒No
If yes, please use an authorized drinking water COC
Is the water sampled intended to be potable for human consumption? ☐Yes ☒No

Guidelines
British Columbia Approved and Working Water Quality Guidelines (JULY, 2013) - BCAWWQG - Freshwater Aquatic Life

SAMPLE CONDITION (lab use only)
☐Frozen ☐Cold ☐Ambient ☐Cooling Initiated

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by: Leah Hull	Date: 4-Nov-2014	Time: 16:00	Received by: Paige	Date: Nov. 5	Time: 12:25	Temperature: 5.5 °C	Verified by:	Date:	Time:	Observations: ☐Yes If Yes add SIF

Appendix H. Water Quality and Air Temperature Site Photographs for the Salmon River and the Quinsam River.

LIST OF FIGURES

Figure 1. Looking river left to river right from SAM-WQ on June 17, 2014.

Figure 2. Looking river right to river left to SAM-WQ on June 17, 2014.

Figure 3. Looking downstream from SAM-WQ on June 17, 2014.

Figure 4. Looking upstream to SAM-WQ on June 17, 2014.

Figure 5. Air temperature sensor at SAM-WQ on June 17, 2014.

Figure 6. Looking river left to river right from QUN-WQ on May 23, 2014.

Figure 7. Looking river right to river left to QUN-WQ on May 23, 2014.

Figure 8. Looking downstream from QUN-WQ on May 23, 2014.

Figure 9. Looking upstream from QUN-WQ on May 23, 2014.

Figure 10. Air temperature sensor at QUN-WQ on May 23, 2014.