2016

Annual Environmental Monitoring Program: Hydrology, Water Quality and Invertebrate Richness of Richards Creek

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Executive Summary

An annual environmental monitoring project was completed in 2016 by three students from Vancouver Island University (VIU) enrolled in the Bachelor of Natural Resource Protection Program. The project took place at Richards Creek, located north of Duncan, British Columbia. The monitoring program ran for the 9th consecutive year and included the collaboration of the Department of Fisheries and Oceans.

Richards Creek is part of an extensive watershed called the Cowichan River Watershed. This watershed is essential habitat to many terrestrial and aquatic organisms, including many varieties of salmonids.

Four stations were monitored that were previously chosen for ease of access and to represent an equal spacing along the 9.2 km stretch. The objective of the program was to contribute to the annual data bank and asses the site for the year for hydrology, water quality parameters and invertebrate richness.

Heavy rains in 2016 contributed to two high flow events which contrasts to previous years. Previous years had a low flow and a high flow event.

Two sets of samples were taken, one was analyzed at VIU and another was shipped to ALS Environmental Laboratory in Burnaby, BC. Dissolved oxygen was found at station 4 during event 1 to be too low to sustain even invertebrate life for the second year in a row. Excess nutrients were found within the stream in some areas. Turbidity was extremely high at station 1 during the first event may be relevant to heavy seasonal rains. All metals detected were below British Columbia Water Quality Guidelines (RISC 1998). Invertebrate diversity populations were acceptable at stations 1 and 2 and good at station 3.

Contents

1.0 Introduction

1.1 Richards Creek Monitoring Program Overview (2016)

Vancouver Island University (VIU) undergraduate students have added to previous years of data collection (2008-2016) archived at VIU. The following pages document the 2016 environmental monitoring program of Richards Creek, located north-east of Duncan, British Columbia (BC). This monitoring project took place in the months of October, November and December (2016). The three field technicians were comprised of third year Bachelor of Natural Resource Protection (BNRP) students. Overall project supervision was administered by Dr. Eric Demers, R.P. Bio, whom instructed RMOT 306 Environmental Monitoring and directed the project for the region. This was the 9th consecutive year of data collection and analyses for this watershed.

Two mountains drain into Richards Creek, Mount Richards and Maple Mountain. Richards Creek (Appendix I, Figure 1) runs south-westerly between Crofton Lake (elevation 142 m) and Somenos Lake (Somenos Marsh elevation 4.5 – 7.5 m). Richards Creek can vary in width (weather/season dependent) from 2 – 20 m. Gradient levels of Richards Creek fluctuate from < 0.1-5.0%. Somenos Lake is 100 ha and Richards Creek is the largest tributary to flow into it. The tributary (Richards Creek) flows for 9.2 km and connects via Somenos Lake and Somenos Creek to the Cowichan River Watershed, this watershed provides an immense part of local habitat for wildlife and has many uses for the human population in both the agricultural and residential sectors. Multiple species of anadromous salmonids such as coho (*Oncorhynchus kisutch*), chum (*Oncorhynchus keta*) and Steelhead (*Oncorhynchus mykiss*) utilize the tributaries of this watershed all months of the year for spawning or rearing/wintering. Some non-anadromous localized species of salmonids such as cutthroat trout (*Oncorhynchus clarkii*) spend their entire lives within the watershed (Guimond and Sheng 2005, Priekshot et al. 2015). The Cowichan River Watershed ultimately runs to sea south of the Strait of Georgia.

1.2 Historical and Potential Environmental Concerns of Richards Creek

Crofton Lake was the beneficiary of a dam built in 1956, originally the dam was designed to release only marginal flow into Richards Creek (MOE 2009). This dam caused extremely low summer flows within the tributary (Richards Creek) up until 2008 and called for action to be taken to increase flow-conditions related to rearing habitat for trout and salmon (MOE 2009).

The urban and agricultural footprint around Richards Creek contribute to excess nutrient loads within the Somenos Basin which causes hypoxic water conditions (Guimond and Sheng 2005). Although in decades past this tributary may have provided optimum habitat for coho salmon (*Oncorhynchus kisutch*) it is thought that low flows of Richards Creek contributed to a reversal of flow and fry die-off in Somenos Lake in 1998 (Guimond and Sheng 2005, Priekshot et al. 2015).

Under 10 years have passed since Crofton became the beneficiary of a new water supply (MOE 2009), this reciprocated in allowance of up to two-thirds of Crofton Lake reservoir to be released into Richards Creek during low summer flows to positively augment salmonid habitat. The remaining one-third will be kept for Crofton to utilize as a back-up water supply (MOE 2009). The flow to Richards Creek has been regulated since these changes took effect by a 5cm valve/pipe which discharges into the creek 60 m below the lake outlet (MOE 2009).

Numerous rare or threatened plant species and communities are indigenous to the Somenos Basin (Williams and Radcliffe 2001) which compete with hearty introduced species (Williams and Radcliffe 2001).

1.3 Project Objectives

Objectives of the environmental monitoring project were to add to the databank (stored at VIU) of collected hydrological parameters and potential/actual environmental impacts from both, the urban and agricultural sectors over the last decade. Data collection was completed at four predetermined sites. At each site parameters and data was archived and analyzed for compilation with the previous 9 years of study. The areas archived included water quality, hydrology, microbiology and invertebrate richness.

2.0 Methods

2.1 Sampling Site, Frequency and Stations

2.1.1 Sampling Site (Richards Creek)

Richards Creek (Figure 1 below) sampling site is composed of four predetermined stations numbered from station 1 (upstream) to station 4 (downstream) (Appendix I, Figure 1). The stations were chosen in October and November 2008 by the original project team members to provide adequate coverage dispersal of Richards Creek and to coincide with stations previously utilized by the Department of Fisheries and Oceans (DFO) (VIU 2008). These sites also provide ease of access to sampling areas (safety), vegetation species variability, similar substrate compositions, potential effluent point sources nearby and adequate flow for study. The upstream stations (station 1, 2 and 3) of Richards Creek flow through agriculturally/residentially zoned areas. The lower reaches of station 4 flow through a riparian (marshland) area that finally comes to a stagnant stand-still as it enters the mouth of Somenos Lake (Somenos Marsh). Data collection location may vary slightly regarding coordinates given that within 9 years of this program it has been permissible to move within 25 m of each site for safety and accessibility reasoning. It is important to note that during our site assessment when our station photographs were taken (early-October) flow was minimal. Heavy rains accumulated through the 2016 program and made sampling conditions more hazardous with a much heavier volume of water flowing downstream during data collection in late-October/early-November.

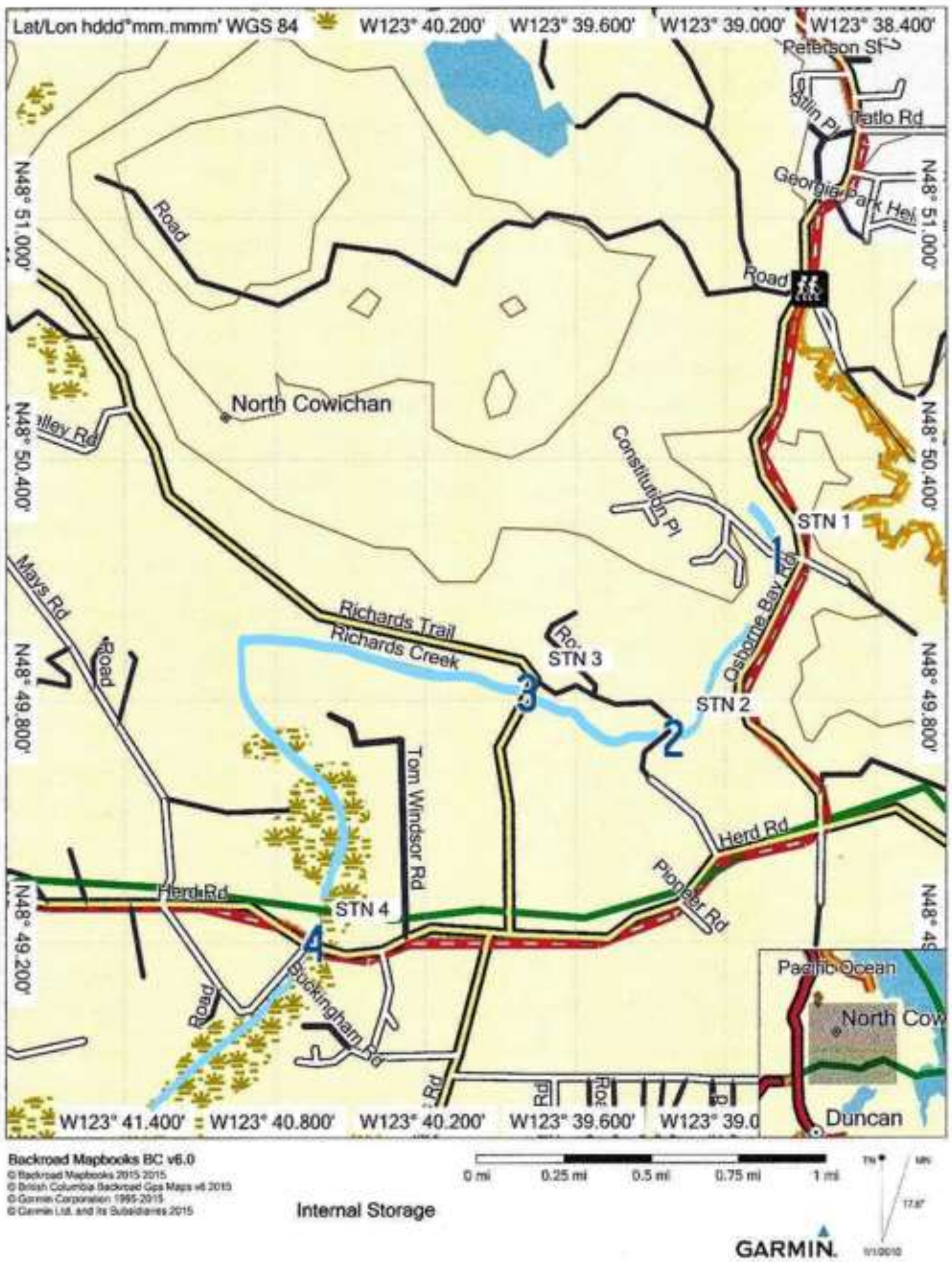

Figure 1: Richards Creek Environmental Monitoring Site (Adapted from Garmin Basecamp Software 2016)

2.1.2 Sampling Frequency (Data Collection Occurred in Two Events)

The Richards Creek field data phase transpired on two separate events (dates). The first field

Figure 14: Richards Creek Environmental Monitoring Site (Adapted from Garmin Basecamp Software 2016) date was October 29, 2016 and the second date was November 21, 2016. In years past this represented a low-flow and a high-flow seasonal pattern. Data collection was followed by corresponding lab days for analyses. The first data set was analyzed in the VIU lab on November 1, 2016 and the second data set was analyzed in the VIU lab on November 23, 2016.

2.1.3 Sampling Station 1

Station 1 (Appendix II, Figure 2) is located at UTM 10U 5409520 mE, 452560 mN. This station had a culvert crossing Escarpment Way. This station was approximately 2.3 km south-east from Crofton Lake. Stream substrate at station 1 was granule (2-4 mm), with some examples of larger rocks. Station 1 was shallow (10 cm) in depth with fast flowing water. The southern bank of station 1 was bordered with ~2 m of riparian vegetation followed by a residential home. Northern banks of station 1 were bordered with no riparian buffer and a large agricultural field.

2.1.4 Sampling Station 2

Station 2 (Appendix II, Figure 3) is located at UTM 10U 5408622 mE, 452083 mN. Station 2 was located at the end of Rice Road, a small hobby farm (Innisvale Farm) had rows of berry bushes growing seen in Figure 3 station photograph. This station was approximately 3.5 km south of Crofton Lake. Stream substrate at station 2 consisted of granule (2-4 mm) and pebble (4-64 mm). Station 2 was approximately 30 cm in depth and fast flowing with a water gauge present. The southern bank of Richards Creek at station 2 had a natural forested area perfect for a riparian buffer zone. The northern bank had an invasive English Ivy (*Hedera helix*) that had completely taken over the bank and was absent any riparian zone. The invasive plant was spreading to the other side of the stream via cement weir. Station 2 access was down a trail off Rice Road and is granted through private property.

2.1.5 Sampling Station 3

Station 3 (Appendix II, Figure 4) location is UTM 10U 5408795 mE, 451331 mN and located at a culvert crossing on Richards Trail. This station is approximately 4.2 km from Crofton Lake, stream substrate for station 3 consisted of pebble (4-64 mm) and cobble (6.4-25.6 cm), it also had large concrete slabs remaining from past infrastructure. This station had a sufficient riparian buffer zone of indigenous species on its southern bank and was bordered by extensive agriculture and a complete lack of riparian area on its northern bank.

2.1.6 Sampling Station 4

Station 4 (Appendix II, Figure 5) is located at UTM 10U 5408795 mE, 451331 mN. This station is located on a heavy traffic road (Herd Rd) at a two-lane bridge crossing. Station 4 is approximately 7.2 km from Crofton Lake and is 2.0 km upstream from Somenos Lake. The substrate at this station was mud, silt and clay with some sand (< 2 mm). The riparian zones at this station were large but had invasive species such as Himalayan blackberry (*Rubus armeniacus*). Richards Creek at station 4 had a population of duckweed (*Lemna minor*) and massive algal blooms, stagnant and collecting on the surface at many areas.

2.2 Sample Collections: Equipment, Methods, Storage and Shipment

2.2.1 Hydrology – Equipment, Methods

When conducting basic stream hydrology testing for this monitoring program the team used a meter stick, a ping pong ball and a stopwatch. The meter stick was held level with the surface of the stream with one end facing upstream and the other end facing downstream, the ping pong ball was placed at the end of the meter stick upstream, the time it took for the ping pong ball to reach the end of the meter stick downstream was recorded, this process was repeated three times for each sample site on both events. The sets of three recorded times for each site were used to mathematically measure discharge of Richards Creek at stations 1,2 and 3. Station 4 was the mouth to Somenos Lake and was a stagnant body of water below testable limits.

Discharge represents the volume of water that flows through a cross section of a stream during a set amount of time. Discharge and slope of a stream indicate the potential for erosion, which in turn affects the amount of sediment and organic material distributed throughout the stream (Demers 2016).

2.2.2 Water Quality (VIU) – Equipment, Methods, Storage and Analysis

Water quality parameters were collected in the field using 500 ml labelled-plastic water bottles on both events (Stations 1-4). Sample bottles were rinsed three times before collection. The samples were collected from within station streams using gumboots, submerging the bottles just below the surface and facing upstream. Care was taken not to disturb stream substrate/sediments. Ice packs were pre-frozen and put in a site cooler to ensure samples stayed at appropriate temperature variations (~ 4°C) during collection, transport and storage. Once all samples were collected they were stored in a refrigerator for no more than 72 hours before analyses. Field parameters were collected with a digital Oxyguard Handy Polaris DO Meter to gather water temperatures (°C), dissolved oxygen (DO mg/L) and saturation (%). Open-lab sessions were held in November to analyze the following water parameters: conductivity (µS/cm), pH, turbidity (NTU), total alkalinity (mg/L as $CaCO_3$), hardness (mg/L as $CaCO_3$), nitrate (mg/L) and phosphate (mg/L). During open-lab a DR 2800 HACH Spectrophotometer was used to measure phosphate and nitrate levels in all VIU samples. Turbidity was tested to the nearest 0.01 NTU (Nephelometric Turbidity Units) using a HACH 2100 Potable Turbidimeter (Demers 2016). Total alkalinity (as $CaCo_3$) was tested to the nearest 0.01 mg/L using HACH

AL-DT digital titration method (Demers 2016). Hardness was tested using the appropriate HACH kit.

2.2.3 Water Quality (ALS) – Equipment, Methods, Storage and Shipment

A separate set of water samples (4 samples total) were collected to ship to ALS Laboratory located at 8081 Lougheed Highway, Burnaby, BC. Samples shipped to ALS were tested for Conductivity, pH, total hardness, nutrients and total metals. The stations sampled in 2016 were stations 2, 3 and 4. Three of the water samples were collected in 250 ml sterile-glass labeled containers from within the stream wearing gumboots and submerging the containers just under the surface while facing upstream. The team was careful not to disturb stream substrate/sediments. The 3 samples taken for ALS testing in the glass containers consisted of analyses of conductivity, pH, total hardness and nutrient levels. An additional sample was taken in 250 ml plastic container for detection of total metals. After collection of each sample preservatives were added in the form of nitric and sulphuric acids and inversed five times to ensure complete mixing (Demers 2016). Nitric acid was added to the 250 ml amber glass jars (nutrients) and sulphuric acid was added to the 250 ml plastic container (metals) (Demers 2016). Once collection of water was complete at each station they were added to the iced site cooler for transport to a refrigerator to ensure samples stayed at the appropriate temperature (~4°C).

2.2.4 Quality Assurance and Quality Control (Water Quality)

During all sampling, storage, shipping and analyses The Ambient Freshwater and Effluent Sampling Manual was followed. This manual was published by the Government of British Columbia in 2003. Numerous measurements were taken to ensure quality assurance and quality control (QA & QC) were as follows: Gloves used in the field and in the lab, rinsing of bottles three times to ensure previous samples had no effect on following ones, storage and transport principles were followed regarding temperature and trip blank/replicate samples always accompanied project samples (VIU 2015). Water samples shipped to ALS laboratories went through chain of custody process for both sampling events (Appendix IV, Figures 25-34). A replicate sample was taken at station 1 on both sampling events to ensure a regimented sampling pattern for 2016. A trip blank filled with distilled water was brought along on both sampling events to detect possible site contamination between station samples.

2.2.5 Microbiology – Equipment, Methods, Storage and Analysis

Microbiology collection and analyses was completed only on the first sampling event to determine total coliform and fecal coliforms (CFU/100 ml). Only three stations were chosen to represent these numbers (stations 1,2 and 3) which has been contradictory from previous years. Water samples were taken in sterile 100 mL Whirlpak bags and transported/stored in the site cooler with the VIU samples until open lab times commenced. The samples were taken with the bag-opening facing upstream at the time of submersion and collection. In open-lab on the 1st of November, 2016 the samples were tested using the m-coliBlue24 membrane filtration method (VIU 2008). Water was extracted from sample bags with a pipette in 25 ml increments and filtered through a membrane filter, equipped with sample paper absorbent pads (saturated with broth) and 3 mm grid lines. Using a vacuum-pressurized hand pump filtration was complete and the pads were transferred to a petri dish for incubation (VIU 2008). Upon completion of an incubation period with an air incubator capable of operating at 35°C ± 0.5 °C, results were posted on a VIU website for further analyses. Since only 25 ml samples were used the sum of coliform units (CFU) was than multiplied by 4 to give results corresponding to 100 ml of station water. Filtration blanks were used at a frequency of 10% for samples taken.

2.2.6 Quality Assurance and Quality Control (Microbiology)

QA & QC for microbiology was assured by using sterile, sealed bags that were transported and stored in the site cooler for no more than 72 hours. The sampling, storing and analyses methods have been the same for the previous 9 years consecutively to ensure results gathered are consistent, additionally the apparatus used was rinsed with sterile water between switching between station analyses.

2.2.7 Invertebrate Sampling – Equipment, Methods, Storage

Invertebrate collection occurred on the first sampling event only, using a Hess sampler. Hess samplers are used to measure invertebrate population/diversity in the stream by limiting areas to be sampled. This is done by ensuring similar substrates are sampled for species. Water should not flow over the top of the Hess sampler so stream conditions and location of the samples can be verified and specimens cannot escape collection. Once placed in substrate (Hess sampler) and secured, the large rocks were removed and braised with the hand to dislodge specimens which in turn were caught in the poly-bottle cod-end (downstream). After being collected in the cod-end, the specimens were transferred into cups which were kept in the iced site cooler. The specimens were stored in a fridge with the water samples until the first open-lab analyses (November 1, 2016). Sampling of invertebrates is a good indicator of over-all stream ecosystem health. The data was recorded on invertebrate field data sheets (Appendix III, Figures 19-24) for stations 1, 2 and 3.

2.2.8 – Invertebrate Lab Analysis

Invertebrate analysis occurred after the first sampling event only in the VIU lab. Lab analysis of invertebrates occurred within 4 days from procurement. Analyzing invertebrates was accomplished by data collection of taxa populations and the diversity of these populations. Within the VIU lab we utilized The Streamkeepers Handbook: A Practical Guide to Stream and

Wetland Care, along with supplementary dichotomous keys to ensure accurate identification of all specimens to Order or Family. The Shannon-Weiner Index was calculated for each station using the invertebrate field data sheets and the data from density, pollution tolerance index, EPT index and predominant taxa ration index. This data compiled determined species diversity in station communities (VIU 2015).

2.2.9 Quality Assurance and Quality Control (Invertebrates)

Quality Assurance during invertebrate sampling was achieved by taking triplicate samples at each station in similar substrates to provide an accurate representation of invertebrate population and diversity for the overall site (Richards Creek). Thoroughly rinsing out the Hess sampler and sampling cups helped to make sure there was no possibility of giving a false representation of species population and diversity. The cups were sealed and placed in the cooler and clearly labeled so during analysis there was no possibility of crossing over the data from sampling stations. Sampling techniques taken to ensure accurate data included taking the first sample downstream and working upstream to minimize disruption of natural habitat and get an accurate population accounting for all stations giving averages. Quality control was achieved by ensuring all mathematics were double checked (Appendix III, Figures 19-24) to receive a better representation of the invertebrates present. We located similar substrates to maintain quality control throughout the varying sample stations.

3.0 Results and Discussion of Analyses

3.1 General Site Timings, Dates and Conditions

As stated in 2.1.2 the data was collected during two sampling events. In years past it was a high flow sampling event and a low flow sampling event. The project site encountered heavy rains in 2016 during the months of October and November thus the second sampling event was of higher flow volume.

3.2 Hydrology and Water Quality

The results from this monitoring program showed a wide variation in water quality parameters from 2015 to 2016, some parameters tested showed similarities to previous testing while others showed either an increase or decrease in results. A comparison of water quality parameters tested in 2015 to 2016 follows (starting next page);

3.2.1 Richards Creek Hydrology Analysis (2016)

Discharge

Discharge (measured in m3/second) was tested at station 1, 2 and 3 for both sampling events in 2016 and only station 3 in 2015 as shown in Figure 10 below. Station 4 was not tested as flow was below the testable limit. Discharge varied from station to station and between both sampling events. The variability could have been due to heavy rainfall between sampling event one and two in 2016. The outlet that controls flow to Richards Creek from Crofton Lake reservoir upstream may have effected this parameter if the reservoir was at maximum capacity and water was being released.

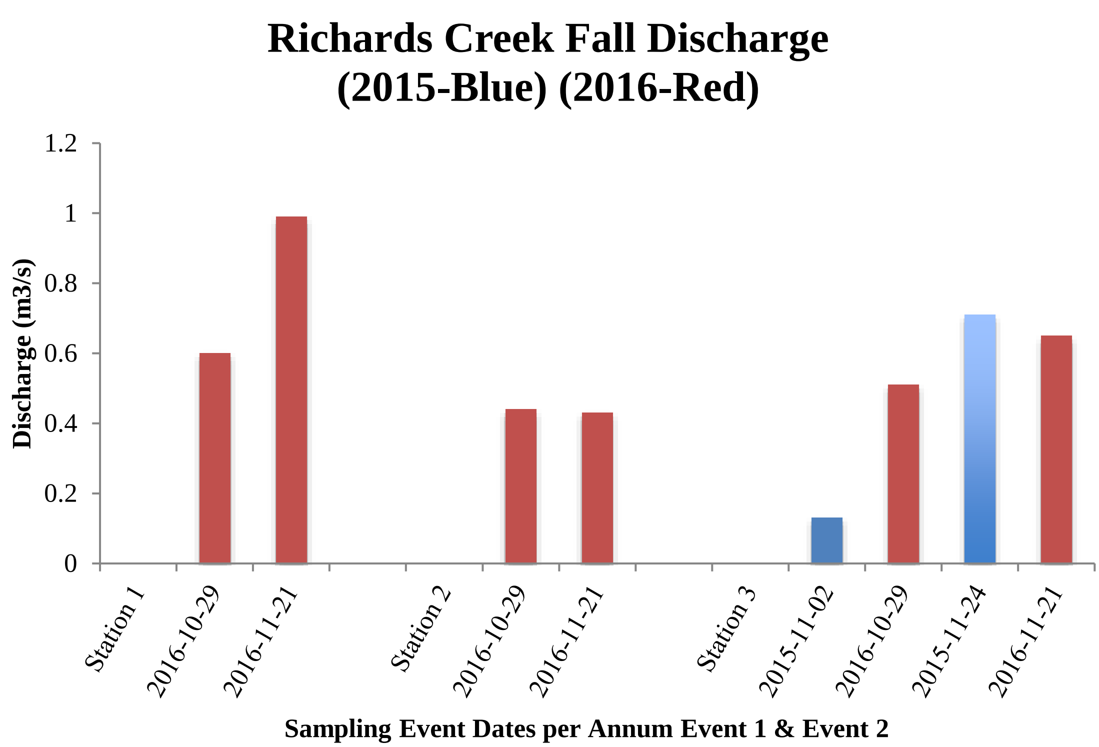

Figure 2: Richards Creek Fall Discharge – 2 Dated Samplings per Annum

3.2.2 VIU Water Quality

Water Temperature

Water temperature was measured and it was found that temperatures from both 2015 and 2016 remained within 1-2 °C for the first sample event as shown below in Figure 8. The water temperature recorded from the second sample event in 2015 is significantly lower than all other samples and in 2016 it was uniform. Winter/fall storm systems from the Pacific Ocean can cause temperature fluctuations in the air which effects shallow bodies of water.

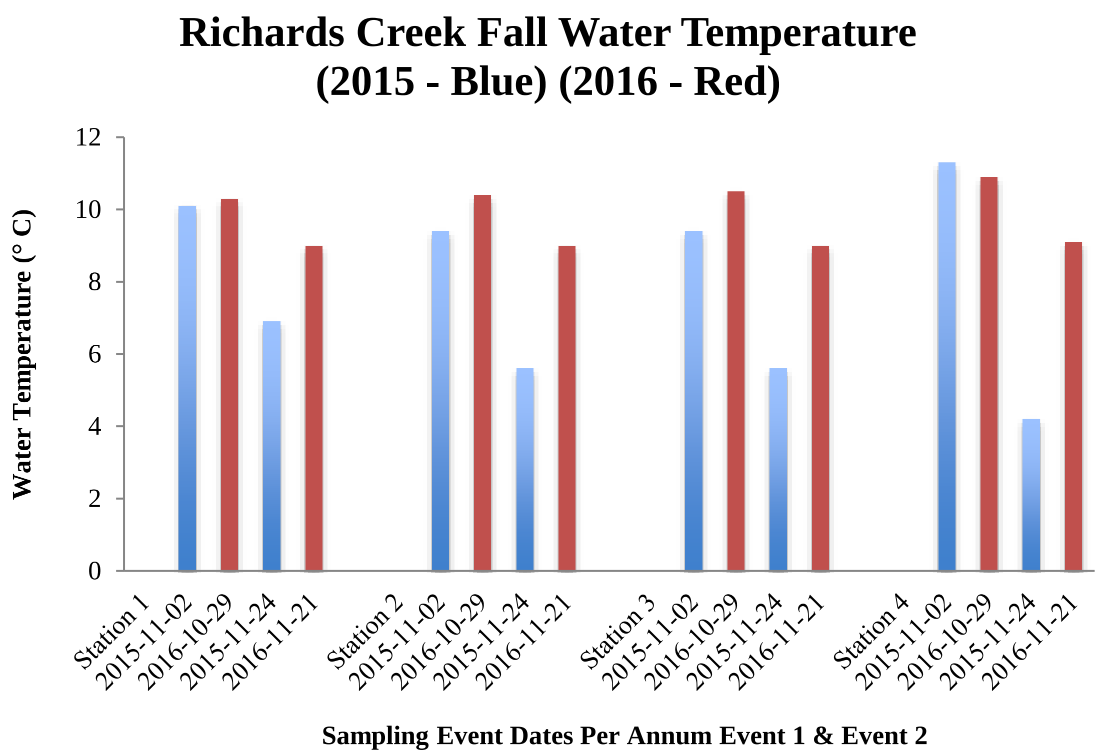

Figure 3: Richards Creek Fall Water Temperature – 2 Dated Samplings per Annum

Dissolved Oxygen

Dissolved oxygen (DO) was tested and it was found that there was a decrease from 2015 results to 2016 data collected (shown Figure 9 below) from all stations except station 4 showed a higher level of dissolved oxygen from the second sampling event from 2016 compared to 2015. Stations 1-3 showed high enough DO to support all life stages of fish both years and events (BC Water Quality Guidelines). Station 4 on the first sampling event both years showed hypoxic conditions incapable of sustaining even invertebrates. Station 4, sampling event 2 in both years recovered significantly with values capable of sustaining all life stages of fish. This could cause population degradation of numerous species during early fall seasons.

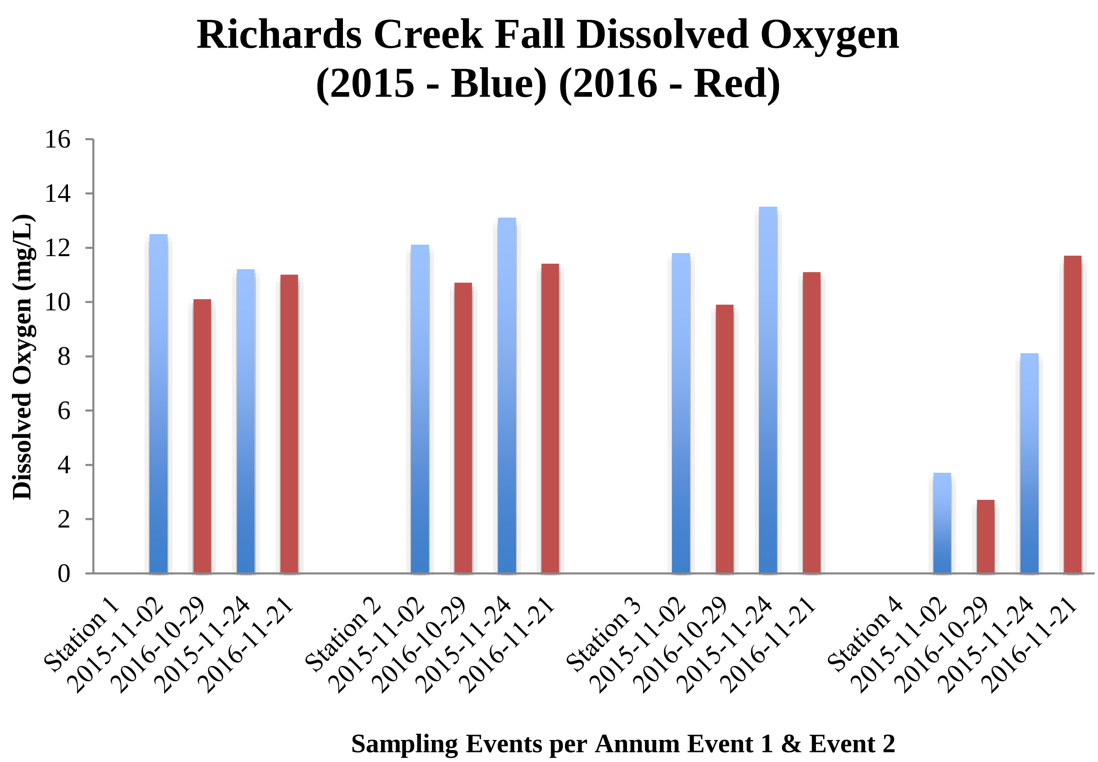

Figure 4: Richards Creek Fall Dissolved Oxygen – 2 Dated Samplings per Annum

Conductivity

Conductivity results in Figure 7 show there is an increase from station 1 downstream through stations 2, 3 and 4 during both years when compared. There is a significant increase in parameter levels from sampling event 1 in 2015 in comparison to results found in 2016. The second sampling events in both years of testing show trending traits.

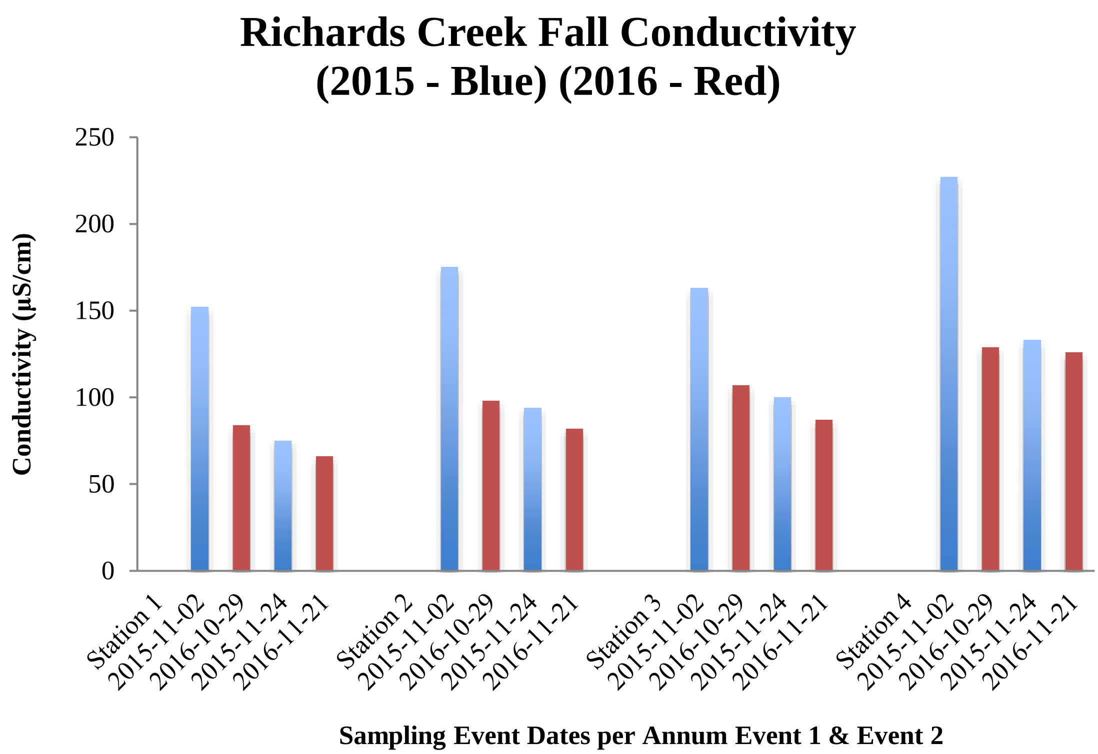

Figure 5: Richards Creek Fall Conductivity – 2 Dated Samplings per Annum

pH

As seen in Figure 1 below the overall pH levels tested in 2016 were lower (more acidic) than levels tested in 2015 by approximately 0.5-1.0 pH units. This was a trend at each station and occurred during both sampling events. There was one exception of this at station 2 during the first sampling event, where the pH levels were very close. The pH levels in 2016 were within the criteria limits for aquatic life, which range from 6.5-9.0 (RISC 1998).

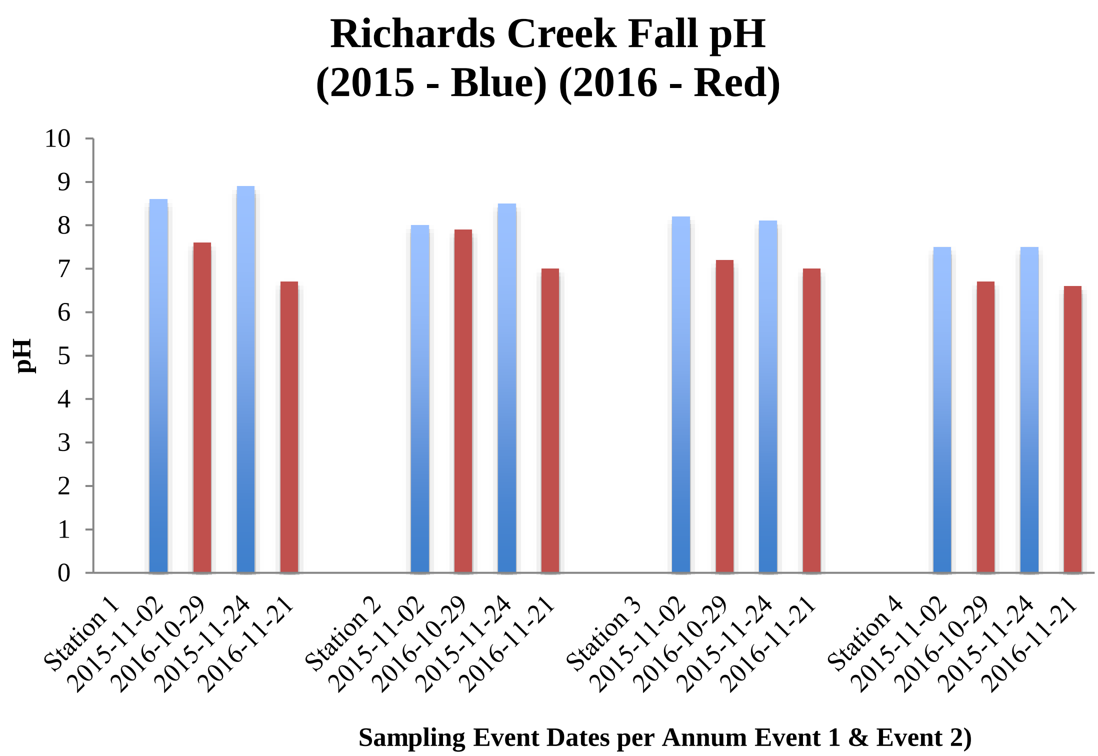

Figure 6: Richards Creek Fall Discharge – 2 Dated Samplings per Annum

Total Alkalinity

Alkalinity was found in 2015 and 2016 to increase from station 1 to 4 downstream on both sampling events (shown in Figure 6). There was a different trend seen in sampling event one from 2015 where measured alkalinity remained stable for all four sample stations in comparison to a spike at station 4 in 2016. An alkalinity level of less than 20 mg/L represents water with "low" sensitivity to acidification (RISC 1998). An observation from 2016 samples concludes all stations except station 1 have over 20mg/L. Station 1 is only slightly under 20mg/L. Samples from 2015 show that all stations during event one had results above 20 mg/L and all stations during event two had results below 20 mg/L.

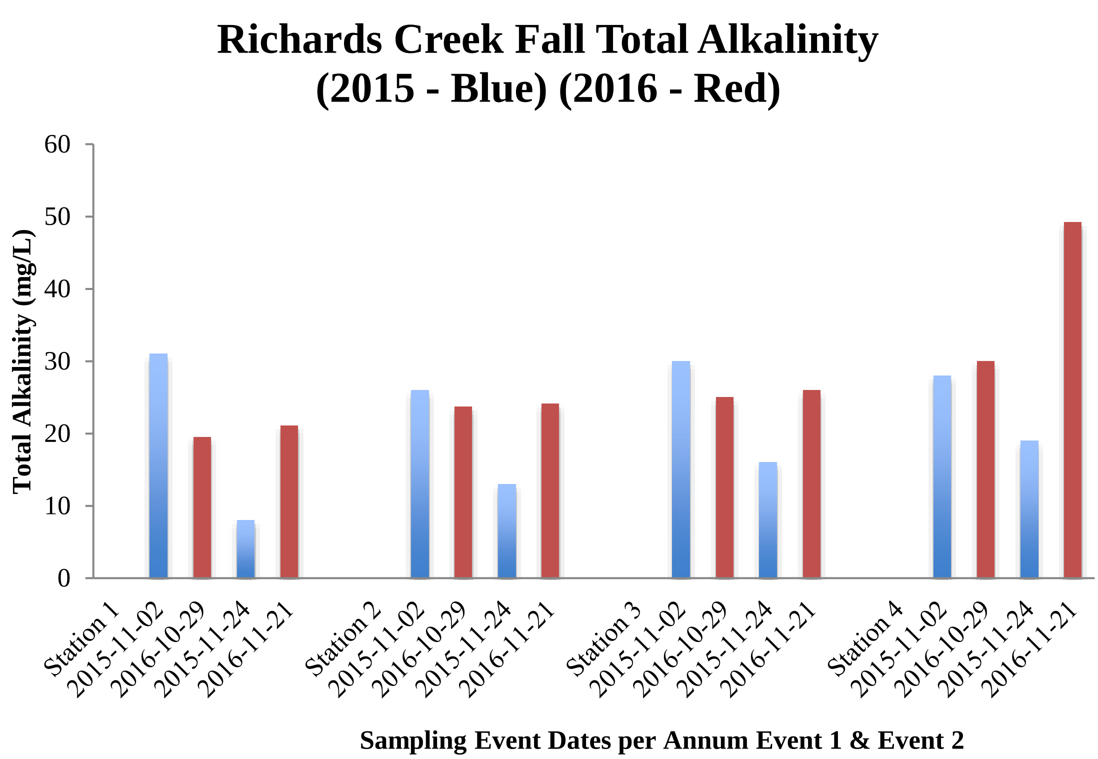

Figure 7: Richards Creek Fall Total Alkalinity – 2 Dated Samplings per Annum

Hardness

Figure 5: Hardness levels below shows water hardness parameters indicated a significant decrease from sampling event one to sampling event two in 2016. This can be correlated with the ALS results (see Tables 1 & 2). Sampling event 2 showed trending levels between both years at all stations. 2015 water hardness levels show a slight increase as you move downstream to station 4. The hardness levels in 2016 from stations 1, 2 and 3 are below 60 mg/L, which is considered "soft" water (RISC 1998). Station four was the only station found to measure over 60 mg/L.

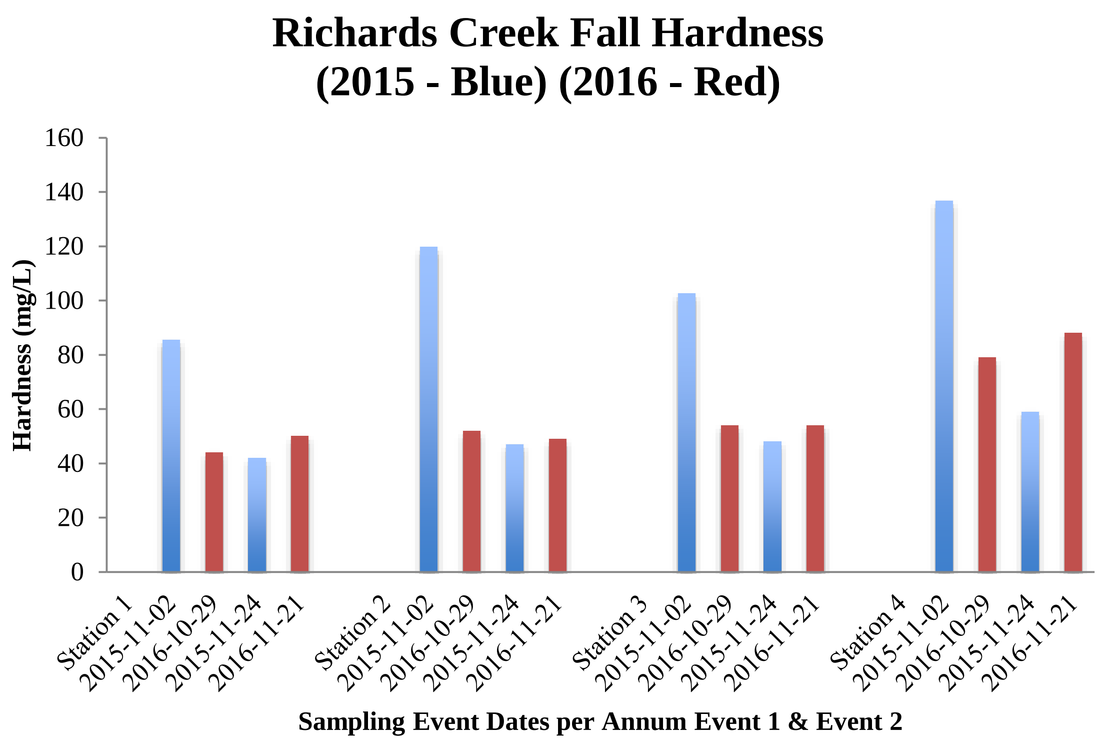

Figure 8: Richards Creek Fall Hardness – 2 Dated Samplings per Annum

Turbidity

The turbidity levels varied considerably between sampling stations (Figure 2 below), events and years (2015-16). Between the two sampling events in 2016 there was considerable rainfall in the area which can cause increased levels of total suspended solids (TSS) in the stream. This provides an explanation to spiking levels of turbidity at station 1 on the second sampling event. Overall the turbidity was lower in 2016 when compared to 2015 during both sampling events. The exception to this in 2016 was at station 1 during sampling event 2.

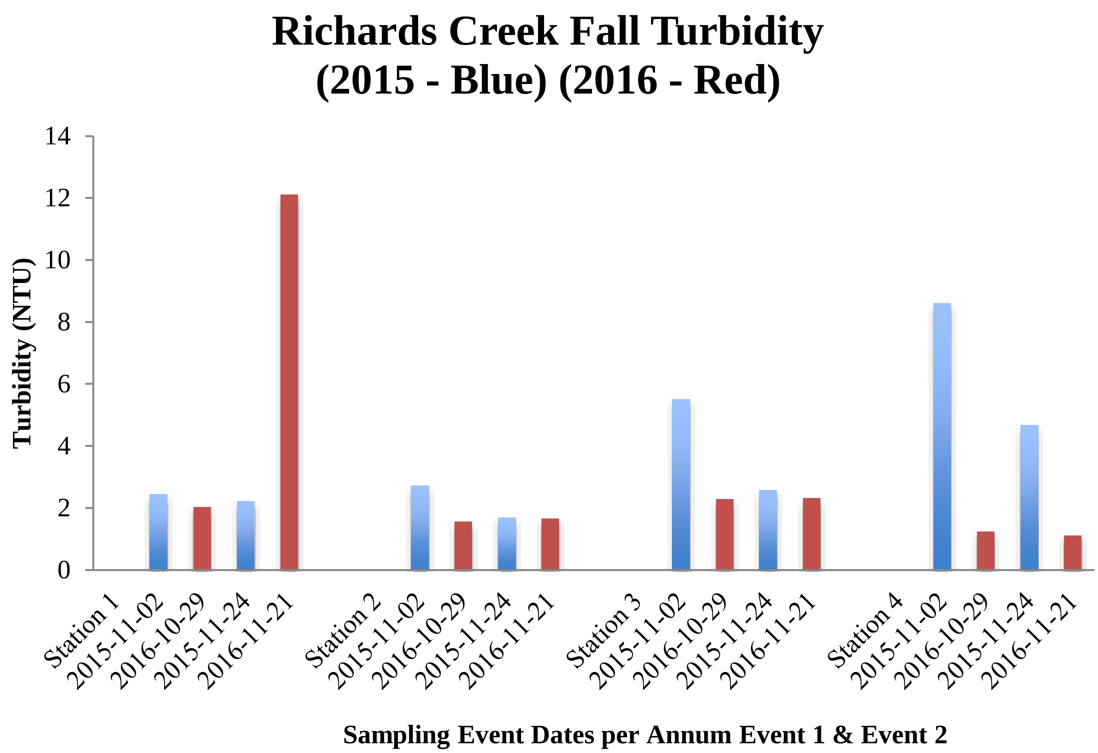

Figure 9: Richards Creek Fall Turbidity – 2 Dated Samplings per Annum

Nitrate

Nitrate concentration levels tested in 2016 and shown in Figure 4 below were considerably lower than levels detected in 2015. Nitrate levels decreased from station 1 downstream to stations 2, 3 and 4. Nitrate levels measured in 2016 did show a decrease between sampling events one and two, which may have been caused by the heavy rainfall between sampling events. The overall decrease in nitrate concentration from 2015 to 2016 may be caused by agricultural practices changing annually or from heavier rainfall levels in 2016 however no evidence has been collected to support this. The overall nitrate concentration levels measured in 2016 fall well below the water quality guidelines for aquatic life, which is 32.8 mg/L maximum (Demers 2016).

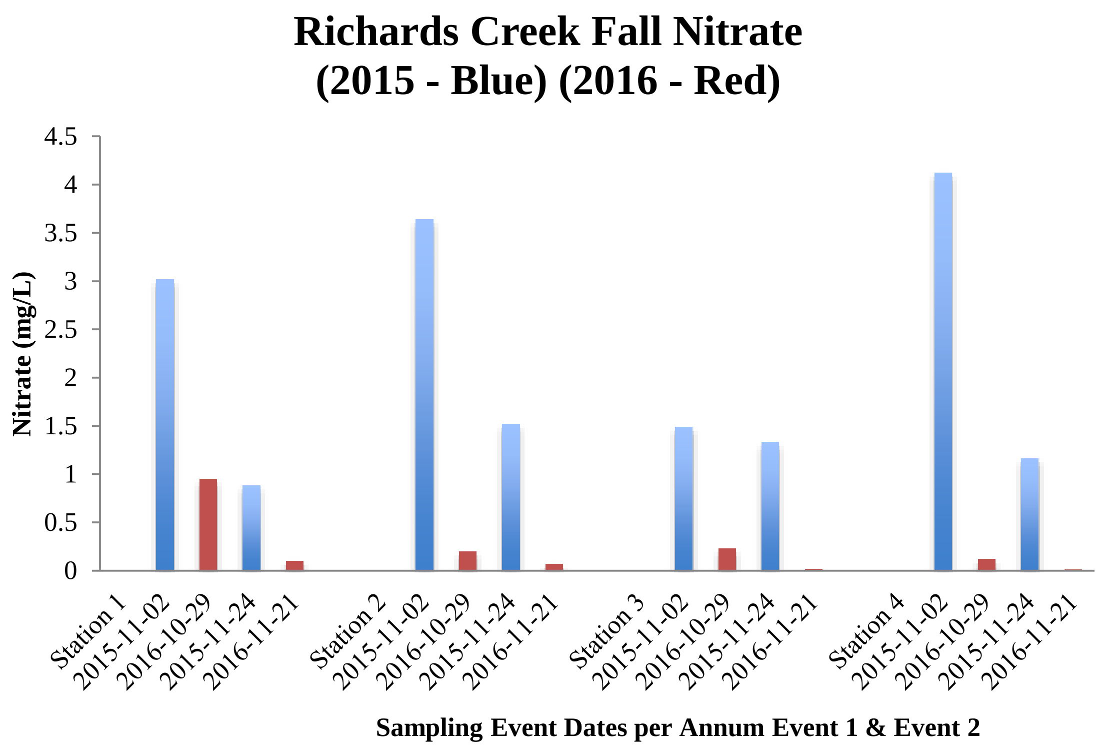

Figure 10: Nitrate Levels – 2 Dated Sampling Events per year – 2015 (blue) and 2016 (red)

Phosphate

Phosphate levels measured (Figure 3 below) from all stations showed a trending pattern between sampling events this year and last. Concentration levels increased downstream through all stations, the exception was station 3 where there was a 0.05-0.1 decrease in 2015 and 2016.

The increased concentration of phosphate downstream may be explained by the proximity Richards Creek has with agricultural land coupled with lack of riparian buffer zones. Phosphate concentrations greater than 0.025 mg/L indicate "eutrophic" water conditions. Phosphate is a limiting factor in plant growth and eutrophic conditions cause an increase to biological growth within the watershed (RISC 1998). This in turn reduces the level of dissolved oxygen and could explain the high algal presence at station 4.

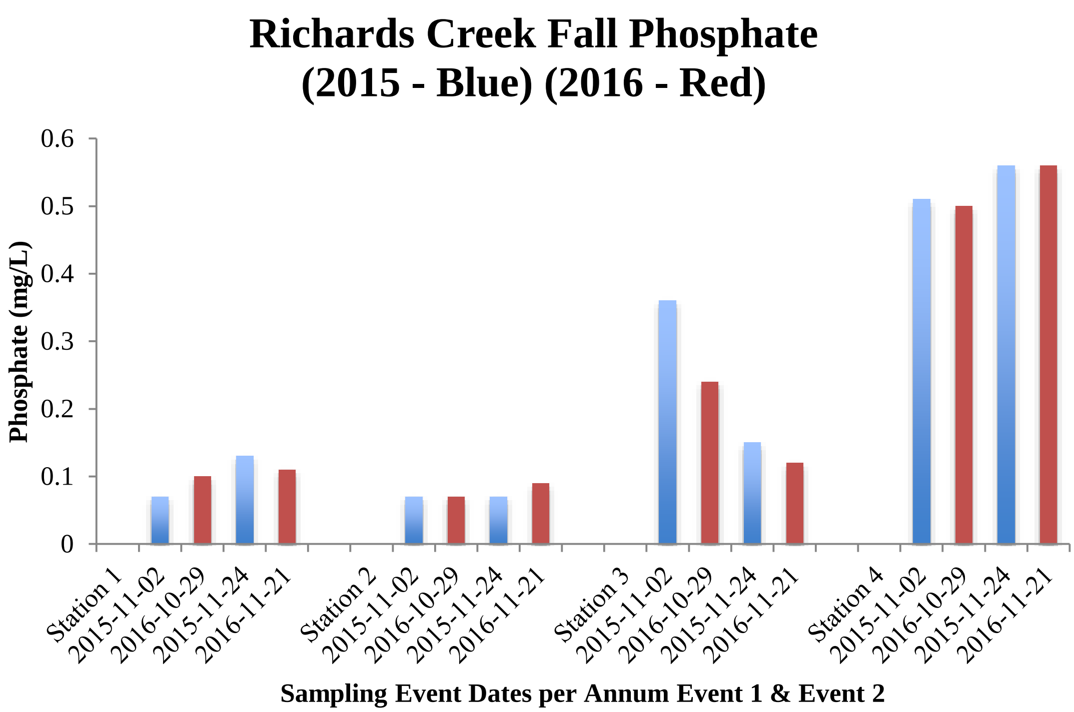

Figure 11: Richards Creek Fall Phosphate – 2 Dated Samplings per Annum

3.2.2 ALS Water Quality

Water quality parameters of ALS lab results were compared with the BC Provincial water quality guidelines for the protection of aquatic life. Detectable nutrients were consistent with both events and all stations, these included phosphorous (P), orthophosphate (as P) and Nitrate (as N). Detectable minerals/metals in the ALS samples included aluminum (Al), barium (Ba), calcium (Ca), iron (Fe), magnesium (Mg), manganese (Mn), sodium (Na), silicon (Si), strontium (Sr) and zinc (Zn).

<u>Conductivity</u>

When compared to VIU lab analysis conductivity levels had variations and were both measured in µS/cm. Event 1 and event 2 showed ALS samples to be slightly higher than the VIU samples. Both analyses showed an increase from upstream to downstream. ALS samples ranged from 125-161 µS/cm during event 1 and samples ranged from 105-154 µS/cm during event 2.

<u>pH</u>

Levels of pH for both ALS and VIU samples were consistent and showed little variation for both events and all stations. Ranging from 7.12-7.72 for ALS and 6.6-7.9 at VIU. This entire spectrum is acceptable when compared to the British Columbia Water Quality Guidelines (RISC 1998).

<u>Hardness (as $CaCO_3$)</u>

Hardness (as $CaCO_3$) increased from upstream to downstream at both events. Event 1 ranged from 44.5-67.1 mg/L and event 2 ranged from 39.1-62. These levels are consistent with soft water <60 mg/L British Columbia Water Quality Guidelines (RISC 1998).

Nitrate

During both sampling events nitrate levels consistently dropped as flow went downstream. The levels were far lower in 2016 than 2015 and fell far below British Columbia Water Quality Guidelines (RISC 1998).

Phosphate

Phosphates during sampling event 1 and 2 showed the same results. Station 2 measured at levels consistent with being an oligotrophic ecosystem (<0.010) while stations 2 and 3 were measured at levels consistent with being a eutrophic ecosystem (≥0.025) BC Provincial water quality guidelines (RISC 1998).

Event 1

Table 1 below shows nutrient loads, minerals and detectable metals found among the tested samples in 2016 for Richards Creek Sampling Event 1 on October 29, 2016.

The results show a moderately healthy ecosystem during event 1. This could be skewed due to heavy rains and a flushing of the tributary ecosystem into the Somenos Basin. All detectable or mentionable metals for event 1 were below British Columbia Water Quality Guidelines (RISC 1998).

Table 1: Water Quality Results for Richards Creek Event 1

Event 1 - Field Sampling Date October, 29 - 2016					
Job Refere	ENVIRONMENTAL MONITORING COURSE				
Report To	Eric Demers, Vancouver Island University				
Client Sample ID			RICHARDS CREEK-STATION 2	RICHARDS CREEK-STATION 3	RICHARDS CREEK-STATION 4
Time Sampled			12:13	11:20	10:35
ALS Sample ID			L1853599-1	L1853599-2	L1853599-3
Parameter	Lowest Detection Limit	Units	Water	Water	Water
Physical Tests (Water)					
Conductivity	2.0	uS/cm	125	125	161
Hardness (as CaCO3)	0.50	mg/L	44.5	47.7	67.1
pH	0.10	pH	7.72	7.63	7.34
Anions and Nutrients (Water)					
Ammonia, Total (as N)	0.0050	mg/L	<0.0050	0.0059	0.0439
Nitrate (as N)	0.0050	mg/L	0.370	0.372	0.0977
Nitrite (as N)	0.0010	mg/L	<0.0010	0.0018	0.0038
Total Nitrogen	0.030	mg/L	0.630	0.727	1.13
Orthophosphate-Dissolved (as P)	0.0010	mg/L	0.0013	0.0322	0.135
Phosphorus (P)-Total	0.0020	mg/L	0.0075	0.0418	0.184
N:P			84.0	17.4	6.1
Total Metals (Water)					
Aluminum (Al)-Total	0.20	mg/L	<0.20	0.20	<0.20
Antimony (Sb)-Total	0.20	mg/L	<0.20	<0.20	<0.20
Arsenic (As)-Total	0.20	mg/L	<0.20	<0.20	<0.20
Barium (Ba)-Total	0.010	mg/L	0.013	0.013	0.017
Beryllium (Be)-Total	0.0050	mg/L	<0.0050	<0.0050	<0.0050
Bismuth (Bi)-Total	0.20	mg/L	<0.20	<0.20	<0.20
Boron (B)-Total	0.10	mg/L	<0.10	<0.10	<0.10
Cadmium (Cd)-Total	0.010	mg/L	<0.010	<0.010	<0.010
Calcium (Ca)-Total	0.050	mg/L	14.3	14.8	20.4
Chromium (Cr)-Total	0.010	mg/L	<0.010	<0.010	<0.010
Cobalt (Co)-Total	0.010	mg/L	<0.010	<0.010	<0.010
Copper (Cu)-Total	0.010	mg/L	<0.010	<0.010	<0.010
Iron (Fe)-Total	0.030	mg/L	0.181	0.233	0.374
Lead (Pb)-Total	0.050	mg/L	<0.050	<0.050	<0.050
Lithium (Li)-Total	0.010	mg/L	<0.010	<0.010	<0.010
Magnesium (Mg)-Total	0.10	mg/L	2.12	2.60	3.91
Manganese (Mn)-Total	0.0050	mg/L	0.0185	0.0204	0.0374
Molybdenum (Mo)-Total	0.030	mg/L	<0.030	<0.030	<0.030
Nickel (Ni)-Total	0.050	mg/L	<0.050	<0.050	<0.050
Phosphorus (P)-Total	0.30	mg/L	<0.30	<0.30	<0.30
Potassium (K)-Total	2.0	mg/L	<2.0	<2.0	<2.0
Selenium (Se)-Total	0.20	mg/L	<0.20	<0.20	<0.20
Silicon (Si)-Total	0.050	mg/L	5.21	5.51	5.46
Silver (Ag)-Total	0.010	mg/L	<0.010	<0.010	<0.010
Sodium (Na)-Total	2.0	mg/L	6.0	6.2	9.5
Strontium (Sr)-Total	0.0050	mg/L	0.0439	0.0545	0.0905
Thallium (Tl)-Total	0.20	mg/L	<0.20	<0.20	<0.20
Tin (Sn)-Total	0.030	mg/L	<0.030	<0.030	<0.030
Titanium (Ti)-Total	0.010	mg/L	<0.010	<0.010	<0.010
Vanadium (V)-Total	0.030	mg/L	<0.030	<0.030	<0.030
Zinc (Zn)-Total	0.0050	mg/L	<0.0050	<0.0050	0.0061

Event 2

Table 2 below shows nutrient loads, minerals and detectable metals found among the tested samples in 2016 for Richards Creek Sampling Event 2 on November 21, 2016.

The results show a moderately healthy ecosystem during event 2. This could be skewed due to heavy rains and a flushing of the tributary ecosystem into the Somenos Basin. All detectable or mentionable metals for event 2 within the tributary were below British Columbia Water Quality Guidelines (RISC 1998).

Table 2: ALS Water Qualit Results for Richards Creek Event 2

Event 2 - Field Sampling Date November, 21 - 2016

Job Reference	ENVIRONMENTAL MONITORING COURSE				
Report To	Eric Demers, Vancouver Island University				
Client Sample ID			RICHARDS CREEK - STATION 2	RICHARDS CREEK - STATION 3	RICHARDS CREEK - STATION 4
Time Sampled			14:30	14:30	14:30
ALS Sample ID			L1862835-1	L1862835-2	L1862835-3
Parameter	Lowest Detection Limit	Units	Water	Water	Water
Physical Tests (Water)					
Conductivity	2.0	uS/cm	105	110	154
Hardness (as CaCO3)	0.50	mg/L	39.1	43.4	62
pH	0.10	pH	7.54	7.56	7.12
Anions and Nutrients (Water)					
Ammonia, Total (as N)	0.0050	mg/L	0.0070	0.0093	0.187
Nitrate (as N)	0.0050	mg/L	0.238	0.258	0.0233
Nitrite (as N)	0.0010	mg/L	<0.0010	<0.0010	0.0037
Total Nitrogen	0.030	mg/L	0.465	0.596	1.02
Orthophosphate-Dissolved (as P)	0.0010	mg/L	0.0017	0.0118	0.121
Phosphorus (P)-Total	0.0020	mg/L	0.0069	0.0306	0.161
N:P	N/A	N/A	67.4	19.5	6.3
Total Metals (Water)					
Aluminum (Al)-Total	0.20	mg/L	<0.20	0.25	<0.20
Antimony (Sb)-Total	0.20	mg/L	<0.20	<0.20	<0.20
Arsenic (As)-Total	0.20	mg/L	<0.20	<0.20	<0.20
Barium (Ba)-Total	0.010	mg/L	0.012	0.013	0.016
Beryllium (Be)-Total	0.0050	mg/L	<0.0050	<0.0050	<0.0050
Bismuth (Bi)-Total	0.20	mg/L	<0.20	<0.20	<0.20
Boron (B)-Total	0.10	mg/L	<0.10	<0.10	<0.10
Cadmium (Cd)-Total	0.010	mg/L	<0.010	<0.010	<0.010
Calcium (Ca)-Total	0.050	mg/L	12.6	13.5	18.5
Chromium (Cr)-Total	0.010	mg/L	<0.010	<0.010	<0.010
Cobalt (Co)-Total	0.010	mg/L	<0.010	<0.010	<0.010
Copper (Cu)-Total	0.010	mg/L	<0.010	<0.010	<0.010
Iron (Fe)-Total	0.030	mg/L	0.214	0.351	0.424
Lead (Pb)-Total	0.050	mg/L	<0.050	<0.050	<0.050
Lithium (Li)-Total	0.010	mg/L	<0.010	<0.010	<0.010
Magnesium (Mg)-Total	0.10	mg/L	1.88	2.33	3.83
Manganese (Mn)-Total	0.0050	mg/L	0.0260	0.0391	0.0732
Molybdenum (Mo)-Total	0.030	mg/L	<0.030	<0.030	<0.030
Nickel (Ni)-Total	0.050	mg/L	<0.050	<0.050	<0.050
Phosphorus (P)-Total	0.30	mg/L	<0.30	<0.30	<0.30
Potassium (K)-Total	2.0	mg/L	<2.0	<2.0	<2.0
Selenium (Se)-Total	0.20	mg/L	<0.20	<0.20	<0.20
Silicon (Si)-Total	0.050	mg/L	5.00	5.47	4.79
Silver (Ag)-Total	0.010	mg/L	<0.010	<0.010	<0.010
Sodium (Na)-Total	2.0	mg/L	5.7	6.1	10.7
Strontium (Sr)-Total	0.0050	mg/L	0.0414	0.0513	0.105
Thallium (Tl)-Total	0.20	mg/L	<0.20	<0.20	<0.20
Tin (Sn)-Total	0.030	mg/L	<0.030	<0.030	<0.030
Titanium (Ti)-Total	0.010	mg/L	<0.010	0.012	<0.010
Vanadium (V)-Total	0.030	mg/L	<0.030	<0.030	<0.030
Zinc (Zn)-Total	0.0050	mg/L	<0.0050	<0.0050	0.0116

3.4 Richards Creek Microbiology (2016)

The purpose of testing for e. coli (*Escherichia coli*) is to find out the ratio of harmful coliform to non-harmful coliform populations at the sample site (Richards Creek). Many types of coliform are harmless and are needed to aid digestion and other body functions of larger warm and cold-blooded organisms (Water Research Center 2014). Table 1 below shows results from Richards Creek stations 2, 3 and 4.

Table 3: Total Coliform Count for Richards Creek Stations 2-4 (Late October 2016)

	Station 2	Station 3	Station 4
Red Coliforms (100 ml)	79	174	273
Blue Coliforms (100 ml)	3	6	11
Total Coliforms (100 ml)	81	200	284

Results from microbiology analyses in 2016 was much lower than retrospective years, this could be a result of heavy rains and rapid flow at Richards Creek in this program year. There was mention of livestock populations in previous years of study, no livestock was at any station sampled this year during the three days the team was assembled at the site. This could explain lower levels of fecal coliforms.

3.5 Invertebrate Richness of Richards Creek (2016)

Invertebrate richness and diversity found in Richards Creek was measured in two different ways. The first method was taken from “Pacific Streamkeepers Handbook” and gives an average stream rating based on diversity and population (Appendix III, Figures 19-24). Maximum scores have a rating of 1.00 which is deemed to be most desirable for stream ecosystems (Taccogna and Munro 1995).

Station 1 had a diversity of 181 invertebrates/m2, and an average rating of 0.539079 which places it scoring acceptable. (Appendix III, Figure 19 & 20). Table 3 below shows the numerical breakdown of species population. Figure 11 on the following page demonstrates species diversity at Station 1.

Station 2 had a diversity of 259 invertebrates/m2 as shown in Table 3 below with an average rating of 0.581955, placing it as acceptable (Figure 21 & 22). Figure 12 below shows specific species diversity for station 2.

As seen in Table 3 below, station 3 had a diversity of 118 invertebrates/m2 with an average rating of 0.76796, scoring it as good (Figure 23 & 24). Figure 13 below represents diversity for station 3. Station 3 had the highest diversity index illustrating this area of Richards Creek to be the most sustainable for salmonids and other organism's dependent on invertebrates for a food source.

Table 4: Total Invertebrate Count for Richards Creek Stations 1-3 (Late October 2016)

Pollution Tolerance	**Invertebrate Taxa**	**Station 1**	**Station 2**	**Station 3**
Category 1	Caddisfly Larva	3	7	0
Pollution	Mayfly Nymph	22	13	14
Intolerant	Stonefly Nymph	1	26	6
Category 2				
Somewhat Pollution	Cranefly Larva	0	0	1
Tolerant	Amphipod	22	1	7
Category 3				
Pollution Tolerant	Aquatic Worm	1	23	4
	Total Abundance	49	70	32
	Density (Invertebrate/m^2)	181	259	118
	Site Assessment Average Rating	2.75	3.5	2.5

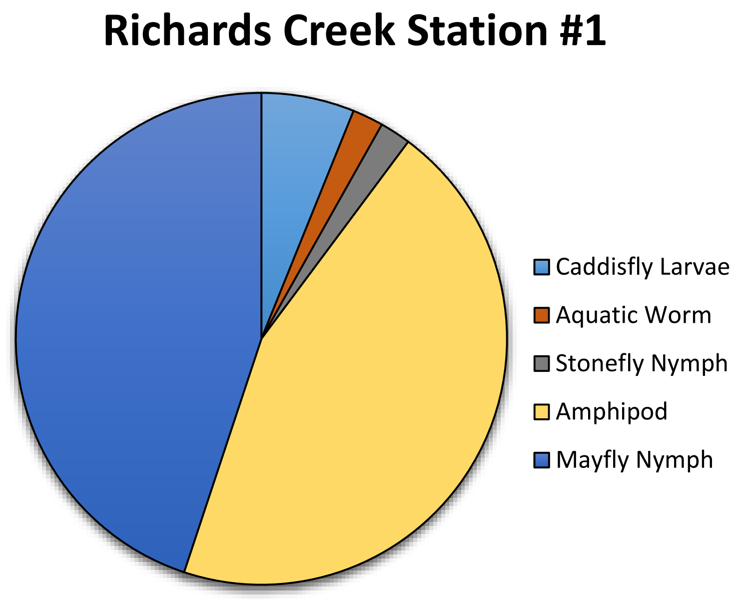

Figure 12: Richards Creek Invertebrate Station 1(Late October 2016)

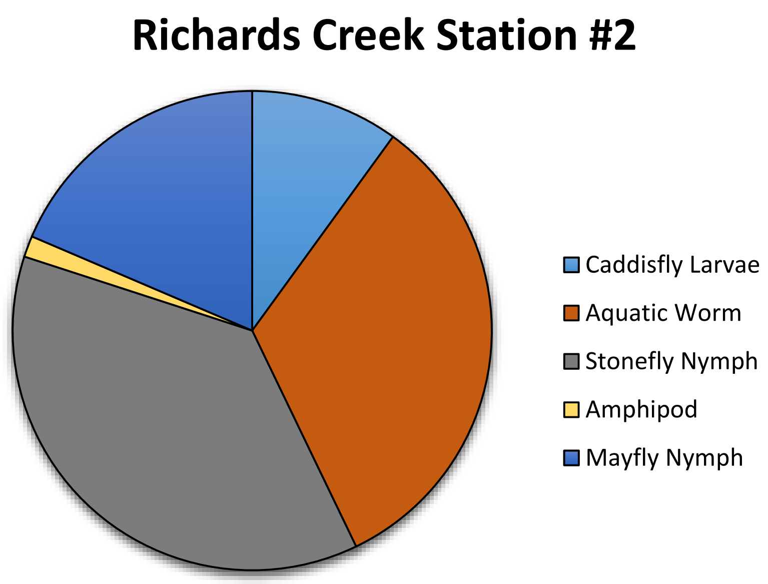

Figure 13: Richards Creek Invertebrate Station 2 (Late October 2016)

Richards Creek Station #3

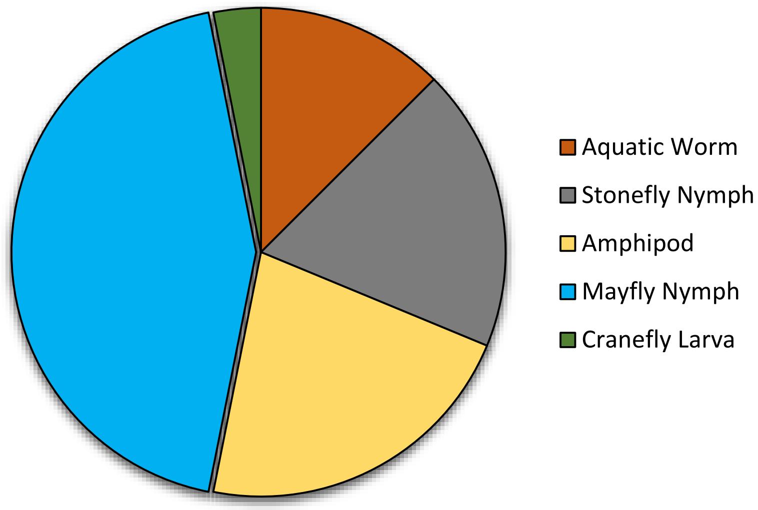

Figure 14: Richards Creek Invertebrate Station 3 (Late October 2016)

4.0 Conclusions and Recommendations

Richards Creek is an important part of the Cowichan River Watershed. This watershed supplies habitat for countless species of organisms of all sizes terrestrial and aquatic. Watershed health is affected by its tributaries (Richards Creek). Salmonids are a very important part of British Columbia culture including sport, nutrition and culture for human populations. Progress has been made in years past and needs to be built on.

It is possible that four monitoring stations do not provide enough data to determine over-all stream health. This could be improved by walking the entire stream and collecting data on other positions. During years of heavy rains and high flow, a number of samples could be taken further into Somenos Lake to give possible representation of nutrient loads and total metals draining into the lake.

Rare or threatened plant communities indigenous to the area (Williams and Radcliffe 2001) should be planted along agricultural areas bordering the stream to create riparian buffer zones where none exist. By increasing the riparian buffer zone, and potentially improving farming practices to reduce nitrate input to Richards Creek, the potential to see improvement is possible.

Reasoning for finding only 6 different invertebrate species within the sample site may be dependent on substrate composition. All sampling sites are made up of small granule substrate such as cobble, pebble and sediment (lacking course substrate to be utilized for habitat for certain invertebrates).

Both urban and agriculturally zoned areas can affect this extensive watershed and should continue to be monitored. Local public in the area should be educated on the importance of their actions. Continued environmental monitoring should be on-going in collaboration with VIU, Nanaimo Regional District and the Department of Fisheries and Oceans.

5.0 Acknowledgements

We would like to thank the Cowichan Valley Regional District and the Department of Fisheries and Oceans (DFO) for their partnership and tutelage with VIU students and staff. For the previous and ongoing collection and monitoring of the Somenos Basin and Cowichan River Watershed.

A special thanks to Dr. Eric Demers (VIU Biology Department), Sarah Greenway, M.A. (Protection of Natural Resource Department) for guidance in the use of lab and field equipment. For tutelage on collection of samples and sample analysis within a lab environment.

Thanks to ALS Environmental Laboratory for their services for water parameter testing at a reduced rate to the University and for ongoing and essential data collection.

Lastly we would like to thank previous students for their data collection to build on and any future students who continue to monitor the Somenos Basin in hopes to restore and preserve this essential part of the Cowichan River Watershed.

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7.0 Appendices

Appendix I – Site Map

Appendix II – Stations

Station 1

Figure 15: Richards Creek - October - Station 1 Site Conditions (George 2016)

STATION 2

Figure 16: Richards Creek - October - Station 2 Site Conditions (George 2016)

STATION 3

Figure 17: Richards Creek - October - Station 3 Site Conditions (George 2016)

STATION 4

Figure 18: Richards Creek - October - Station 4 Site Conditions (George 2016)

APPENDIX III – INVERTEBRATE SURVEY FIELD DATA SHEETS

STATION 1 (1 OF 2)

INVERTEBRATE SURVEY FIELD DATA SHEET (Page 1 of 2)

Stream Name:	Richards Creek	Date:	October 29th 2016
Station Name:	Station 1	Flow statu	Low
Sampler Used:	Number of replicate	Total area sampled (Hess, Surber = $0.09\ m^2$) x no. rep	
Hess	3	0.27	m^2

Column A Pollution Tolerance	Column B Common Name	Column C Number Counted	Column D Number of Taxa
Category 1	Caddisfly Larva (EPT)	EPT1 3	EPT4 1
	Mayfly Nymph (EPT)	EPT2 22	EPT5 2
	Stonefly Nymph (EPT)	EPT3 1	EPT6 1
Pollution Intolerant	Dobsonfly (hellgrammite)		
	Gilled Snail		
	Riffle Beetle		
	Water Penny		
Sub-Total		C1 26	D1 4
Category 2	Alderfly Larva		
	Aquatic Beetle		
	Aquatic Sowbug		
Somewhat Pollution Tolerant	Clam, Mussel		
	Cranefly Larva		
	Crayfish		
	Damselfly Larva		
	Dragonfly Larva		
	Fishfly Larva		
	Amphipod (freshwater shrim	22	2
	Watersnipe Larva		
Sub-Total		C2 22	D2 2
Category 3	Aquatic Worm (oligochaete)	1	1
	Blackfly Larva		
	Leech		
Pollution Tolerant	Midge Larva (chironomid)		
	Planarian (flatworm)		
	Pouch and Pond Snails		
	True Bug Adult		
	Water Mite		
Sub-Total		C3 1	D3 1
TOTAL		CT 49	DT 7

Figure 19: Invertebrate Station 1 (1 of 2)

STATION 1 (2 OF 2)

INVERTEBRATE SURVEY INTERPRETATION SHEET (Page 2 of 2)

SECTION 1 - ABUNDANCE AND DENSITY

ABUNDANCE: Total number of organisms from cell **CT**: S1 49

DENSITY: Invertebrate density per total area sampled:

S1 49 ÷ .27 m^2 = S2 181/ m^2

PREDOMINANT TAXON: Invertebrate group with the highest number counted (Col. C) S3 Amphipod/Mayfly

SECTION 2 - WATER QUALITY ASSESSMENTS

POLLUTION TOLERANCE INDEX: Sub-total number of taxa found in each tolerance category.

Good	Acceptable	Marginal	Poor
>22	17-22	11-16	<11

3 x D1 + 2 x D2 + D3
3 x 4+ 2 x 2+2 = S4 18

EPT INDEX: Total number of EPT taxa.

Good	Acceptable	Marginal	Poor
>8	5-8	2-4	0-1

EPT4 + EPT5 + EPT6
1 +2 + 1 = S5 4

EPT TO TOTAL RATIO INDEX: Total number of EPT organisms divided by the total number of (

Good	Acceptable	Marginal	Poor
0.75-1.0	0.50-0.74	0.25-0.49	<0.25

(EPT1 + EPT2 + EPT3) / CT
(3+22+ 1) / 49= S6 0.530612

SECTION 3 - DIVERSITY

TOTAL NUMBER OF TAXA: Total number of taxa from cell **DT**: S7 7

PREDOMINANT TAXON RATIO INDEX: Number of invertebrate in the **predominant taxon** (S3) div

Good	Acceptable	Marginal	Poor
<0.40	0.40-0.59	0.60-0.79	0.80-1.0

Col. C for S3 / CT
22 /49 = S8 0.44898

SECTION 4 - OVERALL SITE ASSESSMENT RATING

SITE ASSESSMENT RATING: Assign a rating of 1-4 to each index (S4, S5, S6, S8), then calculate

Assessment Rating	
Good	4
Acceptable	3
Marginal	2
Poor	1

Assessment	Rating
Pollution Tolerance In	R1 3
EPT Index	R2 2
EPT To Total Ratio	R3 3
Predominant Taxon R	R4 3

Average Rating
Average of R4, R5, R6, R8
2.75

Figure 20: Invertebrate Station 1 (2 of 2)

STATION 2 (1 OF 2)

INVERTEBRATE SURVEY FIELD DATA SHEET (Page 1 of 2)

Stream Name:	Richards Creek	Date:	October 29th 2016
Station Name:	Station 2	Flow statu	Low

Sampler Used:	Number of replicate	Total area sampled (Hess, Surber = 0.09 m^2) x no. rep
Hess	3	0.27 m^2

Column A Pollution Tolerance	Column B Common Name	Column C Number Counted	Column D Number of Taxa
Category 1	Caddisfly Larva (EPT)	EPT1 7	EPT4 2
	Mayfly Nymph (EPT)	EPT2 13	EPT5 2
	Stonefly Nymph (EPT)	EPT3 26	EPT6 2
Pollution Intolerant	Dobsonfly (hellgrammite)		
	Gilled Snail		
	Riffle Beetle		
	Water Penny		
Sub-Total		C1 46	D1 6
Category 2	Alderfly Larva		
	Aquatic Beetle		
	Aquatic Sowbug		
Somewhat Pollution Tolerant	Clam, Mussel		
	Cranefly Larva		
	Crayfish		
	Damselfly Larva		
	Dragonfly Larva		
	Fishfly Larva		
	Amphipod (freshwater shrim	1	1
	Watersnipe Larva		
Sub-Total		C2 1	D2 1
Category 3	Aquatic Worm (oligochaete)	23	3
	Blackfly Larva		
	Leech		
Pollution Tolerant	Midge Larva (chironomid)		
	Planarian (flatworm)		
	Pouch and Pond Snails		
	True Bug Adult		
	Water Mite		
Sub-Total		C3 23	D3 3
TOTAL		CT 70	DT 10

Figure 21: Invertebrate Station 2 (1 of 2)

STATION 2 (2 OF 2)

INVERTEBRATE SURVEY INTERPRETATION SHEET (Page 2 of 2)

SECTION 1 - ABUNDANCE AND DENSITY

ABUNDANCE: Total number of organisms from cell **CT**: S1 70

DENSITY: Invertebrate density per total area sampled:

S1 70 ÷ .27'm^2 = S2 259.2593 / m^2

PREDOMINANT TAXON: Invertebrate group with the highest number counted (Col. C) S3 Stonefly Nymph

SECTION 2 - WATER QUALITY ASSESSMENTS

POLLUTION TOLERANCE INDEX: Sub-total number of taxa found in each tolerance category.

Good	Acceptable	Marginal	Poor	3 x D1 + 2 x D2 + D3	S4
>22	17-22	11-16	<11	3 x 6 + 2 x 1 + 3 =	23

EPT INDEX: Total number of EPT taxa.

Good	Acceptable	Marginal	Poor	EPT4 + EPT5 + EPT6	S5
>8	5-8	2-4	0-1	2 + 2 + 2 =	6

EPT TO TOTAL RATIO INDEX: Total number of EPT organisms divided by the total number of

Good	Acceptable	Marginal	Poor	(EPT1 + EPT2 + EPT3) / CT	S6
0.75-1.0	0.50-0.74	0.25-0.49	<0.25	(7 + 13 + 26) /70=	0.657143

SECTION 3 - DIVERSITY

TOTAL NUMBER OF TAXA: Total number of taxa from cell **DT**: S7 10

PREDOMINANT TAXON RATIO INDEX: Number of invertebrate in the **predominant taxon** (S3) div

Good	Acceptable	Marginal	Poor	Col. C for S3 / CT	S8
<0.40	0.40-0.59	0.60-0.79	0.80-1.0	26 / 70 =	0.371429

SECTION 4 - OVERALL SITE ASSESSMENT RATING

SITE ASSESSMENT RATING: Assign a rating of 1-4 to each index (S4, S5, S6, S8), then calculate

Assessment Rating	
Good	4
Acceptable	3
Marginal	2
Poor	1

Assessment	Rating
Pollution Tolerance In	R1 4
EPT Index	R2 3
EPT To Total Ratio	R3 3
Predominant Taxon R	R4 4

Average Rating
Average of R4, R5, R6, R8
3.5

Figure 22: Invertebrate Station 2 (2 of 2)

STATION 3 (1 OF 2)

INVERTEBRATE SURVEY FIELD DATA SHEET (Page 1 of 2)

Stream Name:	Richards Creek	Date:	October 29th 2016
Station Name:	Station 3	Flow statu	Low
Sampler Used: Hess	Number of replicate 3	Total area sampled (Hess, Surber = 0.09 m^2) x no. rep	0.27 m^2

Column A Pollution Tolerance	Column B Common Name	Column C Number Counted	Column D Number of Taxa
Category 1	Caddisfly Larva (EPT)	EPT1	EPT4
	Mayfly Nymph (EPT)	EPT2 14	EPT5 2
	Stonefly Nymph (EPT)	EPT3 6	EPT6 2
Pollution Intolerant	Dobsonfly (hellgrammite)		
	Gilled Snail		
	Riffle Beetle		
	Water Penny		
Sub-Total		C1 20	D1 4
Category 2	Alderfly Larva		
	Aquatic Beetle		
	Aquatic Sowbug		
Somewhat Pollution Tolerant	Clam, Mussel		
	Cranefly Larva	1	1
	Crayfish		
	Damselfly Larva		
	Dragonfly Larva		
	Fishfly Larva		
	Amphipod (freshwater shrim	7	1
	Watersnipe Larva		
Sub-Total		C2 8	D2 2
Category 3	Aquatic Worm (oligochaete)	4	1
	Blackfly Larva		
	Leech		
Pollution Tolerant	Midge Larva (chironomid)		
	Planarian (flatworm)		
	Pouch and Pond Snails		
	True Bug Adult		
	Water Mite		
Sub-Total		C3 4	D3 1
TOTAL		CT 32	DT 6

Figure 23: Invertebrate Station 3 (1 of 2)

STATION 3 (2 OF 2)

INVERTEBRATE SURVEY INTERPRETATION SHEET (Page 2 of 2)

SECTION 1 - ABUNDANCE AND DENSITY

ABUNDANCE: Total number of organisms from cell **CT**:

S1	
	32

DENSITY: Invertebrate density per total area sampled:

S1 32 ÷ .27'm^2 =

S2	
118.5185	/ m^2

PREDOMINANT TAXON:

Invertebrate group with the highest number counted (Col. C)

S3
Mayfly Nymph

SECTION 2 - WATER QUALITY ASSESSMENTS

POLLUTION TOLERANCE INDEX: Sub-total number of taxa found in each tolerance category.

Good	Acceptable	Marginal	Poor	3 x D1 + 2 x D2 + D3	S4
>22	17-22	11-16	<11	3 x 4 + 2 x 1 + 1 =	15

EPT INDEX: Total number of EPT taxa.

Good	Acceptable	Marginal	Poor	EPT4 + EPT5 + EPT6	S5
>8	5-8	2-4	0-1	0+ 2 + 2 =	4

EPT TO TOTAL RATIO INDEX: Total number of EPT organisms divided by the total number of

Good	Acceptable	Marginal	Poor	(EPT1 + EPT2 + EPT3) / CT	S6
0.75-1.0	0.50-0.74	0.25-0.49	<0.25	(4 + 13 + 6) /32=	0.625

SECTION 3 - DIVERSITY

TOTAL NUMBER OF TAXA: Total number of taxa from cell **DT**:

S7	
	6

PREDOMINANT TAXON RATIO INDEX: Number of invertebrate in the **predominant taxon** (S3) div

Good	Acceptable	Marginal	Poor	Col. C for S3 / CT	S8
<0.40	0.40-0.59	0.60-0.79	0.80-1.0	14 / 32 =	0.4375

SECTION 4 - OVERALL SITE ASSESSMENT RATING

SITE ASSESSMENT RATING: Assign a rating of 1-4 to each index (S4, S5, S6, S8), then calculate

Assessment Rating	
Good	4
Acceptable	3
Marginal	2
Poor	1

Assessment	Rating
Pollution Tolerance In	R1 2
EPT Index	R2 2
EPT To Total Ratio	R3 3
Predominant Taxon R	R4 3

Average Rating
Average of R4, R5, R6, R8
2.5

Figure 24: Invertebrate Station 3 (2 of 2)

APPENDIX IV – CHAIN OF CUSTODY (EVENT 1 & EVENT 2)

EVENT 1 (1 OF 5)

ALS

Page 1 of 3
04-NOV-16 20:25 (MT)

Sample Receipt Confirmation

Report Distribution:

Company Name: Vancouver Island University
Contact: Eric Demers
Address: Nanaimo Campus, 900 Fifth Street
Nanaimo, BC, V9R 5S5
Phone: 250-753-3245
Fax: 250-740-6482
Email: eric.demers@viu.ca
EDD Email: –
Distribution: Hard Copy: Y Email: Y Fax: N EDD: N

Invoice Distribution:

Acct Name: Vancouver Island University
Contact: Accounts Payable
Address: Nanaimo Campus, 900 Fifth Street
Nanaimo, BC, V9R 5S5
Phone: –
Fax: –
Invoice Email: –
Project #: N/A
Account #: MAL100

Client Information:

Job Reference #: ENVIRONMENTAL MONITORING COURSE
Project PO #:
Legal Site Description: N/A
Quote #: N/A
Date Sampled: 29-OCT-16
Date Received: 04-NOV-16
Sampled By: Students
Chain Of Custody: –

Workorder Summary:

Lab Work Order #: L1853599
Estimated completion date: 14-NOV-16
15 Samples received at ALS in VANCOUVER
Client Job #: ENVIRONMENTAL MONITORING COUR
Account Manager: Amber Springer, B.Sc
Estimated sample disposal date: See Sample Disposal Information section below.

Lab Sample ID	Client Sample ID	Date Sampled	Date Received	Sample Due Date	Priority Flag	Sample Type
L1853599-1	RICHARDS CREEK- STATION 2	29-OCT-16 12:13	04-NOV-16 08:20	14-NOV-16		Surface Water
L1853599-2	RICHARDS CREEK- STATION 3	29-OCT-16 11:20	04-NOV-16 08:20	14-NOV-16		Surface Water
L1853599-3	RICHARDS CREEK- STATION 4	29-OCT-16 10:35	04-NOV-16 08:20	14-NOV-16		Surface Water
L1853599-4	COTTLE CREEK- STATION 1	02-NOV-16 15:00	04-NOV-16 08:20	14-NOV-16		Surface Water
L1853599-5	COTTLE CREEK- STATION 2	02-NOV-16 15:00	04-NOV-16 08:20	14-NOV-16		Surface Water
L1853599-6	COTTLE CREEK- STATION 4	02-NOV-16 15:00	04-NOV-16 08:20	14-NOV-16		Surface Water
L1853599-7	MILLSTONE RIVER - STATION 1	30-OCT-16 09:00	04-NOV-16 08:20	14-NOV-16		Surface Water
L1853599-8	MILLSTONE RIVER - STATION 2	30-OCT-16 09:00	04-NOV-16 08:20	14-NOV-16		Surface Water
L1853599-9	MILLSTONE RIVER - STATION 4	30-OCT-16 09:00	04-NOV-16 08:20	14-NOV-16		Surface Water
L1853599-10	ENGLISHMAN RIVER - STATION 1	31-OCT-16 14:00	04-NOV-16 08:20	14-NOV-16		Surface Water
L1853599-11	ENGLISHMAN RIVER - STATION 2	31-OCT-16 14:00	04-NOV-16 08:20	14-NOV-16		Surface Water
L1853599-12	ENGLISHMAN RIVER - STATION 4	31-OCT-16 14:00	04-NOV-16 08:20	14-NOV-16		Surface Water
L1853599-13	DEPARTURE CREEK- STATION 1	02-NOV-16 09:00	04-NOV-16 08:20	14-NOV-16		Surface Water
L1853599-14	DEPARTURE CREEK- STATION 3	02-NOV-16 09:00	04-NOV-16 08:20	14-NOV-16		Surface Water
L1853599-15	DEPARTURE CREEK- STATION 4	02-NOV-16 09:00	04-NOV-16 08:20	14-NOV-16		Surface Water

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Figure 25: Chain of Custody Event 1 (1 of 5)

EVENT 1 (2 OF 5)

Page 2 of 3
04-NOV-16 20:25 (MT)

Analysis Requested :	Hardness	Total Metals in Water by ICPOES	Total Nitrogen in water by Colour	Ammonia in Water by Fluorescence	Nitrite in Water by IC [Low Level]	Nitrate in Water by IC [Low Level]	Total P in Water by Colour	Conductivity [Automated]	pH by Meter [Automated]	Diss. Orthophosphate in Water by Colour	Sample Handling and Disposal Fee
RICHARDS CREEK-STATION 2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
RICHARDS CREEK-STATION 3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
RICHARDS CREEK-STATION 4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
COTTLE CREEK-STATION 1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
COTTLE CREEK-STATION 2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
COTTLE CREEK-STATION 4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
MILLSTONE RIVER - STATION 1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
MILLSTONE RIVER - STATION 2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
MILLSTONE RIVER - STATION 4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
ENGLISHMAN RIVER - STATION 1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
ENGLISHMAN RIVER - STATION 2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
ENGLISHMAN RIVER - STATION 4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
DEPARTURE CREEK-STATION 1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
DEPARTURE CREEK-STATION 3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
DEPARTURE CREEK-STATION 4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Hold Time Exceedences: The following samples have exceeded recommended holding times prior to sample receipt.

Analysis Requested	Lab Sample ID	Recommended Hold Time	Date Sampled	Date Received
Diss. Orthophosphate in Water by Co	L1853599-1, 2, 3	3 days	29-OCT-16	04-NOV-16
Diss. Orthophosphate in Water by Co	L1853599-7, 8, 9	3 days	30-OCT-16	04-NOV-16
Diss. Orthophosphate in Water by Co	L1853599-10, 11, 12	3 days	31-OCT-16	04-NOV-16
Nitrate in Water by IC (Low Level)	L1853599-1, 2, 3	3 days	29-OCT-16	04-NOV-16
Nitrate in Water by IC (Low Level)	L1853599-7, 8, 9	3 days	30-OCT-16	04-NOV-16
Nitrate in Water by IC (Low Level)	L1853599-10, 11, 12	3 days	31-OCT-16	04-NOV-16

Figure 26: Chain of Custody Event 1 (1 of 5)

EVENT 1 (3 OF 5)

Page 3 of 3
04-NOV-16 20:25 (MT)

Hold Time Exceedences:

Analysis Requested	Lab Sample ID	Recommended Hold Time	Date Sampled	Date Received
Nitrite in Water by IC (Low Level)	L1853599-1, 2, 3	3 days	29-OCT-16	04-NOV-16
Nitrite in Water by IC (Low Level)	L1853599-7, 8, 9	3 days	30-OCT-16	04-NOV-16
Nitrite in Water by IC (Low Level)	L1853599-10, 11, 12	3 days	31-OCT-16	04-NOV-16
pH by Meter (Automated)	L1853599-1, 2, 3	0.25 hours	29-OCT-16	04-NOV-16
pH by Meter (Automated)	L1853599-7, 8, 9	0.25 hours	30-OCT-16	04-NOV-16
pH by Meter (Automated)	L1853599-10, 11, 12	0.25 hours	31-OCT-16	04-NOV-16
pH by Meter (Automated)	L1853599-4, 5, 6, 13, 14, 15	0.25 hours	02-NOV-16	04-NOV-16

Sample Integrity Observations: No observations were identified for this work order submission.

Sample Disposal Information:

Where possible, ALS will store samples for 30 days from the date a final report is issued, or 30 days from the date samples are placed on hold without analytical requests, after which samples may be discarded. Air samples collected on re-usable media are an exception, and are stored for 7 days from the date a final report is issued. Longer storage times are available upon request.

For information about ALS accreditations and certifications please contact your Account Manager or visit our webpage at www.alsglobal.com (see Canada downloads).

ALS Group strives to deliver on-time results to our clients at all times. However, there are times when due to capacity issues or other unforeseen circumstances we are unable to meet our expected turnaround times. The information above is related to a recent workorder you have submitted to our laboratory. In the event that you have an inquiry, please refer to the Lab Work Order # when calling your Account Manager.

ALS Group appreciates your business. Thank you for the opportunity to work with you.

Figure 27: Chain of Custody Event 1 (3 of 5)

EVENT 1 (4 OF 5)

Short Holding Time

Rush Processing

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

COC #

Page 1 of 2

Report To	
Company:	Vancouver Island University
Contact:	Eric Demers
Address:	900 Fifth Street, Nanaimo
Phone:	250-753-3245 Fax: 250-740-6482
Invoice To	Same as Report ? ☑ Yes ☐ No
Hardcopy of Invoice with Report?	☐ Yes ☑ No
Company:	
Contact:	
Address:	
Phone:	

L1853599-COFC

Report Format / Distribution: ☐ Standard ☐ Other ☑ PDF ☑ Excel ☐ Digital ☐ Fax

Email 1: eric.demers@viu.ca
Email 2:
Email 3:

Client / Project Information
Job #: Environmental Monitoring Course
PO / AFE:
LSD:
Quote #:

ALS Contact: Amber Springer — Sampler: Students

Service Requested (Rush for routine analysis subject to availability)
- (●) Regular (Standard Turnaround Times - Business Days)
- ( ) Priority (2-4 Business Days) - 50% Surcharge - Contact ALS to Confirm TAT
- ( ) Emergency (1-2 Bus. Days) - 100% Surcharge - Contact ALS to Confirm TAT
- ( ) Same Day or Weekend Emergency - Contact ALS to Confirm TAT

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

Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	GENERAL PARAMETERS	NUTRIENTS (P)	TOTAL METALS (P)	Number of Containers
Richards Creek - Station 2	29-Oct-16	12:13	Surface Water	X	X	X	3
Richards Creek - Station 3	29-Oct-16	11:20	Surface Water	X	X	X	3
Richards Creek - Station 4	29-Oct-16	10:35	Surface Water	X	X	X	3
Cottle Creek - Station 1	02-Nov-15	15:00	Surface Water	X	X	X	3
Cottle Creek - Station 2	02-Nov-15	15:00	Surface Water	X	X	X	3
Cottle Creek - Station 4	02-Nov-15	15:00	Surface Water	X	X	X	3
Millstone River - Station 1	30-Oct-16	9:00	Surface Water	X	X	X	3
Millstone River - Station 2	30-Oct-16	9:00	Surface Water	X	X	X	3
Millstone River - Station 4	30-Oct-16	9:00	Surface Water	X	X	X	3
Englishman River - Station 1	31-Oct-16	14:00	Surface Water	X	X	X	3
Englishman River - Station 2	31-Oct-16	14:00	Surface Water	X	X	X	3
Englishman River - Station 4	31-Oct-16	14:00	Surface Water	X	X	X	3

Special Instructions / Regulations with water or land use (CCME-Freshwater Aquatic Life/BC CSR - Commercial/AB Tier 1 - Natural, etc) / Hazardous Details

Detection limits: ammonia (MDL = 0.005 mg/L), nitrite (MDL = 0.001 mg/L), orthophosphate (MDL = 0.001 mg/L), total phosphorus (MDL = 0.002 mg/L), total nitrogen.

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as provided on a separate Excel tab.

Also provided on another Excel tab are the ALS location addresses, phone numbers and sample container / preservation / holding time table for common analyses.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date (dd-mmm-yy)	Time (hh-mm)	Received by:	Date	Time	Temperature	Verified by	Date:	Time	Observations Yes / No ? If Yes add SIF
Eric Demers	2-Nov-15	19:00	JC	NOV - 4 2016	8:30am	10 °C				

GENF 18.01 Front

Figure 28: Chain of Custody Event 1 (4 or 5)

EVENT 1 (5 OF 5)

ALS Environmental

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

COC #

Page 2 of 2

Report To	
Company:	Vancouver Island University
Contact:	Eric Demers
Address:	900 Fifth Street
	Nanaimo
Phone:	250-753-3245 Fax: 250-740-6482
Invoice To	Same as Report ? ☑ Yes ☐ No
Hardcopy of Invoice with Report?	☐ Yes ☑ No
Company:	
Contact:	
Address:	
Phone:	

L1853599-COFC

Report Format / Distribution	
☐ Standard	☐ Other
☑ PDF ☑ Excel	☐ Digital ☐ Fax
Email 1	eric.demers@viu.ca
Email 2	
Email 3	
Client / Project Information	
Job #:	Environmental Monitoring Course
PO / AFE:	
LSD:	
Quote #:	
ALS Contact:	Amber Springer
Sampler:	Students

Service Requested (Rush for routine analysis subject to availability)

- ◉ Regular (Standard Turnaround Times - Business Days)
- ○ Priority (2-4 Business Days) - 50% Surcharge - Contact ALS to Confirm TAT
- ○ Emergency (1-2 Bus. Days) - 100% Surcharge - Contact ALS to Confirm TAT
- ○ Same Day or Weekend Emergency - Contact ALS to Confirm TAT

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

Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	GENERAL PARAMETERS	NUTRIENTS (P)	TOTAL METALS (P)	Number of Containers
Departure Creek - Station 1	02-Nov-16	9.00	Surface Water	X	X	X	3
Departure Creek - Station 3	02-Nov-16	9.00	Surface Water	X	X	X	3
Departure Creek - Station 4	02-Nov-16	9.00	Surface Water	X	X	X	3

Short Holding Time
Rush Processing

Special Instructions / Regulations with water or land use (CCME-Freshwater Aquatic Life/BC CSR - Commercial/AB Tier 1 - Natural, etc) / Hazardous Details

Detection limits: ammonia [MDL = 0.005 mg/L], nitrite [MDL = 0.001 mg/L], orthophosphate [MDL = 0.001 mg/L], total phosphorus [MDL = 0.002 mg/L], total nitrogen

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as provided on a separate Excel tab.

Also provided on another Excel tab are the ALS location addresses, phone numbers and sample container / preservation / holding time table for common analyses.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date (dd-mmm-yy)	Time (hh-mm)	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
Eric Demers	2-Nov-15	19:00	JC	NOV - 4 2016	9:20am	1.0 °C				

GENF 18.01 Front

Figure 29: Chain of Custody Event 1 (5 of 5)

EVENT 2 (1 OF 5)

ALS

Page 1 of 3
25-NOV-16 21:21 (MT)

Sample Receipt Confirmation

Report Distribution:
Company Name: Vancouver Island University
Contact: Eric Demers
Address: Nanaimo Campus, 900 Fifth Street
Nanaimo, BC, V9R 5S5
Phone: 250-753-3245
Fax: 250-740-6482
Email: eric.demers@viu.ca
EDD Email: --
Distribution: Hard Copy: Y Email: Y Fax: N EDD: N

Invoice Distribution:
Acct Name: Vancouver Island University
Contact: Accounts Payable
Address: Nanaimo Campus, 900 Fifth Street
Nanaimo, BC, V9R 5S5
Phone: --
Fax: --
Invoice Email: --
Project #: N/A
Account #: MAL100

Client Information:
Job Reference #: ENVIRONMENTAL MONITORING COURSE
Project PO #:
Legal Site Description: N/A
Quote #: N/A
Date Sampled: 21-NOV-16
Date Received: 25-NOV-16
Sampled By: STUDENTS
Chain Of Custody: --

Workorder Summary:
Lab Work Order #: L1862835
Estimated completion date: 02-DEC-16
15 Samples received at ALS in VANCOUVER
Client Job #: ENVIRONMENTAL MONITORING COUR
Account Manager: Amber Springer, B.Sc
Estimated sample disposal date: See Sample Disposal Information section below.

Lab Sample ID	Client Sample ID	Date Sampled	Date Received	Sample Due Date	Priority Flag	Sample Type
L1862835-1	RICHARDS CREEK - STATION 2	21-NOV-16 14:30	25-NOV-16 14:50	02-DEC-16		SURFACE WATER
L1862835-2	RICHARDS CREEK - STATION 3	21-NOV-16 14:30	25-NOV-16 14:50	02-DEC-16		SURFACE WATER
L1862835-3	RICHARDS CREEK - STATION 4	21-NOV-16 14:30	25-NOV-16 14:50	02-DEC-16		SURFACE WATER
L1862835-4	COTTLE CREEK - STATION 1	23-NOV-16 13:00	25-NOV-16 14:50	02-DEC-16		SURFACE WATER
L1862835-5	COTTLE CREEK - STATION 2	23-NOV-16 13:00	25-NOV-16 14:50	02-DEC-16		SURFACE WATER
L1862835-6	COTTLE CREEK - STATION 4	23-NOV-16 13:00	25-NOV-16 14:50	02-DEC-16		SURFACE WATER
L1862835-7	MILLSTONE RIVER - STATION 1	21-NOV-16 12:20	25-NOV-16 14:50	02-DEC-16		SURFACE WATER
L1862835-8	MILLSTONE RIVER - STATION 2	21-NOV-16 12:35	25-NOV-16 14:50	02-DEC-16		SURFACE WATER
L1862835-9	MILLSTONE RIVER - STATION 4	21-NOV-16 13:20	25-NOV-16 14:50	02-DEC-16		SURFACE WATER
L1862835-10	ENGLISHMAN RIVER - STATION 1	21-NOV-16 14:00	25-NOV-16 14:50	02-DEC-16		SURFACE WATER
L1862835-11	ENGLISHMAN RIVER - STATION 2	21-NOV-16 14:00	25-NOV-16 14:50	02-DEC-16		SURFACE WATER
L1862835-12	ENGLISHMAN RIVER - STATION 4	21-NOV-16 14:00	25-NOV-16 14:50	02-DEC-16		SURFACE WATER
L1862835-13	DEPARTURE CREEK - STATION 1	23-NOV-16 09:00	25-NOV-16 14:50	02-DEC-16		SURFACE WATER
L1862835-14	DEPARTURE CREEK - STATION 3	23-NOV-16 09:00	25-NOV-16 14:50	02-DEC-16		SURFACE WATER
L1862835-15	DEPARTURE CREEK - STATION 4	23-NOV-16 09:00	25-NOV-16 14:50	02-DEC-16		SURFACE WATER

ADDRESS 8081 Lougheed Highway, Burnaby, BC, Canada V5A 1W9 | PHONE +1 604 253 4188 | FAX +1 604 253 6700
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Figure 30: Chain of Custody Event 2 (1 of 5)

EVENT 2 (2 OF 5)

ALS

Page 2 of 3
25-NOV-16 21:21 (MT)

Analysis Requested :	Hardness	Total Metals in Water by ICPOES	Total Nitrogen in water by Colour	Ammonia in Water by Fluorescence	Nitrite in Water by IC [Low Level]	Nitrate in Water by IC [Low Level]	Total P in Water by Colour	Conductivity [Automated]	pH by Meter [Automated]	Diss. Orthophosphate in Water by Colour	Sample Handling and Disposal Fee
RICHARDS CREEK - STATION 2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
RICHARDS CREEK - STATION 3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
RICHARDS CREEK - STATION 4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
COTTLE CREEK - STATION 1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
COTTLE CREEK - STATION 2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
COTTLE CREEK - STATION 4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
MILLSTONE RIVER - STATION 1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
MILLSTONE RIVER - STATION 2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
MILLSTONE RIVER - STATION 4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
ENGLISHMAN RIVER - STATION 1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
ENGLISHMAN RIVER - STATION 2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
ENGLISHMAN RIVER - STATION 4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
DEPARTURE CREEK - STATION 1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
DEPARTURE CREEK - STATION 3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
DEPARTURE CREEK - STATION 4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Hold Time Exceedences: The following samples have exceeded recommended holding times prior to sample receipt.

Analysis Requested	Lab Sample ID	Recommended Hold Time	Date Sampled	Date Received
Diss. Orthophosphate in Water by Cı	L1862835-1, 2, 3, 7, 8, 9, 10, 11, 12	3 days	21-NOV-16	25-NOV-16
Nitrate in Water by IC (Low Level)	L1862835-1, 2, 3, 7, 8, 9, 10, 11, 12	3 days	21-NOV-16	25-NOV-16
Nitrite in Water by IC (Low Level)	L1862835-1, 2, 3, 7, 8, 9, 10, 11, 12	3 days	21-NOV-16	25-NOV-16
pH by Meter (Automated)	L1862835-1, 2, 3, 7, 8, 9, 10, 11, 12	0.25 hours	21-NOV-16	25-NOV-16

Figure 31: Chain of Custody Event 2 (2 of 5)

EVENT 2 (3 OF 5)

Page 3 of 3
25-NOV-16 21:21 (MT)

Hold Time Exceedences:

Analysis Requested	Lab Sample ID	Recommended Hold Time	Date Sampled	Date Received
pH by Meter (Automated)	L1862835-4, 5, 6, 13, 14, 15	0.25 hours	23-NOV-16	25-NOV-16

Sample Integrity Observations: No observations were identified for this work order submission.

Sample Disposal Information:

Where possible, ALS will store samples for 30 days from the date a final report is issued, or 30 days from the date samples are placed on hold without analytical requests, after which samples may be discarded. Air samples collected on re-usable media are an exception, and are stored for 7 days from the date a final report is issued. Longer storage times are available upon request.

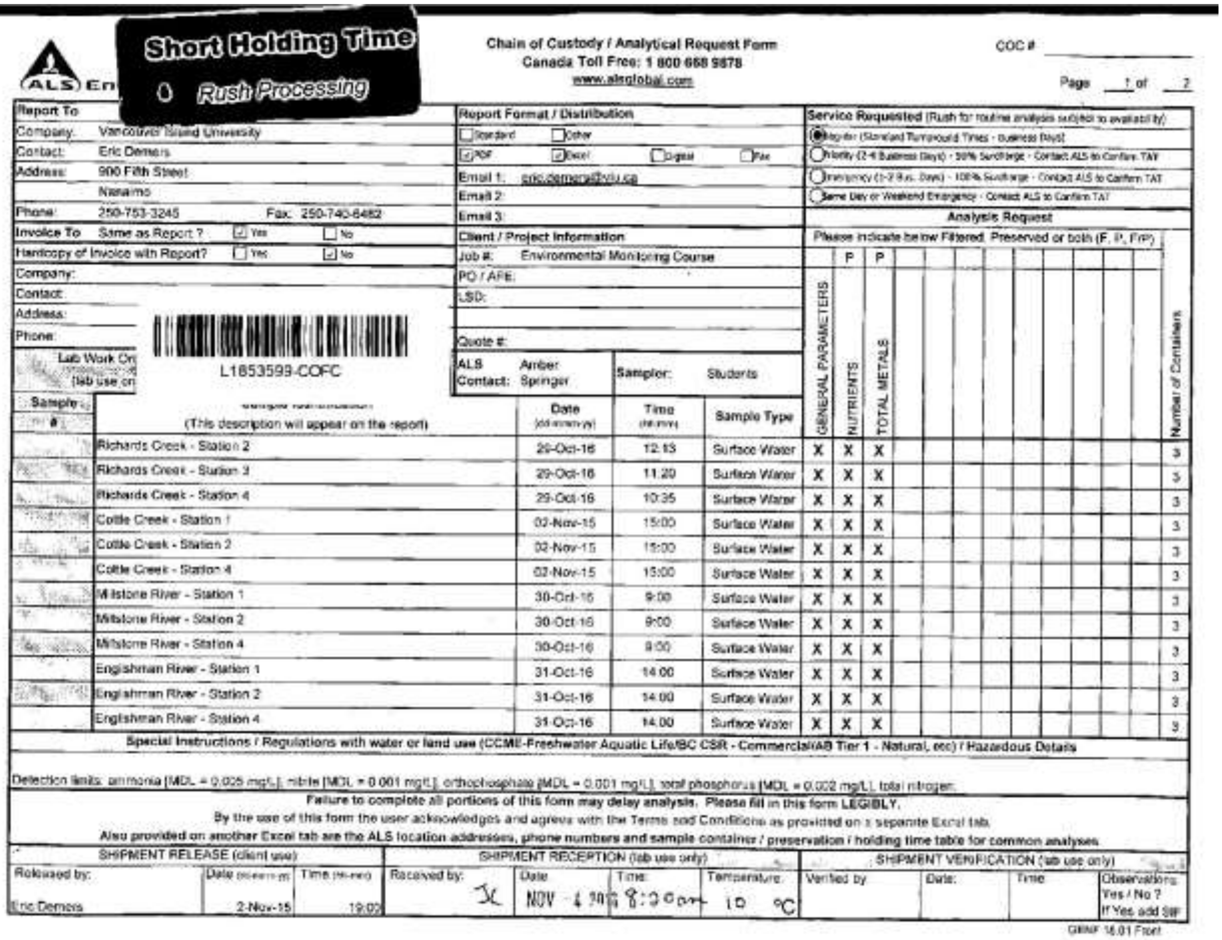
For information about ALS accreditations and certifications please contact your Account Manager or visit our webpage at www.alsglobal.com (see Canada downloads).

ALS Group strives to deliver on-time results to our clients at all times. However, there are times when due to capacity issues or other unforeseen circumstances we are unable to meet our expected turnaround times. The information above is related to a recent workorder you have submitted to our laboratory. In the event that you have an inquiry, please refer to the Lab Work Order # when calling your Account Manager.

ALS Group appreciates your business. Thank you for the opportunity to work with you.

Figure 32: Chain of Custody Event 2 (3 of 5)

EVENT 2 (4 OF 5)



Short Holding Time
Rush Processing

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

COC #
Page 1 of 2

Report To
Company: Vancouver Island University
Contact: Eric Demers
Address: 900 Fifth Street, Nanaimo
Phone: 250-753-3245 Fax: 250-740-6482
Invoice To: Same as Report? ☑ Yes ☐ No
Hardcopy of Invoice with Report? ☐ Yes ☑ No
Company:
Contact:
Address:
Phone:

Report Format / Distribution
☐ Standard ☐ Other
☑ PDF ☑ Excel ☐ Digital ☐ Fax
Email 1: eric.demers@viu.ca
Email 2:
Email 3:

Client / Project Information
Job #: Environmental Monitoring Course
PO / AFE:
LSD:
Quote #:
ALS Contact: Amber Springer
Sampler: Students

Service Requested (Rush for routine analysis subject to availability)
◉ Regular (Standard Turnaround Times - Business Days)
○ Priority (2-4 Business Days) - 50% Surcharge - Contact ALS to Confirm TAT
○ Emergency (1-2 Bus. Days) - 100% Surcharge - Contact ALS to Confirm TAT
○ Same Day or Weekend Emergency - Contact ALS to Confirm TAT

Lab Work Order # (lab use only): L1853599-COFC

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

Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	GENERAL PARAMETERS	NUTRIENTS (P)	TOTAL METALS (P)	Number of Containers
Richards Creek - Station 2	29-Oct-16	12:13	Surface Water	X	X	X	3
Richards Creek - Station 3	29-Oct-16	11:20	Surface Water	X	X	X	3
Richards Creek - Station 4	29-Oct-16	10:35	Surface Water	X	X	X	3
Cottle Creek - Station 1	02-Nov-15	15:00	Surface Water	X	X	X	3
Cottle Creek - Station 2	02-Nov-15	15:00	Surface Water	X	X	X	3
Cottle Creek - Station 4	02-Nov-15	15:00	Surface Water	X	X	X	3
Millstone River - Station 1	30-Oct-16	9:00	Surface Water	X	X	X	3
Millstone River - Station 2	30-Oct-16	9:00	Surface Water	X	X	X	3
Millstone River - Station 4	30-Oct-16	9:00	Surface Water	X	X	X	3
Englishman River - Station 1	31-Oct-16	14:00	Surface Water	X	X	X	3
Englishman River - Station 2	31-Oct-16	14:00	Surface Water	X	X	X	3
Englishman River - Station 4	31-Oct-16	14:00	Surface Water	X	X	X	3

Special Instructions / Regulations with water or land use (CCME-Freshwater Aquatic Life/BC CSR - Commercial/AB Tier 1 - Natural, etc) / Hazardous Details

Detection limits: ammonia [MDL = 0.005 mg/L], nitrite [MDL = 0.001 mg/L], orthophosphate [MDL = 0.001 mg/L], total phosphorus [MDL = 0.002 mg/L], total nitrogen.

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.
By the use of this form the user acknowledges and agrees with the Terms and Conditions as provided on a separate Excel tab.
Also provided on another Excel tab are the ALS location addresses, phone numbers and sample container / preservation / holding time table for common analyses.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by: Eric Demers	Date: 2-Nov-15	Time: 19:00	Received by: JC	Date: NOV - 4 2016	Time: 8:30 am	Temperature: 10 °C	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF

GENF 18.01 Front

Figure 33: Chain of Custody Event 2 (4 of 5)

EVENT 2 (5 OF 5)

ALS Environmental

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

COC #

Page 2 of 2

Report To		Report Format / Distribution	Service Requested (Rush for routine analysis subject to availability)
Company:	Vancouver Island University	☐ Standard ☐ Other	(●) Regular (Standard Turnaround Times - Business Days)
Contact:	Eric Demers	☑ PDF ☑ Excel ☐ Digital ☐ Fax	( ) Priority (2-4 Business Days) - 50% Surcharge - Contact ALS to Confirm TAT
Address:	900 Fifth Street	Email 1: eric.demers@viu.ca	( ) Emergency (1-2 Bus. Days) - 100% Surcharge - Contact ALS to Confirm TAT
	Nanaimo	Email 2:	( ) Same Day or Weekend Emergency - Contact ALS to Confirm TAT
Phone:	250-753-3245 Fax: 250-740-6482	Email 3:	**Analysis Request**
Invoice To	Same as Report ? ☑ Yes ☐ No	**Client / Project Information**	Please indicate below Filtered, Preserved or both (F, P, F/P)
Hardcopy of Invoice with Report?	☐ Yes ☑ No	Job #: Environmental Monitoring Course	
Company:		PO / AFE:	
Contact:		LSD:	
Address:			
Phone:	Fax:	Quote #:	
Lab Work Order # (lab use only)		ALS Contact: Amber Springer / Sampler: Students	

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	GENERAL PARAMETERS	NUTRIENTS (P)	TOTAL METALS (P)	Number of Containers
	Departure Creek - Station 1	23-Nov-16	9:00	Surface Water	X	X	X	3
	Departure Creek - Station 3	23-Nov-16	9:00	Surface Water	X	X	X	3
	Departure Creek - Station 4	23-Nov-16	9:00	Surface Water	X	X	X	3

Short Holding Time
Rush Processing

L1862835-COFC

Special Instructions / Regulations with water or land use (CCME-Freshwater Aquatic Life/BC CSR - Commercial/AB Tier 1 - Natural, etc) / Hazardous Details

Detection limits: ammonia (MDL = 0.005 mg/L), nitrite (MDL = 0.001 mg/L), orthophosphate (MDL = 0.001 mg/L), total phosphorus (MDL = 0.002 mg/L), total nitrogen.

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.
By the use of this form the user acknowledges and agrees with the Terms and Conditions as provided on a separate Excel tab.
Also provided on another Excel tab are the ALS location addresses, phone numbers and sample container / preservation / holding time table for common analyses.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date (dd-mmm-yy) 23-Nov-16	Time (hh-mm) 17:30	Received by:	Date: NOV 2 5 2016	Time: 14:50	Temperature: 9 °C	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF

GENF 18.01 Front

Figure 34: Chain of Custody Event 2 (5 of 5)